Strife in the Wetlands

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Standard Statements:

Know types of pests. 4.5.4.A
Know how pests fit into a food chain.
Explain pest control. 4.5.4.B
Know reasons why people control pests.
Explain how pest management affects the environment. 4.5.7.B
Identify issues related to integrated pest
management that affect the environment.

Standard Statements for Additional Categories in Environment and Ecology:

Watersheds & Wetlands
Explain and describe characteristics of a wetland. 4.1.7.D
Describe the different functions of a wetland.
Describe the impact of watersheds and wetlands on people. 4.1.7.E
Explain the impact of watersheds and wetlands in flood control, wildlife habitats and pollution abatement.

Environmental Health
Describe how human actions affect the health of the environment. 4.3.7.B
Explain biological diversity. 4.3.7.C
Explain biological diversity as an indicator of a healthy environment. 4.3.10.C

Ecosystems & Their Interactions
Explain the flow of energy and matter from organism 4.6.7.A to organism within an ecosystem.

Threatened, Endangered and Extinct Species
Describe diversity of plants and animals in ecosystems. 4.7.7.A
Explain natural and human actions in relation to the loss 4.7.7.C of species.
Explain the significance of diversity in ecosystems. 4.7.10.A

Environmental Laws and Regulations
Explain the role of environmental laws and regulations. 4.9.7.A

Content Objectives:
Student will be able to:
Simulate the effect an invasive plant has on the biodiversity in a wetland.
Prepare a graphic representation of a population of purple loosestrife in comparison to other populations of species in a community from "collected samples".
Draw a food web of a wetland community.
Predict the effect methods of pest management have on the spread of purple loosestrife.

Assessment Strategies:
Completion of bar graph
Analysis of collected data
Offers demonstration of understanding in completion of group project

Suggested Level:
Grades 7-10

Standard Category:

4.5.4 A
4.5.4 B
4.5.7 B

Materials:
Student Reference Pages including background information, a file of supplemental resources and a list of related web sites

4 sets of 2" x 2" cards (can be prepared previous to lesson by teacher or assigned as group work to begin lesson) approximately 100 cards per set (see "List for Suggested Wetlands Organisms")
laminated construction paper or craft foam sheets
color coded to represent the following:
purple - purple loosestrife
green - other plants
gray - microorganisms/algae/fungi
pink - lower forms of animal life/mollusks/worms
yellow - insects and other arthropods
red - fish, amphibians and reptiles
blue - birds
brown - mammals

Graph paper
Rulers
Poster board
Drawing representing an area of a wetland having a boardwalk and observation deck

Drawings of predicted outcomes using IPM
Oral presentations

Alternate Assessments:
Write the biological classification names for purple loosestrife from kingdom through genus and species names.
Refer to Latin and Greek meanings for prefixes and root words. Select ten species mentioned in this activity and tell the literal meanings of their scientific names.
Write a report on another invasive species including its history in the U.S. and how it has been managed.
Design posters as a means to educate people about the importance of using only native species in their landscaping.

Procedures:
Part 1. Direct student attention to the Background Information sheet in their "Student Reference" packet. Inform students that they will be working in groups to simulate the growth of purple loosestrife in a wetland community and that they will work together to decide on a method to use to manage its future growth. Divide the class into four groups and provide each with a set of approximately 100 cards. Cards may be teacher-made previous to the lesson or time may be allotted for groups to make their own sets. (Refer to "List for Suggested Wetlands Species"). Cards will have a name of an organism and information on how it fits into a food web.

Provide for a large working surface (several continuous lab tables, or a large floor space such as a hallway or a gym floor). Spread the cards out face down and inform students that each group will conduct their own "collection" in the wetland. Students will name their wetland and will be responsible for analyzing the relationship of the populations they collect and for presenting their results to the class. Discuss why this activity is termed a "simulation" and that although organisms used in the activity have been identified in an actual wetland, it is very difficult to predict the growth of an invasive species in a natural community due to many interacting factors such as periods of drought, insect infestations and polluted water. Ask students to provide examples of other models which are used to predict event outcomes.

Part 2. For Collection #1, students should select cards as follows:
10 purple
40 green
10 gray
4 pink
10 yellow
6 red
10 blue
8 brown

Record the names of the organisms. Prepare a bar graph (for students grades 7-8 specific directions may be given for graph labeling and colors representing the general classes of organisms graphed. For grades 9-10, allow students to design their own graphs and inform them to count the number of each population of organisms to graph).

Collection #2 represents the same wetland, but five years later. Students should add 10 more purple cards, but reduce their first collection to the following:
30 green
8 gray
3 pink
7 yellow

Instructional Strategies:
Direct instruction using background information

Resources and supplemental web sites provided for additional student research

Use of manipulatives in a simulation format

Small group work using thinking skills in collecting, analyzing, and reporting data

Oral presentation

4 red
8 blue
5 brown

Record the names of the organisms and prepare a bar graph.

Collection #3 represents the same wetland 10 years later. Students should add 10 more purple cards and reduce their collection to the following:
20 green
8 gray
3 pink
6 yellow
2 red
6 blue
4 brown

Record the names of the organisms and prepare a bar graph.

Collection #4 represents the same wetland 15 years later. Students should add 10 more purple cards and reduce their collection to the following:
10 green
6 gray
2 pink
5 yellow
2 red
4 blue
3 brown

Record all organisms and prepare a bar graph.

Part 3. Inform students that they should review the food requirements for each of the organisms from Collections #1 and #4 and to draw a food web on poster paper for each of the two collections. This represents a time span of 15 years of growth in the wetland.

Part 4. Distribute sketches of a boardwalk ending in an observation deck in the wetland. With data from Collection #1, students should draw an arrangement of the purple loosestrife along with the other plant species. They may indicate each stand of plants as a small circle on their drawings labeled with the initials of the Genus species name for each. Students should refer to the IPM for purple loosestrife in the background sheet and decide which method(s) they should use to manage its future growth. Factors to consider include the age of the stand, the density of the growth, the bordering species and the accessibility by foot to the plant area. Students should also refer to the list of web sites for further information.

Students should repeat this procedure using data from Collection #4.

Part 5. Students should analyze the results of this activity and predict the outcome of the IPM selected. The following questions may be answered to provide groups with a framework in the preparation of an oral presentation to the rest of the class.

1. Which collection represents an area which is the most environmentally healthy? Give reasons to support your answer.
2. Explain why you selected the pest management method(s) you used. Explain also why you did not select other methods which are available.
3. Give at least three reasons why purple loosestrife is considered a pest and why it was determined necessary to regulate its planting, transport and sale.
4. Provide at least one act of nature and one human action taken which has allowed purple loosestrife to flourish.

5. How did the decrease in biodiversity over the 15 year span involved in this simulation affect the remaining organisms?
6. Give three reasons why wetlands are a valuable resource for people and three reasons why wetlands are critical to other organisms.

Estimated Duration: 3 - 4 class periods

Conclusion: In this lesson students have become familiar with the definition of an invasive species, have been introduced to the biology of purple loosestrife and have used a simulation to illustrate the impact purple loosestrife has on a wetland and its inhabitants. Students have also become familiar with IPM tactics which are being used in the field to control the spread of purple loosestrife and have selected methods and predicted the outcome of IPM on their model wetland.

Extensions:
Plan a plant sale in the school community of native species for landscaping. Donate the funds collected to a local nature center.
Visit a wetland. Prepare drawings of the relative space occupied by the growth of purple loosestrife. Identify other species observed.

References:

Environmental Protection Agency. Wetlands Fact Sheet #2 . "Values and Functions of Wetlands". EPA 843-F-93-001b, March 1993.

Florio, Gwen. "The beetles and the wily weed". The Philadelphia Inquirer, 15 April 1992.

Gresham, Cyane. "Invasive Plants in Pennsylvania". 8100-pa-dcnr 3007, April 2000.

Long, Jr., J. Kenneth. "Invasive Species Lesson Plan". Integrated Pest Management Program, The Pennsylvania Department of Agriculture and Penn State University, June 2002, p. 5.

Martin, Alexander C. Weeds. New York: St. Martin's Press, 1972.

Mercer, Robert. Naturalist Director, Silver Lake Nature Center, Bristol, Bucks County, PA. Personal interview. 12 July 2002.

Michigan State University. The Purple Loosestrife Project - Cooperator Essentials. PLP@msu, January 1999.
http://www.msue.msu.edu/seagrant/pp/

Mountain, W.L. Purple Loosestrife, Lythrum salicaria. Pennsylvania Department of Agriculture, Bureau of Plant Industry, Regulatory Horticulture 20 (2): 27-34, Weed Circular No. 20, 1994.
Weeden, Sheldon, Li and Hoffman. Biological Contol: A Guide to Natural Enemies in North America. "Galerucella culmariensis and G. pusilla". Cornell University.
http://aruba.nysaes.cornell.edu/ent/biocontrol/weedfeeders/galerucella.html

Related Web Sites:

http://www.miseagrant.org/pp/activity

http://refuges.fws.gov/NWRSFiles/HabitatMgmt/PestMgmt/LoosestrifeProblem.html

http://www.dnr.cornell.edu/bcontrol/purple.htm

Student Reference Sheets

Background: "Strife in the Wetland"

An invasive plant is a weed which aggressively displaces other plants in an ecosystem. Often these plants may grow in remote or marshy areas making their growth difficult to control. Some invasives may be native to North America, but most are termed "exotic" or "introduced" because they arrived in the United States unintentionally.

In the case of purple loosestrife, Lythrum salicaria, eastern seaports were "contaminated" with seed from Eurasia in the 1830's as ships dumped their ballast on the shores to prepare for the loading of cargo. Immigrants familiar with this beautiful rose-purple flowering plant probably planted it in their gardens and may have used it for a medicinal purpose. The genus name "Lythrum" comes from the Greek "luthron" meaning blood, possibly referring to the color of the flower or its use as an herbal remedy to stop bleeding. It was also recognized for its ability to produce large amounts of pollen and nectar. Although purple loosestrife is still admired in landscaping and valued by beekeepers as a long blooming perennial, it is listed as a noxious weed in 24 states. In Pennsylvania it has been regulated since 1997 and identified as illegal to propagate, transport or sell.

So why is it considered to be such a problem? Any sunny wetland is an ideal habitat for invading purple loosestrife and wetlands are critical to maintaining biodiversity, or the variety and abundance of species native to these areas. Many wetland areas were previously considered a nuisance and prevented developers from claiming these areas for new construction, so they were drained and filled in. Those remaining are essential to the survival of many threatened and endangered species and are primary habitats for wildlife in which to breed, nest, feed and use as cover for escaping predators. Only about 5% of our nation's lands are wetlands, but about 35% of all rare and endangered species depend on wetlands. Other vital uses of wetlands include protecting agricultural areas and downstream property from flood damage, helping to recharge ground water supplies to keep streams flowing during droughts, improving water quality by removing excess nutrients and many chemical pollutants and for providing open space for recreational activities such as fishing and observing wildlife.

Purple loosestrife replaces native wetland vegetation, eliminates food and shelter for wildlife, forms dense barriers between land and water to exclude waterfowl and reduces the natural flow of waterways. Populations of wetland birds and other animals such as muskrats, mink and some amphibians have declined. It has reached "pest proportions" in its rate of reproduction because it has no natural predators in the United States. As wetland animals eat stands of other plant species growing around purple loosestrife, these plants remain untouched and continue to flourish as more space is created for them.

Fortunately, a number of pest management strategies have been researched. Biological controls using insects may prove to be very promising in long-term control of large infestations, greater than 1,000 plants. In 1992, three insects which naturally feed on purple loosestrife in Europe were approved by the U.S. Department of Agriculture to release here. *Galerucella calmariensis* and *Galerucella pusilla* feed on bud, leaf and stem tissue. The larvae of the weevil *Hylobius transversovittatus* feeds on its roots.

Among the first sites tested was John Heinz Natural Wildlife Refuge at Tinicum, south of Philadelphia in Delaware County. Thousands of at least one of the leaf beetles survived our winters and has become established. Southeastern Pennsylvania along the Delaware River has been identified as one of the most heavily infested regions in the state. At Silver Lake Nature Center in Bristol, Bucks County, beetles were released by state officials, however, the floodwaters of Hurricane Floyd covered the plants depriving the beetles of their food source. At this same site, a physical management option was used, that of covering stands of purple loosestrife in plastic sheets. Ten years later small patches of native plants have reclaimed areas previously monopolized by these pests. In Ontario, Canada at Presque Isle Provincial Park, young plants were hand-pulled and disposed of in such a way that the seeds could not be released. Data was collected concerning the labor involved in pulling these plants, as well as the successful reduction in numbers in plant growth in the following years.

Both of these options, biological and physical have advantages over chemical management, or the use of potentially harmful herbicides. Rodeo, a broad-spectrum herbicide, has been recommended only for spot spraying of purple loosestrife as it will injure or kill native plants. Since purple loosestrife grows in aquatic habitats, chemical management may affect water quality.

So, if you see an upright, bushy plant, between 2 and 7 feet tall, having rose-purple blooms anytime from late June to early September, with opposite leaf arrangement and a stiff 4-sided stem, you've identified Pennsylvania's #2 noxious weed: Lythrum salicaria!

List for Suggested Wetlands Organisms

Note: Most of these species have been identified as residents of Silver Lake Nature Center, Bristol, Bucks County, PA. Silver Lake receives water from a considerably large watershed. Its pond, marshes and swamp forests feed water into Otter Creek, then to the Bristol Marsh and into the Delaware River. The Delaware River is the primary source for potable water for much of the population of the Delaware Valley. It is also a vital navigable waterway to Philadelphia and other cities in the region. Silver Lake is home to the Pennsylvania endangered Red-bellied turtle, among other protected species.

Refer to the color code in the Materials List to prepare the cards. Each set should have about 100 cards (40 of which represent purple loosestrife). Multiple cards may be made for any of the organisms on this list. For example 8 species of plants may be selected from the following list and five cards made for each for a total of the 40 green cards needed for Collection #1.

Plants: Unless otherwise noted on the cards, songbirds, gamebirds, and other wildlife depend on weed seeds for their existence. All plants use sunlight to make their own food.
Arrow Arum (Peltandra virginica)
Arrowhead (Sagittaria latifolia)
Bulrush (Scirpus actus)
Cardinal Flower (Lobelia cardinalis)
Cattail (Typha latifolia) muskrats feed on edible rootstocks, although they have become scarce; when cattails form dense growths they prevent the growth of other plants that supply waterfowl and other wildlife with food and cover
Dodder (Cuscuta gronovil) this is parasitic and will stunt the growth or kill other plants
Giant Reedgrass (Phragmites australis) this is another exotic species which has dominated wetlands
Joe-Pye-Weed (Eupatoriadelphus dubius)
Marsh Fern (Thelypteris palustris)
New York Ironweed (Vernonia novaboracensis)
Sedges: Bearded (Carex comosa), Hop (C. lupulina), Shallow (C. lurida)
Spikerushes (Eleocharis ocicilaris)
Spotted Smartweed (Polygonum punctatum) competes with exotic plants; eaten by waterfowl
Swamp Mallow (Hibiscus palustris)
Swamp Milkweed (Ascelpias incarnata)
Soft Rush (Juncus effusus)
Tear Thumbs (Polygonum sagittatum and P. arifolium)
Water Plantain (Alisma subcordatum)
Wild Cucumber (Echinocystis lobata)
Yellow Water Lily (Nuphar advena)

Shrubs and Occasional Trees:
Arrowwood (Viburnum dentatum)
Black Willow (Salix nigra)
Buttonbush (Cephalanthus occidentalis)
Swamp Rose (Rosa palustris)
Red Maple (Acer rubrum)
Silky Dogwood (Cornus sp.)
Sweetgum (Liquidarubar styraciflua)

Bacteria and other microorganisms: Help to break down decaying organisms.
Algae: use sunlight to make food, food for fish, insects
Fungi: help to break down decaying organisms
Snails (Mollusca): eat plants, food for fish and birds
Worms (Nematoda): many are parasites of other animals
Leeches (Annelida): blood of turtles, fish and frogs

Insects:
Bees (Hymenoptera) plant nectar
Beetles (Coloeptera) eat plants, food for fish
Cabbage Butterflies (Lepidoptera) plant nectar, observed around purple loosestrife
Caddisflies (Trichoptera) food for fish
Damselflies & Dragonflies (Odontata) eat mosquitoes and other insects, food for fish and birds
Mayflies (Ephemeroptera) food for fish, young mayflies eat plants
Spotted Lady Beetles (Coleoptera) eat other insects
Stoneflies (Plecoptera) food for fish
Mosquitoes (Diptera) eat blood of mammals and birds, eat plant juices, eaten by dragonflies

Other Arthropods:
Crayfish (Crustacea) eat plants
Ticks (Arachnida) eat blood of mammals and birds

Fish: Small fish in wetlands eat algae and insects.
Minnows (Luxilus sp. and Pimephales sp.)
Dace (Rhinichthys spp.)
Catfish (Ictalurus spp.)
Pumkinseed (Lepomis gibbosus)
Swamp Darter (Etheostoma fusiforme)

Amphibians:
Bull frog (Rana catesbaiana) eat small live animals, cannabalistic
Green frog (Rana clamitans) eat small live animals, cannabalistic
Northern Spring Peeper (Pseudacris crucifer) eat insects, small invertebrates
Southern Leopard Frog (Rana utricularia) eat small animals, cannabalistic (Endangered in PA)

Reptiles:
Common Musk Turtle (Sternotherus odoratus) inverts and small vertebrates, some plants, carrion
Common Snapping Turtle (Chelydra serpentina) plants, fish and aquatic vertebrates and inverts, carrion
Eastern Box Turtle (Terrapene carolina) plants, worms, small vertebrates, carrion
Painted Turtle (Chrysemys picta) plants, algae, insects, mosquito larvae
Redbelly Turtle (Pseudemys rubriventris) invertebrates, small aquatic animals, carrion, plants

Birds: Feed as active predators on aquatic animals, small aquatic plants, algae, seeds and tubers of aquatic plants, seeds and fruits of wetland plants.
American Woodcock (Scolopax minor)
Belted Kingfisher (Ceryle alcyon)
Canada Goose (Branta canadensis)
Double-Crested Cormorant (Phalacrocorax sp.) eat fish
Green-backed Heron (Butorides virescens) eat fish and frogs
Mallards (Anas platyrhychos)
Short-eared Owls (Asio flammens) - eats small vertebrates
Osprey (Panadion haliaetus) eats fish
Ring-billed Gulls (Larus delawarensis)
Red-tailed Hawk (Buteo jamaicensis)- eats small vertebrates
Red-winged Blackbird (Agelaius phoeniceus) - uses the stems of purple loosestrife as supports for nest construction
Spotted Sandpiper (Actitis macularia)
Swamp Sparrow (Melospiza georgiana)
Willow Flycatcher (Empidonax traillii)
Wood Duck (Aix sponsa)
Yellow Warbler (Dendroica petechia)

Mammals:
Big Brown Bat (Eptesicus fuscus) eat insects
Little Brown Myotis (Myotis lucifugus) eat insects
Meadow Vole (Microtus pennsylvanicus) eat plants
Muskrat (Ondatra zibethicus zibethicus) depend on cattails
Northern Short-tailed Shrew (Blarina brevicauda talpoides) eat plants
Star-nosed Mole (Condylura cristata) eat plants
Virginia Opossum (Didelphis virginiana) omnivorous, scavenger