Life Right Here & Everywhere

Middle School Student Notebook

Fall 2023

Name: ______________________________

Team Name: ______________________________

Teacher: ________________________ **Period:** ______

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Unit 1: What Species Live in My Community?

Lesson 1: What is a Solution?

Step 1: A letter just arrived for you from the Utah Department of Agriculture:

Utah Department of Agriculture
350 North Redwood Road, PO Box 146500
Salt Lake City, UT
84114-6500

Dear Field Biologists,

Over the past several years, people in Utah has had a big problem with the insects shown here:

Balsam Wooly Adelgid	Boxelder Bug	Brown Marmorated Stink Bug	Common Silverfish
			
Elm Seed Bug	Japanese Beetle	Small Hive Beetle	Velvet Longhorned Beetle
			

These insects are very annoying and may eat or destroy many of the plants and animals in Utah. Because of this, we need your help in studying these animals and in finding out how to remove or reduce them so that the plants and animals that live here, including us, can do well. Over the next few weeks, your task is to create a solution to decrease the number of these insects in your community.

What is a solution? Good question!

A **solution** is *a plan to solve a problem*. In this case, your solution will be designing and building a trap to reduce the number of one of these insects in your area.

Your teacher will be giving you more information to help you learn about your insect and other animals that live in your area so you can create your solution to share with others.

Thank you,

The Utah Department of Agriculture

Step 2: Field Biologists are like nature detectives who explore the outdoors to learn more about plants, animals, and the environment. They go out into forests, wetlands, deserts, oceans, and other natural places to observe and study different living things. Field Biologists might watch how birds build their nests, count how many types of insects are in a certain area, or study how animals interact with each other.

Using this information, what kinds of skills or knowledge do you think you will need to create a solution to decrease the populations of invasive or destructive insects in your area? Discuss.

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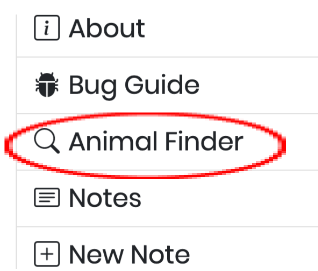
Using Animal Diversity Web (ADW) Pocket Guide to Identify Animals

Step 3: With guidance from your teacher, organize yourself into groups of 2-3 Field Biologists.

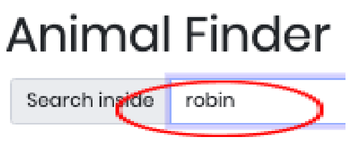
Working in groups, follow the steps below to practice gathering information on animals and signs of animals in your area.

A. Pick up an iPad and turn it on. Go to the ADW Pocket Guide: https://pocketguides.animaldiversity.org. If you have any trouble accessing ADW, please ask your teacher for help.
B. Use the login information your teacher gives you.
C. Click the Animal Finder button.

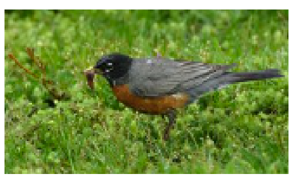


D. Method 1: **Explore categories** - One way to find the animal is to click on the type of animal it is. Click on "birds" to open the list of birds.

E. Method 2: **Search inside** - You may type in a specific animal or category. Try typing in "robin".



You should see information for the American Robin. Click on the image to view the robin's profile.

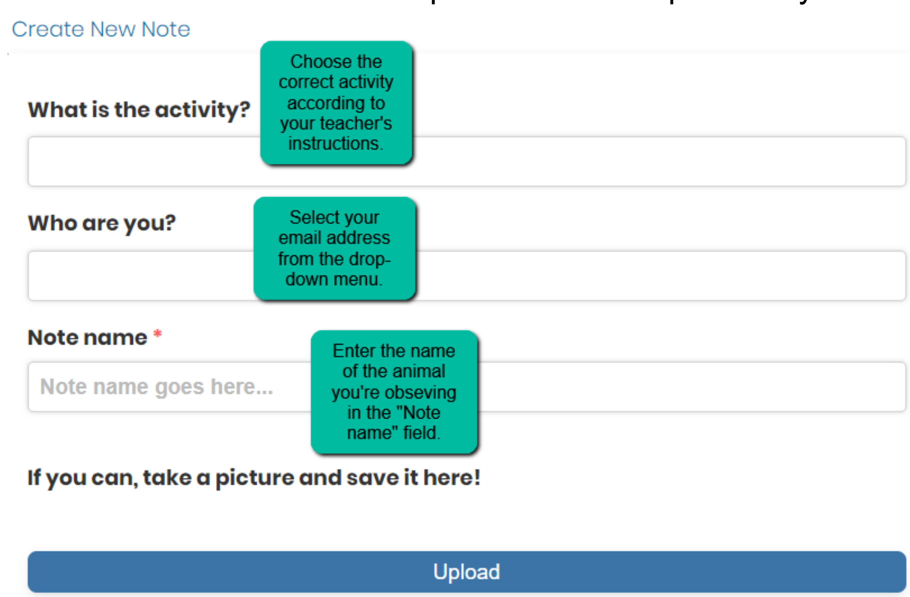


Creating a Note in the Animal Diversity Web (ADW) Pocket Guide

Step 4: You will be given an animal in plastic. Find it in ADW using Method 1 or 2. If you need help, there is a key word attached to the bottom of your animal. Try using this keyword to help guide your search.

Step 5: Use the instructions below to create a note in ADW on your animal in plastic.

1. Use this link to access the ADW Pocket Guide: https://pocketguides.animaldiversity.org.
2. Log in using the information your teacher gives you.
3. Select “Create a New Note” on the left-hand side of the screen. This will take you to the note-taking feature you will be using as you observe organisms.
4. For this activity, select “**Test Note**” under “What is the activity?”
5. Using the insect you have in plastic, complete a note in the ADW Pocket Guide that animal. Add as much detail as possible. Take a picture if you can.



If you are having any troubles accessing the ADW Pocket Guide, or finding the “Create a Note” feature, please raise your hand and ask your teacher for assistance.

Lesson 2: What Animals Live in Our Community?

Step 1: For three minutes, think of and list as many animals as you can that live in your community.

Animal Brainstorm

Exploratory Observation

Making field-based or outdoor **observations** is *the process of viewing and recording events occurring in the natural world*. Observations can be used to help you answer a **scientific question**, which is *a measurable and testable question that leads to a hypothesis, answer, or reason for observation, measurement, or test*.

Step 2: Read the Tips for Outdoor Observations below.

Gather all of the supplies needed for field observations. These supplies include:

- An iPad or Chromebook logged into the ADW Pocket Guide (https://pocketguides.animaldiversity.org/)
- A tote bag with other supplies, including binoculars, magnifying lenses and/or gloves.

Step 3: When your teacher instructs you to do so, your group will go outside and make observations about animals and signs of animals in the location assigned to you.

- To begin your notes, select “Exploratory Observation” under “What is the activity?” in ADW.
- For each animal or sign of an animal, fill in as many parts of the note as you can, but don’t worry if you can’t fill in every part.
- By the end of the time, you should have **at least three notes on animals or signs of animals**. If you have time, you can also take and upload pictures of the animals or signs of animals that you observed.

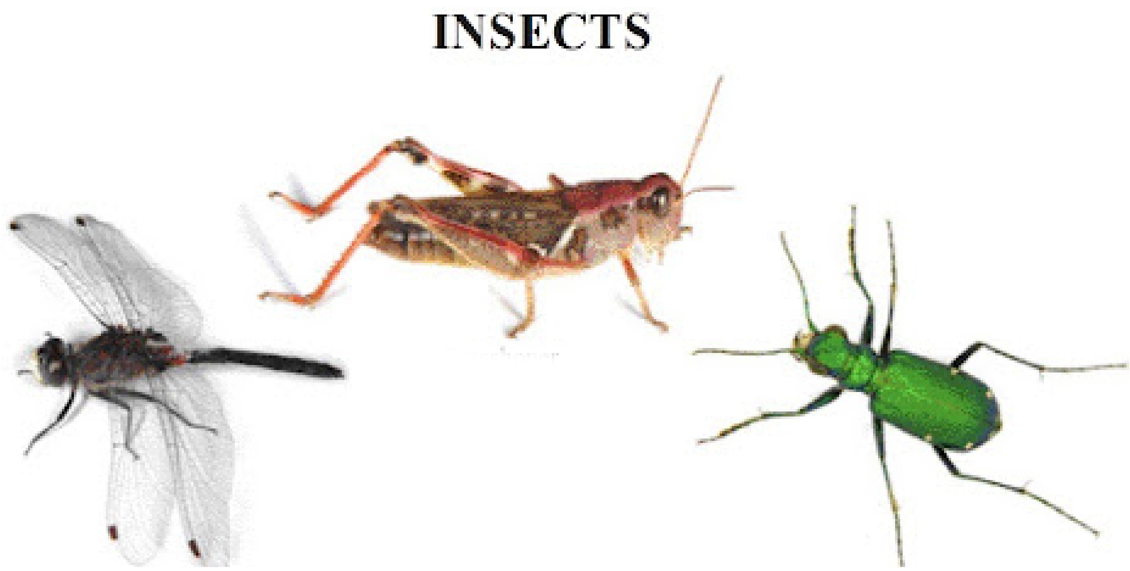
If your computer or iPad has technical difficulties, you can jot down your notes here.

Exploratory Observation Notes:

Step 4: One part of being a Field Biologist is to learn about the animals you observe.

1. What animals did you see?

2. Looking at the pictures below, did you see any insects?



3. If so, how do you know what you saw was an insect?

4. Thinking back to the Tips for Outdoor Observations, what is one thing you could do next time to improve your observations?

Lesson 3: Field Biologists' Data Collection

Step 1: Scientists collect **data**, which is *information or observations, to answer scientific questions*. Data can be many things, such as numbers, charts, images, or patterns.

When instructed by your teacher and working in your teams, as Field Biologists you will collect **data** on animals and signs of animals you observe in one assigned area near you.

1. Make sure one person in your group is logged in to the ADW Pocket Guide website (https://pocketguides.animaldiversity.org/) on your computer or iPad (see the instructions on the previous page if needed).
2. When your teacher instructs you to do so, you and your group will go outside to your assigned area and make observations about animals and signs of animals you find in that area.
3. **Record as many notes as you can.**
4. For this activity, enter "Animals in Our Community Observation " under "What is the activity?" in ADW.

[If your computer or iPad has technical difficulties, you can jot down your notes here.]

Animals in Our Community Notes:

Step 2: Complete the following questions about the observation you completed.

1. What was the **habitat** or *the place and conditions where a plant or animal lives* in your area of the community? Grassy? Sunny? Warm? Were there trees or bushes? Was there dirt?

2. How many of each kind of animal did you see?
    - Mammals ____
    - Birds ____
    - Insects ____
    - Spiders ____
    - Reptiles/Amphibians ____

3. Biologists define **abundance** as *the number of animals observed in a particular location*. During your observation, which animal was the most **abundant**?

4. Biologists define **richness** as *the total number of different species recorded in a given location*. Based on your observation, what is the **richness** of your community?

5. Did your group see any animals that no other group saw? If so, which one(s)?

Step 3: Read the following information about insects:

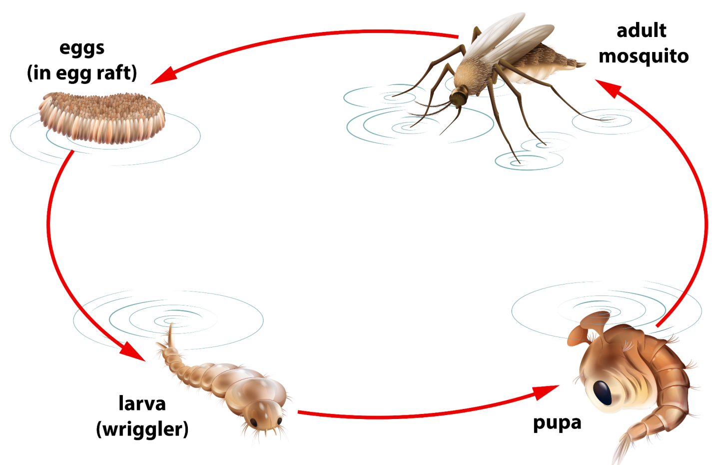
Insects play a very important role in every environment in which they are found. Some of the many functions which they carry out include the following:
- Pollinating plants
- Being a plentiful source of food for other animals
- Assisting in the decomposition of plants and animals

There are over 1 million different kinds of insects. Here are some ways to tell if an animal is an insect:

- **Legs:** *If an animal has 6 legs, it is an insect.* Some animals look like insects, but they have more legs.
- **Body sections:** *All insects have 3 body sections.*
  - The front section is the head - it has eyes, a mouth, and antennae.
  - The middle section is the thorax - the legs and wings attach here.
  - The last section is the abdomen - it contains the insect's stomach.
- **Other insect characteristics:**
  - Insects have 2 antennae on their heads. Antennae look sort of like big hairs. If you see an animal with antennae, it might be an insect, but some other animals have antennae also.
  - Many, but not all, insects have wings. If your animal has wings, but it is not a bird or a bat, then it is definitely an insect.

Insect Life Cycles

There are four life stages insects may go through, though not all insects have four stages. For example, here is a diagram of the mosquito's life cycle:



1. Based on the information on the previous page, is a spider an insect? Why or why not?

2. Are there any other insects whose life cycle you can name more than one stage of? Which insect and what stages can you name? (e.g., mosquito - egg and pupa)

Lesson 4: What Do Our Data Tell Us About Animals in Our Community?

Step 1: Look at your class's **raw data**.
Remember that **abundance** means the number of animals observed. So, if your class saw more ants than any other animal, that would be the most abundant animal for your class.

Find the 6 animals that are the most **abundant** in your community and fill in the table below using numbers of observations of that animal.

Our Most Abundant Animals

Animal	Number Observed/Abundance

Step 2: Use the information you identified in Step 1 to create a bar graph on the following page.

Bar Graph of Class Animal Observations

Abundance

Animal

Step 3: Review the following information on **biodiversity**:

Biodiversity is a term that *describes the variety of life in a particular place*. High biodiversity usually means an **ecosystem** or *the biological system formed by the interaction of all the living things and nonliving features in an area* is healthy and can sustain itself.

In your biodiversity research, you will use two factors that contribute to biodiversity: **abundance and richness**. **Abundance** is the number of animals in a particular location, while **richness** is the total number of different species recorded in a given location.

Consider this example: There used to be an ice cream shop in Townsville. Vanessa would often go there and they would be out of her favorite flavor (strawberry). Also, they didn't have many ice cream flavors - only about 6.

As a metaphor for **biodiversity**, we could say that this ice cream shop had low **richness** of ice cream varieties (not a lot of flavors). It also had low **abundance** of strawberry ice cream (not enough strawberry to feed all customers). For an ice cream shop to stay in business, it should have a wide variety of flavors for different customers (*high richness*) along with a large amount of the customers' favorite flavor (*high abundance*).

When we compare two **ecosystems** we often compare the **richness** and **abundance** of living organisms across them. By doing this, we can compare the **biodiversity** of two **ecosystems**.

For example, if a healthy coral reef has more species of fish AND it has more abundance of fish than the unhealthy coral reef, the healthy coral reef is more biodiverse.

Animals Observed at The Great Salt Lake in April

Animal	**Number Observed (Abundance)**
Pelican	5
Seagull	42
Savannah Sparrow	3
Marsh Gull	2
House Sparrow	12
Long-tailed Duck	6
Frog	5
Garter Snake	1
Blue Bird	4
Snowy Plover	1
Brine Shrimp	955
Antelope	10
Mosquito	1012
Total Animal Richness 13	**Total Abundance 2058**

Scientists use **scientific arguments** *to answer scientific questions*. A **scientific argument** needs a **claim**, **evidence**, and **reasoning.**

Step 4: Using the observation data of your class and the table of data on animals observed in the Great Salt Lake area, write a **scientific argument with a claim, evidence,** and **reasoning** to address the scientific question.

Scientific Question: Is the Great Salt Lake more biodiverse than our community?	
Claim A **claim** is *a complete sentence that answers the scientific question.*	
Evidence *is observations, data, or information that helps you answer the scientific question.*	
Reasoning *tells why your evidence supports your claim.* You can use scientific definitions or ideas to explain why you chose the evidence you did.	

Lesson 5: What Roles Do Organisms Play in the Environment?

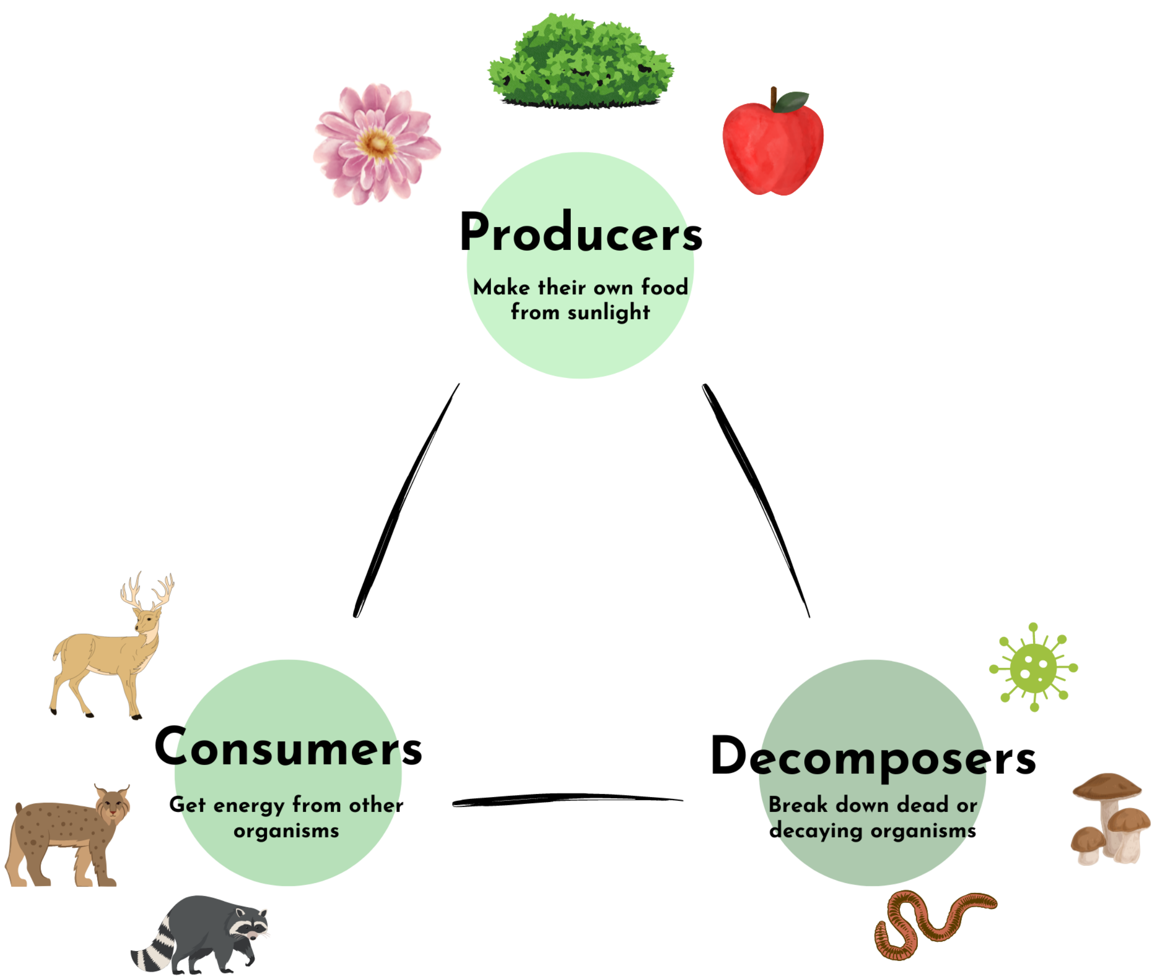
Step 1: Answer the following questions:

1. What is one thing you have eaten so far today? ________________
2. Where did it come from (plant, animal, etc.)? _________________
3. Can you think of anything else (besides humans) that eats it?

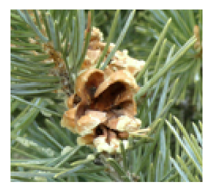
   ____

We eat food because it gives us energy. However, different organisms get energy in different ways.

Step 2: Review the information on energy transfer between organisms.



Step 3: Below are some organisms that live in Utah and how they get energy. Within each box, write whether each is a **producer, consumer,** or **decomposer.**

House Sparrow	**Black Bear**	**House Fly**
 ● Seeds ● Grain ● Insects The house sparrow is a ________________.	 ● Fruit ● Insects ● Small mammals The black bear is a ___________________.	 ● Sugar ● Rotting food ● Animal waste The house fly is a _________________.
Sego lily	**Brine Shrimp**	**Pinyon Pine**
 ● Sunlight The sego lily is a __________________.	 ● Algae ● Debris from dead plants The brine shrimp is a ___________________.	 ● Sunlight The pinyon pine is a ___________________.

Lesson 6: What is an Energy Food Web?

Step 1: Go to the data table that lists the animal observation data collected by your class.

Select two animals that you want to know more about.

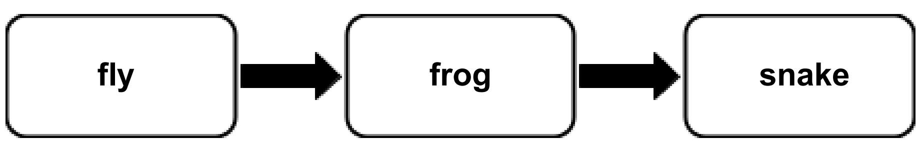
a. ______________________

b. ______________________

Step 2: Log onto the ADW Pocket Guide and go to “Animal Finder”.
Click on the right category (amphibians, birds, etc.).
Find the species you want to learn about.
Click on “Food Habits” and “Predation” to learn what your animal eats and what eats them (if anything).

	What does this animal eat (source of energy)?	**What eats this animal?**
Animal 1		
Animal 2		

An **energy food chain** describes *where animals get their energy*. It uses arrows to mark where energy flows. An energy food chain might look something like this:



In this case, eating the fly gives the frog energy, and eating the frog gives the snake energy.

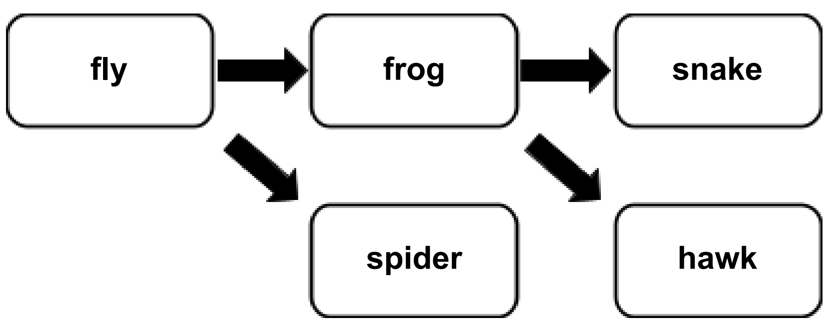
Step 3: Make an **energy food chain** that includes each of the animals you picked on the previous page.

Animal 1

Animal 2

More than one animal may have the same source of food. Also, one animal may be eaten by more than one kind of animal. For example, flies are food for spiders and frogs.

Step 4: An **energy food web** *shows how energy flows through several organisms*. It might look something like this:



1. Where does the spider get its energy? ______________________________

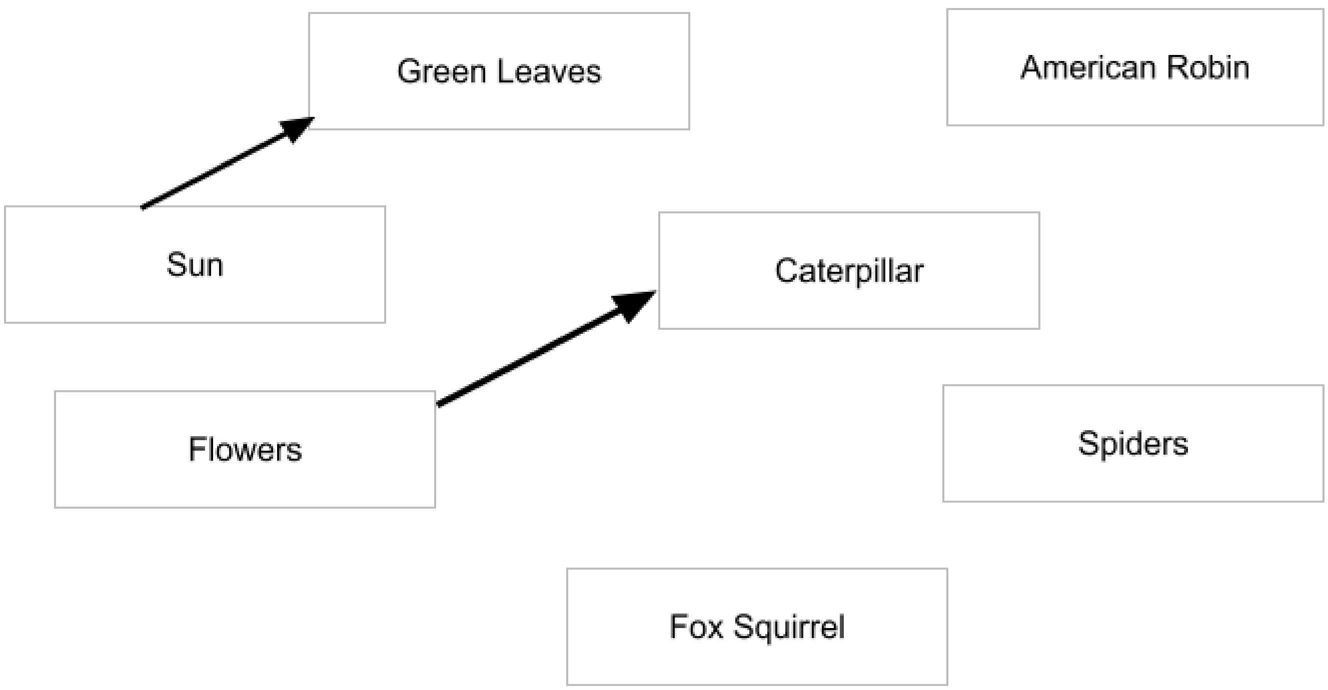
2. What animals does the frog give energy to?

______________________________ and ______________________________

Energy Food Web Activity

Step 5: Complete the food web below using the information in the table on the next page titled **Who Eats What in the Detroit River Area?**

- Fill in the arrows that represent how energy flows.
- Remember to make sure all the arrows are pointing in the correct direction.



Who Eats What in the Detroit River Area

Energy Source	Plant or Animal	Eaten By
sun	green leaves	caterpillars, Canada geese
sun	flowers	squirrels, caterpillars, bees, rabbits
sun	fruits	raccoons, pigeons, squirrels, robins
sun	seeds and nuts	pigeons, squirrels
sun	dead plant stuff	pillbugs, earthworms
seeds, grains, nuts, berries, and other fruits	pigeons (rock doves)	red-tailed hawks
nuts, flowers, fruits, seeds	fox squirrels	raccoons (eat young only), red-tailed hawks
dead plants, dead animals	pillbugs	spiders, robins
dead plants	earthworms	robins, gulls, garter snakes, bullfrogs, raccoons
nectar and pollen from flowers	bees	spiders
green leaves, flowers	caterpillars (moths and butterflies)	spiders, robins
small fruits, pillbugs, earthworms, caterpillars, spiders	American robins	
squirrels, pigeons, garter snakes	red-tailed hawks	
fruits, nuts, earthworms, garter snakes, bullfrogs, johnny darters, eggs and young of robins and Canada geese, squirrels	raccoons	red-tailed hawks (eat young only)
green leaves, flowers	Canada geese	raccoons eat eggs and young only
bullfrog tadpoles, earthworms	garter snake	red-tailed hawks, adult bullfrogs, raccoons
earthworms, yellow perch, logperch, johnny darters, walleye	ring-billed gulls	
pillbugs, bees, caterpillars, mayflies	spiders	robins, bullfrogs
bottom algae, dead plant stuff	burrowing mayflies	bullfrogs, spiders, all fish except walleye

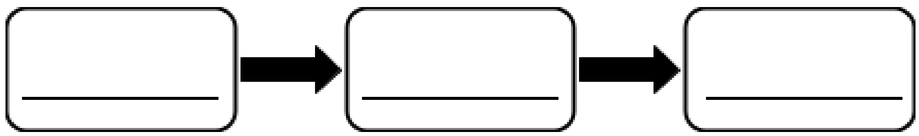
Unit 2: How Do Species Interact With Each Other?

Lesson 1: How Do Organisms Interact?

Step 1: Watch this video on predator/prey relationships:

https://www.youtube.com/watch?v=RXq67cfL9Kc

Using the information you see in the video, create an energy food chain between plants, deer, and mountain lions.



A **predator** is *an animal that eats another organism*, which is its **prey**.

A **predator** doesn't always have to fully consume its **prey**, either. Consider a mosquito. It takes a small amount of its prey's blood, and the prey keeps living.

What is one example of prey for a mountain lion? _______________

Do mountain lions have predators that eat them for food?________________

If not, what is the name of the predator that has no predators above it?

____

Not all relationships between animals are predator-prey. In fact, sometimes they even work together.

Step 2: Watch this video on other animal relationships:
https://www.youtube.com/watch?v=FHwj59QQYUM

A **symbiotic relationship** is *a close ecological relationship between the individuals of two (or more) different species*.

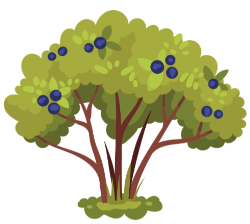
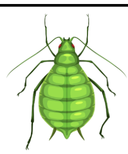
Organisms can engage in different types of symbiotic relationships. Some of these may help or harm one or both species.

Mutualism is *a type of symbiotic relationship in which both species benefit*.

Commensalism is *a type of symbiotic relationship in which one species benefits, and the other is unaffected.*

Parasitism is *a type of symbiotic relationship in which one species benefits, and the other is harmed.*

Step 3: Using the information on the previous page, identify examples of each relationship in the following chart.

Plant/Animal	Relationship Description	Relationship Type
	Trees and small shrubs provide a good place for mockingbirds to nest.	
	Mockingbirds eat many things including berries and bee larvae.	
	Bees help sunflowers by spreading their pollen.	
	Aphids feed on berry bushes and often transmit disease that can harm the bush.	
	Sunflowers provide bees with a source of nectar.	

Lesson 2: How Do Populations of Organisms Interact?

Step 1: Draw arrows to make an energy food chain to represent the relationship between GRASS, BUGS, and BIRDS.

Step 2: Your teacher will run a simulation from https://tinyurl.com/InvSim2022. The simulation has three organisms that we will be working with: GRASS, BUGS, and BIRDS.

Simulation 1 - Your teacher will show you the simulation using only GRASS and BUGS.

1. Describe what happened to the populations, or *the number of individuals of a certain species in a given area* of the organisms over time.

Step 3: Now it's your turn! A third species, BIRDS, are introduced in Simulation 2.

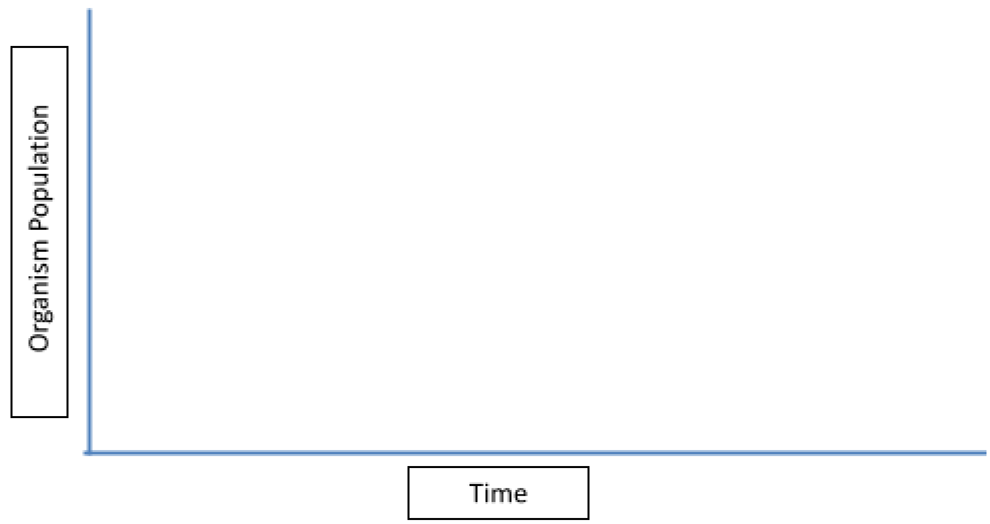
1. On the graph below, complete the initial amounts of grass, bugs and birds. (Your teacher may give you one set of numbers to start.)
2. Select one colored pencil to represent each population of organisms.
3. Make graph line predictions about what happens to BUGS, GRASS, and BIRDS over time as they interact.

Simulation 2 - Prediction

Amount of Grassland = ___

Initial number of bugs = ___

Initial number of birds = ___



4. Describe what you think will happen to the populations of the organisms over time.

____

____

____

____

____

5. Now run the simulation to see what happens. Be sure to set the initial number of populations and click “setup” again before hitting “go/pause”.

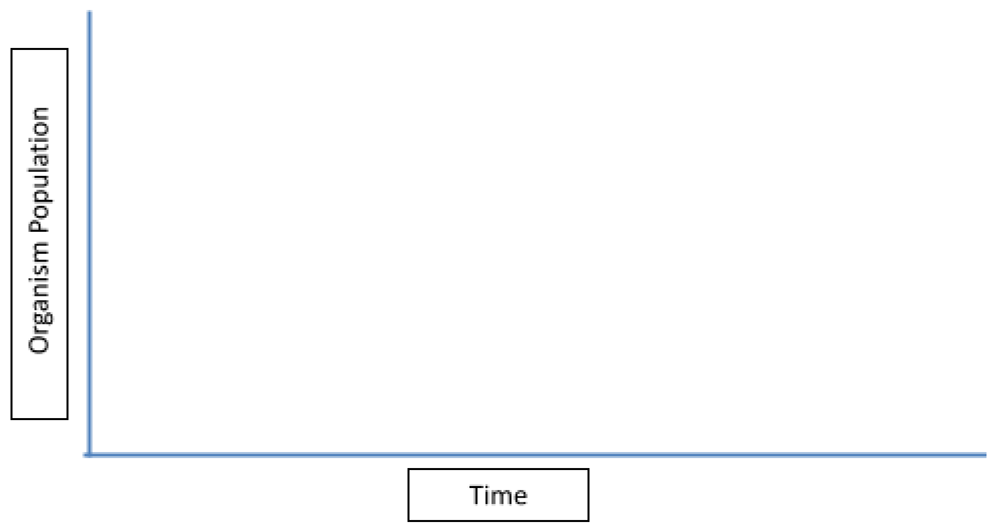
   In the graph below, draw a line that shows what happened over time for each of the organisms.

Simulation 2 - Observation

Amount of Grassland = ___

Initial number of bugs = ___

Initial number of birds = ___



Step 4: Answer the questions below.

1. How does the graph with birds differ from the graph without birds (Simulation 1 vs Simulation 2) ?

2. Why do you think this is?

Step 5: Jesse made a statement that the bird population will increase when there are more bugs. Write a **scientific argument with a claim, evidence,** and **reasoning** to address the scientific question.

Scientific Question: Do you agree with Jesse's statement that lots of bugs will cause the bird population to increase?

Lesson 3: How Do Invaders Impact Other Species?

You have been working with a simulation over the past couple of days looking at the interaction between GRASS, BUGS, and BIRDS. Today we will add another species: an INVADER.

Step 1: Complete a new simulation.

1. The simulation now contains GRASS, BUGS, BIRDS, and a new INVADER. The INVADER eats the BUGS.
2. Select one colored pencil to represent each population of organisms.
3. Your teacher will give you one set of numbers and ask you to make predictions about what happens to the organisms over time in the graph below. Use a different color for each population.

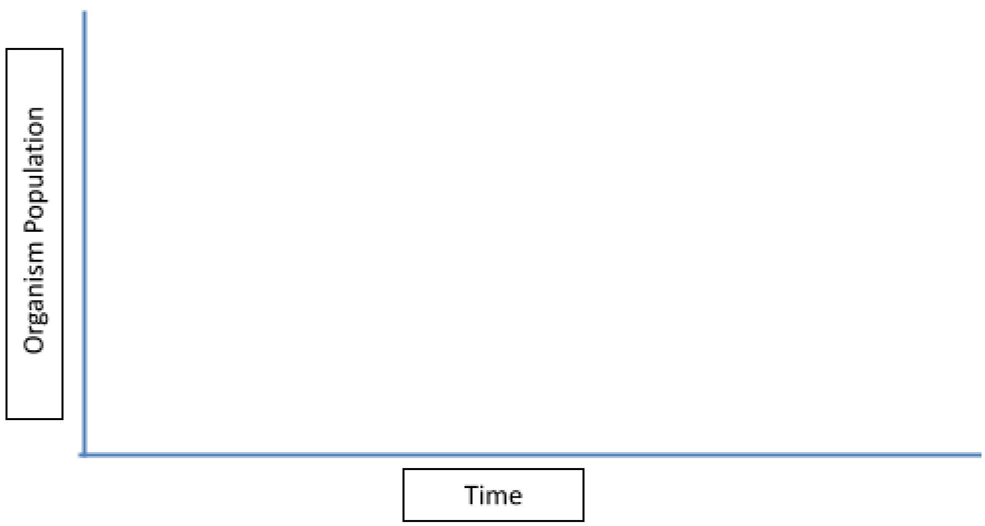
Simulation 3 - Prediction

Amount of Grassland = ___

Initial number of bugs = ___

Initial number of birds = ___

Number of invaders = ___



4. Describe what your graph says about the populations of the organisms over time.

5. Run the simulation and see what happens. Be sure to click "setup" and launch an invasion" before hitting "go/pause".

   In the graph below, draw a line that shows what happened over time for each of the organisms.

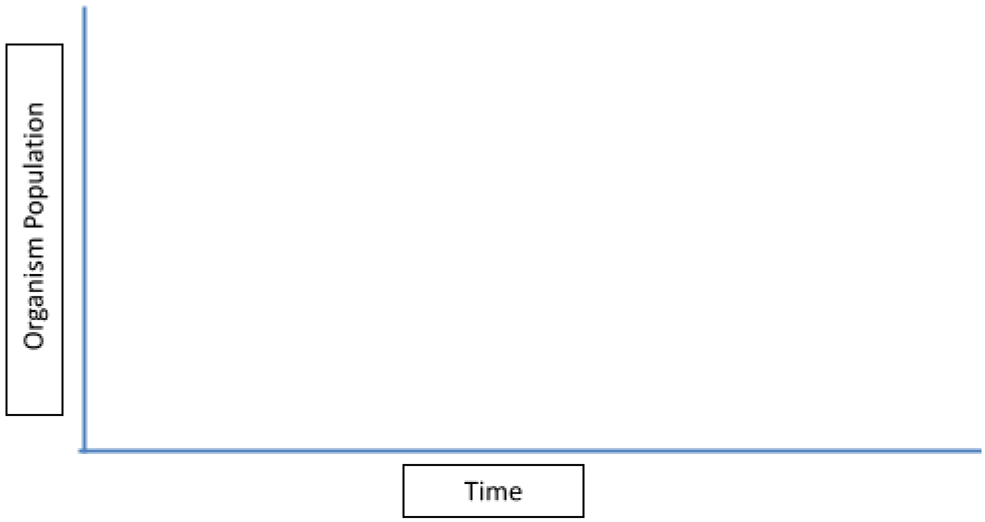
Simulation 3 - Observed Graph

Amount of Grassland = ___

Initial number of bugs = ___

Initial number of birds = ___

Number of invaders = ___



6. Describe what happened to the populations of birds and bugs over time.

____

____

____

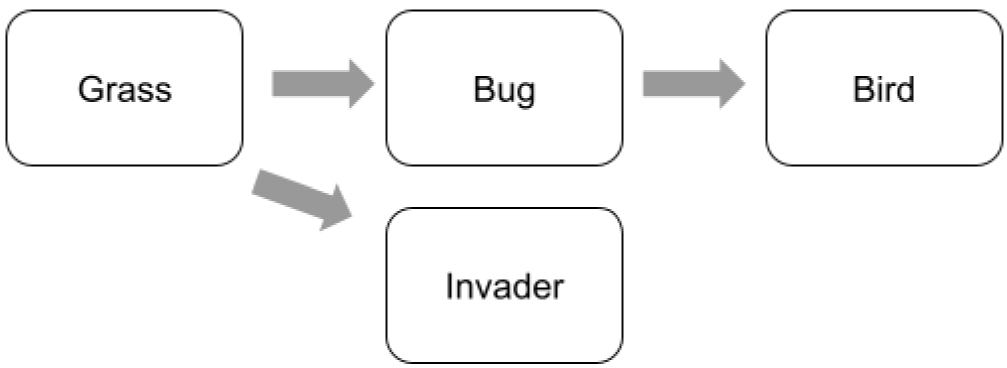
____

____

Step 2: Complete the questions below. You may need to review the previous simulations from Lesson 2.

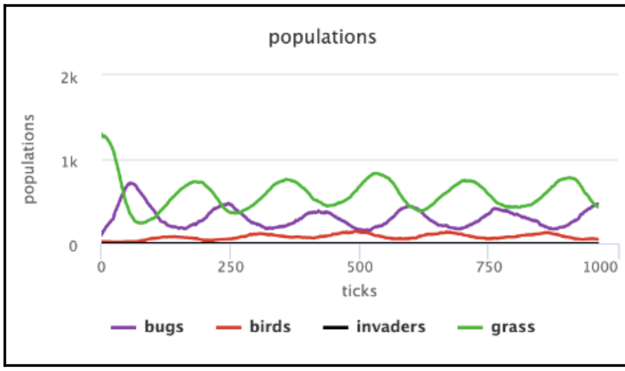
a. What happens to the bug population when invaders are introduced?

b. If the bug population decreases, what do you think will happen to the bird population?

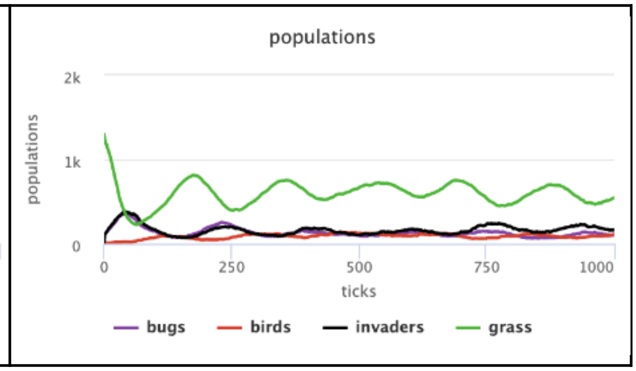


Step 3: The following graphs show populations before and after an invader species is introduced. Use these graphs to write a **scientific argument** with a **claim, evidence,** and **reasoning** to address the scientific question.

Before



After



Scientific Question: Does an invader species impact populations of native species?

Lesson 4: What is an Invasive Species?

Step 1: Read the following information on invasive species.

An **invasive species** is an organism that:

1. *is normally from a different location (e.g., country, continent)*
2. *causes ecological or economic harm to the new location*

In most cases, invasive species are introduced to their new environment by humans. This can be accidentally (such as when invasive species catch a ride on ships or firewood) or on purpose (such as when releasing a non-native pet).

Invasive species can harm the habitat where they are introduced by disrupting food webs and habitats. They compete with native species, or *species whose presence is NOT through human intervention*, for resources like food, light, or nesting sites, and can permanently alter the habitat to suit their needs rather than those of the native species.

Step 2: Watch this video on giant goldfish: https://youtu.be/Ahnr94mX_vM

Step 3: Complete the questions below.

A middle school student, Keisha, learns that earwigs originally came to the United States from Europe, and warm temperatures in June caused an abundance of earwigs in Utah. So many earwigs are around that they have run out of food and are eating many healthy garden trees and plants.

1. Write a **Claim** to address the scientific question, “Would you call earwigs an invasive species?”

2. Some introduced species are harmful to the environment, using the information above, give one piece of **Reasoning** to indicate whether the earwig is an invasive species.

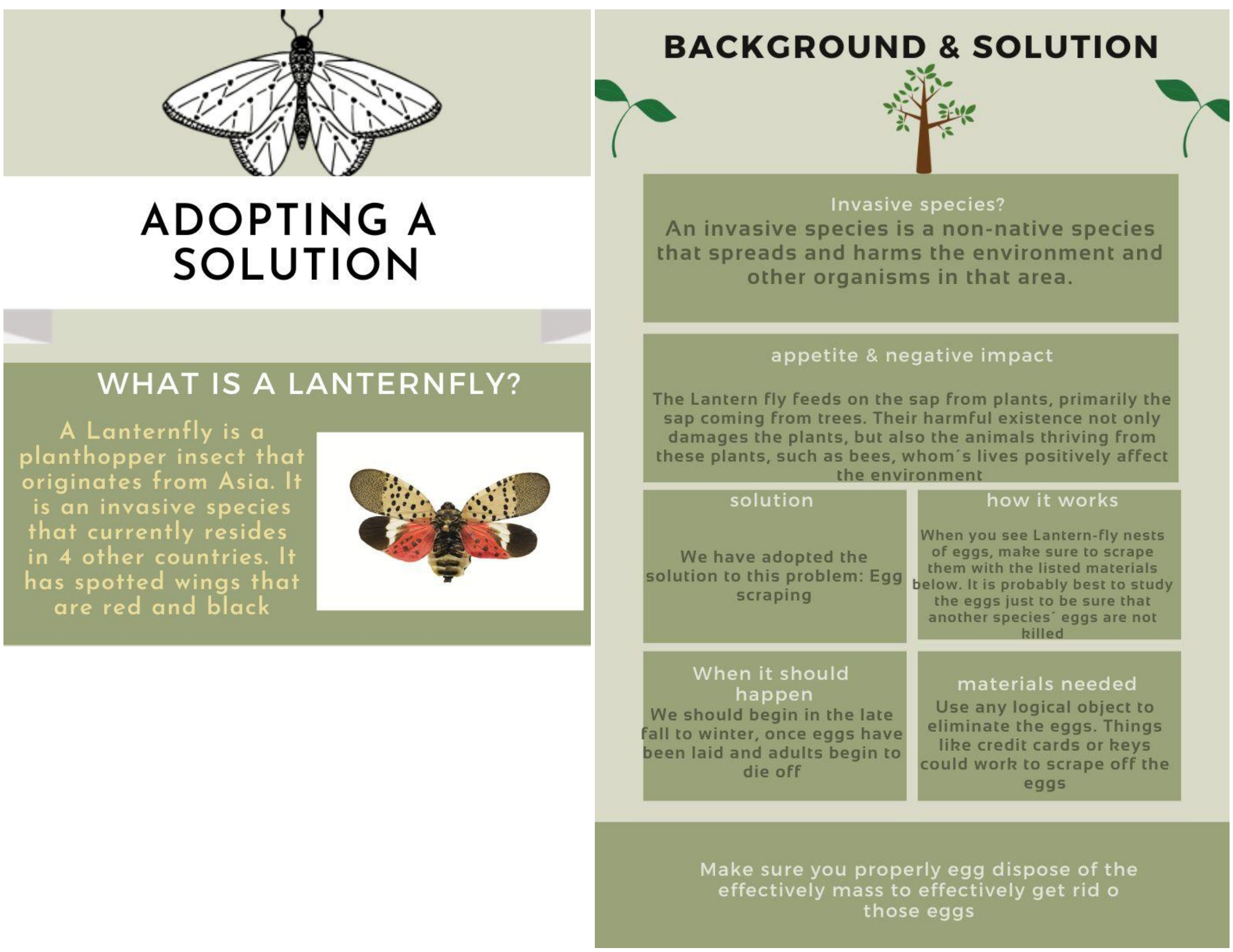
Step 4: Marco and Jada live in Philadelphia and have noticed many invasive Spotted Lanternflies on fruit trees. They are worried that when the Spotted Lanterflies eat tree sap, they damage the trees and harm other animals that live nearby.

They used what they know about invasive insects to create a solution to catching Spotted Lanterflies. Read their poster below.

What are two good things about their poster that helped you to know more about their invasive insect?

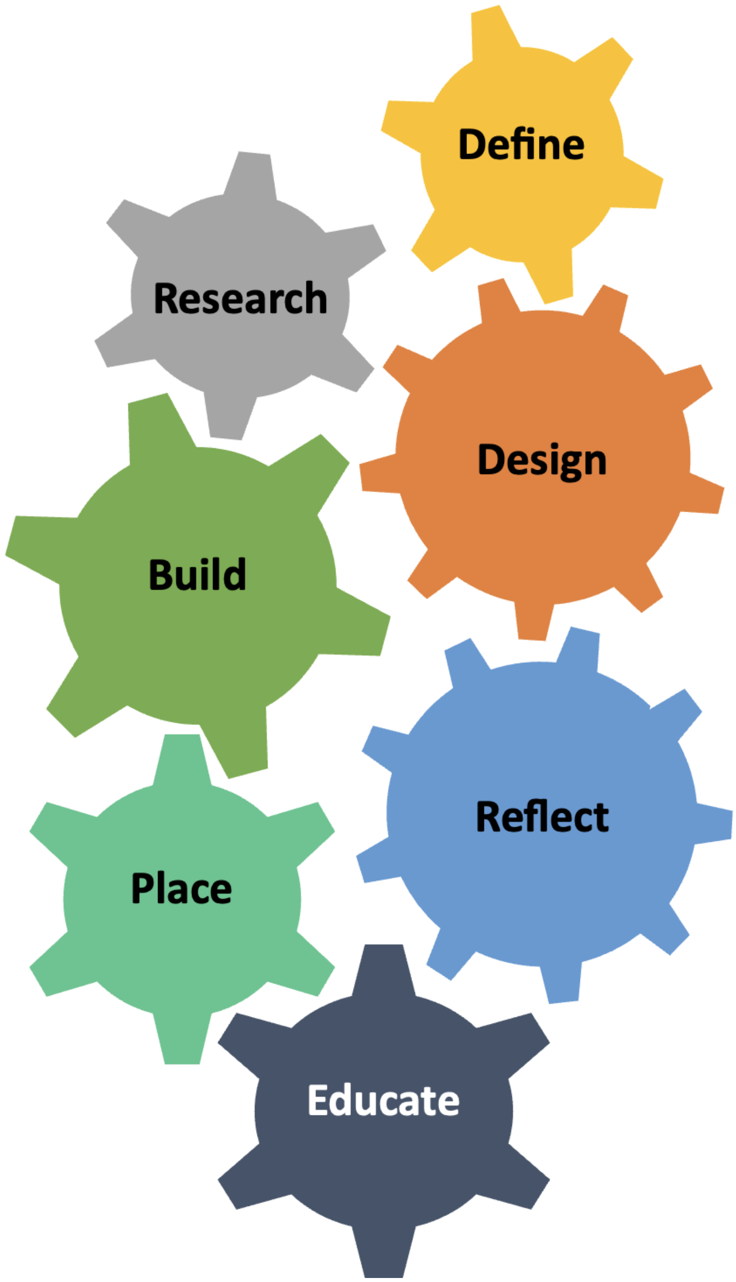
1.

2.



Unit 3: How Does Our Solution Help Reduce Harmful Species?

Lesson 1: The Engineering Design Process



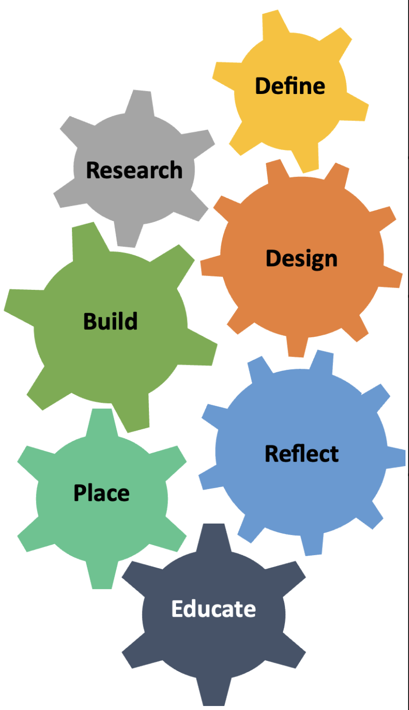
Engineering is defined by the Engineers Council for Professional Development as the *creative application of scientific principles to design or develop*: Structures, Machines, Apparatus, Manufacturing processes, Operating processes.

Step 1: Watch the following videos on engineering design:

Part 1: https://www.youtube.com/watch?v=RM04n0-QtNo

Part 2: https://www.youtube.com/watch?v=zrAl6JQ3sb4

Step 2: Review the Engineering Design Process.



The Engineering Design Process

Define	DEFINE the problem.
Research	Conduct RESEARCH to gather information that will help you solve the problem.
Design	DESIGN a plan to address the problem. This can be done through brainstorming sessions with sketches of multiple solutions before choosing the best one.
Build	BUILD the chosen design. Things like cost of materials, product maintenance, and feasibility should be taken into consideration.
Reflect	REFLECT on your work and seek feedback from others to improve their product. This may lead to additional RESEARCH and DESIGN stages.
Place	When engineers believe they have created an effective solution, they will put their solution into PLACE. In the instance of trap design, this means placing the traps in an appropriate location determined from previous research.
Educate	Finally, you should EDUCATE others. This includes making other people aware of the problem as well as your well-designed solution!

Gears are used to illustrate this relationship between the steps because each step has an impact on the other steps. If one gear turns, the other gears will also turn.

The gears also help show that the steps of the Engineering Design Process are not always followed in a straight line–one after the other. Engineers often repeat steps as they work in order to make a solution to a problem better.
Today you will begin working to come up with a solution that addresses the problem posed to you by the Department of Agriculture.You will be using the Engineering Design Process to DESIGN, BUILD, and PLACE an insect trap.

Step 3: Answer the following questions about the Engineering Design Process.

1. Can you EDUCATE others before you do RESEARCH? Why or why not?

   ____

   ____

2. Mario has DESIGNED a trap for reducing the number of spotted lanternflies in his neighborhood. However, after talking to another engineer, he realized that his trap would likely trap helpful honeybees instead. What step of the Engineering Design Process should Mario return to?

   ____

   ____

Similarly to how scientists use the scientific method, engineers use the Engineering Design Process to create solutions to specific problems. Engineering problems are different from other problems you may have encountered before. Instead of trying to produce a ***correct*** or ***perfect*** answer, engineers come up with a ***good*** answer and try to refine it later. There may be *many* good answers to an engineering problem.

Step 4: Review the story below.

Your friend's family recently adopted a small dog named Sparky. Your friend mentioned that Sparky's legs are too short to jump onto or off of the couch without help and sometimes whines very loudly until someone helps him. Sparky has even started whining in the middle of the night and has woken your friend up several times.

Step 5: In your own words, what is the problem?

____

____

Step 6: List two possible solutions to the problem.

1. ____

____

2. ____

____

At the beginning of this unit, you received a letter:

Utah Department of Agriculture
350 North Redwood Road, PO Box 146500
Salt Lake City, UT
84114-6500

Dear Field Biologists,

Over the past several years, people in Utah has had a big problem with the insects shown here:

Balsam Wooly Adelgid

Boxelder Bug

Brown Marmorated Stink Bug

Common Silverfish

Elm Seed Bug

Japanese Beetle

Small Hive Beetle

Velvet Longhorned Beetle

These insects are very annoying and may eat or destroy many of the plants and animals in Utah. Because of this, we need your help in studying these animals and in finding out how to remove or reduce them so that the plants and animals that live here, including us, can do well. Over the next few weeks, your task is to create a solution to decrease the number of these insects in your community.

What is a solution? Good question!

A **solution** is a plan to solve a problem**.** In this case, your solution will be designing and building a trap to reduce the number of one of these insects in your area.

Your teacher will be giving you more information to help you learn about your insect and other animals that live in your area so you can create your solution to share with others.

Thank you,

The Utah Department of Agriculture

DEFINE the problem is one of the most important steps of the Engineering Design Process. If you don't know what the problem is, how can you be sure that your DESIGN solves it?

To DEFINE a problem, it's important to think about three things: **What** the problem is, **who** has the problem, and **why** the problem is important.

Step 7: Get together with your insect group and discuss the problem described in the letter.

Step 8: *In your own words*, DEFINE the problem described in the letter by answering the questions below:

- What is the problem you are trying to solve?

  ____

- Who has the problem?

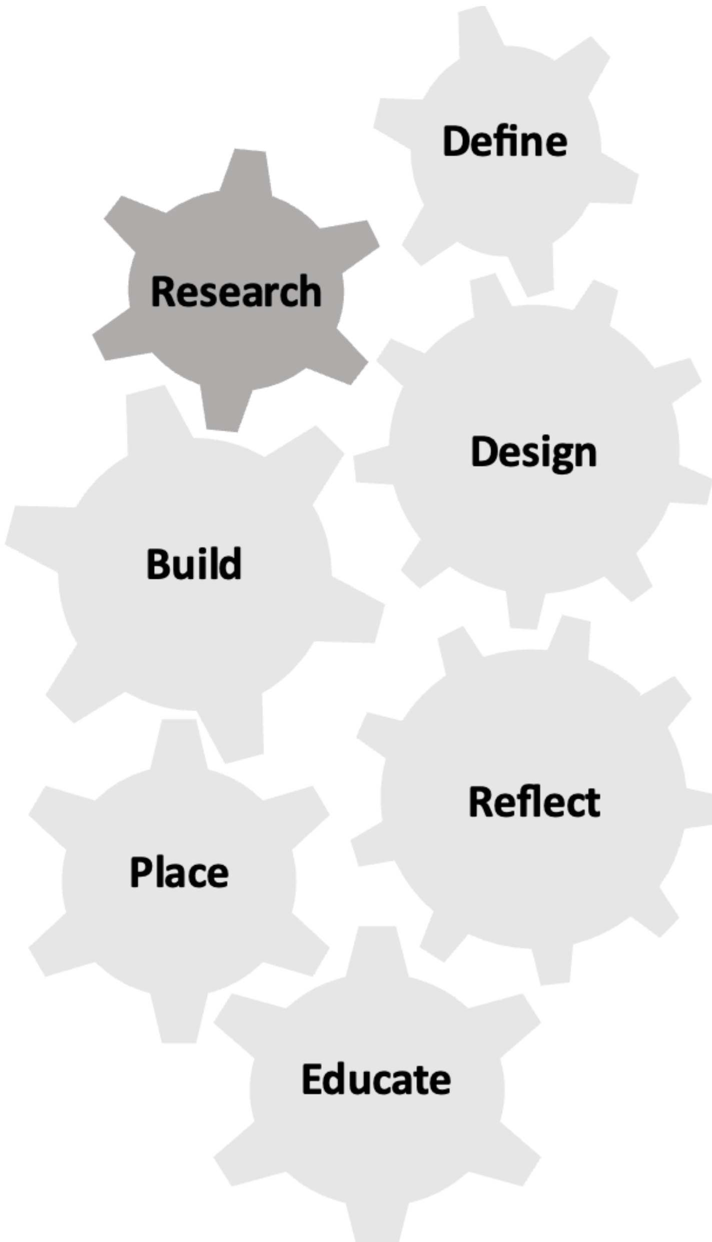
  ____

- Why is the problem important?

  ____

Lesson 2: RESEARCH an Insect

Learn more about your insect through effective RESEARCH.



Step 1: You may have already been assigned to an insect group at the beginning of Unit 1. If not, your teacher will guide you in getting into groups and determining which insect your group will be focusing on:

Balsam Wooly Adelgid
Boxelder Bug
Brown Marmorated Stink Bug
Common Silverfish
Elm Seed Bug
Japanese Beetle
Small Hive Beetle
Velvet Longhorned Beetle

Step 2: The second step in the Engineering Design Process is RESEARCH. Your RESEARCH includes learning all about your insect so that you can design a good trap for that animal.

Use the resources provided to learn about what your insect looks like, and draw a simple **sketch** of the insect. Label at least **four parts** of the insect.

Step 3: Using the resources provided or your own internet searches, answer questions below.

Name of your insect: ______________________________

1. Where did your insect come from (country or part of the world)?

2. When did your insect come to Utah? How did it get here?

3. Draw and label the lifecycle of your insect, including the time of year that your insect experiences each stage.

4. Where does your insect live (e.g., in a tree, on the ground)?

5. What does your insect eat? Do any other animals eat it? (Use terms like **predator** and **prey**.)

6. Describe your insect's behaviors (Does it fly? Does it like warm or cold weather?)

7. What impact does your insect have on humans or the environment?

8. What action(s) have already been to try to reduce the insect population?

RESEARCH Links

Balsam Wooly Adelgid

- USU Extension: https://tinyurl.com/USU-balsam
- United States Department of Agriculture (PDF): https://tinyurl.com/USDA-BWA
- Michigan Invasive Species: https://tinyurl.com/MIS-BWA
- ME.gov: https://tinyurl.com/ME-BWA
- NC State Extension: https://tinyurl.com/NCS-BWA

Boxelder Bug

- Animal Diversity Web (ADW): https://tinyurl.com/ADW-boxelder
- University of Minnesota Extension: https://tinyurl.com/UMN-boxelder
- USU Extension: https://tinyurl.com/USU-boxelder
- Clemson Cooperative Extension: https://tinyurl.com/Clemson-boxelder
- Cornell Pest Management: https://tinyurl.com/Cornell-boxelder

Brown Marmorated Stink Bug

- Animal Diversity Web (ADW): https://tinyurl.com/ADW-BMSB
- PennState Extension: https://tinyurl.com/Penn-BMSB
- USU Invasive Insects of Utah Field Guide: https://tinyurl.com/USU-guide
- Stop BMSB: http://www.stopbmsb.org
- University of Florida: https://tinyurl.com/UF-BMSB

Common Silverfish

- Animal Diversity Web (ADW): https://tinyurl.com/ADW-silverfish
- USU Extension: https://tinyurl.com/USU-silverfish
- University of Florida: https://tinyurl.com/UF-silverfish
- Clemson Cooperative Extension: https://tinyurl.com/Clemson-silverfish
- Texas A&M University: https://tinyurl.com/TAM-silverfish

Elm Seed Bug

- USU Extension: https://tinyurl.com/USU-elmseed
- Insect Identification: https://tinyurl.com/ElmSeedBug
- PNW Pest Management: https://tinyurl.com/PNW-elmseedbug
- Colorado State Extension: https://tinyurl.com/CO-elmseedbug
- University of Idaho (PDF): https://tinyurl.com/UI-elmseedbug

Japanese Beetle

- Animal Diversity Web (ADW): https://tinyurl.com/ADW-jbeetle
- USU Invasive Insects of Utah Field Guide: https://tinyurl.com/USU-guide
- CA.gov: https://tinyurl.com/CA-jbeetle
- Wisconsin Horticulture: https://tinyurl.com/Wisc-jbeetle
- National Invasive Species Information Center: https://tinyurl.com/inv-jbeetle

Small Hive Beetle

- USU Extension: https://tinyurl.com/USU-smallhive
- USDA.gov: https://tinyurl.com/USDA-shb
- Texas A&M University: https://tinyurl.com/TAM-shb
- CDFA Extension (PDF): https://tinyurl.com/CA-shb
- BeeAware: https://tinyurl.com/Bee-shb

Velvet Longhorned Beetle

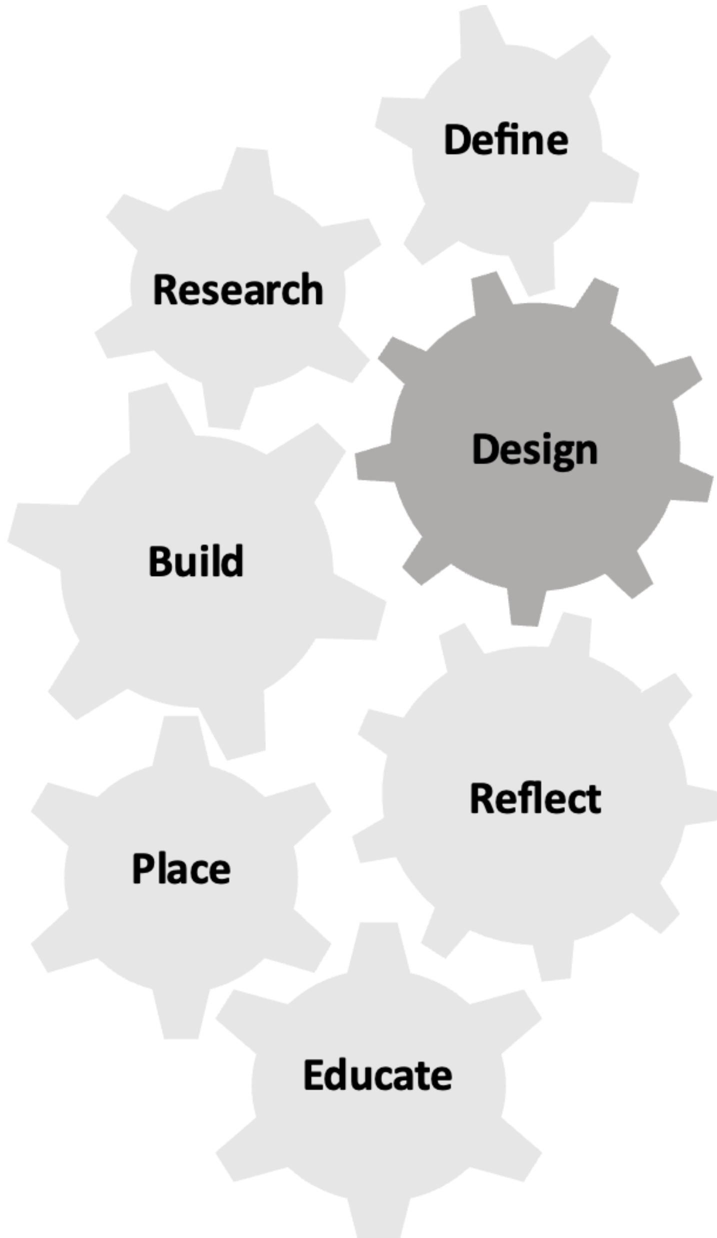
- USU Extension: https://tinyurl.com/USU-velvet-longhorned
- University of Minnesota Extension: https://tinyurl.com/UoM-vlb
- Utah Department of Agriculture: https://tinyurl.com/vlb-Utah
- Cornell University (PDF): https://tinyurl.com/cornell-vlb
- Oxford Academic: https://tinyurl.com/oxford-vlb

Step 4: Write a **scientific argument** with a **claim, evidence,** and **reasoning** to address the scientific question below.

Scientific Question: Is your insect invasive to Utah?

Lesson 3: Trap DESIGN

Every trap is carefully DESIGNED in order to work properly.



Step 1: Think about any traps you have seen in the past. What kinds were there? What was their purpose? How did they work? What attracted the animal to the trap?

Most insect traps have two important parts:

- Something that draws the insect to the trap. This is called a **lure**. Lures can be food, light, colors, smells, or anything else the insect likes. Some traps use more than one lure.
- Something that keeps the insect in, on, or around the trap. There are many ways that insect trap engineers use to keep insects from escaping.

Step 2: Brainstorming is an important part of engineering. Brainstorming is coming up with a lot of ideas in order to find the best idea. Look at the tips for brainstorming below.

Tips for Brainstorming

Step 3: By yourself, brainstorm **three possible** trap design ideas for capturing your invasive insect. Sketch them below:

Step 4: Select one of your sketches, and share your best design with your group. Share with your team why this is your best design, and what features should be a part of your final team DESIGN. Questions you can ask about each person's design include:

Which DESIGN will be the best at **attracting** your insect?

____

Which DESIGN will make sure the insects **don't leave** the trap?

____

Which DESIGN is the **easiest to build**?

____

Which DESIGN is the most **creative**?

____

Which DESIGN requires the **least number of repairs**? (Consider: What will happen when the trap is "full"? How often will you need to replace materials?)

____

Step 5: On the following page, create your final team DESIGN in detail.
For your final DESIGN, you can take the best features from each person's drawing and combine them, or you can come up with a completely different DESIGN. It's up to you.

Label the parts of the trap, draw arrows to show how it works.
While you are drawing, think about what materials you need to BUILD each part. A materials list is provided for you at the end of this lesson.

Drawing with Labels and Arrows

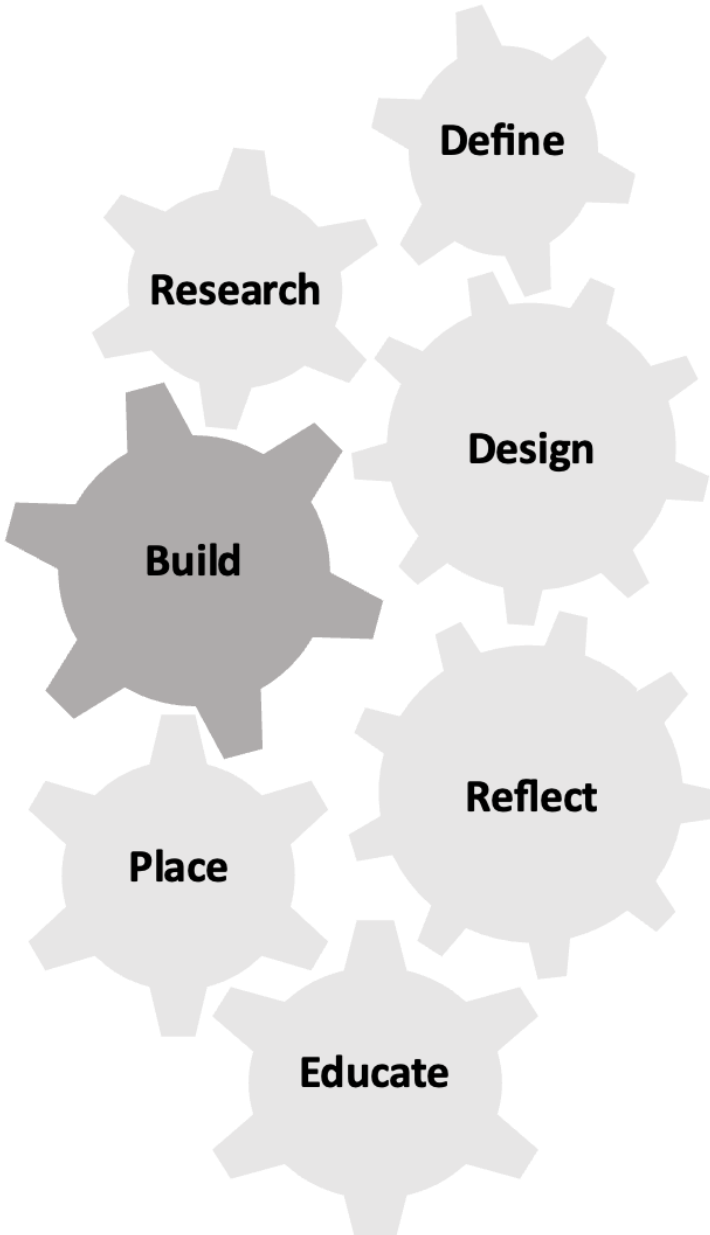
Trap name: ____

Materials

Paint	Dish soap	Rubber bands
Soda bottles/soda cans	Aluminum baking pans	Twine
Cardboard boxes	Push pins	Glue
Large fruit (apples, etc.)	Duct tape	Screen mesh
Small fruit (raspberries, etc.)	Toothpicks	Sugar
Wooden dowels	Funnels	Battery-powered lights
Paper	Vinegar	Twigs and leaves
Plastic wrap	Baking soda	

Lesson 4: BUILD Your Trap

Now it's time to **BUILD your trap**!



Build 1

Step 1: Using the materials listed below and your final design, start building your solution. Make sure each member of your group is included in the building process.

Materials

Paint	Dish soap	Rubber bands
Soda bottles/soda cans	Aluminum baking pans	Twine
Cardboard boxes	Push pins	Glue
Large fruit (apples, etc.)	Duct tape	Screen mesh
Small fruit (raspberries, etc.)	Toothpicks	Sugar
Wooden dowels	Funnels	Battery-powered lights
Paper	Vinegar	Twigs and leaves
Plastic wrap	Baking soda	

Step 2: After building, answer the following questions:

1. What is your lure?

   ____

2. How will your insect get to the lure?

   ____

   ____

3. How does your insect get in the trap and stay in?

   ____

   ____

4. What needs to be changed in your final build?

   ____

   ____

   ____

Build 2

Step 1: Build 2 should be your final BUILD. Take what you've learned about what worked and what didn't in Build 1 to construct your improved trap.

In Build 2, you will need to purchase any and all supplies you need for the trap. Using the money your teacher gives you, buy the supplies you need to build your final trap. You do not get a refund for any remaining materials after you finish BUILDING.

Use your supplies carefully! If you need more supplies than you planned for, you'll have to go back to your teacher to buy more with any money left over from your $10. If you run out of supplies *and* money, you can try to trade with other groups.

Step 2: Use the table on the next page to plan what you'll buy with $10.

Step 3: If the total cost of one trap is more than $10, you'll need to change your plan. In this case, talk with your group members to decide what you can do to save money, and list your changes below.

Changes:

____

____

____

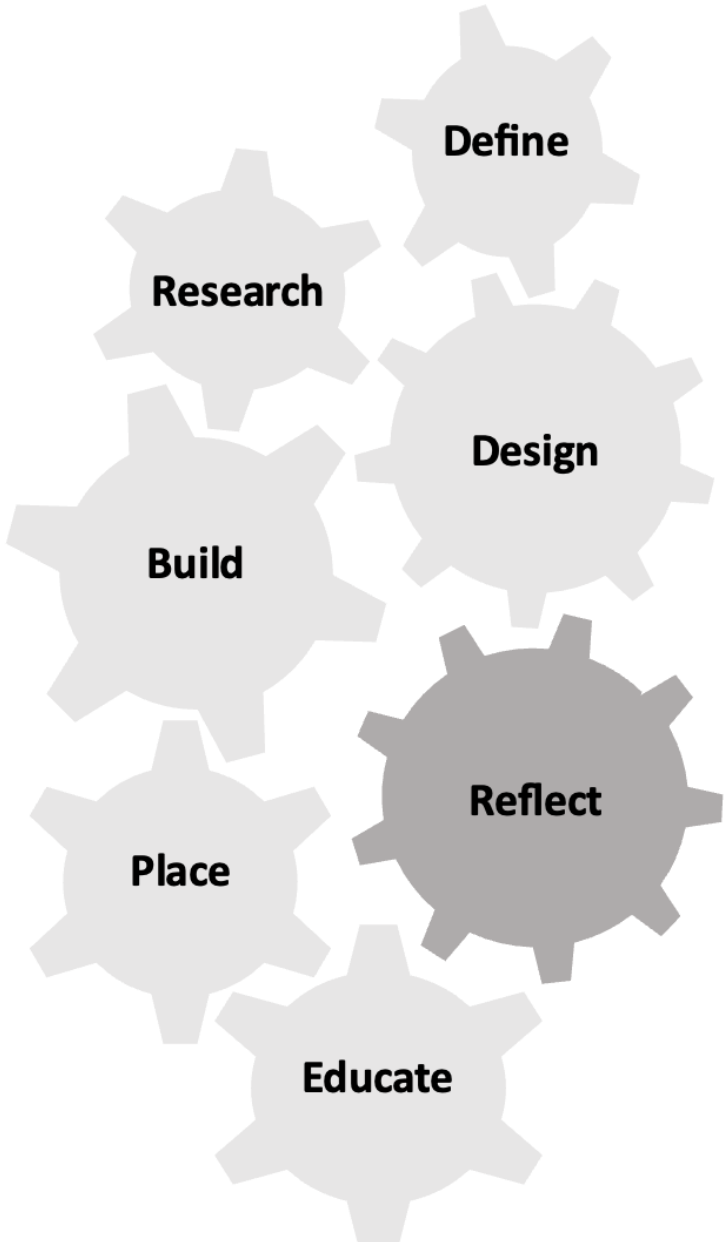
Fill in **How many** and the **Cost** for each material you want to buy.

Materials	Cost of item	How many?	Cost
Cardboard boxes	$1 per box		
Soda bottles OR soda cans	$1 each		
Small fruit (raspberries, etc.)	$1 per 1 fruit		
Large fruit (apples, etc.)	$1 per 1 fruit		
Twigs and leaves	$1 per bundle		
Rubber bands	$1 for 5 bands		
Battery-powered lights	$1 each		
Wooden dowels	$1 for 5 dowels		
Dish soap	$1 per ounce		
Aluminum baking pans	$1 each		
Push pins	$1 per 5 pins		
Duct tape	$1 per 3 feet		
Toothpicks	$1 for 10 toothpicks		
Funnels	$1 each		
Twine	$1 per 3 feet		
Screen mesh	$1 per square foot		
Glue	$1 per ounce		
Sugar or honey	$1 per tablespoon		
Paper	$1 per 10 sheets		
Paint	$1 per ounce		
Vinegar	$1 per ounce		
Plastic wrap	$1 per square foot		
Baking soda	$1 per tablespoon		
Protein patties	$1 per patty		
		TOTAL COST	

Step 4: Build the final version of your trap. Include any of the changes you listed after your first build.

Lesson 5: REFLECT

REFLECT on what worked and did not work.



Often when we DESIGN and BUILD a solution, we need to make improvements. The next step in the Engineering Design Process is to REFLECT on your solution. This means thinking about the problem you DEFINED along with your RESEARCH, DESIGN, and BUILD.

During this REFLECT, you may decide that you could make further changes to make your engineering solution even better. That's okay! Engineers go through the steps of the Engineering Design Process many times before coming up with an optimal solution.

Step 1: Use your insect RESEARCH in Lesson 2 and the brainstorming DESIGN checklist and peer feedback in Lesson to REFLECT on your trap.

REFLECT

1. Does the trap you built look like your final trap design? Why or why not?

   ____

   ____

2. What did you like about your trap?

   ____

   ____

3. What changes would you make to your trap?

   ____

   ____

4. Overall, do you think your trap will or won't work as a solution to the problem of you DEFINED in Lesson 1? Explain.

   ____

   ____

Step 2: Trade one notebook from your team with one other team. Complete the Feedback Form below for their trap. Remember that we are providing feedback on the trap, not the person.

Feedback Form

Completed by ____

Name of the group members providing feedback

Did the other group…?	Yes/No
Tell the name of they insect they are studying	
Tell you what stage of the insect's life cycle is good for catching	
Make a creative trap (colors, interesting design details, original ideas)	
Explain how their trap works (lure, etc.)	
Explain how they will keep their trap working (such as when to add more lure)	

Feedback Form

What suggestions do you have to improve the other group's trap?

1)

2)

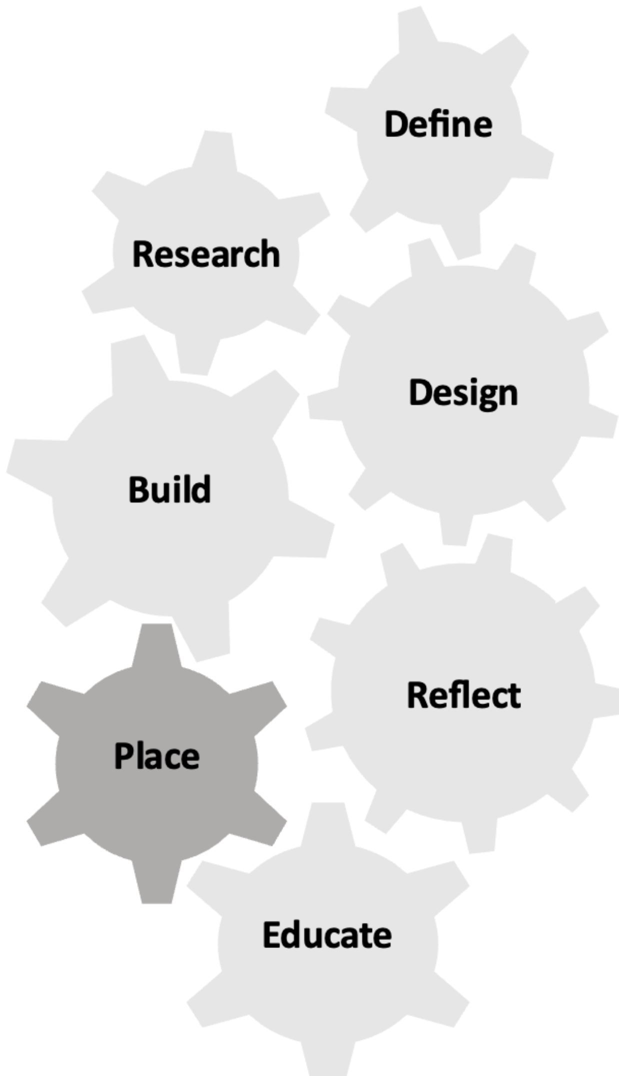
Step 3: As a class, discuss what went well and what didn't.

- What did you learn about the Engineering Design Process?

- Which step of the Engineering Design Process would you like to go back to in order to make your solution even better?

Lesson 6: PLACE Your Trap

Make a decision about where to PLACE your trap and the best time to PLACE it.



Step 1: Choose the best local area to place your trap(s).

- On Google Maps, look in your area for good places to put your trap(s).
- List every place you think might be good. Don't rule out anything yet!
- Fill in the table below with at least three places.

Short place description	Why might this be a good area?	Why might this **not** be a good area?

Step 2: Select the best spot to place your trap(s).

- Your choices should include what you know about the needs, habitat, and life cycle of your insect.
- On the table above, **circle the location you think is the best one.**

Step 3: Choose when–what time of year and time of day–you will place your traps. Consider the life cycle of your insect. Additionally, you will want to consider any maintenance your traps require and how often you might need to replace traps and components. (Hint: It's probably not a good idea to leave your traps out all year, since the wear-and-tear of weather would make your traps wear out faster.)

1. What time of year will you place your trap (summer, winter, etc.)?

   ____

   Why?

   ____

   ____

   ____

2. What time of day will you place your trap? (You may choose to leave them out all day.)

   ____

   Why?

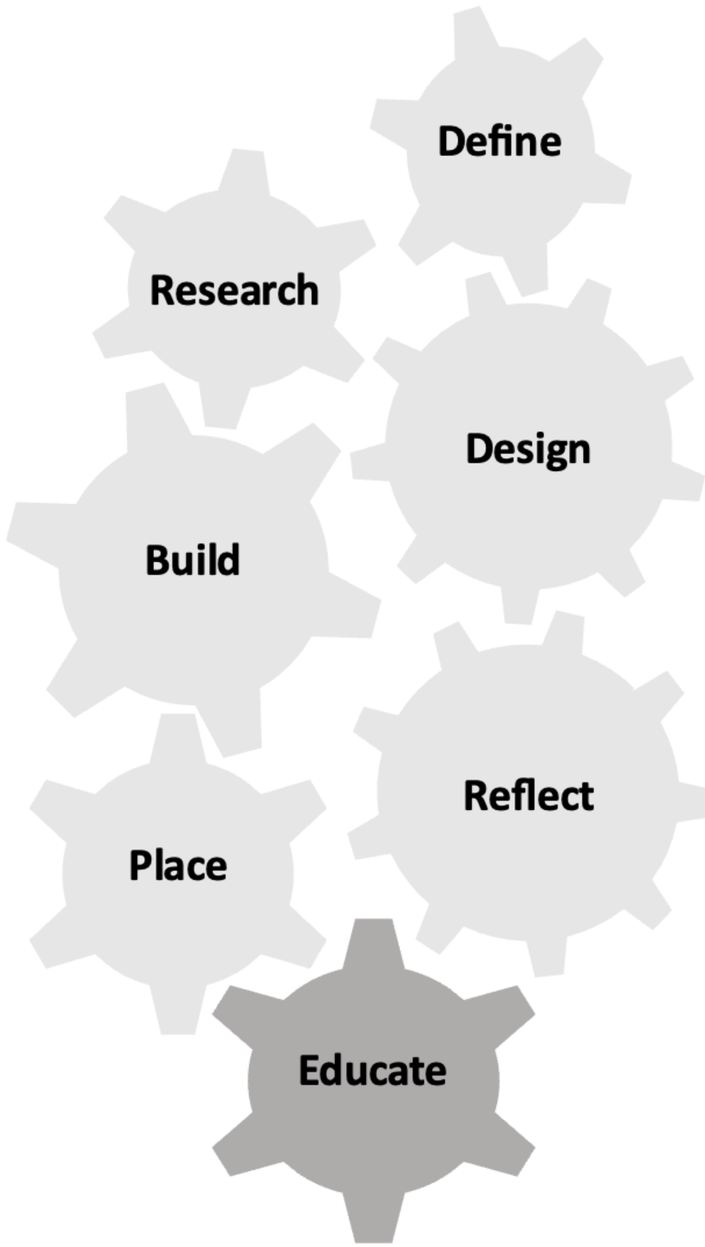
   ____

   ____

   ____

Lesson 7: EDUCATE

Teach others to build and use traps to reduce invasive species.



By going through each of the stages of the Engineering Design Process, you've created a well-researched and carefully designed solution to reduce an insect that's a problem in Utah. In the EDUCATE stage, you'll now have the chance to make your solution even more effective by encouraging your community to build traps, too.

The most effective field biologists and engineers share their knowledge with *everyone*. So, it is important to share your knowledge of insects and how you can capture them outside of school, as well.

Step 1: Choose who you will share your trap with.

Some questions to consider:

- Who do you know who would want to help get rid of your insect?
- Who might want to know what you have learned about this invasive insect? Is there someone who works in a park or who takes care of trees or other areas near your school?
- Where did you see your insect last? If you saw the insect outside your window at home, for example, someone you live with may be very interested in learning how to trap it.
- Do you know someone who runs a farm or might care about this invasive insect causing harm to farms or other local areas?

Who did your group decide to share your solution with? ___________________________

Why did you choose this person or group?

____

____

Step 2: Create a presentation to inform another group about your insect and your solution. With your group, decide which format you want to use for this presentation:

- Slideshow
- iMovie/Video
- Poster
- Pamphlet
- Infographic (An infographic is an online poster that uses pictures, charts, and data, to communicate to others. Check out some examples here: https://tinyurl.com/ig-examples)

Step 3: Create your presentation. Be sure to include at least the information in bold text.

- **The title of your presentation.**
- **The name of your insect.**
- Why is this insect not wanted in Utah? What makes them an invasive species?
- **How the trap works.**
    - Be sure to include which stage of the lifecycle you are targeting.
    - You should show and demonstrate the trap you built. You may also want to include a sketch or a diagram.
- Where and when to place the trap(s).
- **What effect your traps will have.**
    - In other words–why should someone want to build a trap?
    - How many insects can they expect to catch?
- Pictures and other elements that help make your presentation look good.
- How to make your trap.
    - Be sure to include all the materials needed and how many of each.
    - Here, again, you can use the trap you built and/or a sketch or diagram.
- How much each trap costs to make.
- Any regular repairs or replacements for your trap.
- **A particular feature of your trap design that shows creativity or uniqueness.**

Step 4: Share your solution with your teacher, your classmates, the person or group you chose earlier, and others!

Here are some helpful tips for your presentation:

- Talk loudly, slowly, and clearly.
- Make eye contact with the people listening.
- Make sure all of your group members have a chance to speak and participate.
- If you created something small (like a pamphlet), pass it around.
- Smile!
- Thank the people listening.
- Ask for questions.

Presentation Rubric

Category	1	2	3	Score Earned
Communication	Presenters did not speak clearly and/or slowly. Presentation included unnecessary information.	Presenters could have spoken more clearly and/or slowly at times. Most of the information presented was necessary.	Presenters spoke slowly and clearly the entire time. Presentation stayed on topic.	
Eye Contact	Presenters did not maintain eye contact throughout the presentation.	Presenters kept eye contact with the audience most of the time.	Presenters made eye contact with the audience throughout the presentation.	
Information	Presenters left out important information about their insect and/or trap design.	Presenters described their insect and how their trap works, but left out minor details.	Presenters described their insect and how their trap works in detail.	
Visual Appeal	Presentation did not include any pictures of visual elements.	Presentation included a few pictures or visual elements.	Presentation contained several pictures or other visual elements.	
Collaboration	One or two members of the group spoke the entire time.	Some members of the group spoke more than others.	All members of the group presented/spoke equally.	
			Total Score	

Trap Rubric

This is a rubric to evaluate the overall quality of the final trap your team built.

Category	1	2	3	Score Earned
Structure	Trap does not appear to be stable or trap is falling apart	Trap appears to be mostly stable, but some elements may be weak	Trap appears to be fairly strong and resistant to breaking	
Security	Trap does not prevent insect from escaping	Trap makes it difficult for insects to escape	Trap makes it almost impossible for insects to escape	
Lure or means of attracting and removing invasive insect	No lure or attractant is included	A lure or attractant was included but was not correct for the assigned insect	A good lure or attractant was selected for the assigned insect	
Practicality	Trap does not seem feasible or does not match intended insect	Trap seems effective but may have issues (ex. attracts other insects)	Trap seems very effective	
Creativity	The trap does not show innovative thinking	The trap shows a bit of innovation, but is too plain or ordinary	The trap is innovative in design or means to catch the insect	
			Total Score	**/15**

Glossary of Terms

Abundance: The number of an animal in a particular location. Comparing abundance means comparing these numbers across animal kinds. The abundance of honeybees at a hive is very high (hundreds or thousands of individuals) compared to the abundance of wolves in a pack (usually less than 10).

Biodiversity: a term used to describe the variety of life in a particular place. Often biodiversity is used as a way to characterize a place and compare it to other places (island B has higher biodiversity than island C) or places in time (my local area used to have more biodiversity than it does now). There are many factors that can go into calculating biodiversity and many different ways of calculating it. In your biodiversity research, you will use two factors that contribute to biodiversity: richness and abundance.

Carnivore: An organism that ONLY eats primary consumers. They are a kind of secondary consumer.

Carrying Capacity: The number of living organisms that a particular ecosystem or area can support in a sustainable manner.

Claim: A complete sentence that answers a scientific question. It is important to look carefully at data before making a claim.

Commensalism: A type of symbiotic relationship in which one species benefits, and the other is unaffected.

Competition: Two or more species/organisms fight for the same resources, shelter, space, habitat, etc. It can also be described as a type of symbiotic relationship in which neither species benefits.

Consumer: Organisms that can't make food energy from sunlight, and have to get it from other organisms. All animals are consumers.

Data: All the observations and information collected that can be used as evidence to answer a scientific question.

Data Analysis: Thinking about data, doing calculations, constructing charts or graphs, and looking for patterns to help decide whether the data answer the scientific question.

Data Collection: The part of a scientific process where observations are made and data are collected.

Decomposer: Organisms, such as soil bacterium, fungus, or invertebrate, that break down dead or decaying organisms.

Ecosystem: The biological system formed by the interaction of all the living things in an area and the non-living features of that environment (temperature, water, etc.).

Ecosystem Interactions: The relationship of different species in an ecosystem. There can be many different types of interactions. Some are beneficial to both organisms and some that are not. We will be focusing on one specific type of interaction: predator/prey interactions.

Energy Food Chain: An energy food chain is a representation of the flow of food and energy from one organism to another within an ecosystem. For the most part, food and energy flow from producers to consumers to decomposers then back to producers. Each component of the food chain depends on another component of the food chain. If there are no decomposers, for example, then nutrients cannot be returned to the soil and there are few producers. If there are no producers, then the consumers have nothing to eat. The sun plays a major role in each energy food chain since, without it, photosynthesis would not occur. Photosynthesis is the process by which plants make their own food energy.

Energy Food Web: An energy food web is a system of interconnected and interlocking energy food chains. An energy food chain only shows one possible path that energy and nutrients may take as they move throughout an ecosystem, while an energy food web represents many paths that energy and nutrients might take.

Engineering: Is defined by the Engineers Council for Professional Development as the *creative* application of scientific principles to design or develop: Structures, Machines, Apparatus, Manufacturing processes, Operating processes

Evidence: Observations, data, or information that helps you answer a scientific question.

Habitat: is the place and conditions where a plant or animal lives. Habitats include the area where the animal lives, shelters, eats, and drinks. A good habitat has plenty of all the things an animal needs to survive (food, water, shelter). It also includes the climate where the animal is found. Habitats are different for different animals. For example, a pile of dead leaves might be a very good habitat for a slug, but it is not a good habitat for a squirrel.A poor habitat doesn't have enough of these resources to meet the animal's needs.

Habitat Destruction: The various processes through which natural habitats become unable to sustain their native species.

Herbivore: An organism that ONLY eats plants. They are also called primary consumers.

Insect: A small animal that has three body segments and six legs. Some insects have one or two pairs of wings.

Invasive Species: An invasive species is an organism that causes ecological or economic harm in a new environment where it is not native.

Mutualism: A type of symbiotic relationship in which both species benefit.

Native Species: Species whose presence in the area is a result of natural progression over time NOT through human intervention.

Observation: The process of viewing and recording events occurring in the natural world. Observations are data.

Omnivore: An organism that eats both producers and primary consumers. They are a kind of secondary consumer.

Parasitism: A type of symbiotic relationship in which one species benefits, and the other is harmed.

Pollination: The process by which pollinators (those that move pollen) transfer plant pollen from one place or plant to another.

Population: The number of individuals of a certain species in a given area (at the same time).

Primary Consumer: An organism that ONLY eats producers. They are also sometimes called herbivores.

Producer: Organisms (mostly plants) that make their food energy from sunlight.

Predator: An animal that kills and eats other animals.

Prey: An animal that is killed and eaten by another animal.

Reasoning: Tells why your evidence supports your claim in a scientific argument. Reasoning is often either a scientific idea or definition that links your claim to your evidence.

Resources: An item (object, food, mate, shelter, etc.) that an organism needs to survive in a given area.

Richness: The total number of species recorded in a given location. If a community consists of 3 grasshoppers, a fly, 2 mice, and five starlings, then the richness of that community is 4 because there are four kinds of animals.

Scientific Argument: Scientists use scientific arguments to answer scientific questions. A scientific argument includes a claim, evidence, and reasoning.

Scientific Question: A measurable and testable question that leads to a hypothesis, answer, or reason for observation, measurement, or test.

Secondary Consumer: An organism that eats primary consumers. Organisms that ONLY eat primary consumers are sometimes called carnivores. Organisms that eat primary consumers AND producers are sometimes called omnivores.

Solution: A plan to solve a problem

Species: A group of living things that represent a “kind” of animal; a group of related individuals that generally interbreed and resemble each other. Members of species cannot generally breed with other species. Species are the most basic unit of biological classification. (Note: Sometimes people confuse species with other “kinds” of animals, such as breeds of dogs. All dogs are the same species as they can interbreed. In fact, all dogs are the same species as gray wolves–*Canis lupus*. Breeds of dogs, even though they look as different as Chihuahuas and Great Danes, are not different species; they represent variation within a species.)

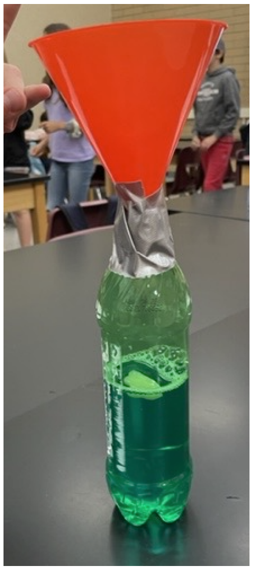
Symbiotic Relationship: A close ecological relationship between the individuals of two (or more) different species. Different types of symbiotic relationships include mutualism, commensalism, parasitism, competition, and neutralism.

Trophic Levels: A particular position in an energy food chain or energy food web. Organisms that occupy the same trophic level share similar sources of energy or food, such as plants (producers), eating plants (primary consumers), or eating animals that eat plants (secondary consumers).

Appendix: Other Traps

A note on sticky traps: Using sticky traps to catch insects *can* be harmful to other creatures. Sticky traps may accidentally capture animals like snakes, birds, frogs, bats, etc., that are good for the environment. If sticky traps are used, mesh should be placed over the sticky part so that only the insects you're trying to get rid of are trapped. See the picture below for an example:

Trap Examples: Here are some examples of traps that other students have created in the past. You may use these for inspiration, but make sure to create a design that is unique.

Design 1	Design 2	Design 3
		

Extra Space