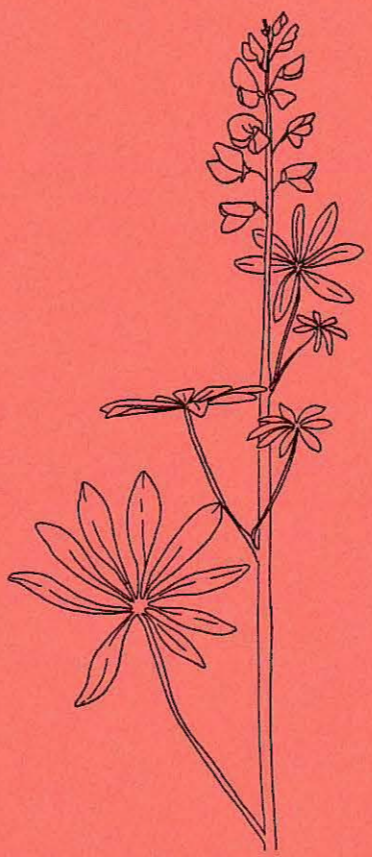
NNIS

Non-native Invasive Species Learning Kit



Do Something!

United States Forest Service - Eastern Region

Non-Native Invasive Species

They're munching our trees, invading our waters, and taking over our favorite natural communities. *They* are invasive species! *They* are plants, animals, and pathogens from other parts of the world – even other parts of our own country! They outcompete, outlast, and outlive our natives. The threat to natural communities posed by invasive species is second only to habitat loss. But before you get too tough on them, remember, they couldn't do it without us! People are the ones who travel around the world, trade with other countries, and transport invasive species to places they could never have gone by themselves.

Everyday, people cross international borders, vacation in pristine natural areas, travel to developing countries, ship materials across the oceans, and obtain plants and animals for fun and profit. Each move, each transaction, each development opens a door.

To stop the invasion, we have to become aware of the threat and become uncomfortable about what we might be losing. This *Non-native Invasive Species Learning Kit* includes four modules designed to take people from awareness of the problem to taking action. Activities in the modules are designed for use by USFS staff, teachers, and non-formal educators with people of all ages.

Get a Grip on Biodiversity!

Celebrate diversity through story and art, check out what happens when invasives take over an area, and get ready to learn more about invasive species. Activities include: *The Salamander Room, Web of Life, Freeze Frame, There's a Hair in My Dirt!,* and *Jargon Unplugged.*

Meet the Invaders!

Confront some invasive species, discover their adaptations, and find out why they are such a problem. Activities include: *Ad-libbed Aliens, Bioblunder Tribunal, Super Alien, Outwit-Outplant-Outlast,* and *Meadow in a Can.*

Close the Doors!

Track down invasive species in your own neighborhood, discover how they arrived, and find out how you can prevent further introductions. Activities include: *BioBlitz, Means & Modes, Sticky Situations*, and *Homeland Security.*

Do Something! - This is the module you have!

Measure the spread of invasives, discover how everyday decisions can make a difference, and create invasive species artwork. Activities include: *Biodiversity Index, Rival for Survival, Pet Detective, Miss Rumphius Revisited*, and *Inspired by Wrath.*

Produced by

United States Forest Service, Eastern Region

Writer and Designer: Beth Mittermaier, EARTH Ltd.

Do Something!

Biodiversity Index

Description

Scientists don't have time to identify and count every plant in an area. Instead, they have developed sampling techniques that allow them to compare the diversity of different habitats. Students will use similar sampling techniques in nearby parks, backyards, and natural areas to measure the effects of invasives on biodiversity. They will also begin an herbarium collection of invasive plants.

Getting Ready

1. Find a location for the outdoor investigation.
2. 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).

Introduction

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

Maximum 30, divided into groups of 2 – 4

Prep Time

Minimal for classroom sampling. Field trip preparation varies with proximity to an appropriate site.

Activity Time

Three 50-minute class periods

Setting

Indoors and outdoors

Materials in Kit

- 100 beads in containers (15)
- tent stakes (8 sets of 2)
- 50' cord wound on bobbin (8)

Materials Not in Kit

- paper, pencils, and writing surfaces
- optional: field guides to local plants
- optional: calculators

National Education Standards

See next page.

National Education Standards

Grades 6 - 8

- Science: A - Abilities Necessary to do Scientific Inquiry
- Science: F - Natural Hazards

Grades 9 - 12

- Environmental Education: 2.2.A - Organisms, Populations, and Communities
- Science: A - Understandings About Scientific Inquiry
- Science: F - Environmental Quality
- Science: F - Natural and Human-induced Hazards

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 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 the 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 represents a different "plant" in the habitat. Assign a letter to each bead color by writing the 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.

   $\underline{P}\overline{B}\underline{GG}\overline{WW}\underline{G}\overline{BB}$

   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.

R = red
O = orange
Y = yellow
G = green
B = light blue
I = indigo
V = violet
P = pink
W = white
E = ebony (black)
S = see-through
C = clear green

6. **Count the number of individuals in the sample.** The example shows nine individual beads.

7. **Calculate the Diversity Index (DI).** Use the following formula:

   DI = number of runs/number of plants = 6/9 = 0.67

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 a non-native 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.)

goldenrod

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 11 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 asign letters to them prior to the field trip.

Alien Herbarium [Outdoors]

Give students a copy of *Starting an Alien Herbarium* on page 12. It will give them directions on how to collect, press, mount, and label invasive plants.

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. You could use the same method to determine a Diversity Index for each kind of organism in a habitat.)
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 page 10.

- 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 Student 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.

Extending the Learning

Complete these advanced calculations. Find out more about the diversity of the area you sampled with these diversity indexes.

- **Species Diversity Index**. This value is based upon the number of different species you encountered along your transect.

  Species Diversity Index = number of different species/ number of runs

- **Modified Diversity Index.** During the beginning phases of an invasion, the addition of invasive species might appear to increase the Diversity Index. Correct for this by using the Modified Diversity Index.

  Modified Diversity Index = total number of runs of native species/ total number of runs

- **Diversity Index of Exotic Species.** Take the square root of the basic Diversity Index times the Modified Diversity Index.

  Diversity Index of Exotic Species = square root of Diversity Index X Modified Diversity Index.

- **Overall Diversity Index.** This index will give the most precise measure of the site's plant diversity. It is calculated by taking the cubic root of the Diversity Index times the Modified Diversity Index times the Species Diversity Index. If you choose to calculate the Overall Diversity Index, perform the initial calculations for each of your transects separately and then average the three indexes to plug into the Overall Diversity Index. This will give the most accurate value.

Advanced calculations are from ***The Purple Loosestrife Project: Cooperator's Handbook***.

Finding Out More!

This activity is adapted from the following activities:

The Spice of Life: Assessing Species Diversity in ***Biodiversity, Wetlands, and Biological Control*** published by the Illinois Natural History Survey ©1999.

Annual Wetland Plant Diversity Survey in ***The Purple Loosestrife Project: Cooperator's Handbook*** published by Michigan State University ©1998.

Insect Madness in ***Windows on the Wild: Biodiversity Basics*** published by the World Wildlife Fund ©1999.

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. 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

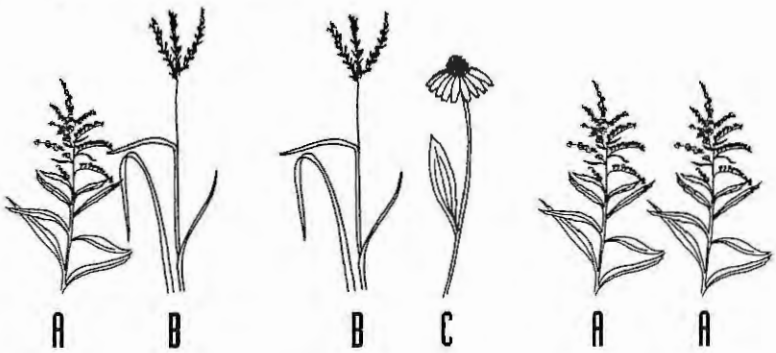
Sample Letter Assignment Chart

A - yellow flowers in a feathery spray (goldenrod)
B - tall grass with birdfoot-shaped seedhead (big bluestem)
C - large purple flower with brown center (purple coneflower)

Sample Data Recording

A B B C A A

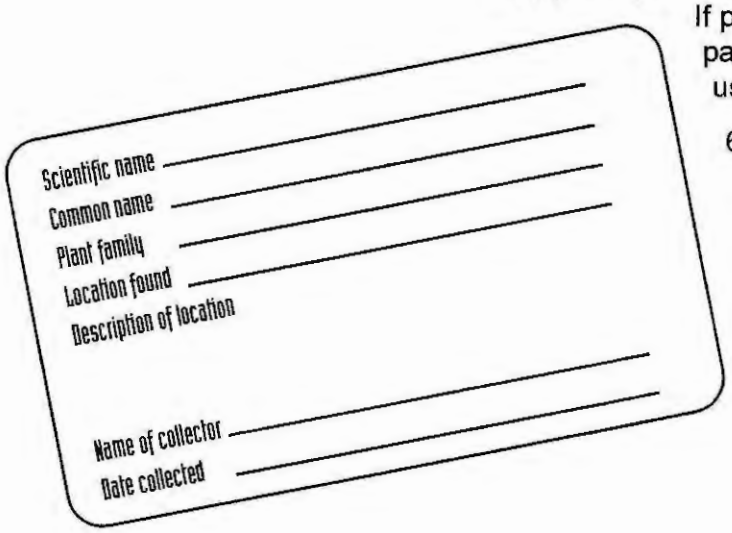
Sample Transect Line



Starting an Alien Herbarium

Collect local invasive plants and press them to serve as a reference collection for your school and community. Before collecting any plants (even invasive species!), ask permission from the landowner.

1. **Find an invasive species to collect**. This shouldn't be hard! Abandoned fields, roadways, and any disturbed area will probably harbor several invasive species.
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 invasive species, wash the soil from the roots, wrap the roots in moist newspaper, and place the plant in a plastic bag.
4. **Press the plants**. While a plant press does the best job of drying plants, you can have reasonable success using materials in the classroom. Arrange each plant on a piece of newspaper. 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. Cover the plant with another piece of newspaper. Sandwich the newspapers containing the plant 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. Change the newspaper every day or so to speed the drying process.
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" X 16.5"). If possible, choose a heavyweight acid-free paper. Attach the plant to the piece of paper using acid-free glue, if possible.



6. **Label the plant**. Include the information shown on the sample label.
7. **Display the specimens to educate others about local invasive plants**.

Rival for Survival

Description

Invasive species have wreaked havoc in the Great Lakes and other inland waters. As kids work their way around the game board, they can test their knowledge of invasive species and discover ways they can prevent further introductions of invasives.

Getting Ready

1. Read the introduction and rules for game.

Introduction

Suppose some people arrive at your home uninvited. They move into your room, sleep in your bed, and eat the food in your fridge. You don't have many options. You could try to live with these unwelcome guests, find a new home, or die. That is what is happening in many of our nation's lakes and rivers. Plants and animals from other parts of the world are invading our waters. These invasions can be harmful, beneficial, or barely noticeable. Here are some of the competitors trying to survive in our lakes and rivers:

- *The native species are the plants and animals that have lived here for centuries. Scientists also call them indigenous. They are specially adapted to live here. Lake sturgeon, yellow perch, and slippershell mussels are native aquatic species.*
- *Non-native species are plants or animals from another part of the country or world. Just to make things interesting, scientists also call them introduced, nonindigenous, and exotic! Species can arrive here by accident or on purpose.*
  - *A non-native species that invades a habitat and takes resources from native plants or animals is called an invasive species. For example, spiny water fleas eat the same foods as native plankton and small fish. Because their long spines prevent small fish from swallowing them, they don't have many natural predators. That means their population can grow and grow!*
  - *Sometimes a non-native species is introduced on purpose. In the 1960s, fish biologists began stocking coho salmon in Lake Michigan. They hoped the salmon*

Objectives

- Give examples of native, non-native, invasive, and introduced aquatic species.
- Identify some of the impacts of non-native invasive species on aquatic ecosystems.
- Recognize the role of individuals in managing the spread of invasive species.

Grades

5 – 8

Group Size

Maximum 30, divided into groups of 3 – 6

Prep Time

Minimal

Activity Time

One or two 50-minute periods

Setting

Classroom

Materials in Kit

- game boards (5)
- *Rival for Survival* cards (5 sets of 30 cards, each set a different color for ease in sorting)
- dice (5)
- pebbles (30)

Materials Not in Kit

- paper and pencil for keeping score

National Education Standards

See next page.

National Education Standards

Grades 5 - 8

- Environmental Education: 2.4.A - Human/Environment Interactions
- Environmental Education: 4.D - Accepting Personal Responsibility
- Science: F - Natural Hazards

would eat the invasive alewives that were out of control, and they did!

- *Occasionally, when a non-native species is introduced, it doesn't cause any significant problems in certain locations. For example, brown trout are really from Europe. While they haven't been a big problem in the Great Lakes, they have caused problems in other parts of the country.*

Underwater survival was never easy. It's a fish-eat-fish world out there—tiny plankton being eaten by larger zooplankton being eaten by little fish being eaten by bigger fish! Of the thousands of eggs animals lay, only a few grow up to become adults.

But now the stakes are higher! We're not talking about survival of an individual plant or animal; we're talking about the survival of whole populations of plants and animals. Invasive species have changed aquatic ecology forever. Who survives and who doesn't is up to the ways of nature, the dynamics of habitats, and us!

Doing the Activity

Note: By playing *Rival for Survival*, your students will learn more about the changes caused by non-native species. The game was designed for the Great Lakes, but invasives are a problem in most of our nation's lakes. No matter where you live, playing the game will help you discover ways you can help save the natives.

1. **Divide the students into groups of 3 – 6.**
2. **Get ready to play.** Each group will need a game board, a set of 30 game cards, a die, and one pebble per student. Assign a scorekeeper for each group and be sure this person has paper and a pencil.
3. **Go over the rules for the game.** See page 16.

Assessing Student Learning

Using some of the scenarios presented on the game cards, ask students to determine the environmental consequences of the various options. For example, what could happen if you flushed your aquarium contents down the drain or dumped the contents in a local pond?

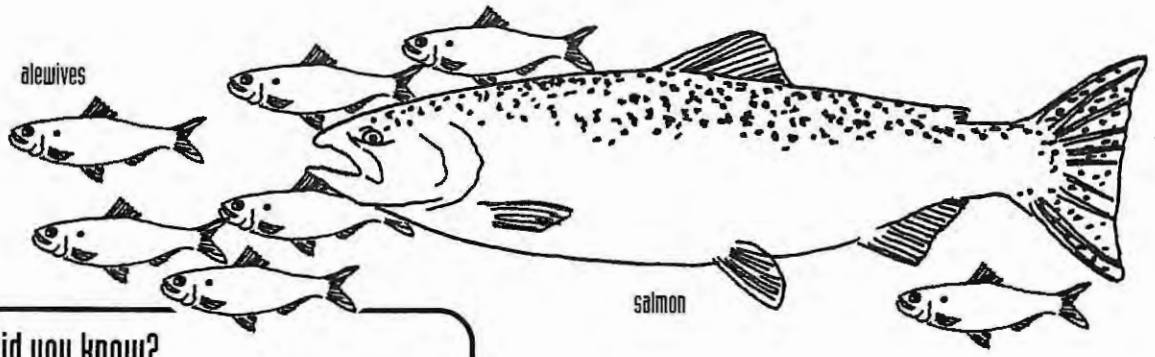
Extending the Learning

Go Local. Aquatic invasive species are almost everywhere. Ask students to identify invasive species in their own community and find out how they are affecting local native species. If possible, join the efforts to control the growth and spread of local aquatic species.

Finding Out More!

Exotic Invaders: Killer Bees, Fire Ants and Other Alien Species Are Infesting America by Jeanne M. Lesinski ©1996. Describes five species that are not native to North America (sea lampreys, fire ants, zebra mussels, European starlings, and African honeybees) and efforts to handle the problems their introductions have caused.

Biodiversity, Wetlands, and Biological Control: Information and Activities for Young Scientists – Purple Loosestrife: A Case Study by Michael Jeffords and Susan Post ©1999. Introductory activities about biodiversity and wetlands lead to lessons concerning the biological control of purple loosestrife in wetland areas. Based in Illinois, but very adaptable.



Did you know?

In the 1960s, fish biologists began stocking salmon in Lake Michigan to eat the invasive alewives that were out of control. Using a non-native species to control the population of an invasive species carries huge risks. Scientists have to be certain that the introduced non-native will not become an invasive species in its new habitat.

NNIS
Non-native Invasive Species

How to Play

The object of the game is to have the most points when all the players reach the finish. Each player rolls the die, and the player with the highest number goes first.

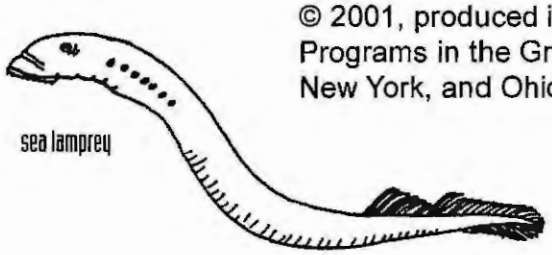
1. Player 1 rolls the die and moves the playing piece the number of spaces shown.
2. Player 2 takes the top question card from the pile and reads the question aloud. Player 1 chooses an answer.
3. Based on Player 1's answer, the scorekeeper records Player 1's points.
4. Play continues in a clockwise direction until all players reach the finish. The player with the **most points** is the winner—not the player who reaches the Great Lakes first. Finishing first may not necessarily be a good thing in this game!

More Rules

When landing on a space that requires the player to move ahead or backward, the player moves the playing piece before the question is read.

Some answers will cause a player to lose points. If the player has no points, he or she cannot go below zero, even if told to subtract a point.

Thanks to the Illinois-Indiana Sea Grant College Program for permission to use this activity. It is from *ESCAPE: Exotic Species Compendium of Activities to Protect the Ecosystem* © 2001, produced in partnership with these Sea Grant College Programs in the Great Lakes Network: Michigan, Minnesota, New York, and Ohio.



Pet Detective

Description

Appropriate pets are wonderful companions when cared for responsibly, but not all pets are appropriate and not all pet owners are responsible. We import exotic pets, release unwanted pets, and allow unsupervised pets to wander among wild animals. These "pets" are often responsible for disrupting food chains and destroying habitat, resulting in the deaths of native animals. Students will play a game based on *Clue* ® to solve the who, where, and how of some mysterious deaths.

Getting Ready

1. Read the directions for playing the game.

Introduction

We don't usually think of our pets as invasive species, but they could be. Unless you are the owner of a native animal like a snake or turtle, you are probably harboring a non-native species in your home! Cats came from Egypt. Dogs are from the Middle East (Israel and India). Most pet birds are from the tropics. Guinea pigs are native to Peru! Having a potentially invasive species as your pet means that you are responsible if it escapes or causes harm to people, other animals, or the environment.*

Exotic pets are strange, unique, or unusual pets that have become very popular. They are usually from other parts of the world, and they often require special care, diets, and housing.

While all pets can be comforting and entertaining, we have to remember that they are usually non-native species, and, as such, they could cause all kinds of problems if not responsibly maintained.

*Note: Keep in mind that many native species are protected and can't be kept in captivity without special permits.

Doing the Activity

1. **Talk about pets.** Encourage students to talk briefly about their pets. Ask if their pets have ever caused a problem for people, other animals, or the environment.

Objectives

- Identify exotic pets as potential non-native invasive species.
- Become aware of the problems that exotic pets can cause to native wildlife.

Grades

5 – 12

Group Size

Maximum 30, divided into groups of 3 – 6

Prep Time

Minimal

Activity Time

One 50-minute class period

Setting

Classroom

Materials

- game directions (5)
- game boards (5)
- dice (5)
- *Who* tokens (5 sets of 6)
- *How* tokens (5 sets of 6)
- *Pet Detective Cases* (6 color-coded 18-card sets in envelopes)
- *Pet Detective Solutions* (6 color-coded scenarios)

Materials in Booklet

- *Pet Detective Notes* (copy as needed)

National Education Standards

See next page.

National Education Standards

Grades 6 - 8

- Environmental Education: 2.4.A - Human/Environment Interactions
- Environmental Education: 4.D - Accepting Personal Responsibility
- Science: F - Natural Hazards

Grades 9 - 12

- Environmental Education: 4.D - Accepting Personal Responsibility
- Science: C - The Interdependence of Organisms
- Science: F - Natural Hazards
- Social Studies: IX - Global Connections (h)

2. **Introduce the game.** Explain that the game *Pet Detective* is based on the board game *Clue* ®. Instead of solving the murder of Mr. Boddy, students will be solving murder cases related to pets. There are six cases in all.
3. **Divide into groups and pass out playing pieces.** Divide students into groups of 3 - 6. If you have more than 30 students, ask some students to work in pairs. Each group will need a game board, *Who* tokens (6 pets), *How* tokens (6 causes of death), a die, a copy of *Pet Detective Notes* for each student, and a set of directions.
4. **Review the directions.**
5. **Pass out cases.** Give each group one of the *Pet Detective Cases*. Ask them to remove the cards from the envelope. The cards should remain face down at all times!
6. **Begin play.** Ask students to follow the directions and play the game. When someone in the group thinks he/she has identified *Who*, *How*, and *Where* ask him/her to tell you. Check the answer against the color-coded solutions sheet. Reward extra points if someone in the group can identify the victim. Obviously, students will not be able to figure out all the details revealed in the solution scenarios. Give the students the solution cards and encourage them to read the *How did it happen?* and *Not just a game!* sections.
7. **Play again.** If there is time, allow them to switch murder cases with another group and play again.
8. **Debrief.** Ask groups to share their cases. Invite students to discuss their feelings about keeping exotic pets.

Assessing Student Learning

Observe student participation in the game and class discussion. Assign students to find a recent story about problems with exotic pets or domestic pets as it relates to their status as invasive species. You might want them to search newspapers or Internet news sites for animal-related diseases (zoonoses) like monkeypox, Newcastle's disease, Lyme disease, or rabies.

Extending the Learning

Find exotic pets on the WWW. The Internet has opened all kinds of possibilities for trade in exotic pets. Challenge students to a contest to see who can find the most outrageous pet available on the Internet. After you vote to see who won the contest, discuss the pros and cons of owning such a pet.

Pet Detective Directions

Object of the Game

Be a pet detective and solve a murder mystery. You must determine who is the murderer, how the murder occurred, and where.

Materials

- game board with *Where* locations (woods, pond, driveway, flowerbed, backyard, front yard, great room, study, sunroom)
- die
- *Who* tokens (Mr. Green's Iguana, Mrs. White's Tropical Fish, Miss Scarlet's Cat, Colonel Mustard's Wolf-dog, Professor Plum's Python, Mrs. Peacock's African Gray Parrot)
- *How* tokens (Mistaken Identity, Bacterial Infection, Competition, Suicide, Decapitation, Strangulation)

Getting Started

1. Set up the game board by placing each *Who* token on its matching "start" square.
2. Obtain a *Pet Detective Case* from your teacher. Don't look at the cards! The envelope contains all of the *Who*, *How*, and *Where* cards except one of each. These three missing cards are the solution to your case. It is your job to deduce who did it, how it was done, and where it happened by determining which cards are missing from your deck.
3. Shuffle the cards and deal them face down around the table. It doesn't matter if some players receive more cards than others.
4. Look at your cards secretly. Because they're in your hand, they can't be involved in the crime!
5. Take a copy of *Pet Detective Notes*, and, so no one can see what you write, fold it in half. Find the column for your case number and check off the cards that are in your hand.

Taking a Turn

Miss Scarlet's Cat always plays first. Play proceeds, in turn, to the first player's left.

When it is your turn, roll the die and move the number of squares on the die. You may move in any direction. You may not land on a square that's already occupied by another pet. You can only enter a room through a door.

Making a *Wild Guess*

As soon as you arrive at a new location, take a *Wild Guess*. By making *Wild Guesses* throughout the game, you try to determine—by process of elimination—which three cards are missing from your deck. To make a *Wild Guess*, move a *Who* token and a *How* token into the location that you just entered. Then suggest that the crime was committed in that location, by that pet, using that method.

Don't forget to suspect all pets, including yourself!

Proving *Wild Guesses* True or False

As soon as you make a *Wild Guess*, your opponents, in turn, try to prove it false. The player to your left looks at his or her cards to see if one of the three things you just named is there. If the player has one of the cards, he or she must show it to you and no one else. If the player has more than one of the cards named, he or she selects just one to show you.

If that player has none of the cards that you named, the chance to prove your *Wild Guess* false passes to the next player on the left.

As soon as one opponent shows you one of the cards that you named, it is proof that this card cannot be missing from the deck. End your turn by checking off this card on your *Pet Detective Notes*. If no one is able to prove your *Wild Guess* false, you may either end your turn or make an *Accusation*.

Making an *Accusation*

When you think you've figured out which three cards are missing from the deck, you may, during your turn, make an *Accusation* and name any three cards. Say, "I accuse (Who) of committing the crime in (Where) by (How)." Then, check with your teacher to see if you are right.

If your accusation is right . . .

If you guessed all three (Who, How and Where) correctly, you win the game!

If your accusation is wrong . . .

If even one of your three guesses is wrong, you can't win. Don't tell anyone the solution. You can still prove other players' *Wild Guesses* false by showing your cards when asked. Other players can still move your token around the game board.

Pet Detective Notes

Case Number	1	2	3	4	5	6
Who?						
Mr. Green's Green Iguana						
Mrs. White's Tropical Fish						
Miss Scarlet's Cat						
Colonel Mustard's Wolf-dog						
Professor Plum's Python						
Mrs. Peacock's African Gray Parrot						
How?						
Mistaken Identity						
Bacterial Infection						
Competition						
Suicide						
Decapitation						
Strangulation						
Where?						
Woods						
Pond						
Driveway						
Flowerbed						
Backyard						
Front yard						
Great room						
Study						
Sunroom						

Pet Detective Notes

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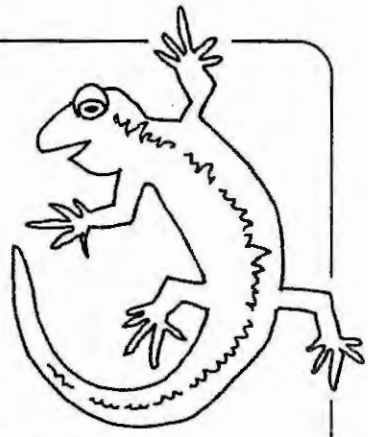
Strangulation						
Where?						
Woods						
Pond						
Driveway						
Flowerbed						
Backyard						
Front yard						
Great room						
Study						
Sunroom						

Pet Detective Case 1



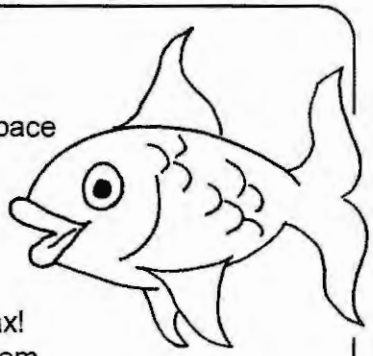
Who did it? Mr. Green's Iguana **How?** Bacterial infection

Where? Study **Who was harmed?** Human child

How did it happen? The eternal bachelor, Mr. Green, decided he was lonely and opted for a housemate from the Animal Kingdom. Always a fan of exotic animals, Mr. Green was thrilled to find a green iguana for sale at a nearby pet shop. Unfortunately, Mr. Green didn't research his new reptilian friend. Therefore, he did not know that his green iguana, like most reptiles, carried salmonella bacteria. Mr. Green always washed his hands after handling the iguana, but when his nieces and nephews came for a visit, he forgot to remind them to do the same. After an afternoon of playing with Mr. Green's scaly friend, his youngest nephew fell ill with salmonellosis. Unfortunately, his infected nephew didn't recover from the infection.

Not just a game! The number of human cases of salmonellosis has skyrocketed – all thanks to a popular new exotic pet, the green iguana. Green iguanas are native to Central America. Like most reptiles, iguanas naturally carry small amounts of salmonella in their intestinal tracts. The bacteria rarely cause any illness in the reptiles themselves. However, pet owners often give their iguanas antibiotics to try to keep them salmonella-free. Unfortunately, the frequent use of antibiotics has led to the development of resistant strains of salmonella. The salmonella transfers to the iguana's human caretakers through the animal's fecal matter, or through scratches and bites. Most cases of salmonellosis are mild (i.e., diarrhea, fevers, and cramping), but it can be fatal if the infection enters the blood stream or nervous system.

Pet Detective Case 2



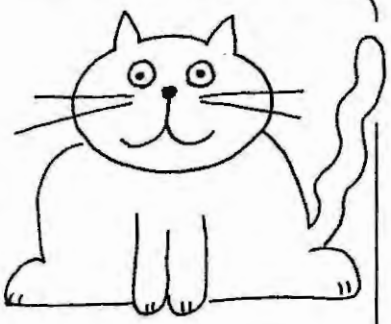
Who did it? Mrs. White's Tropical Fish **How?** Competition for food and space

Where? Pond **Who was harmed?** Native fish

How did it happen? For her retirement, Mrs. White's friends bought her an aquarium with all the accessories and 10 species of tropical fish. Although Mrs. White appreciated the gesture, she didn't want the burden of caring for such exotic fish. She was hoping to travel and relax! Since she did not want to kill the fish, Mrs. White decided to release them quietly in a nearby pond, hoping that her friends would never find out. A few months later, however, one of Mrs. White's friends lamented that many of the native fish she loved to watch were disappearing. "In fact," the friend confided, "there are entirely new fish taking over the pond! They look ever so much like some of the fish we gave to you! By the way, how are your fish doing?"

Not just a game! Recently, divers found 16 species of non-native fish residing in the waters off Florida's southeast coast. Among them were fish from as far away as the western Pacific Islands and the Red Sea. While there is a slight possibility that some of these fish might have arrived in ballast water, it is much more likely that they were released from aquariums. Flushing *Nemo* down the toilet or emptying an aquarium in a local pond is not a responsible way to get rid of fish that a pet owner no longer wants.

Pet Detective Case 3



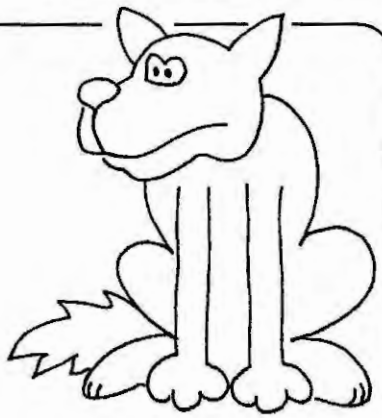
Who did it? Miss Scarlet's Cat **How?** Decapitation

Where? Front yard **Who was harmed?** Songbirds

How did it happen? When Miss Scarlet adopted her cat, Ruby, from the Humane Society, she promised that she would give Ruby a good home, fresh food, and freedom. When the weather is nice, Miss Scarlet lets Ruby outdoors to get some fresh air and practice her tree climbing skills. And when Miss Scarlet isn't watching, Ruby sneaks over to the bird feeder for a little snack.

Not just a game! Loss of habitat due to human activities is the leading cause of declining bird populations. However, scientists now list invasive species as the second most serious threat to birds worldwide. Ruby and her feline friends are an invasive species that were brought to America in the late 1880s to help control a growing rodent population. Since then, populations of outdoor pet cats, stray cats, and feral cats have skyrocketed. The exact number of birds killed by cats each year is hotly debated, but cat predation certainly adds to the pressures birds face.

Pet Detective Case 4



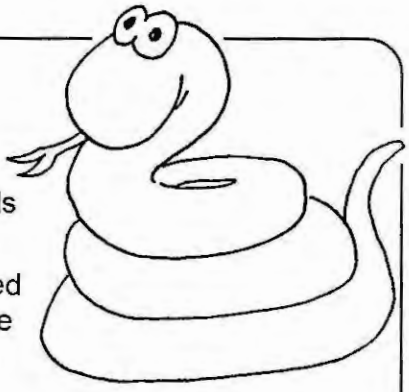
Who did it? Colonel Mustard's Wolf-dog **How?** Mistaken identity

Where? Woods **Who was harmed?** Wild wolf

How did it happen? Colonel Mustard wanted to enhance his tough-guy image. He could have opted for a tattoo or a motorcycle, but decided that he needed something more unique. One day, Colonel Mustard found the "solution" to his image problem – he could buy a wolf-dog puppy! Right from the start, the puppy was a handful, but Colonel Mustard was a firm believer in discipline. He knew that obedience school would take care of everything. As time went on, however, he realized that his pet required more care and time than he could provide. He reasoned that since the animal was half wolf, it would be able to survive in the wild. One day, while out walking, the wolf-dog managed to "escape" from his collar. At first, the wolf-dog had a difficult time finding food, but then it found a sheep farm and began taking lambs on a regular basis. The farmer caught a glimpse of the wolf-dog and reported to local authorities that a wolf was killing his lambs. The authorities had no choice but to trap and kill a local wild wolf.

Not just a game! Wolf-dogs are hybrids of wild wolves and domestic dogs. They pose several problems for people, wolves, and other animals. As pets, wolf-dogs grow up to be unpredictable and dangerous. Since they can't be trusted, they often end up in shelters or abandoned. When released into the wild, their predatory instincts combined with their lack of fear of humans often lead them to look for food where people live. Hungry wolf-dogs are likely to attack humans, pets, and livestock. Besides giving wolves a bad name, wolf hybrids can occasionally interbreed with wild wolves. This interbreeding threatens the genetic purity of wolves.

Pet Detective Case 5



Who did it? Professor Plum's Python **How?** Strangulation

Where? Backyard **Who was harmed?** Native mammals

How did it happen? Professor Plum bought his pet python when it was just a youngster. It lived in an aquarium in his bedroom. He enjoyed taking it out for exercise and showing it to his friends. As the snake grew, it needed larger and larger aquariums. Professor Plum was at the local home improvement store buying some lumber and caging to build an even bigger enclosure when his pet python pushed its way to freedom. When Professor Plum got home, he started sawing and hammering. Meanwhile, his hungry pet python was swallowing an unsuspecting squirrel in the backyard.

Not just a game! Escaped and released snakes show up in amazing places – sewers, apartment building heating vents, parks, and even backyards! Some of these snakes are escapees; others were released when the owner could no longer take care of them. In the Florida Everglades, Burmese pythons are attacking alligators, mammals, and birds, including native mangrove fox squirrels and wood storks. They might also be competing with eastern indigo snakes – a threatened species in Florida. Large snakes even pose a threat to their owners! In 1993, a healthy 15-year-old boy was killed by a Burmese python. The boy was sleeping when the snake attacked. He fought hard, but the snake wrapped coils around his body and suffocated him.

Pet Detective Case 6

Who did it? Mrs. Peacock's African Gray Parrot **How?** Suicide

Where? Sunroom **Who was harmed?** Parrot

How did it happen? One day, Mrs. Peacock's exotic pet parrot began biting her own feathers. Mrs. Peacock noticed the feathers in the bottom of the cage, but she was consumed with plans for her daughter's upcoming wedding and thought that the bird was simply molting. After the wedding was over, she noticed that the parrot had a bloody spot on her breast. Now, Mrs. Peacock was worried and immediately rushed the bird to the vet. The vet gave the bird a very thorough and very costly examination. He ruled out all medical causes for the feather-mutilating behavior and suggested that Mrs. Peacock spend more time with her bird. Mrs. Peacock really didn't have time to figure out what kind of stress could be causing her parrot to self-mutilate; she barely had time to control the stress in her own life! To make a long story short, the parrot tugged, ripped, shredded, and bit until her feather follicles were destroyed. She eventually died from bacterial infections in the open sores.

Not just a game! Exotic birds are very challenging to care for in captivity. The most crucial period for behavioral development seems to be from the time they hatch until they are able to feed themselves. They need attention, exercise, entertainment, and careful monitoring. The choice to own an exotic bird should be made slowly and deliberately. In addition to doubts about one's ability to care for a demanding pet, there are other reasons to forgo an exotic bird. It is almost impossible to know for sure if the bird you are getting was born in captivity or taken from the wild. Wild populations of many exotic birds are in danger due to habitat loss and the pet trade. In addition, many birds smuggled for the pet trade die in transit. Exotic pet owner wannabes should consider whether it is worth that cost for them to own an exotic animal.

Miss Rumphius Revisited

Description

For years, we have looked to Miss Rumphius for inspiration. After all, one person can have an amazing impact on the local environment. But exactly what kind of impact did Miss Rumphius have? Did she beautify her part of the world or did she willfully broadcast non-native lupine seeds?

Getting Ready

1. Read the story.
2. Look over the items in the *Miss Rumphius Revisited* binder.
3. Look over the questions included in this lesson.

Introduction

How many of you are familiar with the story of Miss Rumphius? Many children grew up with this story. The author portrays Miss Rumphius as a kind, intelligent woman who lives an exemplary life. Through the story, the author has probably inspired quite a few people to do something to make the world more beautiful.

Doing the Activity

1. **Read and discuss the story.** Share the story of Miss Rumphius and discuss these questions.
   - What do you think of Miss Rumphius?
   - Do you know anyone like her?
   - Would you want her as your aunt? Why or why not?
   - Why do you think Barbara Cooney wrote this story?
2. **Find out more about wild lupine.** Pass out the pages from the *Miss Rumphius Revisited* binder. Each student should get at least one piece of information. If your class is small, give some students several of the pieces with fewer words. Instruct the students to read over their information and become very familiar with the content. Tell them that they are the only person in the room with that particular piece of information.

   Optional: In a classroom setting, the students could do their own Internet research on wild lupine instead of using the information in the binder. However, the Internet pages in the binder provide a wide spectrum of sources, purposes, and degrees of credibility.

Objectives

- Analyze literature in terms of its environmental message.
- Introduce the topic of personal ethics and choices as related to native and non-native plants.

Grades

9 – adult

Groups Size

Maximum 30

Prep Time

Minimal

Activity Time

Two 50-minute class periods

Setting

Classroom

Materials in Kit

- ***Miss Rumphius*** by Barbara Cooney
- binder with printouts of 30 Web sites

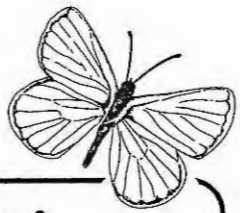
National Education Standards

See next page.

National Education Standards

Grades 9 - 12

- English Language Arts: 1
- English Language Arts: 8
- Environmental Education: 2.4.A, B - Environment and Society
- Environmental Education: 4.B,D - Personal and Civic Responsibility
- Science: C - Interdependence of Organisms
- Science: F - Environmental Quality
- Social Studies: II - Time, Continuity, and Change (e)
- Social Studies: IX - Global Connections (h)



Did you know?

Karner blue butterfly caterpillars are picky eaters! They will only eat the leaves of *Lupinus perennis*.

NNIS
Non-native Invasive Species

3. **Discuss the information in the binder.** Use the following questions to discuss Miss Rumphius and wild lupine. Encourage students to speak up if someone shares information that doesn't agree with what they have read.

Wildflowers evoke different reactions in different people.

- Based on the information you received, how do you feel about wild lupine?
- Would you grow wild lupine in your yard?
- What is the attraction to wild lupine?
- Did you learn anything about wild lupine that surprised you?

In the story, Miss Rumphius planted a few lupine seeds in her garden. They bloomed blue, purple, and rose flowers the next summer. The following spring, there were lupine flowers all over the place. Miss Rumphius said the wind and the birds had done it.

- From what you know about lupine, is this scenario possible? (Not really, lupine takes a while to establish. Also, lupine seeds are very large and not blown by the wind.)

Where you live matters so much! There are over 300 species of lupine in the world. Many species are native to western states. Our natives are someone else's potential invasives! Our invasives are native somewhere! Everything is native somewhere!

- Where do you think Miss Rumphius lived? (Maine)
- What kind of lupine do you think she planted? *(Lupinus polyphyllus)*
- Where is *Lupinus polyphyllus* native? Where is it introduced? Where is it invasive? (It is native to the Pacific Northwest, invasive in New Zealand, and being watched in several European countries.)

Lupines are important economically, ecologically, and aesthetically.

- What did you find out about how lupines are used?
- What is special about *Lupinus perennis* from an ecological standpoint? (This species is the only food source for caterpillars of the Karner blue butterfly.)

Miss Rumphius planted the seeds in her garden. They escaped and soon covered the surrounding countryside. We don't know if they invaded natural areas.

- What other plants have escaped this way? (Purple loosestrife, garlic mustard, kudzu, and buckthorn are examples of invasives that people first used for horticultural or agricultural purposes.)

- Do you think Miss Rumphius beautified the world or introduced a beautiful non-native species? Explain.

Miss Rumphius ordered her seeds from a seed catalog. She ordered five bushels.

- How many seeds could there be in five bushels? (In short, a lot. Exact information isn't available, but there are about 22,000 lupine seeds per pound. Assuming a bushel of lupine weighs about 50 pounds, one can make a rough estimate that Miss Rumphius planted 5,500,000 seeds!)
- How much land would it have planted? (Recommended seeding rates vary from 30 pounds per acre to 80 pounds per acre. She probably had enough seed to plant about 5 acres.)
- Any idea how much it might cost in today's dollars? (One pound of *Lupinus polyphyllus* costs about $15. If there are 50 pounds in a bushel, Miss Rumphius spent about $3750 on seed. *Lupinus perennis* costs about $23 per pound or $5750 for 250 pounds. If she bought *Lupinus polyphyllus* by the packet at 60 seeds for $1.89, her bill would have been $173,250!)

Right now, you can order seeds from all over the world on the Internet.

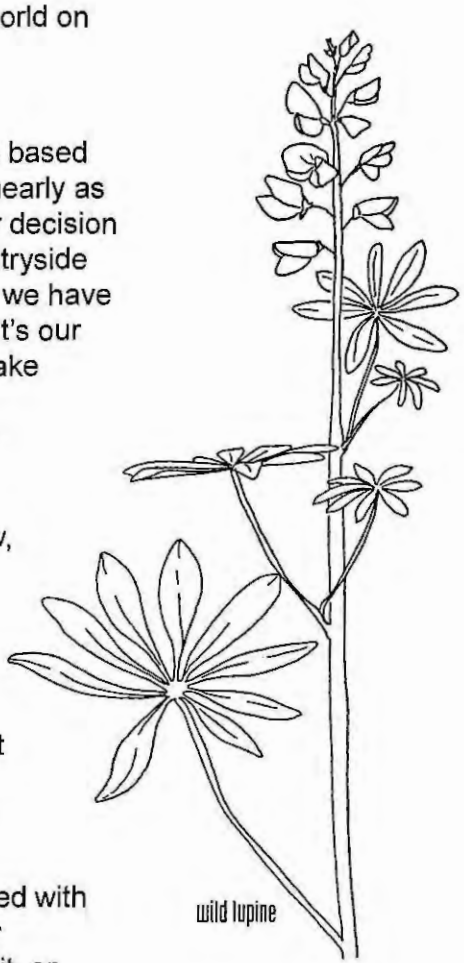
- What are some potential problems with that?

We can assume that the story of Miss Rumphius is based far in the past. Miss Rumphius wouldn't have had nearly as much information about lupine available to her. Her decision to spread lupines and their beauty around the countryside was probably simple. Today, as we have just seen, we have all kinds of contradicting information in our hands. It's our responsibility to sift through this information and make informed decisions.

- What can be the result of too little information?
- What about too much information?
- If Miss Rumphius knew then what we know now, do you think she would have scattered the seeds? Why or why not?

We are often faced with decisions that could influence the environment.

- Share some decisions that you made today that could affect the environment. For example, did you take a long shower, take the bus, or drink coffee in a disposable cup?
- What are some decisions that you could be faced with in regard to invasive or introduced species? For example, pick wildflowers, pull weeds, dump bait, or clean your hiking boots.



wild lupine

- How do we know when we are doing the "right" thing?

One person can have an amazing impact on the local environment and the world.

- Name people (world-renowned celebrities or local heroes) that have had a positive influence on the environment.
- What could you do?

People 100 years from now will have even more information.

- What might they think of the decisions we have made?
- Do you think they will be even more confused than we are? Why or why not?

Barbara Cooney probably never imagined that her book would be picked apart for its scientific accuracy.

- Why do you think Barbara Cooney wrote the book?
- Do authors have a responsibility to be scientifically accurate even when they might be writing for an entirely different reason? Explain your answer.
- *Miss Rumphius* was published in 1982. We didn't know as much about non-native species and their potentially devastating impacts as we do now. What is an author/journalist/reporter to do?

Look at the information that you received. All of this information was found using simple searches on the Internet.

- Does it tell the whole story?
- Is it clear who authored it, where it is from, and why it was written?
- The Internet puts us in touch with information written by people from all over the world. How do we decide what is credible?

Assessing Student Learning

Observe student participation in class discussions.

Extending the Learning

Evaluate Internet sites. Using one of the evaluation tools available on the Internet, encourage students to take a close look at Web sites. The following links will take you to two lesson plans designed to help students scrutinize the information they find on the WWW. <http://mciu.org/~spjvweb/evalwebteach.html> and <http://school.discovery.com/schrockguide/eval.html>

Inspired by Wrath

Description

After trying to manually control an invasive species, you 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!

Introduction

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.

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.
- 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 you have available.

Time

Varies with project.

Setting

Outdoors

Materials

Varies with project.

National Education Standards

Grades K - 4

- Environmental Education: 2.4.A - Human\Environment Interactions
- Science: B - Properties of Objects and Materials
- Social Studies: I - Culture (c)
- Social Studies: IX - Global Connections (a)

Grades 5 - 8

- Social Studies: IX - Global Connections (a)

Grades 9 - 12

- Environmental Education: 2.4.B - Environment and Society, Places
- Social Studies: IX - Global Connections (a)

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 Student 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 winter 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

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.

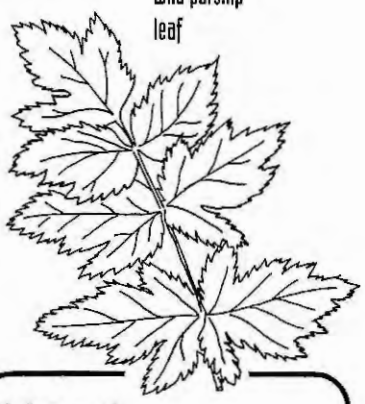
Purple Loosestrife

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.

wild parsnip leaf



Watch out!

Several invasive plants can cause skin irritations upon contact. Here are a few to watch out for:

- wild parsnip
- leafy spurge
- giant hogweed
- St. Johnswort
- yellow flag

NNIS
Non-native Invasive Species

Pounding Flowers and Leaves

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

Materials

- freshly-picked leaves [1] (garlic mustard, buckthorn, Russian olive or other invasives)
- 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. 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 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 for dyeing (cotton, linen, wool)
- aluminum potassium sulfate (alum)
- hot plate (2) or a firepit

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 (180^0 - 200^0 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

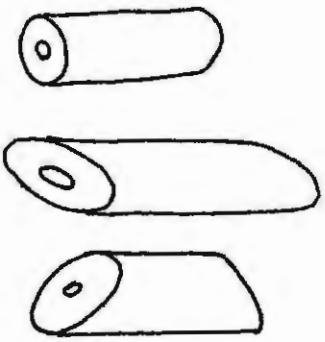
After removing shrubby invasives, take some time to make twig beads. Use the beads to make garlands, necklaces, or decorations for other art projects.

Materials

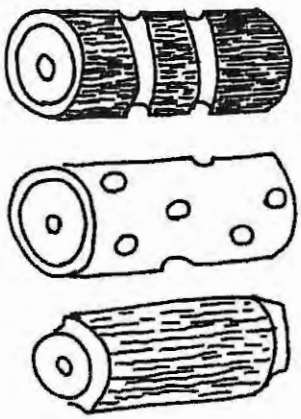
- a variety of twigs at least 3/8" in diameter (The more variety in color and texture, the more interesting the finished product.)
- pruning shears or saws
- vice or large clamps
- hammers and nails or drills and bits to hollow out center
- carving tools
- waxed dental floss

Directions

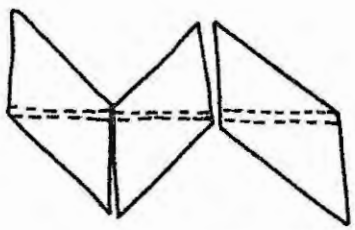
1. Cut the twigs into bead-sized lengths. Vary the diameter of the twig, the length of the bead, and the angle of the cut to make a wide assortment.
2. Make a hole through each bead. If the center is soft, use a nail and hammer. If the center is hard, you will have to drill a hole through the bead. Use 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.



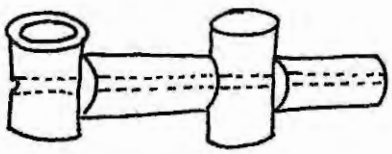
Cut beads at different angles for unique effects.



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

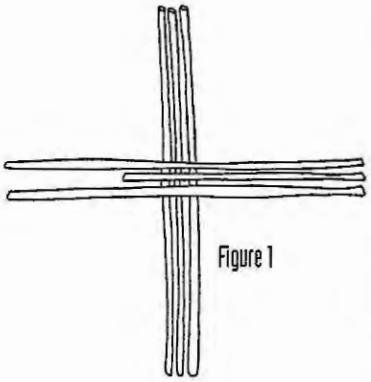


Figure 1

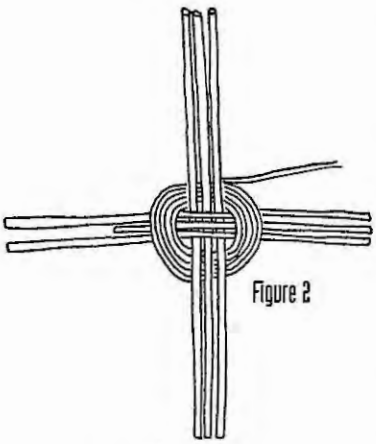


Figure 2

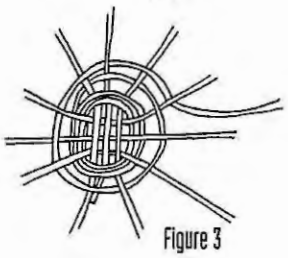


Figure 3

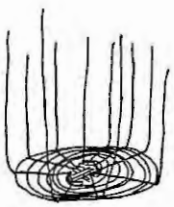


Figure 4

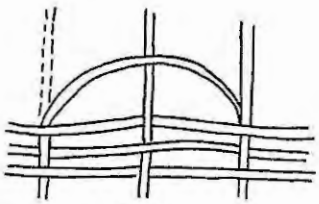


Figure 5

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 can become invasive in wetland areas.

Materials

- kudzu vines

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 over 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

Press the leaves 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

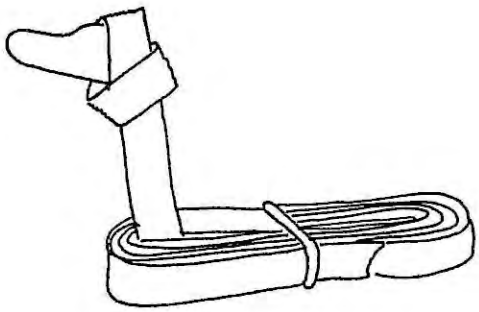
Use the roots and stems of the autumn olive to make strong walking sticks. Autumn olive is a beautiful wood!

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.

More Garlic Mustard Cooking Tips

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

- 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 keep the plant fresh until you are ready to use it. Then cut off the leaves, discard the flower stalk, wash, and use.

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
French sorrel and bronze fennel, one leaf each
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.

Cooking with Earthworms

Just like snails sound more appetizing when called escargot, the French call earthworms Ver de Terre. Here are the basics. Purge the worms by feeding them moist flour for 24 hours or by boiling repeatedly. Then:

- Chop them into pieces and substitute them for chicken or beef in casserole recipes.
- Bake the worms at 200° F for 30 minutes and then grind the dried worms into a protein-rich flour.
- Use worm flour like normal flour in baked goods.
- Use chopped dried worms instead of raisins or nuts in your favorite recipe!

Earthworm Chow

1 cup earthworms
1/2 large onion, chopped
1/2 cup water
1 bouillon cube
1 cup yogurt or sour cream
3 tablespoons butter
1/2 cup mushrooms
whole wheat flour

Wash earthworms thoroughly and place in boiling water for 3 minutes. Pour off water and repeat the boiling process twice. Bake on cookie sheet at 350° F for 15 minutes. Roll the worms in flour, brown in butter, add salt to taste. Add bouillon and simmer for 30 minutes. Sauté onions and mushrooms in butter. Add onions and mushrooms to the worms. Stir in sour cream or yogurt. Serve over rice or noodles.

Earthworm Patties

Patricia H. Howell's winning entry in a California Earthworm Recipe Contest is published in *Entertaining with Insects.*

1 1/2 pounds ground earthworms (Boil purged, live worms for 10 minutes, then grind.)
1/2 cup butter, melted
1 teaspoon lemon rind, grated
1 1/2 teaspoons salt
1/2 teaspoon white pepper
2 tablespoons soda water
1 egg, beaten
1 cup dry bread crumbs
2 tablespoons butter
1 cup sour cream

Combine earthworms, melted butter, lemon rind, salt, and pepper. Stir in soda water. Shape into patties and dip in beaten egg, then in bread crumbs. Place in heated butter and cook for 10 minutes, turning once. Place patties on hot serving dish. Serve with heated sour cream on top.

Cooking with Kudzu

Kudzu is not just for livestock forage. People can forage for the leaves and flowers, too!

Dried Kudzu

Dry only the smallest leaves. Place them between paper towels to absorb the moisture and microwave for 30 seconds, then flip. Continue microwaving and flipping until dry. Leaves are easy to burn, so watch carefully. Crumbled leaves can be used in your favorite bread or pasta recipes. Freeze them for longer storage

Kudzu Candy

Melt almond bark or flavored candy melts from a craft store in a double boiler. Add raisins, nuts, and crushed, dried kudzu leaves. Spread on a cookie sheet. Let cool completely and then break into pieces. Or pour candy into molds and cool completely.

Kudzu Jelly

from the kitchen of Flora Tolar

4 cups of kudzu flowers
1 teaspoon lemon juice
4 cups boiling water
2 boxes fruit pectin (Sure-Jell®)
5 cups sugar

Wash kudzu flowers in cold water, rinse, and drain. Put flowers in a large bowl, and pour boiling water over the blossoms. Refrigerate overnight. Strain and discard blossoms. Add lemon juice and SureJell to remaining juice; bring to a rolling boil. Add sugar and stir constantly. Bring to rolling boil again.

Boil for 1 minute. Pour liquid into sterilized jars, clean rim, and seal. Water bath 5 minutes in hot water.

Activity Crosswalk

	Activities	Biodiversity Index	Rival for Survival	Pet Detective	Miss Rumphius Revisited	Inspired by Wrath
Target Audiences	Preschool - Grade 1					■
	Grade 2 - 4					■
	Middle School	■	■	■		■
	High School	■		■	■	■
	Adult				■	■
Subject Areas	Science	■	■	■	■	■
	Social Studies				■	■
	Math	■				
	Language Arts				■	
	Fine Arts					■
Primary Teaching Methods	Hands-on Investigation	■		■		■
	Game/Simulation	■	■	■		
	Creative Expression					■
	Analysis/Synthesis				■	
	Discussion/Ethics		■	■	■	
	Story				■	
	Dramatic Presentation					
Logistics	Inside	■	■	■	■	
	Outside	■				■
	Time	three 50-minute class periods	one or two 50-minute class periods	one 50-minute class period	two 50-minute class periods	varies
	Group Size	maximum 30, divided into groups of 2-4	maximum 30, divided into groups of 3-6	maximum 30, divided into groups of 3-6	maximum 30	varies

	Activities	Biodiversity Index	Rival for Survival	Pet Detective	Miss Rumphius Revisited	Inspired by Wrath
Key Messages	Biodiversity	■			■	
	Identification/Adaptations	■		■	■	■
	Prevention		■	■	■	
	Early Detection/ Rapid Response		■			
	Control/Management/ Restoration	■	■			■
NNIS	Aquatic Ecosystems		■	■		■
	Terrestrial Ecosystems	■		■	■	■
	Invasive Plants	■	■	■	■	■
	Invasive Animals		■	■		■
Instructor's Knowledge of NNIS	Minimal Background		■	■		
	Average					■
	Advanced Knowledge	■			■	