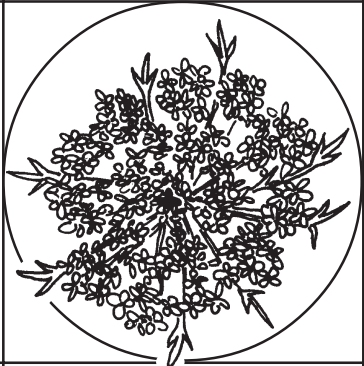
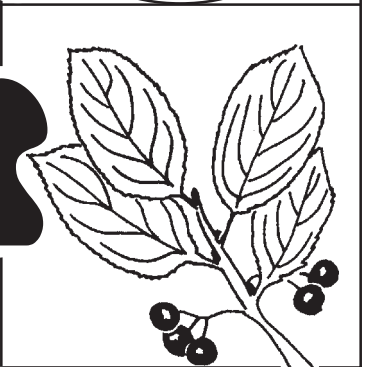
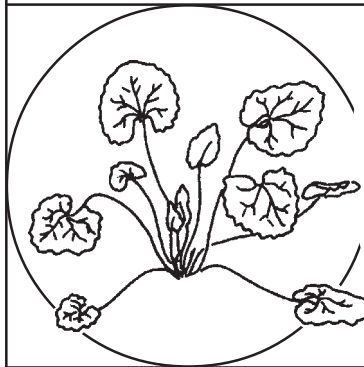


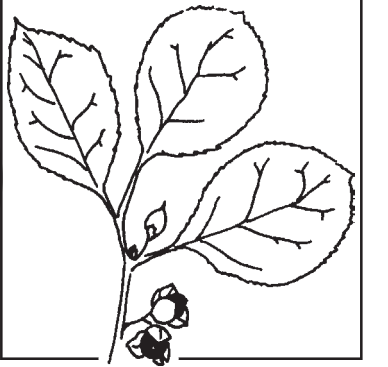
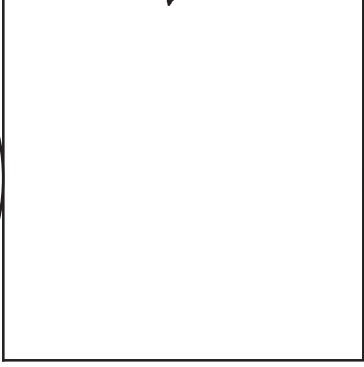
Invaders

of the

Forest



Educators' Guide to
Invasive Plants of
Wisconsin's Forests



Invaders of the Forest

Educators' Guide to Invasive Plants of Wisconsin's Forests

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Defining the Problem

What are native, non-native, and invasive plants? How do they differ from weeds? How much do we know about them? What do they do?

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Additional Resources

You will find listings of helpful resources in the companion to this guide, **Invasive Plants of the Upper Midwest** by Elizabeth Czarapata. See pages 181 – 188 of that book.

Appendix A: Resources for Information about Invasive Plants

(Includes books, journals, manuals, CD-ROMs, curriculums, fact sheets, brochures, posters, videos, and Web sites)

Appendix B: Resources to Help with General Plant Identification

Appendix C: Resources for Natural Landscaping and Ecological Restoration

Using the Activity Guide

We hope you find the lessons in this guide useful as you teach about invasive plants. While this guide is written for Wisconsin educators teaching about invasive forest plants, we trust that creative educators will be able to adapt these activities to other locations and habitats!

Companion Reference

Throughout this guide, you will find references to the book **Invasive Plants of the Upper Midwest: An Illustrated Guide to Their Identification and Control** by Elizabeth J. Czarapata. This book is a complete and up-to-date reference where educators can find both general and species-specific information. It is available in libraries, bookstores, and on the Internet. <www.ipaw.org/order.asp>

Kindergarten - Adult

This guide provides classroom and field activities for formal and non-formal educators working with kindergarten through adult audiences. See the table on page 133 for a breakdown of activities by grade.

Diversity of Activities

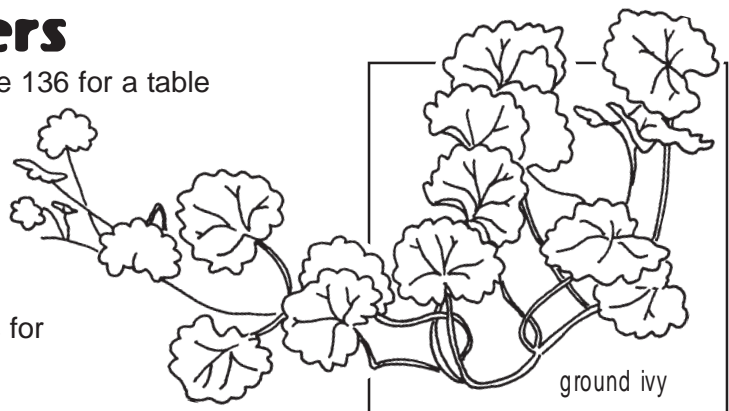
Check out the tables on pages 134 – 135 for a quick look at the variety of subjects and teaching methods in this guide.

Classroom and Field Activities

It's difficult to learn everything there is to know about invasive plants from inside four walls. The table on page 136 gives a quick overview of which activities can be used in the classroom and which need to be done outside.

Field Trip Providers

Non-formal educators should check out page 136 for a table showing activities that fit the time frame of a typical field trip. Some of these activities make great introductions for service learning experiences; others are complete field trips! Extend the learning experience for the students by sending some of the classroom activities in this guide to teachers for use before and after the field trip.



Suggestions for Invasive Plant Units

Grades K – 2

The Plant Hunters
Garlic Mustard Invasion
Eyewitness Accounts
Weed Out!

Grades 3 – 4

Global Marketplace
Ad-libbed Aliens
 or Field Notes
The Plant Hunters
Web of Life
 or Garlic Mustard Invasion
Means & Modes
How to Kill a Dandelion
Weed Out!

Grades 5 – 8

Wildflower, Weed, or Botanical
 Bully?
Field Notes
The Plant Hunters
Outwit–Outplant–Outlast
 or Garlic Mustard Invasion
Means & Modes
 or Wanted Posters
Plotting Plants
Checking Out the Options
Weed Out!

Grades 9 – 12

Wildflower, Weed, or Botanical
 Bully?
Invasive or Not?
The Plant Hunters
Outwit–Outplant–Outlast
A Can of Worms
Means & Modes
Diversity Index
 or Plotting Plants
Checking Out the Options
Weed Out!

Invasive Plant Units

While most of the activities in this guide are “stand alone” activities, your students will get a more complete picture of the invasive species problem by doing a series of activities. Try to choose at least one activity from each section of the guide so that your students can progress from *Defining the Problem* to *Controlling Invasive Plants*. See the sidebar at left for ideas.

Wisconsin’s Model Academic Standards

Activities have been correlated to Wisconsin’s standards. See correlations with each lesson plan and a listing on pages 137 – 138.

Scout Connections

While invasive plants are not the focus of any specific badges or programs, it is important to connect learning about natural resources to the problems caused by invasive plants. Since invasive plants are threatening the natural areas that scouts treasure, controlling the growth and spread of invasive plants makes for wonderful service learning and conservation projects. See correlations with each lesson plan.

Availability

This guide is available in several formats. It can be downloaded free from the Teacher Pages on the WDNR’s Environmental Education for Kids (EEK!) Web site. <www.dnr.wi.gov/eeek/teacher/invasiveplantguide.htm> The file is in PDF format and requires Acrobat Reader version 5.0 or later. For information about print or CD versions of the guide, contact: Endangered Resources, ER-6, Wisconsin Department of Natural Resources, 101 S. Webster St., Madison, WI 53707, or call (608) 266-7012.

June is Invasive Plant Awareness Month!

June is a great time to be involved in invasives species learning and management projects. Go to the state’s Web site to find out about events around the state and resources you can use in your teaching. <www.invasivespecies.wi.gov>

Share Your Stories

The WDNR Plant Conservation Program staff would appreciate knowing about your successes and challenges. Share *Wanted Posters* that your students create, photos of workdays, stories, and suggestions for additional materials that would help you teach about invasive plants. Send to Bureau of Endangered Resources, ER-6, 101 S. Webster St., Madison, WI 53707, bureau.endangeredresources@dnr.state.wi.us, or (608) 267-5066.

Global Marketplace

Method

Students will use a checklist to find out more about the plants they depend on for food and fibers. They will guess which plants originated in the United States and check their guesses by researching individual plants.

Introducing the Activity

“Global” trade and travel are recent buzzwords, but they are nothing new. People have always been on the move. The thing that has changed is the speed and scope of movements. As people traveled to new places, they took with them the plants they depended on for survival (i.e., plants that provided food, clothing, medicine, fuel, and shelter). They also transported plants used for art and celebrations.

Doing the Activity

- 1. Examine common foods, fibers, and medicines.** Pass around several items obtained from plants. See list of materials. Ask students what plants these foods, fibers, or medicines came from. While some are obvious, others are not (e.g., chocolate from cacao tree, linen from flax plant, and aspirin from willow tree). Discuss where these plants originated. You don't need to answer all these questions now; just help students start thinking about them.
 - Does anyone know where cacao trees grow?
 - What about oats? We know we raise oats in the United States, but where did the first oat plant grow?
 - What part of the world did potatoes come from? Who first discovered that they were edible and cultivated them?
- 2. Pass out *Plants of the Global Marketplace*.** Ask students to check how often they use each of the plants listed on the worksheet. Ask them to check if they think the plants originated in the United States.
- 3. Assign homework.** Ask each student to choose one of the plants on the list to find out where it originated. Students can also add plants that interest them to the list. Give extra credit if students can present short histories of the plants' movements around the globe.

Queen Anne's lace
(wild carrot)



Objectives

- Recognize that people move valuable plants around the globe.
- Identify some of the non-native plants we use each day for food, clothing, and medicines.

Grades

4 – 12

Group Size

Individuals

Activity Time

Two 50-minute periods plus homework

Setting

Classroom

Materials

- Commonly used plant products (e.g., chocolate candy bar, oatmeal, cotton t-shirt, linen table napkins, can of carrots, empty aspirin bottle, raisins, and wheat crackers)
- Copy of *Plants of the Global Marketplace* for each student (page 12)
- Access to Internet
- Sticky notes (optional)
- **Invasive Plants of the Upper Midwest**

Connections

See next page.

Academic Standards

Grade 4

- Science: B.4.1
- Social Studies: A.4.7, D.4.3

Grades 5 – 8

- Environmental Education: B.8.14
- Social Studies: A.8.7

Scout Connections

- Junior Girl Scouts: Plants and Animals

Optional for younger students: Ask each student to draw a picture of one of the more familiar plants on a small sticky note. Individually or as a class, stick each plant on a large world map indicating the region of the world where it originated. See answers on page 11.

4. **Discuss findings.** Were there any surprises? Did any of the plants that students use daily originate in the United States? Most of the plants we depend on for food, fiber, and medicine are not native to the United States. If we didn't have access to these foods, our lives would be very different. Help students realize that many non-native plants are beneficial. We plant and tend these plants to provide products that we depend on. Most of these plants could not survive outside of cultivation. Therefore, they are not likely to escape and become a threat to natural areas. In other words, they are non-native, but not invasive.
5. **Find the wild ones.** Challenge your students to find two plants in the list that do grow in the wild. Both carrots and apples grow wild in the United States. Wild carrot, also known as Queen Anne's lace, invades forests and grasslands. See page 104 of **Invasive Plants of the Upper Midwest**.

Assessing the Learning

Assess students' ability to locate and present information about the origins of plants.

Extending the Learning

Reenact the First Thanksgiving. By the time Europeans arrived in America, native peoples had moved many food crops from Central America northward. Here is a list of some of the plant foods that were available to people at the first Thanksgiving:

- Nuts (walnuts, chestnuts, acorns) – native to eastern United States
- Beans (red, black, green, and pinto) – from Central and South America
- Squashes (including pumpkin) – from South America
- Corn – from Central America
- Sweet potatoes – from Central America
- Leeks – native to eastern United States
- Berries (cranberries, blueberries, currants) – native to northern United States
- Maple sugar – native to northeastern United States
- Popcorn – from Central America

Of course, they probably also ate venison, fowl, fish, and seafood. How many of these plant foods arrived from Central and South America before Europeans arrived? Discuss how this menu is different from the Thanksgiving meals that your students enjoy.

Search for natives at the grocery store. Ask students to visit their local groceries and find native foods for sale. Check the contents. Can they find food that is native to the United States, yet raised outside the United States? What foods did people move from our country to other parts of the world?

Finding Out More!

Texas A&M Horticulture Program. 2000. Features an online reprint of a 1949 article by Victor R. Boswell titled "Our Vegetable Travelers." <<http://aggie-horticulture.tamu.edu/plantanswers/publications/vegetabletravelers/index.html>>

Plant Name	Region of Origin
apple	Caucasus mountains, southeast Europe, western Asia
aloe vera	Africa
(source of aloe gel found in skin lotions and cosmetics)	
cacao	Central America, northern South America
(source of chocolate)	
carrot	northwest India, Afghanistan
cinnamon	Sri Lanka
corn	southern Mexico, Guatemala, Honduras, Costa Rica
cotton	Central America, India
cranberry	northern United States, Canada
flax.....	Europe
(source of linen)	
lettuce	Turkey, Iran, Turkistan
oats	eastern Mediterranean, Eurasia
peas	Mediterranean, northwest India, Afghanistan
black pepper	India, Asia
onion	northwest India, Afghanistan, northern and central China
potato	Peru, Ecuador, Bolivia, Chile
pumpkin	Peru, Ecuador, Bolivia
ephedra	Asia
(source of ephedrine in decongestants – commercially made as pseudoephedrine)	
rice	southeast Asia
soybeans.....	central and western China
sugar cane	tropical southeast Asia
(source of sugar)	
sugar maple	northeastern United States, southeastern Canada
(source of maple syrup)	
strawberry	northern United States, Canada
sweet potato.....	southern Mexico, Guatemala, Honduras, Costa Rica
tomato	Peru, Ecuador, Bolivia
black walnut	northern United States, Canada
watermelon	south-central Africa
wheat.....	eastern Mediterranean, Eurasia
white willow	Europe
(source of aspirin – aspirin is now made commercially)	
wild rice	northern United States, Canada

Plants of the Global Marketplace

How much do you know about the plants you depend on for life?

Plant name	How often do you use this plant?				Where is this plant from?	
	Daily?	Weekly?	Monthly?	Rarely or Never?	United States?	Other Country?
apple						
aloe vera						
cacao						
carrot						
cinnamon						
corn						
cotton						
cranberry						
flax						
lettuce						
oats						
peas						
black pepper						
onion						
potato						
pumpkin						
ephedra						
rice						
soybeans						
sugar cane						
sugar maple						
strawberry						
sweet potato						
tomato						
black walnut						
watermelon						
wheat						
white willow						
wild rice						

Wildflower, Weed, or Botanical Bully?

Method

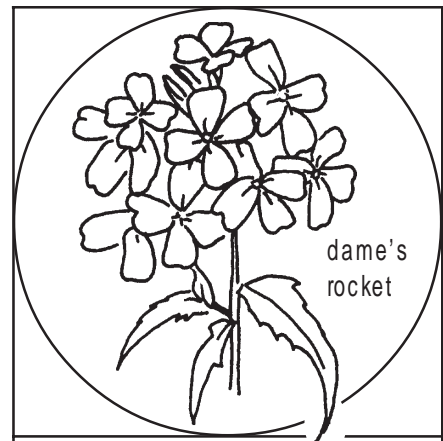
Students will visit a “weedy” area near their school. They will find and observe plants and their surroundings. Back in the classroom, they will identify the plants and determine if they are native, non-native, non-native invasive, or native invasive.

Getting Ready

1. **Optional:** Using the Internet or other resources, find pictures of the plants referred to in the introduction below. See *Finding Out More!* for Web sites that feature plant photos.
2. Find a “weedy” place where students can observe plants closely. Depending on your location, this might be a vacant lot or a forgotten corner of the playground. While highway and railroad right-of-ways are excellent places to find non-native plants, these locations are not safe. If using school property, check with the maintenance staff to be sure the area hasn’t been recently sprayed. If the area is not on school property, obtain permission to collect a limited number of plants. Be sure the site you choose doesn’t have poison ivy, wild parsnip, stinging nettle, or other hazardous plants.

Introducing the Activity

It isn’t easy to tell by just looking at a plant whether it is “good” or “bad.” A dandelion growing on a golf course would be considered a weed. A dandelion given as a gift to a mom would be a wildflower. Some people kill all the dandelions in their yards; others enjoy the yellow flowers as a welcome sign of spring. Poison ivy in a woods provides valuable food for wildlife. Poison ivy in your backyard would be a weed that needs to be controlled! Dame’s rocket cultivated in a garden would be considered a wildflower, but when dame’s rocket invades a wooded area, it is a botanical bully that pushes out native species. Woodland sunflower is a beautiful, native forest wildflower, but given the chance, it can be a botanical bully. If it were growing in a crop field, the farmer would consider it a weed.



Objectives

- Become familiar with plants of weedy areas.
- Understand that many of the plants found in weedy areas are non-native species.
- Identify one plant and determine its ecological status.

Grades

4 – adult

Group Size

Small groups of 3 students

Activity Time

Two or three 50-minute periods

Setting

Weedy area during spring, summer, or fall; preferably when plants are in bloom

Materials

- Pictures of plants (i.e., poison ivy, dandelion, dame’s rocket, woodland sunflower)
- Copies of *Plant Characteristics* (page 18)
- Notebooks and pencils
- Trowels, pruners, or scissors for collecting plants
- Plastic shopping bags
- Plant identification books (See list on page 139.)
- Access to Internet
- **Invasive Plants of the Upper Midwest**

Connections

See next page.

Academic Standards

Grade 4

- Science: C.4.2, C.4.5

Grades 5 – 8

- Science: C.8.2

Grades 9 – 12

- Science: F.12.5

Scout Connections

- Boy Scouts: Plants
- Junior Girl Scouts: Earth Connections, Plants and Animals

Doing the Activity

For students in grades 7 – adult.

1. **Define terms.** Talk about the differences between wildflowers and weeds. Name some plants such as Queen Anne’s lace or goldenrod and ask if students would call these plants wildflowers or weeds. On what do we base our definitions? While terms such as wildflower and weed can be very subjective, native and non-native are more scientific. See definitions on page 17.
2. **Introduce the task.** The best way to learn about plants is to become more familiar with the plants that we see each day. Explain that the students are going to investigate a “weedy” area near the school. In the area, they are going to find and collect plants. Back in the classroom, they will identify the plants and determine if they are native or non-native.
3. **Visit the area.** Set boundaries for the activity. Divide students into teams of three. Instruct students to walk around the area and look for “wildflowers” and “weeds.” Remind them to also look at trees and shrubs, because we often refer to woody plants as “weedy” or “desirable.” Ask if students know the names of any of these plants. Check if all the students agree on the same name. **Note:** Since common names can vary greatly, this would be a good time to point out the advantages of scientific names!
4. **Find unknown plants.** Each team should find an unknown plant. **Note:** Choosing plants that are in flower will make identification much easier, since many identification keys are based on the number of flower petals. If there are no plants in bloom, students should select trees and shrubs for identification.
5. **Study the plants.** Working in teams, students should look at their plant’s leaves, stems, flowers, and seeds. After a few minutes, team members should complete individual tasks.
 - One person sketches the plant.
 - One person makes written notes about the plant.
 - One person counts the number of identical plants within the designated study area.
6. **Collect one specimen of each unknown plant.** Students can either dig up entire plants, cut plants off at ground level, or prune representative twigs from trees and shrubs. Instruct students to place the plants in a bag for transport back to school.
7. **Return to the classroom.**
8. **Identify the plants.** Using plant identification books, Internet sites, or resource specialists, students should identify the plants they collected.

9. **Determine each plant's origin.** Once students know the common and scientific names of the plants, they should determine if the plants are native or non-native (introduced) by visiting the **Wisconsin State Herbarium** Web site. See *Finding Out More!* on page 16.
10. **Determine each plant's ecological status.** Students should determine if their plants could be invasive in natural areas by checking the charts on pages 195 – 204 of **Invasive Plants of the Upper Midwest**.
11. **Graph the occurrence of each type of plant.** Tally the plants in each group (e.g., native, non-native, invasive native, and invasive non-native). Compare the different categories of plants. How many of the plants growing in the “weedy” area were non-native plants? (There were probably many non-native plants in the area. However, only a small number of these non-native plants are invasive in natural areas.) Were there any native plants?
12. **Recheck definitions.** Discuss these questions to clarify definitions:
 - Did any of the plants that you initially called “wildflowers” end up being invasive non-native plants?
 - Were there any “weeds” that turned out to be native plants?
 - How do the definitions used by scientists help us define and discuss plants objectively?

For students in grades 4 – 6.

Follow the steps in this lesson, but choose only one plant at a time to investigate. Keep these things in mind when selecting plants to investigate:

- Choose plants that are abundant enough so that each student or small group of students can gather around a specimen.
- Use a simple plant identification guide (e.g., **Weeds: A Golden Guide** by Alexander Martin) with the students. Be sure that the plants you choose are in the guide. Common “weeds” found in this guide include crabgrass, pigweed, ragweed, chicory, burdock, thistle, and Queen Anne’s lace.

Before heading outside, review plant characteristics that are important to identification. See the chart on page 18. Outdoors, ask each student to complete a sketch of the plant. Collect several specimens to press. If possible, laminate the pressed and identified plants and create a bulletin board or class binder that features “Plants of Our Playground.”

Assessing the Learning

Assess students’ ability to work in a small group while describing, sketching, or locating an unknown plant. Check accuracy of identification and determination of ecological status.



Extending the Learning

Start a herbarium. Use the plants students collected and the information from the activity, *The Plant Hunters* to begin a herbarium collection of local plants. See page 39.

Frame it. Use picture mats or picture frames to look at an area from a new perspective. In an outdoor area, set up a few frames to highlight natural objects or scenes. Take a tour of nature's art gallery by visiting each frame. Ham it up! You might use this as your introduction to the gallery:

Welcome to Nature's Art Gallery! In this beautiful gallery, you will find works of art in all stages of completion. Some works are only on display a few days each year; other works have taken hundreds of years to be formed and will remain relatively unchanged for years to come. This gallery is always changing. We have little control over the lighting in the gallery, so the artworks can change right before your eyes and throughout the day. We also encourage you to visit in different seasons because the works do reflect amazing seasonal variations. Due to the size of the gallery, you will find small works displayed within much larger works. Attention to detail will enhance your experience in the gallery. Watch for repeating patterns and subtle changes in color.

Give students frames and ask them to find interesting plants or scenes to "capture." Allow each student to act as curator for the masterpiece that he or she found. Visit several locations. Compare an area with invasive plants to an area without invasive plants. Which area is the most interesting from artistic point of view?

This activity is adapted from "Nature's Art Gallery" developed by teacher Mural Adams. A more complete description of the activity can be found in "Freeze Frame." **Non-Native Invasive Species Learning Kit — Get a Grip on Biodiversity.** United States Forest Service. 2005.

Finding Out More!

Invasive Species: Plants. Wisconsin Department of Natural Resources. 2005. Online photo gallery of invasive non-native and aggressive native plants. <www.dnr.wi.gov/invasives/plants.htm>

PLANTS Database. United States Department of Agriculture. 2005. Fully searchable online database with photos. <<http://plants.usda.gov/index.html>>

Missouri Weeds. University of Missouri. 2004. Online listing and photos of weeds of field crops, pastures, ornamentals, and turfgrass. Includes keys. <www.psu.missouri.edu/fishel/Default.htm>

WISFLORA: Wisconsin State Herbarium. University of Wisconsin – Madison. 2005. Fully searchable online database with photos. Type in common or scientific name to find ecological status, distribution maps, and herbarium records. <www.botany.wisc.edu/wisflora>

Wildflower or Weed?

When we talk about wildflowers and weeds in daily conversation, our words really don't say much about the plant. They say more about where the plant is growing and how we view it. This guide will usually refer to the terms used by scientists to describe plants. Since these terms are based on criteria, they will help us define and discuss the origin and ecological status of individual plants.

Terms used in everyday conversation

Weeds are very different things to different people. Weeds grow in crop fields, gardens, and landscaping. They are usually defined as plants growing where they are not wanted. However, some people refer to wildflowers as weeds, while others refer to the plants invading natural areas as weeds.

Wildflowers are also very different things to different people. They are usually defined as plants growing freely with no need of cultivation. However, many people cultivate wildflowers in their gardens!

Terms used by scientists to describe plants

Native species have been present in a region for a long time. Most ecologists consider a plant native to North America if it was here before European settlement. *Synonym:* indigenous

Non-native species are not native or naturally occurring within a defined geographic area. Many non-native species are important food crops. Others are considered weeds of gardens, croplands, and pastures. Some are invasive in natural areas. *Synonyms:* nonindigenous, exotic, alien

Non-native invasive species are non-native plants that invade natural communities. Invasive species spread rapidly by producing many seeds and/or reproducing vegetatively. They usually lack natural controls on their populations such as herbivores and diseases. They outcompete and displace native species and disrupt ecological processes.

Invasive native species are aggressive plants that are native to the area, but they are adapted to colonize disturbed sites. They can become dominant and troublesome on a site.

Weeds are plants that are well-adapted to live in disturbed areas such as croplands, pastures, and gardens. Weeds usually have many strategies for survival (e.g., ability to thrive in poor soil conditions and numerous seeds that can disperse long distances). All invasive plants are weeds, but only a small number of weeds are invasive in natural areas.

Terms used by the legal system

Noxious weeds are plants that cannot be sold, traded, or planted. Noxious weeds must be contained. Some plants are on a federal noxious weed list; others are on state, county, or municipal lists. Noxious weeds in Wisconsin include: Canada thistle, leafy spurge, field bindweed, and any other weeds that a particular county or municipality may deem "noxious."

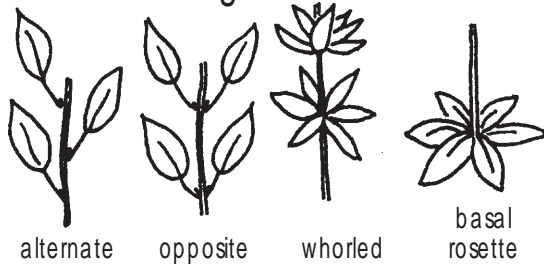
Nuisance weeds are plants that may not be sold, offered for sale, distributed, planted, or cultivated. Wisconsin lists purple loosestrife and multiflora rose as nuisance weeds.

Note: For a more complete glossary, see pages 189 - 194 of **Invasive Plants of the Upper Midwest**.

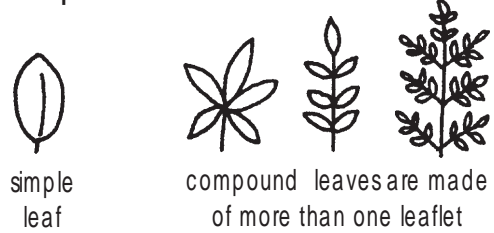
Plant Characteristics

Take a close look at your plant. Ask yourself these questions to help you focus on the things that make your plant unique. Then try to sketch or identify your plant.

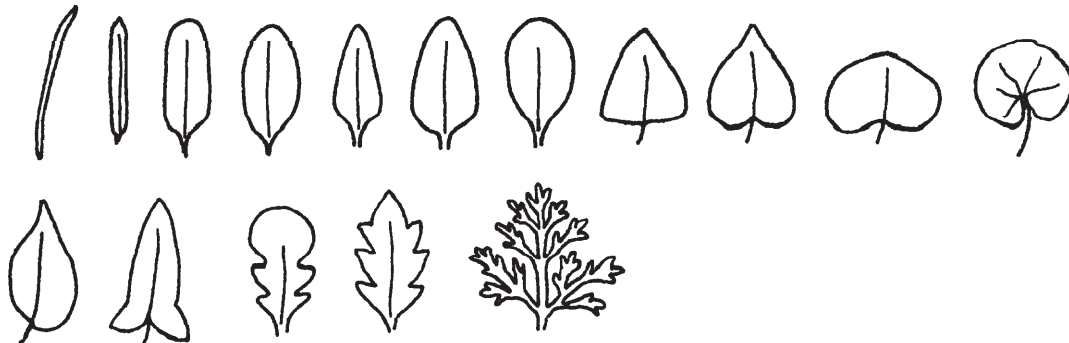
How are the leaves arranged on the stem or twig?



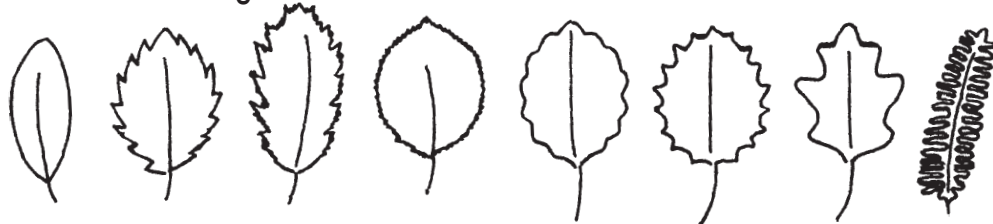
Are the leaves simple or compound?



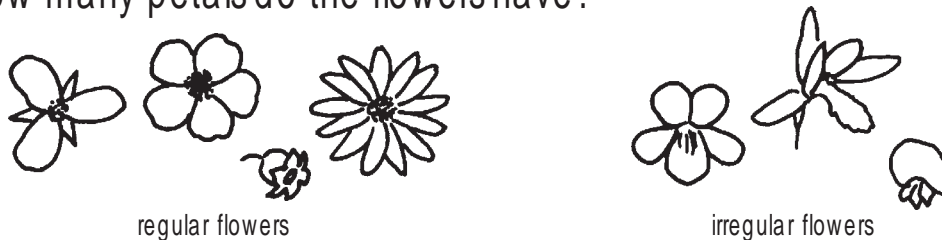
What shape are the leaves?



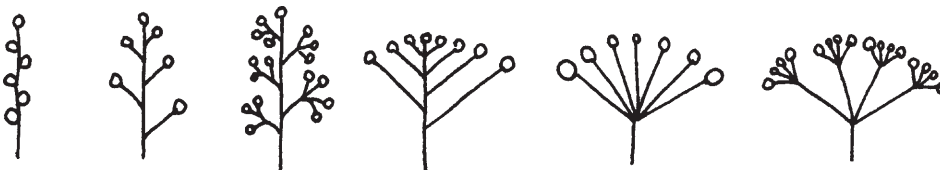
What do the edges of the leaves look like?



How many petals do the flowers have?



How are the flowers arranged?



Sizing Up Weeds

Method

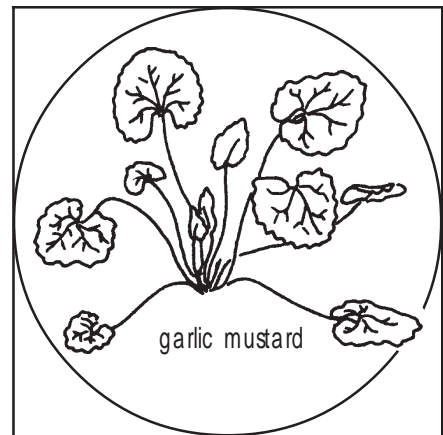
Students will use a simple survey to assess the knowledge of classmates and/or neighbors concerning invasive plants.

Introducing the Activity

Invasive plants are here and they are here to stay. Controlling invasive plants costs Americans over \$35 billion every year, but many people don't understand what invasive plants are or why they are such a problem.

Doing the Activity

1. **Hand out the *Sizing Up Weeds Surveys* and ask students to answer the questions.**
2. **Talk about the questions.** This survey is based on an actual survey conducted in northern California in 1998 (Natural Areas Journal, Volume 18 (3), 1998, Thomas F. Colton and Peter Alpert). Even though the survey is trying to gather information about invasive plants, the researchers used the word "weed." Ask students why the researchers might have made that choice. Be sure students understand the distinction between "weeds" of croplands, gardens, and pastures and "invasive plants" that invade natural areas. See definitions on page 17.
3. **Look at student responses.** Divide into small groups to analyze the responses. Each group should look at the answers to one or two questions. They should record all the answers to their questions, then focus on the top five answers. They should be ready to summarize the results.
4. **Share summaries.** Ask some of the follow-up questions in the box on page 21.
5. **Discuss the initial survey results.** The scientists who conducted the initial survey had one basic question: "Does the public perceive biological invasions by plants as a serious problem?" They were trying to find out if people would be willing to pay for vegetation management or make the sacrifices necessary to prevent and control the spread of invasive plants. They found that most people didn't recognize invasive plants as a serious ecological or economic problem. Most people only perceived weeds as problems when they were personally affected (e.g., weeds in their gardens,



Objectives

- Survey classmates and/or neighbors to assess community awareness of invasive plants.
- Compile and graph results.
- Analyze the survey results to determine how best to educate the community about invasive plants.

Grades

7 – 12

Group Size

Small groups

Activity Time

Two or three 50-minute periods

Setting

Classroom and community

Materials

- Copy of *Sizing Up Weeds Survey* for each student (page 22)

Connections

See next page.

Academic Standards

Grades 7 – 8

- English Language Arts: C.8.1, F.8.1
- Environmental Education: C.8.3, C.8.4, D.8.7
- Math: E.8.1
- Science: A.8.1

Grades 9 – 12

- English Language Arts: F.12.1
- Environmental Education: D.12.6
- Math: E.12.1
- Science: A.12.2

allergy-causing weeds, or weeds that had “stickers”). Most people didn’t recognize local weeds as non-native species or think that they were a problem. Nor did they recognize the negative impacts that weeds have on natural areas. The survey was conducted in 1998. Ask students if they think people understand invasive plants any better today. Discuss how the students’ responses were similar to or different from the original survey responses discussed in this paragraph.

6. **Prepare to conduct a local survey.** Identify the target audience. Select questions for the survey. The class may choose to use the *Sizing Up Weeds Survey* or develop their own survey. They may choose to survey classmates, parents, neighbors, or a cross-section of the community. If students plan to conduct the survey in a public place, be sure to obtain permission. If students are surveying a wide variety of people, they may want to add questions about the age and level of education of their audience. When compiling results, students can then identify if these are factors in awareness of the problem.
7. **Conduct the survey.**
8. **Compile data.** Compile survey responses in simple data tables.
9. **Graph responses.** Divide into groups. Assign each group a question from the survey to graph. Graph the top five responses for each question.
10. **Discuss results.** Ask groups to present the findings from their questions. Here are some possible discussion questions:
 - Is there a basic understanding of “weeds” in the community? For example, did the people surveyed acknowledge that weeds are present in natural areas, as well as gardens, croplands, pastures, and lawns?
 - Did the people surveyed understand that weeds are spread by people, as well as by wind, water, and animals?
 - Did the people surveyed understand that weeds (especially invasive plants) are a problem? Do they think weeds need to be controlled?
 - If it were your job to educate the school/community about invasive plants, how would you begin?

Assessing the Learning

Based on the results of the survey, ask students to write a short paragraph describing how they would begin to educate the people in their community about invasive plants.

Extending the Learning

Discuss the problems caused by invasive plants. Share information from “Why Should We Be Concerned About Invasive Plants?” and “Ethical Implications” from **Invasive Plants of the Upper Midwest**, pages 5 – 7.

Thinking about responses to the weed survey

1. Describe a typical weed.

There are several possible responses. Weeds are plants that grow fast, spread quickly, and sprout where you don't want them. They are persistent, difficult to kill, and ugly. They are often bad-tasting or covered with spines or bristles, making them unpalatable to herbivores. Look for references to non-native plants (e.g., come from other parts of the world).

2. List three weeds that are familiar to you.

Take the top five answers and find out if the plants are native or non-native. Why did you identify these plants as weeds? Are these weeds found in croplands, pastures, gardens, roadsides, and/or natural areas? Do any simply have “weed” in their name (e.g., milkweed)?

3. Name the kinds of places where weeds grow.

Common responses might include gardens, yards, lawns, fields, and croplands. Did any of the responses identify natural areas as places where weeds can grow?

4. How do weeds spread?

Typical responses might include wind or animals. Did any of the responses show people taking responsibility for the spread of weeds?

9. List good qualities of weeds.

Typical answers might include controlling erosion, looking pretty or attractive, and providing food and cover for wildlife. Remember, these are the reasons people introduce new plants in the first place!

10. Are these plants found naturally in Wisconsin or did they come from other countries?

- box elder – native to Wisconsin, but often aggressive
- Norway maple – non-native – Did the name give this plant's origin away?
- common buckthorn – non-native
- garlic mustard – non-native
- burdock – non-native

11. What comes to your mind when you hear the word “biodiversity”?

The initial surveyors were surprised to find that only college graduates were familiar with the term. Has that changed in the years since the initial surveys?

14. Are you concerned about invasive plants?

How many responses showed that “invasive plant” was an unfamiliar term? Did the responses indicate an understanding that “invasive plants” invade natural areas?

Sizing Up Weeds Survey

1. Describe a typical weed.
2. List three weeds that are familiar to you.
3. Name the kinds of places where weeds grow.
4. How do weeds spread?
5. Have weeds ever caused you problems? Yes or no? If yes, briefly describe the problems.
6. Do weeds cause problems for society or the environment? Yes or no? If yes, briefly describe the problems.
7. Do you think weeds pose a threat to endangered plants and animals? Yes or no? If yes, what is the threat?
8. Do you think there should be more efforts to control weeds?
9. List good qualities of weeds.
10. Are these plants found naturally in Wisconsin or did they come from other countries?
 - box elder
 - Norway maple
 - common buckthorn
 - garlic mustard
 - burdock
11. What comes to your mind when you hear the word “biodiversity”?
12. What do you think the term “biological invasion” means?
13. What is a native plant?
14. Are you concerned about invasive plants?

Ad-libbed Aliens

Method

Students will invent crazy plants as they put together new combinations of nouns, verbs, and adjectives. They will be amazed when you introduce real living plants that have adaptations as bizarre as the ones they have created. Then they will create their own alien plants.

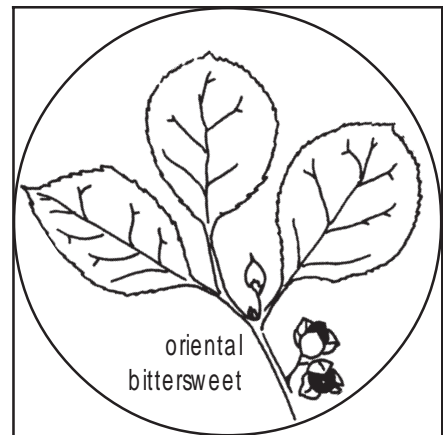
Introducing the Activity

How many of you have played Mad Libs®? You might remember that you have to list nouns, verbs, adjectives, adverbs, and other words without knowing how they will be used. When we insert these random words into the blanks of a story, the results can be weird, funny, or just plain silly!

Doing the Activity

1. **Explain the game.** Briefly show the blank story and explain how the game is played.
2. **Collect nouns, verbs, and other words.** Elicit responses and fill in the blanks in the story.
3. **Read the story.**
4. **Share the *Truth is stranger than fiction!* section.** Show the drawing of the invasive species.
5. **Discuss the invasive species' adaptations.** Discuss what adaptations are and give some examples (e.g., tall plants can take advantage of extra sunshine and shade out their competition). Talk about why plants need adaptations. Ask students to recall the adaptations from the story. **Optional:** Discuss other adaptations that give invasive plants a competitive edge.
6. **Design a super alien.** Instruct each pair of students to design a super alien plant that can invade a forested area. The new plant must have at least five adaptations that allow it to outcompete native plants. Students should brainstorm new super plants, draw pictures of them, label the adaptations, and share their illustrations with the class.

Optional project: Working individually or in small groups, students could brainstorm new super plants and construct 3D



Objectives

- Recognize that invasive species are equipped with adaptations that give them competitive advantages over native species.
- Become familiar with oriental bittersweet, kudzu, and leafy spurge.
- List common adaptations of invasive plants.
- Illustrate an invasive plant that is adapted to invade a forest ecosystem.

Grades

2 – 8 (and up!)

Group Size

Small groups of 4 – 10

Activity Time

One 50-minute period

Setting

Anywhere

Materials

- Fill-in-the-blank stories (pages 26 – 28)
- Art materials

Connections

See next page.

Academic Standards

Grades 2 – 4

- English Language Arts: B.4.1, B.4.3
- Environmental Education: B.4.6
- Science: F.4.1, F.4.2, F.4.3

Grades 5 – 8

- Science: F.8.2

Scout Connections

- Junior Girl Scouts: Earth Connections, Plants and Animals

replicas using art or scrap materials of their choice. Students could also write papers describing the new species and plan formal presentations for the class.

This activity was adapted from “Ad-libbed Aliens” and “Super Alien.” **Non-Native Invasive Species Learning Kits — Meet the Invaders.** United States Forest Service. 2005.

Assessing the Learning

Observe student participation in the discussion. Evaluate each student’s ability to use the information to design a new forest invader. See the sample rubric.

Sample rubric for older students

Drawings/descriptions/presentations will include the following:

1. **Describe the invasive plant’s native climate.** Where did the plant come from? How is the climate of its native habitat similar to the climate of the area it is invading?
2. **Describe the forested habitat that the super alien is invading.** Is it a hardwood or conifer forest? Is it open or shady? Is there thick undergrowth? Is it hilly or flat? What is the average temperature? Include any other characteristics that are relevant to your particular plant.
3. **Illustrate or create the super alien plant.** Prepare a full-color illustration or a 3D representation of the plant. Include all parts listed below.
4. **Describe the super alien plant.** Include a full description along with both a common and scientific name.
 - What kind of plant is it (i.e., annual, perennial, biennial)?
 - Describe the roots (e.g., fibrous, taproot, adventitious).
 - Describe the stem (e.g., hollow, hairy, weak).
 - Describe the leaves (e.g., big, whorled, glossy, hairy).
 - Describe the flowers (e.g., showy, colorful, fragrant).
 - Describe the fruits (e.g., succulent, dried, hairy).
 - Describe the seeds (e.g., small, winged, bristled).
 - Describe any other special parts or attributes that help it survive and thrive.
5. **Describe the five adaptations.** Include a short paragraph for each adaptation that describes how it allows the super alien to outcompete native vegetation. For example, do the seedpods explode and propel seeds into uninfested areas? Do the roots release a toxin that prevents other plants from growing nearby?
6. **Describe why the plant is so difficult to control or eradicate from an area.** For example, describe the effects of cold, heat, desiccation, herbicides, or mechanical removal on the plant. Does the plant survive and persist even when people try to control it?

Extending the Learning

Create more *Ad-libbed Alien* stories. Ask students to write fill-in-the-blank stories based on other invasive forest plants. After assuring that they have used the correct parts of speech, ask them to try their stories on their classmates. Draw pictures of the plants or animals that result and compare them to the real invasive species.

Draw an alien. Many invasive species are unfamiliar creatures with strange parts and weird adaptations. Your students can get to know some invasive plants better through this activity. Give students pictures of invasive plants. Ask students to study their pictures secretly and to write a paragraph describing the plant they have received. Collect the original pictures. Now collect the paragraphs and redistribute them to different students. Using only the descriptions they have received, students should draw pictures of the plants. Now comes the fun part! Post the original pictures, the written descriptions, and the students' drawings on a bulletin board. Can the students match the original pictures with their descriptions and drawings?

Finding Out More!

invasivespeciesinfo.gov. United States Department of Agriculture. 2005. The species profiles at this site include links to Web pages and pdf files sponsored by the federal government, state governments, and universities.
<www.invasivespeciesinfo.gov>

Parts of speech

Adjectives

describe something or somebody.
(big, bug-eyed, hairy)

Adverbs

tell *how* something is done.
(madly, quickly, joyfully)

Nouns

are the names of persons, places, or things.
(forest, armpit, brother)

Verbs

are action words.
(sink, explode, grow)



Look! It's Superplant!

Faster than a speeding _____.
noun

More powerful than a _____.
means of transportation

Able to _____ _____ trees in a single bound.
verb adjective

Look! Up in the _____!
place

It's a/an _____. It's a/an _____.
animal means of transportation

It's Superplant!

Yes, it's Superplant – strange visitor from _____ who
place

came to America with powers and abilities far beyond those of
normal plants. Superplant - who can change the course of

_____ forests, _____ trees with its
adjective verb

_____ vines, and who, disguised as bittersweet,
adjective

a/an _____ - mannered vine, fights the never-
adjective

ending battle for _____, _____ and the
noun noun

American _____.
noun

Truth is stranger than fiction!

Oriental bittersweet is a superplant from Asia. It goes about daily life disguised as an attractive vine with yellow and orange fruits.

Homeowners and craftspeople plant it for use in landscaping, flower arrangements, and holiday wreaths.

But, unlike Superman, its other life is sinister! Oriental bittersweet readily escapes from cultivation and invades

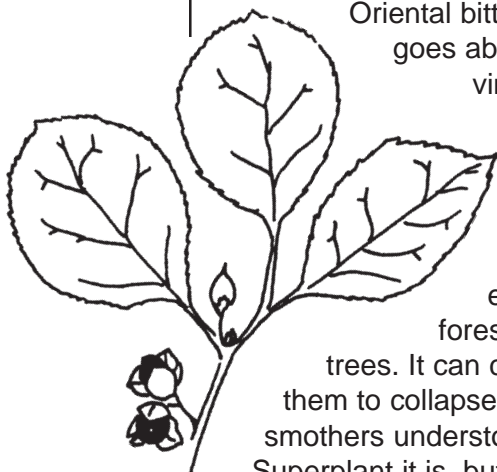
forested areas. It can strangle shrubs and

trees. It can cover tall trees in a season, causing

them to collapse from the weight of its vines. It

smothers understory plants and steals the light.

Superplant it is, but don't expect it to fight any battles but its own!



The Great Cover-up

The other day, _____ stepped out of the house for
some fresh air. _____ was tired, so he/she
stretched out under a/an _____ tree to rest.

He/She fell into a deep sleep just like that old guy in the story
named _____. He/she slept like a _____
for _____ weeks.

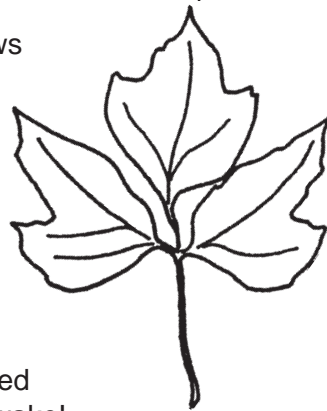
When _____ awoke, he/she could not move a
_____. Vines wrapped around _____'s
_____ and _____. Above his/her head,
_____ saw _____ flowers in the dim
light. The tree was gone and so was his/her _____
house. Was this a dream?

Truth is stranger than fiction!

Kudzu is a vine from eastern Asia. The Japanese government introduced the plant to Americans at a Centennial Exposition in 1876. Its abundant vegetation and sweet-smelling flowers made it a popular ornamental plant. Our government promoted it as a plant to feed livestock and to help control soil erosion, but it quickly escaped and took over!

Kudzu can grow up to 12 inches in one day. It grows right up telephone poles and tree trunks. Kudzu covers the landscape and smothers every other plant in its path. Other plants simply can't grow, because kudzu grows so thick that it blocks the sun. When the native plants die, the animals that depended on them can't find the food and shelter that they need to survive. Just like in the story, kudzu is taking over the landscape!

News flash! Kudzu is moving north and has invaded Illinois. It has not reached Wisconsin – yet. Stay awake!



Fields of Screams

The _____ family went on a/an _____
last name adjective
hike to visit a favorite field of wildflowers. When they arrived,
they _____ in shock. The wildflowers were gone
verb ending in "ed"
and the field was covered with _____ plants. The
color
plants were _____ and _____ with
verb ending in "ing" verb ending in "ing"
_____ dripping off of their leaves.
something you drink

When little _____ reached out to touch a plant, it
boy's name
gave him a/an _____ _____ on his little
adjective noun
_____. Suddenly, a _____ went flying
body part part of a plant
through the air and landed on big sister _____'s
girl's name
_____. The whole family turned and
piece of clothing
_____. As they _____ down the path,
verb ending in "ed" verb ending in "ed"
the _____ jumped off big sis's _____
same part of plant same article of clothing
and turned into a whole new plant. Next year, the whole field
might be invaded!



Truth is stranger than fiction!

Leafy spurge is a very invasive plant from Eurasia. It can completely take over fields and pastures. The plant looks like it is dripping with milk, but the white liquid is really a toxic latex. When an animal eats a leafy spurge plant, the inside of its mouth can become covered with small, irritating scratches. If you touch it, it can cause a bad skin rash. Be extra careful not to get the milky latex in your eyes; it can even cause blindness! Leafy spurge spreads by root and by seed. When leafy spurge fruits are ripe, they explode, sending the seeds up to 15 feet through the air!

Invasive or Not?

Method

Students will visit a natural area and observe native and non-native plants. They will use a checklist of invasive characteristics to predict whether a plant is invasive or not. They will check their predictions by identifying the plant and checking its status.

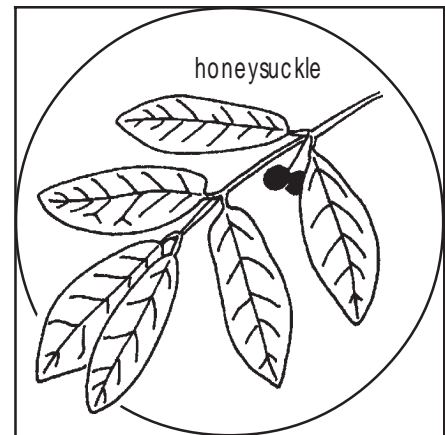
Getting Ready

1. Make copies of the drawing on page 32 or copy it on a transparency for classroom viewing. Make one copy of the *Invasive or Not?* worksheet on pages 33 – 34 for each team of students.
2. Locate an area with a wide variety of native and non-native plants. While several groups of students can observe the same kind of plant, each student group will need access to a specimen.

Introducing the Activity

One of the many challenges of managing invasive species is identifying an invasive plant *before* it has become a problem. Some countries (e.g., New Zealand) and states (e.g., Hawaii) have implemented Weed-Risk Assessment programs. These programs try to screen plants before they are permitted to enter a new area. The screening process looks at the:

- Plant's observable adaptations. (Is it equipped with thorns, toxins, or other defenses? Does it stay green and photosynthesize all winter? Does it grow quickly?)
- Plant's reproductive potential. (Does the plant produce a lot of seeds? Can the plant spread vegetatively by runners or rhizomes?)
- History of the plant. (Is the plant invasive in other parts of the world? Has it repeatedly invaded new areas?)
- History of the plant's relatives. (Are the plant's close relatives invasive in this location or others?)
- Attitudes of people. (Do people want to cultivate/own the plant? Plants people want are planted frequently and are more difficult to keep from spreading.)
- Climate of the plant's native range. (Is the plant's native climate similar to the climate of the new location? Has the plant proven that it can survive in a wide range of conditions?)



Objectives

- Recognize invasive characteristics in plants.
- Identify at least one invasive plant.

Grades

6 – adult

Group Size

Small groups of 2 – 3

Activity Time

Two 50-minute periods

Setting

Outdoors in spring, summer, or fall

Materials

- Copy of *Invasive or Not?* illustration (page 32)
- Copies of *Invasive or Not?* worksheet (pages 33 – 34)
- Clipboards
- Pencils
- Trowels, pruners, scissors for collecting plants
- Plastic bags for holding specimens
- Plant identification books (See list on page 139.)
- **Invasive Plants of the Upper Midwest**

Connections

See next page.

Academic Standards

Grades 6 – 8

- Science: C.8.2, C.8.4, C.8.5, F.8.2

Grades 9 – 12

- Science: C.12.3, F.12.7, F.12.8

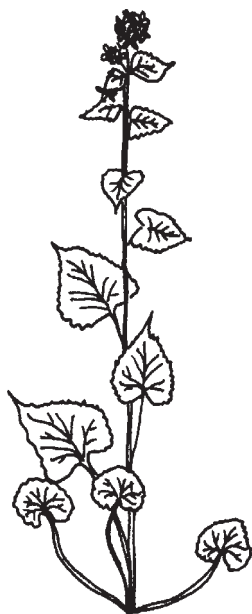
Weed-Risk Assessment programs are not possible or even practical for every place in the world. However, trying to identify and prevent potentially risky plants from entering countries is a great idea. This lesson includes a simplified version of a weed assessment tool that highlights invasive plant characteristics.

Doing the Activity

1. **Display the illustration on page 32.** Ask students to count how many different plants are in the illustration. (Four: Jack-in-the-pulpit, spring beauty, garlic mustard, and basswood.) Ask students what they notice about the plants.
2. **Pass out the *Invasive or Not?* worksheet.** Ask students to read over the sheet. As a group, use the worksheet to evaluate the garlic mustard in the illustration.
3. **Gather equipment and travel to the outdoor study area.**
4. **Divide into groups.** Instruct each group of two or three students to choose a plant to evaluate.
5. **Compare checkmark totals.** Ask each group to tally their checkmarks. Which plant received the highest invasiveness score? Which plant received the lowest? As a class, visit these plants.
6. **Discuss results.** Based on the field work, ask students if they think any of the plants they evaluated could be invasive.
7. **Confirm predictions.** Take samples of any possible invasives back to the classroom. Bag the plants at the collection site so that you do not spread seeds! Use plant identification books to identify the plant/plants you collected. Confirm whether the plant is invasive by using the tables on pages 195 – 204 in **Invasive Plants of the Upper Midwest**.

Assessing the Learning

Assess students' ability to use the checklist to evaluate a plant's invasive characteristics.



garlic mustard
in flower –
second year



garlic mustard –
first year



Jack-in-the-pulpit

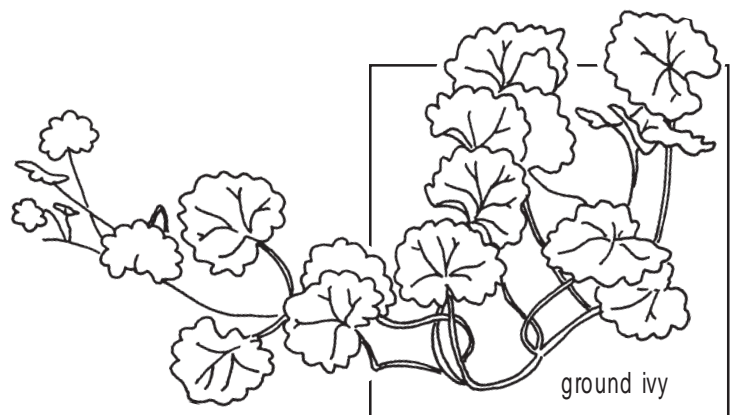


spring beauty

Extending the Learning

Investigate current laws. Several legislative acts give authority to exclude certain species from entering the United States. Ask students to find out about current and pending legislation. <www.invasivespeciesinfo.gov> Discover how authority over border protection has changed since recent terrorist attacks, the passage of the Patriot Act, the formation of the Office of Homeland Security, and the creation of the “Intelligence Czar.” Investigate black lists (banned species), white lists (permitted species), and pied lists. (Pied lists contain banned species and approved species. All species not listed are regarded as potential threats to biodiversity, ecosystems, or economy.) Discuss with students why so many people are opposed to the adoption of the “white list” approach. Debate which list would best protect America’s biodiversity.

Check out Australia’s invasive species awareness campaign. Making people aware of the problems that invasive species cause is one way to slow the intentional and unintentional introduction of new species. Australia, with its unique plants and animals, has suffered vast ecological and economic damage from non-native invasive species. They may be way ahead of us when it comes to protecting their homeland from invasives. They’ve even enlisted the help of the Crocodile Hunter, Steve Irwin! Ask your students to visit their Web site at <www.affa.gov.au> and follow the links to Quarantine and Export Services. They have extensive lists of permitted and prohibited items. Find out why a country has no problem with you bringing in fruitcake, but will confiscate your citrus tea! Check out their Biosecurity Australia publications page to get an idea of how seriously they take this issue. Challenge students to create an awareness campaign for the United States. Who could be our spokesperson? What TV, print, radio, or video strategies could raise awareness?



Invasive or Not?



Invasive or Not?

Whether a plant is invasive or not depends on the plant's characteristics and its location. You will not be able to answer some of these questions at certain times of the year, but do your best. Place a checkmark next to each feature that describes your plant or its surroundings. When finished, add up the checkmarks.

Plant name

(actual name or name you have given it) _____

Location _____

Displays Desirable Characteristics

Some invasive plants are very beautiful and have been planted and cultivated in gardens. Sometimes they escape to natural areas. Check all the desirable characteristics that your plant has.

- Beautiful flowers? Look for showy or colorful blooms.
- Interesting foliage? Look for variegations, unusual color, or large size.
- Screening potential? Look for thick branches and/or foliage that could provide privacy or hide something from view.

Exhibits Bullying Behaviors

Invasive plants are usually aggressive and tend to crowd out other plants. Check all the bullying behaviors that your plant exhibits.

- Grows up and over other plants - often smothering them?
- Forms dense thickets that the sun cannot penetrate?
- Leafy out early in the spring and uses light, water, and soil nutrients before native plants?
- Stays green all winter, continuing to use resources while other plants are dormant?

Defends Itself

Invasive plants are often armed and dangerous! Check the defenses that your plant possesses.

- Spines, thorns, or burs?
- Allelopathy? Allelopathic plants produce substances that inhibit the growth of surrounding plants. Look around. Do you see any other kinds of plants growing nearby?

Produces and Distributes Lots of Seeds

Invasive plants usually produce many seeds that mature quickly. The seeds can often disperse long distances. Check all the boxes that match your plant's seed adaptations.

- Too numerous to count?
- Dispersed by the wind? Look for seeds with parachutes or helicopters.
- Edible? Look for nuts, fruits, or berries that animals can move around.
- Sticky? Look for burs or hooks that allow the seeds to catch in fur, feathers, or fabrics.
- Able to float?
- Tiny?

Reproduces in More than One Way

In addition to seeds, many invasive plants spread by vegetative reproduction. Check all the ways that your plant appears to spread.

- Rhizomes (underground stems)?
- Stolons (above-ground stems)?
- Runners?
- Tubers?
- Bulbs?
- Ability to produce new plants from fragments? Look for tiny rootlets at the stem nodules.

Shows Few Signs of Being Eaten

Native herbivores often overlook or avoid invasive plants. Some plants are toxic or unpalatable; others simply are not familiar as food choices. Check the signs that show your plant is not being eaten.

- Few or no chewed leaves?
- No leaf miners?
- No damage to stem/trunk?
- No fungi? Look for molds, mildews, and powders on the leaves and stems.
- No galls?

Tolerates a Range of Conditions

The more adaptable a plant is to wide ranges of conditions, the more likely it is to be invasive. Look around. Check each place you see a plant like yours growing.

- In the sun?
- In the shade?
- In wet soil (lowland)?
- In dry soil (upland)?

Benefits from Disturbance

The more disturbed an area is, the more likely it is to have invasive species. Look around. Check each sign of disturbance that you observe.

- Foot traffic?
- Vehicle traffic?
- Construction of trails, steps, boardwalks, roads, parking lots, etc.?
- Grazing by cattle? In a forest, look for old fencerows. Do you notice large trees and small trees, but no medium-sized trees that would indicate the forest was grazed at some time?
- Floods?
- Storm damage?

Invades Natural Areas and Displaces Native Species

If you are in a natural area, look around the plant you are observing. Is it dominant? How many other kinds of plants do you see? Check all the boxes that apply.

- In a three-foot radius, is this the dominant plant species growing?
- In a three-foot radius, are most of the seedlings the same species as the plant being studied?

Total number
of checkmarks _____

Field Notes

Method

Students will practice taking field notes while observing an invasive plant.

Getting Ready

1. Find samples of field notes on the Internet or at a library. See references in *Finding Out More!* on page 37.

Introducing the Activity

Sketching is a great pastime, but that's not all it is! Sketching can help people relax, record valuable information, express deep feelings, and remember details. Sketching is particularly valuable for people who enjoy spending time outdoors.

Field biologists engage in a more precise form of sketching and writing called field notes. Writing good field notes is a skill that can only be developed and improved through practice. The notes that field biologists make record their observations so they can remember them more fully and refer back to them as needed. Field notes can provide qualitative and quantitative data for use in asking and answering research questions.

Doing the Activity

1. **Think about the value of field notes.** For hundreds of years, scientists, naturalists, and explorers have been making sketches and jotting down observations to document new species, rare species, and unusual variations in species. Lewis and Clark didn't just explore, they documented amazing plant and animal life for people who would never see the western areas of our continent! Look at the works of Lewis and Clark, Audubon, or other early explorers, which are available on the Internet and in books.
2. **Look at the samples included in this activity.** See pages 37 – 38.
3. **Try making field notes.** Ask students to find “weedy” plants near their homes and take field notes about them. Alternatively, you can conduct this activity on the school grounds or on a field trip. Tell students to model their field notes after the samples you looked at in books, on the Internet, and on pages 37 – 38. Sketches should include distinguishing features, color attributes, and different angles. Narratives must accompany their sketches. They should describe how the plants look, where they live, and what the students observed. Younger students can dictate their narratives to older student helpers.



Objectives

- Discover the value of natural history sketches and notes.
- Observe and describe a plant using a basic field note format.
- Practice and improve observation skills (collecting information, quantifying information, and observing patterns in nature).

Grades

2 – adult

Group Size

Individuals

Activity Time

One 50-minute period plus homework

Setting

Classroom and outdoors

Materials

- Internet access or reference books
- Writing surfaces
- Notebooks
- Pencils

Connections

See next page.

Academic Standards

Grades 2 – 4

- English Language Arts: B.4.1
- Science: A.4.3, C.4.5

Grades 5 – 8

- English Language Arts: B.8.1
- Science: A.8.3, B.8.5, C.8.2

Grades 9 – 12

- English Language Arts: B.12.1
- Science: A.12.6, B.12.4

Scout Connections

- Boy Scouts: Environmental Science
- Junior Girl Scouts: Hiker, Outdoor Creativity, Wildlife, Your Outdoor Surroundings
- Cadette and Senior Girl Scouts: Wildlife

Assessing the Learning

Students should complete self-evaluations of their field notes. The evaluations should list what they did well, what they liked about the process, and what they could improve. They should also evaluate at least two of their classmate's field notes. Encourage students to learn from each other and to make constructive comments.

Grades should be based on the criteria established in class. Field notes should include these features:

- Name of observer
- Date and time
- Specific description of the location so someone else can find the same area (e.g., trail, road, county)
- Written description
- Sketch of plant in color or with color notations

Extending the Learning

Compare botanical illustrations with artistic representations.

People sketch and paint plants for a variety of reasons. While early botanical illustrations were sometimes more art than science, they are very different today. Botanical illustrators know that their art may be used as an aid to identification. Colors must be accurate and plant parts must be drawn to scale. Other artists who paint plants might be interested in capturing the essence of the plant. They don't need to include every plant part. They are free to emphasize the flowers or whatever they find aesthetically pleasing. Challenge your students to find samples of early botanical drawings, current botanical illustrations, and artistic representations of the same plant on the Internet. Compare them. Ask students which type of art they would prefer to create.

Create personal field guides. Each student can make a field guide to common plants in your schoolyard or a nearby natural area. Suggest students use a spiral notebook. Dedicate one page for each plant. Include a sketch, leaf rubbing, or pressed leaf. Use tape to attach seeds or twigs. Students should add hints and notes that help them remember each plant.

Finding Out More!

The Boy Who Drew Birds: A Story of John James Audubon. Jacqueline Davies. 2004. This book tells of the young Audubon and how his youthful hobbies inspired his life work.

Drawing from Nature. Jim Arnosky. 1982. This book shows how to draw water, land, plants, and animals.

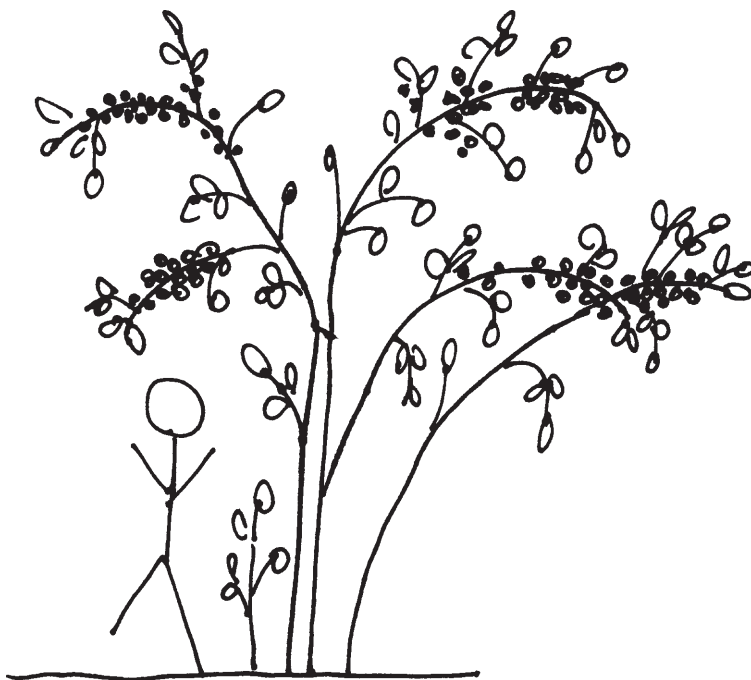
The Journals of Lewis and Clark. American Philosophical Society. 2005. This online journal chronicles the expedition. <<http://amphilsoc.org/library/exhibits/treasures/landc.htm>>

Plants on the Trail with Lewis and Clark. Dorothy Hinshaw Patent. 2003. This book describes the journey of Lewis and Clark throughout the western United States. The focus is on the plants they cataloged, the plants' uses for food and medicine, and the plant lore of Native American people.

Student page – elementary

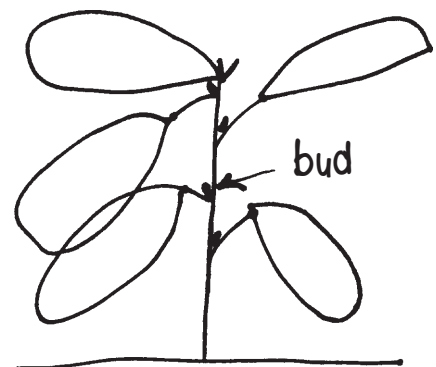
I don't like buckthorn. It is everywhere in the woods behind my house. The little trees grow close to each other and trip me.

Erin Mittermaier
November 3, 2005
N129 W17325 Arthur Court
Germantown, WI



My dad

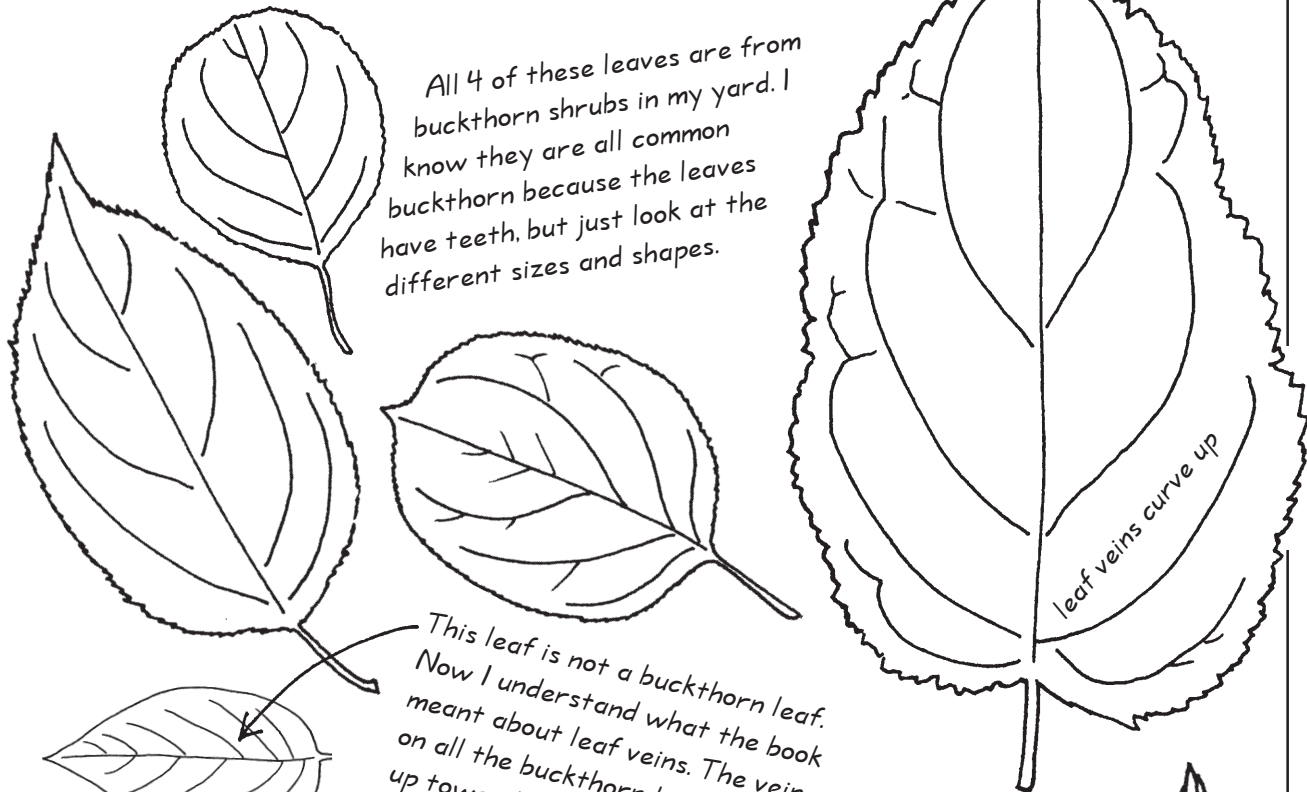
This is the smallest buckthorn tree I could find.



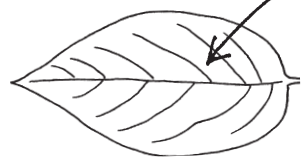
One tree was taller than my dad. The tall buckthorn trees have black berries. The berries are at the top. There are so many they make the branches hang down.

Today is sunny with temperatures in the mid-60s. The wind roared all last night and blew most of the leaves off of the trees. It's easy to see the non-native trees and shrubs in my backyard now, because they are the only ones with green leaves! I'm determined to find out more about buckthorn today. I really want to know how it got its name!

N. Mittermaier
November 3, 2005; 1:30 pm CST
NE Corner of Lancelot & Camelot
in Germantown, WI



All 4 of these leaves are from buckthorn shrubs in my yard. I know they are all common buckthorn because the leaves have teeth, but just look at the different sizes and shapes.



This leaf is not a buckthorn leaf. Now I understand what the book meant about leaf veins. The veins on all the buckthorn leaves curve up toward the tip of the leaf. The veins on this leaf just point to the edge of the leaf.



THORNS

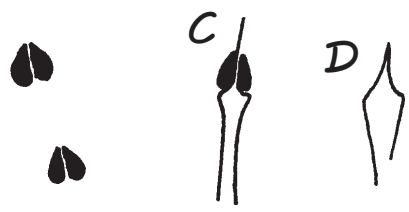
I looked at the end buds on 10 buckthorn shrubs.

- 4 didn't have any sign of thorns (A & B)
- 3 had "thorns" longer than the buds (C)
- 2 had "thorns" that barely stuck out from the buds
- 1 had a thorn that was hidden by the buds (D - buds removed)



The BUCK in BUCKthorn

I think I found the reason for the name. Look at the end buds on twig B. Now look at the deer footprints I found in the mud.



Some of the buds are opposite each other (B) and some are alternate (A).

The Plant Hunters

Method

Students will collect local invasive plants and press them to serve as a reference collection for their school and community.

Getting Ready

1. Before collecting any plants (even invasive species!), ask permission from the landowner.

Introducing the Activity

There have always been plant hunters, but the purpose of the hunt has changed over the years. The first plant hunters were just searching for food! Later when things became a little more settled, the rich sent off others in search of rare bulbs, rootstalks, and fruits that they could plant in their gardens and cultivate. Luca Ghini (1490 – 1556) was the first plant hunter known to have pressed and dried plants to conserve them in a collection. Since that day, plant hunters have gone to the ends of the world to assemble and preserve plants for documentation and study.

Today, herbariums (dried plant collections) play an important role in documenting historical plant communities, tracking the introduction and spread of non-native plants, and monitoring the success of recovery efforts.

Doing the Activity

1. **Share information about the history of plant collecting.**
2. **Discuss the value of plant collections.**
 - A good plant collection presents a snapshot in time, capturing the plants that once inhabited a given area.
 - Plant collections can track the introduction of non-native species and the range of plants.
 - Plant collections can reveal variations and changes in plants over time.
3. **Visit the State Herbarium.** Take a virtual field trip to Wisconsin's online herbarium. Invite students to look up familiar plants, invasive plants, or all the plants in your county. <www.botany.wisc.edu/wisflora>
4. **Make plant presses.** Follow the directions on page 42 to make a plant press for each student or small group of students.



Objectives

- Understand that hunting for plants has gone through many changes.
- Investigate the state herbarium and find out about the value of plant collections.
- Collect and press invasive plant specimens.

Grades

K – adult

Group Size

Individuals or pairs

Activity Time

One or two 50-minute periods; ongoing

Setting

Outdoors and indoors in spring, summer, or fall

Materials

- Access to the Internet
- Rigid end boards
- Cardboard
- Newspaper
- Rope or rubber bands
- Trowels and pruners
- Water
- Plastic shopping bags
- Labels
- Mounting paper
- Glue

Connections

See next page.

Academic Standards

Grades K – 4

- Science: A.4.3, A.4.5

Grades 5 – 8

- Science: A.8.3, B.8.5

Grades 9 – 12

- Science: B.12.4, F.12.5

Scout Connections

- Bear Cub Scouts: Nature Crafts
- Junior Girl Scouts: Outdoor Creativity

5. **Collect and press invasive species.** Follow the directions on page 43. If your collection expands to include native plants, consider these guidelines:
 - Endangered and threatened plants are extremely rare and should be photographed, rather than collected. A list of rare plants is available on the Internet. <www.dnr.wi.gov/org/land/er/working_list/taxalists/TandE.asp>
 - Public and private natural areas usually have additional plant collection restrictions. Be sure to check.
 - Never collect a native plant unless there are at least 10 other identical plants within sight. Try to leave enough of the plant for it to survive.

Plant collecting with lower elementary students.

Plant collecting can be a great cooperative activity. After older students have mastered the collecting and pressing techniques, pair them with lower elementary students. Together they can work on a school herbarium. Be sure to set clear guidelines concerning who does which steps and how older students can “help” without “taking over.”

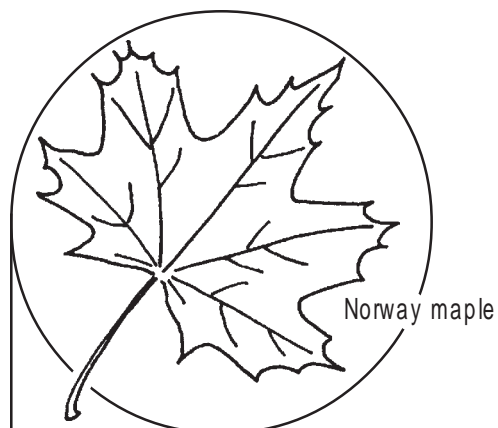
Assessing the Learning

Create a rubric to assess effort, behavior, and competency in:

- Building a plant press.
- Collecting and pressing plants.
- Labeling and mounting.

Extending the Learning

Claim some fame! The Wisconsin State Herbarium keeps plant specimens from all around the state. If your students are the first to send a particular plant specimen from your county, their names will be listed permanently on that specimen and on the WISFLORA Web site. Check the Web site to see which invasives have not been collected in your part of the state. <www.botany.wisc.edu/wisflora> You can find detailed directions for sending in specimens and an Invasive Plant Report Form on the WDNR’s Web site. <www.dnr.wi.gov/invasives/futureplants/index.htm>



Get creative with pressed invasives. Press flowers and leaves from invasive plants for use in art projects. Follow the same pressing procedure, only collect the plant parts to be pressed based on size, shape, and color. You can use pressed leaves and flowers to make:

- Notecards.
- Framed flower/leaf arrangements.
- Leaf prints on fabric or paper.

Be sure to note on your projects that the plants are invasive. The back of notecards could contain a short paragraph that identifies the plant and explains why it is a problem.

Finding Out More!

Collecting and Preserving Plants for Science and Pleasure.

Ruth B. (Alford) MacFarlane. 1985. This book is filled with great ideas!

WISFLORA: Wisconsin State Herbarium. University of Wisconsin – Madison. 2005. Online listing of plants by common name, scientific name, habitat, status, and county.
<www.botany.wisc.edu/wisflora>

Making a Portable Plant Press

Parts of the Press

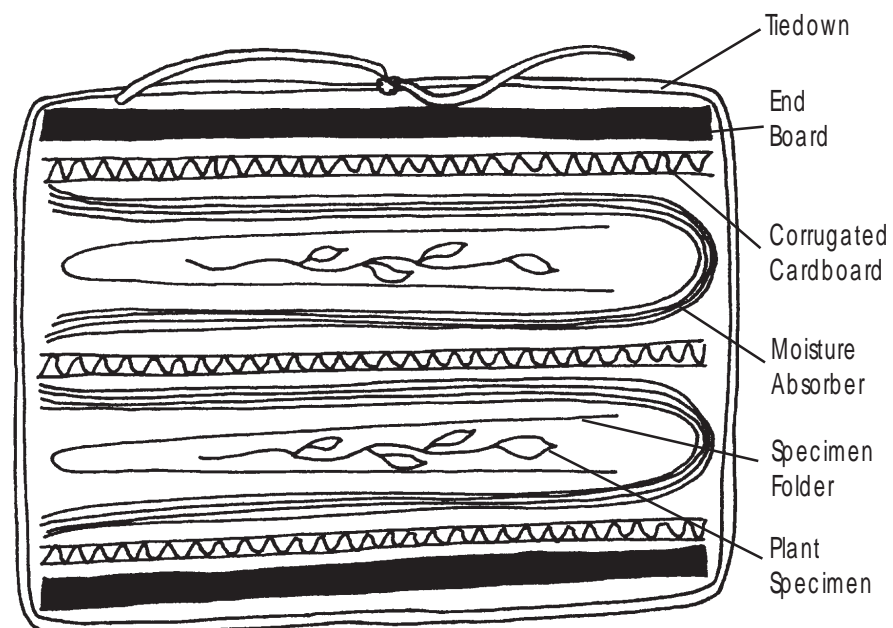
- **End Boards** – Prepare two 9- by 12-inch rectangles of a rigid material. Use plywood, Masonite, pegboard, the backs of two clipboards, the covers from a three-ring binder, or even several pieces of cardboard glued together.
- **Corrugated Cardboard** – Cut up cardboard boxes so the cardboard is the same size as the end boards. Cut so the lines of corrugation run across the shortest distance. This will enhance airflow through the press.
- **Moisture Absorbers** – To wick moisture away from the drying specimens, use sheets of newspaper or paper toweling cut to the same size as the endboards. Sheets of thick blotter paper work well, if available.
- **Newspaper Specimen “Folders”** – Cut folded pieces of newspaper to the same size as the end boards. Arrange specimens inside the newspaper in the same way you would place a document in a file folder.
- **Tiedowns** – Use rope, bungee cords, large rubber bands, or buckle straps to tie the press together.

Assembling the Press

When putting plants in the press, each newspaper specimen folder is sandwiched between moisture-absorbing layers and cardboard. For bulky specimens, extra layers of moisture absorber and cardboard may be needed. Tie the press together tightly. You may need to adjust the tightness as plants dry and flatten out. Include five to ten specimen folders in your press, or as many as you can comfortably carry.

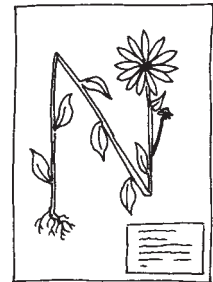
Alternatives

While a plant press does the best job of drying plants, you can have reasonable success using materials in the classroom. Sandwich the newspapers containing your plants between two pieces of corrugated cardboard. Place several layers of cardboard sandwiches on top of each other. Place several heavy books on top of the cardboard sandwiches. You can also simply place plant specimens in an old telephone book and press with heavy books.



Collecting a Plant Specimen

1. **Find an invasive species to collect.** This shouldn't be hard! Abandoned fields, vacant lots, and other disturbed areas will probably harbor several invasive species. Try to find a specimen that is flowering.
2. **Record information.** Record the date, the location of the plant, and a description of the habitat. Habitat descriptions should include some indication of the abundance of the invasive species in that location.
3. **Collect specimens.** Using a trowel, dig up the roots of the plant, and wash the soil from the roots. If you are unable to press the plant immediately, wrap the roots in moist newspaper and place the plant in a plastic bag. If the whole plant is too large to collect, prune off a twig that shows branching and leaf attachments. Collect bark, seeds, and/or fruits. Take a photo of the entire plant.
4. **Press the plants.** Arrange each plant on one half of a newspaper folder so that all parts show (i.e., don't overlap flowers with leaves). Turn over one leaf to show its underside. If the plant is too tall to fit on a piece of paper, fold it into a "V", "N," or "W" so that it fits. Close the newspaper folder. See *Making a Portable Plant Press* on page 42 to put your plants into the press. Change the moisture-absorbing newspapers every day or so to speed the drying process. It is critical to dry specimens quickly to avoid decomposition, prevent mold growth, and maintain color.



5. **Mount the plants.** Your plants will look better and will be easier to handle and display if they are mounted on paper. Special herbarium sheets are available from most biological supply companies (the American standard is 11.5 by 16.5 inches). If possible, choose a heavyweight acid-free paper. Attach the plant to the piece of paper with a neutral-pH formulation of PVA (i.e., polyvinyl acetate: white glue like Elmer's). Dilute the glue with water for general mounting and use it full strength for specimens that need to be more firmly glued, such as a woody branch that only touches the sheet in a few spots. Paint the glue on the underside of the plant specimen. Press gently with a paper towel to squeeze out and blot up excess glue and to push the plant against the paper.
6. **Label the plant.** Include the information shown on the sample label. See *Writing a Plant Label* on page 44. Place the label in the lower right corner of the sheet. Make a small envelope from acid-free paper to hold seeds or small loose parts. Glue it to the page.
7. **Allow the glue to dry.** Cover the plant with a piece of wax paper so the glue doesn't stick to anything else. Place a square of cardboard over the label to hold it flat while it dries. If there are bulky parts like stems or fruits, add padding to press down the flatter parts of the specimen. Place a sheet of cardboard between specimens to distribute the weight. Then, place a board and heavy books on top of the cardboard. Allow to dry overnight.
8. **Store plant specimens.** Protect the specimens from moisture, light, and insects. Store in a tightly-sealed box or cabinet. If insects do get into the specimens, kill them by freezing the specimens in a very cold freezer (-10° F) for three days or longer. Place the specimens in a plastic bag before freezing, and leave them in the bag until they reach room temperature after coming out of the freezer.
9. **Use the specimens.** Encourage students to use the specimens to verify identification, search for variations, and compare plant distribution from year to year. Display the specimens to educate others about local invasive plants.

Writing a Plant Label

Follow your teacher's directions to know what to include in your plant label. For inclusion in the state herbarium, specimen labels must have all items marked with a (*).

Scientific name (genus and species)

Common name

Plant family

Location *

Include at least one of the following to describe where the plant was found:

- Provide the geographic coordinates using a GPS unit, topographic map, or Gazetteer.
- Locate the position on an online topographic map and print it out.
- Include references to roads, mile markers, or distances from permanent landmarks.
- Indicate county, township, range, section, quarter-section

Description of habitat *

- Describe the place the plant was growing (e.g., growing through gravel in an abandoned roadway or growing in the shade of a Norway maple).
- List the type of plant community where the invasive was growing (e.g., forest interior, forest edge, old field, prairie, wetland, lakeshore, crop field, pasture, disturbed ground, urban setting).
- List other plants growing in the same area.
- Indicate the size and density of the infestation of any invasive plants.

Plant description

- Describe characteristics that might be lost, such as colors and smells.
- Record the size of the plant if only part was collected.

Name of collector *

- Include mailing address, phone number, and email address if submitting the specimen to the Wisconsin State Herbarium.

Name of person who identified the plant

- List only if different from the collector.

Date collected *

- Use the format of day, month, year (e.g., 15 July 2005).

Herbarium of Rockfield School
Germantown, Wisconsin, USA

INVASIVE PLANTS OF ROCKFIELD

Hesperis matronalis

Dame's Rocket
<Cruciferae>

WASHINGTON COUNTY: Just S. of Rockfield Rd. on the NE corner of Rockfield School grounds. (Lat. 43°15'26.1" N, Long. 88°7'41.5" W) Growing at edge of playground where mowed grass meets wooded area. There were 25 dame's rocket plants growing in area about 10 feet long. Flowers: lavender

Francine George, Rockfield School, N132 W18473 Rockfield Rd, Germantown, WI 53022, 262-628-1181
with Charles Roe and Allen Evers
17 May 2005

Web of Life

Method

In this simulation game, students will represent plants and animals living in a forest habitat. Sitting in a circle, they will connect themselves to each other using string to represent the ways they depend on each other. As they make connections, the string forms a visual web of life. Finally, they will experience what happens when an invasive species enters their world.

Getting Ready

1. Choose the cards you will use in the activity based on your location and the students' familiarity with the plants and animals on the cards.
2. Arrange for an adult leader for each group of 8 to 15 students.
3. Copy one set of cards per group. Make additional cards for plants or animals that are unique to your location.

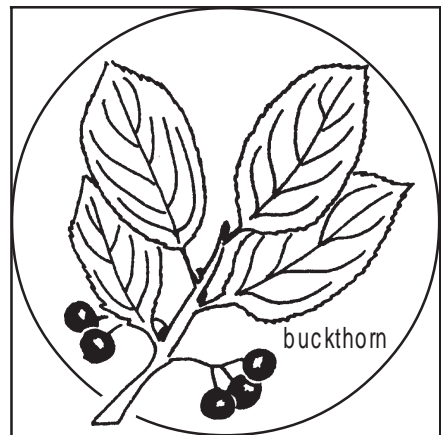
Introducing the Activity

Have you ever seen a perfect spider web? The rays reach out and connect to tree trunks, rocks, and fences. They hold the web in place. The spirals are evenly spaced. They tie the rays together. If you follow the strands of silk, you can eventually get to any place on the web!

Now picture a forest. The forest ecosystem is made up of living and non-living things that are connected to each other. Some of the connections are obvious; some are amazing. Oaks need the light of the sun to live and grow. Mice eat the tree's acorns. Snakes eat mice. If we could take a pencil and magically draw the connections in the forest, the picture might start to look something like a crazy spider web. Imagine a line drawn from the sun to the oak trees to the mice that live in their trunks and eat their acorns to the snakes that slither through their dead leaves and eat the mice. Let's play a game to see how this might work.

Doing the Activity

1. **Divide the students into groups.** Maximum group size is 15. The ideal size would be 8 to 12. Each group should sit in a circle with an adult leader.
2. **Assign each student an identity.** Give each student a plant or animal card. Be sure they know a little about the plant or animal on their cards. To play the game, students will need to know how the plants and animals are connected in food chains.
3. **Start the game.** Show the ball of string and explain that the string will let us see the connections between plants and



Objectives

- Describe a forest food web.
- Identify the connections between plants and animals in a forest ecosystem.
- Explain how the introduction of an invasive species impacts a forest food web.

Grades

2 – 8

Group Size

Small groups of 8 – 15

Activity Time

10 – 20 minutes

Setting

Anywhere

Materials

- Copies of forest plant and animal cards (pages 49 – 52)
- Yarn or string

Connections

See next page.

Academic Standards

Grades 2 – 4

- Environmental Education: B.4.1
- Science: F.4.4

Grades 5 – 8

- Environmental Education: B.8.8, B.8.21
- Science: F.8.9

Scout Connections

- Webelos Scouts: Naturalist
- Boy Scouts: Nature
- Brownie Girl Scouts: Eco-Explorer
- Junior Girl Scouts: Earth Connections

animals. Explain that you will represent the sun. You will start, because all energy comes from the sun. Model the game by saying, “I am the sun. I am passing the ball of string to the sugar maple tree, because I give the tree energy to grow.” You hold onto the string and pass the ball to the tree.

4. **Continue the play.** The “tree” now chooses a plant or animal in the circle that is connected to it in some way. The “tree” holds onto the string and passes the ball to that plant or animal. For example, the tree might pass the ball to the deer that eats tree leaves, the woodpecker that eats the bugs in its bark, or the owl that roosts in its branches. Keep the string tight, but not too tight! Play continues until everyone is holding onto the string. Some plants or animals might have more connections, but everyone should be a part of the crazy web!
5. **Show the power of the sun.** Explain that you, representing the sun, are very important. Ask what might happen if the sun suddenly stopped shining. Briefly discuss some of the consequences. (Obviously, it would be dark! Without the sun to provide warmth, the earth would cool off. The wind would stop blowing. Plants would eventually die. Animals that eat the plants would die. When we used up our food reserves, we would die too.) Ask everyone to sit still. Begin to tug gently on your part of the string. Tell the students that when they feel the tug, they should begin to tug gently. Ask them to watch as the tug moves through the web. Finally, the whole web will be shaking! Everything is connected to everything else.
6. **Explore other connections.** It is easy to understand how the sun influences the connections between plants and animals, because the sun is the source of all energy. What would happen if the mushroom (or some other plant or animal) disappeared? Mushrooms aren’t that important, are they? Try the game again with the mushroom gently tugging on the web. As each plant or animal in the circle feels the tug, he/she should call out the plant or animal he/she represents.
7. **Discuss impacts to the web.** Talk about things that might happen that would change the way the plants and animals are connected. What would happen if:
 - No rain fell for months?
 - A storm blew down all the mature trees?
 - Too much rain fell?
 - Part of the area was cleared for construction?
8. **Consider invasive species.** Ask what might happen if a new plant or animal came into the forest environment. Choose an invasive species that is common in your area. Ask the students how this new species might affect the plants and animals of your little circle. See the list below for some ideas.

Identify one plant or animal that the new invasive species will displace. Change the plant or animal tag of that student. Follow the connections from that student to other plants and animals in the circle. Ask the student to let go of the string. What happens to the web? Ask the other students to pull gently on the string. Watch as the web unravels. This activity helps students understand how the introduction of an invasive plant can impact native animals and vice versa.

- Buckthorn – Outcompetes other woodland plants by leafing out early in the spring and forming a dense canopy. Replaces plants like nannyberries, Virginia creepers, trilliums, mayapples, sugar maples, and basswoods.
- Garlic mustard – Outcompetes woodland wildflowers, such as trilliums and mayapples, by beginning growth very early in the spring and producing an abundance of seeds!
- Eurasian earthworm – Eats away the leaf litter that woodland wildflowers (mayapples and trilliums) and tree seedlings (sugar maples and basswood) need to sprout and grow.
- Gypsy moth larva – Feeds on the leaves of deciduous trees such as basswoods and sugar maples.
- Asian longhorned beetle – Feeds on a tree's growing layer (cambium) that lies just under the bark. Sugar maple is one of the trees that this insect attacks.
- Hemlock woolly adelgid – Feeds on hemlock needles. The feeding causes the needles to fall from the tree prematurely, eventually killing the tree.
- Wild boar – Digs up plants as it feeds. The disturbed ground encourages the growth of invasive forest plants.
- House cat – Preys on small birds and mammals such as chickadees, yellowthroats, robins, and white-footed mice.
- Starling – Takes the best nesting sites and leaves native cavity-nesting birds such as screech owls and chickadees with less desirable nesting locations.

Assessing the Learning

Students each choose one plant or animal from the game. Using a large sheet of paper, each student should draw a plant or animal in the center of the paper. Instruct students to draw or write the names of the other plants and animals from the game around their central drawings. Tell them to draw lines from their chosen plants or animals to other parts of the forest ecosystem that are connected to them in any way. Older students should describe the connections along the lines (e.g., “toads eat mosquitoes”). Encourage students to add nonliving things (e.g., rain, rocks, or soil) or other plants and animals that live in the forest habitat and connect to them.

Extending the Learning

Try a Habitat Lap Sit. After they try this activity, students will definitely understand why everything in a forest depends on everything else! Tell students that they are going to represent the plants and animals that live together in a forest habitat. Find some soft grass or carpet. Have students stand in a circle with shoulders almost touching. Instruct everyone to turn to the right and put their hands on the hips of the person in front of them. On the count of three, students should gently guide the person in front of them onto their lap. If it works correctly, everyone will be sitting on the lap of another person in a huge continuous lap sit! It may take a few attempts to get it right. Adjust the distance between people to match the sizes of your students. Caution: People with back or knee problems should sit this one out!

Encourage students to play with the cards individually.

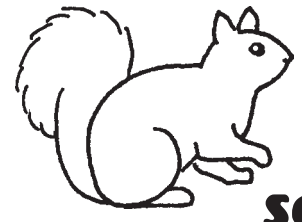
- Put the cards on a bulletin board and use string to connect them to each other in a web of life.
- Use the cards at a learning station and encourage students to play Dominoes. Starting with one card, students should place cards end to end. Each time they place a card, they must describe the connections between the new card and the card on the table.

Play *Web of Life* outdoors. Take the game outside! Create a *Web of Life* in the schoolyard or a nearby park. Start by tying a string to a tree or other plant. Connect the green plant to living and nonliving things. Use animal signs instead of real animals! Don't forget to clean up your string!

Finding Out More!

Who Eats What? Food Chains and Food Webs. Patricia Lauber. 1995. *Let's-Read-And-Find-Out Science* series – Stage 2 Book. Explains the concept of a food chain and how plants, animals, and humans are ecologically linked. Grades 1 - 4.

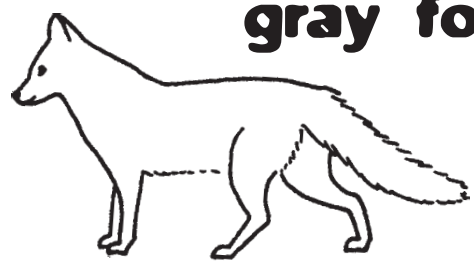
**whitetail
deer**



**gray
squirrel**



star-nosed mole



gray fox

**white-footed
mouse**

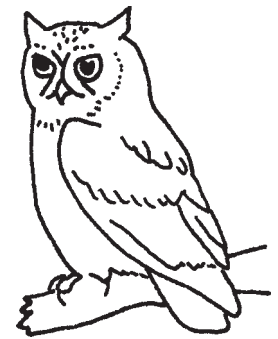


**flying
squirrel**

**Cooper's
hawk**



**screech
owl**

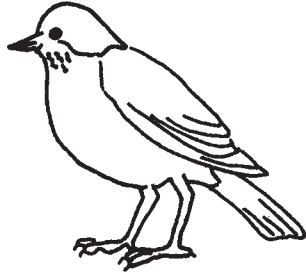


chickadee

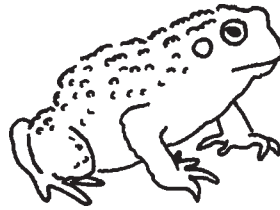


yellowthroat

robin



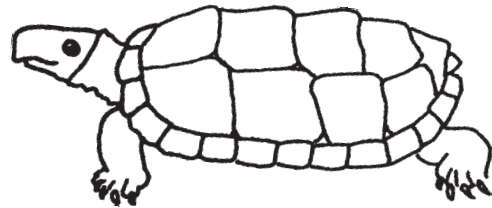
toad



spotted salamander



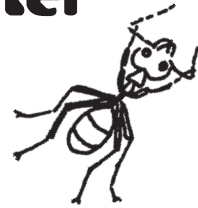
wood turtle



red-bellied snake



**carpenter
ant**



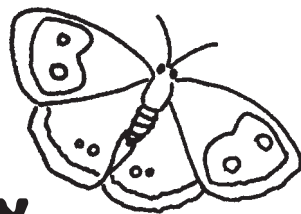
**green June
beetle**



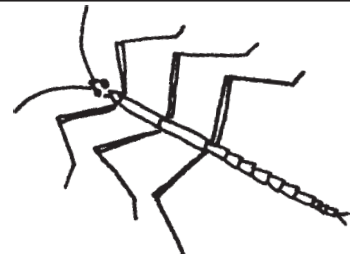
**eastern
tent
caterpillar**









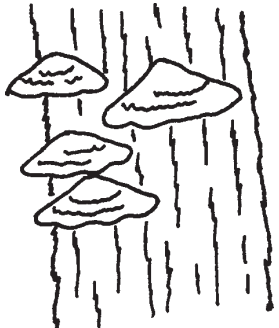
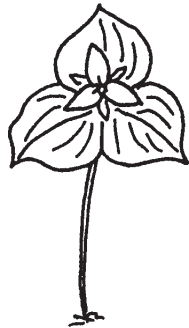


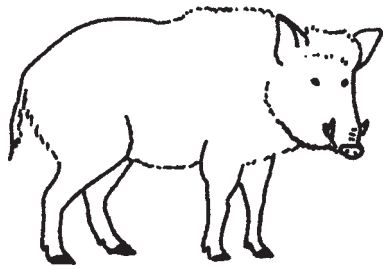
**wood
nymph
butterfly**



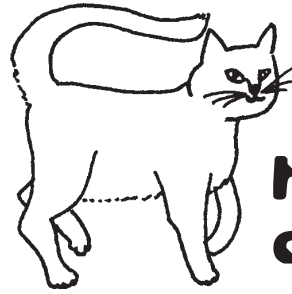
walkingstick



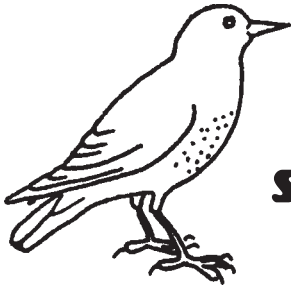
<p>mosquito</p> 	<p>basswood</p> 
<p>sugar maple</p> 	<p>eastern hemlock</p> 
<p>nannyberry</p> 	<p>Virginia creeper</p> 
<p>poison ivy</p> 	<p>mayapple</p> 
<p>shelf fungus</p> 	<p>trillium</p> 



**wild
boar**



**house
cat**

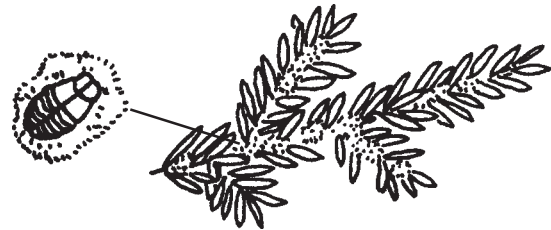


starling

**gypsy
moth**



**Asian
longhorned
beetle**



woolly adelgid

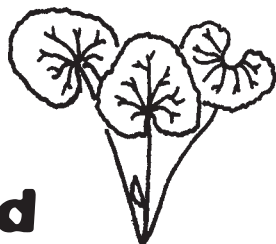


**Eurasian
earthworm**

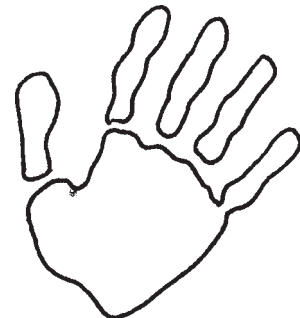


buckthorn

**garlic
mustard**



human



Outwit- Outplant- Outlast

Method

Students will play the parts of native plants, invasive plants, and herbivores in a game. They will quickly see the advantages that invasives have over natives. The invasives need fewer resources and reproduce a lot faster than their native competitors. In fact, it won't take many "seasons" for a few invasives to displace the native plants and take over the playing field.

Getting Ready

1. Prepare the playing field by making 25 one-yard squares. You will need three people to help make the grid. See directions for using a chalk line on page 58. Alternatively, use carpet squares or paper plates to make the playing field.
2. Find two colors of tokens to represent sunshine and water/nutrients. Use poker chips, milk caps, or paper squares.

Introducing the Activity

When you watch a nature show on TV about a pride of lions, a herd of zebras, and a pack of hyenas, it's easy to understand how competition controls the sizes of these populations. It's a little harder to understand how competition works with plants. These three games will help you understand some of the factors that decide who wins and who loses in the plant world.

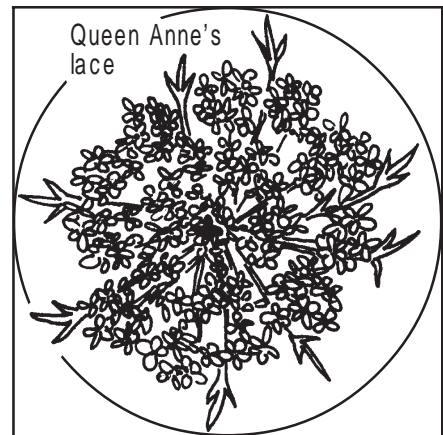
Doing the Activity

Game One

Discover how plants invade an empty field.

This playing field represents a recently plowed field. Each square on the grid has enough space (soil) for one plant. In real life, many different plants and their seeds would invade this bare field. In order to simplify the process and analyze what is happening, we are going to assume that only one seed from an invasive species sprouts in the first year and that no other seeds from other plants can enter the field.

1. **Discuss what plants need to survive.** (Sunshine, water, nutrients, soil).



Objectives

- Experience the vulnerabilities of native species, such as competition, predation, and dependence on nutrients, water, and space.
- List reasons why invasive species have a competitive advantage over native species, such as longer growing season, lower nutrient requirements, and lack of predators.
- Chart the advancement of invasives as they spread throughout a natural area.

Grades

5 – 12

Group Size

15 – 30

Activity Time

One or two 50-minute periods

Setting

Outdoors or gym

Materials

- Chalk line
- Chalk dust for refilling
- Tape measurer
- Sidewalk chalk
- Water/nutrient tokens (100)
- Sunshine tokens (100)
- Cowbell or other noisemaker

Connections

See next page.

Academic Standards

Grades 5 – 8

- Environmental Education: B.8.8, B.8.21
- Math: B.8.7
- Science: F.8.2, F.8.8, F.8.9,

Grades 9 – 12

- Environmental Education: B.12.3, B.12.4, B.12.6
- Science: F.12.7, F.12.8

2. **Explain the tokens.** Show students the water/nutrient tokens and sunshine tokens. Scatter the tokens around the playing field.
3. **Ask one student to represent an invasive plant and to stand in a corner of the grid.**
4. **Start the game.** At the sound of the bell, the student must pick up three water/nutrient tokens and three sunshine tokens. Allow several seconds before sounding the bell again to stop the collecting. The student can't leave the grid square to collect the tokens. After all, plants have roots! **Note:** The student should be able to obtain the necessary tokens easily.
5. **Reproduce.** This invasive weed produces many seeds, but only four of them land and sprout inside the grid. Add four more students to adjacent grid squares.
6. **Renew the supply of tokens.** Redistribute the water/nutrient and sunshine tokens on the playing field.
7. **Sound the bell and have the “plants” collect their requirements. Note:** Distribute tokens so that all the plants survive.
8. **Reproduce.** These plants now all produce lots of seeds, but only four of the seeds produced by each plant survive. Add 20 students. The grid is now full.

Discuss

- How many plants can this field support? (25)
- What would happen if two plants tried to live in the same square? (They might both be small and spindly, or the weaker one might die. However, if enough water/nutrient and sunshine tokens are present, they might both survive.)
- If all 25 plants survive and reproduce, how many seeds will sprout the next year? (100)
- Continue the math for a few more years. What would a graph of this population's growth look like?
- The playing area is full of plants. What happens to all the extra seeds? (While some might sprout and die, many lie dormant in the soil waiting for the ideal conditions to grow.)
- What factors did we ignore in this game? (Most importantly, we ignored the fact that many plants invade at once. In reality, a variety of pioneer plants may have covered the field in the first year. Plants don't live forever; some would have died during the game. Nothing ate the plants. There were no parasites or diseases. There were always plenty of tokens; sometimes plants don't get the things they need to survive.)

Game Two

Discover how natives occupy a natural area.

It didn't take long for the plants in the first game to invade the empty field and completely take over. The soil was bare. There was no competition. Water/nutrients and sunshine were plentiful. What do you think happens in a field that is full of native wildflowers and grasses? Let's try it.

1. **Adjust the size of the grid.** Using sidewalk chalk, "X" out the unneeded squares so that the playing area contains squares equal to one third the number of students. For example, a class of 30 would require a grid with 10 squares. The grid does not have to be square.
2. **Fill the squares with students, one student per square.**
3. **Send in a deer.** Select one student to be a hungry deer that eats two of the plants. (Remind students that they can't move from their squares!) Remove these "plants" from the playing field.
4. **Gather tokens.** The wildflowers need five water/nutrient tokens and five sunshine tokens to survive. Ring the bell to begin and end collecting time.
5. **Reproduce.** All plants that didn't collect enough requirements die. These plants must leave the grid. Plants that did get enough are able to reproduce successfully. They produce quite a few seeds, but only two seeds per plant land in the playing field. Calculate how many seeds the plants will produce. Decide which students will be these seeds.
6. **Send in a mouse.** Designate one student to be the mouse that will eat the seeds. Each year, the mouse will eat half of all seeds produced by the plants. At the signal, the mouse can "eat"/tag the correct number of the seeds on the sideline.
7. **Germinate.** At the signal, the "seeds" can try to take over the empty spaces on the grid. Any unsuccessful seeds return to the sidelines.
8. **Count the number of plants on the grid.** Compare this to the number at the beginning. Talk about what happened. If we played another round, how many plants would we probably have at the end of the round? If the students don't understand that the answer would be the same, play another round to show that while the individual plants may change, the number of wildflowers in the field stays the same.

Discuss

- Why did the population end up the same? (Some plants died because they didn't collect enough tokens or because herbivores ate them. The plants that did survive reproduced and filled the empty spaces.)

Game Three

Discover how weeds invade a natural area.

It was a little harder for an individual wildflower to survive when the field was full of plants. However, the wildflowers as a whole did just fine. When a plant died or was eaten by an herbivore, a seed sprouted in the available space. What would happen if we put the two games together? What if an invasive weed seed sprouted in one of the empty squares?

1. **Place students in the squares without “X”s.** Fill all the squares except one with students representing native wildflowers. Fill the empty square with a student representing an invasive plant. To differentiate between the two, ask the students representing the invasive plants to look “prickly” or wear armbands.
2. **Send in the hungry deer.** The deer doesn’t recognize the new plant as a food plant, but it does dine on two of the native plants.
3. **Allow the plants to gather tokens.** At the signal, the invasive plant can begin to collect its requirements. The invasive plant needs three of each kind of token. A few seconds later, ring the bell again and invite the native plants to collect. Remind the natives that they need five of each colored token. If the natives protest, explain that invasive plants often turn green earlier in the year and stay green longer in the fall, so they should have more time to collect their tokens. Many invasive plants can also survive on smaller amounts of water, nutrients, and sunshine.
4. **Reproduce.** All plants that didn’t collect enough water or sunshine die. These plants must leave the grid. Plants that did get enough are able to reproduce successfully. The invasive produces many seeds, but only four land on the grid. The natives also produce quite a few seeds, but only two per plant land in the playing field. Calculate how many seeds the plants produce. Decide which students will represent these seeds.
5. **Send in the mouse.** Designate one student to be the mouse that will eat the seeds. Each year, the mouse will eat half of all seeds produced by the *native* plants. The mouse doesn’t eat the seeds from the invasives, because they are hairy and unpalatable. At the signal, the mouse can “eat”/tag the correct number of the native seeds on the sideline.
6. **Germinate.** At the signal, the “seeds” can try to take over the empty spaces on the grid. Any unsuccessful seeds return to the sidelines.
7. **Repeat steps 2 – 6 until invasive plants completely overrun the field.** Optional: You could allow two invasives to occupy each square, since invasives often need less space than natives do.

Discuss

- What advantages did the invasive species have over the native species? (They produced more seeds. Herbivores didn't eat either the plants or the seeds. They needed fewer tokens to survive. They began collecting tokens before the natives.)
- Do the native species have a chance in this game? (No, not really. It's rigged!)
- Do the native species have a chance in the real world? (No, not in the presence of extremely invasive species. That's rigged too!)
- Why are herbivores less likely to eat invasive plants? (In addition to invasives just not being recognized as food, some invasives are toxic or contain chemicals that repel herbivores.)
- In the game, the deer and mouse continued to eat the plants and seeds of the native wildflowers, no matter how many there were. Is this realistic? (Maybe not. As the concentration of natives decreased, the herbivores would probably look other places to find food. However, if there is nowhere else to go, herbivores will remain in the area.)

This activity is adapted from "Outwit–Outplant–Outlast." **Non-Native Invasive Species Learning Kits — Meet the Invaders.** United States Forest Service. 2005.

Assessing the Learning

Ask students to chart and graph the plant populations in each of the three games and to write short paragraphs explaining what they predict will happen in future generations.

Extending the Learning

Play Game Three again. This time try to control the spread of the invasive at varying times. What if someone removes the first plant before it makes seeds? What if people don't begin to control the plant until after it produces seeds? Ask students to find out how many seeds invasive plants actually produce. Find out how long the seeds remain viable in the soil. This game makes a strong case for early intervention and rapid response to a plant invasion!

Finding Out More!

Alien Plant Invaders of Natural Areas. Plant Conservation Alliance. 2005. <www.nps.gov/plants/alien/factmain.htm>

Invasive Plants: Weeds of the Week. United States Forest Service: Northeastern Area. 2005. <http://na.fs.fed.us/fhp/invasive_plants/weeds/index.shtm>

Making a Chalk Line

Use a tool called a chalk line to quickly make the playing field for the game.

1. Hold onto the metal tab and pull about 20 feet of string out of the chalk line. Ask two students to hold the string tight just above the surface of the parking lot. A third student should snap the line once by pulling it up about five inches and letting go. The line should hit the ground and leave a line of chalk dust. Use the reel to rewind the string so that it is *rechalked* for the next line.
2. Repeat Step 1 to make a 20-foot chalk line perpendicular to one end of the original chalk line. See Figure 1.
3. Use the tape measure and sidewalk chalk to mark off five sections that are one yard wide along the original chalk line and along an imaginary line where the top of the grid will be. See Figure 2.
4. Following the directions in Step 1, make chalk lines at each of the marks. When you are done with this step, your grid should look like Figure 3.
5. Measure five sections that are one yard wide along the two sides of the grid. See Figure 4.
6. Make chalk lines on each mark. Your grid should be five squares wide and five squares tall. Don't worry if it is a little skewed! See Figure 5.

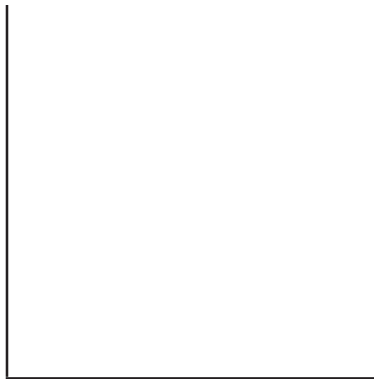


Figure 1

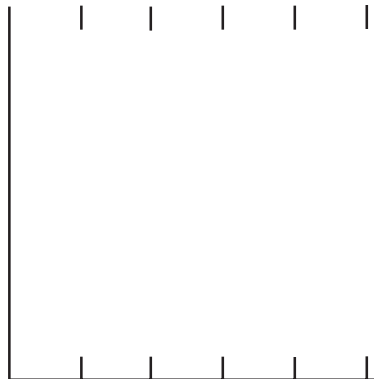


Figure 2

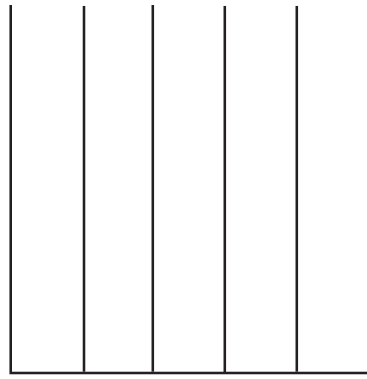


Figure 3

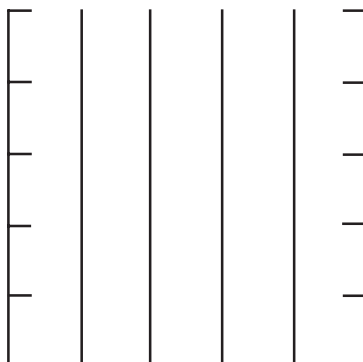


Figure 4

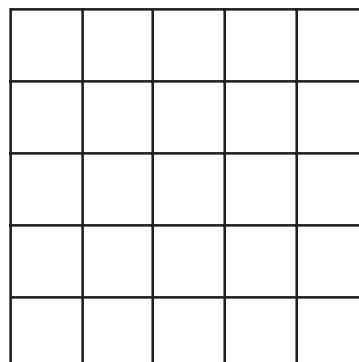


Figure 5

Garlic Mustard Invasion

Method

Students will use a simple sampling method to determine if invasive species impact other plants and animals in the forest. This activity focuses on garlic mustard, but the same procedure can also be used with other invasive plants in different habitats.

Getting Ready

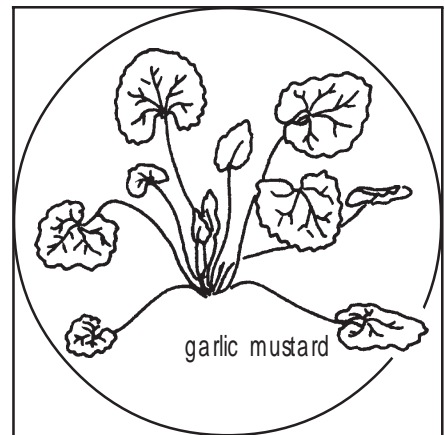
1. Locate an area that has been infested with garlic mustard in close proximity to an area that is free of garlic mustard. Be sure the area does not contain poison ivy, stinging nettles, or other hazardous plants. **Note:** If you can't go outside, do this activity indoors using different kinds of leaves (e.g., real leaves, silk leaves, or paper cutouts) to represent different plants. Spread the leaves out on the floor. You can rig the outcome by clumping the "invasive" leaves. Distribute the plastic insects among the "native" leaves and the earthworms among the "invasive" ones. This indoor activity is a good warm-up for doing the activity outdoors.

Introducing the Activity

The plants and animals that live in a forest depend on each other for survival. When an invasive species takes over an area, the native plants and animals are affected.

Doing the Activity

1. **Introduce garlic mustard (or other invasive plant) to the students.** Be sure students can recognize the plant in different stages of its life cycle. See box on page 61.
2. **Randomly choose a sampling site in an area that garlic mustard has not invaded.** Be sure to work in the uninfested area first so students don't accidentally transfer garlic mustard seeds into the rest of the forest. Ask a student to throw the tennis ball into an area that is free of garlic mustard.
3. **Mark off the sample site.** Find the tennis ball and lay a hula hoop or other frame down so that the tennis ball is in the middle of the sample site.
4. **Carefully observe the plants and animals inside the hula hoop.** Start by looking for vertebrates, invertebrates, and signs of earthworms inside the circle. Then, identify and count any garlic mustard plants. It isn't necessary to identify



Objectives

- Describe the differences between an area invaded by garlic mustard and an area that is free of garlic mustard.
- Observe how invasive plants affect forest plants and animals.

Grades

2 – adult

Group Size

Small groups of 5 – 8

Activity Time

20 – 30 minutes

Setting

Wooded area in early spring

Materials

- Tennis ball
- Hula hoop or other similar-sized frame
- Garlic mustard drawings or photos (Wisconsin Wildcards work well)
- Plant identification books for older students (See list on page 139.)
- Copies of *Garlic Mustard Invasion* data sheet (page 62)
- Clipboards and pencils

Connections

See next page.

Academic Standards

Grades 2 – 4

- Environmental Education: A.4.2
- Science: C.4.5, F.4.1, F.4.2, F.4.4

Grades 5 – 8

- Environmental Education: B.8.8, B.8.21, C.8.2
- Science: C.8.2, F.8.8, F.8.9

Grades 9 – 12

- Environmental Education: B.12.3, B.12.6
- Science: F.12.7, F.12.8

Scout Connections

- Junior Girl Scouts: Plants and Animals

all the other plants in the sample area. Depending on the ages and abilities of your students, you may ask them to simply count the number of other plants, count both the number of different species and the total number of plants, or identify and count all the plants in the sample area. Count the trees and shrubs that are directly above the sample site. Finally, dig up a small area to look for worms.

5. **Ask students to enter their data on the data sheets.**
6. **Choose a sampling site in an area where garlic mustard is present in large quantities.** Follow the same procedure for choosing and marking your sample area.
7. **Observe, count, and record the plants and animals inside this sample area.** As you leave the area with garlic mustard, take time to brush off your clothing and remove any mud from your shoes in order to not spread seeds into uninfested areas. See *Extending the Learning* below.
8. **Compare the results.** Discuss some of these questions:
 - How are the two sites different? How are they the same? Which one is the most interesting?
 - Which sample site had the greatest variety of plants? What do you think is happening in the area with garlic mustard? Which plant do you think is the toughest? How do you think it is taking over?
 - Which sample site had the greatest number of invertebrates? Which site had the greatest number of earthworms or signs of earthworms? See box page 61.
 - What will happen to the forest plants if garlic mustard completely covers the forest floor? Do you see any tree seedlings? What will happen when the big trees die?
 - If garlic mustard takes over, what will happen to the mammals, birds, amphibians, reptiles, and invertebrates that live here? How will they find the food and shelter they need to survive?

Adapted from “Invasive Plant Sampling with Young Children” developed by Kelly Kearns, WDNR.

Assessing the Learning

Instruct students to compare the two areas they observed by drawing pictures, writing a poem, or performing a pantomime that reflects how they feel about garlic mustard.

Extending the Learning

Check out muddy shoes. If the area is muddy, ask everyone to scrape the mud off of their shoes into a bucket. Take the soil to school and place it in a planting flat. Keep the soil moist and watch what happens. What grew from the mud? What does this say about how garlic mustard spreads in the forest? How else can garlic mustard spread?

Investigate the worm/invasive plant connection. Follow up this investigation with *A Can of Worms* on page 67 to find out more about how worms influence soil, forest litter, and vegetation.

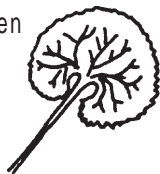
Calculate percent cover. Follow an online lesson plan to teach high school students how to calculate percent cover. The classroom activity focuses on English ivy, but the technique learned can be used with any invasive in any habitat. <www.pbs.org/americanfieldguide/teachers>

Finding Out More!

Wisconsin Wildcards. Wisconsin Department of Natural Resources. 2005. Order 30-packs of select Wildcards. <www.dnr.wi.gov/education/pdf/wildcard.pdf>

Garlic Mustard and Worms

Garlic mustard leaves smell like garlic when crushed.



In spring of its second year, the plant shoots up to about three feet and blooms quickly, crowding out many other flowers. The small, white, four-petaled flowers bloom from May through early July.



As the flowers mature, they form long seedpods. Later in summer, the plant dies back. One plant can produce hundreds of seeds!



The first year, garlic mustard is a low-lying plant that can carpet the forest floor. Garlic mustard stays green throughout the winter. It can photosynthesize all year if there is no snow cover!



Earthworm droppings look like small beads of soil. They are called castings.

Earthworms pull clumps of leaves down into their underground tunnels.

Earthworms are not native to Wisconsin. They act as mini-rototillers, pulling the leaves and other organic matter down into the soil. Many native plants and animals need that leaf litter to germinate or survive. New research is showing that earthworms may alter the soil conditions of a forest floor to encourage invasives and discourage natives.

Garlic Mustard Invasion

Compare two areas — one that has been invaded by garlic mustard and one that is free of garlic mustard. Be careful not to spread garlic mustard seeds into new areas.

Plants and animals found inside the hula hoop	Area with NO garlic mustard	Area with garlic mustard
Vertebrates or signs of vertebrates		
Invertebrates or signs of invertebrates		
Earthworms or signs of earthworms (Count worm holes and castings.)		
Earthworms in the ground (Do this last!)		
Total animals		
Garlic mustard plants with flowers and/or seeds		
Garlic mustard seedlings or rosettes		
Total number of garlic mustard plants		
Understory plants (Count all remaining wildflowers, grasses, ferns, and tree seedlings.)		
Overhead trees and shrubs (Count trees and shrubs in the hula hoop's airspace.)		
Total number of other plants		

On the back of this page, draw a picture of a forest without garlic mustard and a picture of the same area after it has been invaded by garlic mustard.

Bane or Blessing?

Method

Students will check out ads that promote the desirable characteristics of autumn olive. Through simple calculations, they will realize how the promise of “abundant fruit” can be a problem if the plant has invasive tendencies.

Introducing the Activity

Autumn olive sounds like a nice plant. The name has a certain ring to it, bringing to mind bright colors and food. Yet this shrub – once promoted as a wildlife food plant, landscape plant, and restoration plant – has a darker side. The exact qualities that made the plant desirable for one purpose are the qualities that help the plant invade areas where it was never intended to go!

Doing the Activity

1. **Bring in a branch from an autumn olive tree.** Ask students to describe the leaves, bark, and fruits. Talk about whether it is an attractive plant or not. Discuss why someone might want it in his or her yard.
2. **Check out the ads.** Pass out copies of the three autumn olive advertisements (pages 65 – top of 66). The first is slightly adapted from an Alabama Forestry Commission flyer. The second is a standard landscape description used by several nurseries on the Internet. The third is combined information from the Plant Invaders of Mid-Atlantic Natural Areas and Invasive.org Web sites. Discuss these questions:
 - Who do you think wrote each description?
 - Who were the descriptions written for?
 - Why are the descriptions so different? Look at the words the writers used to accentuate the plant’s characteristics.
3. **Look closer at abundant fruit production.** Each of the descriptions mentions the production of fruit, but in very different terms. Discuss these questions:
 - How might the abundant fruits produced by autumn olive be a blessing? Who would benefit?
 - How might the abundant fruits be a bane?
4. **Calculate autumn olive’s reproductive potential.** Ask students to complete the problem on the bottom of page 66 by calculating how many autumn olive shrubs and seeds there would be in nine years.



Objectives

- Analyze the ways information is targeted to different audiences.
- Understand how people have introduced invasive plants into natural areas.
- Calculate the reproductive potential of an invasive plant.

Grades

5 – 12

Group Size

Pairs

Activity Time

One 50-minute period

Setting

Classroom in fall

Materials

- Specimen of autumn olive with flowers or fruits, if available
- Copy of advertisements from a forestry commission, an online nursery, and an invasive species organization for each pair (pages 65 – 66)
- Copies of *The Problem with Invasives* for each pair (page 66)

Connections

See next page.

Academic Standards

Grades 5 – 8

- English Language Arts: A.8.4, E.8.3
- Environmental Education: B.8.21, C.8.4
- Math: B.8.7
- Science: F.8.2

Grades 9 – 12

- English Language Arts: A.12.1, A.12.4, D.12.2, E.12.3
- Science: A.12.2, F.12.8

5. **Discuss potential limits to the population.** Ask students if there would really be that many shrubs in nine years. (Fortunately, autumn olive doesn't produce as many seeds in the woods as in landscape situations. And, not all of the seedlings would survive! For example, seedlings might die because of competition with other plants for water, nutrients, and sunlight. Herbivores might eat the leaves, stems, or fruits. People might mow, herbicide, or burn the seedlings. Disease or fungus might affect the plants.) Remind students that not all of these factors affect all plants equally. One of the advantages that invasive plants have over native plants is a lack of predators, diseases, and fungi in their new homes. For example, many birds and mammals eat autumn olive fruits, but the seeds appear to pass through their digestive systems intact and ready to germinate – often far from the parent tree! Recalculate the problem assuming that only 25% of the seedlings survive.

Assessing the Learning

Students should design and write their own landscape tags for autumn olive. They should include information they think is important for homeowners to know when purchasing an invasive plant.

Extending the Learning

Find out how scientists gather information. Instead of using existing information on average seed production, have students calculate it themselves. In late summer or early fall, locate an autumn olive tree laden with fruit. Ask students to remove all the fruit from the tree. Count and weigh the fruits. One source says the average tree produces 30 pounds of fruit. How close to this average was the tree they analyzed? Ask the students how many trees they would need to evaluate before they could confidently state the average fruit-bearing capacity for their area. What would they need to take into consideration? (Size of trees, density of stand, location, habitat, seasonal variations, and competition) Ask each team of students to collect 20 fruits in a cup. Instruct students to squash the fruits and count the number of seeds. Find a class average for the seeds in each fruit. Given the number of fruits on the tree, approximately how many seeds did the tree produce?

Answer to problem!			
Year	Mature Plants	Seeds	Immature Plants
1	0	0	1
2	0	0	1
3	0	0	1
4	1	66,000	0
5	1	66,000	59,400
6	1	66,000	118,800
7	1	66,000	178,200
8	59401	3,920,466,000	178,200
9	118801	7,840,866,000	3,528,538,200

Forestry Commission Wildlife Plantings

When native vegetation is insufficient, planting wildlife foods such as autumn olive will provide excellent cover and food. Autumn olive is a deciduous shrub that grows to eighteen feet tall and has numerous stems. The branches spread out about as wide as the shrub is tall. The bark is thin and smooth, changing to gray as the plant ages. The leaves are dark green with silvery undersides. This plant produces an abundance of small yellow flowers each spring and a heavy crop of berries that ripen throughout August and September. The berries range in color from yellow to dark red and are one-eighth to one-fourth inch in diameter.

Adaptation: Prefers deep well-drained or moderately well-drained soils. Competition from adjacent herbaceous weeds and woody shrubs should be eliminated. Autumn olive has low water requirements and a high tolerance to salt and alkali soils.

Uses: Provides soil protection and beautification, and is an excellent food plant for many kinds of birds and mammals. Fruit remains on the plant until late winter, potentially becoming an important wildlife food during periods of seasonal food scarcity. Turkey readily take the red berries in early fall.

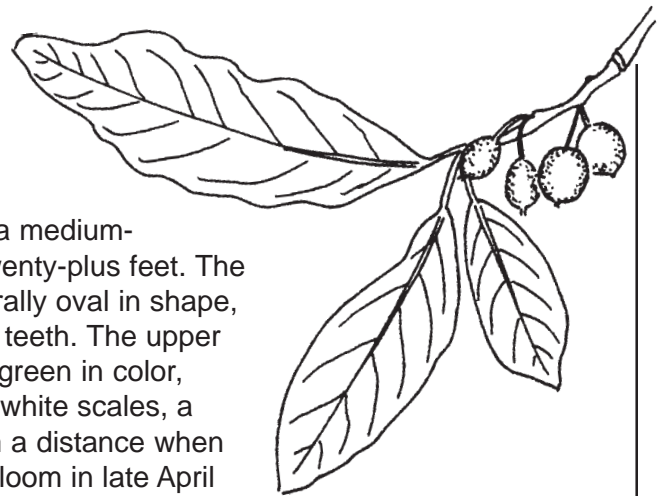
Planting time: From mid-winter to early spring. Not native.

Planting Rate: Space the seedlings eight to ten feet apart for hedgerow planting and at least twelve feet apart for individual plants.

Method of Establishment: Machine or hand plant. The hole must be large enough to accommodate the plant roots without crowding. The hole will have to be four to six inches larger in diameter and four to six inches deeper than the actual plant root measurements.

Shipping: Fall and spring. Shipped bareroot and priced in lots of 25, 50, 100+ seedlings.

Invite Autumn Olive into your yard!



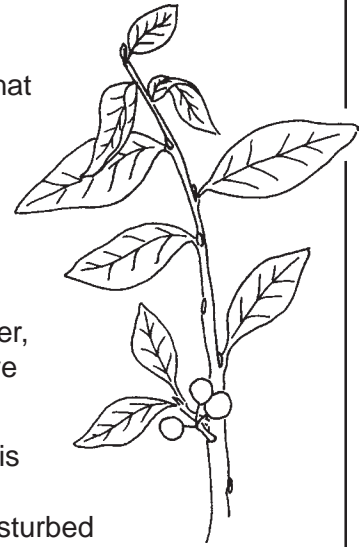
The Autumn Olive tree, *Elaeagnus umbellata*, is a medium-sized tree or a large shrub reaching heights of twenty-plus feet. The leaves, borne alternately on the stems, are generally oval in shape, approximately one to three inches long, and lack teeth. The upper surfaces of the leaves are dark green to grayish-green in color, while the lower surfaces are covered with silvery white scales, a conspicuous characteristic that can be seen from a distance when the leaves move. The small light yellow flowers bloom in late April and May. This deciduous tree is a good plant for fast-growing landscape projects. The small (less than one-fourth inch) fleshy fruits range in color from pink to red, are finely dotted with pale scales, and are produced in abundance each year.

Mature Height 15 – 20 feet
Mature Spread 15 – 20 feet
Mature Form Irregular
Growth Rate Rapid
Sun Exposure Full sun
Soil Moisture Widely adaptable

Soil Type Widely adaptable
Flower Color Yellow
Foliage Color Green
Fall Color Yellow
Zones 3 – 9

Elaeagnus umbellata

Autumn olive is a deciduous shrub from three to twenty feet in height that is easily recognized by the silvery, dotted underside of the leaves. Small, yellowish flowers or red, juicy fruits are abundant and occur on clusters near the stems. Autumn olive is native to China and Japan and was introduced into America in 1830. Since then, it has been widely planted for wildlife habitat, mine reclamation, and shelterbelts. These plantings were often done because the fruits of *Elaeagnus umbellata* are used by many different types of animals as food. However, because the fruit is so desirable to wildlife, birds and other animals have spread the plant throughout a wide range.



Autumn olive is found from Maine to Virginia and west to Wisconsin. It is drought tolerant and thrives in a variety of soil and moisture conditions. This trait allows it to invade grasslands, fields, open woodlands, and disturbed areas. It threatens native ecosystems by outcompeting and displacing native plant species, creating dense shade, and interfering with natural plant succession and nutrient cycling. Because autumn olive is capable of fixing nitrogen in its roots, it can grow on bare mineral substrates.

Do not plant autumn olive. Individual young plants can be hand-pulled, ensuring that roots are removed. If it is burned, it resprouts from the stump. If it is cut, it still resprouts abundantly. Cutting, in combination with herbicide application, is effective. Hedges can be cut down using a brush type mower, chain saw, or similar tool, and stumps treated with a systemic herbicide like glyphosate or triclopyr. Application of these herbicides to foliage is also effective, but is likely to impact non-target species. Herbivorous animals are not known to feed on it, and few insects seem to utilize or bother it. Canker disease is occasionally a problem, but not enough to be useful as a control agent.

The Problem with Invasives

George and Noreen Lapse live next to a beautiful 40-acre wood and enjoy the birds that live there. They are interested in attracting some of the birds into their yard for a closer look. They visit the nursery and purchase a one-year-old autumn olive for their yard. They have heard that the shrub can be invasive, so they vow to watch it carefully. If they see any signs of the shrub spreading into the woods, they will chop it down immediately. Three years later, Noreen gets a job across the state, and the Lapses move. As they drive out of the yard, they sigh as they pass their autumn olive shrub. They are disappointed that it is just now beginning to bear fruit. Someone else will get to enjoy the birds in the yard. When George and Noreen return to visit five years later, will they be surprised?

Calculate how many autumn olive shrubs there will be when the Lapses return and the shrub is 9 years old. Assume all of the seedlings survive. Use a chart to keep track of the number of mature plants, the seeds produced, and the number of immature plants. Use this information to help make your calculations:

- Autumn olive shrubs mature in three to five years. Use an average of four years.
- Mature shrubs produce 40,000 to 120,000 seeds. Use an average of 66,000 seeds per year.
- Seeds can germinate over a wide range of conditions anytime during the growing season. Wisconsin's long, cold winters scarify (scratch) the seed coats and increase germination rates. Up to 90% of the previous season's seeds can germinate in the next year.

A Can of Worms

Method

Students will pour a mustard solution on the ground and watch the worms crawl to the surface! Then they will capture, sort, and count the worms. They'll be amazed at the beneficial *and* detrimental affects of worms on plant communities.

Getting Ready

1. Locate an area where you can conduct the investigation. Be sure you obtain permission to access the property and disturb the ground layer for sampling.
2. Follow directions in the middle of page 69 to mix the mustard solution at least four hours prior to the field trip.
3. Gather and/or check all materials.
4. Divide students into groups based on available equipment.

Introduction

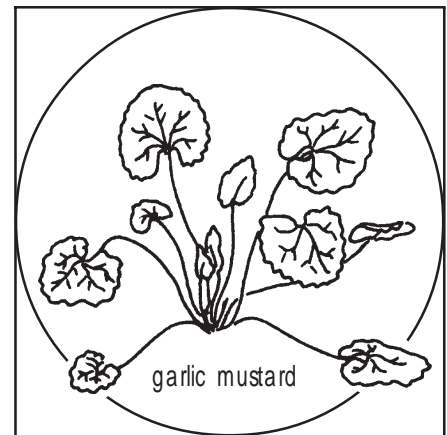
Have you ever opened a can of worms? There are two ways to look at that question. You can look at it literally, as in, "Have you ever gone fishing and opened a can of worms so that you can bait your hook and catch a fish?" Or, you can look at it metaphorically, as in, "Have you ever found a complicated unexpected problem which cannot be resolved?"

It turns out that if you "open a can of worms" to go fishing, and then dump your leftover worms on the ground, you've opened a whole new can of worms for the forest!

Doing the Activity

For students in grades 4 – 8 and adults.

Plan to do this activity with small groups of three to seven students. Begin with a discussion about the importance of worms in gardens and crop fields. Use information presented in this lesson that is age appropriate. Follow the lab procedure outlined on page 72. Watching and counting the worms as they rise from the ground is dramatic! It will inspire an interest in worms, leaf litter, soil ecology, native wildflowers, forest regeneration, and invasive plants. Ask elementary students to prepare a report that describes the affects of earthworms on the forest. Encourage them to use drawings, digital photos, charts, and words to show the differences between an area with earthworms and an area without earthworms.



Objectives

- Identify the changes that occur when earthworms invade a forest ecosystem.
- Extract, count, and identify the earthworms in a sample plot.

Grades

4 – adult

Group Size

Small groups

Activity Time

Three 50-minute periods

Setting

Forest – This activity is best done in spring when wildflowers are visible, soil moisture is high, and soil temperatures are cool.

Materials

- Diagrams of forest floor without and with earthworms (page 71)
- Ground mustard powder (available in spice section of grocery stores)
- Empty gallon milk jugs with lids
- Water
- Rulers
- Tent stakes
- String
- Tweezers
- Ziplock bags
- Copies of lab procedure, data recording, and questions (page 72 – 74)

Connections

See next page.

Academic Standards

Grade 4

- Environmental Education: B.4.4
- Science: A.4.5, C.4.4, C.4.5, F.4.2, F.4.4

Grades 5 – 8

- Environmental Education: B.8.8, B.8.21, C.8.2
- Science: A.8.6, F.8.8, F.8.9

Grades 9 – 12

- Environmental Education: B.12.3, B.12.6
- Science: F.12.7, F.12.8, F.12.9

Scout Connections

- Boy Scouts: Environmental Science
- Webelos Scouts: Naturalist
- Junior Girl Scouts: Earth Connections

For students in grades 9 – 12.

Day One – Introduction

1. **Talk about worms.** Ask students to share positive and negative experiences with worms.
2. **List the benefits of worms.** Most people probably consider worms to be good. What are some of the positive things that worms do?
 - Aerate the soil.
 - Improve water infiltration and increase the water holding capacity of the soil.
 - Mix layers (taking organic matter into mineral soil and bringing minerals to the surface).
 - Break down dead plant and animal material and release the nutrients.
 - Provide an important source of protein to other animals.
 - Offer anglers cheap bait for catching fish.
3. **Discuss the effect of the Ice Age on worm populations.** About 10,000 years ago, the last glaciers covered much of North America to a depth of approximately one mile. What do you think happened to worms during the Ice Age? (If there were worms, they died. When the ice receded, there just weren't any worms or other soil creatures left. Animals and plants slowly returned to the glaciated areas.) Did worms return? (Yes, but worms aren't the fastest creatures! Without help, they can only move about 30 feet a year! At that rate, they could travel a little over half a mile in 100 years.)
4. **Discuss decomposers active in northern forests.** Decomposers are essential in a forested area. Without decomposition, leaves, twigs, and other organic matter would continue to accumulate and nutrients would be trapped. Fungi and bacteria are the active decomposers in forested areas. They work slowly, and, as a result, a thick, spongy layer of leaves and other plant material is always present on the forest floor. Look at the *Wormless Woods* diagram on page 71.
5. **Consider how earthworms invaded northern forests.** Since our native worms are still working their way north after the last Ice Age, how did all the worms that are in our soil get here?
 - Imported soil – Hundreds of years ago, the first settlers brought plants to America. Worms and worm egg cases were in the soil. This method of new infestations continues today as plants and soil are moved by landscapers and gardeners.
 - Ballast soil – Before people used water as ballast in ships, they used soil. The ballast probably contained

worms, worm egg cases, seeds, roots, and other soil inhabitants.

- Fishing bait – Some anglers purchase worms for bait and then discard the leftover bait on the ground. The fact that invasions often radiate from lake shores, fishing resorts, and boat landings confirms this practice.
 - Soil amendments – Gardeners often add earthworms to garden soil to improve its productivity.
 - Compost kits – Composters sometimes release worms purchased for composting into gardens or croplands.
6. **Discuss the problems invasive worms cause.** As the worms radiate out from each introduction, they reproduce rapidly and take over! It turns out that these worms might just be too good at what they do! When they invade a forest, they attack the deep leaf litter and rapidly recycle it. Look at the *Wormy Woods* diagram on page 71. Discuss how rapid recycling of the leaf litter changes the woods.

Day Two – Investigation

Preparation

At least four hours before the field trip, prepare the mustard solution. Prepare at least two gallons for a demonstration. For student lab, prepare two gallons for each team of four to six students. Mix 30 grams (approximately one ounce or 3 ½ tablespoons) of ground mustard with one gallon of water in a clean gallon milk jug. **Caution: Ground mustard can be an eye or skin irritant to some people. Prepare the mustard solution in a well-ventilated area and wear gloves to protect the skin.**

Lab

Follow *Lab Procedure* on page 72.

Day Three – Data Analysis

See *Data Recording and Analysis* on pages 73 – 74.

Answers to select lab questions from page 74.

4. In forested areas, higher populations of earthworms result in reduced leaf litter. The deep-burrowing types of earthworms seem to be more damaging to soil ecology.
5. In forested areas, heavier infestations of earthworms usually result in fewer native plants (i.e., tree seedlings and woodland wildflowers) and more invasive plants. Sugar maple seedlings seem to be very sensitive to earthworm invasions.
6. Unfortunately, this type of disturbance favors the growth of invasive plant species.
8. Educate anglers, gardeners, composters, and other forest users.

9. Scientists haven't found a solution. Maybe one of your students will come up with the answer!

Assessing the Learning

Observe student participation in the demonstration or lab. Older students can write a lab report that demonstrates their understanding of the procedure and outcomes.

Extending the Learning

Identify the worms. Using keys available on the Internet, students can identify the earthworms. Keys can be found at Minnesota Worm Watch and Worm Watch Canada. <www.nrri.umn.edu/worms/key/keyhome.html> <www.naturewatch.ca/english/wormwatch/resources/guide/index.html>

Play a game. With a roll of the die, students can simulate the movement of nutrients in a forest ecosystem both before and after earthworms invade. Game instructions and game tiles for *Invasion of the Exotic Worm* can be found on the Minnesota Worm Watch website. <www.nrri.umn.edu/worms/activities.html>

Set up an indoor worm bin. By monitoring a worm bin, your students can see how much plant material worms can eat through. It will be easy to see how a large population can change the forest floor in a short amount of time. You'll find the directions for setting up a classroom worm bin at Cornell University's Web site. <<http://compost.css.cornell.edu/worms/wormhome.html>>

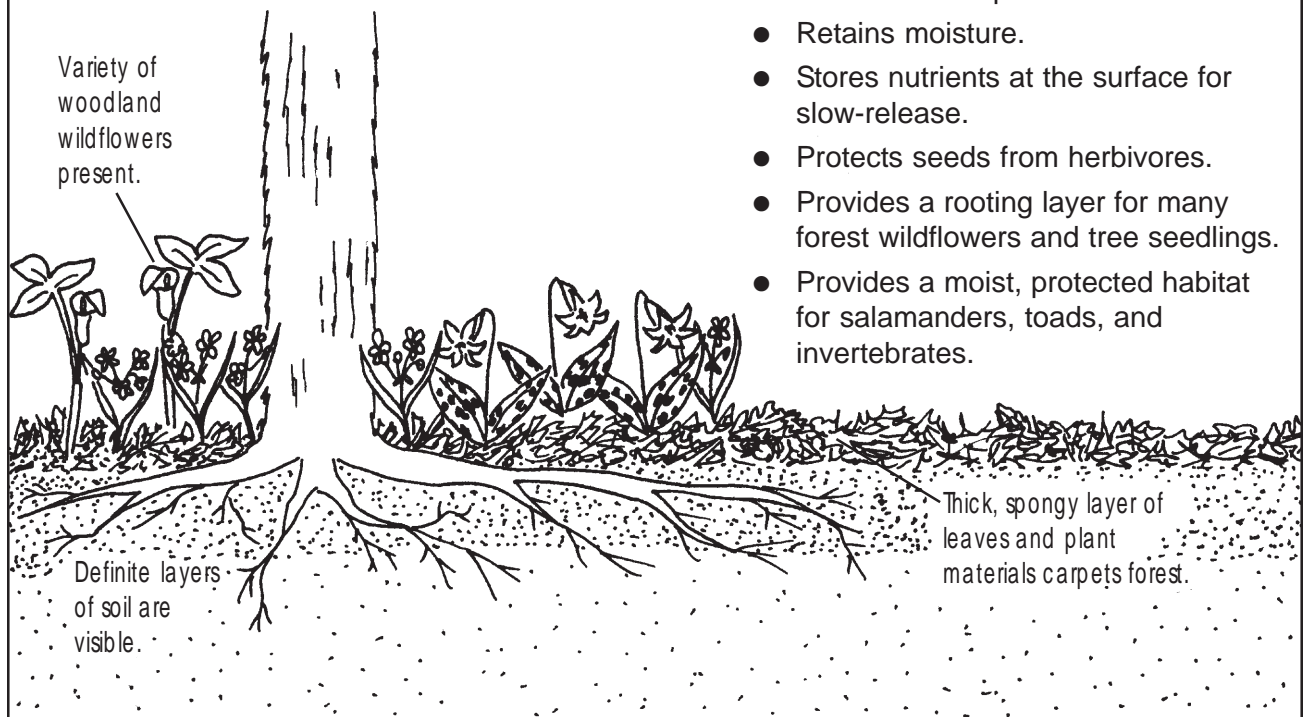
Discover how nature did it first! Hot mustard solution is a relatively new way of getting worms to come out of the ground. While scientists used to rely on formalin (a powerful chemical), other worm-seekers used electrical shocks or waited for a heavy rain. However, the most amazing way to get earthworms out of the ground is probably grunting and fiddling them out! After pounding a stake into the ground, the "grunter" taps and rubs the stake with a metal bar to create a vibration that apparently drives the worms crazy! Within minutes, there are worms crawling all around the post! How did people discover this? They might have learned the technique from wood turtles. It seems that wood turtles stomp their front feet and munch on worms as they scramble to the surface. Anyone game for gruntin' worms?

Finding Out More!

Minnesota Worm Watch. University of Minnesota. 2005. Online earthworm key, learning activities, and monitoring information. <www.nrri.umn.edu/worms/>

Worm Watch Canada. NatureWatch. 2005. Online earthworm key with photos of worms, the Virtual Worm Tour, and information about Canada's National Earthworm Survey. <www.naturewatch.ca/english/wormwatch/>

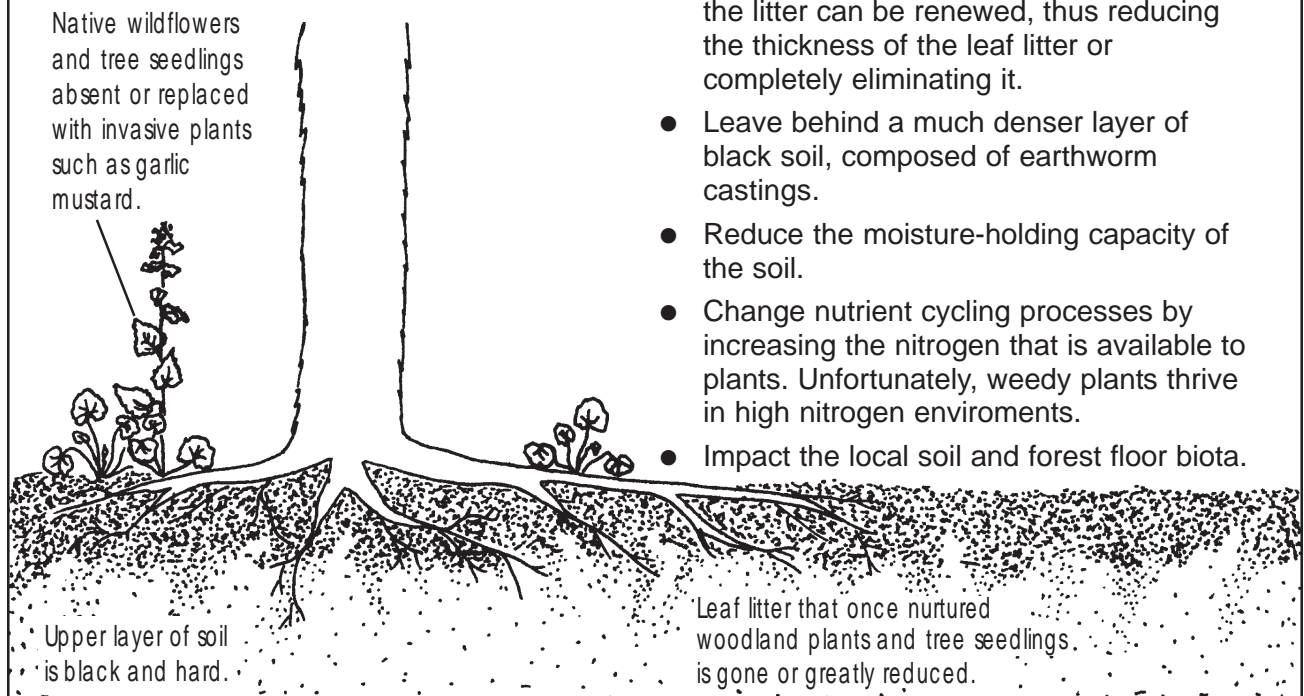
Wormless Woods



Leaf litter . . .

- Holds the soil and prevents erosion.
- Moderates temperature extremes.
- Retains moisture.
- Stores nutrients at the surface for slow-release.
- Protects seeds from herbivores.
- Provides a rooting layer for many forest wildflowers and tree seedlings.
- Provides a moist, protected habitat for salamanders, toads, and invertebrates.

Wormy Woods



Earthworms recycle leaf litter so fast that they . . .

- “Eat” through the plant litter faster than the litter can be renewed, thus reducing the thickness of the leaf litter or completely eliminating it.
- Leave behind a much denser layer of black soil, composed of earthworm castings.
- Reduce the moisture-holding capacity of the soil.
- Change nutrient cycling processes by increasing the nitrogen that is available to plants. Unfortunately, weedy plants thrive in high nitrogen environments.
- Impact the local soil and forest floor biota.

Lab Procedure

1. **Choose two forested locations to investigate.** One location should have native wildflowers and a thick layer of leaf litter. The second location should have greatly reduced leaf litter or bare ground. If possible, do the investigation in an area with sugar maples.
2. **Use the tent pegs and string to mark off a sample area that is one square foot in size.**
3. **Use a ruler to measure the depth of the leaf litter inside the sample area.** Record.
4. **Count the number of native, non-native, and invasive plants present in a three foot radius from the center of the sample area.** Make note of tree seedlings, saplings, and trees. In a forest with sugar maples, note if there are sugar maple seedlings. **Optional:** If approved by your teacher, collect and press plant specimens for later identification.
5. **Clear away the surface litter from within the sample site.** Don't forget to watch for and collect worms that live in the leaf litter! **Note:** Some may be small.
6. **Optional:** Use sticks, rocks, and dirt to make a small dike around the sample area. Follow your teacher's directions based on permission to disturb the site.
7. **Stir/shake the mustard solution and slowly pour one-half gallon of the solution onto the soil inside your sample area.** Pour slowly enough to allow all of the solution to soak into the soil and not run off.
8. **Watch for worms!** The mustard solution doesn't harm the worms, but it does irritate them. If present, they will probably begin to appear within one to two minutes. Use tweezers to collect the worms. Rinse the mustard solution off their bodies with clean water and transfer them to your plastic bag. Collect only the worms that emerge from within the sample area. Wait until each worm completely emerges or is nearly finished emerging before picking it up with the tweezers. If you try to pick it up while it is still in its burrow, you will probably only get half of a worm or it will retreat into its hole!
9. **After worms stop emerging or within five minutes, pour half of the liquid remaining in your gallon container (one-fourth gallon) onto the soil in the sample area.** Collect worms as they emerge.
10. **After five more minutes, pour on the remaining liquid (one-fourth gallon).** Wait at least five minutes after the last pouring to be sure that all worms have emerged.
11. **Complete the data recording sheet.** After you are finished with the worms, release them in an area adjacent to the test plot. **Optional:** Take the worms back to school to identify them.
12. **Repeat steps 2 through 11 at the second sample site with the other gallon of hot mustard solution.**

Can of Worms

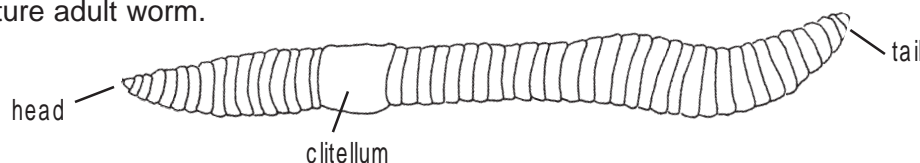
noun [originally U.S.]: a situation or specific problem which threatens to cause trouble and have irresolvable complications for all concerned; a complicated unexpected problem or unsolvable dilemma. The metaphor alludes to a product which might pass for acceptable before it is opened. However, once opened, it reveals a wriggling tangle of intertwined worms. The can of worms would normally be used for angler's bait.

Data Recording and Analysis

Record information for each location tested. Fill in the first two rows with information from your sites. Obtain data from other teams to complete the rest of the chart.

Location	Thickness of leaf litter in inches	Number of native plants	Number of non-native plants	Number of invasive plants	Number of earthworms

Sort the earthworms by age and type for each location. See the *Ecological Types of Earthworms* chart (page 74) for information on separating earthworms into groups. To determine if an earthworm is a juvenile or adult, look for the clitellum. If the clitellum is present, the worm is a sexually-mature adult worm.



Location	Epigeic		Endogeic		Anecic		Total earthworms per square foot
	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	

Lab Questions

1. Which location had the highest number of earthworms?
2. Which location had the highest diversity of earthworms?
3. A square yard of cropland can contain 50-300 earthworms. A similar area of grassland or temperate woodlands can have 100-500 earthworms. How do your numbers compare with these? Be sure you compare equivalent areas!
4. Is there any correlation between the number of earthworms and the thickness of the leaf litter? Is there any correlation between the types of earthworms and the leaf litter?
5. Is there any relationship between the number of native plants (wildflowers and tree seedlings), non-native plants, invasive plants, and earthworms?
6. When earthworms invade, several wildflower species are known to decline. If the native vegetation is disturbed, what will grow in its place?
7. Whether earthworms are considered “good” or “bad” probably depends on who you ask. What kind of response would you expect from a gardener? A robin? A forest wildflower? An angler? An ecologist?
8. What do you think is the best way to prevent further invasions into worm-free forests?
9. Once earthworms invade a forest, is there any way to stop their spread? Try to come up with a solution that removes invasive earthworms without affecting other soil creatures.
10. Some scientists are very concerned about the future of northern woodlands. Invasive earthworms and invasive plants are serious threats. When those threats are combined with growing deer populations, the results can be devastating. Why do you think scientists are so worried about the combination of these threats?

Ecological Types of Earthworms

There are three ecological types of earthworms. When using hot mustard solution, the surface-dwelling earthworms will typically emerge first, followed by soil-dwelling, and, finally, deep-burrowing species. Since soil conditions may prevent the mustard from reaching deep-burrowing species, extraction with mustard liquid is more effective for surface-dwelling species. Table adapted from **Teaching Organic Farming & Gardening: Resources for Instructors. Unit 2.3 Soil Biology and Ecology.** Center for Agroecology and Sustainable Food Systems. 2003.

Ecological type	Description	Habitat	Meaning of name	Examples
Epigeic – litter-dwelling species	Small (less than 3" long); dark red or reddish brown; move quickly	Live above the mineral soil; feed on organic matter	Epi= on Gaia = earth	Red wigglers <i>Dendrobaena octeadra</i> <i>Lumbricus rubellus</i>
Endogeic – soil-dwelling species	Small to medium (3" – 5" long); light gray or no pigmentation; slower moving	Live in the upper layers of the soil; feed on buried organic matter, mineral soil, and decaying roots	Endo = within Gaia = earth	<i>Aporrectodea</i> <i>sp. Octolasion tyrteum</i>
Anecic – deep-burrowing species	Large and muscular (5" – 8" long); reddish brown with wedge-shaped tail; more color on front end, less on tail end	Live deeply in the soil; feed on surface litter by pulling organic matter into burrow; can rapidly change soil ecology	Unknown	Night crawlers <i>Luymbricus terrestris</i>

Plants of the Melting Pot

Method

Students will compare immigration statistics with the arrival of invasive species to begin to understand how and why invasive plants came to America.

Getting Ready

1. Prepare a timeline on the chalkboard or with a roll of paper (e.g., adding machine paper). Make it long enough to include years from 1600 to present, allowing at least three inches per decade.

Introducing the Activity

The first great wave of American immigration started in the mid-1800s. Not surprisingly, some of the most problematic invasive weeds in the United States arrived at the same time. They didn't come here on their own! They were brought here. Our country was not just a melting pot of people; it was a melting pot of plants!

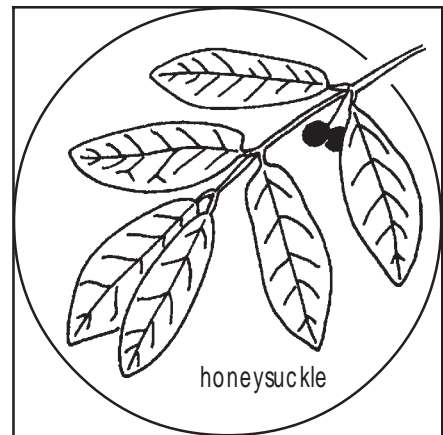
Our well-meaning ancestors brought plants from their home countries for several reasons, such as:

- Agriculture. Plants used for forage for animals. (e.g., reed canary grass, white and yellow sweet clover)
- Food. Plants used as vegetables and herbs for home gardens. (e.g., garlic mustard, chicory, burdock)
- Medicine. Plants used in teas, home remedies, and poultices. (e.g., garlic mustard, dandelions)
- Landscaping. Plants brought for sentimental reasons – to remind homesick immigrants of their homelands. (e.g., exotic honeysuckle, dame's rocket)

More recently, plants have been brought for:

- Wildlife habitat. Plants imported to provide food and cover for wildlife. (e.g., exotic honeysuckle, multiflora rose)
- Erosion control. Plants used to stabilize slopes. (e.g., crown vetch, reed canary grass)

Other plants arrived by accident. Canada thistle seeds, for example, may have come to this country in mattresses stuffed with dried weeds, shipments of cattle feed, dirt used as ballast in ships to provide stability, or someone's pant cuffs.



Objectives

- List three reasons why non-native plants were brought to the United States.
- Locate on a map where the most troublesome invasive weeds came from.
- Compare the arrival of immigrants with the arrival of invasive plants.

Grades

6 – 12

Group Size

Pairs

Activity Time

One or two 50-minute periods

Setting

Classroom

Materials

- Large world map
- Timeline
- Sticky notes
- Access to Internet or copies of plant fact cards

Academic Standards

Grades 6 – 8

- Environmental Education: B.8.10, B.8.18
- Math: A.8.1
- Social Studies: A.8.7, A.8.11, B.8.12

Grades 9 – 12

- Science: A.12.2
- Social Studies: A.12.7

Doing the Activity

1. **Ask students to imagine they are immigrants.** Tell them they will be moving to a faraway country that they know little about. They have heard the conditions are harsh and unfamiliar. Talk about what kinds of plants they would take in order to ensure survival. Be sure that students consider taking plants that will provide food, shelter, clothing, and medicines in the New World.
2. **Post the immigration data.** See page 77.
3. **Ask students to graph the data.**
4. **Assign an invasive plant to each pair of students.** Use plants on page 78. Give students the common and scientific names. If time is short, cut the page apart and give each pair of students one of the plant information cards. Otherwise, make sure students have access to reference books and/or the Internet. Ask them to find out the following information for their plants:
 - From what region did your plant originate?
 - When did your plant arrive in America?
 - Did people bring it intentionally or did it arrive by accident?
 - If people brought it intentionally, why did they bring it?
5. **Locate information about the plants' origins on a world map.** On a sticky note, each pair of students should write their plant's name. Taking turns, students can attach the names of their plants to the regions where they originated.
6. **Construct a timeline of invasions.** On a sticky note, each pair of students should write their plant's name and when it was introduced. Ask students to place the sticky notes on the timeline.
7. **Compile reasons for introduction.** On the chalkboard, each each pair should write their plant's name and the reason it was brought to the United States.
8. **Use the following questions to discuss the information:**
 - How do the reasons plants were brought to the United States compare with the reasons you talked about at the beginning of the lesson?
 - How does the arrival of the first big wave of immigrants correlate with the arrival of non-native plants in the United States?
 - Are non-native plants still being brought to the United States today? (Yes!)
 - Surely, most immigrants no longer fear they will be unable to find food, clothing, and medicines in their new homes.

Why do you think people are still bringing plants to America? (Familiar plants, ornamentals, herbs, folk remedies, special recipes)

- Today, immigrants aren't the main cause of non-native plant introductions. Who is bringing the plants now?

Adapted from "History and Invasive Weeds." **Invasive Weeds.** Betty Czarapata. 1998.

Assessing the Learning

Assess students' ability to work in pairs to gather information about the history of invasive plants.

Extending the Learning

Think about the future. Most scientists predict that major ecological disruptions due to invasive weeds will continue to rise. Ask students to figure out why this might be the case. Here are a few reasons:

- Increased access to remote areas of the world.
- Changes in global trade (e.g., NAFTA).
- Property owners' desire to plant exotic species.

Finding Out More!

Yearbook of Immigration Statistics. 2005. For annual immigration data from 1820 – 2004, visit the Homeland Security Web site and go to Yearbook of Immigration Statistics. <<http://uscis.gov/graphics/shared/statistics/yearbook/2004/table1.xls>>

Decade	Millions of Immigrants
1820 – 1830	0.2
1830 – 1840	0.6
1841 – 1850	1.7
1851 – 1860	2.6
1861 – 1870	2.3
1871 – 1880	2.8
1881 – 1890	5.2
1891 – 1900	3.7
1901 – 1910	8.8
1911 – 1920	5.7
1921 – 1930	4.1
1931 – 1940	0.5
1941 – 1950	1.0
1951 – 1960	2.5
1961 – 1970	3.3
1971 – 1980	4.5
1981 – 1990	7.3
1991 – 2000	9.1

Source: Statistical Yearbook of the INS

<p>Norway Maple <i>Acer platanoides</i> Native to Eurasia Introduced to United States in 1750s Landscape plant</p>	<p>Autumn Olive <i>Elaeagnus umbellata</i> Native to China, Japan, Korea Introduced to United States in 1830s Landscape plant; wildlife food and cover</p>	<p>Reed Canary Grass <i>Phalaris arundinacea</i> Native to Eurasia (There are also native varieties) Introduced to United States in 1800s Forage; erosion control</p>
<p>Garlic Mustard <i>Alliaria petiolata</i> Native to Europe Introduced to United States in 1860s Food plant; medicinal plant</p>	<p>Creeping Charlie <i>Glechoma hederacea</i> Native to Eurasia Introduced to United States in 1840s Medicinal plant; food plant</p>	<p>Japanese Knotweed <i>Polygonum cuspidatum</i>, syn. <i>Fallopia japonica</i> Native to eastern Asia Introduced to North America in 1880s Ornamental plant; erosion control</p>
<p>Oriental Bittersweet <i>Celastrus orbiculatus</i> Native to eastern China, Korea, Japan Introduced to United States in 1860s Landscape plant; crafts</p>	<p>Dame's Rocket <i>Hesperis matronalis</i> Native to Eurasia Introduced to United States in 1600s Garden plant; medicinal plant</p>	<p>Common Buckthorn <i>Rhamnus cathartica</i> Native to Eurasia Introduced to Midwest in 1840s Landscape plant</p>
<p>Canada Thistle <i>Cirsium arvense</i> Native to Eurasia Introduced to Canada in 1600s Unintentional – contaminant in crop seed</p>	<p>Tartarian Honeysuckle <i>Lonicera tartarica</i> Native to Eurasia Introduced to United States in 1750s Landscape plant; wildlife food and cover</p>	<p>Black Locust <i>Robinia pseudoacacia</i> Native to southern Appalachia and the Ozarks Introduced to Midwest in early 1900s Erosion control; fence posts</p>
<p>Crown Vetch <i>Coronilla varia</i> Native to Europe, southeast Asia, northern Africa Introduced to United States in 1950s Erosion control; green fertilizer; ground cover</p>	<p>Japanese Stilt Grass <i>Microstegium vimineum</i> Native to Asia Introduced to Tennessee in 1910s Packing material</p>	<p>Multiflora Rose <i>Rosa multiflora</i> Native to Japan and Korea Introduced to United States in 1830s Erosion control; living fence; snow fence; wildlife food and cover</p>
<p>Queen Anne's Lace <i>Daucus carota</i> Native to Eurasia Introduced to United States by early 1800s Medicinal plant</p>	<p>Princess Tree <i>Paulownia tomentosa</i> Native to east Asia Introduced to United States in 1840s Ornamental plant; lumber; medicinal plant</p>	<p>Garden Heliotrope <i>Valeriana officinalis</i> Native to Eurasia Introduced to United States by 1850s Ornamental; herb; medicinal plant</p>

Means & Modes

Method

Students will pull objects from a box to brainstorm the ways that people knowingly and unknowingly spread invasive plants.

Getting Ready

1. Look through the list of *Means & Modes* items and choose the ones appropriate to your audience, topic, and personal knowledge level.
2. Gather the actual items or representative items (e.g., a toy SUV) and place them in a box. **Optional:** You can also simply write the name of each item on an index card to place in the box.

Introducing the Activity

Have you ever picked up a hitchhiker, smuggled an alien through customs, or purchased an illegal substance? If you think not, think again! No doubt at some point in your life you have, either knowingly or unknowingly, helped a potentially invasive species enter new territory. Most invasive species are incredibly adaptable and can take advantage of opportunities for invasion. However, they rarely swim across oceans, walk over mountain ranges, or hop continents without help from people! Let's find out how invasive species get around and how we might stop giving them a hand.

Doing the Activity

1. **Select items from the box.** Let students take turns selecting items from the box. If you have more students than items, ask students to work in pairs.
2. **Brainstorm connections.** Ask students to think about their items and brainstorm how they might be connected to the spread of invasive species. The items in the box simply serve as springboards for ideas. There are no right or wrong answers. Encourage them to think creatively!
3. **Share ideas.** Allow students to share how they think their items contribute to the spread of invasives. **Note:** Refrain from telling everything you know about each item. Keep the activity moving!
4. **Wrap up the activity.** Ask some of these questions:
 - Did this activity help you think of a time when you might have transported an invasive species?



Objectives

- List everyday activities that can contribute to the spread of invasive species.
- Realize that people spread invasive species both knowingly and unknowingly.
- Analyze personal actions related to the introduction and spread of invasive species.

Grades

3 – adult

Group Size

Individuals or pairs

Activity Time

20 – 40 minutes

Setting

Anywhere

Materials

- Items representing ways people spread invasives (See list on page 81.)
- Box

Connections

See next page.

Academic Standards

Grades 3 – 4

- Environmental Education: B.4.12, D.4.3
- Social Studies: A.4.4, A.4.8

Grades 5 – 8

- Environmental Education: B.8.10, D.8.5
- Social Studies: A.8.7, D.8.11

Grades 9 – 12

- Environmental Education: C.12.1, D.12.4

Scout Connections

- Boy Scouts: Leave No Trace, Camping, Hiking
- Junior Girl Scouts: Camp Together, Your Outdoor Surroundings
- Cadette and Senior Girl Scouts: Backpacking

- Would you share the circumstances with the group?
- Now that you know more about how potentially invasive species move from place to place, what will you do about it?
- Can any of these pathways of invasion be controlled or stopped? How?
- Do you think it is the job of the government or individuals to control the spread of potentially invasive species? Why?

This activity is adapted from “Means & Modes.” **Non-Native Invasive Species Learning Kits — Close the Doors.** United States Forest Service. 2005.

Assessing the Learning

Observe student participation in the discussion. Ask students to choose an item from the box, find out which invasive species might be spread by that item, and suggest ways to prevent the spread. For example, if you wear hiking boots in an area infested with garlic mustard, you are likely to pick up garlic mustard seeds. Thoroughly cleaning the mud off boots before leaving the infested area helps to prevent the accidental spread of seeds into new areas. It would also be a good idea to shake out your boots and brush off your clothes.

Extending the Learning

Leave No Weeds. In many ways, people who love the outdoors are the ones with the most to lose when invasive plants are concerned. Invasives can completely change the land – reducing recreational opportunities, limiting access to areas, and spoiling the diversity and beauty of wild places. Because people who love the outdoors have so much to lose, they have a vested interest in doing everything possible to stop and/or slow the spread of invasive plants. Ask students to develop a code of outdoor ethics that would stop or reduce the spread of invasive plants. See page 82 for a sample Leave No Weeds code of ethics based on Leave No Trace principles. Visit the Leave No Trace Web site for tips on reducing recreational impact to public wildlands. <www.lnt.org>

Investigate commercial seed mixes. Many companies offer seed mixes that are “guaranteed to grow.” These mixes are often advertised as “meadow wildflowers” or “butterfly plants.” The marketing strategy uses words like “robust plants” or “aggressive bloomers.” Investigate what these mixes *really* contain. Are the plants native to the places where they are marketed? If the plants are non-native, are any invasive? Try growing a commercial seed mix in a greenhouse or indoor planting box. Did you grow anything not on the seed list? Check out research done by the University of Washington. <www.washington.edu/newsroom/news/202archive/04-02archive/k041802a.html>

Means & Modes Items

- **Bait container** – What do you do with leftover bait? Have you ever dumped store-bought worms on the ground?
- **Shoestring from hiking boot** – How could shoestrings spread invasives? Have you ever gotten seeds stuck in your shoestrings? What did you do with them? What do you do with the mud that gets stuck in your boot tread?
- **Hay for pack animals** – How could the diet of a pack animal be related to the spread of invasive species? When would you have to start feeding certified “weed free” hay to your pack animal before taking a trip into a restricted area?
- **Dirt bike** – How could vehicles like 4X4s, dirt bikes, and SUVs transport invasive plants? How might an “off road” or “off trail” vehicle damage the landscape? How could this damage increase the number of invasive plants?
- **Landscape tag** - Do landscape tags indicate if a plant is native or non-native? Why do you think nurseries sell plants that are known invasives?
- **Mailable seed packet** – What are some problems with picking up seeds on vacation and mailing them to your friends? How can seeds native to one state/country be a problem in another?
- **Dog** – Do seeds ever get stuck in pet fur? What do you do with the seeds?
- **Birdseed** – What kinds of seeds are in birdseed? Do birds completely digest all the seeds they eat? What problems could undigested seeds cause?
- **Tent stake** – Have you ever had seeds or soil stuck on your camping equipment? What have you done with the seeds? What kinds of seeds do you think invasive plants might have?
- **Plane** – How could the inside or outside of a plane transport invasive species?
- **Military equipment** – Military equipment is used all over the world. What kind of species could military equipment transport?
- **Luggage** – People travel all over the world. What could happen if they decide to carry food items, plant specimens, seeds, or wild animals from place to place?
- **Firewood** – What kinds of invasive species could firewood transport?
- **Livestock** – How could cattle, sheep, pigs, or other livestock transport invasive species? Think about what happens to the food they ate before they were transported.
- **Construction equipment** – How does development add to the problem of invasive species? Besides moving invasives on tires, can you think of ways the disturbance caused by construction adds to the problems with invasives?
- **Carabiner** – What precautions should people take when they venture into wilderness areas to participate in extreme sports?
- **Tractor** – How could raising crops encourage invasive species?
- **Blaze orange cloth** – Could hunters transport invasive species to new areas? How could hunters be sure they don’t move invasives?
- **Dried flower arrangement** – How could a discarded wreath or flower arrangement be a problem?
- **Mowing equipment** – How could mowing equipment result in the spread of invasives? Do workers ever clean mowers?
- **Soil** – Think about what is in soil. What if it contained dormant plant parts?

Leave No Weeds

Adapted from *Leave No Weeds*, Lolo National Forest, Missoula, Montana.

1. **Be aware and prepare!** Be aware of and learn to identify plants in your region.
 - Know what invasive plants to expect in the areas you visit.
 - Brush and clean your shoes, clothes, pets, vehicles, and equipment when leaving an infested area to remove hitchhiking weed seeds and other reproductive plant parts.
 - If using livestock or pack animals, feed them *Certified Weed Seed Free* feed before and during backcountry trips. Animals can spread viable seeds after ingestion.
 - Clean your boat thoroughly before transporting it to a different body of water.
2. **Camp and travel carefully.** Don't be the person who brings an invasive species to a pristine area! Using equipment in or walking through weed patches will spread seeds. They'll stick to your vehicle, tent, shoes, and whatever else you have and hitch a ride to a new spot.
 - Stay on designated roads and trails – going off the beaten path helps to distribute seeds and creates soil disturbances where weeds can spread rapidly.
 - Use established campsites when possible – new campsites create disturbances where weeds can thrive.
 - Rid camping gear, shoes, and clothing of dirt and seeds before each trip and at every campsite.
 - Avoid camping in or hiking through weed-infested areas.
3. **Pull it out, pack it out.** If you find an invasive plant that hasn't gone to seed, PULL IT OUT! If it has gone to seed, at least remove the flowers or seed heads and bag them.
 - Refrain from picking wildflowers or plants, many of which may actually be invasive plants. Picking and transporting them can spread their seeds to new areas.
 - Pull only species that you can identify, and pull only taprooted species. Pulling plants with rhizomes, like leafy spurge, can help increase their rate of spread!
 - Try to get the whole root.
 - Wear gloves for protection against thorns and toxic chemicals produced by some plants.
 - Try to minimize soil disturbance when pulling weeds.
 - And remember – pulling weeds that have gone to seed can help spread the seeds. Better to leave those plants alone, or put the seed heads in a plastic bag and PACK THEM OUT. Don't pick or transport unidentified plants.
4. **Report it.** If you find a new invasive plant not yet established in your area or a small, isolated patch of common invasives, notify the authorities. This could be the landowner, Department of Natural Resources, Forest Service, etc, depending on where you found the plants.
 - Make sure you can give an exact location! If managers can catch infestations while they are new and small, they have a much better chance of controlling them.
 - In Wisconsin, report infestations of invasive plants just entering the state to the Wisconsin Invasive Plants Reporting and Prevention Project. <www.dnr.wi.gov/invasives/futureplants>

Wanted Posters

Method

Students will research invasive forest plants and design “wanted posters” that illustrate the plants’ “shady” characteristics and crimes.

Getting Ready

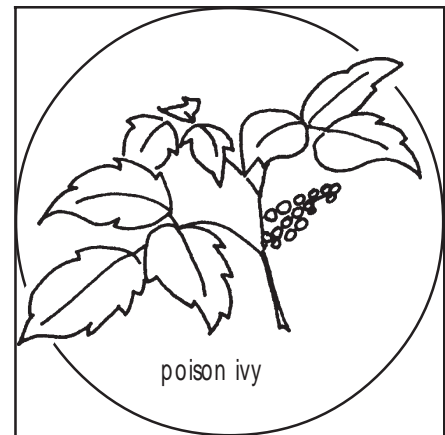
1. Gather reference books and/or obtain access to the Internet for each group of students.

Introducing the Activity

When law enforcement officers want to track down a criminal, they often post wanted posters or display mug shots and distinguishing features on the evening news. We can increase awareness of the problems with invasive plants by making wanted posters.

Doing the Activity

1. **Identify invasive forest plants that could be featured on a poster.** Use the list on pages 195 – 204 of **Invasive Plants of the Upper Midwest** for ideas. Good possibilities include: garlic mustard, oriental bittersweet, Canada thistle, crown-vetch, Eurasian honeysuckles, Japanese knotweed, buckthorns, and multiflora rose.
2. **Brainstorm information needed for the posters.**
 - Common name
 - Scientific name
 - Aliases
 - Image (e.g., photo or line drawing)
 - Distinguishing features (e.g., flowers, leaves, or fruits that identify the plant)
 - Reproductive strategies (e.g., seeds, suckers, or fragments)
 - Crimes it is charged with (e.g., shading out, strangling, or stealing resources from native plants).
 - Ecological reward for arrest (e.g., more beautiful forest, increased biodiversity, and better habitat for local wildlife)
3. **Create posters.** Students can use poster board and markers or computer software to produce their posters.



Objectives

- Research an invasive forest plant.
- Present information about the plant in a creative format.

Grades

4 – 12

Group Size

Individuals or small groups

Activity Time

One 50-minute period plus homework

Setting

Classroom

Materials

- Reference books and/or Internet access
- Paper, pencils, markers
- Optional: access to desktop publishing programs
- **Invasive Plants of the Upper Midwest**

Academic Standards

Grade 4

- English Language Arts: E.4.3

Grades 5 – 8

- English Language Arts: E.8.3

Grades 9 – 12

- English Language Arts: E.12.3

4. **Present posters to the class.**
5. **Display the posters in classroom, school, or community buildings.**

Assessing the Learning

Posters should include all the elements that the class decided were essential. Posters should be neat and well-organized with headings and subheadings to help readers find important information. Drawings or photos should show the plants' identifying features. There should not be spelling errors.

Extending the Learning

Be the photographer. Using a digital camera, allow students to take their own photos of plants for the wanted posters.

Finding Out More!

Weed Hall of Shame. Bureau of Land Management. 2000. View sample wanted posters. <www.blm.gov/education/weeds/hall_of_shame.html>

Integrated Pest Management. University of Nevada. 1999. View sample wanted posters. <www.ag.unr.edu/wsji/pm/Wanted_posters/wpost.html>



Eyewitness Accounts

Method

By reconnecting with the natural rhythms of the seasons, students will become aware of the invasive plants that are out-of-step.

Getting Ready

1. Locate a nearby wooded area that is readily accessible.

Introducing the Activity

Plants and animals change with the seasons. As the earth warms in spring, plants and animals respond in predictable ways. In fall, the days grow cooler and shorter. Again, plants and animals respond. The study of seasonal changes of plants and animals is called phenology.

Doing the Activity

For students in kindergarten – 4.

Your goal is to help students be more aware of the things happening around them. This can be as simple as setting aside time each morning to discuss what students noticed on the way to school. Take several walks around the neighborhood throughout the year. Weekly walks would be best, but any repeated walks in familiar areas will encourage students to notice what has changed as the seasons progress.

In fall

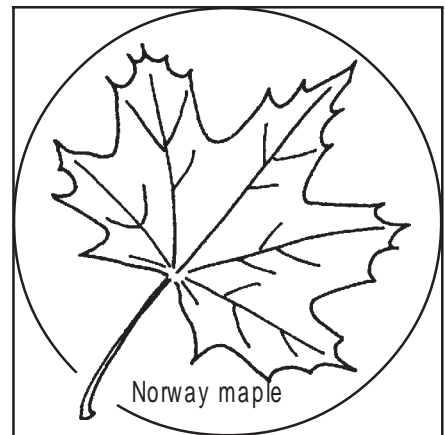
Ask questions:

- “Has the tree outside the school changed color yet?”
- “Could you see your breath on the way to school?”
- “Did ladybugs invade your home this weekend?”

Encourage observations:

- “Watch for Canada geese to migrate this week.”
- “Let’s keep track of leaves falling. Tomorrow I want you to bring in one leaf that you saw fall to the ground.”

Take a walk during the peak of fall colors. Ask the students to look for trees and shrubs that have not started to change colors. Collect a small twig from each kind. Use plant identification books to identify them. How many of these trees and shrubs are non-native? Were they planted as landscape trees? Are they invading wild areas? Press the leaves and save for reference.



Objectives

- Observe the progression of seasonal changes known as phenology.
- Recognize that invasive plants are out-of-step with native plants.

Grades

K – adult

Group Size

Individuals

Activity Time

Ongoing

Setting

Outdoors and indoors

Materials

- Calendar
- Plant identification books (See list on page 139.)

Connections

See next page.

Academic Standards

Grades K – 4

- English Language Arts: B.4.1
- Environmental Education: A.4.2
- Science: E.4.5, E.4.6, F.4.2, F.4.3

Grades 5 – 8

- English Language Arts: B.8.1
- Environmental Education: C.8.2
- Science: A.8.6, B.8.4, E.8.8, F.8.9

Grades 9 – 12

- English Language Arts: B.12.1
- Science: F.12.8

Scout Connections

- Junior Girl Scouts: Earth Connections, Wildlife

In winter:

Ask questions:

- “Have you seen any mammal or bird tracks around your home?”
- “What happens to trees and shrubs during the winter?”

Encourage observations:

- “Try to find a shrub in your neighborhood that still has berries on it.”
- “Ask a parent to help you cut a small twig from a shrub or tree in your yard. Take it inside and put it in a vase.”

Take a walk when the ground is not covered with snow. Look for plants that stay green all winter. While there are some native evergreen groundcovers, most of the green plants that you find in a winter woods are invasive species. Collect leaves; press and identify the plants.

In spring:

Ask questions:

- “Have you seen any earthworms on the sidewalks yet?”
- “Are the tulips blooming in your yard?”

Encourage observations:

- “Listen for bird songs on your way to school tomorrow.”
- “Watch for tree flowers. Don’t expect big beautiful flowers! Look for small greenish flowers.”

Take a walk in very early spring. Watch for the first plants to green up. Trees, shrubs, and plants on the forest floor that green up in March or early April are more likely to be invasive. Keep an eye out for buckthorn, honeysuckle, and garlic mustard. Collect leaves or place flags by these plants so that you can identify them when they flower.

For students in grades 5 – adult.

Encourage the same kinds of observations listed above. In addition you can:

- Keep track of daily weather.
- Trace the movement of the sun through the sky, the changing angle of sunlight, and the variations in day length.
- Encourage students to keep phenology journals. They can record seasonal events they observe related to plants, wildlife, and people.
- Record select events that you can compare from year to year. For example, record the day that the sugar maple tree in the school yard flowers or the first trillium blooms.

Use your observations of greening up and greening down to locate and identify invasive species. Remember, invasives often

have longer growing seasons because they are on different biological clocks. Discuss why greening up early gives invasive plants an advantage over natives. (Spring wildflowers depend on a short window of time to complete their growing and blooming cycle. They can't begin to grow until there is sufficient daylight and warmth, and they must finish most of their growing before the trees leaf out. Invasive plants green up early and shade out native spring wildflowers.)

Assessing the Learning

Ask students to keep simple phenology journals. Decide how often they should make journal entries and how often you will check them. Encourage students to include some of the following: date, location, weather, sketches, photos, pressed leaves, and notes.

Extending the Learning

Nip 'em in the Bud. In 2004, the Wisconsin DNR introduced the Wisconsin Invasive Plants Reporting and Prevention Project. Early detection of invasive plants is crucial. If a new infestation is discovered before the plants go to seed, we can stop the plant from becoming established. But new infestations are difficult to locate. Informed volunteers who can locate and report these infestations can make a huge difference in stopping the spread of invasive weeds. <www.dnr.wi.gov/invasives/futureplants/index.htm>

Track the colors of spring. An easy way for younger students to track the approach of spring is to watch for colors. Make a color tally chart with colors across the top and the weeks of spring along the side. Each week ask students to record the colors they see outside. They can watch as the browns and blacks change to greens and other colors! See "What Color is Spring?" in **Hug a Tree** by Robert E. Rockwell, Elizabeth A. Sherwood, and Robert A. Williams. 1985.

View Wisconsin from space. Your students can watch the changes of the seasons as seen from satellite. Images that show snow melt, spring greening, and fall color changes can all be viewed daily from the MODIS sensor on NASA's Terra satellite. <www.wisconsinview.org>

Keep a phenology calendar. Post a calendar in the classroom and invite students to record natural events on the calendar.

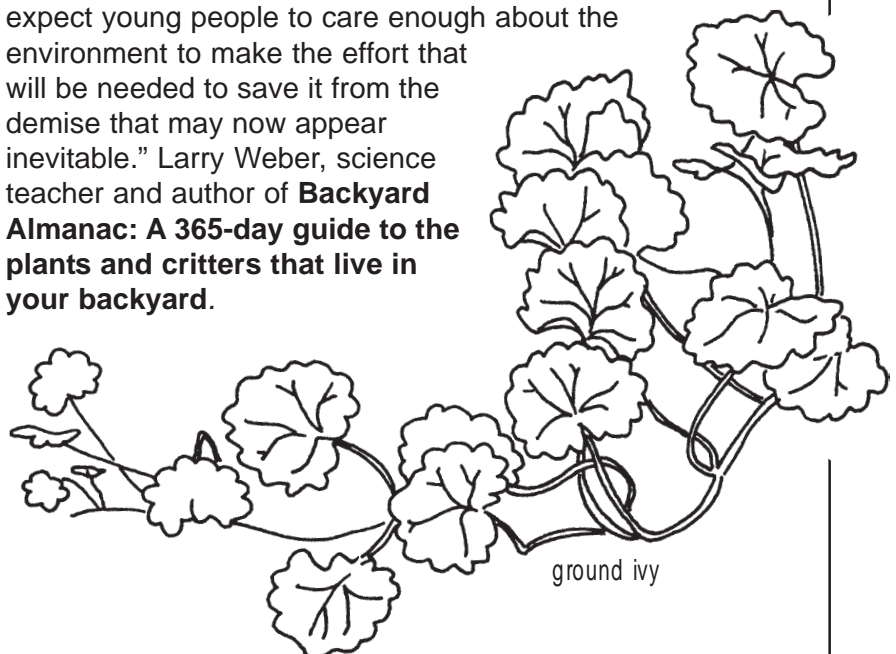
Finding Out More!

EEK! Environmental Education for Kids! Wisconsin Department of Natural Resources. 2005. Visit this Web site to find out what's happening each month in Wisconsin. Use the suggestions to decide what events you might track in your classroom. <www.dnr.wi.gov/eeek/nature/season/pheno.asp>

Journey North. Annenberg Media. 2005. This Internet-based program engages students in investigations of wildlife migration and seasonal change. <www.learner.org/jnorth/index.html>

Wisconsin NatureMapping. Beaver Creek Reserve, Wisconsin Department of Natural Resources, and the Aquatic and Terrestrial Resources Inventory. 2005. This online program provides an opportunity for students and volunteers to perform field studies that contribute to the state's biological databases. <www.wisnatmap.org/index.htm>

"By putting students in touch with nature on a daily basis, by familiarizing them with local flora and fauna, and by teaching and reinforcing the skills of observation, we can help them build the foundation of a lifelong appreciation of the richness of the natural world around them. Only then can we expect young people to care enough about the environment to make the effort that will be needed to save it from the demise that may now appear inevitable." Larry Weber, science teacher and author of **Backyard Almanac: A 365-day guide to the plants and critters that live in your backyard.**



Citizen Scientists

Method

Students will find out about monitoring programs around the state and consider how invasive species might impact the populations being studied.

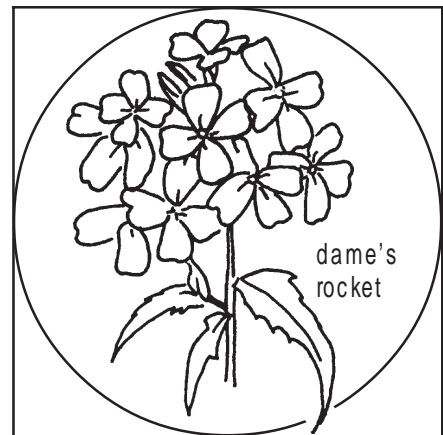
Introducing the Activity

Monitoring plant and animal populations has traditionally been the job of scientists, resource specialists, and other trained professionals. However, the need for monitoring has skyrocketed at the same time that funding for monitoring has decreased. The Wisconsin Department of Natural Resources (WDNR), other state and federal agencies, and private nature organizations conduct regular surveys to collect valuable information about Wisconsin's natural resources. Many of these surveys depend on citizens (including students) to collect information from around the state. See the list on page 91.

In 2004, the WDNR introduced the Wisconsin Invasive Plants Reporting and Prevention Project. Early detection of invasive plants is crucial. If a new infestation is discovered before the plants go to seed, we can stop the plant from becoming established. But new infestations are difficult to locate. Informed volunteers who can locate and report these infestations can make a huge difference in stopping the spread of invasive weeds.

Doing the Activity

1. **Pass out or display the list of monitoring programs available around the state.** See pages 91 – 92.
2. **Ask students, working individually or in pairs, to pick one of the surveys.** Students should determine what information the survey is tracking, who conducts the survey, and how the information is used.
3. **Share information in class.**
4. **Discuss the impacts of invasive species.** While some of the monitoring programs focus on invasive species, most do not. Discuss how invasive species might change the focus of other monitoring programs. How do invasive plants impact the animals or plants being watched? Discuss how scientists might use information collected in the past to help show the impact of invasive species on a population of plants or



Objectives

- Become aware of the need for citizens to be involved in monitoring plant and animal populations.
- Explore one or more monitoring programs to determine how to get involved.
- Realize the impact of invasive species on native wildlife and habitats.

Grades

5 – adult

Group Size

Individuals or pairs

Activity Time

One or two 50-minute periods

Setting

Classroom

Materials

- List of monitoring programs (pages 91 – 92)
- Access to Internet

Connections

See next page.

Academic Standards

Grades 5 – 8

- Environmental Education: B.8.8, B.8.21, B.8.22, B.8.23, C.8.2, D.8.5
- Science: B.8.5, F.8.8, F.8.9
- Social Studies: A.8.5

Grades 9 – 12

- Environmental Education: B.12.5
- Science: A.12.5, F.12.6, F.12.7, F.12.8

Scout Connections

- Boy Scouts: Environmental Science, Fish and Wildlife Management
- Cadette and Senior Girl Scouts: Wildlife

animals. Monitoring the populations of endangered or threatened plants and animals is especially critical. For example, could monitoring show that a population of endangered frogs declined at the same time that the population of an invasive plant increased? What other factors might have led to the decline of the frogs?

This activity is adapted from “Wisconsin Wildlife Watching.” **Go Wild with Wisconsin Wildcards.** Wisconsin Environmental Education Board, Wisconsin Department of Natural Resources, and Friends of Wisconsin State Parks. 2005.

Assessing the Learning

Ask students to write a short paragraph describing the monitoring program they researched. They should include a statement about how invasive species might impact the plants or animals being watched.

Extending the Learning

Get involved! Choose one of the surveys listed in this lesson and see if your group can get involved. The surveys marked with a (!) are recommended for individuals with little or no scientific monitoring experience. If you can't be a part of a survey, invite a citizen scientist to visit your classroom or meeting. Ask them to share how they became involved in the research, how they gather information, and what they have learned as a result of their involvement.

Finding Out More!

Wisconsin NatureMapping. Beaver Creek Reserve, Wisconsin Department of Natural Resources, and the Aquatic and Terrestrial Resources Inventory. 2005. Links to online species lists, maps, surveys, and other information maintained by partner organizations. <www.wisnatmap.org/index.htm>

WISFLORA: Wisconsin State Herbarium. University of Wisconsin – Madison. 2005. Online photos, habitat information, distribution maps, herbarium specimen data, and more. <www.botany.wisc.edu/wisflora>

Citizen Scientists

There are more people watching, monitoring, and surveying Wisconsin's plants and animals than most people realize. And that is a very good thing, because there are a lot of plants and animals to keep track of – many more than scientists and resource specialists can possibly cover! Thanks to a growing number of citizen monitoring programs, we are learning more about plants, animals, and habitats in Wisconsin. Join the fun, help collect valuable information, and discover that we really have a lot to learn about the plants and animals in Wisconsin.

Surveys marked with a (*) depend on citizen scientists. Surveys marked with a (!) are recommended for people with little or no scientific monitoring experience. Visit the **Wisconsin NatureMapping** Web site for a more comprehensive list of citizen-based inventory and monitoring programs, including some local and regional programs. <<http://atriweb.info/cbm/InvMon/index.cfm>>

Invasive Species

Wisconsin Invasive Plants Reporting and Prevention Project*

Wisconsin Department of Natural Resources <www.dnr.wi.gov/invasives/futureplants>

Clean Boats, Clean Waters*

University of Wisconsin – Extension and Wisconsin Department of Natural Resources <www.uwsp.edu/cnr/uwexplakes>

Purple Loosestrife Detectives*

Beaver Creek Citizen Science Center <<http://beavercreekreserve.org/BCR/Purple%20Loosestrife%20-%20CSC.htm>>

Zebra Mussel Watch*

University of Wisconsin – Sea Grant Institute <<http://seagrant.wisc.edu/zebramussels>>

Rare Plants

Rare Plant Field Reports*

Wisconsin Department of Natural Resources <www.dnr.wi.gov/org/land/er/forms/1700-049.pdf>

Trees

Wisconsin's Champion Trees*

Wisconsin Department of Natural Resources <www.dnr.wi.gov/org/land/forestry/UF/champion>

General Animals

Summer Wildlife Inquiry*

Wisconsin Department of Natural Resources <www.dnr.wi.gov/org/land/wildlife/harvest/harvest.htm>

Rare Animal Field Reports*

Wisconsin Department of Natural Resources <www.dnr.wi.gov/org/land/er/forms/1700-048.pdf>

Wisconsin NatureMapping*!

Beaver Creek Reserve, Wisconsin Department of Natural Resources, Aquatic and Terrestrial Resources Inventory <www.wisnatmap.org/index.htm>

Mammals

Wisconsin Statewide Mammal Inventory

Wisconsin Department of Natural Resources <www.dnr.wi.gov/org/es/science/inventory/Mammals.pdf>

Wisconsin's Carnivore Tracking Program*

Wisconsin Department of Natural Resources <www.dnr.wi.gov/org/land/er/mammals/volunteer>

Rare Mammal Observation Cards*

Wisconsin Department of Natural Resources <www.dnr.wi.gov/org/land/er/forms/raremammal.asp>

Winter Track Counts

Wisconsin Department of Natural Resources <www.dnr.wi.gov/org/land/wildlife/harvest/harvest.htm>

Birds

- Wisconsin Checklist Project*
Wisconsin Society for Ornithology
<www.wisconsinbirds.org/WSOChecklist.htm>
- Christmas Bird Count*
National Audubon Society
<www.audubon.org/bird/cbc>
- Bird Nest Monitoring Program*
Wildlife Habitat Council
<www.wildlifehc.org/nestmonitoring>
- Great Backyard Bird Count*!
Cornell Lab of Ornithology
<www.birdsource.org/gbbc>
- Project FeederWatch*!
Cornell Lab of Ornithology
<<http://birds.cornell.edu/pfw>>
- Wisconsin LoonWatch*
Sigurd Olson Environmental Institute
<www.northland.edu/soei/loonwatch.asp>
- North American Breeding Bird Survey*
Patuxent Wildlife Research Center
<www.pwrc.usgs.gov/bbs/>
- Project PigeonWatch*!
Cornell Lab of Ornithology
<www.birds.cornell.edu/programs/urbanbirds/ubs_PiWMMainEN.html>
- Ruffed Grouse Drumming Survey*
Wisconsin Department of Natural Resources
<www.dnr.wi.gov/org/land/wildlife/harvest/harvest.htm>
- Rural Mail Carrier Pheasant Survey*
Wisconsin Department of Natural Resources
<www.dnr.wi.gov/org/land/wildlife/harvest/harvest.htm>
- Wisconsin Shorebird Survey*
Wisconsin Department of Natural Resources
<www.uwgb.edu/birds/shorebird/>

Fish

- Fish and Habitat Surveys
Wisconsin Department of Natural Resources
<www.dnr.wi.gov/org/water/fhp/fish/pages/reports/index.shtml>
- Fish Kill Network*
Izaak Walton League
<www.iwla.org/fishkill>

Reptiles and Amphibians

- Wisconsin Herpetological Atlas Project*
Milwaukee Public Museum
<www.mpm.edu/collect/vertzo/herp/atlas/atlas.html>

Frogs and Toads

- Wisconsin Frog and Toad Survey*
Wisconsin Department of Natural Resources <www.mbr-pwrc.usgs.gov/wifrog/frog.htm>
- FrogWatch USA*
National Wildlife Federation
<www.nwf.org/frogwatchUSA>

Invertebrates

- Wisconsin's Odonata Survey*
Wisconsin Department of Natural Resources <<http://ATRIweb.info/Inventory/Odonata>>
- Butterfly Counts*
North American Butterfly Association
<www.naba.org>
- Citizen Stream Monitoring*
University of Wisconsin – Extension
and Wisconsin Department of Natural Resources <<http://clean-water.uwex.edu/wav/monitoring/index.htm>>
- Minnesota Worm Watch*
The Natural Resources Research Institute <www.nrri.umn.edu/worms>

Plotting Plants

Method

Students will map the invasive species present in an area on their school grounds, school forest, or nearby natural area. Older students may standardize and digitize the information for inclusion in a long-term monitoring database.

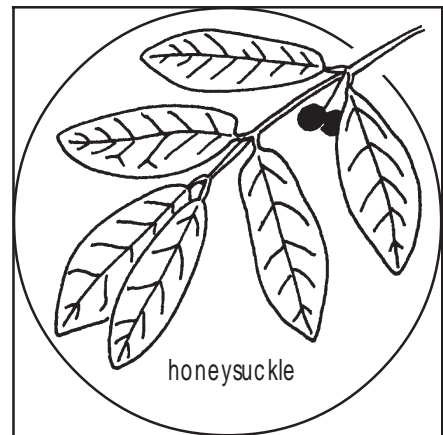
Getting Ready

1. Decide how far you want to take this activity! You and your students can:
 - Step out the back door of your school armed with site plans or plat maps of your neighborhood. Students can plot the locations of invasive plants and make notes about their abundance and distribution.
 - Define a natural area or section of your school forest or nearby park to map. Students can plot the locations of invasives on a topographic map or aerial photo. They can use the attached forms to gather information about the plants.
 - Begin a major monitoring project to track the changes and effects of invasive species in a defined area. Students can use GPS units and mapping tools to create maps. They can use the attached forms to gather baseline data. Each year students can add to the collected data. Over time, they can graph changes in distribution and density of invasive plants in the area being studied.
2. Locate a study area and obtain permission to take your students there.
3. Gather equipment, maps, and books needed to conduct the activity.

Introducing the Activity

Monitoring is an essential part of any invasive plant control project. In addition, monitoring allows you and your students to:

- Be involved in *real* science.
- Collect valuable information on specific species and communities over time.
- Perceive subtle changes in habitats that might not be noticed without consistent data collection.
- Detect the presence of new species (including new invasive species) in an area.
- Evaluate the success or failure of control measures.
- Measure the changes in plant diversity before, during, and after invasive species control.



Objectives

- Collect monitoring information about an invasive species population and location.
- Plot the locations of an invasive species on a map of the area.

Grades

4 – 12

Group Size

Small groups of 3

Activity Time

Varies

Setting

Indoors and outdoors

Materials

- Map of area to be investigated (site plan, topo map, plat map, Gazetteer)
- Access to Internet mapping tools (optional)
- GPS unit (optional)
- Clipboards and pencils
- Copies of *Plotting Plants* data form (pages 96 – 98)
- Plant identification books (See list on page 139.)

Connections

See next page.

Academic Standards

Grade 4

- Science: A.4.3, B.4.1, C.4.3, C.4.4, C.4.5, F.4.3

Grades 5 – 8

- Environmental Education: C.8.2, D.8.6
- Science: B.8.5, C.8.2, C.8.3, C.8.6, C.8.8, F.8.2, F.8.8

Grades 9 – 12

- Environmental Education: D.12.5
- Science: C.12.3

Scout Connections

- Boy Scouts: Surveying
- Cadette and Senior Girl Scouts: Wildlife

Doing the Activity

1. **Discuss the value of mapping invasive plants.**
2. **Introduce the mapping project you have chosen.**
3. **Learn about local invasive plants.** If your students haven't become familiar with local invasives in earlier activities, help them do so now. Encourage each student or small group of students to become the experts on one invasive plant. Students should:
 - Collect descriptions, drawings, and/or photographs of their assigned species.
 - Find out how the plants will look during the time of the survey. For example, will they be in bloom (ideal)? Will they have gone to seed? Will they be dormant? Will they have only a rosette of leaves?
 - Investigate how the invasive plants spread. This will help students locate the plants. For example, if they reproduce by seeds that birds might eat, the plants could be scattered throughout the study area. However, if they reproduce by sending out rhizomes or stolons, the plants are more likely to form discrete clumps. If humans spread them, students might only need to follow the roads and trails to find populations of the plants.
4. **Decide on your protocol.** Discuss how you will record and track the information you gather. This can be as simple as choosing map symbols for each invasive plant. However, with older students you may need to make decisions about how to standardize information so it can be entered in a database. A datasheet is included in this lesson plan. Notice that, in each section, basic information is collected first, followed by information that is more specific. You can cut and paste sections together to create a form that is appropriate for your students.
5. **Collect data.** On the day of the field experience, be sure students understand these guidelines:
 - Students are responsible for staying inside the established boundaries.
 - Students will turn in completed datasheets at the end of the field experience.
 - Students will respect each other and the area they are investigating.
6. **Leave the area.** Before you leave one area or move to a new area, clean off your shoes and remove any plant parts that may be attached to your clothes. This will help prevent invasive species from spreading to new sites.

7. **Compile data.** Back in the classroom, organize your data. Your students could:
- Plot all the occurrences of invasive plants on a large map of the school or neighborhood. Use symbols to represent each different plant. Post the map in a community center along with pressed specimens or drawings. Be sure students include information about what invasive plants are and why they are a problem.
 - Use DNR WebView to plot their GPS data on a map. See *Finding Out More!* below.
 - Compile data in a spreadsheet. Calculate the top five invasives in the area. Are the invasive plants concentrated in a small area or are they evenly distributed around the entire study area? Can students make any generalizations about the ways invasives might be spreading?
8. **Share your findings.** Send completed data sheets, maps, specimens, and/or photos to the address on the data sheets. If your students conducted the survey in a city, county, or state park, encourage them to offer their data to the managers of the property. If they found invasive plants *new* to Wisconsin, visit the Invasive Plants Prevention and Reporting Project Web site. See *Finding Out More!* below. If your students submit the first record of a plant from their county, their names and records will be displayed on the Wisconsin State Herbarium Web site.

Assessing the Learning

Plant information collected by the student should include a written description, a drawing or photograph of the plant, notes on phenology of the plant, and information on the way the plant spreads. All datasheets should be complete and legible. Locations should be plotted on maps as accurately as possible, taking in account the age of the students.

Finding Out More!

Invasive Plants Prevention and Reporting Project. Wisconsin Department of Natural Resources. 2005. <www.dnr.wi.gov/invasives/futureplants>

DNR WebView. Wisconsin Department of Natural Resources. 2005. An online interactive map viewer. Find digital aerial photos, topographic maps, and GIS data for your school forest, community, county, or the whole state! <<http://maps.dnr.state.wi.us/webview/>>

The Global Invasive Species Initiative. The Nature Conservancy. 2005. The Weed Information Management System (WIMS) is a free Microsoft Access-based relational database application that is designed to assist natural resource managers in managing their weed data. Definitely for the serious weed watcher! <<http://tncweeds.ucdavis.edu/wims.html>>

Plotting Plants

Location #

Fill in this information for each location that you map. On your map, mark the place where you are and record the location number. Include this same number on each invasive plant form you complete for this location.

Survey date (dd/month/yyyy): _____

Names of observers: _____

Location Information

Name of the location: _____

State: _____

County: _____

Township: _____

Nearest city/town: _____

Describe the location: (highway/road, distance and direction to nearest town, crossroads or topo map reference point):

Who owns the land? (state, county, city, school, individual) _____

Detailed Location Information (choose one of the following 3 methods)

1. Public Land Survey System

Township: T _____ N

Range: R _____ E / W (circle one)

Section: _____

Quarter: _____

Quarter Quarter: _____

2. Latitude/Longitude Coordinates

Latitude: _____ N

Longitude: _____ W

3. Universal Transverse Mercator

Zone 15 Zone 16

_____ E

_____ N

How did you determine the location? Check most accurate method you used.

- Topo map (15 minute) Source _____ Scale _____ Date _____
- GPS unit (Circle precision: 0-5, 0-30, 0-100, 0-1000, 1000+)
- Plat map
- Aerial photo
- DNR WebView
- TopoZone or other website
- Gazetteer
- Other _____

Habitat Description

Location #

Check the habitat type that best describes the area.

- | | |
|------------------------------------|--------------------------------------|
| <input type="checkbox"/> Woodland | <input type="checkbox"/> Aquatic |
| <input type="checkbox"/> Grassland | <input type="checkbox"/> Urban |
| <input type="checkbox"/> Wetland | <input type="checkbox"/> Other _____ |

Describe the habitat:

Detailed Habitat Description

How is the land being used? (road, trail, agricultural, residential, natural plant community, wild area, park, etc.):

Do you see evidence of disturbance? Check all that apply.

- | | |
|--|---|
| <input type="checkbox"/> Animal use (buck rubs, burrow excavation) | <input type="checkbox"/> Mining (rock quarry, gravel pit) |
| <input type="checkbox"/> Construction | <input type="checkbox"/> Mowing |
| <input type="checkbox"/> Cultivation | <input type="checkbox"/> ORV use |
| <input type="checkbox"/> Erosion | <input type="checkbox"/> Railroads |
| <input type="checkbox"/> Fire | <input type="checkbox"/> Recreation |
| <input type="checkbox"/> Flood | <input type="checkbox"/> Residential use |
| <input type="checkbox"/> Grazing | <input type="checkbox"/> Roads |
| <input type="checkbox"/> Logging | <input type="checkbox"/> Other _____ |

How much disturbance is there? _____

Are there other significant species? List other non-native or invasive species present or rare plants at risk from the infestation.

Plant Information

Location #

Fill in this information each time you find an invasive plant population. Connect the information to your map by matching it to a location number.

Scientific name: _____

Common name: _____

What parts of the plant's life cycle do you see? Check all that apply.

- | | |
|---|--|
| <input type="checkbox"/> Seedlings | <input type="checkbox"/> Fruits |
| <input type="checkbox"/> Rosettes of leaves | <input type="checkbox"/> Seeds |
| <input type="checkbox"/> Buds | <input type="checkbox"/> Seeds dispersed |
| <input type="checkbox"/> Flowers | <input type="checkbox"/> Dead plants |

How many plants are there? Circle one.

(1 = a few plants or small area; 5 = many plants or complete coverage)

1 2 3 4 5

Total number of plants/shoots: _____

Detailed Plant Population Information

Estimated total area of infestation (m² or ha; one hectare = 100 m x 100 m): _____

Do you see reproduction?

- Yes
 No

If seedlings are present; how common are they?

- Few
 Common
 Abundant

How are the plants distributed?

- | | |
|--------------------------------------|--------------------------------------|
| <input type="checkbox"/> Isolated | <input type="checkbox"/> Satellite |
| <input type="checkbox"/> Linear | <input type="checkbox"/> Uniform |
| <input type="checkbox"/> Monoculture | <input type="checkbox"/> Other _____ |

Documentation

Specimen collected. Where sent? _____ Date sent ____/____/____

Photographs taken. Where sent? _____ Date sent ____/____/____

Send this completed form to: Wisconsin Department of Natural Resources ER-6, 101 S. Webster St. Madison, WI 53707-7921. Include a plant specimen and/or photo if possible.

Diversity Index

Method

Students will use sampling techniques in nearby parks, backyards, and natural areas to measure the affects of invasives on biodiversity.

Getting Ready

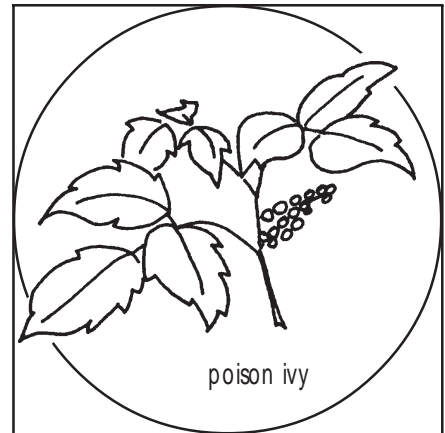
1. Prepare containers of beads for the warm-up activity. There should be 100 beads in each container. Try to vary both the number of different colors of beads and the number of each color. For example, the container representing a very diverse habitat could have equal numbers of 12 different colors of beads while the container representing the least diverse habitat could have only two different colors of beads with most of them one of the colors.
2. Find a location for the outdoor investigation.
3. Be sure the study site does not have any poisonous plants (e.g., poison ivy) or invasives that can cause skin irritations on contact (e.g., wild parsnip, leafy spurge, giant hogweed, St. Johnswort, and yellow flag).

Introducing the Activity

Biological diversity is all around us. It's in the variety of habitats that surround us, the different kinds of plants and animals that we see, and the subtle differences among plants and animals of the same kind. There are three levels of biological diversity:

- If we look out the window and see woodlands, wetlands, and grasslands, we are looking at a scene that has high *ecosystem diversity*. On the other hand, if we can only see croplands or housing developments, the ecosystem diversity is low.
- Another level of diversity is *species diversity*. This diversity is displayed by the number of different plants and animals present. A forest with dozens of kinds of trees and hundreds of kinds of other plants is more diverse than a city park with turf and three kinds of trees.
- The third level of diversity is the hardest to see. It is *genetic diversity*. Within a single species of plant or animal, there is variation. Take a close look at two plants of the same species collected from different locations, and you may notice subtle differences in color, leaf shape, or height.

We are going to focus on species diversity among plants. It's not hard to see that a prairie is more diverse than a lawn or that a woodland is more diverse than a city park. However, sometimes the differences are more subtle than that! How do scientists know that some places are more diverse? How do they know that diversity is declining on a worldwide basis?



Objectives

- Realize that scientists use sampling techniques to measure biodiversity.
- Calculate the Diversity Index of plants along a transect line.
- Understand the importance of diversity indexes in measuring the success of invasive species control methods.

Grades

6 – 12

Group Size

Small groups of 2 – 4

Activity Time

Three 50-minute periods

Setting

Indoors and outdoors

Materials

- 100 beads in a container for each group
- Tent stakes
- 50' cord wound on bobbin
- Paper, pencils, and writing surfaces
- Optional: plant identification books (See list page 139.)
- Optional: calculators

Connections

See next page.

Academic Standards

Grades 6 – 8

- Environmental Education: B.8.3, B.8.21, C.8.2
- Math: A.8.1, B.8.7, E.8.4
- Science: C.8.2, C.8.3, C.8.4, C.8.6, F.8.8, F.8.9

Grades 9 – 12

- Environmental Education: B.12.6, B.12.7
- Science: C.12.5, F.12.7, F.12.8

Scout Connections

- Boy Scouts: Environmental Science

In order for scientists around the world to calculate, compare, and discuss diversity, they have created many tools. One method uses sampling techniques and the Diversity Index to assign numerical values to the biodiversity of a given habitat. The Diversity Index is a tool that scientists use to:

- Calculate the diversity of organisms in an ecosystem and establish baseline information about a site. Baseline information provides a point of reference so that changes to plant communities can be measured.
- Measure the health of an ecosystem or compare healthy and disturbed sites.
- Track changes in diversity at one location over time. Monitoring could help determine if the changes are due to succession, disturbance, or invasion of a non-native species.
- Show the changes to vegetation at a site during and after an invasive species control project or evaluate the effectiveness of various control methods.

Doing the Activity

Diversity Index Warm-Up (Indoors)

1. **Talk about sampling.** If you were a scientist assigned to measure the biodiversity of plants in a habitat, how would you do it? (Entertain all answers, but help students realize that rarely can scientists count every plant in an area. Instead, they take samples using various sampling techniques and then perform calculations on the samples.)
2. **Introduce random sampling and the Diversity Index.** Explain that the students are going to use random sampling and a Diversity Index to study the “populations” of various beads in a “habitat” or container. Explain that the students are going to randomly pick a sample of beads from the container.
3. **Get ready for the warm-up activity.** Divide into teams of two. Give each team a habitat with 100 beads. Each color of bead should represent a different “plant” in the habitat. Assign a letter to each bead color by writing a code on the board or asking students to record it in their lab books.
4. **Conduct the sampling.** Instruct students to randomly choose nine beads from their containers, one at a time. Using the letter symbols, they should record each bead as they remove it. Their results should look something like this:
PBGGWWGBB
5. **Count the number of runs in the sample.** Group letters that are the same by drawing alternating lines above and below the letters. The results from above would look like this:

PBGGWWGBB

The number of runs is the number of groupings, or strings, of the same plant found consecutively in the sample. A run can consist of only one plant. This example has six runs.

6. **Count the number of individuals in the sample.** The example shows nine individual beads.
7. **Calculate the Diversity Index.** Use the following formula:
$$\text{Diversity Index} = \text{number of runs} / \text{number of plants} = 6/9 = .67$$
8. **Discuss the results.** The Diversity Index is a measure of the biodiversity of a group of organisms in an area. The value of the Diversity Index will vary between 0 (no diversity) and 1 (high diversity). Values around 0.5 indicate that an area is relatively diverse. A healthy forest might have a Diversity Index of 0.7 or 0.8 while an agricultural field might have a Diversity Index of 0.02 or less.
 - How did the Diversity Index values vary from group to group? Note that the variety of beads is not the same from container to container. In other words, some habitats are more diverse than others.
 - Which habitat is the most diverse? (Assume that the container with the highest Diversity Index is the most diverse.)
 - Which habitat is the healthiest? Why are populations that are more diverse usually more stable? Why would a diverse population be more resistant to disease, predation, and invasion?
 - Which habitat seems to be dominated by one or two species of beads? What is the Diversity Index of that habitat? What kind of real-life habitat might this represent? (It might represent an area that has been planted for agriculture or an area that has been invaded by an invasive species.)
 - Assume two habitats have the same number of “species” of beads. One habitat is predominantly one species of bead with just a few beads of the other species. The other habitat has equal numbers of all the different species. Which will have the highest Diversity Index? (The habitat with equal numbers of each species will have the higher index. The number of different species [species richness] and the number of individuals of each species [species evenness] are both important measures of biodiversity.)
 - If you repeated the whole process with the same container of beads, do you think you would get the same results? (Probably not. This is why scientists often take several samples and average the results. If you have time, take three samples and average your results. You can also tally the entire container of beads and see how the Diversity Index of the whole compares with the Diversity Index of the sample.)

Plant Transect (Outdoors)

Students working in teams will randomly locate and establish a transect. They will count and identify the plants along the transect. Based on the amount, size, and diversity of vegetation, decide if students should count only those plants that actually touch the string or all plants that lie in the plane of the string. Give students a copy of *Conducting a Plant Transect* on page 104 as a reference during the field experience. Ideally, students should be familiar with the majority of plants they are likely to encounter. Review these plants with the students and assign letters to them prior to the field trip.

Diversity Index Calculations (Indoors or Outdoors)

1. **Determine the number of runs.** Ask students to group letters that are the same by drawing alternating lines above and below the letters. Count the number of changes or runs.
2. **Count the number of plants sampled.**
3. **Calculate the Diversity Index.** Use the following formula:
Diversity Index = number of runs / total number of plants
4. **Find the average Diversity Index for the site.** Instruct students to collect data from all transects studied at one site and compute an average for the location.

Discussion Questions

1. You calculated the diversity of the plants in the area. Can this number tell you anything about the diversity of insects, birds, mammals, or other organisms? (It wouldn't be accurate to say that all of these indexes would be identical. However, a diversity of plants offers other organisms a variety of foods and places to hide. Thus, a high diversity of plants usually results in a high diversity of the organisms that depend on them for survival.)
2. What are some of the limitations of the Diversity Index?
 - The Diversity Index is a snapshot in time. If you did the sampling at a different time of year, you might get different results.
 - A “weedy” area might score a high Diversity Index. While the area might have a wide variety of plants, these plants don't provide the same quality of habitat as a diversity of native plants. There are some variations of the Diversity Index that adjust for weedy and invasive plants. See the Purple Loosestrife Project: Cooperator's Handbook under *Finding Out More!* on page 103.

- The index depends on the skill of the person using it. Someone with more experience identifying or distinguishing between different kinds of plants might get different results.
 - This transect method does not do a very good job of finding and including rare plants.
 - There is the chance that the random selection of the sample area could have resulted in a slice of the habitat that was exceptionally diverse or exceptionally lacking in diversity.
3. We've focused on the human-caused losses of biodiversity (e.g., habitat destruction and introduction of invasive species). Are there any natural events that could alter the Diversity Index? (Storms, disease, cycles of predation, floods, and other natural disasters.)
 4. How do invasive species change the Diversity Index? (As invasive species crowd out native plants, some of the most sensitive species are lost first. The Diversity Index goes down as the number of invasive plants increases. The index goes down because there are fewer kinds *and* numbers of native plants.)
 5. What happens to the habitat as the plant diversity declines? (The variety of food and cover also declines. This means that fewer numbers and kinds of animals can find the things they need to survive. In other words, all aspects of diversity decline.)

Assessing the Learning

Use a rubric to evaluate students' work during this lesson. Evaluate students on how they worked in teams, how they approached and completed the task of counting plants along their transects, whether they could correctly identify different species (if required), whether they could record their data on meaningful charts, and whether they were able to calculate the diversity index.

Finding Out More!

This activity is adapted from the following activities:

Biodiversity, Wetlands, and Biological Control. Illinois Natural History Survey. 1999. See the activity "The Spice of Life: Assessing Species Diversity."

The Purple Loosestrife Project: Cooperator's Handbook. Michigan State University. 1998. See the activity "Annual Wetland Plant Diversity Survey."

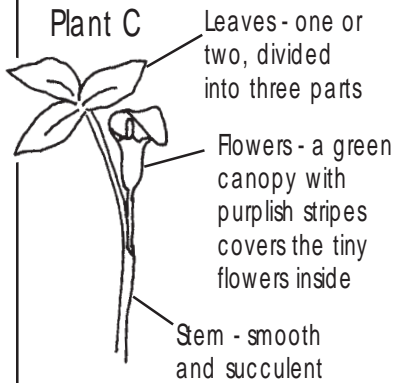
Windows on the Wild: Biodiversity Basics. World Wildlife Fund. 1999. See the activity "Insect Madness."

Conducting a Plant Transect

Follow these directions when you arrive at your sampling site.

1. Tie one end of your cord to one of the tent stakes.
 2. Push the tent stake into the ground at your team's designated starting point.
 3. Stretch the cord to its full length, being careful not to step on the plants that lie along the cord. You will be sampling these plants, so you don't want to disturb them!
 4. Tie the other end of the cord to the other tent stake and push it into the ground.
 5. Divide responsibilities among your team.
 - One person to identify plants along the transect.
 - One person to keep track of letters assigned to plants.
 - One person to record data.
 - One person to sketch plants the team cannot identify.
 6. Starting at one end of the cord, walk the entire transect and record each plant along the transect. Record the plants in order as you walk the line, counting all trees, shrubs, and herbaceous (non-woody) plants. Depending on the habitat, your teacher might instruct you to count only the plants that actually touch the line or to count all the plants in the plane of the line (i.e., above and below).
- Follow the directions given by your teacher to assign a letter (i.e., A, B, C, etc.) to each different kind of plant. Your teacher might require you to identify each plant or to draw pictures of each plant. Either way, you will record each plant by letter similar to the way you recorded beads in the warm-up activity.
7. When you reach the end of the transect, pull up your tent stakes and rewind the cord on the bobbin.

Sample Plant Sketch



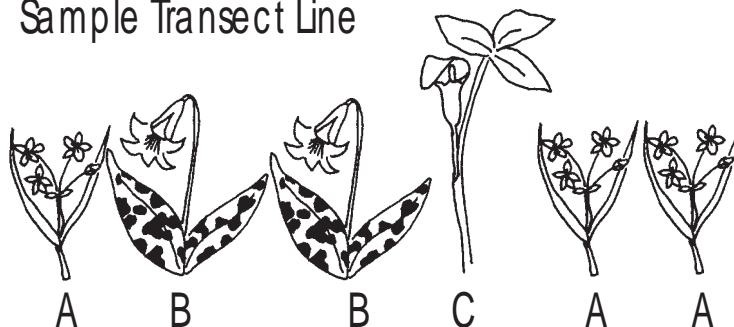
Sample Letter Assignment Chart

- A - white or pink flowers with grass-like leaves (spring beauty)
- B - yellow lillies with spotted leaves (trout-lily)
- C - large green flower with 3-part leaves (Jack-in-the-pulpit)

Sample Data Recording

A B B C A A

Sample Transect Line



Stand Your Ground

Method

Students will read quotes concerning invasive species from a variety of sources. They will identify the position of the writer, choose sides in a debate, and defend a position that might not be their own.

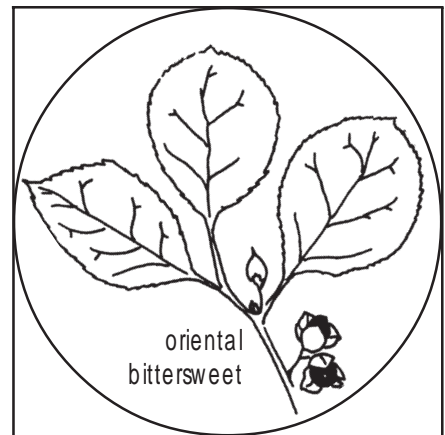
Introducing the Activity

In February 1999, President Clinton signed an Executive Order to combat this major environmental problem. “[N]ow is the time to take action,” remarked Interior Secretary Bruce Babbitt. “The costs to habitats and the economy are racing out of control.”

However, not everyone agrees on whether we should control invasive species, or which plants we should control, or how we should control them.

Doing the Activity

1. **Pass out the quotes and read.** Ask students to read the quotes and indicate next to each quote whether they think the writer is in favor of or opposed to controlling invasive species. **Optional:** Students can also cut the quotes apart and sort them into piles.
2. **Divide into small groups and discuss.** Ask students to compare how they categorized the quotes. Ask them to identify any quotes that were not definitely in favor of or opposed to invasive species control. Do the writers appear to be simply stating their viewpoints or are they trying to convince others of their viewpoints? What methods do some of the writers use to try to persuade others? What does the source of the quote say about its reliability? Can you assume that quotes from authors and professors are based on research, not opinions? Do you “trust” quotes from blogs as much as you “trust” quotes from elected officials?
3. **Prepare for debate.** Assign students to represent one side or the other of the following debate topic: “Should we control invasive plants?” Two students in each group should prepare arguments in favor of control and two students should prepare arguments opposed to control. Allow class time for students to research their positions. They may use the quotes as a starting point for their research.



Objectives

- Realize that there are a variety of viewpoints on any environmental issue.
- Express viewpoints that might be different from their own.
- Refine their personal positions on the control of invasive species.

Grades

9 – adult

Group Size

Small groups of 4 and whole class

Activity Time

Two 50-minute periods plus homework

Setting

Classroom

Materials

- Copy of quotes for each student (pages 107 – 108)
- Access to Internet

Connections

See next page.

Academic Standards

Grades 9 – 12

- English Language Arts: A.12.1, A.12.3, A.12.4, C.12.1
- Environmental Education: D.12.3, D.12.6
- Science: H.12.6
- Social Studies: C.12.8

4. **Practice in small group debates.** Ask the small groups to conduct mini-debates to test their arguments.
5. **Organize for whole class debate.** Allow all students arguing the same position to meet together. Encourage them to share their most persuasive arguments. Together, they should choose a captain, compile a list of debate points, and brainstorm rebuttals to the opposition's viewpoints.
6. **Conduct a debate.** Work with students to set the ground rules for your class debate.
7. **Invite students to share their personal views about invasive species control.** Discuss some of these questions:
 - Was it difficult to represent a viewpoint in conflict with your personal view? Why or why not?
 - Do you agree with any of the positions held by the “other side?” For example, if you think invasives should not be controlled, what are some of the arguments for control that you find convincing?
 - In your opinion, what are the most outrageous views held by either side in this debate?

Assessing the Learning

Take a personal stand. Ask students to write personal statements about whether they believe invasive plants should be controlled or not. Their statements should include the strongest arguments that support their positions. Their statements should also include the strongest arguments against their points of view and their rebuttals to those points.

Check out the local paper. Look for articles, features, or letters that focus on invasive species. Encourage students to respond to items in the local paper by writing letters to the editor.

Extending the Learning

Read one person's rebuttal. Ken Solis is part of The Park People of Milwaukee County. Read his responses to the arguments against invasive plant control. See pages 7 – 10 in **Invasive Plants of the Upper Midwest**.

<p>A few years ago, the state of Idaho floated the idea of poisoning all the rainbow trout in a large stretch of the upper Henry's Fork River, perhaps the most famous trout fishery in the world. After the rainbows were gone, Idaho Fish & Game wanted to restock the river with cutthroat trout, the river's original inhabitants, who had been out-competed over the years by stocked, and subsequently wild, rainbows. Depending on where their priorities lay, various anglers came out either for or against the plan. A friend of mine, who happens to be of Native American origin, offered what I thought was the most appropriate response. "I'm all for getting rid of the exotics," he told me, "as long as we don't stop with the trout."</p> <p>- Posted by tost at April 4, 2005 10:27 PM</p>	<p>Breeding populations of animals do move around even without human assistance, after all. This is a basic part of the natural history of life. It's the pace and scale of the phenomena that has changed, and that obviously has serious implications. But when ecosystems actually endure what we're told is a fatal threat, one has to wonder whether we don't need to be more discriminate and dispassionate about the phenomenon. Say, for example, the way that some places are trying to fight purple loosestrife and predicting environmental disaster if it gets established—but purple loosestrife has been around since the early 19th Century in the East Coast, with some complicated but hardly apocalyptic consequences.</p> <p>- Tim Burke, Swarthmore, history professor</p>
<p>The greatest service that can be rendered to any country is to add [a] useful plant to its culture.</p> <p>- Thomas Jefferson, 3rd president of the U.S.</p>	<p>Give a weed an inch and it will take a yard. Unknown</p>
<p>On a global basis...the two great destroyers of biodiversity are, first habitat destruction and, second, invasion by exotic species.</p> <p>- E.O. Wilson</p>	<p>In pushing other species to extinction, humanity is busy sawing off the limb on which it is perched.</p> <p>- Paul Ehrlich, Stanford University, Center for Conservation Biology</p>
<p>If suburbia were landscaped with meadows, prairies, thickets, or forests, or combinations of these, then the water would sparkle, fish would be good to eat again, birds would sing, and human spirits would soar.</p> <p>- Lorrie Otto, Wild Ones—Natural Landscapers, Ltd.</p>	<p>Alright, well, let me just ask you one sort of a somewhat philosophical question. Why not let nature take its course here? Let the food chain be the food chain, let Darwin take over, and just let this all play its course.</p> <p>- Miles O'Brien, CNN Anchor, September 22, 2002</p>
<p>It's hard to believe that there is nothing more than scientific concern about invasive species behind the current fashion for natural gardening and native plants in America—not when our national politics are rife with anxieties about immigration and isolationist sentiment. The garden isn't the only corner of American culture where nativism is in flower now.</p> <p>- Michael Pollan, <i>NY Times</i>, gardening writer, 1994</p>	<p>If a developer drains a wetland to build a shopping mall, it's a significant loss. But that shopping mall won't of its own accord expand and cover other wetlands nor will birds carry mall seeds one hundred miles and sprout new malls. Invasive species are alive. They reproduce so they'll be around indefinitely.</p> <p>- Robert Devine, <i>Alien Invasion</i></p>
<p>Despite America's status and strength as a super-power, the United States was tragically vulnerable to attack on 11 September 2001. That attack came not from cruise missiles, ballistic missiles, bombing, or other conventional weapons, but by unconventional asymmetric means. Today, the homeland is vulnerable to a different type of asymmetric attack, a biological attack from invasive species. We should act now to strengthen our defenses to protect ourselves from such attacks. Our future and our children's future might depend on it.</p> <p>- Colonel Robert J. Pratt, <i>Invasive Threats to the American Homeland</i>, U.S. Army, 2004</p>	<p>. . . science at its best carries the seeds of self-correction. It's worth noting that a century ago, the scientific community was more or less persuaded that introducing exotic species into ecosystems was a value-neutral event, if not actually a beneficial action for the ecosystem as a whole. It was agricultural scientists who introduced kudzu to the southeast, for instance, choosing it for the very characteristics of fast growth and hardiness that make it anathema today.</p> <p>- Posted by Chris Clarke at April 4, 2005 01:09 PM</p>

<p>The dichotomy of an Invasive Species Act is rooted in its very foundation. The environmentalists believe and profess that any species, plant or animal, which did not exist on this continent prior to the arrival of Christopher Columbus, is an “invasive species.” If one thinks deeply about this philosophy of “environmental hysteria”, one can see the similarities to “ethnic cleansing” in a third world nation. In essence, the environmentalists want to restore any plant or animal whose numbers have declined due to civilization and kill off species that weren’t here prior to Columbus. I am sorry, but their philosophy is clearly “ethnic cleansing” of our plant and animal world. - Jim Slinsky, <i>Ethnic Cleansing of our Plants and Wildlife?</i></p>	<p>While there are a few non-native species which are having a harmful impact in some areas of the country, the majority of plants and animals which have been introduced to America have been brought as crops, livestock and pets. As with our human population, America’s great plant and wildlife diversity is the product of centuries of migration, cultural exchanges and importation. While it is important to prevent and deal with harmful invasive species, federal regulators should not lump all non-native plants and animals into the same category with highly publicized cases like those of the snakehead fish, nutria and brown tree snake. - John Peterson, Pennsylvania congressional representative</p>
<p>The good news is that this is one environmental problem that we can do something about. I have seen the tremendous difference that even a few individuals can make in the battle to regain the land for native species. - Elizabeth J. Czarapata, <i>Invasive Plants of the Upper Midwest</i>, 2005</p>	<p>Our native landscape is our home, the little world we live in, where we are born and where we play, where we grow up, and finally where we are . . . laid to eternal rest. It speaks of the distant past and carries our life into the tomorrow. To keep this pure and unadulterated is a sacred heritage, a noble task of the highest cultural value. - Jens Jensen, landscape architect (1860 – 1951)</p>
<p>I don’t believe that any invasive species has ever been introduced into the United States on purpose by someone who willingly said, ‘Oh yeah, this is going to be a problem, but I don’t care.’ They’ve almost all been inadvertent problems that were introduced by someone who thought they were doing something good or who thought they were bringing in something beautiful. - Katherine Kennedy, Center for Plant Conservation</p>	<p>I have trouble with the concept of invasive species. If plant A can move in and thrive, and grow so successfully that weak plant B fizzles out and dies, isn’t that how it should be? I guess I don’t see how an organism being successful and thriving is a danger. I know the stories about rabbits in Australia and zebra mussels, etc. Y’all can spare me those. I still think things work out the way they should. - posted by waugsqueke, Dec 08 2003</p>
<p>Over the next 100 years or so as many as half of the Earth’s species, representing a quarter of the planet’s genetic stock, will either completely or functionally disappear. The land and the oceans will continue to teem with life, but it will be a peculiarly homogenized assemblage of organisms naturally and unnaturally selected for their compatibility with one fundamental force: us. Nothing—not national or international laws, global bioreserves, local sustainability schemes, nor even “wildlands” fantasies—can change the current course. The path for biological evolution is now set for the next million years. And in this sense “the extinction crisis”—the race to save the composition, structure, and organization of biodiversity as it exists today—is over, and we have lost. - Steven M. Meyer, “End of the Wild,” <i>Boston Review</i>, 2004</p>	<p>Why is it good to eradicate a highly used and appreciated non-native fishery like the introduced salmon in the Great Lakes while reintroducing native wolves that will spread across the country and wreak havoc with stock, pets, game animals, and human safety? Both the salmon and the wolf maintain themselves and interact with the habitat they find themselves inhabiting. Are the Great Lakes somehow poorer? Is the rapidly expanding wolf range somehow richer? The answer is no to each. Just as Asians “invaded” North America 10,000 +/- years ago and were then displaced by Europeans 500 +/- years ago, the environment changed. The environment or ecosystem was neither better nor worse, only different. - Jim Beers, retired United States Fish and Wildlife Service employee</p>

How to Kill a Dandelion

Method

Students will try to kill all the dandelions in their test plot without harming nearby plants.

Getting Ready

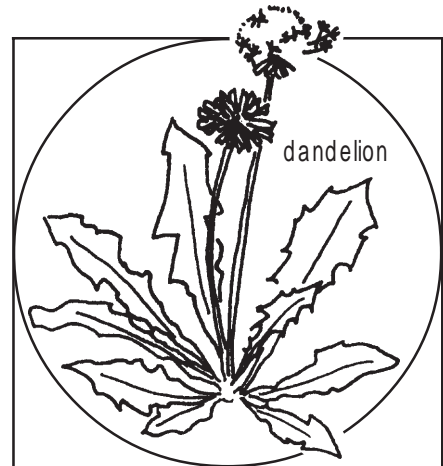
1. Find a location that can be used for experiments. The location should have an abundance of dandelions. It should be off the beaten path, yet easily accessible. Be sure to get permission to conduct the experiments. Alert maintenance staff not to use “weed and feed” or other lawn treatments in the study area. Alternatively, students could work individually or in pairs on test plots in their own lawns. The advantage is that they can observe the test plots more easily; the disadvantage is that it will be more difficult for you to monitor progress.
2. Mark off an area for each group of three to four students. Use tent stakes or wooden posts for temporary markings, or borrow equipment used to paint lines on sport fields for a more complete grid.

Introducing the Activity

Homeowners and farmers know how hard it is to kill a dandelion. Their deep taproots, fast growth, and numerous seeds make them formidable opponents. While dandelions are not considered an invasive plant, they are convenient and serve as ideal experimental plants for discovering the challenges of controlling the growth and spread of invasives.

Doing the Activity

1. **Investigate dandelions.** Encourage students to find out all they can about dandelions. They will need to know how to identify dandelions at several different life stages (e.g., seedling, mature plant, flowering plant, plant that has gone to seed). In order to successfully eliminate dandelions, students will need to know about the plant’s strengths and weaknesses. You can use the information on page 112 as a supplement. To help younger students learn about dandelions, read *The Amazing Dandelion* by Millicent E. Selsam.
2. **Divide into groups of three to four students.**
3. **Visit the study site and assign plots.** Don’t forget to set aside several test plots as controls.



Objectives

- Design a simple experiment using the scientific method.
- Discover some of the variables that affect the control of invasive species.

Grades

2 – 12

Group Size

Small groups of 3 – 4

Activity Time

One or two 50-minute periods for experimental design, monitoring for several weeks

Setting

Outdoors

Materials

- Copies of *Meet the Dandelion* (page 112)
- Tent stakes and string to mark test plots
- Writing boards, lab notebooks, pencils
- Weed diggers
- Other tools or materials that groups need to conduct their experiments (approved by teacher!)

Connections

See next page.

Academic Standards

Grades 2 – 4

- Environmental Education: A.4.1, A.4.2, B.4.6
- Science: B.4.1, C.4.2, C.4.3, C.4.5, C.4.6, F.4.1, F.4.2, F.4.3

Grades 5 – 8

- Environmental Education: C.8.2
- Science: C.8.1, C.8.2, C.8.3, C.8.4, C.8.5, C.8.6, C.8.7, F.8.2

Grades 9 – 12

- Science: C.12.1, C.12.3, C.12.4, C.12.5, F.12.8

4. **Complete preliminary observations.**
 - Map the test plots. If you have access to a digital camera, take overhead pictures showing the distribution of dandelions in the test plots.
 - Count the number of dandelions and/or measure the area that dandelions cover within the each plot. You may want to count mature plants and seedlings separately.
5. **Ask a research question.** For example, “How can you remove all dandelions from your test plot without using chemicals or harming other vegetation?”
6. **Develop hypotheses.** Remind students that a hypothesis is a guiding statement that is well defined and testable. Each pair of students should come up with an age-appropriate statement. For example, second graders might state, “If we dig all the dandelions out by the root, then the dandelions will die.” High schoolers might state, “If we remove the leaves from all dandelion plants, then the percent cover will be decreased by 50% after 3 weeks.”
7. **Discuss variables.** As a class, brainstorm a list of variables for the experiments. Variables are anything that can affect the outcome of the experiment. There will be some variables that you can’t control in an outdoor setting (e.g., rain or drought, seasonal changes, and lawn treatments before the experiment began).
8. **Design and begin the experiment.** As a class, set experiment start and end dates. Students should provide you with a detailed procedure and a materials list. Pending approval, they should assemble the materials and supplies for their experiment, conduct the experiment, and design a data collection process. With younger students, work together as a class to design and conduct the experiment. **Optional:** You may want to add a couple of test plots that demonstrate the use of chemicals designed to kill dandelions. Follow package directions and apply when students are not present.
9. **Document the experiment.** Students should track the progress of their experiments. They should note observations, measurements, and changes they made to the procedures.
10. **Measure success.** How do the test plots compare with the control plots? Did the number of dandelions decrease or increase in the test plots? How did the percent cover change from the start to finish?
11. **Organize data and draw conclusions.** Were hypotheses supported or refuted? What factors influenced the outcomes? Were there any unexpected results? List sources of errors or variables that were overlooked. Compile data in tables and graphs.
12. **Write lab reports and/or share results with class.**

Assessing the Learning

Ask each student to write a lab report stating the hypothesis, procedure, data, results, and unanswered questions of the experiment. Younger students can share the results of their experiments orally with the class.

Extending the Learning

Write the Guinness Book of Dandelions. Add a little competition to your investigation. Keep track of amazing dandelion records such as:

- Flowerhead with the largest number of seeds.
- Root with the greatest diameter.
- Longest root removed with a weed digger.
- Largest number of leaves for one plant.
- Longest single leaf.
- Longest flower stem.

Grow dandelions! Conduct an experiment for growing the largest or the most dandelions in a plot of lawn without using any chemicals. Encourage the students to “think in reverse.” They might try things like removing all other vegetation, disturbing the soil, planting dandelion seeds, or adding natural fertilizers.

Play dandelion games. Non-native plants are not all bad. Dandelions brighten the days of many people and can be used in these playful ways:

- Use dandelion flowers to make chains.
- Blow bubbles through the hollow flower stems.
- Eat dandelion leaves in salads. Be sure to try this before the plant flowers!
- Curl the ends of flower stems by splitting the sides of the stem and placing them in water.

How to Kill a Dandelion

Possible ways to kill all the dandelions in the test plot with minimal disturbance to surrounding plants:

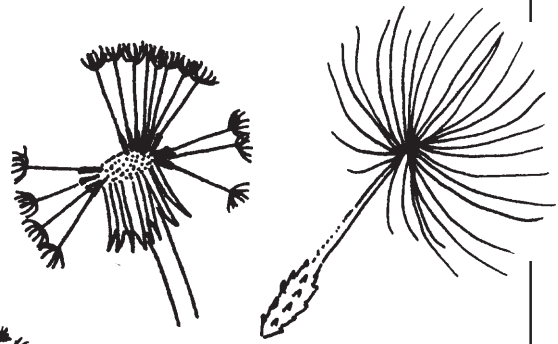
- Use weed diggers to remove dandelions and roots. Experimental design might include soaking the test plot with water before removing dandelions. This will soften the ground and make removal of more of the root possible. Possible complications: If part of the root remains, the dandelion will probably grow back.
- Sever the dandelion roots below the surface and remove the leaves and top of the root. Possible complications: If part of the root remains, the dandelion will probably grow back.
- Remove all the leaves from the dandelion. Put a small disk on top of the root to block sunlight. Possible complications: Energy stored in the root could still allow leaves to develop.
- Remove seedheads and do not allow the dandelion to reproduce. Problems: Dandelions are perennials. Since the energy stored in the root would need to be depleted, it could take a long time to kill a dandelion in this way.
- Kill the root with heat. Possible complications: Surrounding plants might also be damaged.

Meet the Dandelion!

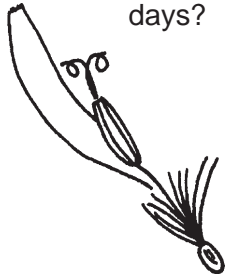
Taraxacum officianale

Dandelions are perennials. In fall, the leaves and flowers may die, but the root lives on underground.

The **flowerhead** is made up of many individual flowers like this one. Why do dandelion flowers close in the evening and on cloudy days?



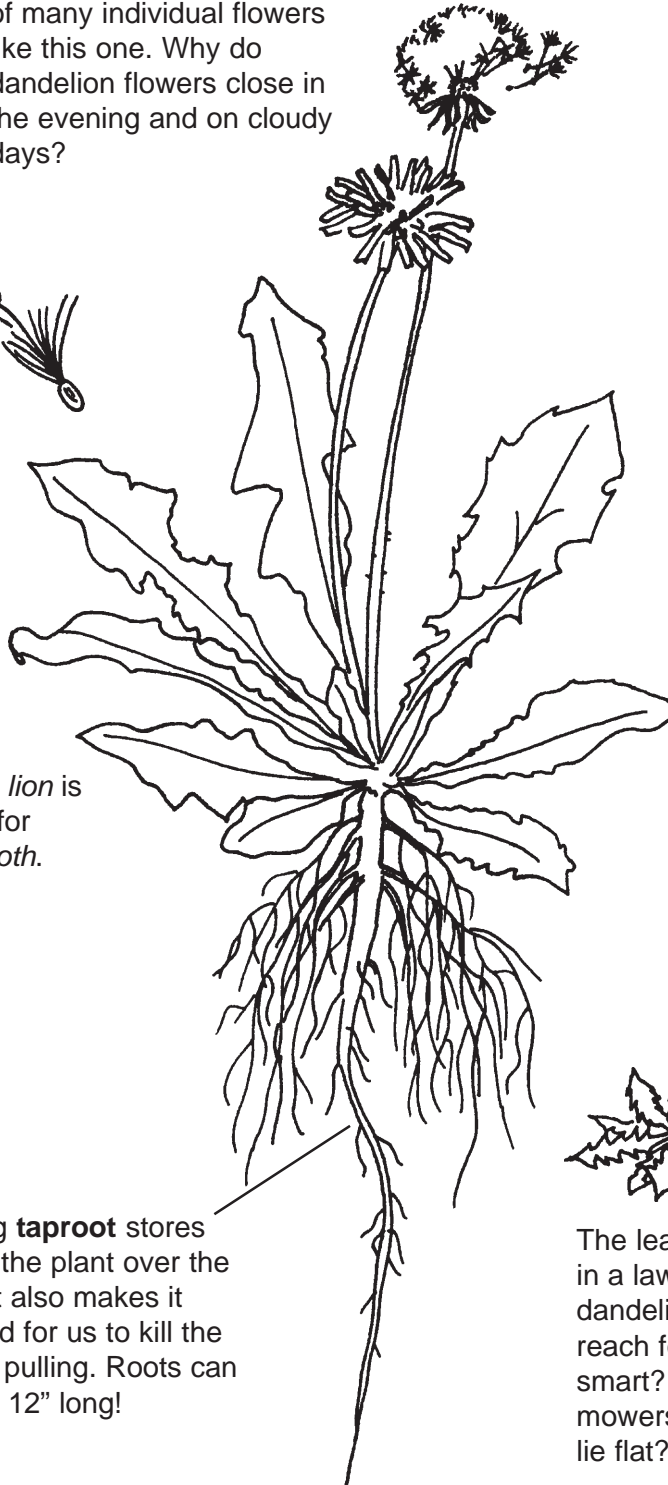
Seeds are designed to fly far from the parent. How many seeds are there on each flower head?



Yum, yum! Young dandelion leaves taste good in salads. You can scrape and boil the roots like potatoes. Some people even make wine from dandelion flowers!

Dent de lion is French for *lion's tooth*.

The long **taproot** stores food for the plant over the winter. It also makes it very hard for us to kill the plant by pulling. Roots can be up to 12" long!



The leaves of dandelions growing in a lawn lie flat. The leaves of dandelions growing in tall grass reach for the sun. Are they smart? Do they "know" lawn mowers can't reach them if they lie flat?

Checking Out the Options

Method

Students will list the different ways invasive plants are controlled and find out more about mechanical controls that they can do.

Getting Ready

1. Obtain Wisconsin Wildcards. See *Finding Out More!* on page 114.

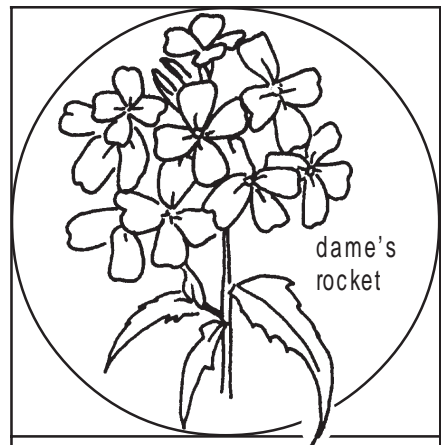
Introducing the Activity

Once you know that you have an invasive plant and decide that you want to get rid of it, you must figure out the best way to accomplish your goal. Fortunately or unfortunately, there are many options available. It's often difficult to determine which one is best for your circumstances (i.e., species, degree of infestation, habitat, soil conditions, presence of native plants, resources, time of year, tools, and/or number and age of volunteers).

Use this lesson to introduce the options available to you and your students. Then, use **Invasive Plants of the Upper Midwest** along with help from area resource specialists to determine a control plan for your situation.

Doing the Activity

1. **Pass out Alien Invaders Wildcards.** Allow time for students to read the backs of the cards. If the cards are not available, assign each student an invasive plant and ask them to find out how the plant is managed.
2. **Brainstorm a list of control methods.** Look for control methods on the back of each card listed under "Management." Ask students if their cards list one or more control methods.
3. **Introduce the concept of Integrated Vegetation Management.** Use the information on page 11 of **Invasive Plants of the Upper Midwest** to introduce this topic. See pages 115 – 116 for advantages and disadvantages of each method.
4. **Check out manual or mechanical control methods.** Look back at the list of control methods that you listed in step 2. Circle the manual control methods that students can do.



Objectives

- List methods used to control invasive plants.
- Identify methods that they can safely use.
- Understand the rationale behind Integrated Vegetation Management.

Grades

5 – 12

Group Size

Individuals or small groups

Activity Time

One 50-minute period

Setting

Classroom

Materials

- Wisconsin Wildcards – Alien Invaders (18 plant cards)
- **Invasive Plants of the Upper Midwest**

Academic Standards

Grades 5 – 8

- English Language Arts: F.8.1

Grades 9 – 12

- English Language Arts: F.12.1
- Environmental Education: D.12.3
- Science: F.12.8, H.12.5, H.12.6

Depending on their age, students could control invasive plants by:

- Pulling by hand.
- Pulling with tools (e.g., using Weed Wrenches or Tug-a-Suckle ropes).
- Cutting (e.g., using saws or pruners).
- Beheading (e.g., using scissors or pruners).
- Severing roots (e.g., using a Parsnip Predator).
- Girdling.

5. **Fine tune control methods.** Mechanical controls alone will rarely kill an established population of an invasive plant. Most resource managers combine two or more methods to conquer. Not only that, they time their control efforts to when the plant is most vulnerable. For example, the best time of the year to control buckthorn is late fall when native plants are dormant and the buckthorn sap is flowing downward. At this time, cutting the shrub and painting the cut stump with herbicide can be very effective.

Assessing the Learning

Ask students to work individually or in small groups to research control methods for an invasive plant. Try to select plants that you know are problems in your area or your school forest. Students should use print and Internet resources. Instruct them to note if one or more control methods are recommended and if those methods are to be used together, consecutively, or in rotation. Remind them to consider the plant's life cycle when determining the most effective time to implement control methods. Ask students to present their information. Discuss whether all the sources agree on all aspects of control. Why would different sources recommend different practices? When using the Internet, be sure students record the source of information. Is the source reliable? Is the source local?

Finding Out More!

Wisconsin Wildcards. Wisconsin Department of Natural Resources. 2005. Invasive plant Wisconsin Wildcards are available at WDNR Service Centers or by calling Endangered Resources at (608) 266-7012. For a list of Wisconsin Wildcards available in classroom sets and an order form, visit this Web site. <www.dnr.wi.gov/education/pdf/wildcard.pdf>

Invasive Species: Plants. Wisconsin Department of Natural Resources. 2005. Online listing of invasive plants and control methods. Photo gallery. <www.dnr.gov.wi/invasives/plants.htm>

invasivespeciesinfo.gov. United States Department of Agriculture. 2005. The species profiles at this site include links to Web pages and pdf files sponsored by the federal government, state governments, and universities. <www.invasivespeciesinfo.gov>

How to Control Invasive Plants

Cultural Controls

Cultural controls involve changing the environment to eliminate the opportunity for non-native species to dominate an ecosystem or to give native species an advantage over non-natives. Cultural controls include:

- Educating people.
- Encouraging actions that minimize the spread of invasive species.
- Changing the environment so that it is not suitable for the invader.
- Manipulating water or soil chemistry to favor the growth of native species.
- Using fire to suppress invasive plants or encourage native plants.

Advantages

- Prevention is by far the most cost-effective way to control invasive plants.
- Everyone can participate in preventing the spread of invasive plants.

Disadvantages

- Changes in the environment (e.g., floods, drought, and fires) can create extreme conditions that kill both native and invasive plants.
- Cultural controls occasionally accelerate the invasion, rather than eliminate it.

Biological Controls

Biological controls involve the encouragement or introduction of control agents specifically tested to control an invasive species. Biological controls include:

- Introducing animals (usually insects) that will feed on the plant.
- Introducing parasites to weaken a plant.
- Introducing disease organisms (i.e., bacteria, viruses, or fungi).

- Encouraging the populations of biocontrol agents already present in an area (e.g., encourage populations of native insects).
- Encouraging succession (the normal process in which dominant plant species change as an ecosystem matures), so that native vegetation has a better chance of outcompeting non-native vegetation.

Advantages

- Biological control is perceived as progressive and environmentally friendly.
- Once the protocol is in place, biocontrols are relatively cheap and easy to implement.
- No chemicals are introduced into the environment.
- Widespread control is possible.
- Control is essentially permanent.

Disadvantages

- Biological control is a slow process. It can be years before the density of the biocontrol agent reaches the point where it makes a significant change in the invasive plant population.
- Testing of biocontrol agents is expensive and can take many years.
- Biological control can slow the spread of an invasive, but generally cannot eradicate the infestation.
- Even though biocontrol agents go through extensive testing, there is a risk in introducing one non-native species to control the population of another non-native species.



Mechanical Controls

Manual or mechanical controls result in physical damage to invasive plants.

Mechanical controls include:

- Pulling invasives by hand.
- Removing invasives with chain saws, pruners, or loppers.
- Mowing (both rotary and flailing).
- Discing or tilling with heavy equipment.

Advantages

- Removal can be very selective, affecting only the target species.
- Timed correctly, mechanical control can be very effective against some plants.
- People of all ages can be involved in management projects.
- Control can be very cost-effective if volunteers participate.
- Combined with chemical control, this method can be very effective. For example, cutting down invasive trees and treating the stumps with herbicide is more effective than either control method used alone.

Disadvantages

- Removing plants from large areas is labor-intensive. Without volunteers, the costs can be prohibitive.
- Native plants can be trampled during the removal process.
- Soil can be disturbed during the process, allowing opportunities for the establishment of the same or different invasive plants.
- Often control methods need to be repeated several times before plants are killed or eliminated.
- Mechanical control stimulates growth of some invasive plants.
- Equipment must be cleaned between sites to prevent moving invasive plant seeds and other plant parts into new areas.

- Mechanical control must be timed to the plant's life cycle. Sometimes the best time to control a plant is a narrow window.
- Pulling weeds may slow the *spread* of weeds, but it does not alter the conditions that first favored the invasion.
- Many of these methods are not specific to the invasive weed. For example, machinery typically cuts, chips, and grinds everything in its path, including native plants, insects, small mammals, birds, and reptiles and amphibians.

Chemical Controls

Chemical controls use herbicides to kill target plants. Chemical controls include:

- Using herbicidal sprays on leaves.
- Painting the stumps of cut trees and shrubs with herbicides.
- Injecting herbicides into trunks and stems.

Advantages

- Herbicides usually kill the target plants with one treatment.
- Herbicides are readily available.
- Herbicides can quickly be applied to target plants.
- Applying herbicides requires less labor than manual control methods.

Disadvantages

- Nearby desirable plants may be killed too.
- Herbicides and herbicide application can be expensive.
- Applicators must be certified and licensed to apply herbicides in some areas.
- Some herbicides could harm wildlife and/or contaminate water sources.
- Some herbicides can persist and accumulate in the environment.

Shears, Sawbuck & Co.

Method

Students will understand that new problems inspire new inventions. After looking at a tool catalog featuring weed-killing devices, they will investigate the special tools designed for use against invasive plants.

Getting Ready

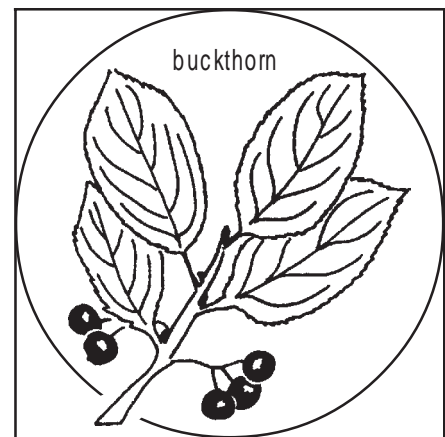
1. Gather as many different kinds of can openers as possible.
2. If possible, obtain traditional weed removal tools (e.g., hoes, shovels, pruners, saws) and new tools specifically for removing invasive plants (e.g., parsnip predators, honeysuckle poppers, dandelion diggers, etc.).

Introducing the Activity

If you're going to do something over and over, a specialized tool will save you time and frustration. Most of us would laugh at an automatic egg peeler until we had to peel hundreds of eggs every day! Think of how much easier it would be if you used the right tool for the job. The need to efficiently and effectively remove invasive weeds has spawned a surge in weed-killing devices!

Doing the Activity

1. **Talk about the need for tools.** Show the students a tin can. Explain that the tin can was invented in 1810, but the first can opener wasn't invented until 1858! The inventor of the tin can was a genius when it came to preserving food, but he didn't have a plan for getting the food out of the can. Instructions on the original cans read: "Cut round the top near the outer edge with a chisel and hammer." It wasn't until almost 50 years later that manufacturers made the metal on tin cans thin enough to allow safe and easy opening.
2. **Think about the demand for specialized tools.** Ask students to list different kinds of can openers that they have used (e.g., cutting wheel can openers, pocket knife can openers, electric can opener, and bottle/can opener combination tools.) **Optional:** As they mention different can openers, show examples.
3. **Think about the need for diversity in tools.** All of these can openers represent different solutions to the same problem. Ask some of these questions:
 - What need do these objects all fill? How are they alike and how are they different? Is one better than the others?



Objectives

- Become aware of how tools and gadgets fill a need.
- Realize that new problems encourage entrepreneurs to invent new solutions.
- Invent, test, market, or evaluate a tool to mechanically remove an invasive plant.

Grades

5 – 12

Group Size

Pairs or small groups

Activity Time

Two or three 50-minute periods

Setting

Classroom

Materials

- Tin can
- Can openers (the more models, the better!)
- Copy of *Shears, Sawbuck & Co.* for each student (page 119 – 120)
- Optional: weed removal tools

Connections

See next page.

Academic Standards

Grades 5 – 8

- Science: G.8.4

Grades 9 – 12

- Science: G.12.3, G.12.5
- Social Studies: D.12.10

Scout Connections

- Cadette and Senior Girl Scouts: Inventions and Inquiry

- How many of these can openers do you have at your house? Why? Can you think of situations that would make the most advanced can opener useless?
4. **Connect to invasive plant removal.** Explain that when a new problem comes along, such as the need to remove invasive plants efficiently and effectively, there will be people ready to invent solutions.
 5. **Brainstorm a list of available tools that could be used to kill invasive plants.** Be sure to consider both herbaceous and woody plants. Your class list might include: hoes, shovels, pruners, saws, weed diggers, and lawn mowers.
 6. **Think about demand for specialized tools.** From what you know about controlling invasive plants, can you think of any special needs that might be filled by a special tool? Try to come up with a list of problems associated with controlling invasive plants. Your list might include:
 - Some invasive plants have very deep taproots.
 - Invasives in wet areas are difficult to get to.
 - Some invasive plants cause severe dermatitis when touched.
 7. **Pass out copies of the tool catalog page.** The catalog pages are modeled after the 1897 *Sears, Roebuck & Co. Catalogue*. That catalog featured everything a person could need or want: familiar items, improved products, and things that people didn't even know they needed! Ask students to look over the tools and talk about the ones that are most interesting to them.
 8. **Divide into small groups and decide on a tool-related project.** Caution: Students should concentrate on mechanical removal and not use any herbicides in their testing or inventing. Students could:
 - Develop a marketing campaign for one of the existing tools.
 - Construct/purchase and test an invasive plant removal tool. Write a review!
 - Invent a new tool that solves an invasive plant control problem. Choose a local invasive that is easy to experiment with.
 - Evaluate the tools in terms of impact on the environment. Are any doing more harm than good?

Assessing the Learning

Ask students to develop a rubric for grading individual projects. Rubrics should be approved before work on the project begins. They should include research, development, and presentation.

Finding Out More!

Tools of the Trade. The Nature Conservancy. 2005. Online tool reviews. <www.tncweeds.ucdavis.edu>

Shears, Sawbuck & Co.

We have spared no pains in selecting a line of tools that we can guarantee in every respect. These tools are crafted by the best companies and brought to you by our dedicated salesmen. Place your order with us and you will not be disappointed.

No. 2619 Red Dragon Torch

We are happy to offer this product from Flame Engineering. Kit includes torch, propane tank, and backpack. Free shipping.
Price, each **\$234.00**

No. 3404 Pulaski

You'll find nothing better for chopping, grubbing, and digging. Head weighs 3.5 pounds. The handle is perfectly sized at 32".
Price, each **\$54.37**

No. 3457 Parsnip Predator

The Prairie Enthusiasts now offer this new innovation to you through our catalog. Cut off those roots right below the ground.
Price, each **\$30.00**

No. 2698 EZject Lance

Deliver quick results with minimal effort on your part. Simply push the lance against the offending tree to inject an herbicide-filled capsule. From Odum Processing Engineering Consulting, Inc.
Price, each **\$425.00**
Price, 4800 brass capsules ... **\$425**

No. 4556 Weed Twister

This contraption is too good to pass up. No bending, stooping, or kneeling - just twist weeds out of the ground. From Ergonica.
Price, each **\$20.12**

No. 4534 Clint's Dandy Digger

This dandelion remover is destined to supercede all other weeders. Get rid of all your tap-rooted weeds. From Clint Jones.
Price, each **\$32.44**

No. 66732 Dandelion Drill

You can't afford to go without this unique drill bit. Spare the expense of chemicals. Note: Drill not included. From Forevergreen.
Price, each **\$16.95**

No. 2690 Punto

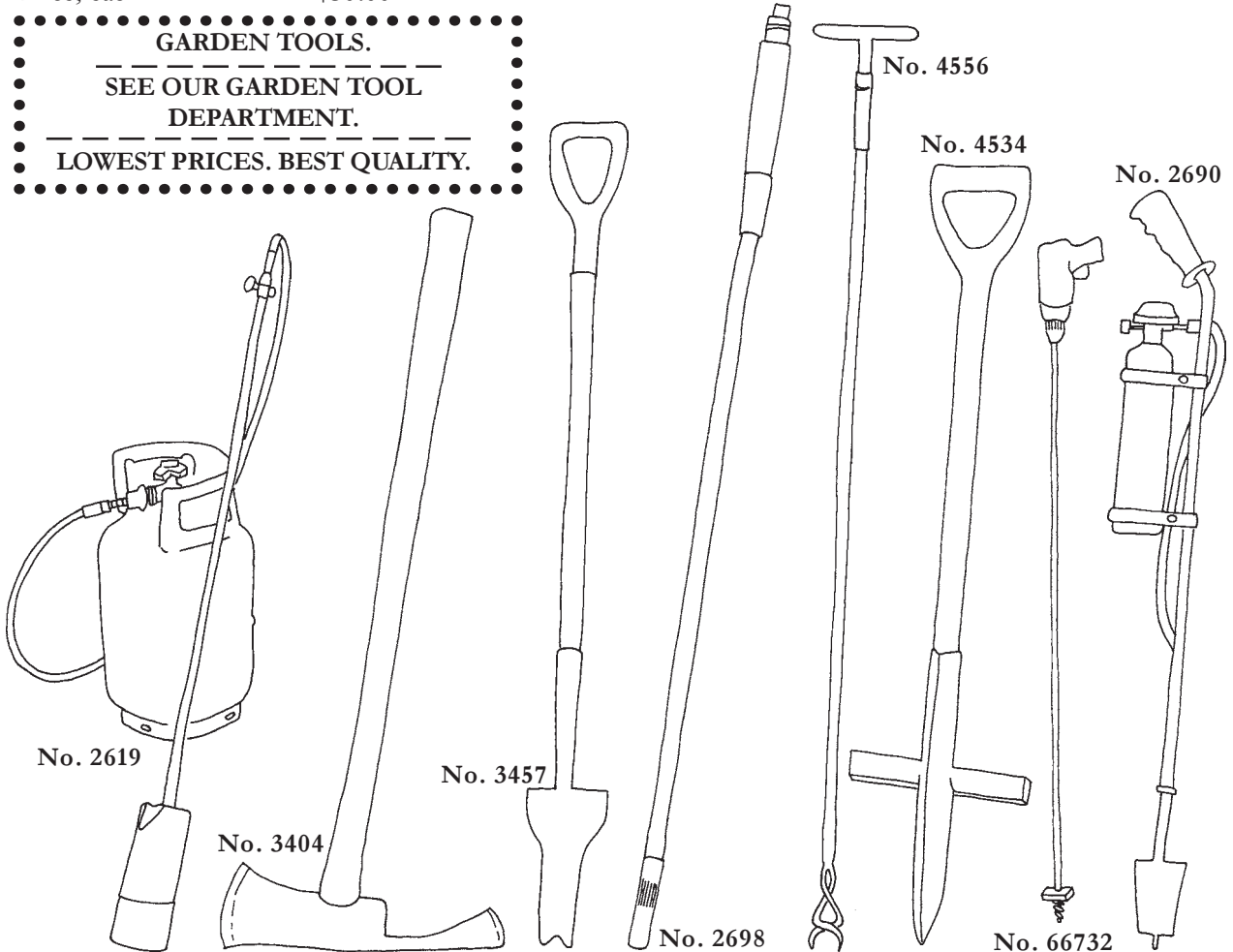
This handy mechanism delivers heat right to the root of your problems. The Punto's thermal element heats to over 1000° Celsius. From Forevergreen.
Price, each **\$195.00**

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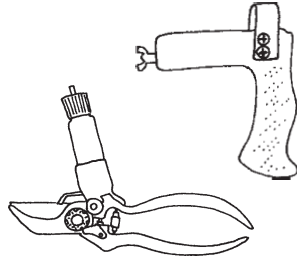


No. 1225

No. 2233



No. 2234



No. 7755

No. 2235

No. 3452 Gloves

In our experience, everyone from gardeners to railroad men can agree on these soft, yet sturdy gloves.

Price, each, \$5.84, dozen \$70.09

No. 2233 Pruners

We recommend buying two of these essential items. Not recommended for shearing sheep.

Price, each \$10.50

Price for two \$21.00

No. 1225 Cattail Knife

We have cleverly patented a new usage for a plain, old carpet knife. Cuts cattails like butter.

Price, each \$8.56

No. 2234 Kut-N-Kill Pruners

Combines all the latest improvements. No need to go back to treat with herbicides. Cut, then apply a drop of herbicide from the reservoir. From E cubed B Squared Farm Services.

Price, each \$39.89

No. 2235 KlipKleen Shears

A widget attached to your shears holds a cartridge of herbicide. As you cut, herbicide is applied to the cut surface. Shears not included. From A.M. Leonard.

Price, each \$17.44

No. 7755 The Ringer

You will find this very simple apparatus easy to use for all your tree girdling needs. From JMC Forest Maintenance Ltd.

Price, each \$189.90

UNCLE SAM MAKES IT EASY FOR YOU TO BUY BY MAIL.

No. 11200 Honeysuckle Popper

Don't let the name deceive you, this exemplary instrument can be used in the excising of countless invasive bushes. From Mr. Honeysuckle.

Price, each \$120.00

No. 1133

Cut-Stump Herbicide Wand

A thoroughly practical way to dispense with your weeds without a drippy mess. Do-it-yourselfers will appreciate Jack McGowan Stinski's low cost invention.

Price, each \$20.05

No. 11344 Weed Wrench

This tool gives the best of satisfaction, as it combines the economy of time, labor, and expense of materials. Comes in 4 sizes to uproot trees and shrubs up to 2 1/2" in diameter. From the Weed Wrench Company.

Prices \$82, \$130, \$155, \$189

No. 3899 Bow Saw

Anyone can sell a satisfactory saw, but our time-tested model is the best on the market.

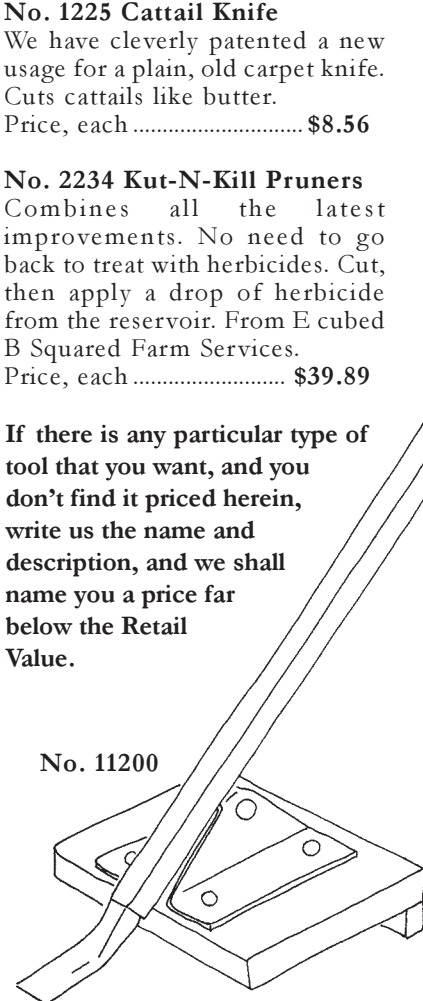
Price, each \$13.10

No. 3877 Loppers

Best loppers ever made at anything like the price. 24" ash handle and steel cutter.

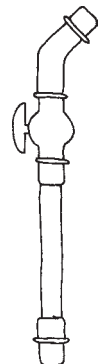
Price, each \$24.53

If there is any particular type of tool that you want, and you don't find it priced herein, write us the name and description, and we shall name you a price far below the Retail Value.

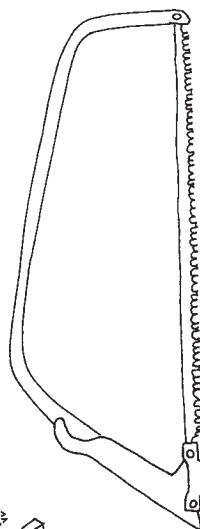


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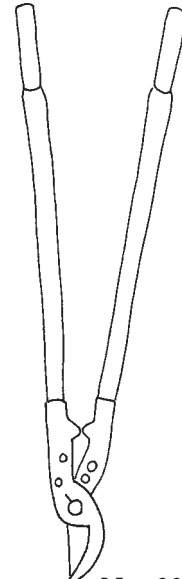
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Weed Out!

Method

Students will plan and implement a strategy to manually remove invasive plants.

Getting Ready

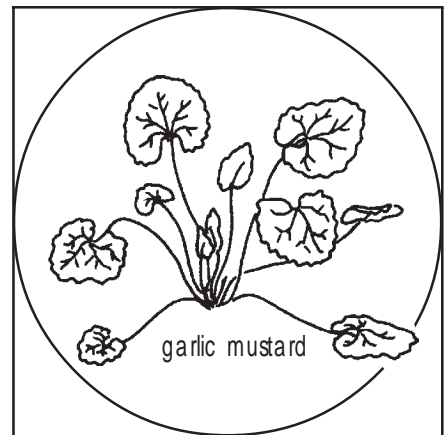
1. As you plan a control project, consider these things:
 - Age and abilities of the students.
 - Availability of appropriate tools.
 - Plant sensitivities. Be sure the plants you intend to control are safe (i.e., avoid plants that can cause rashes). Remember that some people are hypersensitive!
 - Safety of the site. Check out the site ahead of time to be sure there aren't any safety hazards (e.g., broken glass, garbage, poison ivy, hornet nests, etc.).
 - Preparedness of the students. Review how to dress for success (i.e., long pants, long sleeves, sturdy shoes, water bottles, sunscreen, mosquito repellent).
 - Tool/equipment safety. If you are using tools, be sure students know how to use them safely, when to wear safety glasses, and where to place tools when done.
 - Follow-up treatment. If an herbicide application is needed after cutting trees and shrubs, make arrangements for qualified adults to accomplish the task within the recommended time limits.
2. Read pages 11 – 14 of **Invasive Plants of the Upper Midwest** for information on general control considerations. Species-specific information is found throughout the book.

Introducing the Activity

This is the capstone activity! You've tracked down and identified invasive plants. You've collected, pressed, and documented. Now it's time for you and your students to get your hands dirty!

Doing the Activity

1. **Find a site to adopt.** Ideally, you would carry out this project in the area your class has been investigating. You have identified the invasives in this area. You have records of their populations and can monitor the effectiveness of your control methods.
2. **Decide if your project will be site-specific or species-specific.** In other words, you can choose to try to eliminate all the invasives in an area or to eliminate all the plants of a particular species. If this is your first project of this kind, you should probably concentrate on one species.



Objectives

- Research appropriate control measures for a local invasive plant.
- Participate in an invasive species removal project.

Grades

K – adult

Group Size

Small groups

Activity Time

Varies with project

Setting

Outdoors

Materials

Varies with project

Connections

See next page.

Academic Standards

Grades K – 4

- Environmental Education: D.4.1, D.4.6
- Science: B.4.1, F.4.2, F.4.3

Grades 5 – 8

- Environmental Education: B.8.10, D.8.5, D.8.6

Grades 9 – 12

- Environmental Education: D.12.5
- Science: H.12.5

Scout Connections

- Boy Scouts: Fish and Wildlife Management
- Brownie Girl Scouts: Earth Is Our Home
- Junior Girl Scouts: Eco-Action, Outdoors in the City
- Cadette and Senior Girl Scouts: Eco-Action, Wildlife

3. **Research.** Assign students to find out as much as they can about the plant/s in the area. What is the extent of the infestation? What are the recommended control measures? If you did the activity *Checking Out the Options* on pages 113 – 116, this step is already done.
4. **Plan a strategy.** As a class, decide which control method to use, what materials or tools you need, what time of year to conduct the control, and how often you should repeat the control measures. Don't be afraid to ask for help at this stage!
5. **Do it!** See ideas on page 123 for making the *work* more fun.
6. **Follow through.** Monitor the area as long as possible and schedule additional work days if necessary. Don't just monitor the invasive plants; investigate the impact your project has on other plants and animals at the site.

Assessing the Learning

Assess students' ability to work together to accomplish a common goal. Set age-appropriate expectations and criteria to help students monitor their own participation and behavior during the project.

Extending the Learning

Keep a classroom scrapbook. Detecting, preventing, controlling, and monitoring invasive species may have been a big part of your year! Now it's time to preserve the thoughts, findings, experiences, and memories in a classroom scrapbook. Together decide what your scrapbook will include. See a list of possibilities on page 124. Encourage each student or pair of students to select an idea, day, project, species, or some specific topic to develop. Set aside a day to invite parents and volunteers that have worked with you to unveil the class scrapbook. Be sure that students consider these things while designing their pages:

- Title each page with catchy words or phrases.
- Select photos, sketches, or other illustrations to accompany the themes of the pages.
- Include leaf rubbings, twigs, pressed flowers, or other natural items, if appropriate.
- Write notes, captions, and stories using complete sentences and correct grammar.
- Choose appropriate colors, borders, backgrounds, graphics, and lettering to help tell the stories.
- Use archival, acid-free papers, glues, and inks whenever possible.
- Store pages in sheet protectors or laminate to protect.

More than a Weed Pull

Students might need a little fun thrown into their invasive control project. Consider some of these ideas:

Tug a Suckle

Put a rope around the base of a honeysuckle shrub and have a tug of war with a plant! How many people does it take to yank the shrub out of the ground – roots and all? The tug-a-suckle rope is a one-half inch rope about 20 feet long. Tie a rock-climbing carabiner to one end and stagger knots throughout the rope for tuggers to hold onto. Wear gloves!

Pile Up the Plants

Divide into teams. Lay down a large tarp for each team. Which team has the biggest pile of invasives after 10 or 20 minutes of pulling? If laying down a tarp would damage desirable vegetation, count the number of full garbage bags per team.

Search and Destroy

(This technique works well with garlic mustard and other forbs that spread by seed.) Often there is a central area of infestation surrounded by isolated plants. Arm participants with flags or flagging tape. Form a search line and move through the survey area together. Each time students find invasive plants, they should destroy them and mark the spots with flags. The flags will allow your students to return to the area and watch for signs of regrowth.

Have a Contest

When pulling plants with taproots, have a contest to see who can pull out the longest intact root. Brainstorm other possible challenges (e.g., plant with the most flowers/seeds or tallest plant).

Acknowledge the Hidden Costs of Invasives Control

Count the number of mosquito bites or scratches after a pulling party. Give the winner a certificate or simple prize.

Sing with the Buckthorn Busters

Join the Buckthorn Busters in their marching chant. Sung to the tune of *This Old Man*.

Buckthorn scum! Buckthorn Scum!
We will get you one by one
With a knick knack, paddy whack
Pull it from the ground
Buckthorn Busters comin' 'round.

Create Art

See the activity *Inspired by Wrath* on pages 125 – 132. Use invasive plants to dye fabric, make notecards, create necklaces, or weave baskets.

Design T-shirts

Hold a contest and pick a winning weedy design. Have the T-shirts printed to help spread the word about your class project.

Sponsor a Pull-A-Thon

Gather pledges for each stem, pound, or bag of invasive plants pulled. Use the pledge money to revegetate an area with native plants.

Scrapbooking Ideas

Classroom scrapbooks can take off in many directions. Decide together if you want to include a wide variety of subjects or narrow your focus to one subject. Scrapbooks kept in the classroom become a record of activities, progress, and changes that can provide insight to future students.

Science

- Track natives. Students can keep records of all the native plants they see at the site each year. Include photos of newly discovered species.
- Snap photopoints. Set up a series of posts at strategic points in your study area. On a seasonal or annual basis, take reference pictures from the posts. Try to use the same camera and lens each time. By maintaining a regular interval at a specified angle, you will gain incredible insight into how the area is growing and changing. You will also see how your control efforts have helped a piece of land.
- Record the invasive plants and their abundance.
- Record phenology. Include a log or calendar in the scrapbook and encourage students to record seasonal happenings such as wildlife sightings, blooming flowers, and weather events. Compare the recordings from year to year. See *Eyewitness Accounts* on page 85 for more information.

Language Arts

- Write short stories and poems that reflect on the project or describe what students have learned about invasive species.
- Archive newspaper articles that feature your class and your invasive species control work.

Fine Arts

In addition to making each page aesthetically pleasing, encourage students to:

- Snap candid and scenic photos.
- Write music and lyrics.
- Draw or sketch plants, animals, or people in action.
- Make leaf rubbings.
- Press flowers.
- Make your own paper to use in the scrapbook.

Math

Find creative ways to share numbers.

- Record data collected during plant transects. See *Diversity Index* on page 99 for more information.
- Track the number of volunteer hours that students spent controlling invasive species.
- Count how many bags or pounds of invasives students removed.

Social Studies

- Create maps that show the locations of rare plants or areas where invasive plants were removed.
- Take “before and after” photos of all projects.
- Capture action shots of students and other volunteers at work and at play.

Inspired by Wrath

Method

After trying to manually control an invasive species, you and your students will either be consumed with wrath or filled with satisfaction. In a more creative mood, what could you do with a pile of garlic mustard plants, buckthorn leaves, or purple loosestrife flowers? Could you dye or decorate T-shirts? Are any of our invasives edible? This activity will recommend a few creative possibilities and give you the encouragement to pull weeds for supply – not spite!

Introducing the Activity

It should come as no surprise that many of the plants we are fighting to get rid of were purposely brought to this country for beneficial reasons. Early settlers brought with them the plants that had provided their families with food, medicine, and art for generations. Try some of these projects and maybe invasive species will become the weeds you love to hate.

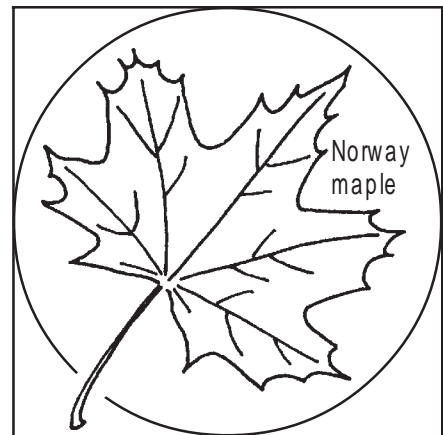
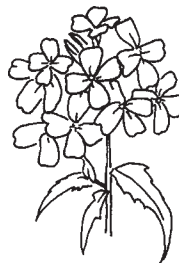
Doing the Activity

See individual project sheets for materials and directions.

This activity is from “Inspired by Wrath.” **Non-Native Invasive Species Learning Kit – Do Something.** United States Forest Service. 2005.

Remember:

- Always know exactly what species you are using for crafts or cooking!
- Be aware of poisonous plants and the potential hypersensitivity of participants.
- Always ask permission before harvesting any plant material from public or private land. You must get this permission even if the plants are invasive!
- Never plant an invasive plant so that you can use it for art or cooking. Even if you are careful, it might escape cultivation and invade a natural area.
- Never use invasives for art or eating if they have been treated with a chemical.
- Be careful that your artwork does not spread the invasive!
- Have fun!



Objectives

- Create art or food from invasive species.
- Understand the usefulness of plants to people of all times and cultures.

Grades

Varies with project

Group Size

Depends on the tools and equipment available

Activity Time

Varies with project

Setting

Outdoors

Materials

Varies with project

Scout Connections

- Webelos Scouts: Artist
- Brownie Girl Scouts: Plants
- Junior Girl Scouts: Outdoor Creativity
- Cadette and Senior Girl Scouts: Artistic Crafts, Eco-Action, Textile Arts

When cooking with invasives:

- Limit participants to adults or family groups. Be sure parents know that they are responsible for monitoring their own children's eating.
- Be sure participants know they are tasting at their own risk.
- Offer very small portions.
- Caution participants that different people can have different reactions to new foods.

Assessing the Learning

Ask students to create portfolios of their artwork. Work together to organize an invasive species art show. Display the works at the local library or other community building.

Extending the Learning

Check out native uses of invasive plants. Our invasives are often valued plants in their native homes. Here are a few uses from other cultures and eras to start the students thinking!

Common Reed Grass

People around the world have used *Phragmites* spp. for food, decoration, weapons (arrow shafts), weaving (basketry), building (mat weaving for house construction), writing (pen points for calligraphy pens), paper making, and even musical instruments (flutes and bagpipes).

Garlic Mustard

This herb is high in vitamins A and C. Europeans used it in salads and as a garlic or onion substitute in recipes. People even used it to clean wounds and abrasions, because it contains an antiseptic.

Yellow Flag (Iris)

All parts of the yellow flag plant can cause vomiting and diarrhea, but it is used medically to treat several ailments. The flowers and roots make yellow and black/brown dyes, respectively.

Purple Loosestrife

The scientific name for loosestrife, *Lythrum*, comes from the Greek word for blood; so it makes sense that loosestrife's medicinal uses include astringents. Tonics made from flowering branches, leaves, and roots have been used to treat dysentery, wounds, and ulcers.

Kudzu

Japanese and Chinese people use kudzu for both its culinary and herbal properties. Some doctors use kudzu to reduce hypertension; others are experimenting with kudzu to reduce the cravings associated with alcoholism.

Leaf Pounding

Take out your frustration by hammering the pigments out of invasive plants and on to fabric or paper!

Materials

- Freshly-picked leaves of invasive plants ¹
- Paper or fabric ²
- Wood (use a wood chopping block or smooth scrap wood)
- Paper towels or paper ³
- Hammers (any hammer with a flat head will work)

Directions

1. Working on the ground, place materials in this order: wood, paper toweling, fabric or paper to print, leaf (try both right side up and upside down to find the best way to print), and paper toweling.
2. Hammer over the entire leaf surface. Start with gentle taps to slowly break down the cells of the leaf. Gradually increase the power of your hammering until the print is the way you want it.
3. Gently separate the paper towel from the paper or fabric. If little pieces of crushed leaves are stuck to your print, wait until they dry before brushing them off.
4. If you want to do multiple leaves on the same piece of paper, do them one at a time. You can even overlap them!
5. Heat set the image on paper or fabric with an iron set for the fabric content. Iron each section for 45 to 60 seconds. Be careful not to scorch it.
6. **Optional:** Highlight the edges and veins of your design with a permanent, fine tip marker.



buckthorn leaf
pounded on
paper



buckthorn
leaf
with highlights

¹ Most leaves will work, but remember that the amount of “juice” and pigment in leaves varies by species, season, and rainfall. You will probably get slightly different results each time you try this craft! Flowers also make very interesting prints, but they are a little harder to work with. See the reference book listed below for tips on working with flowers.

² For a quick and easy activity, pound on paper. Try a smooth white or cream-colored paper without a glossy finish. Card stock, bond, or linen papers seem to work well. Be sure the students realize the print will fade with time. For a more lasting finished product, you can pound the leaves on fabric that has been pretreated to accept and hold the pigments. Some art stores sell prepared for dyeing (PFD) fabric. If you can't find PFD fabric, use the reference book listed below for directions on how to pretreat fabric yourself. You can also pound the prints on paper and scan them! Then you can use the prints to make stationery, book covers, and even iron-on transfer prints!

³ Use better quality paper towels. The cheap ones just don't stand up well to repeated hammering. The number of paper towels depends on the “juiciness” of the leaves. Fresh spring leaves might need several layers to soften the blow. Fall leaves might not need any padding. Simply use a piece of paper to protect your work surface.

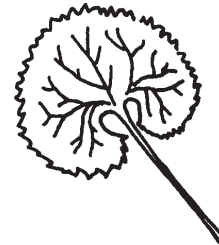
For more information check out **The Art and Craft of Pounding Flowers** by Laura C. Martin.

Natural Dyeing

The color of natural dyes depends on the season, cooking pot, mordant, fabric, duration, concentration, and numerous other factors! Just experiment and keep track of exactly what you do. If you happen onto a good "recipe," repeat it. Just don't be surprised if your results are different. Each time you try natural dyeing, you will invent a new color!

Materials

- Garlic mustard leaves
- Knives and chopping blocks or scissors
- Large pots (2)
- Natural fibers or fabrics for dyeing (cotton, linen, wool)
- Aluminum potassium sulfate (alum)
- Hot plates (2), firepit, or stove



garlic mustard leaf

Directions

1. Gather plant material for dyeing.
2. Make the dye solution. Chop plant material into small pieces and place in a pot. Add twice as much water as plant material. Bring to a boil, then simmer for about an hour. Strain.
3. Choose the fabric. Linen, cotton, and wool work best for natural dyes.
4. Get the fabric ready for the dye bath so the color will set in the fabric.
 - Find the dry weight of the material to be dyed. Divide this weight by four, and weigh out that much alum mordant. Stir the mordant into water.
 - Presoak the fabric 40 minutes in a separate bath of warm water.
 - Add the fabric to the water with alum and simmer for an hour (180° - 200° F).
 - Rinse the material and squeeze out excess. Rinse with cool water until the water runs clear.
5. Add the fabric to the dye. Simmer one hour, stirring occasionally for evenness of color.

Thanks to Marc Imlay of the Maryland Native Plant Society for these directions.

Other Non-native Dyes

This recipe for garlic mustard yields a bright sap green color. Try purple loosestrife flowering shoots in full bloom for a purple, green, or black dye. Use buckthorn berries for a dark brown, almost black, dye.



garlic mustard
in bloom

Twig Beads

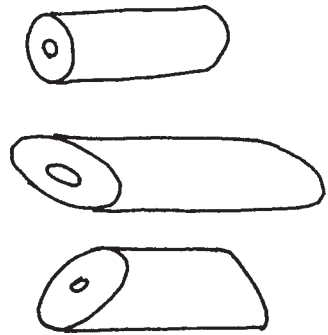
After removing shrubby invasives, take some time to make twig beads. Use the beads to make garlands, necklaces, or decorations for other art projects. Invasive honeysuckles, with their hollow pith, work especially well for this project.

Materials

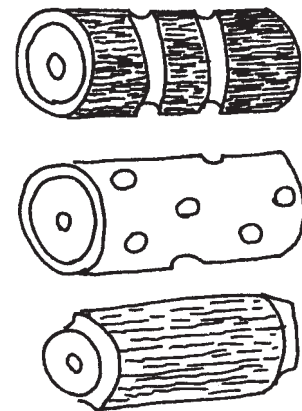
- Variety of twigs at least 3/8" in diameter (The more variety in color and texture, the more interesting the finished product.)
- Pruning shears or saws
- Vice or large clamps
- Hammers and nails or drills and bits to hollow out centers
- Carving tools
- Waxed dental floss

Directions

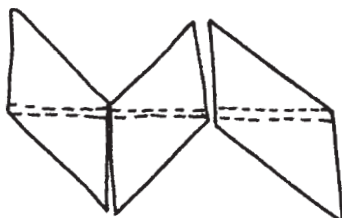
1. Cut the twigs into bead-sized lengths. Vary the diameter of the twig, the length of the bead, and the angle of the cut to make a wide assortment.
2. Make a hole through each bead. If the center is soft, use a nail and hammer. If the center is hard, you will have to drill a hole through the bead. Use a vise to hold the bead during drilling. You can also drill a hole sideways through the bead for a completely different look.
3. Decorate the beads.
 - Peel off the bark. Peel just the outer bark on some. Peel the inner and outer bark off of others.
 - Carve designs such as grooves, dots, or spirals into the bark or the wood.
4. String the beads on dental floss and allow them to dry before use.



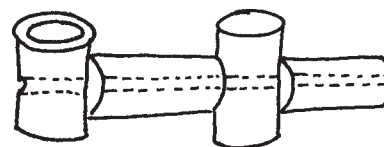
Cut beads at different angles for unique effects.



Decorate the beads by removing some or all of the bark.



Cut beads on an angle, drill holes as shown, and string to form a zig-zag pattern.



Drill holes end-to-end or sideways.

Baskets or Bird Nest Weaving

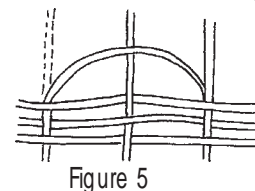
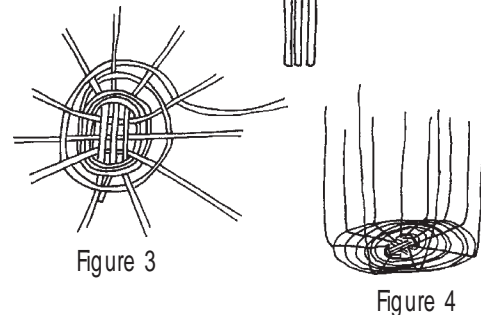
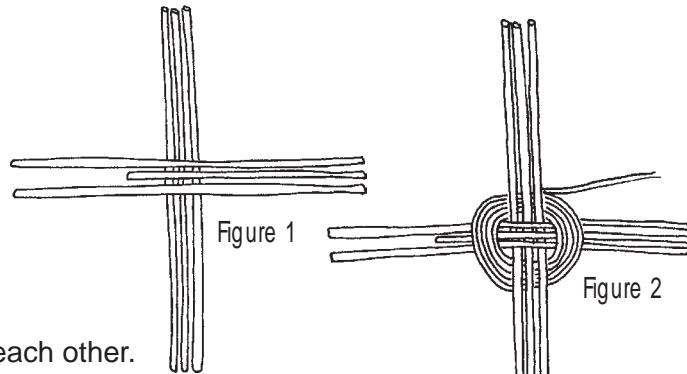
Several invasive plants can be used for basket making. Directions are given for a kudzu basket, but feel free to experiment. You can try making the base and spokes out of kudzu or willow. Then use phragmites or other grasses to weave the sides of the basket. Check with managers of local natural areas. They may be familiar with native willow species that have become invasive in wetland areas.

Materials

- Kudzu, willow, or other invasives

Directions

1. Take 5 pieces of vine about 24" long and 1 piece about 16" long.
2. Lay 3 of the long vines parallel to each other.
3. Lay the other 3 vines across the first 3, with the shortest vine in the middle. Align 1 end of the short piece with the ends of the other 2 long pieces. See Figure 1.
4. Take another long piece of thin, strong vine. Weave the 6 segments together, going over the top 3 (as a group), and under the bottom 3 about 3 times. Make sure the vines are securely fastened together. See Figure 2.
5. Do not cut this vine. It will be used for weaving.
6. Spread the vines so they are evenly spaced like spokes of a wheel.
7. Pick up the thin, long vine and start weaving over and under each spine. Pull tightly. See Figure 3. Note: The short extension of the original 16" piece becomes part of the spine next to it. Weave them together as one. This gives an uneven number of spines for weaving.
8. When you get to the end of the first vine, add another. Make sure they overlap by at least one spine so that the basket won't fall apart.
9. After making the bottom of the basket as large as desired, fold and crease all the spokes upward. See Figure 4.
10. Continue weaving up the sides, but don't go up more than 1/3 the height of the spokes.
11. Finish the basket by bending a spoke sideways past the adjacent spoke and pushing it through the space beside the third spoke. See Figure 5. You may need an awl or ice pick to tuck the spokes. Then tuck the skipped spoke beside the fourth spoke, etc. Continue all the way around the basket.
12. If the spokes stick out the bottom of the basket, cut off the excess. Finish the basket by tucking or trimming any ends that stick out. Be sure the ends are secure enough to hold the basket together before trimming them.



Other Possibilities

Pressed Leaves and Flowers

Press the leaves and flowers of invasive plants and use them in art projects.

- Make animals and scenes. See the book **Look What I Did With a Leaf!** by Morteza E. Sohi for more ideas.
- Use paint or ink and a brayer to make leaf prints on fabric or paper.
- Decorate stationery or note cards with pressed leaves.

Paper

Use fibers from phragmites or kudzu to make handmade papers.

Carvings

Use buckthorn to make:

- Rustic furniture
- Turned tool handles
- Bowls, spoons, decorative turnings

Invite a woodcarver to a work day to demonstrate techniques. If you want to try carving buckthorn, cure the wood a year before carving.

Walking Sticks

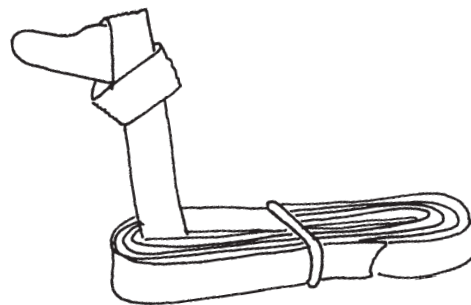
Use the roots and stems of the autumn olive to make strong walking sticks. Autumn olive is a beautiful wood!

Weed Weaving & Rope Making

Try phragmites and cattails to make mats, ropes, and decorative weaving. Experiment with wheat-weaving designs using phragmites.

Toys

Create dolls and floating ducks out of cattails. Directions for this Native American craft are available on the Internet. <www.nativetech.org/cattail/catdoll.htm>



Recipes for Revenge

Why not eat our invasive species problems! Try out some of these recipes, but be careful. Even a plant that is edible by many people may not be edible by everyone. Remember, some people are hypersensitive to foods. If you experiment with eating invasive species, take the same precautions you would take trying any new food in a foreign country.

Cooking with Garlic Mustard

- Use the leaves year-round in any recipe calling for mustard greens.
- Harvest the roots before the plant flowers and use them like horseradish.
- Save the seeds and use them as a spicy condiment.
- Young plants have a mild mustard flavor with hints of garlic and can be used raw.*
- Older, larger leaves and plants have a stronger, more bitter flavor.*
- The round leaves are less bitter than the triangular ones on the flower stalk.*
- If the plant is in full flower or has produced seeds, it will taste more bitter.*
- Pull up the entire plant gently. The roots will help keep the plant fresh until you are ready to use it. Then cut off the leaves, discard the flower stalk, wash, and use.*

Tips with (*) are from the *Garlic Mustard Challenge*, co-sponsored by the Patapsco Valley State Park and the Friends of the Patapsco Valley and Heritage Greenway (Maryland).

Winning Recipes from the *Garlic Mustard Challenge*

Garlic Mustard Pesto

Submitted by Robert Dunn, Executive Chef,
Belmont Conference Center

- 1 cup garlic mustard
- ½ cup basil
- 3 cloves garlic
- 2 ounces toasted pinenuts
- 4 ounces olive oil
- juice of 1 lemon

In food processor, combine all ingredients except olive oil. Puree and add olive oil with processor running. Toss cooked raviolis with pesto.

Mrs. Z's Garlic Mustard

Mashed Potatoes

Submitted by Steve Wecker

- 4 large baking potatoes
- ½ cup sour cream
- ¼ pound butter
- 2 slices salt pork, chopped
- ¼ cup garlic mustard leaves (chopped)
- Pepper to taste

Boil 4 large russet potatoes until soft. Peel and mash. Saute garlic mustard with salt pork. Drain. Add to potatoes with butter. Add sour cream and pepper. Bake for 25 minutes at 350°.

Garlic Mustard Pasta

Submitted by Alex Streat, age 12

- 1 pound linguine
- 2 tablespoons butter
- ½ cup garlic mustard (washed, crisped, and chopped)

Cook linguine according to directions on box. Saute garlic mustard in butter. Blend with cooked linguine. Garnish with garlic mustard stems. Serve hot or chilled.

Sally's Tossed Salad

Submitted by Sally Voris

- 4 - 6 leaves ruby red leaf lettuce
- 4 - 6 leaves romaine lettuce
- 1 - 2 handfuls tender garlic mustard leaves
- one leaf each French sorrel and bronze fennel
- 1/3 cup mandarin orange slices (drained)
- 1 slice of smoked salmon
- 1/8 cup sunflower seeds
- croutons

Wash and crisp all the leaves and tear the lettuce leaves into a salad bowl. Cut the garlic mustard leaves, the French sorrel, and the fennel into narrow strips and add to the salad. Cut the oranges and the smoked salmon into thin strips and place in the salad. Sprinkle on sunflower seeds and fresh herbed croutons. Dress lightly with Italian dressing. Serve immediately.

Activities by Grade

	K-1	2	3	4	5	6	7-8	9-12	Adult
Ad-libbed Aliens (page 23)		●	●	●	●	●	●		
Bane or Blessing? (page 63)					●	●	●	●	
A Can of Worms (page 67)				●	●	●	●	●	●
Checking Out the Options (page 113)					●	●	●	●	
Citizen Scientists (page 89)					●	●	●	●	●
Diversity Index (page 99)						●	●	●	
Eyewitness Accounts (page 85)	●	●	●	●	●	●	●	●	●
Field Notes (page 35)		●	●	●	●	●	●	●	●
Garlic Mustard Invasion (page 59)		●	●	●	●	●	●	●	●
Global Marketplace (page 9)				●	●	●	●	●	
How to Kill a Dandelion (page 109)		●	●	●	●	●	●	●	
Inspired by Wrath (page 125)	●	●	●	●	●	●	●	●	●
Invasive or Not? (page 29)						●	●	●	●
Means & Modes (page 79)			●	●	●	●	●	●	●
Outwit-Outplant-Outlast (page 53)					●	●	●	●	
The Plant Hunters (page 39)	●	●	●	●	●	●	●	●	●
Plants of the Melting Pot (page 75)						●	●	●	
Plotting Plants (page 93)				●	●	●	●	●	
Shears, Sawbuck & Co. (page 117)					●	●	●	●	
Szing Up Weeds (page 19)							●	●	
Stand Your Ground (page 105)								●	●
Wanted Posters (page 83)				●	●	●	●	●	
Web of Life (page 45)		●	●	●	●	●	●		
Weed Out! (page 121)	●	●	●	●	●	●	●	●	●
Wildflower, Weed . . . (page 13)				●	●	●	●	●	●

Activities by Subject Area

	Language Arts	EE	Math	Science	Social Studies	Fine Arts
Ad-libbed Aliens (page 23)	●			●		●
Bane or Blessing? (page 63)	●		●	●		
A Can of Worms (page 67)		●		●		
Checking Out the Options (page 113)	●			●		
Citizen Scientists (page 89)		●		●		
Diversity Index (page 99)			●	●		
Eyewitness Accounts (page 85)	●			●		●
Field Notes (page 35)	●			●		●
Garlic Mustard Invasion (page 59)		●		●		
Global Marketplace (page 9)		●			●	
How to Kill a Dandelion (page 109)			●	●		
Inspired by Wrath (page 125)				●		●
Invasive or Not? (page 29)				●		
Means & Modes (page 79)		●			●	
Outwit-Outplant-Outlast (page 53)			●	●		
The Plant Hunters (page 39)				●		●
Plants of the Melting Pot (page 75)		●	●		●	
Plotting Plants (page 93)				●	●	
Shears, Sawbuck & Co. (page 117)				●	●	
Szing Up Weeds (page 19)	●	●	●	●		
Stand Your Ground (page 105)	●	●		●	●	
Wanted Posters (page 83)	●					●
Web of Life (page 45)		●		●		
Weed Out! (page 121)		●		●		
Wildflower, Weed . . . (page 13)			●	●		

Activities by Teaching Strategy

	Hands-on	Process Skills	Game/Simulation	Creative Expression	Research	Discussion Analysis
Ad-libbed Aliens (page 23)				●	●	
Bane or Blessing? (page 63)	●	●			●	●
A Can of Worms (page 67)	●	●				●
Checking Out the Options (page 113)					●	●
Citizen Scientists (page 89)					●	●
Diversity Index (page 99)	●	●	●		●	●
Eyewitness Accounts (page 85)	●	●		●		
Field Notes (page 35)	●	●		●		
Garlic Mustard Invasion (page 59)	●	●				●
Global Marketplace (page 9)					●	●
How to Kill a Dandelion (page 109)	●	●			●	
Inspired by Wrath (page 125)	●			●		
Invasive or Not? (page 29)	●	●				●
Means & Modes (page 79)			●			●
Outwit-Outplant-Outlast (page 53)			●			●
The Plant Hunters (page 39)	●	●				
Plants of the Melting Pot (page 75)					●	●
Plotting Plants (page 93)	●	●			●	
Shears, Sawbuck & Co. (page 117)	●	●			●	●
Szing Up Weeds (page 19)		●			●	●
Stand Your Ground (page 105)		●			●	●
Wanted Posters (page 83)				●	●	
Web of Life (page 45)			●			●
Weed Out! (page 121)	●					
Wildflower, Weed . . . (page 13)	●	●				

Activities by Location/Season

A “ ● ” indicates the activity is not dependent on the seasons and can be done anytime of the year.

	Classroom Activities	Field Experiences	Field Trip to Nature Center ¹
Ad-libbed Aliens (page 23)	●		●
Bane or Blessing? (page 63)	fall		
A Can of Worms (page 67)	spring	spring	spring
Checking Out the Options (page 113)	●		
Citizen Scientists (page 89)	●		
Diversity Index (page 99)	●	growing season	growing season
Eyewitness Accounts (page 85)	●	●	
Field Notes (page 35)	●	●	●
Garlic Mustard Invasion (page 59)		spring	spring
Global Marketplace (page 9)	●		
How to Kill a Dandelion (page 109)	growing season	growing season	
Inspired by Wrath (page 125)	●	●	●
Invasive or Not? (page 29)		growing season	growing season
Means & Modes (page 79)	●		●
Outwit-Outplant-Outlast (page 53)	●		●
The Plant Hunters (page 39)	●	growing season	
Plants of the Melting Pot (page 75)	●		
Plotting Plants (page 93)	●	growing season	growing season
Shears, Sawbuck & Co. (page 117)	●		
Sizing Up Weeds (page 19)	●		
Stand Your Ground (page 105)	●		
Wanted Posters (page 83)	●		
Web of Life (page 45)	●		●
Weed Out! (page 121)	●	●	●
Wildflower, Weed . . . (page 13)	●	growing season	

¹ Activities in this column are appropriate for use by field trip providers. The activities can be used in conjunction with a service project or as part of a field trip. See notes on page 8 for more information.

Wisconsin's Model Academic Standards

English Language Arts

- A. Reading and Literature
 - Bane or Blessing? (A.8.4, A.12.1, A.12.4)
 - Stand Your Ground (A.12.1, A.12.3, A.12.4)
- B. Writing
 - Ad-Libbed Aliens (B.4.1, B.4.3)
 - Eyewitness Account (B.4.1, B.8.1, B.12.1)
 - Field Notes (B.4.1, B.8.1, B.12.1)
- C. Oral Language
 - Sizing Up Weeds (C.8.1)
 - Stand Your Ground (C.12.1)
- D. Language
 - Bane or Blessing? (D.12.2)
- E. Media and Technology
 - Bane or Blessing (E.8.3, E.12.3)
 - Wanted Posters (E.4.3, E.8.3, E.12.3)
- F. Research and Inquiry
 - Checking Out the Options (F.8.1, F.12.1)
 - Sizing Up Weeds (F.8.1, F.12.1)

Environmental Education

- A. Questioning and Analysis
 - Eyewitness Account (A.4.2)
 - Garlic Mustard Invasion (A.4.2)
 - How to Kill a Dandelion (A.4.1, A.4.2)
- B. Knowledge of Environmental Processes and Systems
 - Ad-Libbed Aliens (B.4.6)
 - Bane or Blessing? (B.8.21)
 - A Can of Worms (B.4.4, B.8.8, B.8.21, B.12.3, B.12.6)
 - Citizen Scientists (B.8.8, B.8.21, B.8.22, B.8.23, B.12.5)
 - Diversity Index (B.8.3, B.8.21, B.12.6, B.12.7)
 - Garlic Mustard Invasion (B.8.8, B.8.21, B.12.3, B.12.6)
 - Global Marketplace (B.8.14)
 - How to Kill a Dandelion (B.4.6)
 - Means & Modes (B.4.12, B.8.10)
 - Outwit-Outplant-Outlast (B.8.8, B.8.21, B.12.3, B.12.4, B.12.6)
 - Plants of the Melting Pot (B.8.10, B.8.18)

- Web of Life (B.4.1, B.8.8, B.8.21)
- Weed Out (B.8.10)
- C. Environmental Issue Investigation Skills
 - Bane or Blessing? (C.8.4)
 - A Can of Worms (C.8.2)
 - Citizen Scientists (C.8.2)
 - Diversity Index (C.8.2)
 - Eyewitness Accounts (C.8.2)
 - Garlic Mustard Invasion (C.8.2)
 - How to Kill a Dandelion (C.8.2)
 - Means & Modes (C.12.1)
 - Plotting Plants (C.8.2)
 - Sizing Up Weeds (C.8.3, C.8.4)
- D. Decision and Action Skills
 - Checking Out the Options (D.12.3)
 - Citizen Scientists (D.8.5)
 - Means & Modes (D.4.3, D.8.5, D.12.4)
 - Plotting Plants (D.8.6, D.12.5)
 - Sizing Up Weeds (D.8.7, D.12.6)
 - Stand Your Ground (D.12.3, D.12.6)
 - Weed Out! (D.4.1, D.4.6, D.8.5, D.8.6, D.12.5)

Math

- A. Mathematical Processes
 - Diversity Index (A.8.1)
 - Plants of the Melting Pot (A.8.1)
- B. Number Operations and Relationships
 - Bane or Blessing? (B.8.7)
 - Diversity Index (B.8.7)
 - Outwit-Outplant-Outlast (B.8.7)
- E. Statistics and Probability
 - Diversity Index (E.8.4)
 - Sizing Up Weeds (E.8.1, E.12.1)

Science

A. Science Connections

- Bane or Blessing? (A.12.2)
- A Can of Worms (A.4.5, A.8.6)
- Citizen Scientists (A.12.5)
- Eyewitness Accounts (A.8.6)
- Field Notes (A.4.3, A.8.3, A.12.6)
- The Plant Hunters (A.4.3, A.4.5, A.8.3)
- Plants of the Melting Pot (A.12.2)
- Plotting Plants (A.4.3)
- Sizing Up Weeds (A.8.1, A.12.2)

B. Nature of Science

- Citizen Scientists (B.8.5)
- Eyewitness Accounts (B.8.4)
- Field Notes (B.8.5, B.12.4)
- Global Marketplace (B.4.1)
- How to Kill a Dandelion (B.4.1)
- The Plant Hunters (B.8.5, B.12.4)
- Plotting Plants (B.4.1, B.8.5)
- Weed Out! (B.4.1)

C. Science Inquiry

- A Can of Worms (C.4.4, C.4.5)
- Diversity Index (C.8.2, C.8.3, C.8.4, C.8.6, C.12.5)
- Field Notes (C.4.5, C.8.2)
- Garlic Mustard Invasion (C.4.5, C.8.2)
- How to Kill a Dandelion (C.4.2, C.4.3, C.4.5, C.4.6, C.8.1, C.8.2, C.8.3, C.8.4, C.8.5, C.8.6, C.8.7, C.12.1, C.12.3, C.12.4, C.12.5)
- Invasive or Not (C.8.2, C.8.4, C.8.5, C.12.3)
- Plotting Plants (C.4.3, C.4.4, C.4.5, C.8.2, C.8.3, C.8.6, C.8.8, C.12.3)
- Wildflower, Weed, or Botanical Bully (C.4.2, C.4.5, C.8.2)

E. Earth and Space Science

- Eyewitness Accounts (E.4.5, E.4.6, E.8.8)

F. Life and Environmental Science

- Ad-Libbed Aliens (F.4.1, F.4.2, F.4.3, F.8.2)
- Bane or Blessing? (F.8.2, F.12.8)
- A Can of Worms (F.4.2, F.4.4, F.8.8, F.8.9, F.12.7, F.12.8, F.12.9)
- Checking Out the Options (F.12.8)
- Citizen Scientists (F.8.8, F.8.9, F.12.6, F.12.7, F.12.8)
- Diversity Index (F.8.8, F.8.9, F.12.7, F.12.8)

- Eyewitness Accounts (F.4.2, F.4.3, F.8.9, F.12.8)

- Garlic Mustard Invasion (F.4.1, F.4.2, F.4.4, F.8.8, F.8.9, F.12.7, F.12.8)

- How to Kill a Dandelion (F.4.1, F.4.2, F.4.3, F.8.2, F.12.8)

- Invasive or Not? (F.8.2, F.12.7, F.12.8)

- Outwit-Outplant-Outlast (F.8.2, F.8.8, F.8.9, F.12.7, F.12.8)

- Plant Hunters (F.12.5)

- Plotting Plants (F.4.3, F.8.2, F.8.8)

- Web of Life (F.4.4, F.8.9)

- Weed Out! (F.4.2, F.4.3)

- Wildflower, Weed, or Botanical Bully (F.12.5)

G. Science Applications

- Shears, Sawbuck & Co. (G.8.4, G.12.3, G.12.5)

H. Science in Social and Personal Perspectives

- Checking Out the Options (H.12.5, H.12.6)

- Stand Your Ground (H.12.6)

- Weed Out! (H.12.5)

Social Studies

A. Geography: People, Places, and Environments

- Citizen Scientist (A.8.5)
- Global Marketplace (A.4.7, A.8.7)
- Means & Modes (A.4.4, A.4.8, A.8.7)
- Plants of the Melting Pot (A.8.7, A.8.11, A.12.7)

B. History: Time, Continuity, and Change

- Plants of the Melting Pot (B.8.12)

C. Political Science and Citizenship

- Stand Your Ground (C.12.8)

D. Economics: Production, Distribution, Exchange, Consumption

- Global Marketplace (D.4.3)
- Means & Modes (D.8.11)
- Shears, Sawbuck & Co. (D.12.10)

Plant Identification Guides

Wildflower Guides

The Audubon Society Field Guide to North American Wildflowers: Eastern Region. W. A. Niering and N. C. Olmstead. 2001.

A Field Guide to Trees and Shrubs. G. A. Petrides. 1973. Peterson Field Guides.

A Field Guide to Wildflowers of Northeastern and North-central North America. Roger Tory Peterson and Margaret McKenny. 1998. Peterson Field Guides.

Flowers. Herbert S. Zim and Alexander C. Martin. 1991. Little Golden Guide.

Newcomb's Wildflower Guide. L. Newcomb. 1989. Personal favorite of the author! Includes a key that older students and adults find easy to use.

Wildflowers and Weeds. Booth Courtney and James H. Zimmerman. 1978. Photos small, but usually capture the distinguishing features. Out of print, but available in libraries.

Specialized Weed Guides

Invasive Plants of the Upper Midwest: An Illustrated Guide to Their Identification and Control. Elizabeth Czarapata. 2005.

Weeds. Alexander C. Martin. 2001. Little Golden Guide.

Weeds of the North Central States. Lloyd M. Wax. 1981. Complete key based on flower color.

Weeds of the Northeast. Richard H. Uva, Joseph C. Neal, Joseph M. Ditomaso. 1997. Identification resource that contains useful tables of similar plant species, foldout identification keys, and notations of unusual identification characteristics.

Weeds of Northern U.S. and Canada. F. Royer and R. Dickinson. 1999. In addition to photos of flowering plants, this book includes photos of seeds and weeds in the seedling stage!

Guides for Plants that Look Dead!

A Guide to Wildflowers in Winter. Carol Levine. 1995. Black and white photos of basal rosettes and drawings of seeds, seed heads, and seed pods.

Pods: Wildflowers and Weeds in Their Final Beauty. Jane Embertson. 1980. Color photos of seedpods from garlic mustard to multiflora rose!

Wildflowers and Winter Weeds. Lauren Brown. 1997. Line drawings of dried weeds. Includes a key.

Internet Guides

Invasive Species: Plants. Wisconsin Department of Natural Resources. 2005. Online species information, photo gallery, and control recommendations. <www.dnr.wi.gov/invasives/plants.htm>

WISFLORA: Wisconsin State Herbarium. University of Wisconsin – Madison. 2005. Online listing of plants by common name, scientific name, habitat, status, and county. Includes *What's Blooming*, an online listing of common roadside plants organized by month and color. Great place to start identifying common flowers in bloom. <www.botany.wisc.edu/wisflora>



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