Bioinvasion

Middle Level Lesson Plan

Topic

Ecology

Grade Level

7-8

Overview

Are "aliens" lurking in our backyards? This teaching unit examines the impact that non-native, invasive species have on native organisms and habitats in Maine, New Hampshire, and Vermont. Students will discover how increased human mobility and expanded global trade have resulted in an unprecedented invasion of non-native species in northern New England. Lessons in this unit showcase the risks to habitat, natural resources, and biodiversity from alien species. Students will also explore the economic impact of such invasions, as well as prevention and control strategies being introduced in the region.

Introduction

Middle school students that participate in this teaching unit will have an opportunity to learn about the impact of invasive organisms on local ecosystems through a variety of activities. A discussion about what students already know about the threats of invasive species in their area engages students in the unit and piques their curiosity. Using the QUEST: *Bioinvasion* video, students examine the similarities and differences between a specific aspect of the invasive species issue in conjunction with viewing the tape. To "experience" first-hand the effects invasive species have on a particular habitat, students "become" an invasive or native species living in a lake. Through research and their prior experiences, students are given the opportunity to defend or accept invasive "Truths & Myths," strengthening and refining students' thinking about invasives. In the culminating activity, pairs of students create "Most Un-Wanted Posters" that teach others about the impact and threat of invasive species in their area.

QUEST: Investigating Our World is a regional public television series seen on Maine Public Broadcasting Network, Vermont Public Television, and New Hampshire Public Television

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At the end of this teaching unit, students will be able to:

- Define an invasive species and identify some that are threats to northern New England ecosystems.
- Demonstrate the impact an invasive species has on native species through a role-playing situation (using an aquatic species/lake setting as an example).
- Recognize the potential impact of invasive species on the economies of Maine, New Hampshire, and Vermont.
- Be familiar with prevention and control techniques being applied in northern New England.

Time Allotment

Approximately 5 class sessions of 45 minutes each

Accessing Prior Knowledge

Students should have a basic understanding of ecological relationships such as predator/prey, competition, and food webs/food chains. They should also be able to give examples of the ways in which living things interact with their environment and the ways in which humans influence these interactions.

Concepts to Clarify

Middle-school students often have difficulty differentiating between an organism's habitat and its niche. **Habitat** is best described as *where* an organism lives, whereas **niche** includes the organism's connections within food webs, its specific behaviors, and so on – in other words, its *role* in the ecosystem. In addition, the concept of adaptation is usually not well developed in students of this age. Students tend to believe that an individual organism can adapt to change in an environment as needed, rather than seeing adaptation as a result of change over time, linked to "survival of the fittest." Lastly, it is important to remind students that some "invasive" species have been introduced into Maine, New Hampshire, and Vermont in a number of ways. Some have been introduced by accident, but in other cases it has been deliberate (though not necessarily malicious).

CONNECTIONS TO THE STANDARDS

Maine Learning Results	New Hampshire Curriculum Framework	Vermont Learning Standards	National Science Education Standards	Benchmarks for Science Literacy
Science and Technology B. Ecology Generate examples of the variety of ways that organisms interact (e.g., competition, predator/prey, parasitism/ mutualism). M. Implications of Science and Technology: Give examples of actions which may have expected or unexpected consequences that may be positive, negative, or both. Describe an individual's biological and other impacts on an environmental system.	**3b. Curriculum Standard (Grade 6)** Identify and describe examples of New Hampshire animals and plants that live together in one ecosystem. (Grade10) Predict, with rationale, the effects of changing one or two factors in an ecosystem.	**The Living World** Organisms, Evolution and Interdependence (5-8) 7.13.ccc. Describe, model and explain the principles of interdependence of all systems that support life.	**Content Standards (5-8)** C. Life Science: Populations and Ecosystems: Populations of organisms can be categorized by the function they serve in an ecosystem…. The number of organisms an ecosystem can support depends on the resources available and abiotic factors…	**Chapter 5: The Living Environment** 5D. Interdependence of Life: In all environments… organisms with similar needs may compete with one another for resources… Two types of organisms may interact with each other in several ways: They may be producer/consumer, predator/prey, or parasite/host relationships. Or, one organism may scavenge or decompose another. Relationships may be competitive or mutually beneficial. Some species have become so adapted to each other that neither could survive without the other.

Materials Needed

- TV with VCR
- QUEST: *Bioinvasion* video
- 8 1/2 x 11-inch scrap sheet of paper (1 per student)
- Graph paper (1 sheet per student)
- Computer(s) with Internet access for student to conduct research
- Classroom/library resources on invasive species of northern New England
- Chart paper and markers
- Student Handout 1: *Bioinvasion – Compare and Contrast*
- Student Handout 2: QUEST: *Invasive Species Truths and Myths*
- Student Handout 3: *Most Un-Wanted Poster Quality Criteria*
- Student Handout 4: *QUEST at Home: Be an Invasive Species Detective!*
- Teacher Reproducible 1: Invasive Species List

For role-playing activity:

- Rope (approximately 12 feet)
- Chart paper and markers or access to blackboard
- 12 paper plates – 6 plain, 6 marked with an "X" on both sides.
- Fish-shaped name tag (with a picture of a chain pickerel)
- Green yarn or string (to represent Eurasian water milfoil)
- Toy boat and trailer (or picture of these)
- 4 "seed" packets (purple loosestrife)
- Picture of northern pike
- Picture of zebra mussel
- Dish scrubber or hose attachment
- Toy ship or picture of one (or a bucket)

For poster-making activity (for each pair of students):

- *Mission: Impossible* theme or other crime-stopping music (optional)
- Poster board 22"x 28"
- Markers

1. Introducing the Concepts

In this introductory lesson, students will become familiar with some invasive species affecting northern New England. They will begin to determine the defining characteristics of an invasive species. As students view the QUEST *Bioinvasion* video, they will complete a compare/contrast activity sheet which will help them apply critical-thinking skills to this topic.

Step 1
Ask students if they know what is meant by an "invasive species." Have them share examples and issues associated with these organisms, but resist going into too much detail. Tell the class that these ideas will be further explored in later activities.

Step 2
Inform students that they will be watching a program about invasive species. As they watch the video, they will be asked to note the similarities and differences between some types of invasive species. (For example, you might ask them to compare and contrast terrestrial invasive species versus aquatic invasive species, Maine invasives versus New Hampshire and Vermont invasives, prevention strategies versus eradication issues, hemlock wooly adelgid versus hydrilla.)

Step 3
Distribute copies of Student Handout 1: *Bioinvasion* – Compare and Contrast. Review the graphic organizer with the class, clarifying its structure as needed. Then assign the categories of invasive species that you would like students to compare/contrast as they watch the video. (See Step 2 for suggestions. If you wish, you can assign different topics to different students so that a wide variety of species and issues can be examined.)

Step 4
Play the video. When it is over, discuss with students the similarities and differences they found while viewing. If time permits, give students some extra time to do research to complete their charts in more depth.

2. Exploring the Concepts

The following role-playing activity gives students the opportunity to "experience" firsthand the effects of invasive species on a particular habitat. The activity was modified from a lesson called "Don't Stop for Hitchhikers," part of the ESCAPE Curriculum developed by the Illinois-Indiana Sea Grant College Program (author Peter L. Edwards). The organisms selected broadly represent species found across Maine, New Hampshire, and Vermont, although not all species inhabit all states. The script could be modified to fit a scenario for a specific lake, if you prefer. (**Note:** *Italic* type is used for script that you can say during implementation of the activity.)

Step 1
Before students enter the classroom, create a "lake" outline by placing the rope in a circle on the floor. (If weather permits, you can also perform this activity outdoors.)

Step 2
Have students come into the room and stand around the outline of the "lake." Say:

This large circle represents a lake, and today you will hear the story of the chain pickerel. These fish live in quiet, shallow waters in lakes with muddy bottoms. Chain pickerels are voracious carnivores. Their diet includes golden shiners, brown bullheads, yellow perch. and sunfish. Pickerel like to hide in weeds and wait for a meal to swim by. In this activity, you will play the part of inhabitants of this lake. You will learn about how invasive species affect the habitat and niche of native species in the lake.

Tell students that the chain pickerel is a native inhabitant of the lake. Ask students to define "native inhabitant" and/or "native species." Elicit students' ideas regarding invasive (a.k.a. *nonnative, alien, exotic*) species. Record their ideas on chart paper or the blackboard. Then, on a separate piece of chart paper or separate area on the blackboard, write the words *habitat* and *niche* at the top of two columns. Ask students what is meant by these two terms. After students have generated their ideas, save this pre-assessment activity to use in summarizing the activity.

Step 3

Ask for volunteers to play the parts of the various lake inhabitants. Give the first volunteer the fish-shaped name tag, and show him/her a picture of the chain pickerel. Take the student who will be the chain pickerel to the middle of the "lake." Explain to students, "This is the biggest chain pickerel in the lake."

Step 4

Place the six plain paper plates on the floor inside the "lake." Explain to students, "These are the favorite food of the chain pickerel." Now place the six plates marked with an "X" on the floor inside the "lake." Explain, "These are the favorite sleeping spots of the chain pickerel." Tell students that the chain pickerel swims and eats all over the lake.

Step 5

Now the role play begins. Have the chain pickerel "swim" up to one of the paper plates and pretend to eat or sleep.

Step 6

Next, introduce an invasive species of your choice to the lake. Show a picture of the invasive species and/or use a prop. Explain how to identify it, the harmful effects it has on the habitat, and how it is spread. You may introduce various invasive species in any order; this script starts with Eurasian water milfoil for ease of use. Read or summarize the information below:

Eurasian water milfoil was accidentally introduced to North America from Europe, probably by boaters and waterfowl. This densely growing plant has feather-like whorled leaves. This plant forms a thick mass of underwater tangled stems, which can create mats of plant material on the water's surface. Eurasian water milfoil spreads rapidly because tiny fragments break off from the main plant, allowing them to easily establish new growth in the lake. A single fragmentation is all that is needed for boats and trailers, fishermen, or waterfowl to transport the plant to other lakes, rivers, and streams. In fact, Eurasian milfoil has been found in lakes in nearly every state and poses numerous water quality problems. To prevent this plant from spreading, boaters must clear off and remove all weeds from their boats and trailers.

Use a toy boat and trailer prop (or a picture) to demonstrate how the milfoil gets tangled in the propeller or attached to other parts of the boat.

Now give a group of three or four volunteers a ball of green yarn or string. Explain to the group that the yarn represents the milfoil. This group of volunteers must remain connected by all holding onto the yarn throughout the simulation. As each turn is taken, more strands of yarn must be shared among group members as they spread out and crowd into the "lake." Say: *You are now Eurasian water milfoil, and you must remember how you spread.* Have the group move one or two steps closer to the center of the circle to represent loss of habitat for the chain pickerel.

Finally, say: *But the chain pickerel can find other places to eat or sleep.* Instruct the chain pickerel student that s/he should try to move to a sleeping or eating spot (a.k.a. another paper plate) in the lake each time an event occurs.

Step 7

Introduce the next invasive species by saying:

Northern pike is a fast-growing, voracious predator that eats small fish. As the pike gets bigger, it adds other animals – such as frogs, ducklings, and even small muskrats – to its diet. Pike are found in quiet, shallow, weedy areas of the lake. They are highly prized sport fish. Northern pike were introduced to the area illegally. They can hybridize with chain pickerel, and the resulting hybrid may possess markings common to either or both species.

Give a picture of the northern pike to three volunteers. Explain that this fish can occupy the same food and shelter locations (paper plates) as the pickerel. Explain to the group of "northern pike" students: *You are northern pike. Remember how you got into this lake. In each subsequent round of this game, you must bring one more student into the lake to act as another pike.*

Have each of the northern pike stand on paper plates. Have all role-playing students take another step forward.

Say: *But the chain pickerel can find other places to eat or sleep.*

Step 8

Introduce the next invasive species by saying the following:

Purple loosestrife is a wetland plant from Europe and Asia. It was introduced to the Northeast in the 1800s. This plant first spread along roads, canals, and drainage ditches; later is was distributed as an ornamental plant. It now exists in 40 states and in all Canadian border provinces. Purple loosestrife invades marshes and lakeshore, replacing cattails. It crowds out other wetland plants, too. The plant forms dense, impenetrable strands that are not suitable for cover, food, or nesting sites for a number of native wetland animals such as ducks, geese, muskrat, frogs, toads, and turtles. Purple loosestrife has been successful in expanding due to its lack of predators in the Northeast. This plant's seeds easily escape from gardens and nurseries, falling into

wetlands, lakes, and rivers. To prevent the spread of purple loosestrife, don't pick them and take them elsewhere. Don't buy these plants from nurseries, and don't buy wild seed mixtures that contain loosestrife.

Give two seed packets to each of the two volunteers to represent purple loosestrife. Explain to the "loosestrife" students that in each round, they are to each add another person to represent the spread of purple loosestrife. Say, *You are now purple loosestrife. You must remember how you are spread.*

Tell all students introduced thus far into the role-play to take another step forward. Then say: *But the chain pickerel can find other places to eat and sleep.*

Step 9

Introduce another species by saying:

Zebra mussels are thumbnail-sized, freshwater mollusks. They have varying patterns of alternating dark and light on their shells. For part of their lives, zebra mussels exist as free-swimming larvae that are invisible to the eye and are very abundant. The adults secrete strong byssal threads which allow them to attach to a number of surfaces, including water systems, power plants, and irrigation pipes. Because zebra mussels filter-feed, they compete with zooplankton for phytoplankton. They wreak havoc with boaters – attaching themselves to the bottom of boats and creating drag. They also enter the cooling systems of boats, causing them to overheat. Scientists suspect that the microscopic larvae of zebra mussels were first sucked into the ballast waters of a ship and then released into New England waters, where colonies were quickly established. To prevent the spread of zebra mussels, you must remove any aquatic weeds from your boating gear. Flush the engine and wash your boat and trailer with hot water, away from bodies of water. (Water temperatures over 140^{o} F kill zebra mussel adults and larvae.)

Show a picture of a zebra mussel to the class. Then give one student a dish scrubber or hose attachment. Give another student a toy ship or bucket (to represent ballast water). Have these two students take a step into the "lake." Say: *You are zebra mussels. You must remember how you were introduced into this lake.*

Tell all other student in the role-play to move forward another step. Then say: *But the chain pickerel can find other places to eat or sleep, can't it?*

Step 10

Play new rounds of the game until all of the paper plates are covered up and students have crowded the chain pickerel. Ask students to think about how the habitat for the native species, the pickerel, has been reduced to the point of having its very survival threatened. Discuss the pressures placed on the native species each time a new invasive species is introduced.

As a way of introducing a follow-up discussion, begin by having each invasive species group remind the class of how they are spread. Discuss with the class what is being done by the government or by local organizations to prevent the spread of invasive species. Using the initial student-generated ideas about niche and habitat, revisit the terms. Encourage students to use specific examples from the role playing scenario to clarify the difference between the two terms. (Review "Concepts to Clarify" section again

before this discussion.) Be certain that at this point, students understand the invasive species impact both the **habitat** and **niche** of native species in a particular ecosystem. Be certain at this point that their definitions for the two terms are accurate. Have students record accurate definitions in their notebook. Here are suggestions:

- **Invasive species** – A species that is (1) non-native (or alien) to the ecosystem under consideration and (2) whose introduction causes, or is likely to cause, economic or environmental harm or harm to human health (Executive Order #13112; *http://www.invasivespecies.gov*).

- **Habitat** – The place or environment where a plant or animal naturally or normally lives and grows.

- **Niche** – The ecological role of an organism in a community, especially with regard to food consumption.

Step 11 (optional)

Consider one of the following extension activities to further explore the effects of invasive species on local habitats:

- Have a trained volunteer from a local watershed organization, or an employee from the Department of Environmental Protection, come in to discuss specific problems of invasive species in your area.

- Visit a lake in your area that is known to contain one or more invasive species. Develop a system so that students can monitor the species' growth in population or its spread in infested areas.

Resources for the Role-Play Activity

Basic information on the chain pickerel as it relates to each of the three northern New England states:
Maine: *http://www.state.me.us/ifw/fishing/f-picker.htm*
New Hampshire: *http://www.wildlife.state.nh.us/Fishing/fish_species_profiles.htm*
Vermont: *http://www.vtliving.com/fishing/species.shtml*

Invasive plant atlas of New England: *http://invasives.eeb.uconn.edu/ipane/index.html*

Maine Department of Environmental Protection (contacts: Christine Smith and Dave Halliwell)

Maine Volunteer Lake Monitoring Program: A Field Guide to Invasive Aquatic Plants

Stop the zebra mussels! Northern New England Zebra Mussel Watch:
http://sgnis.org/publicat/stopzm.htm

Vermont invasive aquatic plants fact sheets:
http://www.anr.state.vt.us/dec/waterq/ans/objects%5Cewmfs.pdf

3. Developing the Concepts

In this activity, students will develop a deeper understanding of some specific issues involving invasive species in northern New England. They will test their knowledge by taking a "Truth or Myth" quiz, and they have to support their reasoning either with knowledge gained in previous activities or with evidence found through additional research.

Step 1

Distribute copies of Student Handout 2: Invasive Species Truths and Myths. Review the directions with students, clarifying as needed. Allow students time to complete the "quiz" individually.

Step 2

Have students form groups of three or four. Explain that now their job is to share their responses to the quiz on Student Handout 2. Tell students that as they share their answers, they need to give reasons that support and defend their thinking about a particular statement. Allow time for groups to discuss each of the 10 statements on the handout.

Step 3

Have student groups report out to the whole class about their responses to the "quiz." Ask each group if there were any statements they could not agree on, or if there were any statements that are still unclear. Explain to students that they will now be given the opportunity to find further evidence to clarify their thinking about any statements on the handout that gave them trouble.

Step 4

Allow students time to do additional research as needed. Have them use the Internet or other available materials in the classroom and the school library.

After adequate time for research has passed, have the original groups reconvene and come to a consensus on each statement. Make sure that they are able to cite evidence that they have gathered from all available sources.

4. Synthesizing and Applying the Concepts

The following activity was designed to allow pairs of students to investigate one invasive species in more detail. Each student pair will create a poster detailing the organism and describing ways in which people can help to prevent the spread of the invasive. (**Note:** This activity was adapted from *Exotic Aquatics on the Move: Lesson Plans* by Christine Hedge.)

Step 1

Before class, make a copy of Teacher Reproducible 1: Invasive Species List. Cut along the lines on the page to make separate strips containing the names of invasive species. Put the strips into a container.

Step 2
As students enter the room, have music playing, such as the *Mission: Impossible* theme or other suitable crime-stopping selection.

Step 3
Explain to students that today, they will begin a very important mission: that of alerting the public about some of northern New England's "Most Un-Wanted." Distribute copies of Student Handout 3: Most Unwanted Poster Quality Criteria Guide. Go over the handout step by step, and determine due dates for research, rough draft, and final poster.

Step 4
Arrange students in pairs. Then have each pair of students randomly choose a slip of paper out of the container. The slip that is drawn represents the invasive species that the pair will be researching.

Step 5
Direct students to visit the following Web site. It is a good starting point for finding information about each organism. *http://webapps.lib.uconn.edu/ipane/search.cfm*
From this initial Web site, student pairs should move on to further research sites until they have gathered enough information to fulfill all of the criteria on Student Handout 3 (under the heading Information Required). Provide assistance as needed throughout this research phase.

Step 6
Once each pair of students has gathered the necessary information, have them begin to create their poster. Circulate through the classroom to make sure that students are following the guidelines on Student Handout 3 (under the heading Poster Format and Materials). Provide assistance as needed.

Step 7
When the due date for the completed project arrives, direct students to display their posters around the classroom. All students should circulate through the room, reading each poster and recording what they have learned. Instruct them to note similarities and patterns among the various invasive species. Encourage them to brainstorm solutions to the invasive species problem.

Step 8
Once the review process is complete, have students display their posters where they can be seen by the general public – perhaps in the school hallway, or in your town hall or community center.

5. Extending the Concepts

QUEST at Home
Distribute copies of Student Handout 4: *QUEST at Home: Be An Invasive Species Detective!* Review the handout with students before they take their copies home. Agree upon a due date for students to return to class with their findings.

Community Connections

Link up with local environmental groups – for example, with watershed associations, especially volunteer monitors. Many have had special training in how to aid state agencies in early detection of invasive species. These groups know the status of species in your area, and they have a wealth of informational materials on invasive species. State park rangers, entomologists, and individuals from sport fishing associations are also good sources of information. Many also have ways that students can get involved.

Talk to a forester or another individual associated with the forest industry. Find out their concerns about invasive species. Find out what changes these professionals have noticed in laws, the environment, harvest practices, and so on as they relate to invasive species.

Individuals from state agencies (e.g., the Department of Environmental Protection, Fish and Wildlife Services.) are very knowledgeable in the area of invasive species. Many departments have educational outreach programs that bring programs into schools to education students about various issues.

Career Opportunities

Have students visit their state's Department of Environmental Protection Agency, Department of Wildlife and Inland Fisheries, Park Services and Forestry web sites. Have students explore all of the different jobs related to protecting natural resources. What special skills do these people need? What kinds of work are they involved with?

Are you the type of kid that is fascinated by insects? Maybe a career in entomology is for you! Send students to the web to investigate the many roles entomologists play in our states or invite an entomologist in to talk to students. The link below gives students a snapshot of why one person entered the field of medical entomology:
http://www.findarticles.com/cf_dls/m0BTR/1_20/56220384/p1/article.jhtml

Have students check out the diverse and exciting career possibilities in this listing of Ecology and Environmental Sciences department compiled by the University of Maine, Franklin Pierce College in New Hampshire and Clarkson University in New York.
http://www.umaine.edu/nrc/career.htm
http://www.fpc.edu/pages/Academics/nscience/envsci/ENrequir2.html
http://www.clarkson.edu/~tlangen/joblinks.htm

Additional Resources

Print Publications

Krasny, Marianne E. ***Invasive Ecology***. Virginia: National Science Teachers, Association Press, 2003.

A Field Guide to Invasive Aquatic Plants. Maine Volunteer Lake Monitoring Program, P.O. Box 445, Turner, ME 04282 (207) 225-2070

ESCAPE (***Exotic Species Compendium of Activities to Protect the Ecosystem***), from Great Lakes Sea Grant Network, including Illinois-Indiana, New York, Ohio, Michigan and Minnesota
http://www.iisgcp.org/edu/escape

Web Sites

A listing of organizations and agencies by state related to invasive species.
http://www.invasivespecies.gov/other/orgstate.shtml

The Invasive Plant Atlas of New England has a variety of materials on invasive plants, including a searchable database and photographs. *http://invasives.eeb.uconn.edu/ipane/*

References used to create these materials (some cited within this teaching guide)

Smith, Christine. Interview. Maine Department of Environmental Protection, January 2004.

Swartz, R.J.; Fischer, S.D.; and Parks, S. *Infusing the Teaching of Critical and Creative Thinking into Secondary Science*. Pacific Grove, CA, Critical Thinking Books & Software, 1998, pp. 96-106.

ESCAPE (Exotic Species Compendium of Activities to Protect the Ecosystem), from Great Lakes Sea Grant Network, including Illinois-Indiana, New York, Ohio, Michigan and Minnesota
http://www.iisgcp.org/edu/escape

BioLEARN
http://www.wise.edu/cbc/biolearn/index.html

Bioinvasion – Compare and Contrast

Adapted from: *Infusing the Teaching of Critical and Creative Thinking Into Secondary Science* by Robert J. Swartz, et al.

Example

Animal	Plant

HOW ALIKE?

- Both threaten native species in ME, NH and VT
- Both have no natural predators
- Both have specialized body parts and/or behaviors that make them successful in their ecosystem
- Both have highly successful reproductive strategies
- Both impact ME, NH, VT economically (tourism, agriculture, forestry, etc.)
- Both are costly and difficult to eradicate
- Both can be prevented with human care and awareness

HOW DIFFERENT?

WITH REGARD TO

Animal		Plant
Animal invasive species often out compete native species for their food.	Role in the Food Chain	Invasive plant species have highly successful propagation strategies, allowing them to quickly take over areas once occupied by native plants, and out compete them for sunlight, nutrients and space.
Hemlock Woolly Adelgid has a straw-like mouth that sticks into hemlock trees to feed. It also injects toxic saliva, which eventually leads to tree death.	Specific Adaptations	Hydrilla has numerous reproductive strategies- fragmentation, seeds, rissones, tubers that make removal nearly impossible.
Species like the Wooly Adelgid threaten the forest industry in Northern New England.	Economic Impact	Lower water quality = lower real estate values, costs of removal in the millions.
Burn infested trees, regulate nursery stock imports, check for pests frequently, inform public	Prevention	Remove all plant material from boats and fishing equipment, inform public, etc.

PATTERNS OF SIGNIFICANT SIMILARITIES AND DIFFERENCES

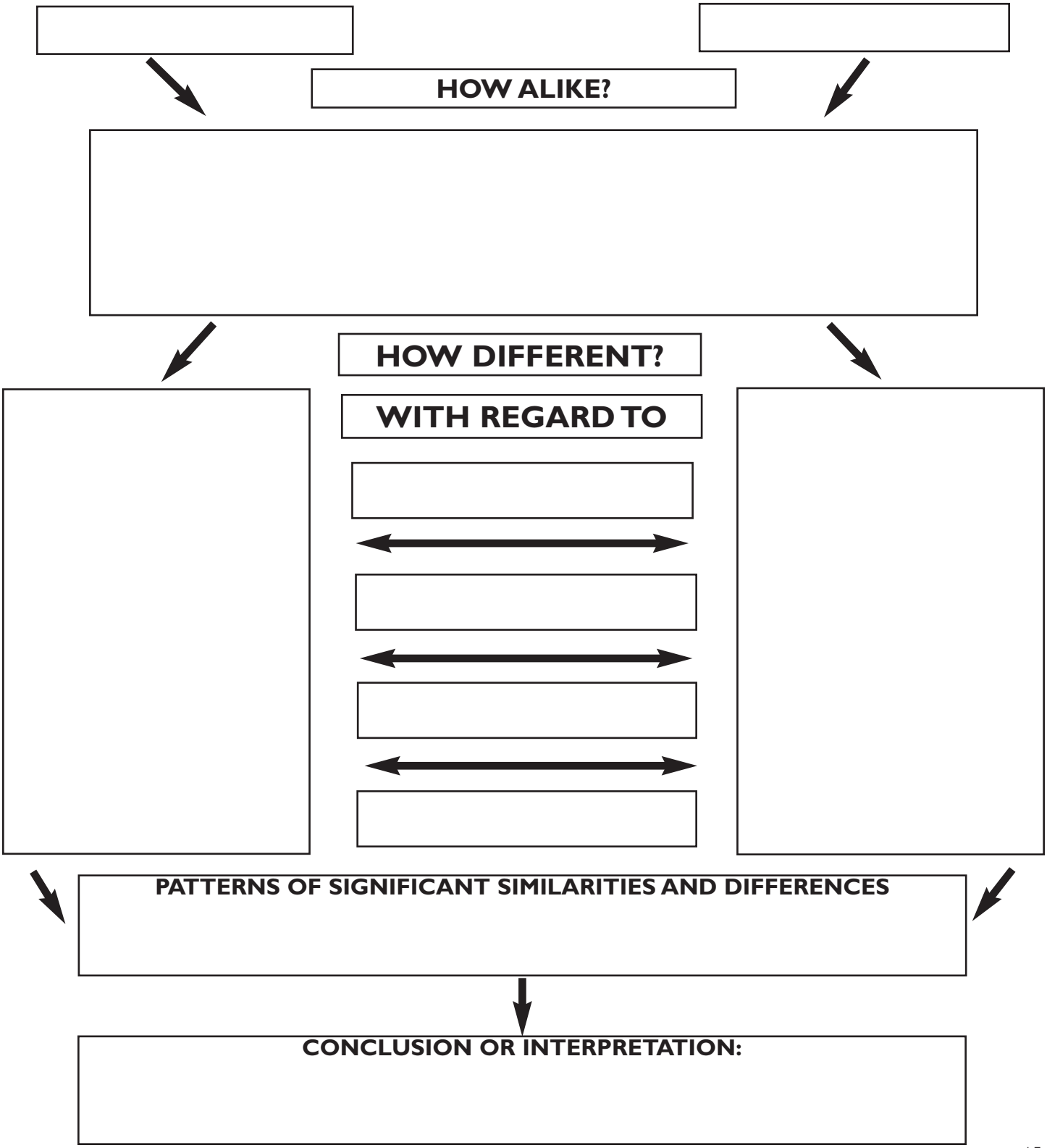
Invasive species are successful because they have no natural predators and have specialized features that allow them to take over native species' niche. They have high reproductive success, making them a serious threat to ecosystems … economically …

CONCLUSION OR INTERPRETATION:

Complex issues surrounding invasive species – one strategy does not fit all. Bottom line, prevention! If we want to sustain the diversity of species and protect the ecosystems in Northern New England, we must increase awareness, working to avoid inadvertently introducing threats.

Bioinvasion – Compare and Contrast

Adapted from: *Infusing the Teaching of Critical and Creative Thinking Into Secondary Science* by Robert J. Swartz, et al.



Invasive Species Truths and Myths

Directions: Read each statement below. Indicate if it is a Truth or Myth by circling the appropriate word. Be ready to support your answer with evidence.

Truth / Myth **1.** Maine, New Hampshire, and Vermont all face different invasive species threats.

Truth / Myth **2.** All invasive species were introduced to northern New England by accident.

Truth / Myth **3.** Scientists track the spread of invasive plant species like hydrilla and purple loosestrife on maps.

Truth / Myth **4.** Invasive species include animals, plants, and microbes.

Truth / Myth **5.** Species are only considered "invasive" if they do harm to humans.

Truth / Myth **6.** Introduction of a natural predator to an area with invasive species is one method of easily eradicating unwanted species.

Truth / Myth **7.** Each year, billions of dollars are spent in efforts trying to combat unwanted, non-native species in the United States.

Truth / Myth **8.** Invasive species cause the extinction of native species.

Truth / Myth **9.** Eradication of an invasive species is always the best strategy, because then the region can return to the pre-invasive state.

Truth / Myth **10.** Informed, observant individuals are often the first line of defense in controlling the spread of invasive species.

Most Un-Wanted Poster
Quality Criteria Guide

Research due date: _____
Rough draft due date: _____
Final draft due date: _____

Information Required

Common name(s)

Scientific name

Description of organism – Highlight special characteristics that make this species especially suitable for its new habitat

Origin – Where is the native habitat of this organism?

How or why was this species introduced?

Ecological impacts
- Current invasive range
- Population growth
- Impact on existing food webs (What eats it? What does it eat?)
- Impact on biodiversity of ecosystem it lives in now

Control and prevention methods

Color picture or sketch of organism

Poster Format and Materials

22" X 28" poster board
Vertical orientation
Centered title headline, common name listed below.
Neat, easy-to-read type (both size and font).
Author names and date in bottom left corner
References listed on back

"Most Un-Wanted"
Common name of organism

PHOTO

Be An Invasive Species Detective!

You're on a QUEST!

Are invasive plants or animals a problem in your neighborhood? As you take a walk or drive around your neighborhood, see if you can spot invasive organisms. Ask your parents or elders if they have noticed whether the flora and/or fauna have changed in the area. List specific changes in your area. Are these the result of an invasive species? If so, which one(s)?

Make a visit to a boat launch, state park, or nature center. Is there any material posted regarding invasive species? Describe your observations and findings:

Investigate the current laws in your state regarding invasive species. There are many good resources available from state agencies, local environmental groups, and on-line. Record your findings here:

QUEST: Investigating Our World is a regional public television series seen on Maine Public Broadcasting Network, Vermont Public Television, and New Hampshire Public Television

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Invasive Species List

MAINE	NEW HAMPSHIRE	VERMONT
Purple Loosestrife *Lythrum salicaria*	**Purple Loosestrife** *Lythrum salicaria*	**Purple Loosestrife** *Lythrum salicaria*
Hydrilla *Hydrilla verticillata*	**Variable Water Milfoil** *Myriophyllum heterophyllum*	**Common Buckthorn** *Rhamnus cathartica*
Eurasian Water Milfoil *Myriophyllum spicatum*	**Eurasian Water Milfoil** *Myriophyllum spicatum*	**Japanese Knotweed** *Polygonum cuspidatum*
Water Chestnut *Trapa natans*	**Water Chestnut** *Trapa natans*	**Eurasian Water Milfoil** *Myriophyllum spicatum*
White Pine Blister Rust *Cronartium ribicola*	**White Pine Blister Rust** *Cronartium ribicola*	**White Pine Blister Rust** *Cronartium ribicola*
Woolly Hemlock Adelgid *Adelges tsugae*	**Woolly Hemlock Adelgid** *Adelges tsugae*	**Woolly Hemlock Adelgid** *Adelges tsugae*
Green Crab *Carcinus maena*	**Green Crab** *Carcinus maena*	**Zebra Mussel** *Dreissena polymorpha*
Gypsy Moth *Lymantria dispar*	**Gypsy Moth** *Lymantria dispar*	**Sea Lamprey** *Petromyzon marinus*
Northern Pike *Esox lucius*	**Northern Pike** *Esox lucius*	**Northern Pike** *Esox lucius*
West Nile Virus *Flavivirus*	**West Nile Virus** *Flavivirus*	**West Nile Virus** *Flavivirus*