Chinese Yam leaf, UGA1237002, James H. Miller, USDA Forest Service, www.bugwood.org

NOXIOUS NEIGHBORS:

Invasive Species in Our Backyards

Activity Guide

CREATED BY:

Center for Environmental Education
MTSU Biology

GRANT PARTNERS:

NATIONAL PARK SERVICE

Discovery Center at Murfree Spring

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Noxious Neighbors: Invasive Species in Our Backyards

Activity Supplement to "If It's Green, It's Good?" Video

Preface

The Center for Environmental Education at Middle Tennessee State University has invested more than 30 years in collaboration with education and resource agencies that share our mission to advance high quality education about the environment. Terri Hogan, National Park Service ecologist at Stones River National Battlefield, and Rachel Anderson, director of Education at Discovery Center at Murfree Spring, have been key partners in this project. Special thanks to LeAnn Hays, 6th grade teacher at Homer Pittard Campus School, and her students; Aaron Burcham, undergraduate preservice teacher at MTSU; and, Morgan Cook-Shivers, graduate student at MTSU, for their inspiration and time.

The activity guide and video were initially developed and published in 1998 through a USDA Forest Service and MTSU Public Service Grant, but thanks to support from the National Park Service's Cost Share Program, the guide and video have been revised (2007-2008) to include information about Chinese yam. Commonly called cinnamon vine or air potato, this heart/fiddle-shaped leaved vine forms a dense mass that covers and kills native vegetation beneath it. Found in a variety of moist habitats, it produces aerial tubers (bulbils) at each leaf junction that drop off, float downstream, and establish another plant. Introduced from Asia, this plant escaped cultivation and is now a threat to native species found in the riparian zone.

The purpose of this teacher guide is to raise awareness about the threat of invasive exotic plants to native Tennessee plant and wildlife species, to provide classroom activities to enhance the use of the video "If It's Green, It's Good?," and to promote responsible decision-making about plants and trees for Tennessee citizens of all ages.

When used in conjunction with the video, which provides an overview of the problems caused by exotic plant species, this guide gives educators a variety of activities to explore major concepts about these 'plants out of place,' a glossary for new terms, and a resource list of additional agencies or organizations for further information.

We wish you well on your 'backyard safari'--but watch out for those noxious neighbors!

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Points of view are those of the author(s) and do not necessarily represent the position of the Department of the Interior, 2008.

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Help! Something's Choking Auntie Elm!

CONCEPT

Exotic pest plants upset the checks and balances in natural habitats.

Adapted from "Home Sweet Home" Project Learning Tree, Secondary-Level Module The Changing Forest/ Forest Ecology.

Correlations to the Tennessee Science Curriculum Standards can be found on page 44.

Grade Level: 6-8
Subject: ecology, geography, science
Skills: acquiring information, communicating, determining causes and effects, group participation, problem solving, valuing
Duration: preparation (20 minutes); Activity (two to three 50-minute periods)
Group Size: (25-30)
Setting: indoors
Key Vocabulary: species, ecosystem, quarantines, flora, fauna

OVERVIEW

Species that are introduced into non-native environments can be beneficial or detrimental to the ecosystem.

OBJECTIVES

In this activity, students will identify "exotics" that have already been introduced into the North American environment and will determine their effect. Students will also gather information about a selected plant or animal species within their adopted forest and determine its natural range.

MATERIALS

Copies of "Auntie Elm Cards" on Student Page; resource listed at the end of this activity; correlations to Tennessee Science Curriculum Standards are included in referenced section.

BACKGROUND

Species distribution patterns are always changing. Historically, this change has occurred through a natural progression of species to new ecosystems. But today, species distribution is rapidly increasing worldwide because of human travel and commerce. The colonization of an environment by nonnative plant or animal species is known as species invasion, and the invading species is known as an exotic species. Not all species are introduced through commerce and human travel. Some species, such as kudzu, were intentionally introduced as a means of controlling certain ecological problems. The effect of species invasion on a community can be totally devastating. Some environments are extremely vulnerable to invaders. A single species can cause irreversible damage to the ecosystem.
Exotics can dominate the ecosystem and reduce populations of native species, causing eventual extinction. In some instances, exotics can live in conjunction with

native species with little adverse effect on the natural inhabitants. In some communities they have even proven to be beneficial. The United States has taken measures to deal with the influx of exotic species. The U.S. government has imposed quarantines to contain the spread of certain species. Management practices have been put into effect to negate the harmful effects of predatory exotic species.

PROCEDURE

1. Make a copy of the Student Page, "Auntie Elm Cards," and cut out the cards.
2. Begin the activity by asking you students to share their definitions of exotic plants and animals.
3. Then divide your students into teams. Ask each team to list several ways exotic species are introduced and to describe their effects (both harmful and beneficial) on the ecosystem. Invite the teams to share their ideas, and post the teams' work.
4. Considering the number of teams, give each team one or more Visitor Cards fom the Student Page "Auntie Elm Cards." Have the students gather information about the species on their card(s) so they can address the following questions:
    - Why or how was the plant or animal brought here?
    - Has the plant or animal thrived? If yes, how and why? If no, why? What part of the local ecosystem has benefited from the exotic species; what part has been harmed?
    - Draw a "web of life" for this exotic species showing its place in the ecosystem and those species with which it interconnects.
    - Which connections are stressing the system?
5. Have the students, as teams, determine what issues about their exotic plant or animal would be subject to public debate concerning how to deal with the presence of that plant or animal in the local ecosystem. If the species is causing financial hardship for a community (for example, overgrowth of the kudzu requires significant resources to keep power lines and public rights of way clear), what remedies or actions do the teams suggest? Have them research possible alternatives and present their findings.

EXTENSIONS

Exotics in Hawaii: Have students research exotic species introduction in Hawaii. How has it harmed or helped that environment? If harmful, what management practices have been implemented?

Exotics in Your Area: Have someone from your local or state agriculture department come in and discuss the exotic species within your area. Include in the discussion the harmful and beneficial aspects of species invasions.

EVALUATION

Each team makes a PSA (public service announcement- TV or radio), poster, display, or pamphlet that will educate the public about an exotic, tell how to discourage (or encourage) its introduction, and explain what effect the "Visitor" has on the environment. Students will present their PSAs, pamphlets, or posters to the class and will report on the effect of the "visitor" to their region.

Student Page

Auntie Elm Cards

The following exotic species were introduced to North America during the past 200 years. Some, like kudzu, were brought to the continent with the best intentions but quickly caused problems that their importers never expected. Others, like the ringneck pheasant, have shown no tendencies to harm their new environment.

Hemlock Woolly Adelgid is an insect pest of the eastern hemlock and Carolina hemlock trees that can cause the defoliation and tree death within several years. The hemlock woolly adelgid feeds during all seasons, sucking sap from young twigs which retards or prevents tree growth. Needles discolor and drop prematurely. In the past few years, it has killed hundreds of acres of hemlock trees in the eastern United States.

Gypsy Moth, an insect that originally arrived from Europe in 1869, defoliates millions of acres of trees each year. The damage varies from year to year.

Chinese Yam, is a perennial vine that is native to China. It was brought to the United States in the 1800s as an ornamental. By 1986 it had escaped from cultivation and began to take over the Southeastern States.

Leafy Spurge, a Eurasian plant, infests about 1.2 million acres (86,000 hectares) of range land in North Dakota alone.

Starlings were introduced from Europe in 1890 by a drug manufacturer. Eugene Scheifflin let 40 pairs of starlings go in New York's Central Park, because he wanted to establish in this country every bird species mentioned by Shakespeare. Starlings are now established throughout North America and are often considered pests.

White Pine Blister Rust, an exotic disease caused by the fungus *Cronartium ribocola,* infects white pine trees nationwide. Introduced from Europe in the late 1800's, the disease caused death in young white pine trees, and disfiguration and eventual death in larger trees. Young white pine regenerations would often become infected, leading to the declining use of white pine as a planted species. White pine seedlings are being genetically engineered for resistance to the rust, and the seedlings are used for reforestation.

Water Hyacinth, an aquatic weed pest that originated in the tropics and is now found in the Gulf Coast states, was originally sold in the late 1800's as a nursery plant. Power plant water intakes and other mechanical systems are frequently clogged with the plant.

Kudzu, also known as "the vine that ate the South," was first imported from Asia to help control soil erosion. Kudzu now blankets roadside trees, telephone and power poles, and wires across the southeastern U.S..

Canada Thistle, a native of Eurasia, first appeared in Canada 200 years ago. It is now one of the most prevalent weeds in the northern part of the United States.

Dutch Elm Disease, is caused by a fungus, *Ophiostoma ulmi,* that first arrived in the United States in the early 1900's on elm logs shipped from Europe. Dutch elm disease is one of the most devastating diseases of urban shade trees (principally American elm), accounting for huge losses throughout the United States. The Dutch elm disease fungus, which originally came from China, is also responsible for large losses of European elms.

Chestnut Blight, an introduced fungal disease, wiped out American chestnut trees. In the early 1900s the trees had been wide spread in mixed hardwood forests. Some wild chestnut trees can still be found, but they rarely achieve full stature because of their infection from the blight.

A Date With Freddie Kudzu

CONCEPT
Exotic pest plants are intrusive; they grow rapidly, spread rampantly, and reproduce precociously.

Adapted from "The Blob" found in The New Games Book.

Correlations to the Tennessee Science Curriculum Standards can be found on page 44.

Grade Level: 4-12
Subject: life science, math, social studies, physical education
Skills: application, comparing similarities and differences, description, discussion, generalization, kinesthetic concept development, observation, psychomotor development.
Duration: 30 minutes
Group Size: Class (25-30) or larger
Setting: outdoors area with boundaries or large indoor area
Key Vocabulary: invasive exotic pest plant, habitat, niche, population, competition, ecosystem

OVERVIEW
Students become invasive exotic pest plants by spreading rapidly in a highly interactive physical activity

OBJECTIVES
Students will: 1) Define and describe an invasive exotic plant; 2) describe how the characteristics of exotic plants make them successful; and 3) describe the effect of an exotic plant infestation on an ecosystem.

MATERIALS
An area, either indoors or outdoors, large enough for students to run. An outdoor area will need defined boundaries, so flags or soccer cones may be necessary; chalkboard or flip chart; writing materials.

BACKGROUND
Plants introduced into a region by humans are "exotics." Exotic plants are not a part of the native, or indigenous, landscape. Introductions since European settlement have changed the composition of native plant communities throughout North America. Biological diversity (biodiversity) is reduced as native species are displaced by invasive exotics such as *kudzu, Japanese honeysuckle*, and *purple loosestrife.*

Biodiversity is further impacted when exotic plants harbor invasive pathogens (harmful microorganisms), fungi, or other organisms that decimate native species.

For example, the American chestnut blight was caused by a fungus introduced with the Chinese chestnut. The blight destroyed one of the most important hardwoods in eastern North America. Exotic species tend to be destructive because they usually have no controls (such as insects or other predators) that keep them in check. Exotics have limits on their range and reproductive capacities because they have not evolved within the native ecosystem. For this reason, invasive exotics have a competitive edge over native species. Exotics tend to take over and force out native populations. Many invasive exotic plants thrive not only in native plant communities but on disturbed sites, such as abandoned fields and construction sites.

Characteristics of invasive exotics plants are that they:

- grow and mature rapidly
- have prolific reproductive capacities
- are highly successful in seed dispersal, germination, and colonization
- rampantly spread and out-compete native plants
- are difficult and costly to remove and control

Most introductions of exotic plants are intentional and usually relate to aquaculture, horticulture, or conservation purposes. When problems occur later, exotics are not as economical as they first seemed. Awareness of the problem caused by invasive exotics is the first step in preventing their continued widespread use. Public awareness will increase responsible landscaping practices. Awareness by resource managers will help prevent introductions on public lands and preserve our natural heritage.

PROCEDURE

1. Begin by telling the students that they are native plants in a given community. The markers serve as boundaries for the community and the plants can grow anywhere they choose within the boundaries. Discuss the types of requirements plants need: sun, water, space, nutrients, and soil. Ask the students to go and stand anywhere they wish to grow in the community.
2. One student will be selected to be an invasive exotic plant, such as kudzu. This plant will be'introduced' to the community by the leader. The leader will bring the student to any place they wish to 'grow'. The invasive plant is going to grow rampantly, spread rapidly, and reproduce precociously in the community by tagging native plants and forming a long kudzu vine (chain of students holding hands).
3. Native plants are free to run anywhere within the boundaries of the community to escape the effects of competition with the exotic plant. Plants are not mobile in nature but compete with exotic plants for sun, water, space, nutrients, and soil. Running or hiding is a simulation of the competition that exists for these resources.
4. Students will stop when the whistle is blown to allow time for discussion. When instructed to begin, kudzu will tag a native plant. The two join hands or elbows and tag another native plant. That third plant will join and become part of the invasive plant vine. Only the students on the outside of the chain can tag; the chain has to stay together by holding hands.
5. The invasive exotic plant vine is going to continue to grow as other native plants are tagged. When a native plant is tagged, that student will join hands with a student at the end of the chain. Only the outside students can tag native

plants; everyone in the middle part of the chain must continue to hold hands as the vine continues to grow longer.

6. When the invasive plant chain has four students, it will split apart. The vine has reproduced and the two new invasive plant chains can tag other native plants! Each time a kudzu vine contains four students, it will split again (reproduce).
7. Decrease the boundary after three minutes to model the impact of the invasive exotic taking over the habitat and out competing native species. Students that leave the boundary are removed (their plant has died).
8. The thrilling climax occurs when there's only one native plant left to put up a heroic last ditch effort on behalf of our natural heritage. Unfortunately, there is no defense against Freddie Kudzu!
9. The last native plant tagged has the honor of being 'introduced' as a new invasive exotic plant in the next round. Play as many rounds as time will permit. Which plants were most successful?

EXTENSIONS

1. Identify controls for invasive exotic plants. Several possibilities are: biological (using an insect or fungus to control the growth of the exotic plant; something that would not upset the ecological balance of the ecosystem), mechanical removal or destruction of the exotic plant, and chemical sprays that are not toxic to other plants. Students could be secretly chosen to be one of these types of control mechanisms. When that student is tagged by the invasive pest plant chain, the entire chain breaks apart and becomes native plants again. The controls would only be effective for three attacks. When tagged for the fourth time, the student must join the invasive plant chain.
2. Exotic pest plants disrupt the entire community, not just plants. Identify other relationships
   that exist in a community between plants and animals. Selected animals can try to compete with the exotic pest plant chain. Identify two students that will be animals with bandanas or headbands. In order to survive, an animal needs to tag five native plants. The animal is the only one who can tag a native plant (and only has one hand free) and all members of the animal/native plant chain must hold hands. The activity continues until all the native plants are tagged.
3. Research the origin and introduction of several invasive exotic plants in your area. As a class project, clear an area infested with exotic plants. Schedule monthly visits to the area and keep a photographic journal or videotape each visit. What changes do you observe before and after the removal of the invasive plants?

EVALUATION

1. Define and give an example of an invasive exotic plant.
2. Identify characteristics of exotic pest plants.
3. Describe the impact exotic plants have on native plant communities.
4. Name three methods of controlling invasive exotic pest plants.

The More Things Change, They'll Never Be The Same

CONCEPT
Exotic pest plants reduce biological diversity.

Adapted from "Trouble At Home" found in Tennessee's Watchable Wildlife.

Correlations to the Tennessee Science Curriculum Standards can be found on page 44.

Grade Level: 4-12
Subject: science, social studies, language arts, visual arts.
Skills: analysis, discussion, evaluation, research, small group work, synthesis.
Duration: varies; can be a research project and presentation, or two 40-minute class periods.
Group Size: Class (25-30)
Setting: indoors
Key Vocabulary: exotic, native

OVERVIEW
Species that are not native to North America have been deliberately or accidentally introduced and some are causing harm to native plants and animals in Tennessee.

OBJECTIVE
Students research and report on exotic species that threaten native species.

MATERIALS
Copies of Student Page *Exotic Wildlife in Tennessee: The Trouble At Home.*

BACKGROUND
The word "exotic" can mean "exciting and different," but in nature, exotic means trouble. Exotics are plants or animals that live in Tennessee natural areas but are native to other continents. They simply don't belong here. Throughout the world, exploration and colonization of new areas by early explorers, traders, and settlers led to the spread of plant and animals species from areas in which they were native to new parts of the world. In many cases, the success of the exotics in their new environment was so great that most casual observers in these habitats today would assume that the plant or animal in question had been there all along. In the case of plants used as human food, the introductions are generally viewed as having a positive effect. Unfortunately, many introduced species have had unforeseen impacts on native plants and animals.

Chinese yam was introduced into the United States in the 1800s. Originally from China, it was brought here as an ornamental plant.
Until the 1980s, Chinese yam stayed contained in its cultivated areas. In 1986 scientists began to notice that Chinese yam had escaped and was invading native

habitats. It can out compete and eliminate native species. Chinese yam can weigh down and break branches of trees and shrubs and completely cover up a stand of native shrubs. Think of the possible consequences to Tennessee forests and forest wildlife!

PROCEDURE

1. Introduce the terms ''exotic'' and ''native'' as they relate to plants and animals.
2. Divide the class into cooperative learning groups of 4 students. Assign each group one of the ''exotics'' illustrated on the following page #. Point out to them that in each drawing the artist has tried to show how the exotic harms native wildlife or native plants.
3. Each group is to research their assigned plant or animal to find out:
    - When, how, and why the exotic was introduced into North America.
    - How it has spread since its introduction.
    - What effects it has had on native plants and animals.
    - Efforts to control its spread or its effects.
4. Each group may choose means by which they present the information they gather. Some may elect to create a ''Not Wanted'' poster, others may conduct a mock interview of the creature, etc. Since two or more groups may have been assigned the same exotic, the groups with the same exotics should choose different presentation modes.
5. When the groups have prepared their presentations, provide time for them to share their information with the rest of the class. You may wish to have all the reports on the same exotic presented together, or to alternate from one exotic to another.
6. After the presentations, lead a discussion about ways that we can help prevent future spread or introduction of exotics. (Never ''release'' exotic pets; don't plant invasive exotic plants; learn to recognize exotics such as zebra mussels and report any sightings to the proper authorities.) Also point out that many of our regulations about what people can bring into the United States after a visit to a foreign country (no live plants or animals, etc.) are designed to avoid accidental introduction of harmful exotics.

EXTENSION

1. Students may want to investigate other harmful exotics, such as the fungus that killed American chestnut trees, or the gypsy moth (an exotic that is expected to soon pose a threat to forests in East Tennessee).
2. During the period when a lot of attention was being given to celebration of Columbus' travels, many good articles were written about the plants and animals that were introduced from the Old World to the New and from the New World to the Old after European exploration of the New World began. This material could serve as the background for further study of ''exotics''.

EVALUATION

1. Select an exotic species; describe its effect on native plant and animal species.
2. Describe efforts to control exotic species.

STUDENT PAGE

EXOTIC WILDLIFE IN TENNESSEE: TROUBLE AT HOME

The **European starling** evicts native bluebirds, martins, and flickers from their tree cavity homes.

Asian **zebra mussels** encrust boar hulls, clog water intakes, and even attach themselves to native mussels.

Kudzu and Chinese yam, both vines, kill native plants by growing over them.

Wild boar, descendents of domestic pigs and the European boar, consume massive amounts of acorns needed by native wildlife. Find out about exotics in your area and learn how you can help prevent further damage.

Clueless or Careless?

CONCEPT:
Some exotics were introduced deliberately; some were introduced accidentally.

Adapted from "Ethi-Reasoning", Project WILD

Correlations to the Tennessee Science Curriculum Standards can be found on page 44.

Grade Level: 4-12
Subject: science, social studies, language arts
Skills: analysis, application, discussion, evaluation, observation, problem solving, small group work, synthesis, writing.
Duration: one 45-minute period
Group Size: any; small group sizes of two to four suggested
Setting: indoors or outdoors
Key Vocabulary: dilemma, responsibility

OVERVIEW
Students read, discuss, make judgments and write about a hypothetical dilemma concerning natural resources

OBJECTIVES
Students will: 1) examine their own values and beliefs related to the environment; 2) listen to and respect the rights of others to maintain different values and beliefs; and 3) evaluate possible actions they might take that have an impact on the environment.

MATERIALS
Copies of Student Page *Dilemma cards*; writing materials.

BACKGROUND
This activity is designed to give students the opportunity to examine their own values and beliefs as they relate to elements of the environment. It is not the intent of this activity to prescribe "right" and "wrong" answers for the students. One exception is in the areas where information about laws is conveyed. There are variations from state to state in laws affecting wildlife and the environment. Each state has an official public agency that is legally responsible for caring for most wildlife within the state. In Tennessee, this is the Tennessee Wildlife Resource Agency (TWRA). This agency can be contacted to request information about law affecting wildlife in Tennessee.

The Division of Natural Heritage (DNH) through the Department of Environment and Conservation (TDEC), has a Rare Plant Protection Program which is responsible for listing federally endangered or threatened species of plants and recovery efforts. There are also federal regulations affecting plants and wildlife. The U.S. Fish and Wildlife Service (USFWS) can be contacted for information about such laws.

For example, federal law protects all birds of prey (eagles, hawks, and owls) from shooting or any other intentional cause of death, injury, or harassment. Songbirds are protected by law. It is also generally illegal to possess birds' nests, eggs and feathers, even those found lying on the ground.

It is illegal to pick, transplant, or take seeds from an endangered or threatened plant. Commercial nurseries that trade in endangered plants are licensed by the state. Never take or purchase endangered or threatened plants from an individual that does not have a license. Do not take cuttings or seeds from native plants from one region and transport them to another region.

Plants introduced into a region by humans are "exotics." Exotic plants are not a part of the native landscape. Most exotic pest plant introductions have been intentional. Introductions since European settlement have changed the composition of native plant communities throughout North America.

Whether right or wrong, questions of law can be separated from questions of ethics. At a personal level, an individual's choices as to what seem right or wrong for him or her in terms of values and behaviors may be described as a personal code of ethics. Hunting, for example, is controversial for some people from an ethical point of view. Some people say that even though hunting is legal, it is unethical, because a human being is taking the life of a wild animal. Others believe hunting to be a responsible and ethical form of recreation, acquiring food, or animal population control. These differences of belief may be sincerely held. Whether or not a person chooses to hunt is a personal choice dictated by one's personal ethics. In regard to protecting endangered plants or biological diversity, some people may feel that is not important because plants don't have "feelings" and human populations are all that matter. Conflicts arise, however, when a person motivated by one set of ethics tries to force his or her ethics on others through activities such as arguments, harassment, or legislative action.

It is the major purpose of this activity to provide students with an opportunity to come to their own judgments about what they think are the most responsible and appropriate actions to take in situations affecting the environment.

PROCEDURE

1. From the attached pages, the teachers should copy and cut the dilemma cards.
2. Divide the class in groups of four and give each group a stack of dilemma cards. Place them face down at the center of the group. Each group member has a number, one through four.
3. Each student, in order, draws a card from the top of the stack. Individually, each student studies the situation, decides what he or she should do, and formulates his or her reasons. Students should be encouraged to make brief notes to organize their thoughts.
4. When each student is ready, typically in less than three minutes, the first student reads the situation and the options aloud to the rest of the group. The student gives the decision he or she has chosen and describes the reasoning involved. In turn, each of the other members of the groups is invited to comment of the dilemma and what he or she would do in the situation. The discussion of each dilemma by the members of the group should take about

five minutes. The person whose dilemma is being discussed will lead the group and can ask other members of the group questions. The discussion gives the students experience in having ideas examined by peers and is intended to remind the students of the need to take personal responsibility for decision-making. It is not necessary and may not be desirable for the students to reach a consensus; there are legitimately ranging views of the most appropriate and responsible actions to take in many situations. The purpose is to provide students with an opportunity to examine, express, clarify and take responsibility for their own reasoning.

5. After the first student returns their dilemma card to the bottom of the stack, the second, third, and fourth students will continue the same process. Each student in the team will have an opportunity to express their decision and rationale about a dilemma.

EXTENSIONS

1. Adapt this to a debate format!
2. Write and discuss your own dilemmas based on local news and information. Students should be involved in the process of creating the dilemma cards, with each student responsible for one card. Dilemmas can be left entirely open-ended, with no options suggested for consideration.

ASSESSMENT

Choose a dilemma.

- Write a short paragraph on the positive and negative effects of all the options listed for that dilemma.
- Indicate what additional information, if any, is needed in order to make a responsible and informed decision.
- Give two opposing and convincing arguments for how to respond to this dilemma.
- Identify what you judge to be the most responsible decision; explain your reasoning.
- Explain how someone else could reach a different, yet valid, opinion with the same information.

STUDENT PAGE

Dilemma Card

Hydra, the mythological nine-headed serpent, sprouted two heads for each one Hercules severed with his sword. Its namesake, *Hydrilla*, is a real-world monster that is taking over our waterways. Native to Asia, Africa, and Australia, this aquatic plant was introduced into Florida waters in the 1950's, where it was cultured for the aquarium industry. It is now found in the waterways of all the southeast and southwestern states, plus Oregon. *Hydrilla* can grow 10 inches in a day and can photosynthesize under low light levels and produce a canopy that shades out other submersed aquatic vegetation. *Hydrilla* infestations can also eliminate open-water feeding areas for birds and spawning sites for fish. It tolerates many different environments and could easily spread throughout most of the United States and Canada, with serious consequences for aquatic systems, native biodiversity, recreation, and agriculture. Should you:

- Encourage everyone you know who has a fish tank boycott the aquarium industry for causing this problem in the first place.
- Spray all infested waterways with herbicides.
- Develop a mechanical harvester that will physically remove the huge masses from the clogged waterways.
- Prevent the weed from spreading through public information programs.
- Pretend there isn't a problem because you don't like fish, or swim anyway.
- Other

Dilemma Card

You live in a very small community in Tennessee. Your local politician, Mr. Crumb, owns land with a rare plant called *Pyne's ground-plum* growing on it. You studied threatened and endangered species in school and learned that *Pyne's ground-plum* is only known from three small populations in Rutherford County. It is not found anywhere else in the world and is protected by law. Mr. Crumb wants to establish a limestone quarry on part of his property. The citizens in the community are concerned because they don't want the erosion, traffic, and noise. You are concerned because you saw *Pyne's ground-plum* in front of the proposed quarry site and mentioned this to him at a community meeting. When you went back to the proposed quarry site to look at the plants, they were gone! Should you:

- Forget about it and pretend you just imagined seeing the plants on his land.
- Contact the Tennessee Natural Heritage Program's Rare Plant Program Director and explain the mystery to them.
- Confront Mr. Crumb all by yourself and call him a crook.
- Explain the situation to the community council; let them figure out what needs to be done.
- Go back to the site and try to find some seeds and try to grow the plant in your own yard.
- Other

Dilemma Card

"The plant that ate the south" is one of our most notorious exotics- *kudzu*. This aggressive vine can grow 60 feet per year, forming a continuous blanket of foliage and resulting in large-scale alteration of biotic communities. A native of Asia, *kudzu* was introduced into the United States at the Philadelphia Centennial Exposition in 1876. By 1900 *kudzu* was available through mail order and sold mainly as livestock forage. The Soil Erosion Service distributed 85 million seedlings starting in 1933 in an effort to control agricultural erosion. By 1953 the USDA had removed *kudzu f*rom the list of acceptable ground cover plants because the soil continues to erode underneath the vine. It is estimated that kudzu now covers seven million acres in the southeast. *Kudzu* can grow in any type of soil, large roots allow plants to survive in drought conditions, and new growth can exceed one foot a day. The preferred habitats are disturbed areas, such as abandoned fields. To control kudzu, should you:

- Let goats and cows graze freely in infested areas.
- Make a few bucks for yourself by researching the use of kudzu as a food source in Asia and selling a "How to Prepare Kudzu Cookbook."
- Market *kudzu* vines as the "coolest Tarzan toy" in town.
- Research potential biological controls.
- Spray all infected areas with agent orange (leaf defoliant) from low-flying aircraft.
- Other

STUDENT PAGE (cont)

Dilemma Card

You have purchased a beautiful piece of property next to the lake. When you built your house, your best friend said he would do the landscaping around the house for a very good price. It was a wonderful gesture and you agreed to let your friend do the landscaping. You were going to be out of town for two weeks and this is when your friend would be able to work on your yard. When you returned, your friend had planted *Chinese yam* everywhere. It is used by nurseries because it grows fast and is inexpensive. Your best friend was very proud because he was able to save you so much money and time, but you know that *Chinese yam* is an exotic invasive plant and has the potential to take over your whole yard and the adjacent wooded areas. Should you:

- Say what a terrific job your friend did and forget the impact of this invasive pest plant.
- Confront them about using plants that will potentially escape and over-run your property in a matter of years.
- Demand they pull everything up and burn it on the spot.
- Say thank you graciously and spray everything with a poisonous plant spray after friend leaves and tell them later that it all died mysteriously.
- Share your knowledge about exotic pest plants with your friend andtry to figure out what other native plants could be used instead.
- Other

Dilemma Card

A lavender-colored weed called *musk thistle* looks like an artichoke flower. It invades the sod used in highway construction projects, quickly crowding out adjacent grazing pastures or agricultural fields. It also causes problems with plants growing in nurseries because it has a large tap root and can reseed itself. *Musk thistle* is a big problem in central and eastern Tennessee. Efforts to suppress it are expensive, labor-intensive, and time-consuming. Should you:

- Spray with herbicides.
- Hire people to pull the plant up by the root.
- Develop a biological control, such as an insect that will feed on ONLY the thistle.
- Fine landowners that don't take care of their musk thistle problem.
- Forget about the problem because you live in the city.
- Other

Dilemma Card

Purple loosestrife was first brought to New England in the early 1800's as an ornamental plant. The plant moved rapidly north into Canada, south into Virginia, and west through the Great Lakes, earning it the nickname the "purple plague." This alien now exists throughout much of the United States and is a serious threat to wetlands. It can out-compete native plants, including species of endangered orchids. Each *loosestrife* plant can produce millions of tiny seeds that are carried along by wind and water. As a result, many wetlands once inhabited by a rich diversity of native plants are now overrun by dense stands of *purple loosestrife* that can be thousands of acres in size. The loss of native habitat is a threat to wildlife, including several rare amphibians and butterflies. *Purple loosestrife* is sold commercially despite its devastating effect on natural communities. It is promoted by horticulturalists for its beauty as a landscape plant and by beekeepers as a nectar plant. Should you:

- Start a nation-wide spraying program for loosestrife.
- Forget about the problem because it is obviously beyond our control.
- Notify each state (42 states have loosestrife infestations) of the problem and hope that will take care of things.
- Inform the public about the dangers of landscaping with *purple loosestrife* and include horticultural society and nursery-owners in the information distribution.
- Develop a biological control, similar to something that which controls the obnoxious spreading of *purple loosestrife* in its native Europe.
- Educate resource managers for early detection of *loosestrife*.
- Other

Don't Gripe- Get a Grip!

CONCEPT

Education about pest plants helps people eradicate exotics already growing in an area and prevents careless planting practices.

Adapted from "Which Niche?" --Project W.I.L.D.

Correlations to the Tennessee Science Curriculum Standards can be found on page 44.

Grade Level: 7-12
Subject: social studies (community studies, economics), career education, science (biology), language arts, vocational agriculture
Skills: analysis, application, classification, comparing similarities and differences, description, discussion, generalization, interview (guest speaker), listening, listing, public speaking, reading, reporting, research, small group work, synthesis, writing
Duration: one to four 45-minute periods
Group Size: any
Setting: indoors
Key Vocabulary: niche, career, community

OVERVIEW

Students compare ecological niches with careers in their community.

OBJECTIVES

Students will: 1) define ecological niche; and 2) give at least one example of an animal and its ecological niche.

MATERIALS

Guest speaker; chalkboard, reference materials (see "Resources" at the end of this guide)

BACKGROUND

Each animal has a role in the community. This is called its ecological niche. The niche includes such things as where the animal lives, where and how it gathers food, its role in the food chain, what it gives to and does for the community, its habits, periods of activity, etc.

An animal's niche can be described as what it does for a living. In a sense, this can be compared to what people do for a living--that is, what their jobs or professions are in the community in which they live.

The major purpose of this activity is for students to understand the concept of ecological niche, simultaneously learning more about potential careers in their own community.

PROCEDURE

1. Explain to the students that in this activity, they will be comparing human professions to the roles of plants (and animals) in environments (plant or animal "professions").

2. Begin with a discussion of jobs in your community. What jobs are there (those of parents, friends, their own, etc.)? (OPTIONAL: Invite parents to your class to talk about their work.) Select a few interesting jobs for discussion. (NOTE: If a speaker visits, ask these questions of them or provide them in advance. Work with the students to develop the questions. Have the students take notes and record the answers during or immediately after the presentation, asking additional questions for clarification as necessary.)

Points to include:

- What they do for the community (the service provided).
- How they provide the service.
- What resources are used by them in providing the service.
- Where they live and work.
- The times during which they work.
- What other professions they are dependent upon for the functioning their profession (janitor, maintenance, delivery, secretary, etc.).
- What special adaptations (skills, tools, training, behaviors) they use or they are required to have.
- What special habits they exhibit.
- What other professions they compete with, if any.
- What other professions they cooperate with, if any.

Ask the students to produce a written summary of the information they acquire concerning each of the jobs they investigate.

3. Have the students brainstorm a variety of plants and animals living in a particular community (forest, stream, desert, tundra). A photograph could serve as a stimulus. List representative members of this natural community on the blackboard. Make sure a variety of plants and animals including producers, predator, prey, scavengers, etc. are included.

4. Pick one of the plants or animals listed, and, as a group, begin discussing the same questions for it that were asked of the visiting professional. In this way the students can see how the profession concept applies as a metaphor. Identify the plant's or animal's profession as its ecological niche.

OPTIONAL

As individual projects or in teams, students should select one plant or animal, research the niche it fills, and answer the same questions used for human jobs. As a culmination, each team can make a visual and/or verbal presentation about its plant (or animal) and its niche.

EXTENSIONS

1. Identify niches which are overlapping and where there is competition or cooperation for resources and services. Connections may also be made between niches to illustrate interdependency webs in the community. (#1 is very appropriate for discussing the effect of exotic, invasive species on native species, habitat, and resources.)

2. Develop commercials or ads for "recruiting" individual plant (or animal) species into given ecological niches, using special contributions, advantages, etc. as points to highlight.

3. Select the plant (or animal) you'd most like to be from among those studied, basing your selection on the contribution of the ecological niche to the community's health, as well as other factors. Describe the reasons for your choices. You could do this for human professions, too!

EVALUATION

1. Define ecological niche.

2. Select any plant, animal or person and describe its ecological niche.

Include what they do for:

- the community, how they provide this service, the resources they use,
- where they live,
- when they do their work, what other organisms depend upon them,
- what other organisms they are dependent upon,
- what special adaptations they use or are required to have,
- what special habits they exhibit,
- what other organisms they compete with for the same niche and
- anything else you think is especially interesting about this niche and how it is filled.

3. Create a poster that shows all the facets of a plant's or animal's niche.

You Can't Grow Home Again

CONCEPT

It's important to preserve biological diversity, for we may not even realize all the connections until they are gone.

Adapted from "Web of Life"- Project Learning Tree

Correlations to the Tennessee Science Curriculum Standards can be found on page 44.

Grade Level: 4-8
Subject: science, language arts, visual arts
Skills: researching, discussing, identifying relationships and patterns, predicting
Duration: preparation- 30 minutes; Activity- two 50-minute periods
Group Size: class (25-30)
Setting: indoors/outdoors
Key Vocabulary: dominant, ecosystem, photosynthesis, food chain, threatened, endangered

OVERVIEW

In this activity, students will take a close look at one particular ecosystem (a forest) and will discover the ways the plants and animals are connected to each other. By substituting the appropriate information, you can also use the activity to study other ecosystems, such as oceans, deserts, marshes, or prairies.

OBJECTIVES

Students will: 1) collect information about various organisms in an ecosystem; 2) create a mural that depicts the interdependence of various organisms with other components in an ecosystem; and 3) create a simulated web of life using a ball of string.

MATERIALS

Enough large sheets of cardboard from boxes (or heavy paper) to construct a mural 4'x 8' (1.2m x 2.4m), tape, glue, pins, a ball of string or yarn, resource materials about forest plants and animals, folders (optional)

BACKGROUND

A forest is a living community dominated by trees. Each plant in the forest, from tiny mosses to giant trees, has its own needs for things like sunlight and moisture. Because environments vary tremendously, a specific location will be better for certain plant species than others, and those species will grow more abundantly as a result.

The most dominant tree species in a forest usually determines the forest's appearance and suitability as a habitat for plants and animals.

For example, in some forests, large, dominant trees may reduce the sunlight and monopolize the moisture and nutrients, thus limiting the types of plants that can grow beneath them. While trees and plants are usually in its most conspicuous elements, the forest ecosystem also depends on animals. Animals are vital to most plants because they help pollinate flowers and disperse seeds. At the same time, animals such as deer, rabbits, and insects may eat certain plants, greatly reducing their presence. Some insects can substantially damage a forest ecosystem if their numbers get too high. Insect-eating birds play an important role in keeping insect populations in check.

Another way that forest plants and animals are connected is through a web of eating relationships. One primary function of a forest, like any other ecosystem, is to produce and distribute energy. All life depends on the ability of green plants to use sunlight to synthesize simple sugars from carbon dioxide and water. Through this process, called photosynthesis, plants take energy from sunlight and make it available to animals. Plant eaters, or herbivores, eat the plants directly; animal or flesh eaters, carnivores, in turn eat both herbivores or other carnivores, thus forming a food chain. A food chain is a simplified way of showing energy relationships between plants and animals in an ecosystem. For example, a food chain of sun-> sunflower-> mouse-> owl shows that a seed is eaten by a mouse, which is in turn eaten by an owl. However, rarely does an animal eat only one type of food. A food web describes the interconnection of the food chains in an ecosystem and gives a clearer picture of how plants and animals in an ecosystem are related to each other.

In this activity, students will create a "web of life" to depict the relationships among members of a forest ecosystem. This web includes eating relationships (as in a food web), but also shows the various other kinds of relationships found in a forest (shelter, reproduction). The web of life suggests that all living things are connected to all others. No matter how unrelated organisms may seem, they are, in fact, connected.

PROCEDURE

For each team, begin a folder of information on a specific forest animal or plant. Folders might include pictures you cut from magazines or calendars, and articles or other information you glean from nature journals or other sources. If possible, select a variety of plants and animals so folders include at least two of each type: mammal, arthropod (insect or spider), bird, reptile, amphibian, trees, and other plants (see step two of the activity for specific suggestions). Students will also need access to resource materials about forest plants and animals.

1. Ask the students to work in pairs or teams to brainstorm all the components they think they would need to make a healthy forest. Invite them to share their ideas with the rest of the class.
2. Afterward, make a class list of animals that live in the forest. Some examples are bark beetles, bats, beavers, bears, box turtles, butterflies, chipmunks, deer, earthworms, field mice, red fox, tree frogs, grasshoppers, king snakes, lizards, mosquitoes, moths, opossum, barred owls, rabbits, raccoons, skunks, snails, red squirrels, ticks, or woodpeckers.

3. Make a class list of plants that live in a forest. Some examples might be azalea, columbine, cottonwood, honeysuckle, lichen, maple tree, Douglas fir, pine tree, poison ivy, shelf fungus, or violet.
4. Divide the class into teams of two to four students (you can use the same teams as before). Have each team select a forest organism to study using one of the folders prepared earlier. Make sure groups select a variety of plants and animals. For instance, try to have at least two groups that study each of the following kinds of organisms: mammals, insects, birds, reptiles, trees, and other plants.
5. Instruct groups to collect as much information as possible about their chosen organism.

Plant groups should answer these questions:

- Where does the plant live?
- What does it need to survive?
- How does it reproduce? Does it have seeds? If so, how are they dispersed?
- How much sunlight and water does it require?
- Does it live near other plants? If so, what kinds?
- What animals eat this plant?
- How does this plant influence its environment?

Animal groups should answer these questions:

- Where does the animal live? (on the ground, in trees, at the edge of the forest, in the forest)
- What does it need to survive?
- What shelter does it require? Where does it perch, hibernate, breed, and sleep?
- Does it migrate? If so, when and where?
- Where and how does it get its water?
- What animals does it prey on? How much does it eat?
- What animals prey on it?
- With what animals does it live? With what plants?
- How does the animal influence its environment?

6. Ask groups to find photographs or drawings of their plant or animal. (They can draw their own pictures or take their own photos.) If possible, pictures should show the organism in its natural habitat.
7. Ask the class to create a forest mural on large cardboard or paper sheets. Students can use pictures from magazines or their own drawings to show hills, valleys, streams, homes, plants, animals, and other features. The mural should

show important elements like sun, water, soil, and atmosphere. The mural can show various forest areas: wet, urban, young, or mature. Each team can work on a separate panel and focus on a particular type of forest area.

8. When the mural is finished, each team should send a representative to place a picture of the organism (plant or animal) they studied into its appropriate habitat. The student should explain the team's reason for placing each organism in a particular spot. When all organisms are in place, you might discuss the following questions:
    - What did you discover about your plant or animal that surprised you the most?
    - Why did you select the species you did? Have you ever seen the plant or animal you selected? Would you know where and when to look for it? Did you know before you studied it?
    - Is it a threatened or endangered species? If so, for what reasons is it endangered? Is anything being done to help or harm it?
9. When all animals are in place, introduce the web of life concept (see background).
10. Place a push pin next to each plant or animal. Then use yarn to connect each animal to other animals and plants with which it directly or indirectly interacts (for example, "eats," "is eaten by," or "depends on for shelter"). Students can help by acting as experts on the species they researched.
11. Ask each team to make sure that its organism is *appropriately* attached to other components in the ecosystem depicted on the mural. The completed mural forms a web of life for this ecosystem.
12. Discuss these questions:
    - What would happen if one element of the ecosystem were missing? (You can demonstrate by removing a pushpin.) What will happen to other organisms?
    - What important elements are not included in our web?
    - What are some webs of life within your school or community? (Students go to school -> teachers teach them-> cafeteria workers feed them -> parents pay taxes so teachers and cafeteria workers can buy food.)
    - What are some global webs of life?

VARIATION

1. After they research the organisms (in step 5 above), have the teams each make a name tag for their forest plant or animal, including a picture. Ask one person from each group to sit on the floor in a circle. (If you have a small group, each student may research an organism, make a name tag, and sit in the circle.)
2. Starting with one "plant," ask that student to hold the end of a ball of string. Ask the team that studied the first plant to name another organism in the circle with which the plant interacts (for example, is eaten by or depends on). Pass the ball to this second student, who will wrap the string around one hand and pass the ball to the student representing an organism that the second team chooses to connect with. This process will continue until each "organism" is linked to the ecosystem, and the ball is returned to the first student.
3. Now, have the students slide back until the string is taut. Tell students to keep still. But if they feel a tug, they should tug in response. When everyone is still, tell the student holding the original end of the string to begin gently tugging. Keep reminding everyone that if they feel a tug, they should tug in response. Though

this mechanism, vibration will spread through the food web until everyone is tugging and the whole web is shaking.

4. Ask students how the tugging demonstration might illustrate what happens when one of the links in an ecosystem is damaged through natural or human made-stress. (The rest of the ecosystem feels the effect.)
5. Ask students to pick one organism in the system that is less important than the others, and have it drop out. Ask if any other organisms should drop out because they depend on the removed organism. After one or more have dropped, ask the students to again identify an organism that seems less important, and repeat the procedure. Continue playing for a few more rounds, then ask the following questions:
    - What happens when we remove a link in the forest ecosystem? (organisms that depend on it are affected.)
    - Were the changes more dramatic when the system was composed of many parts or when it had fewer? (fewer)
    - What can we say about the relationship between how many parts the system has (its complexity or diversity) and how stable it is? (In general, complexity makes it more stable.)
6. Ask students to pick an exotic species to add to their system. Let the exotic species start taking over the system. Have the student that is the exotic species begin collecting the strings of those organisms that it could successfully out compete and ask the students of those species to drop out. Ask the students the following questions:
    - What happens when an exotic species is introduced?
    - What happens to the biodiversity of the system?
    - Can an exotic species destroy an entire ecosystem?

EXTENSION

Make food web mobiles. Have each student select a plant or animal that is part of the forest ecosystem or another ecosystem. Students should research their organism's place in the food web and make a cutout of all food web organisms from construction paper and colored markers. Using clothes hangers and thread to hang cutouts in the proper arrangement, students can construct a mobile that represents their food web.

EVALUATION

Have teams of students demonstrate (by writing, drawing, or role-playing) a web of life in which humans play a critical part.

"The Natives Are Friendly"

CONCEPT
Habitat loss is the most serious threat to the survival of our native wildlife in Tennessee.

Adapted from "Going Wild For Wildlife," in Tennessee's Watchable Wildlife.

Correlations to the Tennessee Science Curriculum Standards can be found on page 44.

Grade Level: K-12
Subject: science, social studies, math,
Skills: application, comparing similarities and differences, description, discussion, observation
Duration: ongoing
Group Size: any
Setting: outdoors
Key Vocabulary: habitat, landscaping, native, exotic.

OVERVIEW
Landscaping for wildlife can help minimize the habitat loss that accompanies development.

OBJECTIVE
Students will: 1) be able to identify wildlife habitat needs and 2) students will create a landscape designed with the needs of wildlife in mind.

MATERIALS
Back issues of *Southern Living* (optional), copies of the 3 Student Pages at the end of this activity (*Wildlife Habitat Planning, Common Native Woody Plants of TN, and Our Noxious Neighbors*), field guides or reference books on plants of the southeastern U.S., butcher paper, newsprint, or other paper for planning landscape designs, posterboard for drawing final versions of designs.

BACKGROUND
Wildlife includes all animals that are not tamed or domesticated; from small organisms only visible to humans if seen through a microscope to those as large as a whale. Wildlife examples include, but are not limited to, insects, spiders, birds, reptiles, fish, amphibians, and mammals, as long as the animals are non-domesticated.

Habitat is the arrangement of food, water, shelter/cover, and space suitable to animals' needs. Habitat loss is the most serious threat to the survival of our native wildlife in Tennessee. In response to the threat, many concerned people are considering landscaping with wildlife in mind. A few simple differences in the types of plants used in landscaping and their arrangement can make the difference for many birds and small animals.

As a start, conversion of just a small plot of land, in a yard or on the schoolgrounds, into a WILD site, planned to meet the needs of wildlife, can illustrate the principles of landscaping for wildlife. Suggestions for habitat components and native plants, as well as exotics to avoid, are found at the end of this activity.

PROCEDURE

Ideally, this activity should lead to the actual landscaping of a small area on the schoolgrounds. If that is not possible, the activity can be done as a simulation, with completed designs displayed. Ahead of time, read over the annotated version of the information on planning, secure additional reference materials, and consider using one or more of the activities listed as an introduction for students.

1. Divide the students into cooperative learning groups of four students each.
2. Explain to the students that the purpose of this activity is to create a landscape design that would meet the needs of some native wildlife. (You may want to do the activity "The More Things Change, They'll Never Be The Same" to introduce the concept of native versus exotic species.)
3. If an actual site is to be used, take the students to the site and have them map it, noting details such as its size, types of plants presently on the site, location relative to the school buildings, etc. If a hypothetical site is to be used, provide a hand-drawn map of the site.
4. Make the supplies and reference materials available and pass out copies of the guidelines and tables.
5. Allow sufficient time for the students to create a landscape plan for the specific or hypothetical site.
6. Have each group present its proposed plan to the class, explaining reasons for the types and arrangement of plants.
7. As a class, select one of the plans for implementation, or create a composite plan that incorporates elements of several of the designs.

EXTENSION

1. Invite a landscaper or nurseryman to talk to the class and assist in the process of planning.
2. If you teach the 4th grade, participate in the Metro Beautification Project *ReLeaf Tennessee*. For more information visit: (www.nashville.gov/beautification) and click on Education Programs.
3. Follow up with other activities on gardening, plant propagation, or wildlife habitat.
4. Have students estimate the total cost of purchasing the plants that they propose to use, using price information from local nurseries or from a catalog.
5. Have each group "become" a specific native animal. After researching the animal's needs, they are then to evaluate each of the class plans from the point of view of their animal, explaining their rating of the plan.

EVALUATION

1. List the components of the created habitat. Include plant and animal species.
2. List the food, water, shelter, and space needs for each species.
3. Identify ways an introduced exotic species could disrupt this habitat.

STUDENT PAGE

WILDLIFE HABITAT PLANNING

Here are some suggestions on how you may provide the habitat needs for wildlife in your area:

Food

Native trees and shrubs can provide food for many wildlife species. Oak, beech, hickory, and walnut all provide valuable nuts to birds and other wildlife. Dogwood, blackgum, cherry, blackhaw, persimmon, sassafras, and hackberry provide soft fruit for birds. Some trees such as tulip poplar provide valuable nectar to butterflies and hummingbirds. Many native wildflowers such as columbine, trumpet creeper and butterfly weed provide nectar to butterflies and hummingbirds.

Birdfeeders provide food to wildlife and create hours of enjoyment to the wildlife observer. Black oiled sunflower seeds can be placed in a variety of feeders including platform feeders and hanging feeders. Suet (beef fat) can provide valuable protein to the insect eaters in the winter months. Hummingbird feeders of course supply nectar to hummingbirds.

Water

Water is an amazing wildlife attractant and an invaluable component of habitat planning. Water can be acquired through bird baths or puddles for birds, butterflies and other insects; and a small pond for amphibians.

Shelter or Cover

Shelter can be provided in a variety of ways, such as nesting boxes for birds, squirrels, etc., roosting boxes for bats, nesting shelves for robins, or standing dead trees with empty cavities. Cover can be provided in the form of evergreens such as cedar or pine, unmown areas, fence rows, or other native trees and shrubs.

Space

Space can be provided for wildlife by leaving as much of your project site as natural as possible. In other words, save a place for wildlife!

STUDENT PAGE

COMMON NATIVE WOODY PLANTS OF TENNESSEE

Size	Site	Common Name	Scientific Name
s*	x	Carolina Buckthorn	*Rhamnus carolina*
s*	x	Winged Sumac	*Rhus copallinum*
s	x	Fragrant Sumac	*Rhus aromatica*
s	x	Coralberry	*Symphoricarpos orbiculatos*
s	x	St John's Wort	*Hypericum frondosum*
s	x	Glade Privet	*Foresteria ligustrina*
s*	x	Bumelia	*Bumelia lycoides*
t	x	Eastern Red Cedar	*Juniperus virginiana*
s*	x	Rough Leaf Dogwood	*Cornus drummondi*
t	x	Winged Elm	*Ulmus alta*
st	x	Rusty Haw	*Viburnum rufidulum*
st	x, m	Hop Tree	*Ptelia trifolium*
st	x, m	Flowering Dogwood	*Cornus florida*
st	x, m	Black Haw	*Viburnum prunifolium*
s	x, m	Prairie Rose	*Rosa setigera*
st	x, m	Redbud	*Cercis canadensis*
st	x	Staghorn Sumac	*Rhus ~yphina*
st	m	Paw Paw	*Asimina tribola*
s	m	Hearts-a-bustin'	*Euonymus americana*
st	m	Wahoo	*Euonymus astropurpureus*
s	m	Spicebush	*Lindera benzoin*
s	m	Bladdernut	*Staphylea trifolia*
s	m	Elderberry	*Sambucus canadensis*
st	x, m	American Plum	*Prunus Americana*
s	m	Hydrangea Aborescens	*Hydrangea aborescens*
st	x, m	Eastern Hophornbeam	*Ostrya virginiana*
St	m	American Hornbeam	*Carpinus caroliniana*
st	x, m	Hawthorn	*Crataegus spp.*
st	x, m	Hercules Club	Aralia spinosa
st	u, x, m	Sourwood	*Oxydendrum arboreum*
s	u, a, x	Sparkleberry	*Vaccinium arboreum*
s	u, a, x	Deerberry	*Vaccinium stamineum*
s	u, a, x	Lowbush Blueberry	*Vaccinium pallidum*

Abbreviations:

Size ("habitat"):
- s = shrub
- s* = shrub or small tree
- st = small tree
- t = tree
- v = vine

Site condition:
- x = dry (often shallow soil)
- m = mesic, moist (rich woodlands)
- u = upland
- a = acidic soil
- w = near water

COMMON NATIVE WOODY PLANTS OF TENNESSEE (cont'd)

Size	Site	Common Name	Scientific Name
t	u, x, m	Black Gum	*Nyssa sylvatica*
t	x, m	Sassafras	*Sassafras albidum*
t	m	Sugar Maple	*Acer saccharum*
t	m	Tulip Poplar	*Liriodendron tulipera*
t	m	American Beech	*Fagus grandifolia*
t	x, m	American Holly	*Ilex opaca*
t	x, m	Shagbark Hickories	*Carya ovata and Carya spp.*
t	x, m	Red Oak	*Quercus rubra and Quercus spp.*
s	u, a, x	Mountain Laurel	*Kalmia latifolia*
s	u, a	Wild Honeysuckle	*Rhododendrum nudiflorum*
st	u	Serviceberry	*Amelanchier arbora*
s	w	Buttonbush	*Cephalanthus occidental*
s	w	Red-osier Dogwood	*Cornus stonifera*
s	w	Common Alder	*Alnus serrulata*
t	w, u, x	Sweetgum	*Liquidambar styraciflua*
t	w	River Birch	*Bertula nigra*
t	w	Sycamore	*Plantanus occidentalis*
t	w	Silver or Water Maple	*Acer saccharinum*
v		Virgins' Bower	*Clematis virginiana*
v		Leather Flower	*Clematis crispa*
v		Clematis	*Clematis viorna*
v		Passion-flower	*Passiflora incarnata*
v		Yellow Passion Flower	*Passiflora lutea*
v		Virginia Creeper	*Parthenocissus quinque*
v		Wild grape	*Vitis spp.*
v		Anglepod	*Matelea goncarpa*
v		Cross-vine	*Anisostichus capreolata*
v		Carolina Snailweed	*Cocculus carolinus*
v		Canada Moonseed	*Menispemum canadense*
v		Heartleaf Ampelopsis	*Ampelopsis cordata*
s		Beaty Bush	*Callicarpa americana*

Abbreviations:

Size ("habitat"):
- s = shrub
- s* = shrub or small tree
- st = small tree
- t = tree
- v = vine

Site condition:
- x = dry (often shallow soil)
- m = mesic, moist (rich woodlands)
- u = upland
- a = acidic soil
- w = near water

STUDENT PAGE

OUR NOXIOUS NEIGHBORS

A partial list of invasive exotics, which should NOT be selected for planting:

Common Name	Scientific Name
Chinese Yam	*Dioscorea oppositifolia*
Kudzu Vine	*Pueraaria lobata*
Purple Loosestrife	*Lythrum salicaria*
Japanese Honeysuckle	*Lonicera japonica*
Shrub Honeysuckle	*Lonicera maackii*
Autumn Olive	*Elaeagnus umbellata*
Common Privit	*Ligustrum sinese*
Creeping Euonymus	*Euonymus fortuei*
Burning Bush	*Euonymus alatus*
Tree of Heaven	*Ailanthus altissima*
Multiflora Rose	*Rosa multiforma*
Vinca	*Vinca minor, V. major*
Lespedeza	*Lespedeza cuneata*
Crown Vetch	*Coronilla varia*
Garlic Mustard	*Alliaria petiolata*
Princess (Empress) Tree	*Paulownia tomentosa*
Water Hyacinth	*Eichhornia crassipes*
Hydrilla	*Hydrilla verticillata*
Waterlettuce	*Pistia stratiotes*
Leafy Spurge	*Euphorbia esula*
Fescue	*Festuca sp.*


Hydrilla


Multiflora
Rose


Japanese
Honeysuckle


Purple
Loosestrife

Plotting Against Invasive Plants

CONCEPT

Ecologists use multiple sampling strategies to measure and count invasive plant infestations.

The background information for this activity was obtained from various internet sites. The quantitative characters information came from the following source: *Ocean Commotion website* (http://www.tamug.edu/seacamp/virtual/methods.htm)

We also encourage you to visit this site for an interesting discussion of different methods and applications:*Offwell Woodland and WildlifeTrust website* (http://www.countrysideinfo.co.uk/howto.htm).

Correlations to the Tennessee Science Curriculum Standards can be found on page 44.

Grade Level: 6-12
Subject: science and math
Skills: analysis, application, communicating, description, discussion, graphing, observation.
Duration: one 50-minute period
Group Size: any
Setting: classroom
Key Vocabulary: abundance, biodiversity, competition, density, population, quadrat analysis, sampling plot, species

OVERVIEW

The quantitative estimates that ecologists/land managers use to determine invasive pest plant infestations involve sampling techniques that vary with the type of area. Using the quadrat sampling method, students generate population counts for native and invasive plant species and observe the change in population numbers over time. Instead of plants, the model used for creating population estimates is a bag of 15 bean soup (the plants), an aluminum pan (the sampling area plot), and a 1'' square quadrat sampler (made from pipe cleaner, paperclip, or straw).

OBJECTIVE

Students will sample, count, and analyze data generated through quadrat sampling techniques.

MATERIALS

Each team will need: 1 bag of 15 Bean Soup, a 9 x 13 inch aluminum pan, 1 zip lock bag or cup to store extra beans, a ruler, 1'' square quadrat sampler made from pipe cleaner wire, a large paperclip, straws taped together, ect)

BACKGROUND

Ecologists use a variety of methods to sample plant populations based on many aspects: type of plant, size of plant, size of area, type of area that plant is found. The

quadrat sampling method is one type of quantitative strategy in which a quadrat sampling frame (usually 1 meter square) is randomly placed in a given area (study plot) and all the plants of interest are counted within that quadrat area. Random sampling is very important, so tossing a 1 meter quadrat could not truly be random because there is always bias in regard to where you are standing and many other factors. To randomly sample an area, study plots are divided up into grids which are each numbered; the grids to be sampled are selected from a random number generator table. With that said, this activity is a modified version of quadrat analysis in which plant biodiversity is calculated by randomly tossing a 1'' quadrat sampling frame.

Some, but by no means all, of the quantitative characters that can be measured by these methods are:

- **Abundance** - estimates on the numbers of a species or target group according to a predefined scale, such as rare, infrequent, abundant, etc.
- **Density** - abundance, measured by actual count, per unit area. Counts are averaged when more than one sample is taken.
- **Species Richness** – the number of different types of species or the number of different taxa in an area.
- **Frequency** - the percentage of sample plots in which a species or target group appears. Frequency data are often grouped into classes, such as A = 1-20%, B = 21-40%, C = 41-60%, D = 61-80%, E = 81-100%.
- **Cover** - commonly measured as "Total Cover", which is the percentage of all vegetation covering the ground surface inside the quadrat, or as "Species Cover", which is the percentage of the target species covering the ground surface inside the quadrat.

PROCEDURE

1. Divide the students into teams of 2 to 4 and distribute materials.
2. Instruct each student to make a 1'' square quadrat sampling frame from the material provided (ruler and large paperclip/pipe cleaner/wire).
3. Students will pour half the bag of 15 bean soup in the 9 x 13 pan and shake the pan so there is only a single layer of beans. Explain that this is a model to demonstrate a concept; in nature would plants be growing on top of each other? (Yes, vines – shrubs – trees grow over other plants).
4. Each student will take a turn randomly tossing their quadrat frame into the study plot. Ask them why they need to randomly toss and not deliberately place the quadrat frame. (True randomness is an important element in ecology because statistics are used to analyze the results of the sampling; common statistical techniques are only valid on truly random samples.)
5. This is where it gets tricky, without MOVING or MARKING on the beans, students will count the number and type of bean inside the quadrat frame. This works best with one student counting while another records the data. Any bean that touches or is within the frame is counted; half beans or pieces are counted, if identifiable.
6. Each team should do at least 5 quadrat frame samples; the more, the better the data.
7. Instruct students to calculate the Density for the beans counted in their plot. (To calculate Density, students will average the number of each type of bean from

the quadrat frame samples they took. For example, if 30 pinto beans were counted from 5 quadrat frame samples, the Density of pinto beans would be 6 per 1'' quadrat sample.

8. From this information, an estimate of the number of each type of bean can be determined in the study plot. (The study plot pan area is 9'' x 13'' = 117'' and there is an average of 6 pinto beans per 1'' for an estimated total of 702 pinto beans.)

EXTENSION

The previous activity will provide insight into population counting but not the impact of invasive plant species. To demonstrate the impact of an invasive exotic such as Chinese yam or Kudzu, continue the activity with the following instructions:

1. After student groups have their baseline data for the study plot of plants, explain that they are going to compare their existing data with a future scenario. All of the split peas, green and yellow, are actually an invasive plant species that can outcompete several native plants. The native species that cannot compete with the split peas are the large and small white lima beans, the medium white navy beans, and the garbanzo beans.
2. To show the impact of the invasive plants, instruct students to remove from the study plot all the large and small white lima beans, the medium white navy beans, and the garbanzo beans (do not remove the tiny white beans).
3. One characteristic of invasive plant species is the ability to grow rapidly. To model the rapid growth, students will add all the split peas (yellow and green) remaining in the other half of the bag of beans not used.
4. After the designated native white beans have been removed and the invasive split peas added, students will conduct another count to determine species Density. Remind students to shake the plot (pan) to create a single layer of beans.
5. Students may also want to calculate Frequency for the invasive split peas, comparing the data from the first sample with the native white beans and the second sample with the native white beans removed. How has the invasive plant introduction impacted this particular area?
6. There are many more aspects to this activity that can be continued after this second set of sampling data has been recorded. For example, students could model invasive plant removal efforts by removing invasive split peas from one specific area of the plot and then conducting another quadrat frame sampling analysis to determine differences. Do living things distribute evenly in an area? (No, there are different distribution patterns – clumped, scattered, etc...)

EVALUATION

1. Ecologists will establish study plots and monitor these over a period of years to determine the impact of an invasive species in an area. Develop a hypothesis and design a study that an ecologist could conduct using study plots and different chemical treatments for an invasive pest plant that grows like a vine (like Chinese Yam).
2. How is species abundance different from species richness? In a biologically diverse ecosystem, describe how both of these terms would apply in the evaluation of the stability and health of that system.

I "Yam" What I "Yam"

CONCEPT

Factors that influence the success of an invasive exotic plant population are similar to native species.

Adapted from "Oh Deer" - Project Wild

Correlations to the Tennessee Science Curriculum Standards can be found on page 44.

Grade Level: 6-12
Subject: science and math
Skills: application, comparing similarities and differences, description, discussion, graphing, kinesthetic concept development, observation.
Duration: one 50-minute period
Group Size: needs to be 18 or larger to be effective
Setting: large open flat space or field suitable for running or walking quickly
Key Vocabulary: limiting factors, habitat, nutrients, water, sunlight, and

OVERVIEW

This activity deals with the factors that influence the success of an exotic invasive plant species such as sunlight, water, nutrients, and space.

OBJECTIVE

Students will be able to identify factors that influence growth of an exotic invasive plant population.

MATERIALS

Poster board and markers for recording data; graph paper for creating a graph of the Chinese yam population growth over several generations

BACKGROUND

Any species that is introduced to an ecosystem is considered an exotic species. Not all introduced species become a problem but since every ecosystem has a limited quantity of resources, the introduced species will compete with native species for resources.

Due to many factors, if an invasive species is a successful competitor in its new environment, the populations of native species may begin to decline due to the introduced competition. Chinese yam is a perennial vine originally from China. Fast growing, Chinese yam can grow on and over adjacent vegetation creating a thick blanket of coverage. This blanket of yam leaves shades the native plants by blocking much needed sunlight.

Like all flowering plants, Chinese yam reproduces sexually through flowers; the entire plant produces either male or female flowers. Since there are only male Chinese yam plants in the United States it does not reproduce sexually in the U.S.,

but it reproduces quickly by producing vegetative structures that look like small potatoes at each leaf node (the nickname for this plant is air potato). The small bulbils drop off and grow into another plant; some plants can produce three generations in one growing season. Rapid growth and vegetative reproduction are two reasons the Chinese yam can out-compete native plants for limited resources such as space, sunlight, water, and nutrients. This activity explores the limiting factors for plant growth.

PROCEDURE

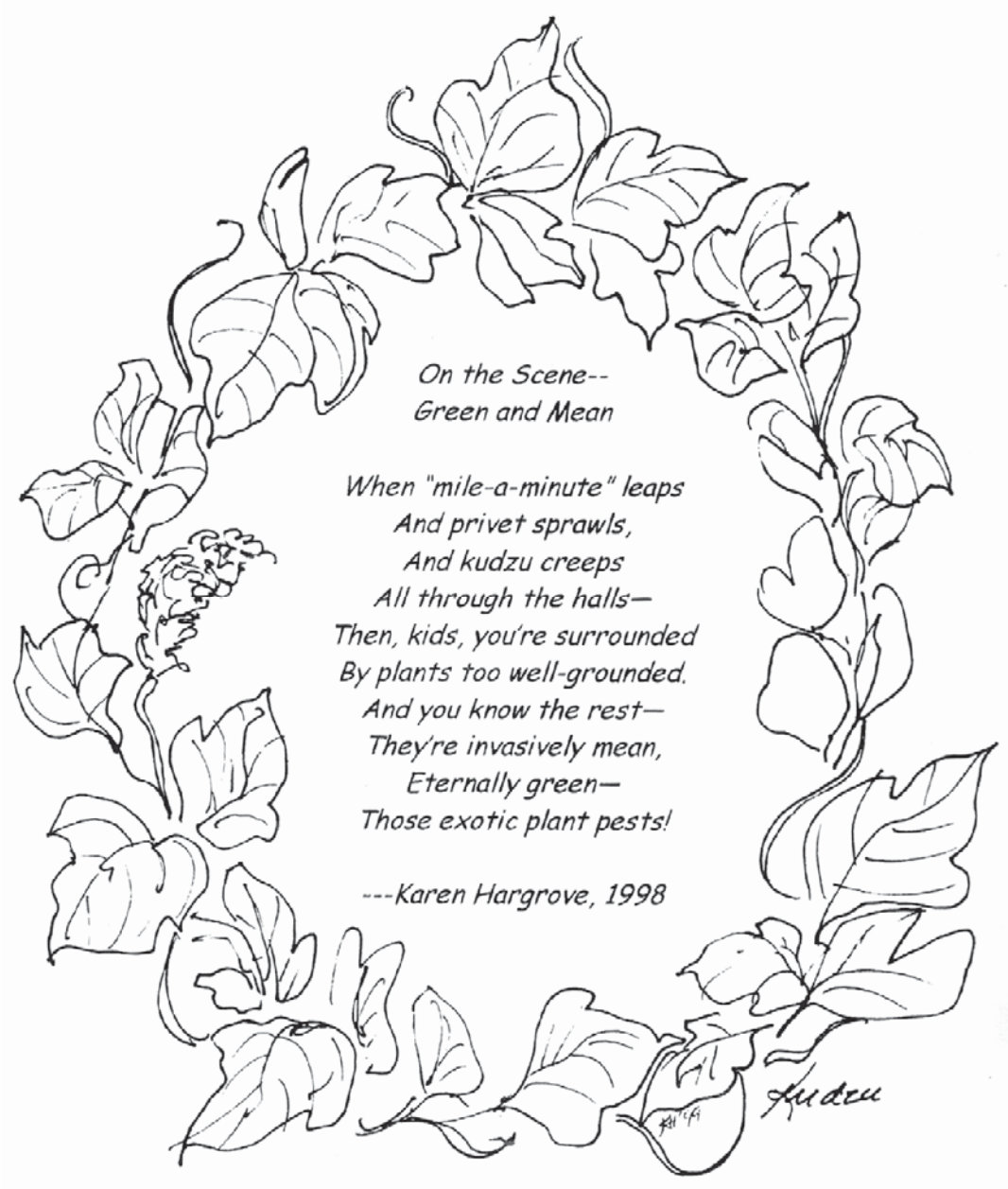
1. Divide the students into two groups (2/3 of class are Chinese Yams, 1/3 of class are Needs).
2. The objective of the activity is for the Chinese Yams to run and find their Need before another yam plant claims that Need. Explain to the students that the purpose of this activity is to look at limiting factors in the environment and the needs of a species to be successful.
3. Once students are divided, the Chinese Yams and Needs move to opposite sides of the field, about 40 feet apart. Mark boundaries, if someone steps out of bounds, they immediately become a Need.

   Here are the different symbols for the Needs:
   - **Water** (hand over mouth)
   - **Nutrients** (hands holding stomach)
   - **Sunlight** (hands held over head)
4. The Chinese Yams and the Needs will line up on opposite sides of the field, not facing each other. The Chinese yams will choose the Need it plans to go after by making the corresponding hand gesture. The Need will choose to be water, nutrients, or sunlight by making the corresponding hand gesture.
5. When told to begin, both the Yams and the Needs will turn and face each other. The Chinese yams will run toward the Needs that matches their need (hand gesture). The Needs are stationary and do not run; only one Yam per Need is permitted.
6. The Yams who find (tag) their Need first, survive and reproduce; the Need will now become a Chinese yam plant and walk to the other side of the field to join the other Yams. Those Yams who do not meet their needs perish and will now become a Need.
7. Record the number of Chinese yam plants at the beginning of each round. Play at least 12 rounds, which represent 12 generations of yam plant growth or 4 years growth.
8. Create a graph to examine the impact of available resources on the growth of the Chinese yam. Students will notice increases and decreases in the Chinese yam population based on the resources that are available. As long as there are sufficient resources available, and no competition, the Chinese yam plant will continue to thrive and multiply year after year.
9. Ask the students to examine the graph and discuss the relationship of this activity to what they have learned about exotic invasive plants. (All plants have basic requirements of sunlight, water, and nutrients - even exotic invasive plants.
   - What this graph does not show is the competitive edge that invasive species have against the native species.)
   - What do resource managers see happening with invasive species that we did not show on the graph? (The growth of invasive species does not seem to be limited; growth tends to be exponential. High reproductive capacity and

rapid growth are two advantages Chinese yam has over native species in the areas where it grows.)

EXTENSION

Another class could join the activity and represent Native plants; Natives will stand with the Yams and make a Need sign, just like the Yams. When instructed to turn and meet their Need, the Native plants would have to hop on one foot, instead of running on two like the Chinese yam plants. Students will continue for 10 rounds, counting the number of Yams and Native plants at the end of each round. Compare the difference in numbers. What are some advantages exotic invasive plants have over native plants?



Cracking Up with Invasive Species

CONCEPT

The consequences of deliberate or accidental introductions of invasive species creates an imbalance in the native ecosystem.

Adapted from "*Learn the Terms"* included in An Educator's Guide to the Threatened and Endangered Species and Ecosystems of Tennessee*; d*eveloped by the U.S. Fish and Wildlife Service.

Correlations to the Tennessee Science Curriculum Standards can be found on page 44.

Grade Level: 6-12
Subject: science
Skills: communicating, compare and contrast, description, discussion, inference, observation, research
Duration: one 50-minute period
Group Size: any
Setting: Classroom
Key Vocabulary: species, population, habitat, ecosystem, nonnative species, threatened, endangered, extirpated, extinct, and Endangered Species Act

OVERVIEW

Species that are not native to North America have been deliberately or accidentally introduced and are causing harm to native plants and animals in Tennessee; reintroduction of native species to an area and protection of declining native species may offer some solutions to this problem.

OBJECTIVE

This activity is designed to give students an introduction to invasive species, examples of how they affect the ecosystem in which they are introduced, and an introduction to ecological terms associated with these concepts.

MATERIALS

Cupcake liners or paper cups, goldfish crackers, and oyster/soup crackers or a different kind of goldfish cracker such as pretzel goldfish, vocabulary word sort strips in an envelope, vocabulary definitions handout

PROCEDURE

1. Ask students to form groups of 2 to 4. Distribute word sort envelopes to each group. To prepare word sort envelopes type vocabulary words into a table, print a word set for each group, cut out words, and place in an envelope.
2. Instruct students to examine each word in the envelope and: (a) attempt to define in their own words; (b) sort the words in the envelope to show the relationship to each other on the desktop – similar to a concept map.

3. While students examine the ecology word sort, prepare cups for each student by placing 10 goldfish crackers in each. This can be modified for older students by filling each cup approximately 2/3 full, no need to count goldfish crackers.
4. Introduce the terms to the students by telling students that:
    - All the crackers in your cup are the same kind of cracker; in other words, they are the same *species*. Examine the crackers, are they all identical? (students will notice that although they look the same at first glance, they are not identical because there is still much variation among an individual species)
    - How many species are in your cup? (ten, or however many 2/3 cup equals)
    - There are ten/_____ crackers of the same one species. These ten crackers in your cup make up a *population* of the goldfish cracker species. The cup you are holding represents the goldfish cracker population's *habitat* or home. Imagine your species can find food, water, shelter, and living space here.
    - All of these habitats (cups) are in our classroom, right? Our classroom represents the *ecosystem* in which the goldfish cracker species' habitat exists. The goldfish cracker species depends on the living (biotic factors - plants and animals) and non-living (abiotic factors - soil, water, air) in the ecosystem for a healthy habitat and for survival.
5. Explain that something is affecting the species population.
6. Tell each student to eat one cracker. (older students, let them pick how much to eat)
    - What is the population in your habitat? (one)
    - Total population count of the goldfish cracker species in our ecosystem? (nine)
7. Place three oyster/soup crackers in each student's cup.
    - A *nonnative* species has been introduced to the ecosystem and is taking over the goldfish cracker species' habitat. This new species will upset the stability of the ecosystem by out-competing the native species for food, water, and space.
    - How many species are in your habitat/cup? (two – goldfish crackers and oyster crackers)
    - How many in the population of each species? (3 oyster crackers and 9 goldfish)
8. Have each student eat three of the goldfish crackers in his/her cup.
    - What is the goldfish cracker species' population now? (six goldfish)
    - The population has declined because of the nonnative species; the goldfish cracker species is currently *threatened*.
9. Unfortunately, poorly planned human development is also destroying the goldfish cracker species' habitat. Have half of the students gently squeeze or crumple their cups without crushing crackers in order to represent habitat destruction. Ask the students with crumpled cups to eat three more goldfish crackers (the other half of the students should do nothing).
    - How many of the goldfish cracker species are left? Some of the populations have continued to decline because of habitat destruction. The goldfish cracker species is now in danger of disappearing; it is

endangered. Air and water pollution are harming the ecosystem as well; although we cannot see these pollutants, they affect our goldfish cracker species.

10. Instruct all the students to eat three goldfish crackers. (Half the students will have no goldfish crackers left.)
    - Now the goldfish cracker species is missing from half the classroom. The species is *extirpated* from that half, but it still exists in the other half of its original range.
    - What will happen if populations of the endangered goldfish cracker species continue to decline? There will be no more goldfish crackers, and the species will be *extinct*; it will no longer exist. We do not want that to happen, so let's pass a law to protect our goldfish cracker species. The law that exists today which protects threatened and endangered species on Federal and State lands in the United States is called the *Endangered Species Act*.
    - What else can we do to help threatened and endangered species? As students give ideas like conserving water, not littering, recycling, stopping erosion, respecting nature, etc., ask them to "restore" habitats by smoothing out the crumpled cups and add goldfish crackers to each cup to represent the reestablishment of a population.

11. Instruct student teams to return to the word sort strips and discuss word sort terms again; is there anything they would arrange differently after this activity? What are the relationships of the terms to each other? Distribute the vocabulary word handout; do the student definitions compare with those on the handout? What terms could be changed?

EXTENSION

Students can create this model of an endangered ecosystem using any type of goldfish cracker (there are assorted colors, sizes, and shapes), colored candy pieces, popcorn, or other tokens. To introduce the concept of the complexity of the issue of introduced species, the chunky white salt crystals covering goldfish pretzels could represent another threat or a parasite upon the exotic invader. Depending on which you select, you can continue the activity accordingly. You could then ask students to research examples of invasive exotics that brought along other invaders as hitchhikers. You can also ask students to research examples of bioremediation, where biological controls have been used to control an invasive pest. When another biological agent is introduced to control an invasive pest, what are the considerations scientists must keep in mind? Is it possible to know all the connections? How could scientists 'test' a biological control agent to rule out the most likely problems? What are the risks? What are the benefits?

EVALUATION

1. Students will write an essay about an exotic invasive plant introduction, using the appropriate vocabulary terms, and addressing these points: (a) How was the invasive pest introduced; what is the country of origin? (b) What is the life history of the pest plant? (c) What native populations are suffering as a consequence of the introduction? (d) What are some possible means of eradication of the invasive pest plant?

2. Instruct students to create a concept map of the vocabulary terms introduced in this activity to graphically show the relationships of the terminology.

STUDENT PAGE

VOCABULARY WORDS FOR WORD SORT ACTIVITY

Biodiversity:
The variety of life in an area, including species, ecosystems, & their interactions

Species:
A group of genetically related organisms (typically have similar physical structure & behavior) that reproduce with one another to produce fertile offspring

Habitat:
The place where a plant or animal lives, its 'home address' or where you will typically find it. Habitat includes food water, shelter, & cover (space) in proper arrangement

Niche:
The role or "job" an organism has in a particular habitat. This includes what it eats (how it obtains energy) as well as what it does to be successful in that particular place

Ecosystem:
All living (plants/animals) & nonliving (air/water) parts of any size area, interacting & supporting each other (an ecological unit)

Population:
The number of a single species in a defined area

Community:
An assembly of many different types of populations (different species) in a defined area

Native species:
An organism that naturally occurs in a particular environment

Non-native species:
An organism that doesn't naturally occur in a particular environment, but has been introduced from another region or country, most likely by humans

Threatened:
Any species likely to become endangered in the near future

Endangered:
Any species in danger of extinction through its entire range

Extirpated:
Missing from a certain area but present in others

Re-introduce:
Releasing organisms *back* into areas where they once occurred naturally

Extinct:
No longer in existence

Endangered Species Act:
A federal law protecting endangered & threatened species & the ecosystems they depend

STUDENT PAGE

WORD SORT ACTIVITY LABELS

(copy and cut out sets for teams; blank squares are for additional terms to be added by the teacher or student)

Endangered Species Act	**Extinct**	**Re-introduce**
Extirpated	**Endangered**	**Threatened**
Non-native Species	**Native species**	**Community**
Population	**Ecosystem**	**Niche**
Habitat	**Species**	**Biodiversity**

Design an Invasive Plant

CONCEPT
There are multiple factors that make an exotic invasive species successful in an introduced environment.

Adapted from "Design an Exotic Fish"- Non Indigenous Species Activities for Youth Publication) by John Guyton.

Correlations to the Tennessee Science Curriculum Standards can be found on page 44.

Grade Level: 9 - 12
Subject: science
Skills: acquiring information, communicating, determining causes and effects, group participation, problem solving
Duration: two 50-minute period
Group Size: any
Setting: classroom
Key Vocabulary: adaptation, competition, land management, sexual reproduction, vegetative reproduction

OVERVIEW
Understanding the characteristics that offer a competitive advantage to an invasive plant help land managers identify control strategies.

OBJECTIVE
Students will identify characteristics that make an exotic invasive plant successful.

MATERIALS
Paper, markers

BACKGROUND
There are multiple factors that allow exotic invasive plants to proliferate. For example, invasive plants that have adaptations to survive in a wide range of environments are most successful. Another advantage is when invasive plants are introduced to an area in which they have not evolved, there is normally a lack of competition in the form of herbivory (other organisms feeding upon that plant). This lack of predation helps the species thrive, because there are no other organisms to keep it in check. Chinese privet is a commonly used landscape shrub that has escaped to natural areas at an alarming rate.

One of the things land managers have noticed is very few animals (such as deer and insects) graze on Chinese privet, even the young tender sprouts. It is not understood why, but perhaps Chinese privet contains substances that repel native predators. Exotic plants that can reproduce asexually have the ability to out produce native plants that need both male and female plants to reproduce. Chinese yam, for instance, vegetatively produces axillary bulbils that look like small potatoes. Each vine of Chinese yam can produce 20 bulbils a year and each bulbil can spout in less

than 2 weeks. Chinese yam proliferates in the riparian zone next to a river because the bulbils drop off easily and float downstream; when the water subsides, the bulbil begins to germinate and produce a new vine. Due to its successful reproduction abilities, Chinese yam is currently listed in the Southeast Exotic Pest Plant Council's Invasive Exotic Pest Plant List for Tennessee as a Rank 1-Severe Threat species.

PROCEDURE

1. Lead students in a discussion of how various characteristics of an invasive plant allow it to survive, such as
    - Habitat (marsh, desert, rainforest, dry forest, etc.)
    - Reproduction (sexual or asexual)
    - Temperature range
    - Water requirement
    - Nutrient requirement
    - Size (small/large leaves, short/tall stem, etc.)
    - Shape and growth habit (tree, shrub, vine, etc.)
2. Instruct students to research the following exotic invasive plants, paying special attention to the above characteristics. Students will place the information in a table format so it is easy to compare and contrast characteristics among the selected invasive plants.
    - Chinese Yam
    - Kudzu
    - Japanese Honeysuckle
    - Milk Thistle
    - Hydrilla
    - Purple Loosestrife
    - Others listed on previous "Our Noxious Neighbors" Student Page
3. When students have completed their research and included all the relevant information in a table format, ask them to: (a) identify features that are shared among the invasive plants in each of the categories; (b) identify features that are very different among the invasive plants in each of the categories. They will notice that several may have shared characteristics (for example, Chinese yam, Kudzu, and Japanese honeysuckle are vines) but they all have great variation related to their adaptations and success as an invasive plant. The common thread among all exotic invasive plants is the ability to out compete native plant populations; how this competition occurs varies with each invasive plant.
4. After students have discussed invasive plant characteristics, students will design an exotic invasive plant, addressing each of the seven characteristics. Students will (a) name; (b) draw their exotic invasive plant; (c) identify the habitat; and (d) describe the function of the various structures that lead to the success of the invasive exotic plant.
5. Students should be allowed three to five minutes to show and describe their invented exotic invasive plant to the class, explaining how the selected characteristics make it successful in the introduced environment.

EXTENSION

There are so many difficulties associated with controlling invasive plants. Students will have an opportunity to examine some of the challenges land managers face by evaluating another student's invasive plant and developing a control management plan for that invasive plant.

Invite someone from the community that is responsible for invasive plant control to come and speak with your class. After their presentation, ask students to swap their invented invasive plant with another student and pretend they are a land manager for an area that is over taken with the imaginary invasive plant. Instruct them to write a control management plan that will attempt to eradicate the invasive plant. Things they need to keep in mind would be physical removal (is this even possible), chemical control (is the application of herbicides or plant hormones possible in that area without destroying native species), and biological control (is it possible to introduce an organism from the invasive plants native range that won't decimate or create problems here).

Another consideration for land management that needs to be addressed once the invasive plant has been removed, is what actions need to be taken in the area that has been cleared that will prevent future invasions of the same or even a different invasive species. This may be difficult to work out, but if the individual that came to speak with your class about invasive plant control could return to your class and hear the student's invasive plant control plans.

EVALUATION

1. Identify three characteristics of exotic invasive plants that promote success in an environment in which they have been introduced.
2. What problems do land managers face when trying to control invasive plants?

CORRELATIONS TO
TN SCIENCE CURRICULUM STANDARDS

Elementary and Middle School Tennessee
Science Curriculum Standards (Grades K-8) for
'Noxious Neighbors: If It's Green, It's Good?' Activities

Activity: A Date With Freddie Kudzu
Life Science Standards

Grade 4
Standard 2 Interdependence
Grade Level Expectations:
• Analyze the effects of changes in the environment on the stability of an ecosystem
Standard 4 Heredity
Grade Level Expectations:
• Recognize the relationship between reproduction and the continuation of a species
Standard 5 Biodiversity and Change
Grade Level Expectations:
• Analyze physical and behavioral adaptations that enable organisms to survive in their environment
• Describe how Environment changes caused the extinction of various plant and animal species

Grade 5
Standard 2 Interdependence
Grade Level Expectations:
- Establish the connections between human activities or natural disasters and their impact on the environment

Grade 6
Standard 2 Interdependence
Grade Level Expectations:
• Draw conclusions from data about interactions between the biotic and abiotic elements of a particular environment

Grade 7
Standard 4 Heredity
Grade Level Expectations
- Compare and contrast the fundamental features of sexual and asexual reproduction

Grade 8
Standard 5 Biodiversity and Change
Grade Level Expectations:
• Analyze how structural, behavioral, and physiological adaptations within a population enable it to survive in a given environment
• Describe the importance of maintaining the earth's biodiversity

Activity: Help! Something's Choking Auntie Elm!
Life Science Standards

Grade 5
Standard 2 Interdependence
Grade Level Expectations:

- Explain how organisms interact through symbiotic, commensal, and parasitic relationships

Grade 6
Standard 2 Interdependence
Grade Level Expectations:

- Examine the roles of consumers, producers, and decomposers in a biological community
- Describe how matter and energy are transferred through an ecosystem
- Draw conclusions from data about interactions between biotic and abiotic elements in a particular environment
- Analyze the environments and the interdependence among organisms found in the world's major biomes

Grade 7
Standard 4 Heredity
Grade Level Expectations

- Compare and contrast the fundamental features of sexual and asexual reproduction

Grade 8
Standard 5 Biodiversity and Change
Grade Level Expectations:

- Analyze how structural, behavioral, and physiological adaptations within a population enable it to survive in a given environment
- Explain why variation within a population can enhance the chances for group survival
- Describe the importance for maintaining the earth's biodiversity

Activity: The More Things Change, They'll Never Be the Same
Life Science Standards

Grade 4
Standard 2 Interdependence
Grade Level Expectations:

- Analyze the effects of changes in the environment on the stability of an ecosystem

Standard 4 Heredity

- Recognize the relationship between reproduction and the continuation of a species

Standard 5 Biodiversity and Change

Grade Level Expectations:

- Analyze physical and behavioral adaptations that enable organisms to survive in their environment
- Describe how environmental changes caused the extinction of various plant and animal species

Grade 5

Standard 2 Interdependence
Grade Level Expectations:

- Establish the connections between human activities or natural disasters and their impact on the environment

Grade 6

Standard 2 Interdependence
Grade Level Expectations:

- Draw conclusions from data about interactions between the biotic and abiotic elements in a particular environment
- Analyze the environments and the interdependence among organisms found in the world's major biomes

Grade 8

Standard 5 Biodiversity and Change
Grade Level Expectations:

- Analyze how structural, behavioral, and physiological adaptations within a population enable it to survive in a given environment
- Explain why variation within a population can enhance the chances for group survival
- Describe the importance of maintaining the earth's biodiversity

Activity: Clueless or Careless?

Life Science Standards

Grade 4

Standard 2 Interdependence
Grade Level Expectations:

- Analyze the effects of changes in the environment on the stability of an ecosystem

Standard 5 Biodiversity and Change
Grade Level Expectations:

- Describe how environmental changes caused the extinction of various plant and animal species

Grade 5

Standard 2 Interdependence
Grade Level Expectations:

- Establish connections between human activities or natural disasters and their impact on the environment

Grade 6
Standard 2 Interdependence
Grade Level Expectations:

- Draw conclusions from data about interactions between biotic and abiotic elements of a particular environment
- Analyze the environments and the interdependence among organisms found in the world's major biomes

Grade 8
Standard 5 Biodiversity and Change
Grade Level Expectations:

- Analyze how structural, behavioral, and physiological adaptations within a population enable it to survive in a given environment
- Describe the importance of maintaining the earth's biodiversity

Activity: Don't Gripe---Get a Grip!
Life Science Standards

Grade 6
Standard 2 Interdependence
Grade Level Expectations:

- Examine the roles of consumers, producers, and decomposers in a biological community
- Describe how matter and energy are transferred through an ecosystem
- Draw conclusions from data about interactions between the biotic and abiotic elements of a particular environment
- Analyze the environments and the interdependence among organisms found in the world's major biomes

Grade 8
Standard 5 Biodiversity and Change
Grade Level Expectations:

- Analyze how structural, behavioral, and physiological adaptations within a population enable it to survive in a given environment
- Explain why variation within a population can enhance the chances for group survival

Activity: You Can't "Grow Home" Again
Life Science Standards

Grade 4
Standard 2 Interdependence
Grade Level Expectations:

- Analyze the effects of changes in the environment on the stability of an ecosystem

Standard 3 Flow of Matter and Energy

- Demonstrate that plants require light energy to grow and survive
- Investigate different ways that organisms meet their energy needs

Standard 5 Biodiversity and Change
Grade Level Expectations:

- Analyze physical and behavioral adaptations that enable organisms to survive in their environment
- Describe how environmental changes caused the extinction of various plant and animal species

Grade 5

Standard 2 Interdependence
Grade Level Expectations:

- Investigate different nutritional relationships among organisms in an ecosystem
- Explain how organisms interact through symbiotic, commensal, and parasitic relationships
- Establish the connections between human activities or natural disasters and their impact on the environment

Standard 3 Flow of Matter and Energy
Grade Level Expectations:

- Demonstrate how all living things rely on the process of photosynthesis to obtain energy

Standard 5 Biodiversity and Change

- Investigate physical characteristics associated with different groups of animals

Grade 6

Standard 2 Interdependence
Grade Level Expectations:

- Examine the role of consumers, producers, and decomposers in a biological community
- Describe how matter and energy are transferred through an ecosystem
- Draw conclusions from data about interactions between the biotic and abiotic elements in a particular environment
- Analyze the environments and the interdependence among organisms found in the world's major biomes

Grade 7

Standard 3 Flow of Matter and Energy
Grade Level Expectations:

- Distinguish between the basic features of photosynthesis and respiration
- Investigate the exchange of oxygen and carbon dioxide between living things and the environment

Grade 8

Standard 5 Biodiversity and Change

- Analyze how structural, behavioral, and physiological adaptations within a population enable it to survive in a given environment

- Explain why variation within a population can enhance the chances for group survival
- Describe the importance of maintaining the Earth's biodiversity

Activity: The Natives Are Friendly
Life Science Standards

Kindergarten
Standard 3 Flow of Matter and Energy
Grade Level Expectations:
- Recognize that living things require water, food, and air

Standard 4 Heredity
Grade Level Expectations
- Observe how plants and animals change as they grow
- Observe that offspring resemble their parents

Grade 1
Standard 2 Interdependence
Grade Level Expectations
- Distinguish between living and non-living things in an environment

Standard 3 Flow of Matter and Energy
Grade Level Expectations:
- Recognize that plants and animals are living things that grow and change over time

Standard 4 Heredity
Grade Level Expectations
- Observe and illustrate the life cycle of animals

Standard 5 Biodiversity and Change
Grade Level Expectations
- Investigate how plants and animals can be grouped according to their habitats

Grade 2
Standard 2 Interdependence
Grade Level Expectations
- Investigate the habitats of different kinds of local plants and animals
- Investigate living things found in different places
- Identify basic was that plants and animal depend on each other

Standard 3 Flow of Matter and Energy
Grade Level Expectations
- Recognize that animals eat plants and other animals for food

Standard 4 Heredity
Grade Level Expectations
- Compare the life cycles of various organisms

Standard 5 Biodiversity
Grade Level Expectations

- Investigate the relationship between an animal's characteristics and the features of the environment where it lives

Grade 3

Standard 4 Heredity
Grade Level Expectations

- Identify the different life stages through which plants and animals pass

Standard 5 Biodiversity and Change
Grade Level Expectations

- Explore the relationship between an organism's characteristics and its ability to survive in a particular environment

Grade 4

Standard 3 Flow of Matter and Energy
Grade Level Expectations

- Demonstrate that plants require light energy to grow and survive

Standard 4 Heredity
Grade Level Expectations

- Recognize the relationship between reproduction and the continuation of a species
- Differentiate between complete and incomplete metamorphosis

Grade 5

Standard 2 Interdependence
Grade Level Expectations

- Investigate different nutritional relationships among organisms in an ecosystem

Standard 3 Flow of Matter and Energy
Grade Level Expectations

- Demonstrate how all living things rely on the process of photosynthesis to obtain energy

Grade 6

Standard 2 Interdependence
Grade Level Expectations

- Draw conclusions from data about interactions between the biotic and abiotic elements of a particular environment

Grade 7

Standard 4 Heredity
Grade Level Expectations

- Demonstrate an understanding of sexual reproduction in flowering plants

Grade 8
Standard 5 Biodiversity and Change
Grade Level Expectations

- Identify various criteria used to classify organisms into groups
- Use a simple classification key to identify a specific organism
- Describe the importance of maintaining the earth's biodiversity

Activity: I "Yam" What I "Yam"
Life Science Standards

Grade 6
Standard 2 Interdependence
Grade Level Expectations

- Draw conclusions from data about interactions between the biotic and abiotic elements of a particular environment

Grade 7
Standard 4 Heredity
Grade Level Expectations

- Demonstrate an understanding of sexual reproduction in flowering plants

Grade 8
Standard 5 Biodiversity and Change
Grade Level Expectations

- Identify various criteria used to classify organisms into groups
- Use a simple classification key to identify a specific organism
- Describe the importance of maintaining the earth's biodiversity

Activity: Cracking Up with Invasive Species
Life Science Standards

Grade 6
Standard 2 Interdependence
Grade Level Expectations

- Draw conclusions from data about interactions between the biotic and abiotic elements of a particular environment

Grade 7
Standard 4 Heredity
Grade Level Expectations

- Demonstrate an understanding of sexual reproduction in flowering plants

Grade 8
Standard 5 Biodiversity and Change
Grade Level Expectations

- Identify various criteria used to classify organisms into groups
- Use a simple classification key to identify a specific organism
- Describe the importance of maintaining the earth's biodiversity

Tennessee High School
Science Curriculum Standards (Grades 9-12) for
'Noxious Neighbors: If It's Green, It's Good?' Activities

Activity: A Date With Freddie Kudzu
Grades: 4-12

ECOLOGY
Standard 1- Individuals
- CLE 3255.1.4 Investigate various approaches to maintain biodiversity.

Standard 3- Communities
- CLE 3255.3.1 Explain ecological niches within various habitats.
- CLE 3255.3.2 Relate species interactions such as competition, predation and symbiosis to co-evolution.

Standard 4-Ecosystem
- CLE 3255.4.4 Summarize the human impact on ecosystems.
- CLE 3255.4.5 Describe how biodiversity relates to stability of an ecosystem.

BIOLOGY I
Standard 2-Interdependence
- CLE 3210.2.1 Investigate how the dynamic equilibrium of an ecological community is associated with interactions among its organisms.
- CLE 3210.2.3 Predict how global climate change, human activity, geological events, and **the introduction of non-native species impact an ecosystem**.

Activity: The More Things Change, They'll Never Be the Same
Grades: 4-12

ECOLOGY
Standard 2-Communities
- CLE 3255.3.2 Relate species interactions such as competition, predation and symbiosis to co-evolution.

Standard 4-Ecosystem
- CLE 3255.4.4 Summarize the human impact on ecosystems.
- CLE 3255.4.5 Describe how biodiversity relates to stability of an ecosystem.

BIOLOGY I
Standard 2-Interdependence
- CLE 3210.2.1 Investigate how the dynamic equilibrium of an ecological community is associated with interactions among its organisms.
- CLE 3210.2.3 Predict how global climate change, human activity, geological events, and the introduction of non-native species impact an ecosystem.

Activity: Clueless or Careless?
Grades: 4-12

ENVIRONMENTAL SCIENCE
Standard 4- Water and Land Resources
- CLE 3260.4.4 Evaluate the impact of human activities on natural resources.

Standard 7- Global Change and Civic Responsibility
- CLE 3260.7.2 Compare and contrast methods used by various governments to protect biodiversity.

ECOLOGY
Standard 2-Communities
- CLE 3255.3.2 Relate species interactions such as competition, predation and symbiosis to co-evolution.

Standard 4-Ecosystems
- CLE 3255.4.4 Summarize the human impact on ecosystems.

Standard 6-Humans and Sustainability
- CLE 3255.6.2 Examine state, national, and international efforts to sustain native species.
- CLE 3255.6.3 Evaluate the impact of personal actions on the environment.

BIOLOGY I
Standard 2-Interdependence
- CLE 3210.2.1 Investigate how the dynamic equilibrium of an ecological community is associated with interactions among its organisms.
- CLE 3210.2.3 Predict how global climate change, human activity, geological events, and **the introduction of non-native species impact an ecosystem**.

Activity: Don't Gripe---Get a Grip!
Grades: 7-12

ECOLOGY
Standard 3- Communities
- CLE 3255.3.1 Explain ecological niches within various habitats.
- CLE 3255.3.2 Relate species interactions such as competition, predation and symbiosis to co-evolution.

BIOLOGY I
Standard 2-Interdependence
- CLE 3210.2.1 Investigate how the dynamic equilibrium of an ecological community is associated with interactions among its organisms.

Activity: The Natives Are Friendly
Grades: K-12

ENVIRONMENTAL SCIENCE
Standard 2- The Living World
- CLE 3260.2.3 Using temperature, latitude and longitude, infer the types of animal and plant life found in each of earth's major biomes.

Standard 4- Water and Land Resources
- CLE 3260.4.4 Evaluate the impact of human activities on natural resources.

ECOLOGY
Standard 1- Individuals
- CLE 3255.1.4 Investigate various approaches to maintain biodiversity.

Standard 2- Populations
- CLE 3255.2.1 Cite examples of populations limited by natural factors, humans or both.

Standard 3- Communities
- CLE 3255.3.1 Explain ecological niches within various habitats.
- CLE 3255.3.2 Relate species interactions such as competition, predation and symbiosis to co-evolution.

Standard 4-Ecosystem
- CLE 3255.4.5 Describe how biodiversity relates to stability of an ecosystem.

BIOLOGY I
Standard 2-Interdependence
- CLE 3210.2.1 Investigate how the dynamic equilibrium of an ecological community is associated with interactions among its organisms.
- CLE 3210.2.3 Predict how global climate change, human activity, geological events, and the introduction of non-native species impact an ecosystem.

Standard 5- Biodiversity and Change
- CLE 3210.5.1 Associate structural, functional, and behavioral adaptations with the ability of organisms to survive under various environmental conditions.

Activity: I "Yam" What I "Yam"
Grades: 6-12

ECOLOGY
Standard 2-Communities
- CLE 3255.3.2 Relate species interactions such as competition, predation and symbiosis to co-evolution.

Standard 4-Ecosystem
- CLE 3255.4.4 Summarize the human impact on ecosystems.
- CLE 3255.4.5 Describe how biodiversity relates to stability of an ecosystem.

BIOLOGY I
Standard 2-Interdependence

- CLE 3210.2.1 Investigate how the dynamic equilibrium of an ecological community is associated with interactions among its organisms.
- CLE 3210.2.3 Predict how global climate change, human activity, geological events, and the introduction of non-native species impact an ecosystem.

Activity: Cracking Up with Invasive Species
Grades: 6-12

ECOLOGY
Standard 1- Individuals
- CLE 3255.1.4 Investigate various approaches to maintain biodiversity.

Standard 2- Populations
- CLE 3255.2.1 Cite examples of populations limited by natural factors, humans or both.

Standard 2-Communities
- CLE 3255.3.2 Relate species interactions such as competition, predation and symbiosis to co-evolution.

Standard 3- Communities
- CLE 3255.3.1 Explain ecological niches within various habitats.

Standard 4-Ecosystem
- CLE 3255.4.4 Summarize the human impact on ecosystems.
- CLE 3255.4.5 Describe how biodiversity relates to stability of an ecosystem.

BIOLOGY I
Standard 2-Interdependence
- CLE 3210.2.1 Investigate how the dynamic equilibrium of an ecological community is associated with interactions among its organisms.
- CLE 3210.2.3 Predict how global climate change, human activity, geological events, and the introduction of non-native species impact an ecosystem.

Activity: Design an Invasive Plant
Grades: 9-12

ECOLOGY
Standard 2-Communities
- CLE 3255.3.2 Relate species interactions such as competition, predation and symbiosis to co-evolution.

Standard 4-Ecosystem
- CLE 3255.4.4 Summarize the human impact on ecosystems.
- CLE 3255.4.5 Describe how biodiversity relates to stability of an ecosystem.

BIOLOGY I
Standard 2-Interdependence
- CLE 3210.2.1 Investigate how the dynamic equilibrium of an ecological community is associated with interactions among its organisms.
- CLE 3210.2.3 Predict how global climate change, human activity, geological events, and the introduction of non-native species impact an ecosystem.

PREVIEW/REVIEW QUESTIONS
and RELATED ACTIVITIES

1. Why do we call exotics ''plants out of place''?
   [''Home Sweet Home,'' ''Which Niche?,'' ''Trouble At Home'', ''Design an Invasive Plant'']

2. Why are exotic pest plants a problem?
   [''The Blob,'' ''Home Sweet Home'']

3. Name several ways that exotics are introduced into a new area.
   [''Ethi-Reasoning,'' ''Home Sweet Home,'' ''Design an Invasive Plant'']

4. What is biological diversity?
   [''Web of Life'', ''Plotting Against Native Plants'']

5. Why is preserving biological diversity important?
   [''Trouble At Home'', ''Cracking Up with Invasive Species'']

6. What can YOU (as a person, class or community) do to prevent the introduction of exotic pest plants and to protect native Tennessee plant species?
   [''Ethi-Reasoning,'' ''Going Wild for Wildlife'', ''I Yam What I Yam'']

GLOSSARY

Abundance: Estimates on the numbers of a species or target group according to a predefined scale, such as rare, infrequent, abundant, etc.

Career: An occupation or profession followed as one's life work.

Community: All the plants and animals in a particular habitat that are bound together by food chains and other interrelations.

Cover : Commonly measured as "Total Cover", which is the percentage of all vegetation covering the ground surface inside a quadrat.

Density: Abundance, measured by actual count, per unit area; counts are averaged when more than one sample is taken.

Dilemma: A situation in which a choice must be made from among different alternatives; a difficult of complex set of circumstances.

Dominant: Any plant or animal that exerts so important an influence on the conditions of an area as to determine what other organisms can live there.

Ecology: The study of the relationships of living things to one another and the environment.

Ecosystem: All living things and their environment in an area of any size. All are linked together by energy and nutrient flow.

Endangered: Referring to a species whose numbers have fallen so low that it is likely to become extinct in the near future.

Environment: The aggregate of surrounding things, conditions, or influences, especially as affecting the existence or development of people or of nature.

Exotic: Species introduced into a region by humans.

Fauna: Animal species.

Flora: Plant species.

Frequency : The percentage of sample plots in which a species or target group appears. Frequency data are often grouped into classes, such as A = 1-20%, B = 21-40%, C = 41-60%, D = 61-80%, E = 81-100%.

Food chain: A series of plants and animals linked by their food relationships. A green plant, a leaf-eating insect, and an insect-eating bird would form a simple food chain. Any one species is usually represented in several or many food chains.

GLOSSARY (cont)

Habitat: The native environment of an animal or plant, or the kind of place that is natural for an animal or plant.

Invasive exotic pest plant: Non-native plant species that did not originally inhabit an area and spreads rampantly.

Landscaping: To improve the appearance of an area of land by planting or by altering the contours of the ground.

Native: A native species is one original to a particular region.

Niche: The specific arrangement of food, shelter, water, and resources that meets the survival requirements of a particular species, and the role that species plays in its ecosystem.

Photosynthesis: The process by which green plants convert carbon dioxide and water into simple sugar. Chlorophyll and sunlight are essential to the series of complex chemical reactions involved.

Population: A group of individuals of the same species that live in a defined area at a particular time.

Quarantine: A strict isolation imposed to prevent the spread of something.

Responsibility: The quality of being accountable for one's actions.

Species: A class of organisms having some common characteristics or qualities. The major subdivision of a genus or subgenus, regarded as the basic category of biological classification, composed of related individuals that resemble one another, are able to breed among themselves, but are not able to breed with members of another species.

Species Richness: The number of different types of species or the number of different taxonomic groups in an area.

Threatened: Species most likely to become endangered if protective measures are not taken immediately.

PRINTED SOURCES

An Educator's Guide to the Threatened and Endangered Species and Ecosystems of Tennessee developed by the U.S. Fish and Wildlife Service.

Non Indigenous Species Activities for Youth, John Guyton, Mississippi State University Extension Service Coastal Research and Extension Center, 2002.

Project Learning Tree, American Forest Foundation, Washington, D.C.,1993

Project WILD, Western Regional Environmental Education Council, Bethesda Maryland, 1992,1985, 1983.

Tennessee's Watchable Wildlife, Mary V. Ball, Ph.D., Carson-Newman College, Jefferson City, TN, 1994.

The New Games Book. New York: Doubleday, 1976.

Note* Activities referenced but not included in this guide may be obtained by request from:

Middle Tennessee State University, The Center for Environmental Education, Box 60, Murfreesboro, TN 37132, phone: 615/898-5449, fax: 615/898-5920.

RESOURCES

Center for Environmental Education
Middle Tennessee State University
MTSU Box 60
Murfreesboro, TN 37132
(615) 898-5449
http://www.mtsu.edu/~mtsucee/index.htm

Discovery Center at Murfree Spring
502 Southwest Broad Street
Murfreesboro, TN 37130
(615) 890-2300
www.discoverycenteronline.org

Stones River National Battlefield and Natural Area
3501 Old Nashville Highway
Murfreesboro, TN 37129
(615) 893-9501
www.nps.gov/stri/

Excellent Image Library for Exotic Invasive Species
www.bugwood.org
Many of the images used in the video and the cover photograph of the yam leaf were obtained, with permission, from this database. This database hosts an enormous collection of images on invasive species.

Gardening with the Native Plants of Tennessee
http://www.gardeningwithnativeplants.com/link.html
This is wonderful website packed with information about resources for planting native plants and information about many other things related to Tennessee's natural heritage.

Invasive Plant Control, Inc.
2800 Columbine Place
Nashville, TN 37204
Phone: 615.385.4319
http://www.invasiveplantcontrol.com
Invasive Plant Control (IPC) is one of only a few companies in the United States whose sole purpose is the management of Invasive Species nationwide.

Native Plant Resources in the Nashville Area
http://www.nashville.gov/parks/pdfs/nature/ResourcesNativePlants.pdf

Ocean Commotion
http://www.tamug.edu/seacamp/virtual/methods.htm
This website discusses the terminology associated with field ecology sampling techniques.

Offwell Woodland and Wildlife Trust website
http://www.countrysideinfo.co.uk/howto.htm).
Visit this site for an interesting discussion of different methods and applications of field sampling techniques in ecology.

Tennessee Dept. of Environment and Conservation (TDEC)
Division of Natural Heritage
401 Church St., 8th Floor, LandC Tower
Nashville, TN 37243-0447
615/532-0436
www.state.tn.us/**environment**/

Tennessee Exotic Pest Plant Council (TN-EPPC)
http://www.tneppc.org/
http://www.webriver.com/tn-eppc/index.htm
This is an excellent list of native plants that are alternatives to planting exotic plants in landscaping practices
http://www.tneppc.org/Landscaping/Landscaping_Guide_Middle.pdf

Tennessee Native Plant Society
P.O. Box 159274
Nashville, TN 37215
http://www.tnps.org/

TVA Native Plant Selector
http://www.tva.gov/river/landandshore/stabilization/plantsearch.htm
More than 140 plants native to the Tennessee Valley are featured on this site. It includes photographs and details about height, light preference, bloom time, and more. This list will expand as more native plants become available through commercial markets.

Weeds Gone Wild: Alien Plant Invaders of Natural Areas
http://www.nps.gov/plants/alien

VIDEO SCRIPT

Noxious Neighbors: Invasive Species in Our Backyard
If It's Green, It's Good?

SCENE	AUDIO
Show a variety of areas infested with exotics	If it's green, it's good
Kudzu flower	If it's gorgeous, it's good
More Kudzu	It's good in its own place in the world
Kudzu	Let's examine what happens when we take something from its natural habitat, where natural controls or checks and balances exist, and it is really just a small part of a big picture.
More invasive plants	…and take it to another habitat where it becomes an overwhelming part of the picture
More invasive plants	Plants introduced into a region by humans are called "exotics." Exotics are not a part of the native landscape.
Chinese yam	Exotics are "plants out of place." The impact of invasive alien plant species on the environment has caused scientist to describe the problem as biological pollution.
Native verses Asian Persimmon tree shots Scene of wheat growing	Not all exotic plants are pests, such as this persimmon tree from Asia which produces larger, sweeter persimmons than the native persimmon tree. Ninety-eight percent of the US food supply, including wheat and rice, comes from introduced species.
Shots of land manager removing grass runners	Exotic pest plants have intrusive characteristics and are the second most significant threat to wildlife because they spread rampantly, grow rapidly, and reproduce precociously.
Photo of Chinese yam More strangled landscapes	In competition for resources such as sun, water, and soil the invasive alien plants choke out native plants. Biological diversity is reduced as native species fail to survive the green scourge.
Wooly adelgid	Biological diversity is further impacted when exotic plants harbor other organisms that decimate native species.
More kudzu	Let's look at some examples of invasive exotic pest plant introductions. Seventy-three million kudzu seedlings were planted in 1935 by the US Soil Conservation service to control soil erosion along road cuts in the South.
Map with arrows	Kudzu was introduced from China and has since spread, smothering and degrading vast numbers of southern ecosystems.
Honeysuckle photo Map with arrows	Japanese honeysuckle was introduced as an ornamental plant in 1806. In the early 1900's similar measures were taken by the railroads to plant Japanese honeysuckle along railroad embankments to control soil erosion.
Chinese yam Map with arrows from China	Chinese yam is another invasive plant native to China. Introduced to the United States as an ornamental or edible food crop in the 1800's, it escaped cultivation and has been identified in most of the Eastern United States.
Purple loosestrife	Not all exotics were brought here deliberately. Even before the influx of English settlers purple loosestrife seeds arrived here in soils used in the ballasts of ships.
More loosestrife and bar graph	A strikingly handsome plant with magenta flowers on showy spikes, reaching 5 or 6 feet in height, purple loosestrife has more than 100 species of insects that control it in its native European range.
Loosestrife	In North America, its biological controls are absent and it is a dangerous competitor. Once it escapes cultivation, it turns wetland into wastelands. A single plant can produce more than 2 million seeds per year; each seed can be viable in the soil for 20 years.

SCENE	AUDIO
Ducks in flight	Waterfowl are displaced along with native wetland plants as food sources disappear. Damage to agriculture and wildlife in the Northeast and Midwest alone costs tens of millions of dollars.
Tree of heaven	Tree of Heaven is an invasive exotic tree brought to this county by immigrants from Asia for cultural purposes. A distinctive characteristic about this tree is that the leaves smell like a skunk when crushed.
Photo of tree inside shop window	Typical of an invasive exotic, Tree of Heaven can grow just about anywhere! This aggressive tree can be observed growing where no other large plant would dare to grow…seen here growing inside a shop window in a downtown area.
Mile a minute weed	Another aggressive exotic, Mile-a-minute weed will even compete with automobiles. This herbaceous vine will literally take over a parking lot.
Mile-minute weed list of plants scrolling over the top of the image	The list of invasive exotic plants is unfortunately, lengthy. You may even recognize some of the plants growing in your backyard on this list.
Mile-minute weed	We have only recently become aware how these 'plants out of place' impact natural communities.
Mile-minute weed	Natural communities are interdependent and made up of many different types of organisms, or in other words, they are biologically diverse.
Nature scenes here (river)	Competition for resources such as water, light, space, and food in a natural system is ongoing.
More nature scenes (mountains, deer)	Plants and animals that have evolved together in an ecosystem compete for limited resources through their own specializations.
More nature scenes (wolf, flower)	These specializations are adaptations that allow them to successfully compete and survive.
Nature scene/flower	The role, or niche, that a particular species maintains is connected to other species in that ecosystem.
Scenic view/dogwood flower	The importance of this relationship is that this provides resources for each kind of organism in that particular ecosystem.
Infested area, kudzu	Invasion of natural areas by exotic species creates shortages of resources for native species.
Infested area, kudzu	Like a sour note in a symphony, exotic interlopers disrupt the harmonic balance in a natural system.
Infested area, man walking through	Invasive exotic plants leave behind natural controls and can grow and mature rapidly.
Shots of fruits of mile-minute	They have prolific reproductive capacities and are successful in seed dispersal, germination, and colonization.
Yam Bulbil	Terri Hogan talking about Yam life history here
Animal/butterfly on milkweed	The result of this competitive edge is they displace wildlife that depends on native vegetation.
Animal/bird in flight and deer	It is the plant community that defines the animal population in a natural system. A threat to native plants is a threat to native wildlife.
World map with arrows	Although corridors through which invasive exotics have been brought into this country are very different, the results of these introductions have the same impact. Examining how these "plants out of place" were initially brought here will help prevent future introductions.
Purple loosestrife	Some introductions were accidental. An example of this is purple loosestrife which was discussed earlier.
Shots of invasive plants	There are many instances where introductions have been deliberate for things such as ornamental plantings or erosion control. Examples are Chinese yam, kudzu, honeysuckle, multiflora rose and many others.
High school kids removing plants	We are now battling the 'plants out of place' with the same manpower with which they were planted in the first place!
Chinese privet in bloom	Commercially, some exotics with invasive characteristics are profitable because they grow rapidly and have a high survival rate.

SCENE	AUDIO
Bus travelers	Tourists and travelers are notorious for finding plant souvenirs on vacation and transporting potential invasive alien plants in their suitcases and pockets.
Paulownia shots	Other invasive exotic plants have been part of the natural landscape for so long; no one knows how they were initially introduced. *Paulownia*, native to China, is rumored to have been introduced to Delaware in the mid-1800s when Admiral DuPont returned from a trip to China, with a number of porcelain jars packed in crates stuffed with *Paulownia* seed pods to cushion against breakage. The 20,000 windborne seeds in each pod spread *Paulownia* over most of the Eastern US.
Yam infestation	The cost to maintain natural areas is high. Federal western wild lands lose thousands of acres per day to invasive pest plants. Dr. Randy Westbrooks, Invasive Species Prevention Specialist from USGS explains….
Photo of weed spraying	Agricultural systems have dealt with pest plants for years with chemical applications
Elementary Kids removing pest plants	Eradication programs that involve physical removal of pest plant vegetation and root systems early in growth have been fairly successful in some urban areas.
Footage of Smoky Mountain staff working	However, the magnitude of the exotic invasion in vast natural areas like the Great Smoky Mountain National Park makes physical removal strategies like hand pulling, digging up root stock and cutting, an on-going task. Selective use of chemicals is an option when the only alternative is loss of native habitat from invading species. Chemical herbicides are used selectively and applied in a manner that will have the least toxic effect on non-target plants and wildlife.
Joe Rogers talking native hearts-a-bursting	Planting only native plants in highway and landscaping practices is a critical part of preventing exotic introductions.
Sign explaining native planting worksite and Kids on greenway	Public education about this silent form of biological pollution will prevent careless planting practices.
Kids on greenway Terri Hogan speaking on volunteers	Organizations such as the Exotic Pest Plant Council facilitate communication and education.
Kids on greenway doing each of the actions mentioned	The things you can do to help are: • Get involved and support organizations that protect biodiversity • Volunteer in a program to remove invasive plants • Plant native plants • Ask your nursery to stock propagated native plants
Natural landscape	Green is good; you see this is what we want to preserve.
More nature	So is this.
More nature	It is a clear choice to protect our natural heritage.
More nature	We are all a part of, not apart from, earth's web of life.
More nature and music	We may not see all the connections right now; therefore, we will not miss them until they are gone.
Credits and music	

MIDDLE TENNESSEE STATE UNIVERSITY