


Sea Grant

Exotic Aquatics Flashcard Set!

If you are interested in a set of Exotic Aquatic Flashcards for use with the “Where in the World?” lesson plan by Paul Heimowitz and Nancy Lerner, they are available from Washington Sea Grant Program:

Price: \$13.00 plus shipping and handling

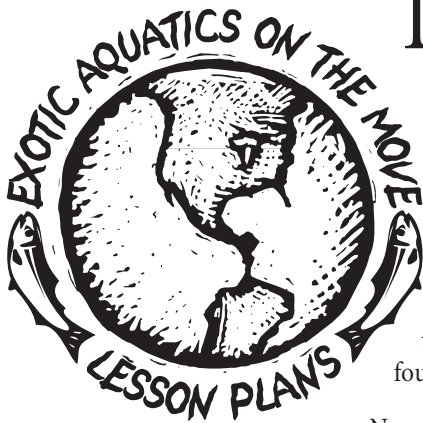
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EXOTIC AQUATICS ON THE MOVE

LESSON PLAN COMPENDIUM



This compendium contains lesson plans created by teachers participating in the *Exotics Aquatics on the Move* workshops. This series of interactive workshops was designed to help teachers link national geographic standards to concepts involving non-indigenous aquatic species, and to provide useful tools that teachers can use in their classrooms, involving concepts from geography, social studies, and biology. Sea Grant Programs in Louisiana, New York, Illinois-Indiana, and Washington State sponsored these workshops in association with the Geographic Alliance. More information can be found at www.iisgcp.org/EXOTICSP.

Non-native organisms are moving in. Plants, animals and microbes from faraway places grow out of control, causing significant economic and biological damage. In our own backyard, we see weedy species like Himalayan blackberry, Scots broom and English ivy. We read about the alien zebra mussels advancing in U.S. and Canadian waterways, encrusting everything in their path. And we wonder if deadly pathogens, like cholera, might be lurking around the corner.

Species that are introduced into habitats where they are not native—called “exotics,” nonindigenous species,” or “aliens”—can result in habitat alteration and degradation. They can outcompete native species for food, space and other resources, sometimes even causing the extinction of native species. It has been estimated that invasive species are already costing the United States billions of dollars every year in eradication or damage remediation efforts. Alien species have been cited as second only to habitat loss as a threat to biodiversity. Once established, it can be nearly impossible to eradicate an invasive species. The Exotics Aquatics on the Move workshops focused on invasive aquatic species.

Teaching about invasive species is important not only because of the environmental and economic effects of invasives, but because human actions are responsible for most introductions. It is only through education that we can eliminate some of the pathways of species introductions. People can unintentionally spread “alien” aquatic species simply by releasing an unwanted pet into the wild, by dumping a bait bucket overboard, or by forgetting to wash off their boat before launching it into a new body of water.

Lesson plans created from the concepts presented at each of the workshops have been compiled in this report and are ready to be used in the classroom to create interdisciplinary links between the social and natural sciences. The goal of *Exotic Aquatics on the Move* is to teach students about the ecological impacts of non-native species, as well as to show them how environmentally responsible decisions can help prevent the spread and transport of these organisms. As a supplement to their participation in the workshops, teachers were also encouraged to have their students carry out community stewardship projects. Additional information on these projects is available from Robin G. Goettel, Illinois-Indiana Sea Grant College Program, 217.333.9448 or email at goettel@uiuc.edu.

Teachers interested in adapting any of the attached lesson plans to their own classrooms are encouraged to review all of the plans to determine the ones that best fit their needs. The variety of lesson plans included in this report will provide teachers with many options. Some deal with specific regions or species of concern to a region, while others are more global in scope. Most of the concepts involved in the lesson plans, however, can be altered to suit any region or species. Some lesson plans can be used for any age group, while others have been designed with a particular age group in mind. There is even a lesson plan in Spanish. We have tried to provide some guidance as to the appropriate age groups in the chart below and among the title material of each lesson plan.

<i>Author</i>	<i>Elementary School</i>	<i>Middle School</i>	<i>High School</i>
Barnhart	X	X	
Book		X	X
Bujan		X	
Butler	X	X	
Camilotto/Peterson			X
Cooper/Dole		X	
Ferro			X
Fickert			X
Freeman/Redd		X	X
Hedge		X	X
Heimowitz/Lerner1	X	X	
Heimowitz/Lerner 2		X	X
Heimowitz/Lerner 3		X	X
Howard	X		
Johnson et al.	X	X	
Keith, C.	X		
Keith, S.		X	X
Kiffe	X		
MacDonald		X	
Marquez		X	X
Meaux		X	X
Penrod			X
Robson	X	X	X
Sebouian/Wyman		X	
Staab		X	
Strange			X
Syrek/Domske	X	X	X

The Exotic Aquatics on the Move project is funded through the National Sea Grant Office in partnership with Illinois-Indiana, Louisiana, Minnesota, Ohio, New York, and Washington Sea Grant programs. Ohio Sea Grant has developed a website related to the Exotics Aquatics on the Move workshops at <http://www.ag.ansc.purdue.edu/EXOTICSP/>.

The National Sea Grant College Program is a network of 30 Sea Grant programs in the coastal and Great Lake states that encourage the wise stewardship of our marine resources through research, education, outreach, and technology transfer. Our federal partner is the National Oceanic and Atmospheric Administration (NOAA) located in the Department of Commerce. Sea Grant is a partnership between the nation's universities, industry, government and the public. More information on the National Sea Grant College Program can be found at: <http://www.nsgo.seagrant.org>

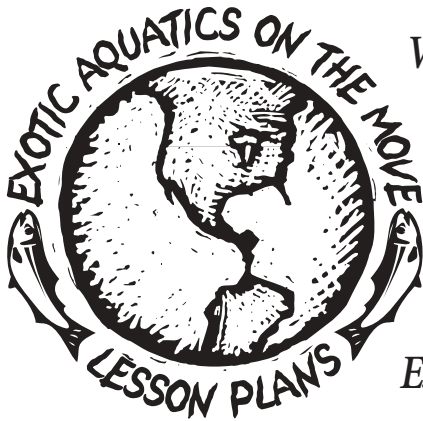
A Washington Sea Grant Program publication

This report is published in part by Grant #NA76RG0119, Project A/PC-5, from the National Oceanic and Atmospheric Administration to Washington Sea Grant Program, University of Washington. The views expressed herein are those of the author(s) and do not necessarily reflect the views of NOAA or any of its subagencies.

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website: <http://www.wsg.washington.edu>



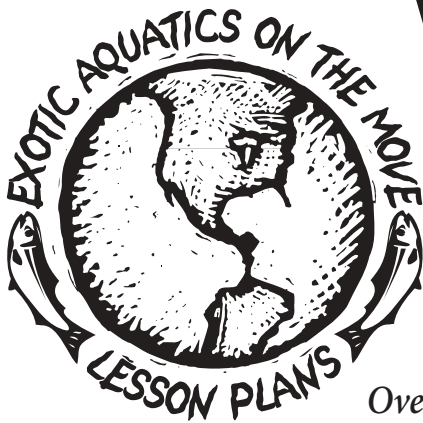
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WHO IS WELCOME IN THE WETLANDS OF ORENCO?



Grade Level: 1st–8th Grades [This activity was initiated with the learners are the students of Orenco Elementary, including the primary students, the staff, and the community, via information shared with the neighboring golf course through the local newspaper (the *Hillsboro Argus*) and, possibly, with the wider Metro community through the *Oregonian* newspaper and TV media.]

Overview

Students will read about/learn about through various media what “exotic” means (by definition and by consequences of introduction of exotic species). They will understand that this includes flora and fauna, and consider how these exotics move into a habitat.

Background

Orenco Elementary School opened in 2001. The site includes a wetland area with an observation deck. The intermediate students are to begin a plan to restore the health of the wetlands area, and will be studying what makes a healthy wetland, what type of organisms live in a wetland, and how the wetlands help the surrounding environment.

In January, the students will consider the impact human activity can have on a wetland and will consider what positive impacts they can have. As students see the wetland habitat as a preferred habitat for many organisms, they may not understand that the balance of any habitat can be thrown off by both physical changes and changes to the food web. Most people are unaware of the extreme impact of introduced species on native species, and the students will study examples of the impact and develop a program of education for the community.

Setting

In the Orenco wetland, with some reading material going home to share with family and some videotapes used in the classroom

Objectives

When the learners have completed this unit of study, they should be able to identify how exotics might be introduced into the Orenco wetland, and be able to communicate to the general public both the dangers of such introduction and how steps can be taken to prevent such introduction.

Geographic Standards

Standard 4. The physical and human characteristics of a place

Standard 7. The physical processes that shape patterns on Earth’s surface

Standard 8. The characteristics of ecosystems on Earth’s surface

Standard 14. How human actions modify the physical environment

Standard 16. Changes that occur in the meaning, use, distribution, and importance of resources (“wetlands” used to just be “swamps”)

Keywords

Native species, invasive species, introduced species, food web, loss of habitat

Author
Maureen Barnhart

School
Orenco Elementary School

City
Hillsboro

State
Oregon

Grade Levels Taught
4th–6th grades

Materials

Review of appropriate materials continues at this time. Model newspaper articles, review of persuasive writing techniques, etc.

Schedule

The introduction to wetlands and wetland habitat precedes the lessons regarding invasive/introduced species. In 30 to 45 minute sessions: introduction to invasive species, brainstorm on how species may be introduced into a habitat, how human activity may result in introduction of invasive species, brainstorm how to educate the community and prevent human introduction, three to four sessions to carry out the plans.

Prerequisite Skills

Understanding of the wetland habitat

Curriculum Connections

According to age/ability to understand:

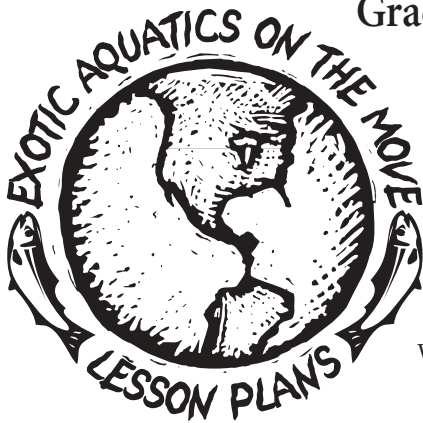
- Mathematics: population growth, birth and mortality rates for species (simplified to help students understand why a species thrives where there is no natural predator or other limiting factors)
- Writing: persuasive writing

Procedure

Review what students have come to understand about ecosystems; share, through various media, information on the effects of invasive populations, brainstorm ways in which exotics may be introduced to the Orenco wetlands, what might be the results, and how some exotics may be prevented from taking hold through appropriate human actions and education. Finally, create a campaign to educate the Hillsboro community about preventing introduction of exotics. (Students, with appropriate suggestions from the educator, usually determine projects.)

WATCH WHERE YOU STEP!

Grade Level: 6th–12th Grades



Overview

The participants will spend time searching their neighborhoods, in their spatial memory, for exotic species. The group will orally describe what species were visualized in their area. They will brainstorm the information to determine which of the exotic species are beneficial or detrimental to their region. We will gather the information and organize a chart on a poster. In summary, the class will compare their neighborhoods with a second area located near their school.

Background

Often communities are unaware of which exotic species are particular threats to their region or the impact that exotic species are having on the local economy, ecosystem and recreational opportunities. Understanding how these species are different from our native species and why exotics are viewed as a threat to these species is a challenge to communicate. Getting students to recognize some of the more common exotic species is important.

Setting

Classroom, community, city hall, computer lab, and a park

Objectives

1. The participants will be able to locate and visually recognize exotic species in their area.
2. The group will be able to involve the community in the search for the different species.
3. We will be able to compare and contrast the species in their neighborhoods to other neighborhoods.

Geographic Standards

Standard 16. The changes that occur in the meaning, use, distribution and importance of a resource

Standard 18. How to apply geography to interpret the present and plan for the future

Keywords

Region, detrimental, nonindigenous, intrusion, indigenous, exotic

Materials

Cameras, film, poster board, VCR, TV, computers, Project TELLUS *Exotic Species* video tape, maps (Louisiana, world), markers, folders, paper, transparencies, overhead, informational brochures

Schedule

4–6 class periods

Prerequisite Skills

Basic research skills and knowledge of how to use the library and Internet, ability to use a digital camera, ability to find locations on a local and world map

Curriculum Connections

Geography, Louisiana History, American History, Science

Procedure

1. Use the video *Exotic Species* from the Project TELLUS video series (information on obtaining this video is found in Resources section) to introduce the topic of exotic species. If possible, do all three activities incorporated in the video. If time is short, do at least the first activity using the water hyacinth.

Author

George K. Book

School

S. P. Arnett Middle School

City

Westlake

State

Louisiana

Grade Levels Taught

8th grade

2. Provide students with brochures on the exotic species or lead a discussion about common exotic species that are present in your region. Ask students to think about which species they have seen in their neighborhoods.
3. Ask students to take pictures of the exotic species in their neighborhoods using a camera. Students should write down location information (general location, street address, city, etc.) for each exotic species photo they take.
4. On a local map, have students devise an exotic species key and plot the location of each type of species that was documented by a photograph. Key the photograph with each location marker by assigning it a number. Display both the photos and the map on a bulletin board in the classroom.
5. Have students research each of the exotic species they located in their neighborhoods and find out where the species is native, how it may have spread to their neighborhood (or the U.S.), and what characteristics have enabled it to survive in their neighborhood. This information can be summed up in an Exotic Species Chart that is displayed alongside the photos and the area map.
6. On a map of the world, have students plot the native ranges of the species that were located in their neighborhoods. Discuss with students the benefits or the problems these species have caused in their neighborhoods.
7. Discuss whether the exotic species located in your neighborhood have any positive contributions to the environment. Also discuss if their impact is more serious in other parts of the United States.

Teacher Notes

The instructor should provide material concerning the exotic species in the area. This information should be gathered in advance (see Resources). Arrangements for loan of several cameras, preferably digital, should also be made. If the teacher is hesitant to send a camera home with his students, perhaps photos could be taken on a short walk around campus or on a field trip.

Include information/discussion that most non-natives are beneficial and non-invasive. Given their task, they will discover and map non-invasive trees, shrubs, grasses, as well as garden plants and flowers.

Applications

The information gathered would open the door to a stronger understanding of what exotic species are located in our region. The contact with the community will provide a pathway to the importance of the study of exotic species concerning the rest of the United States. This should lead to an awareness of similar problems in the rest of the world. Through this knowledge communities around the world might be able to create safeguards against these invaders.

Evaluation

The students will be able to list what general areas of their particular state matches up with their community's exotic species. They will be able to gather in small groups and take turns orally interpreting their community's nonindigenous species. The groups will finish their activities by placing their chart's information, with the title of each species found in their neighborhoods, on the poster. We will brainstorm the future endeavors concerning the control of these nonindigenous species in our neighborhoods.

Resources

Magazines and newspapers—recent stories concerning exotic species

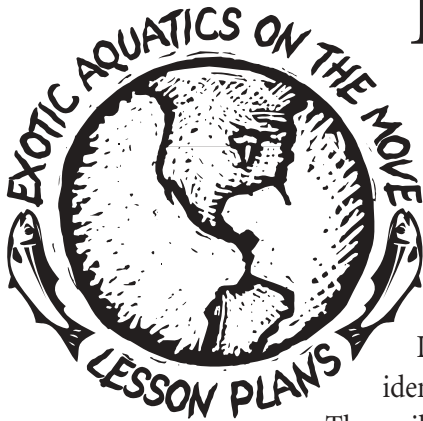
ENCARTA CD

Project TELLUS video on *Exotic Species*. Video and teacher guide available from Louisiana Sea Grant College Program, Louisiana State University-Sea Grant Building, Baton Rouge, LA 70803. (225)578-1558.

Credits

Prepared by author.

MOVEMENT TO AND FROM THE SEA



Grade Level: Intermediate grade level

Overview

This lesson is an excellent way to integrate Language Arts, Geography, Science, and Art. Students will develop their listening skills and map skills during the reading of the story. Students will become familiar with the Great Lakes and the waterways that connect them to the Atlantic Ocean. They will identify the physical characteristics and human interactions with these waters.

They will become aware of how the movement of water currents, wind, and human action have affected the Great Lakes by introducing a variety of exotic species. Students will need to work together in groups to gather data about their particular exotic species. Then they will illustrate and write a story incorporating factual information into a book that can be read to other students to inform them about the dangers of exotic species.

Author

Lorraine Bujan

School

Mark Sheridan
Academy

City

Chicago

State

Illinois

Grade Levels Taught

3rd-7th grades

Background

Students need to learn about the Great Lakes and the St. Lawrence Seaway because it is a major source of transportation, drinking water, and recreation for millions of people. The plants and animals that are part of the ecosystem of this region are profoundly affected by the introduction of exotic plants and animals through movement within the human (e.g., ships and canals) and physical (e.g., water currents) systems. Exotic plants and animals usually have no natural enemies in this part of the world and have adaptations that make it possible for them to take over and cause native species to diminish, thus altering the ecosystem. Students need to be aware of this situation and share the information about exotic species with others.

Setting

Classroom

Objectives

1. Identify and label the Great Lakes, St. Lawrence Seaway, and major cities of the region.
2. Explain how exotic species might arrive and be transported throughout the region.
3. Demonstrate knowledge by creating a book to inform other students about the spread of exotic species in the Great Lakes region.

Geographic Standards

Standard 1. The world in spatial terms

Standard 4. The physical and human characteristics of place

Standard 14. How human actions modify the physical environment

Standard 15. How physical systems affect human system

ILLINOIS STATE GOALS/CHICAGO STANDARDS AND FRAMEWORK:

1. Social Studies State Goal 17, CAS C & D
2. Language Arts State Goal 4, CAS B
3. Science State Goal 12, CAS B

Keywords

Buoy, ballast water, current, downstream, grain elevator, freighter, breeches buoy, dry dock, canal lock, portage

Materials

Teacher: a copy of *Paddle-to-the-Sea* by Holling Clancy Holling, Houghton Mifflin Company, Boston, 1941

- A wall map of the St. Lawrence Seaway and the Great Lakes
- Two large sheets of paper or poster board

Student: Folder containing information about exotic species. (The amount of information in the folder will depend on the age of the student and resources available.)

- Paper, crayons, markers, or colored pen

Schedule

Days 1–3: readings from *Paddle-to-the-Sea* and charting exercises

Days 4–7: group work and making of the books

Day 8: present group books and discussion

Curriculum Connections

Reading, writing, and comprehension skills — understanding the readings and creating a book

Geography — charting exotic species movement and map skills

Science — researching exotic species

Procedure

OPENING THE LESSON

1. Give each student a map of the Great Lakes region. Have a similar map on the overhead or posted on the wall. Introduce the story *Paddle-to-the-Sea* and explain that the students will chart the voyage of *Paddle-to-the-Sea* and learn about the physical and human characteristics of the region. Read aloud to the class and discuss Paddle's journey through the Great Lakes. Read two or three pages daily, include discussion of physical and human characteristics and keep a list on the two large sheets or posterboard. Show Paddle's journey by making a line and identifying stopping points.
2. Introduce vocabulary such as ballast water, current, downstream, grain elevator, freighter, breeches buoy, dry dock, canal lock, portage.
3. Discuss the direction the water is flowing and why. Include these questions in your discussion: What specific types of fish, animals, or plants live in and near the lakes? How do people use the waterways? How can their use spread exotics? How can the waterways be affected?

DEVELOPING THE LESSON

1. Introduce the term exotic species. (The term for organisms that have been introduced into habitats where they are not native.) Use the purple loosestrife as an example. Discuss how humans introduced it as an ornamental plant and how it has spread throughout wetlands causing a decline of native species.

2. Break class into six groups each with a different exotic species research.

Group 1: Zebra mussel

Group 2: Sea lamprey

Group 3: Spiny waterflea

Group 4: Ruffe

Group 5: Alewife

Group 6 : White perch

(Other possible groups could be round goby, watermilfoil, common carp, or rudd.)

3. Have class create questions to be answered. Examples: How did this exotic species arrive in the Great Lakes? Where did this species originally come from? How did this species spread? (Have them remember Paddle's journey.) Where has the species spread since its arrival? What is the impact of this invader on the Great Lakes ecosystem?
4. Distribute folders with exotic species information and websites where students might find information. Provide at least two class periods for group work.
5. Have students use their research to create a book about their exotic species. The book should be modeled after *Paddle-to-the-Sea*. It needs to contain a map tracing the introduction, movement, and the extent of the invasion. Pictures should be drawn by students sequencing the arrival and spread of the species. Students should write text for their pictures by answering the questions developed by the class. Factual information should be used. The group may write either a non-fiction or narrative-style book.

CONCLUDING THE LESSON

1. Have students visit other rooms to read their books and the story of exotic species on the move in the Great Lakes region.
2. In class, use a Venn diagram to compare and contrast how different elements supplied movement for Paddle and exotics species. Example: Paddle hitched a ride on a log, while the zebra mussel hitched a ride on a freighter.

Applications

1. Discuss how movement can cause "things" to journey to places where they may not be wanted. Example: germs, diseases, the Chinese long-horned beetle.
2. Discuss biological controls and prevention.

Evaluation

Each group should be evaluated on their book and final research. In addition, students can be evaluated on classroom participation and participation within the group.

Resources

Illinois-Indiana Sea Grant website:
<http://iisgcp.org>

Sea Grant Nonindigenous Species Site (SGNIS): <http://www.sgnis.org>

Credits

Prepared by author.

EXOTIC AQUATIC TUNES

Grade Level: 3rd grade and above



Overview

This musical activity can be used as a culminating activity or review of the identifying characteristics, pathways, and effects of non-native species.

Background

The natural habitats of Washington are diverse and contribute to the dynamic interactions between people and environment. Washington plays an important role as a member of the Pacific Rim regions. We are a major trade, economic, cultural, intellectual, and social center in this international arena. This can and does affect our natural marine and wildlife environment in ways that we often neglect to consider. Washington values the beauty and diversity of her natural environments. Our students will be the caretakers and restorers of our habitats.

Setting

Classroom

Objectives

1. Identify basic characteristics of non-native species.
2. Locate the places of origin.
3. Explain the possible human and non-human pathways.
4. Analyze the effects, both harmful and beneficial.

Geographic Standards

Standard 1. The student uses maps, charts, and other geographic tools to understand the spatial arrangement of people, places, resources, and environments on Earth's surface. 1.1. Use and construct maps, charts, and other resources.

Standard 2. The student understands the complex physical and human characteristics of places and regions. 2.1 Describe the natural characteristics of places and regions. 2.2 Describe the patterns humans make on places and regions. 2.3 Identify the characteristics that define the Pacific Northwest and the Pacific Rim as regions.

Standard 3. The student observes and analyzes the interaction between people, the environment, and culture. 3.1 Identify and examine people's interaction with and impact on the environment. 3.2 Analyze how the environment and environmental changes affect people. 3.3 Examine cultural characteristics, transmission, diffusion, and interaction.

Keywords

Nonindigenous species, pathways of introduction, natural dispersal, human-mediated dispersal, identifying features, management

Materials

Pen, paper, overheads, reference materials, review materials

Schedule

This activity would require one class period (approximately 30-45 minutes) to prepare. Presentation time would be approximately 3-5 minutes.

Prerequisite Skills

Students will have completed a unit on specified non-native species. Students will have an understanding of the basic characteristics of native and non-native species, places of origin, pathways, possible effects on the native eco-system, and potential solutions. Students will be able to apply the geographic themes of location, place, region, movement, and human-environment interaction.

Curriculum Connections

This activity could be used in Science (study of habitats), Geography (places of origin), Math (distance traveled, graphing, recording data), Language Arts (written song verses), Fine Arts (use of melody, dance actions, drawings).

Author

Vicki Butler

School

Seattle Academy of Arts and Sciences

City

Seattle

State

Washington

Grade Levels Taught

6th grade

Procedure

1. Choose one specific non-native species.
2. Browse through the information provided and identify the following:
 - Name of species
 - Origin of species
 - Pathway of transmission
 - Effects on “new” habitat
3. Identify unique features of the organism.
4. Choose a tune, such as “My Bonnie Lies Over the Ocean” or other seaworthy tune (“Popeye the Sailor Man”) or something action-oriented like “The Macarena.”
5. Using the information from your non-native species, geographic themes, and understanding of habitat, create your own little “show tune.”
6. Write your new tune on an overhead (PowerPoint slide, poster).
7. Practice your tune and prepare to share it with your classmates.
8. Encourage your classmates to learn the tune (action/steps) that you’ve created!
9. Have classmates critique your song based upon the information presented.

Teacher Notes

Provide adequate time for review of material. Small groups of three students are ideal for this activity. Pre-group students prior to class. Brainstorm tune suggestions to provide a wide variety of musical options for the class groups. Provide groups with the evaluation rubric at the beginning of the assignment so they can self-assess. Allow students adequate time for preparation of song but limit it to one class period. Presentations can be made during the following class time. Encourage students to learn songs from other groups.

Applications

This activity is good for a section review. Songs can be kept and used for later unit reviews. Students utilize a variety of learning modalities during this activity and enjoy the opportunity to create. Students could also share songs (learnings) with younger grade levels or create skits to go with the songs.

Evaluation

Students will complete rubric below. Students will present to their classmates.

Resources

Washington Sea Grant Program materials

Credits

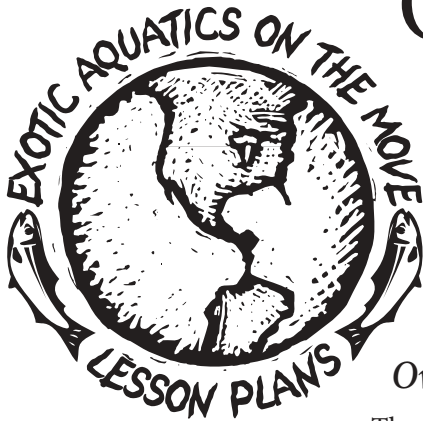
Prepared by the author.

EVALUATION RUBRIC

Learning	Accurately presented	Included in presentation	Not included in presentation	Comments
Name of species				
Origin of species				
Pathway of transmission				
Positive effects on “new” habitat				
Negative effects on “new” habitat				
Geography themes				

THE GEOGRAPHY OF THE GREAT LAKES AND NONINDIGENOUS SPECIES

Grade Level: 9th–12th grades



Overview

These activity lessons will inform the student on how exotic species and geography are combined together to study the Great Lakes Region. Students will be introduced to large ships by studying *The Wreck of the Edmund Fitzgerald* ballad and video. A map of the Great Lakes is provided for improved understanding of the basin. A world atlas will help students understand the location and environment of the region. Students will be made aware of decisions involving water use. Students will then map the major ports of the Great Lakes on a large map. The same map will then be used to put small colored dots where the nonindigenous species are located. And finally, the question of ballast water will be studied, as it has much to do with the nonindigenous species found in the Great Lakes.

Authors

Lou Camilotto
Mike Peterson

School

McCutcheon High
School

City

Lafayette

State

Indiana

Grade Levels Taught

9th–12th Grades

Background

Geography explains the place of where something is, and it explains what is there once you get to it. Nonindigenous species are in the news. We hear about plants and animals from foreign places that have grown out of control. How do these organisms spread across the ocean to the Great Lakes? Why are they a cause for concern? Habitats will be altered due to the colonization by exotics. They can cause the extinction of native species. Once established exotics can be rarely eliminated. Major pathways through which we introduce non-native species into inland and coastal waters include: ballast discharge, and hull fouling by way of boats/ships. Ballast water can contain aquatic plants, animals, and pathogens. Marine vessels take on and discharge millions of tons of ballast water daily in ports and harbors around the Great Lakes. Because of the huge volume of ballast water, it is considered a major pathway for aquatic organisms. Fouling of vessel hulls, including the hulls of sea or floatplanes, by encrusting organisms also provide a mechanism for the transfer of species.

Transport of marine organisms in ballast water has received increasing attention in recent years. Modern vessels using water as ballast and the increased number and speed of ships have undoubtedly increased the frequency of transfer of living aquatic organisms. Ballast water is believed to be the vector for the transportation of the freshwater zebra mussel from Europe to the Great Lakes. Today, the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 directs the U.S. Coast Guard to issue mandatory ballast exchange requirements for the Great Lakes. In October 1996, the National Invasive Species Act became law. The Act directs the Secretary of Transportation to provide guidelines for a ballast water exchange program. Some antifouling paints are used, but some become less effective over time.

As human populations and commerce grow, so will the impacts of exotics. The Great Lakes is a case in point. In just the past ten years, the region has experienced the introduction of several alien organisms that have had profound effects. Zebra mussels, the perchlike ruffe, and the crustacean, spiny

waterflea are just a few of the more high profile exotics. Their introduction was the inevitable consequence of human enterprise, policies and technology, in this case, expanded international trade, the recent development of fast, giant ocean freighters, and the discharge of ballast water.

Since 1993 commercial ships entering the Great Lakes must exchange their ballast water while they are at sea, in accordance with the 1990 Act. This exchange ensures that few freshwater organisms from the point of origin remain in the water and sediment at the bottom of the ballast tanks. The organisms that are picked up in the ocean water are unlikely to thrive in the inhospitable freshwater of the Lakes. Similarly mid-ocean water pumped from ballast tanks in coastal and estuarine areas poses little risk as the suite of open ocean organisms do not live easily in nearshore waters. Today, it is estimated that many exotic organisms are released into the Great Lakes each day of the shipping season. Once exotics become established, today's highly mobile and mechanized human population presents risk for their spread.

The Great Lakes region of North America is important to any understanding of the biology and ecology of the great global biotic interchange that is now going on. A collection of watersheds spanning portions of seven states and two provinces, and stretching from northern New York and southwestern Quebec in the east, to Minnesota and southern Ontario in the west, the region has been the natural conduit for a steady stream of traffic, biological and otherwise, for the past 300 years. A major route into the continent's interior for European explorers, and later, a major artery for waves of European settlement, the region today is a principal international transshipping point for raw materials, commodities, and manufactured goods. Regularly accessible to some 40 million people, the region also accommodates some of the largest cities on the continent. Over that time, its aquatic habitats—rivers, lakes, streams, marshes, ponds, seeps, fens, and wet meadows—have been subjected to a variety of disturbances. Throughout the years, these aquatic habitats were drained, polluted, diverted, filled, dammed, overfished, and the recipient to a steady stream of accidental and intentionally stocked exotic organisms. The region provides an object lesson in how alien organisms, in conjunction with

other human-caused habitat disruption, can profoundly alter ecological relationships across entire systems.

Setting

Classroom

Objectives

1. Locate on a map the major ports on the Great Lakes.
2. Locate on a map the location of nonindigenous species around the Great Lakes.
3. Be informed about the description of pollution in the Great Lakes.
4. Decide on how water is to be used in the Great Lakes.
5. Understand how the issues of water on the Great Lakes affect people and aquatic life. Groups of people will understand the Great Lakes differently based on their needs and interests.
6. Participate in the Great Lakes Adventure CD to understand how the EPA protects the Great Lakes, and the steps it takes to monitor.
7. Students will interact with the ship, *Lake Guardian*, as part of the CD experience.

Geographic Standards

Standard 1. How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information from a spatial perspective

Standard 2. How to use mental maps to organize information about people, places and environments in a spatial context

Standard 4. The physical and human characteristics of place

Standard 5. That people create regions to interpret Earth's complexity

Standard 8. The characteristics and spatial distribution of ecosystems on Earth's surface

Standard 14. How human actions modify the physical environment

Standard 18. How to apply geography to interpret the present and plan for the future

Keywords

Exotic aquatics, ballad, nonindigenous, Great Lakes Basin, environmentalist, tailings, ballast water, global biotic interchange

Examples of nonindigenous species: zebra mussel, watermilfoil, ruffe, white perch, common carp, purple loosestrife, rainbow smelt, round goby, alewife, flowering rush, sea lamprey, quagga mussel, coho salmon, rainbow trout, spiny waterflea, goldfish, chinook salmon, rusty crayfish, brown trout, curly-leaf pondweed, tubenose goby, rudd

Materials

Each student should have: world atlas, maps of the Great Lake Basin, color pencils, handouts on Exotic Aquatics on the Move (from Websites), color dots

Schedule

Activities will require seven days or less depending on each activity.

Monday: Gordon Lightfoot's ballad, *The Wreck of the Edmund Fitzgerald*
Video: *Fitzgerald* (14 min.) 1993, Great Lakes Shipwreck Historical Society

Tuesday: Making Decisions on Water Use

Wednesday: Mapping major ports of the Great Lakes Activity. Teacher explains nonindigenous species to class.

Thursday: Video, *Alien Ocean*
Maryland Sea Grant College Program, NOAA
30 min. Discuss video.

Friday: Mapping of Nonindigenous Species

Monday: ballast water experiment and song, *Migrant Species*

Prerequisite Skills

There are no prerequisite skills necessary. Students should have some idea of map skills.

Curriculum Connections

These lesson activities will be conducted along with a unit on the Great Lakes or regional geography. It should be introduced when one studies World Geography or American History. Ecology/Biology classes may use the unit of study as well.

Procedure

Each lesson can be taught individually or as a unit, but it is better if the entire unit is taught. Once materials are handed out, the teacher may introduce each part as the week progresses.

Each lesson has the pertinent instructions on it for teacher/student. Teacher should go over the major objectives of the unit before the class begins.

Teacher Notes

It will be necessary to have all materials ready for students to use. The atlas is imperative. A wall map and pictures would be helpful. Videos should not be rushed. Let the students watch and make comments/discussion time available to the student immediately after viewing. Maps should be as large as you can copy them. Consider displaying the milk jugs, which look like the ballast of a ship, for the students' benefit. Everyone should sing Mike Peterson's song "Whatever Floats Your Boat"!!!

Application

After all the activities have been applied, the teacher should have a round-table discussion on the importance of the environment in and around the Great Lakes Basin. If they were in charge, (citizens of tomorrow) what would they do? How will they think and act? How do they feel?

Evaluation

Students are to decide on their assessment from one of the categories below:

1. Write an illustrated story about an exotic aquatic species and read your story to the class.
2. Design a T-shirt about exotic aquatic species.
3. Design a David Letterman-type Top 10 List.
4. Design a poster about an exotic aquatic species.
5. Write a letter to your newspaper editor telling the community about the exotic species problem.
6. Display a presentation poster at the local mall informing the community about the exotic problem.
7. Write to your President or Congressman stating the need for Federal support in fighting nonindigenous species.

8. Students may do another project involving the Great Lakes Basin.
9. Students may set up a display in the Social Studies display case/ bulletin board at school.
10. Students can contact Sea Grant or the EPA for more information on protecting the Great Lakes environment.
11. Students may use the Internet to explore other nonindigenous species.

Resources

Sea Grant Nonindigenous Species (SGNIS) website: <http://sgnis.org>

Great Lakes Information Network (GLIN) website: <http://www.great-lakes.net/envt/exotic/exotic/html>

Lake Guardian CD (\$10.00)
<http://www.epa.gov/glnpo/guard/ship.html>
 Fax: 765-496-1356
 E-mail: fbpa@ecn.purdue.edu
 Phone: (765)494-1174

Alien Ocean video (30 min.) Maryland Sea Grant College Program
<http://www.mdsg.umd.edu/MDSG/>

Great Lakes Sea Grant Network website:
<http://www.h20.seagrant.wise.edu/greatlakes/glnetwork/glnetwork.html/>

WEBSITES FOR NONINDIGENOUS SPECIES:

Nonindigenous aquatic species:
<http://nas.er.usgs.gov>

Nonindigenous freshwater species:
<http://nas.er.usgs.gov/freshwaterlinks.htm>

Sea Grant Nonindigenous Species Web site:
<http://www.sgnis.org>

Exotic species and their effects on the Great Lakes: <http://www.great-lakes.org/exotics.html>

Great Lakes Information Network:
<http://www.great-lakes.net>

Nonindigenous Species website links:
<http://nas.er.usgs.gov/links.html>

Nonindigenous aquatic plant:
http://nas.er.usgs.gov/plants/fact_sheets.htm

What are nonindigenous aquatic species?
<http://nas.er.usgs.gov/whatis.htm>

Nonindigenous fish distribution information (maps): <http://nas.er.usgs.gov/fishes/maps.htm>

Nonindigenous fishes within the USA:
<http://nas.er.usgs.gov/fishes/fisheslist.htm>

Credits

Exotic Aquatics on the Move
 Illinois-Indiana Sea Grant Workshop
 Indiana Dunes State Park
 Chesterton, IN

Great Lakes Sea Grant Network

J.A. Drake. *Biological Invasions: Global Perspective*.

John Wiley and Sons, Ltd. 1989.

Navigating the Great Lakes
 St. Lawrence Seaway System
 Constitution Square
 360 Albert St., Suite 1400
 Ottawa, Canada K1R7X7

LESSON ONE:

MAKING DECISIONS ON WATER USE IN THE GREAT LAKES

The issue is that the water of the Great Lakes has multiple uses. How should the water be used?

Role-Playing: Divide the class into five groups, each group taking on one of the following roles:

- A. An environmentalist wants to stop all waste dumping in the Great Lakes.
- B. A developer wants to dredge the Lakes and use the newly created land to build a lakefront condominium.
- C. A developer of a sewage treatment plant wants to dump treated sewage into the Lakes.
- D. A city resident is concerned about drinking clean water from the Lakes.
- E. An iron ore mine executive wants to dump tailings into the Lakes.
- F. A nuclear power plant executive wants to dump partially radiated water into the Lakes.

Put yourself into this person's values and attitudes. You become one of the people mentioned above. In your group, answer these questions:

1. How do you want to use the Lakes?
2. What are you interested in?
3. What do you value most?
4. What rules, concepts, and principles do you live by?
5. What would be the advantages and disadvantages of your lake use?
6. What are the costs and benefits of your alternative?
7. What will be the consequences of your lake use?

A good resource to use for your arguments would be William Ashworth's book, *The Late Great Lakes*.

Each group should choose a spokesperson. Each spokesperson is allowed to give an opening statement, then debate the issue.

To close the debate, take a secret ballot. Vote for the person who has persuaded you.

Write a paragraph to justify your choice. Can you formulate a solution to the issue. Is there a compromise solution that will make several sides happy?

LESSON TWO:

THE WRECK OF THE EDMUND FITZGERALD

by Gordon Lightfoot

*The legend lives on from the Chippewa on down
Of the big lake they call Gichigumi.
The lake, it is said, never gives up her dead
When the skies of November turn gloomy.*

*With a load of iron ore 26,000 ton more
Than the Edmund Fitzgerald weighed empty,
The big skip and crew was a bone to be chewed
When the gales of November came early.*

*The ship was the pride of the American side
Coming back from some mill in Wisconsin.
As the big freighters go, it was bigger than most
With a crew and a captain well seasoned.*

*Concluding some terms with a couple of steel firms
When they left fully loaded for Cleveland,
And later that night when the ship's bell rang, Could
it be the north wind made them feeling.*

*The wind and the wire made a tattle-tale sound
And a wave broke over the railing.
And every man knew as the captain did too
'Twas the witch of November come stealing.*

*The dawn came late and the breakfast had to wait
When those gales of November came slashing.
When afternoon came it was freezing rain
In the face of a hurricane west-wind.*

*When suppertime came, the old cook came on deck
Saying, "Fellows, it's too rough to feed ya."
At 7:00 p.m. the main hatchway caved in.
He said, "Fellows, it's been good to know ya."*

*The captain wired in: He had water coming in
And the big ship and crew was in peril.
And later that night when his lights went out of sight,
Came the wreck of the Edmund Fitzgerald.*

*Does anyone know where the love of God goes,
When the waves turn the minutes to hours?
The searchers all say they'd have made Whitefish Bay
If they'd have put 15 more miles behind her.*

*They might have split up or they might have
capsized.
They may have drove deep and took water.
And all that remains are the faces and the names
Of the wives and the sons and the daughters.*

*Lake Huron rose and Superior sings
In the rooms of their icewater mansions.
Old Michigan steams like a young man's dreams.
The islands and bays are for sportsmen.*

*Farther below, Lake Ontario
Takes in what Lake Erie can send her.
When the iron boats go, as the mariners all know,
With the gales of November remembered.*

*In a musty old hall in Detroit they prayed
In the maritime Sailors' Cathedral.
The church bell chimed 'til it rang 29 times
For each man on the Edmund Fitzgerald.*

*The legend lives on front the Chippewa on down
Of the big lake they call Gichigumi.
Superior they said never gives up her dead
When the gales of November come early.*

LESSON THREE:

MAP WORK OF THE GREAT LAKES

Locate the places mentioned in the song on the map. After the song is over, ask the following questions:

1. What does this ballad tell you about the Great Lakes?
2. Would you like to be a seaman/sailor on the Great Lakes? Why/Why not?
3. What makes seafaring on the Great Lakes dangerous?
4. Which month is the most dangerous when travelling on the Great Lakes?
5. The ship the Edmund Fitzgerald ran into trouble on which of the Great Lakes?
6. What type of ship was the Edmund Fitzgerald?
7. What caused the ship to sink?
8. Why was it surprising that this ship went down?
9. The author of this song, Gordon Lightfoot, is a Canadian. Why would a Canadian be concerned with what happens on the Great Lakes?
10. Why do you suppose he wrote this particular song? What did he want you to think and feel?
11. A ballad is a song that is meant to tell a particular kind of story. What kind of story does a ballad tell?
12. How was this story a tragedy?

Show the video on the Edmund Fitzgerald. Seeing this video will enhance Gordon Lightfoot's ballad, *The Wreck of the Edmund Fitzgerald*.

The ballad by Gordon Lightfoot is on his album entitled, *Sundown*.

Use an atlas to locate the following on the Great Lakes Map:

Name the five Great Lakes:

H _____

O _____

M _____

E _____

S _____

Place the letter on the map to show where it is located. Letters A–M

- A. On which lake is Chicago located?

- B. On which lake are Duluth and Thunder Bay located? _____
- C. On which lake are Cleveland and Buffalo located? _____
- D. Detroit is located on a river that connects which two lakes? _____

- E. Sault Ste. Marie is located on the narrows between which two lakes? _____

- F. On which body of water is Montreal located? _____
- G. Toronto is located on which lake?

- H. The biggest Great Lake is _____
- I. The smallest Great Lake is _____
- J. The deepest lake is _____
- K. The shallowest lake is _____
- L. The Soo Locks links which two Great Lakes? _____

- M. The Welland Canal links which two lakes?

LESSON FOUR:

MAJOR PORTS ON THE GREAT LAKES IN CANADA AND UNITED STATES

Place the number (1–30) on the map where the port is located.

Place a key/legend at the bottom of the map to designate the name of each port.

- | | |
|-------------------|--------------------------|
| 1. L'Anse | 16. Sault Ste. Marie |
| 2. Thunder Bay | 17. Kingston |
| 3. Leland | 18. Waukegan |
| 4. Montreal | 19. Buffalo |
| 5. Windsor | 20. Sandusky |
| 6. Chicago | 21. Alpena |
| 7. Grand Portage | 22. Fort Michilimackinac |
| 8. Ludington | 23. Milwaukee |
| 9. Ottawa | 24. Cape Vincent |
| 10. Rochester | 25. Sarnia |
| 11. Duluth | 26. Detroit |
| 12. Toledo | 27. Toronto |
| 13. Erie | 28. Cleveland |
| 14. Marquette | 29. Put-In-Bay |
| 15. Niagara Falls | 30. Port Huron |

LESSON FIVE :

BALLAST EXPERIMENT

This lesson explains why ballast is necessary for a ship and how ballast contributes to the spread of exotic species. The following discussion explains some of the problems with the current practices in keeping a ship in trim, or balanced. Along with the information are questions for students to explore and research. It would also be helpful for students to learn about a ship's design. A good online source for information about a ship's design is in the following Encarta Encyclopedia article: Howard I. Chapelle, "Ships and Shipbuilding," Microsoft(R) Encarta(R) 96 Encyclopedia. (c) 1993-1995 Microsoft Corporation. Funk & Wagnalls Corporation.

Explanation

When loading a ship with cargo, the weight of the cargo helps to stabilize the ship for travel. After off-loading the cargo, a ship no longer has the same weight to give it stability in the ocean. Therefore ballast is required to keep a ship stable in lake or ocean currents, when it is no longer loaded with cargo and leaves the port.

Questions to consider

1. How would you describe the "shape" of the area that is built into a ship to store ballast?
2. Does this shape cause a problem in finding a material to fill it? Why or why not?
3. What are the characteristics required for a material to be used as ballast?
4. What immediately available coastal or seaside substances meet these requirements? Is there more than one?
 - a) sand, soil
 - b) water
 - c) other cargo
5. What are the advantages or disadvantages to the use of these substances in terms of injection, retraction, or availability?
6. What do you suppose has been the material used by most ships in the great lakes?

Explanation

A ship comes in from another area with ballast tanks full of water that was loaded to give the ship stability when it left its homeport. The originating port for a ship will often be a foreign country. When such a ship arrives in an American cargo port, the ballast water has often been flushed into the American harbor being visited by the foreign ship. Then the cargo the ship loads into its hold replaces the ballast that had been required to keep the ship in balance.

All water in its natural outdoor state has life forms living in it. Just like every country has a variety of life forms that live on land, the ocean and the seashore of every country have life forms that may be specifically found only in that one location. Transporting ballast water from one foreign country to another foreign country will introduce species of life that may not be native to the receiving country. In every ecological system, there is also a balance of creatures that are predators, prey, or neutral to every other life form in that system. When foreign life forms are introduced, they often upset the balance of the ecological system, replace predators, or otherwise upset the natural balance of the system in other ways. Examples of this introduction of foreign species are the zebra mussel, sea lamprey, and several other fish species introduced into the Great Lakes by cargo vessels over the past years. In some cases, these foreign invader species have completely replaced native species that are no longer present. Some of these invaders also present specific problems in nature which impact on the shipping industry and other business and manufacturing systems in the Great Lakes.

Questions to consider

7. What body of water is that potentially separates seashore of one country, from the seashore or coastline of any other country?
8. How do you suppose this body of water can be used to prevent bringing foreign species into fresh water, or sea coastal areas?

Explanation:

Current practices for ships that return to homeport without stabilizing cargo include taking on ballast water in the port they are visiting and returning to the ocean on their way home. In between the port they are leaving and their home port, the ships can flush the ballast water they took on in the foreign port and then take on ocean water to continue the voyage home. Water from the deep ocean has less likelihood of carrying life forms or organisms that will survive in the coastal or harbor areas of the ships' home port when they will again flush their ballast tanks and take on new cargo.

Question to consider

9. Are there other possible solutions to preventing foreign species from being introduced into waterways from one country to another?

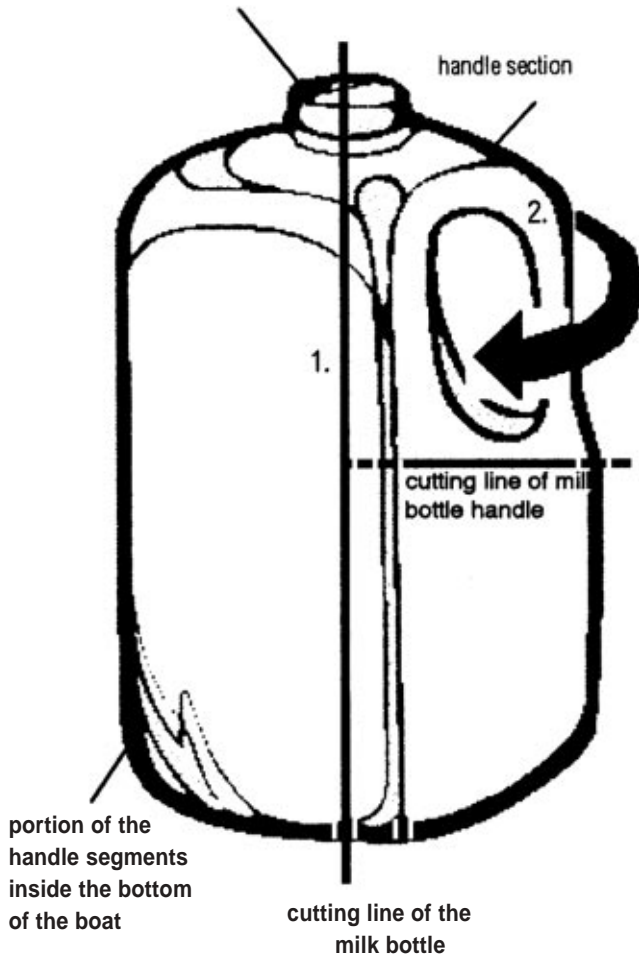
Making the model ship with ballast

Consider the various problems posed with filling ballast and extracting ballast. Experience the stability or instability factor with and without ballast or cargo while your boat is in a tub of water. Follow the directions in the diagram on the next page for making a milk bottle ballast boat and see what conclusions you can make concerning the use of ballast, lack of ballast, and solutions to preventing foreign life forms from invading ports.

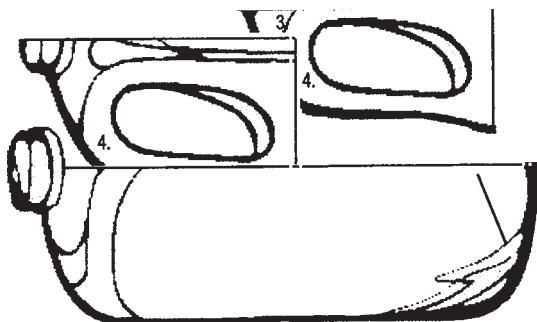
Materials needed

1. Two milk bottles or cartons cut in half (placed one inside the other to create a fillible chamber).
2. Realistically available substances to fill the ballast space (e.g., sand and water).
3. A "cargo" weight such as model cars or wooden blocks to represent cargo containers.
4. A tub of water with sufficient depth to allow the water bottle "ship" to settle sufficiently to view and make conclusions.
5. You may wish to use a waterproof marker to mark the side of the bottle boat and track stability. You can alter the design of the milk bottle boat or even use a design of your own to do the experiments listed along with the following milk bottle boat design chart.

1. hot glue the cap back to the top of the remaining bottle (the bottom)

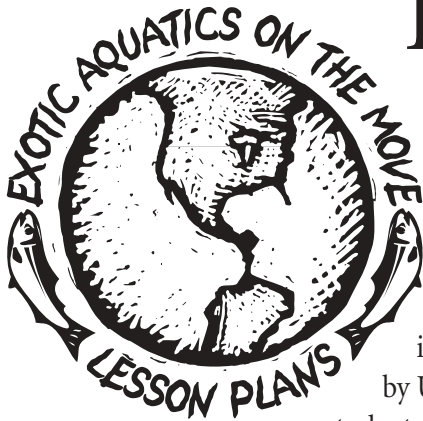


2. Place the handle segments inside the bottom of the boat.



1. Cut one bottle in half as shown in the picture to the left. Separate the handle section from the body as symmetrically as possible. Hot glue the original lid to this bottom section and set this bottom part aside for a moment
2. Retrieve the handle which has been cut away. First, trim the lid section (mouth) of the handle section slightly, then rotate this handle section to the inside of the bottom of the bottle boat and hot glue it into place with the two lid segments together. The handle should be hot glued, upside down, to the interior bottom of the boat bottom.
3. Take the handle section from another bottle, trim it down further in order to fit against the first handle section which has been glued into place, and hot glue this second handle section into place with the mouth of the segment facing the same direction as the hot-glued lid.
4. Fill the inside of the handles with sufficient hot glue and other plastic pieces to keep water from being able to return up into the "cargo" area. These handles, hot glued and handle side down, will act somewhat as the girder inside a ship, which braces the bottom and separates the "cargo" section from the "ballast" area between the hull and the cargo. Hot glue these two handle pieces into place. If you wish, you could gather other scrap plastic and refine the interior "shelf," which can be used for the "cargo" area. Leave some room at the back end of the milk bottle boat to be able to add water for ballast.
5. Fill a dish tub sufficiently with water and place the milk bottle boat into the tub. Note what happens to the boat without a ballast. Why do you think this happens? Place a cargo load on the hot-glued handle platforms. What happens to your boat with a different upon center of gravity?
6. Remove the cargo and fill the bottom of the boat (the ballast area) with water, replace it into the tub of water and see what happens to the general stability or balance of the boat Does it appear that some sort of ballast is necessary?
7. Would better partitions for sealing in the ballast water in the chamber be helpful? Why?
note: (Of course steel is better than flexible plastic)
8. What are the visible problems with filling and unfilling the ballast chamber? How does a real ship have to fill and empty the chambers?
9. Place some "cargo" weight in the hot-glued handle platforms. When you try to move the boat in the tub of water, what do you notice about the cargo?
What is necessary to further add stability to the boat in terms of the cargo?
10. Why do you think the current solution-ships return to open sea before emptying the ballast water they took on in port-is the best possible solution with the current design of ships?
11. Can you think of a ship design that would be better in terms of taking on and purging ballast, or not requiring ballast at all? Can you think of a way to replace the current system of ballast purging at sea and still prevent foreign species from migrating from their home territory to another location?

THERE ARE ZEBRAS IN LAKE ERIE?



Grade Level: 5th–8th grades

Overview

This activity reflects current educational practice in testing for NYS-ELA (English/Language Arts) standards, and is based on zebra mussel information collected at the August 1, 2000 Erie Canal Workshop presented by US Fish and Wildlife Service and New York Sea Grant. It will introduce students to what the zebra mussel is, the mussel's history of distribution, and how its population affects us today.

Background

Intermediate level students in WNY need to have the knowledge of invasive species so that when they use watercraft on Lake Erie, they will be able to recognize the zebra mussel and be aware of signs of infestation. Hopefully this will lead to future good habits in the cleaning of water crafts after use in our Great Lakes. This activity is designed to address skill reinforcement needed to meet state educational standards and to help students prepare for this test-taking format.

Setting

Classroom activity: whole group, small cooperative group or individual

Objectives

1. Examine samples of zebra mussels.
2. Read and interpret graphic data (documents) about the zebra mussel.
3. Analyze the information in a chart form.
4. Summarize the information in a written essay.

Geographic Standards

Standard 8. The characteristics and spatial distribution of ecosystems on Earth's surface.

Standard 14. How human actions modify the physical environment.

Keywords

Zebra mussel, mollusk, introduction/invasion, exotic/native, life cycle, ecosystem, ballast, range

Materials

Zebra mussel samples from Sea Grant Travel Trunk, Document-Based Question (DBQ) Sheets

Schedule

Two 45-minute classes

Prerequisite Skills

Work cooperatively in small groups; read and interpret printed material; manipulate hands-on materials; knowledge of ecosystems

Curriculum Connections

Science, Social Studies, Reading/Language Arts

Author
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School
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City
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State
New York

Grade Taught
5th grade

Author
Kathy Dole

School
Lake Shore Central Schools

City
Angola

State
New York

Grade Taught
5th – 6th grades

Procedure

This is a self-contained Document-Based Question lesson and should be used following an ecosystem unit or as a practice exercise for any of the NYS exams: ELA, Science, or Social Studies.

Teacher reads the introduction page to the class, and then has the following options:

1. Cooperative Learning Activity: Divide the class into small groups, allowing each group to choose members to do certain tasks (for example, materials handler, reader, recorder, reporter) for each page of documents. Small groups analyze individual documents and report to the large group what they've learned. The whole class completes the chart. Individuals write an essay.
2. Independent practice: Students look at zebra mussel samples, and then read and follow directions on their own.
3. Whole Class "Work on It Together" Activity: Teacher directs examining of zebra mussel samples, leads a discussion which includes all the documents and writes answers on the summary chart as students give them. Teacher models the writing activity for the essay, and students work independently at the writing process.

Application

1. Environmental impact study including steps being taken for control and eradication of zebra mussels
2. Field trip to a lakefront site, fishery resource office, or water intake plant
3. Website research

Evaluation

1. Holistic: Chart: 6 points + Essay: 4 points (using generic rubric from State Ed.).
2. Cooperative Learning assessment could be used for each group: self-evaluation of participants and products, using a scale designed by the teacher.

Resources

Document 1: MN Dept. of Natural Resources, 1995

Document 2: SUNY Sea Grant, Feb. 1996

Document 3: Ohio Sea Grant, 1995

Document 4: Ontario Fed. of Anglers and Hunters, Aug. 1999

Document 5: MI Sea Grant, Revised 4-21-92

Document 6: Ohio Sea Grant, 1995

Document 7: NY Sea Grant Copyright 2000

Document 8: Illinois-Indiana Sea Grant

EXOTIC SPECIES WEBSITES:

for NY Sea Grant:
www.seagrantsunysb.edu/

for Univ. of MN Sea Grant:
www.d.umn.edu/seagr/

Credits

Created by authors.

Zebras in Lake Erie?



*An Instructional Activity Using
Document-Based Questions*

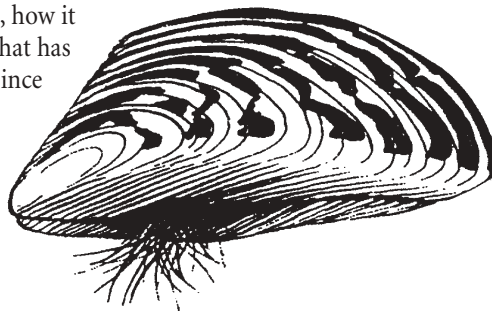
“EXOTIC AQUATICS ON THE MOVE” WORKSHOP: SUMMER 2000

by Linda Cooper and Kathy Dole

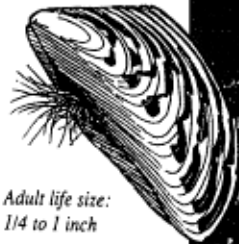
Exotic species are organisms introduced into habitats where they are not native. The organisms are transported by humans, wildlife, wind and water into regions where they did not historically exist. Species introduced into new habitats often overrun their new home and crowd out native species. With enough food and a favorable environment, their numbers will explode. Once established exotics are almost impossible to get rid of. They compete with native plants and animals and eventually will displace them.

One well known exotic that lives in the Great Lakes region is the zebra mussel. Why are people so concerned about this little animal?

1. Investigate the attached documents which show information about the invasion of the zebra mussel.
2. Complete the notes on the chart.
3. Write an essay about the invasion of the zebra mussel. Be sure to include: a description of the zebra mussel, how it came to the Great Lakes, and what has happened to the environment since it first arrived.



Many zebra mussels attached to a native clam.



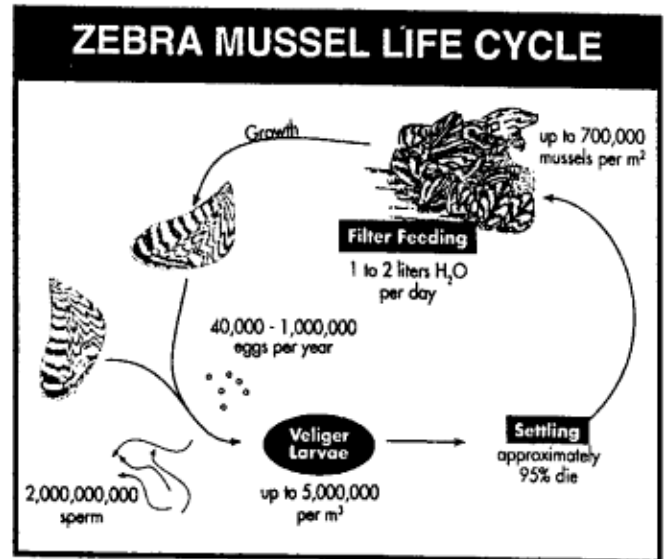
Adult life size:
1/4 to 1 inch

Zebra Mussel

Dreissena polymorpha



Document 1



Adapted from a fact sheet produced by the Lake Champlain Basin Program.

Document 2

INTRODUCTION

Originally it came from the Caspian Sea region of Poland, Bulgaria, and Russia. Canals built during the early 1800s allowed it to spread throughout Europe. By 1830 it had invaded Britain. First introduction into the Great Lakes was about 1985, 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 to its liking.

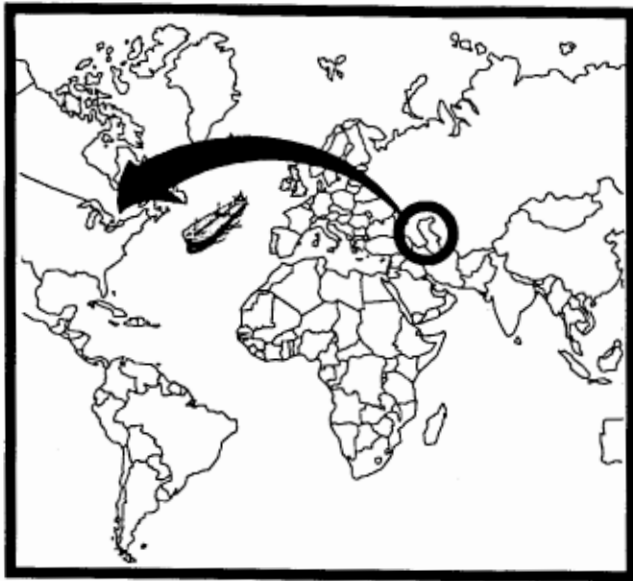
ECOSYSTEM IMPACT

It filters the plankton from the water, binding what it doesn't use into pellets that cannot be used by other plankton-feeding organisms. It accumulates on objects such as boat hulls and underwater pipes, clogging valves of both industrial and municipal water intake sources.

EFFECTS OF GLOBAL CLIMATE CHANGE

It is very likely that this bivalve will be a permanent part of the Great Lakes environment. It is limited to waters with a temperature between 12-27°C. As global warming increases the temperature of the Great Lakes, it will spread faster north into warmer waters. As the water level in the Great Lakes recedes, it will be able to colonize new areas that at one time were too deep for its survival.

Document 3

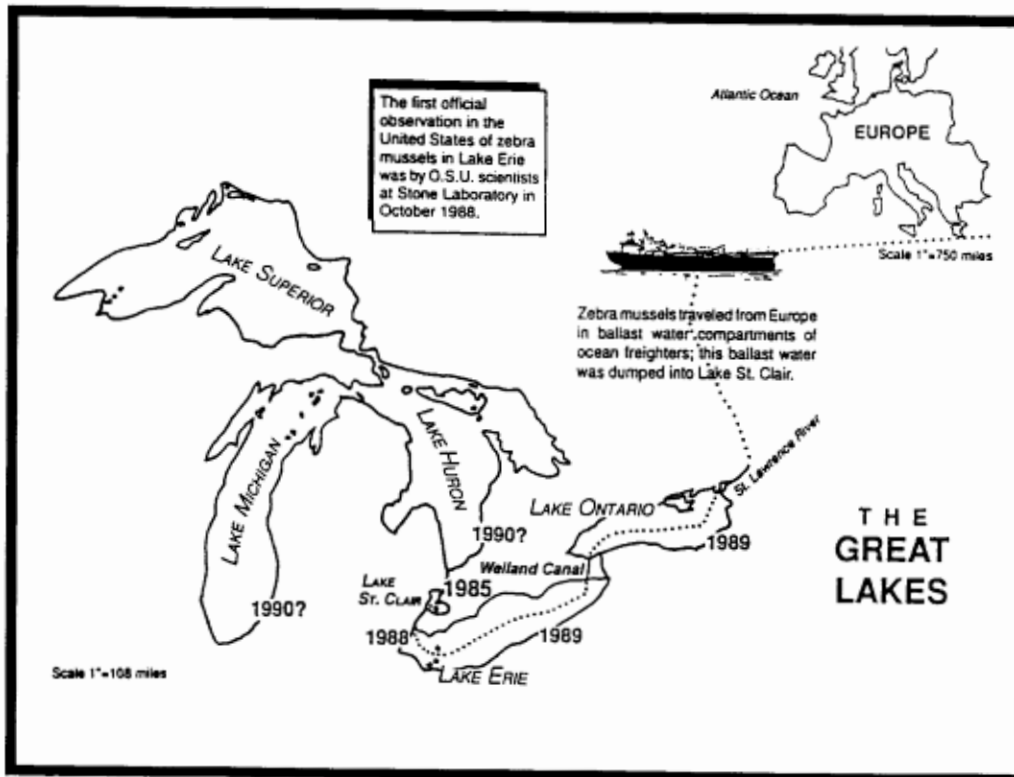


Document 4



This striped freshwater mollusk, native to the drainage basins of the Black, Caspian, and Aral Seas was accidentally introduced into the Great Lakes in the mid-1980s.

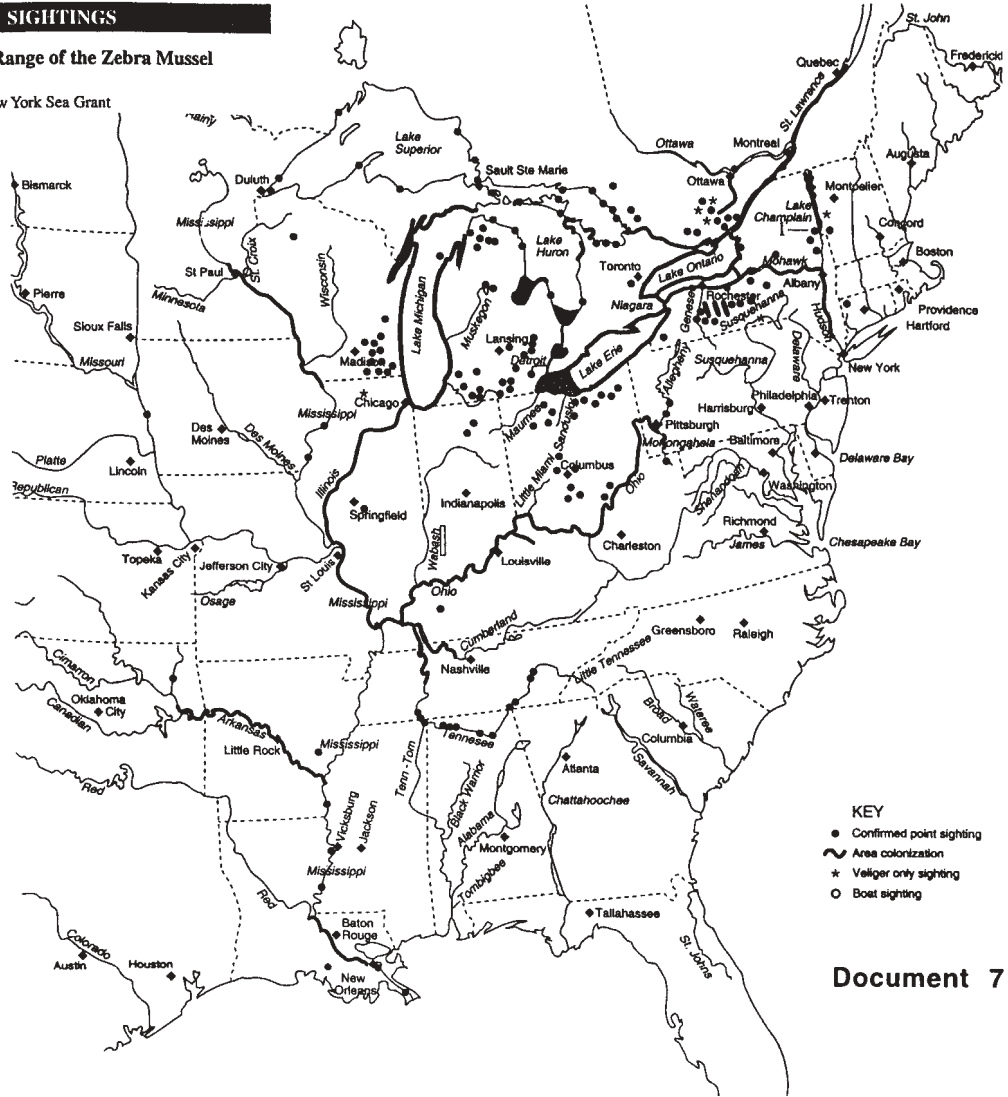
Document 5



Document 6

SIGHTINGS

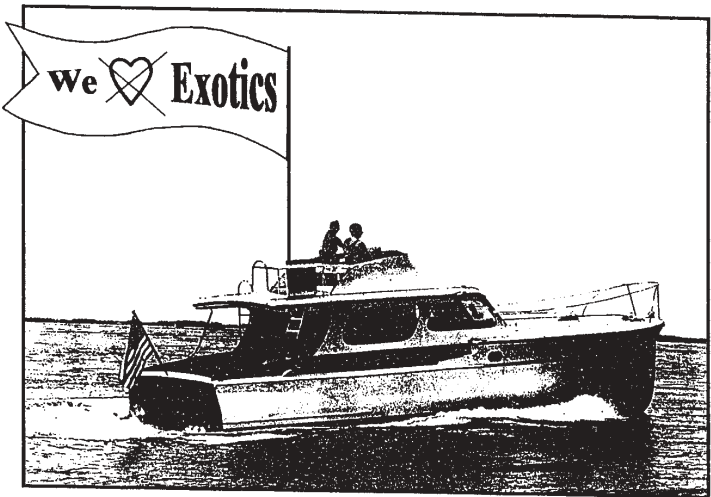
North American Range of the Zebra Mussel
 as of 26 May 2000
 © Copyright 2000, New York Sea Grant



KEY
 ● Confirmed point sighting
 ~ Area colorization
 ★ Veliger only sighting
 ○ Boat sighting

Document 7

Help Prevent the Spread of Aquatic Exotic Plants and Animals



Aquatic exotic species are organisms that are not native to our waters. Some of these species, such as Eurasian water milfoil and zebra mussels, can clog boating areas and be harmful to lake and river ecosystems.

Document 8

ZEBRA MUSSEL FACTS

1. WHAT: *Zebra Mussel*

2. DESCRIPTION OF ORGANISM:

3. WHEN WAS IT FIRST INTRODUCED
IN THE GREAT LAKES REGION?

4. WHERE IN THIS REGION WAS
IT FIRST SITED?

5. WHERE DID THE ZEBRA MUSSEL
COME FROM?

6. HOW WAS IT TRANSPORTED TO
THIS REGION?

7. LIST THREE PROBLEMS CAUSED BY
THE ZEBRA MUSSEL:

ZEBRA MUSSEL FACTS

1. WHAT: *Zebra Mussel*

2. DESCRIPTION OF ORGANISM:

Aquatic, temperate, freshwater mollusk, striped, bivalve, filter feeder, lays eggs, reproduces with egg and sperm, 1/4 to 2 inches long

3. WHEN WAS IT FIRST INTRODUCED IN THE GREAT LAKES REGION?

About 1985

4. WHERE IN THIS REGION WAS IT FIRST SITED?

It was found in Lake St. Clair which is located between Lake Huron and Lake Erie.

5. WHERE DID THE ZEBRA MUSSEL COME FROM?

It is from the Caspian Sea region of Poland, Bulgaria and Russia.

6. HOW WAS IT TRANSPORTED TO THIS REGION?

It was transported in the ballast water of transoceanic ships which contained larvae and possibly juveniles.

7. LIST THREE PROBLEMS CAUSED BY THE ZEBRA MUSSEL:

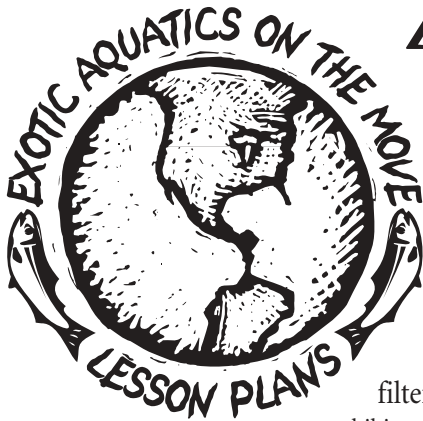
- 1. Accumulates on boat hulls*
- 2. Clogs pipes and valves of intake sources*
- 3. Filters plankton from the water limiting the food supply for other species*

NAME _____ DATE _____

WRITING TOPIC: ZEBRA MUSSEL

	EXCELLENT	VERY GOOD	GOOD	NEED TO IMPROVE
TOPIC SENTENCE				
DESCRIPTION OF MUSSEL				
HISTORY OF MUSSEL				
CHANGES TO ENVIRONMENT				
ENDING SENTENCE				
PUNCTUATION				
PARAGRAPHING				
SPELLING				
NEATLY DONE				

WHAT IS THE EFFECT OF ZEBRA MUSSEL FILTRATION? A SCIENTIFIC EXPERIMENT



Grade Level: 9th–12th grades

Overview

This is a scientific experiment. The activity is designed to demonstrate the filtering capabilities of zebra mussels. [Note: Many U.S. States and Canadian provinces prohibit possession and transport of Zebra mussels even for research without permit. Always contact your local natural resources management agency for more information.]

Background

Students should be familiar with the biology of zebra mussel and quagga mussels and what impact they have had on the Great Lakes and other aquatic ecosystems that they have invaded.

Setting

Laboratory, science classroom

Objectives

In this laboratory activity, students will predict, document and calculate feeding impacts of zebra mussels.

Schedule

The experiment is designed to be conducted over the course of two days with two or three students working together. However, extending the feeding time may be necessary to illustrate clearing effects. Adjust length of feeding time as needed. A stock culture of green algae should be started about two weeks before initiation of the experiment. Cultures can be obtained from a supply company or started by isolating healthy green algae from a pond water sample.

Geographic Standards

Standard 8. The characteristics and spatial distribution of ecosystems on the Earth's surface.

Prerequisite Skills

Students should know laboratory and safety procedures before attempting this experiment.

Teacher Notes

A permit is needed to possess zebra mussels in New York State, so one should be obtained from the NYS Department of Environmental Conservation. If this laboratory experiment is attempted outside of New York, teachers need to check on regulations for their own state before conducting this experiment. Desiccate mussels at the end of this experiment.

Introduction

Filtering water is one of the first steps in zebra mussel feeding. Water, along with phytoplankton, rotifers, and other organisms, is pulled into the mussel by the incurrent siphon. Algae and plankton become trapped and eventually are consumed by the animal. Excess water and wastes are excreted from the mussel via the excurrent siphon. Each mussel can filter about one liter per day. Depending on lake morphology, zebra mussel density and volume of the lake, zebra mussel filtration can greatly impact the lake ecosystem at the base of the food pyramid.

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Materials and Methods

36 zebra mussels (permit required), siphon tube, algae culture, 10 test tubes, 5, 2-L pop bottles, scale, tape measure, air pump with air stones, calculator, graduated cylinder

- Put 1.0 L of tap water into each of the five bottles. Siphon 1.0 L of water from the algae culture tank into each of the bottles.
- Mark the test chamber as follows:
 - “Control” (no zebra mussels will be introduced)
 - “Treatment₁” (one zebra mussel introduced)
 - “Treatment₅” (five zebra mussels introduced)
 - “Treatment₁₀” (10 zebra mussels introduced)
 - “Treatment₂₀” (20 zebra mussels introduced).
- Create a data table that will illustrate each of the five zebra mussel densities and their masses.
- Mass the total number of zebra mussels within each of the five treatment levels. Determine the total mass for Treatment₁, Treatment₅, and so on.
- Introduce the proper number of zebra mussels into each of the test chambers.
- Place air stone into each of the test chambers to allow for respiration, water mixing and distribution of phytoplankton.
- Leave undisturbed for 24 hours.
- When you return, note differences in water transparency within each of the treatments.
- Estimate percent of algae consumed by the mussels by comparing each of the treatments with water from the control. Use the control water to prepare a series of dilutions for this procedure.
 - Transfer 50 mL of control water to one of the test tubes and label 100%.
 - Transfer 40 mL of control water and 10 mL of tap water to a test tube labeled 80%.
 - Transfer 30 mL of control water and 20 mL of tap water to a test tube labeled 60%.
 - Transfer 20 mL of control water and 30 mL tap water to a test tube labeled 40%.
 - Transfer 10 mL of control water and 40 mL tap water to a test tube labeled 20%.
 - Transfer 50 mL of tap water to a test tube labeled 0%.
- Fill a test tube with water from treatment₁, shake and compare with the serial dilution you just prepared. Record the closest dilution percentage in the data table. Repeat this step for all of the original treatments. Construct a graph that represents this relationship.
- Calculate zebra mussel density by finding the bottom area of the test chambers. Measure circumference to find bottom area (assume that the bottom is flat).
 - $A = \pi r^2$
 - $D = C/\pi$
 - $r = D/2$



Control



Treatment₁



Treatment₅



Treatment₁₀

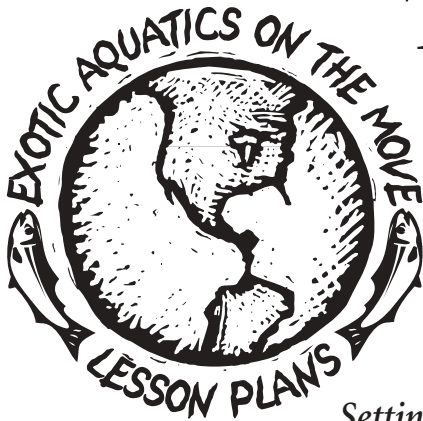


Treatment₂₀

Conclusion Questions

Write a reflective essay on this experiment and make sure you address the following questions. What effect do zebra mussels have on water clarity? Describe other potential food web changes that zebra mussels can cause. How do the test densities compare to the control? What has a stronger correlation; water clarity and zebra mussel density or water clarity and mass of zebra mussels? Why? Find out the zebra mussel density in a natural body of water near you. Based on your data, calculate zebra mussel body mass for the natural body of water. Can calcium levels in a body of water limit zebra mussel distribution? How? Describe other abiotic factors that may influence zebra mussel biology, distribution, and impacts.

EXOTIC AQUATICS ON THE MOVE



Grade Level: 9th grade

Overview

This unit was designed for freshman students in a Washington State History class.

Setting

Classroom

Objectives

The objectives of this unit are to introduce students to the concepts of the environment and nonindigenous species in a geographic setting and to further develop research, writing and presentation skills.

Geographic Standards

Standard 4. Physical and human characteristics of places

Standard 6. How culture and experience influence people's perceptions of places and regions

Standard 8. Characteristics and distribution of Earth's ecosystems

Standard 14. How human actions modify the physical environment

Standard 18. How to apply geography to interpret the present and plan for the future

Keywords

Adaptation, carnivore, bivalve, carapace, crustacean, ecology, ecosystem, endangered, estuary, exploiters, extinction, food chain, food web, habitat, herbivore, intertidal, kelp, krill, marine ecology, mud flat, mussel, niche, plankton, predator, prey, range, scavenger, seaweed, wetlands

Materials

Beach Explorations book, *Beach Explorations* species cards, Kraft or butcher paper, markers/chalk, magnifying glasses, nets, large world wall map, nonindigenous (NIS) samples, *Alien Ocean* video, pictures

Schedule

This unit will take 10 days.

Curriculum Connections

This unit provides an opportunity for involvement with science teachers in social studies classes.

Procedure

Day 1: Discuss the meaning of the word "environment" — its factors and limiting factors. A very large piece of butcher paper should be taped to the wall or blackboard to create a mural. The teacher will start by adding factors or examples of the factors to the mural ending up with a generic environment or ecosystem. The idea of limiting factors will be introduced with various scenarios ensuing. Teacher will introduce concept of NIS and for homework, students will write down the possible consequences of NIS on this environment (see attached).

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Grade Levels Taught
9th grade

Day 2: Explore the meaning of NIS (nonindigenous species). Share answers from Monday's homework—possible consequences of NIS. Use visuals: video *Alien Ocean*, pictures, examples, maps.

Day 3: Vocabulary List — (see Keywords). Use glossary from *Beach Explorations*. Can be assigned or written down as notes. Draw pictures as well when possible.

Day 4: Review vocabulary. Introduce research project, Questions, Answers, Details (QAD) poster (see attached). Have librarian pull resources to use in class. Have an Internet source page available. Possibly bring Science teachers on board to help with research and if necessary offer cross-credit opportunities.

Days 5 and 6: In class research. Start rough drafts. Review details/suggestions for posters.

Days 7 and 8: Check rough drafts and start posters. Finish posters at home.

Day 9: Individual presentations to class. Choose some to display in library.

Day 10: Culminating field trip to Owens Beach, Point Defiance Park, Tacoma, WA. (Preferably at low tide). Details for this trip and goals to be determined as unit goes on. Discuss NIS as they pertain to Washington shorelines.

Resources

Beach Explorations kit from Washington Sea Grant Program, University of Washington, Seattle, Washington.

Alien Ocean video, MD Sea Grant College Program. Phone: 301-405-6371

Credits

This lesson was developed by the author.

FACTORS

affect and influence the growth, development and reproduction of organisms:

- Water
- Air
- Vegetation
- Animals
- Human elements
- Climate
- Location

LIMITING FACTORS

influence an organism's ability to maintain its population:

- Food
- Water
- Shelter
- Space
- Temperature
- Light
- Salinity
- Oxygen
- Type of bottom
- Predators
- Competition
- Pollution
- Overharvesting

DAY 4 ATTACHMENT- QAD POSTER

GRAPHIC

(map)

TITLE

(name of species)

GRAPHIC

(picture of species)

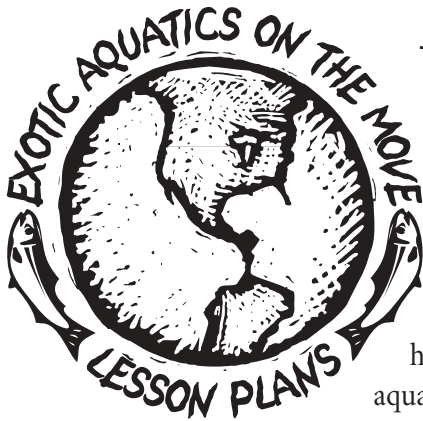
QUESTIONS

ANSWERS

DETAILS

1. What are the characteristics?
2. This species is native to what area?
3. What areas has this species invaded?
4. What species does this animal prey on?
5. What is the survival rate of this species?
6. How does it reproduce?
7. What damage has it done?
8. What are its pathways?
9. Does it pose an economic threat?
10. What can be done to eradicate or control it?

ZEBRA - BINGO WITH A TWIST!



Grade Level: Intended for 9th-12th grade, but could be suitable for 5th-8th

Overview

This lesson will impact the students by allowing them to utilize handouts, Websites, and other sources of information related to exotic aquatics. It is intended to facilitate a fun way to actively review previously taught concepts pertaining to aquatic invasive species.

Background

Questions posed on the Exotic Aquatics on the Move workshop handout are as follows:

ORIGIN

1. Where did these exotic species come from?
2. What regions have the potential of being suitable habitats for exotic aquatics?

DISTRIBUTION

1. What is the range of each of the exotic aquatic species?
2. What factors influence the suitability of one location over another for establishment?

MOVEMENT

1. What are the vectors of spread?
2. How are each exotic aquatic species moved?
3. How quickly have each species spread?
4. Where are each exotic aquatic species likely to move next?

CONSEQUENCES

1. What impact have each aquatic species made on the human systems (such as those of industry, economics, and public utilities)?
2. What has been the cost to government and private industry to remove these plants or animals or perform damage control?

SOLUTIONS

1. What can be done to decrease the population of each species?
2. What can be done to stop the spread?

Objectives

1. Have fun learning about exotic species through the use of the ZEBRA game board, which is similar to the familiar game known as Bingo.
2. Explore and review questions posed on the Exotic Aquatics on the Move Workshop handout, while playing the game in order to arrive at the desired answer.

Materials

ZEBRA game board, teacher question sheets (according to category)

Schedule

The activity will require an estimated 30-45 minutes.

Prerequisite Skills

None

Procedures

1. Each student will obtain a ZEBRA Bingo game card that includes a list of exotic species.
2. Each student should pick any of the aquatic exotic plants and animals and write one word in each open space on their game card. They may put any word they choose in any space they want. (Ideally, each student's card should look different from their neighbor's.)

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Grade Levels Taught

9th -12th

3. The teacher will start the game off by calling out a letter at the top and one on the side (for instance, “Z top, E side”). At this point, they will read any question they choose off of the categorized question sheet, and any student who thinks they have the exotic species that answers the question (Z top, E side), may cross out that space. The teacher should ask a student to provide the correct answer, so there is no confusion. For example: What exotic aquatic resembles the yellow perch? The answer is ruffe, so students who wrote “ruffe” in that space get to cross it off.

Variation: The teacher could write the names of the plants and animals on slips of paper and randomly pick the names to ask questions pertaining to that exotic. Or they could write down the plants and animals selected and try to give random choices.

4. At this point, the teacher will call out another letter across the top and one down the side (for instance, “R top, R side”), and read another question. Once again, if the students believe they have the answer to that question in the corresponding box (R top, R side), they may cross out that space.
5. The game will continue like this until the first student yells out “ZEBRA!”, which will indicate they have a row of tokens either across, down, or diagonally on their game board.

Teacher Notes

The teacher has the option of having the students either try and get a row of exotics across, down, or diagonally. They could also play for four corners or try to cover the whole card.

The exotic plants and animals given on the sample board are those found in the Great Lakes. Teachers from outside the Great Lakes should select exotic plants and animals that pose problems in their own areas. Consult the EATM Website for information that can be used to create questions regarding those exotics.

Resources

Exotic Aquatics on the move website:
<http://ag.ansc.purdue.edu/EXOTICSP>


Credits

Prepared by the authors.

"Muscle" up some brain power, to play this awesome BINGO game!



INVASIVE SPECIES BINGO

	Z	E	B	R	A
Z					
E					
B			F R E E  S P A C E		
R					
A					

Select any of the following exotic plants and animals and place one of each in every space above. You can use the same plant or animal more than once, but you must use each at least once: Zebra Mussel - Ruffe - Round Goby - Spiny Waterflea - Purple Loosestrife - Quagga Mussel - Eurasian Watermilfoil - Rudd - Sea Lamprey

QUESTION & ANSWER SHEET

EURASIAN RUFFE

1. In the Great Lakes, what coldwater exotic fish from northern Europe poses a threat to fisheries?
Ruffe
2. What exotic fish is currently only found in Lake Superior and Lake Huron? *Ruffe*
3. What exotic has become the dominant species in Minnesota's St. Louis River? *Ruffe*
4. What exotic was first discovered in Lake Superior in 1986? *Ruffe*
5. What invasive fish has evolved to living in deep, dark water by having its large eyes located near the top of its head? *Ruffe*
6. In the St. Louis River, the populations of yellow perch, emerald shiners and other forage fish have declined dramatically as populations of what exotic fish have risen? *Ruffe*
7. This spiny exotic fish is a problem partly because it grows rapidly and can reproduce at a young age. What is it? *Ruffe*
8. What exotic has sharp spiny fins, making it difficult for larger fish to eat it? *Ruffe*
9. What exotic fish is a European member of the perch family? *Ruffe*

ROUND GOBY

10. What exotic fish was discovered in St. Clair River in 1990? *Round Goby*
11. What exotic fish feeds on zebra and quagga mussels? *Round Goby*
12. What exotic fish is flattened on its underside, making it perfect for benthic (bottom) habitats?
Round Goby
13. What exotic fish relies on large, dark males to protect the nests? *Round Goby*

ZEBRA MUSSELS

14. One danger of this exotic is that it fouls beaches with stinky razor-sharp shells. What is it? *ZM*
15. What exotic can cause drag on boats, reducing fuel and operation efficiency? *ZM*
16. What clam-like exotic has spread to southern river systems such as the Arkansas, Tennessee, Mississippi? *ZM*
17. What exotic was accidentally introduced into North American waters in the mid-1980s, and has since spread throughout the Great Lakes and into the Mississippi River basin? *ZM*
18. What exotic bivalve was first introduced to Lake St. Clair? *ZM*
19. What exotic spreads by their planktonic larvae (veligers) being carried by water currents? *ZM*
20. What is the common name for *Dreissena polymorpha*? *ZM*
21. What exotic is native to the Black, Caspian and Aral Seas and was spread to Europe in the 1700s? *ZM*
22. The average lifespan of this exotic bivalve is 3.5 years, but can be highly variable. *ZM*
23. What invasive looks like a small clam with a "d" shaped shell? *ZM*

SPINY WATERFLEA

24. What exotic is capable of reproducing asexually, with females releasing over-wintering eggs? *SWF*
25. What exotic is also known as “B.c.”? *SWF*
26. What exotic is less than 1/2 inch long, even as an adult? *SWF*
27. What exotic looks like globs of jelly with black dots on fishing lines and downrigger cables?
SWF
28. What exotic is planktonic and feeds on other zooplankton? *SWF*
29. What exotic is an important food source for larvae and early juvenile stages for many species of Great Lakes fish? *SWF*
30. What tiny exotic found in all the Great Lakes is actually a crustacean? *SWF*
31. What exotic is protected by its long, pointed tail? *SWF*

EURASIAN WATERMILFOIL

32. One short piece of stem of this aquatic invader can cause the infestation of an entire lake. *EW*
33. What exotic has feather-like leaves with long, flexible stems? *EW*
34. What aquatic exotic grows rapidly, choking native plants? *EW*
35. What aquatic exotic European plant is commonly used in garden ponds? *EW*
36. What exotic plant forms extensive beds and gets tangled on boat propellers and trailers? *EW*
37. This exotic was spread primarily by boats and reached the Midwest states between 1950 and 1980. What is it? *EW*
38. What exotic plant forms a floating canopy that can crowd out important native water plants?
EW

SEA LAMPREY

39. What eel-like invasive species feeds by attaching itself to hosts with a circular tooth-lined mouth? *Sea Lamprey*
40. What is the name of a parasitic eel-like fish? *Sea Lamprey*
41. What exotic has caused the decline of the native lake trout throughout the Great Lakes?
Sea Lamprey
42. The Great Lakes Fishery Commission spends 12 to 15 million dollars annually to control this exotic. *Sea Lamprey*
43. This fish is found as harmless young in streams, but transform into parasitic adults.
Sea Lamprey
44. This exotic sucks the blood and body fluids out of other fish. *Sea Lamprey*
45. This exotic is a native of the Atlantic Ocean, and used canals to move through the Great Lakes.
Sea Lamprey

RUDD

46. What exotic can reproduce with native shiners? *Rudd*
47. These exotic fish inhabit shallow, weedy areas around shorelines of lakes and rivers and rarely move to open water. *Rudd*
48. What adult exotic can be identified by its reddish fins and tail? *Rudd*
49. What is the common name for *Scardinius erythrophthalmus*? *Rudd*
50. What exotic fish is sometimes confused with the native golden shiner? *Rudd*

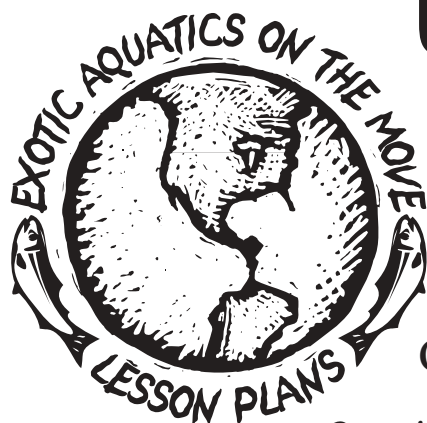
QUAGGA MUSSELS

51. What is the name of the second species of bivalves that are related to zebra mussel? *QM*
52. In the Ukraine and some areas of the Great Lakes, what exotic is displacing the zebra mussel? *QM*
53. This exotic gets its common name from an extinct zebra species. *QM*
54. This exotic can team up with another mollusk to clog water intake pipes. *QM*
55. What exotic is often mistaken for the zebra mussel? *QM*
56. This exotic bivalve usually lacks the flattened area on the bottom of its shell, having a more oval shape. *QM*

PURPLE LOOSESTRIFE

57. What attractive exotic plant invades wetlands and degrades habitat? *Purple Loosestrife*
58. What invasive plant arrived in eastern North America in the early 1800s, probably in solid ballast and as an ornamental plant? *Purple Loosestrife*
59. What exotic plant has been successfully controlled using specialized beetles? *Purple Loosestrife*
60. What exotic is best controlled in June, July, and early August when it is easily recognized and before it goes to seed? *Purple Loosestrife*
61. What exotic, when mature, can produce over 2 million seeds annually? *Purple Loosestrife*
62. What invasive has smooth edged downy leaves, usually arranged in pairs that are opposite each other? *Purple Loosestrife*
63. What exotic is often sold by nurseries and garden shops? *Purple Loosestrife*
70. On mature plants, rootstocks are extensive and can send out 30 to 50 shoots creating a dense, impenetrable stand. What am I? *Purple Loosestrife*

AMERICA'S MOST UNWANTED: HOW DO THESE ALIEN SPECIES GET HERE, AND WHY ARE THEY SUCH A NUISANCE?



Grade Level: 7th–12th grades

Overview

People have been transporting plants and animals from country to country for centuries. Some species spread, unwanted, into the wild. These invaders are known as **invasive alien species** or **invasive exotic species**. Not all exotic species have the qualities to spread rapidly in the wild; the term “invasive” refers to those that move into new areas and push other native species out. This research activity will allow students to become experts on one invasive alien species and learn about many others. They will create a research project in a “Wanted Poster” format and survey their peers’ research to find similarities and differences.

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Grade Levels Taught

7th Grade

Background

What are the threats to biodiversity in the U.S.? Why do species become endangered?

Most students would say pollution, habitat loss, or even hunting. In reality, the greatest threat to biodiversity is habitat loss. The second greatest threat is the invasion of exotic species. Exotic species are going to be a big issue for the next generation and few American students have any exposure to this latest environmental/political challenge. Humans have been transporting species from place to place for centuries. Some alien species stay where they are put and offer benefits to humankind. An example is the soybean. Others spread into the wild interfering with native ecosystems, decreasing biodiversity, and often costing taxpayers millions of dollars.

If this has been going on for so long, why is

it now considered a big problem? Global travel and trade have increased the number and type of species that travel the planet. Native plants and animals evolved over millions of years to fill unique ecological niches. Global shipping, air travel, and multinational commerce allow new species to be introduced to locations, changing systems that took millions of years to create. Invasive aliens do not just impact the native species of a region; they can also impact human health, the economy, and entire ecosystems. Studying invasive aliens is a great way to integrate science, current events, geography, and economics.

Setting

Students will need access to the Internet and a media center with good periodical, science, and geography resources. Working in pairs or small groups is preferred.

Objectives

1. Name (common and scientific) some invasive alien species.
2. Explain the life cycle and “adaptations for success” for their specific species.
3. Locate the origins, movement, and current distribution of their species.
4. Explain the way this species was introduced and why it succeeded in spreading.
5. Identify the problems alien species have caused or may cause in the future.
6. Evaluate the existing solutions for dealing with alien species and suggest others.

Geographic Standards

Standard 1. How to use maps to report information. Students will create a map showing the origin, movement, and distribution of their invasive alien species.

Standard 8. The characteristics and spatial distribution of ecosystems on Earth’s surface. Students will compare the characteristics of the origin ecosystem and invaded ecosystems.

Standard 14. How human actions modify the physical environment. Students will identify the changes the invasive alien has caused in its new habitat. Also how changes we make in physical environment (i.e., St. Lawrence Seaway) impact ecosystems.

Standard 15. How physical systems affect human systems. Students will identify how the invasive alien has impacted the economy/health of human populations.

Keywords

Native species, invasive species, exotic/alien species, biodiversity, nonindigenous species, biotic/abiotic

Materials

For each pair/group of students:

Invasive species list
Blank world maps
Glue and art supplies
Internet access
Wanted Poster Requirements
“Survey of Wanted Posters” handout
Research materials from media center
Large wall space to hang posters
Music from *America’s Most Wanted* or *Cops* TV show or *Men in Black*
Video (*Alien Ocean* or other that captures the invasive alien concept)

Schedule

This project will require about two weeks: one day for introduction, about one week for research and creation of posters, one day for the “Survey of Wanted Posters,” and one day for discussion of student findings.

Prerequisite Skills

Students should have word processing and research skills. Students should know how to create a map and key. They should also have basic background in biology and ecology. This is a good culminating project for students studying real world applications in ecology or ecosystems.

Curriculum Connections

Social Studies: human population growth and dispersal, mapping skills, reading and interpreting graphs and charts, creating graphs

Science: biotic and abiotic components of ecosystems, lifecycles, predator/prey relationships

Procedure

1. As students enter the room, have music playing from one of the choices in Materials list. Inform students that Alien Bad Guys have invaded America. There are many species; they come in all shapes and sizes. Ask students to define **Alien**. Record definitions of alien on board. Repeat the same procedure with **Native**.
2. Show *Alien Ocean* video. Discuss the concepts and vocabulary in the video.
3. Make a copy of the Invasive Species List. Cut the list up and put into a container. Each student team can randomly pick the species they will research. Remind students to record the common and scientific names.
4. Give each student the Wanted Poster Requirements. Go over the handout step-by-step. Establish due dates for research, rough draft, and final poster.
5. Display posters around your room or in a hallway.
6. Distribute “Survey of Wanted Poster” Handout. Review activity with students. Students should read each poster and record what they learn.
7. As students visit each poster in this “Gallery of the Unwanted,” they will record similarities, patterns, and devise strategies to combat this problem.
8. In groups of four, students will discuss patterns they see emerging in the invasive alien problem and overall strategies for combating invasive exotics using what they have learned from their research and their peers. Each group will present their opinions on this final “seminar” day.

Teacher Notes

Internet searching is more specific with scientific (Latin) names. Put the scientific name in quotes in a search engine and you will have more success. Be sure students have seen a Wanted Poster and understand the concept. This project can be done in other formats if Wanted Posters don't suit you. PowerPoint, Zebu, or flipbooks would be just as successful. You can limit the number and type of species you give to students. If you wish to focus on aquatic species, just use that list. If you want to look at just animals or just plants, that can work too!

Applications

Surveying all of the posters gives students an opportunity for peer review and a chance to identify patterns. The final discussion day will lead students to ponder how this issue may impact their lives and what they might do about it.

Evaluation

Students will be evaluated on their final projects according to the requirements listed in the handout. In addition each group can be evaluated on classroom contribution during the discussion period.

Resources

<http://www.sgnis.org/>
(Aquatic species)

<http://www.d.umn.edu/seagr/areas/aqua/rusty.html> (Rusty Crayfish)

<http://consci.tnc.org/library/pubs/dd/>
(Variety of species)

<http://www.earthchangestv.com/biology/0927everyonefighting.htm> (Variety)

<http://www.sdearthtimes.com/et0399/et0399s8.html> (Economics)

<http://www.providence.edu/polisci/projects/megaport/Chesapeake.htm> (Chesapeake, Narragansett, and San Francisco Bays)

<http://fireant.tamu.edu/> (Fire Ants)

<http://www.hear.org/AlienSpeciesInHawaii/index.html> (Hawaii invaders)

<http://invader.dbs.umt.edu/>
(Plant invaders)

<http://www.nbio.gov/> (Variety of species)

<http://www.nps.gov/plants/alien/index.htm>
(Plants)

Alien Ocean is a production of:
Maryland Sea Grant College
0112 Skinner Hall
University of Maryland
College Park, MD 20742
[/www.mdsg.umb.edu/MDSG/](http://www.mdsg.umb.edu/MDSG/)

Credits

Prepared by the author.

SURVEY OF WANTED POSTERS

Instructions: Visit each poster and read the facts.
Answer the questions below with what you have learned from your classmate's research.

1. List 3 or more species that travel by ballast water:
2. Where do most species come from? Is there a pattern?
3. List different ways that people are using to control the spread of exotics.
4. List some species that require warm, tropical climates.
Will these be a problem in your home state?
5. List some of the adaptations that help an alien species to be successful.
6. List some species that are or may become a problem in your home state. Had you ever heard of them before?
7. Which species seems to cause the most economic damage?
8. Get together with a group of 3 other students. Look for patterns in your answers. Discuss this question and be prepared to share your ideas with the class: **Is fighting invasive exotics worth what it costs? Why should we bother?**

WANTED POSTER REQUIREMENTS

Directions: Your group will create a Wanted Poster on standard poster board to be displayed at school. Your fugitive is an Invasive Alien Species, which is causing grave problems in America. Your posters must answer all the questions listed below.

*GRADING: your poster will be graded on the following point system.
Spelling and grammar do count!*

COMMON AND LATIN NAME OF YOUR SPECIES. <i>You may also give it a funny name: "Crusty Two Claws" Or "The Purple Menace"</i>	10 PTS.
A PHOTO OF YOUR SPECIES	5 PTS.
WHERE DID IT COME FROM? AND WHERE WAS IT LAST SPOTTED? <i>Using a world map template, create a graphic showing origin, Movement, and current North American distribution of this species.</i>	15 PTS.
MODE OF TRANSPORTATION (MOVEMENT) <i>Using full sentences: explain how this species traveled from its native land to North America. Accidental or on purpose?</i>	10 PTS.
HOW TO RECOGNIZE THIS BAD GUY! (BIOLOGY OF YOUR SPECIES) <i>Using full sentences: Describe your species: plant, animal, crustacean, mammal, perennial.... What does your species need to survive, habitat, food, moisture? What adaptations make this species so successful? Life cycle: If appropriate, describe how its appearance changes. Use a graphic in this section, graph, photo, chart, flow chart or map.</i>	30 PTS.
CRIMES – WHAT PROBLEMS DOES THIS SPECIES CAUSE? <i>Using full sentences: Explain the economic, human, health, recreational, or ecosystem impacts caused by your species. How does it interact with native species?</i>	15 PTS.
IF YOU SPOT THIS BAD GUY (SOLUTIONS) <i>Using full sentences: Explain what people are doing to fight back this alien invader. How are we using science, education, and/or government? to battle this invader?</i>	15 PTS.

TOTAL: 100 PTS.

Rough draft due date: _____ Final Poster due date: _____

INVASIVE SPECIES LIST

INVASIVE AQUATIC SPECIES

Rusty Crayfish <i>Orconectes rusticus</i>	Zebra Mussel <i>Dreissena polymorpha</i>	Spiny Water Flea <i>Bythotrephes cederstroemi</i>
Round Goby <i>Neogobius melanostomus</i>	Sea Lamprey <i>Petromyzon marinus</i>	Purple Loosestrife <i>Lythrum salicaria</i>
River Ruffe <i>Gymncephalus cernuus</i>	White Perch <i>Monrone Americana</i>	Eurasian Water Milfoil <i>Myriophyllum spicatum</i>
Water Hyacinth <i>Eichhornia crassipes</i>	Nutria <i>Myocastor coypus</i>	European Green Crab <i>Carcinus maenas</i>
Common Carp <i>Cyprinus carpio</i>	Hydrilla <i>Hydrilla verticillata</i>	Blue Tilapia <i>Oreochromis aurea</i>
Rapa Welk <i>Rapana venosa</i>	Flathead Catfish <i>Pylodictis olivaris</i>	

OTHER (TERRESTRIAL) INVASIVE ANIMAL SPECIES

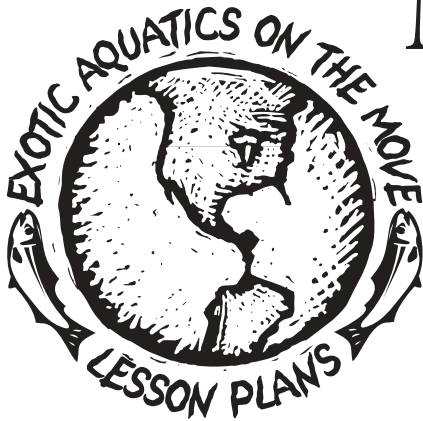
Rosy Wolfsnail <i>Euglandina rosea</i>	Brown Tree Snake <i>Boiga irregularis</i>	Gypsy Moth <i>Lymantria dispar</i>
Balsam Woolly Adelgid <i>Adelges piceae</i>	Argentine Fire Ants <i>Solenopsis invicta</i>	Africanized Honey Bees <i>Apis mellifera scutellata</i>
European Starling <i>Sturnus vulgaris</i>	House Sparrow <i>Passer domesticus</i>	

OTHER INVASIVE PLANT SPECIES

Tamarisk <i>Tamarix species</i>	Leafy Spurge <i>Euphorbia esula</i>	Miconia <i>Miconia calvescens</i>
Chinese Tallow <i>Sapium sebiferum</i>	Garlic Mustard <i>Alliaria petiolata</i>	Kudzu <i>Pueraria lobata</i>
Canada Thistle <i>Cirsium arvense</i>	Japanese Honeysuckle <i>Lonicera japonica</i>	Autumn Olive <i>Elaeagnus umbellata</i>
Crown Vetch <i>Coronilla varia</i>	Bush Honeysuckles <i>Lonicera maackii / L. tatarica/L. morrosii</i>	Oriental Bittersweet <i>Celastrus orbiculatus</i>
Buckthorns <i>Rhamnus cathartica</i> <u>and</u> <i>R. frangula</i>		Phragmites (Common Reed) <i>Phragmites australis</i>

DON'T HOOK A MITTEN CRAB

Grade Level: 4th–6th grades



Overview

In this fun warm-up activity, students will learn geographic associations for a variety of aquatic exotic species. It is based on the game “hangman,” with a twist.

Background

The Chinese mitten crab, native to Asia, arrived in San Francisco Bay, California in the early 1990s. Among numerous impacts, Chinese mitten crabs have disrupted recreational fishing by fouling hooks and stealing bait. The mitten crab is an exemplary example of an invasive species that has achieved a speedy and highly destructive establishment in a non-native region.

Setting

Classroom

Objectives

Students will be able to identify exotic species, regions to which they have been introduced, and pathways by which they have been transported.

Geographic Standards

Standard 4. The physical and human characteristics of places

Standard 14. How human actions modify the physical environment

Keywords

Nonindigenous species, habitat, region

Materials

Chalkboard, flip chart, or overhead projector

Schedule

One to two periods should be enough to present background information for students and for in-class activity. The activity will take about 15–20 minutes.

Prerequisite Skills

Background information on exotic aquatic species

Curriculum Connections

Environmental Science, Biology, Geography

Procedure

This group activity is a variation of “hangman,” where students guess letters to identify a word or phrase, aided by a clue. An incorrect guess results in a mitten crab body part drawn on a fishhook. After 11 incorrect guesses, a complete mitten crab has been “hooked” and the round is over. To draw the mitten crab, first draw a round shell for first incorrect answer, followed by two claws and then eight legs.

Here are some examples of clues and associated answers:

Clue: Considered the most invaded estuary on the U.S. West Coast.

Answer: SAN FRANCISCO BAY

Clue: This animal arrived by boat into the Great Lakes in the 1980s.

Answer: ZEBRA MUSSEL

Consider using this activity in conjunction with mapping activities; each answer can be used to plot location or species on a map.

Authors

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Nancy Lerner

School

Oregon and
Washington
Sea Grant Programs

State

Oregon and
Washington

Resources

Sea Grant Nonindigenous Species Website:
<http://www.signis.org>

Exotic Aquatics on the Move Website:
<http://www.ag.ansc.purdue.edu/EXOTICSP/>

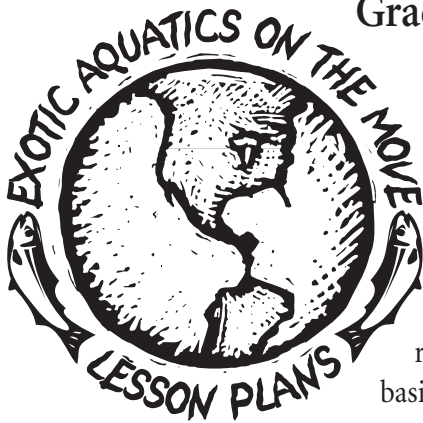
Washington Sea Grant Program
Nonindigenous Species Educational
materials, including Pathways fact sheet,
Mitten Crab fact sheet, European green
crab fact sheet, Bio-Invasions booklet, or
“Least Wanted” brochure. Also available
on-line at <http://www.wsg.washington.edu>

Credit

Created by authors.

WHERE IN THE WORLD?

Grade Level: 6th –12th grades



Overview

This activity uses geographical skills to understand the nature and extent of the problem of invasive species. Students map the routes of invasive species from their native habitat to some of the regions to which the exotics have spread on a large laminated wall map. Colored lengths of yarn illustrate the routes of the invasives, showing how invasives have spread to and from all regions of the Earth. Notecards on different species give the students some basic information about the species and how they spread.

Background

Biological invasions are a global problem. Human activities, especially through the movement of ocean-going ships, have distributed marine organisms to new regions all over the world. One such species, the European green crab, has spread from its origin in Northern Europe to both coasts of North America, to Africa, and Australia. Species that have had multiple introductions around the world are considered “cosmopolitan.” Exotic species, or invasives, become established in different regions and affect native organisms and ecosystems, often outcompeting native species. They can alter nutrient regimes, develop into monocultures, or drive native species to extinction. Reducing the risk of species introduction is a difficult task, and although the risk has been recognized in many countries, measures to reduce introductions have been difficult to implement.

Setting

Classroom

Objectives

Learn about the distribution of various aquatic exotic species, including their native ranges. Exercise critical thinking skills to analyze common traits of locations where these species are well established.

Geographic Standards

Standard 1. How to use maps and other geographical representations, tools, and technologies to acquire, process and report information from a spatial perspective

Standard 3. How to analyze the spatial organization of people, places and environments on Earth’s surface

Standard 4. The physical and human characteristics of places

Standard 8. The characteristics and spatial distribution of ecosystems on Earth’s surface

Standard 14. How human actions modify the physical environment

Keywords

Nonindigenous species, region, indigenous, exotic, habitat, ecosystem

Materials

Wall-sized world maps (preferably laminated), exotic species cards (three per species), colored thumbtacks, colored yarn, tape

Schedule

The mapping exercise will take one class period.

Prerequisite skills

Ability to use and read maps

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Sea Grant Programs

State

Oregon and
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Curriculum Connections

Ecology, Environmental Science, Geography

Procedure

The teacher places a large laminated world map up on the wall. Students each receive notecards prepared with the name and a picture of an exotic species on one side, and a geographic location, plus a few sentences about the species, on the other side. One of each group of cards will have the native location, and the rest will have introduced locations (we color coded the cards by making all cards with a native location of one color, introduced locations a second color. It is important that for each species, the native location card is given out, even if all of the introduced locations are not used). The teacher can prepare up to four cards (more if they wish) per exotic species, depending on how many destinations the organism has arrived at. Students with the same species need to find each other and share information on their exotic organism. The students then plot both native and introduced locations on the map. The group attaches colored yarn from point of origin to point of transport, and brainstorms a list of common features these locations share. Each group tells the room a little about their organism. At the end, the map will be covered with lengths of colored yarn, showing how the organisms have traveled all over the globe.

Once everyone has posted their yarn on the map, each group summarizes their species, its native distribution, and the locations to which it has been introduced. A classroom discussion should take place. Among points to cover:

Do the regions that have had introductions have habitat characteristics in common with each other or the native region?

Are there longitude or latitude similarities in the distribution pattern? Does that mean anything?

How are species likely to have traveled these distances?

What characteristics, if any, do the species that have been successful invaders share?

Attachment A contains sample species and locations.

Teacher Notes

If the teacher doesn't want to create all the notecards by his or herself, the teacher can have that as one of the class projects, providing the students with different handouts and asking them to create some notecards.

Applications

This activity is a great introduction into the concept of exotic aquatic species. It gives a great graphical representation on how, literally, widespread the problem is. It also illustrates that a location can both "donate" or "receive" an exotic species to its shores. It may also be used to explore why certain regions are more likely to receive a species, what characteristics might make it a good invader, etc.

Resources

Sea Grant Nonindigenous Species Website:
<http://www.signis.org>

Exotic Aquatics on the Move Website:
<http://www.ag.ansc.purdue.edu/EXOTICSP/>

Pacific Northwest Marine Invasive Species Website: <http://seagrant.orst.edu/mist/publications.html>

Washington Sea Grant Program Nonindigenous Species Educational materials, including Pathways fact sheet, Mitten Crab fact sheet, European Green Crab fact sheet, Bio-Invasions booklet, or "Least Wanted" brochure. Also available on-line at <http://www.wsg.washington.edu>

Reducing the Risks of Species Introductions: Guilty until proven innocent, by Jennifer Ruesink et al. *Bioscience* Vol. 45 No. 7, July/August 1995. pp. 607-615.

Ecological Roulette: the global transport of nonindigenous marine organisms, by James Carlton and Jonathan B. Geller. *Science*, Vol. 261. July 2, 1993. pp. 78-82.

Credit

Created by authors.

ATTACHMENT A

SAMPLE CARDS

Side One (Species name plus photo or sketch)	Side Two
<p>European Green Crab (<i>Carcinus maenas</i>)</p>	<p>Origin: Baltic Sea</p> <p>Although often referred to as the “green crab,” this crab’s color can vary widely. Juveniles can change color to match their surroundings. Adults are generally dark green, with a bright red or yellow underside.</p>
<p>European Green Crab (<i>Carcinus maenas</i>)</p>	<p>Introduced to: Oregon Coast</p> <p>European green crab has been known to alter the community structure of areas to which it has been introduced. It can pose a threat to native crabs.</p>
<p>European Green Crab (<i>Carcinus maenas</i>)</p>	<p>Introduced to: Australia</p> <p>European green crabs can tolerate a wide variation in environmental conditions, making it an effective invader.</p>
<p>Zebra Mussel (<i>Dreissena polymorpha</i>)</p>	<p>Origin: Caspian Sea</p> <p>Zebra mussels are striped, fingernail-sized mussels. They reproduce quickly—females can produce 40,000 eggs in one spawning and up to a million eggs annually.</p>
<p>Zebra Mussel (<i>Dreissena polymorpha</i>)</p>	<p>Introduced to: Lake Michigan</p> <p>Zebra mussels produce a strong threadlike material called “byssal threads.” These threads enable them to attach to other surfaces, including boat hulls or the shells of other animals.</p>
<p>Zebra Mussel (<i>Dreissena polymorpha</i>)</p>	<p>Introduced to: Louisiana</p> <p>Zebra mussels have cost millions of dollars in damage in areas where they clog facilities at powerplants, water utilities, industrial facilities, fish ladders, and navigation lock and dam operations.</p>
<p>Chinese Mitten Crab (<i>Eriocheir sinensis</i>)</p>	<p>Origin: South Korea</p> <p>The mitten crab is named for the dense patches of hairs on its two front claws.</p>
<p>Chinese Mitten Crab (<i>Eriocheir sinensis</i>)</p>	<p>Introduced to: England</p> <p>In Asia, the mitten crab is prized as a delicacy, particularly the roe, or eggs.</p>

Side One (Species plus photo or sketch)

Side Two

Chinese Mitten Crab (<i>Eriocheir sinensis</i>)	Introduced to: San Francisco Bay Mitten crabs migrate in late spring, often very long distances. They are adept walkers on land and will leave the water to walk around barriers.
Water Hyacinth (<i>Eichhornia sp.</i>)	Origin: Brazil This aquatic plant has beautiful, showy pink/purple flowers, making it popular in aquatic gardens.
Water Hyacinth (<i>Eichhornia sp.</i>)	Introduced to: Florida Because it has one of the fastest reproductive rates of any plants, this plant can establish itself in new waterbodies quickly.
Water Hyacinth (<i>Eichhornia sp.</i>)	Introduced to: Uganda Water hyacinth is a non-rooted, floating plant. It forms dense floating mats of vegetation.
Nutria (<i>Myocaster coypus</i>)	Origin: Argentina These small furry mammals are herbivorous. The word “nutria” is Spanish for otter.
Nutria (<i>Myocaster coypus</i>)	Introduced to: Texas Nutria have the head and coat of a beaver, the tail of a rat, webbed hind feet and yellow teeth.
Nutria (<i>Myocaster coypus</i>)	Introduced to: Portland, OR Nutria grow to 15–20 lbs. and are equally comfortable in salt or fresh water.
Veined Rapa Whelk (<i>Rapana venosa</i>)	Origin: Sea of Japan The rapa whelk is a predatory gastropod, or snail. It often eats shellfish such as oysters, clams or mussels.
Veined Rapa Whelk (<i>Rapana venosa</i>)	Introduced to: Black Sea The veined rapa whelk has a heavy, short, spired shell. Its color varies from gray to red-brown, with dark brown dashes on the spiral ribs. Most specimens have distinctive black veins throughout the shell.

Side One (Species plus photo or sketch)

Side Two

Veined Rapa Whelk (<i>Rapana venosa</i>)	Introduced to: Chesapeake Bay The veined rapa whelk lives in areas of wide temperature variations. In winter, populations may migrate from the estuary into deeper waters, possibly to avoid freezing.
Brown Trout (<i>Salmo trutta</i>)	Origin: Germany Brown trout grow to 16–24 inches in length, and about 2 to 8 lbs in weight. They generally have a light brown or tawny back, becoming silvery on the sides and belly.
Brown Trout (<i>Salmo trutta</i>)	Introduced to: New Zealand Brown trout have a reputation as a wary fish that feeds at dusk or at night.
Brown Trout (<i>Salmo trutta</i>)	Introduced to: Nevada Brown trout, a European relative of the Atlantic salmon, is a popular choice for sports fishers.
Comb Jelly (<i>Mnemiopsis leidyi</i>)	Origin: Chesapeake Bay These jellyfish-like organisms are only about 2 to 4 inches wide, but are voracious eaters. They eat zooplankton (microscopic animals), small fish, jellyfish, or even other comb jellies.
Comb Jelly (<i>Mnemiopsis leidyi</i>)	Introduced to: Black Sea Once introduced into the Black Sea, the population of these animals exploded. Their total mass reached 900 million tons!
Comb Jelly (<i>Mnemiopsis leidyi</i>)	Introduced to: Aegean Sea Comb jellies have eight moving plates (comb plates) that move food to its mouth. Because they do not have stinging cells, they are not true jellyfish.
Smooth Cordgrass (<i>Spartina ssp.</i>)	Origin: New Jersey Coast In areas where it is native, <i>Spartina</i> is a prized marsh grass and is used widely for erosion control.
Smooth Cordgrass (<i>Spartina ssp.</i>)	Introduced to: San Francisco Bay <i>Spartina</i> is a hardy variety of cordgrass, adaptable to changes in salinity and tide range.
Smooth Cordgrass (<i>Spartina ssp.</i>)	Introduced to: Grays Harbor, WA If introduced into a mudflat, this marsh grass can transform the area into a marsh by trapping sediment and elevating the landscape. This displaces native plants and animals, and migrating shorebirds.

WHAT WOULD YOU DO...?

Grade Level: 6th–12th grades



Overview

Managing aquatic exotics is a tough business. Prevention efforts must target many different avenues of introduction, some related to important economic resources. Controlling existing invasions is very difficult and often involves choosing between the lesser of two evils. This activity is designed to have students employ role-playing in an effort to examine the real-life trade-offs involved in managing natural resources. They must first learn about the species and the issues surrounding it (such as its affect on native habitat or species, alterations in ecosystems, a change in resources for the community as a result of an introduction, etc.). They then must work in a group to try to address the problems that have arisen.

Background

Although species have been transported from one region to another for hundreds of years, recent technology has increased the speed and frequency of transportation. More and more species are able to survive transportation, and become established in new areas. Some species have been deliberately introduced for certain perceived positive benefits.

While many introductions are unsuccessful, a small but critical number can be highly damaging to the new environment. Often, the effects of an introduction cannot be foreseen. It is only through modification of human actions that natural resource managers and others concerned about exotics can moderate the impacts caused by these species. In making decisions about how to control invasives, there are significant trade-offs. This lesson is designed to have students consider some of these trade-offs and come to some decisions regarding management of exotic species.

Setting

Classroom

Objectives

1. Consider different options for managing invasions of exotic aquatics.
2. Exercise critical thinking skills and learn about difficult choices facing natural resource managers.

Geographic Standards

Standard 14. How human actions modify the physical environment

Standard 15. How physical systems affect human systems

Standard 16. The changes that occur in the meaning use, distribution and importance of resources

Standard 18. How to apply geography to interpret the present and plan for the future

Keywords

Nonindigenous species, natural resource management, indigenous, exotic, habitat, ecosystem

Materials

Scenario cards or worksheets

Schedule

Two to three classroom periods. One class period should be used for presentation of relevant materials and information. One period would be used for the group activity, possibly two including presentations by the group to the whole class.

Authors

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State

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Prerequisite Skills

Basic research skills and knowledge of how to use library and Internet

Curriculum Connections

Ecology, Biology, Environmental Science

Procedure

One class period (at a minimum) should be used to introduce the concept of invasive species and the related issues. Students are then divided into groups of five or six, and each is presented one of the below scenarios. The students in each group can be assigned a particular role they will play or interest that they will defend within the group as it tries to make its decisions. Each group then tries to reach a consensus on the problem presented. Time should be allotted to allow the students to do some research on the issue they have been assigned.

Each group then reports back to the entire class with their problem and their conclusions, followed by class discussion. If done as a role-play, the students can portray their different characters in the scenario and come up with a skit to illustrate their discussion in front of the entire class. A written paper should also be turned in, summarizing the group's decision and the basis for it.

SOME POSSIBLE SCENARIOS:

1. An invasive algae from France is transforming marine intertidal habitats in your state, reducing the diversity of native species and ruining popular tidepool areas. A snail that feeds exclusively on this alga in France is available to import to your state as a possible biological control. It is unknown whether this snail will feed on native species.

Possible role-play characters: Manager in charge of import permit, marine environmental educator, beach community resident, French shellfish farmer, local environmental group leader.

2. You are a scientist at a local marine lab, and want to conduct research on an exotic crab that has not yet invaded your state, but may in the future. Your experiments may lead to new control tools, but you'll have to import and keep live specimens, which creates a potential for escape.

Possible role-play characters: Research scientist, marine lab director, state invasive species manager, local environmental group leader, local shellfish farmer, invasive species manager from another state where the species has already invaded.

3. An economically valuable non-native clam has been introduced into the bay where you live. However these clams are harming native shellfish populations. A local fisherman has proposed to commercially harvest these clams as a way to reduce their populations and stimulate the area's poor economy. However, people in neighboring states fear that this will create an incentive for the clam to be illegally introduced into their bays.

Possible role-play characters: Local fisherman, local environmental group member, state invasive species manager, invasive species manager from neighboring state, local economic development council leader.

4. Your state is developing a new law to help prevent invasions by aquatic exotics. Most states have developed a "red list" approach, which lists prohibited species and allows any unlisted species to be imported without a permit. Some in your state are calling for a "green list" approach, which lists species that appear to be safe, and does not allow any others to be imported unless safety can be demonstrated. The green list approach

will slow down imports, particularly for pet stores that are always looking to stock new, interesting fish.

Possible role-play characters: State invasive species manager, leader of state environmental group, leader of aquarium club, owner of aquatic plant nursery, pet store owner.

5. After years of suffering chemical pollution from nearby factories, recent restoration efforts are reviving the health of a local estuary. Local shellfish growers are finally able to market their products. However, a new threat has just emerged in the form of an exotic saltmarsh plant. Where it has become established in other regions, this plant displaces native species, including several necessary for the survival of endangered birds. The only method that has shown some success controlling the exotic plant involves use of an aquatic herbicide while the infestation is still small. People living along this estuary are concerned about the invader, but are also now very sensitive to any chemical pollution.

Possible role-playing characters: President of local Audubon Society chapter, state invasive species manager, shellfish grower, regional representative of herbicide supplier, county water quality agent, president of local environmental group.

Teacher Notes

Education is a large part of reducing impacts from aquatic invasions. Students might also develop and conduct a survey to learn the extent that others in their school or community are aware of aquatic exotics. Students could develop educational posters on a particular non-native species in their state and if/how it is being managed.

Applications

This unit will introduce students not only to the problem of exotic species, but to the difficulties that are faced in the “real world” when trying to make management decisions about natural resources. It will foster cooperative work and consensus building.

Evaluation

Oral presentation from each group will be the basis for evaluation, as well as synopsis turned in to teacher.

Resources

Sea Grant Nonindigenous Species:
<http://www.signis.org>

Exotic Aquatics on the Move:
<http://www.ag.ansc.purdue.edu/EXOTICSP/>

Washington Sea Grant Program
Nonindigenous Species Educational materials, including Pathways fact sheet, Mitten Crab fact sheet, European green crab fact sheet, Bio-Invasions booklet, or “Least Wanted” brochure. Also available on-line at <http://www.wsg.washington.edu>
<http://www.nbii.gov>

Credit

Prepared by authors.

WHAT INVADER IS ONBOARD THAT SHIP? WHERE DID IT COME FROM?



Grade Level: 2nd grade

Overview

This activity will allow the students to use science lessons to study the zebra mussel. They can then think of ways to control the spread of the zebra mussel to other areas.

Background

Before beginning the lesson, a unit in science on water would have been completed. Lessons would have covered both fresh and salt water. There would be a brief discussion on the route of the water supply to students' homes. In 2nd grade, students discuss how body coverings can camouflage and protect animals. Animals are classified according to what they eat, and students learn how to make these classifications. They learn to describe animals according to where animals live and how they are suited to their habitats. In social studies, lessons have been completed on map skills. The zebra mussel would then be introduced. The children then can study the zebra mussel using information that has been presented to them. A conclusion can be made of the damage they can create, how they can spread, and finally what can be done to stop the spread.

Setting

Classroom

Objectives

To be able to draw conclusions about the zebra mussels habitat in the Black Sea area and local waters in the Great Lakes. Learn about the physical characteristics that help animals adapt to a new area. Trace the path the zebra mussel used to the Great Lakes and the means of transport to the area. To be able to discuss the problems that could occur if it continues to expand its territory.

Geographic Standards

Standard 14. How human actions modify the environment

Scientific Standards

Scientific Inquiry - Students ask "why" questions in attempt to seek greater understanding concerning objects and events they have observed and heard about.

Standard 7: students analyze problems and issues that affect their home, school, or community and carry out a remedial course of action.

Keywords

Habitat, continents, oceans, rivers, zebra mussel, compass rose, map key, adaptation

Materials

Destinations in Science by Addison-Wesley; Unit B *Neighborhoods and Communities* by Macmillan/McGraw-Hill pp. 114–115, p.60, 2, 3 map of the world, picture of zebra mussels.

Author

Karen Howard

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City

North Tonawanda

State

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Schedule

One week of 45-minute lessons. The first day would be for the geography lesson on labeling the continents, oceans, St. Lawrence River, the Great Lakes and their community. On the second day, the class would use the maps to trace the route of the ship from the Black Sea to the Great Lakes. At this time the class would discuss how ships take in water at one point then release it at another point. The third day, the class would discuss what might live in the water. The question would be if the new habitat would be the same as its native range. The fourth day, the class would discuss the zebra mussel. Show pictures of zebra mussels and have them draw their own picture with mussels attached to a boat. The fifth day, the discussion would revolve around the damage zebra mussels cause and how we can stop them from spreading.

Prerequisite Skills

1. Map skills
2. Knowledge about salt and fresh water
3. Science lessons about animals and their habitats

Curriculum Connections

There is a connection between map skills and animal studies in 2nd grade.

Social Studies, Geography

Procedure

1. On a map of the world, label the continents, oceans, and the Great Lakes.
2. Trace the route from the Black Seas to the Great Lakes.
3. Discuss how ships take in water in Europe, then release it in the Great Lakes.
4. What do you think is in the water when it is released?
5. What does the zebra mussel look like? What do you think it eats?
6. If zebra mussels build up on the boat, what might the problems be? What if they collect in the water intakes? How are they transported? How can we stop them?

Applications

In the last lesson the children will do an art project to be placed in the hallway. Their own drawings of the zebra mussel will be included and they will show different ways of stopping the spread of zebra mussels. We will place their maps of the route from Europe to the Great Lakes with one color colored pencil and with another color where they could spread if not stopped. As a class we will do a list of the problems caused by the zebra mussel. This list will also be placed in the hallway.

Evaluation

The children's pictures and discussion will be used as an evaluation because of the age of the children.

Resources

Internet sites

Exotics Invade the Great Lakes:
<http://www.great-lakes.org/exotics.html>

Great Lakes Aquatic Nuisance Species:
<http://www.glc.org/ans/anspanel.html>

Great Lakes Information Network: Exotic Species: <http://www.great-lakes.net/envt/exotic/exotic.html>

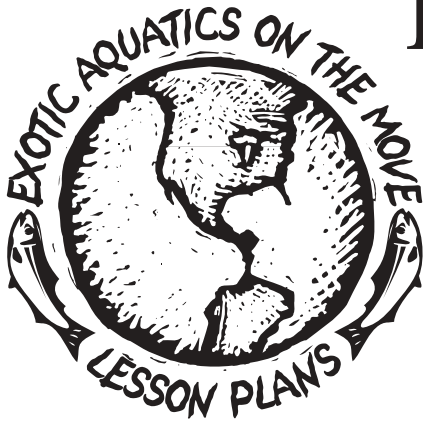
Great Lakes:
<http://www.greatlakesed.org>

Center for Great Lakes Environmental Education
c/o ECEEI
P.O. Box 56
Buffalo, New York 14205-0056

Credits

Created by author.

WHO ARE THE GREAT LAKES INVADERS?



Grade Level: 4th–6th grades

Overview

Students will research and acquire an awareness of six exotic species. As a culminating activity, students will test their knowledge of these species in a game called *Great Lakes Invaders*.

Background

This lesson focuses on six exotic species that threaten the biodiversity of native species in the Great Lakes region by competing for habitat and by disrupting the food chain:

- The round goby and Eurasian ruffe are fish that compete with native fish for food and habitat. The resulting decline in the population of native fish threatens sport and commercial fishing.
- Sea lamprey use a sucking disk and sharp teeth to attach to the side of a host fish to feed on its body fluids, resulting in scarring or death of the host fish. Lake trout, whitefish, and chub populations have been attacked and reduced by sea lamprey.
- The zebra mussel is a barnacle-like bivalve resembling a small clam. Colonies of zebra mussels have clogged intake pipes for power plants and water treatment plants causing power outages and disrupting supplies of drinking water. Zebra mussels blocking the cooling system for motors in recreational boats have caused overheating and damage.
- Eurasian watermilfoil is an aquatic plant with a long flexible stem. Thick feather-like leaves attach in whorls of four along the stem. This fast-spreading dense plant quickly chokes out native plants eliminating the shelter and food source for other native species. Both fish and waterfowl populations decrease. Thick mats of water milfoil growth interfere with boating, fishing, and swimming.
- Purple loosestrife is an invasive plant in wetlands. It displaces the native species such as cattails. The major impact is on the

animals in this habitat. Fewer native insects feed on loosestrife so there are fewer insects for birds such as red winged blackbirds to feed on. Ducks will not nest in loosestrife areas. Muskrats will not use loosestrife-infested areas.

Setting

Classroom

Objectives

1. Research informational Sea Grant documents, videos, and related Internet pages to learn about exotic species.
2. Identify the distinguishing characteristics of six nonindigenous species in the Great Lakes region.
3. Locate the origin of these exotic species.
4. Explain how these exotic species move to new locations.
5. Analyze the effects of exotic species on the native ecosystems.
6. Evaluate the solutions being used to control exotic species.
7. Create a school-wide public service announcement to be broadcast on the closed-circuit TV channel to make other students aware of the problems of exotic species.
8. Write an informational article about Great Lakes exotic species for the school newspaper, *Hawk Headlines*, to be distributed to school patrons.

Author Names

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School

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State

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Grade Levels Taught

4th grade

Geography Standards

Standard 1. How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information from a spatial perspective

Relationship to lesson: Students will use maps to locate the origin and movement of exotic species.

Standard 9. The characteristics and spatial distribution of ecosystems on Earth's surface

Relationship to lesson: Students will analyze the impact of purple loosestrife on wetland ecosystems. Students will investigate the impact of exotic species on the Great Lakes ecosystem.

Standard 10. How human actions modify the physical environment

Relationship to lesson: Human activities, commercial shipping and recreational boating, have facilitated the movement of exotic species to the Great Lakes region and their spread to other rivers and bodies of water. Human activities to control the invaders have also affected the physical environment.

Keywords

Purple loosestrife, sea lamprey, zebra mussel, watermilfoil, round goby, Eurasian ruffe, exotic species, predator/prey, habitat, ecosystem, tributary, St. Lawrence Seaway, Lake Superior, Lake Michigan, Lake Huron, Lake Erie, Lake Ontario, Lake St. Claire

Materials

Teacher-prepared informational booklets for students containing Sea Grant exotic species fact sheets (or students may research fact sheets on the Internet)

Videos: *Great Lakes Invader: The Sea Lamprey Battle Continues* and *Alien Ocean*

Overhead transparency of Great Lakes Invader game question categories and money scorekeeping grid

Game questions mounted on 4" x 6" index cards

Copies of the lyrics to *The Great Lakes Invaders Song* sung to the tune of Jeopardy.

THE GREAT LAKES INVADER SONG

Tune: Jeopardy Theme Song

Purple loosestrife, zebra mussels,
watermilfoil

Have invaded uh-us.

Native species will be wiped out

If we do not stop them now.

Round goby, sea lamprey, and the

Eur-asian ru-uffe

Down our waterways they keep spreading

Snuffing out our na-tive life.

Schedule

Three to four days; two or three 50-minute periods per day introduction. Students will research the background information (description, origin, movement, impact, solutions) for each exotic species and view related videos.

One 50-minute period to play the whole class game, *Great Lakes Invaders*.

Prerequisite Skills

Descriptive identification, origins, movement, environmental impact, and solutions for each of these exotic species: purple loosestrife, watermilfoil, zebra mussel, round goby, sea lamprey, Eurasian ruffe.

Curriculum Connections

Science concepts and vocabulary development that are emphasized in plant and animal units include the interdependence of life, survival needs of plants and animals, predator/prey relationships, producers/consumers in a food chain or food web, conditions in habitats that can limit what kinds of living things survive. Each of these concepts can be discussed during the lesson. Using maps to locate the origin and movement of these exotic species develops geographic awareness in Social Studies. There is also a mathematical connection in this lesson when students calculate their team's score.

Procedure

Divide the class into two to four equal groups, depending on class size. All students will participate. Every student on each team will eventually have a turn to choose a question and give a response at least once. Determine the order in which the teams will play. This order becomes the team's number to be used to mark the overhead transparency scorekeeping grid. Introduce and sing the *Great Lakes Invader Song*. The object of the game is to win "money" for correct answers to questions about Great Lakes exotic species. The team with the most money at the end of the game is the winner.

Place the Great Lakes Invader game grid transparency on the overhead.

1. The first student on the first team selects a question by naming one species and a category. For instance, a student may select sea lamprey and impact to try to give a \$40.00 answer.
2. The teacher reads the chosen question.
3. The student and team members have ten seconds to quietly discuss the answer. The student who chose the question for the team must give the answer to the question.
4. If the student answers correctly, the team number is placed in the appropriate grid of the transparency by the scorekeeper (teacher). No one may choose that section again. The turn goes to the next team.
5. If the question is *not* answered correctly, it stays on the board. No monetary award is given. The turn goes to the next team. (A possible variation of scoring is to penalize incorrect answers by subtracting the amount from the team's score.)
6. Continue alternating teams as students choose and answer questions until all the questions have been answered and the grid monetary amounts have been marked for the appropriate team's correct answer.
7. Total the value of the squares for each team. The team with the highest dollar amount has earned the title, "Great Lakes Protector."

Teacher Notes

Color-coding: Duplicate all the question cards for each exotic species in a separate color. Use lamination to preserve the playing cards.

Applications

Students will prepare a news broadcast about exotic species to air on the school's closed circuit TV channel. Students will write an informative article about exotic species for the school newspaper.

Garlic mustard is an invasive plant in Tippecanoe County. Students can be part of the solution as they help pull this noxious weed.

Evaluation

Students will be evaluated on the research they do to prepare for the game by completing a data fact-finding sheet. Student participation and student responses to questions during the game, Great Lakes Invaders, will also be evaluated.

Resources

<http://www.sgnis.org>

<http://www.great-lakes.net/>

<http://www.entryway.com/seagrant/>

Credits

Prepared by the authors.

**INVADER QUESTIONS
FOR PURPLE LOOSESTRIFE**

**Purple Loosestrife
IDENTITY \$10 QUESTION**

1. The purple loosestrife is an invasive plant that grows to a height of _____ to _____ feet tall.
(Answer: 1.5 ft. to 8 ft.)
-

**Purple Loosestrife
ORIGIN \$20 QUESTION**

2. The purple loosestrife is a native plant of _____ and _____ that has spread throughout much of the United States and Canada.
(Answer: Europe and Asia)
-

**Purple Loosestrife
MOVEMENT \$30 QUESTION**

3. Seeds of the purple loosestrife were accidentally introduced to the Great Lakes Region in ballasts of ships and on the wool of imported _____.
(Answer: sheep)
-

**Purple Loosestrife
IMPACT \$40 QUESTION**

4. Purple loosestrife invades and takes over an area, creating scarcity of natural foods for animals in that habitat. The purple loosestrife continues to spread because there are no natural _____ for the plant.
(Answer: predators)
-

**Purple Loosestrife
SOLUTION \$50 QUESTION**

5. Researchers have found and introduced an insect called the _____ into the United States. This beetle is a natural predator of the purple loosestrife in Europe.
(Answer: Galerucella beetle)
-

**GREAT LAKES INVADER QUESTIONS
FOR ROUND GOBY**

**Round Goby
IDENTITY \$10 QUESTION**

1. The round goby is three to ten inches long, is mostly slate gray, has frog-like eyes and is mottled with black to brown spots. No other native fish in the Great Lakes has the _____ pelvic (bottom) fin.
(Answer: single or fused or only one)
-

**Round Goby
ORIGIN \$20 QUESTION**

2. The round goby comes from the same area of the world as the zebra mussel. The two seas where the round goby originated are part of the commonly accepted division between Europe and Asia. Name the two seas.
(Answer: Black Sea and Caspian Sea)
-

**Round Goby
MOVEMENT \$30 QUESTION**

3. Since its discovery in the St. Claire River in 1990, this _____-dwelling fish has spread rapidly to many areas of the Great Lakes.
(Answer: bottom)
-

**Round Goby
IMPACT \$40 QUESTION**

4. The round goby can displace native fish, eat their eggs and young, take over optimal habitat, survive in poor quality water, and _____ several times a season making its population increase rapidly.
(Answer: spawn or reproduce)
-

**Round Goby
SOLUTION \$50 QUESTION**

5. Fishermen need to learn to _____ the round goby because these aggressive fish are commonly caught by hook and line.
(Answer: identify or recognize or not release)
-

**GREAT LAKES INVADER QUESTIONS
FOR RUFFE**

**Ruffe
IDENTITY \$10 QUESTION**

1. Ruffe are small fish, 4-6 inches long, that resemble a yellow perch. They are often confused with a number of fish; however, they have several identifiable traits on the dorsal fin. Name one of the two dorsal fin traits.
(Answer: a continuous dorsal fin with no notch or there are spots between the spiny rays on the dorsal fin)
-

**Ruffe
ORIGIN \$20 QUESTION**

2. The ruffe are a foraging, bottom-dwelling fish that were native to the slow moving rivers and muddy lakes of two continents. Name one of the two continents.
(Answer: Europe or Asia)
-

**Ruffe
MOVEMENT \$30 QUESTION**

3. The ruffe were introduced as larvae into Lake Superior from the ballast water discharge of a transoceanic ship that had picked up water in one or more European or Asian ports. What waterway did the ship travel to connect the Atlantic Ocean to the Great Lakes?
(Answer: The St. Lawrence Seaway)
-

**Ruffe
IMPACT \$40 QUESTION**

4. The European ruffe has spread to rivers and bays along the south shore of Lake Superior. Because the ruffe may compete with many species, including yellow perch, it is a serious ecological threat to water environments and to sport and commercial _____.
(Answer: fishing)
-

**Ruffe
SOLUTION \$50 QUESTION**

5. To control the ruffe, a fisherman should never dump live fish from one body of water into another. Never dip a bait bucket into one lake if it has been in another. Don't empty a bait bucket into water; always empty it on _____.
(Answer: land)
-

**GREAT LAKES INVADER QUESTIONS
FOR SEA LAMPREY**

**Sea Lamprey
IDENTITY \$10 QUESTION**

1. Sea lampreys are parasitic aquatic vertebrates resembling _____.
(Answer: eels)
-

**Sea Lamprey
ORIGIN \$20 QUESTION**

2. Sea lampreys are eel-like fish native to the _____ Ocean.
(Answer: Atlantic)
-

**Sea Lamprey
MOVEMENT \$30 QUESTION**

3. Since the 1830s sea lampreys have been migrating into the Great Lakes. In 1938 sea lampreys entered Lake Superior by being attached to boats going through locks on the St. Mary's River. In which Great Lake were lampreys first found?
(Answer: Lake Ontario)
-

**Sea Lamprey
IMPACT \$40 QUESTION**

4. Sea lampreys attach to, and suck on, host fish. After invading the Great Lakes, sea lampreys caused the collapse of what two native freshwater fish populations?
(Answers: trout, whitefish, or chub)
-

**Sea Lamprey
SOLUTION \$50 QUESTION**

5. Different types of chemical controls and mechanical and electronic barriers are being used to control lampreys. An underwater, high power _____ is being used in the St. Mary's River lamprey spawning ground to "suck up" thousands of lamprey larvae for sampling populations.
(Answer: vacuum)
-

**GREAT LAKES INVADER QUESTIONS
FOR WATERMILFOIL**

**Watermilfoil
IDENTITY \$10 QUESTION**

1. The watermilfoil, a submerged perennial aquatic plant forms thick strands of tangled stems under the water and vast mats of vegetation at the water's surface. The plant grows mostly on _____ lakes.
(Answer: shallow)
-

**Watermilfoil
ORIGIN \$20 QUESTION**

2. The Eurasian watermilfoil is natural to Europe, Asia, and _____.
(Answer: Northern Africa)
-

**Watermilfoil
MOVEMENT \$30 QUESTION**

3. The watermilfoil was probably introduced to this continent in the ballast water of ships as early as _____.
(Answer: 1800)
-

**Watermilfoil
IMPACT \$40 QUESTION**

4. Watermilfoil can inhibit the natural _____ of lakes making fishing, boating, and swimming difficult.
(Answer: waterflow)
-

**Watermilfoil
SOLUTION \$50 QUESTION**

5. As a means of control, attempts are being made to find natural _____ for watermilfoil plant.
(Answer: predators)
-

**GREAT LAKES INVADER QUESTIONS
FOR ZEBRA MUSSEL**

**Zebra Mussel
IDENTITY \$10 QUESTION**

1. The zebra mussel is a small freshwater mussel that can grow to a size of 5 cm. They have the ability to attach themselves to nearly any firm surface using their small thread-like features called _____.
(Answer: byssal threads)
-

**Zebra Mussel
ORIGIN \$20 QUESTION**

2. Zebra mussels are native to waters in Russia. Locate and name the two seas on a map.
(Answer: Black Sea and Caspian Sea)
-

**Zebra Mussel
MOVEMENT \$30 QUESTION**

3. The introduction of zebra mussels into the Great Lakes is believed to have happened in Lake St. Claire between Lake Huron and Lake Erie. How did transoceanic ships unsuspectingly release the zebra mussels into the lake?
(Answer: discharge of ballast water)
-

**Zebra Mussel
IMPACT \$40 QUESTION**

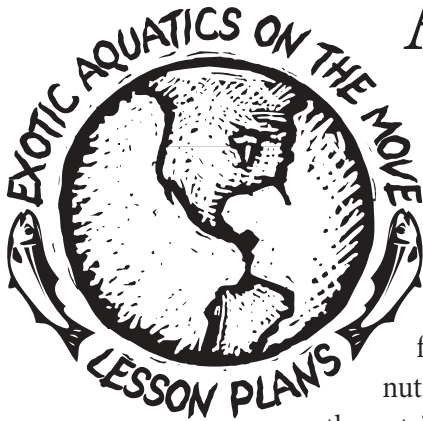
4. Colonies of zebra mussels have encrusted and clogged intake pipes of power plants and water treatment plants along Lake Michigan, Ontario, and Erie, forcing temporary shutdowns. Additional harm is done when zebra mussels filter feed on phytoplankton. This disturbs the aquatic _____.
(Answer: food chain)
-

**Zebra Mussel
SOLUTION \$50 QUESTION**

5. What can boaters and fishermen do to help prevent the spread of zebra mussels?
(Answer: clean and remove zebra mussels and vegetation from the bottom of their boats, trailers, and motors; dispose of unwanted bait and baitwater onshore)
-

COLOR THE NUTTY NUTRIA A NUISANCE CHALLENGE

Grade Level: 3rd–5th grades



Overview

This challenge invites students to learn more about the nutria and the problems they are causing in our environment. This is done in a game format; it is a challenge between two teams. After reviewing information about nutria the students are divided into teams. Each team is asked a question about the nutria. A volunteer from that team will answer the question. If the volunteer gets it right, he or she will be invited to color a piece of the nutria picture (included) using a brown crayon or marker. (Each nutria picture has previously been divided into as many sections as needed by the teacher. It will look like a jigsaw puzzle that has been put together.) If the student misses the question, the question will then be asked to the next team. If that team volunteer gets it right, then they get to color in a piece of their nutria puzzle. That team has just stolen the other team's answer, and now they get asked another question that belongs to them. It is possible to get two or more pieces colored in a row. Then the other team is asked the next question. The challenge continues until one team gets their nutria completely colored in.

Author

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City

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State

Louisiana

Grade Levels Taught

4th grade

Background

The nutria is a beaver-like creature, but its tail is more like a rat's. It is a rodent. Many call this creature a "nutria-rat" or "swamp rat." Louisiana and other swampy or coastal areas make perfect habitats for the nutria. They live in the water and on land.

In the 1930s this mammal was brought in from South America and raised for its fur. During the 1980s people frowned on the selling and wearing of furs, and the demand for it declined. Trappers could not control the numbers of nutria since they breed very rapidly. Nutria do not have many predators and are not afraid of humans or their activities.

Nutria are eating away the lower stems and roots of vegetation, causing erosion, flooding, and cave-ins of levees. They also carry parasites that have infected both people and pets.

Setting

This can be done in a classroom. You may want to hang pictures of the nutria, one for each team.

Objectives

1. State facts about nutria and their habits.
2. Analyze the problems associated with nutria's lifestyle.
3. Compare ways to get rid of the nutria nuisance.

Geographic Standards

Standard 6. How culture and experience influence people's perceptions of places and regions. Fur traders and others supported introducing nutria in the area because of the positive influence the nutria could have on the economy. As the fur trading industry waned, and these creatures were destroying the land, the positive perception of the nutria changed.

Standard 15. How human actions modify the physical environment. If humans had never brought the nutria to our area in the 1930s, our physical environment, the wetland areas, would have not been so drastically modified or destroyed by these exotics.

Standard 16. How physical systems affect human systems. The feeding activity of the nutria kills the vegetation in our marshes, making the marsh susceptible to erosion and coastal land loss. They are damaging the sugar cane and rice crops. The diseases they carry can affect humans and domesticated animals.

Keywords

Nutria, exotic, invasion, native, habitat, coastal, marshes, erosion, disease, fur trading

Materials

Reference aids and Internet sites to find information on the nutria

Questions to ask each team (examples included in lesson)

Large blackline copy of a nutria for each team (included in lesson)

Brown crayon or marker, one for each team

Schedule

Two to three class periods

Prerequisite Skills

After the introduction of the lesson and the keywords have been presented and discussed, the teacher can either present acquired information about the nutria, or have the students assist in this task. This could be done as group work, or individual topics could be assigned. The students should have general knowledge about nutria or information available to them during the lesson, depending on the questions to be asked during the challenge.

Curriculum Connections

Science, Language Arts, Math, Art

Procedure

1. Introduce the lesson using the background material provided and any additional information you would like to provide the students.
2. Have the students do research on the nutria utilizing print and non-print media. You may prefer to have them answer some

leading questions through their research to focus in on certain aspects of the nutria. The students could do this as a group or as independent work. The teacher could disseminate information about the nutria to analyze.

3. After information has been acquired the teacher can decide how it is to be used during the challenge. The students can use their information as a guide, or you can have them study and recall the facts during the challenge or use a combination of both techniques.
4. Make two copies of the large nutria art included in this lesson. Using a marker divide the nutria artwork into sections making it look like a jigsaw puzzle (see below). You can create as many sections as you would like for the challenge, depending on how many students there are on each team. Make sure both pictures have the same amount of pieces to color in.
5. Divide the class into two teams.
6. Ask one team a question about nutria (sample questions and answers are included in this lesson). You can decide if you want them to have the information to look at, or if you want them to converse with each other to come up with the answer. If that student, or team, gets the answer correct they get to come up and color in one section of the nutria art using a brown crayon or marker. If that team, or student, misses the question, the same question is asked to the other team. If that team gets it right they get to color in a section of their nutria art. Then the second team gets their next question asked to them. Therefore it is possible to color in two sections in a row because the second team has stolen the first team's question and then get to answer their own team's question. If the question is not answered it can be passed back and forth until it is finally answered.
7. The team that completely colors in their nutria art first *wins!*

Teacher Notes

Be careful to keep up with which team originally had that question so you can ask the other team the next question. Make sure you have enough questions. You may need to prepare additional questions and add them to the list that is provided.

Applications

You can make your questions factual or analytical. The student could have to come up with conclusions or evaluations of ideas or solutions. You can turn this lesson into whatever you want to. Writing activities could follow up this activity. You could write to the newspaper or television station. You could debate issues spurred by the challenge. Use the challenge as the beginning of many exciting things.

Evaluation

It is easy to see if the students have grasped knowledge as they color in their nutria during the challenge. You can adjust the difficulty of the questions asked during the challenge as needed. I would evaluate the students as a group using a rubric, giving points for following directions, cooperation, and of course the winners should get a little something extra.

Resources

Scribe— “Louisiana Department of Wildlife and Fisheries Nutria Harvest and Wetland Demonstration Project”: <http://www.netwwworks.com/98etc/12dec/scribe/>

Audubon Institute: Louisiana Nature Center Creature Feature — Nutria: http://www.auduboninstitute.org/html/creature_nature.html

USGS National Wetlands Research Center— USGS Biological Resources “Frequently Asked Questions about Nutria” Source: Nutria Harvest and Wetland Demonstration Project: <http://www.nwrc.nbs.gov/special/nutquest.html>

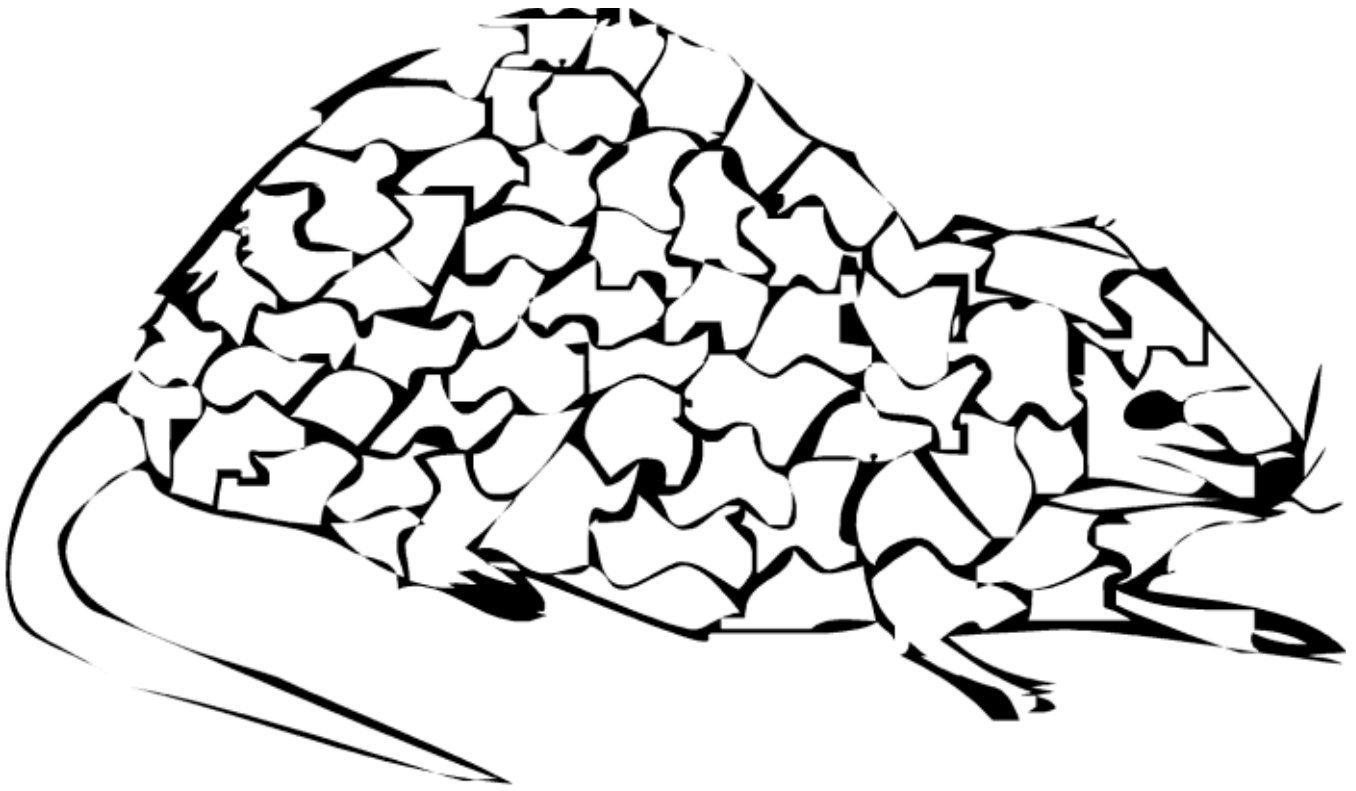
Seattle Insider.com “Ecologists Wage War on Exotic Species” by Joseph B. Verrengia—AP Science Writer: <http://seattleinsider.com/technology/news/1999/09/25/ecologyfight2.html>

Nutria Picture: <http://www.gnofn.org/~nopl/images/nutria2.jpg>

Credits

Prepared by author.

Color the Nutty Nutria, a Nuisance Challenge



SAMPLE QUESTIONS FOR CHALLENGE: LOWER LEVEL QUESTIONS

Which animal does the nutria most resemble?

Answer: beaver

Which animal does the tail of a nutria most resemble?

Answer: rat

Are nutria herbivores, carnivores, or omnivores?

Answer: herbivores

Where were the nutria brought in from?

Answer: South America (Argentina)

Who brought the nutria to our area?

Answer: E.A. McIlhenney of the Tabasco Sauce fame, to Avery Island

Why has the population of nutria gotten out of control?

Answer: reproduce rapidly, not many predators, warm weather, perfect habitat, abundance of food

What helped control the population of nutria in the 1960s?

Answer: fur trading, wearing fur was popular

What stopped the control of nutria in the 1980s?

Answer: wearing fur was unpopular

What do the dining habits of nutria cause?

Answer: they kill the vegetation that binds the soft marshy soil, erosion, coastal and agricultural land loss, disease

Name what a nutria is good for (besides fur).

Answer: to eat

SAMPLE QUESTIONS FOR CHALLENGE: HIGHER LEVEL QUESTIONS

Sequence the events of the nutria invasion.

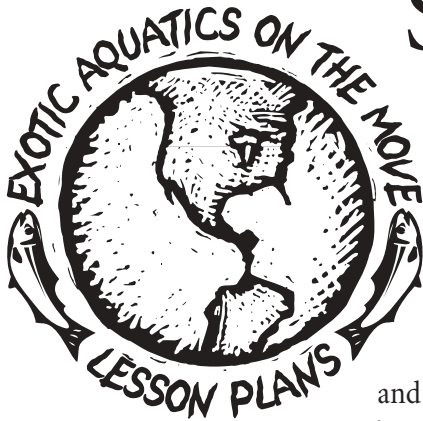
Distinguish between trapping, poisoning, and eating the nutria as far as eradication is concerned.

Propose your own solution to the nutria problem.

Assess the value of using nutria as “target practice.”

Debate the issue of how to get rid of the nutria.

CIVIL COURT LAWSUIT: STATE OF LOUISIANA VS. NUISANCE NUTRIA



Grade Level: 6th–12th grades

Overview

This is an activity in which students will research, using provided materials and Internet sources, in order to hold a trial in which the nutria are sued by the people of the state of Louisiana for the damage that they have done to the local environment and economy.

Background

The nutria is a species imported from Argentina and Chile. It has few natural predators in Louisiana, and is a prolific breeder, able to bear up to 13 young per *month*. It is responsible for the undermining of essential levees by burrowing, causing flooding and loss of crawfish from breeding ponds. In south Louisiana, it also enjoys eating sugar cane, an important Louisiana economic crop. The nutria can cause degradation of wetland areas, eliminating tender marsh grasses as well as cypress trees. They also carry numerous parasites, endangering both pets and humans.

Setting

This lesson can be done in a classroom or auditorium, although research must be done in the library.

Objectives

1. Research the method of bioinvasion of the nutria into the wetlands of Louisiana.
2. Explore the impact of the nutria on the environment and the economy of Louisiana.
3. Use critical thinking skills in the performance of role-play in a courtroom format.

Geographic Standards

Standard 6. How culture and experience influence people's perceptions of places and regions. The nutria's reputation has changed over time as it affects people directly.

Standard 14. How human actions modify the physical environment. People brought the nutria to Louisiana to begin a fur industry as well as to eat invasive water hyacinths. Nutria have denuded the wetlands, and now there is no market for its fur.

Standard 15. How physical systems affect human systems. As canal banks and levees are undermined, people's property and methods of livelihood are endangered. Crops are eaten, and diseases carried by the nutria are endangering humans and pets.

Keywords

Habitat, ecosystem, bioinvasion, established species, introduction (of non-native species), herbivore

Materials

Reading material (as well as Internet sources) on the nutria, chart to guide research, rules of courtroom procedure, lawsuit form, counter suit form, witness form (see attached), and one large manila envelope for each team.

Author

Susan Keith

School

Caddo Magnet High School

City

Shreveport

State

Louisiana

Grade Levels Taught

11th and 12th grades

Schedule

Three to five class periods

Prerequisite Skills

Knowledge of courtroom procedure, as well as courtroom terminology; background information on the nutria and the damage it can inflict.

Curriculum Connections

Environmental Science, Biology, Geography, Economics, and Civics

Procedure

1. Students should be divided into two groups: one group is the defense, the other is the prosecution. These groups are to be subdivided into lawyers and witnesses. The teacher will serve as the judge in the case. One witness from each group will serve as the bailiff, when not needed as a witness.
2. The teacher should explain that this activity will include role playing in the form of a courtroom trial. The teacher should explain that this is a civil trial brought by the State of Louisiana against the nutria, which means that arguments will be given by the nutria's lawyers as well as the state lawyers. The judge will make the final determination of a monetary settlement, if any; there is no jury in a civil trial. Judgment will be based on the strength of the arguments given, as well as creativity.
3. Distribute copies of the **Rules of Courtroom Procedure** to the class. Discuss them as a class. Students are to keep their copies with them during the trial so that they can refer to them as needed.
4. Pass out a set of the **Readings on the Nutria** to each student as well as a **Chart to Guide Research**. The teams should read and share facts from the readings within the group. They should take notes on what they have read and put them on the charts, which will be used as a basis for the trial. The students will turn in their charts at the end of the trial for a grade, along with the other required materials, in packets (one for the defense team and one for the prosecution).
5. Students should be given time in the library

to do additional research on the impacts of nutria on the Louisiana environment and economy. Sources should include periodicals, books, and the Internet. Again, notes should be taken on the material and included on their charts.

6. The prosecution (State of Louisiana) must fill out the **Lawsuit Form**, including a minimum of six specific charges against the nutria. The prosecution team must also determine a monetary amount for damages based on facts not folly. This will be given to the judge (teacher) for approval, and a copy will be provided to the defense team.
7. The defense and prosecution teams should be given time in class to collate their research and determine their arguments, using the **Lawsuit Form** as a guide. Lawyers for each team should be preparing for the trial, and witnesses for each team should be informed of their part in the trial. All witnesses must fill out the **Witness Form**, which is turned in to the judge before the trial. One surprise witness will be allowed for each team. The teacher may limit the number of witnesses, according to time constraints.
8. The defense team should be given a **Counter Suit Form**, which they are to keep secret from the other team. The defense team should fill out this form and the team may use any charge that they can defend. They are also to determine a monetary amount for damages. This form is to be turned in to the judge for approval before the trial.

NOTE: The counter suit is to be filed at any point during the trial by the defense, and only then will the prosecution be given a copy. This should be a moment of high drama in the trial. The witnesses will NOT be included on the counter suit.

Teacher Notes

On the day of the trial, the teacher should instruct the students to have their Rules of Courtroom Procedure in front of them. The teacher should guide the proceedings, having the bailiff call court into session and read the lawsuit.

A rubric will be used by the teacher to determine the grade earned by the winning team's performance during the trial. It will also include credit for the materials turned in with the packet of each team. A copy may be included in the manila envelope given to each team as a part of their packets that will be turned in.

Make sure that each student has a chance to participate. Do not let individuals dominate or even disrupt the proceedings. Watch the time; you may need to limit witnesses.

The judge will announce the verdict on the original lawsuit and for the counter suit. Then the packet for each team should be placed in a large manila envelope, with all team members' names on the envelope, to be turned in to the teacher.

Applications

This activity can be used to culminate a unit on exotic flora and fauna and the effects on economy, culture, government, and science research. It can be a part of a cross-curricular unit in cooperating Social Studies and Science classrooms.

Evaluation

The evaluation of packets and participation is based on a teacher-designed rubric. Teacher comments are to be included, explaining the scoring used. The rubric will be returned, along with the packet of each team.

Resources

Coast and Sea Magazine: Marine and Coastal Research in Louisiana's Universities. Copies from Louisiana Sea Grant Communications office, Louisiana State University, Baton Rouge, LA 70803.

Environmental News Network: <http://www.enn.com>. Type in the word "alien" on their search engine.

Mississippi Sea Grant Advisory Service information. Mississippi Cooperative Extension Service, Coastal Research and Extension Center, 2710 Beach Blvd., Suite 1E, Biloxi, MS 39531. (228) 388-4710.

Sea Grant Nonindigenous Species Website: <http://www.sgnis.org>

Exotic Aquatics on the Move Website: <http://ag.ansc.purdue.edu/EXOTICSP/>

USGS Non-Indigenous Website: <http://nas.er.usgs.gov>

The Bridge, Ocean Sciences Education Teacher Resource Website: <http://www.vims.edu/bridge/exotic.html>

Ouchley, Amy, and Gay Brantley, "Louisiana Nature Investigator Education Corner: Exotics," *Louisiana Conservationist Magazine*, November–December 1997, p. 29.

"Warning: Invasion of Alien Species," *Louisiana Legacy*, Spring 1999, pp. 12–13.

Credits

Prepared by author.

Name _____ Team _____

Page _____

Chart to Guide Research
STATE OF LOUISIANA VS. NUISANCE NUTRIA

Source Title and Author	Information	Miscellaneous

RULES OF COURTROOM PROCEDURE

1. Lawyers for the defense will make a three-minute statement.
2. Lawyers for the prosecution will make a three-minute statement.
3. Prosecution begins calling witnesses. They will continue bringing up their witnesses until they rest their case.
4. Defense lawyers may question witnesses of the prosecution if they wish.
5. Defense case begins calling witnesses. They will continue bringing up their witnesses until they rest their case.
6. Prosecuting attorneys may question witnesses called by the defense lawyers if they wish.
7. Lawyers may object to the questioning of the other team for leading the witness, being argumentative, badgering the witness, or irrelevance. The judge will sustain or overrule the objections.

LAWSUIT FORM

LAWSUIT NAME _____

Text of Lawsuit:

WHEREAS, The party known as _____ has caused damage to
_____ through the following actions:

1. _____

2. _____

3. _____

4. _____

5. _____

and,

6. _____

THEREFORE, the party of the first part, _____, demands from
the party of the second part, _____, the sum of _____
in damages.

SIGNATURE OF JUDGE _____

DAMAGES AWARDED _____

COUNTER SUIT FORM

COUNTER SUIT NAME _____

Text of Counter Suit:

WHEREAS, The party known as _____ has caused damage to the party known as _____, through the following actions:

1. _____

2. _____

and,

3. _____

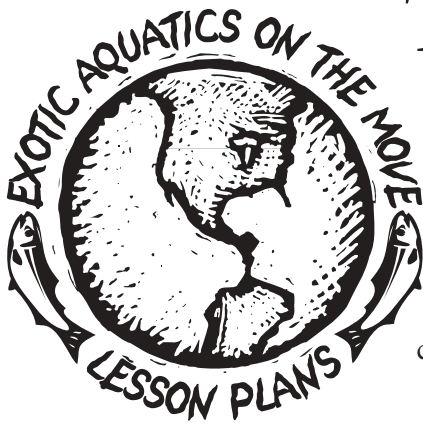
THEREFORE, the party of the first part, _____, demands from the party of the second part, _____, the sum of _____ in damages.

SIGNATURE OF JUDGE _____

DAMAGES AWARDED _____

WHAT IS THE BEAUTY IN THE BEASTIES SPECIES?

Grade Level: 1st-5th grades



Overview

The worksheets of this lesson are designed to enable students to recognize five of the exotic species along with information describing their characteristics and the individual effect they can have on their adopted habitat.

Background

One may look out over a field of brilliant purple flowers and think, “How wonderful!” Or, one might look out over a pond or lake and see lovely white flowers and bright green leaves and think, “How beautiful!” Scenes such as these may appear to be healthy, vibrant intriguing vegetation, but there may be a problem—all those beautiful flowers may not just be “beauties”—they may also be “beasties.”

Exotic species are plants and animals that spread beyond their native lands to new homes on continents and in oceans and lakes far away. Some of the exotic aquatic species are very beautiful and we may wonder why they would be a problem. It is important to understand that exotic species can interfere with native plants and animals by taking over the native species’ habitat. Exotic species can outcompete native species for food and habitat resources that eventually cause the native species to decline in numbers. With enough food and favorable conditions, the exotic species’ numbers can explode, causing harm to recreational areas and ecosystems.

Some exotics have been introduced accidentally, and others intentionally. Many exotics arrive in our ports, rivers and the Great Lakes when the ballast water of ocean-going cargo ships and tankers is discharged. Once these species are able to catch a foothold in these waters, it is only a matter of time before they pose a risk of spreading to other water bodies by other boats and recreational watercraft and equipment. Education of the public through reading material, school lesson plans, posters and seminars will help the public recognize these exotics and learn how they can help stop the spread of these “beasty species.”

Setting

The lesson can be conducted at tables. Students can include children in school situations or recreational workshops in libraries, state parks, and other outdoor settings.

Objectives

1. Identify several exotic species.
2. Identify how the exotic species have effected the environment where they have been introduced.

Geographic Standards

Standard 14. How human actions modify the physical environment

Standard 15. How physical systems affect human systems

Standard 16. The changes that occur in the meaning, use distribution, and importance of resources

Standard 18. How to apply geography to interpret the present and plan for the future

Keywords

Hydrilla, purple loosestrife, water hyacinth, zebra mussel, ruffe, giant salvinia

Author

Catherine Kiffe

School

N. P. Moss Annex

City

Lafayette

State

Louisiana

Grade Levels Taught

Homebound,
1st-12th grade

Materials

Worksheets (see attached), glue, information sheets, pencils, crayons (markers or colored pencils), polystyrene trays cut into 2" x 2" pieces, paper, scissors, 1" x 1/2" strips of paper folded as illustrated below, stamp (ink) pads in different colors



Schedule

This activity should take about two hours to complete.

Prerequisite Skills

It would be helpful for students to have had some type of introduction to exotics and the effect on native habitats.

Curriculum Connections

Science, Math, and Social Studies

Procedure

1. Introduce the background information on exotic species.
2. Show the examples of each of the species presented in this activity.
3. Give each student an example page and the "Find It" worksheet. Discuss how plants surround us every day. Some of the plants have always been here and others have come from distant countries in different ways. The new plants are "disguised" because they seem to fit in with no problems. Ask learners to investigate the "Find It" worksheet to discover and color in the five exotic aquatic invasive species that we are concentrating on for this project.
4. After discovering the five exotic species on the "Find It" page, tell the learners that we will be working on landscapes showing how exotic species impact the environment by reproducing and therefore taking over the space that the native species would normally live.
5. Give each student a blank sheet of paper. Discuss how simplified drawings can be used as symbols to represent an object. Show examples of some symbols that could be used for each of the exotic species. Tell them we will be making stamps with the symbols to represent each exotic species. We will use the stamps on landscape scenes that represent environments that are invaded by the exotic species.
6. Give each student the pre-cut pieces of Styrofoam (2" x 2"). Have them transfer their symbol drawings onto the Styrofoam using a pencil.
7. Demonstrate how to attach the small piece of paper to make the handle for the stamp. Fold the paper as illustrated above. Using small dots of glue, attach the paper to the back of the Styrofoam pieces. Allow glue to dry fully.
8. Provide stamp pads in different ink colors if possible. Have students use their six symbol stamps on the appropriate scene worksheet (attached) to simulate the explosive reproduction of the exotic species in an environment.
Scene 1 - hydrilla infestation
Scene 2 - zebra mussel infestation
Scene 3 - ruffe infestation
Scene 4 - giant salvinia infestation
Scene 5 - water hyacinth infestation
Scene 6 - purple loosestrife infestation
9. Discuss how exotic species take over the native species' habitats, making some even disappear. The effect may seem beautiful at first, but then we need to look at the loss of native species and a changed environment and recognize that the effects of an exotic species are often more than illusionary beauty.
10. Discuss with students that just becoming aware of the effects of exotic species is important in stopping the spread. Discuss the chart that details some ways people can help in saving our native plants and animals as well as our natural environment. Allow time for students to fill out the Student Observation Worksheet. Students may work separately, in groups, or as a class and then share everyone's comments and input.

Evaluation

Rubric for evaluating exotic species invasion worksheets

	1	3	5
Colored the following exotic species on the "Find It" worksheet: <i>Hydrilla, giant salvinia, water hyacinth, ruffe, purple loosestrife</i>			
Created symbols for: <i>Hydrilla, giant salvinia, water hyacinth, ruffe, purple loosestrife</i>			
Stamped each Infestation Worksheet with appropriate: <i>Hydrilla, giant salvinia, water hyacinth, ruffe, purple loosestrife</i>			
Completed student observation worksheet			

Teacher Notes

The class could be divided into groups, with each group working on a different species and infestation scene. Several copies of each infestation scene could be distributed to teach the group and each student in the group could be responsible for stamping different amounts to simulate the sequential growth patterns of the exotic species in the environment.

Several infestation scenes could be interchanged and used for two or more of the symbols for the species simulation of the exotic species infestations.

Applications

Many newspaper articles have been written lately about the impact of exotics on the environment and the effect it is having on recreational sports, such as fishing and hunting. Ask students if they or their parents have been aware of any of these. Has the growth of exotic species affected their families directly or indirectly? Do any family members go fishing? If so, have they had any first-hand experience with exotic species' explosive reproduction? If the students do not live near water, how are their lives impacted?

Resources

WEBSITES:

<http://www.fws.gov/r3pao/alpena/nuisance.htm>

<http://aquat1.ifas.ufl.edu/photos.html>

<http://aquat1.ifas.ufl.edu/nyodpic.html>

Credits

Prepared by author.

NAME _____

DATE _____

STUDENT OBSERVATION WORKSHEET

Results shown on Infestation Worksheets
after stamping symbols

What is happening with the growth of the
exotic species as you add stamps to your
Infestation Worksheets?

Have you observed exotics infesting habitats
in a ...
... real place close to your home?
... real place far from your home?
... pictures in books?
... newspaper articles?
... news story on TV?
... show on TV?
... video?

How would the invasion of exotic species
affect your life if you lived close to one
of the landscape pictures? Why should
you care?

FIND IT ACTIVITY

Find It Key



RUFFE



ZEBRA MUSSEL



GIANT SALVINIA



HYDRILLA



PURPLE LOOSESTRIFE



WATER HYACINTH



SYMBOL EXAMPLES

Ruffe



Giant Salvinia



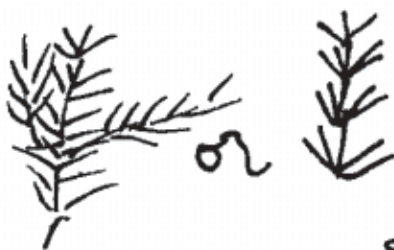
Purple Loosestrife



Zebra Mussel



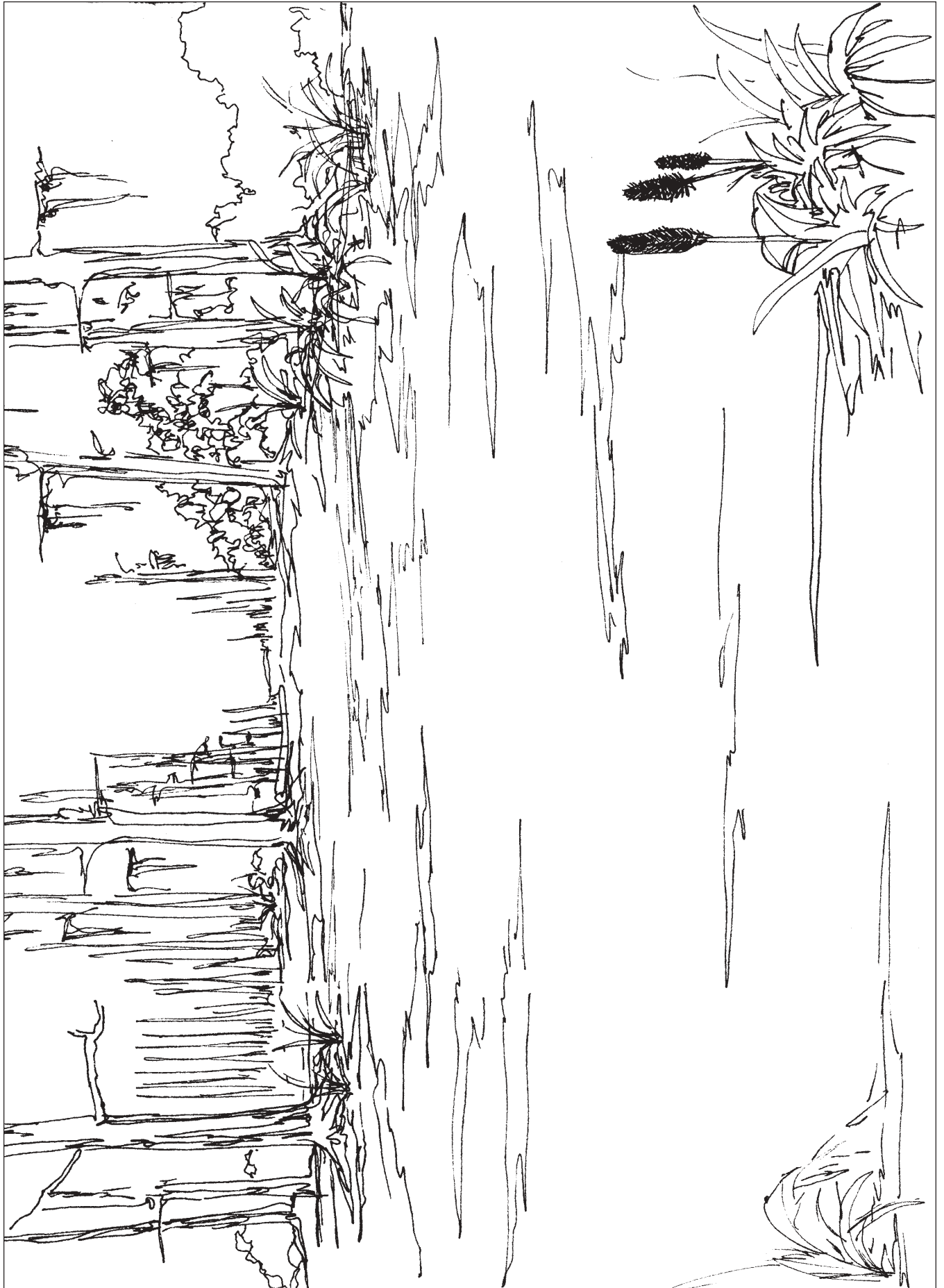
Hydrilla

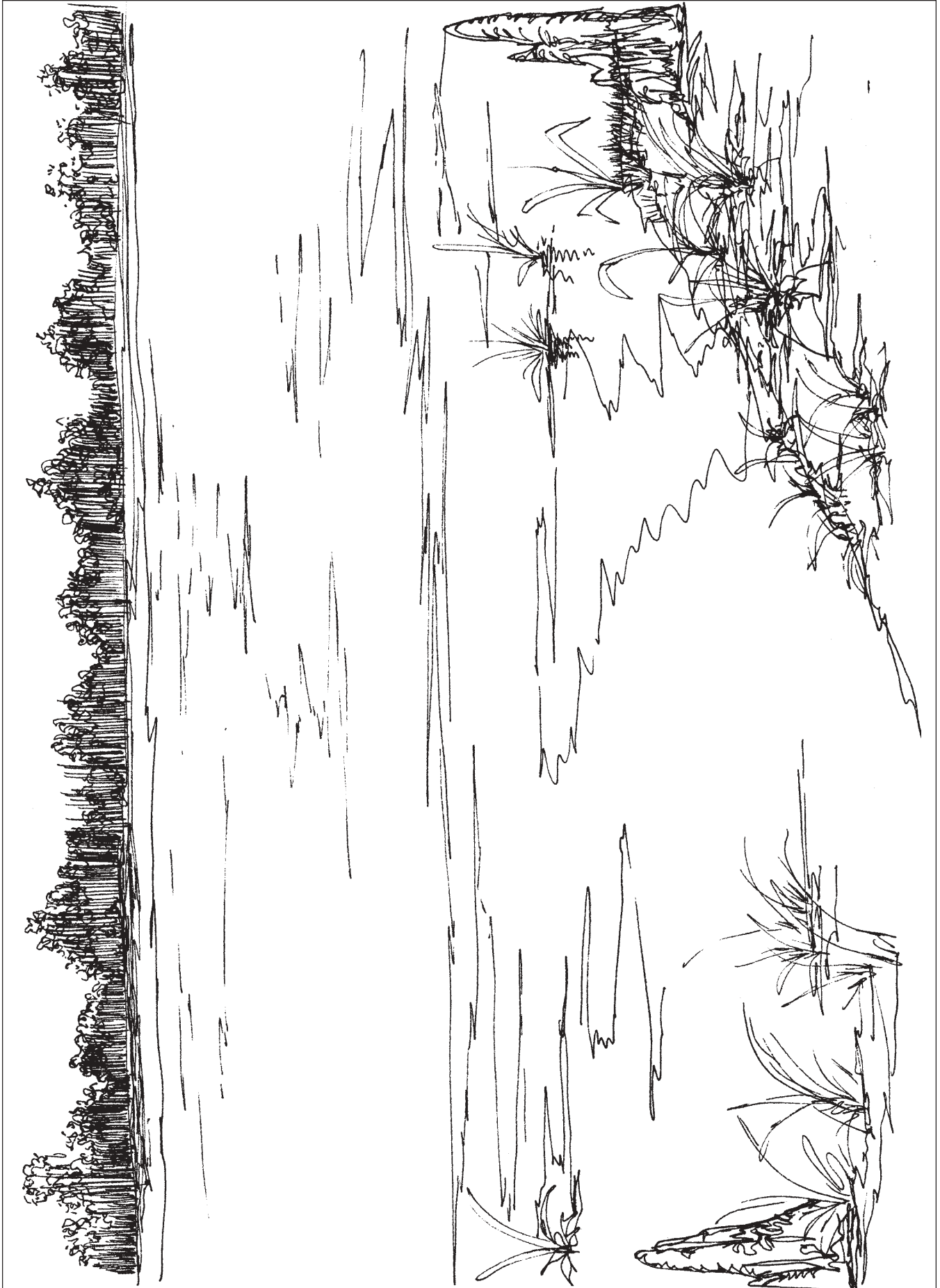


Water Hyacinth



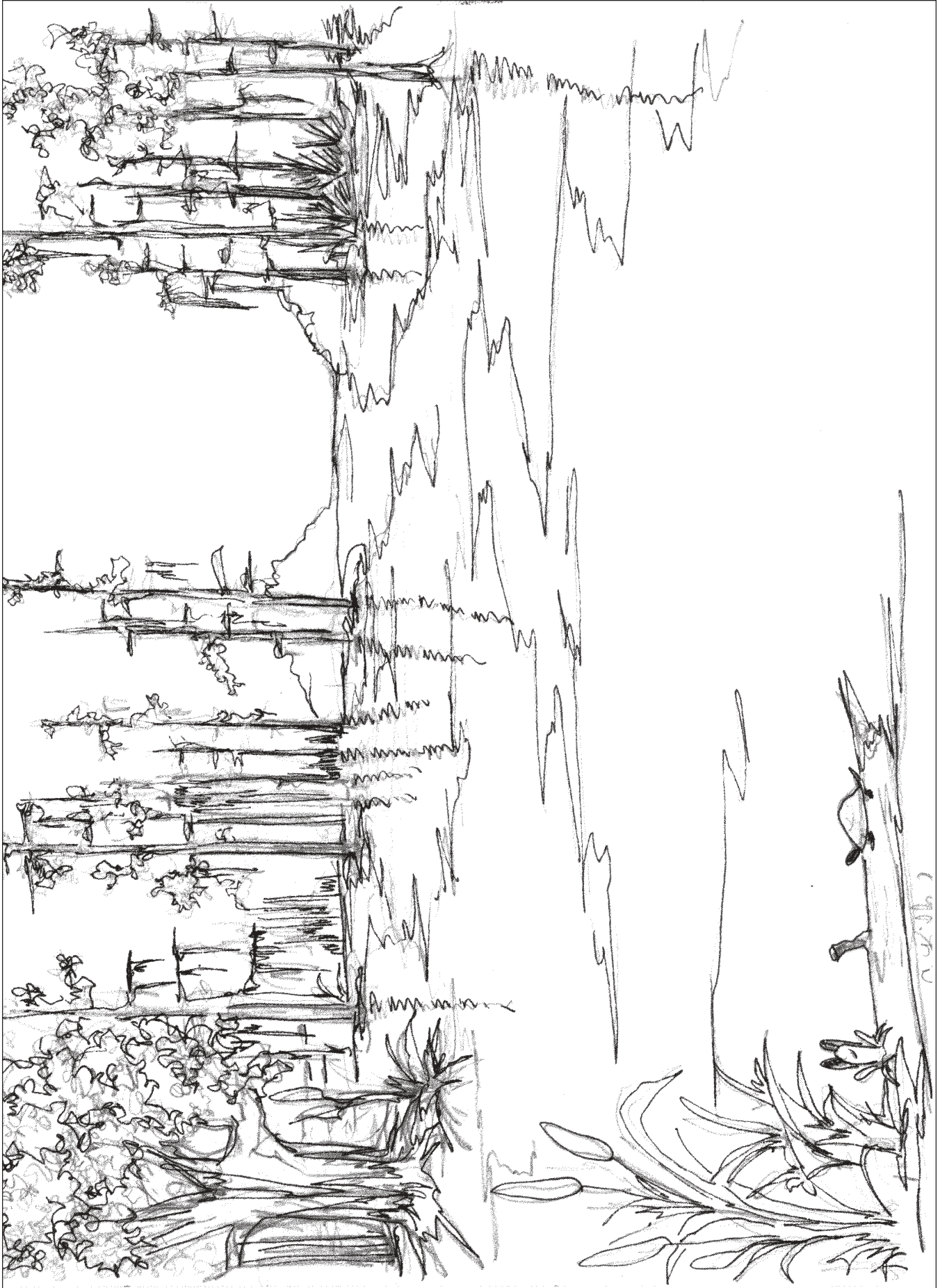
GIANT SALVINIA INFESTATION

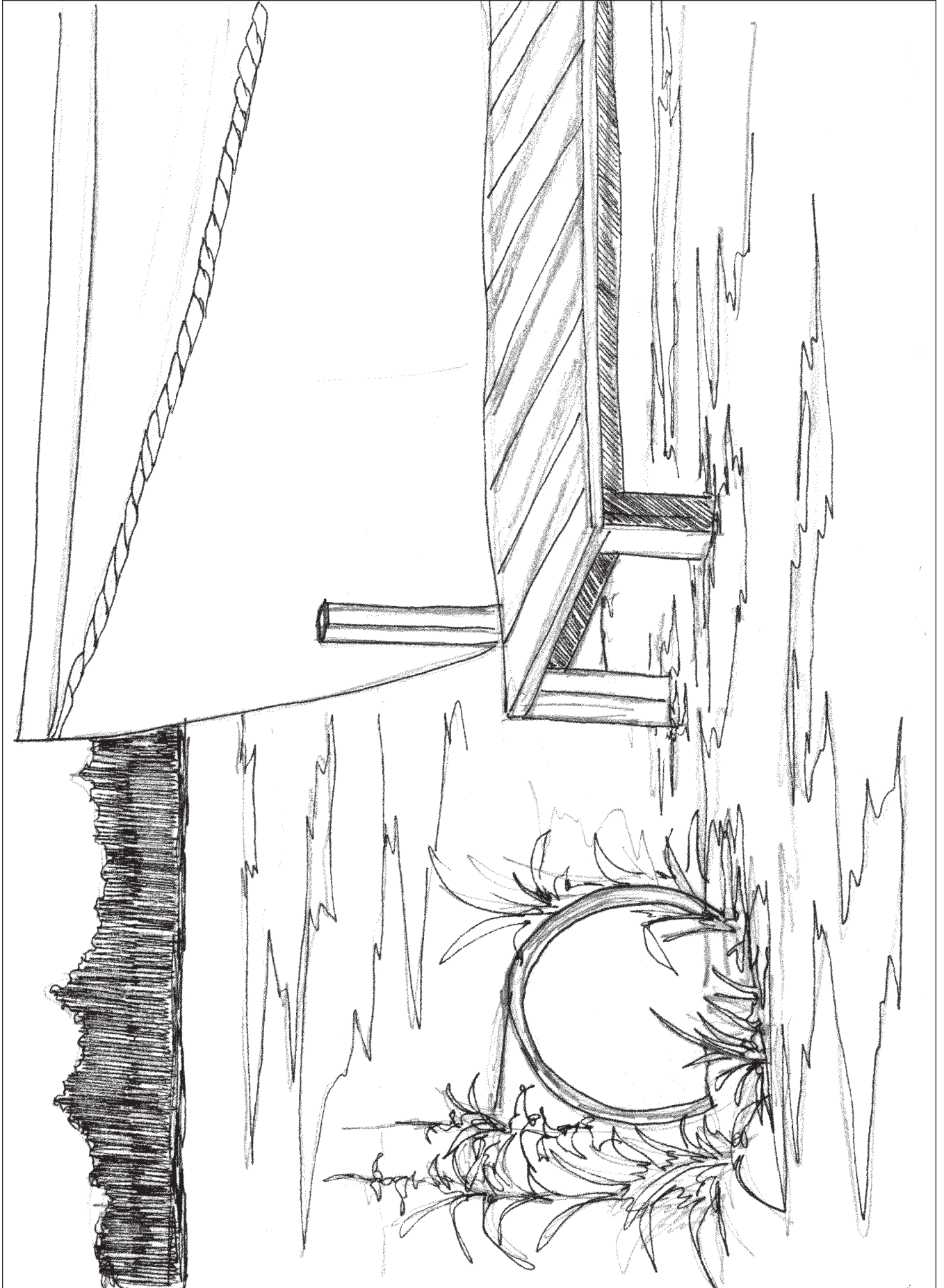




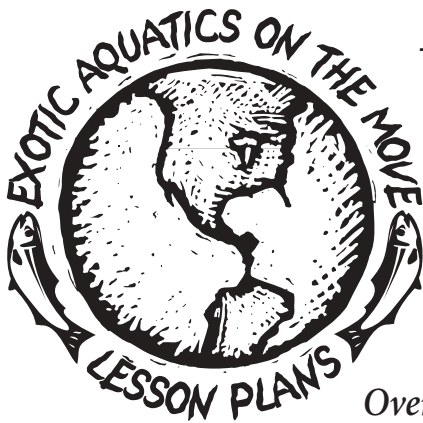


WATER HYACINTH INFESTATION





HOW DO SCIENTISTS USE THE SCIENTIFIC METHOD TO STUDY THE INVADERS OF THE GREAT LAKES?



Grade Level: 7th grade

Overview

In science class, students will work in groups to research a problem with an invader of the Great Lakes and then use the scientific method to design an experiment to test their hypothesis.

Background

While students are exploring the steps of the scientific method, they can make a real life connection by using invading species as their focal point of concern. The scientific method is addressed in the New York State Learning Standards. Not only do students learn about the scientific method and invaders of the Great Lakes, but they also get a chance to create and possibly execute their own scientific experiment. Through problem solving, inquiry, and cooperative learning students become scientists in this journey.

Setting

Science lab or possibly outside at the location of their experimental testing.

Objectives

When the learners have completed this activity, they should be able to:

1. Follow the steps of the scientific method by designing their own experiment to test their hypothesis about a problem with an invader of the Great Lakes.
2. Possibly execute one of the experiments in class.
3. Evaluate the experiments they created.

Geographic Standards

Standard 15. How physical systems affect human systems

Standard 16. The changes that occur in the meaning, use, distribution, and importance of resources

Science Standards

Inquiry: Depending upon the topic/problem/experiment chosen by each group, students will be addressing certain standards related specifically to their research areas.

Keywords

Scientific method, observations, hypothesis, experiment, data, research, variable, control, theory, law, invader, exotic species, vector, nonindigenous species, Great Lakes, sea lamprey, zebra mussel, purple loosestrife, round goby, alewife

Materials

For groups of three to four students: paper, markers, colored pencils, computers, Internet access, word-processing programs, spread-sheet programs, resources on invaders, supplies for experiments

Author

Jennifer K. MacDonald

School

Fredonia Middle School

City

Fredonia

State

New York

Grade Levels Taught

7th – 8th Grades

Schedule

Day 1: Instructions, Keywords, Scientific Method Sample, and Group Formations.

Day 2: Assign roles in groups, brainstorm, identify problem with invader, and begin designing an experiment.

Day 3: Continue experimental design, gather information (library, Internet, books, etc.), and create a hypothesis.

Day 4: Map out experiment and predict results.

Day 5: Create charts, tables, graphs and a lab report.

Day 6: Present experiments to class and vote for the best experiment.

Day 7: Try to simulate or execute one or several of the experiments in the lab to review the scientific method.

Prerequisite Skills

Students should have a basic idea of the scientific method and invaders of the Great Lakes.

Curriculum Connections

Science: Scientific method and biological studies of invaders.

Math: Measurements, data collection, and graphing.

Social Studies: Impact of invader problem on our community (economically, socially, recreationally, biologically, and geographically)

English: Research techniques, scientific method write up, and vocabulary.

Technology: Use of computer and design of experiment.

Art: Drawings and graphics.

Careers: The many different types of scientists.

Extensions

Guest speakers from and/or field trips to the Department of Environmental Conservation, Aquarium, Sea Grant, and/or local colleges or universities.

Procedure

1. **Anticipatory Set**—Tell students that they are going to be scientists for the next week or so. Go over the different kinds of scientists who study the Great Lakes. Give each student a strip of paper with the name of a particular type of scientist on it. For example, Biologist (a person who studies life), Chemist (a person who studies chemistry), Geologist (a person who studies the earth), Botanist (a person who studies plants), Zoologist (a person who studies animals), Aquatic Biologist (a person who studies life in the water), Liminologist (a person who studies lakes), Ichthyologist (a person who studies fish), Microbiologist (a person who studies microscopic life), etc.
2. Ask students if they know what that scientist they selected studies. Have students raise their hands if they think they know what their scientist does. Tell the other students that it is OK if they don't know anything about their own because there are so many different kinds of scientists in the world—they all study different things and have different names! Have students check with their partner to see if they can figure them out together. Use numbers on the back of the strips to divide students into groups. Once in the groups, encourage students to share their scientist with each other and once again cooperatively figure out their roles. Have a class discussion about the different kinds of scientists and how they work together to help us learn more about the Great Lakes.
3. In their groups go over directions to the activity. Students are to work together to develop an experiment to test a problem with a Great Lake invader. You can do this in one of two ways. You can either jigsaw this project by randomly assigning an invader to each group or just allow the students to choose any invader they want.
4. Use the tentative schedule provided to see what the groups should be working on each day.
5. When the students have completed their projects have them present to the class. You can have the students vote on the best experiment and try to simulate it in your lab to review the steps of the scientific method. There may be some experiments that can be modified to be conducted in your lab.

Teacher Notes

Assign groups heterogeneously or form them randomly.

This lesson plan is flexible in many ways. You can take as much time as you want to work on this lesson in your own classroom and take ideas from it to modify for your students.

Allow students to think as scientists do. If their thinking and their experiments go way beyond your lab, it is fine. As long as their experiments are scientifically sound it is acceptable for them to imagine themselves with resources that may not be readily available in your room. You can decide whether or not you want them to think realistically or use their imaginations.

Applications

Execute and refine.

Evaluation

Students will evaluate each other's research projects. They are to provide positive feedback and constructive criticism. Students should fill out an evaluation form for each group's presentation and a class discussion should follow each presentation.

Credits

Prepared by author.

GREAT LAKES INVADERS AND THE SCIENTIFIC METHOD

(Designed after the New York State Math, Science, and Technology Test Pilot of 2000)

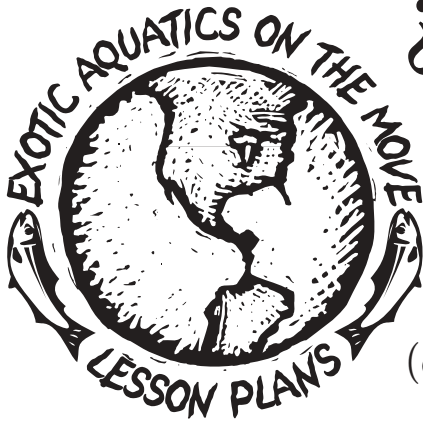
1. Planning Page
Brainstorming with Group
 - Invaders
 - Problems with Three Invaders
 - Hypothesis
 - Experiments To Do

2. Project Page
Designing Experiment
 - Topic/Invader
 - Problem
 - Gather Information
 - Hypothesis
 - Test Hypothesis/Experiment
 - Materials
 - Design
 - One Picture/One Table/One Graph
 - Variable/Control
 - Data
 - Analysis
 - Conclusion

3. Reflection Page
Reflection Log/Journal
 - Working with Others
 - How's it Going?
 - Feelings about Project
 - Predictions

4. Evaluation Page
Within Group and with Other Groups
 - Positive Feedback
 - Constructive Criticism
 - Did you think about...?

ACUÁTICOS EXÓTICOS, ¿POR QUÉ HAY UN PROBLEMA CON PURPLE LOOSESTRIFE?



Grade level: 9th–12th grades
(could be used 6th–8th grades)

Overview

This play is about the dangers of purple loosestrife. It is in Spanish, to be presented to Hispanic children and adults in the community and to classmates. Also, it is incorporated into a merengue, cumbia, or salsa dance, where the purple loosestrife dancers eventually knock out all of the other plants. It gives the students chances to practice their Spanish, learn a new dance, become aware of environmental problems and how they can help, and, finally, practice their mapping skills.

Author

Susan E. Marquez

School

North White High
School

City

Monon

State

Indiana

Background

Purple loosestrife has been invading the Great Lakes region and beyond. When it crowds out native plants such as cattails, the ecosystem is changed. Some species of mammals, birds and insects that are needed leave because they can't use the purple loosestrife for nests, food, or cover.

Most or all of the materials are in English so some Spanish speakers who can't read English need to learn about these problems. Then they could help or at least not be part of the problem.

In Spanish cultures flowers are very important. They are more likely to have gardens and flowers than the average Anglo. Since the purple loosestrife is a beautiful flower they might even plant the seeds in their gardens.

Setting

Classroom with chairs pushed back, auditorium lobby, or larger open area

Objectives

1. Recognize purple loosestrife.
2. Dance the merengue, cumbia or salsa.

3. Tell why, in Spanish, they shouldn't plant purple loosestrife.
4. Make a map of where students and teacher have found purple loosestrife plants in the surrounding counties.

Geographic Standards

Standard 1. How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information from a spatial perspective

Standard 7. The physical processes that shape the patterns of Earth's surface

Standard 16. How culture and experience influence people's perceptions of places and regions (This is, if they talk to Hispanic families)

Standard 14. How human actions modify the physical environment

Standard 18. How to apply geography to interpret the present and plan for the future

Keywords

Mapa, distribución, extinción, mudanza, plantas exóticas

Materials

CD Selena– “Baila Esta Cumbia”
CD Celia Cruz–salsa; CD El General “Las Chicas”– merengue
cardboard
scissors
markers
play (attached)
Mapquest <http://maps.yahoo.com/py/ddResults.py>
Computer connected to the Web
Person who knows how to teach a Latin dance
Video: purple loosestrife video from the Indiana Dunes National Lakeshore education office at (219)926-7561 x243

Schedule

One week, two days
Monday: See video, read play, decide on parts, dancers
Tuesday: All students learn dance
Wednesday through Friday: Work on memorization, art, props
Following Monday: Do Mapquest to map sightings
Tuesday: Present and film play/dance on video

Prerequisite Skills

Students should already know how to pronounce all Spanish sounds. For that reason it would be done in 2nd to 4th year classes or later in the year in 1st grade, or with 7th grade.

Curriculum Connections

Science—looking for species
Art—drawing the props and costumes for the dancers to look like different plants
Music—hearing music and dancing the salsa, merengue, or cumbia
Math—mapping and getting the dimensions correct for costumes and maps

Procedure

Monday: Pass out questions about purple loosestrife that students can answer after viewing the video program or doing computer research. Show video of purple loosestrife, get on computer and look up information/pictures of purple loosestrife, read the play with correct pronunciation. Have students decide who will have which parts: lines or dancers.

Tuesday: All learn the dance.

Wednesday–Friday: Work on memorizing lines; making art materials, props, costumes for dancers to look like plants.

Following Monday: Report on any purple loosestrife found and where while driving on weekend (bonus: not all students will find this). Map those or ones teacher found. Go to computer lab and use Mapquest. Print maps of areas where purple loosestrife was found. Draw in locations where found.

Tuesday: Do a video presentation.

Teachers notes

Students really enjoyed learning the dance. After they found the plants in the wild they realized that those plants really were out there. They were excited to recognize that something they learned in class could be applied to the outside world.

Applications

After the play has been memorized it can be presented to the community, especially to the many Spanish-speaking children and parents who have moved here.

Design posters in Spanish about exotic aquatic species and distribute them to Spanish families or to stores where they go.

Design a T-shirt about purple loosestrife in Spanish and/or English.

Evaluation

1. Did students learn their lines? The dance?
2. A True/False test can be given afterwards (in Spanish) about the main ideas.
3. Answer in Spanish the 11 questions that were introduced at the beginning.

Resources

CDs by Selena and Celia Cruz

Rearing of Biological Agents for Purple Loosestrife Video 147VRBCA, Cornell University. To order: phone 607-255-2080, email: resctr@cornell.edu, web: <http://freedom.cce.cornell.edu/publications/natural.resources.cfm>

<http://maps.yahoo.com/py/ddResults.py>

<http://www.yahoo.com>

(Go to the above website, type in “purple +loosestrife” and then hit “search” for about 6000 sites to go to and explore information and pictures about purple loosestrife on the World Wide Web)

Credits

Prepared by author.

QUESTIONS TO ASK BEFORE THE VIDEO OR COMPUTER SEARCH

1. ¿Qué es “purple loosestrife”?
2. ¿Dónde crece?
3. ¿Por qué es un problema?
4. ¿Qué podemos hacer que dañe el ambiente?
5. ¿Qué podemos hacer para ayudar?
6. ¿Cuándo se trasladó la planta “purple loosestrife” al Nuevo Mundo?
7. ¿Cómo llegó la planta aquí?
8. ¿Quiénes la trajeron?

QUESTIONS AFTER MAPPING EXERCISES

9. ¿En cuántos condados se halló esta planta en Indiana? (cuántos estados?)
10. ¿Cuántas plantas se veían por lo general?
11. ¿Cuántas personas de la clase hallaron estas plantas?

ENGLISH TRANSLATION OF QUESTIONS TO ASK BEFORE THE VIDEO OR COMPUTER SEARCH

1. What is purple loosestrife?
2. Where does it grow?
3. Why is it a problem?
4. What do we do that hurts the atmosphere?
5. What can we do to help?
6. When was the purple loosestrife plant brought to the new world?
7. How did the plant get here?
8. Who brought it?
9. In how many counties was the plant found in Indiana? How many states?
10. How many plants were seen in general?
11. How many people in the class found these plants?

RESPUESTAS A LAS PREGUNTAS

- 1) Es una planta de color violeta que destruye otras plantas al crecer en su lugar.
- 2) Crece en los lugares muy húmedos como al lado de las carreteras y en los pantanos.
- 3) Es un problema porque después los animales, los pájaros, y los insectos no tienen plantas nativas para comer, usar para nidos y para protección. El “purple loosestrife” no sirve para esto.
- 4) Al plantar esto, tocarlo y transportar su semilla dañamos el ambiente.
- 5) Podemos no transportarla, reportarla, y usar pesticida, escarabajos que la comen.
- 6) Se trasladó al Nuevo Mundo en el siglo XIX.
- 7) Llegó aquí en los barcos.
- 8) La trajeron los inmigrantes.
- 9) Se halló en _____ condados.
- 10) Por lo general se veían _____ plantas.
- 11) _____ personas hallaron la planta al observar cuando viajaban.
*(_____ se llenan con números que depende de los estudiantes)

LA OBRA

Personajes: Estudiante A (el líder)

Estudiante B (el que se cree muy listo)

Estudiante C (el jardinero)

Estudiante D (persona que siempre sigue a los demás)

Estudiante E (tipo inteligente y científico)

(EL SÁBADO)—ESCENA 2

A: ¡Miren, qué bonita planta!

B: ¿Cómo se llama esta planta de color violeta?

C: No sé, pero la voy a llevar a mi casa.

D: Sí, vamos a plantar las semillas.

E: No. Es una planta dañosa.

A,B,C y D: ¡Ay, tú!

A: ¿Cómo sabes que es dañosa?

B: Yo no te creo nada.

C: Creo que lo estás inventando.

D: Sí, creo que te crees mucho.

E: No, de veras. Yo lo vi en las noticias.

A: ¿Qué tiene de malo?

E: Destruye todas las otras plantas.

B: ¿Cómo hace esto?

E: Crece más rápido que las otras plantas.

A: Entonces, ¿no debemos plantarla?

C: ¿Qué debo hacer en vez de llevarla a mi casa?

E: No la toques ni la plantes. Destruyela.

D: ¡Qué buena idea! Vamos a formar un club para destruirla.

A,B,C y E: Sí, ayudemos en su destrucción.

D: Ahora vamos a llamar el club “DePa Pe Ele” que significa “Destrucción Para la Planta de “Purple Loosestrife.”

ESCENA 1

A: Vamos al campo, ¿quieren?

B,C,D y E. Sí, vamos.

B: Conozco un lugar muy bonito. Ahí se puede hacer caminata.

C: ¡Qué bueno! Me gusta mucho caminar.

D: ¿Qué necesitamos llevar?

E: Hay que llevar botas, pantalones de mezclilla, y camisas de manga larga.

A: ¡Y no olviden un sombrero y lentes para el sol!

B: También, llevemos lonches, protección solar, y un bolso de primeros auxilios.

C: ¿Cuándo vamos?

D: ¿Qué les parece este sábado?

E: Me parece muy buena idea. ¿Están todos de acuerdo?

A,B,C y D: Sí, vamos el sábado.

EL FIN

EL BAILE

Baile: empuja una planta cada 10 segundos.

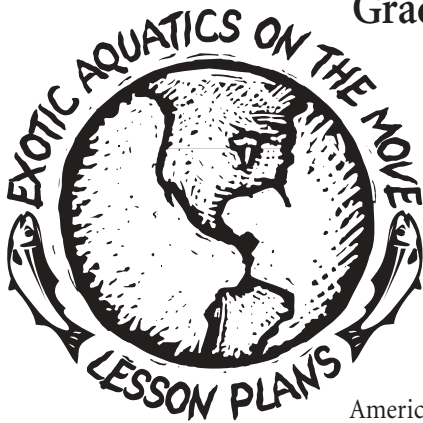
Hay ____ número de bailadores (depende).

Empiezan muchas plantas pero una a una van desapareciendo hasta que todas se quedan del tipo de “purple loosestrife.”

(Los bailadores cambian de traje o cartel hasta que todos sean con traje o cartel de “purple loosestrife.”)

HYACINTH JEOPARDY

Grade Level: 6th –12th grades



Overview

This Jeopardy game will help students understand basic information about water hyacinth.

Background

Water hyacinth came from South America and has spread quickly, clogging many waterways over the past century. Millions of dollars have been spent trying to control this exotic species. It grows quickly into a dense cover, cutting off sunlight and killing other light-dependent species in the water. See Attachment #2 for Student Summary of Water Hyacinth Information.

Setting

Classroom

Objectives

When learners have completed this activity, they should be able to discuss basic information about the water hyacinth. This information will include the origin, distribution, movement, consequences and solutions dealing with the water hyacinth.

Geographic Standards

Standard 14. How human actions modify the physical environment

Standard 15. How physical systems affect human systems

Standard 16. The changes that occur in the meaning, use, distribution, and importance of resources

Keywords

Exotic, fragmentation, habitat, water hyacinth, ecosystem, food web

Materials

This game can be done a number of ways. A game board like the one used in Jeopardy can be made from stiff cardboard or transparencies (as described in the procedure that follows), or teachers can simply use a blackboard to create the categories.

Schedule

Three class periods: one class period to familiarize students with exotics and the problems associated with water hyacinth invasions; one class period to play the game; one class period for evaluation.

Prerequisite Skills

Students should discuss the basic information about exotic species and the water hyacinth, provided in Attachment #2.

Curriculum Connections

Science

Author

Peggy Meaux

School

Acadiana High School

City

Lafayette

State

Louisiana

Grade Levels Taught

High School

Procedure

Pre-lesson preparation: Make the transparencies of the game board and the game cover as provided in Attachment #1. Use an exacto knife to open each of the award windows. This cut should be made on three of the four sides, so that one side is left to act as a hinge. Optional: use a small tab to close each window and provide a means of easily opening each award window.

1. Day One: Introduce the background information on the water hyacinth that is provided in Attachment #2. These two attachments can be handed out to students. Students should be led in a discussion of the important concepts, as outlined by the questions provided in Attachment #3.
2. Day Two: Divide the class into five teams. Conduct the Jeopardy Game using the game board. Suggested “correct questions” are listed on the teacher handout, Attachment 4. Keep track of the points accrued by each team.
3. Day Three: Create an evaluation based on the material covered the previous two days. Suggested questions can be found in Attachment #5.

Teacher Notes

The teacher should read information about the water hyacinth before beginning the unit. The teacher can contact their local and state department of natural resources to obtain information about locations and any control measures currently available and/or being implemented in their area.

Applications

Through this exercise students will become informed, share knowledge, learn to identify invasive species, and be able to make wise choices. They can remove the exotics from their yards, and volunteer to help remove exotics from their community.

Evaluation

A test the day after the game can be given, using the same question as used in the game. Visual evaluation can also be made based on the students’ interest.

Resources

Excellent websites that contain great water hyacinth information:

USGS, Nonindigenous Aquatic Species website: <http://nas.er.usgs.gov>

University of Florida, IFAS, Center for Aquatic Plants: <http://aquat1.ifas.ufl.edu/hyacin2.html>

Excellent websites that contain general information on exotic species:

National Invasive Species Council: <http://www.invasivespecies.gov>

Exotic Aquatics on the Move website: <http://ag.ansc.purdue.edu/EXOTICSP/>

University of Florida, IFAS, Center for Aquatic Plants: <http://aquat1.ifas.ufl.edu/>

Other products:

Guyton, John, Burrage, D., and Kastner, R., *Nonindigenous Species Activities for Youth*, Mississippi State University Extension Service, Biloxi, MS, 79 pp. Can be downloaded for FREE from <http://msstate.edu/dept/crec/publish/nis.wpd>

Credits

Prepared by author.

ATTACHMENT #1

HYACINTH JEOPARDY GAMEBOARD

- Make the transparencies of the game board and the game cover as provided in Attachment #1.
- Use an exacto knife to open each of the award windows. This cut should be made on three of the four sides, so that one side is left to act as a hinge.
- Optional: use a small tab to close each window and provide a means of easily opening each award window.

WATER HYACINTH JEOPARDY

ORIGIN

DISTRIBUTION

MOVEMENT

CONSEQUENCES

SOLUTIONS

100

100

100

100

100

200

200

200

200

200

300

300

300

300

300

400

400

400

400

400

500

500

500

500

500

Tropical regions of South and Central America	Name two vegetative strategies used by water hyacinths	Birds and storms	Major negative consequence on human recreation	Taxpayer money
Event at which the water hyacinth was introduced	The number of states & countries in which it is found in today	Characteristic enabling water hyacinths to move across water	Major negative consequence on the ecosystem	Easier boat navigation, accessible fishing and recreational areas
Year in which it was introduced	Number of days it takes the water hyacinth to double in size	Two ways humans move water hyacinth	Major negative consequence on economy	Development of a herbicide that kills water hyacinth without harming other plants/animals
City where introduction was first made in the U.S.	Recreational fishing and boating	Internal stem characteristic enabling plant to float	Major negative consequence on biodiversity	Most effective control method
The beauty of the plant with its violet flower	Pond and nursery trade	Climatic requirements for water hyacinths	Major beneficial consequence on water quality	Proposed beneficial uses for water hyacinth

WATER HYACINTH BACKGROUND INFORMATION FOR STUDENTS

Water hyacinths are native to Central and South America but were brought into the United States for the Cotton States Exposition held in New Orleans in 1884. Because of their beauty, they were given as gifts for visiting the Japanese Pavilion at the Expo. Attendees took them home to add to backyard ponds. By 1900, water hyacinths had escaped cultivation and had become a serious pest, clogging waterways throughout the coastal states.

Water hyacinth's success in its new habitats within the United States can be traced to a number of characteristics:

- Water hyacinths reproduce very effectively by two vegetative methods. They can make new plants by the process of fragmentation, or breaking into smaller pieces. Fragmentation can be caused by the churning propellers of motor boats, the thrashing of swimming animals, grazing by animals and by being tossed around by wave action during storms. They can also reproduce by forming plantlets at the end of a shoot that grows from the base of the stems. This method of reproduction is very effective at making many new plantlets in a relatively short time.
- * Water hyacinth stems are spongy and filled with air spaces, which allow them to stay afloat easily.
- Water hyacinth leaves are fanlike and slightly cupped. This shape makes a very effective sail and allows the plants to spread easily over water bodies when the wind blows.
- Water hyacinth have a feathery network of roots, which allow them to gather nutrients very easily from the water.

All these characteristics give the water hyacinth a tremendous advantage over other native floating aquatic plants. A small number of plants are able to cover the surface of their new aquatic habitat in a relatively short period of time. Today, water hyacinths are found in 13 states within the United States and in 53 countries.

The effects of water hyacinths on natural systems in which they are not native can be devastating. As hyacinths cover the water's surface, they restrict life-sustaining sunlight that submerged native plants need in order to grow. Eventually the shaded underwater plants die and decay. The decaying process depletes the amount of dissolved oxygen in the water. As the oxygen

level declines, fish such as bass, perch, and bream, seek new habitat areas, leaving fish such as catfish, carp, and gar, all of which can tolerate lower oxygen levels than the more desirable fish. Once oxygen levels become so low that even these less desirable fish cannot not survive, the waters below water hyacinth masses become devoid of most life.

Humans are also affected by the invasive overgrowth of water hyacinths. Dense mats of the plants interfere with boat navigation, clog drainage systems, and prevent fishing, swimming and other recreational activities.

EFFORTS TO CONTROL WATER HYACINTH POPULATIONS HAVE MET WITH MIXED RESULTS.

- Mechanical methods used to chop up the water hyacinth cannot reach all the water hyacinth in a given water body and result in fragmentation—one of water hyacinth's reproductive strategies.
- Herbicides are very effective in killing water hyacinth plants. Spray programs are costly and in many cases are only used on waterways necessary for navigation or heavily used in recreation.
- The use of natural predators, in particular a weevil species from Argentina and a carp species from the Soviet Union, both of which use the water hyacinth as a food source, would mean introducing other exotic species that may, in time, become as serious a pest as water hyacinth has become.

When growing out of control, water hyacinths are a nuisance, but some researchers have suggested uses for this exotic that would make it a harvestable resource.

- Use as food for cattle.
- Use as fertilizer and soil conditioner.
- Produce a biogas fuel similar to natural gas to meet some energy needs.
- Use the plants as part of a filtration system for water purification systems.

Even though these are all possible uses, so far the negative impact of these aquatic plants on their adopted habitat far outweighs their contributions to the environment.

DISCUSSION QUESTIONS FOR THE INTRODUCTION OF EXOTIC SPECIES

1. What is an exotic species?
A plant not native to the area.
2. What does the term invader mean?
A plant or animal that takes over a native environment or ecosystem. The invader is usually a threat to the environment in which it's growing and developing.
3. Are all exotics plants invasive?
No. Some exotic plants survive in their new environment without taking over the habitat.
4. Why do exotics plants become invasive?
When they reproduce rapidly, adapt to the environment, and gather nutrition easily and have no or few natural enemies or disease.
5. What do you think would happen over the long-term to an area in which an invasive exotic species is introduced?
The invading plant would overtake it, disrupting the natural ecosystem.
6. What is an adaptation?
It is a trait allowing change that helps something live and reproduce in its environment.
7. What is a food web?
Each organism, through feeding, is interconnected to many other organisms. This interconnection is called a food web.
8. Will exotic species introduced into an area alter the food web?
Invasive organisms do alter the food web because they become integrated into the ecosystem. They feed on other organisms (or extract nutrients from the water, in the case of the water hyacinth). They are also fed upon by other organisms in the ecosystem. In the case of water hyacinth, nutria sometimes eat them.
9. How are exotic species introduced into a new area?
Introductions happen in many ways. Humans either on purpose or accidentally introduce exotics. For example, hyacinth was at first cultivated by water gardeners, whose ponds eventually were overrun by the plant.
10. What things may be needed for the success of an exotic?
Extra plants were tossed into lakes or bayous rather than being disposed of properly. Other methods of introductions by humans include transportation of water plants on boat engines and trailers, releases of unwanted aquarium plants and fish. Occasionally storms and water currents can help spread them.
Exotic species need to be able grow fast, reproduce quickly, be good at getting life's necessities (food, water, shelter and space) and have few, if any, natural predators.

KEY TERMS

Exotic Species - foreign plants or animals that are introduced to a habitat.

Habitat - the area where a particular species lives. It provides all the species requirements for life.

Ecosystem - a natural interrelated environment in which plants and animal lives coexist with each other. They function together as a whole environment dependent on each other to function.

Fragmentation - a type of asexual reproduction that occurs when part of a parent plant breaks off and begins to grow independently.

Food web - the complex feeding relationships among the organism in an ecosystem.

Water hyacinth - a free-floating plant, but typically is found in large, compacted beds. The leaves are dark green, glossy and oval-shaped. The stems are bulbous and spongy on the free-floating plants. Plants vary in size from a few inches to several feet in height. The flowers are blue, violet, or white and have an orchid-like appearance. The roots are dark, feathery and fibrous.

HYACINTH JEOPARDY GAME ANSWER/QUESTION PAIRS

NOTE:

- Teachers will need to use their judgment on accepting a correct “desired question” as an answer to any particular award level.
- The categories follow the five major geographic strands. Questions in each category relate to the Category Title. Students should be alerted to this so that they can frame their questions accordingly.

ORIGIN

100 TROPICAL REGIONS OF SOUTH AND CENTRAL AMERICA.

Desired Question: Where is the water hyacinth native?

200 EVENT AT WHICH THE WATER HYACINTH WAS INTRODUCED.

Desired Question: What is the Cotton States Exposition?

300 YEAR IN WHICH WATER HYACINTH WAS INTRODUCED TO THE U.S.

Desired Question: What is 1884?

400 CITY WHERE INTRODUCTION WAS FIRST MADE IN THE UNITED STATES.

Desired Question: What is New Orleans?

500 THE BEAUTY OF THE PLANT WITH ITS VIOLET FLOWER.

Desired Question: What characteristic made the water hyacinth appealing to be chosen as the gift for visiting the Japanese Pavilion at the Expo of 1884?

DISTRIBUTION

100 NAME TWO VEGETATIVE REPRODUCTIVE STRATEGIES USED BY WATER HYACINTH.

Desired Question: What are fragmentation and stolons?

200 THE NUMBER OF STATES IN THE U.S. IN WHICH WATER HYACINTH IS FOUND TODAY.

Desired Question: What are 13 [American states]?

300 NUMBER OF DAYS IT TAKES THE WATER HYACINTH TO DOUBLE IN SIZE.

Desired Question: What is in as little as 12 days?

400 RECREATIONAL FISHING AND BOATING.

Desired Question: What are two ways that water hyacinth is spread by humans?

500 POND AND NURSERY TRADE.

Desired Question: What is one intentional reason for the distribution of the water hyacinth?

MOVEMENT

100 BIRDS AND STORMS.

Desired Question: *What are two ways the water hyacinth is spread by nature?*

200 CHARACTERISTIC ENABLING IT TO MOVE ACROSS WATER.

Desired Question: *What is the cupped sail shape of its leaves?*

300 TWO WAYS HUMANS MOVE WATER HYACINTH.

Desired Question: *What are boat propellers and trailers, fishing and recreational equipment?*

400 INTERNAL STEM CHARACTERISTIC ENABLING PLANT TO FLOAT.

Desired Question: *What is spongy tissue?*

500 CLIMATIC REQUIREMENTS FOR WATER HYACINTH.

Desired Question: *What are humid tropical climates, where it does not freeze?*

CONSEQUENCE

100 MAJOR NEGATIVE CONSEQUENCE ON HUMAN RECREATION.

Desired Question: *What is blocking boat traffic and preventing or restricting swimming and fishing?*

200 MAJOR NEGATIVE CONSEQUENCE ON THE ECOSYSTEM.

Desired Question: *What is preventing sunlight from penetrating the water? or What is depleting oxygen from the water?*

300 MAJOR NEGATIVE CONSEQUENCE ON THE ECONOMY.

Desired Question: *What are expensive control methods? or What is reduced boat traffic, resulting in lost tourist and transportation dollars?*

400 MAJOR NEGATIVE CONSEQUENCE ON BIODIVERSITY.

Desired Question: *What are reduced numbers of native submerged aquatic vegetation? or What is change from desirable to less desirable fish species?*

500 BENEFICIAL CONSEQUENCE TO WATER QUALITY.

Desired Question: *What is water filtration?*

SOLUTION

100 TAXPAYER MONEY.

Desired Question: *How are control methods for water hyacinths paid for?*

200 EASIER BOAT NAVIGATION, ACCESSIBLE FISHING AND RECREATIONAL AREAS.

Desired Question: *What are the possible benefits of removing water hyacinths?*

300 DEVELOPMENT OF A HERBICIDE THAT KILLS WATER HYACINTH WITHOUT HARMING OTHER PLANTS/ANIMALS.

Desired Question: *What is the importance of limiting the negative effects of a spray program on other organisms or desirable plants?*

400 MOST EFFECTIVE CONTROL METHOD.

Desired Question: *What are costly spray programs?*

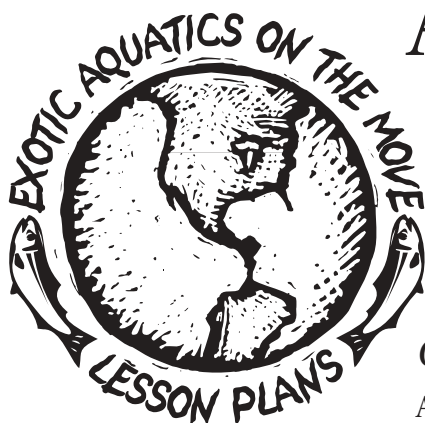
500 PROPOSED BENEFICIAL USES FOR WATER HYACINTH.

Desired Question: *What are fertilizer and soil conditioner? or What is cattle feed? or What is natural gas for energy needs?*

EVALUATION QUESTIONS.

1. Where is the point of origin of water hyacinth?
The Amazon Basin of South America.
2. Who introduced the plant into the U.S.?
The Japanese delegation to the 1884 Cotton States Exposition in New Orleans.
3. Why was it introduced at the Expo in 1884?
Because water hyacinth was considered a beautiful plant suitable for use in backyard ponds.
4. To how many American states and countries has this plant spread?
Thirteen American states and 53 countries worldwide.
5. What are the factors that limit its distribution?
Water hyacinth is limited by freezing temperatures. Water hyacinth will not inhabit ponds and lakes that freeze over during the winter.
6. Why does water hyacinth spread so easily?
Water hyacinth is able to reproduce rapidly (it doubles its size in as little as 12 days), gather nutrients effectively, has several different vegetative reproduction strategies, and has few natural predators or diseases in the U.S.
7. What are a few ways that water hyacinth are spread?
Water hyacinth can be spread by humans (boat and recreational activity and from backyard water gardens) as well as during storms.
8. How does water hyacinth interfere with boating and fishing?
It clogs waterways.
9. What is one of the beneficial aspects of water hyacinths?
Research shows they may be useful in removing harmful chemicals from polluted water.
10. How does water hyacinth affect an ecosystem's biodiversity?
Water hyacinth prevents sunlight from penetrating water resulting in the death of submerged native aquatic vegetation. In addition, as the dissolved oxygen is depleted from the water, less desirable fish begin to dominate the fish population until even these low-oxygen demanding fish are driven from the area as the oxygen continues to be depleted.
11. How does water hyacinth affect the economy?
Water hyacinth control requires costly herbicide spray programs and as waterways become clogged with the water hyacinth mats, recreational boaters must find new locations to utilize. This can result in business loss or closure. Parks and recreation areas are also affected as water hyacinth infestations restrict areas that can be used by patrons.
12. What are some suggested uses for water hyacinths?
Water hyacinths can be used as fertilizer, compost, and soil condition. They can also be used as feed for cattle and other animals. They can be used to produce some form of natural gas for energy needs.

WHAT AND WHERE CAN AN AQUATIC NUISANCE SPECIES BE?



Grade Level: This activity could be used with many grade levels. I have targeted a 9th grade Language Arts group.

Overview

As good detectives you will identify your aquatic nuisance species (ANS) and locate information about it. Your final task will be to develop a “Most Wanted” flyer or brochure for your ANS. The flyers and brochures will be assembled on a world map to indicate the ANS location both past and present.

Background

Exotic species have been reported extensively in various publications from many organizations around the Great Lakes. These exotic species have become a nuisance and a threat to indigenous species.

Setting

Internet lab and study tables for layout
Classroom for peer editing
Main hallway or building entrance for display

Objectives

1. Identify aquatic nuisance species (ANS).
2. Describe location of ANS.
3. Apply information researched by exhibiting flyers or brochures on a world map indicating location of ANS past and present.

Geographic Standards

Standard 1. How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information from a spatial perspective

Standard 15. How physical systems affect human systems

Standard 18. How to apply geography to interpret the present and plan for the future

Keywords

Habitat, aquatic species, nuisance, exotic

Materials

World map, Internet lab, word-processing program with templates for flyer or brochure, teacher-made editing and outline worksheets

Schedule

The activity will probably take two to three 55-minute periods.

- 1st period—organize and research
2nd period—research and plan brochure/flyer
3rd period—complete and evaluate brochure/flyer

Prerequisite Skills

Students will need to know how to use the Internet as a research tool and be able to use a word processing program.

Curriculum Connections

Science, Social Studies, Language Arts and Technology

This activity may be used during National Geography week as a school-wide ANS awareness campaign. It could also be used as a multi-curriculum activity incorporating science, social studies, language arts and technology.

Author
Mickey J. Penrod

School
McCutcheon
High School

City
Lafayette

State
Indiana

Grade Levels Taught
Special Education
6th–12th grades

Procedure

Students will develop an ANS brochure or flyer containing the following information:

- a picture of their ANS
 - identify common and scientific name
 - physical description
 - habitat
 - interesting facts
1. Log on to network and use general search engine to locate information about ANS. Location: <http://www.entryway.com/seagrant/index.cfm>
 2. Research the ANS to locate information for flyer or brochure. Use reading note handout to record information.
 3. Develop flyer or brochure layout. Save picture of ANS to file and insert it into flyer or brochure template. If you do not have a specific template in your word processing program you can follow the handout "How to Create Your Brochure."
 4. Check to see if all information that is listed in "TASK" is included in your flyer or brochure.
 5. Peer edit using checklist.
 6. Using yarn and stick pins, position brochure on U.S. map where ANS were located in the past and where they are located presently.

Applications

The students will become aware of aquatic nuisance species and begin to realize the impact the ANS have on human environments. When the students share their brochures/flyers to younger groups of children or to their community, they will hopefully see how resources around the world are being affected and feel positive about their activities to inform others.

Evaluation

Grade will be an average between peer edit and teacher grade. The total points will be reflected on the final project checklist.

Resources

General Search Engine

National Aquatic Nuisance Species Clearinghouse: <http://www.cce.cornell.edu/aquaticinvaders/>

Sea Grant Zebra Mussel and Nonindigenous Species, Great Lakes Sea Grant Network: <http://www.seagrant.wisc.edu/greatlakes/GLnetwork/>

Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990

Credits

Prepared by the author.

HOW TO CREATE YOUR BROCHURE:

TRI-FOLD BROCHURE (MICROSOFT WORD)

⇒ = “point with mouse to and click”

1. ⇒File ⇒Page Setup ⇒Paper Size ⇒ Select “landscape” ⇒OK
2. ⇒ Format ⇒ Columns ⇒ Select “three” ⇒ OK
1. This will create a three-column brochure for you. To get to the top of the next column, you must press “enter” several times and it will take you to the next column.
2. To do the back side of your brochure, you must create a new document and do all of these steps again. *
5. Be sure to save your work!!!

* Teacher may need to take printed copies to copier and make a two-sided brochure.

TWO-FOLD BROCHURE (MICROSOFT WORD)

1. ⇨ File ⇨ Page Setup ⇨ Paper Size ⇨ Select “landscape” ⇨ OK
2. ⇨ Format ⇨ Columns ⇨ Select “two” ⇨ OK
3. This will create a two-column brochure for you. To get to the top of the next column, you must press “enter” several times and it will take you to the next column.
4. To do the backside of your brochure, you must create a new document and do all of these steps again. *
5. Be sure to save your work!!!

* Teacher may need to take printed copies to copier and make a two-sided brochure.

EDITING SHEET FOR ANS BROCHURE

BROCHURE DEVELOPER _____

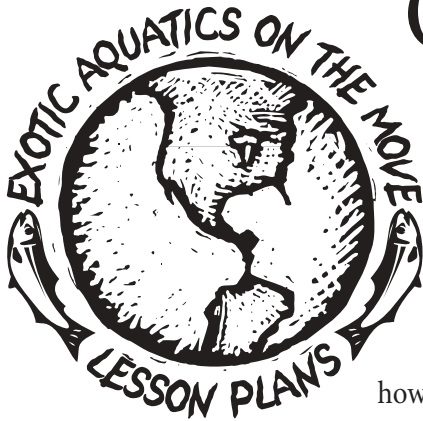
NAME OF PEER EDITOR _____

TEACHER INITIALS _____

DATE _____

CONTENT CATEGORY POSSIBLE	POINTS EDITOR SCORE	PEER SCORE	TEACHER
IDENTITY / COMMON NAME	5		
SCIENTIFIC NAME	10		
PICTURE	10		
PHYSICAL DESCRIPTION	10		
HABITAT DESCRIPTION	10		
LOCATION	10		
INTERESTING FACT 1	10		
FACT 2	10		
FACT 3	10		
FACT 4	10		
✓ TEACHER OUTLINE	5		
BROCHURE LAYOUT	20		
NEATNESS	10		
CORRECTNESS	10		
PRINTED BROCHURE	50		
LOCATION ON MAP	10		
SUBTOTAL FOR PEER EDITOR AND TEACHER		/200	/200
COMMENTS:		AVERAGE	

WHERE DID THESE EXOTICS COME FROM AND WHY ARE THEY HERE?



Grade Level: 5th–12th grades

Overview

This map activity will help students see where exotic species come from and how they came to America.

Author

Ed Robson

School

Benton Central
Jr. and Sr. High
School

City

Oxford

State

Indiana

Grade Level Taught

7th grade

Background

This is an important topic for students. The lesson helps students get a sense of how geography is important to them. First, the students will see how wildlife from around the world arrived in their area. Second, the students will see the importance of trade and its effects on people. Once they learn about exotic species, students will naturally want to know where they came from and the reasons they are here. Also, with 7th graders in Indiana and other states that study world cultures, this lesson will help students see how the world is connected to their area.

Setting

The best place for the lesson is in the classroom. You may want to have the desks put together so students can work in groups.

Objectives

1. To identify the origins and movements of exotic species that have come to the United States.
2. To identify what imports come from those areas identified in objective #1.
3. To evaluate both positive and negative effects of trade with their region and other parts of the world.

Geographic Standards

Standard 1. How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information from a spatial perspective

Standard 14. How human actions modify the physical environment

Keywords

Exotic species, origin, movement, import, ballast water

Materials

Maps of the world (one per person)

Colored pencils (one per group)

Information on origins and movements of species (one per group). See Resources section for possibilities.

Almanacs or information on imports coming to the U.S. (one per group)

Atlases (one per group)

Schedule

One to three days

Prerequisite Skills

It would be beneficial but not necessary for students to have knowledge of locations in Europe and the United States. This lesson should follow a lesson on the definition of exotic species and examples of exotic species in their area.

Curriculum Connections

This lesson works well with Life Science and Geography. The migration of the species can be part of each discipline. Math can be added by having students calculate the distances the species have traveled from one location to another. After this lesson, students should study the consequences of migration of these exotic species.

Procedure

1. Have students either work with a partner or form groups of three.
2. Distribute a world map for each person. Distribute colored pencils, an almanac, and information on the exotic species to each group.
3. Review with the students what they know about exotic species and examples from their area. Explain that this lesson will show both how and why the species are here.
4. Tell the students to use information on the exotic species to mark the origin of the species on each map, the path it took to come to the United States, and where they made their first arrival in the United States. Creating a key may be necessary to differentiate between the exotic species. The origin should include water body and associated countries.
5. After completion of this activity, have the students discuss the origins of the exotic species from their map. Ask the students why they think these species have ended up in the United States. Try to lead students to the idea of trade between countries. Ballast water discharge is one example of ANS introductions via trade.

6. Have students use the almanac or internet search engines such as Ask Jeeves or Yahoo to research what items are traded between the United States and the countries in Step 4.
7. Have the students create a chart showing what is exported and imported from the countries in Step 4.
8. Lead the students on a discussion on the importance of trade. Ask the students what is gained by this trade between countries? Should trade stop to prevent exotic species? (Note: Have students think about all the positives of trade, e.g., jobs for boat workers.)
9. Have the students then think of negative consequences of trade. (Note: Besides exotic plants and animals, what else can be transported because of trade?)
10. To finish the lesson, have the students write a paragraph answering the following questions: Where do exotic species come from? How does trade play a role in the movement of exotic species? Besides exotic species, what are other consequences of trade?

Teacher Notes

Teachers may want to demonstrate one example on how to mark up the map in Step 4. Also if you do not want students to write a paragraph to finish the lesson, have them create a poster or PowerPoint presentation. They may title it "Trade and the Exotic Species" and answer the three questions in Step 10.

Applications

This lesson can lead to a lesson on the consequences of having the exotic species.

Evaluation

Students should be evaluated on accuracy and effort put into their finished paragraphs. In addition, students should be evaluated on their participation in groups and in classroom discussions. If placed in larger groups, it may be beneficial to have them peer-evaluate each other.

Resources

Alien Ocean. This video, created by Maryland Sea Grant, tells how zebra mussels, green crabs, and other exotic species come to America.

Maryland Sea Grant's Website, is
<http://www.mdsg.umd.edu/MDSG>

Great Lakes Instructional Materials for the Changing Earth System by the Ohio Sea Grant College Program. This publication gives you information and activities on exotic species. To order, contact the following address:

Ohio Sea Grant Publications
The Ohio State University
1314 Kinnear Road
Columbus OH 43212-1194

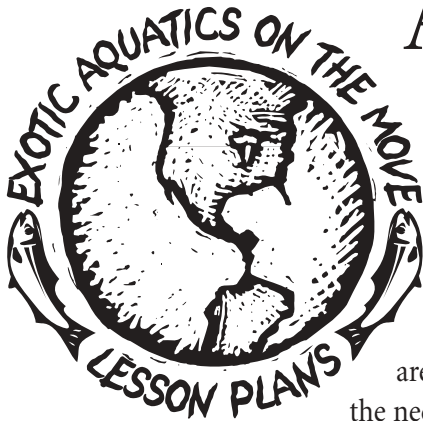
Sea Grant Nonindigenous Species Website. This website gives information on exotic species found in the Great Lakes area. The address is www.sgnis.org

Exotic Aquatics on the Move Website. This site defines exotic species, their impacts, and examples of exotic species, and has links to other sources. The address is <http://www.ag.ansc.purdue.edu/EXOTICSP>

Credits

Prepared by the author.

INFORMING OTHERS ABOUT EXOTICS



Grade Level: 7th grade

Overview

In English and Social Studies, students will research exotic species and the dangers they present to their local area. They will break into groups and, with the information they have researched, write letters to local legislators, area nurseries, the Department of Transportation, and local newspapers about the necessity of taking action to prevent the spread of exotics. Students will also write informative articles to parent groups, their in-school newsletter, and smaller area newspapers. Students will also create posters on the importance of cleaning boats and other water vehicles and will post them at local marine launches.

Background

The Great Lakes and other waters in our watershed have major economic and recreational impacts on students' lives. Students and their families need to become aware of the increasing negative impact of exotics on the health of these water systems and the individual's responsibility to maintain healthy water environments. Because of the increase of zebra and quagga mussels, sea lamprey, and purple loosestrife, local areas are endangered. Purple loosestrife already has a firm foothold in nearby fields, just a few miles from Fredonia Central School.

Setting

In the English and Social Studies classrooms and in the auditorium.

Objectives

1. Identify the specific exotics that are endangering the health of the area waterways.
2. Know how to write persuasive business letters to local, state, and federal agencies, and legislators.
3. Know how to write informative news articles.
4. Produce informative posters for local launches.

Geographic Standards

Standard 3. Students will demonstrate their understanding of the geography of the interdependent worlds in which we live.

Key Words

Exotics, exotic species, zebra mussel, quagga mussel, purple loosestrife, sea lamprey

Materials

Samples of various exotic species, plus pens, computers, paper, poster board, envelopes, stamps, colored pencils, video camera, and videotapes

Schedule

This part of the unit will take approximately two weeks.

Prerequisite Skills

The skills will be taught within the unit.

Curriculum Connections

This unit will be taught as part of an interdisciplinary team of Math, Science, Social Studies, English, Home, and Careers and will use all the standards in each of these disciplines.

Authors

Rose Sebouhian
Ilisa Wyman

School

Fredonia Central
School

City

Fredonia

State

New York

Grade Levels Taught

7th grade

Procedures

Social Studies will present the themes of geography (place, location, region, movement of people and goods, and interaction of people with their environment) stressing the Great Lakes region and how it interacts with the world. Studies will continue with trade and its effects on the introduction of exotics by using maps and drawing connections with various geographical areas within our latitude and longitude. Information on various exotic species will be presented, where they are found, and their impact. Students will brainstorm various actions they can take to inform the public and improve the environment.

English will introduce the business letter format and the elements of persuasion, so that students will be able to effectively write to area business groups, media, and local, state, and federal officials. Students will also learn basic journalism standards for both editorial and feature articles.

Teacher notes

Teachers are advised to attend workshops on the Great Lakes and exotic species to familiarize themselves with the ecological impacts of invasive species.

Application

Students will be publishing their letters and articles and posting posters throughout the community. Distribution of information and displaying posters at local boating facilities is a valuable public service.

Evaluation

Each letter will be peer-edited and teacher-assessed. Responses to the letters will also indicate effectiveness of their communication.

Resources

Pamphlets:

Purple Loosestrife: What You Should Know, What You Can Do by Ontario Federation of Anglers & Hunters, phone: 1-800-563-7711

A Field Guide to Aquatic Exotic Plants and Animals by the Minnesota Department of Natural Resources

Biological Invasions by The Great Lakes Panel on Aquatic Nuisance Species.
Phone: 313-665-9135
Email: shwayder@glc.org

Exotic Species Websites:

EATM Website: <http://ag.ansc.purdue.edu/EXOTICSP/>

SGNIS Sea Grant Website: www.sgnis.org

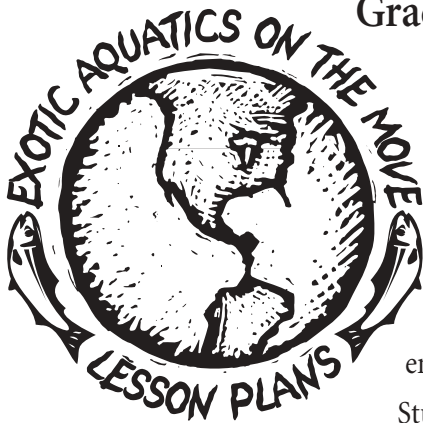
Great Lakes Information Network: <http://www.great-lakes.net/envt/> (select invasive species on left margin)

Credits

This is an original activity using NYS and Sea Grant literature.

THE PURPLE PROBLEM

Grade Level: 6th–8th grades



Overview

Through this lesson, students will learn about *Lythrum salicaria*, which is commonly referred to as purple loosestrife.

Students will learn content pertaining to purple loosestrife. The teacher will assign small groups of students a section of the background reading. Once familiar with the content, the group will peer teach the material to the entire class.

Students will use their new knowledge, maps and their observation skills to identify changes to the land. They will also identify threats to the ecosystem because of those changes. Focus questions will deal with purple loosestrife and its connection to the biodiversity of native species, ecosystem functioning, as well as economic issues. Students will then hypothesize origins of the problem, make decisions concerning methods to deal with the problem, and will also address what could happen if this issue goes unchecked. The assessment for this activity will require each group to clearly communicate their ideas and solution to the problem in front of their peers. Students will be prepared to support their decision and reasoning. The teacher should also read background information to be familiar with the content pertaining to purple loosestrife.

Author

Jeanine Meyer Staab

School

Medford Area
Middle School

City

Medford

State

Wisconsin

Grade Levels Taught

7th grade

Background

Purple loosestrife is currently found in every state except Florida and also in many countries around the world. It is an invasive species that originated in Europe and was brought to North America in the ballast of ships. People also brought this plant to North America because they treasured purple loosestrife's medicinal purposes and beauty.

As with all invasive species, purple loosestrife displaces native flora due to its fast growth rates, effective seed dispersal mechanisms, and its tolerance of a wide range of conditions.

Purple loosestrife lacks the natural predators and diseases in our country that controlled the species in its native habitat. This plant has the ability to disrupt and alter the structure and function of wetland ecosystems. Once this occurs, decreases in native vegetation follows, which leads to decreases in native wildlife in that region. It also costs millions of dollars to control loosestrife and also millions of dollars in economic loss for landowners.

Setting

Classroom

Objectives

1. Make observations dealing with maps.
2. Describe changes to the land over the years, and how those changes have affected the biodiversity of native plant and animal species, ecosystem functioning, and economic costs.
3. Analyze maps and construct hypotheses as to how or why this problem exists today.
4. Compare and contrast methods of control.
5. Synthesize old and new background knowledge and also specific map information.
6. Communicate your problem and corresponding solution to your peers.
7. Debate and defend your decision and reasoning.

Geographic Standards

Geography Standard 1–3. Students should learn to view the world in spatial terms, and organize information about people, places, and environments in a spatial context.

Geography Standards 9–13. Students should learn how physical processes and human activities can shape the patterns of the Earth’s surface, how Earth-Sun relationships affect physical processes and patterns on Earth, and how to predict the consequences of physical processes on the Earth’s surface.

Geography Standards 14–16. Students should learn how human actions modify the physical environment, how these actions lead to other changes, and the role of technology in the human modification of the physical environment.

National Science Standards

Content Standard C: Life Science

Students should develop an understanding about the structure and function of living systems, reproduction and heredity, regulation and behavior, populations and ecosystems, and the diversity and adaptations of organisms.

Content Standard F: Science in Personal and Social Perspectives

Students should develop an understanding of personal health, populations, resources, environments, and the natural hazards. Students should also learn about the role of science and technology in society.

Keywords

Ecosystem, propagation, migration, native, non-native, germinate, habitat, disperse, perennial, food chain, monoculture, weed, mechanical control, biological control, chemical control, predator, purple loosestrife

Materials

Handouts, maps, chart paper for presentation, markers

Schedule

Two or three 45-minute periods

Prerequisite Skills

Students should have good reading and comprehension skills, along with map reading skills, and some background in biology.

Curriculum Connections

Geography – map reading and comprehension

Science – research and readings on purple loosestrife and methods of control

Reading Comprehension – group readings of purple loosestrife resources and application to the project

Procedure

1. Divide the students into small cooperative groups. Give each group a section of the background material to read (Example: Habitat, Movement, Description.).
2. Have each group present their information to the rest of the class. In this way, the students will learn about all aspects of purple loosestrife without having to read each page.
3. Using these same groups, hand out the map sets (example maps A1 and A2) to the different groups. Several groups may work on the same sets. You may need to make several sets.
4. Hand out the Focus Question sheet (Attachment A).
5. Students will investigate these maps in more detail and complete the Focus Question sheet. They will describe the changes that have taken place over the course of five to ten years. They will also explain the cause of these changes, and how they affect the biodiversity of the native plants and animals species in this area. (Example: new housing will cause loss of habitat for native animals.)
6. Using their specific map, students will then focus on the purple loosestrife in their area. Hand out background information sheets to each group, or leave the background sheets in an area where the groups can access them for information (hand out sheets found in Attachment B).

7. Students will describe the changes on the Focus Questions handout that have occurred over the years concerning this exotic plant addressing the issues of biodiversity of native species, ecosystem functioning, and economic costs.
8. Using their new background knowledge and any previous knowledge, students will hypothesize how this problem originated in their area.
9. They will then look over the three methods available to deal with this problem (hand out Attachment C). Using the information gathered concerning their map, students will address *all three* methods of control for this plant. They must consider all factors and write down the advantages, disadvantages, and special challenges that they might encounter when trying to implement this type of control mechanism.
10. They must also consider and describe what they believe would happen if this plant is allowed to continue growing unchecked in that particular area.
11. Finally, as a group they must decide on a method of control and will present their information and decision to the class for discussion.
12. Discussion Questions:
 1. What are some of the challenges that face wetland owners in our state?
 2. How can you help preserve the native and endangered species in our wetlands?
 3. What organizations can you turn to for more information or help in dealing with this issue?

Application

Students will learn the effects and impacts of purple loosestrife, as well as a broader understanding of wetland environments. In addition, working in groups and presenting to the class will teach them valuable cooperation and presentation skills.

Evaluation

Students should be evaluated on their participation and activity within the group, as well as their participation in the final class discussion. The final research and completed presentation of each group will also serve as a basis for evaluation.

Resources

Canada's Conservation Co.:
<http://www.ducks.ca/purple>

Canada's Conservation Co. "Purple Loosestrife Information Center":
<http://www.ducks.ca/purple> 22 June 2000

National Park Service:
<http://www.nps.gov/plants/alien/fact/lysal.htm>

National Wildlife Refuge System:
<http://refuges.fws.gov/pests/loosestrife/index.html>

National Wildlife Refuge System "Purple Loosestrife Management" 13 April 1997:
<http://refuges.fws.gov/pests/loosestrife/index.html> 5 Jan. 2001

U.S. Fish and Wildlife Service:
<http://invasives.FWS.gov>

U.S. Fish and Wildlife Service:
"Invasive Species Program":
<http://invasives.FWS.gov> 5 Jan. 2001

WA State Dept. of Ecology:
<http://www.wa.gov/ecology>

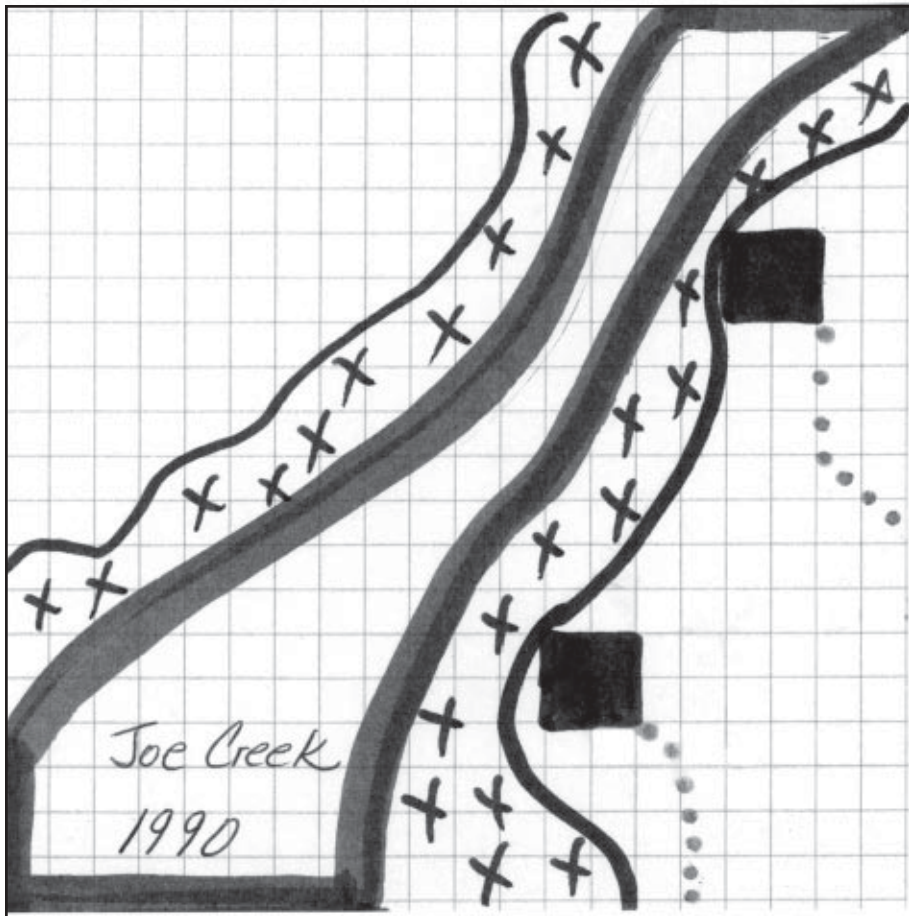
WA State Dept. of Ecology "Non-Native Freshwater Plants Purple Loosestrife":
<http://www.wa.gov/ecology> 5 Jan 2001

WI Dept. of Natural Resources - EE For Kids "Alien Profile-Purple Loosestrife":
<http://www.dnr.state.wi.us/org/caer/ce/eeek>
13 Dec. 2000

WI Dept. of Natural Resources - EE for Kids:
<http://www.dnr.state.wi.us/org/caer/ce/eeek>

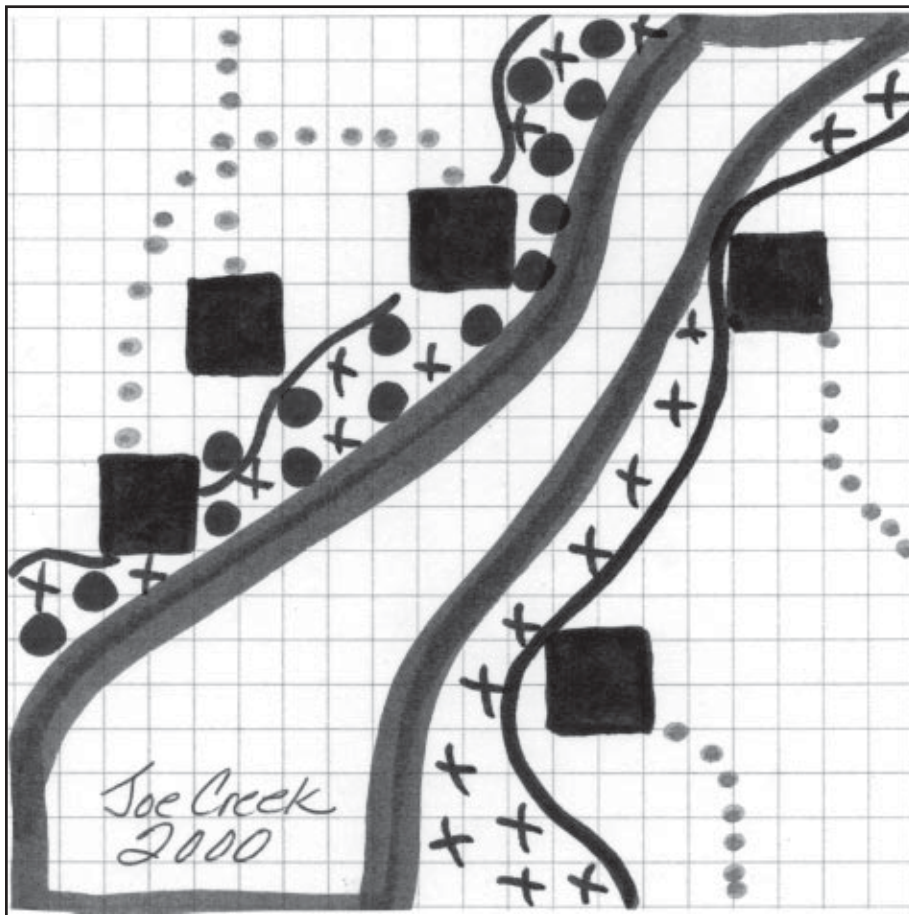
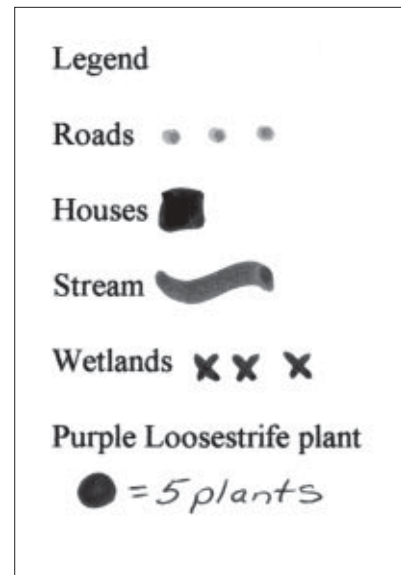
WI Dept. of Natural Resources "Purple Loosestrife" 1997 Edition:
<http://www.dnr.state.wi.us/org/land/er> 22 June 2000

WI Dept. of Natural Resources:
<http://www.dnr.state.wi.us/org/land/er>



JOE CREEK

Date: 1990

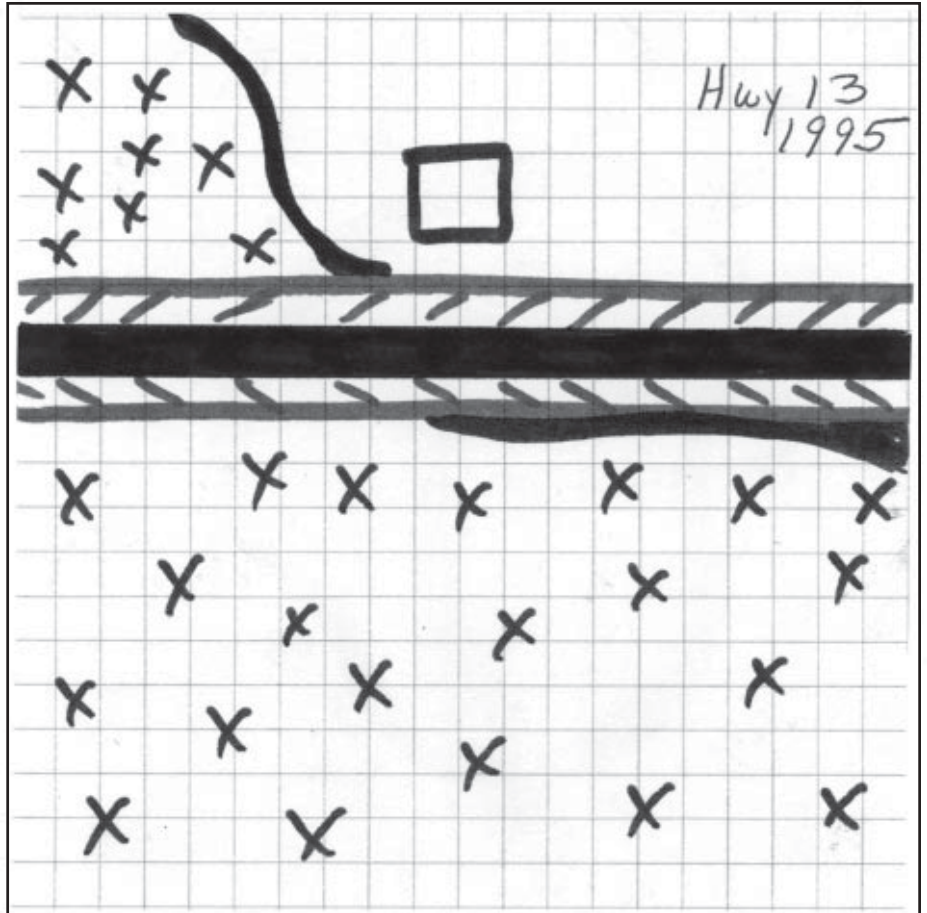


JOE CREEK

Date: 2000

HIGHWAY 13

Date: 1995

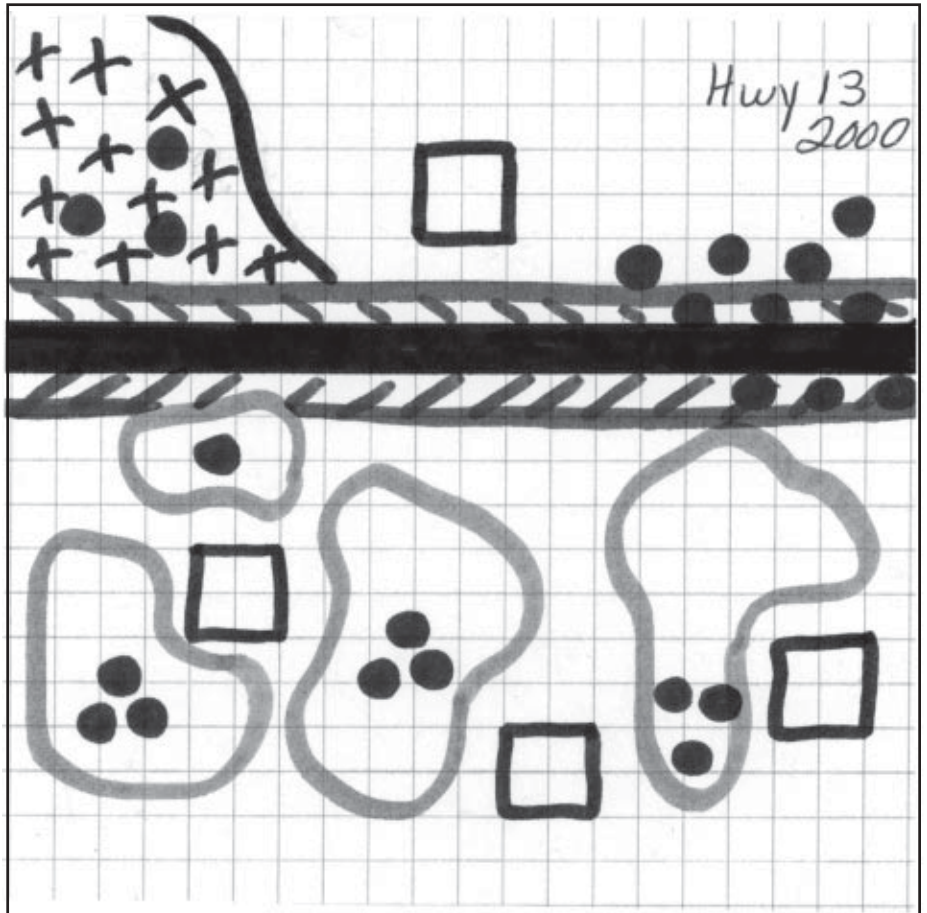


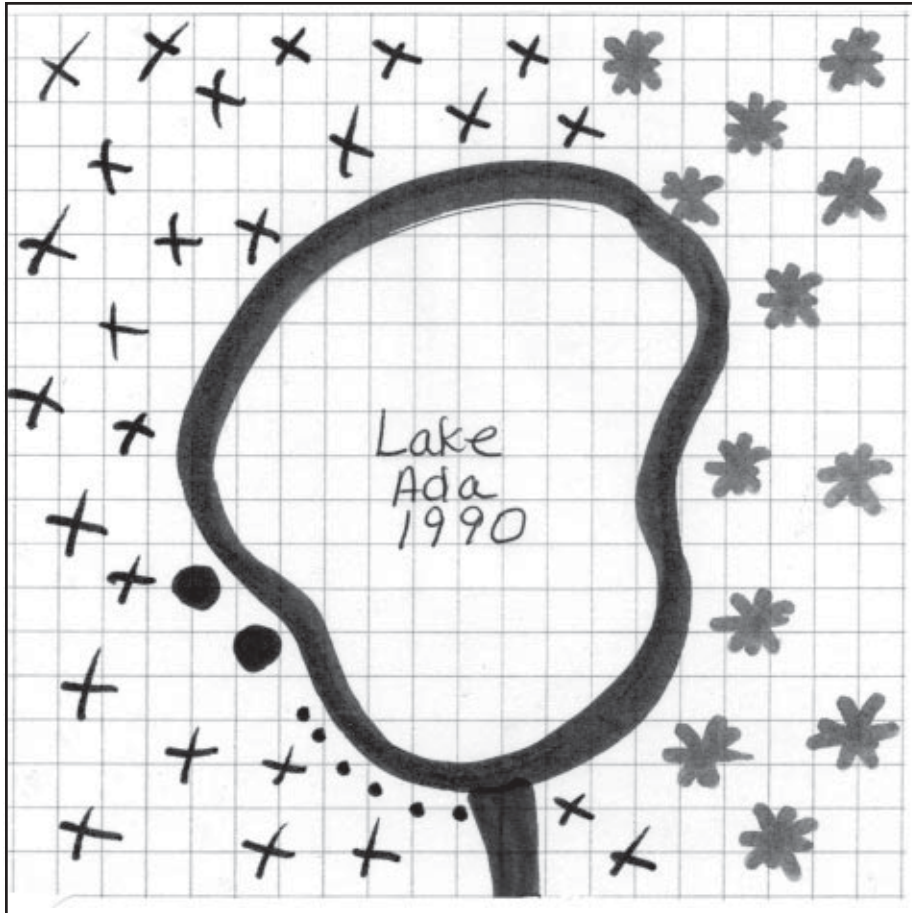
Legend

- Roads
- Houses
- Wetlands
- Purple Loosestrife plant = 5 plants
- Gardens
- Ditch

HIGHWAY 13

Date: 2000





LAKE ADA

Date: 1990

Legend

Hiking Trails ● ● ●

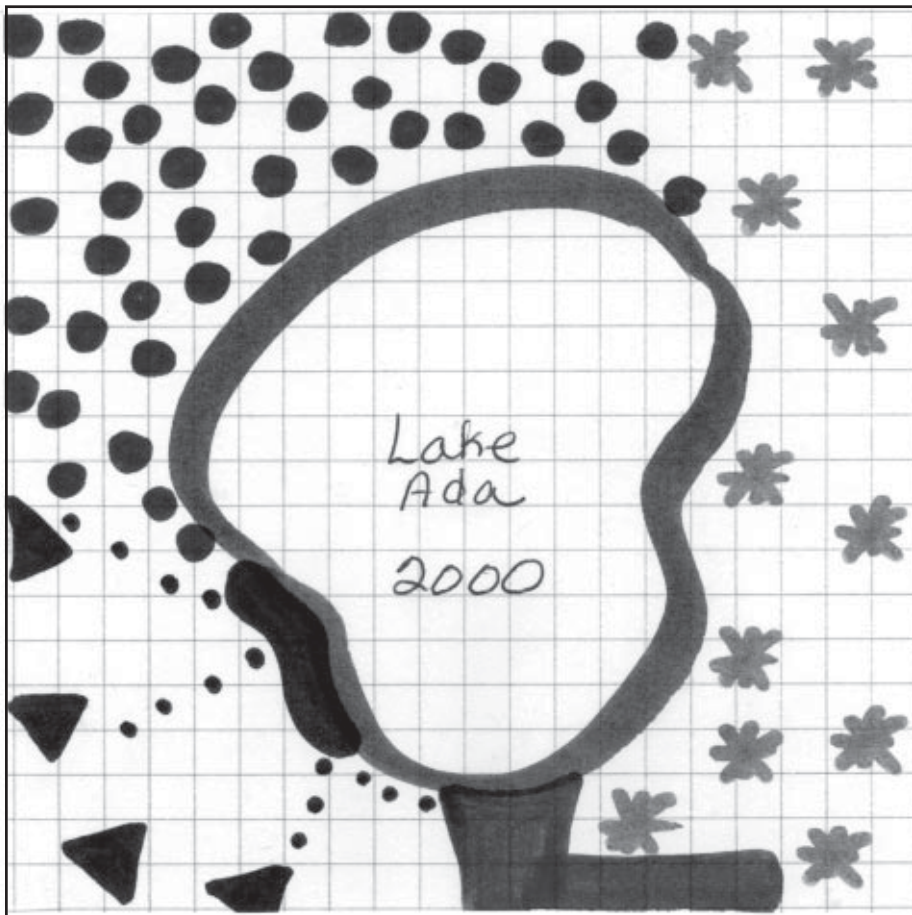
Campground ▲

Wetlands × ×

Purple Loosestrife plant ●

Forest ★

Boat Landing ▽



LAKE ADA

Date: 2000

PATRICK'S MARSH

Date: 1995



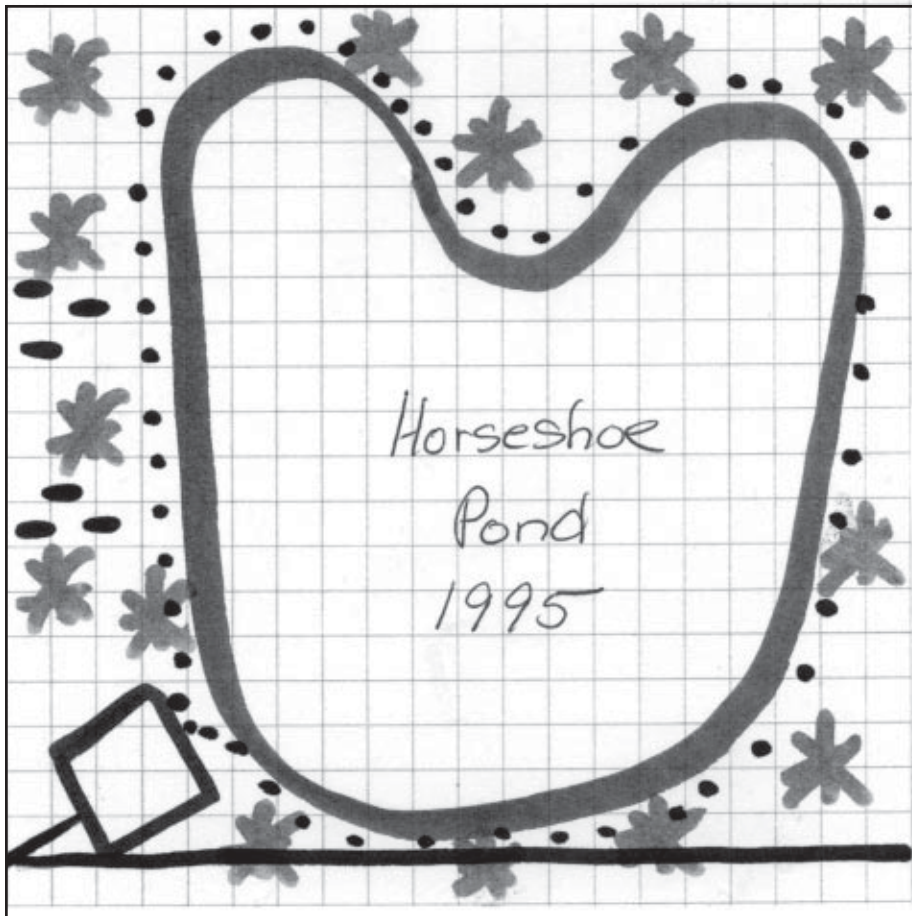
Legend

- Hunter trail ● ● ●
- Sedges/waterfowl vegetation ∇
- Wetlands X X
- Purple Loosestrife plant ●
- Forest *
- Wood duck house ■

PATRICK'S MARSH

Date: 2000





HORSESHOE POND


Date: 1995

Legend


Nature Trail

pasture 

Purple Loosestrife plant

Cabins  = 5 plants

Highway/Roads 

grazing animals 



HORSESHOE POND

Date: 2000

ATTACHMENT A

FOCUS QUESTIONS

1. Look at your set of maps from now and then. Investigate these maps in more detail.
2. What changes to the land have taken place over the course of the years?
Who or what has caused these changes? Describe those changes in the space provided.
3. How have the changes you described affected the biodiversity of the native plant and animal species in this area? Explain those changes here.
4. Center your attention on the purple loosestrife on each map. Describe the changes that have occurred over the years concerning this plant addressing the following issues:
 - a. Biodiversity of native species
 - b. Ecosystem functioning
 - c. Economic costs
5. Using your background knowledge of purple loosestrife, hypothesize how this problem originated in your area.
6. Review the methods available to deal with this problem.
(See Attachment B and C)

Using the information gathered concerning your area/map, address all three methods of control for purple loosestrife. What would be the advantages and disadvantages of using each of the following methods to control purple loosestrife in your area?

MECHANICAL CONTROL

Advantages:

Disadvantages:

Special Challenges:

CHEMICAL CONTROL

Advantages:

Disadvantages:

Special Challenges:

BIOLOGICAL CONTROL

Advantages:

Disadvantages:

Special Challenges:

7. What will happen to this area if the problem goes unchecked? Especially focus on the economic costs and ecosystem functioning.
8. As a group, decide on the method of control that you will want to implement in your specific map area. Be prepared to present this information to the class and to support your decision.

Names of group members

Map name

Year _____

page number _____

Year _____

page number _____

PURPLE LOOSESTRIFE

(*LYTHRUM SALICARIA L.*)

Historical movement and migration of purple loosestrife

Purple loosestrife is a perennial herb that originated in Eurasia. It was accidentally brought to North America in the ballast of ships back in the 1800s. The seeds from this plant quickly invaded northeastern port cities. As with most invasive species, it had a tolerance of a wide range of conditions. It could also reproduce prolifically through both seed dispersal as well as vegetative propagation. In its homeland, disease and insects kept the plant in check. With no native predators here in North America, such as the herbivorous beetles of Europe, this pioneer seed quickly adapted to disturbed wetlands, such as the newly constructed inland canals and waterways. During the next 100 years, it became well established along the St. Lawrence River Valley.

Immigrants on board these ships also brought the plant with them to the U.S. They valued purple loosestrife as a medicinal herb that was used for treatment of ulcers, wounds, sores, dysentery, and diarrhea. They also brought it as a perennial for their flower gardens and for bee forage. The last two reasons are the most probable reasons for the initial establishment of purple loosestrife here in Wisconsin.

Once established on the eastern seaboard, the herb then took an east-to-west migration route. The ground disturbance that accompanied the construction of our modern highway system spurred the distribution and growth of this plant. Wind currents, created by traffic and construction, carried these seeds to nearby waterways or drainage systems.

Native Range

Purple loosestrife's origin is thought to be Europe or Asia. Today, purple loosestrife is found to cover much of Europe. This plant is found in China, over the main islands of Japan, mainland Australia, the island of Tasmania, northern India, eastern Africa, and also southeastern Asia. It continued to spread in

North America as well, and as of 1996 it was found to inhabit all Canadian provinces, as well as every state (except Florida) in the Union.

It has been recorded in 70 of Wisconsin's 72 counties. Many of these counties report low densities which suggests that it is still in the pioneering stage of establishing itself. Areas reporting the densest populations of loosestrife are in the southeastern part of the state, and along sections of the Wisconsin, Wolf, and Fox River drainage systems.

In Wisconsin, only about 5% of our wetlands have purple loosestrife. Of the colonies surveyed in 1988, half of the purple loosestrife colonies have fewer than 20 plants. Eighty percent of the colonies have fewer than 100 plants.

Habitat

Purple loosestrife can occur in both freshwater and brackish water (water that has mixed with salt water). The plants are shade intolerant. Loosestrife can invade most types of moist soils or shallow wetlands. It favors water levels that fluctuate and also areas with disturbed soil. Areas where heavy machinery has been used caused a favorable environment for this plant and also weakens other native vegetation.

Those areas include: ditches, pond edges, river and stream banks, lake margins, tidal and non-tidal marshes, freshwater wet meadows, reservoirs, alluvial flood plains, sedge meadows, pastures, and wet prairies. It is unable to invade saline wetlands.

Older plants can tolerate drier conditions and can grow on upland sites. Purple loosestrife can also flourish in lawn and gardens. This is one of the ways that seeds have been introduced into wetland areas, rivers, and local lakes.

Disturbances, including water drawdowns and exposed soil, greatly accelerate the growth rate of loosestrife germination. Loosestrife seeds germinate best in soil temperatures that are between 15°C and 20°C. Day length does not seem to affect this process.

Purple loosestrife has a broad pH range. Seeds have germinated anywhere between pH of 4.0 to 9.1. When conditions are favorable, germination occurs in 8 to 10 weeks.

Description

Purple loosestrife is an herb, though it grows like a weed. It is called a perennial, emergent aquatic plant. This means it comes back year after year and that it is a water plant that grows above the water.

Small flowers with five or six petals grow on spikes. These flowers can be white to red to purple to dark pink. There can be 1–50 spikes on each plant. These short slender stems branch out to form wide-topped crowns that compete for the sun. It will shade everything else out. The flowers are pollinated by bees and butterflies and bloom early July into early September.

The stalks have 4–6 sides. They grow from 4–10 feet high. The leaves of purple loosestrife are long and are opposite each other on the stalk.

Young plants can produce 100,000 seeds per year, with mature plants producing as many as 2.7 million seeds. Seed survival is approx. 60% – 70%. These seeds are thin and flat in appearance. Although seeds only germinate in wet soils at high temperatures, the seeds can lay dormant in the soil for many years and can even live in water for approx. 20 months.

Other plants are often mistaken for purple loosestrife. Some of those are: blazing star, winged loosestrife, blue vervain, swamp loosestrife, fireweed, and gayfeather.

The large, woody taproot of loosestrife has rhizomes that form dense mats. These submerged stems develop the tissue characteristics of aquatic plants. Each year, they produce about one new foot of stem underground.

How seeds move

Seeds are light enough (weight 0.5–0.6 mg) that the wind can carry and disperse them. Most seeds fall close to the parent plant though, usually within 34 feet. They are usually moved downslope rather than downwind.

Seeds fall into the wetland mud, where they can adhere to aquatic wildlife, livestock, machinery, boats, and people. These seeds are then transported to other areas, boat landings, and wetlands unknowingly. Both the seedlings and the ungerminated seeds can float.

Seeds are eaten by some animals and are then deposited via feces in a different area.

Purple loosestrife is also spread vegetatively. This means that if you break off a stem, or just try to stomp a plant to death, new buds will appear. If a piece of purple loosestrife is on your boat trailer, you could be transporting this alien to a new place where it might resprout.

Some people plant loosestrife in their gardens. It has long been a favored, showy perennial in flower gardens. Although this might seem harmless, this is one of the ways in which the seed has spread to area lakes, rivers, and wetlands.

In some states, including Wisconsin, it is illegal to sell, offer for sale, distribute, plant, or cultivate purple loosestrife. It can still be purchased legally in some states. Violators should be reported to the Dept. of Agriculture, Trade and Consumer Protection at Bureau of Plant Industry. A fine of \$100 can be imposed on the violators. It is good to be aware that some wildflower or seed mixtures contain purple loosestrife seed. Always check the label to see if your mixture contains this species.

Problems

Purple loosestrife disrupts the normal structure and function of an ecosystem. The herb will displace or completely take over native vegetation and plants. It will eliminate native sedges, other flowering plants, and natural grasses. It competes with reed canary grass and Japanese millet. It can expand over thousands of acres.

This is because purple loosestrife has no natural predators or disease here in the United States to keep the plant in check. As with many invasive species, purple loosestrife is tolerant of many environmental conditions and thus can grow rapidly. It becomes a problem for fish, furbearing animals, and birds that are looking for food, shelter, a place to nest, reproduce, and raise their young.

Often the first species to be eliminated are the rare and endangered species of the area. For example, the bog turtle in the northeastern U.S. is severely impacted as its source of food is eliminated. For example, a species of orchid is also endangered because of purple loosestrife.

As purple loosestrife spreads its thick mat of vegetation over an area, it often becomes a monoculture (only species in the area.) Having a variety of plants and vegetation is important in wetland areas. Most waterfowl, fur bearing animals, and birds depend on these other plants for their food. The purple loosestrife is not eaten, nor is it a nutritious source of food for most animals.

Purple loosestrife can take over thousands of acres. Once a wetland is dominated by purple loosestrife, traditional residents such as muskrat and waterfowl decline in numbers significantly. Besides losing their food source, they are also losing their nesting material and ground cover due to this native vegetation loss and loosestrife replacement. The root mats create a 3-ft opening between plants in the water. This eliminates cover for nesting ducks. Other birds or waterfowl, such as marsh wrens and least bitterns, are displaced completely from the wetland.

Purple loosestrife interrupts food chains. The red-winged blackbird nests in this foliage. The long-billed marsh wren is the blackbird's greatest threat concerning nesting mortality, but avoids purple loosestrife. One can easily see how this could affect the population of the red-winged blackbirds. This increased population of blackbirds will also need to look to other areas for a source of food, as they do not eat purple loosestrife seeds as part of their diet.

Purple loosestrife can also choke recreational waterways. This can be detrimental to wildlife refuge users and managers. Recreational hunting grounds and trapping grounds also disappear.

This plant can also cause thousands of dollars of damage in agricultural communities by clogging irrigation systems, thus impeding the water flow. Often wetland pastures are completely lost to grazing because of the monoculture takeover. It was recorded in 1942 as a problem weed in the pastures of Quebec, stating that this land, which once supported 800 head of cattle, was since declared useless. It is also becoming more of a concern in areas where wild rice is grown and cultivated, such as northern California.

Economics

Purple loosestrife does have several economic benefits. Beekeepers look to purple loosestrife as a source of nectar and pollen for their colonies of bees. It is estimated they will experience a loss of 1.3 million in honey sales over the next 20 years due to the purple loosestrife control. If traditional wetland plants were allowed to reestablish themselves, bee colonies would then return to their original source of forage.

Purple loosestrife seed was sold around the world. Gardeners worldwide have long looked to purple loosestrife as a source of beauty for flower gardens. It is mentioned as far back as the Middle Ages. The plant was also used for medicinal purposes. Its flowers, roots, and branches were used for tonics that were used to treat ailments such as dysentery, internal and external bleeding, and the healing of wounds and ulcers.

The detrimental impacts of this plant clearly outweigh any economic gain. The plant continues to alter wetlands and disrupts ecosystem functioning. As hunting, trapping, and recreational grounds are lost to this plant, there is an accompanying decrease in the value of those lands. That can add up to large sums of money for landowners and managers of operational wetlands.

Purple loosestrife is known to clog irrigation systems, impeding water flow. It can also overrun meadows leaving the land useless for grazing. These agricultural losses are estimated to exceed \$2.6 million annually.

CONTROL METHODS

Mechanical Control

Mechanical control works best for small populations of purple loosestrife. Because it takes many people to monitor for new pioneering plants trying to take root and also to remove plants by hand, this method can become extremely costly.

If an area of infestation is extremely large, flooding is sometimes recommended. When flooding an area, the water must be drawn down or reduced until the loosestrife has sprouted. Then water levels must be increased to drown the stems. Problems can arise when trying to maintain a constant water level. When flooding an area, often many other native plants are impacted.

Time of flooding is of utmost importance. Flooding must be done before the onset of seed in early August, or you could be transporting thousands of seeds to a new location. Also, if the water drawdown is done too late in the spring or early summer, purple loosestrife growth is encouraged. For these reasons, flooding is not often recommended.

Mowing is another type of mechanical control. The purple loosestrife plants are cut below a level that the water will cover for approximately 12 months. Mowing does not prevent seed production! Cut plants must be picked up. These plants can still produce seeds. Also, small pieces of plants can develop new shoots and roots that will bud into new plants. Cutting late in the season will help hinder this process.

If the colony of purple loosestrife is relatively small, hand pulling of the plants might be successful. Young plants are easily removed in this manner. Older plants will be more difficult to pull. You must be sure to get the entire root or it will resprout. You may need to use a pitchfork or shovel. Stomping or breaking underground stems in removal initiates new bud growth.

If any of the root remains, new shoots will resprout. You should try to handle the plants prior to the onset of seed in early August. Once the petals begin to fall from the bottom of the spike, seed production will begin.

If the plants are in seed when you remove them, care must be taken in bagging seed heads to avoid spreading the seed further. Also, the removed plants and seeds should be dried and

disposed of properly. If you are bagging the seed, make sure the landfill you are taking it to does not require the bags to be broken. Do not throw the plants into a compost pile. Those seeds may not be destroyed and may take root. Also it takes the thick woody stems a long time to decompose. If there is an incineration facility in your area, this is an effective way to dispose of the plants.

Be aware that your clothes, boat, boots, and equipment used during this process may also serve as transport units for these tiny seeds. Brush off your clothes, footwear, and equipment before moving to uninfested areas. If you are using a boat, make sure you rinse all trailers and boats as well.

Also remember that purple loosestrife favors disturbed soil, so try not to disturb the soil. Burning is not effective because the plant has a high moisture content. Also be careful not to disrupt the habitat for the other amphibians, mammals, waterfowl, etc. that live in the same area. Take care not to destroy wetland vegetation and other delicate plants when mechanically removing the purple loosestrife.

Chemical Control

You will need a permit when applying any herbicides to Wisconsin waters. Teachers in other states should check local regulations. This permit helps to protect people and the environment.

This method of control is best used for small populations or individual plants. When used carefully, herbicides can be effective and efficient on spot treating large, older plants (e.g., Rodeo for wetlands, Roundup for uplands). These herbicides can be costly and also require continued long-term monitoring and maintenance. Also in the case of herbicides, many are non-selective and environmentally degrading.

The use of glyphosate (Rodeo) can be used for killing loosestrife. This chemical must be used in late July or August to be effective, as this is when the plant is preparing for dormancy. It may also be advantageous to do a mid-summer and late season treatment. This will help reduce the amount of seeds that could be produced. It should be applied to 25% of the plant in a 1% active ingredient solution. It is designed for use on wet or standing water sites.

Glyphosate mixed to 3%–10% can be used on freshly cut stems. This has been proven to be effective on larger plants in areas of low densities. You cut the stem near the ground and then paint a dab of the chemical on the fresh cut surface with a 50% solution. Remove the cut stems from the wetland or they may take root.

Glyphosate will also kill any other green foliage that it comes in contact with, so great care must be taken to avoid treating non-target plants.

Another chemical that can be used is triclopyr or Garlon 3A (Roundup). This chemical is broad leaf specific, meaning that it will not harm grasses, sedges, cattails, rushes, reeds, etc. or monocots. You must cover nearly the entire foliage. It is only for use on dry sites. It is not yet approved for over-water use (as of 1997).

Backpack sprayers are used by applicators to apply the herbicide to each plant. This is time consuming and expensive. It also requires multi-year applications to manage those plants that survived.

Biological Controls

Biological controls are seen as the most likely candidate for effective long-term control where purple loosestrife has taken over large areas of land. Biological controls are other plants and animals that feed on a specific plant.

When a plant is accidentally introduced into a new continent or area, it often leaves its natural predators and disease behind. The purpose of a biological control is to reestablish this connection in order to reduce and control the number of plants in an area. These biological controls will never eradicate the problem, but will help to bring about a healthier balance in the ecosystem.

Consideration must be taken when introducing one organism to control another. Prior to any introductions of a biological control species, extensive testing is conducted. In this case, a beetle was tested to see that it was a safe and effective agent in controlling loosestrife. These tests are also important so that the new species does not also become a pest, feeding on plants that we don't want it to.

Over 100 European insects were tested to feed on purple loosestrife. Special feeding trials were conducted where these insects were exposed to approximately 50 species, both wetland plants and upland vegetation. Of those tested, five were selected for approval for release in North America. These were introduced without fear of negative impacts. These beetles do adapt to a wide range of ecological and climatic conditions. The U.S. and Canada have released three beetles listed below.

Galerucella pusilla and *G. californiensis* are two leaf-eating beetles that seriously affected the growth and seed production of purple loosestrife. The adult beetles defoliate the plant by feeding on the leaves, flowers, and new shoot growth. You can see evidence of this damage by examining the round holes in the leaves.

Female beetles can produce up to 500 eggs during a 45-day period. Four to six eggs are laid on the stems, axils, or underside of the leaves. These larvae feed on the leaf's underside, leaving just a thin cuticle on the topside of the leaf. Plants can be destroyed or weakened if the insect population per plant is over 200. Just ten larvae, though, can prevent seed production by killing the terminal buds.

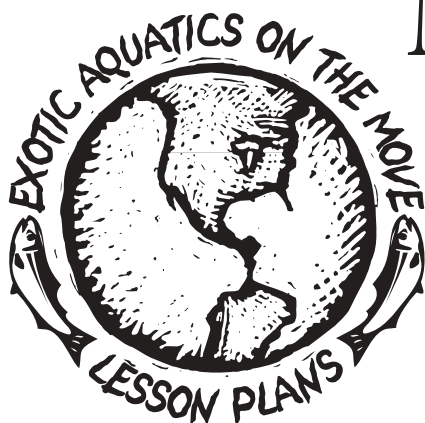
Hylobius transversovittatus is the other beetle that has been imported to control purple loosestrife. This beetle will bore into the lower 2 to 3 inches of the plant stem where she will lay 1–3 eggs daily from July to September. Some beetles will burrow into the soil and will deposit their eggs near the root of the plant. The newly hatched larvae then burrow to the root where they enter and severely damage the pithy xylem and phloem tissue. This reduces the carbohydrate reserves for the plant, depleting it of its energy. The plant does not have the energy source to develop new leaves. The mature plant will then die. A zigzag pattern in the root is evidence of this beetle damage.

As of 1996, 25 states have introduced these beetles as a control device for this plant. Pertinent data is taken during the time of release. This includes: soil type, size of infestation, water levels. Monitoring is again conducted later in the season and in following years, so that the survival rate of the beetle can be assessed, as well as the impact on the plant population.

It is believed that once these insects have become established at these plant sites, the insect populations will increase and will reduce the density of this plant. As the loosestrife colonies begin to die, the beetle will need to find a new source of food. The beetles do not spread to new sites easily. People physically move beetles to new locations. Because the beetle will never be able to completely eradicate the plant, there will always be a food source for the remaining insects.

Here in North America, it is estimated that the beetle will help to eradicate approximately 80% of the loosestrife population. It may take 10 to 20 years before insect populations will become established enough to accomplish this goal.

WOULD IT BE POSSIBLE FOR ME TO STAY A WHILE?



Grade Level: 10–12th Grades

Overview

This research activity explores the similarities and differences among ecosystems and the impact that species transference from one system to another could have.

Background

The transportation of exotic species, both purposefully and accidentally, is an occurrence that has taken place throughout history. International trade has been a part of civilization since the earliest formations of cities and political regions. The movement of species has therefore been led by both economical and recreational motives.

The introduction of a species into a foreign environment can have many drastic yet unknown effects. For a species to become a problem in a new ecosystem, the species must be able to adapt to its new environment. This adaptation is made easier by the similarities in climate between regions. No matter how hard a person tries, it would be impossible for someone to transplant a collection of penguins into Louisiana and expect them to establish a wild population. On the other hand, species from other subtropical areas could easily adapt to the climate here and establish their own populations. This activity is designed to explore the relations between differing ecosystems in order to determine the possibilities of a nonindigenous species surviving in a foreign system.

Setting

Classroom, computer center and/or library

Objectives

1. The student will analyze the inherent properties of differing ecosystems, (i.e. temperature, precipitation, humidity, and soil type).
2. The student will compare the properties of differing ecosystems.
3. The student will evaluate the probability of species movement between the ecosystems.

Geographic Standards

Standard 8. The geographically informed person understands the characteristics and spatial distribution of ecosystems on Earth's surface. Thorough understanding of the distribution and interactivity of ecosystems is essential to understanding the effects of species introduction on the receptive ecosystem.

Keywords

Ecosystem, movement, climate, research, species transference, exotic species

Materials

Geography textbooks, class set of atlases, encyclopedias for additional climate information, Internet access, a large global map, presentation projection device of some kind, coordinate cards for students, a list of the supplied URLs for student use.

Author

Jonathan Strange

School

East Baton Rouge
Parish

City

Baton Rouge

State

Louisiana

Grade Levels Taught

10th grade

Schedule

Allow two weeks for in-class and outside research, including at least three trips to the school library. For a class of 20 in 50 minute blocks, two periods should be sufficient for in-class presentations.

Prerequisite Skills

General research skills (i.e., Internet search usage, card catalogs), ability to use a gazetteer or atlas, good understanding of latitude and longitude.

Curriculum Connections

Science: How does the natural ecosystem of an organism allow it to survive?

English: Preparation and presentation of a research project.

Social Studies: How has world trade allowed the introduction of exotic species into foreign ecosystems?

Economics: How have economic advances and benefits affected the environment in which we live?

Procedure

The students should be allowed to draw (such as from a hat or box) a set of coordinates pre-selected by the instructor. Suggested coordinates for exotic species are attached. The students will then be instructed on the guidelines they should use in their research.

Guidelines for research: The student should be sure to include pertinent climatic information such as average temperature, precipitation, soil types, temperature variation, etc. To further stimulate understanding of a global “environment,” ecosystems which are chosen should be those which have some sort of connection to the exotic ecosystem, such as economic, a point of migration or as a point of tourism. A variety of research tools should be provided to allow for as in-depth of a project as possible.

STEP BY STEP:

- 1) Preview Questions:
 - What climatic factors determine whether an organism will be able to inhabit a particular ecosystem?
 - What conditions would need to exist for an organism to be transplanted successfully from one ecosystem to another?
 - Through what methods could an organism be transplanted from one ecosystem to another?
 - What kind of climatic factors would an organism require to survive in an ecosystem where our school is located?
- 2) The class should be divided into pairs.
- 3) The teacher should select pertinent locations throughout the world based on relations with the exotic ecosystem. These locations should then be written on slips of paper in latitude and longitude format. (This step could be avoided if you feel that your students have an adequate understanding of latitude/longitude but I believe it is just another review time.) (In the Resources section you will find a selection of exotic species, along with their native and exotic range coordinates. These can be used to focus the activity toward understanding why particular organisms succeeded rather than a general project dealing with *if* a species could make it.)
- 4) The students should be given the chance to brainstorm with the class on research methods.
- 5) Students should be allowed time to go to a computer lab or library to begin research if the activity was started at the beginning of class or allowed to prepare a trip the next day.
- 6) Students should be informed of the methods of evaluation listed below.
- 7) The project should be scheduled to last for about two weeks with a few days at the end to allow for presentations of findings.

Teacher Notes

The coordinates (with or without accompanying exotic species) should be set up beforehand, as well as group assignments. It would also be a good idea to take a look at the URLs supplied in the Resource section beforehand so that you are somewhat familiar with the layout. The <http://www.about.com> site in particular contains so much information that it deserves special attention.

Find the attached table of selected exotic species along with their native and exotic ranges. Coordinates were chosen on the following basis: Native Ranges were centered on the capital cities of a country for the most part. Exotic Coordinates were diversified as best as possible where the ranges of differing species overlapped. The coordinates are accurate to the best of my knowledge.

Applications

Here in southern Louisiana, the big picture is all around us. According to the Louisiana Department of Wildlife and Fisheries, one in four Louisiana residents either hunt or fish, and therefore come in contact with exotic species such as water hyacinth, hydrilla and salvinia. All three of these species directly interfere with boating—restricting passage to favorite hunting and fishing grounds. Water hyacinth and salvinia cover the water surface and deter waterfowl from landing.

All around us we can see the effects that exotic species have had on our ecosystem. It is important for students of all regions to realize the importance of the control of exotic species. For any sportsman in Louisiana, it is impossible to miss the effects of nuisance species on our natural resources, and for others, it is important to realize the damage levied on the tourist and fishing industries and the subsequent effect on our pocket books as the cost of goods and services increase due to the need for increased control of exotic species.

Evaluation

Students will be evaluated in multiple ways. First, the students written work should be evaluated based on proper grammatical usage. The written report should include graphs or charts relating information gained through the research project. Second, the group will present its findings to the class in a 5–10 minute discussion of their findings. The presentation should include not only oral presentation but graphical as well. Finally, the students should be evaluated based on information gained from the class's research as a whole. There should also be a large global map provided on which students can summarize their research as a school display.

Resources

Global Climate Perspectives System: <http://www.ncdc.noaa.gov/onlineprod/prod.html>
Offers climatological datasets on a range of information including precipitation and temperature averages.

Desktop References and Travel Sites: http://www.vwc.edu/library_tech/wwwpages/dgraf/refer.htm
Offers a wide selection of links to various Social Studies topics including climatological data and a global gazetteer.

Black Lake Computer Club: <http://www.thegrid.net/jhbowen/blcc10.htm>
Offers a selection of links to geographic references including atlases, maps, gazetteers and others.

About.com Geography Page: <http://geography.about.com/science/geography/>
This is absolutely the best map source I have located on the Web. They have maps and mapping tools for anything I could think of. Resources include everything from world maps, state maps, city locators, and even feature locators. This is a site I plan to spend a great deal of time with.

Credits

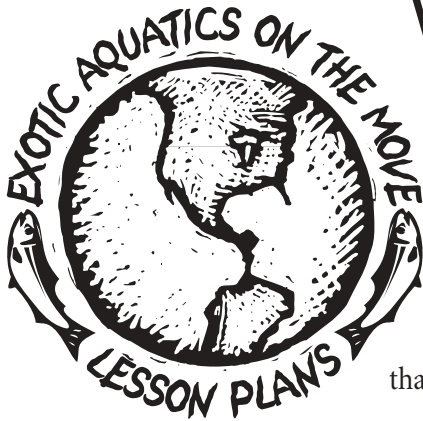
Prepared by author.

SPECIES

COORDINATES

	NATIVE RANGE	EXOTIC RANGE
Water Hyacinth	Brazil: 15S 46' 47", 47W 55' 47"	Atchafalaya Basin: 30N 10' 43", 91W 31' 33"
Hydrilla	Australia: 33S 52' 13", 151E 13' 23"	North Carolina: 35N 46' 15", 78W 38' 03"
Formosan Termite	Taiwan: 25N 03' 16", 121E 31' 19"	California: 32N 43' 26", 117W 09' 23"
Rio Grande Cichlid	Northern Mexico: 27N 30' 56", 99W 31' 27"	Arizona: 33N 27' 49", 112W 04' 38"
Zebra Mussel	Caspian Sea: 42N 58' 12", 49E 30' 39"	Lake Erie: 39N 56' 09", 104W 57' 37"
Nutria	Argentina: 34S 36' 42", 58W 27' 01"	Oregon: 45N 27' 42", 123W 51' 13"
Kudzu	Vietnam: 20N 15' 8", 105E 59' 38"	Mississippi: 32N 21' 14", 90W 53' 22"
Giant Salvinia	Brazil: 15S 46' 47", 47W 55' 47"	Toledo Bend Reservoir: 31N 11' 47", 93W 34' 19"
Ruffe	Latvia: 57N 10' 19", 23E 13' 27"	Lake Huron: 44N 13' 59", 83W 32' 51"
Grass Carp	Amur River, Siberia: 52N 56' 00", 141E 10' 00"	Arkansas: 33N 57' 05", 91W 51' 27"
Chinese Tallow	China: 39N 55' 42", 116E 25' 07"	Georgia: 33N 45' 16", 84W 23' 31"

AROUND THE WORLD WITH EXOTIC SPECIES



Grade Level: 4th–9th grades, depending on level of involvement and information research.

Overview

Through this activity, students will learn about the geographical distribution, type of transfer vector and home range for selected exotic species that have entered the Great Lakes and coastal regions of the United States.

Background

Students can combine geography and science skills in this activity while they map the spread of aquatic exotics and learn about the transfer mechanisms that allowed them to expand their range.

Setting

Classroom, science lab or technology lab for Internet access

Objectives

When learners have completed this activity, they should be able to:

1. Locate and mark on a map of the world the home range (or one point of that range) where a specified aquatic invader came from.
2. Locate and mark on a map of the world the entrance point of introduction for specified aquatic exotics, either around the Great Lakes or near U.S. coastal areas.
3. Learn about the vector or transfer mechanism that made it possible for that aquatic exotic to move from its native range.
4. Report back to classmates and visually share this information with string and a map of the world.

Standards

GEOGRAPHY STANDARD

The World in Spatial Terms. Students use mapping skills and analyze spatial organization of these exotics and the environments that they invaded.

SCIENCE STANDARD

Inquiry. Students conduct research on exotic species and learn about their movement into new environments.

Keywords

Exotic species, vectors, range expansion, home range, nonindigenous species

Materials

Color map of the world on a transparency, overhead projector, or large paper map of the world, lengths of string or yarn, removable tape, stickers (address labels) for attaching to string and marking names of exotic species and the transfer mechanisms

Schedule

If aquatic exotic species have been introduced as part of unit, this activity should only take 1-2 classes. If the information research was given as part of a homework assignment, the activity can be done in one classroom period, depending on the background that the students have received prior to the activity.

Authors

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State

New York

Prerequisite Skills

Map reading skills, Internet researching skills.

Procedure

To enhance cooperative learning skills, students should be paired up or asked to work in small groups. Depending on the class size, one aquatic exotic can be assigned to each pair or several species can be assigned to each team. To add interest, teams or groups can randomly pick the selected exotic from slips of paper with the names written on them. For older students, use both the scientific and common species names.

Depending on the grade level and level of involvement in this activity, students can be given the scientific and common name of the aquatic exotic and asked to research the home range, point of entry into the United States, and the type of transfer mechanism that was used by the exotic. This research could be done as a homework assignment or as part of a classroom session. For younger students, this information could be given to them and they could just work on the mapping skills that it would take to find the two locations on a map of the world.

You may want to provide students with a smaller copy of the world map, so they can find the country of origin before being asked to find the spot on the larger, projected map.

Once students have the information ready, their locations checked on the map and the length of string cut - the students are ready to share their information with classmates. At this point, presentations can be made with the students connecting the strings from the point of origin to the point of introduction. They can then place their tags with the method of introduction on the connected string and share that information with the class.

Examples

Green crab, *Carcinus maenas*

Origin: North and Baltic Seas in Europe (Students could select one location)

Introduction: Atlantic coast of the U.S. and Canada, from New Jersey to Nova Scotia

Method of Introduction: Came over in or on ships.

Water hyacinth, *Eichhornia crassipes*

Origin: Amazon River, South America

Introduction: Florida, 1880s

Method of Introduction: Brought in for the World's Industrial and Cotton Centennial Exposition of 1884-1885 in Louisiana. A visitor from Florida took some home and introduced it to the St. John's River.

Application

Students could make a bulletin board display using a large map of the world.

Such a display could be put on display in a hallway or in a display case to make other students aware of aquatic exotics.