Weeds vs. Bugs

Essential Question:
How can biological control agents be used to help manage invasive species?

Adapted from Alien Invasion: Plants on the Move Weed Curriculum
http://www.weedinvasion.org/weeds/weed_home.php

At a Glance:
In this activity, learners will gain knowledge of about biological control of invasive species through an interactive game of tag. The case study focuses on the invasive plant, purple loosestrife, and a leaf-eating beetle that has been successful in limiting its expansion. Any invasive species and biological control method could be substituted (i.e. Klamath weed and Chrysolina beetles)

Location: Outdoors or Indoor Gymnasium

Objectives: *Learners will*
1) describe how invasive species can out-compete native species.
2) examine host-specificity and why populations of control agents decline as their host declines.
3) relate the dynamic relationship between a host and a control agent.
4) distinguish the difference between eradication and management.

Skills: teamwork, competition

Supplies:
- Photos of purple loosestrife and beetles
- Chalkboard or paper and chalk/marker

Subjects: science

Time: 30 minutes - 1 hour

Background Information:

Learners will actively participate in a physically demanding game, which is an adaptation of Blob Tag. The game demonstrates what happens when a leaf-eating beetle that feeds on the invasive plant species purple loosestrife, *Lythrum salicaria*, is introduced into an area as biological control.

Activities, "*Aliens on Your club Site!"* and *"Native and Alien Species"* discuss how invasive species have become established in the United States and how certain adaptations enable these plants to grow and spread with the absence of natural limiting factors.

In this activity, learners will investigate how humans respond to the problem of invasive weed species. Invasive weed species have the advantage of few natural enemies and an ability to persist in a wide range of habitat and environmental conditions. When controlling invasive weeds, a single method of control is rarely effective. Land managers may control invasive weeds using chemical, mechanical (including fire), and biological control methods. Integrated Weed Management (IWM) involves using two or more control methods.

This activity demonstrates how the biological control method operates. Learners will observe changes that occur to native and invasive plants following the introduction of a host-specific control agent. Biological control is the use of animals, fungi, or other microbes to feed upon, parasitize or otherwise interfere with a targeted pest species. The most common form of

biological control involves introducing a host-specific agent, such as an herbivore or disease organism. Host specificity is very important. If an agent impacts only one particular plant, the plant's population may be reduced to more acceptable levels, and the agent's population may increase. The biological control agent's population may be kept in check as the population of its invasive host decreases. Biological control programs are dynamic. Populations of weed and control agents continue to fluctuate with biological control. Biological control does not usually eliminate populations of undesirable weeds; this method reduces populations to an acceptable level. Control agents must be imported, because invasive weed species arrive without their natural herbivores or control agents. Importing control agents introduces another alien, or exotic, species to the ecosystem. Scientists must conduct extensive research and testing before introducing biological control agents to ensure that the agent impacts only the target species and does not cause more damage to the ecosystem. An advantage of biological control as invasive species management, is that once it is established, it will persist 'forever' and it may spread on its own to cover most or all of the area where the pest is present, generally with little or no additional cost.

Invasive Plant Biography: Purple Loosestrife, *Lythrum salicaria*

Purple loosestrife is a perennial plant. Its flowers are deep purple in color and end in terminal spikes up to 18 inches in length. Square-sided stems support leaves that are opposite or in whorls of three. Leaves are lanceolate. A large root crown supports established plants.

Purple loosestrife is native to Europe and Asia. This plant established itself in the early 1800s in the northeastern United States. Its means of introduction is unknown; however, some theories propose that the plant was intentionally introduced as an ornamental. Or, it may have arrived in wool, hay, or ship ballast. Since this plant grows in wet areas, its seeds may have been part of ballast picked up in seaport areas. By 1830, this plant was common on the Atlantic coast of North America. Purple loosestrife has continued to spread westward through wetlands, and today it is found throughout North America. Purple loosestrife often dominates wetlands and impedes water flow in irrigation ditches and streams. Prolific seed production (2.5 million seeds per plant) and robust seedling survival displace native vegetation and food sources, such as cattails, sedges, and grasses for wildlife. Seeds can float in streams; or birds, humans, and other animals can transport the seeds.

Biological Control Case Study

Cutting and mowing this species is impractical because it grows on semi-aquatic stream banks. Burning also is ineffective in wet areas. Manual removal is difficult and often ineffective. The herbicide, glyphosate, kills purple loosestrife, but it is a non-selective herbicide that also kills most desirable species. Purple loosestrife usually continues to occupy the habitat when seeds in the soil sprout. Re-treatment with herbicide is then necessary. The following four insect species have been introduced to control Purple loosestrife in the Pacific Northwest:

- Two leaf-feeding beetles: Black- margined loosestrife beetle, *Galerucella calmariensis,* and Golden loosestrife beetle, *Galerucella pusilla*
- One flower-bud weevil, Loosestrife seed weevil, *Nanophyes marmoratus*
- One root weevil, Loosestrife root weevil, *Hylobius transversovittatus*

The leaf-feeding beetles have been the most effective control agents. Since the two European leaf-feeding beetles are nearly identical morphologically and in their life cycles, this activity refers to these beetles as a single entity—leaf beetle. This leaf beetle is approximately 5 mm long. It is light brown in color. In spring (late April or early May), overwintering adults emerge from the soil and litter beneath loosestrife plants to feed for several days on new foliage. Adults then begin to reproduce. Females lay eggs on leaves and stems during May and June. One female may lay up to 500 eggs during the egg-laying period. Larvae emerge in 7-10 days and begin feeding on shoot tips. At this time, adults disperse to other plants. Larvae feed for three weeks before moving into the soil or litter to pupate. Upon emerging, the new adults harden and feed (July to September) before moving into the soil or litter to overwinter. Total maturation time from egg to adult is 30-40 days.

All this leaf eating is not good for the purple loosestrife plant! These beetles can completely defoliate the plant, making it incapable of photosynthesis and flowering, which kills the plant. If the leaf beetle does not completely defoliate the plant, leaf damage reduces photosynthetic capability, which may lead to reduced starch stores in the roots, and reduced starch stores can result in overwintering mortality. Photosynthetic inhibition also results in reduced stem and root growth, which weakens or kills plants. Once the plants are gone, native species may return. Adult beetles can fly between plants. Adults, larvae, and pupae can float, which allows them to spread by current or wind. Scientists expect that the establishment of permanent, stable populations of this leaf beetle will eventually reduce Purple loosestrife populations to tolerable levels for North American wetland ecosystems.

Getting Ready:

1. Remind learners of the problem of invasive plant species and how adaptations help them become established in non-native regions. Provide learners with the definition of biological control. Go over the *Invasive Plant Biography of Purple Loosestrife* and *the Biological Control Case Study* of the *Leaf-eating Beetles with learners.*

2. *Show learners a photo of the plant, purple loosestrife,* and a picture of the leaf beetle(s) that feeds on it—Black margined loosestrife beetle, *Galerucella calmariensis,* and Golden loosestrife beetle, *Galerucella pusilla*.

3. Ask learners which organism would win in a struggle between the two. As learners discuss ideas, record key points on the chalkboard. Organize ideas into two columns, one for the strengths the plant might bring to the contest, the other for those of the leaf beetle. Label these columns "weed vs. bug."

4. After hearing the learners' ideas, tell them more about the two species. (See *Invasive Plant Biography* and *Biological Control Case Study* for more information.)

Procedure:

Part A: Invasive Species Attack!

1. This activity is adapted from the game, Blob Tag. Tell learners they are going to be magically transformed into plants and beetles. Some learners will be native plants (provide a few examples), some will be the invasive plant, purple loosestrife, and some learners will be leaf beetles. When native plants, purple loosestrife, and leaf beetles come together, learners will see what happens when an alien plant enters a native ecosystem, and when an alien beetle is introduced to the ecosystem to attack the alien plant.

2. In the gym or outside play area, establish boundaries for the game. Tell learners that everyone, except for one student, will begin as a native plant. Select and identify a student to play the role of Purple loosestrife.

3. Explain the following rules for the game:

- Tell learners to try to stay away from the purple loosestrife.
- Demonstrate what purple loosestrife can do. Explain that purple loosestrife converts native plants to more loosestrife by tagging them. (Demonstrate how to gently tag.) When tagged, a native plant must join hands with the purple loosestrife. Joining hands represents purple loosestrife successfully out-competing a native species and spreading.
- Hand in hand, both learners will search for more native plants to overcome. Only the outside hands on either end of the chain may tag learners. Learners who have been tagged must join the growing loosestrife chain.
- Loosestrife may split into smaller groups in its pursuit of native plants. Loosestrife must have at least two people per group—no individual runners. Any number of plants is acceptable. The splitting and joining of loosestrife to best meet the needs of the game represents the plant's ability to adapt.

4. Once learners understand the rules, allow native plants to distribute themselves on the playing field.

5. Have the purple loosestrife enter the playing field and begin the game. Loosestrife will eventually take over the entire field of native plants.

6. When the invasion is complete, gather learners together, and identify and congratulate the last student to be tagged.

7. Ask learners to describe what happened on the field. Ask the following questions:

- What happened to the native plants?
- What happened to purple loosestrife?
- What was the loosestrife able to do that made it so successful?

8. Give examples of why loosestrife is so successful in real life—massive seed production, seedling survival rate, lack of native herbivores. Discuss how losing the native cattails, reeds, and grasses might affect wildlife. When loosestrife takes over a waterway, it can clog ditches and streams. People and other animals might not be able to use a waterway when it gets clogged with loosestrife.

Part B: Introduce Biological Control

1. Ask learners if they think a leaf-eating beetle should be allowed to play. Designate one student as a beetle. Explain that it is easy to identify the beetles, because beetles must beat their wings. Demonstrate a beetle by rapidly waving your hands at all times.

2. Begin the game as before. Allow native plants to enter the playing field first, followed by a purple loosestrife.

3. Allow purple loosestrife to grow to about 10 learners before introducing the leaf beetle. Explain the following rules for beetles:

- The leaf beetle is host-specific; it feeds only on purple loosestrife, not native plants.
- When a beetle touches a loosestrife, the loosestrife is converted to a beetle, because the beetle has successfully met its nutritional needs and reproduced.
- A beetle may tag only one plant at a time, and it must tag the loosestrife only at its active ends, where learners tag others. If it is only a pair (two learners) of loosestrifes, one will become a beetle and the other will become a native plant. This shows how native plants will be able to reestablish an area after the purple loosestrife is removed.

4. Play the game until the beetle population has increased.

5. Stop the game while there are still some native plants, loosestrife, and beetles.

6. Gather learners together and again ask them to describe what happened. Ask the following questions:

- Was it easier for the native plants to survive?
- What would have happened if the game continued?
- If the beetles eliminated all the loosestrife, what would happen to the beetles?

7. Describe what happens to the populations of native plants, loosestrife, and beetles in real life. The native plants begin to reestablish themselves and the loosestrife and beetle populations go up and down cyclically, with the loosestrife remaining at levels lower than they were prior to introducing the beetle.

Extension

- Ask a weed manager from your area to visit your class to talk about biological control.
- Have learners conduct research on other weeds that are controlled effectively with the biological control method.
- Visit areas that are being taken over by weeds. Have learners raise and release control insects under the supervision of a weed manager.

Discussion/Assessment:

What adaptations allow alien species to become invasive and out-compete native species?

What is biological control and what are some possible dangers of using this method of invasive plant management?
What is the difference between invasive species eradication, or elimination, and reduction?