Alice Ferguson Foundation's

BRIDGING THE WATERSHED

EXOTIC INVADERS

Assessing Exotic Invasive Species

An outreach program of the Alice Ferguson Foundation in partnership with the National Park Service and area schools that offers secondary school students opportunities to study real-world science in national parks.

Teacher's Guide & Resources

EXOTIC INVADERS

Assessing Exotic Invasive Species

Teacher's Guide & Resources

Alice Ferguson Foundation, 2001 Bryan Point Road, Accokeek, Maryland 20607
Phone: 301-292-5665 • Email: btwinquiries@fergusonfoundation.org • www.fergusonfoundation.org

Illustrations by: Mary Ellen Didion-Carsley, Media Art & Design Studio
Design & Artistic Production by: Media Graphics, Inc. • 7141 Rice Street • Falls Church, VA 22042 • www.designwithmgi.com

TABLE OF CONTENTS

MODULE ORGANIZER

This module is divided into three sections: activities completed prior to the park visit (Pre-Field Study), activities conducted in the park (Field Study), and activities completed subsequent to the park visit (Post-Field Study). In this module, students will learn about exotic invasive species, and how their introduction into an ecosystem diminishes biodiversity. The activities provide students with an opportunity to learn how to sample, how to identify exotic invasive species, and how exotic plants, animals, and pathogens impact human health and well-being.

Note: The teacher guide includes all the lessons, including student sheets. The student materials are included with the supplementary materials and can be printed out as needed.

TITLE	GOAL(S)	MATERIALS LIST
	PRE-FIELD STUDY	
• **Biodiversity: Variety of Life** • **The Biodiversity Game**	To understand biodiversity and its importance in an ecosystem.	Variety of Life: • Reading Lesson & Questions The Biodiversity Game • 1 wooden block game per group (or one per class) • 1 sheet of 54 plant and animal species stickers found in the Potomac River watershed (one for each block) • 1 sheet with 54 stickers of the same type of invasive species
Bean There, Done That	To learn the sampling technique students will use in their field study.	For each group of 3-4 students: • 50 mL assorted dried beans • Lid of a cardboard box (approximately 1 ft x 2 ft) • Pair of dice with two sides red, two blue, and two white
Interactive Web Site Activity: Plant Identification Decision Tree	To learn to identify plants using a decision tree and to become familiar with plants likely to be found in your field study habitat.	• Computer with Internet access
	FIELD STUDY	
Measuring the Invasion	• To identify plant species and diagram the distribution of individual plants in a given habitat. • To determine the relative percentages of native plants versus alien plants in that area.	• Appropriate clothing • Adequate food and drink • All other materials will be provided
	POST-FIELD STUDY	
Data Analysis	• To compile data from your group's study area and calculate the percentage of exotic invasive plants. • To compute the class average for percentage of exotic invasive plants in the site studied.	• Computer with Internet access (to compare with other data)
Performance List	To provide a tool for students to evaluate their work.	• Performance List

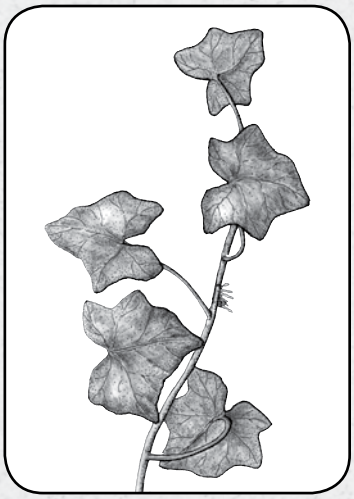
TITLE	GOAL(S)	MATERIALS LIST
	POST-FIELD STUDY	
Exotic Invasives: Is Your Town Next?	• To choose a pair of exotic invasive organisms to compare: 1) negative impacts they have on habitats they invade, 2) characteristics that make them successful invaders, and 3) methods they use to travel to new regions. • To decide if your chosen pair of exotic invaders could threaten your community.	• 1 red marker or colored pencil • 1 blue marker or colored pencil
Student Action Project: Take Action!	To increase awareness of the need for individual environmental action.	• Computer with Internet access
	RESOURCES	
• These resources will provide additional information on the subjects of all the activities. Teachers may use them for a personal reference, or may assign them to students for further reading.		

NOTE: *The overview module, "Potomac River Watershed: Water, Water, Everywhere," contains several activities that introduce the concept of a watershed and nonpoint source pollution that are excellent supplements to this module. "Who Polluted the Potomac?," also in the overview module, provides a basic understanding of nonpoint source pollution.*

Introduction to Exotic Invaders

BACKGROUND INFORMATION:

This module and the field study in the park are designed to heighten students' awareness about the watershed in which they live and to help them understand the important role they play in the health of the watershed. Activities focus on exotic invasive species and their impact on the balance of an ecosystem.



Goal:

To introduce students to the scientific concepts and activities in this module.

Class Time:

20 minutes

Special Considerations:

- Explain that the student sheets are used for recording data collected and responses to questions should be recorded.
- Although students may be working in groups, each student should keep and record his or her own answers.
- The Resources section provides all additional information needed to complete activities.
- Review the Bridging the Watershed website at fergusonfoundation.org.

Biodiversity: Variety of Life

ENGAGEMENT

BACKGROUND INFORMATION:

In this activity, students read to explore the concept of biodiversity and its importance to humans and to sustaining life on the planet. Stewardship of Earth's biodiversity is an important human responsibility. Biodiversity contributes to food, shelter, clean air, drinkable water, and health. Yet human activity contributes to the loss of biodiversity at a rapid rate through habitat destruction, exploitation, pollution, climate change, and the introduction of exotic species.

Students will be introduced to "exotic invaders" (i.e., non-native plant species) that impact local ecosystems.

PROCEDURE, QUESTIONS, AND POSSIBLE RESPONSES:

1. **The following paragraph is difficult to understand because letters have been removed. What letters are missing?**

   Bioiversiy is he variey of iving hings in an ecosysem. I incues he popuaions in a communiy, he species wihin hose popuaions, an every organism in each of hose species. Each organism may ea many ifferen organisms an/or be prey for many oher organisms. hus each member of he communiy fis ino a number of foo chains. Because he foo chains in a communiy overap, his se of inerocking foo chains is cae a foo web. he more compex a foo web (os of inerocking foo chains) he more sabe he foo suppy is for a members of he communiy. If one foo chain fas apar, he foo web si works an species survive. If a foo web is simpe (few inerocking foo chains), he oss of one foo chain may coapse he enire web, eaing o exincion of many species. Greaer bioiversiy eas o greaer sabiiy in ecosysems.

   Missing letters: T, L, D

2. **Think about how removing letters changed the paragraph. What if only one letter had been removed?**

   If only one letter had been removed, it would be easier to understand.

3. **Think of the letters in words as species in a food chain. How are the incomplete words analogous (similar) to food chains when species disappear?**

   A food chain would be disrupted or unbalanced and could become non-functional just as the paragraph becomes more meaningless as more letters are removed.

Goal:

To understand biodiversity and its importance in an ecosystem.

Class Time:

20 minutes

Group Size:

Groups of 2-3 students

Special Considerations:

Depending on the background of the students, you may need to review the concepts of an ecosystem and genetic diversity. Students should have some understanding of how species become extinct.

This activity can be done one of two ways or both ways. The first is by inserting the missing letters in the accompanying paragraph. The second is a game approach, using a Jenga™ game with labels representing native and invasive species. The goal of the second approach is to provide students with a visual understanding of how invasive species impact biodiversity.

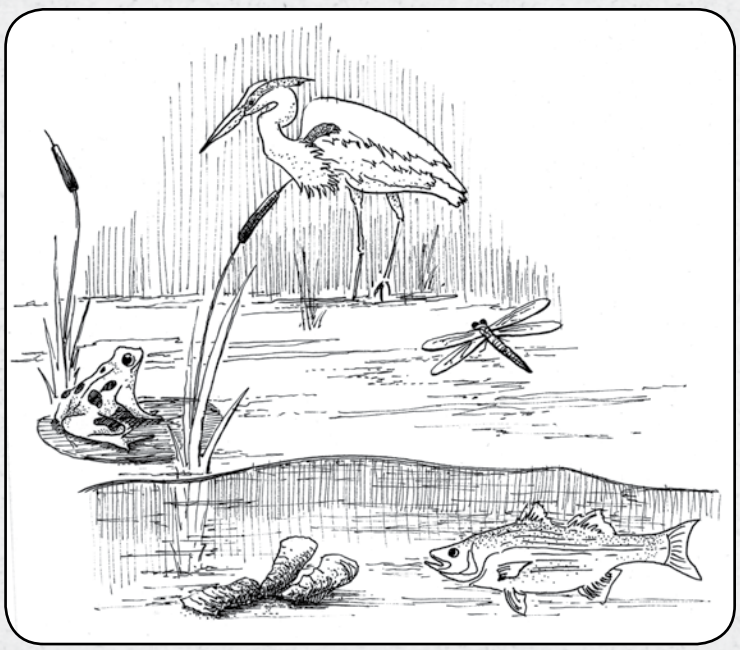
New terms and topics introduced in this activity:

- Ecosystem
- Keystone species
- Genetic diversity
- Biodiversity

Biodiversity: Variety of Life

ENGAGEMENT

4. **Try to insert the missing letters. Then re-read and summarize the corrected version of the paragraph.**



Biodiversity is the variety of living things in an ecosystem. It includes the populations in a community, the species within those populations, and every organism in each of those species. Each organism may eat many different organisms and /or be prey for many other organisms. Thus each member of the community fits into a number of food chains. Because the food chains in a community overlap, this set of interlocking food chains is called a food web. The more complex a food web (lots of interlocking food chains), the more stable the food supply is for members of the community. If one food chain falls apart, the food web still works and species survive. If a food web is simple (few interlocking food chains), the loss of one food chain may collapse the entire web, leading to extinction of many species. Greater biodiversity leads to greater stability in ecosystems.

5. **Read about biodiversity on pages 32-33 of your Resources. What human activities do you see in the list that could affect biodiversity where you live?**

   Habitat loss and destruction, over exploitation, pollution, climate changes, alterations in ecosystem composition, introduction of exotic (non-native) species.

6. **Are all exotic species invasive?**

   No. Only a small fraction of exotic species become invasive. However, it is difficult to predict which exotic species will invade, so it is prudent to avoid introducing exotic species to an ecosystem.

7. **Read about exotic invasive plants beginning on page 35 of the Resources section. Are exotic species a problem in your area? Explain.**

   Yes. Rock Creek National Park has Oriental bittersweet, porcelainberry, English ivy, and Japanese honeysuckle. Maryland has kudzu, multiflora rose, purple loosestrife, Tartarian honeysuckle, garlic mustard, autumn olive, Japanese stilt grass, tree-of-heaven, spotted knapweed, tear-thumb, water chestnuts, and Phragmites.

The Biodiversity Game

ENGAGEMENT

BACKGROUND INFORMATION

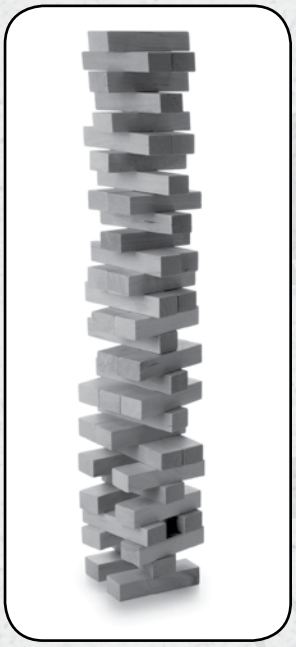
This variation allows students to explore the concept of biodiversity in a kinesthetic manner. By removing native species from an ecosystem and adding non-native, exotic invasive species, students see and understand how these actions may ultimately compromise the health and stability of an ecosystem. Students learn why biodiversity matters to an ecosystem and how the removal and/or addition of a new species affects the overall balance of an ecosystem.

PROCEDURE, QUESTIONS, AND POSSIBLE RESPONSES:

1. **The Jenga™ tower represents the Potomac River watershed ecosystem. Each block represents one different species in the ecosystem (list on page 6).**

2. **Take turns removing one block at a time. Removing one block represents the removal of one species from your ecosystem.**

   Every time a block is removed, the relative importance of the remaining blocks changes. As in any living, changing ecosystem, the role each block (species) plays in the stability of the tower is relative and constantly changing.



3. **After removing a species, students must introduce a new species to the ecosystem by replacing the block on top of the tower with an invasive species (list on page 7).**

   All blocks that are replaced on the top of the Jenga™ tower represent the same species. The ecosystem will gradually shift from one that is diverse to one that has all the same species.

4. **Collect data in a table. Keep track of the number of native species removed, and the number of new individuals introduced before the ecosystem collapses.**

Goal:

To understand biodiversity and its importance in an ecosystem.

Class Time:

20 minutes

Group Size:

Groups of 4-5. If materials are limited, the activity can be conducted by the entire class.

Materials List for Each Group:

- 1 Jenga™ game per group (or one per class)
- 1 sheet of 54 plant and animal species stickers found in the Potomac River watershed (one for each block)
- 1 sheet with 54 stickers of the same type of invasive species

Special Considerations:

You may need to review the concepts of an ecosystem and genetic diversity. Students should have some understanding of how species become extinct.

The Biodiversity Game

ENGAGEMENT

5. **Discuss the results. Have students read about biodiversity in the Resources section, and then ask them to explain what happened in their Potomac River watershed tower. Does this really happen in an ecosystem? What factors lead to species being removed from ecosystems? Could this happen in the Potomac River watershed?**

   Natural processes include succession, storms, floods, fire, habitat loss, changing climate conditions, predator/prey relationships, and competition with other species for resources. Human-induced activities include habitat destruction, exploitation, pollution, climate change, and the introduction of exotic species. This process is occurring in many watersheds, including the Potomac River watershed.

6. **Read about exotic plants in the Resources section. Are exotic species a problem in your area?**

   Yes. In most of the study sites there will be a long list of exotic plants. Students can research and report on one of the exotic invasive plants in their chosen study site.

EXTENSIONS:

- In preparation for the game, students can list the various kinds of resources within the Potomac River watershed for which organisms compete. Students can describe the ways in which two types of organisms may interact including competition and predator/prey.
- Students can "adopt" a native species to research for the game. When their species block is removed from the tower, they can report on why it is an important species in the ecosystem and what effect its removal might have on the Potomac River watershed.
- Students can research and choose the invasive species for the game and describe what characteristics give the exotic species an advantage over native species.
- Label a block "keystone" species and put it in a critical spot in the Jenga™ tower (lower edge). When this block is removed, it will collapse the food web and the entire ecosystem. Students can discuss the concept of "keystone" species and whether or not all species are an integral part of a healthy ecosystem.

POTOMAC WATERSHED NATIVE SPECIES AND EXOTIC SPECIES LIST

Native Plants	Native Animals	Invasives (Plant Only)
American Beech	American Bumblebee	Beefsteak Plant
American Elm	American Eel	Bush Honeysuckle
American Hornbeam	American Toad	Common Reed
American Sycamore	Bald Eagle	Creeping Euonymous
Butterfly Weed	Baltimore Checkerspot	English Ivy
Common Milkweed	Barred Owl	Garlic Mustard
Common Persimmon	Beaver	Gill-Over-the-Ground
Eastern Hemlock	Broad-Headed Skink	Hydrilla
Green Ash	Common Muskrat	Indian Strawberry
Hackberry	Common Whitetail Dragonfly	Japanese Barberry
Jack-In-The-Pulpit	Copperhead Snake	Japanese Honeysuckle
Joe Pye-Weed	Coyote	Japanese Knotweed
Mayapple	Diamondback Turtle	Japanese Stiltgrass
Mockernut Hickory	Eastern Cottontail	Kudzu
New York Ironweed	Eastern Mole	Lesser Celandine
PawPaw	Great Blue Heron	Mile-a-Minute
Red Maple	Green Frog	Mimosa Tree
Red Oak	Meadow Jumping Mouse	Multiflora Rose
Saltmarsh Cordgrass	Osprey	Norway Maple
Skunk Cabbage	Red Fox	Oriental Bittersweet
Spicebush	Red Salamander	Periwinkle
Trout Lily	Red-Tailed Hawk	Porcelainberry
Trumpet Honeysuckle	River Otter	Princess Tree
Turtlehead	Ruby-Throated Hummingbird	Purple Loosestrife
Virginia Pine	Small Milkweed Bug	Tree of Heaven
White Oak	Spicebush Swallowtail	Wineberry
Wild Grape	Zebra Swallowtail	Wisteria

The Biodiversity Game

ENGAGEMENT

EXAMPLE OF INVASIVE SPECIES

Kudzu	Kudzu	Kudzu
Kudzu	Kudzu	Kudzu
Kudzu	Kudzu	Kudzu
Kudzu	Kudzu	Kudzu
Kudzu	Kudzu	Kudzu
Kudzu	Kudzu	Kudzu
Kudzu	Kudzu	Kudzu
Kudzu	Kudzu	Kudzu
Kudzu	Kudzu	Kudzu
Kudzu	Kudzu	Kudzu
Kudzu	Kudzu	Kudzu
Kudzu	Kudzu	Kudzu
Kudzu	Kudzu	Kudzu
Kudzu	Kudzu	Kudzu
Kudzu	Kudzu	Kudzu
Kudzu	Kudzu	Kudzu
Kudzu	Kudzu	Kudzu
Kudzu	Kudzu	Kudzu

Bean There, Done That

EXPLORATION

BACKGROUND INFORMATION:

Students will be conducting a statistical sampling of a tiny measured area in the park. They will use the data they collect to assess the exotic invasive plant invasion. This activity will help them understand the concept of sampling.

PROCEDURE, QUESTIONS, AND POSSIBLE RESPONSES:

1. **Your group will find 5 random numbers from 1 to 18 by rolling the dice and using the following grid.** To find the first random number, roll the dice. Match the number on the uncolored die with the corresponding column number above the grid. Then, match the color on the other die with the corresponding color in the left column of the grid. Follow the column and row that you just located until they intersect. The number in the cell where they intersect is your first random number. (For example, a 4 and a blue would generate a 16 as a random number.) Find all five random numbers in this manner and record them in the row of five blocks below the grid. All random numbers must be different.

Grid	1	2	3	4	5	6
Red	1	2	3	4	5	6
White	7	8	9	10	11	12
Blue	13	14	15	16	17	18

Random Numbers	16	10	7	11	1

2. **Draw a grid of 18 sections of equal size on the inside of your lid. Use the same number pattern as shown in the grid in Step 1.**

3. **Your group will be given a handful of assorted dried beans.**

   Assume that each different type of bean is a different species. Assign each type of bean an abbreviation and describe its physical characteristics (e.g., BB = black bean; small, round, and black in color). Record this information on Table I: Bean Species. Your teacher will designate which beans are exotic invasives. Place a check in the "Exotic invasive" column for each of those species.

Goals:

- To understand the concept of statistical sampling.
- To learn the sampling technique you will use on your field study.

Class Time:

45 minutes

Group Size:

Groups of 3–4 students

Materials List for Each Group:

- 50 mL assorted dried beans
- Lid of a cardboard box (approximately 1 ft X 2 ft)
- Pair of dice (one die is colored red, white, and blue)

Special Considerations:

- To simplify the process of rolling dice to list five random numbers, use permanent magic markers to color two sides of one die red, two sides blue, and leave the remaining two sides white.
- Feel free to reduce the number of bean species if your students are new to the concept of sampling and need to learn the process rather than spend too much time learning the species codes.

Technology Connection:

- Take photos of the beans in the boxes instead of asking students to draw a map. Let students add labels to their photos to complete the activity.

Bean There, Done That

EXPLORATION

TABLE I: BEAN SPECIES

Species Symbol	Species Description	Exotic Invasive
TS	Tan, spots	
B	Black	✓
G	Green	
Y	Yellow	
WF	White, Flattened	
WB	White, Black spot	
BUR	Burgundy	
T	Tan	
TF	Tan, Flattened	
RO	Red, oval	✓
W	White	
TR	Tan, round	

New Terms and Topics Introduced in this Activity:

- Sampling
- Random numbers
- Physical characteristics
- Abbreviation

4. **Toss a handful of beans across the grid. Be careful not to move the tray after the beans have been tossed. The beans need to stay in the block where they landed. Each block represents a "sample" of how all the beans are distributed.**

5. **On Table II: Bean Distribution, fill in one of your random numbers at the top of each column.**

   Then fill in the rest of the sample #s with your four other random numbers.

TABLE II: BEAN DISTRIBUTION

Sample 1 Random # 7	Sample 2 Random # 10	Sample 3 Random # 16	Sample 4 Random # 11	Sample 5 Random # 1
TS TR TF	B B WB B G G Y	 B B T B B TR BBB T W T	 B B G G WB TS TF W	B T TS B B TF B B B

Bean There, Done That

EXPLORATION

6. **Now look at how the beans are spread in the numbered boxes on your grid. Find the corresponding number on the box lid and observe the distribution of the beans within it. Using the species symbols (Table I), diagram the location of each bean in the Sample 1 block. If a bean is on a line but 50% or more is within the sample area, then count it. Only count beans in the sample area.**

7. **Repeat this procedure for each of your samples.**

8. **Using the data from Table II, fill in Table III: Bean Data with the symbol and number of each bean type found in that sample.**

9. **Complete Table III. Compute and write the total for each species in the column labeled Total Species. For each exotic invasive species write this total again in the Total Exotic Invasives column. See table below for example data and computations.**

TABLE III: BEAN DATA

	Number of Each Species						
Species Symbol	Sample 1 Random # 7	Sample 2 Random # 10	Sample 3 Random # 16	Sample 4 Random # 11	Sample 5 Random # 1	Total Species	Total Exotic Invasives
TS	I			I	I	3	
B		III	~~III~~ II	II	~~III~~ I	18	18
G		II		II		4	
Y		I				1	
WF						0	
WB		I		I		2	
BUR						0	
T			III		I	4	
TF	I			I	I	3	
RO						0	
W			I	I		2	
TR	I		I			2	
					Totals	39	18

10. **Use the totals for "species" and "exotic invasives" in Table III and compute the percent exotic invasives present.**

    46% exotic invasives

11. **Why is the percent more useful than the total number?**

    The percent provides a better idea of the extent to which exotic invasives are present and makes it easier to compare one sample to another.

12. Review your results. Why was it necessary for you to gather data on multiple samples?

One sample will not provide as accurate a picture of the whole population as will multiple samples.

13. Look back to step 1 on page 4. What is the scientific reason for listing random numbers before the beans were tossed?

This is a way of choosing samples that are unbiased by the experimenter.

14. Based on what you learned in this activity, explain "sampling."

When an area is very large and the population too numerous to count, an accurate "estimate" of the relative percentages of the various species can be obtained by sampling.

If there is a wide range of species and no single species is overly abundant, it is clear that the community of organisms is in balance. If a single organism is invading and eliminating others, it is clear that the system is not in balance.

Plant Identification Decision Tree

EXPLORATION

BACKGROUND INFORMATION:

Most students do not have experience identifying plants. It is very important that they are introduced to a method of distinguishing one plant from another before the field study, such as the method explained on the AFF website activity. Practicing before the field study will greatly increase students' ability to complete the project successfully, to become fully engaged in the learning experience, and to feel that they are truly doing scientific research.

PROCEDURE, QUESTIONS, AND POSSIBLE RESPONSES:

1. **Go to http://fergusonfoundation.org/btw/plantid/habitats.shtml**

2. **Click on the habitat most similar to the one that your students will study in the park (woodland edge, meadow, or lowland forest).**

3. **Identify the six plants in your habitat and complete Table IV: Exotic Plants and Their Characteristics.**

   See Table IV on the following page.

Goals:

- To learn to identify plants using a decision tree.
- To become familiar with plants likely to be found in your field study habitat.

Class Time:

45 minutes

Group Size:

Individually or in groups of 2

Materials List for Each Group:

- Computer with Internet access
- Plant Identification Decision Tree

Plant Identification Decision Tree

EXPLORATION

TABLE IV: EXOTIC PLANTS AND THEIR CHARACTERISTICS

Habitat: Woodland Edge		Habitat: Meadow		Habitat: Lowland Forest	
English Ivy	Host for pathogens; dense cover that prevents other plants from germinating; injures trees by covering them thickly; uses water, space and sunlight that other plants need	Beefsteak Plant	Uses resources needed for other plants; grows quickly; difficult to eradicate; toxic to cattle	Porcelainberry	Host for pathogens; dense cover that prevents other plants from germinating; reduces air flow, which increases conditions for fungus infections
Oriental Bittersweet	Host for pathogens; dense cover that prevents other plants from germinating; reduces air flow, which increases conditions for fungus infections; causes trees to topple from the weight of the vines	Purple Dead-nettle	Uses resources needed for other plants; grows quickly; difficult to eradicate; out-competes crop seedlings	Oriental Bittersweet	Host for pathogens; dense cover that prevents other plants from germinating; reduces air flow, which increases conditions for fungus infections; causes trees to topple from the weight of the vines
Japanese Honeysuckle	Kills trees and shrubs by girdling, cutting off food and water	Musk Thistle	Uses resources needed for other plants; grows quickly; difficult to eradicate	Bush Honeysuckle	Alters natural field-to-forest succession; toxic to other seedlings; reduces air flow, which increases conditions for fungus infections; uses resources needed by other plants
Garlic Mustard	Competes in limited habitat of several endangered plants; reduces host plants for native insects; reproduces very quickly	English Plantain	Uses resources needed for other plants; grows quickly; difficult to eradicate	Multiflora Rose	Less nutritious than native plants for birds; alters natural field-to-forest succession; uses resources needed by other plants

Plant Identification Decision Tree

EXPLORATION

Habitat: Woodland Edge		Habitat: Meadow		Habitat: Lowland Forest	
Tree-of-Heaven	Alters natural field-to-forest succession; toxic to other seedlings	Field Garlic	Uses resources needed for other plants; grows quickly; difficult to eradicate	Common Reed	Displaces native wetland species; provides little food or shelter
Multiflora Rose	Less nutritious than native plants for birds; takes resources from native plants	Broad-leaved Plantain	Uses resources needed by other plants; grows quickly; difficult to eradicate; out-competes crop seedlings	Autumn-Flowering Clematis	Dense cover that prevents other plants from germinating; blocks light

Plan Wisely For Your Students' Field Study

ENGAGEMENT

BACKGROUND INFORMATION:

It is crucial that all students be prepared for the field study in the park. For many students, working outdoors will be an unusual and challenging experience. You should review the information in this section carefully with the class to help students prepare mentally for the field study and to ensure that they have the appropriate dress and supplies to be comfortable in the park. It may be beneficial to review this information several times before the park visit to be sure all students understand the required preparations and plan well for their visit. Listening to the weather and developing a what-to-wear list for the day is a great homework assignment or class discussion in advance of the field study. Some teachers opt to have students come to school a few days in advance, wearing their field study clothes with their backpacks packed for the field study.

Before the site visit, complete the activities in this module to ensure that all students understand the concept of a watershed, and review the directions for data collection in this module. The Resources section provides the information they will use in the park.

BE PREPARED FOR THE PARK VISIT:

Students need to be dressed appropriately and have adequate food and drink. Expensive clothes and shoes are not appropriate for work in the out-of-doors, and wearing these items makes students reluctant to engage in field studies. Advise students not to wear skirts, shoes with high heels, or sandals.

The AFF Educator and National Park Service Ranger will have all the supplies for the field study.

PARK INFORMATION:

Students can review information about the park and its history on the Bridging the Watershed website at fergusonfoundation.org.

THINGS TO BRING:

- There won't be a place to buy food. Students must bring a bag lunch and plenty to drink, preferably water. If given adequate notice, your cafeteria staff can help coordinate lunches for students on free or reduced-meal programs.
- The hotter the weather, the more students should bring to drink. Have students pack their lunch and drinks in a backpack or bag that they can easily carry into and out of the park study site.

Goal:

To help students plan and prepare for their **field** study in a local national park.

Plan Wisely For Your Students' Field Study

ENGAGEMENT

- Keeping in the ecology-minded spirit, suggest that students make their lunch as trash free as possible. Some areas and parks have no trash cans. What is packed in must be packed out.

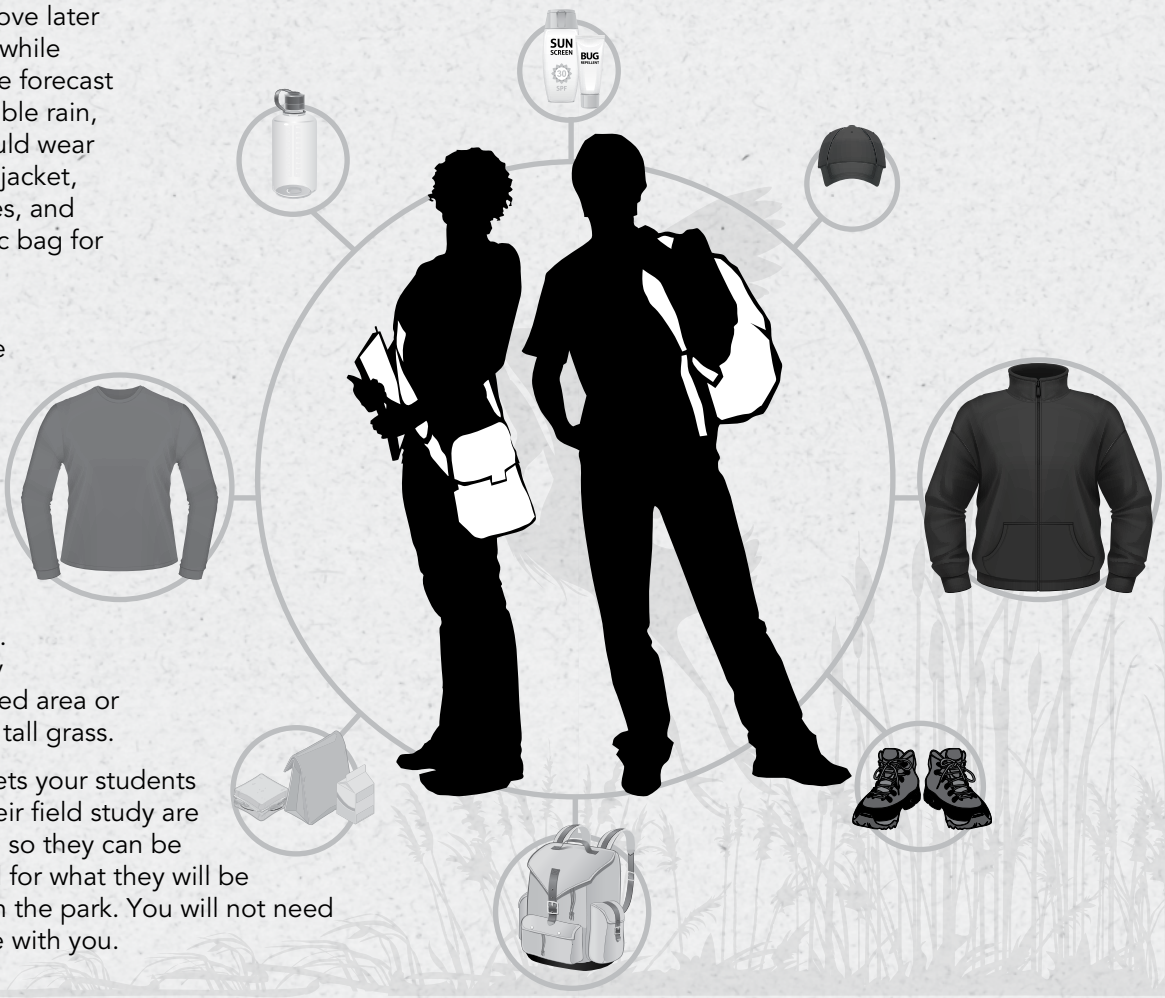
- Make sure that students bring sunscreen and insect repellent if desired.

PARK STEWARDSHIP:

- Remind students that collecting of any type is prohibited.
- Remind students to take only photographs and leave only footprints.

TIPS ABOUT CLOTHING:

- Students should wear comfortable clothing that allows them to easily move, hike, bend, and climb. Students may have to gather data in a wet and muddy environment, so they should choose clothes they don't mind getting wet and dirty.
- Dress for the weather. In cool weather, have students wear layers of clothing to keep them warm in the early morning, but that they can remove later in the day or while working. If the forecast calls for possible rain, students should wear a waterproof jacket, hat, and shoes, and bring a plastic bag for materials.
- Even in warm weather, have students wear long pants and a long-sleeved shirt for protection from poison ivy and briars. Students may be in a wooded area or walk through tall grass.
- The data sheets your students will use on their field study are included here so they can be well prepared for what they will be asked to do in the park. You will not need to bring these with you.



Bridging the Watershed

Exotic Invaders Datasheet

Date:

Park: Study Site:

Park Rangers & Educators: (one per row)	Group Members: (one per row)

Latitude: North _____ ° Longitude: West _____ °

Why is it important to know the latitude and longitude?

	Yesterday	Today
Air Temperature	° C	° C
Cloud Cover	☐ Clear ☐ Partly Cloudy ☐ Cloudy	☐ Clear ☐ Partly Cloudy ☐ Cloudy
Precipitation	☐ None ☐ Rain ☐ Other	☐ None ☐ Rain ☐ Other

How could weather affect today's field study?

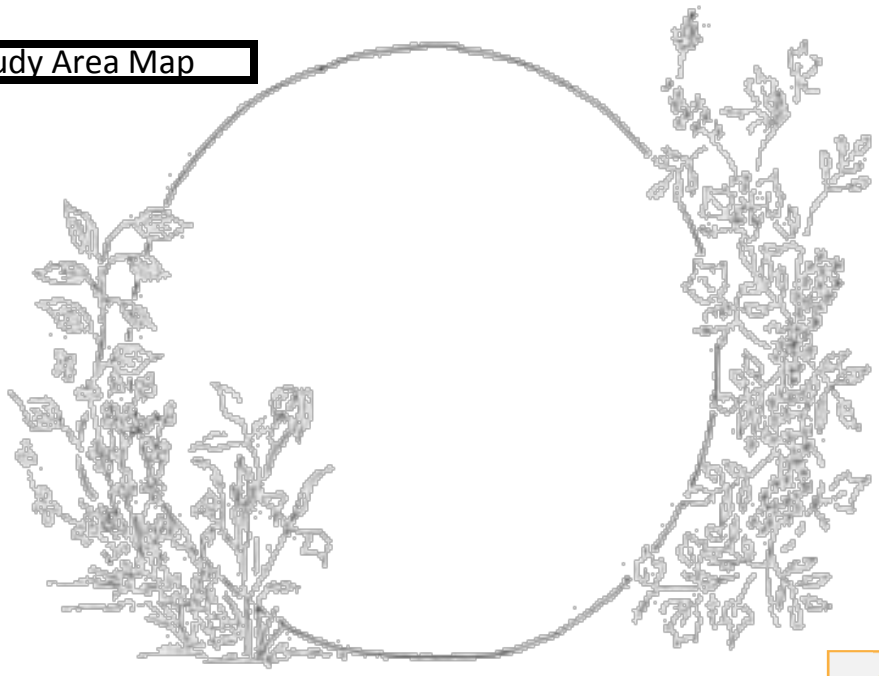
Sketch the study site, showing all details that affect your field study:

What features of your field study site might encourage invasive species?

Study Area Map

Describe each plant in 2-3 words (e.g. "woody vine"). Then give it an abbreviation (e.g. "wv"). Write "wv" in the diagram to the right in each place you see that plant.

Tip: if there are a lot of the same plant in one spot, use a number to indicate how many e.g. "wv-8".



After mapping the plants, use the field guide to identify each plant and determine if it's native or exotic.

Plant Description	Abbreviation	Plant Name	Total	Exotic?	Total Exotics
				☐	
				☐	
				☐	
				☐	
				☐	
				☐	
				☐	
				☐	
				☐	
				☐	
				☐	
				☐	
				☐	
				☐	
				☐	
		Total:		Total:	

Bridging the Watershed • www.fergusonfoundation.org

Measuring the Invasion

EXPLORATION

BACKGROUND INFORMATION:

Students will work in small groups in a designated study area to observe and count plant species, both native and exotic invasive. Your AFF educator and park ranger will mark off the study area and transect line and supply each team with necessary materials and equipment.

PROCEDURE:

Your AFF educator will have everything your students will need for their field study. Students should familiarize themselves with the field study procedure outlined below.

1. **Work in assigned groups to complete your data collection in the park. One person will record for the group.**

2. **The park ranger will set up a 20-meter transect that will cut across the middle of the study area. This line will define the area to be studied. The line will be marked in 1-meter intervals.**

3. **Complete the first page of the Data Sheet.**

   Sketch an overhead view of the general study area. Include the location of nearby features, such as rivers, creeks, and trails. Try to represent or indicate on your sketch such information as the slope of the land (flat, gentle, steep), canopy coverage (open sky, dense, or light tree coverage), soil texture (sand, clay, etc.) and moisture content (wet, dry, muddy), condition of vegetation (dry, trampled, chewed), and if there are any signs of animal use (scat, footprints, presence of insects). Then note any features of your study site that might encourage invasive species.

4. **The AFF educator will help your group determine a random number from 1 to 20.**

5. **Place your group's hula-hoop along the transect at the meter mark corresponding to your chosen number. For example, if your group is assigned the number 7, the hula-hoop should be placed along the 7th 1-meter section of the transect. The hula-hoop should touch the transect at least once.**

6. **After your group's hoop is in place, record its location on your sketch of the site.**

Goals:

- To identify plant species and diagram the distribution of individual plants in a measured plot.
- To determine the relative percentages of native plants versus exotic invasive plants in that area.

Class Time:

The field study will be completed in a single, minimum four-hour visit to a national park.

Group Size:

Students should be divided into groups of 4-5 for this activity before the trip.

Measuring the Invasion

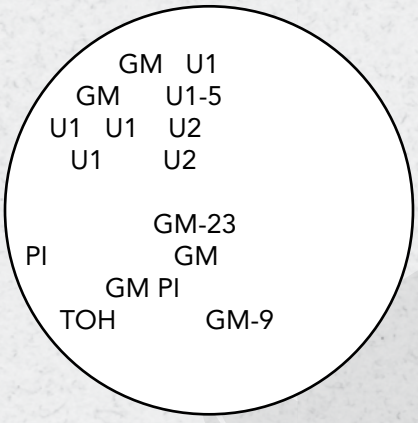
EXPLORATION

7. **Describe each plant species inside your hoop in as much detail as possible. Record your descriptions on page 2 of the data sheet and assign each plant an abbreviation, such as LT for a plant with long, thin leaves. Because all groups have to agree on descriptions and abbreviations in order to be able to complete the post-field study activities, one member of each group must meet with the representatives of the other groups to decide on a common abbreviation code for each plant.**

8. **The rest of the group members should begin to identify each species. Record each plant name on the chart. If you cannot identify the plant, assume it is native and call it unknown 1, unknown 2, etc.**

9. **Diagram the location of each plant inside your hoop using its abbreviation. There is a blank Individual Study Area Map on the top of page 2 of the data sheet for this purpose. If the plants form dense clusters of individuals, count the number of individuals and indicate this on your map using the plant abbreviation and the number present (see example below).**

EXAMPLE: INDIVIDUAL STUDY AREA MAP



10. **Record in the Total Plants column the number of each plant species you find.**

11. **Record in the Total Exotic Invasives column the total number of exotic invasive plants.**

12. **Compute the percentage of exotic invasive plants present and record your answer at the bottom of the page.**

Data Analysis

EXPLANATION

BACKGROUND INFORMATION:

Using the data they collected, each group will prepare a summary report describing the general health and conditions of the study area, focusing primarily on the plant population, the presence of exotic invasive species, and their effect on the area. Other classes, conducting similar tests, will be able to compare results.

When they have completed their written report, each group will use the self-evaluation form to rate its own work. You will also use the evaluation form to rate the work of each group and help you select the best report to send to the AFF educator. Remind students that, by contributing a real service to their community, their efforts can help improve the environment.

Groups can also access data from other classes on the Bridging the Watershed website at fergusonfoundation.org. This database offers an ongoing accumulation of comparative data about exotic invasive plant species for use in monitoring changes in populations.

PROCEDURE, QUESTIONS, AND POSSIBLE RESPONSES:

1. **Compute the percentage of exotic invasive plants for all groups by completing Table V: Class Total of Plants in Study Area.**

   Suggestion: Have each group report its findings orally and compute a class total for each species (exotic invasive and native).

2. **Each group will use the class data to prepare a report. Begin your report with the name of the park you visited, the date of your visit, and the name of the module. Define the study area and weather conditions using data from the data sheet, sketch of the site, site description, and the study area map.**

3. **For each exotic invasive plant your class found at the study site, examine the invasive characteristics and describe the potential effects on the native plants of your study site.**
4. **Students may want to learn more about exotic invasive species. Website resources are available at fergusonfoundation.org.**

Goals:

- To compile data from your group's study area and calculate the percentage of exotic invasive plants.
- To compute the class average for percentage of exotic invasive plants in the site studied.

Class Time:

90 minutes.

Group Size:

Same as field study group.

Materials List for Each Group:

Computer with Internet access

Data Analysis

EXPLANATION

TABLE V: CLASS TOTAL OF PLANTS IN STUDY AREA

Plant Name	Total Plants	Total Alien Plants
Totals		
	% Alien Plants	

5. **Refer to the student pages for a copy of the Performance List. Use the Performance List to evaluate your group's data collection efforts in the park and your final report.**

Using Performance Lists to Assess Student Work:

Performance lists are often used to assess and evaluate student work. Performance lists consist of criteria that define the essential elements of the performance and /or product and are used to "paint the target" for both students and teachers. Because of the design and intent of performance lists, feedback to students is analytical in that both strengths and weaknesses of the performance can be delineated. In the classroom, performance lists have proven to be the easiest assessment tools for the teacher to design and for the student to use. Typically, they are the first and most important step toward building other assessment tools, such as holistic and analytical rubrics.

The essential performance criteria provided in the performance list are defined in clear, concise, descriptive, and unambiguous language so that all audiences understand that target performance lists are often best used for self-assessment.

Once the criteria have been defined, you can "weight" the various elements of the performance by assigning different point values. This serves to draw attention to the most important criteria for a particular performance. For example, suppose you decide to assign a scale of 0–5 points to element #1, which states, "All group data are entered, and the percent exotic invasive plants present is accurately determined." Element #1 clearly defines one essential component of the performance and can be scored anywhere between 0 and 5 points. Element #2 states, "All class data are entered, and an average percent of exotic invasive plants for the class is accurately determined." By contrast, this task is assigned a 0 -10 point value. Obviously, element #2 receives greater emphasis for this particular performance. Thus, the various elements of the performance can be "weighted" depending upon the goals of the teacher. Points for all criteria can be totaled at the end and used for student revision and/or assignment of grades.

Performance List

EXPLANATION

Group Members_____ Date _____

Performance Criteria	Assessment		
	Points	Group	Teacher
1 All group data are entered, and the percent exotic invasive plants present is accurately determined.			
2 All class data are entered, and an average percent of exotic invasive plants for the class is accurately determined.			
3 The summary report begins with a detailed description of the study area and weather conditions.			
4 Along with the summary of class data, a descriptive assessment of the invasive characteristics and potential effects on native plants is included.			
5 The summary is clear, concise, and accurately reflects the findings of the study.			
6 Scientific terminology and concepts are accurately explained and applied to illustrate major points of the report.			
7 Visual aids (photographs, charts, graphs, drawings, etc.) enhance the understanding of the text.			
8 Visuals are clearly titled, labeled, and referenced within the text.			
9 Language used in the report is purposeful, descriptive, and appropriate for the intended audience.			
Total			

Teacher Comments:

Exotic Invaders on the Move: Is Your Town Next?

ELABORATION

While in the national park, you studied some of the exotic invasive plants that inhabit this region. Many other types of organisms besides plants can be invasive, and the problems they cause should concern all of us. The following paragraph, excerpted from President Clinton's 1999 Executive Order, addresses this issue:

"Many Americans are all too familiar with gypsy moths and other non-native insects that devour our gardens and trees. Few realize, however, that countless other non-native plants and animals are upsetting nature's balance, squeezing out native species, causing severe economic damage, and transforming our landscape. Those affected range from Western ranchers plagued by a weed called leafy spurge to Chicago homeowners whose stately maple trees have fallen prey to the Asian long-horned beetle. Some experts estimate the cost to the American economy to be as high as $123 billion a year."

The following is a list of random pairs of exotic invasive organisms. Some are dangerous to humans, but most are harmless and even beautiful or otherwise interesting. Think about how something might be beautiful or interesting and still be a threat.

Goals:

- To choose a pair of exotic invasive organisms to compare:
  1) negative impacts they have on habitats they invade,
  2) characteristics that make them successful invaders, and
  3) methods they use to travel to new regions.
- To decide if your chosen pair of exotic invasive organisms could threaten your community.

Materials List for Each Group:

- Computer with Internet
- 1 red marker or colored pencil
- 1 blue marker or colored pencil

Exotic Invaders on the Move: Is Your Town Next?

ELABORATION

Invasive Flora	Invasive Fauna	Pathogens
Porcelainberry *Ampelopsis brevipedunculata*	Chinese Mitten Crab *Eriocheir sinensis*	White Pine Blister Rust *Cronartium ribicola*
Oriental Bittersweet *Celastrus orbiculatus*	Northern Snakehead *Channa* argus	Dutch Elm Disease *Ophiostoma ulmi*
Kudzu *Pueraria montana var. lobata*	Zebra Mussel *Dreissena polymorpha*	Sudden Oak Death *Phytophthora ramorum*
Japanese honeysuckle *Lonicera japonica*	Emerald Ash Borer *Agrilus planipennis*	White Nose Syndrome *Geomyces destructans*
Tree-of-Heaven *Ailanthus altissima*	Hemlock Woolly Adelgid *Adelges tsugae*	Southern Bacterial Wilt *Ralstonia solanacearum r3b2*
Garlic Mustard *Alliaria petiolata*	Asian Stink Bugs *Halyomorpha halys*	
Purple Loosestrife *Lythrum salicaria*	Rapa Whelk *Rapana venosa*	
Mile-a-Minute *Persicaria perfoliata*	Grass Carp *Ctenopharyngodon idella*	
Multiflora Rose *Rosa multiflora*	Parasitic Bee Mite *Varroa destructor*	
Japanese Stiltgrass *Microstegium vimineum*	European Earthworms *Lumbricus rubellus*	
Scotch Thistle *Onopordum acanthium*	Red Imported Fire Ant *Solenopsis invicta*	
Leafy Spurge *Euphorbia esula*		
Eurasian Water Milfoil *Myriophyllum spicatum*		
Hydrilla *Hydrilla verticillata*		
Phragmites *Phragmites australis*		
Wineberry *Rubus phoenicolasius*		
Water Hyacinth *Eichhornia crassipes*		
English Ivy *Hedera helix*		
Amur Honeysuckle *Lonicera maackii*		

Exotic Invaders on the Move: Is Your Town Next?

ELABORATION

PROCEDURE AND QUESTIONS:

1. **Choose one pair of exotic invasive organisms from the list on page 25. Record the names of your organisms on Table VI: Notes on Exotic Invasive Invaders on page 27.**

2. **Find out as much as you can about your organisms, including their negative impacts on the habitats they invade, the characteristics that make them successful invaders, and how they travel to new regions. Find out how humans have made the invasion easier. Record the information on Table VI.**

3. **Continue your research to find out how natural resource managers are dealing with removing or controlling the spread of your exotic invaders. Additional website resources are available at fergusonfoundation.org. List your findings below.**

Organism 1:_____ Organism 2: _____

_____ _____

_____ _____

_____ _____

_____ _____

4. **Construct a graphic organizer to display all the information you gathered.**

5. **Determine the "original range" of each of your organisms. The original range includes the areas of the world where the organism originally lived. Two world maps have been provided on pages 28 and 29; use one map for one of your organisms and the other map for your second organism. Color the original range of each organism blue.**

6. **Now find out the geographic areas into which each of your organisms has spread or the new places where they live. Color these areas red.**

Exotic Invaders on the Move: Is Your Town Next?

ELABORATION

TABLE VI: NOTES ON EXOTIC INVASIVE INVADERS

Name of Organism	Name of Organism
Notes	Notes

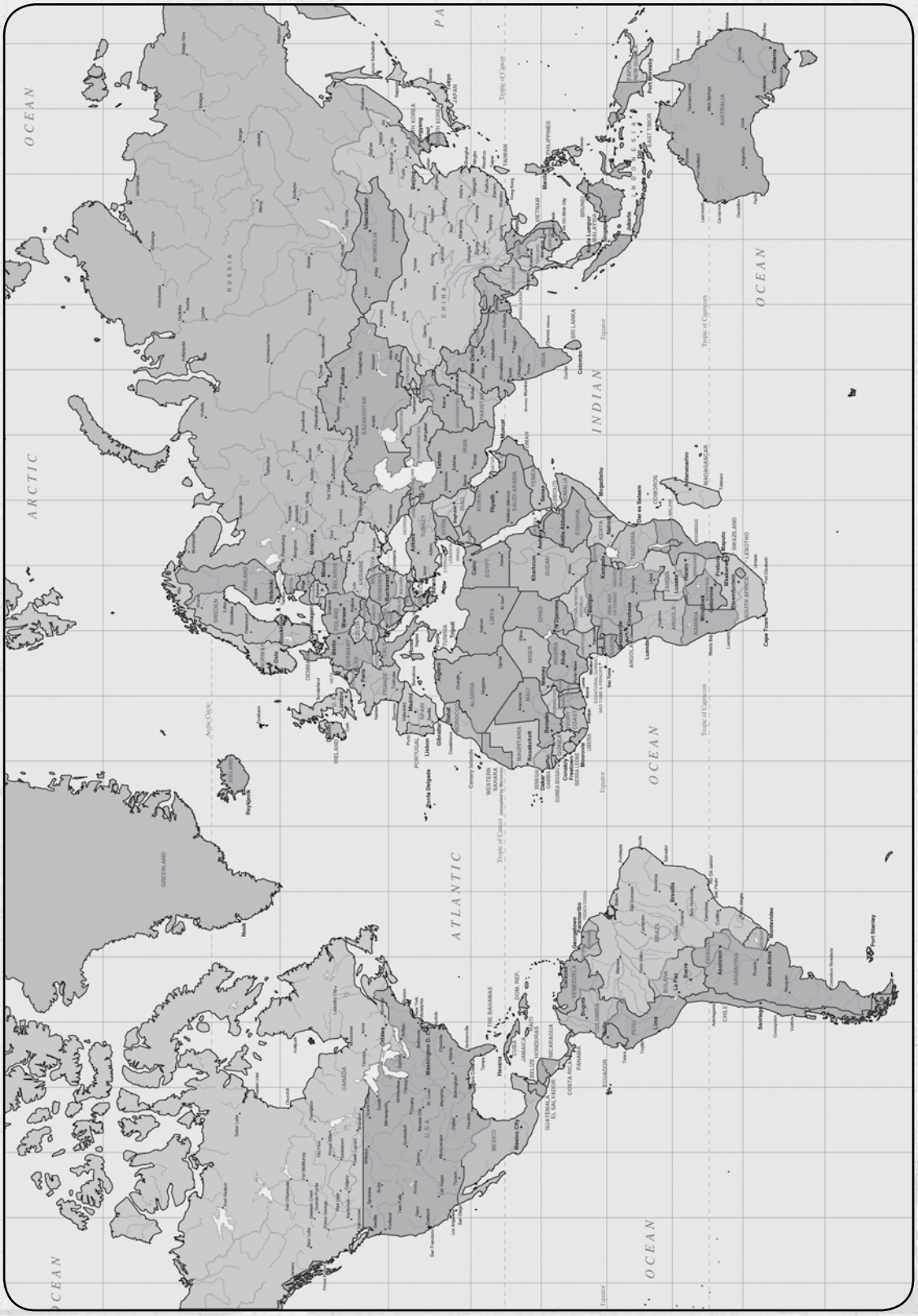
7. **Is either of the organisms you studied already in your community? If so, which organism(s)?**

8. **What effects could their presence have on human health or environmental health?**

Exotic Invaders on the Move: Is Your Town Next?

ELABORATION

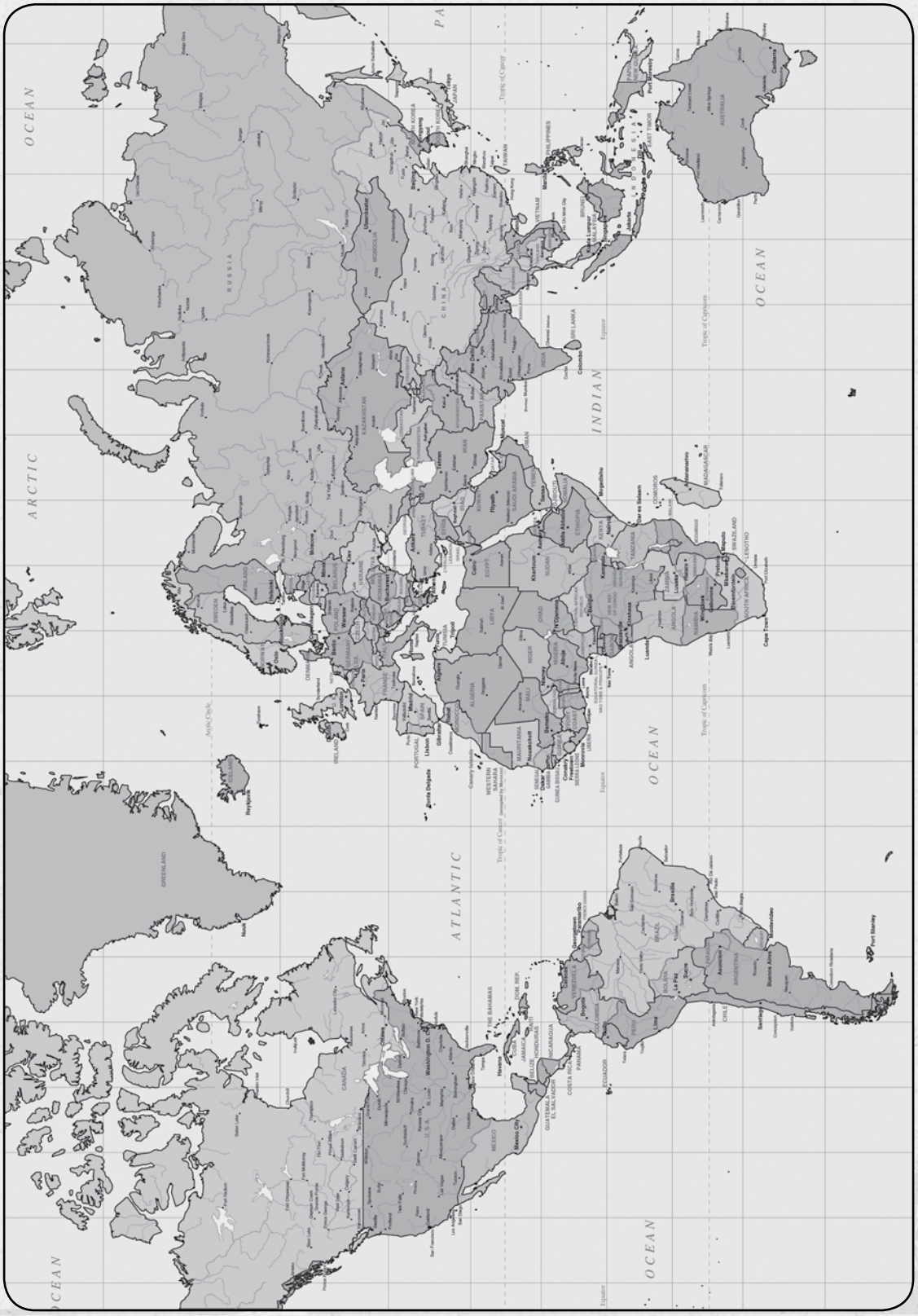
Organism 1:_____



Exotic Invaders on the Move: Is Your Town Next?

ELABORATION

Organism 2:_____



Student Action Project: Take Action!

ELABORATION

BACKGROUND INFORMATION:

Your students have looked at the problems caused by exotic invasive species in the Potomac River watershed. Recognizing a problem is the first step to solving it. The next step is to take what they've learned and apply that knowledge at the local level in the community.

During the field study in the park, students investigated a portion of their local watershed. This module and the field experience in the park were designed to heighten students' awareness and help them understand the important role they play in the health of their watershed. The choices they make about how to interact with their environment make a long-term difference, not only to the area in which they live, but also to the watershed as a whole.

TAKE ACTION!

Visit the BTW website to find information on how to take on a watershed action project. We provide some step-by-step instructions, but students provide the inspiration and execution.

Goals:

- To increase awareness of the need for individual environmental action.
- To "act locally" and get involved in a service project.

What Your Class Can Do:

When students are ready to take the challenge, there are many great ways they can get involved. The first step is to head to the BTW website and check out our detailed guide on organizing a student-led conservation project.

Resources

Biodiversity Defined

The word "biodiversity" is derived from a combination of the prefix "bio," meaning "living," and the word "diversity," meaning variety. Thus, biodiversity is the variety of living things in an area. Biodiversity includes all populations in a community, all the species within those populations, and every individual in each of those species. Biodiversity also includes the variety of genes contained in a population that are consistently re-shuffled when individuals reproduce. Biodiversity includes the interactions of the organisms in an ecosystem with each other and with their environment. There are three levels of biodiversity:

1. Genetic diversity – all the different genes contained in all individual plants, animals, fungi, and microorganisms. Genetic diversity occurs within a species and between different species.

2. Species diversity – all the differences within and between populations of species, as well as between different species.

3. Ecosystem diversity – all the different habitats, biological communities, and ecological processes. Ecosystem diversity also includes variation within individual ecosystems.

THE IMPORTANCE OF BIODIVERSITY

The Ecological Society of America calls for every human being to be responsible for the stewardship of Earth's living things. The diversity of life enriches the quality of our lives. The diversity of life allows all organisms to take advantage of the resources available. Humans depend on Earth's biodiversity for our survival.

As humans, we get food from many species. We rely on insects, birds, and other animals to pollinate plants. Parasites and predators are natural pest controls. We use forest products and fibers such as wool and cotton for shelter, warmth, and protection. Decomposers recycle organic materials and maintain the productivity of the soil. Most of our breathable oxygen is a byproduct of plant photosynthesis. Biodiversity also contributes to our health. Many of our medicines are derived from biological sources. In addition, biodiversity provides models for research on the solutions to human heath problems.

Threats to Biodiversity

Species are becoming extinct at the fastest rate known in geological history. Many of the extinctions are related to human activity. The threats to biodiversity include:

1. Habitat loss and destruction
   - Often a direct result of human population growth and economic development.
   - Often the result of pollution.

2. Over–exploitation of resources
   - Over–hunting.
   - Over–fishing
   - Over–collecting.
   - Clear–cutting of forests.

3. Climatic changes
   - There is no disagreement among scientists that climate change, as a result of global warming, is caused by humans and, more specifically, by the burning of fossil fuels.
   - May be related to deforestation.
   - May be related to increase in heat-holding substances (e.g., more concrete).

4. Alterations in ecosystem composition
   - Changes in soil type, vegetation, or water availability caused by humans.
   - Change in territory size compared to organism populations.
   - Eradication of "predator" or "pest" species by humans.

5. Introduction of an exotic (non-native) species
   - Competes with native species for limited resources (plants and animals).
   - Mates with native species (these animals are the same/similar species).
   - Infects native species (plants and animals) with new diseases.
   - Actively kills native species.

How Exotic Invasive Species Survive and Impact a New Environment

The success of a native species within its natural ecosystem is the result of millions of years of adaptation through natural selection. Thus, it is difficult for most organisms to survive outside their native habitats. In cases where a non-native species does survive in a new area, it usually has an advantage in its new home because it has none of the predators, competitors, parasites, or diseases that kept its population in check in its native habitat.

A non-native species can alter the composition of an entire ecosystem by decreasing populations of rare species and changing or degrading the functioning of the ecosystem in many ways. Exotic invasive animal species can eat native species. If they are very closely related to a native species, they can change the genetic make-up of a population by mating with native species. Herbivorous mammals, such as

Exotic: Porcelainberry

goats, rabbits, pigs, and horses, can threaten native species by transforming scrublands and forests into grasslands or reducing the available nutrients. In agricultural production, invasive plants may out-compete crops for soil and water resources, reduce crop quality, and interfere with harvesting. On rangelands, invasive plants may crowd out more desirable and nutritious forage, cause soil erosion, and poison some wildlife and livestock species. Invasive plants can smother native vegetation or change the timing and severity of fires and floods. In addition, invasive species, both plants and animals, may introduce pathogens and parasites that can eliminate a dominant native.

Exotic: Oriental Bittersweet

Exotic Invasives in the United States

There are approximately 50,000 non-native species in the United States. Some species were intentionally brought into the United States, while others entered accidentally. A rapidly increasing human population has led to greater distribution of invasive species. People take their plants and animals with them when they move into new regions. Increased demand for food and fiber and the overuse of public lands for recreation and commercial purposes have also contributed to the non-native invasion. Finally, flooding can transport non-native aquatic and marsh species to new regions.

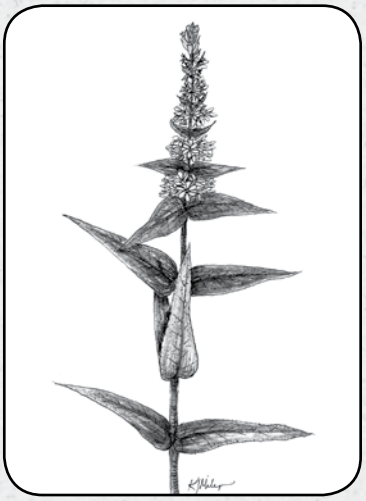
Exotic: Kudzu

The kudzu vine was brought into the United States from Japan and China to control soil erosion. It is now killing native plants throughout the Southeast. European colonists brought European birds such as starlings and English sparrows to the New World. Game fish have been transferred to stock sport fisheries. Hundreds of marine animal species have been moved globally by the transfer of edible oysters for "replanting." The gypsy moth escaped from a research lab in Boston in the 1860s and has defoliated vast amounts of forest in the northeastern United States. The sea lamprey, introduced accidentally into the Great Lakes through the Erie Canal, has decimated populations of native fish. Purple loosestrife, an ornamental plant native to Europe, is displacing wetland vegetation. The European zebra mussel attaches itself to boats, pipes, and shells of other mollusks to invade aquatic habitats throughout the eastern United States where it is changing the invaded habitat and causing native clams to starve to death. Leafy spurge, native to Asia and Europe, infests almost 2.5 million acres of North America. It causes severe irritation of the mouths and digestive tracts of cattle and can even result in death. The increased trade in unusual pets, including aquarium species, introduces a variety of species that may escape or be released by uninformed owners.

On Native Ground By Alice Lukens, excerpt from The Baltimore Sun

Brenda Belensky…natural resources manager for the Howard County Department of Recreation and Parks has nothing against the European import [purple loosestrife] per se. In bloom, they have pretty magenta-colored spikes that attract bees and butterflies. But when she sees a sprig of loosestrife, she thinks about each plant… producing as many as 2.5 millions seeds a year, primed by years of evolution to spread and multiply and crowd out native American plants. And then her mind turns to the other foreign plants that have similar tendencies, and the enormity of the invasion in the county and around the state, and her powerlessness to stop it.

Borne by wind, water and birds, aided by human ignorance, non-native, or "exotic," plants from Europe, Asia and Africa are spreading across the landscape. And scientists like Belensky say they have neither the money nor the manpower to stop it.



Exotic: Loosestrife

"Some biologists feel that non-native invasives pose the greatest threat to the ecosystem on the planet," Belensky said. "They are disrupting the ecology, replacing the natives, competing for light and nutrients. It's kind of like somebody stealing something without you even knowing it."

Nationally, non-native species cost the economy as much as $123 billion a year, President Clinton said in February [1999] after signing an executive order directing federal agencies to expand their efforts to combat the environmental threat.

Marc Imlay, invasive exotic plants committee chairman for the Maryland Native Plant Society, said exotic invasive plants make up 30 percent to 90 percent of the ground cover in Maryland's parks. …He said it might be possible to control three-fourths of the invasive exotics, but it would take 10 times the present effort.

"Therefore, …our future is out there pulling them, spraying them, replacing them, introducing biological controls, conducting research on better methods of control, and preventing their introduction in the first place," Imlay said.…

[Belensky] is most worried about a multiflora rose invasion at the old Smith Farm in Columbia, a kudzu patch at Rockburn Branch Park in Elkridge, a flood of purple loosestrife at the Font Hill community park in Columbia, proliferating mile-a-minute, and Tartarian honeysuckle at the Middle Patuxent Environmental Area in Columbia. She also has her eye on invasive garlic mustard, autumn olive, Asiatic stilt grass, tree of heaven, spotted knapweed, and tear-thumb. Even the country flower, Queen Anne's lace, is a non-native plant, she said, though not a particularly invasive one.

STATE VOLUNTEER EFFORTS

The [Maryland] State Department of Natural Resources has two major programs to stem invasive exotics: one battling water chestnuts in portions of the Bird and Sassafras Rivers, the other battling phragmites, or tall grasses, on the Eastern Shore in areas that abut the Chesapeake Bay.

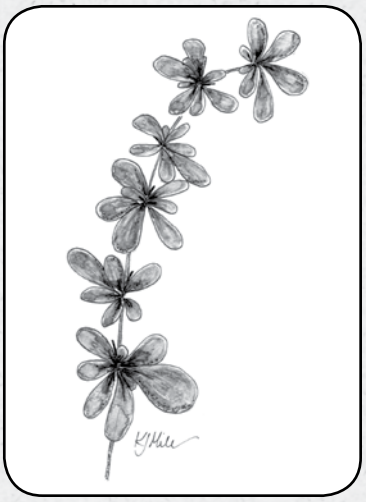
Volunteers work at places like Rock Creek Park, Patapsco Valley State Park, Battle Creek Cypress Swamp in Calvert County, and Ruth B. Swann Park in Charles County. Imlay said volunteers are also organizing at Sandy Point State Park in Anne Arundel County and Wheaton Regional Park in Montgomery County.

Louisa Thompson, an Ellicott City master gardener and a member of the Maryland Native Plant Society, became so concerned about the problem, …that she decided to start a volunteer conservation stewardship program in Patapsco Valley State Park. Since April, she has organized efforts to clear exotic invasives from different parts

of the park. …Volunteers tackled garlic mustard, which crowds out native wildflowers. …They pulled wineberry and planted trees in its place. [Next] … they have turned their efforts on Japanese stiltgrass before it goes to seed. …

"We're interested in native plants not just because we love them," [Thompson] told a recent group of volunteers, "but because they form the foundation for the food web." She talked about the ways seeds can spread: by wind, by water, especially during a flood; in the beaks of birds, the soles of hikers' boots, the treads of bike tires. And she talked about animals, like butterflies, that can suffer as a result.

"The plants just spread so fast that it's hard to keep up," she said, acknowledging that she sometimes feels powerless in the face of rampant plant invasion. "There is no public agency that has enough staff to deal with this." But Thompson is an optimist who believes that if humans care enough, they can stem the problem. "We really will have to start a movement, create a real change of attitude both in the public and private areas," she said.



Exotic: Barberry

Pulling Together

Excerpts from Pulling Together, a National Strategy for Invasive Plant Management, published by the Federal Interagency Committee for Management of Noxious and Exotic Weeds

Of the thousands of introduced plant species established in the United States, 1400 are scientifically recognized as pests. Currently 94 kinds of foreign weeds are officially recognized as Federal Noxious Weeds and many more species are designated on state noxious weeds lists. Experts estimate that invasive plants already infest well over 100 million acres and continue to increase by 8 to 20 percent annually. This means 3 million acres, an area twice the size of the state of Delaware, are lost to invasive plants each year. In particular, invasive plants are recognized as a direct threat to agricultural production and biodiversity in the United States. Our croplands, rangelands, forests, parks, preserves, wilderness areas, wildlife refuges, and urban spaces all are adversely impacted by invasive plants. The habitat of fully two-thirds of all threatened and endangered species is threatened by invasive species.

Invasive plants have encroached upon millions of acres in every region of the country, causing billions of dollars in lost revenue and control costs. In 1993, total direct control costs for noxious weeds were an estimated $3.6 to $5.4 billion annually, with an additional $1 billion in indirect costs. In agricultural production, invasive plants outcompete crops for soil and water resources, reduce crop quality, interfere with harvesting operations, and reduce land values. The estimated annual loss in productivity of 64 crops is $7.4 billion. On rangelands, invasive plants crowd out more desirable and nutritious forage, cause soil erosion, and poison some wildlife and livestock species. In natural areas, invasive plants reduce habitat for native and endangered species, degrade riparian areas, create fire hazards, and interfere with recreational activities. Aquatic invasive plants clog lakes and waterways and adversely affect fisheries, public water supplies, irrigation, water treatment systems, recreational activities, and shipping.

Any effort to devise a response to this serious national problem must bring together a complex set of interests that includes private landowners, industry, and government agencies at all levels. Fortunately, there are numerous examples of cooperative efforts to control invasive plants based at the local or regional level that bring together the people who have a stake in protecting their lands. The challenge facing us is to create public awareness of this issue and focus public and private resources to implement these models of cooperative action on a scale commensurate to meet this serious invasion.

Invasive plants, commonly called harmful, noxious, or weedy plants, are a serious problem in the United States, causing billions of dollars in damages annually to agricultural, recreational, and tourist industries. These plants severely threaten biodiversity, habitat quality, and ecosystem functions—the very basis of our natural heritage. Invasive plants are growing out of control in our parks, preserves, and refuges, and in our rangelands, forests, agricultural fields, and urban green spaces. Our public natural areas are being lost at an estimated rate of 4,600 acres per day to invasive species. Aquatic invasive plants such as hydrilla and water hyacinth choke our lakes and waterways. Kudzu in the Southeast, purple loosestrife in the Midwest, mile-a-minute vine in the Northeast, and yellow star thistle in the West are just a few examples of the hundreds of invasive plants of foreign origin that have been introduced in this country, accidentally or intentionally, and have since raged out of control.

Exotic: Indian Strawberry

The National Strategy for Invasive Plant Management outlines a nationwide effort to stem the tide of potentially invasive plants arriving in the United States; to control or eradicate those that are already a problem; and to restore full function to our degraded agricultural lands, rangelands, forests, and ecosystems. This Strategy proposes three national goals: prevention, control, and restoration.

Exotic Invasives Among Us

By Howard Youth, excerpt from The Washington Post, 4/14/99

THE GREEN INVASION

To many Washingtonians, Rock Creek Park seems a narrow but pristine paradise running through the heart of our frenetic urban landscape. To Susan Salmons, it's a war zone. Salmons, the park's vegetation management specialist, combats the relentless march of non-native plants. Armed with herbicides, she and a part-time assistant fight weeds gone wild. It's an uphill battle. In the early 1990s, a survey revealed that 36 percent of the park's 656 plant species were introduced species.

Exotic: Japanese Honeysuckle

The plants we're most concerned about are tree vines—Asian bittersweet, porcelainberry, English ivy and Japanese honeysuckle," Salmon says. "For us, those are the 'big four.'"

These fast-growing, temperate-weather plants flourish in the region's fertile soils, overwhelming native species. Having spread into the park from nearby gardens, many of the vines are decades old and blanket large areas, blotting out native plants and dragging down trees during windy storms…

Exotics may be harmful or beneficial, depending on where they grow. Sometimes, they can be both at once. Hydrilla, an Asian and African water weed that can grow as much as 10 inches a day, gives local boaters and botanists fits. It grows into thick mats that tangle in boat motors and block sunlight from native aquatic plants. But waterfowl love it… some waterfowl species eat the plant; others dine on the many invertebrates, fish and other creatures, that live in it… Waterfowl numbers… are up along the Potomac River, where hydrilla mats attract a wide variety of species.

Student Pages

Biodiversity: Variety of Life Procedure

1. **The following paragraph is difficult to understand because letters have been removed. What letters are missing?**

   Bioiversiy is he variey of iving hings in an ecosysem. I incues he popuaions in a communiy, he species wihin hose popuaions, an every organism in each of hose species. Each organism may ea many ifferen organisms an/or be prey for many oher organisms. hus each member of he communiy fis ino a number of foo chains. Because he foo chains in a communiy overap, his se of inerocking foo chains is cae a foo web. he more compex a foo web (os of inerocking foo chains) he more sabe he foo suppy is for a members of he communiy. If one foo chain fas apar, he foo web si works an species survive. If a foo web is simpe (few inerocking foo chains), he oss of one foo chain may coapse he enire web, eaing o exincion of many species. Greaer bioiversiy eas o greaer sabiiy in ecosysems.

2. **Think about how removing letters changed the paragraph. What if only one letter had been removed?**

3. **Think of the letters in words as species in a food chain. How are the incomplete words analogous (similar) to food chains when species disappear?**

4. **Try to insert the missing letters. Then re-read and summarize the corrected version of the paragraph:**

   Biodiversity is the variety of living things in an ecosystem. It includes the populations in a community, the species within those populations, and every organism in each of those species. Each organism may eat many different organisms and /or be prey for many other organisms. Thus each member of the community fits into a number of food chains. Because the food chains in a community overlap, this set of interlocking food chains is called a food web. The more complex a food web (lots of interlocking food chains), the more stable the food supply is for members of the community. If one food chain falls apart, the food web still works and species survive. If a food web is simple (few interlocking food chains), the loss of one food chain may collapse the entire web, leading to extinction of many species. Greater biodiversity leads to greater stability in ecosystems.

5. **Read about biodiversity on pages 32-33 of your Resources. What human activities do you see in the list that could affect biodiversity where you live?**

6. **Are all exotic species invasive?**

7. **Read about exotic invasive plants beginning on page 35 of the Resources section. Are exotic species a problem in your area? Explain.**

Bean There, Done That Procedure and Tables

1. **Your group will find 5 random numbers from 1 to 18 by rolling the dice and using the following grid.**
   To find the first random number, roll the dice. Match the number on the uncolored die with the corresponding column number above the grid. Then, match the color on the other die with the corresponding color in the left column of the grid. Follow the column and row that you just located until they intersect. The number in the cell where they intersect is your first random number. (For example, a 4 and a blue would generate a 16 as a random number.) Find all five random numbers in this manner and record them in the row of five blocks below the grid. All random numbers must be different.

Grid	1	2	3	4	5	6
Red	1	2	3	4	5	6
White	7	8	9	10	11	12
Blue	13	14	15	16	17	18

Random Numbers					

2. **Draw a grid of 18 sections of equal size on the inside of your lid. Use the same number pattern as shown in the grid in Step 1.**

3. **Your group will be given a handful of assorted dried beans.**
   Assume that each different type of bean is a different species. Assign each type of bean an abbreviation and describe its physical characteristics (e.g., BB = black bean; small, round, and black in color). Record this information on Table I: Bean Species. Your teacher will designate which beans are exotic invasives. Place a check in the "Exotic invasive" column for each of those species.

TABLE I: BEAN SPECIES

Species Symbol	Species Description	Exotic Invasive

Bean There, Done That Procedure and Tables

4. **Toss a handful of beans across the grid. Be careful not to move the tray after the beans have been tossed. The beans need to stay in the block where they landed. Each block represents a "sample" of how all the beans are distributed.**

5. **On Table II: Bean Distribution, fill in one of your random numbers at the top of each column.** Then fill in the rest of the sample #s with your four other random numbers.

TABLE II: BEAN DISTRIBUTION

Sample 1 Random # 7	Sample 2 Random # 10	Sample 3 Random # 16	Sample 4 Random # 11	Sample 5 Random # 1

6. **Now look at how the beans are spread in the numbered boxes on your grid. Find the corresponding number on the box lid and observe the distribution of the beans within it. Using the species symbols (Table I), diagram the location of each bean in the Sample 1 block. If a bean is on a line but 50% or more is within the sample area, then count it. Only count beans in the sample area.**

7. **Repeat this procedure for each of your samples.**

8. **Using the data from Table II, fill in Table III: Bean Data with the symbol and number of each bean type found in that sample.**

9. **Complete Table III. Compute and write the total for each species in the column labeled Total Species. For each exotic invasive species write this total again in the Total Exotic Invasives column.**

Bean There, Done That Procedure and Tables

TABLE III: BEAN DATA

	Number of Each Species						
Species Symbol	Sample 1 Random #___	Sample 2 Random #___	Sample 3 Random #___	Sample 4 Random #___	Sample 5 Random #___	Total Species	Total Exotic Invasives
					Totals		

10. Use the totals for "species" and "exotic invasives" in Table III and compute the percent exotic invasives present.

11. Why is the percent more useful than the total number?

12. Review your results. Why was it necessary for you to gather data on multiple samples?

13. Look back to step 1 on page 4. What is the scientific reason for listing random numbers before the beans were tossed?

14. Based on what you learned in this activity, explain "sampling."

Plant Identification Decision Tree Procedure and Table

1. **Go to http://fergusonfoundation.org/btw/plantid/habitats.shtml**
2. **Click on the habitat most similar to the one that you will study in the park (woodland edge, meadow, or lowland forest).**
3. **Identify the six plants in your habitat and complete Table IV: Exotic Plants and Their Characteristics.**

TABLE IV: EXOTIC PLANTS AND THEIR CHARACTERISTICS

Habitat:	
Exotic Plant (Common Name)	**Invasive Characteristics**
1.	
2.	
3.	
4.	
5.	
6.	

Bridging the Watershed

Exotic Invaders Datasheet

Date:

Park: Study Site:

Park Rangers & Educators: (one per row)	Group Members: (one per row)

Latitude: North _____ ° Longitude: West _____ °

Why is it important to know the latitude and longitude?

	Yesterday	Today
Air Temperature	° C	° C
Cloud Cover	☐ Clear ☐ Partly Cloudy ☐ Cloudy	☐ Clear ☐ Partly Cloudy ☐ Cloudy
Precipitation	☐ None ☐ Rain ☐ Other	☐ None ☐ Rain ☐ Other

How could weather affect today's field study?

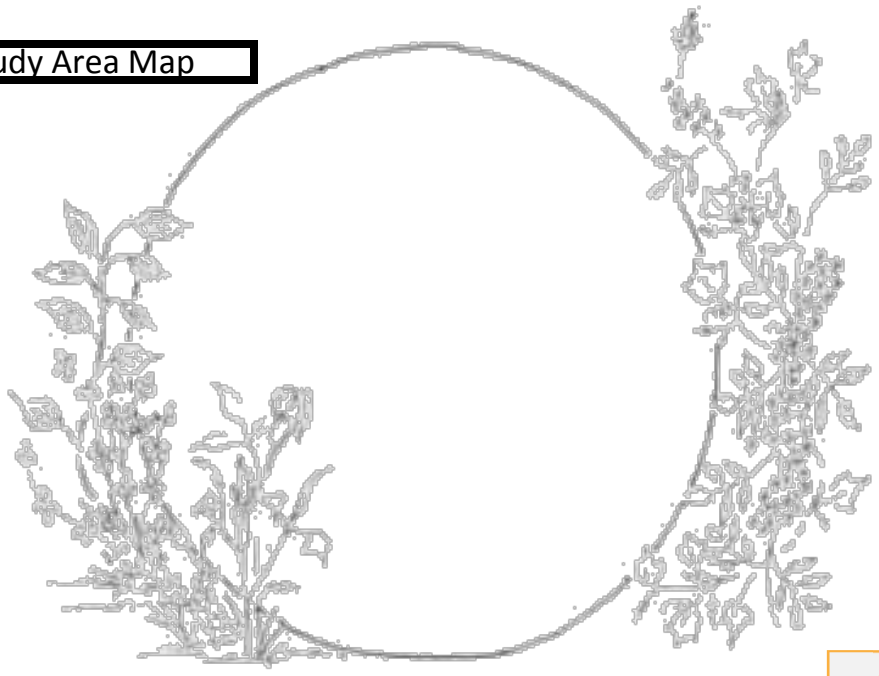
Sketch the study site, showing all details that affect your field study:

What features of your field study site might encourage invasive species?

Study Area Map

Describe each plant in 2-3 words (e.g. "woody vine"). Then give it an abbreviation (e.g. "wv"). Write "wv" in the diagram to the right in each place you see that plant.

Tip: if there are a lot of the same plant in one spot, use a number to indicate how many e.g. "wv-8".



After mapping the plants, use the field guide to identify each plant and determine if it's native or exotic.

Plant Description	Abbreviation	Plant Name	Total	Exotic?	Total Exotics
				☐	
				☐	
				☐	
				☐	
				☐	
				☐	
				☐	
				☐	
				☐	
				☐	
				☐	
				☐	
				☐	
				☐	
				☐	
		Total:		Total:	