



# Bioinvasion

## High School Lesson Plan

**Topic** Competition in ecosystems from invasive species

**Grade Levels** 9-12

### Overview

This teaching unit explores bioinvasion – the rising occurrence of organisms from other parts of the world “invading” New England and eliminating native species of plants and animals. This trend of organisms “hitchhiking” from one part of the world to another is on the increase. Once a foreign species enters a new ecosystem, it often finds a favorable environment where it can outcompete a native species. Since other organisms in the habitat are unfamiliar with the newcomer, it may not have any predators. As a result, it takes over the landscape from the native species. Its population goes unchecked, reproducing rapidly and invading other territories.

### Introduction

In this unit, students will explore the phenomenon of rapid expansion of an invasive organism in an ecosystem. They will begin by reviewing the types of relationships that organisms have in an ecosystem – either cooperative or competitive. They will then examine the checks and balances that control communities of organisms in an ecosystem. Finally, they will investigate what it is about invasives that cause them to be so successful – for example, lack of predators and the ability to multiply rapidly.

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

- Describe and give examples of cooperative and competitive relationships in an ecosystem.
- Identify the impact of species loss in ecosystems.
- Identify the life history of an invasive species in New England, and suggest methods for controlling the spread of the species.

**Time Allotment** 6 class periods of 45 minutes each, or 3-4 longer blocks of class time

### Assessing Prior Knowledge

Students should have a basic understanding of population dynamics. They should know the key factors that affect population size, such as birth rate, mortality rate, life expectancy, and basic resource needs (food, water, shelter). Students should also have some background knowledge about cooperative or competitive relationships between organisms in an ecosystem.

**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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## Concepts to Clarify

Research has shown that many high-school students can determine how the removal of a producer or primary consumer from the food web impacts the species above it. However, students sometimes have difficulty tracing the effects of the removal of a predator species on organisms below it in the food web. It has also been suggested that using the food-chain model in an effort to build up to the food-web model can make it difficult for students to identify the impact on specific species from one trophic level to another in complex ecosystems. Students tend to believe either that every predator feeds upon all of the organisms at all of the lower trophic levels in the food web, or, conversely, that when a predator is removed, the only impact to lower-trophic-level organisms is on those that are directly connected in a food chain.

## CONNECTIONS TO THE STANDARDS

<b>Maine Learning Results</b>	<b>New Hampshire Curriculum Framework</b>	<b>Vermont Learning Standards</b>	<b>National Science Education Standards</b>	<b>Benchmarks for Science Literacy</b>
<p><b>Implications of Science and Technology</b></p> <p>M2. Demonstrate the importance of resource management, controlling environmental impacts, and maintaining natural ecosystems.</p>	<p><b>Life Science</b></p> <p>3b. Predict, with rationale, the effects of changing one or two factors in an ecosystem, e.g., “What would happen if mosquitoes were to suddenly disappear?”</p>	<p><b>The Living World: Organisms, Evolution, and Interdependence</b></p> <p>7.15. Eee. Analyze and explain natural resource management and demonstrate an understanding of the ecological interactions and interdependence between humans and their resource demands on environmental systems (e.g., production, consumption).</p>	<p><b>Content Standards (9-12)</b></p> <p><b>C. Life Sciences: The Interdependence of Organisms</b></p> <p>Organisms both cooperate and compete in ecosystems. The interrelationships and interdependencies of these organisms may generate ecosystems that are stable for hundreds or thousands of years.</p>	<p><b>Chapter 5: The Living Environment</b></p> <p>5D. Like many complex systems, ecosystems tend to have cyclic fluctuations around a state of rough equilibrium. In the long run, however, ecosystems always change when climate changes or when one or more new species appear as a result of migration or local evolution.</p>



### Materials Needed

- TV with VCR
- QUEST: *Bioinvasion* video
- Computer(s) with Internet access for teacher and/or student use
- Chart paper and markers
- Colored pencils, crayons, or markers
- Student Handout 1: Relationships in Your Life
- Student Handout 2: Relationships in a Forest Ecosystem
- Student Handout 3: QUEST: *Bioinvasion* Video Viewing Guide
- Student Handout 4: Researching Bioinvasives
- Student Handout 5: *QUEST at Home: What's Growing Out There?*

## I. Introducing the Concepts

In this introductory activity, students will explore the types of relationships they experience in their everyday lives. They will identify relationships that are based on competition, predation, parasitism, commensalism, or mutualism.

### Step 1

Give each student a copy of Student Handout 1: The Relationships in Your Life. Direct students to complete the chart individually. Each student should describe a variety of types of relationships with living things in the world around them – the broader the variety the better. These relationships should include people such as parents, brothers or sisters, friends or foes, pets, livestock, bacteria or viruses etc. Have the students identify the person or organism in column one. In column two, ask them to describe in their own words the relationship such as “I am dependent upon parents for home,” or “my dog is dependent upon me for food.” They should describe the relationship in their own terms. When they have finished, have students discuss their lists in small groups. (Arranging students in teams of three allows for good participation by each group member.) Have the teams try to cluster relationships into groups of similar types. In the third column, write the characteristic they used to identify the groups.

Hand out the list of biological categories and definitions of relationships. In Part II of the handout, ask students to list their relationships under the appropriate terms, then discuss their decisions with their team.

### Step 2

After all teams have completed their handouts, discuss some of the examples that students have identified, clarifying terms where necessary. Allow time for questions and discussion.

## 2. Exploring the Concepts

In this activity, students will further explore different kinds of relationships by applying them to forest ecosystems. They will identify examples for each type of relationship and will create a food web that incorporates the variety of types.

### Step 1

Give each student a copy of Student Handout 2: Relationships in a Forest Ecosystem. Have students complete Section I of the handout individually. Then direct them to gather in their earlier teams to discuss their work. Each team should be able to identify a pair of organisms in a forest ecosystem that can be an example of each type of relationship such as:

- Competitive:** coyote and fox;
- Predatory:** fox and rabbits
- Parasitic:** deer and ticks
- Commensal:** lichen and tree
- Mutual:** squirrel and oak

Check students' understanding either by circulating and checking their examples or by leading a whole-class discussion with teams providing specific examples.

### Step 2

Using the examples they have identified in Part I, teams should now draw a food web for a forest ecosystem with at least one example of each type of relationship.

## 3. Developing the Concepts

In the next activity, students will investigate more thoroughly the role of competition in an ecosystem. They will identify how competition for resources can be a limiting factor in population growth.

### Step 1

(**Note:** You can have students do this part of the activity either individually or in teams.) First, ask students to look at the food web diagrams they created in the previous activity. Then distribute one sheet of white paper to each student or team. Direct students to draw three equidistant boxes running horizontally across their paper. In each box, they should draw and label a species that is a producer in the forest. Above each species, students should identify at least two species that are primary consumers that might compete for their food resource. (Primary consumers can be repeated from one box to another, but not more than twice.) Have students repeat this process for secondary consumers.

### Step 2

Now ask students to introduce a new species to the diagram. It will be a secondary consumer, and it will be able to outcompete any other organism for the selected food resource. Direct students to draw a



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new box containing the “invader” in a different color from the other species on their papers. Next, ask them to draw a line across the species that would be affected by the invader.

If you have not already grouped students in teams, do so now. In their teams, have students discuss all of the ways in which the invading species would impact the forest ecosystem food web. They should note these changes on their sheets of paper.

### Step 3

Ask each team to list three factors that control the population levels of an organism (reproductive success, mortality, available resources, etc.). Make a class list of these factors on chart paper. Then, as a class, discuss what might allow the dynamics of the forest to return to a balance after the “invasion.”

Next, ask students to introduce a new species at the producer level. Tell them that this new species will consume all of the resources within the identified niche of the one producer it replaces. Once again, direct students to add this new species to their papers with a different color, and have them mark any and all affected species with the same color.

### Step 4

Ask students to brainstorm with their teams to decide what factors might be able to control the population levels of this invasive species. Then ask, “If a New England species moved from one state or region to another, would it have the same impact, more impact, or less impact than a species coming from the Far East?” Allow teams time to discuss this question. Have each team develop a rationale for their opinion. Then ask teams to respond to the following questions:

- What might control the invading species’ population growth if it were a native New England species?
- Why couldn’t that same factor control an exotic species?

Have teams share their responses; discuss as a whole class.

### Step 5

Next, present students with the following scenario: The invasive producer population explodes because of low mortality, high reproductive success, and aggressive growth. The species will now outcompete all of the identified producers, creating a monoculture of this species. Have students mark, in a third color, all of the species that will be affected by this.

Lead a whole-class discussion about the impact of an invasion of this magnitude. Explore with students what might control the population levels of such a new species moving into an ecosystem if it were a native species (such as coyotes expanding their territory). Then ask, “What is the difference if the species is not from anywhere in the United States? How could resource managers work to control these invasive species?”



### 4. Synthesizing the Concepts

In the next activity, students will watch the QUEST: *Bioinvasion* video and will take notes on the cases presented.

#### Step 1

Distribute copies of Student Handout 3: QUEST: *Bioinvasion* Video Viewing Guide. Tell students to work in their teams. Then have each team divide the questions on the handout amongst its members. Each team member should collect information in response to at least one question while watching the video.

#### Step 2

**Play** the QUEST: *Bioinvasion* video. If possible, view the entire tape. If not, watch either the segment on the hemlock woolly adelgid or the segment on the aquatic hydrilla invasion in Pickerel Pond. Check to make sure that students are noting down information while they view the film.

#### Step 3

When students have finished viewing, have them share their responses to the handout questions with team members. Then have teams share their answers with the whole class.

### 5. Applying the Concepts

The following activity allows students to investigate further one of several species of invasive species that threaten New England. They will be asked to create a presentation with visuals to share their research findings with the class or, if possible, the larger community.

#### Step 1

Give each student a copy of Student Handout 4: Researching BioInvasives. Review the information with students and make sure that they understand the assignment. Point out the Web sites listed; they provide good research materials on New England bioinvasives. Also, be sure to assign a due date for teams to present their findings.

Each team of students should work together to research one bioinvasive species. They will then compile a presentation based on their research findings. One component of their presentation should be written – either a flyer, a brochure, or a report. It should be relatively short, and it must include some recommended action steps to take in the community. A second component should be visual – either a poster, overheads, or a PowerPoint™ presentation. The third component should be an oral report.

**Note:** When giving the assignment, be sure to establish criteria for successfully completing each component. Quality criteria should include a rating of how well the three components work together. Each student can be marked on the quality of the research as well as on his or her presentation component.

#### Step 2

Each team should begin by determining the kind of presentation they want to give and what kinds of information they will need to research their chosen species. Their next step will be to conduct the



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actual research. Then, once teams have assembled all the necessary information, they should begin to design their presentations.

Each student will need either access to the Internet or print materials from the resource sites listed on the handout. Library resources can, of course, also be used.

### Step 3

Upon completion of their projects, have student teams make presentations to the class. You can choose to invite parents or community members to these daytime presentations, or you might consider having a parent information evening. You might also choose to have teams present their information to the local conservation commission or a civic organization.

## 6. Extending the Concepts

### QUEST at Home

Distribute copies of Student Handout 5: *QUEST at Home: What's Growing Out There?* 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.

### Career Opportunities

The monitoring and control of bioinvasive species is thought to be one of the fastest growing fields in biology. The following are a list of some of the professions that are involved in managing invasive species. Discuss some of the following related career options with students. See if they can identify what role each professional might play in trying to control bioinvasives. If possible, invite one or more of these professionals to come to school and speak with the class about their jobs and what they entail.

**Botanist, aquatic biologist, zoologist, limnologist, entomologist, conservation biologist, forester, resource manager, environmental educator**

### Community Connections

Investigate invasive species in your community. Contact your local USDA Agricultural Extension Service Representative and ask whether there are any exotic species growing in the local area. Inquire whether these species pose a threat to native species. Inform your neighborhood about any species that are of concern.

If you have a pond or lake in your area, see if there is a local lake monitoring group that examines the water periodically for invasive species. If there is a boat launch, contact the state to see if there are any posters that could be placed at the launch to notify boat owners about exotic species and preventing the spread from water body to water body. If your lake has many boats in the summer, determine if there is a volunteer group that could hand out information about aquatic invasive species, or a marina that could post such information. You may be able to obtain posters or other information from your state offices to post around the lake.



### Resources

Botany glossary:

<http://biology.jbpub.com/Botany/glossary.cfm>

Invasive species and natural resource pest information:

<http://pronewengland.org/Content/PROInfoInvasiveNatRes.htm>

A government-sponsored invasive species Web site:

<http://www.invasivespecies.gov>

An invasive plant atlas of New England:

<http://invasives.eeb.uconn.edu/ipane>

Information about loosestrife:

<http://ceinfo.unh.edu/Counties/Hillsborough/loosestr.htm>

New Hampshire Lakes Association: information about aquatic exotics

[http://www.nhlakes.org/ed\\_aqu\\_exo.htm](http://www.nhlakes.org/ed_aqu_exo.htm)

New England Wildflower Society – information about invasive plants:

<http://www.newfs.org/conserve/invasive.htm#links>

U.S. Department of Environmental Protection: New England Region – Invasive Species:

<http://www.epa.gov/region1/topics/ecosystems/invspecies.html>

Native plants of New England:

<http://gardening.about.com/cs/msubnativene>

New England Wildflower Society: information about native plants

[www.NEWS.org](http://www.NEWS.org) Invasive species and natural resource pest information:

<http://pronewengland.org/Content/PROInfoInvasiveNatRes.htm>

A government-sponsored invasive species site:

<http://www.invasivespecies.gov>



## Relationships in Your Life

### Part I. IDENTIFYING RELATIONSHIPS

Individual or Organisms	Description of Relationship	Category of Relationship

### Part II. DEFINING RELATIONSHIPS

First, review definitions on the second page of this handout. Then, sort your relationships using those terms:

**Competitive:** \_\_\_\_\_  
\_\_\_\_\_

**Predatory:** \_\_\_\_\_  
\_\_\_\_\_

**Parasitic:** \_\_\_\_\_  
\_\_\_\_\_

**Commensalism:** \_\_\_\_\_  
\_\_\_\_\_

**Mutualism:** \_\_\_\_\_  
\_\_\_\_\_

## Definitions of Biological Relationships

**Competitive:** In a competitive relationship, two individuals are trying to use the same resource.

**Predatory:** In a predatory relationship, one individual feeds on another.

**Parasitic:** In a parasitic relationship, one organism (the parasite) lives on or in another organism (host). The parasite gets nourishment or protection from the host. The host does not benefit and is usually harmed.

**Commensal:** In a commensal relationship, one organism lives in or on another (host). One organism benefits, and the host is not affected. It is neither harmed nor benefits.

**Mutual:** In a mutual relationship two different kinds of organisms live in cooperation. Both organisms benefit from the association, neither is harmed.



## **Relationships in a Forest Ecosystem**

### **Part I. RELATIONSHIP CHART**

Species 1	Species 2	Type of Relationship

### **Part II. FOOD WEB**

Create food web for a forest ecosystem that incorporates at least one example of each type of relationship.



## **QUEST – Bioinvasion Video Viewing Guide**

**Divide the following questions among the members of your team.  
Record notes in response to your question(s) while you watch the video.**

1. How was the invasive species first identified?
2. What are the characteristics that make each invasion species identifiable?
3. How was this species introduced to this region?
4. Has the species been found elsewhere in the United States? Where?
5. What threat does the species pose to New England plants or animals?
6. Has a response action been determined for eliminating the species?



## Researching Bioinvasives

A local conservation group has recently become aware of the threat that bioinvasives pose to your state. They have heard that you are studying these pest species, and have asked that you provide their club members with some background information. They would also like to know your opinion on what actions they might take to protect the community from these species.

- You are asked to create a presentation. It should include **three** components:
  - 1) A **written** component – either a brochure, a flyer, or a summary report. This should include some ideas about actions for the conservation group to take.
  - 2) A **visual** component – a poster, a PowerPoint™ presentation, or overheads that illustrate the problem
  - 3) A 5-minute **oral presentation** that summarizes the key points you found during your research. You should use your visual component during the oral presentation; you should also explain your rationale for the actions you are recommending.
- Each member of your team will be responsible for **(1) researching one invasive species** and **(2) doing one component of your presentation**. Each component should complement the others, providing additional important information.

### Web Sites on Bioinvasives

Invasive species and natural resource pest information:

<http://pronewengland.org/Content/PROInfoInvasiveNatRes.htm>

A government-sponsored invasive species site:

<http://www.invasivespecies.gov>

Invasive plant atlas of New England:

<http://invasives.eeb.uconn.edu/ipane>

Information about loosestrife:

<http://ceinfo.unh.edu/Counties/Hillsborough/loosestr.htm>

New Hampshire Lakes Association: information about aquatic exotics:

[http://www.nhlakes.org/ed\\_aqu\\_exo.htm](http://www.nhlakes.org/ed_aqu_exo.htm)

New England Wildflower Society: information about invasive plants

<http://www.newfs.org/consERVE/invasive.htm#links>

U.S. Department of Environmental Protection – New England Region: invasive species:

<http://www.epa.gov/region1/topics/ecosystems/invspecies.html>



# What's Growing Out There?

## You're on a QUEST!

**D**o you have any exotic species invading your neighborhood? Find out about any bioinvasives in your region by speaking with local county extension agents, or visiting one of the web sites listed below. Research those species that might grow near you. Learn what type of habitat they grow in and how to identify them by using resources at the library or on the Internet. Take a walk around your neighborhood and see if you can find any of these exotic species. Many of the most harmful species are aquatic – they live in freshwater lakes or ponds. Become familiar with these species and how they spread in order to share the information with family and friends who might go boating. Create a map of where possible suitable habitats are in your neighborhood so that you can keep a “watch” on them.

Some bioinvaders, such as Japanese barberry and purple loosestrife, were originally used as ornamental plantings around homes. Some aquatic species were introduced when they were sold as live aquatic plants for aquariums. These have slowly been taking over the countryside and eliminating the native plant populations. Many wildflower groups encourage nurseries and home owners to cultivate native species rather than import more exotic ornamental plants. Investigate native plant species that might be nice to add to your garden by doing research at the Web sites below. Talk to a local nursery about the availability of native plant species versus ornamental plants for landscaping. Make a list of those exotic species commonly used for home gardening, and alternative native plant species. Share your ideas with your class.

## Resources

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Botany glossary:

<http://biology.jbpub.com/Botany/glossary.cfm>

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A government-sponsored invasive species Web site:

<http://www.invasivespecies.gov>

An invasive plant atlas of New England:

<http://invasives.eeb.uconn.edu/ipane>



Japanese Barberry  
(*Berberis thunbergii*)



Purple Loosestrife  
(*Lythrum salicaria*)

Information about looestrife:

<http://ceinfo.unh.edu/Counties/Hillsborough/loosestr.htm>

New Hampshire Lakes Association: information about aquatic exotics

[http://www.nhlakes.org/ed\\_aqu\\_exo.htm](http://www.nhlakes.org/ed_aqu_exo.htm)

New England Wildflower Society – information about invasive plants:

<http://www.newfs.org/conserve/invasive.htm#links>

U.S. Department of Environmental Protection: New England Region – Invasive Species:

<http://www.epa.gov/region1/topics/ecosystems/invspecies.html>

Native plants of New England:

<http://gardening.about.com/cs/msubnativene>

New England Wildflower Society: information about native plants

[www.NEWS.org](http://www.NEWS.org)

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