The Enemy Release Hypothesis

Investigating patterns in Michigan flora to test whether natural enemies promote invasion

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Goals for today:

- Discuss invasive species of Michigan, and one of the major hypotheses on their success – ERH
- Provide resources for the classroom that can be used to address Next Generation Science Standards
- Discuss ways to use this activity in your own classroom/schoolyard
- Introduce Data Nuggets and other teaching materials available on MSU's GK-12 website

What is an invasive species?

- Introduced from another area by people
- Aggressively grow and take over
  - Harm native species, reduce biodiversity
  - Cost people time and money

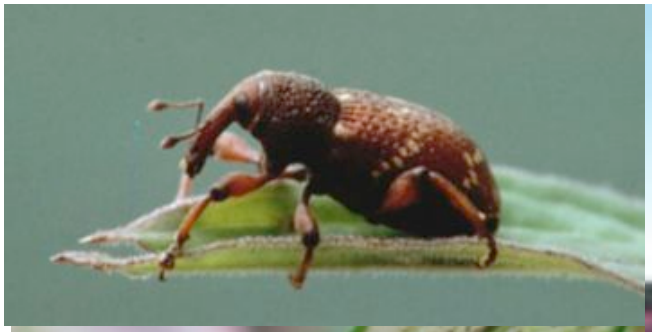

Asian carp
Garlic mustard
Purple loosestrife

To combat Asian carp other invasive species, which could threaten the Great Lakes ecosystem and its $7 billion fishing industries, the resources defense council has proposed physical barriers to separate Chicago waterways and Lake Michigan from the Mississippi.

- NY Times, November 2011

Garlic mustard

The insects and fungi that feed on Garlic Mustard in its native habitat are not present in NA, increasing its seed productivity and allowing it to out-compete native plants. Additionally, because white-tailed deer rarely feed on Garlic Mustard, large deer populations may help to increase its population densities by consuming competing native plants.



Purple loosestrife

Introduced in 1800s in ship ballast. Infestations result in dramatic disruption to water flow and sharp declines in biodiversity as purple loosestrife crowds out native plant species. Biocontrol is currently reducing loosetrife invasions – K-12 classes raised and released beetles.

ERH: Enemy Release Hypothesis

When a species is moved to a new area, it escapes the natural enemies that once controlled it, resulting in increases in growth and spread.

Keane & Crawley 2002, Hallett 2006


One of the early and drastic prickly pear treatment pear methods - fumes from a boiling arsenic mixture drifting through the scrub (circa 1919 - photographer unknown).
From
www.northwestweeds.nsw.gov.au

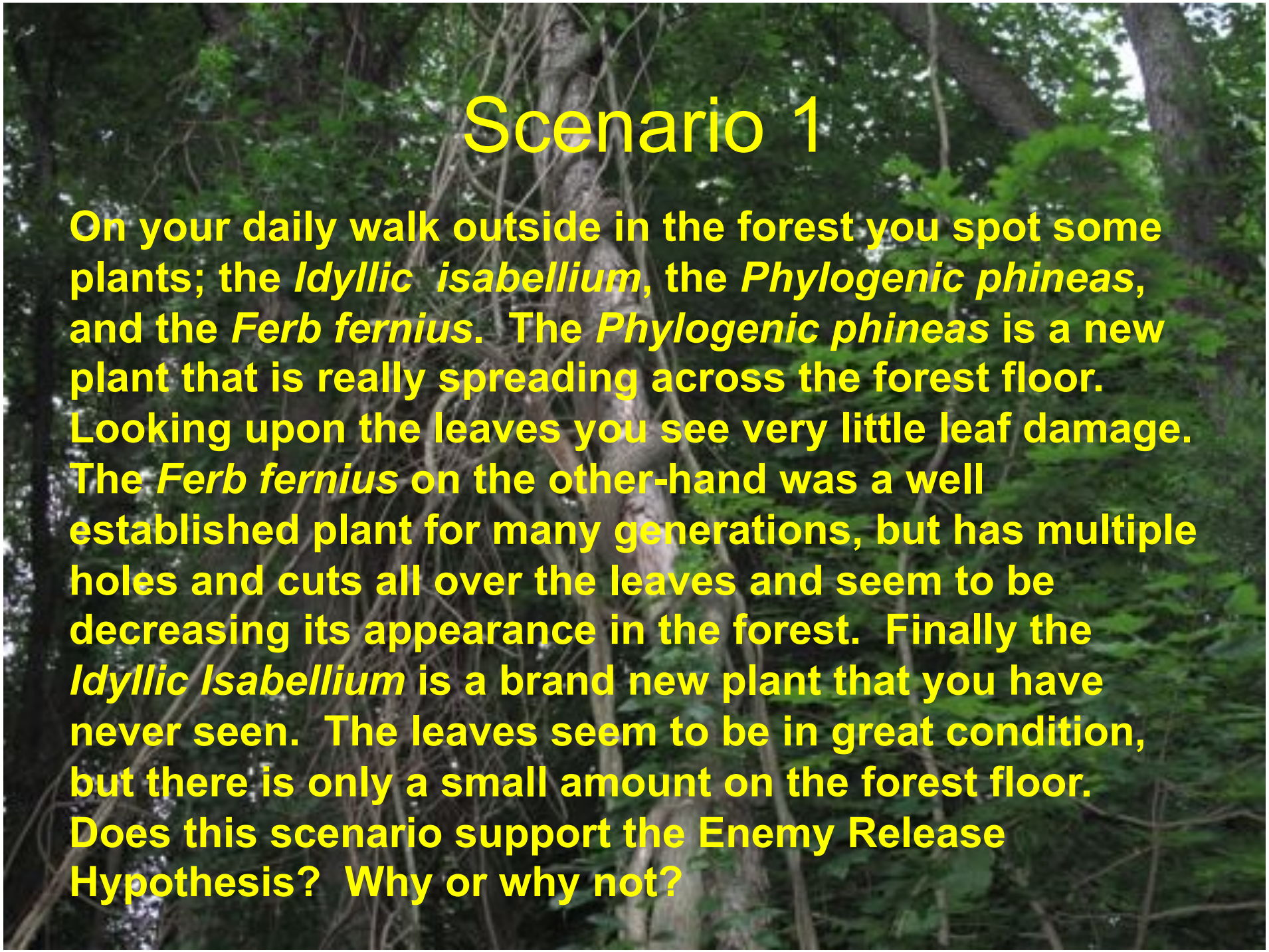

C1b
C1c

Terminology you should know!

Native Species: an organism that is living in an area for entirely natural reasons, with no human intervention involved.

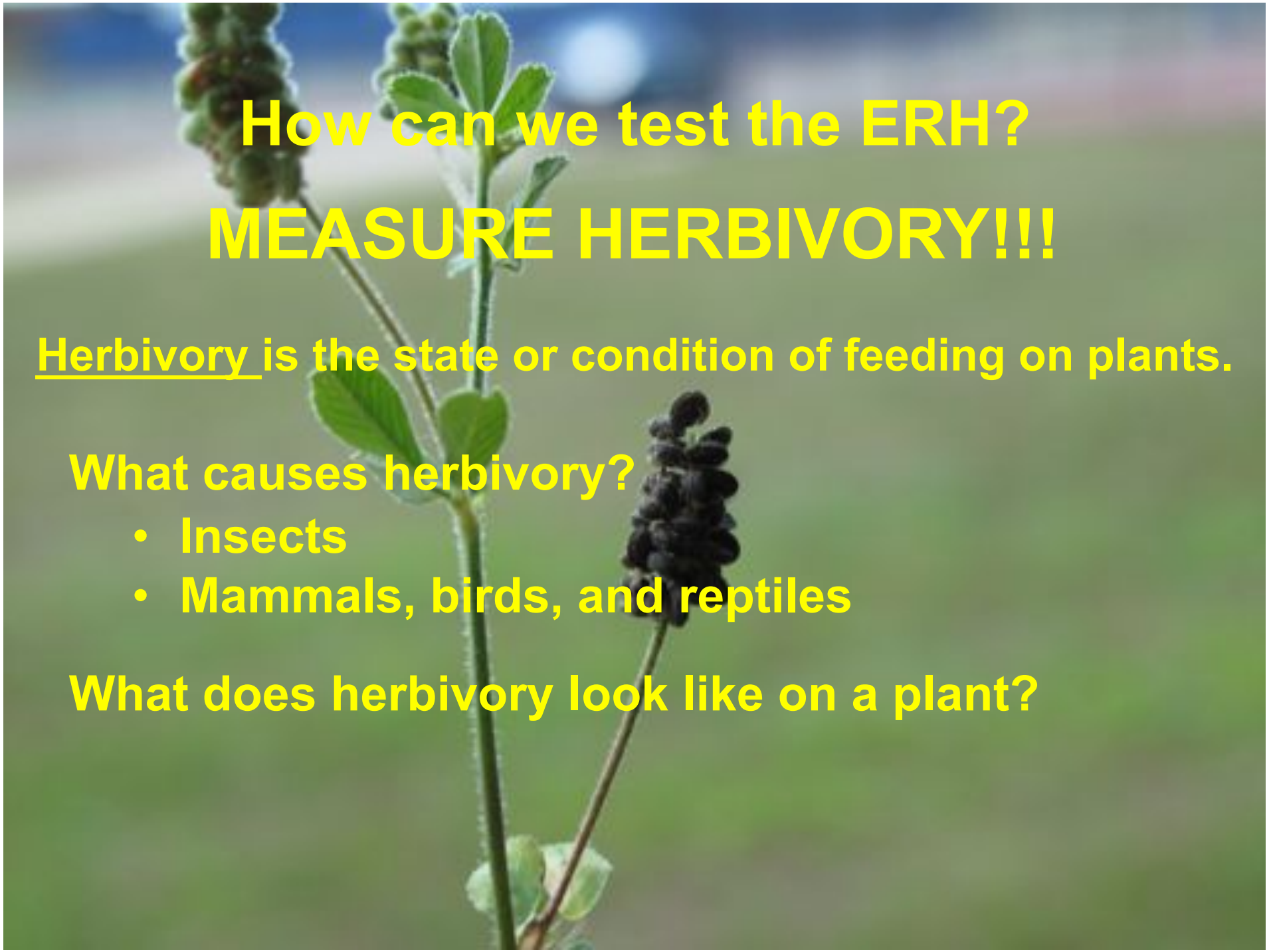
Invasive species: an organism that usurps the habitat of other species, causing the decline and disappearance of the native species

Natural Enemy: a biological interaction where a predator feeds on (or a disease infects) its prey.



Scenario 1

On your daily walk outside in the forest you spot some plants; the *Idyllic isabellium*, the *Phylogenic phineas*, and the *Ferb fernius*. The *Phylogenic phineas* is a new plant that is really spreading across the forest floor. Looking upon the leaves you see very little leaf damage. The *Ferb fernius* on the other-hand was a well established plant for many generations, but has multiple holes and cuts all over the leaves and seem to be decreasing its appearance in the forest. Finally the *Idyllic Isabellium* is a brand new plant that you have never seen. The leaves seem to be in great condition, but there is only a small amount on the forest floor. Does this scenario support the Enemy Release Hypothesis? Why or why not?



How can we test the ERH?

MEASURE HERBIVORY!!!

Herbivory is the state or condition of feeding on plants.

What causes herbivory?

- Insects
- Mammals, birds, and reptiles

What does herbivory look like on a plant?

Examples of different types of herbivory on a leaf.

Close In-Counters

- How is herbivory calculated?
  - Can you just count the number of holes in each leaf? Why or why not?
  - What may be a better way to calculate herbivory?
    1. Lay the leaf on a piece of graph paper.
    2. Make an estimation of area of the plant, each square on standard graph paper is 1 cm^2.
    3. Now estimate the area of herbivory of the plant using the same grid system.
    4. Calculate the percent of herbivory.
       - (Area Damaged/Leaf Area) x 100

Experimental Design

- Sampling techniques
  - Randomization
  - Consistent between species and groups
- Things to measure
  - Herbivory
  - Growth

Go into the field!

The Three Oaks Problem

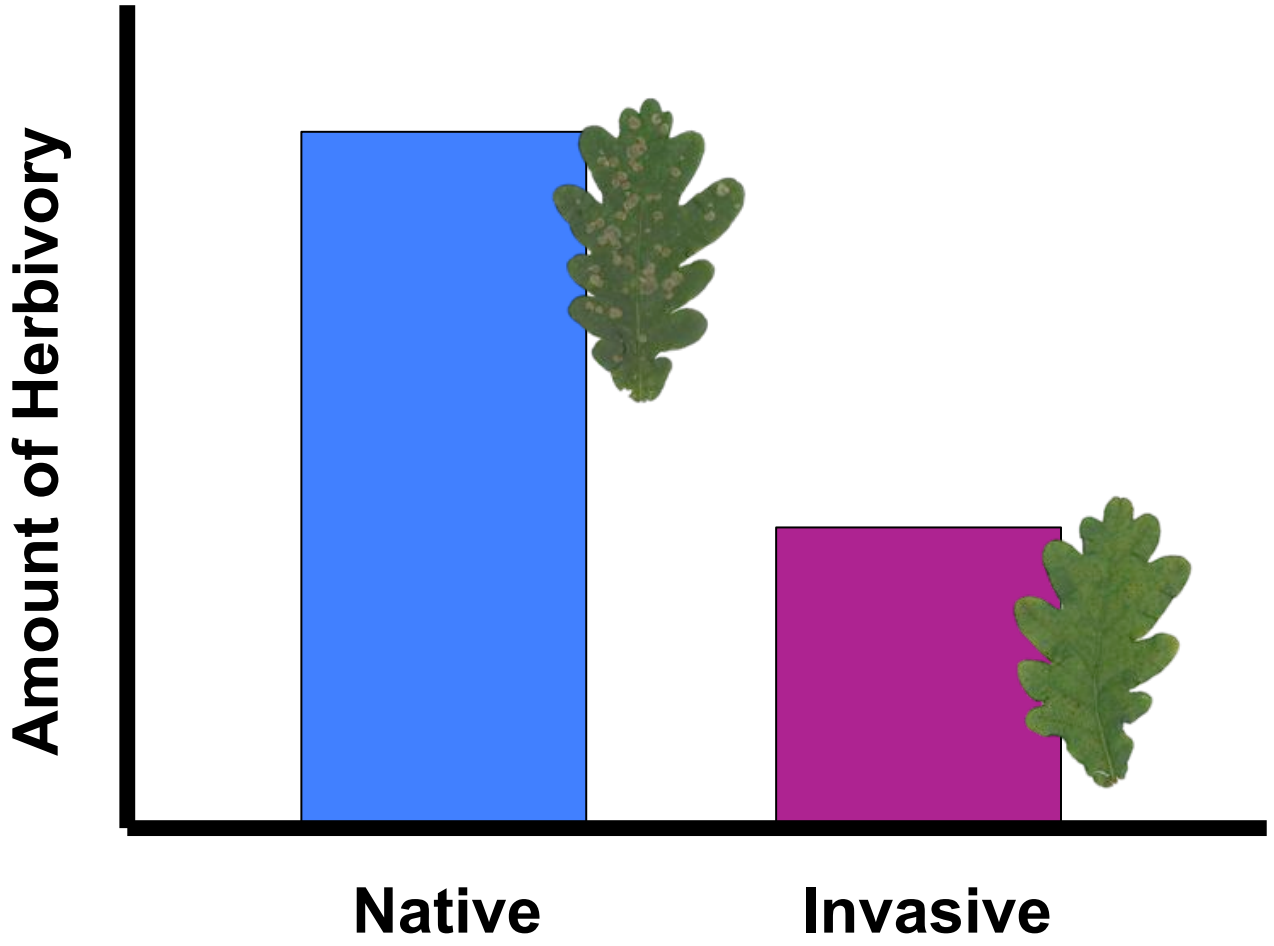
The English, Red, and White Oak are a population of trees found in Michigan. The Red and White Oak are native species to the area while the English is nonnative. Calculate the herbivory of the following leaves to see if the ERH is supported or rejected.

White

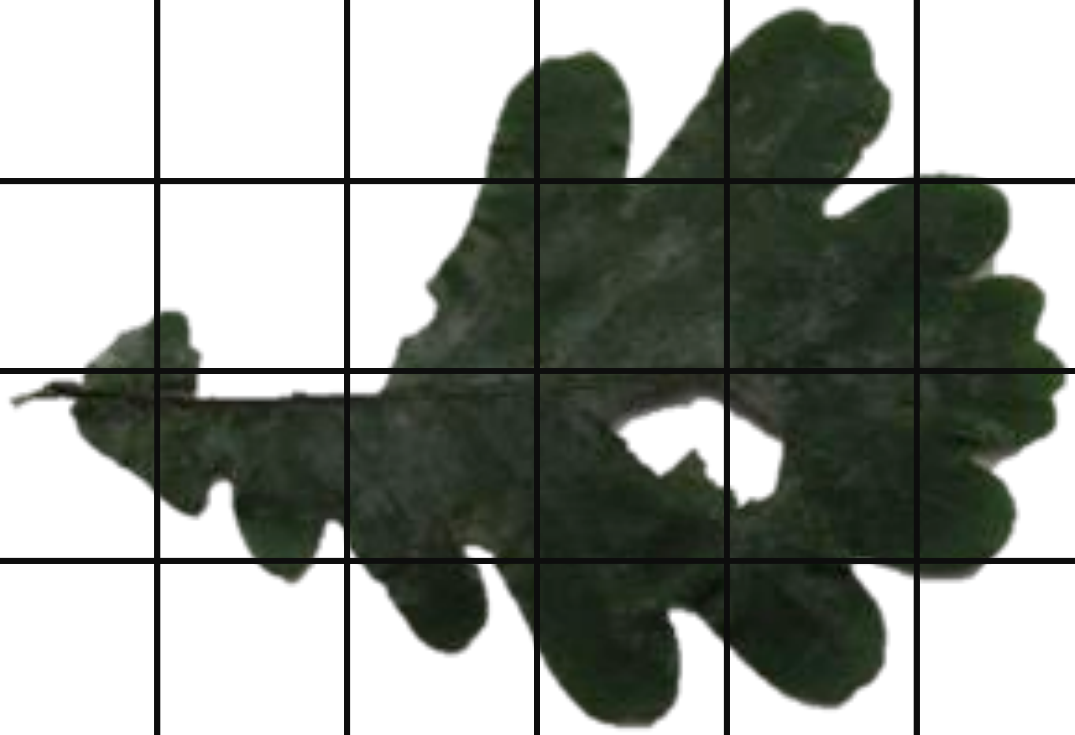
English

Red

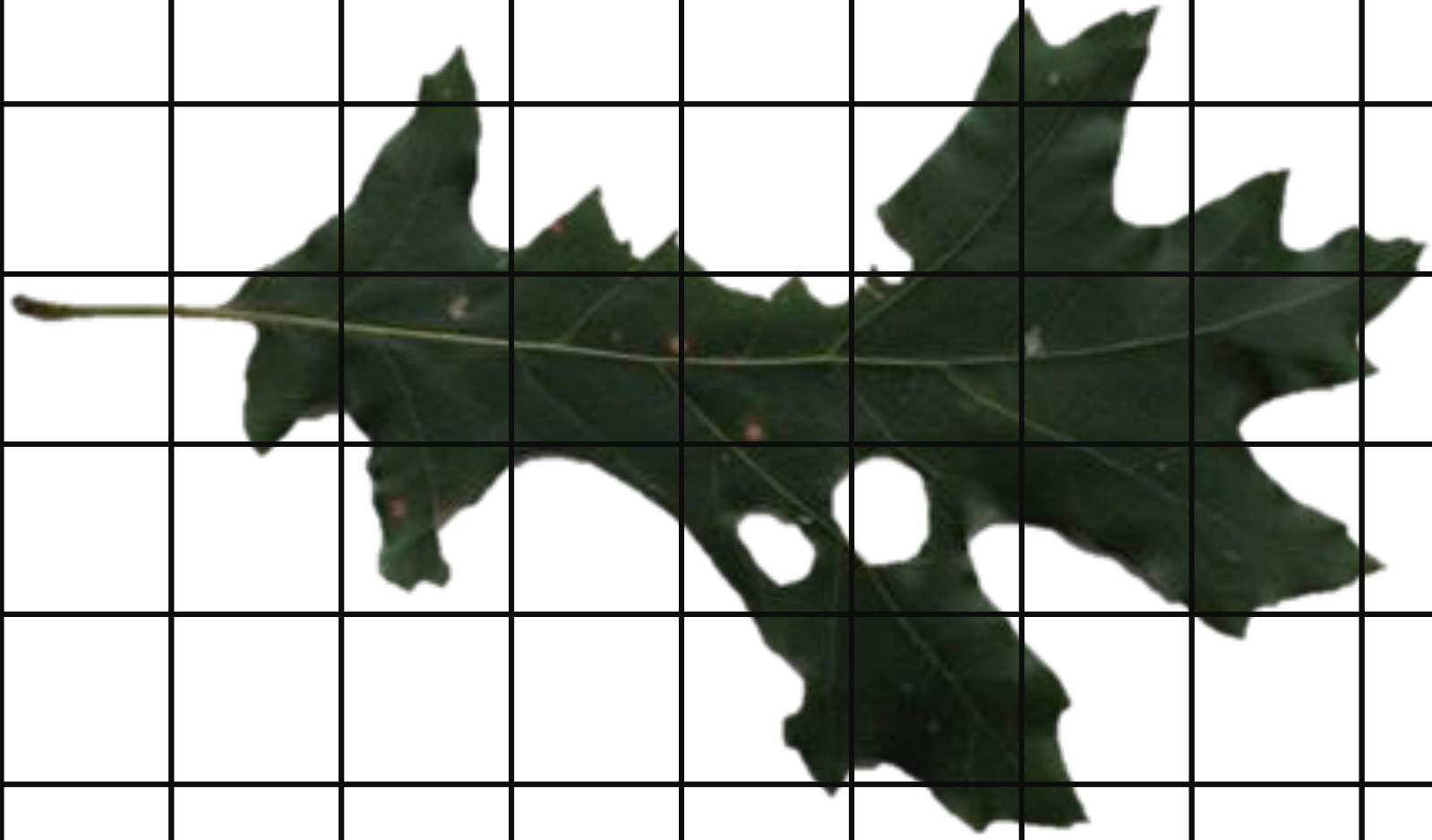
Enemy Release Prediction:



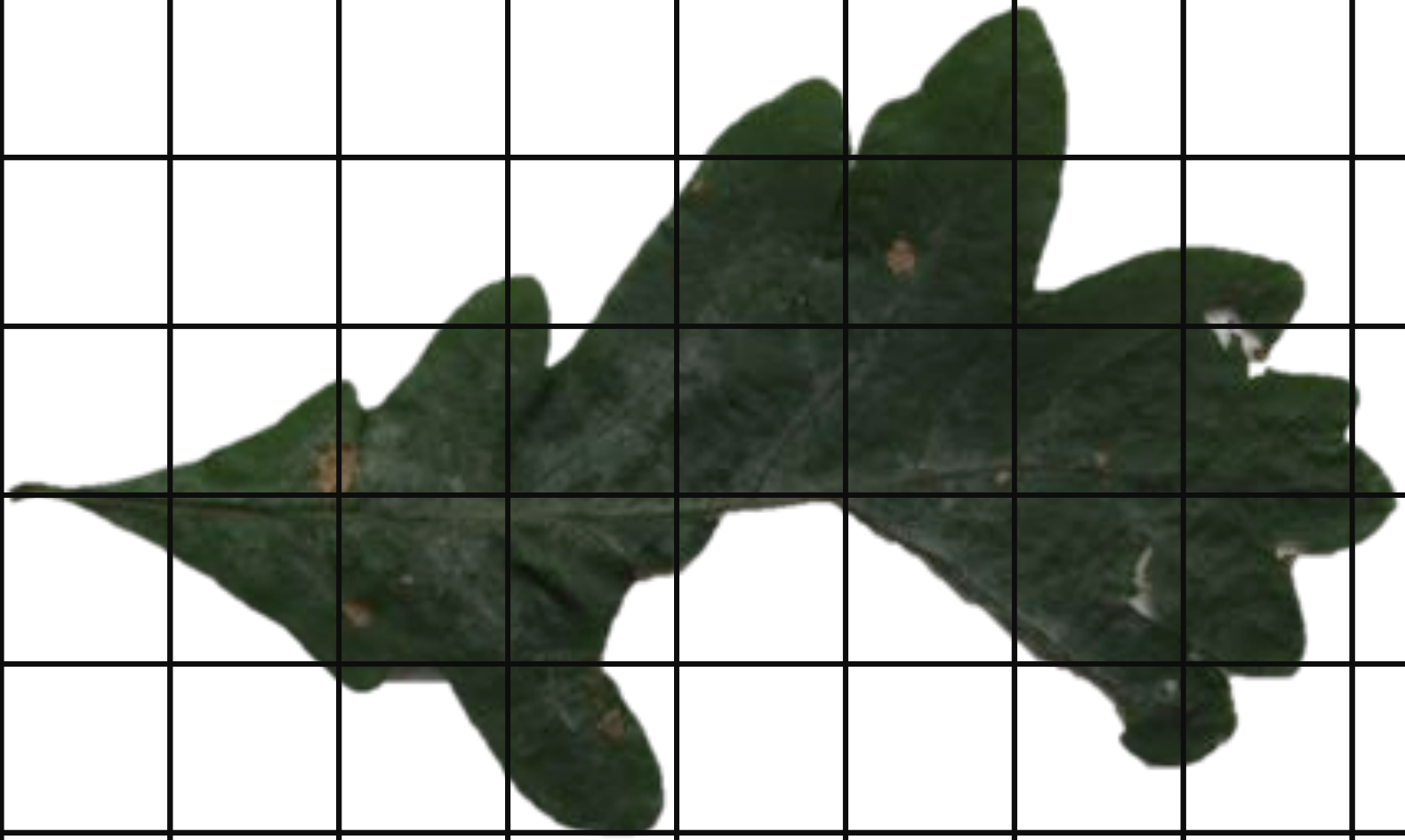
English Oak



Red Oak



White Oak



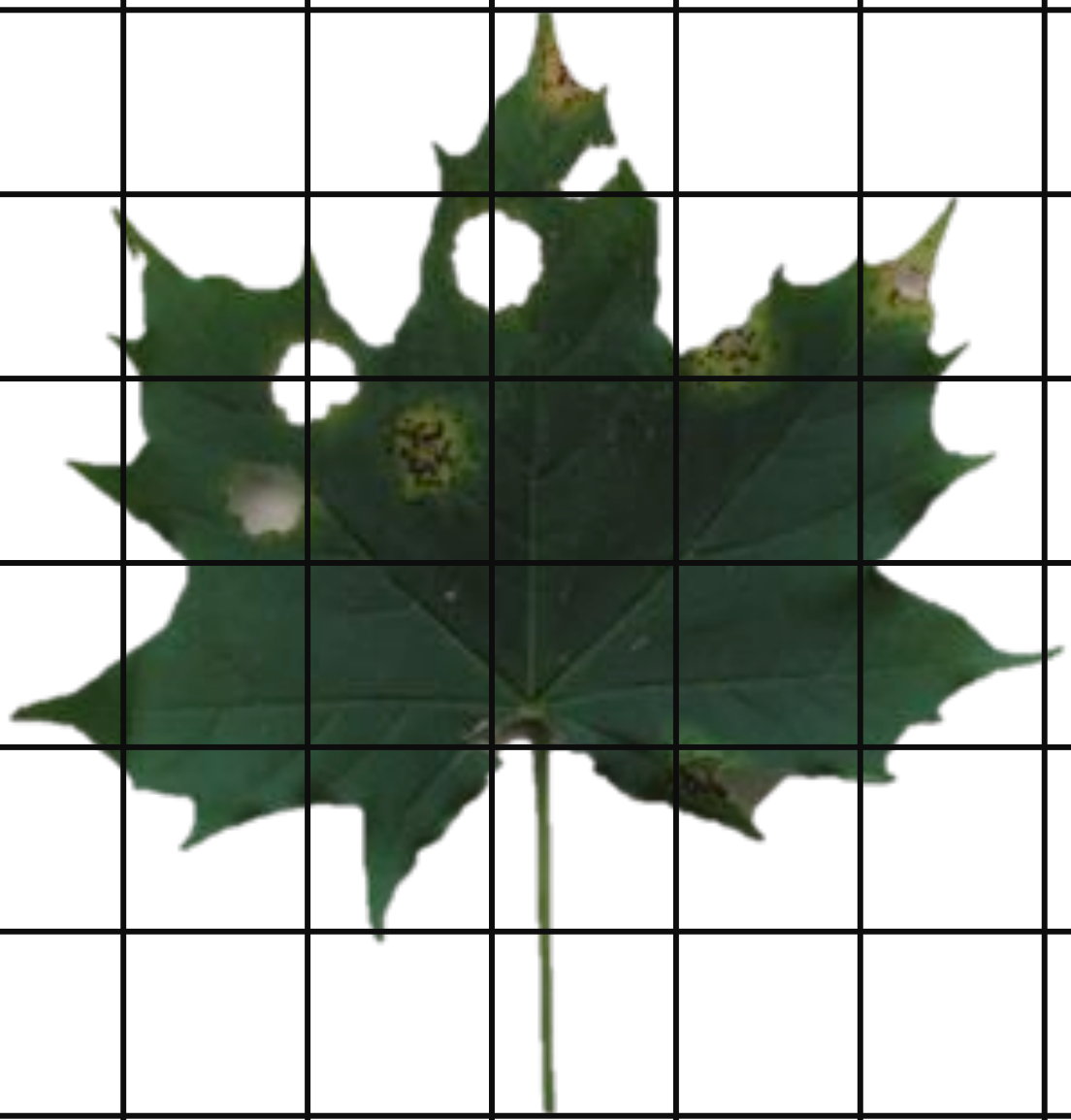
Data

- Using the class data graph the mean area of each leaf, area of herbivory, and percentage of herbivory.
- Which leaf had the highest herbivory?
- Do the three oaks support or reject the Enemy Release Hypothesis? How?

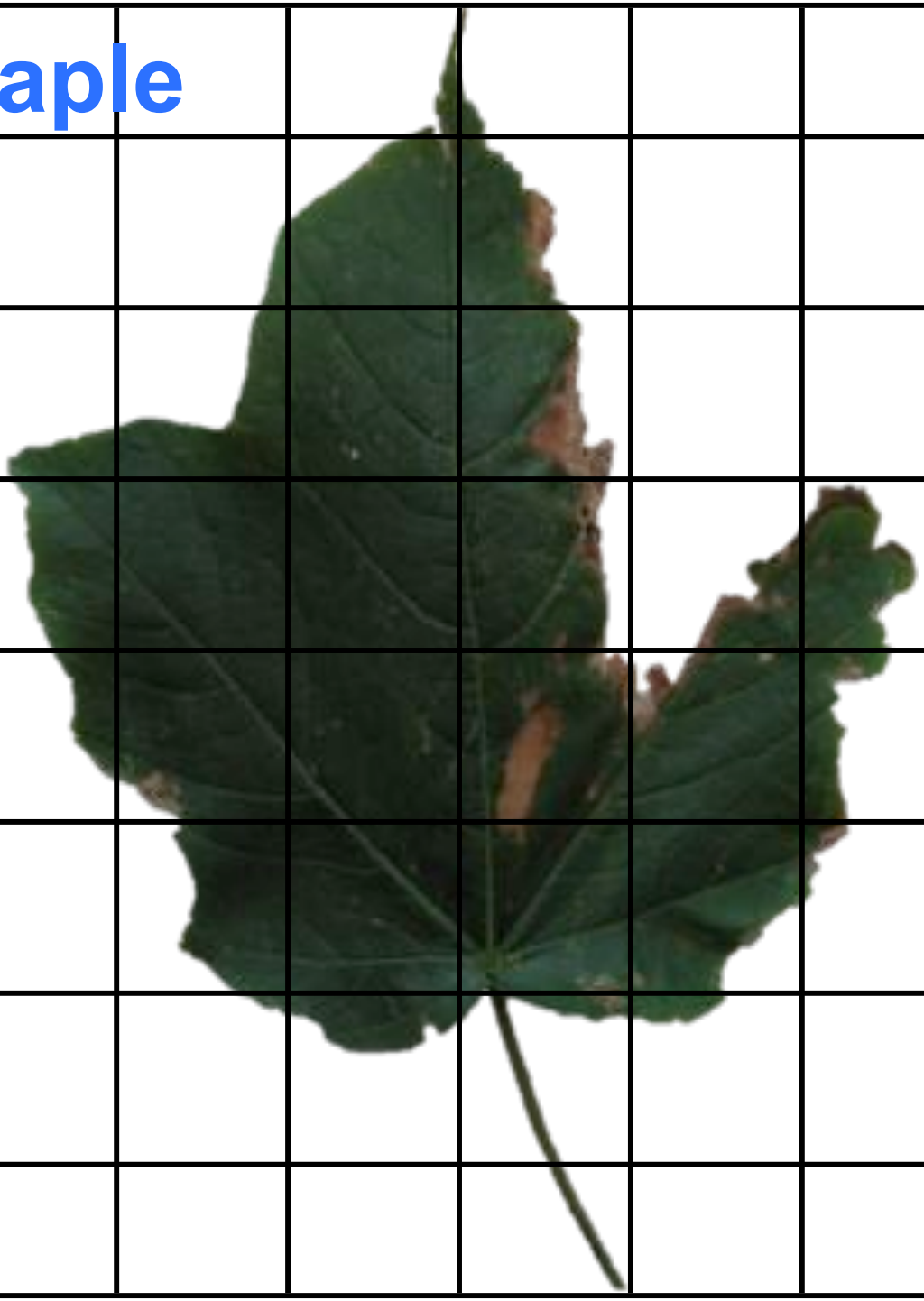
Investigate the Enemy Release Hypothesis!

Norway Maple (I) Sugar Maple (N)

Norway Maple



Sugar Maple

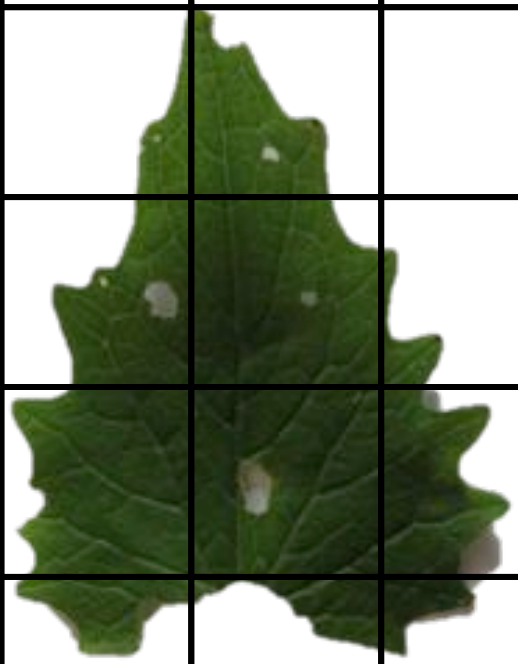


Garlic Mustard (I) vs…

http://myweb.loras.edu/as298365/InvasiveSpecies/garlicmustard/index.html


Golden Ragwort (N)

Garlic Mustard



Honeysuckle (I) vs…


Red Honeysuckle (N)

Honeysuckle

Red Honeysuckle


Asian Bittersweet (I) vs…


American Bittersweet (N)

Asian Bittersweet

American Bittersweet


Dame’s Rocket
(I) vs…

Dame’s Rocket

Multiflora Rosa (I) vs…


Prairie Rose (N)

Multiflora Rose

Prairie Rose


Purple Loosestrife (I) vs…


Blue Vervain (N)

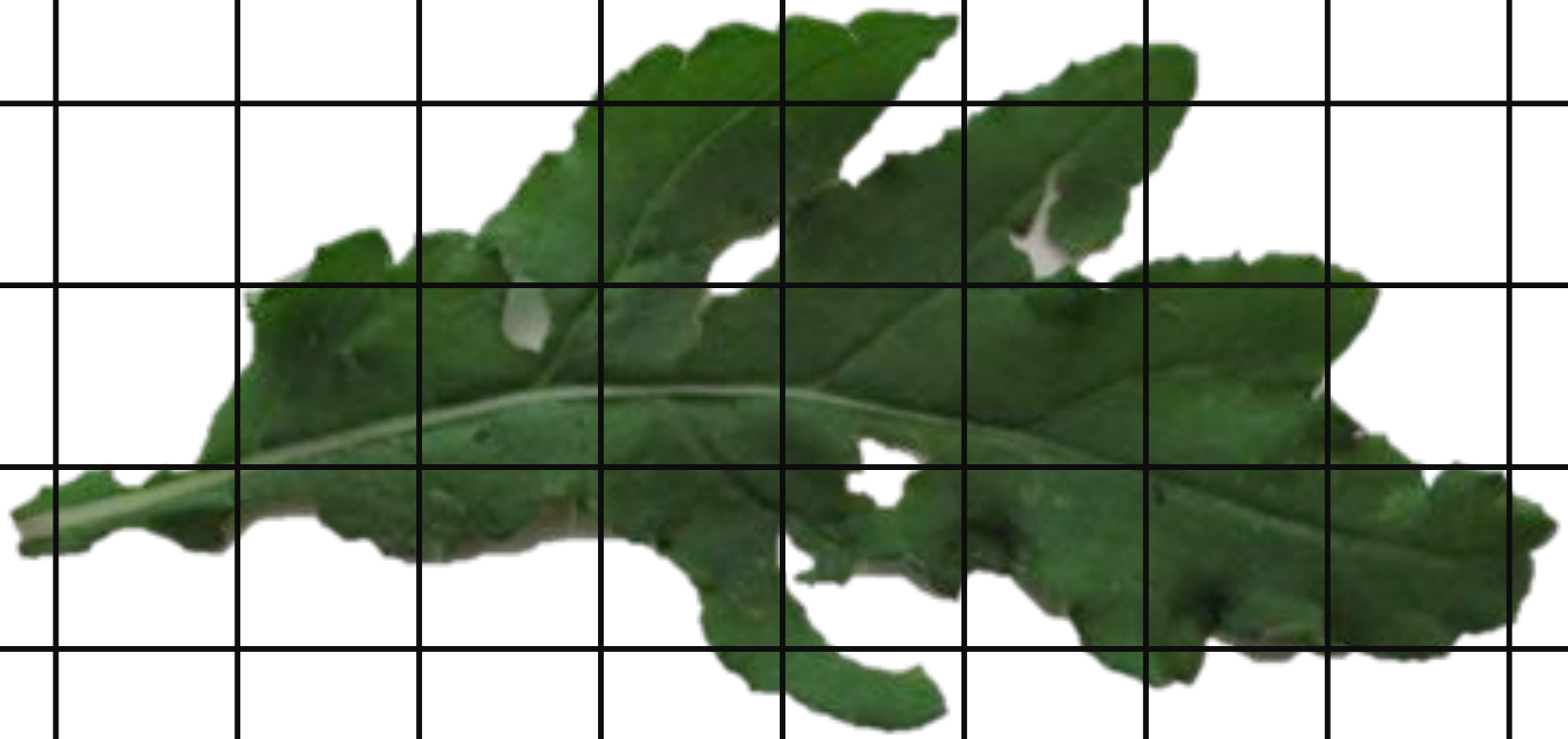
Purple Loosestrife

Blue Vervain

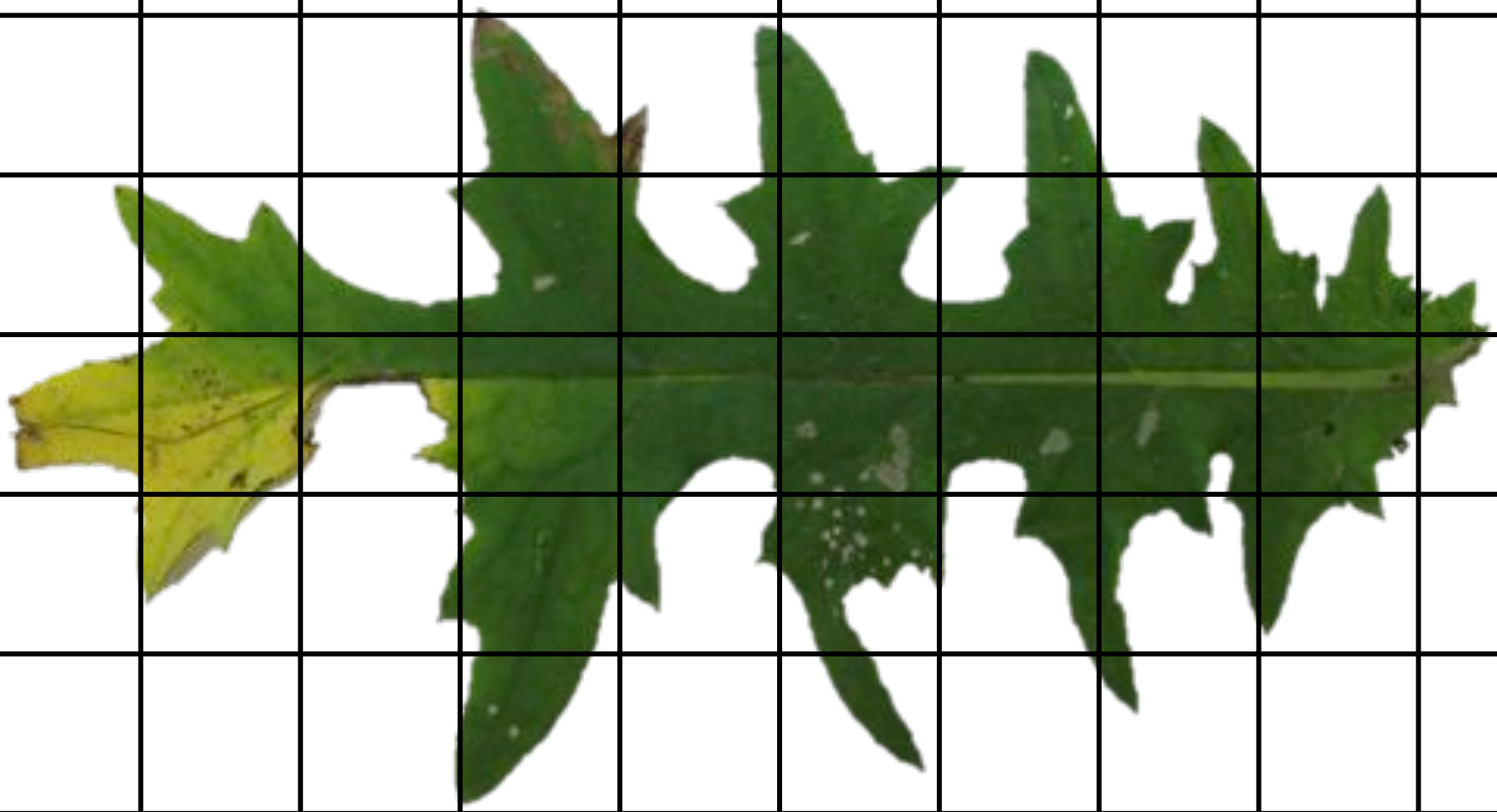

Canadian Thistle (l) vs…


Tall Thistle (N)

Canadian Thistle



Tall Thistle



Summary

- Did the different species reject or support the Enemy Release Hypothesis?
- How close were you predicted results to the actual observe data?
- Looking at the data from other groups, were your results similar or different? If there were different results come up with reason why that happened.

A KBS K-12 Partnership Activity

http://kbsgk12project.kbs.msu.edu/lessons/

Do Herbivores Prefer Local or Exotic Foods?

Testing the Enemy Release Hypothesis

Marcia Angle & Liz Schultheis

OVERVIEW

Students will examine herbivory on exotic vs. native tree species planted into plantations in the Kellogg Forest. We will use our data to test the Enemy Release Hypothesis, which posits that exotic species escape from specialized natural enemies in their invaded range, contributing to their success. Students will develop predictions, design experimental sampling methods, collect data, and create graphs to summarize data.

OBJECTIVES

At the conclusion of the lesson, students will be able to:

- Give reasons why invasive species are so successful in their introduced range and can displace native species
- Compare ecosystem processes acting on native and exotic species
- Identify new plants species and different types of herbivore damage
- Present data in visual format for interpretation

LENGTH OF LESSON

To complete the lesson would take two class sessions. The first session would be used to identify the questions of the study and provide relevant background information. Teachers will present the species to be used in the study and describe the Enemy Release Hypothesis and the success of invasive species. Students would practice identifying the species and the types of herbivore damage, without being told which species were exotic or native. At the end of

Exercises in Evidence-Based Claims and Graphing

DATA Nugget

Data Nuggets are worksheets that give students practice interpreting quantitative information and making **claims based on evidence**. Each worksheet asks students to answer a scientific question using real data collected by scientists at Michigan State University. These materials are being developed by NSF-funded GK-12 fellows at Michigan State University's Kellogg Biological Station in collaboration with K-12 teachers in southwest Michigan.

Level 1	• Upper Elementary and above
Level 2	• Middle School and above
Level 3	• High School
Level 4	• Advanced High School students (e.g., Honors and AP Biology) • College undergraduates

http://kbsgk12project.kbs.msu.edu/data-nuggets/

DATA Nugget

Do invasive species escape their enemies?

Invasive species, like zebra mussels and garlic mustard, are species that have been introduced by humans to a new area and negatively impact places they invade. Invasive species cost the United States over $100 billion per year by damaging habitats, displacing native species, and interfering with human interests. Researchers at the Kellogg Biological Station (KBS) are studying invasive plant species and **how release from enemies (like disease, predators, and herbivores) ma invasiveness**. Scientists predict that invasive species may be m species because, while native species get lots of damage from en example, if a native plant species has tons of insects that can eat or none, this could explain how the invasive plants can take spac researchers find that both types of species have the similar numb damage, this might mean that enemy release is not a good expla

http://kbsgk12project.kbs.msu.edu/data-nuggets/

DATA Nugget

Do insects prefer local or foreign foods?

Insects that feed on plants, called **herbivores**, can have big effects on how plants grow. They can change the size and shape of plants, the number of flowers and seeds, and even what species can survive in a habitat. For this reason, scientists study how insects and plants interact, and how much damage insects to do plants. A plant with more herbivore damage will most likely grow smaller and produce fewer seeds.

Scientists measuring herbivory data on native, exotic, and invasive plants.

Plants can protect themselves form herbivores. For example, plants produce defense chemicals in their leaves or protect leaves with small hairs that make it hard for insects to take a bite. **Native plants** are species that naturally occur in an area. Native plants and insects have grown together for thousands of years, so native plant defenses tend to be effective. An **exotic plant** is one that people have moved into new areas, and has the potential to become an **invasive species** that can take over habitats. An exotic plant may not have defenses against the insects occurring in its new range, and therefore may receive more damage than native species. More

http://kbsgk12project.kbs.msu.edu/data-nuggets/

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