NNIS

Non-native Invasive Species Learning Kit

Meet the Invaders!

United States Forest Service - Eastern Region

Non-Native Invasive Species

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

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

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

Get a Grip on Biodiversity!

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

Meet the Invaders! - This is the module you have!

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

Close the Doors!

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

Do Something!

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

Produced by

United States Forest Service, Eastern Region

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Meet the Invaders!

Ad-libbed Aliens

Description

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

Getting Ready

1. Read the instructions and check to be sure that you have all the materials.

Introduction

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

Doing the Activity

1. **Explain the game.** Briefly show the blank card and explain how the game is played.
2. **Collect nouns, verbs, and other words.** Elicit responses and fill in the blanks on the card using the transparency pen.
3. **Read the story.**
4. **Share the invasive species.** Read the *Truth is Stranger than Fiction* paragraph on the back of the card. Show the picture of the invasive species.
5. **Discuss the invasive species' adaptations.** Ask students to recall the adaptations listed on the card. Optional: Discuss other adaptations that give invasive plants and animals a competitive edge.

Assessing Student Learning

Ask students to write short stories based on other invasive species. After assuring that they have used the correct parts of speech, ask them to try their stories on their classmates. Draw pictures of the plants or animals that result and compare them to the real invasive species.

Objectives

- Recognize that invasive species are equipped with adaptations that give them competitive advantages over native species.
- Become familiar with kudzu, leafy spurge, and snakehead fish.

Grades

2 - 8 (and up!)

Group Size

Maximum 30, divided into small groups of 4 - 10

Prep Time

Minimal, unless you write new fill-in-the-blank stories

Activity Time

10 - 20 minutes

Setting

Anywhere

Materials in Kit

- laminated cards with fill-in-the-blank stories and pictures of invasive species (3 sets of 3)
- transparency pens (3)
- *Wisconsin Wildcards* featuring invasive plants and animals (30)

Materials in Booklet

- fill-in-the-blank stories (pages 7 - 8) for use if you don't have the kit

National Education Standards

See next page.

National Education Standards

Grades 2 - 4

- English Language Arts: 3
- Science: C – Characteristics of Organisms

Grades 5 - 8

- English Language Arts: 3
- Science: C – Diversity and Adaptations of Organisms

Extending the Learning

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

Finding Out More!

invasivespecies.gov The species profiles at this site include links to Web pages and pdf files sponsored by the federal government, state governments, and universities. <www.invasivespecies.gov>

Adjectives

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

Adverbs

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

Nouns

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

Verbs

are action words.
(sink, explode, grow)

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Fields of Screams

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

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

Truth is stranger than fiction!

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

Fishing for Trouble

_____ (name) and _____ (name) went fishing on a/an _____ (adjective), _____ (season) day. Things were going _____ (adverb) until _____ (first name) pulled in a huge fish. It was _____ (number) feet long and had about _____ (number) teeth. They struggled to get the fish in their _____ (noun). When they got back to _____ (place), they put the fish on the _____ (noun).

They could hardly believe their _____ (part of body) when the fish started _____ (verb ending in "ing") across the _____ (noun).

Truth is stranger than fiction!

Meet the snakehead fish from Asia! When you learn more about it, you'll understand why some people call it *Frankenfish*! The snakehead grows to about three feet long and has numerous canine-like teeth. When the pond where it lives dries up, it can walk on its pectoral fins to another pond! It can live out of water up to three days and breathe air using a primitive air bladder (similar to a lung). Now for the really bad news – it eats almost anything smaller than it is and doesn't have any natural predators in the United States!

The Great Cover-up

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

He/She fell into a deep sleep just like that old guy in the story named _____ (teacher's name).

He/she slept like a _____ (noun) for _____ (number) weeks.

When _____ (same name) awoke, he/she could not move a _____ (body part). Vines wrapped around _____ (same name)'s _____ (body part) and _____ (body part). Above his/her head, _____ (same name) saw _____ (color) flowers in the dim light. The tree was gone and so was his/her _____ (adjective) house.

Was this a dream?

Truth is stranger than fiction!

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

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

Bioblunder Tribunal

Description

Students will hold mock trials to determine if the individuals or groups responsible for introducing invasive species should be held accountable for their actions. Through this process, they will discover how people move invasives around the globe. They will also discover the long-lasting and far-reaching consequences of non-native plant and animal introductions. Optional: The two scripted trials in this lesson can be performed in front of an audience as educational entertainment.

Getting Ready

1. Evaluate the ages and abilities of your students and the amount of time you can commit to this activity. You can either present students with *Trial Briefs* (see pages 12 - 15) or simply give them the names of the non-native invasive species and have them find out how the invasives were introduced.
2. If needed, make copies of *Trial Briefs*.
3. Arrange Internet access for student research.
4. Prepare a rubric to evaluate student presentations.
5. If staff and/or students will be performing in front of an audience, allow time for reading, staging, and rehearsing.

Introduction

Hindsight is almost always 20-20. When we look back at historical events, we have the knowledge of the present to judge the mistakes of the past. Some invasive species were introduced on purpose! No doubt, those charged with aiding and abetting invasives were probably not aware of the long-term consequences of their actions. Can we learn from history? Can we make better decisions by realizing the far-reaching consequences of simple actions?

Doing the Activity

1. **Introduce the *Trial Briefs* found in this lesson.**
2. **Divide the students into groups of 3 - 5.**
3. **Allow each group of students to choose an invasive species and begin their research.** Students can use the Internet to find out more about their cases. Encourage

Objectives

- Recognize that people introduce invasive species by accident and on purpose.
- Realize that the introduction of invasive species is tied to human actions, specifically travel, trade, and transportation.
- Realize that decisions we make today can have far-reaching consequences.

Grades

9 - adult

Group Size

Maximum 30, divided into small groups of 3 - 5

Prep Time

Minimal

Activity Time

Preparation and research, minimum of two 50-minute periods. Presentation time varies with group size

Setting

Classroom or outdoor amphitheater

Materials in Kit

- scripts (*Shakespeare's Birds* and *Mingling of the Waters*)
- black robe for judge
- gavel

Materials in Booklet

- *Trial Briefs* (pages 12 - 15)
- *Mingling of the Waters* script (pages 16 - 18)

National Education Standards

See next page.

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National Education Standards

Grades 9 - 12

- English Language Arts: 7
- English Language Arts: 8
- Environmental Education: 2.4.A - Human/Environment Interactions
- Science: F - Environmental Quality
- Science: F - Natural and Human-induced Hazards
- Social Studies: I - Culture (b)
- Social Studies: II - Time, Continuity, and Change (d and e)

students to pinpoint the crimes, charges, defendants, plaintiffs, witnesses, evidence, and verdicts.

4. **Optional: Present one of the scripted trials included in this lesson.** Your students might be more creative if they don't have a sample to model! However, you might want to present one of these trials after they have begun their preparations to give them more ideas. If you do present a scripted trial, don't assign that trial brief to a group.
5. **Encourage students to prepare their trials.** Give the groups time to write their scripts, gather props, and practice their trials. The group members should play the roles of the major characters in their trials. They can give scripts to classmates to play the roles of judges, juries, witnesses, and other parts as needed. Be sure to give students a rubric!
6. **Arrange your classroom so it is similar to a courtroom.** Designate a bench, witness stand, and jury box. Set up places for the attorneys, defendants, and plaintiffs to sit. Prepare courtroom seating for those not involved in the trial.
7. **Present the trials.** Allow students to present their trials. Try to keep the trials moving along. Set time limits if necessary. Allow juries only a few minutes to deliberate.
8. **Discuss the trials.** Tackle some of these questions:
   - What are the common threads from trial to trial?
   - Put the trial briefs in chronological order. When did many of these intentional introductions take place? What else was happening in history at this time? Can you draw any correlations?
   - Many of the people who introduced invasive species had "good" intentions. What have we learned from history? Are there safeguards in place today to prevent well-meaning individuals from introducing potentially harmful species? Describe these safeguards. Do we need more?

Did you know?

Starlings were released in Central Park in 1890. It took them 1 year to travel to Staten Island. Sixty-nine years later, they arrived at the Pacific Ocean.

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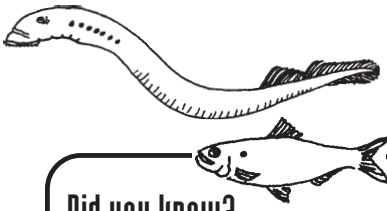
Assessing Student Learning

Evaluate each group's project. The rubric could include these benchmarks:

- Players are accurately identified (e.g., defendants, plaintiffs, and witnesses).
- Dates are correct. Award extra points for speech, costumes, and props that would have been used at that time.
- Locations are correct.
- Trial points out how the invasive species was introduced.
- Trial points out why the invasive species was introduced, if applicable.

- Trial identifies native species that were harmed by the invasive species.
- Trial identifies how native species were affected.
- Sufficient evidence is presented to either convict or acquit the defendant.
- Trial points out the long-reaching effects of the introduction.
- Trial addresses whether the invasive species is still a problem today.
- Defense attorney presents other possible introductions, extenuating circumstances, or other plausible defenses.



Did you know?
Sea lampreys and alewives reached the Great Lakes via the Erie Canal.

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Extending the Learning

Search the news. Assign each student to find a newspaper article about invasive species. The article should focus on a decision concerning invasive species that is controversial or could have long-reaching impacts. How might people 100 years from now view this decision differently?

Think local. As a class, pick a local invasive and find out how it arrived in North America. Can the invasion be traced to a single introduction? Was the introduction intentional or accidental? If intentional, do you think the people knew what they were *really* doing?

Think positive. *Bioblunder Tribunal* points out the far-reaching negative influences of a misinformed decision made by one individual or small group of individuals. What about the far-reaching positive influences of individuals or groups? Can the students name people or organizations that have changed the world one small step at a time?

Finding Out More!

Tinkering with Eden : A Natural History of Exotics in America by Kim Todd ©2001. This engaging book contains carefully-researched histories of how several exotic species arrived in America.

Trial Briefs in chronological order

Case of the dodo bird vs. early sailors

Date: 1505
Defendants: Portuguese and Dutch sailors
Plaintiffs: Flightless dodo birds
Trial Brief: Dodo birds, having lived undisturbed on the island of Mauritius for thousands of years, lost the need and ability to fly. When Portuguese and Dutch sailors arrived on the island, they slaughtered dodos for meat and introduced pigs, monkeys, and rats to the island. The dodo bird, which nested on the ground, found its eggs completely unprotected from these new predators. Within 100 years of the arrival of humans on Mauritius, the once-abundant dodo was a rare bird. The last one was killed in 1681.
NNIS: Humans (*Homo sapiens)*; also pigs, monkeys, and rats

Case of native species vs. Hernando De Soto

Date: 1539
Defendant: Explorer Hernando De Soto
Plaintiffs: Woodland plants and animals
Trial Brief: Hernando De Soto brought hogs to the area that would be called Tampa Bay, Florida to feed his expedition. As he explored the southern parts of what was to become the United States, he took the hogs with him. Some of them escaped; others were captured by native peoples. It is unclear if any of his hogs survived to begin wild populations. However, he did set the precedent of bringing hogs to the region. Wild hogs compete with woodland mammals for food. Their rooting behavior destroys woodland vegetation and disturbs the homes of mammals, amphibians, and ground-nesting birds.
NNIS: Wild hogs *(Sus scrofa)*

Case of the Great Lakes vs. Governor De Witt Clinton

Date: November 4, 1825
Defendant: De Witt Clinton
Plaintiff: Lake Erie
Trial Brief: On October 26, 1825, Governor De Witt Clinton boarded a boat called the *Seneca Chief* in Buffalo. He took with him numerous officials, two kegs full of Lake Erie water, and bottles of water collected from 13 of the world's largest rivers. He headed down the newly completed Erie Canal. When his boat reached the Atlantic Ocean at New York City, he celebrated the "wedding of the waters" by dumping the water from Lake Erie and all the other rivers into the ocean. Whether or not this wanton act introduced any invasive species, it was still a case of reckless endangerment. He was also oblivious to the invasive species that followed him back up the Hudson River, through the Erie Canal, and right into the Great Lakes. It was just a short time after the opening of the canal that both sea lampreys and alewives appeared in the Great Lakes.
NNIS: Sea lampreys *(Petromyzon marinus)* and alewives *(Alosa pseudoharengus)*

Case of Hawaii vs. the Wellington

Date: 1826
Defendants: Crew of the *Wellington*
Plaintiffs: Hawaiian residents and native birds
Trial Brief: In 1826, the *Wellington*, a whaling ship from San Blas, Mexico, arrived in Lahaina, Hawaii. Following routine practices, the crew emptied and rinsed the ship's water barrels. According to Dr. Gerrit Judd, they also dumped the first recorded mosquito larvae into area waters. Soon after their departure, Dr. Judd, a Christian missionary based in Hawaii, discovered that some of the mosquitoes were carriers for avian malaria and pox. He treated many native people for the disease. In addition, Hawaii's native birds were severely affected. Unfortunately, they were not genetically equipped to cope with the newly introduced diseases. Whether the dumping of invasive mosquitoes was intentional or accidental, the crew of the *Wellington* should be held responsible for the death and disease that followed their brief visit to the islands.
NNIS: Mosquitoes (*Culex quinquefasciatus*)

Case of the native birds vs. Nicholas Pike

Date: 1850

Defendant: Nicholas Pike

Plaintiffs: Native birds

Trial Brief: In 1850, Nicholas Pike was a homesick Englishman living in Brooklyn, New York. He released 50 house sparrows near his home to remind him of his beloved England. Other accounts state that Pike was director of the Brooklyn Institute of New York. As part of his job, he released the sparrows as a biological control for the destructive tree pest *Eunomos subsignarrius,* commonly called measuring worms or hanging worms. Regardless of why they were introduced, the sparrows survived and thrived. They outcompeted native birds, took over their nesting cavities, broke their eggs, and killed their nestlings. By 1887, some states had already launched English sparrow eradication programs.

NNIS: English sparrows *(Passer domesticus)*

Case of Australia vs. Thomas Austin

Date: 1859

Defendant: Thomas Austin

Plaintiffs: Native Australian species

Trial Brief: In 1859, Thomas Austin imported 24 European rabbits from England. He released them on his land in Southern Victoria so that he and his friends could enjoy sport hunting. He certainly achieved his shortsighted goal! Just seven years later, he and his friends had shot more than 14,000 rabbits on his land alone. Not realizing the extent of the problem, other sportsmen extended the range of the rabbits by deliberately releasing them into new areas. By the early 1900s, rabbits inhabited all parts of the country. Their population peaked around 1950 at more than a billion rabbits. Even today, with extensive biological control programs, the direct economic damage from rabbits is estimated to exceed $110 million annually.

NNIS: European rabbits *(Oryctolagus cuniculus)*

Case of America's trees vs. Leopold Trouvelot

Date: 1869

Defendant: Leopold Trouvelot

Plaintiffs: North American woodlands, landowners, all people who enjoy trees, animals that depend on trees, etc.

Trial Brief: Leopold Trouvelot was an amateur entomologist with a special interest in silkworms. He was apparently trying to identify native silkworms that he could use in silk production. In the late 1860s, he returned from France with some gypsy moth egg masses. He might have been hoping to cross gypsy moths with silkworms to produce a new, heartier silk-producing insect. While his intentions are unclear, the results of his negligence are perfectly obvious. When several gypsy moth larvae escaped, he alerted local entomologists, but did nothing else. It wasn't long before the invasive moths took over his hometown of Medford, Massachusetts. The rest is history.

NNIS: Gypsy moths *(Lymantria dispar)*

Case of southern and eastern United States vs. the Japanese government, et. al.

Date: 1876

Defendants: Japanese government, organizers of the Centennial Exposition, and the Soil Conservation Service

Plantiffs: Native plants and animals, timber growers, farmers, and homeowners

Trail Brief: At the Centennial Exposition in Philadelphia, the Japanese government created a display garden. One of the featured plants was an ornamental vine called kudzu. Americans loved its abundant vegetation and sweet-smelling flowers, and they planted it extensively. By the 1930s, the Soil Conservation Service was encouraging landowners to plant it for erosion control. Farmers were paid as much as $8.00 per acre to plant fields of the vine in the 1930s and 1940s. Not until the 1950s did the US government cease advocating the use of this plant. In 1970, the USDA declared kudzu a noxious weed.

NNIS: Kudzu (*Pueraria lobata)*

Case of America's water resources vs. Cotton States Exposition organizers

Date: 1884

Defendant: Organizers of the Cotton States Exposition

Plaintiffs: Native aquatic species and residents along infested waterways

Trial Brief: In 1884, New Orleans hosted the Cotton States Exposition. One exhibit, the Japanese Pavilion, featured lovely water hyacinths. The plants were so beautiful that they were given as gifts to Pavilion visitors. Attendees graciously accepted the gifts and took them home to their backyard ponds. The water hyacinths escaped cultivation and became a serious problem, clogging waterways throughout the coastal states.

NNIS: Water hyacinths *(Eichhornia crassipes)*

Case of native trout vs. Fred Mather

Date: April 11, 1884

Defendant: Fred Mather, former head of the United States Fish Commission

Plaintiffs: Trout and other wildlife negatively affected by the introduction of brown trout

Trial Brief: In 1877, Fred Mather visited Germany and went fishing for brown trout. He was so thrilled by the sport of fishing for this wary trout that he decided to introduce it into American waters. In 1884, he arranged for eggs from Berlin to be raised at the Michigan Federal Fish Hatchery. On April 11, he released 4,900 fry into the Pere Marquette River system. From this beginning, the species (known in Germany as *Bachforelle*) has become widely established throughout the United States. While fly-fishers might defend its introduction, others argue over its impact on native species.

NNIS: Brown trout *(Salmo trutta)*

Case of native birds vs. Eugene Schieffelin

Date: 1890

Defendant: Eugene Schieffelin

Plaintiffs: native birds

Trial Brief: Eugene Schieffelin was a wealthy New York drug manufacturer and avid reader of Shakespeare. He had also read *The Ornithology of Shakespeare* by James Edward Harting. In this book, Harting had compiled a list of all the birds that Shakespeare ever mentioned in his works. Possibly inspired by the list, Schieffelin set out to bring all of Shakespeare's birds to America. In 1890, he made several attempts to establish various birds in Central Park for "the good of the community." His greatest "success," by far, was the release of about 80 starlings. By 1959, the invasive starlings had reached the West coast!

NNIS: European starlings *(Sturnus vulgaris)*

Case of chestnut trees vs. Asian nursery owners

Date: 1913

Defendant: David Fairchild and Frank Meyer

Plaintiffs: Chestnut trees

Trial Brief: Chestnut trees used to be one of the tallest and most common trees in eastern hardwood forests. Not willing to leave well enough alone, many people, including Thomas Jefferson and Luther Burbank, imported European, Chinese, and Japanese chestnut trees to America. There were, no doubt, numerous introductions of chestnut blight fungus. By 1904, chestnut blight had infected and killed the trees lining the avenues of the Bronx Zoo in New York City.

However, in 1913, David Fairchild of the USDA might have committed the most obvious bioblunder of all. He asked plant explorer Frank Meyer to look for the disease in Asia, send back samples, and innoculate the fungus into trees near Washington, DC. By 1940, more than 3.5 billion American chestnut trees were dead and the eastern forests were changed forever.

NNIS: Chestnut blight fungus *(Cryphonectria parasitica)*

Case of the Americas vs. Warwick Kerr

Date: 1956

Defendants: People, livestock, and wildlife that have been stung by Africanized honeybees

Plaintiffs: Warwick Kerr and the Brazilian Agriculture Ministry

Trial Brief: In 1956, the Brazilian Agriculture Ministry asked Warwick Kerr to experiment with African honeybees and European honeybees. They wanted him to hybridize the bees to produce a bee more productive than the European bee and less aggressive than the African bee. His experiments began with 63 queen bees from South Africa. In the fall of 1957, he had several hives outdoors with worker bees moving freely in and out. These hives were equipped with queen excluders that prevented the queen bee from escaping and starting a wild population of Africanized bees. Due to Kerr's negligence, a local beekeeper removed the excluders and the queen bees escaped. Today, Africanized honeybees continue to expand their range northward.

NNIS: Africanized honeybee *(Apis mellifera scutellata)*

Case of the United States vs. the unknown Arkansas fish farmer

Date: 1973

Defendant: Unknown Arkansas fish farmer

Plaintiffs: Native fishes (especially juveniles) and native mussels

Trial Brief: In 1973, an Arkansas fish farmer was having trouble controlling the phytoplankton in his fishponds. He was also interested in increased fish production and thought silver carp might be the answer to his concerns. Silver carp are native to eastern Asia and the Amur River in China. News of the carp spread, and so did the carp! By the mid-70s, six state, federal, and private facilities in Arkansas, including the Arkansas Game and Fish Commission, were experimenting with the fish. By the early 1980s, the carp had escaped to open waters. Silver carp are currently invading the Mississippi River Basin.

NNIS: Silver carp *(Hypophthalmichthys molitrix)*

Case of resident fauna of the Black and Caspian Seas vs. the United States shipping industry

Date: sometime in 1979 or 1980

Defendant: Unknown United States cargo ship

Plaintiffs: Zooplankton, kilka, sturgeon, and other residents of the Black and Caspian Seas

Trial Brief: In 1979 or 1980, a United States cargo ship was bound for a Russian port on the Black Sea. Before departing, it took on ballast water off the US coast. Stowed away in that ballast water were two-inch long comb jellyfish. Two years later, a Russian scientist discovered the jellyfish while taking plankton samples in the Black Sea. By 1988, the invasive jellyfish from America had spread throughout the Black Sea. By 1999, it had spread to the Caspian Sea and devoured the native zooplankton. As a result of the invasion, populations of kilka and sturgeon have plummeted because kilka feed on zooplankton and sturgeon feed on kilka.

NNIS: Comb jellyfish *(Mnemiopsis leidyi)*

Mingling of the Waters

The Trial of the Great Lakes vs. Governor DeWitt Clinton

This fictional trial is based on information from "The Erie Canal: A Brief History" prepared by the New York State Canal Corporation and "Narrative of the Festivities Observed in Honor of the Completion of the Grand Erie Canal Uniting the Waters of the Great Western Lakes with the Atlantic Ocean" by William L. Stone ©1825.

(Actors in order of appearance: bailiff, judge, Governor Clinton, prosecutor, Mr. Wilkinson, defense attorney, Dr. Mitchell, and spokesperson for the Great Lakes Fishery Commission)

Bailiff: All rise. Your Honor, we bring before you the case of the Great Lakes vs. Governor DeWitt Clinton.

Judge: Governor Clinton, you have been charged with reckless behavior. Specifically, you have been charged with endangering the health of the entire Great Lakes ecosystem by introducing water teeming with invasive organisms. How do you plead?

Clinton: Innocent, Your Honor.

Judge: Prosecutor, please call your first witness.

Prosecutor: The prosecution calls Judge Wilkinson to the stand.

(Wilkinson takes the stand. He is a naturally nervous man who quickly realizes the implications of his actions and responds uneasily to questions.)

Prosecutor: Now, Judge Wilkinson, please think back to the fall of 1825. You were a member of the celebration committee for the opening of the Erie Canal, were you not?

Wilkinson: Yes, sir, I was.

Prosecutor: This opening ceremony was quite an event, was it not?

Wilkinson: Oh, yes, sir! Why, we had artillery salutes, parades, dinners, balls! And that doesn't even include the opening ceremony itself!

Prosecutor: What did this "opening ceremony" entail?

Wilkinson: *(guiltily)* Oh, well, you know – the usual –

Prosecutor: Perhaps I need to refresh your memory –do you recall a certain "mingling of the waters" ceremony? As I understand, it was quite a unique event. What can you tell us about that, sir?

Wilkinson: *(laughs nervously)* Oh, it was nothing major. We just emptied a few kegs of water from the deck of the *Seneca Chief*. It was hardly worth mentioning.

Prosecutor: Au contraire, Judge. It seems that, at the time, it was quite an affair. Please give us the details.

Wilkinson: *(sadly with matter-of-fact voice)* We filled two elegant kegs with Lake Erie water. We carried them aboard the *Seneca Chief* all the way down the Erie Canal to the New York City harbor. During the ceremony on November 4th, we emptied the water into the Atlantic Ocean.

Prosecutor: Mr. Wilkinson, is that all? Was there not more to the "mingling of the waters" ceremony?

Wilkinson: After the celebration, we were presented with a keg filled with water. When we returned to Buffalo, we poured this water into Lake Erie.

Prosecutor: Where, pray tell, did this water come from?

Wilkinson: *(quietly)* From the Atlantic Ocean, sir.

Prosecutor: *(raises eyebrows)* Was this "mingling of waters" your idea?

Wilkinson: No, sir. Governor DeWitt Clinton dreamt it up, sir. It seemed like such a good idea at the time.

Prosecutor: No further questions.

(Defense attorney stands and begins to interrogate Wilkinson.)

Defense: You say it was the idea of Governor Clinton. I'm sure Governor Clinton could never have envisioned that such a simple act could have such troublesome consequences. Tell me, Judge, did anyone on the committee – or anyone *remotely* involved with the ceremony – ever say anything about the potential for harm from "mingling" these two waters?

Wilkinson: Never, sir.

Defense: So, am I hearing you correctly? Did it never occur to anyone that plants or animals in the water from *one* location could become invasive if moved to a *different* location?

Wilkinson: No, sir. Not in my wildest imagination could I have foreseen the damage to the fisheries of the Great Lakes that has resulted from the opening of the Erie Canal.

Defense: *(pleased)* No further questions, Your Honor.

Prosecutor: The prosecution calls Dr. Mitchell to the stand.

(Mitchell rises and hobbles up to the stand. He is a very egotistical man, slow to admit any error on his part and indignant when his actions are questioned. He doesn't realize his potential missteps until the end.)

Prosecutor: Dr. Mitchell, you also took part in the "mingling of the waters." Could you please describe your role to the court?

Mitchell: *(confidently, but rambling)* I corresponded extensively with other learned individuals around the globe. When I shared with them the idea for commemorating this momentous occasion by mixing the waters from the world's major rivers, they were more than happy to comply. I received bottles of water from friends and colleagues around the world! The response was tremendous, if I do say so myself.

Prosecutor: How many flasks of water did you receive?

Mitchell: Thirteen, sir. From the Ganges and the Indus of Asia; the Nile and Gambia of Africa; the Thames, the Seine, the Rhine, and the great blue Danube of Europe; the Mississippi and the mighty Columbia of North America; and the Oronoko, La Plata, and Amazon of South America.

(Prosecutor looks surprised.)

Mitchell: I see you are amazed, good sir. I, myself, could not have anticipated such an eager response!

Prosecutor: *(incredulously)* And you poured all this water right into the New York Harbor?

Mitchell: Yes, sir.

Prosecutor: Did you in any way or at any time attempt to sterilize these foreign waters?

Mitchell: *(indignantly)* Why ever would I want to sterilize the water? The significance of this ceremony would have been seriously compromised had I done such a thing! It would have been a diplomatic nightmare for me if I had collected all the waters from across the globe and then *sterilized* them! Why would you even suggest such a thing?

Prosecutor: Aha! So if I am to take you at your word, Dr. Mitchell, you did not try to kill any living organisms in the water before *wantonly* pouring it into America's waters.

Mitchell: *(dawning comprehension, looks worried and shuffles around uncomfortably, talks to himself)* But . . . it was such a small amount of water. It couldn't have changed the course of history.

Prosecutor: *(looking triumphant)* No further questions, but the prosecution would like to retain the right to requestion this witness, if necessary.

Defense: Dr. Mitchell, you are a good man, a renowned scholar. Surely, you did not intend to introduce aquatic organisms from other parts of the world to New York City's harbor, much less the whole Great Lakes system.

Mitchell: *(shattered)* Never. The pouring of the water was simply symbolic.

Defense: No further questions, Your Honor, but for the record, please let me say that this prosecutor is making outrageous accusations against this good man!

(Judge does not respond. Prosecutor stands.)

Prosecutor: Judge, may I reexamine?

(Judge nods.)

Prosecutor: If it was, in fact, symbolic, why did you use real water?

Mitchell: You fool! Do you truly believe that it would have had the same impact if we had poured *air* out of the flasks into the ocean?

Prosecutor: *(ignores Dr. Mitchell)* I have no further questions for Dr. Mitchell. I would now like to call a witness from the future. Could the representative from the Great Lakes Fishery Commission please come forward?

(Great Lakes Fishery Commission spokesperson takes the witness stand.)

Prosecutor: Thank you for coming. How long have you worked for the Great Lakes Fishery Commission?

GLFC spokesperson: I began my work in the 1990s, sir. I've been at my job for over 15 years.

Prosecutor: As I understand, some of your research has involved the history of invasive species in the Great Lakes. When was the earliest known invasion?

GLFC spokesperson: The earliest known invasion occurred shortly after the opening of the Erie Canal, back in 1826. Both sea lampreys and alewives appear to have entered the Great Lakes through the Erie Canal.

Prosecutor: *(confidently)* And, correct me if I'm wrong, but these invasive species were in the kegs of water used during the celebration, were they not?

GLFC spokesperson: That's highly unlikely, sir. The kegs of water could easily have transported smaller organisms, but there is no proof that anything survived the trip in the keg or lived after being dumped into the lake. The sea lamprey and alewife got to the Great Lakes on their own – probably by swimming up the Erie Canal. And, that's not all. The spread of purple loosestrife can also be linked to the construction and use of the Erie Canal and other canals built during that time.

Prosecutor: *(looks surprised, then talks to himself)* Oh! I see. Therefore, I shouldn't be focusing on the ceremony so much as the actual construction of the canal . . . *(gaining confidence)* Since this canal would never have been built without the untiring efforts of Governor DeWitt Clinton, my case remains airtight. No, it is even stronger! I see no need for further deliberation. I'm ready to send this to the jury. Jury, do your civic duty, and find Governor DeWitt Clinton guilty of endangering the health of the entire Great Lakes ecosystem.

Judge: Is there a closing statement from the defense?

Defense: Ladies and gentlemen of the jury, the honorable Governor was acting in the best interest of the people of New York. He was trying to bring prosperity to this developing land. Is it fair to judge him in light of knowledge that was unavailable to him at the time? I think not. What would you have done if you had been governor in the early 1800s? Don't judge based on hindsight. Do you want your own decisions questioned 200 years after you make them?

Judge: Jury, you now have a few minutes to deliberate and make your decision.

Super Alien

Description

Students will meet *Hydrilla*, the perfect aquatic plant, through a short presentation with props. Then they will have the chance to create their own super plant that has everything it needs for a successful invasion!

Getting Ready

1. Try on the hydrilla props so that you are familiar with how they fit and feel. Practice the script. Memorize the script for the greatest dramatic impact!
2. Gather materials students will need to create their super aliens.

Introduction

Use the hydrilla props and enclosed script to introduce hydrilla and its amazing adaptations for survival.

Doing the Activity

1. **Look at other invasive aquatic plants.** Distribute a set of six *Wisconsin Wildcards* to each pair of students. Each set contains cards for purple loosestrife, Eurasian water-milfoil, reed canary grass, common reed grass, curly pondweed, and narrow-leaf cattail. Give students time to read over the cards and list the adaptations that these plants possess. Add to their lists any other invasive aquatic plants common in your area. Include special invasive adaptations that these plants possess.

2. **Design a super alien.** Instruct each pair of students to design a super alien plant that can invade a specific watery environment. The new plant must have at least five adaptations that allows it to outcompete native aquatic plants. Students should brainstorm new super plants, draw pictures of them, label the adaptations, and share their illustrations with the class.

   Optional project. Working individually or in small groups, students could brainstorm new super plants and construct 3D replicas using art or scrap materials of their choice. Students could also write papers describing the new species and plan formal presentations for the class.

Objectives

- List common adaptations of invasive aquatic plants.
- Illustrate an invasive plant that is adapted to invade an aquatic ecosystem.

Grades

5 - 12

Group Size

30

Prep Time

15 - 20 minutes

Activity Time

45 - 60 minutes

Setting

Classroom

Materials in Kit

- hydrilla props (fragments of fabric hydrilla to attach to head, arms, waist, and legs; and props to represent tubers, turions, and stems)
- laminated hydrilla script
- *Wisconsin Wildcards* (15 sets of 6 aquatic invasives)

Materials in Booklet

- hydrilla script (page 22)

Materials Not Included

- drawing paper
- colored pencils, markers, or crayons

National Education Standards

See next page.

National Education Standards

Grades 5 - 8

- Environmental Education: 2.2.A - Organisms, Populations, and Communities
- Science: C - Diversity and Adaptations of Organisms

3. **Optional: Relate invented plants to real ones.** As the students present their super aliens, try to draw parallels with real life aliens that are a problem in your location.

Assessing Student Learning

Observe student participation in the discussion. Evaluate the student's ability to use the information to design a new aquatic invasive. Here is a sample rubric.

Sample Rubric

Drawings/descriptions/presentations will include the following:

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

Extending the Learning

Study real plants. Bring in plant specimens of local invasives for further study. Encourage students to use field guides to identify the specimens. Search the Internet for information on countries of origin, means of invasion, special adaptations, and methods of control. Find out if anyone is tracking local aquatic invasives or trying to control their populations. If possible, try to help them in their efforts!

Make a reference collection of local aquatic invasives. Plants with rigid stems can be collected, pressed, and mounted on paper like terrestrial plants. However, fragile aquatic plants mounted in this way will fall apart or look like a tangled mass. Instead, float them in a shallow pan of water. Carefully slip a piece of mounting paper under the plant. Gently move the plant around until it looks natural. Lift the paper slowly to allow the water to drain. When all the water has drained off, cover the plant with clean muslin and blotting paper, and place it in a plant press to dry. When the plant is completely dry, remove the muslin, and label the specimen. Note: If your state has a watch list, expand your collection to include drawings or photos of the species that are threatening to invade your state.

Finding Out More!

Invasive Aquatic Plants: What Every Plant Enthusiast Needs to Know ©2002 Illinois/ Indiana Sea Grant. Publication number IISG-01-02.<http://aquat1.ifas.ufl.edu/seagrant/inaqplbr.pdf>

Plant Invaders of Mid-Atlantic Natural Areas by J. Swearingen, K. Reshetiloff, B. Slattery, and S. Zwicker ©2002. National Park Service and US Fish and Wildlife Service. <http://www.nps.gov/plants/alien/pubs/midatlantic/index.htm>

Hydrilla – The Super Alien Plant

(Performance notes for educator: Stumble onto the stage, breathe heavily, and drag one leg as if struggling under a heavy load. Play the part of a scientist who has discovered a truly amazing plant. Be enthusiastic. Talk like all these adaptations are just the coolest things in the whole world!)

I found it! I can't believe that I actually found it! Here it is. It's the perfect aquatic plant. I was down at the lake. I reached my hand in to collect a water sample, and it was right there! It's everywhere! I was so excited, I fell in. Look, I'm completely covered. This is so cool. Just check it out.

This thing grows so fast, you can see it growing.

(aside) Well, if you had some extra time on your hands, you could see it growing.

But an inch a day is really pretty fast for a plant!

And look how thick it is. All this vegetation came from one little spot on the lake. It grows so thick that light can't even get through it. Talk about wiping out your competition! When this plant moves in, other plants and pond animals move out of the way.

You have to understand that it has everything it needs to survive in the water.

Some aquatic plants are *soooo* picky. Conditions must be *just right* for them to grow. They have to have *stable* water that doesn't move *too* fast that has *just the right* amount of dissolved oxygen and *ideal* lighting. Not this plant – it's truly ready for any challenge.

- It can handle low oxygen levels.
- It doesn't mind a little salt.
- Lots of nutrients or few nutrients – it can handle both. It can even store some nutrients, like phosphorous, and use them later.
- Low light levels? No problem! In fact, this plant starts photosynthesizing earlier in the morning than most pond plants and keeps photosynthesizing later in the day. With all that extra time, it can grow faster, farther, and longer than other plants.
- Slow water, fast water – it doesn't matter. It seems it can even grow *faster* in fast-moving water.
- And, what about pH levels, you ask? It can grow in a wide range from acidic to basic.

(Really start talking fast now. You're on a roll!)

And that's just the beginning. You know how some plants only produce seeds once a year and if something goes wrong, they don't reproduce at all. This plant has the spreading thing down pat. Look at this:

- It has these tubers. Whole new plants can grow from these things. One plant can make thousands of tubers. Tubers can survive for several days out of water. They can survive four years in pond sediment! They can survive freezing temperatures, drought conditions, and herbicide applications. They can even be eaten by ducks and regurgitated! After all that, they can still sprout and turn into new plants!
- It has these little turion things. They're like superbuds. They can form all year, but the ones that form in fall are tough. They survive the winter and grow the next spring.
- Not only that, but it spreads by these underground stems (rhizomes) and aboveground stems (stolons).
- And check this out. If a piece of the plant gets broken off, it can grow a whole new plant. From just one little whorl of leaves! A whole new plant! Is that cool or what!
- And then, it can also reproduce the old-fashioned way with flowers and seeds and stuff. But really, why even bother when it has all these other ways to get around!

You're probably wondering what this marvelous plant is and where it came from. Well, I have the clue right here. See this old plant tag! You've probably seen it in an aquarium somewhere. People have been using these plants in their aquariums for years. You can hardly kill the stuff, so it makes a great aquarium plant!

(tone changes drastically – to an almost defeated tone)

And *that* is exactly where it came from. In the 1950s, this plant was cultured for use in the aquarium trade. It escaped, and the rest is history. In places where hydrilla has become established, it has outcompeted native vegetation, damaged habitat for fish and other wildlife, altered water quality, and interfered with recreational activities such as swimming, boating, fishing, and water skiing. It's going to take everybody to stop the spread of this super plant. Now that you know all about it, do you have any ideas on how to prevent it from entering new waters?

Outwit-Outplant-Outlast

Description

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

Getting Ready

1. Prepare the playing field by making 25 one-yard squares. You will need three people to make the grid. See directions for using a chalk line on page 28.

Introduction

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

Doing the Activity

Game One - Discover how plants invade an empty field.

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

1. **Discuss what plants need to survive.** (Sunshine, water, nutrients, soil)
2. **Explain the tokens.** Show students the water/nutrient tokens (blue) and sunshine tokens (white).
3. **Ask one student to represent an invasive plant and to stand in a corner of the grid.**
4. **Start the game.** At the sound of the bell, the student must

Objectives

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

Grades

5 - 10

Group Size

15 - 30

Prep Time

15 minutes

Activity Time

60 minutes

Setting

Outdoors

Materials in Kit

- chalk line
- chalk dust for refilling
- tape measurer
- sidewalk chalk
- blue water/nutrient tokens (100)
- white sunshine tokens (100)
- cowbell

National Education Standards

See next page.

National Education Standards

Grades 5 - 8

- Environmental Education: 2.2.C - Systems and Connections
- Science: C - Populations and Ecosystems

Grades 9 - 12

- Environmental Education: 2.2.A - Organisms, Populations, and Communities
- Science: C - The Interdependence of Organisms

get three water/nutrient tokens and three sunshine tokens. Allow several seconds before sounding the bell again to stop the collecting. The student can't leave the grid square to collect the tokens. After all, plants have roots! Note: The student should be able to obtain the necessary tokens easily.

5. **Reproduce.** This invasive weed produces many seeds, but only four of them land and sprout inside the grid. Add four more students to adjacent grid squares.
6. **Renew the supply of tokens.**
7. **Sound the bell and have the "plants" collect their requirements.** Note: Distribute tokens so that all the plants survive.
8. **Reproduce.** These plants now all produce lots of seeds, but only four of the seeds produced by each plant survive. Add 20 students. The grid is now full.

Discuss

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

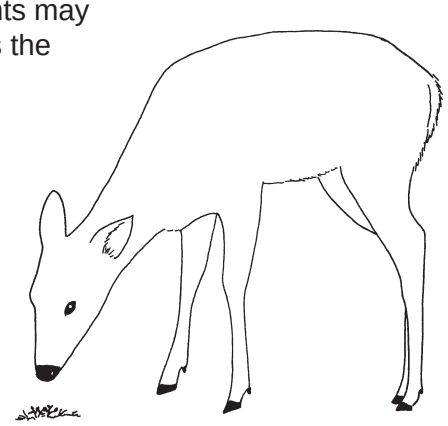
Game Two - Discover how native wildflowers occupy a natural area.

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

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

Discuss

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



Game Three - Discover how weeds invade a natural area.

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

1. **Place students in the squares without "X"s.** Fill all the squares except one with students representing native wildflowers. Fill the empty square with a student representing an invasive weed.
2. **Send in the hungry deer.** The deer doesn't recognize the new plant as a food plant, but it does dine on two of the native plants.
3. **Allow the plants to gather tokens.** At the signal, the invasive plant can begin to collect its requirements. The invasive plant needs three of each kind of token. A few seconds later ring the bell again and invite the native plants to collect. Remind the natives that they need five of each colored token. If the natives protest, explain that invasive plants often turn green earlier in the year and stay green longer in the fall, so they should have more time to collect their tokens. Many invasive plants can also survive on smaller amounts of water, nutrients, and sunshine.
4. **Reproduce.** All plants that didn't collect enough water or sunshine die. These plants must leave the grid. Plants that did get enough are able to reproduce successfully. The invasive produces many seeds, but only four land on the grid. The natives also produce quite a few seeds, but only two per plant land in the playing field. Calculate how many seeds the plants produce. Decide which students will represent these seeds.
5. **Send in the mouse.** Designate one student to be the mouse that will eat the seeds. Each year, the mouse will eat half of all seeds produced by the *native* plants. The mouse doesn't eat the seeds from the invasives, because they are hairy and unpalatable. At the signal, the mouse can "eat"/tag the correct number of the native seeds on the sideline.
6. **Germinate.** At the signal, the "seeds" can try to take over the empty spaces on the grid. Any unsuccessful seeds return to the sidelines.
7. **Repeat steps 2 – 8 until invasive plants completely overrun the field.** Optional: You could allow two invasives to occupy each square, since invasives often need less space than natives do.

Did you know?

Each purple loosestrife plant can produce up to two mililion seeds in one year!

NNIS
Non-native Invasive Species

Discuss

- What advantages did the invasive species have over the native species? (They produced more seeds. Herbivores didn't eat either the plants or the seeds. They needed fewer tokens to survive. They began collecting tokens before the natives.)
- Do the native species have a chance in this game? (No, not really. It's rigged!)
- Do the native species have a chance in the real world? (No, not in the presence of extremely invasive species. That's rigged too!)
- In the game, the deer and mouse continued to eat the plants and seeds of the native wildflowers, no matter how many there were. Is this realistic? (Probably not. As the concentration of natives decreased, the herbivores would probably look other places to find food.)

Assessing Student Learning

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

Extending the Learning

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

Create "wanted posters." Now that your students know the shady character traits that invasive species possess, ask them to create a wanted poster for an invasive that is prevalent in your area. There are a few sample "wanted posters" in the kit. You can also view them on the Web at University of Nevada's Integrated Pest Management Web site <www.ag.unr.edu/wsj/ipm/Wanted_posters/wpost.html> and Bureau of Land Management's Website <www.blm.gov/education/weeds/weedposters>.

Finding Out More!

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

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

Making a Chalk Line

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

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

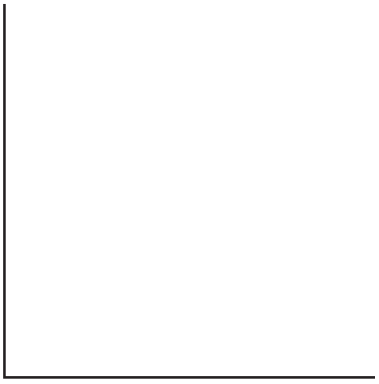


Figure 1

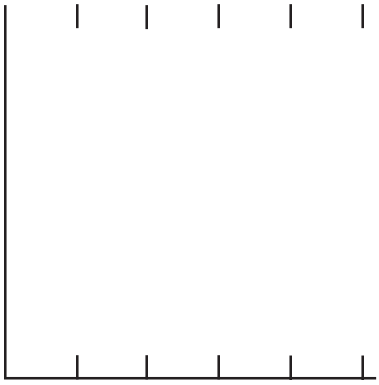


Figure 2

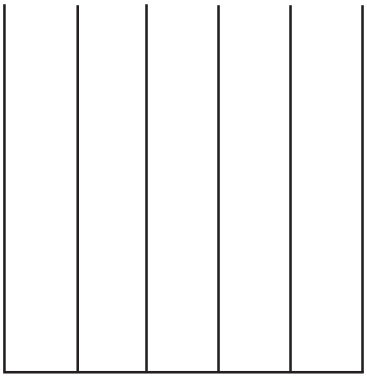


Figure 3

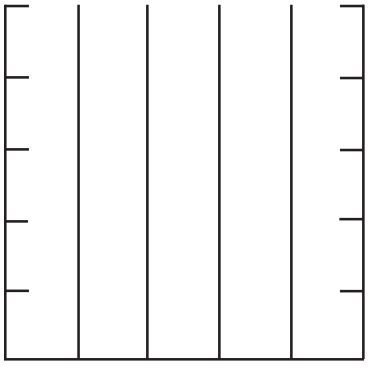


Figure 4

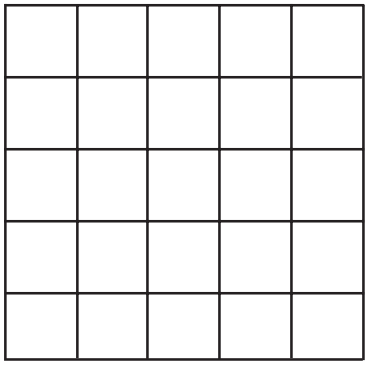


Figure 5

Meadow in a Can

Description

Over the years, gardeners, landscapers, and nursery owners have allowed many plant species to escape into natural habitats. Often people don't realize they are cultivating and caring for a potentially invasive plant until it is too late. Using seed packets and nursery ads, students will practice being cautious consumers and decide if they should plant a seed mix in their location.

Getting Ready

1. Look through the seed packets and advertisements included in the kit.

Introduction

"Wildflower," "meadow," "native," "natural beauty," "easy-to-grow," "butterfly favorites," "great for celebrations," "grows almost everywhere" – these catchy words and phrases can make a product sound almost too good to be true.

Doing the Activity

1. **Consider some of the reasons a company might include "weedy" plants in its seed mixes.** Distribute or project with an overhead *A Tale of Two Flowers* from page 34. It shows the germination, growth, and bloom specifications for cornflowers and wild indigo. Compare the characteristics of the two plants. Invite students to imagine they work for a seed company. Ask them to consider which plant they would include in a new wildflower seed mix that their company is developing. They should think about what customers want? How will they satisfy their customers? (A company wants happy customers. Most customers want quick and reliable results. Seed companies are not likely to include species that have specific germination requirements, are difficult to establish, or take a long time to bloom. They will more likely include tough plants with high success rates. These plants tend to be aggressive and are sometimes invasive.)

Objectives

- Analyze the species selection process and marketing strategies used by companies producing seed mixes.
- Identify the contents of wildflower seed mixes.
- Become aware that consumers must be well-informed when purchasing plant material from garden centers, nurseries, and seed companies.

Grades

9 - adult

Group Size

5 - 30

Prep Time

Minimal

Activity Time

40 - 60 minutes

Setting

Classroom

Materials in Kit

- seed packets (15)
- catalog ads (4)
- Internet ads (5)

Materials in Booklet

- *A Tale of Two Flowers* (page 34)
- *Meadow in a Can* seed list (page 35)
- *Local Ecotype Guidelines* (page 36 - 37)

National Academic Standards

See next page.

National Academic Standards

Grades 9 - 12

- Environmental Education: 2.2.C - Systems and Connections
- Environmental Education: 2.4.A - Human/ Environmental Interactions
- Environmental Education: 4.D - Accepting Personal Responsibility
- Science: C - The Interdependence of Organisms
- Science: F - Environmental Quality

2. **Pass out seed packets and ads to look at overall marketing/packaging.** Encourage students to examine the package labels, text, and photos. Ask some of these questions:
   - What does the packaging communicate?
   - What are some of the words that seed companies use to sell these products? (Native, wild, meadow, natural) What do these words imply?
   - How should you interpret phrases such as “robust plant,” “aggressive bloomer,” “grows anywhere,” or “very vigorous grower”?
   - Is there enough information for you to grow the plants in your garden successfully?
   - Does the package indicate where the company collected the seeds?
   - Does the package specify the number of seeds from each plant or the percentages of each species?
   - Can you tell from looking at the package if the plants are native to North America? If so, can you tell the region, state, or native community where they are found?
3. **Look at the seed list.** Check out the list of seeds on the packet or in the ads. Consider the following:
   - Does the seed packet include a complete list of wildflowers, or does it list a couple of species and then add “and many more”?
   - Scientific names are two-part names that precisely identify a plant. Does the package list common names, scientific names, or both?
   - Why are the scientific names important to consumers? (One plant can have several common names. Two plants might also have the same or similar common names and be very different from each other. The scientific name is unique to one species. It is the only way to be sure of what plant you are purchasing and planting.)
   - Do you have any assurance that the company has correctly identified the species in the packet?
4. **Discover the origin of the seeds in a mix.** Look at the list of plants from a typical wildflower seed mix such as *Meadow in a Can*, on page 35. Read the list and mark any plants whose names sound suspicious. For example, *Chinese Houses* doesn’t sound like a native plant. Ask if any of your students are familiar with any of the plants. Use the information in the list below to fill in the native region of each plant. Determine how many of the wildflowers in the mix are native to your specific area. Ask what “native” might mean to a seed company. Remind students that every plant is a native plant in some location!

Common Name	Country/Area of Origin
Hard Fescue	Europe
Strawberry Clover	Eurasia
White Yarrow	Eurasia
Bachelor Button	Eurasia – considered invasive
Shasta Daisy	Eurasia
Chicory	Eurasia, North Africa
Chinese Houses	western North America
Cosmos	Central America, West Indies
Purple Coneflower	southeastern and midwestern US
California Poppy	southern California to southern Washington
Indian Blanket	south central US
Blue Flax	western states
Lupine	California and Baja California
Baby Blue Eyes	California
Evening Primrose	Pennsylvania to Virginia
Shirley Poppy	Eurasia
Clasping Coneflower	Georgia to Texas
Black Eyed Susan	most of US, except far western and northeastern states
Red Flax	northern Africa

NNIS Non-native Invasive Species

Optional: Instead of having students use the list included in this lesson, ask students to research the flowers listed on one of the packets or ads in the kit. Instruct them to copy the common and/or scientific names and to use the Internet to determine the country/region of origin for each plant in the list. Searches including the scientific name of the wildflower and the word “origin” are most successful.

5. **Discuss what consumers should do.** When consumers purchase seed mixes, they are asking the seed company to provide them with a mix that will grow well and beautify their surroundings. Many people who purchase seed mixes want a “quick fix.” They might not have the time or knowledge to determine local growing conditions (i.e., soil type, pH, drainage, light levels, hardiness zone, etc.) that determine which plants will grow best in their yards. Instead, they rely on the seed companies to provide them with a mix that will “grow everywhere.” That mix will likely contain non-native and aggressive plants that have the potential to become invasive. What’s a gardener to do? Talk about some of these considerations:
   - The Internet has made it possible for people to easily obtain seeds from all over the world. Who has the responsibility for being sure that consumers don’t buy seeds that could become invasive in their locations? The consumers? The seed companies? The government?
   - Should seed companies be held accountable for including the seeds of known invasives in the mixes they sell? Who pays for the control of invasive species that

escape from home gardens and other landscaped areas?

- Should consumers buy seed mixes that don't list both the common name and scientific name of all plants in the mix?
- Researchers who have grown seed mixes have found that there are often seeds from plants not listed on the packets. These seeds either are considered "filler" or are simply contaminants. Should consumers expect the lists on wildflower seed mixes to be accurate?
- Seed mixes containing non-native plants are often labeled with words like "native," "meadow," and "wildflower." What are the consequences of planting these seed mixes in a window box? A backyard? A meadow? Adjacent to a natural area? Think about how seeds travel. Is it "safe" to plant a known invasive anywhere?
- What does *naturalized* or *adapted* to an area mean? How is that different from *native?*

6. **Consider the alternatives to wildflower seed mixes.** Read *Local Ecotype Guidelines* on page 36 - 37. Some companies offer seed mixes for local or small regional areas. They guarantee that the seeds have been collected from plants within a specified area (local ecotypes). These plants are native to the area and adapted to the local conditions. These seed mixes are more difficult to find and usually more expensive. Discuss the advantages and disadvantages of these seed mixes vs. more generic seed mixes.

Assessing Student Learning

Ask students to demonstrate what they have learned about seed mixes by designing a seed packet or advertisement. They could:

- Design a wildflower packet that shows "truth in labeling."
- Research local plant species and put together a native seed mix.
- Create plant labels for non-native species that inform people of the potential problems with growing non-natives and that suggest native alternatives.

Extending the Learning

Grow a Meadow in the Can! If you have access to greenhouse facilities or indoor window boxes, have the students plant the contents of a wildflower seed mix. Start with sterilized soil. How many different plants grow from the mix? Can you

identify any of them? You might be able to grow the annuals to flowering stage and identify them from the blooms. Check out some of the research that has been done with contents of mixes at the University of Washington. <www.washington.edu/newsroom/news/2002archive/04-02archive/k041802a.html>

Visit a native plant nursery. Take a class field trip to a nursery or greenhouse that sells native wildflowers. Read the plant labels. Talk with the owner about the types of plants they offer for sale. Ask them where they get their plant material. Are the "native" plants all native to the local area. In other words, do they sell only local ecotypes? Remember that a plant might be native to a large area. Within that large area, there might be several ecotypes that are specifically adapted to local soil and climate conditions.

Question company practices. As your students research wildflower seed mixes and the companies that sell them, they may have questions about what plants the companies sell and where they sell and market their products. Encourage them to contact the companies and question their practices. For example, why is a company with a stated philosophy of protecting native ecosystems willing to ship its seeds all over the world?

Finding Out More!

Native Plants Database. Lady Bird Johnson Wildflower Center. 2004. Information on characteristics and distribution. Links to images and related websites. <www.wildflower2.org/NPIN/Plants/plant.html>

The PLANTS Database. United States Department of Agriculture, NRCS. 2004. Includes characteristics, distribution, and images. <http://plants.usda.gov/index.html>

purple coneflower

A Tale of Two Flowers

Flower	Bachelor Buttons *Centaurea cyanus*	Wild Indigo *Baptisia leucantha*
Plant Type	Annual, but reseeds freely	Perennial
Seed Collection	Collect seedhead/pod when flowers fade; allow to dry.	Allow pods to dry on plant; break open to collect seeds.
Seed Treatment	None	Scarification, inoculation, moist stratification for 10 days
Propagation Methods	Sow seed directly into the soil in fall or spring. Seed can be started earlier in spring indoors in pots or outdoors in covered containers, coldframes, or unheated greenhouses.	Sow seed directly into the soil in fall or spring. If starting seed in spring, stratify seed and germinate in a damp paper towel before sowing. Seed can be started earlier in spring indoors in pots or outdoors in covered containers, coldframes, or unheated greenhouses.
Soil Type	Dry, moist, chalky/alkaline, well-drained/light, clayey/heavy	Dry
Planting Time	One or two weeks before your region's last average frost date	After your region's last average frost date
Planting Depth	¼" deep	½" deep
Special Instructions	None	Place seed in refrigerator before planting.
Time till first bloom	About one month	4 - 5 years
Bloom Time	Late spring to early fall	Late spring to mid-summer
Comments	These cheerful, ragged blossoms are at home in temperate gardens around the world. They bloom so prolifically with so little care that they often are the first plants that children grow on their own. They are fail-proof, always attractive, and rarely decimated by bugs or disease.	Once established, this plant's raceme of white flowers can be seen from 200 yards. The 3 - 4' tall plant is quite impressive in summer, fall, and winter. Caution: Parts of the plant are poisonous if ingested.
Skill Level	Beginner	Advanced

Meadow in a Can Seed Mix

This canister contains 87% pure seed and only 13% inert matter to assist with the even distribution of the seed at time of planting. Covers 500 square feet.

Common Name	Scientific Name	Plant Type	Country/Area of Origin
Hard Fescue	*Festuca ovina var. duriuscula*	Perennial	
Strawberry Clover	*Trifolium fragiferum*	Perennial	
White Yarrow	*Achillea millefolium*	Perennial	
Bachelor Button	*Centaurea cyanus*	Annual	
Shasta Daisy	*Chrysanthemum leucanthemum*	Perennial	
Chicory	*Cichorum intybus*	Perennial	
Chinese Houses	*Collinsia heterophylla*	Annual	
Cosmos	*Cosmos bipinnatus*	Annual	
Purple Coneflower	*Echinacea purpurea*	Perennial	
California Poppy	*Eschscholzia californica*	Perennial	
Indian Blanket	*Gaillardia pulchella*	Annual	
Blue Flax	*Linum lewisii*	Perennial	
Lupine	*Lupinus succulentus*	Annual	
Baby Blue Eyes	*Nemophilia menziesii*	Annual	
Evening Primrose	*Oenotheria argillicola*	Biannual [2]	
Shirley Poppy	*Papaver rhoeas*	Annual	
Clasping Coneflower	*Rudbeckia amplexicaulis* [1]	Perennial	
Black-eyed Susan	*Rudbeckia hirta*	Perennial	
Red Flax	*Linum grandiflorum rubrum*	Biannual [2]	

[1] *Dracopis amplexicaulis* is more widely accepted as the scientific name for clasping coneflower.

[2] Term biannual (blooming twice each year) is probably incorrect. The plant type is probably bienniel (blooming every two years).

Local Ecotype Guidelines

The following guidelines are intended to assist Wild Ones® members and others in their natural landscaping efforts. They were developed by a committee of national board members and others who read widely in the scientific literature and consulted with experts. While there is ongoing debate within the restoration community concerning the issues below, we offer the following guidelines with the hope that they will help make our natural landscapes places of health, diversity, and ecological integrity.

Wild Ones Natural Landscapers advocates the selection of plants and seeds derived, insofar as is possible, from local or regional sources at sites having the same or similar environmental conditions as the site of planting. Such plant material is often termed the local ecotype.

- Environmental Conditions: These include everything from soil, climate, elevation, drainage, aspect (such as north/south slope), sun/shade, precipitation, etc.
- Local or Regional Sources: Plant material that originates in and is native to your geographic region is generally the best to use. These regions have ecological, not political boundaries; i.e., it is better to use a source from your geographic region but outside your state than to use a source from a different geographic region inside your state. Such regions are often referred to as ecoregions by scientists. The ecoregions within the US are best delineated by *The Nature Conservancy* in the US and the *Conservation Data Centres* in Canada. (Maps of the ecoregions can be obtained from these groups.)

Why Choose Local Ecotypes:

- To insure the greatest success in your landscaping efforts.

  In general, the more closely you match the environmental conditions of the source of your plant material to that of the planting site, the better it will grow. Studies show that this is because species have become genetically adapted to the local conditions to varying degrees — some species more than others. Since there is little species specific information, it is best to take a conservative approach so plantings will do better both in the short term and in the long term.

  Example: A red maple from the deep South will not do well in the North. Also, a red maple from a lowland will not do well if transplanted to an adjacent upland site.

  Exception: Threatened and endangered species which have reduced genetic variability may need an infusion of genetic variability from plants from other, maybe distant locales, in order to insure their survival over the long term. Work with such species should be conducted under the supervision of the state and federal agencies which have jurisdiction over them.
- To help preserve local pollinators, insects, birds, mammals, and other wildlife which have co-evolved with plants of local ecotype and depend upon them for food, shelter, etc.
- To preserve the genetic diversity and integrity of native plants.

  An all-important concern today is the preservation not only of a diversity of species, but also of the genetic diversity within each species. A native species varies genetically in its adaptation to the particular localities and environmental conditions under which it grows. This results in a number of ecotypes of the same species or gradations (clines) between populations, not clonal stock or cultivars.

You can help preserve the local ecotypes in your area by using them in your landscaping. There can also be significant genetic variation within an ecotype in terms of form, size, growth rate, flowering, pest resistance, etc. You can help preserve this gene pool by asking for seedling stock.

How to Find Your Local Ecotypes:

To prevent the local extinction of native plants, plants should be bought from reputable nurseries, not dug from natural areas.

- Exception: Plants rescued from a site slated for immediate development. (However, every effort should be made to save such sites whenever possible.)

Where to Buy:

A list of nurseries carrying native plants of local ecotypes can often be obtained from local nature centers, from state natural resource departments, from local Wild Ones chapters, or from native plant organizations. Nature centers or nurseries dealing exclusively with native plants are more apt to have stock of local ecotypes.

- Ask the nursery about the sources of their plant material. Does it originate within your ecoregion?
- Beware of plant material dug from the wild or plants which are “nursery grown” in pots after being dug from the wild. Plants should instead be “nursery propagated” from seed or cuttings, not collected from the wild. It is environmentally unethical and contrary to the mission of Wild Ones to buy plants dug from our last remaining natural areas in order to naturalize your yard.
- Ask for seedling stock, not clonal stock, cultivars, or horticulturally enhanced plants. Clonal stock, cultivars, and horticulturally enhanced varieties lack genetic variation. They are usually selected for bigger, showier flowers or more sturdy stems, and this goal of aesthetic uniformity is at the expense of genetic diversity. Cultivars and horticulturally enhanced varieties are often propagated asexually, and thus are clones rather than unique, genetic individuals. (A variety of an individual species can be a naturally occurring variety or a horticulturally produced variety.) Check with local lists of native plants to see if the varieties are native locally or horticulturally produced.

Seed Collection:

When collecting seeds, collect from many individual plants from within the same ecotype of each species (rather than taking seeds only from the biggest plant, for example), and do not take all the seeds from any plant. This will help preserve and increase the genetic variation of the population. Also, be sure to get permission for seed collecting; it is not allowed in some natural areas.

Document Your Project:

Keep records of the origins of the plant material you use. This is particularly important for large scale restorations, especially if they are at nature centers or other places of education. Detailed records on sources of plants used can help us understand their success or failure and adapt our plant selection strategies, as needed. This may become increasingly important given the changes in climate expected with global warming.

This guideline has been drafted by the Local Ecotype Committee: Pat Armstrong, Lorraine Johnson, Chistine Taliga, and Portia Brown, with final revisions made by committee chair, Mariette Nowak, August 7, 2001 and revised March 19, 2002.

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Activity Crosswalk

	Activities	Ad-libbed Aliens	Bioblunder Tribunal	Super Alien	Outwit-Outplant-Outlast	Meadow in a Can
Target Audience	Preschool - Grade 1					
	Grade 2 - 4	■				
	Middle School	■		■	■	
	High School		■	■	■	■
	Adult		■	■		■
Subject Area	Science	■	■	■	■	■
	Social Studies		■			■
	Math				■	
	Language Arts	■	■			
	Fine Arts			■		
Primary Teaching Method	Hands-on Investigation					■
	Game/Simulation	■			■	
	Creative Expression			■		
	Analysis/Synthesis			■	■	■
	Discussion/Ethics		■		■	■
	Story					
	Dramatic Presentation		■	■		
Logistics	Inside	■	■	■	■	■
	Outside	■			■	
	Time	10-20 min.	minimum of two 50-minute periods	45-60 min.	60 min.	45-60 min.
	Group Size	maximum 30, divided into groups of 4-10	maximum 30, divided into groups of 3-5	maximum 30	15 - 30	5-30

	Activities	Ad-libbed Aliens	Bioblunder Tribunal	Super Alien	Outwit-Outplant-Outlast	Meadow in a Can
Key Message	Biodiversity					
	Identification/Adaptations	■		■		■
	Prevention		■		■	■
	Early Detection/ Rapid Response		■		■	
	Control/Management/ Restoration					
NNIS	Aquatic Ecosystems	■	■	■		
	Terrestrial Ecosystems	■	■		■	■
	Invasive Plants	■	■	■	■	■
	Invasive Animals	■	■			
	Species	kudzu leafy spurge snakehead	starling aquatic invasives	hydrilla		
Instructor's Knowledge of NNIS	Mimimal Background	■				
	Average		■	■		
	Advanced Knowledge				■	■