Don't Stop for Hitchhikers!

Destination
Students will be able to
* Identify exotic species and ways they are transported.
* Learn about several exotics that affect water habitat.
* Identify the negative or positive effects of exotic species on native animals.
* Know how these exotics are transported and ways people can help to stop further spread.

Adventure Levels
Grades 4–8
This activity can be adapted for younger students.

Areas of Interest
Science and Social Studies

Locale
Gymnasium, outdoor setting, or classroom

Length of Stay
Approximately 45 minutes

Invader Background Check
Today there are several aquatic exotic species that pose a severe threat to all of the lakes and river systems of many states. These exotic species by definition are nonnative, “severe worldwide agents of habitat alteration and degradation.” Natural boundaries are in place that limit the spread of these species, but human actions in the form of recreation and sports have allowed the exotics to diffuse to other lakes and rivers. There are, however, simple actions that we can do to stop the proliferation of these harmful species.*

As stated in the suggested script to read to students, “Exotic species are invading lakes and rivers by hitching a ride with you, and there’s no stopping them, unless you do something about it.”

* Adapted from A Field Guide to Aquatic Plants and Animals, a pamphlet from the Minnesota Department of Natural Resources.
### Foreign Language

- Ballast water
- Eurasian watermilfoil
- Exotic species
- Purple loosestrife
- Round goby
- Ruffe
- Sea lamprey
- Zebra mussel

### Amenities Provided

Role-Playing Activity Script and Directions immediately following this activity

### Things to Pack

- Picture/drawing of several aquatic exotics—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

### Itinerary

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 an aquatic exotic species.

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 exotic species 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 the exotic aquatics can be in any order, but the sea lamprey should be last. See the activity script for information about each exotic species, which props to use with each, and what to tell students about the meaning of each prop. The exotic species include Eurasian watermilfoil, purple loosestrife, zebra mussel, ruffe, round goby, and sea lamprey.

6. Explain how the exotic 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 of students present), and tell them that they are now the exotic species 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 exotic species is added. Have students notice that the amount of living space is being reduced and is getting smaller.

9. The final exotic 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 resume 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 exotic species is spread. Explain what is being done by the government to stop the spread of exotics. 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.

**Travel Tips**

- 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 exotic species can vary depending on the number of students. The best outcome would be 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.

**Debriefing**

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

**Extending the Visit**

- Have the students create a “Public Service Announcement” in the form of posters, signs, audio tapes, or videos informing other classes on ways to stop the spread of exotic species.
- Visit a local lake, pond, or boat access and look for signs of exotic species. At the boat landing, see if there are warning signs about one of the exotics. If there are none, ask the water resource manager or fisheries biologist at the Department of Natural Resources (DNR) to post some signs.
- Visit a lake known to contain exotic species and monitor the growth in population or the spread in infested areas.
- Have the students identify other exotic species.
Places to Go

Fact Sheets and Publications
Fact sheets on aquatic exotics 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://www.nsgo.seagrant.org

Minnesota Department of Natural Resources. A Field Guide to Aquatic Exotic Plants and Animals. 1995. View at Minnesota Department of Natural Resources Web site: http://www.dnr.state.mn.us or the Minnesota Sea Grant Web site: http://www.seagrant.umn.edu

Travel Agent

Peter L. Edwards
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Role-Playing Activity Script and Directions

This is a compilation of information about various exotic species, directions for conducting the activity “Don’t Stop for Hitchhikers!” and suggestions for what to say and do during the activity. Note that **bold italics** are used for all sections that are the exact words teachers could use during this activity. All information pertaining to exotics that is indented below has come from the Minnesota Department of Natural Resources pamphlet, *A Field Guide to Aquatic Exotic Plants and Animals*.

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!” Exotic 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 exotic species.*

Explain the definition of an aquatic exotic species.

**Exotic species**—organisms introduced into habitats where they are not native—are severe 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 the work of humans. Some introductions, such as carp and purple loosestrife, are intentional and do unexpected damage, but many exotic introductions are accidental. Some exotic introductions are ecologically harmless and some are beneficial, but other exotic introductions are harmful to recreation and ecosystems. They have even caused the extinction of native species—especially those of confined habitats such as island and aquatic ecosystems.

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 exotic is spread. (The introduction of the exotic aquatics 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 mussel 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. Adults can attach to boats that sit in the water. Adult life size: 1/4 to 1 inch.
Prevention: 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 before moving to a new lake.

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 exotic species 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 exotic species are likely to survive the journey and thrive in the new waters.

Negative effects of the round goby: dominate fisheries quickly, reach densities of over 100 per square yard, no effective predators, can spawn several times per year, grow to about 10 inches, are aggressive, and compete with native bottom-dwellers like sculpins and log perch. They are expected to be harmful to Great Lakes and inland fisheries. Adult life size: 10 inches.

Prevention: Drain water from livewells in same lake or river; do not dump in any other body of water.

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 exotic species is added. Have students notice that the lake is getting smaller. Say:

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 also by waterbirds, 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. The plants 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 and trailers can spread the plant to other lakes. Milfoil may become entangled in boat propellers or may attach 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:** Clear and clean off all weeds from boats and trailers.

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

Ruffe (ruf) was introduced to Duluth harbor, probably in tanker ballast water, around 1985, and is spreading 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. Ruffe could be accidentally transported in livewells, bilge water, bait buckets, and ballast water. Adult life size: 3 to 5 inches.

**Prevention:** Empty livewells, bilge water, and bait buckets on the ground before entering a different lake or river.

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 exotic plant is in 40 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 wetland animals easily spread loosestrife seeds. Adult height: 2 to 7 feet.

**Prevention:** If you see them in a wetland area, don’t pick them and take them somewhere else. Don’t buy loosestrife plants from nurseries; avoid wild seed mixtures that contain purple loosestrife seeds.

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

The final exotic introduced should be the sea lamprey.

**Sea lamprey** is an eel-like fish with a circular suctioning mouth with sharp rasping teeth on its inner surface* native to the coastal regions of the Atlantic Ocean. They entered the Great Lakes through the Welland Canal about 1921. They contributed greatly to the decline of whitefish and lake trout in the Great Lakes. Negative effects of the sea lamprey: One adult can consume 40 pounds of fish. Adult life size: 12 inches.

**Prevention:** Chemical controls, called lampricides, are being used by water resource managers.

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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.

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 exotic is spread (optional). Questions to consider:

*What is being done by the government to stop the spread of exotics?*


U.S. ballast water regulations mandated under the Act help limit introductions through transoceanic shipping.*

Possession of exotic species is illegal in most states.

*What are some other exotic species?*

Spiny water flea, rusty crayfish, white perch, flowering rush, curly-leaf pondweed, alewife, and mosquito fish.
OBJECTIVES

After participating in this activity, learners will be able to:

- name and visually recognize some invader (nonindigenous/exotic) species of the Great Lakes
- understand and analyze the positive and negative impacts of invader species on the Great Lakes ecosystem
- explain the ways in which invader species are introduced into the Great Lakes
- describe and act out ways to avoid the spread of exotic species

ACTIVITY SUMMARY

Learners will work in small groups to organize scrambled exotic species cards. Each group will present a different exotic species in a poster or fact sheet to the class, and then the group will act out (charades) a way to avoid the spread of their exotic species.

BACKGROUND

An exotic plant or animal is one that does not naturally occur in a specific location or ecosystem. Exotics arrive through intentional or accidental actions by humans. Exotics 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, and upon ecosystems. Exotics sometimes have no natural predators in their new locations, and this may allow them to overpopulate an area and kill off native species.

Since the early 1800s, over 140 species of aquatic plants, algae, fish, worms, mollusks, and other organisms have been introduced in the Great Lakes. Some introductions have been intentional and some accidental. Effects from the introduction of exotic or non-native species can range from detrimental to beneficial. Some introductions may have no noticeable effect. Many times humans have a limited understanding of the variety of effects that may result from an introduction. Some introductions may have both positive and negative effects, depending on one’s perspective. Many exotics may compete with native species for limited resources or feed upon them.

It is estimated that about 15 percent of the 175 species of fish in the Great Lakes are non-native species that were introduced accidentally or intentionally. Eighty-six invader species are plants,
although plants have received less attention as invaders. A few exotics 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 lampreys swim inland into fresh waters to spawn. Natural barriers, like Niagara Falls, previously prevented them from reaching the Great Lakes. However, once shipping canals were opened up, the sea lamprey easily found its way to the Great Lakes, where it decimated populations of native fish species.

Many exotic species 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 exotic species, such as zebra mussels, the goby, ruffe, and spiny water flea, were sucked up from European harbors by powerful water pumps. Ballast tanks are filled with water from the harbor 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, 34 percent of the invader species entered in solid ballast and 56 percent through ballast water.

The United States and Canada require that most ships entering the Great Lakes discharge their freshwater ballast while still in the ocean, replacing it with saltwater ballast to reduce the introduction of new exotic 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.

Accidental introductions of exotic species should be completely avoided. People can help to avoid the spread of exotic species by taking careful precautions. Boaters should be careful to rinse the bottoms of boats, bilge pumps, and live wells with clean tap water before leaving lake or river areas. They should remove aquatic plants that get stuck on boat trailers and boats. This will reduce the chances of transporting exotic plants and animals. Ships should always release foreign ballast before reaching their destination. This will prevent the transport of exotic plankton, plants, and animals. Pets, plants, and unused bait should not be released into the wild.

MATERIALS
For each group of 3–4 learners:
• copies of the included information cards. Each of the three card categories (invader picture, introduction, positive and negative impacts) should be copied onto a different color card stock paper (18 cards per group)
• answer sheet

PROCEDURE
1) Introduce the topic of exotic species to the class. Explain key points made in the background section and define difficult vocabulary words such as exotic, non-native, invader, ballast, plankton, etc.
2) Have learners work in groups of three to four people, each with a complete set of 18 shuffled cards (six “Great Lakes Changes Cards,” six “Picture Cards,” and six “Introduction Cards”).
3) Beginning with the picture of the invader, match the cards to determine which introduction and Great Lakes Changes Card goes with each invader. For each picture, there should be one
matching card of each other color.

4) When group members agree that they have matched the cards to the best of their ability, they may check their answers on the answer sheets.

5) Each group selects an invader to present to the class; construct a poster on the invader or develop a fact sheet. The impact of the invader on human affairs should be included.

6) After the group has presented their exotic species, have the learners play a short charade-like game. The group acts out a way to prevent the spread of their exotic species, and the rest of the learners guess the action they are doing.

7) After all the groups have presented and acted, review with learners the importance of decision making in exotic species. Remind them there are some positive changes as a result of exotic species, but that there are also many negative impacts to the Great Lakes ecosystem, and that we are all responsible for making good decisions.

ASSESSMENT/EVALUATION

- Observe groups as they discuss and organize their cards.
- Observe group presentations of exotic species.
- Collect the groups' invader posters or fact sheets to evaluate according to teacher criteria.
- Ask the learners, “Why should people be concerned about exotic species? How do they affect ecosystems?” (Invading species threaten to change present ecosystems, often in unpredictable ways that may be beneficial or very detrimental.)

SOURCE

Modified by Anne Williamson, Michigan State University, and Mike Klepinger, Michigan Sea Grant. Adapted with permission from “What do scientists know about invader species of the Great Lakes?” in Earth Systems—Education Activities for Great Lakes Schools: Life in the Great Lakes.

ADAPTATIONS

- 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 exotic invaders, such as the Eurasian milfoil, to determine ecological impacts. Add your species to this game.
- Draw a humorous cartoon depicting the problem or benefit of an invader species. (Example: A zebra mussel looking for a place to attach on an already overcrowded lake bottom, a white perch nudging out a yellow perch, purple loosestrife choking other plants, a fisherman eating a salmon whole, etc.)
- Look for exotic species the next time you visit Great Lakes waters!

COMPUTER EXTENSIONS

Great Lakes Education Program: http://www.msue.msu.edu/seagrant/
Purple Loosestrife Pages: http://www.msue.msu.edu/seagrant/pp/
Exotic Species in the Great Lakes: http://www.great-lakes.net/envt/exotic/exotic.html
National Biological Services, Nonindigenous Aquatic Species (NAS) Information Resource: http://www.nfrcg.gov/nas/nas.htm

ADDITIONAL RESOURCES

Local Contacts
St. John’s Marsh—MDNR
MDNR Research Station, South River Road, Harrison Township
Macomb County Community College, Environmental Centers (South and Center campus)—Contact the Biology Department
Belle Isle Aquarium
Teaching Materials and References

Additional Activities
Exotic Aquatics Traveling Trunk. From: Minnesota Sea Grant, Exotic Species Information Center, 2305 E. Fifth St., Duluth, MN 55812-1445.

Subjects: Science, Social Studies, English.

Michigan Standards: s1, s4, s6, s7, ss6, ss8, ss9, ss21, ss22, ss23, ss26, e7, e8.

Skills: Citizenship, Classification, Comparison, Description, Discussion, Listening, Media Construction, Problem Solving, Public Speaking, Reading, Reporting, Responsibility, Role-Playing, Small Group, Writing.

Timing: Pre-cruise.

Charting the GLEP Course: Do this activity after completing the “Great (Lakes) Connections” activity.

Conceptual Framework Reference: IA1, IA2, IC1, IC2, IC3, ID1, ID2, IIA1, IIID1, IID2, IIA2, IVD1, IVE1, IVF1, VA1, VB1, VC1, VD1, VIA1.

Duration: 2 hours. Introduction and card matching = 30 minutes, Report and skit writing = 30 minutes, Report and skit presentations = 1 hour.

Setting: Classroom.
### Exotic species #1 causes changes in the Great Lakes:

**+ Positive**
1. Sea lamprey larvae (young) provide some food for other fish. They can also be used as fishing bait.
2. Adult sea lamprey are food for birds, snakes, raccoons, and other fish.
3. Sea lamprey are eaten as a delicacy (tasty food) in Europe. The lamprey are smoked, grilled, fried, and steamed.

**– Negative**
1. Sea lamprey are parasites and feed on other fishes’ bodies. Each sea lamprey can kill 40 pounds of fish in its life.
2. Sea lamprey kill large, predator fish. Without predator fish, small fish populations can get very large.
3. Sea lamprey contributed to lower numbers of native lake trout, whitefish, and chubs in the Great Lakes.
4. Since native fish numbers were so low in the 1950s because of sea lamprey, commercial fishermen were not able to harvest much fish to sell.
5. U.S. commercial fishermen do not harvest and sell sea lamprey because Americans do not like to eat them.
6. The exotic sea lamprey might compete with native Great Lakes lamprey or fish for nesting areas and food.

Are there any more positive changes in the Great Lakes because of sea lamprey? Please add any you can think of.
4) 5) 6)

### Exotic species #3 causes changes in the Great Lakes:

**+ Positive**
1. Salmon eat alewives. This helps keep the alewife population under control.
2. People like to eat salmon, so commercial fishermen can catch them and sell them for a profit.
3. Sport anglers enjoy catching them with hook and line.
4. Many jobs were created. Sport anglers spend millions of dollars at bait shops, on boats, for fishing tournaments, and on fishing licenses.

**– Negative**
1. Salmon eat smelt and other forage (small) fish that native fish populations also need to eat.
2. Salmon may compete with native lake trout for food.
3. Male and female salmon die after spawning.

Are there any more negative changes in the Great Lakes because of salmon? Please add any you can think of.
4) 5) 6)

### Exotic Species #2 causes changes in the Great Lakes:

**+ Positive**
1. Large predator fish feed on alewives.
2. When alewives spawn in rivers and near shore, the large predator fish follow them. Sport anglers enjoy catching the large fish that come close to shore.
3. Commercial fishermen catch alewives to sell for pet food, fertilizer, and oils.

**– Negative**
1. Alewives compete with and reduce numbers of native herring, shiners, and yellow perch.
2. Alewives eat the eggs and baby fish of native herring, shiners, and yellow perch.
3. People do not like to eat Great Lakes alewives, but herring and yellow perch are very tasty.
4. In the 1960s and 1970s, billions of alewives died and covered the beaches. The flies were very thick and the rotting fish were very smelly and had to be bulldozed away. Many beaches were unusable.
5. Dead alewives clog our water treatment (drinking water) plants and industrial plants, and they cost money to clean up.

Are there any more positive changes in the Great Lakes because of alewives? Please add any you can think of.
4) 5) 6)

### Exotic species #4 causes changes in the Great Lakes:

**+ Positive**
1. A few fish are able to eat the spiny water flea for food.

**– Negative**
1. Spiny water fleas eat small plankton and may compete with natural Great Lakes zooplankton. This is a problem for the Great Lakes food web.
2. Spiny water fleas compete with small and juvenile (baby) fish for plankton such as Daphnia.
3. Spiny water fleas have a long spine, and small fish have a hard time eating them. Most fish learn to avoid them.

Are there any more negative changes in the Great Lakes because of the spiny water flea? Please add any you can think of.
4) 5) 6)
**Exotic species #5 causes changes in the Great Lakes:**

+ Positive
1) Since every zebra mussel filters about a liter of water per day for food, Great Lakes waters are clearer, so people can see farther, especially underwater divers.
2) Zebra mussels are a source of food for diving ducks, drum (a fish), catfish, and carp.
3) There are more jobs in the water treatment and industrial plants. Many people work very hard to get rid of zebra mussels. Are there any more positive changes in the Great Lakes because of zebra mussels? Please add any you can think of.

– Negative
1) Zebra mussels filter and eat small plankton and compete with native Great Lakes zooplankton. This is a problem for the Great Lakes food web.
2) Zebra mussels attach to native Great Lakes mussels and clams. This leaves the native mussels and clams handicapped and unable to compete well with the zebra mussels.
3) Zebra mussels attach to water treatment plants and clog pumps. It is very expensive to keep water pumps unclogged.
4) Zebra mussels attach to boats and overheat engines. Broken engines are expensive to fix.
5) When zebra mussels die, they sometimes wash onto beaches. Their lifeless shells cover up the sand and are smelly when they rot. Zebra mussel shells make some swimming beaches dangerous to bare feet.

Are there any more negative changes in the Great Lakes because of zebra mussels? Please add any you can think of.

6)

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**Exotic species #6 causes changes in the Great Lakes:**

+ Positive
1) Purple loosestrife is a very beautiful plant with lovely purple flowers.
2) Honeybees and butterflies are attracted to purple loosestrife because of its flowers and nectar.
3) Redwing blackbirds build nests in the stems of purple loosestrife.

Are there any more positive changes in the Great Lakes because of loosestrife? Please add any you can think of.

4)
5)
6)

– Negative
1) Purple loosestrife competes with native Great Lakes wetland plants and quickly takes over habitats.
2) Thick roots allow purple loosestrife to fill in wetlands, ponds, lakes, and reservoirs.
3) Purple loosestrife fills in drainage ditches, causing flooding.
4) Purple loosestrife fills in wetlands, causing less fish spawning habitat and water quality problems.
5) Purple loosestrife does not provide food for many animals that live in the habitat, causing ducks, fish, and frogs to leave or die.

Are there any more negative changes in the Great Lakes because of loosestrife? Please add any you can think of.

6)
INTRODUCTION

First introduction into the Great Lakes was about 1986. Scientists think the ballast water of a ship from Europe probably contained this exotic's larvae, and it was dumped right into Lake St. Clair. Larva is the "baby" form of the exotic and floats around in the water as plankton before it attaches itself to a hard surface and rapidly forms colonies.

To avoid the spread of this exotic animal:

• People with ski boats or fishing boats should be careful to rinse everything with clean tap water before leaving lakes or rivers. The bottoms of boats, pumps inside the boats, fish buckets, water skis, jet skis, and anything else that was in the water should be rinsed. This will reduce the chances of transporting the planktonic larvae. If you see adult zebra mussels on boats or equipment, be sure to remove them before moving to the next lake or stream.

• People should also be careful not to collect live animals and then let them go in new areas such as local ponds or rivers. The animals can be studied in tanks, but it is very important not to let the animals go free, especially in new areas. Give them to a scientist or to a nature center.

INTRODUCTION

Originally this animal came from river mouths at the Atlantic Ocean. For centuries it swam up freshwater rivers like the St. Lawrence Seaway and Hudson River to spawn, but it was not able to swim over natural barriers such as Niagara Falls to reach the Great Lakes. The exotic animal invaded the upper Great Lakes by swimming through the manmade Erie and Welland shipping canals. It also attached itself with its sucker-like mouth to the hulls, or bottoms, of boats for a free ride into the Great Lakes. By 1938, this exotic invaded all five of the Great Lakes.

To avoid the spread of this exotic animal:

• Anglers using this exotic juvenile (baby form) as fishing bait need to be very careful. Anglers should not use the exotic species for bait in streams and lakes that do not already have this exotic species. The reason for this is because sometimes bait gets off the hook and goes free. The juvenile exotic would then grow up and mature, and then be an invader species into the lake or stream. This would happen because the exotic bait got off the angler’s hook.

• Anglers using this exotic juvenile (baby form) as fishing bait in a stream or lake that has already been invaded by the exotic adult forms also need to be careful. After using the exotic juveniles for fishing, the anglers should not let the extra exotic bait go free in the stream or lake. The extra bait should be taken back to the bait shop, or saved for another fishing trip. This will help reduce the number of exotic species in the stream or lake.

• Fish caught with an adult sea lamprey attached to it should not be released without first removing the lamprey from its body. The lamprey should then be killed or taken to a scientist or to a nature center. Do not release the lamprey back into the lake or stream.

INTRODUCTION

This invader swam in schools through water routes and canals from the Atlantic Ocean. It was able to invade the upper Great Lakes by swimming through the manmade Erie and Welland shipping canals since 1930.

To avoid the spread of this exotic animal:

• Anglers using this silvery fish as fishing bait need to be very careful. Anglers should not use the exotic species for bait in streams and lakes that do not already have this exotic species. The reason for this is because sometimes bait gets off the hook and goes free. The exotic would then be an invader species into the lake or stream because the exotic bait got off the angler's hook.

• Anglers using this exotic silvery fish as fishing bait in a stream or lake that has already been invaded by the exotic adult forms also need to be careful. After using the exotic juveniles for fishing, the anglers should not let the extra exotic bait go free in the stream or lake. The extra bait should be taken back to the bait shop, or saved for another fishing trip. This will help reduce the number of exotic species in the stream or lake.

• Fish caught with an adult sea lamprey attached to it should not be released without first removing the lamprey from its body. The lamprey should then be killed or taken to a scientist or to a nature center. Do not release the lamprey back into the lake or stream.

INTRODUCTION

This exotic species was introduced into the Great Lakes on purpose in 1966 by Michigan Department of Natural Resources (DNR) officials. This large predator fish was introduced to help reduce (eat) the huge numbers of alewives (silver bait fish) that invaded the Great Lakes.

To avoid the spread of this exotic animal:

• Anglers catching these large exotic sport fish should not release them into new lakes or streams for their own fun. Some anglers may want to release these large fish into their own streams or lakes to catch again, but that is illegal. Only officials from the DNR who have done proper research and experiments should release this exotic into new streams and rivers.
INTRODUCTION
This tiny animal was accidentally carried into the Great Lakes in fresh water or in mud carried as the ballast for a freighter ship. The shrimp-like plankton was first released in Lake Huron in 1984, and then spread quickly to all the other Great Lakes by 1987. It is hard for other organisms to swallow because of its stiff tail.

To avoid the spread of this exotic animal:
• People with ski boats or fishing boats should be careful to rinse everything with clean tap water before leaving lakes or rivers. The bottoms of boats, pumps inside the boats, fish coolers, water skis, jet skis, and any thing else that was in the water should be rinsed. This will reduce the chances of transporting exotic plankton.
• Anglers without boats should also be careful to rinse all their fishing gear with tap water. The exotic plankton with their spiny tails with hooks sometimes get caught on fishing lines and nets. Anglers would not like to accidentally introduce this exotic species into new streams or lakes!

INTRODUCTION
This colorful plant probably first arrived in North America from its home range in Europe in the ballast of sailing vessels in the early 1800s. It is thought that it might have also arrived in imported sheep’s wool, because some of the oldest stands on the continent are found just downstream from woolen mills. Because its flowers are very beautiful, it was imported by gardeners and florists for many decades. It is now illegal to sell or distribute this plant in most states.

To avoid the spread of this exotic plant:
• This exotic plant should not be planted in yards or fields because it spreads very quickly. An average plant creates over two million tiny seeds per year, so care needs to be taken not to take any seeds with you in your clothing when you leave an infested wetland. Shake out and brush off shirts, pants, socks, and shoes.
Sea Lamprey

Alewife

(Zebra mussel shell [1 inch wide] shown for size comparison.)

(Zebra mussel shell [1 inch wide] shown for size comparison.)

Zebra Mussel

Coho Salmon

(Actual size approximately 1 inch wide)

(Zebra mussel shell [1 inch wide] shown for size comparison.)
Spiny Water Flea

Purple Loosestrife

(Zebra mussel shell [1 inch wide] shown for size comparison.)
Exotic Species #1: Sea Lamprey
Exotic Species #1 causes changes in the Great Lakes:

+ Positive
1) Sea lamprey larvae provide some food for other fish. They can also be used as fishing bait by anglers.
2) Adult sea lamprey are food for birds, snakes, raccoons, and other fish.

Introduction
Originally this animal came from river mouths at the Atlantic Ocean. For centuries it swam up freshwater rivers like the St. Lawrence Seaway and Hudson River to spawn, but it was not able to swim over natural barriers such as Niagara Falls to reach the Great Lakes. The sea lamprey invaded the upper Great Lakes by swimming through the manmade Erie and Welland shipping canals. It also attached itself with its sucker-like mouth to the hulls, or bottoms, of boats for a free ride into the Great Lakes. By 1938, this exotic invaded all five of the Great Lakes.

Exotic Species #2: Alewife
Exotic Species #2 causes changes in the Great Lakes:

+ Positive
1) Large predator fish feed on alewives.
2) When alewives spawn in rivers and near shore, the large predator fish follow them. Anglers enjoy catching the large fish that come close to shore.
3) Commercial fishermen catch alewives to sell for pet food, fertilizer, and oils.

Introduction
This invader swam in schools through water routes and canals from the Atlantic Ocean. It was able to invade the upper Great Lakes by swimming through the manmade Erie and Welland shipping canals since 1930.

Exotic Species #3: Pacific Salmon
Exotic Species #3 causes changes in the Great Lakes:

+ Positive
1) Salmon eat alewives. This helps keep the alewife population under control.
2) People like to eat salmon, so commercial fishermen can catch them and sell them for a profit.
3) Sport anglers enjoy catching them with hook and line.
4) Many jobs were created. Sport anglers spend millions of dollars at bait shops, on boats, for fishing tournaments, and on fishing licenses.

Introduction
This exotic species was introduced into the Great Lakes on purpose in 1966 by
the Michigan Department of Natural Resources (DNR) officials. This large predator fish was introduced to help reduce (eat) the huge numbers of alewives (silver bait fish) that invaded the Great Lakes.

Exotic Species #4: Spiny Water Flea
Exotic Species #4 causes changes in the Great Lakes:

+ Positive
1) A few fish are able to eat the spiny water flea for food.

Introduction
This tiny animal was accidentally carried into the Great Lakes in fresh water or in mud carried as the ballast for a freighter ship. The shrimp-like plankton was first released in Lake Huron in 1984, and then spread quickly to all the other Great Lakes by 1987. It is hard for other organisms to swallow because of its stiff tail.

Exotic Species #5: Zebra Mussel
Exotic Species #5 causes changes in the Great Lakes:

+ Positive
1) Since every zebra mussel filters about a liter of water per day for food, Great Lakes waters are clearer, so people can see farther, especially underwater divers.
2) Zebra mussels are a secondary source of food for diving ducks, drum, catfish, and carp.
3) There are more jobs in the municipal water supply and industrial plants. Many people work very hard to get rid of zebra mussels.

Introduction
First introduction into the Great Lakes was about 1986. Scientists think the ballast water of a ship from Europe probably contained zebra mussel larvae, and it was dumped right into Lake St. Clair. Larvae are the "baby" form of the exotic, and they float around in the water as plankton before they attach themselves to a hard surface and rapidly form colonies.

Exotic Species #6: Purple Loosestrife
Exotic Species #6 causes changes in the Great Lakes:

+ Positive
1) Purple loosestrife is a very beautiful plant with lovely purple flowers.
2) Honeybees and butterflies are attracted to purple loosestrife because of its flowers and nectar.
3) Redwing blackbirds build nests in the stems of purple loosestrife.

Introduction
This colorful plant probably first arrived in North America from its home range in Europe in the ballast of sailing vessels in the early 1800s. It is thought that it might have also arrived in imported sheep’s wool, because some of the oldest stands on the continent are found just downstream from woolen mills. Because its flowers are very beautiful, it was imported by gardeners and florists for many decades. It is now illegal to sell or distribute purple loosestrife in most states.
Rival for Survival

Destination
Students will be able to
★ Analyze situations and factors affecting ecosystems.
★ Recognize exotic species found in the Great Lakes.
★ Create a concept map that interrelates the topics presented in the game.

Adventure Levels
Grades 6–9
This activity can be adapted for younger students.

Areas of Interest
Science and Citizenship

Locale
Classroom tables, desks, and/or the floor

Length of Stay
Two class periods

Invader Background Check

Exotic species 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 exotic species does well, it usually means a preexisting species begins to decrease in numbers through intense competition for ecosystem resources.

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

Foreign Language

<table>
<thead>
<tr>
<th>Foreign Language</th>
<th>Indigenous species</th>
<th>Round goby</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alewife</td>
<td>Niche</td>
<td>Sea lamprey</td>
</tr>
<tr>
<td>Eurasian watermilfoil</td>
<td>Organism</td>
<td>Zebra mussel</td>
</tr>
<tr>
<td>Exotic species</td>
<td>Purple loosestrife</td>
<td></td>
</tr>
<tr>
<td>Fishhook flea</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Amenities Provided
Rival for Survival game board found in “Posters and Games”
Game Cards 15.1–15.6
Rival for Survival game Instructions 15.7

Things to Pack
Dice
Movable game pieces
Paper for keeping score
Pen or pencil

Itinerary
Preparing for the activity
1. Copy and assemble the game boards for each learning group. See “Travel Tips” for a way to prepare the game board and other materials.

2. Copy game cards and instructions. Copy one set of cards for each game (matching front and back by letters, such as “Front a” to “Back a”). Copy one game instruction page for each game.

First class period: Introducing and playing the game
3. Divide students into cooperative learning groups of two to five people.

4. Provide an introduction to exotic species. Ask the following questions:
   What are exotic species?
   How do you think exotic species affect the environment?
   (See “Invader Background Check.”)

5. Explain that students will be playing this game to learn about exotic species—how they affect the ecosystem and how our actions affect the control or spread of exotic species.

6. Distribute the games and materials. Read the directions and rules of the game. Explain that students will be allowed to play the game for the majority of the class hour. Establish a time limit for play so that they are aware that all points will be counted at a certain time.

7. Clean up with five minutes left in class.

Second class period: Building concept maps
8. Give each student a sheet of paper and request that a concept map be developed for the term “exotic species.” Ask the following questions to direct students to the relevant topics that should be included:
   Can you name some exotic species?
   What are the potential problems of taking a species out of its natural habitat?
   How did some exotic species get transported to the Great Lakes region?

9. After their individual concept maps have been collected for evaluation, create a “class” concept map for the term “exotic species” using an overhead projector or the chalkboard. Discuss how their concept maps compare to the one the class created.
Directions

1. The objective of the game is to have the most points when all players have reached the "Finish" position, at the Great Lakes.

2. Each player rolls the die, and the player with the highest number goes first.

3. Player 1 rolls the die and moves the playing piece the number of spaces shown on the die. Player 1 chooses a question card and hands it to the player on the left, who reads the question aloud. Player 1 chooses the best answer.

4. Points received are based on the player's answer and are recorded on the score sheet.

5. When landing on a space that requires the player to move ahead or backward, the player moves the game piece before picking a question card.

6. Some answers will cause a player to lose points. If the player has no points, however, he or she cannot go below zero, even if told to subtract a point.

7. Play continues in a clockwise direction until all players reach the Great Lakes region or the time limit is reached. The player with the most points is the winner—not the player who reaches the Great Lakes first. Finishing first may not necessarily be a good thing in this game!

Travel Tips

★ Here is a great way to preserve and store your games. Glue each game board inside a file folder, and glue the game instructions on the back of the folder. For each game, make an envelope to store the cards for that game. Laminate everything: the folders, the game cards, and the envelope. Place the envelope into the file folder. Then it's ready to store.

★ To help the game move more smoothly, you can
- Make sure you keep the numbers in the cooperative groups as low as possible.
- Have each player keep track of his or her own score on a sheet of paper, or assign one scorekeeper per group if you feel there will be arguments about the scores.
- Assign one student to pick up and return the game so that there is no confusion at the end.

★ This activity relates to several 9th Grade Proficiency Test Learning Outcomes [noted for the state of Ohio but likely relates to other states as well]:
  - Science: Trace the flow of energy and/or interrelationships of organisms in an ecosystem.
  - Science: Describe how a given environmental change affects an ecosystem.
  - Citizenship: Identify opportunities for involvement in civic activities.

Debriefing

Use a rubric similar to the following to evaluate the concept map and assess what the students have learned:

Exotic Species Concept Map Rubric

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demonstrates what an exotic species is</td>
<td>1</td>
</tr>
<tr>
<td>Mentions at least three exotic species</td>
<td>3</td>
</tr>
<tr>
<td>Includes one method of transport of exotic species</td>
<td>1</td>
</tr>
<tr>
<td>Includes one way native species are affected</td>
<td>1</td>
</tr>
</tbody>
</table>

Total: 6
Sample Concept Map Information
Exotic species are nonindigenous organisms that have invaded an ecosystem.
Some exotic species are purple loosestrife, goldfish, zebra mussels, sea lamprey, and starlings.
Some were transported intentionally by people, such as purple loosestrife for landscaping.
Some were transferred unintentionally, such as zebra mussels, through the ballast water of ocean freighters.
If exotics do well, they can lower the numbers of some native species in an ecosystem through intense competition for the ecosystem resources.

Extending the Visit

- Take a field trip to places where students can observe actual specimens of exotic species. If possible schedule a talk by park staff or a water-resource manager knowledgeable about the effects of the organisms and any actions that have been taken to control them.

- Add more questions to the game that are geared specifically to your curriculum.

Places to Go

Web Sites
Great Lakes Information Network (GLIN)
Main Web site: http://www.great-lakes.net

National Aquatic Nuisance Species Clearinghouse Web site: http://www.entryway.com/seagrant

U.S. Geological Survey, Biological Resources Division
Nonindigenous Aquatic Species Web site: http://nas.er.usgs.gov

Fact Sheets and Publications
Great Lakes Commission. ANS (Aquatic Nuisance Species) Update quarterly newsletter. View at the Great Lakes Commission Web site: http://www.glc.org/ans/ansupdate/ansupdate.html or e-mail: shwayder@glc.org

Multimedia
Zebra Mussel Information System CD-Rom, available from the U.S. Army Corps of Engineers:
Waterways Experiment Station
3909 Halls Ferry Rd.
Vicksburg, MS 39180
Phone: 601-634-2972

Travel Agents
Pauline LoCascio
Birmingham Elementary—Grade 1
Toledo, OH

Cathy Mielke
Byrnedale Junior High—Grades 7–8
Toledo, OH

Gwen Petrosini-McLaughlin
Byrnedale Junior High—Grade 8
Toledo, OH
**Rival for Survival Game Instructions**

**Materials**
- Game board
- Movable pieces
- Game cards
- Score paper
- Die
- Pen or pencil

**Number of Players**
- 2–5

**Objective**
To have the **most points** when all players have reached the “Finish” position, at the Great Lakes.

**Directions**
1. Each player rolls the die, and the player with the highest number goes first.
2. Player 1 rolls the die and moves the playing piece the number of spaces shown on the die. Player 1 chooses a question card and hands it to the player on the left, who reads the question aloud. Player 1 chooses the best answer.
3. Points received are based on the player’s answer and are recorded on the score sheet.
4. When landing on a space that requires the player to move ahead or backward, the player moves the game piece before picking a question card.
5. Some answers will cause a player to lose points. If the player has no points, however, he or she cannot go below zero, even if told to subtract a point.
6. Play continues in a clockwise direction until all players reach the Great Lakes region or the time limit is reached. The player with the **most points** is the winner—not the player who reaches the Great Lakes first. Finishing first may not necessarily be a good thing in this game!
### Game Cards—Front a

#### Q Your aquarium is no longer functioning. You decide to get rid of the fish. You should
- a. flush them.
- b. find them a new home in another aquarium.
- c. drop them in the local pond.

#### Q To prevent the transfer of exotic species from one lake to another, you should
- a. pull your boat quickly from one lake to another.
- b. inspect your boat trailer and equipment.
- c. wash your boat in cold water.

#### Q How many of these species are exotic: goldfish, purple loosestrife, sea lamprey, starling?
- a. one
- b. three
- c. four

#### Q Bringing in natural predators may be the way to handle exotic species such as purple loosestrife. Choose a potential problem with the above idea.
- a. Purple loosestrife would decrease.
- b. Predators may not die out after plants are gone.
- c. Native plants would repopulate area.

#### Q You find a beautiful plant while on vacation in Mexico. Do you
- a. take a picture?
- b. dig it up and transplant it in your garden?
- c. pick the flowers off of it?

#### Q Some exotic species can be a nuisance. How many of these are nuisance species: carp, alewife, purple loosestrife, zebra mussels, sea lamprey?
- a. two
- b. three
- c. five

#### Q The role an organism has in its environment is its niche. Exotic species
- a. try to take over the niche of another organism in an ecosystem.
- b. have no niche in an ecosystem.
- c. are not organisms.

#### Q Zebra mussels each filter about
- a. 0.25 liter of water per day.
- b. 0.50 liter of water per day.
- c. 1.0 liter of water per day.

#### Q How many of these species are exotic: goldfish, purple loosestrife, sea lamprey, starling?
- a. one
- b. three
- c. four

#### Q In any ecosystem, there is a limited amount of resources. If an exotic does well in a new ecosystem, that usually means native species are
- a. getting more resources than before.
- b. getting the same amount of resources than before.
- c. getting less resources than before.

#### Q The sea lamprey is an exotic species in Lake Erie. Why is it so damaging to other fish?
- a. It eats their eggs.
- b. It carries a large number of diseases.
- c. It sucks out the blood and body tissues of other fish through its suckerlike mouth.

#### Q Exotic species are
- a. rare organisms.
- b. organisms brought into an environment not their own.
- c. worth a lot of money.
**Game Cards—Back a**

A  

a = 0 pts. No! You might transfer species from one body of water to another.  
b = 3 pts. Good decision! You ensure there are no organisms transported on your boat.  
c = 1 pt. You’re trying to remove all organisms—use 140°F water.

A  

a = 0 pts. Not a good choice!  
b = 3 pts. This is the best thing to do.  
c = –1 pt. Take a point away. You could be introducing a new species to the pond and upsetting the ecosystem!

A  

a = 1 pt.  
b = 2 pts. All four are exotic!  
c = 3 pts.

A  

a = 0 pts. This is what we would want to happen!  
b = 3 pts. Could be a very real problem. You’d just be trading one exotic species for another.  
c = 0 pts. This is a positive effect of introducing a natural predator; the question asked for negative effect.

A  

a = 3 pts. Correct! You can enjoy the plant without damaging it or carrying it into an ecosystem not its own.  
b = –1 pt. Take a point away. You risk creating an invader species that could damage the ecosystem back home.  
c = 0 pts. This could damage the plant.

A  

a = 0 pts. Not right!  
b = 0 pts. Closer, but still not right.  
c = 3 pts. You got the right answer!

A  

a = 3 pts. They try to do this.  
b = 0 pts. No.  
c = 0 pts. All living things are organisms.

A  

a = 0 pts. Not true.  
b = 0 pts. Not the problem.  
c = 3 pts. Gross, but true.

A  

a = 1 pt. Good choice, but not the best!  
b = 1 pt. Good choice, but not the best!  
c = 3 pts. This is the best choice!

A  

a = 0 pts. Have new competition for and usually get less.  
b = 0 pts. No! If there are more organisms trying to eat the same food, they won’t get as much.  
c = 3 pts. Correct, because there are more species competing for the resources.
**Game Cards—Front b**

<table>
<thead>
<tr>
<th>Question</th>
<th>Option A</th>
<th>Option B</th>
<th>Option C</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>You find some zebra mussels on a beach. You should</strong></td>
<td>a. leave them where they are.</td>
<td>b. take them home.</td>
<td>c. put them in a pond near your home.</td>
</tr>
<tr>
<td><strong>Exotic species are</strong></td>
<td>a. plants.</td>
<td>b. animals.</td>
<td>c. both.</td>
</tr>
<tr>
<td><strong>Zebra mussels are believed to have entered the Great Lakes</strong></td>
<td>a. by traveling in the ballast water of commercial freighters.</td>
<td>b. by attaching to large fish.</td>
<td>c. because people brought them here to increase the mussel population.</td>
</tr>
<tr>
<td><strong>Purple loosestrife was brought into the United States to</strong></td>
<td>a. beautify wetlands.</td>
<td>b. be used in landscaping.</td>
<td>c. feed large herbivores.</td>
</tr>
<tr>
<td><strong>While traveling through another part of the country, you encounter a small tortoise. Do you</strong></td>
<td>a. put it in your aquarium?</td>
<td>b. sell it to a pet store?</td>
<td>c. leave it alone?</td>
</tr>
<tr>
<td><strong>Indigenous plants and animals are those</strong></td>
<td>a. that are naturally found in an ecosystem.</td>
<td>b. are imported into an ecosystem.</td>
<td>c. make you sick if you eat them.</td>
</tr>
<tr>
<td><strong>Exotic species</strong></td>
<td>a. are good for the environment they enter.</td>
<td>b. are bad for the environment they enter.</td>
<td>c. can be either good or bad, and some have no effect.</td>
</tr>
<tr>
<td><strong>The effect zebra mussels have on water intake pipes is to</strong></td>
<td>a. help rebuild them.</td>
<td>b. clog them.</td>
<td>c. clean them.</td>
</tr>
<tr>
<td><strong>Round gobies can eat up to</strong></td>
<td>a. five sea lampreys per day.</td>
<td>b. 1 pound of purple loosestrife per day.</td>
<td>c. 78 zebra mussels per day.</td>
</tr>
<tr>
<td><strong>How are yellow perch affected by aquatic invaders?</strong></td>
<td>a. The round goby eats yellow perch eggs.</td>
<td>b. The fishhook flea competes for the same food as the yellow perch.</td>
<td>c. The yellow perch swallows zebra mussels that get stuck in its digestive system.</td>
</tr>
<tr>
<td><strong>The fishhook flea keeps from being eaten because</strong></td>
<td>a. its long tail, shaped like a fishhook, makes it difficult for larger fish to swallow.</td>
<td>b. it latches on to fishhooks and escapes when fishermen pull their poles out of the water.</td>
<td>c. it stays away from fishhooks and thus is not eaten by fish.</td>
</tr>
</tbody>
</table>
**Game Cards—Back b**

**A**

a = 1 pt. True, but not the best choice.
b = 1 pt. Also true, but not the best choice.
c = 3 pts. Exotic species can be plants or animals.

**A**

a = 0 pts. Not true.
b = 3 pts. This was why people brought purple loosestrife into the United States.
c = 0 pts. Purple loosestrife has no natural enemies in the United States.

**A**

a = 0 pts. Wrong.
b = 0 pts. Wrong.
c = 3 pts. Purple loosestrife is a wetland plant.

**A**

a = 1 pt. Might be true, but unlikely.
b = 1 pt. True often, but not always.
c = 3 pts. This is the best choice.

**A**

a = 0 pts. This would be helpful, but it is not true.
b = 0 pts. This is also incorrect.
c = 3 pts. This is correct.

**A**

a = 3 pts. Exactly! This is why it is called the fishhook flea.
b = 0 pts. Sorry, this is incorrect.
c = 0 pts. This is also a wrong answer.

**A**

a = 3 pts. This is the correct definition of indigenous.
b = 0 pts. This is the definition of nonindigenous.
c = 1 pt. Some may make you sick, others may not. Not the best choice.

**A**

a = 0 pts. No, zebra mussels do not help rebuild pipes.
b = 0 pts. This is also incorrect. They clog pipes, not clean them.

**A**

a = 3 pts. Good answer!
b = 3 pts. This is also a correct answer!
c = 0 pts. The yellow perch do not eat zebra mussels.
Boaters or anglers can prevent the spread of zebra mussels by
a. wearing gloves while they are fishing.
b. emptying their bait buckets on land only.
c. washing their boat, tackle, trailer, and other equipment in 104° F water.

A sea lamprey can grow
a. up to 6 inches long.
b. up to 36 inches long.
c. up to 18 inches long.

The fishhook flea most likely traveled to the United States
a. attached to other fish migrating toward the United States.
b. because it got lost.
c. in the ballast water of freighters.

How might a native brown trout be killed by an aquatic invader?
(a. Round gobies could eat eggs of the brown trout.
b. A sea lamprey could carve a hole in the side of the brown trout and suck out its bodily fluids.
c. The brown trout could try to swallow a fishhook flea and get it stuck in its digestive system.

A female zebra mussel can produce up to
a. 10,000 eggs a year.
b. 100,000 eggs a year.
c. 1 million eggs a year.

The fishhook flea most likely traveled to the United States
a. attached to other fish migrating toward the United States.
b. because it got lost.
c. in the ballast water of freighters.

A female zebra mussel can produce up to
a. 10,000 eggs a year.
b. 100,000 eggs a year.
c. 1 million eggs a year.

What do round gobies do to make fishermen angry?
(a. They eat all the eggs of the native fish, leaving no more fish to catch.
b. They tease them that they can’t catch fish.
c. They aggressively take bait from hooks used by fishermen.
Game Cards—Back c

A  a = 0 pts. Sea lampreys can get bigger than that!
   b = 0 pts. Wow, that would be one giant sea lamprey.
   c = 3 pts. That is correct!

A  a = 2 pts. This is close. Round gobies eat the eggs of the lake trout.
   b = 3 pts. Exactly, this is why the sea lamprey is so dangerous!
   c = 1 pt. This might be possible.

A  a = 1 pt. This is a possibility.
   b = 0 pts. This is unlikely.
   c = 3 pts. That’s right!

A  a = 0 pts. Unfortunately, wearing gloves has nothing to do with it.
   b = 3 pts. Good job! This will help prevent the spread of zebra mussels.
   c = 3 pts. This too will aid in the prevention of zebra mussel infestation.

A  a = 0 pts. No, it is the sea lamprey that attaches to fish.
   b = 0 pts. This is incorrect.
   c = 3 pts. You got it!

A  a = 0 pts. This isn’t even close.
   b = 1 pt. This is getting closer.
   c = 3 pts. Yes, this is correct.
We're the Future of the Great Lakes

Destination
Students will be able to
• Identify several native species, the nonnative species that cause impacts to them, and how this takes place.
• State what comprises a healthy, balanced food chain or ecosystem, and what is not a normal balance.
• Identify human causes of exotic species invasion, which disrupt the normal Great Lakes food chain.
• Generate alternate solutions, given problem situations and current solutions.
• Read with improved fluency and motivation.

Adventure Levels
Grades 4–7

Areas of Interest
Science, Music, and Social Studies

Locale
Classroom, computer lab, and library

Length of Stay
Several weeks for doing all components
One week for learning and practicing the rap

Invader Background Check

The topics of food chains and natural environment destruction are salient to the lives of students for several reasons. First, students need improved connection with and understanding of what is and is not a healthy ecosystem. They need improved understanding of how human beings impact the environment negatively and the consequences of that impact so they can respond, as future stewards of that environment, with informed and wise planning to make good decisions. The actions of human beings to advance trade and industry at the expense of the natural environment have been the primary cause of the ecosystem’s disruption.

Furthermore, inner city students with limited experience of wetlands, the Great Lakes, and causes of exotic species invasion, such as boating, can relate more readily to a rap song with colloquial vocabulary about a neighborhood than a more remote scenario such as boating on Lake Michigan.

Foreign Language

<table>
<thead>
<tr>
<th>Alewife</th>
<th>Native species</th>
<th>Sea lamprey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dam</td>
<td>Nonnative species</td>
<td>Spiny water flea</td>
</tr>
<tr>
<td>Food chain</td>
<td>Parasite</td>
<td>Trade</td>
</tr>
<tr>
<td>Forager</td>
<td>Plankton</td>
<td></td>
</tr>
<tr>
<td>Industry</td>
<td>Predator</td>
<td></td>
</tr>
</tbody>
</table>

ESCAPE 1

We're the Future of the Great Lakes (3)
Amenities Provided

We've Gotta Survive Rap (song sheet) 3.1–3.2
We've Gotta Survive Rap on ESCAPE Song and Game CD-ROM

Things to Pack

Background information on exotic species
CD player
Cassette tape player or videotape recorder (optional)
Zebra Mussel Mania Traveling Trunk (optional, see "Places to Go")

Passport for Success

For reading the rap, students should be able to read at least at the fourth-grade level. Students need background and guidance in research skills and use of resources including the Internet, glossaries, and encyclopedia indexes. Students need to be able to speak with clarity and correct pronunciation and to read aloud with a sense of the beat or rhythm.

Itinerary

1. Using research materials and resources, students should learn about the native Great Lakes food chain and how exotic species affected this chain. Students should also find out what some of these species are, what impacts they have had on the Great Lakes, and the approaches taken to help solve the problem of this invasion. Questions such as the following could be assigned:

   What is the basic structure of the native Great Lakes food chain? List the representative creatures from each level. Students can write, verbalize, or diagram the basic components of the food chain including flora and fauna (e.g., plankton and algae), foragers (e.g., chub), and predators (e.g., lake trout and burbot).

   What main exotic species have disrupted this food chain? Show how they have disrupted it. You may use diagrams. Students can write, verbalize, or diagram takeovers at the flora and fauna level such as the spiny water flea (plankton not good for native foragers), the forager level such as the alewife overpopulating and outcompeting native foragers, and the lamprey killing so many of the native predators.

   What makes a food chain healthy and balanced? What is not a healthy, balanced food chain? Use compare/contrast strategies. A food chain is healthy when each level survives and thrives, even though its population is eaten by the level above it. It is healthy when that balance is not unnaturally disrupted by any level becoming endangered or extinct from invaders. An unhealthy food chain is one in which there is a disruption in the natural balance and extinction or endangerment of species at any or all levels.

   What are two negative effects humans have had on the Great Lakes native species? Research, analyze, and explain your answer. Many examples are possible. Zebra mussels and lamprey invaded by attaching themselves to European trading boats. The lumber industry caused unnatural conditions in the Great Lakes in which nonnatives multiplied and natives decreased in numbers. Attempts at controlling exotics through chemicals have only further polluted the Great Lakes.

   How can you determine the effectiveness of one approach to solving an exotic species problem? Use evaluation strategies to determine your answer. There are many possible approaches to evaluate (e.g., using chemicals to control lamprey, building dams, and using beetles to destroy purple loosestrife). Evaluations should include reasons why student thinks an approach is effective or not.
2. Learn and practice the rap. Then enhance the rap with such things as music, additional group or individual parts, dance, or artistic components (e.g., costumes, masks, props, scenery, or posters).

3. Present the rap and make an audiotape and/or videotape.

4. Students can write sequels or expansions of the rap, or write new raps based on what they have learned.

5. Students can engage in problem-solving cooperative groups. Given a particular exotic species and given their assigned roles (e.g., scientist, industry manager, or politician), they must arrive at a consensus on a solution to controlling or eliminating that species.

6. Another group activity could involve planning an approach to solving an exotic species problem and justifying the reasons for choosing this approach. Each group is given a problem and possible solutions. Students are assigned their roles. They must decide on one of the given solutions or generate a new one and give their reasons for choosing their solution.

**Travel Tips**

- If you're not familiar with rap music, listen to a lot of it before trying to teach this rap. Students will need to practice it at a slow tempo first, as certain words are stumbling blocks if they try to say them too fast.

- The rap could be learned and performed in the classroom and presented in other classrooms or in a gym or auditorium as part of an all-school program about the environment or ecosystems.

- In the problem-solving part of this activity, it is recommended that each member of the group be given a responsibility for ensuring that communication flows smoothly (e.g., timekeeper, secretary, and discussion manager).

- Many good materials are available from the *Zebra Mussel Mania Traveling Trunk*. It includes illustrations and information cards, fact sheets on species, videos, and laminated zebra mussel and native species ID cards that would be helpful for each character in the rap to wear. See "Places to Go" for information on how to obtain this resource.

- The population target for this activity is adaptable. Primary students can memorize the rap by listening to it on the CD and then reciting it. Intermediate and junior high school students can do the rap as a reader's theater and read it themselves. Many schools have vocal arts groups that learn and perform rap music. Special interest groups of students could also participate in this activity.

**Debriefing**

The evaluation can be based on many assessments, including participation in learning and presenting the rap, enhancing the rap with talents in the arts, answering questions through oral presentations, discussion participation, charts, graphic organizers, diagrams, participation in problem-solving groups, and presentation of solutions to problems.

**Extending the Visit**

- This activity can tie in with art projects, such as use of art in theater, by creating masks for the characters, building props, and designing sets. It can connect with music in the teaching of rhythm as students play percussion instruments as accompaniment, learn to count out a beat/meter, and express themselves in a spoken song. The activity can connect with drama in a focus on reader’s
theater used to increase awareness and change people's thinking or actions. In social studies, the activity connects with learning about the impact of European migration/settlement, trade, and industrialization on the natural environment.

- Students could generate solutions to a local or neighborhood environmental imbalance or destructive invasion. A community service project could include assisting in loosestrife control at a pond or lake. In association with the exotic species focus on the environment, students could be involved in an environmental problem at their school by cleaning up can, bottle, and garbage pollution strewn in the area around the school. They could write to congressional representatives about improving laws against factories polluting air in their local neighborhood.

- Students could research and report current problems involving the Asian long-horned beetle invasion.

**Places to Go**

**Web Sites**
Sea Grant Nonindigenous Species (SGNIS) Web site: http://www.sgnis.org

**Kits**
*Zebra Mussel Mania Traveling Trunk*, a hands-on, inquiry-based kit and curriculum that contains simulations, experiments, videos, games, stories, and a CD-ROM; plus includes ideas for student-led community action projects. Available at 32 lending centers across the United States and Canada. Contact Robin Goettel, Illinois-Indiana Sea Grant, 217-333-9448; e-mail: goettel@uiuc.edu or visit the Web site: http://iiisgcp.org

**Multimedia**
*Zebra Mussels: Lessons Learned in the Great Lakes Region* videos, set of four videos—Biology, Spread and Impact, Control, and Outreach Tools. Purchases of videos can be made through the Illinois-Indiana Sea Grant's Web site: http://iiisgcp.org or contact Susan White, 217-333-9441; e-mail: white2@uiuc.edu

**Travel Agent**
Laura Brodsky
Jenner Academy—Grades K-5
Chicago, IL

*We're the Future of the Great Lakes (3)*
We've Gotta Survive Rap

By Laura Brodsky

Narrator
I'm shootin' to you straight 'bout hootis in the lakes
Where the food chain's been disturbed
By some species I'll call "fakes"
Cause they weren't from the Great Lakes
They hitched rides from other waters
They're the reasons why my homies lost
Their mothers and their fathers.

Now since at least one hundred years back
This food chain once balanced has been under attack
Native plankton and plants were the first in the chain
On them fed the foragers, so few which now remain
Native predators ate foragers like the chub
Those lake trout and burbot once had plenty of grub
One hundred native predators kept our ecosystem right
Soon to be victims of the future fight.

Lamar Lake Trout
A part of that fight I can tell you about
Is what almost has wiped out my species lake trout
My grandpa told me 'bout the lamprey, bad guy in the fight,
A bloodsucking eel-like fish, It's called a parasite
These lamprey did kill or wound so many of my kind
Now mostly just us shorties are all that's left behind
The top native predators now no longer thrive
In fact it's gotten difficult just to survive.

Charise Chub
About that fight I too can relate
Native forage fish like chubs suffered similar fate
When the lamprey killed off species like Lamar's
Nonnative foragers like alewives eat out ours.

Pete Plankton
Before the nonnative foragers took over our hood
We had the right balance, our lives were so good
There were enough of us to continue the race
But then nonnative plankton also overran the place
This Invasion has destroyed our healthy population
Native foragers remaining now perish of starvation.

Student
From what I understand of the sad event I'm seein'
The wrong is mostly caused by the thoughtless Human Bein'
Who when he doesn't care 'bout the effects of his actions
Hurts the lakes and native species with bus'ness transactions
Bringin' nonnative species in on great big trading* boats
Blockin' waters with those huge lumber industry floats.
Most everythin' they've tried just has caused more pollution
*could substitute failing for trading

ESCAPE

We're the Future of
the Great Lakes (3.1)
Come on y'all, think, let's find some better solutions!
We're the future of this world, its scientists and teachers
Let's improve the Great Lakes for its water and its creatures.

Optional refrain for native fish chorus to say between each part:
We're dyin' out, we're cryin' out
We've gotta survive
We've gotta get some help
So we can live and thrive

We're the Future of the Great Lakes (3.2)