Adopt a Habitattitude™

A series of classroom-tested, electronically available activities designed to be used by teachers and informal educators in grades 6-12.

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Adopt a Habitattitude™

Introduction

Adopt a Habitattitude™ is a series of classroom-tested, electronically available activities designed to be used by teachers and informal educators in grades 6-12. These innovative and engaging activities can help students learn about and prevent the spread of aquatic invasive species (AIS). In order to protect and sustain our water bodies for future generations, youth—our future decision makers and leaders—need to acquire relevant knowledge about AIS to become effective and responsible decision makers.

Using the alignment tables, educators can see how each activity is matched with Next Generation Science Standards, Common Core State Standards, Great Lakes Literacy Principles and New York State Science Standards. This standards-based framework will enable educators to integrate the *Adopt a Habitattitude*™ curriculum into classrooms and learning environments.

Additional Information:

Habitattitude™ is an international campaign partnership of the Pet Industry Joint Advisory Council, U.S. Fish and Wildlife Service and National Oceanic and Atmospheric Administration Great Lakes Sea Grant Network, led by Minnesota Sea Grant. Unlike other efforts that are solely driven by agency actions, *Habitattitude*™ benefits from the support of the pet, aquarium, water garden, nursery, and landscape industries as well as colleges, schools, and non-profits. This unique partnership gives *Habitattitude*™ the capacity for partners to educate and empower water gardeners, aquarium owners, teachers and students not to release unwanted fish, aquatic plants and classroom study specimens into the environment.

For more information visit: habitattitude.net

Classroom Plants and Animals

Live plants and animals are valuable teaching tools! However, they can also become invasive species if they escape from the classroom. By integrating the concept of AIS into your lessons and talking about why it is important not to release, you will be helping your students take good care of the classroom plants and animals while at the same time becoming stewards of their local environment and community.

Nab the Aquatic Invader! is a youth education program, featuring a fun and interactive website that teaches students and educators about AIS, their spread and impacts. The *Nab the Aquatic Invader!* program began through the efforts of Illinois-Indiana Sea Grant and New York Sea Grant, who were joined by other Sea Grant programs, widening its focus from the Great Lakes to include coastal areas along the Atlantic, Pacific, and Gulf of Mexico. The Nab! website also serves as the hub of the AIS Stewardship Network. This program features top-notch, student-developed AIS stewardship projects that also serve as models for other students.

Protecting the Great Lakes from aquatic invaders requires information, resources and the right Habitattitude™. Teachers can incorporate relevant and engaging information on various species, their modes of entry and their impacts by visiting the Top Desk Administrator site. Everything educators need to turn their classrooms into full-fledged student investigators is here-from project ideas to examples of student stewardship projects throughout the Great Lakes. By engaging in the activities and playing the games on the Nab! website, students can learn about ecosystems and be inspired to help the environment. They can "nab" these pesky critters and realize that in real life, their actions can make a difference.

For more information visit: www.iiseagrant.org/NabInvader

Stop Aquatic Hitchhikers!™ is a campaign based on social marketing to help prevent the spread of AIS by boaters, anglers, and other water recreationists. This international campaign empowers water users to be part of the solution by taking simple steps that prevent the spread of AIS. The first steps are learning the threats, and where to look for them. The campaign also encourages reporting of new AIS sightings to authorities. Protect our waters. Be a good steward. Clean, drain, dry.

For more information and a pledge of action visit: stopaquatichitchhikers.org

Overview

Teachers who use living plants and animals in their classrooms extol the many benefits of these organisms, from encouraging scientific observation to teaching student responsibility. Unfortunately, at the end of each school year, animals are often released into the environment. These teachers have no idea they can be introducing aquatic invasive species (AIS) that can harm the environment and impact populations of local native plants and animals.

Benefits of Classroom Plants and Animals:

- Classroom plants and animals can help students learn science (food requirements, behaviors), math (measuring weights, length), language arts (writing stories, keeping journals) or geography (creating maps of origins or range).
- Caring for living things can also help increase students' awareness of nature, nurturing skills and inquiry.
- Many teachers use these classroom plants and animals as a source of fun and enjoyment for their students.

Although useful as teaching tools, living plants and animals that are no longer wanted, have outgrown their tanks or enclosures, or become a burden to care for, can become invasive species if released into the environment. There are documented cases of invasive crayfish that were used in classroom experiments and learning, which were unknowingly released well outside their natural range, posing a threat to local aquatic habitats. Once released, as invasive species, these plants and animals can degrade local habitats, outcompete native plants and animals, alter food webs, and reduce biodiversity. Some common classroom plants and animals that have the potential to become AIS are organisms such as goldfish and other aquarium fish, crayfish, and Chinese mystery snails. Aquarium plants like elodea, hydrilla and Eurasian watermilfoil can spread quickly and harm waterways where released. Reptiles, like red-eared slider turtles, and amphibians, like frogs, can also cause ecosystem harm if released to the environment. Even classroom organisms that are native to the region should not be released since they could introduce diseases or be hosts to other hitchhikers, and such releases are illegal in many states.

Unwanted Classroom Plants and Animals: Once a classroom animal is no longer wanted or cannot be cared for, teachers need to take the proper steps to prevent them from becoming AIS.

- Check with the seller or provider and see if they will take the animal back. Some aquarium or pet stores, depending on their policies, will take back animals that outgrow their tanks or enclosures.
- Sign an Adoption Pledge Form (Page 92) when animals are taken from the classroom, or when a student is permitted to take an animal home to prevent releases into the environment.
- Check with local zoos, aquariums or aquarium clubs.
- Offer them to another teacher, a friend, or parent.
- If other options do not work out and euthanasia is considered, consult a local veterinarian for assistance.
- For unwanted plants, you can dry them completely or freeze them before placing them in the trash. Do not add them to compost, as their seeds could still be viable.

Selecting Classroom Plants and Animals:
When choosing plants or animals for classroom use, carefully research species you are considering and choose native or non-invasive species. There may be state regulations that prohibit keeping non-native species, so check with wildlife officials in your area. This is essential if animals are purchased through the internet. School policies may restrict the use of classroom animals, so check with an administrator.

Depending on the species selected for classroom use, it may be helpful to consider any student allergies or asthma. Also, a valuable lesson to teach students right from the start is that they should carefully wash their hands after handling or caring for classroom animals.

You should learn about the animals' needs and care requirements before obtaining them. Create a plan for eventual fate, transfer or disposition of plants and animals before bringing them into the classroom. Proper care of any living organism is essential and consideration must be given to the animal's welfare during weekends, holidays, and summer recess.

"Hitchhikers" to Avoid: When you purchase plants or animals for classroom use from biological suppliers, make sure to carefully inspect your shipment for unwanted "hitchhikers" on the packaging. Rinse containers with a diluted bleach solution and discard all packaging in the trash. Even the water that contains the plants or animals could be contaminated and should be treated with a diluted bleach solution before pouring down the toilet or sink. This water should not be put into a storm drain or ditch.

Classroom Plants and Animals: Useful Teaching Tools to Prevent Potential Invasive Species
Helen Domske, Coastal Education Specialist, New York Sea Grant; Associate Director, Great Lakes Program

Photo credits: Oregon Sea Grant, Washington Sea Grant, University of Southern California Sea Grant and IL-IN Sea Grant

For additional information:
The Aquatic Nuisance Species (ANS) Task Force's Classroom Guidelines for Preventing the Introduction and Spread of Aquatic Invasive Species (AIS)
https://www.anstaskforce.gov/Documents/ANSTF_Classroom_Guidelines_Final.pdf

Remember to:

- ✓ **Inspect** live study specimen orders and remove unwanted seeds, plants or animals
- ✓ **Give** unwanted organisms to another school, environmental learning center, aquarium or zoo
- ✓ **Sterilize** discarded water and **drain** water away from water bodies – never down a storm drain
- ✓ **Dispose** of aquatic plants and packaging materials in a sealed plastic bag in the trash
- ✓ **Contact** a veterinarian or pet retailer for guidance on humane disposal of animals

Acknowledgments

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Invader Species of the Great Lakes

Next Generation Science Standards:
www.nextgenscience.org/
MS-LS1
MS-LS1-5
MS-LS2
MS-LS2-1
MS-LS2-2
MS-LS2-3
MS-LS2-4
MS-LS2-5
MS-ESS3
MS-ESS3-3
New York State P-12 Science Learning Standards:
www.p.12nysed.gov/ciai/mst/sci/nyssls.html/
MS-LS1-5
MS-LS2-1
MS-LS2-3
MS-LS2-4
MS-LS2-2
MS-LS2-5
MS-ESS3-3
Common Core State Standards Connections:
ELA/Literacy:
www.corestandards.org/ELA-Literacy/
RST.6-8.1
RST.6-8.2
RST.6-8.7
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WHST.6-8.2
WHST.6-8.7
WHST.6-8.8
WHST.6-8.9
WHST.6-8.1
SL.8.1
SL.8.4
SL.8.5
Mathematics:
www.corestandards.org/Math/
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6.RP.A.3
6.SP.B.4)
6.SP.B.5
7.RP.A.2
6.EE.B.6
6.EE.C.9
7.EE.B.4
MN Standards - Gr 6, Science, Social Studies, Language Arts
SC 61311, 61312
SS 61112, 62481
LA 66511, 66744, 66911, 66944, 61311, 61322

Great Lakes Literacy Principles:
www.greatlakesliteracy.net/
Principles 5, 6, 8

Nab The Aquatic Invader:
http://www.iiseagrant.org/NabInvader/
Stop Aquatic Hitchhikers:
http://stopaquatichitchhikers.org/
Habitattitude:
http://habitattitude.net/

Background and Teacher Activity

Activity at a Glance

Students do a card-matching activity to learn about aquatic invasive species (AIS). In groups students select an aquatic invasive species, create a poster or factsheet and develop a charade-like game to demonstrate ways to prevent invasive species from spreading.

Objectives

Students will be able to:

- Name and recognize some AIS of the Great Lakes.
- Understand and analyze the positive and negative impacts of AIS in the Great Lakes ecosystem.
- Explain the ways in which AIS are introduced into the Great Lakes.
- Describe and act out ways to avoid the spread of AIS.

Materials

- Invader Species picture cards
- Introduction cards
- Ecosystem Impact cards
- 8 ½" x 11" colored paper
- Scissors

Subject & Grade

Science, Social Studies, Language Arts
Grade 6

Class Time

Three class periods

Vocabulary

Alewife
Ballast water
Invasive species
Great Lakes
Non-native species
Pacific salmon
Plankton
Purple loosestrife
Sea lamprey
Spiny waterflea
Zebra mussel

Background

An invasive plant or animal is one that does not naturally occur in a specific location or ecosystem. Invasive species arrive through intentional or accidental actions by humans, and those that survive always affect local ecosystems. Biologists usually judge the consequences of these impacts based on how much they add to, or detract from some important human endeavor. They also attempt to examine the effects upon other species of animals or plants. Invasive species sometimes have no natural predators in their new locations, and this may allow them to overpopulate an area and reduce native species.

Since the early 1800s, over 180 species of aquatic plants, algae, fish, worms, mollusks, other organisms, and diseases have been introduced into the Great Lakes. It is estimated that about 20% of the 170 or so species of Great Lakes fish are non-native species that were introduced accidentally or intentionally.

A few aquatic invasive species (AIS) have had very substantial impacts. One such invader to the Great Lakes is the sea lamprey. Common to the ocean waters from Florida to Labrador, sea lamprey swim inland into fresh waters to spawn. Natural barriers, like Niagara Falls, previously prevented them from reaching the rest of the Great Lakes. However, once shipping canals like the Erie and Welland Canals were opened up, sea lamprey easily found their way to the Great Lakes, where it decimated populations of native and stocked fish species.

Many AIS hitched a ride to the Great Lakes region in the ballast of ships. When ships are not loaded with cargo, they take on ballast for better balance, stability and safety. The use of water as a ballast has replaced the use of sand and stones during the past 100 years or so. Scientists think many of today's invasive species, such as zebra mussels, the round goby, Eurasian ruffe, and spiny waterflea, were sucked up from foreign harbors by powerful water pumps. Ballast tanks are filled with water from the harbors wherever ships are loaded, and then the water is dumped, along with any aquatic organisms present, when ships reach their destination. It is estimated that in the history of the Great Lakes, over 30% of the invader species entered in solid ballast and over 50% through ballast water.

The United States and Canada now require that all ships entering the Great Lakes discharge their fresh water ballast while still in the ocean, replacing it with saltwater ballast to reduce the introduction of new aquatic invasive species.

There are always trade-offs involved with the accidental or intentional introduction of a species into an ecosystem. Sometimes the impacts are difficult to judge ahead of time. Laws and regulations are intended to force a careful review of pros and cons before the intentional introduction of a new species is allowed. Introduction of a species that will have mostly detrimental impacts is not allowed.
People can help to avoid the spread of AIS by taking precautions. They should be careful to rinse the bottoms of boats, bilge pumps, and livewells with clean, heated tap water before leaving lake or river areas. Boaters should remove aquatic plants that cling to boat trailers and hulls. Ships should always release foreign ballast before entering their destination.

Helpful Hints

This activity involves a wide range of skills including citizenship, classification, comparison, description, discussion, listening, media construction, problem solving, public speaking, reading, reporting, responsibility, role-playing, small-group dynamics and writing.

Procedure

1. Decide how many students you would like to have work together. Prepare a complete set of cards for each group. Copy each of the three types of cards (Ecosystem Impact, Introduction, and Invader Picture cards) on different colored paper. Have students cut them apart, or have cards precut before doing the activity. One complete set contains 18 cards.
2. Introduce the topic of AIS to the class. Explain key points made in the background section and define difficult vocabulary words such as invasive, non-native, invader, ballast and plankton.
3. Divide students into cooperative learning groups, and distribute the cards.
4. Have students match each AIS to its corresponding cards.
5. When group members agree that they have matched the cards to the best of their ability, have them check their answers using the answer sheet.
6. Each group selects an invader to present to the class. Have students construct a poster or develop a factsheet. They should include the impact of the invader on humans or the ecosystem. Then have them prepare a charade-like presentation that demonstrates how to prevent the spread of their invasive species.
7. Each group presents its AIS using the poster or factsheet that was developed. The group acts out a way to prevent the spread of AIS and the rest of the class guesses the action they are performing.

After all groups have presented and acted, review the importance of informed decision-making with regard to AIS. Remind them that there are some positive changes as a result of AIS; however, there are often many negative impacts to the Great Lakes ecosystem, and we are all responsible for making good decisions. Help guide students to the conclusion that invading species can harm the ecosystem in sometimes unpredictable ways that may have short-term benefits, but long-term detrimental impacts.

Discussion questions include:

Why should people be concerned about AIS?
What are some negative impacts of AIS?
What are some positive changes that result from introduction of AIS?
What actions can you take to prevent the spread of AIS?
What are some examples of good and bad decisions people can make with regard to AIS?
How do AIS affect ecosystems?

Wrap-Up

- Observe groups as they discuss and organize their cards.
- Observe group presentations of invasive species.
- Collect the groups' invader posters or factsheets to evaluate according to teacher criteria.

Extension

- Do research on control methods that have been tried on various invader species and report on their successes or failures. Brainstorm a creative way to control one of the invaders.
- Investigate other Great Lakes invaders, such as the Eurasian watermilfoil, to determine ecological impacts. Add your species to this game.
- Draw a humorous cartoon depicting the problem or benefit of an invader species. Some examples are a zebra mussel looking for a place to attach on an already overcrowded lake bottom, a white perch nudging out a yellow perch or purple loosestrife choking out other plants.
- Look for AIS the next time you visit Great Lakes waters.

Resources

Websites:

- Great Lakes Information Network (GLIN): http://www.great-lakes.net/envt/flora-fauna/invasive/invasive.html
- A Field Identification Guide to Invasive Plants in Michigan's Natural Communities http://mnfi.anr.msu.edu/invasive-species/InvasivePlantsFieldGuide.pdf
- U.S. Geological Survey, Nonindigenous Aquatic Species Website https://nas.er.usgs.gov/about/default.aspx
- Great Lakes Aquatic Nonindigenous Species Information System https://www.glerl.noaa.gov/glansis/

Kits:

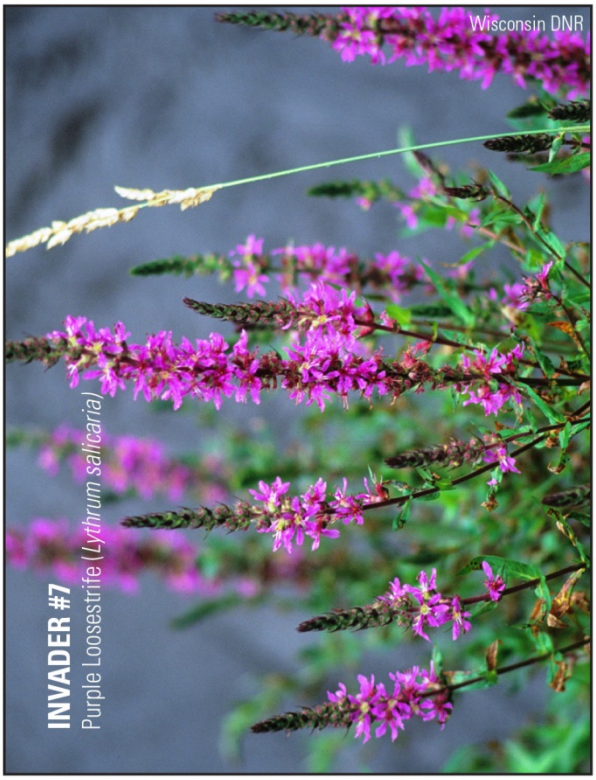
- Exotic Aquatics Traveling Trunk: an interactive kit containing preserved and facsimiles of AIS available from Minnesota Sea Grant College Program.
  Contact Doug Jensen via e-mail at djensen1@d.umn.edu or visit http://www.seagrant.umn.edu/educators/tt

- Zebra Mussel Mania Traveling Trunk: hands-on, inquiry-based kit and curriculum that contains simulations, experiments, videos, games, and stories. Also includes ideas for student-led community action projects. Available at lending centers across the United States and Canada.
  Contact Terri Hallesy via email at thallesy@illinois.edu or visit http://iiseagrant.org/catalog/ed/zmm.php

Credits

Originally created for ESCAPE Compendium, Great Lakes Sea Grant Network
Created by: Jim Alvaro, Anchor Bay School District, Clinton Township, MI
Modified by: Terri Hallesy, Illinois-Indiana Sea Grant
Invader Picture cards*, Introduction* cards, and *Ecosystem Impact* cards were included in the student activity of this lesson with permission from Ohio Sea Grant.

INVADER SPECIES: CARD MATCHING (Student Activity)



INTRODUCTION

Originally, it came from the Caspian Sea region of eastern Europe and western Asia. Canals built during the early 1800s allowed it to spread throughout Europe. First introduction into the Great Lakes was about 1989, when one or more transoceanic ships discharged ballast water into Lake St. Clair. Freshwater ballast from a European port likely contained larvae and possible yearlings. Being a temperate, freshwater species, it found the plankton-rich Lake St. Clair and Lake Erie to its liking.

B

INTRODUCTION

Originally it came from the Atlantic Ocean, the St. Lawrence and Hudson Rivers, and their tributaries for spawning. It swam from Lake Ontario into Lake Erie through the Erie and Welland Canals, gaining entry into the upper Great Lakes by attaching to boat hulls.

H

INTRODUCTION

A native of northern Europe, it made its way into the Great Lakes watershed in 1990. It is believed to have been brought over in fresh water or mud in ballast water of European freighters from eastern Baltic ports. They are currently spreading inland via rivers and canals.

C

INTRODUCTION

This ANS actually consists of a number of species, collectively known by a common name. It was introduced to the United States for aquaculture and fish farming, but is thought to have escaped farm ponds and entered the Mississippi River system and its tributaries as early as the 1970s. This group is currently considered on the cusp of invading the Great Lakes, as they have been found in shipping channels connecting Lake Michigan to the Mississippi River watershed.

A

INTRODUCTION

Coming from the salty Atlantic Coast, this species migrated through water routes, including canals in New York State and the St. Lawrence River. It swam into the upper Great Lakes through the Welland and/or Erie barge canal before 1931.

G

INTRODUCTION

From saltwater areas of the Atlantic coast, this invader moved up the Hudson River and via various canal systems into Lake Ontario and Lake Erie. Because of intentional stocking, it can now be found in all five Great Lakes.

D

INTRODUCTION

This species was intentionally imported from northern Europe over 100 years ago, because its hardiness and beautiful flowers were popular with landscapers, florists, and gardeners.

F

INTRODUCTION

It came from Europe, Asia, and North Africa and was introduced into North America as an aquarium plant. It also spreads when it gets entwined on boats, fishing equipment or waterfowl. It is now found in 37 states and 3 Canadian provinces.

E

ECOSYSTEM IMPACT

Like its better-known cousin, it filters plankton from the water; this allows sunlight to reach greater depths resulting in an overgrowth of aquatic plants. It accumulates on objects such as boat hulls and underwater pipes, clogging valves of both industrial and municipal water intake sources.

U

ECOSYSTEM IMPACT

It destroys valuable fish, especially lake trout, by attaching with its sucker-like mouth to suck out blood and body tissues. It upsets the ecological balance by removing top predators, allowing for explosion of populations of smaller fish such as alewives. It had great economic impact on the commercial fishing industry of the Great Lakes during the 1950s. Current control measures are able to keep populations in check, but the ANS still impacts fish species in the Great Lakes today.

W

ECOSYSTEM IMPACT

This aquatic nuisance species spawns from April to September, longer than many other fish, and producing a large number of offspring quickly. Males ferociously defend the nests, reducing the reproductive success of native species by denying them access to spawning habitat. This fish feeds on the eggs and young of native species, including many important sport fish like yellow perch, damaging an important industry for many Great Lakes states.

The species has also become a primary food source for the previously endangered Lake Erie Watersnake, demonstrating that some invasive species can have a beneficial impact on some areas while acting as a damaging influence in others.

S

ECOSYSTEM IMPACT

This species loves to eat plankton, mussels and snails, and can consume 5-20% of its body weight each day, easily outcompeting native species in the search for food. The fish is also less popular for recreational and sport fishing than the native species it would replace, potentially damaging a Great Lakes fishing industry valued at $7 billion per year.

Z

ECOSYSTEM IMPACT

Feeding primarily on zooplankton, this vertebrate competes for food with juveniles of almost all fish species. Large numbers die off in spring and summer because of electrolyte imbalance from living in fresh water. These die-offs clog municipal and industrial intake pipes and foul beaches. In 1967 bulldozers had to remove 50,000 tons of the rotting fish from the southern shores of Lake Michigan.

Y

ECOSYSTEM IMPACT

This aquatic nuisance species is suspected to be partially responsible for the decline of Lake Erie's yellow perch because of competition for food resources. It is also detrimental to walleye and white bass population because these species' eggs can be a primary food source.

V

ECOSYSTEM IMPACT

It is called "the beautiful killer" because its dense roots choke waterways as it competes with other vegetation. It spreads quickly, crowding out valuable plants that provide food for migrating waterfowl, and destroys habitat for almost all other forms of wetland life.

X

ECOSYSTEM IMPACT

It forms thick mats on the water's surface that choke out native aquatic vegetation. The mats alter the nutrient composition and flow of water, which in turn affects the amount of oxygen available to fish. It also disrupts all forms of water recreation—boating, swimming and fishing—because plants get caught in boat rotors, and swimmers and anglers are blocked from access to the water.

T

Invader Species: Card Matching Activity Answer Key

1. Quagga Mussel: B, U
2. Sea Lamprey: H, W
3. Round Goby: C, S
4. Asian Carp: A, Z
5. Alewife: G, Y
6. White Perch: D, V
7. Purple Loosestrife: F, X
8. Eurasian Watermilfoil: E, T

Find 7 Ways Aquatic Invaders Are Spread

Next Generation Science Standards:
www.nextgenscience.org/
MS-LS1
MS-LS1-5
MS-LS2
MS-LS2-1
MS-LS2-2
MS-LS2-3
MS-LS2-4
MS-LS2-5
MS-ESS3
MSESS33
New York State P-12 Science Learning Standards:
www.p.12nysed.gov/ciai/mst/sci/nyssls.html/
MS-LS1-5
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MS-LS2-3
MS-LS2-4
MS-LS2-2
MS-LS2-5
MS-ESS3-3
Common Core State Standards Connections:
ELA/Literacy:
www.corestandards.org/ELA-Literacy/
RST.6-8.1
RST.6-8.2
RST.6-8.7)
RI.8.8
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WHST.6-8.9
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Mathematics:
www.corestandards.org/Math/
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MN Standards - Gr 6, Science, Social Studies, Language Arts
SC 61312
SS 61112, 61113, 62481
LA 66722, 66922

Great Lakes Literacy Principles
www.greatlakesliteracy.net/
Principles 5, 6, 8

Nab The Aquatic Invader:
http://www.iiseagrant.org/NabInvader/
Stop Aquatic Hitchhikers:
http://stopaquatichitchhikers.org/
Habitattitude:
http://habitattitude.net/

Background and Teacher Activity

Activity at a Glance

Aquatic invasive species (AIS) can be introduced into new bodies of water through various human pathways. Being aware of these pathways is one step that people can take in reducing the chances of future infestations. For ways to prevent their spread, please visit http://stopaquatichitchhikers.org/

Objectives

Students will be able to:

- Name and recognize seven ways that aquatic invasive species (AIS) can be introduced into new bodies of water by people.
- Understand and analyze the impact of AIS on the Great Lakes ecosystem.
- Describe how to avoid the spread of AIS.

Materials

- *Find 7 Ways Aquatic Invasives are Spread* student activity

Subject & Grade

Science, Social Studies, Language Arts
Grade 6

Class Time

One class period

Vocabulary

Angler
Bait well
Boat trailer
Great Lakes
Hunting decoy
Hydroplane
Invasive species
Pontoon
Predator
Propeller
Recreationist
Watercraft
Scuba gear

Background

Aquatic invasive species (AIS) are organisms that have been introduced, either intentionally or unintentionally, into an ecosystem that is not their own. For example, if an angler releases bait after fishing, or if someone dumps aquarium plants in a local waterway, they could be unintentionally introducing AIS into the environment. These harmful, non-native organisms create additional competition for food and shelter, burdening species that were already present in the ecosystem.

Because invaders lack natural predators their population increases rapidly and they begin to take over an area. It is almost impossible to eliminate them once they dominate a habitat. It costs tens of millions of dollars each year to control AIS. Students need to become aware of how native species in an ecosystem depend on each other to survive and the steps we can take to make a difference in keeping our waterways clean and healthy.

Helpful Hints

Prior to completing this activity, students should develop understanding about issues associated with aquatic invasive species by visiting Nab the Aquatic Invader's website, http://www.iiseagrant.org/NabInvader/great_lakes.html.

Procedure

1. Have students count off from one to three. Each student must then find the other student(s) with the same number.
2. Provide each student with a copy of *Find 7 Ways Aquatic Invaders are Spread* activity to complete.
3. Provide a brief introduction to AIS. In their groups, have students work cooperatively to find seven ways that AIS are spread. Students can visit http://stopaquatichitchhikers.org/ to gather tips and clues on ways to control their spread.

Wrap-Up

Evaluation is based on the written responses to questions assigned in the *Find 7 Ways Aquatic Invaders are Spread* activity. The answers should indicate that students have gained understanding in finding the information requested.

Extension

1. One of the most important lessons students can learn in a unit about AIS is how to stop the spread of invaders. Working in groups, students could generate hypothetical solutions to a local environmental imbalance or destructive invasion.
2. A community stewardship project could include writing to congressional representatives about improving laws to prevent further AIS spread, creating a video to share on YouTube, or partnering with a community organization to raise awareness about AIS issues.
3. Students could research and report on current problems involving AIS and discuss successful control measures used to reduce spread.
4. Invite a guest speaker from the Department of Natural Resources or Sea Grant to address action steps people can take to become an agent for change in one's community.
5. Students could research and report on the importance of the Great Lakes with regard to industry, recreation and tourism, agriculture, commercial and sports fisheries, forestry and mining.

Resources

Websites:

- Sea Grant – Nab the Aquatic Invader: http://www.iiseagrant.org/NabInvader/index.html
- Great Lakes Information Network (GLIN): http://www.great-lakes.net/envt/flora-fauna/invasive/invasive.html
- U.S. Geological Survey, Nonindigenous Aquatic Species Website https://nas.er.usgs.gov/about/default.aspx
- Great Lakes Aquatic Nonindigenous Species Information System https://www.glerl.noaa.gov/glansis/
- IL-IN Sea Grant - Aquatic Invasive Species: http://www.iisgcp.org/topic_ais.php
- IL-IN Sea Grant – Sea Grant takes AIM at AIS: http://www.iiseagrant.org/newsroom/sea-grant-takes-aim-at-ais
- IL-IN Sea Grant – What's in your water garden? Learn more about AIS: http://www.iiseagrant.org/newsroom/whats-in-your-water-garden-learn-more-about-ais
- IL-IN Sea Grant – Biologists can be heroes too: http://www.iiseagrant.org/newsroom/biologists-can-be-heroes-too
- IL-IN Sea Grant – Be a Hero-Release Zero:™ http://www.iisgcp.org/ais/releasezero.php
- IL-IN Sea Grant – Asian Carp: http://www.iisgcp.org/ais/asiancarp.php

Credits

Originally created for ESCAPE Compendium, Great Lakes Sea Grant Network
Created by: Kristin TePas and Pat Charlebois and designed by Jerry Barrett and Susan White, Illinois-Indiana Sea Grant
Modified by: Terri Hallesy, Illinois-Indiana Sea Grant

What is wrong with this picture?

FIND 7 WAYS AQUATIC Invasives

What is wrong with this picture?

FIND 7 WAYS AQUATIC Invasives

Find 7 Ways Aquatic Invasives are Spread

Name:_____

Directions: Answer the questions below based off of the *Find 7 Ways Aquatic Invasives are Spread* picture.

1. What vehicle can transport zebra mussels on its pontoons?

_____

2. Which watercraft can act as an effective carrier of aquatic invaders?

_____

3. What enjoyable indoor hobby creates problems in local ponds and rivers?

_____

4. What does this recreationist wear that can move species to other water bodies?

_____

5. How do hunting decoys spread AIS?

_____

_____

6. Where should anglers dispose of bait that is no longer needed?

_____

_____

7. If you catch more fish than you want, what's wrong with throwing them into a different lake or river?

_____

_____

Find 7 Ways Aquatic Invasives are Spread

Name:_____

Directions: Answer the questions below based off of the *Find 7 Ways Aquatic Invasives are Spread* picture.

1. What vehicle can transport zebra mussels on its pontoons?

_____

2. Which watercraft can act as an effective carrier of aquatic invaders?

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_____

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_____

5. How do hunting decoys spread AIS?

_____

_____

6. Where should anglers dispose of bait that is no longer needed?

_____

_____

7. If you catch more fish than you want, what's wrong with throwing them into a different lake or river?

_____

_____

Find 7 Ways Aquatic Invasives are Spread Answer Key

Directions: Answer the questions below based off of the *Find 7 Ways Aquatic Invasives are Spread* picture. Accept all reasonable responses.

1. What vehicle can transport zebra mussels on its pontoons? Seaplane is the correct answer. However, if students answered "boat" thinking of a pontoon boat, this response would also be correct. Pilots should be aware of the status of AIS in waterbodies they travel in, to avoid the possible infestations.

2. Which watercraft can act as an effective carrier of aquatic invaders? The correct answer is boat. Boat trailer and seaplane are also appropriate answers. Invasive species can cling to the boat motor/propeller, and the trailer. Three steps to prevent the spread of AIS are: 1) clean vegetation from boat, trailer, and equipment, 2) flush the motor, bait wells, and live wells, and 3) let the boat air-dry for 5 days.

3. What enjoyable indoor hobby creates problems in local ponds and river? Aquarium plants and animals typically are not from lakes and ponds within the United States. If they are dumped into a waterbody, these fish could possibly breed and reproduce. If released, aquarium plants and animals can outcompete native species, causing them to suffer and die.

4. What does this recreationist wear that can move species to other water bodies? Scuba gear. All scuba equipment should be properly cleaned and dried after each use. Even clothing and scuba tanks can be a mode of transportation for aquatic invaders.

5. How do hunting decoys spread invasive species? Invasive plants and animals, like Hydrilla and zebra mussels, can attach to hunting decoys and be carried to another lake, river, or pond. As with all equipment used in water, decoys should be properly rinsed off and dried after each use.

6. Where should anglers dispose of bait that is no longer needed? "In the trash" is the best answer. Like aquarium fish, bait fish should never be released into a body of water. The proper way to dispose of unwanted minnows, worms and fish parts is in the trash. Some types of bait fish can reproduce rapidly and cause havoc for native fish.

7. If you catch more fish than you want, what's wrong with throwing them into a different lake or river? All fish that will not be eaten should only be released back into the waterbody from which they were taken. Non-natives introduced into a new ecosystem can disrupt the food web.

Seeing Purple: A Population Explosion

Next Generation Science Standards:
www.nextgenscience.org/
MS-LS1
MS-LS1-5
MS-LS2
MS-LS2-1
MS-LS2-2
MS-LS2-3
MS-LS2-4
MS-LS2-5
MS-ESS3
MS-SS3-3
New York State P-12 Science Learning Standards:
www.p.12nysed.gov/ciai/mst/sci/nyssls.html/
MS-LS1-5
MS-LS2-1
MS-LS2-3
MS-LS2-4
MS-LS2-2
MS-LS2-5
MS-ESS3-3
Common Core State Standards Connections:
ELA/Literacy:
www.corestandards.org/ELA-Literacy/
RST.6-8.1
RST.6-8.2
RST.6-8.7
RI.8.8
WHST.6-8.2
WHST.6-8.7
WHST.6-8.8
WHST.6-8.9
WHST.6-8.1
SL.8.1
SL.8.4
SL.8.5
Mathematics:
www.corestandards.org/Math/
MP.4
6.RP.A.1
6.RP.A.3
6.SP.B.4
6.SP.B.5
7.RP.A.2
6.EE.B.6
6.EE.C.9
7.EE.B.4
MN Standards – Gr 6-8 Mathematics, Science
MATH 66411, 66135, 66211, 77432, 88212, 88221
SC 61312, 71112, 71123, 74213, 74323, 81111

Great Lakes Literacy Principles
www.greatlakesliteracy.net/
Principles 5,6,8

Nab The Aquatic Invader:
http://www.iiseagrant.org/NabInvader/
Stop Aquatic Hitchhikers:
http://stopaquatichitchhikers.org/
Habitattitude:
http://habitattitude.net/

Background and Teacher Activity

Activity at a Glance

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

Objectives

Students will be able to:

- Recognize purple loosestrife and tell how the seeds are dispersed.
- Describe that purple loosestrife produces over 2 million seeds and have a concept of how much that really is.
- Determine the population of purple loosestrife seeds for their wetland ecosystem through sampling.

Materials

- Purple loosestrife (*Lythrum salicaria*) factsheet
- Dot worksheet
- How Much is Two Million Seeds? worksheet
- One bag of purple confetti (or hole-punches from purple construction paper)
- Fan or blow dryer
- Meter sticks
- String (optional)

Vocabulary

Population
Purple loosestrife
Sampling

Subject & Grade

Mathematics, Science
Grades 6-8

Class Time

Three or four class periods

Background

Purple loosestrife is an aggressive nonindigenous plant that rapidly disperses throughout wetland areas. It is an unwelcome intruder because it interferes with the growth of native species and fills in the spaces where the natives would normally grow. Purple loosestrife creates many problems through its competitive advantage that cause an imbalance in the wetland ecosystem.

Helpful Hints

Students should already have an introduction to invasive species and wetlands. They should understand how purple loosestrife can endanger a wetland.

Students should know how to multiply and use a calculator. It would be helpful for students to be able to use linear measurements to construct a grid.

Procedure

1. Distribute the informational factsheet on purple loosestrife.
2. Have students complete the worksheet *How Much Is Two Million Seeds?* to realize the enormity of this number. If possible, bring in two reams of paper (500 sheets). Two reams of paper with 50 dots on each page would make 2 million dots!
3. Groups of students should be given large sheets of paper or poster board and asked to draw a wetland ecosystem. The teacher can show pictures of wetlands to help them understand.
4. Students make a grid on their wetland by drawing lines to make equal-sized sections. For example, poster board that is 22 x 28 inches (56 x 70 centimeters) could be divided into sections of 14 square centimeters. Students could mark off every 14 centimeters down (4 marks) and every 14 centimeters across (5 marks). The total number of sections would be 20. Then have students draw lines in at these marks. Finally, have students number the poster board sections.
5. Each group lines up their wetland ecosystem side-by-side leaving no spaces. The teacher spreads out a bag of purple confetti (or purple hole-punches) on cardboard. With a fan or hair dryer, the teacher simulates the wind and spreads the seeds to every ecosystem.
6. Students should take their ecosystem back to their desks to count the seeds. They must guess how many purple loosestrife seeds are in one section. Then they should guess how many seeds are dispersed throughout the whole ecosystem. Students should look at their wetland and choose what section should be used to count the purple loosestrife "seeds." All the seeds in this section are to be counted. To find the estimate, students should know that the size of the population equals the number in the section that was counted multiplied by the number of sections: *population estimate = number in one section x number of sections.*
7. If there is time, have students estimate and then count another section. Compare the results.
8. Compile the data from each of the groups. The ecosystem closer to the parent plant (fan) will receive more seeds (confetti or hole-punches). Notice how the seeds can be spread by the wind.
9. Discuss the following questions (with sample answers):
   Purple loosestrife seeds can also travel by water and on things that move from place to place. It can also reproduce from its roots and parts of the stem. How would this affect our findings?
   The different ways they are transported would affect how far and fast the seeds could be dispersed.
   Did each section of your wetland ecosystem have the same number of seeds? Which wetland ecosystems had the most seeds? The least seeds? What factors determined which wetland ecosystem got the most?
   Each section counted should yield a different number of seeds. Students need to realize that typically a scientist cannot possibly count every organism in the environment.

Wrap-Up

- Have students describe how to count the number of insects in a square meter area of the playground, using the sampling method.
- By making calculations, have students compute how many sheets of paper with dots are needed to make 3 million.

Extension

Have students research the difficulty of getting rid of purple loosestrife and its impact on a wetland - how it can upset the balance of a wetland ecosystem.

Resources

Factsheets and Publications:

- Why Are Wetlands Important? USEPA https://www.epa.gov/wetlands/why-are-wetlands-important
- Purple Loosestrife. Minnesota Department of Natural Resources http://www.dnr.state.mn.us/invasives/aquaticplants/purpleloosestrife/index.html
- Purple Loosestrife: What you should know, what you can do. Minnesota Sea Grant http://www.seagrant.umn.edu/ais/purpleloosestrife_info

Credits

Originally created for ESCAPE Compendium, Great Lakes Sea Grant Network
Created by: Jan Durbin, St. Francis Education, Sylvania, OH
Shirley Fulop, Christ the King School, Toledo, OH
Janet Struble, Christ the King School, Toledo, OH
Lynn Henderman, Reynolds Elementary, Toledo, OH
Modified by: Terri Hallesy, Illinois-Indiana Sea Grant

Seeing Purple: A Population Explosion

Student Activity

Purple Loosestrife (Lythrum salicaria) Factsheet

Purple loosestrife is a harmful invasive wetland plant that is native to Europe and Asia. Purple loosestrife was purposely introduced in eastern North America as a garden flower in the 1800s. It may also have entered with imported sheep in dry ship ballast. It has a very attractive purple flower, which made it a seemingly desirable garden plant. Although lovely to look at, this invasive aquatic plant is spread easily from gardens to swampy areas, marshes, and ditches. It is aggressive and very harmful to wetlands because it crowds out the native plants and fills open spaces.

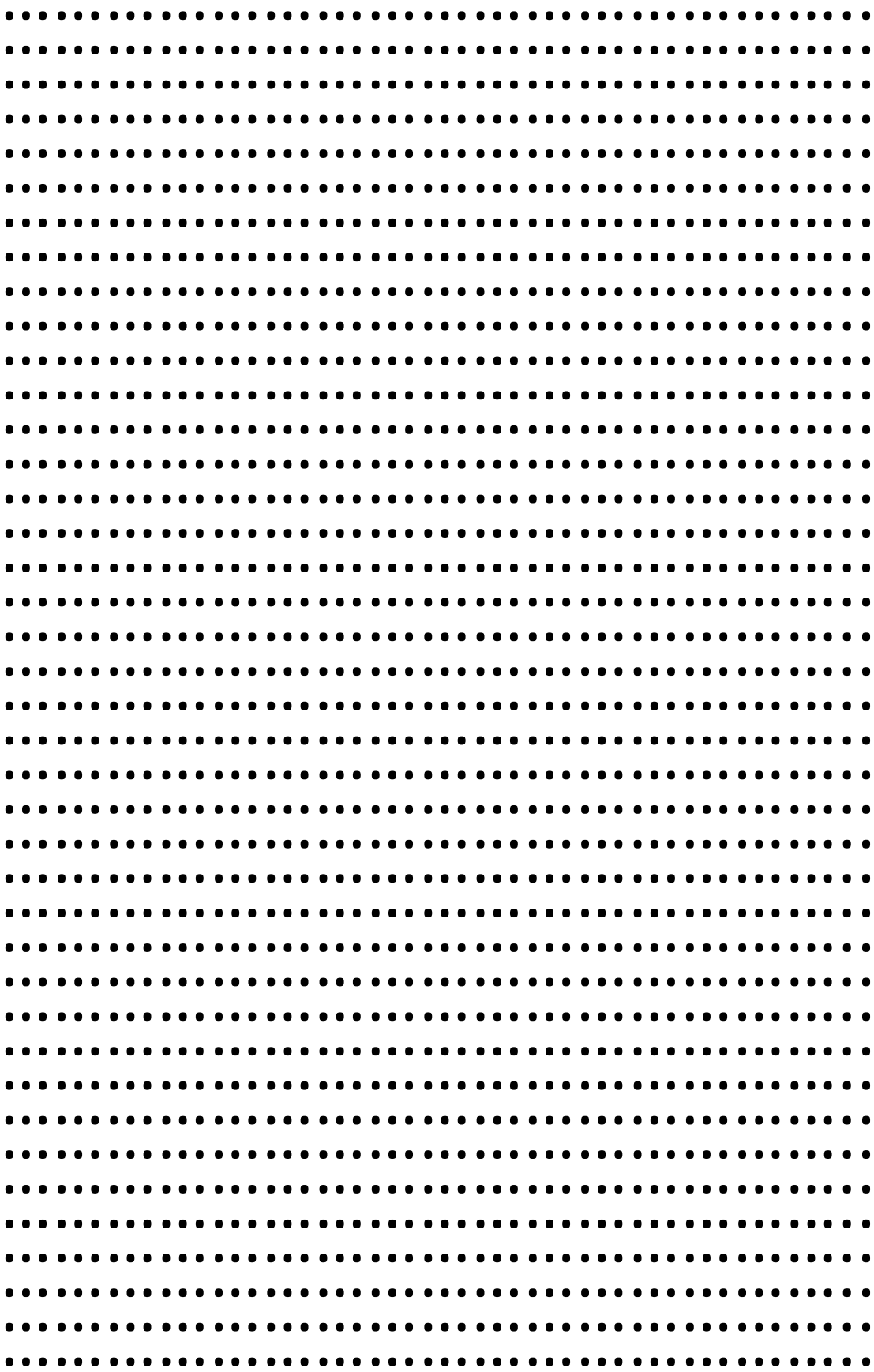
Cattails, bulrushes, grasses and other native plants support many of the wetland animals. Cattails provide shelter, nesting and breeding spaces, and food for the animals. Purple loosestrife grows so densely that it cannot be used for shelter, nesting, or breeding. It has very few native predators; deer are one of the few animals that eat this plant. However, deer do not do enough damage to keep purple loosestrife in check.

Purple loosestrife is a beautiful plant when in bloom from July through September. It grows 2 to 7 feet tall and produces a long spike of purple-colored flowers, with 5 to 6 petals per flower. Purple loosestrife has linear-shaped leaves. It is a perennial species that develops a woody taproot with a fibrous root system, forming a dense mat. Purple loosestrife blooms for a long time. It dispenses seeds almost continuously, as each flower up the stalk matures and goes to seed. Each stalk can have 300,000 seeds. Every mature plant produces an alarming number of seeds—over 2 million! Another important factor is that the seeds are carried by moving water and are dispersed over the entire watershed area. Seeds can remain dormant for many years (such as when they experience a hostile environment) and sprout when conditions improve. Loosestrife seeds also use the usual methods of dispersal, such as wind and rain, cars and trucks, railroads, and animals including humans. People involved in sprout control must be careful not to carry seeds on shoes and clothing when leaving the area.

This invasive aquatic plant can reproduce from roots and stem pieces as well as from seeds. On mature plants the roots can send up 30 to 50 shoots, creating a very dense growth, which chokes out other plant life. Because of the enormous numbers of seeds and roots and stem replication, the purple loosestrife plant is probably impossible to eradicate and very difficult to control to an acceptable degree.

When purple loosestrife gets established in a wetland, the native plants are in short supply for the animals. This lowers the animal population and destroys the healthy balance in the area. This is a direct effect of purple loosestrife. Another impact is that if insects cannot breed in the cattail area due to a decrease in its density, some bird species will have less food and will move elsewhere. Purple loosestrife totally chokes plant life in wetlands under a sea of beautiful purple flowers. The dense strands of plants also reduce the ability to use wetlands, and rivers for recreation. Also, drainage ditches are unable to drain properly, which can increase the threat of flooding.

Dot Worksheet



How Much Is Two Million Seeds?

Name: _____

Objective: To realize the magnitude of large numbers and to see how many dots will make 2 million.
Directions: Please read all questions and show any work necessary to calculate your answers. All questions refer to the number of dots on the worksheet.

1. How many dots are on the worksheet? _____
2. How many total dots would there be on 5 sheets of paper? _____
3. How many total dots would there be on 50 sheets of paper? _____
4. How many sheets of paper would it take to make 1 million (1,000,000)? _____
5. How many sheets of paper would it take to make 2 million (2,000,000)? _____

How Much Is Two Million Seeds?

Name: _____

Objective: To realize the magnitude of large numbers and to see how many dots will make 2 million.
Directions: Please read all questions and show any work necessary to calculate your answers. All questions refer to the number of dots on the worksheet.

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3. How many total dots would there be on 50 sheets of paper? _____
4. How many sheets of paper would it take to make 1 million (1,000,000)? _____
5. How many sheets of paper would it take to make 2 million (2,000,000)? _____

How Much Is Two Million Seeds? Answer Key

Objective: To realize the magnitude of large numbers and to see how many dots will make 2 million.
Directions: Please read all questions and show any work necessary to calculate your answers. All questions refer to the number of dots on the worksheet.

1. How many dots are on the worksheet?
   40 x 50 = **2,000 dots**

2. How many total dots would there be on 5 sheets of paper?
   2,000 x 5 = **10,000 dots**

3. How many total dots would be on 50 sheets of paper?
   2,000 x 50 = **100,000 dots**

4. How many sheets of paper would it take to make 1 million?
   1 million dots would be 10 x the bold number above. So, 10 x 50 sheets = **500 sheets of paper**

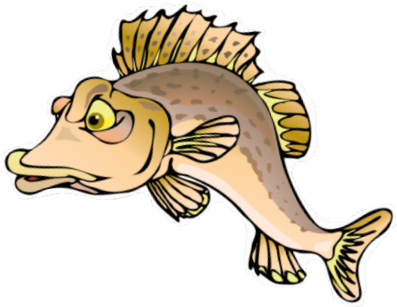
5. How many sheets of paper would it take to make 2 million?
   2 million would require 2 x the bold number of sheets above. So, 2 x 500 sheets = **1,000 sheets of paper**

Awareness of Aquatic Invaders

Background and Teacher Activity

Activity at a Glance

This classroom project provides a puzzle-type activity to help students become aware of problems associated with aquatic invasive species (AIS). Students put sentence parts together; completed sentences are then read and discussed as a class.



Objectives

Students will be able to:

- Identify two AIS that are found in the Great Lakes—purple loosestrife and zebra mussels.
- Explain what an invasive species is.
- Describe problems associated with AIS.
- Describe methods used to control purple loosestrife.

Materials

- Sample zebra mussel shells*
- *Sentence Sheets*
- *Student-Team Evaluation* Sheet
- *Zebra Mussel Quiz*
- Envelope for each sentence
- Colored pens
- Colored paper (optional)
- Chart for groups to record completed sentences

Vocabulary

Bait bucket
Ballast water
Bivalve
Byssal threads
Galerucella beetle
Habitat
Indigenous species
Invasive species
Livewells
Organism
Predator
Purple loosestrife
Veliger
Zebra mussel

Subject & Grade

Science, Language Arts, Reading Comprehension
Grade 6

Class Time

Eight class periods

**Use of shells may be illegal in some jurisdictions. Contact your local natural resource management agency for more information.*

Next Generation Science Standards:
www.nextgenscience.org/
5-LS2 5-LS2-1
5-ESS3 5-ESS3-1
MS-LS1 MS-LS2
MS-LS2-1 MS-LS2-2
MS-LS2-3 MS-LS2-4
MS-LS2-5 MS-ESS3
MS-ES33-3
New York State P-12 Science Learning Standards:
www.p.12nysed.gov/ciai/mst/sci/nyssls.html/
5-LS2-1
5-ESS3-1
MS-LS1-5
MS-LS2-1
MS-LS2-3
MS-LS2-4
MS-LS2-2
MS-LS2-5
MS-ESS3-3
Common Core State Standards Connections:
ELA/Literacy:
www.corestandards.org/ELA-Literacy/
RI.5.1
RI.5.7
RI.5.9 W.5.8
W.5.9
RST.6-8.1
RST.6-8.2
RST.6-8.7
RI.8.8
WHST.6-8.2
WHST.6-8.7
WHST.6-8.8
WHST.6-8.9
WHST.6-8.1
SL.8.1
SL.8.4
SL.8.5
Mathematics:
www.corestandards.org/Math/
MP.2
MP.4
6.RP.A.1
6.RP.A.3
6.SP.B.4
6.SP.B.5
7.RP.A.2
6.EE.B.6
6.EE.C.9
7.EE.B.4
MN Standards – Gr 6 Science, Language Arts, Reading Comprehension
SC 61341
LA 66744, 66911
RC 66455

Great Lakes Literacy Principles:
www.greatlakesliteracy.net/
Principles 5, 6

Nab The Aquatic Invader:
http://www.iiseagrant.org/NabInvader/
Stop Aquatic Hitchhikers:
http://stopaquatichitchhikers.org/
Habitattitude:
http://habitattitude.net/

Background

Aquatic invasive species (AIS) are organisms that are brought into an ecosystem that is not their own. These organisms attempt to fill the niche of organisms that are already present. There is a limited amount of resources in any environment. Adding new species means that species already present now have more competition for food and shelter. If an AIS does well, it usually means a preexisting species begins to decrease in numbers through intense competition for ecosystem resources.

AIS have been introduced into new environments both intentionally and unintentionally. For example, purple loosestrife was introduced for landscaping and beekeeping purposes. Other species, such as zebra mussels, were spread unintentionally through the discharged ballast water of ocean freighters.

Zebra mussels filter plankton from water making the water clearer. This may seem helpful; however, in some areas this causes the algae population to increase. In addition, zebra mussels filter out organic pollutants that can be introduced into the food chain by animals that consume them. Boaters can help prevent the spread of zebra mussels by cleaning and washing their boat, motor and trailer with 140°F water for 10 seconds. Bait buckets and livewells should be drained on land to avoid spreading zebra mussels.

Helpful Hints

As written, this activity is geared toward groups of three students, but it can be easily adapted for individuals or pairs of students.

This activity can reinforce students' understanding of sentence structure - especially that sentences begin with capital letters and end with periods.

Use one chart for the entire class at the front of the room, instead of, or in addition to, the individual group charts. Have students write the team name (in parentheses) next to sentences on a class chart.

Procedure

Preparing for the activity

1. The class will take turns using each puzzle, or sentence, so only one set of copies is needed. Make one copy of the sentence sheets (32 sentences). If desired, use a different color for each page of sentences.
2. Cut each sentence into phrases at the dashed lines. Put the sentence number on the back of each piece. Place the pieces into an envelope. Write the sentence number on the outside of the envelope. Write the total number of pieces for that sentence on the flap of the envelope. If you are using color coding, use the matching color to write the sentence number on the envelope or put a colored square on it.
3. Prepare a large sheet of paper for each group to use to record the unscrambled sentences. Draw lines for sentences, and write the numbers 1 to 32 down the left side.

Six class periods: Putting the sentences together

4. Provide a brief introduction to AIS and their impact on the ecosystem. Describe the two AIS discussed in the activity: the zebra mussel and purple loosestrife.
5. Place students in cooperative learning groups of three students. Designate each student with a number. Student 1 gets the envelope from the teacher. Student 2 writes the sentence on the chart. Student 3 takes charge of the group and asks the teacher the meaning of unfamiliar words.

6. Distribute the instruction sheet and explain the procedure that each group will follow. Student 1 gets an envelope from the teacher, counts the number of sentence pieces in the envelope, and takes it back to the group.
7. After the group has constructed a sensible sentence, Student 2 writes the sentence next to the sentence number on the group's chart. Student 3 crosses off the sentence number on the S*tudent-Team Evaluation Sheet*.
8. As Student 2 finishes writing the sentence, Student 1 returns the envelope, counts the number of pieces for the teacher to be sure there are the correct number as shown on the envelope, and takes another envelope. This continues for the duration of the activity or until all the sentences are finished.

Two class periods: Reading and correcting charts

9. The class will spend two days reading through the correct answers as the students are given another team's chart to grade. Incorrect sentences are marked with an "X." Students on the same team are given the same grade based on the number of correct sentences that group produced.
10. Concluding questions to discuss with the class include:
    How did you become aware of AIS while doing this activity?
    What specifically did you learn?
    Might you be interested in growing your own beetles to help control purple loosestrife?
    Did you enjoy the "sentence puzzle" approach to learning about invasive species?

Wrap-Up

The *Student-Team Evaluation Sheet* and the *Zebra Mussel Quiz* allow sufficient means for evaluating student progress. Two months after this activity, it might be a good idea to ask the students to write a paragraph about AIS in order to judge student retention of the material covered.

Extension

- Students can use the skills acquired in this activity in science projects. This activity should also be able to keep students interested over the summer months as a review.

Resources

Websites:

- Great Lakes Information Network (GLIN): http://www.great-lakes.net
- GLIN Invasive Species in the Great Lakes region: http://www.great-lakes.net/envt/flora-fauna/invasive/invasive.html
- U.S. Geological Survey, Nonindigenous Aquatic Species: http://nas.er.usgs.gov
- Great Lakes Aquatic Nonindigenous Species Information System https://www.glerl.noaa.gov/glansis/

Credits

Originally created for ESCAPE Compendium, Great Lakes Sea Grant Network
Created by: Joan Smith, Klondike Elementary, West Lafayette, IN
Modified by: Helen Domske, New York Sea Grant

Sentence Sheets Instructions to the Students

Teacher Activity

For the next several days, you will be working on the following activity with your team.

Team Contest
Your team will pick an envelope. As a group, unscramble the words until it makes a sensible statement. Next your team will write the sentence on a chart in the front of the class. Each person on your team will receive the same grade, based on the number of correct sentences your team completes. You may do the sentences in any order; however, be sure to put the answers in the correct spot on your chart. Your teacher will answer questions about words you do not understand.

There are 30 envelopes altogether. The team with the highest score wins. Good luck!

Teams may earn points for the following:

3 points for each correct sentence (30 sentences x 3pts = 90 possible points).

1 point for getting the numbered sentences on the paper in correct order.

1 point for using a different colored marker each day.

1 point for each team member's name next to his or her job number.

1 point for having a team name at the top of the chart. You will be assigned a team number, but your group needs to come up with its own name.

A Team Works Together

Student 1 gets the envelope from the teacher, counts the pieces before taking the envelope, and counts the pieces when returning it.

Student 2 writes down the sentences on the chart when the team agrees how the sentence should be written. Student 2 gets the colored marker from the teacher and returns it at the end of each class period.

Student 3 is in charge of the group, settling any questions about what words mean, etc. Student 3 may ask the teacher questions about the meaning of the words in the sentence.

Sentence Sheets

Teacher Activity

Print the next four pages single sided. Cut these phrases on the dashed lines and place them into individually numbered envelopes corresponding to the number on the sentence.

1. Zebra mussels, which	invaded North America	In 1988,		
have caused	serious economic	and environmental problems.		
2. Zebra mussels are	rapidly spreading beyond	the Great Lakes		
region into	many inland waterways.			
3. Invasive species are	animal and plant life	organisms introduced		
into a	habitat where	they are not native.		
4. Invasive	species are	a real	environmental	threat.
5. Invasive	species are without	natural predators	so they	often displace
native species.				
6. A zebra	mussel is a bivalve	fingernail-sized mollusk		
with yellowish	or brownish shells	marked in wavy bands.		
7. Female	zebra mussels	can produce	up to 1,000,000	
eggs per year.				
8. Zebra mussel	eggs develop into	free-swimming	larvae,	
called veligers,	that quickly begin to form shells.			
9. Zebra mussel	larvae, or veligers,	attach to	hard surfaces	
such as	stones, metal,	or crayfish.		
10. Zebra mussel	larvae, or veligers	attach to	surfaces using their	
byssal (rhymes with missile)	threads, which have	a strong		
adhesive that	even sticks	underwater.		

11. Almost 300	different species of	native mussels have		
been identified	from streams, rivers	lakes, and ponds		
in North America.				
12. Zebra mussels compete	with native mussels			
for food, space, and oxygen;	but the competition			
is “no contest” because	the zebra mussels reproduce			
so quickly.				
13. To preserve our native	mussels and control	or eliminate zebra		
mussels, we need	to be able to	tell them apart.		
14. Zebra mussels clog	intake lines of power			
companies and water	treatment plants	along rivers and lakes.		
15. Zebra mussels attach	to rocks, docks,	boats,	and even	
each other.				
16. The first zebra	mussels arrived in	North America around 1988		
in the ballast water	of transoceanic ships	that released	the water into	
Lake St. Clair.				
17. Zebra	mussels clog	and damage	engines	on boats.
18. Purple	loosestrife is a	wetland plant with	lovely	purple
flowers.				

19. Purple loosestrife was imported from Northern Europe over 100 years ago because it was hardy, and the beautiful flowers were popular with landscapers, florists, beekeepers and gardeners.

20. Purple loosestrife is called "the beautiful killer" because its dense roots choke waterways as it competes with other vegetation.

21. Purple loosestrife grows from four to seven feet in height and can be seen more and more in wetlands along highways in much of the United States and Canada.

22. Purple loosestrife crowds out valuable plants that provide food for migrating waterfowl.

23. Purple loosestrife is a widespread and serious problem affecting both coastal and inland wetlands, and lakes and waterways throughout the Great Lakes region.

24. Purple loosestrife destroys habitats for almost all forms of wetland life.

25. Purple loosestrife has long spikes of beautiful purple flowers.

26. A mature purple loosestrife plant produces 30 or more flowering stems and can produce over 2.5 million seeds per year.

27. Purple loosestrife	arrived in North America	without its natural
enemies, but	plant-feeding beetles	are effective as biological
controls	for purple	loosestrife.
28. As part of the biological	control effort, educators,	students, and
citizen leaders raise	and release	*Galerucella* beetles.
29. The *Galerucella*	beetles feed	on leaf and plant tissue,
preventing the production	of flowers and seeds,	
which eventually leads to the	reduction of numbers	of plants.
30. Many states	have banned	the sale of purple
loosestrife and are	working to control	and minimize it.

Student-Team Evaluation Sheet

There are 30 sentences in all to unscramble.
Team Number: _____ Team Names: _____

Team Members:

1. _____

2. _____

3._____

Mark off each sentence when completed

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

19 20 21 22 23 24 25 26 27 28 29 30

Team Points Earned:

Number of sentences correct _____ x 3 =	_____ (90 possible points)
All sentences in order	_____ (1 point possible)
Different color sentences each day	_____ (1 point possible)
Team member names _____ x 1 =	_____ (3 points possible)
Team name	_____ (1 point possible)
TEAM TOTAL POINTS =	_____ (96 points possible)

Zebra Mussel Quiz

Student Activity

Name:_____

Draw a zebra mussel in the space below (5 points) and label its byssal threads.

Matching

_____ 1. Ballast water

_____ 2. Byssal thread

_____ 3. Invasive species

_____ 4. Indigenous species

_____ 5. Veliger

A. Organism that is foreign, not native to a particular location

B. Zebra mussel larva

C. Carried in a boat to keep it from tipping upside down

D. String like substance on a mollusk used to attach to cans, rocks, boats, etc.

E. Organism that is native to a particular location or area

True-False

_____ 6. Zebra mussels filter the water in lakes and waterways, making it clearer.

_____ 7. The Great Lakes have been affected by zebra mussels.

_____ 8. Zebra mussels traveled to North America in ballast water of ships.

_____ 9. Zebra mussels live well in water that is very salty and very cold.

_____ 10. Zebra mussels help the food chain on a lake.

_____ 11. Zebra mussels can move into other bodies of water by people carrying bait water from one lake to another.

_____ 12. Zebra mussels invaded North America in 1999, in the bottom of an airplane.

Fill-in-the-Blanks (Choose from the answers at the bottom of the page.)

13. Mussels and clams which have two shells are _____ mollusks.

14. Through _____, zebra mussels improve the clarity of water.

15. Invasive species are _____ life organisms introduced into a habitat where they are not native.

16. Invasive species are a real _____ threat.

17. Zebra mussel larvae, or _____, attach to hard surfaces such as stone, metal or crayfish.

18. Zebra mussels are without natural _____, so they often try to take the place of native species.

19. Zebra mussels attach to _____, _____, boats, and even to each other.

20. Zebra mussels _____ and damage engines on boats.

animal and plant	bivalve	filtering	veligers
clog	rocks, docks	predators	environmental

Zebra Mussel Quiz Answer Key

Matching

1. C
2. D
3. A
4. E
5. B

True or False

6. T
7. T
8. T
9. F
10. F
11. T
12. F

Fill-in-the-Blank

13. bivalve
14. filtering
15. animal and plant
16. environmental
17. veligers
18. predators
19. rocks, docks
20. clog

Don't Stop For Hitchhikers

Next Generation Science Standards:
www.nextgenscience.org/
MS-LS1
MS-LS1-5
MS-LS2
MS-LS2-1
MS-LS2-2
MS-LS2-3
MS-LS2-4
MS-LS2-5
MS-ESS3
MS-ESS3-3
New York State P-12 Science Learning Standards:
www.p.12nysed.gov/ciai/mst/sci/nyssls.html/
MS-LS1-5
MS-LS2-1
MS-LS2-3
MS-LS2-4
MS-LS2-2
MS-LS2-5
MS-ESS3-3
Common Core State Standards Connections:
ELA/Literacy:
www.corestandards.org/ELA-Literacy/
RST.6-8.1
RST.6-8.2
RST.6-8.7
RI.8.8
WHST.6-8.2
WHST.6-8.7
WHST.6-8.8
WHST.6-8.9
WHST.6-8.1)
SL.8.1
SL.8.4
SL.8.5
Mathematics:
www.corestandards.org/Math/
MP.4
6.RP.A.1
6.RP.A.3
6.SP.B.4 -5
6.SP.B.5 -2
7.RP.A.2
6.EE.B.6
6.EE.C.9
7.EE.B.4
MN Standards – Gr 6-8 Science, Social Studies
SC 61311, 61312, 71123, 74211, 74212, 74213, 74222, 74323, 74412, 81121, 83412
SS 61112, 62481, 72111, 81111

Great Lakes Literacy Principles
www.greatlakesliteracy.net/
Principles 5, 6, 8

Nab The Aquatic Invader:
http://www.iiseagrant.org/NabInvader/
Stop Aquatic Hitchhikers:
http://stopaquatichitchhikers.org/
Habitattitude:
http://habitattitude.net/

Background and Teacher Activity

Activity at a Glance

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

Objectives

Students will be able to:

- Identify AIS and ways they are transported.
- Learn about several invasives that affect water habitat.
- Identify the negative or positive effects of AIS on native animals.
- Know how these invasives are transported and ways people can help to stop further spread.

Materials

- Role-playing activity script and directions immediately following this activity
- Picture/drawing of several aquatic invasives (Eurasian ruffe, zebra mussel, round goby, purple loosestrife, sea lamprey, Eurasian watermilfoil)
- Bait bucket (available at bait stores)
- Bucket
- Seed package
- Two 6-foot lengths of rope
- Toy boat/trailer (or picture)
- Paper fish
- Twelve paper plates, six marked with "X" on both sides

Subject & Grade

Science, Social Studies
Grades 6-8

Class Time

One class period

Vocabulary

Ballast water
Round goby
Eurasian watermilfoil
Eurasian ruffe
Invasive species
Sea lamprey
Purple loosestrife
Zebra mussel

Background

Today there are several aquatic invasive species (AIS) that pose a severe threat to all of the lakes and river systems of many states. They are non-native, worldwide agents of habitat alteration and degradation. Natural boundaries are in place that limits the spread of these species, but human actions in the form of recreation and watersports have allowed the invaders to diffuse to other lakes and rivers. There are, however, simple actions that we can do to stop the spread of harmful species.

As stated in the suggested script to read to students, “AIS are invading lakes and rivers by hitching a ride with humans, and there is no stopping them, unless you take actions to prevent it.”

Helpful Hints

The best place to conduct the lesson is in an area large enough for the entire class to spread out in a large circle (e.g., a classroom, gymnasium, or outdoor setting).

The number of volunteers for each AIS can vary depending on the number of students. The best outcome is for all students to be involved as one of the species. Any species of fish can be used in place of the walleye.

This activity involves various scientific fields including biology, wildlife management and botany.
This activity can be adapted for younger students by editing the script accordingly.

Procedure

1. Begin the program with the students forming a circle in a large open space, and tell them that the circle represents a lake. Explain that they will hear the story of the mighty walleye (or select a different fish) that lives in a big lake. Explain the definition of AIS.
2. Tell them that you need volunteers to play the parts of the lake inhabitants. The first volunteer is given a picture or drawing of the fish and taken to the “middle of the lake.” Explain that he or she is the biggest walleye in the lake.
3. Drop the paper plates on the ground around the inside of the circle, telling the group that this is the favorite food (the plain plates) and the favorite sleeping spots (plates with an “X”) of the walleye.
4. Now the story begins. Explain that the walleye swims and eats all over the lake. Have the volunteer walleye “swim” up to one of the paper plates and pretend to eat or sleep.
5. Next, introduce one of the AIS by first showing the students the picture and explaining how to identify it and the harmful effects it has on the habitat. The introduction of AIS can be in any order, but the sea lamprey should be last. See the activity script for information about each invasive species, which props to use with each, and what to tell students about the meaning of each prop. The AIS include Eurasian watermilfoil, purple loosestrife, zebra mussel, Eurasian ruffe, round goby, and sea lamprey.
6. Explain how the invader is spread. Demonstrate this by using the appropriate prop. Give the picture to a group of students (about four or five students depending on the number present), and tell them that they are now AIS and must remember how it is spread.
7. Next, have the group move one or two steps closer to the center of the circle to represent the loss of habitat for the walleye. After the students move in, say, “But the walleye doesn’t care, it has other places to sleep or eat.”
8. Each time a new species is introduced and the volunteers take a step forward, the prior groups

must take a step forward as well, ultimately covering up all the paper plates and surrounding the walleye. Have students think about how the habitat for the native animals is reduced to the point of being a threat for the native species' survival each time a new AIS is added. Have students notice that the amount of living space is being reduced and is getting smaller.

9. The final invader introduced should be the sea lamprey. Set the rope pieces down parallel to each other about three feet apart, "entering" the edge of the lake. Introduce the ropes as a canal that was built to connect the lake to a river. Have a volunteer swim through the "canal" and simulate the attack of the sea lamprey. The student can simply touch the walleye on the arm or wrap his or her arms around the walleye.
10. At this point, the demonstration and role-playing are finished. Students can take their seats in the classroom or sit down at their current location for a follow-up and review. Ask each group to remind the class how its invasive species is spread. Explain what is being done by the government, industry, academia and others to stop the spread of AIS. This information is found at the end of the role-playing script.
11. If desired, ask questions on the material covered in this lesson, to be answered either orally or in written form. This can be used as an evaluation tool. You could also have students match species with its mode of transport.

Wrap-Up

Students can be evaluated on the discussion following the demonstration or on items listed in step 11.

Extension

- Have the students create a "Public Service Announcement" in the form of posters, signs, audio recordings or videos informing other classes on ways to stop the spread of AIS.
- Visit a local lake, pond or boat access and look for signs of AIS. At the boat landing, see if there are warning signs about one of the invasives. If there are none, ask the water resource manager or fisheries biologist at your local Natural Resources, Environmental Conservation Department or Sea Grant program to post some signs.
- Visit a lake known to contain AIS and monitor the growth in population or the spread in infested areas.
- Have the students identify other AIS.

Resources

Factsheets and Publications:

- Factsheets on aquatic invasives can be obtained from state Sea Grant programs. For your closest program, visit the National Sea Grant College Program Web site and click on state program: http://seagrant.noaa.gov/about
- Minnesota Department of Natural Resources. A Field Guide to Aquatic Invaders. 1995. http://www.seagrant.umn.edu/ais/fieldguide

Credits

Originally created for ESCAPE Compendium, Great Lakes Sea Grant Network
Created by: Peter L. Edwards, Jay Cooke State Park, Carlton, MN
Modified by: Terri Hallesy, Illinois-Indiana Sea Grant

Role-Playing Activity Script and Directions

This is a compilation of information about various AIS, directions for conducting the activity "Don't Stop for Hitchhikers!" and suggestions for what to say and do during the activity. Note that ***italics*** are used for all sections that are the exact words teachers could say during this activity. The information pertaining to invasives comes from the Minnesota Department of Natural Resources pamphlet, A Field Guide to Aquatic Invaders. http://www.seagrant.umn.edu/ais/fieldguide

Have students form a large circle. Say:
This large circle represents a lake, and you will hear the story of the mighty walleye (or select a different fish) that lives in a big lake. We are going to do an activity called "Don't Stop for Hitchhikers!" Invasive species are invading lakes and rivers by hitching a ride with you, and there's no stopping them, unless you do something about it. You will all play the part of inhabitants of this lake and learn about invasive species.

Explain the definition of aquatic invasive species (AIS).

> **Aquatic invasive species**—organisms introduced into aquatic habitats where they are not native—are worldwide agents of habitat alteration and degradation. A major cause of biological diversity loss throughout the world, they are considered "biological pollutants." They compete for food and habitat of native species. Most species introductions are through human activity. Some introductions, such as carp and purple loosestrife, are intentional and do unexpected damage, but many introductions are accidental. Most non-native introductions are ecologically harmless and some are beneficial, but a few invasive introductions are harmful to recreation and ecosystems. Aquatic invasive species have actually caused the extinction of native species.

Ask for volunteers to play the parts of the lake inhabitants:
I will need volunteers to play the inhabitants of this lake.

Give the first volunteer a picture or drawing of the fish, and take him or her to the "middle of the lake." Say:
You are the biggest walleye in the lake.

Drop the paper plates on the ground around the inside of the circle, and say:
This is the favorite food (the plain plates) and the favorite sleeping spots (plates with an "X") of the walleye. The walleye swims and eats all over the lake.

Have the volunteer walleye "swim" up to one of the paper plates and pretend to eat or sleep.

Show a picture of the zebra mussel and explain how to identify it, the harmful effects it has on the habitat, and how the invasive is spread. (The introduction of the aquatic invasives can be in any order, but the sea lamprey should be last. For ease of use, this script suggests an order and starts with the zebra mussel.) Read or summarize information below:

> **Zebra mussels** are small, fingernail-sized mussels native to Asia, which may produce as many as 1 million eggs per year. They were discovered in Lake St. Clair near Detroit in 1988. Zebra mussels have now spread to parts of all the Great Lakes and the Mississippi River and are showing up in inland lakes. Zebra mussels clog water systems and irrigation pipes. They have severely reduced and eliminated native mussel species. Microscopic larvae may be carried in livewells or bilge water.

Adult zebra mussels can attach to boats that are docked in the water. Adult life size: 1/4 to 1 inch. **Prevention***: Tell students: Drain water from livewells in the same lake or river; do not dump in any other body of water. Since zebra mussels can attach to any hard surface, clean your boat and trailer and drain motor before moving to another waterbody.*

Use the **boat** to represent how they are transported.

Give the picture to a group of students (about four or five students depending on the number of students present) and tell them:
You are now the AIS and must remember how it is spread.

Have the group move one or two steps closer to the center of the circle to represent the loss of habitat for the walleye. After the students move in, say:
But the walleye doesn't care, it has other places to sleep or eat.

Introduce the next species. An explanation of ballast water appears with round goby information.

Round goby is a bottom-dwelling fish, native to Eastern Europe, which entered the eastern Great Lakes in ballast water.

Ballast water: Ships take on ballast water for stability during travel. This water is pumped out when the ships pick up their loads in Great Lakes ports. Because the ships make the crossing so much faster now and harbors are often less polluted, more AIS are likely to survive the journey and thrive in the new waters.

Round gobies are aggressive fish that can grow quickly to a size of up to 7 inches, although most adults are typically 5-6 inches long. The negative effects of the round goby include: dominating the fishery quickly, having no effective predators, can spawn several times per year and compete with native bottom-dwellers like sculpins and log perch. They have proven to be harmful to Great Lakes and inland fisheries.

Prevention: Tell students: *Clean off plants and animals from boats, trailers, motors and gear. Drain water from livewell; do not dump that water into any other waterbodies. Dry everything for at least 5 days.*

Use the **bucket filled with water** to represent ballast water.

Each time a new species is introduced and the volunteers take a step forward, the prior groups must take a step forward as well, ultimately covering up all the paper plates and surrounding the walleye.

Have students think about how the habitat for the native animals is reduced to the point of being a threat for the native species' survival each time a new AIS is added. Have students notice that the lake is getting smaller. Ask the students:
Do you notice that the living space is getting reduced and is getting smaller? Think about how the habitat for the walleye is being threatened.

Eurasian watermilfoil was accidentally introduced to North America from Europe, spread

westward into inland lakes primarily by boats, and reached Midwestern states between the 1950s and 1980s. It can form thick underwater stands of tangled stems and vast mats of vegetation at the water's surface. In shallow areas the plant can interfere with water recreation such as boating, fishing, and swimming. Its floating canopy can also crowd out native water plants. A key factor in the plant's success is its ability to reproduce through stem fragmentation and runners. A single segment of stem and leaves can take root and form a new colony. Fragments clinging to boats, motors and trailers can spread the plant to other lakes. Milfoil may become entangled in boat propellers or may cling to keels and rudders of sailboats. Stems can become lodged among any watercraft apparatus or sports equipment that moves through the water, especially boat trailers.

Prevention: Tell students: *Clear and clean off all aquatic plants from boats, motors and trailers*.

Use the **boat** to explain how Eurasian watermilfoil gets tangled in the trailer and boat prop.

Eurasian ruffe (Pronounced "ruff") was introduced to Duluth, Minnesota harbor, probably in tanker ballast water, around 1985, and has spread to other rivers and bays around Lake Superior. The ruffe's ability to displace other species in newly invaded areas is due to (1) its high reproductive rate, (2) its feeding efficiency across a wide range of environmental conditions, and (3) characteristics that may discourage would-be predators such as walleye and pike. Eurasian ruffe could be accidentally transported in livewells, bilge water, bait buckets, and ballast water. Adult life size: 3 to 5 inches.

Prevention: Tell students to: *Empty boat livewells and bilge water at water access points. Empty bait bucket contents in the trash.*

Use the **bait bucket** to demonstrate how ruffe may be spread.

Purple loosestrife is a wetland plant from Europe and Asia that was introduced into the East Coast of North America in the 1800s. First spreading along roads, canals, and drainage ditches, then later distributed as an ornamental plant, this invasive plant is in 46 states and all Canadian border provinces. Purple loosestrife invades marshes and lakeshore, replacing cattails and other wetland plants. The plant can form dense, impenetrable stands that are unsuitable as cover, food or nesting sites for a wide range of native wetland animals, including ducks, geese, rails, muskrats, frogs, toads, and turtles. Many rare and endangered wetland plants and animals are also at risk. A major reason for purple loosestrife's expansion is a lack of effective predators in North America. Seeds escape from gardens and nurseries into wetlands, lakes and rivers. Once in aquatic systems, moving water and wind easily spread loosestrife seeds. Plant height: 2 to 7 feet.

Prevention: Tell students: *If you see them in a wetland area, don't pick them and take them somewhere else. Don't buy purple loosestrife plants from nurseries instead select native loosestrife species where available. Avoid wild seed mixtures that contain purple loosestrife seeds.*

Use the **seed packet** to show how careless gardeners help spread purple loosestrife.

The final invader introduced should be the sea lamprey.

Sea lamprey is an elongated fish with a circular suctioning mouth with sharp rasping teeth on its

inner surface, and is native to the coastal regions of the Atlantic Ocean. They entered the Great Lakes through the Welland Canal around 1921. Sea lamprey contributed greatly to the drastic decline of whitefish and lake trout in the Great Lakes. Negative effects of the sea lamprey: One adult can consume 40 pounds of fish as an adult. Adult size: 12-20 inches.

Prevention: Tell students: *Chemical controls, called lampricides, are being used by water resource managers, which help keep sea lamprey populations in check.*

Set the **rope pieces** down parallel to each other about three feet apart, for "entering" the edge of the lake. Introduce the ropes as a canal that was built to connect the lake to a river.

Have a volunteer swim through the "canal" and simulate the attack of the sea lamprey. The student can simply touch the walleye on the arm or wrap his or her arms around the walleye.

Students can resume their seats in the classroom or sit at their current location for a follow-up and review. Ask each group to remind the class how its invader is spread (optional).

What are some other AIS?
Spiny waterflea, rusty crayfish, white perch, flowering rush, curly-leaf pondweed, alewife, and mosquito fish.

Fishing for Invader Clues

Next Generation Science Standards:
www.nextgenscience.org/
MS-LS1 MS-LS1-5
MS-LS2 MS-LS2-1
MS-LS2-2 MS-LS2-3
MS-LS2-4 MS-LS2-5
MS-ESS3 MS-SS3-3
New York State P-12 Science Learning Standards:
www.p.12nysed.gov/ciai/mst/sci/nyssls.html/
MS-LS1-5
MS-LS2-1
MS-LS2-3
MS-LS2-4
MS-LS2-2
MS-LS2-5
MS-ESS3-3
Common Core State Standards Connections:
ELA/Literacy:
www.corestandards.org/ELA-Literacy/
RST.6-8.1
RST.6-8.2
RST.6-8.7
RI.8.8
WHST.6-8.2
WHST.6-8.7
WHST.6-8.8
WHST.6-8.9
WHST.6-8.1
SL.8.1
SL.8.4
SL.8.5
Mathematics:
www.corestandards.org/Math/
MP.4
6.RP.A.1
6.RP.A.3
6.SP.B.4
6.SP.B.5
7.RP.A.2
6.EE.B.6
6.EE.C.9
7.EE.B.4
MN Standards – Gr 6-12 Science, Social Studies
SC 61312, 61341, 71111, 71121, 71123, 74211, 74212, 74213, 74222, 74323, 74412, 81111, 81121, 81341, 91112, 91115, 91311, 91313, 91343, 94412
SS 61112, 61113, 71111, 72111, 81111, 91111, 91114

Great Lakes Literacy Principles
www.greatlakesliteracy.net/
Principles 5,6,8

Nab The Aquatic Invader:
http://www.iiseagrant.org/NabInvader/
Stop Aquatic Hitchhikers:
http://stopaquatichitchhikers.org/
Habitattitude:
http://habitattitude.net/

Background and Teacher Activity

Activity at a Glance

This activity offers an engaging way for students to conduct research on a specific aquatic invasive species (AIS) based on a research source being "caught" during a fishing game. Sources of research include websites, Sea Grant factsheets, pamphlets, journal articles and other library resources.

Objectives

Students will be able to:

- Identify and explain the characteristics of one AIS, including physical description, habitat, mode of introduction, ecological impact and potential solutions.
- Interact in cooperative learning groups to share research information about an AIS with other students, create a poster and give an oral presentation to classmates.

Materials

- *Invasive Species Factsheet*
- *Invader Clue Cards*

Subject & Grade

Science, Social Studies
Grades 6-12

Class Time

Three to five class periods

Vocabulary

Ballast water
Biodiversity
Common name
Competition
Ecosystem
Invasive species
Habitat
Indigenous species
Invader species
Mode of introduction
Native species
Nonindigenous species
Nuisance species
Scientific name

Background

The introduction of aquatic invasive species (AIS) into the Great Lakes ecosystem threatens plant and animal biodiversity. These AIS are often aggressive competitors that can negatively impact the populations of native species, either intentionally or accidentally. Education about AIS may be the best way to prevent the spread of these invaders.

Helpful Hints

"Fishing for Invasive Clues" was tested in schools and proved to be a successful learning activity in both urban and suburban settings. Students were enthusiastic and engaged in meaningful learning. Classroom management problems were minimal. Students were eager to share new knowledge with classmates. Middle school students enjoyed working in groups and teaching one another.

Some helpful suggestions include:

- Prepare clue cards in advance (teacher can fill in sources or have students find their own).
- Work as a team with the school librarian to locate additional resources.
- Bookmark websites prior to activity.
- Arrange and set up tables in advance.
- Use labels to indicate which article/pamphlet/factsheet should be at each location.
- Encourage students to reach beyond the required questions.
- Display posters on bulletin board or in hallway to share with all students in the school.

Preparing for Activity

- 3" x 5" index cards (1 per student)
- Magnets (attached to back of each clue card or to use on the poles)
- Four fishing poles (or wooden dowels)
- Paper clips or doughnut-shaped magnets (one attached to each line of the pole)
- Poster paper (one sheet for each group of four)
- Markers and/or colored pencils
- Articles, factsheets or pamphlets

Procedure

Preparing for the activity

1. Prepare clue cards for the fishing expedition so that each source is represented on an index card. Use the clue card master as well as your own sources: article, pamphlet, website, or other resource.
2. Attach magnets to the bottom of each card with the blank side facing up. Attach paper clips to the fishing pole (or attach paper clips to the edge of each card and magnets to the poles).
3. Spread out materials onto different tables and label them to avoid confusion.

Individual research (50 minutes)

4. Introduce the topic of AIS and provide a working definition for the term. Locate relevant places on a map: the five Great Lakes, St. Lawrence River, Lake Champlain, Atlantic Ocean, Black Sea, and Caspian Sea.
5. Distribute the blank factsheet to each student. Briefly explain that they will obtain the following information: common name, scientific name, physical characteristics, native habitat or location,

current habitat or location, mode of introduction, problems, potential solutions to problems and a drawing or picture.

6. Have each student use a fishing pole with a paper clip or magnet hook to "fish" for a research clue on an AIS. The card provides a source for the student to investigate first and assigns an AIS to the student.
7. Students continue to investigate resource(s) of his or her choices and complete the information on the factsheet.

Sharing information in groups (50-100 minutes)

8. Students investigating the same species come together at the same table to form a cooperative learning group. They share information from various resources and discuss ideas. This can include having students list possible solutions for the problem and ways to increase the public's awareness of the problem. If a written test is desired, you could also have the groups synthesize questions for use on a written test.
9. Students design and create an educational poster that includes a picture and information about the AIS. Encourage students to present information in an original, imaginative, and unique manner.

Group presentations (50 minutes)

10. Student groups present information to classmates using their poster as a visual aid. Classmates may ask questions about their AIS (about 5-10 minutes per group).
11. Show prepared slides about AIS (optional). Provide additional information and answer student questions. Summarize by discussing questions such as:

    Why do the Great Lakes have such a problem with AIS?

    What procedures now exist that may prevent further introduction of AIS into the Great Lakes?

Wrap-Up

- Possible assignment rubric (100 points):

  30 points: Poster (creativity, originality, neatness)

  30 points: Presentation (eye contact, clarity, poise, information)

  20 points: Factsheet

  20 points: Student evaluation (15 points = evaluation by 3 other groups members; 5 points = self-evaluation)
- A written test based on the questions generated in step 8 could be used for formal evaluation.

Extension

- Additional assignments, extra-credit work, or interdisciplinary activities:

  Find 10 additional facts on each AIS.

  Create a Webpage for each AIS.

  Create and label a map that shows where an AIS originated and where it has spread.

  Explain the effect of the unintentional consequences of ballast water discharges on the spread of AIS in the Great Lakes.

  Find out why the sport-fishing industry is so important to the Great Lakes region and what the economic impact of this industry is in the basin or the Great Lake nearest your school.

  For a creative language arts activity, write a short story about an aquatic invasive species' journey to the Great Lakes.
- Invite a scientist, biologist or researcher to your school to share the latest information on AIS.

Resources

Websites:

- Great Lakes Information Network (GLIN) http://www.great-lakes.net
- Invasive Species in the Great Lakes Region: http://www.great-lakes.net/envt/flora-fauna/invasive/invasive.html
- U.S. Geological Survey, Biological Resources Division, Nonindigenous Aquatic Species Site (Gainesville, FL) http://nas.er.usgs.gov
- Great Lakes Aquatic Nonindigenous Species Information System https://www.glerl.noaa.gov/glansis/

Factsheets and Publications:

- Minnesota Sea Grant
  Rusty Crayfish: A Nasty Invader, Biology, Identification, and Impacts.
  http://www.seagrant.umn.edu/ais/rustycrayfish
- US Geological Survey, Round goby factsheet
  http://nas.er.usgs.gov/queries/FactSheet.aspx?speciesID=713

Credits

Originally created for ESCAPE Compendium, Great Lakes Sea Grant Network
Created by: Tracy A. Trzebuckowski, Brooklyn High School, Brooklyn, OH
Troy Trzebuckowski, Ford Middle School, Berea, OH
Modified by: Helen Domske, New York Sea Grant

Invasive Species Factsheet

Student Activity

Name: _____

Common name:

_____

Scientific name:

_____

Physical characteristics:

_____

_____

_____

Native habitat or location:

_____

Current habitat or location:

_____

Mode of introduction:

_____

How is AIS a problem? Explain.

_____

_____

_____

_____

What are potential solutions to the problems?

_____

_____

_____

Draw a picture of this species:

Invader Clue Cards

Zebra mussel

Circle one
Website, Pamphlet, Article, Other:_____

Title

Web address (if relevant)

Rusty crayfish

Circle one
Website, Pamphlet, Article, Other:_____

Title

Web address (if relevant)

Eurasian ruffe

Circle one
Website, Pamphlet, Article, Other:_____

Title

Web address (if relevant)

Quagga mussel

Circle one
Website, Pamphlet, Article, Other:_____

Title

Web address (if relevant)

Sea lamprey

Circle one
Website, Pamphlet, Article, Other:_____

Title

Web address (if relevant)

Purple loosestrife

Circle one
Website, Pamphlet, Article, Other:_____

Title

Web address (if relevant)

Spiny waterflea

Circle one
Website, Pamphlet, Article, Other:_____

Title

Web address (if relevant)

Round goby

Circle one
Website, Pamphlet, Article, Other:_____

Title

Web address (if relevant)

Aquatic Invasives Rule!

Next Generation Science Standards:
www.nextgenscience.org/
MS-LS1
MS-LS1-5
MS-LS2
MS-LS2-1
MS-LS2-2
MS-LS2-3
MS-LS2-4
MS-LS2-5
MS-ESS3
MS-SS3-3.
New York State P-12 Science Learning Standards:
www.p.12nysed.gov/ciai/mst/sci/nyssls.html/
MS-LS1-5
MS-LS2-1
MS-LS2-3
MS-LS2-4
MS-LS2-2
MS-LS2-5
MS-ESS3-3
Common Core State Standards Connections:
ELA/Literacy:
www.corestandards.org/ELA-Literacy/
RST.6-8.1
RST.6-8.2
RST.6-8.7
RI.8.8
WHST.6-8.2
WHST.6-8.7
WHST.6-8.8
WHST.6-8.9
WHST.6-8.1
SL.8.1
SL.8.4
SL.8.5
Mathematics:
www.corestandards.org/Math/
MP.4
6.RP.A.1
6.RP.A.3
6.SP.B.4
6.SP.B.5
7.RP.A.2
6.EE.B.6
6.EE.C.9
7.EE.B.4
MN Standards – Gr 7-12 Science, Social Studies
SC 71111, 74212, 74213, 74323, 74412, 81341, 83412, 91311, 91313, 91343, 94211, 94212, 94335, 94412
SS 71111, 81111, 91111

Great Lakes Literacy Principles
www.greatlakesliteracy.net/
Principles 5,6,8

Nab The Aquatic Invader:
http://www.iiseagrant.org/NabInvader/
Stop Aquatic Hitchhikers:
http://stopaquatichitchhikers.org/
Habitattitude:
http://habitattitude.net/

Background and Teacher Activity

Activity at a Glance

Students research the physical, biological, and behavioral characteristics of aquatic invasive species (AIS) that help them to out-compete native species. The activity concludes with an *Aquatic Invasive Species Advantage Forum* where students present their findings and conclusions.

Objectives

Students will be able to:

- Compare and contrast an AIS with a similar native species.
- Describe their life cycles, habitat needs, physical structures and behavioral characteristics.
- Identify specific adaptive characteristics of AIS that help them to be successful in the environments to which they are introduced.

Materials

- *Aquatic Invasive Species Advantage Forum Rubric*
- *Zebra Mussel Quiz*
- Sample zebra or quagga mussel shells. (It may be illegal to obtain in your area. Contact local authorities to check.)
- Preserved specimens of native and invasive species from the same habitat (if legal to obtain, i.e. zebra or quagga mussels and native mussels). Detailed anatomical charts will suffice.
- Photographs of AIS and the native species being researched.
- Information on the life cycle and behaviors of the animals or plants being compared.

Subject & Grade

Science, Social Studies
Grades 7-12

Vocabulary

Adaptation
Competition
Dispersal
Habitat

Class Time

Three class periods

**Use of shells may be illegal in some jurisdictions. Contact your local natural resource management agency for more information.*

Background

Not all aquatic invasive species (AIS) appear to be harmful, but many are detrimental to native species because of rapid reproduction rates, ability to survive in adverse circumstances and lack of predatory pressures. The behavior and physical structure of AIS have an effect on all these facets.

Animal and plant anatomies are often studied in life science classrooms. Animal behavior is studied less frequently, particularly during the middle school or junior high years. Very seldom are the concepts of anatomy, structure, function and behavior looked at collectively to see how they relate to an organism's success in its environment. This activity takes a more encompassing look at these factors as they pertain to the dispersal, reproduction and successful establishment of AIS over similar native species sharing the same habitats.

Helpful Hints

The grade level and purpose of this activity will determine its scope. Teachers may want to limit research to a specific pair of organisms for younger students, or may want to look at AIS as a whole to determine the reasons for their success. This activity can fulfill needs in the curricula for anatomy, animal behavior, ecology, social studies and geography.

Preserved specimens may be available from science supply companies, or it may be possible to borrow them from local college biology departments, US Fish and Wildlife Services offices, state department of natural resources, environmental conservation departments or Sea Grant offices.

Procedure

1. Provide a definition of AIS, and have student groups examine preserved specimens or representations (e.g., photographs, line drawings, and anatomical representations) of various aquatic invasive and native species that occupy the same habitats.
2. After students select an AIS and a related native species to research, have them study those specimens or their representations closely. Explain that they will be gathering information to discover why the AIS can thrive in their habitats. The information researched for the aquatic invasive and native species should include: distribution, habitat needs (including needs for food, shelter, and reproduction), life cycles and analysis of relationships among body structure, behavior and function.
3. Students conduct research and organize their information as required by the teacher (e.g., in journal form, note form or a formal report.) Then they synthesize the information into conclusions about AIS adaptations. Teachers could require answers for the questions below. Or, since national and state standards call for extended study inquiry, students could generate the questions themselves.
    - What similarities/differences does this AIS have with a native species occupying the same environment? (Include anatomy, behavior, habitat needs and life cycle.)
    - How does the presence of the AIS in the environment affect the particular native species you selected for study?
    - What specific adaptations relate to geographic dispersal of AIS and methods for controlling their spread?
4. Students present their findings in an "Aquatic Invasive Species Advantage Forum" as representative experts on their researched species. Groups of students could serve as advertising agencies for the species and their adaptation advantages.

Wrap-Up

The *Aquatic Invasive Species Advantage Forum Rubric* and the *Zebra Mussel Quiz* allow sufficient means for evaluating student progress. Two months after this activity, it might be a good idea to ask the students to write a paragraph about AIS in order to judge student retention of the material covered.

Extension

Relate AIS adaptations to a local problem with such a species. Are there fishing lakes being affected by an AIS invasion? What are the far-reaching effects of this invasion? What is known about the adaptations of this species that will help people to understand and control its spread?

Resources

Websites:

- Great Lakes Information Network (GLIN): http://www.great-lakes.net
- Great Lakes Aquatic Nonindigenous Species Information System https://www.glerl.noaa.gov/glansis/
- Invasive Species in the Great Lakes Region: http://www.great-lakes.net/envt/flora-fauna/invasive/invasive.html
- U.S. Geological Survey, Biological Resources Division, Nonindigenous Aquatic Species Site (Gainesville, FL): http://nas.er.usgs.gov

Kits:

- Exotic Aquatics Traveling Trunk: an interactive kit containing preserved and facsimiles of AIS available from Minnesota Sea Grant College Program.
  Contact Doug Jensen via e-mail at djensen1@d.umn.edu or visit http://www.seagrant.umn.edu/educators/tt

- Zebra Mussel Mania Traveling Trunk: hands-on, inquiry-based kit and curriculum that contains simulations, experiments, videos, games, and stories. Also includes ideas for student-led community action projects. Available at lending centers across the United States and Canada.
  Contact Terri Hallesy via email at thallesy@illinois.edu or visit http://iiseagrant.org/catalog/ed/zmm.php

Credits

Originally created for ESCAPE Compendium, Great Lakes Sea Grant Network
Created by: Marlene Schoeneck, Parkers Prairie High School, Parkers Prairie, MN
Modified by: Helen Domske, New York Sea Grant

Aquatic Invasive Species Advantage Forum Rubric

Teacher Activity

Criteria	Exemplary	Proficient	Developing	Beginning	Unacceptable	Score
Written content from student research (journal, notes, formal report, etc.) **(30 points)**	Developed conclusions fully. Good, logical organization. Used reliable sources. Referenced accurate and relevant facts/ examples. **(27–30)**	Satisfactory development of conclusions. Decent organization. Used mostly accurate and relevant facts/examples. **(21–26)**	Showed weakness in development of conclusions. Showed some organization. Used some accurate and relevant facts/examples. **(15–20)**	Minimally developed conclusions. Little or no organization. Little or no use of relevant facts/ examples. **(10–14)**	Incomplete development of conclusions. Unclear ideas. Hard to understand. **(0–9)**	
Oral presentation from Aquatic Invasive Species Advantage Forum. **(50 points)**	Elaborate, quoted sources, correctly answered questions. Referenced accurate and relevant facts/ examples. Spoke clearly, did not read from notes. **(45–50)**	Less elaborate, correctly answered questions. Used mostly accurate and relevant facts/examples. Spoke clearly, referred to notes. **(35–45)**	Less elaborate, answered questions. Used some accurate and relevant facts/examples. Spoke clearly, read directly from notes. **(25–34)**	Simple, unable to answer questions. Used little or no relevant facts or examples. Unclear speech, referred to notes. **(16–24)**	Incomplete, unable to answer questions. Unclear speech, read notes. **(0–15)**	
Grammar & Spelling. **(10 points)**	All grammar and spelling correct. **(9–10)**	One or two grammar and spelling errors. **(7–8)**	Three or four grammar and spelling errors. **(5–6)**	More than four grammar and spelling errors. **(3–4)**	Very frequent grammar and spelling errors. **(0–2)**	
Timeliness **(10 points)**	Assignment handed in on time. **(10)**	One day late. **(8)**	Two days late. **(6)**	Three days late. **(4)**	More than three days late. **(2)**	

Zebra Mussel Quiz

Student Activity

Name:_____

Draw a zebra mussel in the space below (5 points) and label its byssal threads.

Matching

_____ 1. Ballast water

_____ 2. Byssal thread

_____ 3. Aquatic Invasive species

_____ 4. Indigenous species

_____ 5. Veliger

A. Organism that is foreign, not native to a particular location

B. Zebra mussel larvae

C. Carried in a boat to keep it from tipping upside down

D. String like substance on an invasive mollusk used to attach to cans, rocks, boats, etc.

E. Organism that is native to a particular location or area

True-False

_____ 6. Zebra mussels filter the water in lakes and waterways and make it clearer.

_____ 7. The Great Lakes have been affected by zebra mussels.

_____ 8. Zebra mussels traveled to North America in ballast water of ships.

_____ 9. Zebra mussels survive well in water that is very salty and very cold.

_____ 10. Zebra mussels help the food chain on a lake.

_____ 11. Zebra mussels can move into other bodies of water by people carrying bait water from one lake to another.

_____ 12. Zebra mussels invaded North America in 1999, in the bottom of an airplane.

Fill-in-the-Blanks (Choose from the answers at the bottom of the page)

13. Mussels and clams which have two shells are _____ mollusks.

14. Through _____, zebra mussels improve the clarity of water.

15. Aquatic invasive species are _____ life organisms introduced into a habitat where they are not native.

16. Aquatic invasive species are a real _____ threat.

17. Zebra mussel larvae, or _____, attach to hard surfaces such as stones, metal or crayfish.

18. Zebra mussels are without natural _____, so they often try to take the place of native species.

19. Zebra mussels attach to _____, _____, boats, and even to each other.

20. Zebra mussels _____ and damage engines on boats.

animal and plant	bivalve	filtering	veligers
clog	rocks, docks	predators	environmental

Zebra Mussel Quiz Answer Key

Matching

1. C
2. D
3. A
4. E
5. B

True or False

6. T
7. T
8. T
9. F
10. F
11. T
12. F

Fill-in-the-Blank

13. bivalve
14. filtering
15. animal and plant
16. environmental
17. veligers
18. predators
19. rocks, docks
20. clog

Characteristics of Great Lakes Invasive Species

Next Generation Science Standards:
www.nextgenscience.org/
5-ESS3 5-ESS3-1
MS-LS1 MS-LS1-5
MS-LS2 MS-LS2-1
MS-LS2-2 MS-LS2-3
MS-LS2-4 MS-LS2-5
MS-ESS3 MS-ESS3-3
New York State P-12 Science Learning Standards:
www.p.12nysed.gov/ciai/mst/sci/nyssls.html/
5-ESS3-1
MS-LS1-5
MS-LS2-1
MS-LS2-3
MS-LS2-4
MS-LS2-2
MS-LS2-5
MS-ESS3-3
Common Core State Standards Connections:
ELA/Literacy:
www.corestandards.org/ELA-Literacy/
RI.5.1
RI.5.7
RI.5.9
W.5.8
W.5.9
RST.6-8.1
RST.6-8.2
RST.6-8.7
RI.8.8)
WHST.6-8.2
WHST.6-8.7
WHST.6-8.8)
WHST.6-8.9
WHST.6-8.1
SL.8.1
SL.8.4
SL.8.5
Mathematics:
www.corestandards.org/Math/
MP.2
MP.4
6.RP.A.1
6.RP.A.3
6.SP.B.4
6.SP.B.5
7.RP.A.2
6.EE.B.6
6.EE.C.9
7.EE.B.4
MN Standards – Gr 6-8 Science, Social Studies
SC 61311, 61341, 74211, 74212, 74222, 74323, 81121
SS 61112, 71111, 81111

Great Lakes Literacy Principles:
www.greatlakesliteracy.net/
Principles 5, 6

Nab The Aquatic Invader:
http://www.iiseagrant.org/NabInvader/
Stop Aquatic Hitchhikers:
http://stopaquatichitchhikers.org/
Habitattitude:
http://habitattitude.net/

Background and Teacher Activity

Activity at a Glance

Students use puzzle pieces to match Great Lakes aquatic invasive species (AIS) with their characteristics, classification, origin, and introduction to the ecosystem.

Objectives

Students will be able to:

- Name and recognize some AIS of the Great Lakes.
- Identify the characteristics of AIS in the Great Lakes ecosystem.
- Match the ways in which AIS are introduced into the Great Lakes.

Materials

- *AIS Puzzles*
- Blank puzzle template
- Envelope with colored pencils for each group
- 8 ½ x 11 colored paper (8 sheets per group, one color per group)
- Scissors

Subject & Grade

Science, Social Studies
Grades 6-8

Class Time

One or two class periods

Vocabulary

Alewife
Characteristics
Classification
Common name
Eurasian watermilfoil
Exotic species
Origin
Purple loosestrife
Eurasian ruffe
Scientific name
Sea lamprey
Spiny waterflea
White perch
Zebra mussel

Background

Knowledge of Great Lakes aquatic invasive species (AIS) is important if students are going to make educated decisions about them and the environment in the future. The zebra mussel (*Dreissena polymorpha*) originally came from areas near the Caspian Sea and entered waterways at Lake St. Clair around 1985. Zebra mussels are bivalve mollusks that were carried in the ballast tanks of ocean-going ships. They filter water by feeding on plankton, reducing food for other animals and fish that feed on plankton. Zebra mussels attach to any object, including water intake pipes, boat trailers and boat hulls.

Sea lamprey (*Petromyzon marinus*) swam up the St. Lawrence River or the Erie Canal from the Atlantic Ocean and entered the Great Lakes. They are classified as primitive fish. They spawn up freshwater tributaries and are a parasite on native and stocked freshwater fish.

The spiny waterflea (*Bythotrephes longimanus*) is native to Northern Europe and parts of Asia. They entered Lake Ontario in 1982 and can now be found throughout the Great Lakes. They were introduced into the Great Lakes by ballast water discharged from ocean-going ships. Spiny waterfleas feed on smaller zooplankton, such as *Daphnia*, which are important food for fish.

Ruffe (*Gymnocephalus cernuus*) came from freshwater of Eurasia. They were discovered in Lake Superior in 1987, (based on 1986 samples) and had "hitchhiked" in ballast water. They have a dark spot on their dorsal fins and are a perch-like fish.

The alewife (*Alosa pseudoharengus*) came from the Atlantic Ocean. It entered the Great Lakes through the Welland and Erie Canals. They are a herring-like fish with one dorsal fin and they compete with other fish that feed on plankton.

White perch (*Morone americana*) came from the Atlantic Ocean through the Erie and Welland Canals. White perch compete with native fish species and have the potential to cause decreases in fish populations because they eat the eggs of walleye and other fish species.

Purple loosestrife (*Lythrum salicaria*) is native to northern Europe and was intentionally imported for its hardiness and beautiful flowers. Purple loosestrife invades marshes and wetlands, replacing cattails and other aquatic plants. They form dense, impenetrable stands and are unsuitable as cover, food, or nesting sites for many native wetland animals.

Eurasian watermilfoil (*Myriophyllum spicatum*) is native to Europe, Asia, and Africa. This aquatic plant was introduced as an aquarium plant and by boats. It forms thick mats that choke out native aquatic plants. It has the ability to reproduce through stem fragments and runners, so a single segment of stem and leaves can actually form a new colony.

Helpful Hints

Students should have studied or researched specific AIS of the Great Lakes. If research did not cover all of the categories used for the puzzle, have students do the necessary research before doing all the puzzles.

You may want to limit the number of AIS you put into each envelope. Four or six AIS may be a better way to start, depending on the group's ability level. This activity may take longer than one class period if you use all eight puzzles.

Make sure that the puzzles are all the same color and are shuffled in each individual envelope.
Have the students take turns choosing puzzle pieces, but have them work together as a team deciding on the proper placement of the puzzle pieces.

The teacher should move between groups questioning the students on their progress. It may be helpful to ask:

What is the number of puzzle pieces?
What category does the number represent?

Procedure

Preparing for the activity

1. Copy the included puzzles on colored paper. Each group of students should have a different color, and all the puzzle pieces for a group should be the same color.
2. Using scissors, cut out the puzzles. Each AIS has six pieces, and there should be 48 pieces when complete, if all the species are used.
3. Shuffle puzzle pieces in each group's envelope. Copy the puzzle template with category name for each group.
4. Have students use resources to locate any information that is represented in the puzzle and has not been previously researched; origin, introduction to the Great Lakes, characteristics, or classification.

Conducting the activity

5. Divide students into cooperative learning groups of two or three students. Give each group an envelope with the shuffled puzzle pieces.
6. Provide each group with the puzzle template that contains the category names so they know what each of the numbered puzzle pieces represents.
7. Have students sort the puzzle pieces by number and then try to separate and match the pieces, in order by number. For example, have students first lay out all the pieces numbered as "1", which is the common and scientific name. Then have them match each of the pieces numbered "2", the pictures, with each of the corresponding names. Then go to the pieces numbered "3" to match the species origin to the correct puzzle and so on.
8. Let students use their notes the first time through the puzzle. Check to see that they have made the right choices, then scramble the pieces and let them try the puzzle without their notes. Switch group members, if time allows, and try the puzzle again.

Wrap-Up

The information from the puzzles could be used to design an objective test if a formal method of evaluation is desired. For an informal evaluation, teachers can determine grades for each group based on their success with completing the puzzles and doing the activity.

Extension

Students can create their own puzzles for other invasive species using the blank puzzle template.

Resources

Websites:

- Great Lakes Information Network (GLIN): http://www.great-lakes.net/envt/flora-fauna/invasive/invasive.html
- Great Lakes Commission: http://glc.org/projects/invasive
- U.S. Geological Survey, Nonindigenous Aquatic Species Web Site https://nas.er.usgs.gov/about/default.aspx
- Great Lakes Aquatic Nonindigenous Species Information System https://www.glerl.noaa.gov/glansis/

Kits:

- Exotic Aquatics Traveling Trunk, an interactive education kit containing preserved and facsimiles of aquatic exotic species available from Minnesota Sea Grant College Program.
  Contact Doug Jensen, 218-726-8712; e-mail: djensen1@d.umn.edu or visit the Website:
  http://www.seagrant.umn.edu/educators/tt

- Zebra Mussel Mania Traveling Trunk, a hands-on, inquiry-based kit and curriculum that contains simulations, experiments, videos, games, stories, and a CD-ROM; also includes ideas for student-led community action projects. Available at lending centers across the United States and Canada.
  Contact Terri Hallesy, Illinois-Indiana Sea Grant, 217-244-8809; thallesy@illinois.edu
  or visit: http://iiseagrant.org/catalog/ed/zmm.php

Credits

Originally created for ESCAPE Compendium, Great Lakes Sea Grant Network
Created by: Thomas E. Cooper (Retired) Gowanda Central School, Gowanda, NY
Modified by: Helen Domske, New York Sea Grant

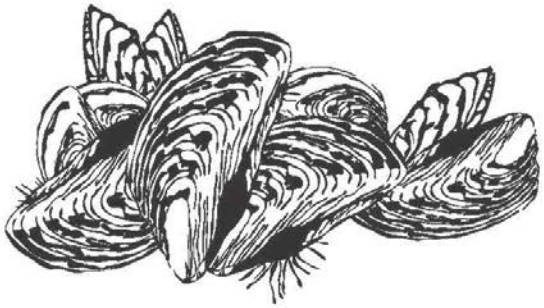
1

Aquatic Invasive Species #1

Zebra Mussel

(Dreissena polymorpha)

2



3

Came from the Caspian Sea

4

Entered Lake St. Clair in 1985 from ship ballast tanks.

5

Mollusk (bivalve)

6

Filter feeds on plankton

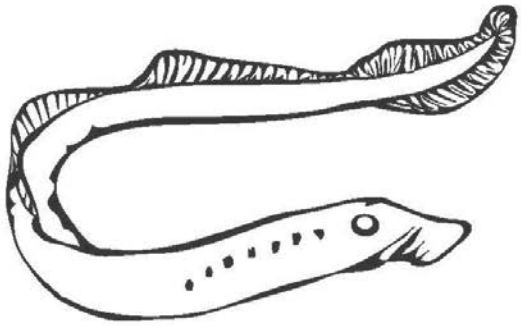
1

Aquatic Invasive Species #2

Sea Lamprey

(Petromyzon marinus)

2



3

Came from Atlantic Ocean

4

Spawn up freshwater tributaries

5

Sucker-like mouth and parasitic on fish, especially Lake Trout.

6

Primitive fish

1

Aquatic Invasive Species #3

Spiny Waterflea

(Bythotrephes cederstroemi)

2

3

Native to Northern Europe

4

Entered Lake Ontario in 1982, and can now be found throughout the Great Lakes. Spread by ballast water of ships.

5

This form of lake plankton feeds on smaller plankton.

6

Invertebrate

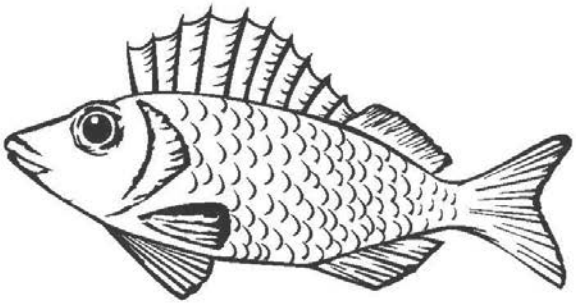
1

Aquatic Invasive Species #4

Eurasian Ruffe

(Gymnocephalus cernuus)

2



3

Freshwater and brackish water of Northern Europe

4

Discovered in Lake Superior in 1987, where it "hitchhiked" in Ballast water.

5

This bottom feeder has many dark spots on its dorsal fin.

6

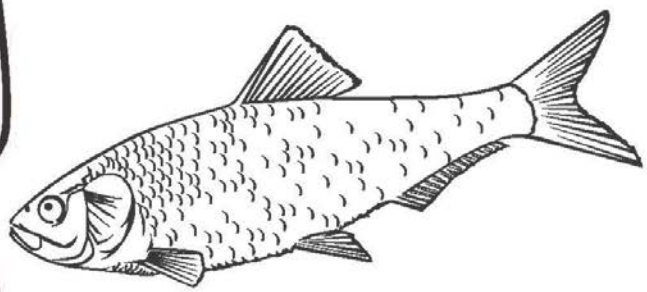
Perch-like fish

1

Aquatic
Invasive Species #5

Alewife
(Alosa pseudoharendus)

2



3

Atlantic Ocean

4

It swam to the upper Great Lakes prior to 1932, through the Welland and Erie Canals.

5

Grows to approximately 5 inches and has one dorsal fin.

6

Herring-like fish

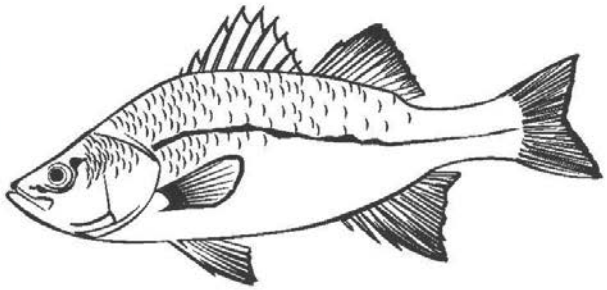
1

Aquatic Invasive Species #6

White Perch

(Morone americana)

2



3

Atlantic Ocean

4

Swam through various canal systems.

5

Grows to 8-12 inches and has no dark spots on the dorsal fin.

6

Fish

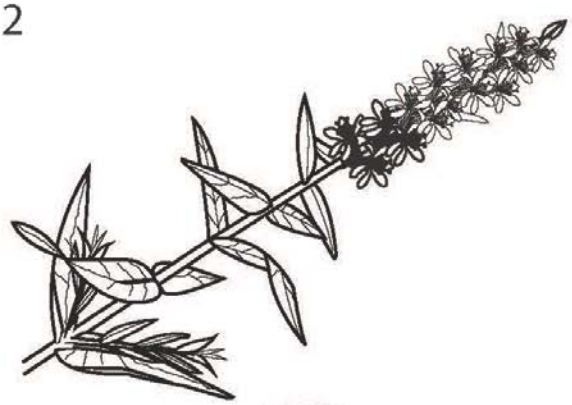
1

Aquatic Invasive Species #7

Purple Loosestrife

(Lythrum salicaria)

2



3

4

Northern Europe

Imported for its hardiness and beautiful flowers.

5

6

The “beautiful killer” crowds out other plants and grows to 10 feet tall.

Flowering plant

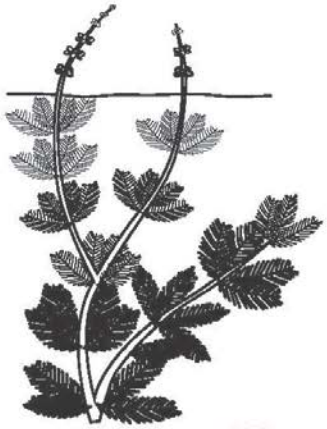
1

Aquatic Invasive Species #8

Eurasian Watermilfoil

(Myriophyllum spicatum)

2



3

Europe, Asia, and Africa

4

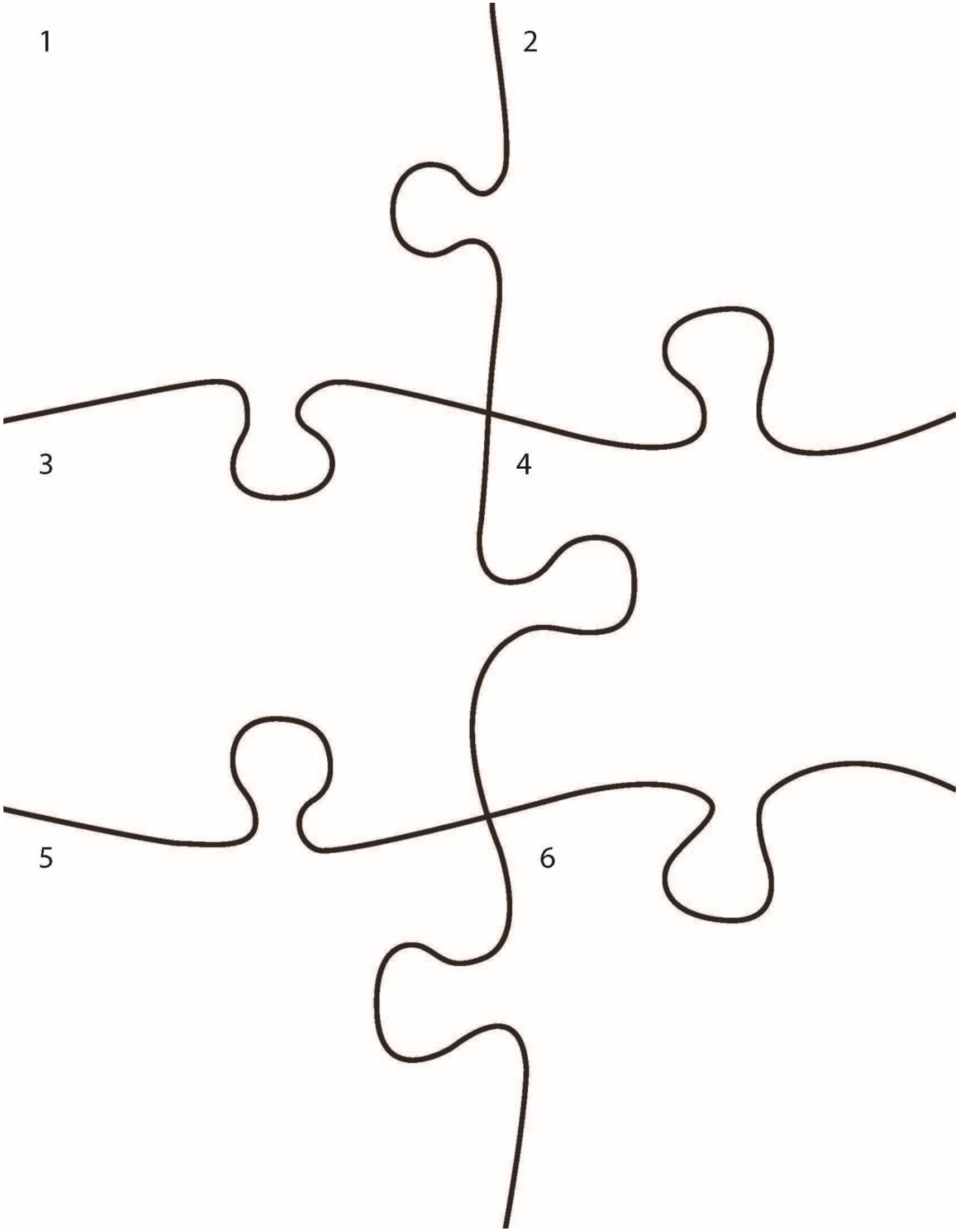
Introduced as an aquarium plant.

5

Forms thick mats that choke out native aquatic plants.

6

Aquatic plant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Rust Never Sleeps

Next Generation Science Standards:
www.nextgenscience.org/
MS-LS1
MS-LS1-5
MS-LS2
MS-LS2-1
MS-LS2-2

New York State P-12 Science Learning Standards:
www.p.12nysed.gov/ciai/mst/sci/nyssls.html/
MS-LS1-5
MS-LS2-1
MS-LS2-2

Common Core State Standards Connections:
ELA/Literacy:
www.corestandards.org/ELA-Literacy/
RST.6-8.1
RST.6-8.2
RST.6-8.7
WHST.6-8.2
WHST.6-8.9
WHST.6-8.1
SL.8.1
SL.8.4

Mathematics:
www.corestandards.org/Math/
6.SP.B.4
6.SP.B.5

MN Standards – Gr 6 Science, Social Studies, Mathematics
SC 61311, 61341
SS 61112, 61113, 62481
MATH 66211, 66411

Great Lakes Literacy Principles:
www.greatlakesliteracy.net/
Principles 5, 6

Nab The Aquatic Invader:
http://www.iiseagrant.org/NabInvader/
Stop Aquatic Hitchhikers:
http://stopaquatichitchhikers.org/
Habitattitude:
http://habitattitude.net/

Background and Teacher Activity

Activity at a Glance

Through a role-playing simulation, students focus on negative impacts on aquatic ecosystems created by the invasion of rusty crayfish. Students assume the role of rusty crayfish, native crayfish, juvenile fish or largemouth bass.

Objectives

Students will be able to:

- Describe the effects that rusty crayfish have on aquatic ecosystems.
- Identify reasons why rusty crayfish populations have spread.
- Compare food chains that include native species and those that include introduced species.

Materials

- *Identification Tags*
- *Rusty Crayfish Factsheet*
- 150-200 poker chips or cardboard squares to represent food (aquatic plants and insects)
- Six rope circles to represent safe areas in aquatic plant beds
- Dry erase board, paper, tablet or computer

Subject & Grade

Science, Social Studies, Mathematics
Grade 6

Class Time

One class period

Vocabulary

Ecosystem
Invasive species
Food web
Rusty crayfish

Background

Crayfish ("crawdads") are found in almost all aquatic habitats of the Great Lakes region including lakes, creeks, rivers and wetlands. By feeding on plant materials, insects, and snails and by being a favorite prey item of sport fish, such as bass and sunfish, crayfish function as important members of aquatic food webs.

The use of crayfish as fishing bait and for school projects has led to the introduction of non-native or invasive crayfish species, such as the rusty crayfish and red swamp crayfish. Teachers who purchase crayfish for classroom use from biological supply operations should not allow the release of these animals into local environments. Commercial harvesters and bait bucket releases have also been implicated as a means of transport.

Rusty crayfish cause a variety of negative impacts to aquatic ecosystems. They are a large, very aggressive species that can displace native crayfish. Being forced out of habitats that provide refuge from predators, native crayfish are either consumed by fish or mammal species, or forced to move to other areas to feed. Rusty crayfish have also been shown to reduce aquatic plant abundance and diversity. In some lakes, plants have nearly been eliminated. These aquatic plants are important because they provide habitat for invertebrates, shelter for young fish and nesting substrate for fish.

Helpful Hints

Students should have already been introduced to food chains, ecosystems and aquatic invasive species (AIS). Instead of identification tags, different colored arm bands can be used to identify adult bass, juvenile fish, rusty crayfish, and native crayfish.

Refer to diagram in step 3 under Procedure for setting up the playing area. Use a dry erase board, note pad, laptop, etc. to graph results of population changes. Impress on students that aquatic ecosystems are very complex and that this activity is a very simplified version of what may happen. Be sure to adjust length of feeding time and number of each species for larger and smaller classes.

Procedure

1. Before the activity begins, prepare the Identification Tags (located at the end of the instructions). Make copies, laminate them (optional), and cut out individual tags. See step 4 for the number of each species needed to start the game. More rusty crayfish and adult bass are used as the game progresses, and additional tags are needed if variations are used as described in step 5 of "Directions."

2. Go over background information with students. Read the *Rusty Crayfish Factsheet* to the class for introductory information on why rusty crayfish possess many advantages. Present an overview of the simulation and read the rules for each species (these are written on the Identification Tags found at the end of the instructions and also provided below).

   Rusty Crayfish

   - You are safe as long as you are in the rope circle. If you are tagged, go to the sideline. In the wild, crayfish would seek shelter under a rock or in vegetation.
   - You must collect 10 food chips in order to survive.
   - You can use two hands to collect and store your food.
   - You will be given an additional 20 seconds to feed (due to higher metabolic rate).

Native Crayfish

- You are safe as long as you are in the confines of the rope circle. If tagged, you must go to the sideline. In the wild, crayfish would seek shelter under a rock.
- You must collect 7 food chips in order to survive.
- You can use only one hand to collect and store your food.
- You may be asked to leave a plant bed if you have been displaced by the rusty crayfish.
- You must leave the plant bed once all the food chips have been used up.

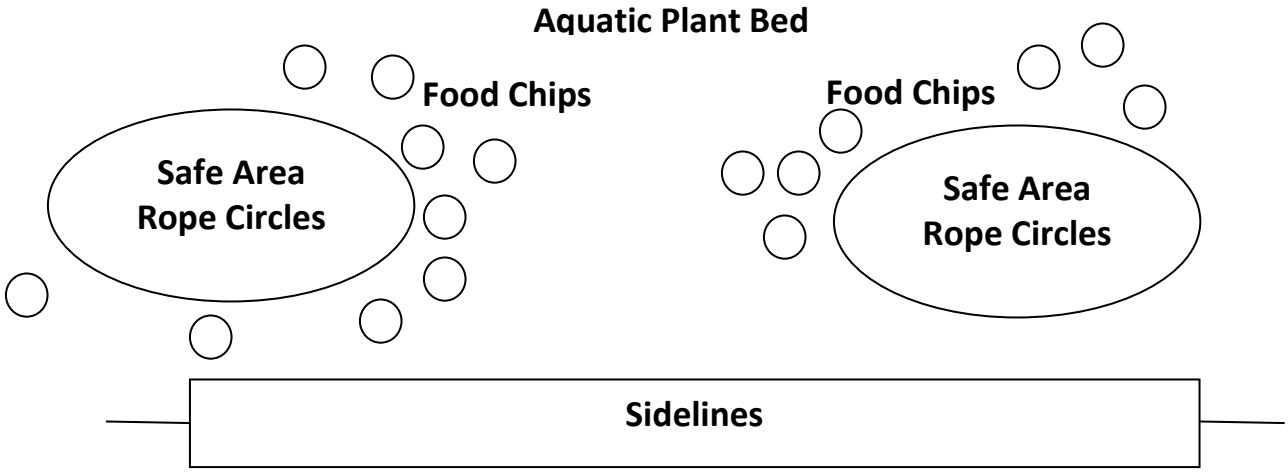
Juvenile Fish

- You are safe as long as you are in the confines of the rope circle. If tagged, you must go to the sideline.
- You must collect 5 food chips in order to survive.
- You can use only one hand to collect and store your food.
- You may be asked to leave a plant bed if you have been displaced by the rusty crayfish.
- You must leave the plant bed once all the food chips have been used up.
- There can be only 2 juvenile fish at each plant bed. This number may change depending on class size.

Adult Bass

- You may tag any crayfish or juvenile fish while they are feeding to indicate that you consumed them. You may not tag them if they are in the rope circle.
- If you tag any crayfish or juvenile fish, you must walk them over to the sidelines before feeding again.

3. Set up the simulation areas as shown below. Place the six rope circles in the playing area and scatter poker chips around each of the rope circles. The poker chips represent food items found in aquatic plant beds; the rope circles are safe areas in the aquatic plant beds. Poker chips can be divided evenly among each plant bed, or you can have some plant beds that are more productive (more chips) or less productive (fewer chips).



4. Distribute the identification tags to assign students roles as adult bass, juvenile fish, rusty crayfish, or native crayfish. For a class of 25 students, you may wish to have five adult bass, five juvenile fish, ten native crayfish, and five rusty crayfish. This could reflect a situation just after rusty crayfish

have been introduced into the area. Discuss the food chain that the simulation portrays, and have students visualize the habitat in the simulation as it might occur in its natural setting.

5. Conduct the simulation following the steps in "Directions" and have a follow-up discussion when students resume their seats in the classroom. Possible questions (with possible answers) include the following:
   What happened to the native crayfish population as the game went on?
   Native crayfish populations went down, while rusty crayfish populations increased.
   Why did this happen?
   They displace native crayfish in lakes, creeks, and rivers. After being forced out of habitats that provide refuge from predators, native crayfish are either consumed by fish or mammal species or forced to move to other areas.
   What happened to the rusty crayfish population and why?
   They grow larger, are more aggressive and attain very high population densities. It has also been shown that because of their higher metabolic rate, rusty crayfish might consume twice as many invertebrates than do native crayfish.
   How are juvenile fish affected by rusty crayfish? What might happen to the aquatic ecosystem if there are fewer juvenile fish?
   Juvenile fish may need to compete with rusty crayfish for food sources. This competition may cause a bottleneck effect that can reduce fish populations.
   What other organisms might be affected by the introduction of rusty crayfish?
   There may be less vegetation available to fish which are dependent on vegetation for laying eggs. (Female crayfish carry their eggs on the ventral side of their abdomen on the swimmerets; eggs are not laid on vegetation. Once hatched, young crayfish may stay with the female for several weeks.)

6. Additional work to assign for assessment purposes includes the following:
   - Draw or write a description of food chains that include native species and food chains that include introduced species.
   - List the reasons why rusty crayfish have been able to outcompete native crayfish.
   - List other AIS and impacts they have had on ecosystems.
   - List ways to get the public to help stop the spread of rusty crayfish (in the form of a public service announcement, poster or sign). Raise awareness that crayfish used as bait or released from aquaria into the environment can cause biological pollution and can be illegal in some states.

Game Directions

1. Start the game by having the juvenile fish, native crayfish, and rusty crayfish feed by collecting food chips. (Adult bass are actively feeding throughout the game.) Stop the game after crayfish have had a chance to feed for a few minutes (depending on class size). Native crayfish and juvenile fish must now stop feeding, but rusty crayfish can continue for an additional 30 seconds.

2. If all the food chips have been used up at this time, inform the crayfish and juvenile crayfish that they must move to another plant bed. If there are food chips remaining, only the larger more aggressive rusty crayfish may stay and feed; the native crayfish and juvenile fish must leave.

3. Begin the feeding activity again and continue until all the food chips have been gathered or only rusty crayfish are left. Only the juvenile fish, rusty crayfish, and native crayfish that have collected

enough food chips to survive will remain as they are for the start of the second round.

4. Begin the second round by having all tagged students on the sidelines reenter the game as adult bass or rusty crayfish. Native crayfish and juvenile fish that did not collect enough food reenter the game as rusty crayfish. Species that survived by collecting enough food chips will assume the same role as before. Count the numbers of each species for the beginning of the second round. This is the count used for your graph.

5. Continue game for another two or three rounds, or as time permits. After each round, compute the number of fish and crayfish that are ready to start the next round, and graph this data. For "Round 1" data, plot the numbers for each species that were used to start the game (at step 4 of the "itinerary"). Plot the number of species starting the second round for "Round 2" of your graph, and so on. You may wish to try a round without any rusty crayfish, or with only rusty crayfish and bass.

Wrap-Up

Evaluation is based on the written responses to questions assigned at step 6 of the procedure.

Extension

- This activity can be used as an introduction to AIS. Students may wish to research other AIS and the impacts they have had on other ecosystems.
- On a state or Great Lakes map have students locate areas near them where rusty crayfish are found. The US Geological Survey has an animated map of the spread which can be used for reference: http://nas.er.usgs.gov/queries/SpeciesAnimatedMap.aspx?speciesID=214

Resources

Websites, Factsheets and Publications:

- Minnesota Sea Grant - Rusty Crayfish: A Nasty Invader: http://www.seagrant.umn.edu/ais/rustycrayfish
- US Geological Survey – Rusty Crayfish Factsheet: http://nas.er.usgs.gov/queries/FactSheet.aspx?speciesID=214
- Wisconsin Department of Natural Resources – Rusty Crayfish: http://dnr.wi.gov/topic/Invasives/fact/RustyCrayfish2012.html
- IL-IN Sea Grant Classroom Pet Adoption Pledge: http://www.iiseagrant.org/NabInvader/ClassroomPetAdoptionPledge.pdf

Credits

Originally created for ESCAPE Compendium, Great Lakes Sea Grant Network
Created by: Tim Prange and Dave Guritz, Max McGraw Wildlife Foundation, Dundee IL;
Mary Mickus, Jurica Nature Museum, Lisle, IL
Modified by: Helen Domske, New York Sea Grant

Rusty Crayfish Factsheet

Student Activity

Crayfish or ("crawdads") are found in almost all aquatic habitats in the Great Lakes region, including lakes, creeks, rivers and wetlands. They feed on plant materials, insects and snails and serve as a favorite prey item of sport fish, such as bass and sunfish, which makes them an important part of aquatic food webs. The appetite of sport fish for crayfish has led to the introduction of non-native or invasive species. When anglers use crayfish as bait, they often dump unused crayfish into lakes and rivers when they are finished fishing. This practice has increased the establishment and rapid spread of the rusty crayfish (*Orconectes rusticus*). Rusty crayfish and red swamp crayfish are also sold to schools by biological supply houses and unknowing teachers have released rusty crayfish into the environment. Commercial bait harvesters have also been implicated in the transport of rusty crayfish.

Rusty crayfish are thought to be native to the Ohio River basin, including such states as Ohio, Kentucky, and Indiana. Today, they can be found in these states as well as the other Great Lakes states, New Mexico, and all the New England states, except Rhode Island.

Rusty crayfish cause a variety of negative impacts to aquatic ecosystems. They are a large, very aggressive species that may displace native crayfish. If forced out of habitats that provide refuge from predators, native crayfish are either consumed by fish or mammal species or forced to move to other areas. In some areas where rusty crayfish are now found, many native crayfish are either present in small numbers or totally absent.

Rusty crayfish have also been shown to reduce aquatic plant abundance and diversity. In some lakes, plants have been nearly eliminated. These aquatic plants are important for aquatic systems in that they provide habitat for invertebrates, shelter for young fish, and nesting substrate fish. Although other crayfish eat aquatic plants, rusty crayfish eat even more because of their higher metabolic rate and appetite. Rusty crayfish also grow larger, feed longer, and attain very high population densities. It has also been shown that because of this higher metabolic rate, rusty crayfish might consume twice as many invertebrates than do native crayfish. Rusty crayfish can also reduce the population numbers of juvenile fish species through competition for food sources.

The activity "Rust Never Sleeps" focuses on some of the negative impacts rusty crayfish have had on aquatic ecosystems. Students take the role of rusty crayfish, native crayfish, juvenile fish, or largemouth bass during this activity.

This information was taken from the Minnesota Sea Grant publication, Rusty Crayfish: A Nasty Invader
http://www.seagrant.umn.edu/ais/rustycrayfish_invader

Identification Tags

Make as many copies of this page and the next (printed front and back) as needed for your class size.

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- You must collect 10 food chips in order to survive.
- You can use two hands to collect and store your food.
- You will be given an additional 20 seconds to feed (due to higher metabolic rate).

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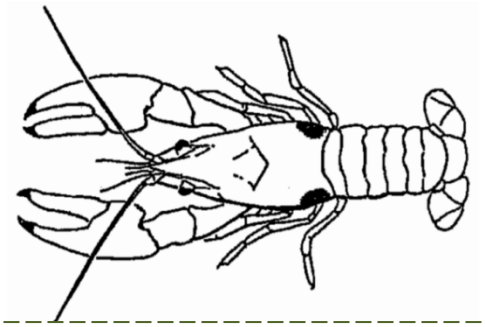

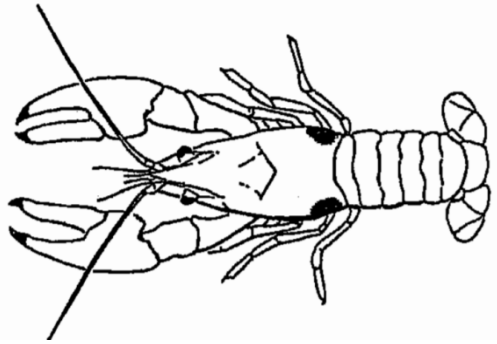

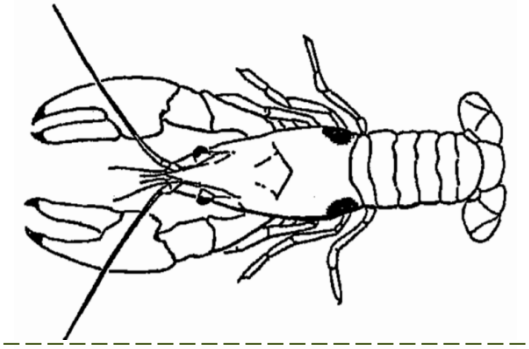

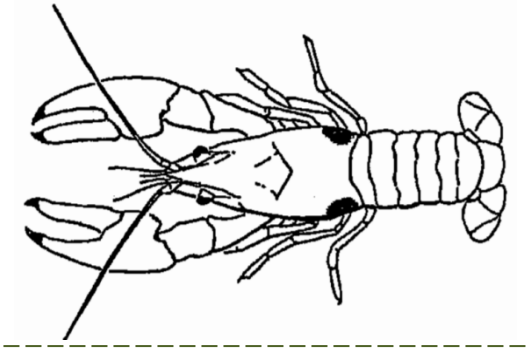

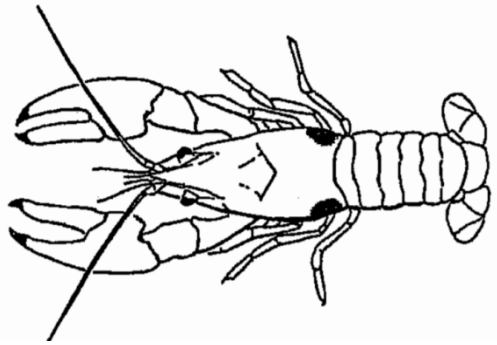

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Adult bass

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You may not tag them if they are in the rope circle.
If you tag any crayfish or juvenile fish, you must walk them over to the sidelines before feeding them.

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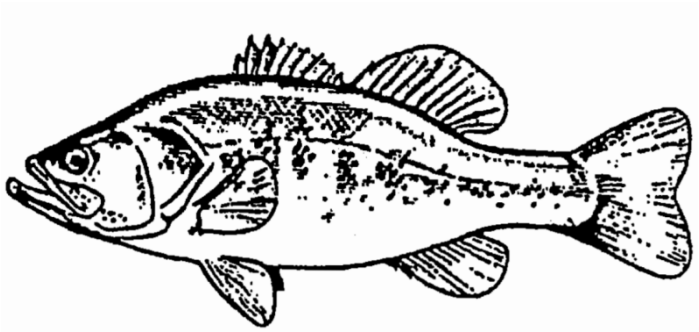

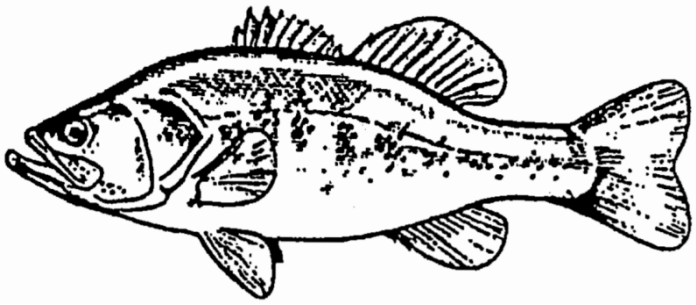

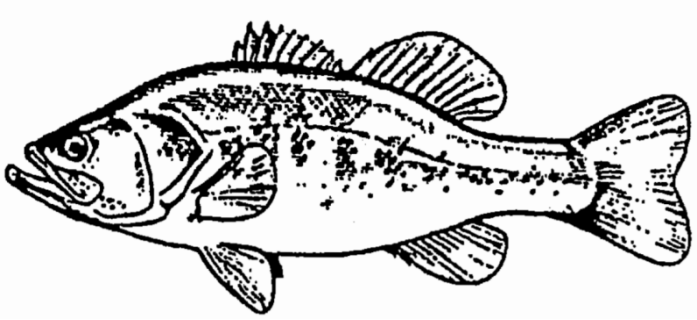

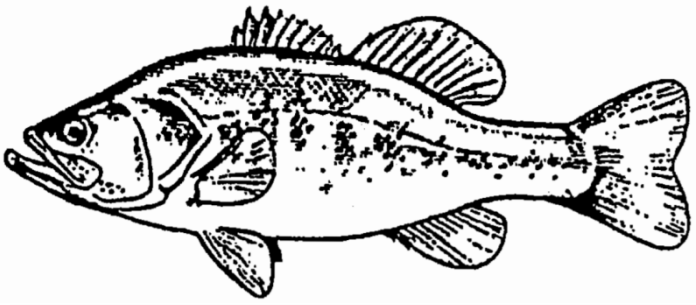

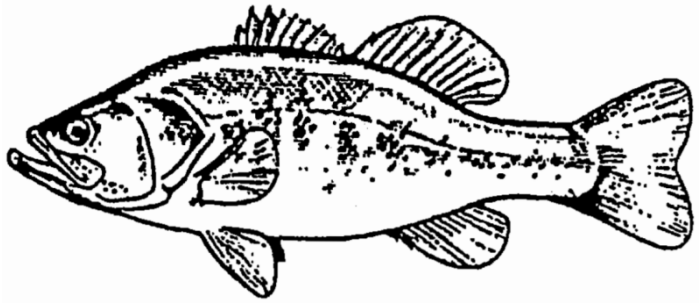

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Juvenile fish

- You are safe as long as you are in the confines of the rope circle. If tagged, you must go to the sideline.
- You must collect 5 food chips in order to survive.
- You can use only one hand to collect and store your food.
- You may be asked to leave a plant bed if you have been displaced by the rusty crayfish.
- You must leave a plant bed once all the food chips have been used up.
- There can be only 2 juvenile fish at each plant bed. This number may change depending on class size.

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- You are safe as long as you are in the confines of the rope circle. If tagged, you must go to the sideline.
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Native Crayfish

- You are safe as long as you are in the confines of the rope circle. If tagged you must go to the sideline. In the wild, crayfish would seek shelter under a rock or in vegetation.
- You must collect 7 food chips in order to survive.
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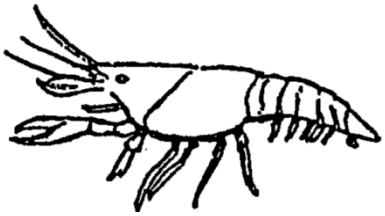

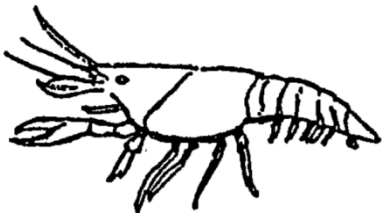

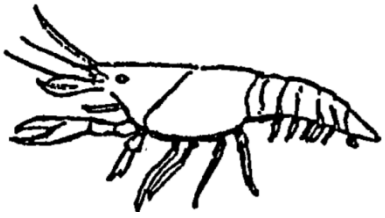

Interview With A Vampire

Next Generation Science Standards:
www.nextgenscience.org/
MS-LS1 MS-LS1-5
MS-LS2 MS-LS2-1
MS-LS2-2 MS-LS2-3
MS-LS2-4 MS-LS2-5
MS-ESS3 MS-ESS3-3
New York State P-12 Science Learning Standards:
www.p.12nysed.gov/ciai/mst/sci/nyssls.html/
MS-LS1-5 MS-LS2-1
MS-LS2-3 MS-LS2-4
MS-LS2-2 MS-LS2-5
MS-ESS3-3
Common Core State Standards Connections:
ELA/Literacy:
www.corestandards.org/ELA-Literacy/
RST.6-8.1
RST.6-8.2
RST.6-8.7
RI.8.8
WHST.6-8.2
WHST.6-8.7
WHST.6-8.8
WHST.6-8.9
WHST.6-8.1
SL.8.1
SL.8.4
SL.8.5
Mathematics:
www.corestandards.org/Math/
MP.4
6.RP.A.1
6.RP.A.3
6.SP.B.4
6.SP.B.5
7.RP.A.2
6.EE.B.6
at hand, any number in a specified set. (MS-ESS3-3)
6.EE.C.9
7.EE.B.4
MN Standards – Gr 6-12 Science, Language Arts
SC 61311,61341, 71121, 71123, 71341, 71342, 74211, 74212, 74213, 74222, 74323, 74412, 81121, 81341, 83412, 94211, 94212, 94335, 94412
LA 66722, 66744, 66911, 661311, 66922, 661377, 77722, 77744, 77911, 88722, 88744, 88911, 88922, 99722, 99744, 99911, 991311, 991377, 11.11711, 11.11911, 11.11722, 11.11744, 11.111322, 11.111377

Great Lakes Literacy Principles:
www.greatlakesliteracy.net/
Principles 5, 6, 8

Nab The Aquatic Invader:
http://www.iiseagrant.org/NabInvader/
Stop Aquatic Hitchhikers:
http://stopaquatichitchhikers.org/
Habitattitude:
http://habitattitude.net/

Background and Teacher Activity

Activity at a Glance

Students will act as reporters to research the effects of sea lamprey on the ecosystem. They write investigative reports, prepare posters, and/or give presentations to the class.

Objectives

Students will be able to:

- Use research skills and analyze scientific information about sea lamprey.
- Identify the impacts made by aquatic invasive species (AIS) and explain that these impacts do not occur from malicious intent, but rather through natural exploitation of resources.
- Create a poster and presentation.

Materials

- Poster board
- Glue or paste
- Computer for PowerPoint presentations

Subject & Grade

Science, Language Arts
Grade 6-12

Class Time

Two weeks

Vocabulary

Invasive species
Habitat utilization
Homeostasis
Predator-prey relationship
Resources
Sea lamprey

Background

The sea lamprey (*Petromyzon marinus*) is an invasive fish that has been introduced to the Great Lakes system. It has had a disastrous effect on the native fish populations, such as whitefish and lake trout. Since sea lamprey feed on many species of fish, they are called the "Vampires of the Great Lakes" due to their blood-sucking behavior.

Helpful Hints

This activity should follow an introductory lesson on AIS. It would be helpful to have taught investigative reporting skills utilizing the five W's (Who, What, Where, When, Why?) and research skills.

Procedure

1. Provide a brief introduction to AIS and show pictures and actual specimens (if available). Please note: preserved sea lamprey are available from science supply companies and it may be possible to borrow them from local college biology departments, USFWS offices, state environmental conservation departments or Sea Grant offices, where permitted.

2. Explain that students will be researching the sea lamprey to present information in the form of a poster or PowerPoint presentation, in conjunction with a 2-4 page investigative news report. Explain that they will be creating an "Interview with a Vampire" due to the sea lamprey's need to suck the blood and body fluids out of fishes.

3. Assign the following questions to direct the students' research (sample responses are provided) and have them include the information into their final poster, PowerPoint presentation or report:
    a. **Where does the sea lamprey naturally occur?** They are native to the coastal Atlantic Ocean.
    b. **How did the sea lamprey enter the Great Lakes and inland waterways?** They migrated through the St. Lawrence River and Welland and Erie Canals.
    c. **When did the sea lamprey arrive?** It is believed that they entered Lake Ontario before scientists began studying the environment and were first reported in the 1830s. They were found in Lake Erie in the 1920s and recorded in all the Great Lakes by 1938.
    d. **What is their reproductive strategy?** They enter freshwater to spawn by building crescent-shaped nests, where they lay as many as 60,000 eggs. Of these, less than 1,000 survive long enough to hatch, which takes place in 10-20 days.
    e. **What are other important life history factors? Migration? Life cycles?** Normally, sea lamprey live in the ocean, but migrate into freshwater to spawn, although they can live their entire life in freshwater, as they do in the Great Lakes basin. The sea lamprey larvae burrow into mud or soft sediment where they can spend 3-17 years, depending on environmental conditions. The larval sea lamprey feed on plankton, detritus and small organisms, until they reach "transformer" size (about the size of a pencil). In the Great Lakes, the transformers begin their journey out to the open water and spend approximately 12-20 months as parasitic adults.
    f. **Do they have any natural predators in inland waters?** In the Great Lakes, adult sea lamprey have very few predators, although bald eagles have been known to prey upon them.
    g. **How do they disrupt the ecosystem?** There has been a noticeable decline in native fishes such as lake trout and whitefish, which has resulted in a disruption of the predator-prey balance. Sea lamprey feed on all the large species of fish in the Great Lakes including Chinook and coho salmon, brown and rainbow trout, walleye, burbot and even sturgeon.

h. **Can sea lamprey be removed or controlled?** The Great Lakes Fishery Commission is responsible for controlling sea lamprey and they routinely treat spawning streams and creeks with a chemical lampricide, which is a pesticide that is selective to lampreys. Other control methods include various barriers: Low-head dams, adjustable-crest barriers, as well as velocity and electrical barriers. Anglers can help by checking their minnow traps to make sure they are not moving larval sea lamprey from Great Lakes tributaries.

4. Assign due dates for outlines of the poster or PowerPoints and their reports. Schedule 5-10 minute presentation times, including a question and answer period and discussion.

5. Make sure the class knows about the available resources, including the Internet, school library, environmental agencies and the Great Lakes Fishery Commission.

6. After the first week of research, provide guidelines for the poster or PowerPoint slides. The key to the poster or slides is to make them concise. Encourage students to use a minimum amount of text and make type size large enough to be easily read. You may wish to suggest a poster or PowerPoint slide format similar to the following:

<table>
<tr><td rowspan="2">Introduction</td><td>Title/Name</td><td rowspan="2">Information</td></tr>
<tr><td rowspan="2">Photos/Graphics</td></tr>
<tr><td rowspan="2">Information</td><td rowspan="2">Information</td><td rowspan="2">Conclusion</td></tr>
</table>

Wrap-Up

Evaluation is based on the written responses to questions assigned in number 3 in the procedure above.

Resources

Websites:

- Great Lakes Fishery Commission: http://www.glfc.org
- Great Lakes Aquatic Nonindigenous Species Information System https://www.glerl.noaa.gov/glansis/
- U.S. Geological Survey, Biological Resources Division, Nonindigenous Aquatic Species Site: http://nas.er.usgs.gov
- Nab the Aquatic Invader: http://www.iiseagrant.org/NabInvader/great_lakes.html

Credits

Originally created for ESCAPE Compendium, Great Lakes Sea Grant Network
Created by: Cara Ewell, Silver Creek High School, Irving, NY
Modified by: Helen Domske, New York Sea Grant

Adopting a Classroom Animal

Pledge Form

DON'T LET IT LOOSE!

By adopting this classroom animal, I hereby pledge to:

1. Never release or allow this animal to escape into the environment;
   (Releasing an animal can be harmful to both the animal and the environment. It may be illegal to release animals and plants in your state.*)
2. Provide and properly care for the animal's essential needs (see animal care sheet on back);
3. Share this pledge with anyone wishing to adopt this or another animal.

Date: _____

Species being adopted: _____

Student (print name): _____

Student Signature: _____

Parent/Guardian (print name): _____

Parent/Guardian Signature: _____

Teacher (print name): _____

Teacher Signature: _____

*Please check with your state wildlife agency/local natural resource agency or visit www.iiseagrant.org/speciesregs regarding the regulation for your state.

Adopting a Classroom Animal

Care Sheet

To provide the best care for the animal:

√ Make sure it is legal. Some organisms, especially those available through the internet, may not be allowed in your state*;

√ Make sure the animal will be happy living in your classroom or home before adopting it. (For example, are the needs and behavior of the animal well-matched with student or family health needs, student age and maturity, school policy, possible allergies and work schedule?);

√ Provide food, water, and space of sufficient quantity and quality to support normal growth, exercise, healing, or maintenance of body weight;

√ Provide confinement that prevents escape and provides an area free of excess food, fecal waste, or other contaminants that could harm the animal;

√ Provide shelter from unfavorable conditions, predators, and injury; and

√ Develop a plan for future care or disposition of the animal if it can no longer be cared for.

- You may be able to return the animal to the point of purchase or donate to a pet store, university, or zoo;
- Find the animal a home with a friend or another classroom. (Make sure they take this pledge first!); or
- If you cannot find a new home for your animal and you want to consider euthanasia as an option, consult with a veterinarian.

*www.iiseagrant.org/speciesregs

DON'T LET IT LOOSE!

It's bad for your pets. It's bad for the environment.

DISPOSE OF CLASSROOM PLANTS AND ANIMALS PROPERLY!

WHY SHOULDN'T I RELEASE CLASSROOM PLANTS AND ANIMALS INTO THE WILD?

Common aquatic plants and animals can become invasive when released into the wild, including:

- ✔ goldfish and other aquarium fish
- ✔ Chinese mystery snail
- ✔ elodea, hydrilla, and other aquarium plants
- ✔ crayfish
- ✔ red-eared slider turtle

Chinese mystery snail

Animal Picture Archive

WHAT DAMAGE DO INVASIVE SPECIES CAUSE?

- ✔ Degrade aquatic habitats
- ✔ Outcompete desirable native species
- ✔ Decrease biodiversity
- ✔ Alter food chains
- ✔ Introduce diseases
- ✔ Limit recreation
- ✔ Damage infrastructure
- ✔ Contaminate water resources
- ✔ Necessitate expensive controls

Red-eared slider turtle

Bullfrog

iStockphoto.com/Jim Jurica

WHAT IF MY CLASSROOM PLANT OR ANIMAL IS NATIVE TO MY REGION?

Even if your plant or animal is native to your region, it may carry diseases and should never be released into the wild.

WHAT SHOULD I DO WITH UNWANTED CLASSROOM PLANTS AND ANIMALS?

PLANTS: Completely dry or freeze aquatic plants, then put them in your garbage. Composting should be avoided, as seeds can still sprout.

FISH, INVERTEBRATES, AND REPTILES: Return to the seller or find them a home with a friend or another classroom. Ask the new owner to take a pledge* not to release. If you cannot find a new home for your animal and you want to consider euthanasia as an option, consult a veterinarian.

WATER: The water that contained your aquatic plant or animal could be contaminated and should be sterilized. To sterilize, add 5 drops of bleach for each quart (about 1 liter) of water, 1/4 teaspoon for each gallon, or 5 teaspoons for 10 gallons of water. Put the sterilized water down the toilet or sink—never down a storm drain.

PACKAGING: Invaders can also hitchhike on packaging. Inspect packaging and remove any visible plants or animals. Rinse containers with a bleach solution that contains 2 fluid ounces of bleach per quart of water (or 1/4 cup bleach per gallon of water). Dispose of it in your garbage.

LEARN HOW YOU CAN TAKE ACTION ON THESE WEBSITES!

Fun ways for teachers and students to learn about aquatic invaders:
www.iiseagrant.org/NabInvader

Educational Toolkit on Aquatic Invasive Species:
http://seagrant.oregonstate.edu/invasive-species/toolkit

*Classroom animal adoption pledge:
www.iiseagrant.org/NabInvader/Lakes/admin/classroom.html

**Aquatic species regulations database:
www.iiseagrant.org/speciesregs

Ways you can prevent invasions:
www.protectyourwaters.net/prevention

The Urban Ocean Program at USC Sea Grant:
http://www.usc.edu/org/seagrant

Information from Canada about invasive species:
www.InvadingSpecies.com

THINKING OF GETTING A CLASSROOM PLANT OR ANIMAL?

- ✔ Plan ahead and research the best species to use in your classroom. Select species that are native or non-invasive.
- ✔ Use the aquatic species regulations database** as a resource.
- ✔ Develop a plan for future care or disposition of the animal or plant in case it can no longer be held in your classroom.

Sea Grant

Illinois-Indiana Sea Grant
University of Southern California Sea Grant
Oregon Sea Grant
Washington Sea Grant

NOAA

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