PURDUE EXTENSION

EXPERT REVIEWED

FNR-532-W

The NATURE OF TEACHING

WILDLIFE

Invasive plants: impact on environment and people

LESSON PLAN

This lesson teaches students about the significant environmental and economic losses that can be caused by the introduction of invasive plant species.

AUTHORS / CONTRIBUTORS

Mysha Clarke and Dr. Zhao Ma, *Department of Forestry and Natural Resources, Purdue University*

OVERVIEW

ESTIMATED TIME

45 minutes

VOCABULARY

- Invasive plants
- Native plants
- Ecosystem
- Population
- Community
- Forest ecosystem

UNIT OBJECTIVES

Students will be able to:

- Define an invasive species and a native species.
- Identify the differences between an invasive plant and a native plant.
- Explain how invasive plants can negatively impact people and the environment.
- Give one example of an invasive plant and its impact on people and the environment.
- Demonstrate how invasive plants can encroach on an ecosystem by participating in a game that simulates the process.

INDIANA STANDARDS

IAFNR-5.1

Natural Resources
NR-1.2, NR-1.3, NR-1.4, NR-1.5, NR-5.1

Plant and Soil Science
PSS-7.2

Science
3. LS.3, 4.LS.2, 4.LS.3, 4.ESS.4, 4.LS.2, 4.LS.3, 5.LS.2, 6.LS.3, 6.LS.4, 6.LS.5, 8.ESS.2, 8.ESS.3

Social Studies
4.1.12, 5.3.6, 5.3.8, 5.4.3, 6.1.20, 6.3.7, 6.3.8, 6.3.13, 7.3.1, 7.3.5, 7.1.10, 7.1.16, 7.1.17, 6-8.LH.5.1

Environmental Science
S.1, S.4, S.7, S.8

Mathematics
S.1., S.2, 3.1, 5.1, 5.2

MATERIALS

- Invasive Plant vs. Native Plant worksheet (1 per student)
- Photos of garlic mustard plant
- Printed photos of white-tailed deer
- Map of garlic mustard distribution
- Map of the world showing climatic zones
- Printed cards from digital file, 10 each
  - Native Plant cards (pages 16-17)
  - Invasive Plant cards (pages 18-19)
  - Deer (predator) cards (pages 20-21)
  - Resources cards (pages 22-23)
- 1 empty box or designated area to put resources
- Garlic mustard plant for display and for students to feel and smell
- Garlic mustard film from The Potomac Highlands Cooperative Weed and Pest Management Area: *https://www.youtube.com/watch?v=J5FHSu_uOjE*

ACKNOWLEDGEMENTS

The authors would like to thank the Purdue GK-12 Program Coordinator Christopher Roemmele and Indiana licensed teacher Nicholas Gaspar for reviewing previous drafts of this publication and for providing feedback after piloting the lesson in the classroom.

April 2017

PURDUE UNIVERSITY

PURDUE EXTENSION | LOCAL FACES COUNTLESS CONNECTIONS
1-888-EXT-INFO • extension.purdue.edu

Order or download materials from
Purdue Extension • The Education Store
edustore.purdue.edu

INTRODUCTION

Invasive species are plants, animals, or pathogens that are nonnative (or alien) to the ecosystem under consideration and whose introduction causes or is likely to cause harm (National Invasive Species Council). Invasive plants are a significant threat to the health and production of ecosystems. An invasive species is a nonnative species that can cause significant environmental and economic losses. Invasive species are said to be the second leading cause of biodiversity loss, after habitat loss. They can disturb a forest ecosystem by displacing native species and outcompeting native species for resources and habitat. In addition, many invasive species, especially invasive plants, have advantages such as rapid reproduction, production of many offspring, and high tolerance to a wide range of weather conditions. Many invasive plants also have an advantage in the new habitat, because they have no evolved predators in this new environment, whereas the native plants compete with the invasive plants while being preyed on by predators such as the white-tailed deer. In Indiana, garlic mustard is one of the most problematic invasive plants. Garlic mustard also has no significant predators and is said to be allelopathic (the plants excrete a toxic chemical that makes it harder for other plant seedlings to grow).

GARLIC MUSTARD (*Alliara petiolata*)

Garlic mustard is one of the most problematic and widely distributed invasive plants in Indiana. For this lesson, garlic mustard is used as an example for the students, because it was intentionally introduced by people, spreads very quickly, can be easily identified, and can be found in many areas of the state. Garlic mustard can be found in public parks, backyards, meadows, forests, gardens, and along roadsides throughout Indiana. The students will also easily remember this plant, because it has a very strong garlic smell emanating from its leaves.

Garlic mustard was first introduced from Northeastern Europe in the 1860s to Long Island, New York. It was brought from Europe by immigrants to be used as food, an herb, medicine (for ulcers, gangrene), and erosion control. Garlic mustard can be spread by water, insects, wind, or humans. Each year one plant can produce up to 15,000 seedlings that are viable for up to 5 years (Kleinstein, 2001)[1]. While garlic mustard has many insect predators in Europe, it has no known serious predators in the United States. Additionally, evidence shows that white-tailed deer indirectly facilitate the spread of garlic mustard by eating native plants and creating disturbances in the forest understory, allowing the invasive plant to spread.

Garlic mustard can be found in many habitats including forests, savannas, urban yards, lawns and even on disturbed landscapes like roadsides. While garlic mustard prefers shady growing conditions, they can also thrive in a sunny environment and are self-fertile. Garlic mustard has 2 main stages of development. For each stage of development, garlic mustard can be identified by different features.

First stage:

- The young leaves produce a strong "garlic" odor, especially when the leaves are crushed.
- The leaves form a small rosette of about 4-8 leaves and are usually found at ground level.
- The leaves are dark green with scalloped edges.

Second stage:

- The plant now has an erect stem and can range in height from several inches to 4 feet.
- They have alternate leaves, triangular leaves, coarsely toothed edges and become gradually smaller towards the top of the stem. It also has the strong odor of garlic when crushed, but the odor lessens as the plant gets older.
- Clusters of white, small, 4-petaled flowers bloom in late spring through summer.
- Garlic mustard develops slender seed pods that open in the late spring/summer.

More information about garlic mustard identification, distribution, and treatment can be found through:

- *National Park Service,*
- *National Invasive Species Council, and*
- *The Nature Conservancy of Indiana.*

1 Kleinstein, D. 2001. Garlic Mustard (*Alliaria petiolata*). Introduced Species Summary Project. Retrieved March 24, 2017.

PROCEDURE

1. Begin lesson by asking students:
   - *What plants need to survive in a forest?*
   - *What are some reasons that plants die in an ecosystem?*
   - *What is a native plant?*
2. Define for the students the term **native plant**—a plant that occurs naturally within a region, either evolving there or arriving and becoming established without human assistance. Ask students if they know examples of plants or animals that are native to Indiana.
3. Ask the students if they know the term for a plant that is nonnative and can cause a lot of damage? If students did not respond, provide the answer and definition: **invasive plant**—a plant that is not naturally from an area and that was directly or indirectly introduced to that area by humans.
4. Ask students if they know of any invasive plants in Indiana.
5. Show the short film about garlic mustard produced by The Potomac Highlands Cooperative Weed and Pest Management Area. This was filmed with the help of the Petersburg Elementary School 5th-grade class at Seneca Rocks in West Virginia and covers plant identification, history, and treatment.
6. Introduce a photo of garlic mustard. Ask students why they think it might be called "garlic mustard." If available, provide students with a garlic mustard plant and have them pass it around, smell it, feel it, and look at it.
7. Have students do the following invasive plants activity, *Attack of the Garlic Mustard*.
8. Following the game, have the students complete the Invasive Plants vs Native Plants worksheet (page 7).

WHAT CAN STUDENTS DO TO HELP?

1. **Volunteer to do garlic mustard pulls** at your local parks, trails, or conservation areas. Depending on your location, there are many organizations that have organized days for the public to volunteer and pull garlic mustard. These include Niches Land Trust, Indiana Department of Natural Resources, The Nature Conservancy, Indiana Native Plants and Wildlife Society, Southern Indiana Cooperatives Management, Sycamore Trails R & D, Northwest Indiana Cooperative Weed Management Area, and West Central Indiana Cooperative Weed Management Area.
2. **Organize a day session** with your students to visit one of their favorite nature areas to assist them with invasive plant removal, not only of garlic mustard but also other species.
3. **Do your own research** about how invasive plants are transported by humans.
4. There is a list of many other problematic invasive plants in Indiana. Be aware of these plants and discourage others from buying or planting them.
5. **Help natural resource authorities** manage invasive plants. The easiest way to do that is to use your smartphone and upload photos and locations of invasive plants you come across them in the landscape. Check out EDDMaps (*www.eddmaps.org*). This can be a fun classroom activity for students to learn about geographic coordinates, citizen science, data sharing, maps, and satellite imagery. Students can also keep track of other invasive species at the county, state, and national levels by analyzing interactive maps. In short, students can have fun taking photos of invasive plants and then uploading the photos like they would on social media, and the computer recognizes their location and converts it to geographic coordinates. The students would get the opportunity to see their data point added to a national study and they also get a better understanding of science and data. This can be done at any time as a group or individual effort.

ATTACK OF THE GARLIC MUSTARD!

HOW TO PLAY THE GAME

The aim of the game is to show that invasive plants can be very competitive, because they have several advantages that put native plants at a disadvantage.

This game has 10 rounds. Each round is made up of 4 phases:

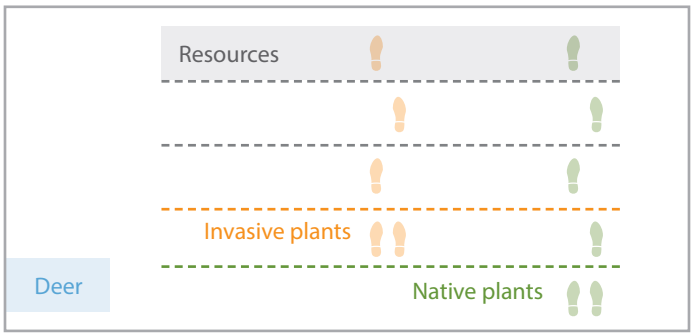
- Resources: Step, Stop, Collect
- Reproduction: Survive or Thrive
- Predators: Oh Deer!
- Reset and Record

There are 3 active player groups in the game (native plants-green, predators-blue, and invasive plants-orange) and 1 set of ecosystem resources.

SETUP

Mark the game space with 4 parallel lines (shown below) – this could be with string, using marker cones or chalk (if outside). Each line should be spaced approximately 2 ft from the previous line. Starting at one end, mark the first line as the native plant line and the next as the invasive plant line. Place the resource cards behind the furthest line from the native plant line.

Hint: *If possible, try to match the line colors to the card colors to create a visual cue for students.*



Note: *This game play is based on a class size of 25. You may need to adjust starting numbers–refer to the table below for guidance. To make the game go more quickly, use more native plant cards, a moderate number of invasive plant and deer cards, and very few resources cards.*

CLASS SIZE	NATIVE PLANTS	INVASIVE PLANTS	DEER	RESOURCES
15	4	1	1	8
20	7	2	2	12
25	10	3	3	15
30	12	5	4	20

Have 5 students receive player cards: 3 receive green (Native plants), 1 receives orange (invasive plant), and 1 receives a blue (predator/deer) card. Students with blue cards will form a line behind the native plant line (shoulder-to-shoulder), facing the resources. Students with orange cards will form a line behind the Invasive plants line, facing the resources. Students with the predator card should stand to the side of the game area, beside the native plants.

GAME PLAY

There are 4 phases in each round. Each phase must be completed in order before progressing to the next round.

Resources: Step, Stop, Collect.

In this phase, all students holding a plant card will take a **step** together over the line in front of them, **stop** and see if they can **collect** a resource; repeat. Once the plants reach the resources (initially, this will take native plants 4 steps and invasive plants 3 steps), and collect one, the plants will turn around and step, stop, collect back to their starting point. Once back at their starting point, they can turn and continue back towards the resources. This process repeats until all the resources are gone.

Example: *the invasive plants will collect resources faster than the native plants over time, as their starting point is closer to the resources.*

Reproduction: Survive or Thrive!

Each plant requires one Resources card to **survive** the round, and 2 Resources Cards to **thrive** (reproduce). Start by asking if any students crossed the "Resources" line, but did not collect a Resources card. If no Resources card was collected, the plant failed to survive and the student should sit down—out of the game. This student can re-enter the game later. Each student who collected one Resources card survived and stays in the game. Each student who collected a second Resources Card thrived and they can now choose another student (who does not already have a card) to join their species.

No resources – the plant died, and the student retires from the game.

1 resource – the plant survived, the student can remain in the game.

2 resources – the plant thrived, the student can recruit another student to join their species.

Predators: Oh Deer!

Deer are now invited to eat a native plant. Students holding a deer card select a plant to "eat," the unfortunate plant (student) must then sit down. The deer can now choose another student to join the herd for the next round. If there are not enough native plants for the deer to eat, any deer without a meal must return to their seat.

Reset and Record

The final phase is to reset native plants, invasive plants, and deer to their starting positions, ready for a new round to begin. Record the numbers of each species, and the resources available for later analysis. At this stage, as the moderator, assess how many resources are available compared to the number of plants. You may want to add more.

The game should last 10 rounds, and can be adjusted to suit your needs.

Remind the students, they should be 'rooting' for the native plants!

Group Assessment

1. At the end of the 10th round, have students reassess the forest ecosystem. As time allows, ask students to:
   a. describe the native and invasive plants' interactions that they saw in the forest ecosystem.
   b. answer the worksheet questions about native and invasive plants and discuss the answers.
   c. describe what happens in a forest when there are no invasive plants.
   d. discuss the consequences of unplanned human intervention in nature.
   e. look at a world map and predict where garlic mustard might spread.

INVASIVE PLANTS VS NATIVE PLANTS

NAME: _____

1 What are four things that plants need to survive in a forest?

_____ _____

_____ _____

2 What are some of the reasons that plants die in an ecosystem?

_____

_____

_____

3 What is a native plant?

_____

_____

4 What is an invasive plant?

_____

_____

5 What are 2 differences between a native plant and an invasive plant?

_____

_____

6 Name an example of a plant that is invasive in Indiana: _____

» *What continent did this plant come from?* _____

7 How did the invasive plant impact the forest ecosystem?

_____

_____

_____

8 How did humans contribute to the spread of invasive plants in the forest ecosystem?

_____

_____

_____

INVASIVE PLANTS VS NATIVE PLANTS

1 What are four things that plants need to survive in a forest?

1. *Nutrients*
2. *Water*
3. *Sunlight*
4. *Carbon dioxide*

2 What are some of the reasons that plants die in an ecosystem?

Predation (eg., by white tailed deer, insects); Diseases; Competition from other plants in the ecosystem; Unsuitable habitat conditions.

3 What is a native plant?

A plant that occurs naturally within a region, either evolving there or arriving and becoming established without human assistance.

4 What is an invasive plant?

A plant that is not naturally from an area and that was directly or indirectly introduced to that area by humans.

5 What are 3 differences between a native plant and an invasive plant?

NATIVE PLANTS	*INVASIVE PLANTS*
They naturally evolved or established in an ecosystem without human assistance.	*They were either intentionally or accidentally introduced into an ecosystem, usually by humans.*
They usually have natural predators within their habitats.	*They may or may not have any predators in their new habitat.*
They have evolved certain capacities such as reproduction, weather tolerance, etc., that takes a long time to develop to be in harmony with their natural ecosystem (not to disrupt the natural ecosystem).	*They can be very disruptive to the natural processes and life forms of an ecosystem, and even people's lives.*

6 Name an example of a plant that is invasive in Indiana: *Garlic mustard*

» *What continent did this plant come from?* *Europe and Asia, and parts of Africa*

7 How did the invasive plant impact the forest ecosystem?

1. *They outcompete the native plants for resources (water, food, nutrients, and sunlight) and available space.*
2. *They compete for the habitat native plants need to survive and eventually displace the native plants living in that habitat.*
3. *They can tolerate harsh climates. They also have a longer growing season, because they can survive longer into the fall and begin sprouting earlier in the winter than the native plants.*
4. *They have larger population sizes, because they do not have any predators. This allows invasive plants, such as garlic mustard, to grow as much as possible, because it doesn't have any predators to keep its population in check.*

Garlic mustard can completely overtake the forest understory, because it is one of few plants that can tolerate shaded conditions. Garlic mustard also has the ability to release a chemical that prevents the growth of other seedlings and plants in the soil. This ensures only garlic mustard seedlings will survive in the affected soil (this is known as allelopathy).

5. *The displacement of native plants in this habitat will have a serious "cascading effect" on the other animals that live in that ecosystem. With the disappearance of native plants, the animals that usually depend on those plants for survival will also be threatened and most likely displaced.*

8 How did humans contribute to the spread of invasive plants in the forest ecosystem?

1. *Humans introduced garlic mustard into the ecosystem intentionally, because they wanted to use it as food, herb, and medicine.*
2. *Humans can accidentally spread garlic mustard by carrying the seeds on their shoes or clothing and transporting it to other natural areas.*
3. *Humans can also help to prevent the further spread of garlic mustard by controlling its growth. Garlic mustard spread can be controlled by using chemicals such as herbicides, or by using physical methods like pulling, shoveling, or mowing.*
4. *Humans can also make a commitment to research the impacts of nonnative plants before introducing them to a new area.*

Use the following questions to guide critical thinking on invasive plants.

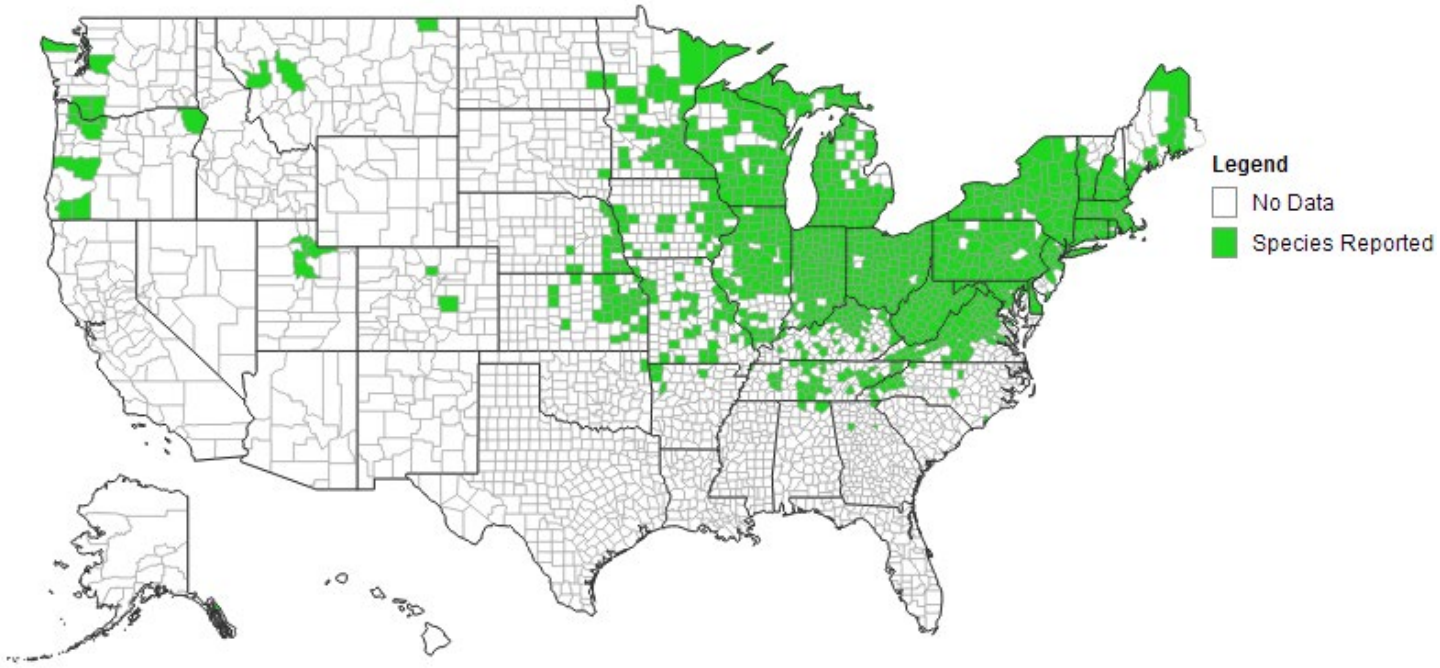
1. *Why would humans introduce a nonnative species to an ecosystem?*
2. *What are some of the challenges involved in controlling invasive species from a social, ecological, and political perspective? Challenges include:*
   - *People might be resistance to control the invasive plants because they don't like to use chemicals.*
   - *They think that killing any living thing is bad.*
   - *They like the plants and want to keep them because they are pretty.*
   - *People may be uninformed about the differences between native and invasive plants, etc.*
3. *How can we protect native ecosystems from invasive plants and animals?*
4. *Are there any laws in place to protect these ecosystems or human interests (such as agriculture) from harmful invasive plants? What types of rules are in place? Are they effective?*
5. *Do you think the environmental problems associated with invasive species will improve or worsen?*
6. *How can climate change impact invasive species distribution?*

Garlic Mustard – Stage 1 (first year)

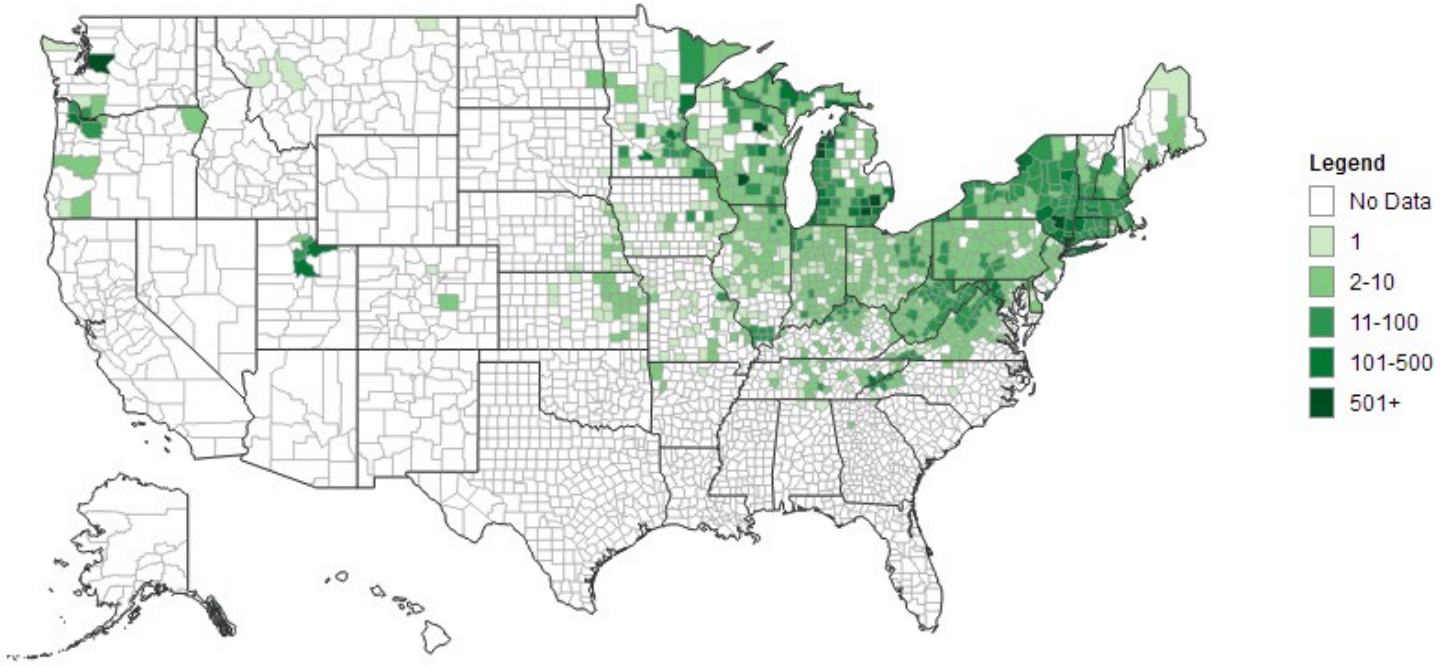
Garlic Mustard – Stage 2 (second year)

White-tailed deer

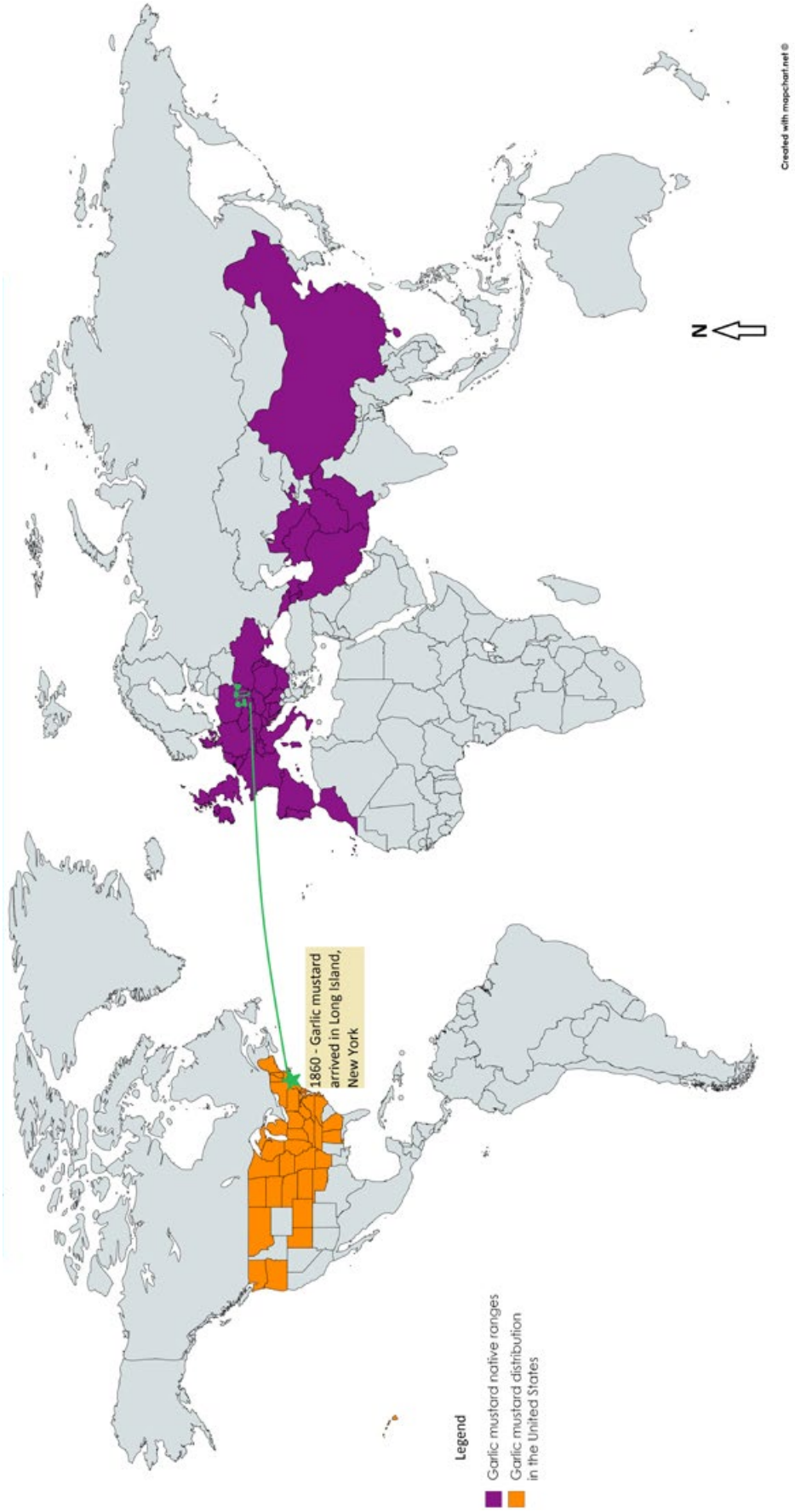
Map of Garlic Mustard (Alliaria petiolata) distribution – by county



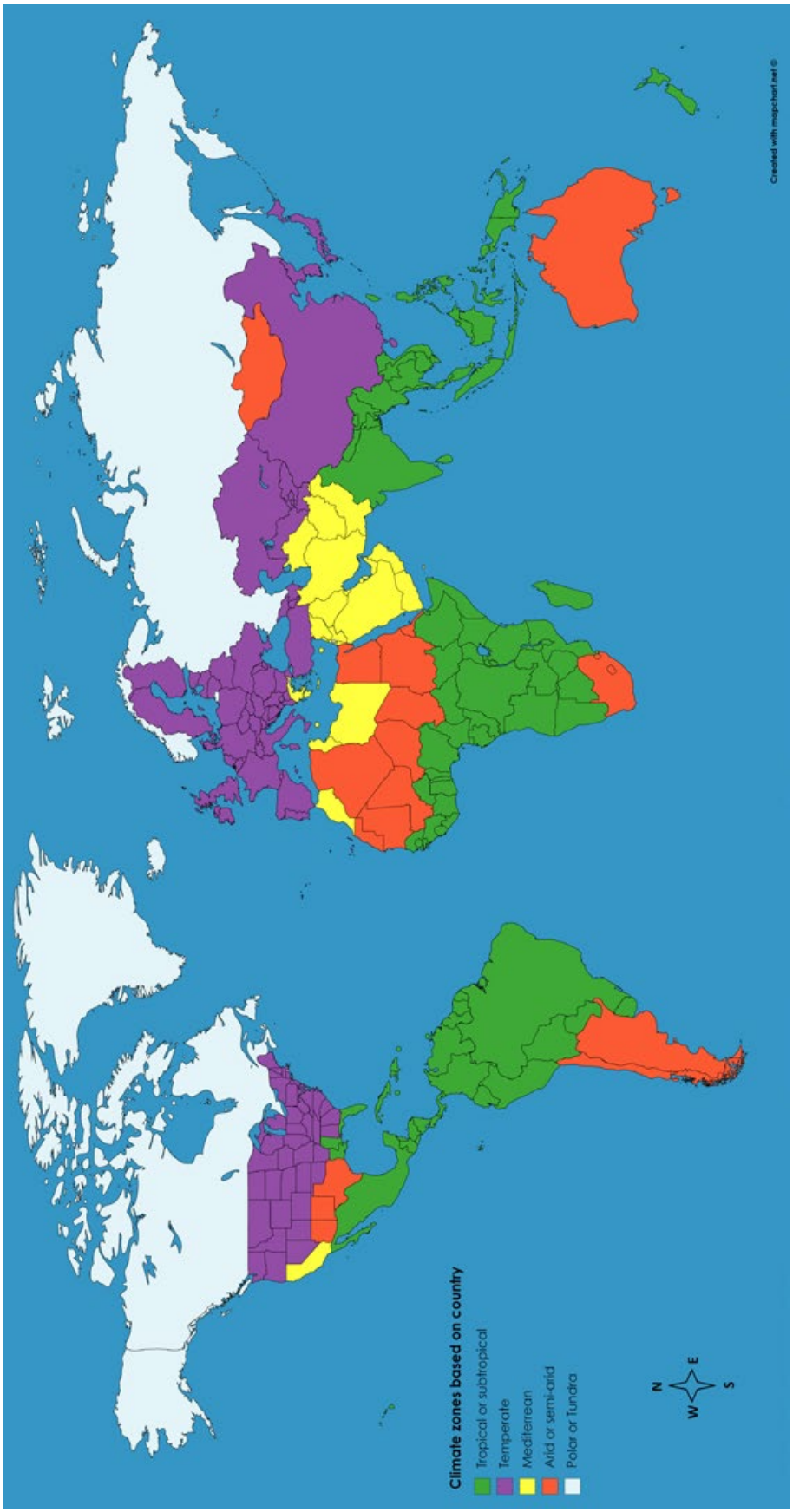
Map of Garlic Mustard (Alliaria petiolata) density – by county



EDDMapS. 2017. Early Detection & Distribution Mapping System. The University of Georgia - Center for Invasive Species and Ecosystem Health. Available online at www.eddmaps.org; last accessed March 17, 2017.



Map showing garlic mustard (Alliaria petiolata) native ranges and invaded areas (in the United States)



Map showing dominant climate zones of world countries

***Note:** This map is simplified to show the primary climate of a country—it does not include all climate zones within each country. Depending on the students, you may want to use a more detailed climate map.*

Early Detection & Distribution Mapping System

The maps included here can be used for a larger classroom discussion about the future spread of garlic mustard based on current trends. Other maps showing how invasive plants spread in real time can be found at *eddmaps.org*.

eddmaps.org/distribution/usstate.cfm?sub=3005

Indiana Invasive Species Council

This working group of professionals and researchers reviews current and emerging invasive species risks, distribution, and identification.

entm.purdue.edu/iisc/invasiveplants.php

National Invasive Species Council

This national group provides information about invasive species risks and distribution, along with references to organizations and services about invasive species throughout the country.

invasivespeciesinfo.gov/index.shtml

Garlic Mustard, an Invasive Plant
(YouTube video about garlic mustard, approx. 4 min.)

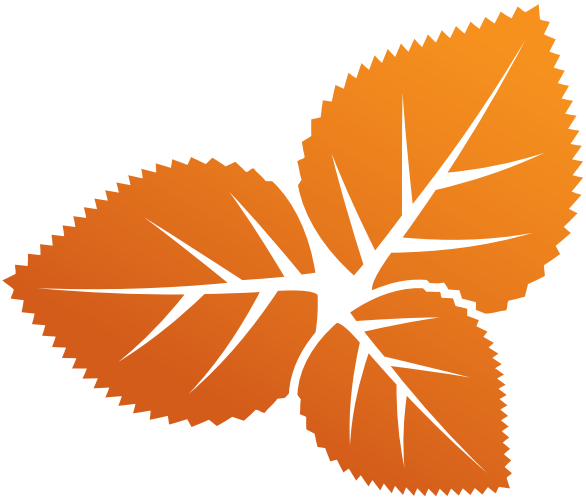
The Potomac Highlands Cooperative Weed and Pest Managemenet Area filmed this with the help of the Petersburg Elementary School 5th-grade class at Seneca Rocks in West Virginia. It covers garlic mustard identifying characteristics, history, and treatment.

youtube.com/watch?v=J5FHSu_uOjE

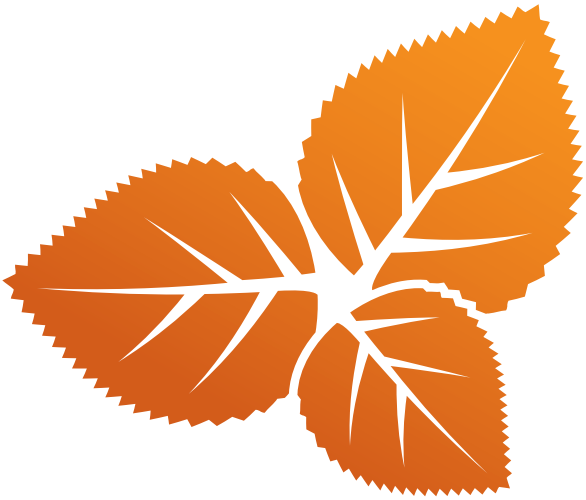
Native Plant Cards – Front

Native Plant Cards – Back

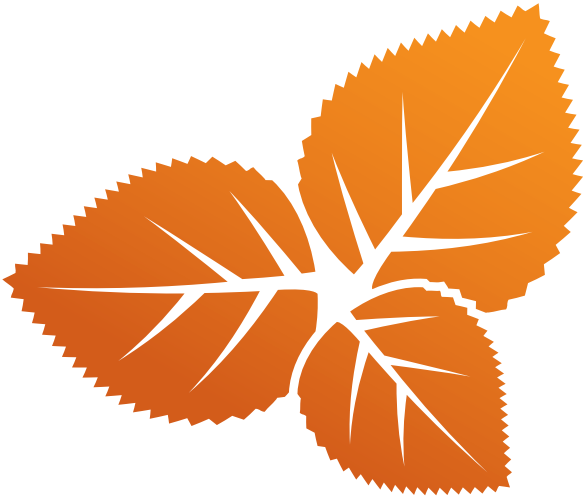
Invasive Plant Cards – Front



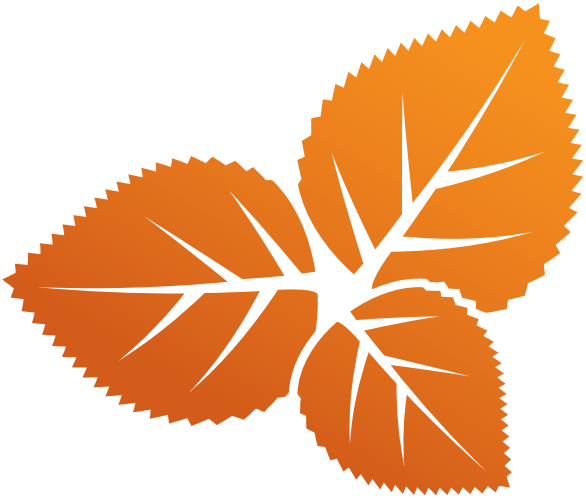
Invasive Plant



Invasive Plant

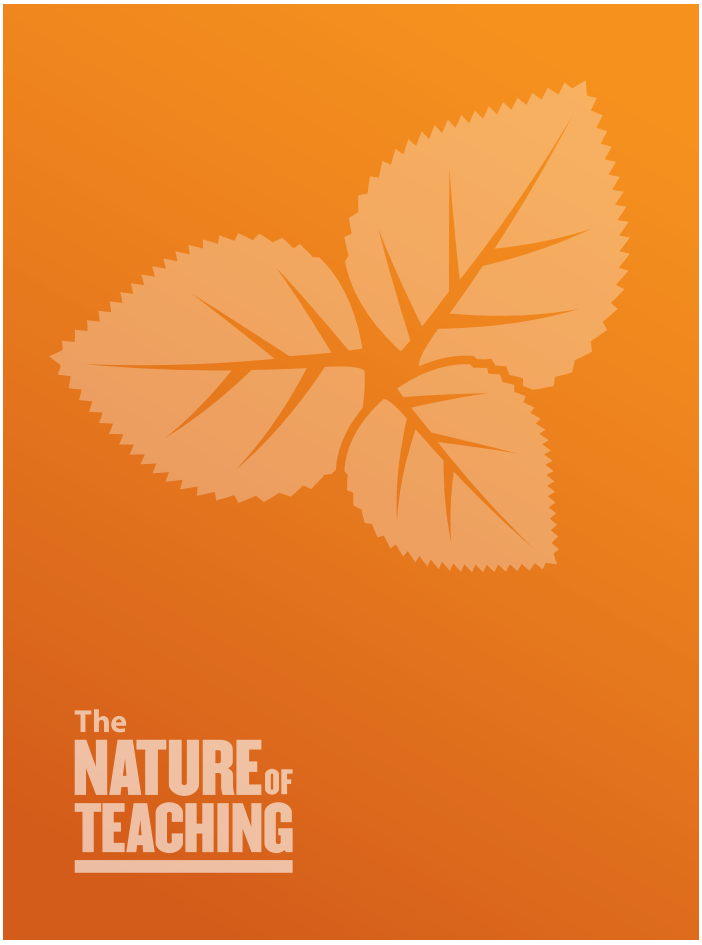


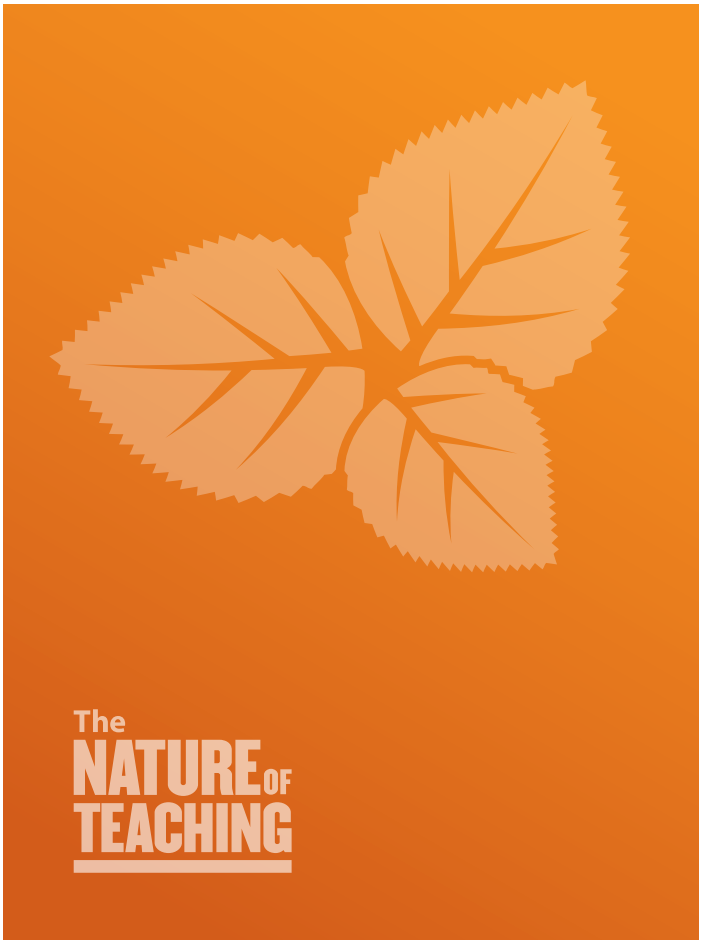
Invasive Plant



Invasive Plant

Invasive Plant Cards – Back





Deer (predator) Cards – Front

Deer

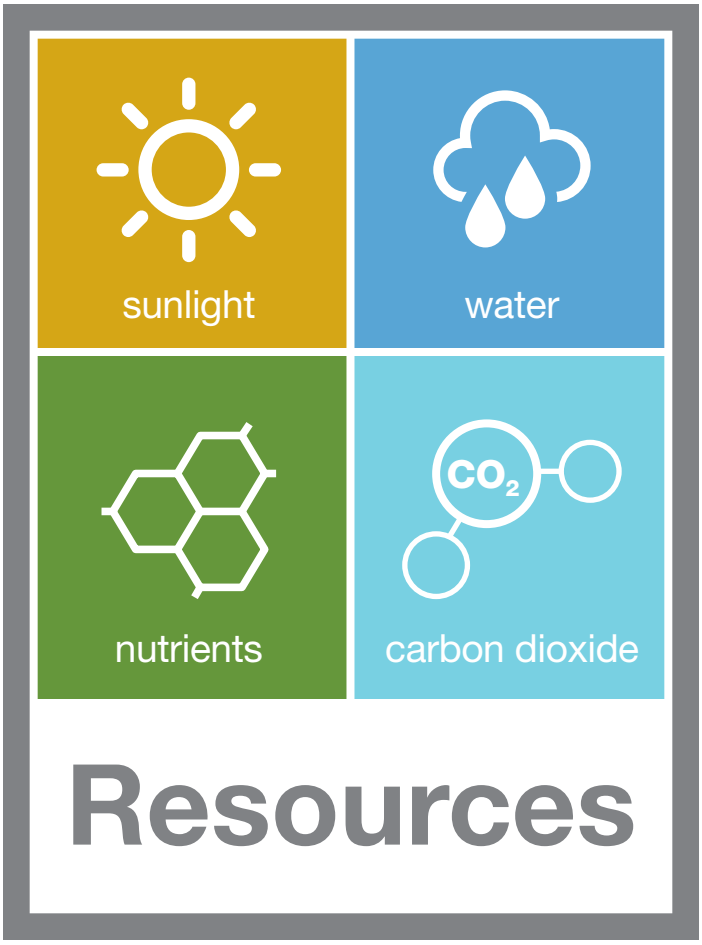
Deer

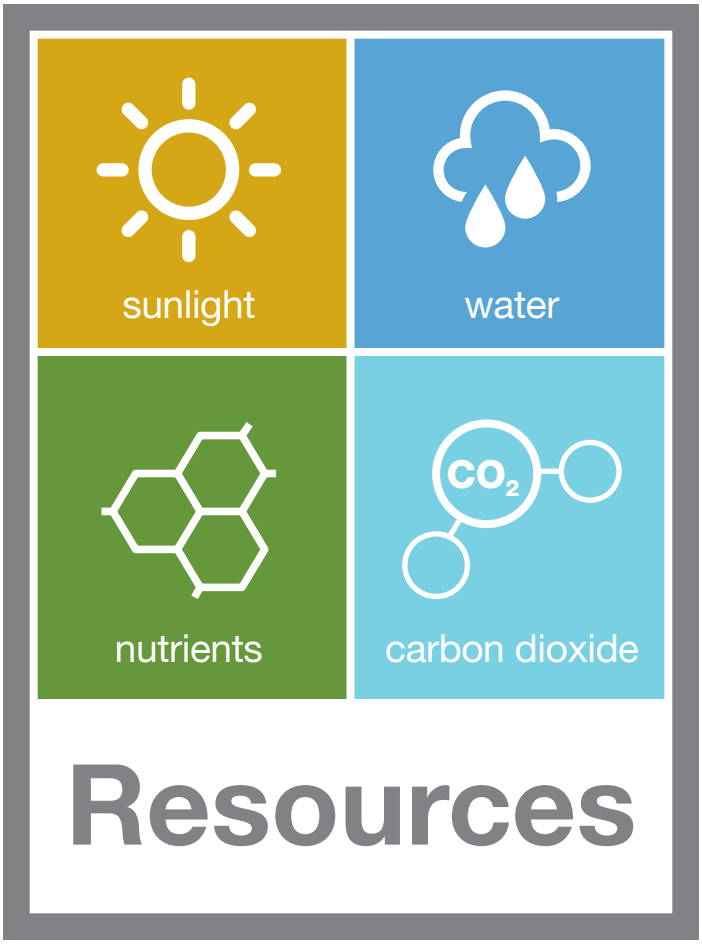
Deer

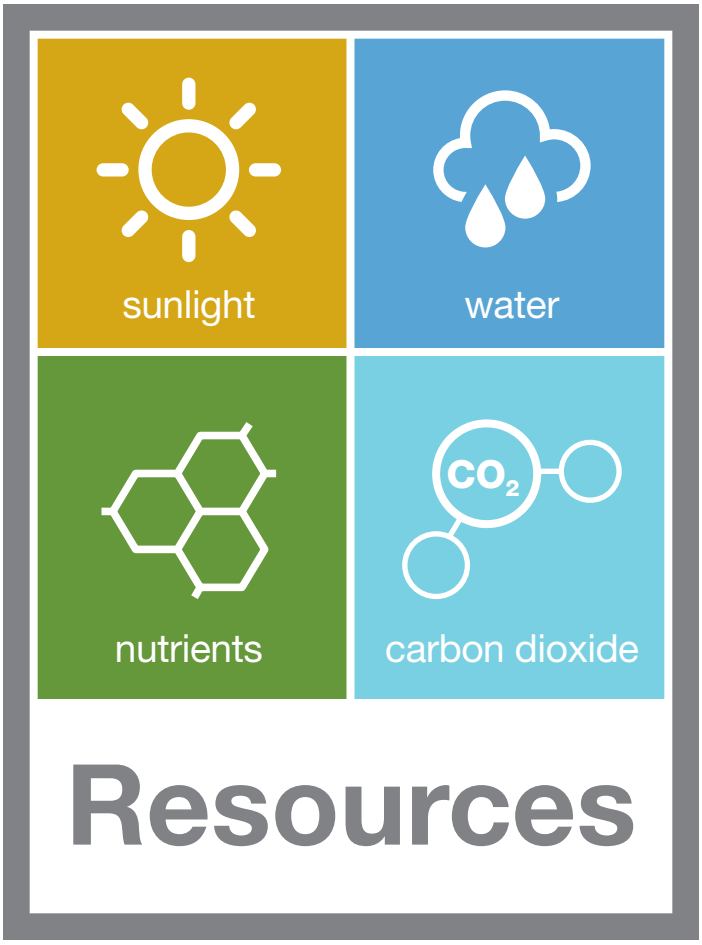
Deer

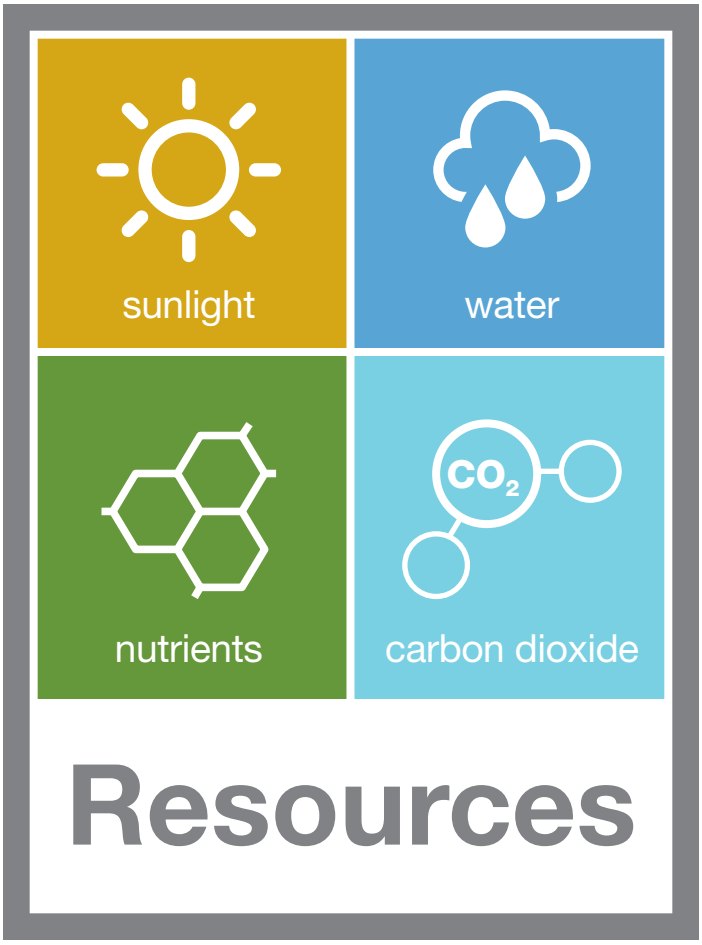
Deer (predator) Cards – Back

Resources Cards – Front









Resources Cards – Back