INSTRUCTIONS FOR GARLIC MUSTARD TAG GAME

Garlic Mustard Invasion

Activity adapted from the Biodiversity Education and Awareness Network BEAN by the Royal Botanical Gardens:
https://drive.google.com/file/d/1pQyR187ukO0rv4APVoHJjvwIBkGy87nL/view

ACTIVITY DESCRIPTION:

All plants need sun, water, nutrients, space, and to avoid being eaten to survive and reproduce. Any plant that can do any of these things better than the other plants around it has a huge advantage and may come to dominate the landscape. Since its introduction from Europe in the early 1800s, garlic mustard has become one of Ontario's most aggressive forest invaders. This lesson plan includes three activities for students in grade four, six, and seven. Students play a game that simulates the introduction of one non-native invasive species, garlic mustard, into the landscape and discover the resulting changes in the plant community. Students then brainstorm and learn to control the spread of garlic mustard. Students then play the simulation game again, only this time adding control measures to try and limit the spread of garlic mustard.

BACKGROUND:

Invasive species are plants and animals that do not belong to a specific natural system. Because native species are not adapted to compete effectively with these invaders, invasive species populations often grow exponentially. This leads to disturbances or degradations to natural ecological functions. Invasive species now form the second most dangerous threat to biodiversity globally.

Garlic mustard is an invasive herb native to Europe and was brought to North America in the early 1800s. Since its arrival in North America, it has escaped into the wild and is now one of Ontario's most aggressive forest invaders. While garlic mustard is now established in southern Ontario, resource managers are still trying to limit its spread, and to remove the plant and rehabilitate the forest understory.

CURRICULUM CONNECTIONS:

Grade 7 – Understanding Life Systems: Interactions in the Environment

- 3.2 identify biotic and abiotic elements in an ecosystem and describe the interactions between them.
- 3.3 describe the roles and interactions of producers, consumers, and decomposers within an ecosystem.
- 3.4 describe the transfer of energy in a food chain and explain the effects of the elimination of any part of the chain.

ACTIVITIES 1 & 3:
Site Needed: Large indoor or outdoor space

Materials Needed:
- 4 pylons to mark boundaries
- 4 sets of pinnies or other means to identify players Sun, Water and Nutrient cards (attached) or 3 sets of coloured tokens (15 of each)

TIME NEEDED:
30-45 minutes each

ACTIVITY 2:

Materials Needed:
- Garlic Mustard Fact Sheets (attached)
- Paper and pens
- Flip chart and markers

TIME NEEDED:
- 30 minutes

TEACHING PROCESS AND CLASS ACTIVITIES:

ACTIVITY 1: A SIMULATION OF AN INVASIVE SPECIES IN FOREST ECOSYSTEMS

ROUND 1 – THE UNDISTURBED FOREST
- Distribute Sun, Water and Nutrient cards/tokens at one end of the play area.
- Five students start as native plants at the end of the play area opposite the tokens. One student will be an herbivore in the middle of the play area. Remaining students stay on the sidelines but will be soon enter the game.
- In order to survive the first round, plants must collect one each of the Sun, Water and Nutrient cards. They may only take one card each trip down the field. They must also avoid being tagged by the herbivore.
- The herbivore may tag the plants when they are between the pylons. They must escort tagged plants to the sidelines before they may tag another plant.
- Limit the round to three minutes or when all the plants have been caught or collected three cards.
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- The surviving plants reproduce. For each plant that survives, one student from the sidelines will join the game as a native plant.

ROUNDS 2 & 3 – THE INVADER ARRIVES

- Redistribute the cards to one end of the field and the surviving and new plants at the other. Add one student as a garlic mustard (GM) plant, newly arrived in the area.
- One student will be an herbivore in the middle.
- The game follows the same steps as Round 1 except the herbivore does not recognize GM as food or does not like its taste and therefore leaves it alone.
- For each native plant that survives, one student from the sidelines will join the game as a native plant. GM produces large numbers of seeds, so two students from the sidelines will become GM plants in round 3 for each GM that survives.
- Redistribute the cards and repeat the round. At the end of this round some plants may not survive because there are not enough cards to go around. Any plant not getting one of each card does not survive and moves to the sidelines.

ROUND 4 – THE COMPETITION

- Redistribute the cards in the playing area.
- Garlic mustard is a biennial which means that its life cycle takes two years to complete. It overwinters as a rosette of leaves under the snow. This gives it a head start in spring - most native woodland species are either annuals, starting from seed each year, or Perennials that start from roots or bulbs underground. It grows quickly and spreads rapidly, crowding out native species. To simulate this, in this round, the surviving garlic mustard plants get a 15-second head start on the native plants. The rest of the game follows the same rules established in rounds 2 and 3.
- If there are any native species left at the end of the round, go on to play round five.

ROUND 5 – THE DOMINATION

- Redistribute the cards on the playing area.
- GM plants release a chemical into the soil that kills soil fungi. This inhibits the formation of connections between the roots of native plants and fungi in the soil that help them absorb water and nutrients, giving GM a huge advantage. To simulate this, the GM players may pick up both Water and Nutrient cards on the same trip.
- For Discussion: What advantages does garlic mustard have over native species? What would happen to the herbivores after all the native species are gone? What can be done to control garlic mustard?

ACTIVITY 2: MANAGING GARLIC MUSTARD

- Divide the class into groups of three and give each group the first page of the Garlic Mustard Fact Sheet, a sheet of paper and a pen. Indicate that they are going to use what they have learned in the simulation game, and the information contained in the sheet, to come up with ways to reduce the impact of garlic mustard.
- Have each group study the information, and brainstorm: 1) possible ways to eliminate the species from an area, and 2) possible ways to limit their spread into new areas. Remember, more is better!
- In a loose circle of group clusters, have each group list one new method of elimination each until all methods are out and recorded on the flip chart. Then do the same with ways to limit the spread. Rank what they think are the best methods in each case.
- Give each group the second page of the Fact Sheet and compare methods.
- For Discussion: Did they come up with the same ones? Any new ones? Are their "best" ones reflected on the sheet? How might they move forward with their top ideas?
- Extension: Find a nearby location with Garlic Mustard, and design and carry out a local public information campaign about the plant and how people can limit its spread.

ACTIVITY 3: MANAGING GARLIC MUSTARD SIMULATION GAME

- Play the simulation game from activity one again, only this time add one of the following controls.
- Human cutting. Add one or more people to the middle to tag the garlic mustard players. This represents people manually cutting the plants before they flower to prevent them from reproducing. Eventually the seed supply will be exhausted and garlic mustard will be controlled, but this takes several years.
- Bio-Control. Add one or more people to the middle to tag the garlic mustard. This represents the possible outcome of research that is currently underway to find something that will eat garlic mustard but not everything else.
- Fire. Add many people to the middle during the first 15 seconds of the round. They may tag garlic mustard, even out of bounds. This represents the use of controlled burn fires in the early spring when garlic mustard has begun to grow, but native plants are still dormant.
- For Discussion: Did the controls work? What are the limits/risks of the controls? Is it easier to prevent the introduction of an invasive species or to try to control it after it has escaped?
- For Assessment: Students summarize what they have learned about garlic mustard by creating a fact sheet or report that would engage and inform the public about the threat of garlic mustard. This could take many forms including brochure, poster, comic book, or blog post.

GARLIC MUSTARD FACT SHEET

The Plant: Garlic mustard is a cool-season, biennial (i.e. two- year growth cycle) herb with stalked, triangular to heartshaped, coarsely toothed leaves that give off an odor of garlic when crushed (particularly new leaves). First-year plants appear only as a cluster of green leaves close to the ground. Clusters remain green through the winter and develop into flowering plants the following spring. Flowering plants of garlic mustard reach from 0.6 to 1 m in height and produce button like clusters of small white flowers, each with four petals in the shape of a cross. Flowers are either self-pollinated, or pollinated by insects.

Garlic Mustard, showing first and second year leaves, flowers, seedpod, seeds and root. C.A.M. Lindman.

Beginning in May, tiny seeds are produced in erect, slender pods, and become shiny black when mature. Seedpods may hold fertile seed through the summer. In dense woodland stands, seed production can range from 9,500 to over 100,000 seeds per square metre per year.

When mature, the capsules burst open and can throw seeds several metres. Further distribution is mostly by humans and other animals accidentally carrying seeds, or mud containing seeds. Seeds aren't easily blown around, and do not float well. Populations spread an average of 5.4 m/year, which may not sound like a lot until you add it up: 6,400 km2/year in North America! Because it's primarily carried by humans and animals, natural or human-made roads and trails become prime corridors for invasion. Seeds quickly sprout in disturbed soil, and disturbing soil with seeds in it will cause more seeds to sprout. Seeds can remain alive in the soil for five years or more.

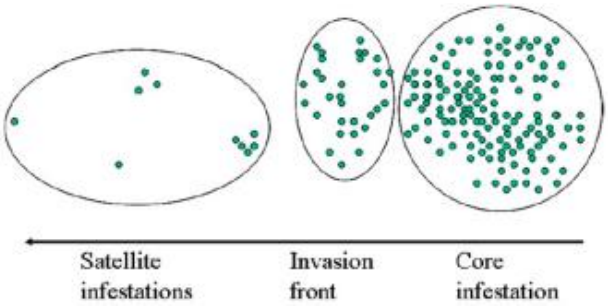
The Threat: Garlic mustard is one of the few non-native herbs able to invade and dominate both disturbed and undisturbed forest understory communities. Its ability to grow in low light, high seed production, and relatively rapid spread make garlic mustard a strong competitor, dominating forest groundcover within 5-7 years of introduction. It takes resources away from native spring woodland plants such as spring beauty, white trillium, trout lily, sweet Cicely and many others. Because it begins growing very early in the spring, garlic mustard has a head start on other flowering plants and tree seedlings.

It also changes the soil, impacts natural associations between plants and fungi by destroying the fungi, and changes the forest ecosystem. Several chemicals produced by garlic mustard reduce the growth of grasses, herbs and tree seedlings, including sugar maples. Researchers in Ohio removed garlic mustard from a forest understory and found that the richness and abundance of annuals and woody perennials, including tree seedlings, increased. Garlic mustard appears to reduce habitat quality for several species of salamanders and molluscs through changes in forest litter layer depth and composition. Insect communities are also impacted by the presence of garlic mustard. The impacts of garlic mustard on vertebrates are largely unknown. Deer do not eat it, but encourage its spread by grazing on native competitors, disturbing the soil, and carrying seed from one location to another.

Management Efforts: Garlic mustard spreads from established (core) infestations along an invasion front. Satellite infestations occur when seeds are transported to new areas. This often occurs along trails, roads or forest edges. Priority should be given to annual removal of all satellite infestations to prevent further spread.

In addition, satellite areas and invasion fronts nearest to or within prime native habitat should have top priority. After these areas are treated, begin working back through the invasion front.

Monitoring should focus on areas where garlic mustard seeds are likely to be dispersed and find disturbed areas suitable for germination. Trails, parking areas, transportation corridors and recreation sites in suitable habitats are known sites of early infestation.



There are a number of approaches to removal:

1. Cutting flowering plants near ground level by hand will kill a high percentage of garlic mustard plants. The lower the cut, the more effectively the plant will be killed. Because cutting does not remove the root crown, it may be necessary to cut multiple times in a season to prevent seeds from developing on secondary stems. If cut precisely after flowering and before seed maturation (when the stem becomes tough and fibrous), resprouting is less likely. Even though cutting does not disturb the soil, it may still be necessary to cut for at least five consecutive years or until the seed bank is exhausted, but less regrowth might be expected than with pulling.

2. Pulling individual garlic mustard plants by hand is a simple and effective approach to managing small or isolated infestations. However, garlic mustard prefers and can rapidly spread in disturbed areas. Because pulling disturbs the soil, seeds remain alive in the soil for at least five years, and root fragments may regenerate plants, it is important to pull all garlic mustard plants in an area every year until the seed bank is exhausted and seedlings no longer appear. This may require multiple efforts each year as rosettes can continue to grow and produce flowers over an extended period (April-June).

3. Pulling, treating and transplanting. If you combine pulling with soil treatment, for example the use of clean mulch, and the transplanting of native species back into the area, you may be able to reduce the number of years it takes to exhaust the seed bank and re-establish native species.

4. Other methods. In limited, very controlled situations, fire or herbicides may be used by experts in the use of these methods.

Of course, the best approach would be to limit the spread of garlic mustard in the first place. People should be told about the plant and how it's spread, asked to restrain dogs in invaded areas, and encouraged to brush off any bits of mud or vegetation from clothing, boots or paws before leaving the area.