NASHUA RIVER WATERSHED ASSOCIATION

Nashua River Watershed Investigations for Grades K - 8

Lesson # 8-3

Title: 8-3 How do genetic and environmental factors favor exotic aquatic plants in some locations?

Grade Level & Standard: Grade 8
8MS-LS1-5. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.

Objectives: Students will examine a collection of aquatic plants from a local river or pond, identify several species, and determine if invasive or native plants are genetically more successful in that environment. (If collection of plants is not possible, there are many online resources for learning about invasive plants. See extensions.) In Activity 2, students will compare two texts: map reading and text to make inferences about how environmental factors influence the growth of aquatic invasive plants.

Background: In the Nashua River watershed there are several invasive aquatic plants that are very successful at out-competing local aquatic plants. They are successful at reproduction, have fewer predators and very rapid growth. These exotic plants create mats of plant growth that damage local aquatic ecosystems.

Vocabulary

- **Submerged aquatic plant** - plant rooted in the river bed and completely submerged below water surface
- **Exotic plant** - plant introduced from another country
- **Invasive plant** - an invasive species is a non-native species (including seeds, eggs, spores, or other propagules) whose introduction causes or is likely to cause economic harm, environmental harm, or harm to human health
- **Plant density** - number of individuals of a given species that occurs within a given sample unit or study area
- **Chemical control** - chemical means of controlling plant growth
- **Mechanical control** - cutting, harvesting or pulling plants

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Discussion Points: Have you ever been to a lake or river that is completely covered with aquatic plants?

Materials:

- collection of aquatic plants from a river or pond or images of invasive plants such as water chestnut, fanwort, milfoil and native plants such as duckweed, elodea, and hornwort. Images can be found using attached booklets in pdf below.
- pressed plant samples or copies of pressed plants
- white basins
- magnification tools (hand lens, magiscope, dissecting scope)

Resources included:

- *Guide to Invasive Aquatics DCR (booklet)*
- *A Guide to Aquatic Plants in Massachusetts (booklet)*
- Water Chestnut Fact Sheet: U.S. Fish & Wildlife Service
- Reading: The Problem: Plants are Choking Pepperell Pond!
- *Invasive Plant Survey at the Pepperell Hydroelectric Project, 2013.*

Procedure:

Activity 1 - Aquatic Plant Lab Investigation:

1. Collect aquatic plants from a local pond or mature river one day before lab. Plants can be collected in advance and pressed for later use. Plants can be harvested from April to November.
2. Separate different plants by looking at characteristics.
3. Use the plant keys to identify plants.
4. Count the number of plants of each type and determine the most common species.
5. If plants can not be collected, images can be used instead.The teacher can alter the percentages of invasive vs native. See extensions.
6. Complete data sheet 8-3: Aquatic Plant Lab Investigation.

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Activity 2 - Reading maps and text to assist with problem solving:

1. Students will look at three maps in the ***Resource Study Report: Aquatic, Littoral and Riparian Vegetation Assessment and Invasive Plant Survey at the Pepperell Hydroelectric Project*, 2013**.
2. Map of the Pepperell Hydroelectric Project (PHP) study area on page 3- Figure 1 of the study. Notice the location of the town of Pepperell, the river morphology, and study areas A and B.
3. Use two maps on pages 16 and 17: Density of water chestnut beds within the PHP area (figure 3-Parts A and B).
4. Determine the **Water Chestnut density classes** of study areas Part A- #1-11 and Part B-#13 and 18.
5. Refer to page 6, Table 1: Plant density classes employed in the assessment of invasive plant populations at the PHP study areas to determine the percentage cover within study areas.
6. Students will also complete the reading, The Problem: Plants are Choking Pepperell Pond, to develop background knowledge.
7. Using information from Activities 1 and 2, students answer questions on "**Can you solve the invasive plant problem in Pepperell Pond?"** attached below.

Data sheets attached

- Aquatic Plant Lab Investigation
- "Can you solve the invasive plant problem in Pepperell Pond?" study sheet

Extension:

- www.mass.gov/eea/agencies/dfg/dfw/natural-heritage/land-protection-and-management/invasive-species/invasive-plants.html
- https://www.invasivespeciesinfo.gov
- https://www.fws.gov/invasives/index.html
- DESE Model Curriculum Unit - *Invasive Species: A Study of the Disruption of an Ecosystem's Dynamics (grade 7) and Shaping Natural Systems through Evolution (grade 8)*

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Aquatic Plant Lab Investigation NRWI Lesson 8-3

1. Observe and draw four species of aquatic plants in your sample. Label leaves, stem, roots and flowers if present. Use the aquatic plant identification keys to determine the species and if the plant is invasive or native.

Species_____	Species_____
Species_____	Species_____

2. Using class data from all students, determine the occurrence of invasive plants and native plants within the total sample of plants collected.

Native plants	#
Invasive, non-native plants	#

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The Problem: Plants are Choking Pepperell Pond

There are many invasive plants covering Pepperell Pond, an area of the Nashua River that is held back by a hydroelectric dam. If the dam was not in place, the Nashua River would be narrower and flowing faster.

What?
Water chestnut, fanwort, Eurasian watermilfoil, variable-leaf watermilfoil, and curly-leaf pondweed are in an advanced stage of invasion within the study area, together infesting hundreds of acres of the Pepperell Hydroelectric Project (PHP). Water chestnut cover is extensive in the northern half of the study area. The water chestnut footprint—the measured area in which plants have been observed in varying densities—is about 91 acres, more than 70% of which is made up of dense beds of overlapping plants.

Why so bad?
Though water chestnut is known to improve some aspects of water quality (through heavy metal accumulation and inorganic nitrogen uptake), and can provide habitat for certain insects and birds, a large infestation like the one at PHP poses ecological and recreational problems. Documented detrimental effects include displacement of natural aquatic vegetation, including waterfowl food plants, decreased dissolved oxygen levels that may degrade water quality and harm fish populations, and reduced recreational boating and swimming access (Hummel and Kiviat 2004).

Why have they grown?
Water quality assessments of Pepperell Pond and nearby reaches of the Nashua River (MA DEP 1998, 2003, 2007, Carelli et al. 2008) have demonstrated that the impoundment receives excessive nutrient inputs from the surrounding landscape resulting in eutrophication. High levels of aquatic vascular plant and algal growth are common during the summer (MA DEP 2007). Three invasive aquatic plants (water chestnut, fanwort, and curly-leaf pondweed) were documented from Pepperell Pond, and two (Eurasian watermilfoil and variable-leaf watermilfoil) from other reaches of the Nashua River in 1998 and 2003 (MA DEP 1998, 2003).

Solution?
Currently there is no simple solution for gaining control over such a large water chestnut infestation. As water chestnut is an annual, control efforts must focus on consistently preventing seed set each year for many consecutive years. Though no suitable biocontrol agent has been made available to managers to date, prospective candidates are under investigation (Hummel and Kiviat 2004, Ding et al. 2006, Bugwood Wiki 2013). A common current control approach is to employ a combination of chemical and mechanical methods (Hummel and Kiviat 2004), all of which are expensive and labor intensive.

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Can you solve the invasive plant problem in Pepperell Pond? NRWI Lesson 8-3

Maps and texts will be used to answer the following study questions.

1. First look at the map of the Pepperell Hydroelectric Project (PHP) study area on page 3-Figure 1 of the study. Notice the location of the town of Pepperell, the river morphology, and study areas A and B. **What else do you notice about the study areas?**

2. Next, look at the Water Chestnut Density map on page 16, figure #3-Part A. The scientist has used numbers to identify the study areas. Find seven environmental factors of study areas #1-11, such as open water, narrow channel, man-made features.

3. Now look at the Water Chestnut Density map on page 17, Figure #3-Part B. The scientist has used numbers to identify the study areas. Look closely at the environmental factors of study areas 13 and 18 and list seven factors.

4. Now compare Water Chestnut densities and locations of study areas in Parts A and B. Look at the Chestnut Density keys for Part A and B and refer to Table 1: "Plant density classes employed in the assessment at invasive plant plots at the PHP study areas"" on page 6 to find percentage density. What is the density of chestnuts in study areas? Why do some areas have more water chestnuts?

5. Why have these invasive plants been so successful? What genetic and environmental factors have contributed to their growth? Refer to the reading, lab notes and maps to write one paragraph about genetic factors and one paragraph about environmental factors.

6. How could you change the environment to control the invasive aquatic plants in Pepperell Pond? Research several ideas to control water chestnut growth.

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