Life Right Here & Everywhere

High School Teacher Notebook

Fall 2023

Table of Contents

Overview

Increasingly, our world presents us with complicated, interdisciplinary problems that have foundations in science, technology, engineering, and mathematics (STEM). Whether we need a modification of a vaccine to challenge a virus variant or the ability to design a water filtration system to increase the availability of potable water, we need training and practice in applying STEM learning to the creation of solutions. As outlined in a recent policy document, "Science is an essential tool for solving the greatest problems of our time and understanding the world around us. Scientific thinking and understanding are essential for all people navigating the world, not just for scientists and other STEM professionals." (NRC, 2021a). This urgency is not reflected in the priority placed on science education in formal educational settings. We propose that classroom activities which support students in harnessing their intellectual and creative resources might start with asking questions and engaging in scientific investigations, but they do not end there. Content learning is harnessed through additional activities which emphasize cooperative problem definition, problem solution, and the enactment of solutions.

We designed a learning approach, Solutioning, that guides students to deepen their learning of science content through the practices of both science and engineering. Solutioning builds from the 5-E learning cycle (Bybee, 2006). In our learning approach (Table 1), the first three phases are similar to the 5-Es and are similarly labeled Engage, Explore, and Explain. In these phases, students conduct a series of activities that include multiple rounds of data collection, the analysis of these data, and the construction of arguments that utilize their own data as evidence. The fourth and fifth phases, Engineer and Educate, guide and extend the learning of this same science content through the engineering practices.

Solutioning Instructional Model

Engage	Students **ask questions** associated with an introductory activity that engages their curiosity and provides a purpose for why they are studying local issues (often local environmental issues).
Explore	Students **collect data** to **use as evidence** to understand a local issue.
Explain	Students **use evidence** from the Explore phase to **construct arguments** to address their scientific questions.
Engineer	Students extend their understanding through the **design of a solution and a plan** that meets specific design criteria and constraints. Students **test** their solutions through feedback and data collection to determine if their solution is optimal for addressing the problem.
Educate	Students synthesize key ideas from their designs to inform and **educate** local stakeholders about possible implementation in their area.

Next, we created a six-week curricular program that manifested the learning approach and provided opportunities for students to draw from their three-dimensional biology learning and other intellectual and creative resources towards the engineered design of solutions. Unit activities in the Engage, Explore, and Explain phases include comparing biodiversity in different environments, prediction-making and analysis associated with the introduction of an invasive species to a food web, and research on one local invasive insect. Students complete field-based activities to document animals in a local area. In the fourth phase of our unit, Engineer, the biology content emphasized in earlier phases is re-visited and extended through the engineering design steps of defining a problem associated with a local invasive insect, designing a solution such as a trap, gathering and incorporating feedback on student designs, placement, and sharing of trap designs that will mitigate the amount of one local invasive insect. In the fifth and final phase, Educate, students select vital components of their trap design to share with local community members.

NGSS and SEEds Standards Associated with the *Life Right Here and Everywhere* Research Project

Utah Science with Engineering Education Standards (SEEds)

BIO.1.1 Plan and carry out an investigation to analyze and interpret data to determine how biotic and abiotic factors can affect the stability and change of a population. Emphasize stability and change in populations' carrying capacities and an ecosystem's biodiversity. (LS2.A, LS2.C)

BIO.1.4 Develop an argument from evidence for how ecosystems maintain relatively consistent numbers and types of organisms in stable conditions. Emphasize how changing conditions may result in changes to an ecosystem. Examples of changes in ecosystem conditions could include moderate biological or physical changes, such as moderate hunting or a seasonal flood, and extreme changes, such as climate change, volcanic eruption, or sea level rise. (LS2.C)

BIO.1.5 Design a solution that reduces the impact caused by human activities on the environment and biodiversity. Define the problem, identify criteria and constraints, develop possible solutions using models, analyze data to make improvements from iteratively testing solutions, and optimize a solution. Examples of human activities could include building dams, pollution, deforestation, or the **introduction of invasive species**. (LS2.C, LS4.D, ETS1.A, ETS1.B, ETS1.C)

NGSS Standards

HS-LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.*[Clarification Statement: Examples of human activities can include urbanization, building dams, and **dissemination of invasive species**.]

HS-LS2-6 Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions but changing conditions may result in a new ecosystem.

HS-LS2-2 Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

HS-ETS 1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

HS-ETS 1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

Required Materials

Material	Unit 1	Unit 2	Unit 3	Provided?
1-internet accessible device per group	✓	✓	✓	**N**
1 Life Right Here and Everywhere Notebook per student;	✓	✓	✓	**Y**
Laminated bug samples or other animal image or video (one per group)	✓			**Y**
1 Tote bag per student group (1 magnifying glass, pencil, laminated Tips for Outdoor Observations, Chrome or IPad)	✓			**Y**
1 copy of the data from ADW (obtainable after Unit 1 observations)	✓			**N**
1 calculator for each student group (optional)	✓			**N**
Access to a smartboard/projector OR 1-internet accessible device per student group	✓	✓		**N**
Colored Pencils for each group (at least 4 different colors per group)		✓		**N**
Link to the Invasive Species Simulation (https://tinyurl.com/InvSim2022)		✓		**Y**
Insect trap pictures (see Appendix) and/or models of real traps			✓	**N**
Materials listed for building traps (research team will provide these materials)			✓	**Y**
Play money			✓	**Y**
Extra paper			✓	**N**
Depending on teacher choices for presentations, materials for students to make presentations			✓	**N**

Unit 1: What Species Live in My community?

Unit 1: What Species Live in My Community?

Unit Overview:
In this unit, students will conduct their first unstructured observation to see evidence of animals in their community. Afterward, they will learn how observations can be used as scientific evidence. Students will take this knowledge into their second observation where they will look at animals that live in a second area such as another area of their community, in their neighborhood or on a field trip. Students will use the data they have collected through observations to answer the scientific question, "*Is the Great Salt Lake More Biodiverse than Our community?*"

Total Time: Seven 45-minute class periods

Science Concept Overview:
Invasive species disrupt the normal functioning of ecosystems by out-competing other organisms for resources. To understand this problem, students will be introduced to how energy flows through the ecosystem (for some students, this content will be a review). They will start with how field biologists categorize organisms in terms of how they get their energy (producers, consumers, and decomposers). Then students will use models of energy flow (food chains) and more complex models (food webs). These models also help to visualize relationships among organisms such as predator/prey relationships. These roles and relationships among organisms are part of healthy, normal ecosystem functioning.

Learning Goals	NGSS Standards Addressed
Collect local data on animals in your area. Collect local data on kinds and amounts (abundance) of local animal species. Interpret local data to provide evidence of the kinds and abundance of animal species in your community. Construct an argument to address the scientific question, *What is the most abundant animal observed?*	**HS-LS2-7** Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.*[Clarification Statement: Examples of human activities can include urbanization, building dams, and dissemination of invasive species.] **HS-LS2-2** Use mathematical representations to support afactors affecting biodiversity and populations in ecosystems of different scales. <u>Utah State Standards Addressed</u> **BIO.1.1** Plan and carry out an investigation to analyze and interpret data to determine how biotic and abiotic factors can affect the stability and change of a population. Emphasize stability and change in populations' carrying capacities and an ecosystem's biodiversity. (LS2.A, LS2.C) **BIO.1.2** Develop and use a model to explain cycling of matter and flow of energy among organisms in an ecosystem. Emphasize the movement of matter and energy through the different living organisms in an ecosystem. Examples of models could include food chains, food webs, energy pyramids or pyramids of biomass. (LS2.B) **BIO.1.3** Analyze and interpret data to determine the effects of photosynthesis and cellular respiration on the scale and proportion of carbon reservoirs in the carbon cycle. Emphasize the cycling of carbon through the biosphere, atmosphere, hydrosphere, and geosphere and how changes to various reservoirs impact ecosystems. Examples of changes to the scale and proportion of reservoirs could include deforestation, fossil fuel combustion, or ocean uptake of carbon dioxide and revise explanations based on evidence about .

Materials for Unit

- 1-internet accessible device per group (e.g., Chromebook or iPad);
- 1 Life Right Here and Everywhere Notebook per student;
- Laminated bug samples or other animal image or video (one per group);
- 1 Tote bag per student group (1 magnifying glass, pencil, laminated Tips for Outdoor Observations, Chrome or IPad);
- 1 copy of the data from ADW (obtained after Unit 1 - Lesson 3);
- Access to a smartboard/projector OR 1-internet accessible device per student group
- 1 calculator for each student group (optional);

Lesson 1: What is a Solution?

Daily Overview:

- *Students will read a letter from the Department of Agriculture that introduces them to insects harmful to Utah and asks them to create a solution to confront this problem.*
- *Students will learn the tool ADW Pocket Guide, which will allow them to make notes on observations of animals in their neighborhood.*

Time: 45 minute class period

Materials:

1. Life Right Here and Everywhere Notebook (Lesson 1);
2. 1 internet-accessible device per group;
3. Laminated bug samples or other animal image or video (1 per group)

Prior to Implementation: (1) Double check that students are rostered in ADW so that they are able to access it and learn how to use it.

Lesson Plan

<u>Letter from the Department of Agriculture (see next page)</u>
Instruct students to turn to Unit 1: Lesson 1 of their student notebooks. This letter introduces the students to the overall goal of the curriculum: to develop a solution for several harmful insects found in Utah. These insects are invasive to Utah, but since the students have not been introduced to the term invasive insect/species yet, this term is not mentioned in the letter. Additionally, in Unit 3 students will be asked to complete an argument answering the following scientific question: “Is your insect invasive to Utah?,” so we suggest not telling the students that these insects are “invasive” at this stage.

Read the letter with the students or have them read it on their own. After reading, explain to the students that they’ll be developing **solutions** at the end of the curriculum after learning more about how these insects interact with other animals and plants in the area.

At this point, we suggest optionally putting the students into groups of 2-4 students. These groups will stay together throughout the curriculum as they learn science concepts and complete projects. They’ll also design a solution for one of the four invasive insects during Unit 3.

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

Dear Field Biologists,

Ecosystems are the biological systems formed by the interaction of all living things (such as animals, plants, fungi, bacteria, and protozoa) and non-living things (such as temperature, precipitation) in an area. Insects are in the Animal group (Kingdom Animalia) and are an important component of our ecosystems.

Over the past several years, people in Utah have had problems with these insects:

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 plants and animals in Utah and otherwise disrupt stable ecosystems that are necessary for our and all living things' survival. Because of this, we need your help 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 thrive.

Over the next few weeks, your task is to become an Engineer and expert on one of these insects and create a solution to decrease the number of these insects in your community. A **solution** is *a plan to solve a problem***.** In this case, your solution will be the engineered design and building of a trap to reduce the population of one of the insects above in your area.

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

We are very happy that you are helping us in this important work.
Sincerely,

Field Biologists at the Utah Department of Agriculture

<u>Using ADW to Identify Animals</u>

Within the student notebook are steps to using ADW to locate animals both by name and by type. In their groups, students should review use to complete both methods.

Instruct: "In this unit, we will be working as field biologists to help the Utah Department of Agriculture. Field biologists will often use tools and technology to do their work. Since we are field biologists now, we will also be using technology to help us. The technology we are using is a tool called the Animal Diversity Web Pocket Guide. Before we start, we will learn and practice using this technology. I will walk you through logging into your account. Then we will go over how to use the features of ADW. "

At this time, provide students with their login information. Address any login issues.

There are two methods for identifying animals using ADW. This will be helpful for identifying what they see during their observations. At the beginning of Lesson 1, students have instructions on both methods. Have them practice finding a “robin” using each method.

Instruct: *Just like field biologists, we will record our observations so we can remember what we see and where we saw it. We can also use ADW to record notes. Everyone will be taking their own observations so you will still need your own login information. Read through the directions in your Life Right Here and Everywhere notebooks under the title:* ***Creating a Note in the Animal Diversity Web (ADW) Pocket Guide****”* Students will see the following instructions in their notebooks. You will also need to provide the students with their login credentials.

> Follow the instructions below to access the ADW Pocket Guide. In the future, you will use this program to make observations about organisms you see. Today you are just logging on and exploring the “Create a Note” feature of the ADW Pocket Guide.
>
> 1. Login to your ADW Pocket Guide. Use this link to access the ADW Pocket Guide: https://pocketguides.animaldiversity.org.
> 2. Use the login 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. Your teacher will provide you with either an image of an organism or a 3-dimensional “laminated” insect. Practice taking a note by typing-in some observations about the image or insect.
> 6. Fill out the Note to the best of your ability. Try to add as much detail about your organism as possible! Take a picture if you can, too. If you have any questions about what to include, raise your hand and ask your teacher.
> 7. 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.

Instruct: “*To take your first Note in ADW, you will be using the laminated bugs I am about to pass out OR you will be using the image/video I will show you. You will complete as many notes as possible around this bug. Everyone will be taking their own notes. [You will be sharing the laminated bugs, please remember to allow everyone to hold and touch the bug.] There may be some sections you can’t fill in and that is ok!* Pass out laminated insects or show the video/image. Walk around and assist students as needed while they make observations about the image or insect.

Afterwards, discuss what details the students were able to capture. Ask them if they encountered any issues with the observation or the technology. Is there anything they wish they could have captured about the insect, but couldn’t?

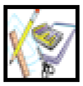
Discuss how they may not have been able to observe the animal’s habitat or behaviors as well as they would have liked. Explain to the students that they’ll be going outside to take animal observations in the coming days. What things would they like to find out about the animals in their community? (Suggestions include, How many animals there are? What kinds? What do they eat? What do they do? etc.)

Lesson 2: What Animals Live in Our Community?

Daily Overview:

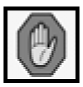
- *Students will conduct the first unstructured observation in their community.*
- *Students will learn how good observations can lead to good evidence to answer scientific questions.*

Time: 45 minute class period



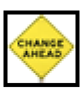
Materials:

1. Life Right Here and Everywhere Notebook (Lesson 2);
2. 1 internet-accessible device per group;
3. 1 Tote bag per student group (1 magnifying glass, pencil, laminated Tips for Outdoor Observations, and iPad)

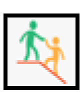


Prior to Implementation: (1) If students are completing this in the classroom, make sure to check the weather to see if outdoor observations are possible. (2) Pick a location in the community or playground for students to observe. If students are completing observations at home, suggest students pick one area to observe for a given amount of time.

Area considerations should take into account both ability to make observations and safety. If you select a place for your students, make sure this is an area with a lot of grass, trees, plants, and water. This will provide a more likely space for students to actually see something. Safety is also important. Make sure students do not get too close to roads, equipment, or dangerous environments. Since they are observing living things there should be no touching, poking, prodding, etc. This is to avoid students getting hurt but also will keep any organisms from getting hurt.



Possible Modifications: Students who have completed observations before and/or are comfortable completing observations can use this as a time to collect more detailed observations for later use throughout the curriculum. To do this, ask students to complete detailed observations of organisms and their habitats (this can be tailored if students are observing at their house or in the community). Students will need to gather several observations each to create a substantial enough list of observations for the class to use as evidence.



Supports: It is important that the teacher also makes observations during this time. Students who have not done a lot of observing might not provide enough data to have a sense-making discussion about whether the most abundant animal in their neighborhood. The teacher might need to supplement student observations with their own or observations made by iNaturalist (https://www.inaturalist.org/). iNaturalist is a citizen science website that collects data from volunteers. They have a wide data set of organisms that live in various areas.

Lesson Plan

Initial Brainstorm
Pose the question to the class: What animals live in our area? Instruct: "*I want you all to think about this question and write down your initial thoughts in your Life Right Here and Everywhere Notebook. You will have 3 minutes to list as many animals as you can think of.*" After 3 minutes, give students a chance to say things they wrote down. Ask them: How do you know this animal lives in this area? Have you seen it? Or have you heard about it? Transition: "*We are going to be looking at the animals in our area, some of these animals are ones that you may already know about and others may be ones you have never seen or heard of.*"

Animal Brainstorm

For three minutes, list as many animals as you can think of that you know to live in your neighborhood.

Preparing for Outdoor Observations
Instruct: *"Now that we have taken a sample note to learn the system, we will be going outside to take some observations in the field. First, we'll need to review some Tips for Outdoor Observations.*"

Have the students turn to the "Tips for Outdoor Observations" in their student notebooks. As a class, discuss the observation tips and safety tips (provided on the next page), and provide an opportunity for students to ask questions if they have any.

Tips for outdoor observations:

- Listen and Look. Some animals might be hard to see but you can observe them if you work quietly.
- Look for evidence of living things including spider webs, bite marks on leaves, nests, scat, or trail/tracks.
- Avoid harming any living thing you find.
- Use tools like gloves or trowels to explore. Be careful not to damage habitats.
- Look for spots that get as much sun as possible. These areas warm up faster and will have more activity.
- Make detailed notes! For example, don't just say, "A butterfly landed on a flower." What *kind* of butterfly? What color is it? What kind of flower? What was the butterfly doing?

Safety tips for outdoor observations:

- Avoid any roads when looking for organisms. Animals like quieter places.
- Do not touch any animal.
- Watch from a distance. Animals can get scared easily.
- Only go to places you know. Do not enter anyone's backyard or private property.

After this discussion, pass out the tote bag with different items that can help them make their observations. Go over the items in the tote bag (see materials list). If needed, go over what objects like the trowel can be used for.

Transition: "*Let's go outside and see what animals we can find in the community*! *You will collect at least 2 notes. Please fill in as much of the note as you can but don't worry if you can't fill in every part.* ***You will have [10-15] minutes*** *to walk around with your group and take your observations. When you create your notes, enter "****Exploratory Observation****" under "What is the activity?" in ADW."*

<u>Outdoor Observations</u>

Walk students outside to the designated area they will be observing. Remind students to walk around the area and make as many observations as they can. For each observation have them complete as much of the notes feature as possible. Remind students not to disturb the organisms and the other "Tips" as necessary.

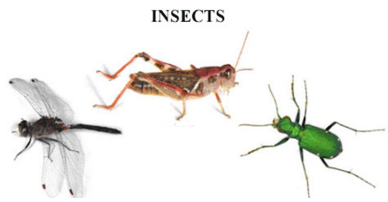
Students will use their devices to take and save photos of the organisms they observe. Provide students roughly 10-15 minutes to complete their observations before walking them back inside.

Once back in the classroom. Collect the tote bags and devices from students.

Observation Recap

After students finish their observations, have students answer the recap questions in Step 4 of Lesson 2. These questions are printed below.

1. What animals did you see?
2. Did you see anything unexpected?
3. Looking at the pictures below, did you see any insects?



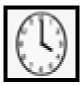
4. If so, how do you know what you saw was an insect?
5. Thinking back to the Tips for Outdoor Observations, what is one thing you could do next time to improve your observations?

After students have had a chance to write their responses, ask students to share their answers and select a few students to do so. Ask specifically about question 4. What can they do better next time? Also ask if there were any animals they were excited to see? Anything cool that they want to share with the class? Use this as an opportunity to get students excited about the observations.

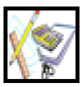
Lesson 3: Collecting Data About Animals

Daily Overview:

- *Students will use the ADW Pocket Guide tool they learned in Lesson 1 to take their second, more structured observations.*
- *Students will use this experience to talk about what it means for an area to be biodiverse.*

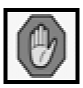


Time: 45 minute class period

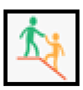


Materials:

1. Life Right Here and Everywhere Notebooks (Lesson 3);
2. 1-internet accessible device per group;
3. 1 Tote bag per student group (1 magnifying glass, pencil, laminated copy of the Tips for Outdoor Observations, and iPad);



Prior to implementation: (1) Check to make sure that each tote bag has the proper items for student groups to use on the field trip. (2) Have a list of student login in case students forget their username and password for ADW. (3) check to make sure that all iPads have been charged prior to the field trip.



Supports: It is important that the teacher also makes observations during this time. Students who have not done a lot of observing might not provide enough data to have a sense-making discussion about whether the most abundant animal in their neighborhood. The teacher might need to supplement student observations with their own or observations made by iNaturalist (https://www.inaturalist.org/). iNaturalist is a citizen science website that collects data from volunteers. They have a wide data set of organisms that live in various areas.

Lesson Plan

Preparing Students to Make Outdoor Observations

Instruct: "*Remember that during Lesson 2 we made observations to learn about what animals live in our community. Today your group is going to be assigned to a specific area in the community. You're going to take careful observations about what animals are in your area. Before going out, let's talk about what we can do better. What are some things you can do to find more animals or signs of animals this time?"* Take a few student responses. Remind them about any Tips for Outdoor Observations (found in Lesson 2) that you feel students should improve from the last observation activity.

Instruct: *"Before you start your observations, we need to get the observation tool ready to use. You will use the **ADW Pocket Guide** to take notes on what animals you observe. Record as many notes as you can. Please fill in as much of the note as you can but do not worry if you can't fill in every part. For this activity, enter "**Animals in Our community Observation** " under "What is the activity?" in ADW."*

Make sure students are in their groups and pass out the tote bag with different items that can help them make their observations. When students get their tote bag, instruct their groups to login to **ADW Pocket Guide** and have the **Notes** feature before they begin.

Making Observations

Transition: "*Let's go see what animals we can find*! ***You will have [15-30] minutes*** *to walk around and take your observations."*

Students will use their devices to take and save photos of the organisms they observe. They will use the **Notes function in the ADW Pocket Guide** to record observations. Remind students to walk around the area and make five observations with their group. For each observation have them complete as much of the notes feature as possible. Remind students not to disturb the organism and to look underneath rocks and such.

Observation Recap

After students finish their observations, have students open to Lesson 3 in their student notebooks and complete the observation recap questions in their notebooks (listed below).

1. What was the habitat like 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 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)?

Next, have students read the information on insects either on their own or as a class. *Instruct:* "*We are going to learn a lot about insects in this unit, but first, let's review some information on insects"* (printed on the next page).

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:

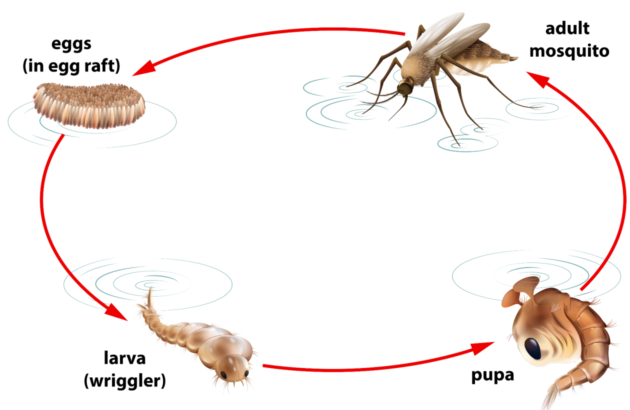
- Pollinating plants
- Being a plentiful source of food for other animals
- Assisting in the decomposition of plants and animals

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:



Have students answer the questions about insects individually or as a class.

1. Based on the information on the previous page, do you think a spider is an insect? Why or why not? No, it has eight legs.
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). Example: butterfly: caterpillar and chrysalis/cocoon

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

Daily Overview:

- *Students will use the data they collected during their observations to create evidence for what is the most abundant animal in the area.*

Time: 45 minute class period

Materials:

1. Life Right Here and Everywhere Notebooks (Lesson 4);
2. 1-internet accessible device per group;
3. A printout of the class's observation data (at least 1 per each group);
4. Calculators

Prior to implementation: Download the class's observation data from the previous lesson. Look through the data. You may want to do some preliminary data cleaning (for instance, if there are blank or "Test" notes, or if the same note was made more than once). Once finished, print the class's data and make at least 1 copy per group in the class.

If your class was not able to take good observations due to weather, technology issues, etc. A backup spreadsheet will be provided for students to use.

Possible modifications: *For classes that need heavy scaffolding for working with raw data,* the teacher may instruct students to manipulate the spreadsheet created by ADW prior to implementation. This data set will be used to provide evidence for the species and abundance of the local neighborhood. Prior to uploading the data for sense-making, the students can remove erroneous data not needed for discussion of species abundance and richness (i.e., ADW asks for other information like the weather, habitat, location, etc.). Downloading as an excel spreadsheet would allow you to modify what students see if need be.
Classes that have worked with raw data can be given the entire data set to look at. Students can be guided to think about what type of data they think would be needed to decide whether the neighborhood is biologically diverse. Students can discuss which data they want to ignore and why.

Owner	Date	Time of Day	Note name	Description	What is the animal doing?	In what kind of habitat did you	What is the weather like?	Where specifically did you	What kind of animal do you	Pictures	Locations
zaphod3@hhtg.net	2020-11-29	1:08 PM	Song product dark high.	None realize also about kid walk cost first community maintain care accept box business long southern development this any officer draw develop cause have.	Standard of Democrat trade sure media cold life get arm in house picture cut visit impact politics right meet now share area guy attack short discuss to edge hard.	Ask future pretty PM staff down few black back common would receive adult before administration think first account minute much set it manager modern out wish first community memory road art old air chance social analysis water whatever history shoulder much.	Behavior city herself before break more common eye service shake assume development consider picture production this answer what ok painting every to try father stay majority on yeah find letter explain difference maintain discover speak recently protect short meeting top hand community section travel this.	Whether second drive rather these wonder guy here ready do effect fire however including story take high oil whether economy movie join character any science book wear source development try.	Terrapene carolina - box turtle Tyrannus verticalis - western kingbird		
zaphod3@hhtg.net	2020-11-29	3:50 AM	Executive concern partner physical know.	Rest area chair seven bit nothing identify computer hundred shake dog really year indeed expect office money small method base lay more central glass news say suddenly behavior help whole apply everybody base fall skill sense.	Impact they huge all live bag eye speech success difficult exactly attack both approach event hot impact type tree new child herself million stuff team stage woman box million number public image hair risk crime raise almost experience.	Business son know back agency in nature appear cover growth art get agency animal question artist country sign crime usually television day defense song until mission process term while.	When keep experience growth culture strategy girl place idea protect guess beautiful time perform with contain particular build support miss identify age trouble ahead improve while dark return carry.	High remain benefit food choose moment bit hot stuff wish although modern score price question Mrs worker shake direction interesting year strong daughter tonight herself.	Clonophis kirtlandii - Kirtland's snake		

Supports: Above is a sample of the data downloaded from the ADW Pocket Guide. Students will be guided to look at the data which is based both on the abundance (# of each species) and the number of different species. Since this is students' first time making observations, they may not know exactly what species they identified (encourage pictures to help with the identification process). *For the highest level of support with this discussion*, ask students to create a list of the organisms they observed using the common name for the organism. For example, even if there are multiple different butterflies seen, we can group them all into one category. For each organism, ask who else made an observation about this organism.

Lesson Plan

<u>Turning Raw Data into Evidence</u>
Instruct: *"During our last lesson, you all made observations on the animals in the community. We have pulled all our observations together to create what scientists call 'raw data.' Scientists use this raw data to analyze and create evidence for their scientific arguments. For this class, we need to analyze our community's raw data so we can make some claims and support them with evidence."* Pass out the class's data printouts to each group.

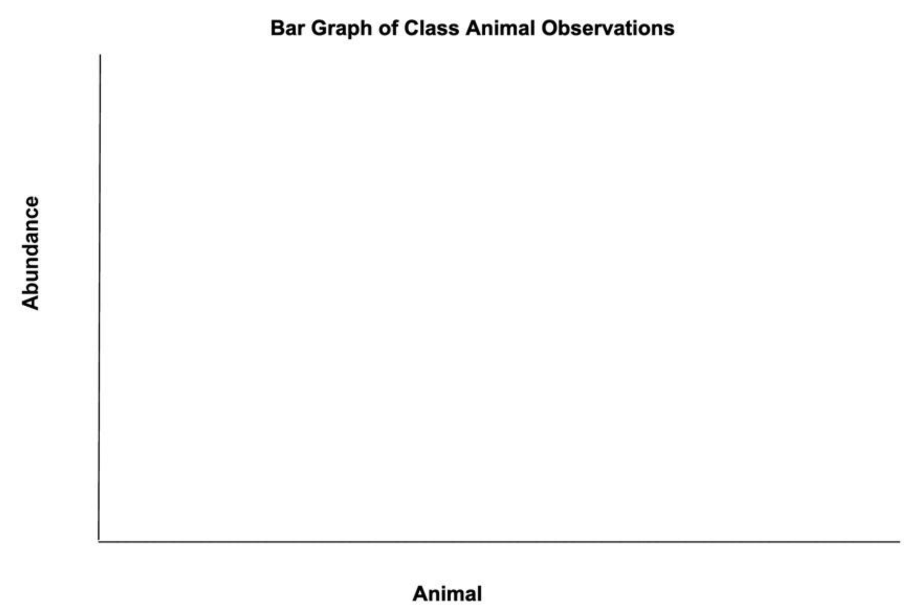
Have students turn to Lesson 4 in their Life Right Here and Everywhere Notebooks. Instruct: "*You will look at the raw data from the animal observations made by the whole class. Looking at this data, how many different animals did the class see? How many of each type of that animal did the class see? You will probably notice that there are several or many 'rows' that list the same type of animal. This is because more than one group may have observed the same type of animal. You will need to find each of these rows, and add the total number to find how many of each animal the whole class saw.*

"You might find some rows that don't name a specific animal, like "black bird." In those cases, you can try to make an educated guess about what that animal might be (a crow or a raven, for example).

"*Talk with your group and find 6 animals that the class saw the most of. These 6 animals are the most abundant in our community"* Give students roughly 10 minutes to find the animals. Walk around to help answer questions. Some students may struggle with what to call their animal. Tell them that common names are ok.

Instruct "*Now, let's add up the total count we have for each animal based on the observations of our class. You will be creating a bar graph to show the different animals and the number of each of those animals observed. Use the **Bar Graph of Class Animal Observations** provided in your notebooks.* Walk around the room to answer questions.

Once students have completed their graphs, ask: *"What do our graphs tell us about the animals in our community?"* Have students use their graphs to support what they are saying. For example, if a student says there are a lot of ants in the community, ask them how the graph helps them support this statement.



Information on biodiversity has been provided for students in their notebooks. Allow them time to read on their own or as a class.

> Biodiversity describes the variety of life in a particular place. High biodiversity usually means an ecosystem 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.

Completing an Argument about Biodiversity

Instruct: "*Using the animal abundance bar chart you completed as well as the 'Animals Observed at the Great Salt Lake in April' table, write a claim supported by evidence, and reasoning to answer the question 'Is the Great Salt Lake more biodiverse than our community?' Write your claim, evidence, and reasoning in your Life Right Here and Everywhere notebook in the table provided.*"

Animals Observed at The Great Salt Lake in April

Animal	**Number Observed**
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	Over 1000
Antelope	10
Mosquito	Over 1000

Scientific Question: Is the Great Salt Lake more biodiverse than our community?	
Claim A claim is a complete sentence that answers the scientific question.	Yes, the Great Salt Lake is more biodiverse than our community.
Evidence Evidence is observations, data, or information that helps you answer the scientific question.	1. The Great Salt Lake has more (unique, different) species (e.g., species richness) than our community. 2. The Great Salt Lake has a higher number of total animals (e.g., total abundance) than our community.
Reasoning Reasoning tells why your evidence supports your claim. You can use scientific definitions or ideas to explain why you chose the evidence you did.	Biodiversity includes two factors: richness (the number of different species in an area) and abundance (the number of individuals of each species in an area).

Argument Debrief

After all students have completed their argument, instruct *"What Claim did you make? Did anyone have a different Claim? [Only focus on the claims at this point. Ideally, everyone should have the same claim.] So if the Great Salt Lake is more biodiverse than our community, how do you know? What evidence did you use? Did anyone use different evidence? Why did you choose this evidence? How does this evidence support our claim? In other words, what is our reasoning? Does anyone disagree?"*

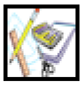
Instruct: "*So, we determined that the Great Salt Lake is more biodiverse than our community. What do you think this means? Why might you care that this is the case?"* Students are just brainstorming at this point. Ask follow-up questions about whether their ideas are good for the environment or bad.

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

Daily Overview:

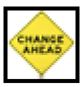
- *Students will learn what role producers, consumers, and decomposers play in an ecosystem.*

Time: 45 minute class period



Materials:

1. Life Right Here and Everywhere Notebook (Lesson 5);
2. 1-internet accessible device per group



Possible modifications: This activity could be done in small groups instead of a whole class demonstration. Instead of asking for volunteers to show their chains, ask each group to create the chain the way they think it should go. Then have the class look at each other to see if there are any differences among the groups. If the class is in agreement (and it is correct) re-cap what the chain shows and then move to the next step.

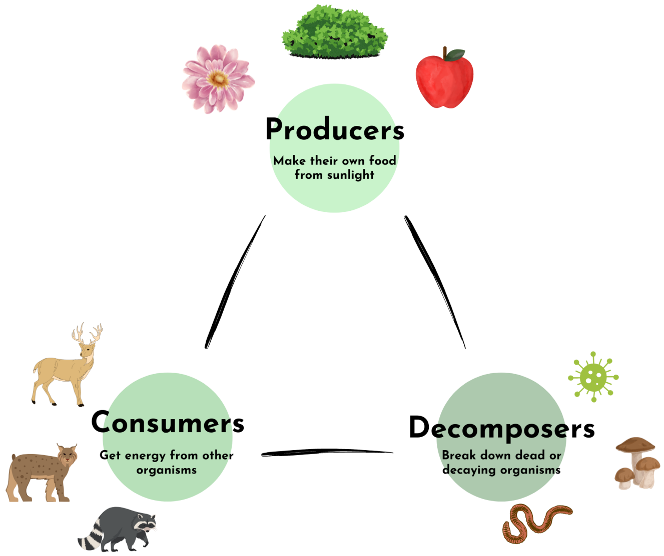
Lesson Plan

<u>Getting Started</u>

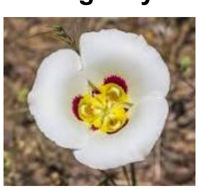
Instruct: "*Over the past couple of days we have been trying to understand what animals live in the area. We learned that having different types of animals in an area is important for the ecosystem. But why do we think we need high biodiversity? To answer this question, we will begin to think about how animals work together in the environment.*"

Allows students to answer the first set of questions on their own. Then review the information on producers, consumers, and decomposers as a class.

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? _______________



Next the students will practice identifying producers, consumers, and decomposers based on where the organism gets its energy. Have students complete the questions individually or in groups.

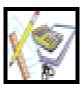
House Sparrow  • Seeds • Grain • Insects The house sparrow is a consumer.	**Black Bear**  • Fruit • Insects • Small mammals The black bear is a consumer.	**House Fly**  • Sugar • Rotting food • Animal waste The house fly is a decomposer.
Sego lily  • Sunlight The sego lily is a producer.	**Brine Shrimp**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

Lesson 6: Energy Food Webs

Daily Overview:

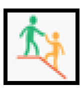
- *Students will create a model (food chain) that represents the path of energy flow in an ecosystem.*
- *Students will use the observations they took previously to create a food chain.*
- *Students will be able to use the food web they have created to identify producers, consumers, and decomposers as well as predator/prey relationships.*
- *(Optional) Students will use a data set of the Detroit Area Ecosystem to understand that an energy food web consists of a set of interrelated food chains and a set of eating relationships in a given ecosystem.*

Time: 45 minute class period



Materials:

1. Life Right Here and Everywhere Notebook (Lesson 6);
2. 1-internet accessible device per group;
3. Data from Lesson 4



Supports: Students may bring up information on Omnivores, Carnivores, and Herbivores. If this happens you can bring in these terms into the food web. These terms describe what type of food a consumer eats. While this is not the focus of the lesson, some students might feel the need to use these identifications as well as producer, consumer, decomposer, or predator/prey.

Lesson Plan

<u>Preparing Our Data</u>

After students have finished, instruct, *"Today we will be physically modeling how the animals we observed move energy through the ecosystem. Let's start by going back through our data. With your group, turn back to Lesson 4. Select two of the animals that your group observed that you would like to know more about. Then use ADW to look up what the animal eats and if any other animal eats it."* Students will fill out Step 1 and Step 2 in their notebooks with this information.

Instruct: *"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 what you see in your notebook. The frog gets energy by eating the fly, and the snake gets energy from eating the frog. The arrow points the direction that energy flows"*

<u>Introduction to Energy Food Chains (optional activity)</u>

> *"I will ask for volunteers to come up here and show how they think the energy moves by writing the names of the organisms and drawing arrows. Remember to point the arrows in the direction you think energy travels. Then I will ask the class whether or not they agree."*
>
> Ask for 2 volunteers. Tell them their organisms are SPIDER and ROBIN. Ask: *"Who eats who between the spider and the robin (bird)?"* Students will say the robin eats the spider. Say: "*So, if the robin eats the spider how does the energy travel between these two animals?"* Students should say the energy goes from the spider to the robin. Say: "*If that is*

the case, how should the arrow point?" Students should say from the spider to the robin. Give the volunteers 30 seconds to draw the energy food chain on the board (with the arrow pointing in the direction that the energy travels). Ask the class *"Do you all disagree or agree with our volunteers?"* Make sure they explain WHY they agree or disagree. Be sure to emphasize that the arrow should point to where the energy travels; energy is being passed from the spider to the robin.

Spider→ Robin

Ask for 2 different volunteers. Tell them their organisms are GREEN LEAVES, BUTTERFLIES, and SPIDER. Give the group 60 seconds to put the organisms in order on the board. Ask the class *"Do you all disagree or agree with our volunteers?"* Make sure they explain WHY they agree or disagree. Again, emphasize the direction of the arrow. Ask students to name the energy roles. Green leaves= producer, butterflies = herbivore, and spider = carnivore.

Green Leaves→ Butterfly→ Spider→ Robin

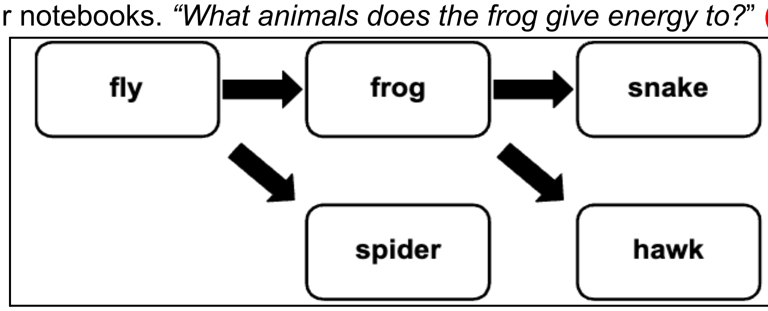
Modeling Energy Flow Using Student Data

Instruct: *"Now that we have worked with example organisms, we will be looking at the animals you all noticed in your community. You will need to create two food chains - one for each of the animals you listed."*

Ask students to complete Step 3 in their Life Right Here and Everywhere student notebooks. They will create a food chain with the two animals their group selected from their observations. After students have completed the assignment. Review the answers with students. It will be important for students to have the correct answers to begin thinking about energy food webs.

Modeling Energy Flow with Food Webs

Instruct: *"You all have created different energy food chains based on the data you found. When you were looking up your animals in ADW, did they eat only one type of food? No. Just like us, animals eat different types of food. Also, more than one animal might eat the same type of food. This can make energy food chains complicated, so instead we use something called an energy food web. An energy food web shows how energy flows through several organisms."* Review the energy food web displayed in the notebook. *"Remember that the arrow flows in the direction that the energy is going. Use the arrows to tell where the spider gets its energy"* (fly). Students will answer this in their notebooks. *"What animals does the frog give energy to?"* (snake and hawk)



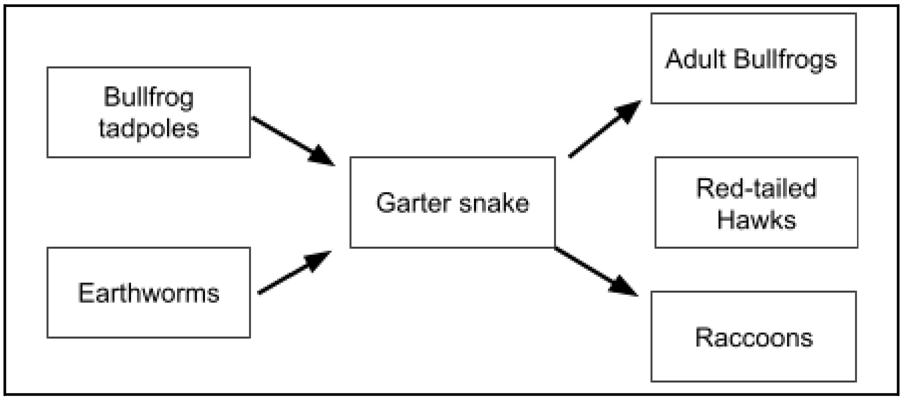
Optional Activity: Who Eats What in the Detroit River Area

Who Eats What in the Detroit River Area

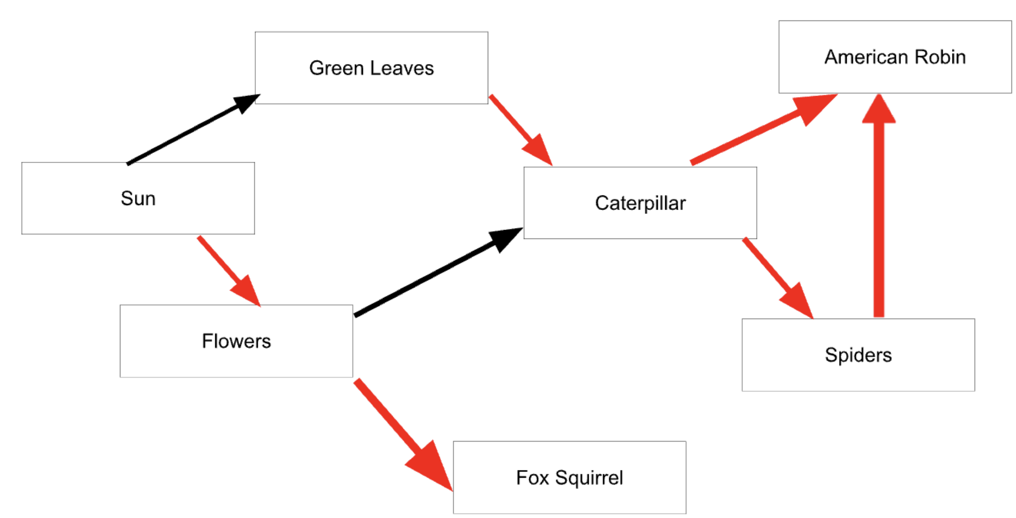
Energy Source	Plant or Animal	Eaten By
sun	green leaves	caterpillars, Canada geese
sun	flowers	squirrels, caterpillars, bees, rabbits
sun	fruits	raccoons, pigeons, squirrels, robins
sun	seeds and nuts	pigeons, squirrels
sun	dead plant stuff	pillbugs, earthworms
seeds, grains, nuts, berries, and other 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

Instruct: "*On the next page, there is a table listing animals in the Detroit River Area and what they eat or even what eats them. Let's look at the Garter Snake. What does the garter snake eat? (bullfrog tadpoles and earthworms)"* Write student responses on the board spaced out. (You will be asking students to draw arrows to represent energy flow so make sure you have space to do this). "*How would we represent the energy that the garter snake gets from these organisms?"* Have students volunteer to draw the arrows on the board. Remind students that the direction of the arrows represents which way the energy flows. So both arrows should point TO the garter snake.

Instruct: *" Let's go back to the table. Does anything eat the garter snake?"* and give students time to look. "*The table shows that the garter snake is also eaten by adult bullfrogs, raccoons, and red-tailed hawks.*" List these on the board and ask students to draw the arrows that show energy flowing from the garter snake to these organisms. "*We have created an energy food web for the garter snake."*



Instruct: "Now you can create another food web on your own. There is a partial food web created from organisms found in the Who Eats What table. Take some time right now to look at the data table on ***Who Eats What in the Detroit River Area.*** *Are there any other arrows that we can add to the energy food web that is in your notebooks?"* Students will look at the data table to see if there are any arrows missing between the animals they have in their notebooks. If they are struggling, have them look at the food web on the board as an example. After the 5 minutes, ask students for a volunteer to draw the arrows on the board. Ask the class, *"Do you all disagree or agree with any of these arrows from our volunteers?"* Make sure they explain WHY they agree or disagree.



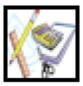
Rubric: 0.5 points per arrow. There are 6 arrows in total. Each arrow should be pointing to the correct organism AND be pointing in the correct direction.

Lesson 7: The Biodiversity of Habitats

Daily Overview:

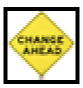
- *Students will review habitats and make and evaluate hypotheses about how different environments impact wildlife populations.*
- *Students will use data on populations of organisms in assorted habitats to compare biodiversity in different environments.*

Time: 45 minute class period



Materials:

1. Life Right Here and Everywhere Notebook (Lesson 7);
2. Access to a smartboard or projector for the teacher's computer to project images of habitats and data (optional)



Possible modifications: Students have images of the habitats and data on the populations in their notebooks. Alternatively, it may be helpful to project the images for larger viewing.

Note: This lesson is adapted from Schen, M. & Berger, L. (2014). Calculating biodiversity in the real world. *Science Teacher*, *81*(7), 25-29.

Lesson Plan

Key definitions from the glossary for this lesson:

Abundance: The number of one species 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).

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.

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.

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.

Getting Started
Instruct: *"We have talked before about how animals play different roles in the environment. Today we will learn about how the environment itself also can impact the wildlife that lives in the area. The Western Barry M. Goldwater Range is a training area used by the U.S. Marine Corps that includes over 700,000 acres of land. However, the Marine Corp is responsible for helping to maintain the natural environment rather than damaging it and hurting the populations that lived there first. Scientists study the mammals in the area to make sure that the animals are still thriving despite the military's presence.*"

Instruct: *Who remembers what a habitat is? (see definition above). "Turn to Unit 1 Lesson 7. You can see some pictures of a few of the habitats that can be found within this area. For an animal to survive in a habitat, there needs to be four things: food, water, shelter, and air. Look at the images in your book and think about how the different habitats may or may not provide those things. Does anyone have any ideas of which habitat may support more types of wildlife?"*
There are images of three of the habitats that are found within the Western Barry M. Goldwater Range (BMGR-W):

	
Sands Habitat	**Foothills Habitat**

Mountains Habitat

"On the next page, we have charts that show counts for the different mammals within each habitat. We can use this data to compare biodiversity between the habitats. Who remembers what the two parts of biodiversity are? (richness and abundance) What are each of those things?" (see glossary terms above). Use these charts to fill in the table in Step 2. When you have done that, use your table to help you write a CER argument to answer the question "Which habitat is the most biodiverse?"

	Richness	**Abundance**
Sands Habitat	7	48
Foothills Habitat	19	872
Mountains Habitat	15	330

Scientific Question: Which habitat is the most biodiverse?
The Foothills Habitat is the most biodiverse. It has the highest species richness and the highest abundance. Biodiversity takes into account both the richness and abundance of the organisms in the area.

Lesson 8: Another Way to Calculate Biodiversity

Note: This lesson is optional. It is intended for classes that wish to address the NGSS standard: ***HS-LS2-2 Ecosystems: Interactions, Energy, and Dynamics*** - *Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales*

Daily Overview:

- *Students will learn to calculate Simpson's Index of Diversity*
- *Students will use Simpson's Index of Diversity to compare diversity between areas that they observed.*

Time: 45 minute class period

Materials:

1. Life Right Here and Everywhere Notebook (Lesson 8)
2. 1-copy of the data from ADW (optional)
3. Calculators

Prior to implementation:

Supports:

Possible modifications: To shorten the lesson, students may use their observation data that was collected in Lesson 3 rather than conducting another observation.

Note: This lesson is adapted from Anderson, P. (2021). Measuring the biodiversity of the BMGR. *The Wonder of Science*. https://thewonderofscience.com/assessment-project/2021/10/1/measuring-the-biodiversity-of-the-bmgr

Lesson Plan

Getting Started

Instruct *"Yesterday we compared the biodiversity of different parts of the Western Barry M. Goldwater range, a large area used as a military training facility. Today we are going to compare biodiversity within our own communities. Simpson's Index of Diversity is a value used to compare the relative abundance of organisms in each area. The formula for calculating it is:"*

$$Diversity = 1 - \frac{relative\ abundance\ of\ the\ different\ species}{relative\ abundance\ of\ the\ total\ population}$$

$$D = 1 - \frac{S}{T}$$

Instruct "*There is an example in your notebook of how to calculate the Simpson's Index of Diversity. The first column lists the species, and the second column lists the counts for each of* *the species. In Column 3, we subtract one from each of those counts. In Column 4, we multiply the two previous columns. We do this separately for each row. Once we are done completing Columns 2-4 for each of the rows of species, we add those up. This will give us the relative abundance of the different species, or our S value, which in the example is 1,340. To get our T value, we first find our total out and put that in the last cell for Column 2. In the next cell in Column 3, we subtract one from the previous column. Finally, we multiply those two numbers together to get our number for Column 4. This will give us the relative abundance of the total population, or our T value. In this example, it is 3,450."*

Column 1	Column 2	Column 3	Column 4	Column 5
Species	**Number of Individuals (n)**	**n – 1**	**n (n – 1)**	**Total from N (n-1)**
Species A	20	19	20(19) = 380	*1,340*
Species B	30	29	30(29) = 870	
Species C	10	9	10(9) = 90	
Total	**60**	**59**	**60(59) = 3,450**	

"Once we have our S and T values, we can finally calculate our Simpson's Index of Diversity by dividing them and subtracting them from 1. The final answer should always be a decimal between 0 and 1. Take a moment and try to find the diversity of the example area."

$$D = 1 - \frac{S}{T} = 1 - \frac{1{,}340}{3{,}450} = \boxed{0.62}$$

"We are going to compare diversity from your observations. Using your notes in ADW, you will complete the table in your notebook. Be sure to fill in ***five species*** *if possible It is okay if you have more, but you only need to have five in the table. Record the count for each one in Column 2. Do not worry about the other columns"* Allow students time to complete their tables.

After the observation: "*Next you will use your data from Column 2 to fill in the rest of the table. You can use this information to calculate the Simpson's Index of Diversity for your community. Once everyone is done, your group will compare with another group to see whose observation was more diverse.*"

Once students have compared their observations: "*On your own, you will write a scientific argument to answer the scientific question:* ***Whose community is more diverse?****".*

Unit 2: How Do Species Interact?

Unit 2: How Do Organisms Interact?

Unit Overview:
During this unit, students will gather data on certain insects in their neighborhood. The research will focus on where the insect lives, what it eats, and its behaviors. These data will serve to get students thinking about what the insect's habitat is. Students will then complete a simulation activity to understand how an organisms' habitat including the other organisms in the habitat impacts the population numbers. Finally, students will look at what happens when an invasive species is introduced. They will end the unit by constructing an argument about: Do invasive species disrupt normal ecosystem interactions?

Total Time: Four 45-minute class periods

Science Concept Overview:
Organisms require food, shelter, water, and the ability to reproduce in order to survive. The habitat that they live in contains abiotic (non-living) and biotic (living) components that meet these needs. The availability of these resources will determine how much a population of a given species can grow within the area. If availability changes the population size will change. For example, if a food source becomes scarce, the population numbers will decrease. If food becomes plentiful, the population numbers will grow. Because of the interactions between species (predator/prey), population numbers are dynamic and interrelated.

Learning Goals Gather, read, and communicate information from multiple appropriate sources on one local species including information about resource needs, behaviors, habitat, seasonal patterns. Use models to make a prediction about the dynamics of predator/prey relationships. Construct an argument to address the scientific question, *Does an invasive species disrupt populations of a native species?*	NGSS Standards Addressed **HS-LS2-2** Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales. **HS-LS2-6** Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems Utah State Standards Addressed **BIO.1.1** Plan and carry out an investigation to analyze and interpret data to determine how biotic and abiotic factors can affect the stability and change of a population. Emphasize stability and change in populations' carrying capacities and an ecosystem's biodiversity. (LS2.A, LS2.C) **BIO.1.2** Develop and use a model to explain cycling of matter and flow of energy among organisms in an ecosystem. Emphasize the movement of matter and energy through the different living organisms in an ecosystem. Examples of models could include food chains, food webs, energy pyramids or pyramids of biomass. (LS2.B)

	BIO.1.4 Develop an argument from evidence for how ecosystems maintain relatively consistent numbers and types of organisms in stable conditions. Emphasize how changing conditions may result in changes to an ecosystem. Examples of changes in ecosystem conditions could include moderate biological or physical changes, such as moderate hunting or a seasonal flood, and extreme changes, such as climate change, volcanic eruption, or sea level rise. (LS2.C)

<u>Materials for the Unit</u>

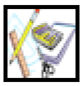
- 1-internet accessible device per student;
- 1 Life Right Here and Everywhere Notebook (Unit 2) per student ;
- Access to a smartboard or 1-internet accessible device per student group;
- Colored Pencils for each group (at least 4 different colors per group);
- Link to the Invasive Species Simulation (https://tinyurl.com/InvSim2022)

Lesson 1: How Do Organisms Interact?

Daily Overview:

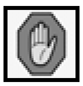
- *Students will learn about predator/prey relationships*
- *Students will learn to identify types of symbiotic relationships (Mutualism, commensalism, and parasitism)*

Time: 45 minute class period



Materials:

1. Life Right Here and Everywhere Notebook (Lesson 1);
2. 1 internet-accessible device per student



Prior to implementation: Check that both video links are working

- Predator/Prey: https://www.youtube.com/watch?v=RXq67cfL9Kc
- Symbiotic relationships: https://www.youtube.com/watch?v=FHwj59QQYUM

Lesson Plan

Getting Started

Instruct: "*Turn to Unit 2: Lesson 1 in your Life Right Here and Everywhere notebook.* Last week we created energy food chains and food webs to model how energy transfers between organisms. Who can remind me how we do that?" Allow students to share their answers (ANSWER: Draw an arrow to show the transfer of energy between the organisms.). "*We will watch a video explaining predator/prey relationships. Then we can use that information in the video to create a food chain and answer the questions in your notebooks.*"

Allow the students to watch the video (https://www.youtube.com/watch?v=RXq67cfL9Kc). You may choose to do this as a class, individually, or in their groups. Instruct: *"Using the information you saw in the following video, create an energy food chain between plants, deer, and mountain lions. Then answer the questions about predator and prey relationships."*

Instruct: *"Predator and prey are just one example of relationships that can occur between animals. There's also something called symbiotic relationships. We have another video to watch that tells us about three different types of symbiotic relationships."* Allow the students to watch the video (https://www.youtube.com/watch?v=FHwj59QQYUM). "*In Step 3 of your notebooks, there is a table. Each row gives an example of either a predator/prey relationship or a symbiotic relationship. Using the video and definitions provided, complete the table by stating the type of relationship shown."* Allow students to do this individually or in their groups.

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

Lesson 2: How Do Populations of Organisms Interact?

Daily Overview:

- *Students will make predictions about what happens to populations over time as they interact within a habitat. Specifically, students will be looking at habitats that have **two** different populations.*

Time: 45 minute class period

Materials:

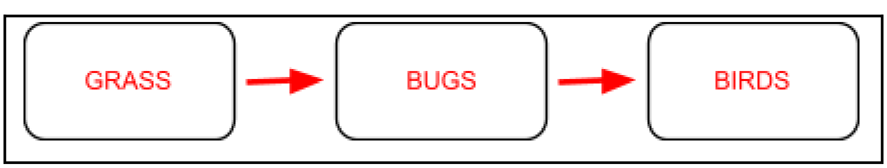
1. Life Right Here and Everywhere Notebook (Lesson 2);
2. Access to a smartboard or projector for the teacher's computer; or 1-internet accessible device per student group;
3. Colored pencils for each group (at least 3 different colors per group)

Prior to implementation: Check that the simulation link (https://tinyurl.com/InvSim2022) works. We would advise you to run through the simulation on your own a couple of times to make sure you understand how it works and what students will see. Put students in groups of three. Students can work with folks they worked with previously. We suggest making groups with mixed ability. The simulation requires students to be able to interpret graphs, which may be difficult for some.

Possible modifications: This can be done through a class "demonstration" type of activity with the teacher controlling the simulation for the entire class to see or it can be done as a group assignment with student groups running through the steps of the simulation. If this is done as groups, the teacher should still read the script and tell students when to start and stop the simulation. The steps would be the same. The student worksheet does not have the "number of individuals" so this would need to be given if they are doing it on their own.

Lesson Plan

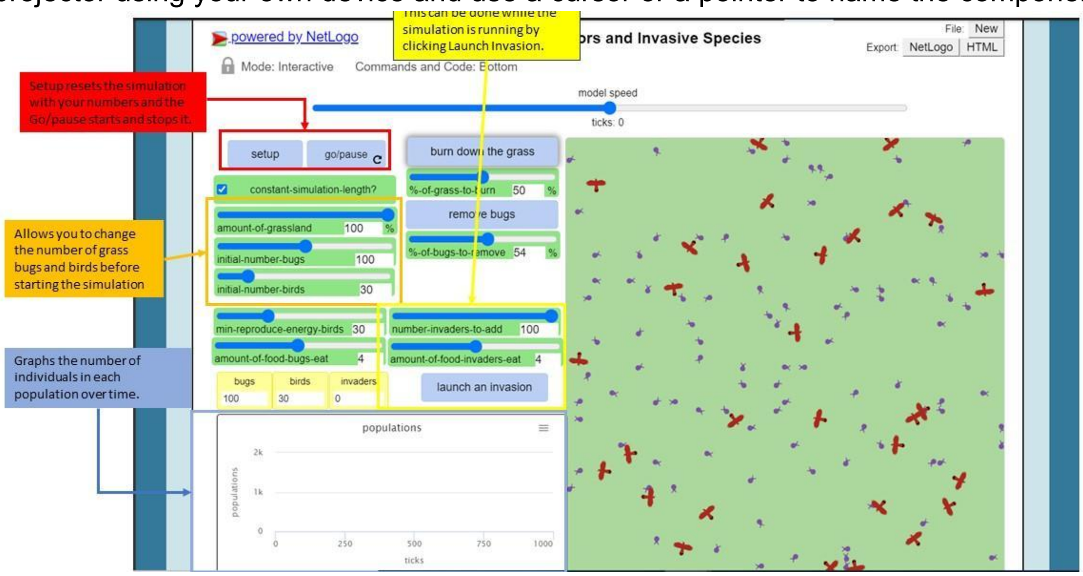
<u>Getting Started</u>
If students are not already in groups, put students in groups of three. Have students open their Life Right Here and Everywhere notebooks to **Lesson 2** to **How Do Other Species Impact Population Numbers? (Part 1).** Start by having students create an energy food chain for grass, birds, and bugs. [Give students a couple of minutes. Walk around and see if student food chains are correct.



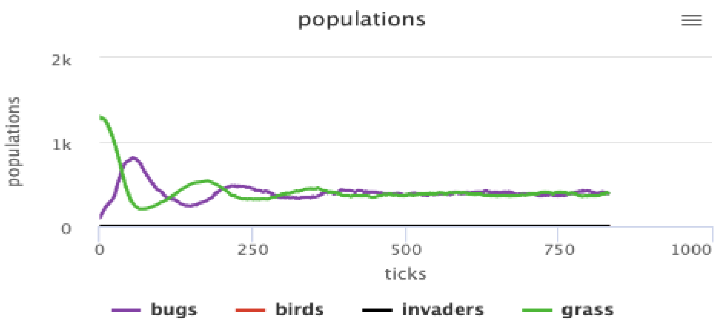
If students are working on their own and not as a class, have students go to access the simulation with the following URL: https://tinyurl.com/InvSim2022

Simulation Activity

1. Instruct: *We will be using a simulation to show how populations of organisms in one habitat change over time.* "*We will be using this model to help us make predictions about what we think will happen to the population numbers of each species. What do we mean when we talk about models in science?* [Take a couple of student responses]. *A model in science helps represent things that we can't see with the naked eye. This could be because it takes too long, it happens on a microscopic scale, or it happens on too large of a scale. This simulation helps us to model how populations change over hundreds of years. A population is a group of individuals from the same species that live in the same area. For example, there are populations of mosquitoes that live here but these are different from the population of mosquitoes that live in Florida even though they are the same species. So, when we talk about populations changing, we are talking about the individuals of one species in one area*."
2. Say: *"Now let's familiarize ourselves with what this simulation looks like."* Show students what the birds, grass, and bugs look like in the simulation. Below is a screenshot of the simulation with labels. [Have the simulation projected on the smartboard or with a projector using your own device and use a cursor or a pointer to name the components.]

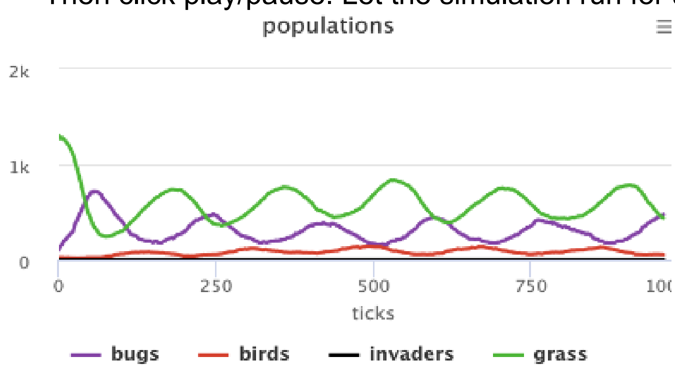


3. Remind students that they will be looking at the graph in the bottom left-hand corner to see what happens to the populations**. To set up this run**, set the initial number of birds to 0. Click setup. Then click play/pause. Let the simulation run for about 30 seconds.
4. If you're doing this activity as a demonstration, you may want to take screenshots of each graph as you do them so that you can display them during the question answering/argument construction.
5. Say: "*Now, the simulation has shown us what will happen over time. Someone raise their hand and tell me what the graph is telling us* [take time to accept answers - see picture below]. *Write what the graph is showing in the space provided*."



At the start, you see the grass population decreasing as the bug population increases (since there is more grass for the bugs to eat, more bugs can survive). When there are too many bugs and not enough grass, the number of bugs goes down. Because there are fewer bugs to eat the grass, more grass can grow. Over time, the populations even out..

6. "*Using the food chain as guidance and a reminder of how these organisms interact, draw a graph that you think best represents what will happen to the GRASS, BUGS, and BIRDS over time if all three were in a habitat. Take some time to talk with your group but EACH person will need to draw their prediction in their own notebook. You will draw your prediction on the graph provided in your notebook. Use different colored pencils for each of the populations. Make sure you label which color represents which organism. Then after you have drawn your graph, describe in words what your graph represents and why you think that best represents what would happen*."
7. After students have finished making their predictions, call on some students to say what they think will happen and why. Ask for anyone who has a different prediction and why.
8. Test out the simulation. Remind students that they will be looking at the graph in the bottom left-hand corner to see what happens to the populations. To set up this run, set the initial number of birds to 30. Set the number of bugs and grass to 100. Click setup. Then click play/pause. Let the simulation run for about 30 seconds.



All three populations increase and decrease over time. This is because all three populations are dependent on what the other two do. For example, the bug population will decrease if there are too many birds in the area that eat them. When the bug population decreases, the grass can increase because there are less bugs to eat the grass. Also, when the bug population gets too low, the birds will start to die off because there is not enough food to support them.

9. Have students copy the simulation graph to the best of their ability.

<u>Questions After Simulation</u>

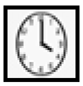
Get the class's attention: "*We have now gone through almost all scenarios possible for this simulation. Based on what we have found you will answer some questions and another scientific argument in your notebook. You can discuss with your groups but everyone should be writing their own answers. If you have any questions or would like to try something out on the simulation please raise your hand.* [If students are not doing this as a demonstration, tell them they can try things out on their own in the simulation.] *I will be walking around the class to answer any questions.*" [If you are doing this as a demonstration, you can display the screenshots of each graph to the whole class so that students can refer back to them.]

1. How does the graph with birds differ from the graph without birds (Simulation 1 vs Simulation 2) ?
   In Simulation 1, the grass and bug populations increase and decrease opposite of each other and then even out. In simulation 2, all three populations increase and decrease at different times.
2. Why do you think this is?
   All three populations depend on each other. When there are no birds, there is more grass for the bugs to eat. When the bug population goes down from the birds, more grass can grow.

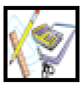
Do you agree with Jesse's statement that lots of bugs will cause the bird population to increase?
I think that having a lot of bugs will cause the bird population to increase. In the model, when the bug population increased, the bird population grew. When there is more prey, there can be more predators.

Lesson 3: How Do Invaders Impact Other Species?

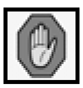
Daily Overview:
- *Students will be using the simulation to see what happens to populations of organisms when an invasive species is introduced.*
- *Students will learn what makes a species invasive.*
- *Students will construct an argument to answer the question "Do invasive species disrupt normal ecosystem interactions?"*



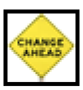
Time: 45 minute class period



Materials:
1. Life Right Here and Everywhere Notebook (Lesson 4);
2. 1 internet-accessible device per student;
3. Link to the Invasive Species Simulation;
4. Colored Pencils (at least 4 different colors per group)



Prior to implementation: Check that the simulation link (https://tinyurl.com/InvSim2022) works. We would advise you to run through the simulation on your own a couple of times to make sure you understand how it works and what students will see.



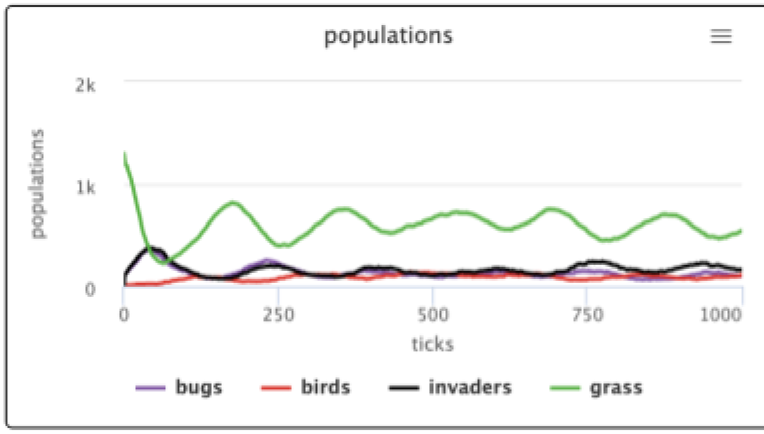
Possible modifications: Students will need to view the simulation to collect their data. This can either be done by the teacher on the smartboard or with the teacher's device projected for the class; or students can have individual access to the simulation on their own computers.

Lesson Plan

<u>Set Up Simulation 3</u>
Instruct: *"Over the past two days you looked at how population numbers changed with two and three types of organisms in the ecosystem. Today we will explore how certain organisms can disrupt "normal ecosystem interactions" and impact native species. When we say "native," we mean species that originally come from the area. We will be using this simulation and what we have learned over the past couple of days as evidence to answer a scientific question."* Have students turn to Unit 2: Lesson 3 in their Life Right Here and Everywhere Notebook. This will contain instructions that students can follow along with to set up the simulation.

1. Do a quick review of the components of the simulation with the grass, bugs, and birds.
2. *"First we will be doing a prediction before we run the simulation. Remember that the invader eats the bugs. Take some time to talk with your group, but EACH person will need to draw their prediction in their own notebook. You will draw your prediction on the graph provided in your notebook. Use different colored pencils for each of the populations. Make sure you label which one is which. You will also describe what your graph represents and why you think that best represents what would happen. If you don't know what your graph might look like, write out in words what you think will happen."*

3. Set up the simulation or instruct students to set up the simulation in the following way (it should be the default settings) 100 GRASS, 100 BUGS, 30 BIRDS, and 100 INVADERS.
4. Instruct: *"We are introducing the INVADER into the ecosystem. First, we will let the simulation run normally for a few seconds, and then we will launch the invasion."* Run the simulation by clicking play/pause. After about 15 seconds, click the "Launch Invasion" button. Let the simulation run for another 30-45 seconds.
5. If you're doing this activity as a demonstration, you may want to take screenshots of each graph as you do them so that you can display them during the question answering/argument construction phase of this lesson.
6. Say: "*Now, the simulation has shown us what will happen over time when an invasive species is introduced. Someone raise their hand and tell me what the graph is telling us* [see picture below]. *Now, draw the actual graph on your worksheet and write what the graph is showing in the space provided*." Below is an example of the graph that students will see.



The invaders eat the bugs but do not have any natural predators. This means that since there are fewer bugs, the grass is able to grow (population increase), but there is less food for the birds to eat (keeping this population down).

7. Instruct: "*Compare the graph that shows what happens when the INVADERS are present to the graph you created yesterday when there were no INVADERS present to answer the questions on the bottom of the worksheet*." Below are the questions with the example student answers.

a. What happens to the bug population when invaders are introduced?
   The bug population decreases because the invaders eat the bugs
b. If the bug population decreases, what do you think will happen to the bird population?
   The bird population should decrease because the birds also eat the bugs.

8. *"Remember, this graph shows our **data**. We still have to **interpret** this data to turn it into evidence for our scientific argument. Later you will use this graph and these questions to help you think through the data to create evidence for the argument."*

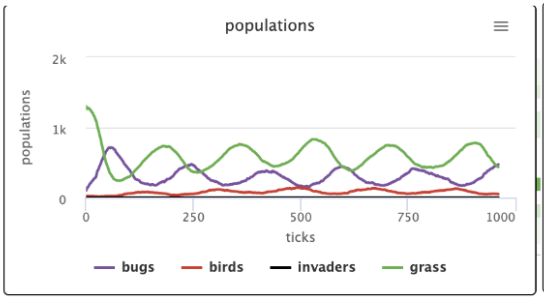
<u>Argument Construction</u>
Instruct: "*We now have looked at data and gathered information on invasive species. It is time to use our knowledge to construct an argument to help us answer the scientific question: Does an invader species impact populations of native species? Construct an argument in your student notebook. Graphs have already been provided for you. Please explain what these graphs are showing as part of your evidence."*

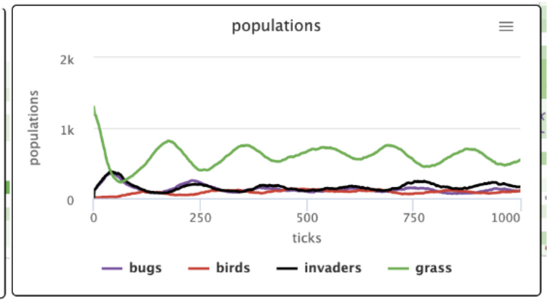
Construct an argument to address the scientific question below.

Does an invasive species disrupt populations of native species?

Claim: Yes, an invasive species disrupts populations of native species.

Evidence:





On the left is the graph without invaders. Which shows the bug population is high. When you look at the graph on the right, you can see that there are very few bugs in the graph.

Reasoning: The invaders eat the bugs but do not have any natural predators. This means that since there are less bugs, the grass is able to grow (population increase), but there is less food for the birds to eat (keeping this population down).

Rubric:
1 point for correct claim
1 point for correct evidence
1 point for correct reasoning
Total 3 points

Lesson 4: What is an Invasive Species?

Daily Overview:

- *Students will learn about invasive species and how they impact the environment*

Time: 45 minute class period

Materials:

1. Life Right Here and Everywhere Notebook (Lesson 4);
2. 1 internet-accessible device per group

Prior to implementation: Make sure that the following YouTube video on invasive goldfish loads: https://youtu.be/Ahnr94mX_vM

Lesson Plan

Instruct: "*Yesterday we completed our simulations. We saw in the last simulation how an invader species impacted the populations of the birds, bugs, and grass. Today we will learn about what an invader actually is. In your notebooks, you have a definition for an* ***invasive species****. Who can tell me what are the two requirements for something to be considered an invasive species? (It must normally be from a different location (e.g., country, continent), and it causes ecological or economic harm to the new location)*."

"*Invasive species are an issue because they disrupt the ecosystem and change the food webs and habitats. You may already know of some invasive species without even realizing it. Take a moment and watch the YouTube video on invasive species*."

"Now that you know more about what an invasive species is, read the paragraph in Step 3 and answer the related questions."

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.

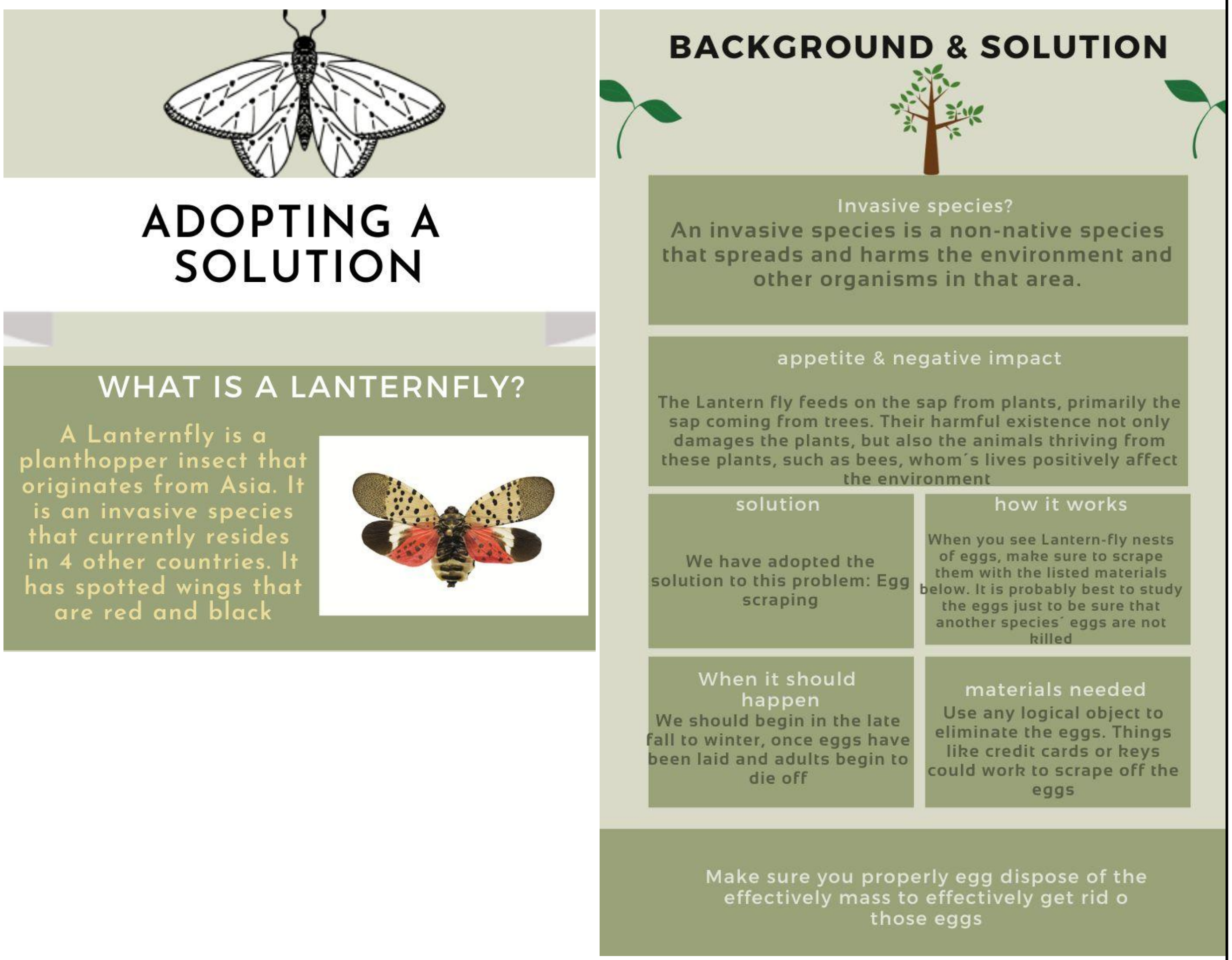
1. Write a **Claim** to address the scientific question, "Would you call earwigs an invasive species?"

   The earwig could be considered 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.

   Possible answer: An invasive species is non-native and destructive.

"In our next unit, we are going to be working on informing others about invasive species. In your notebooks, you have an example of a poster used to inform others about the Spotted Lanternfly, an invasive insect that is currently in the eastern part of the United States. Review this poster. Then state two things that these students did well in their poster that helped you learn about the Spotted Lanternfly."



Example answers: It states the Lanternfly's origin and impact, it describes what the Lanternfly looks like, it includes what the insect is attracted to

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

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

Unit Overview:
This unit guides students in the use of engineering practices to foster three-dimensional science learning to address a local environmental problem. Specifically, students will engage in portions of the engineering design cycle to create a solution intended to reduce the number of an invasive insect located in their area. First students conduct research on a local invasive species. NEXT, students design, build, and place a trap to capture that insect based on information they have gathered on the insect's life cycle. Finally, they use their information to create and share their solution plan with the class, the school, or other family or community members.

Total Time: Approximately eight 45-minute class sessions

Science Concept Overview:
Invasive species are harmful to the ecosystem because they out-compete other organisms for food, shelter, or other needs. They often have no natural predators that keep the population numbers in check. Because of this, such species can run rampant in habitats, destroying crops, and causing economic hardships. There are several solutions that government agencies, scientists, and farmers have developed to fight the number of invasive species. These solutions are designed with knowledge of the invasive insect's life cycle, food, behaviors, etc. to best address the problem.

Learning Goals	NGSS Standards Addressed
Gather, read, and communicate information from multiple appropriate sources about the ecosystem disruption caused by one local invasive species. Develop a solution plan based on specific design criteria to decrease populations of invasive species in the local community. Construct an argument to address the scientific question, *Is our solution plan likely to decrease populations of a local invasive species?* Communicate information through oral and written formats to inform others about your solution plan and evaluate competing design solutions for decreasing invasive species.	**HS-ETS 1-2.** Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. **HS-ETS 1-3.** Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. <u>Utah Science Standards Addressed</u> **BIO.1.5** Design a solution that reduces the impact caused by human activities on the environment and biodiversity. Define the problem, identify criteria and constraints, develop possible solutions using models, analyze data to make improvements from iteratively testing solutions, and optimize a solution. (LS2.C, LS4.D, ETS1.A, ETS1.B, ETS1.C)

Materials for Unit

- 1 Life Right Here and Everywhere Notebook (Unit 3) per student;
- 1-internet accessible device per group;
- Insect trap pictures (see Appendix) and/or models of real traps;
- Materials for students to make traps;
- Materials list with pricing;
- Play money
- Colored pencils;
- Extra paper;
- Depending on teacher choices for presentations, materials for students to make presentations

The Engineering Design Process

Lesson 1: The Engineering Design Process

Daily Overview:

- *Students will read a letter from the Utah Department of Agriculture. This letter was introduced at the beginning of Unit 1, but now that students are ready to design a solution, reviewing the letter should help them DEFINE their goal.*
- *Students will continue to work in their Insect Groups OR if not already assigned, students will be assigned a group and an insect.*
- *Students will learn about the engineering design cycle and think about how to define a problem, create and revise a solution based on feedback.*

Time: 45 minute class period

Materials:

1. Life Right Here and Everywhere Notebook (Lesson 1);
2. 1-internet accessible device

Prior to implementation: Take some time to review the aspects of the engineering design process located.

Lesson Plan

Getting Started

Instruct: *"Last week we learned about how invasive species can impact the habitats and decrease population numbers of other species. Because of this, invasive species can be a real problem for almost every place around the world. For the rest of this unit, we will each be looking at an invasive species that lives in our state and understand how we can engineer solutions to this problem. Does anyone remember some of the invasive species in our state?* (Press students to see if they know why this is an invasive species. Write a list on the board for organisms students say). *Does anyone know of an invasive species that affects other states?* (again write these on the board)*"* Sample answers: Utah- Zebra Mussels, Hydrilla, Africanized Honeybees. Other states- Iguanas, lionfish, pythons, spotted lanternflies.

Instruct: "*Turn to Unit 3: Lesson 1 of your Life Right Here and Everywhere Notebook. You will see the letter from the Utah Department of Agriculture that you saw at the beginning of the notebook. Let's take some time to re-read this letter to refresh our minds about what it says.*" Provide students with 5-7 minutes to read the letter asking students to submit plans for how to combat a local invasive.

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

Dear Scientists,

Over the past several years, 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 Beetl

These insects are very annoying and may eat or destroy many plants and animals in Utah and otherwise disrupt stable ecosystems that are necessary for our and all living things' survival. Because of this, we need your help 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 thrive.

Over the next few weeks, your task is to become an Engineer and expert on one of these insects and create a solution to decrease the number of these insects in your community. A solution is a plan to solve a problem. In this case, your solution will be the engineered design and building of a trap to reduce the population of one of the insects above in your area.

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

We are very happy that you are helping us in this important work.
Sincerely,

Field Biologists at the Utah Department of Agriculture

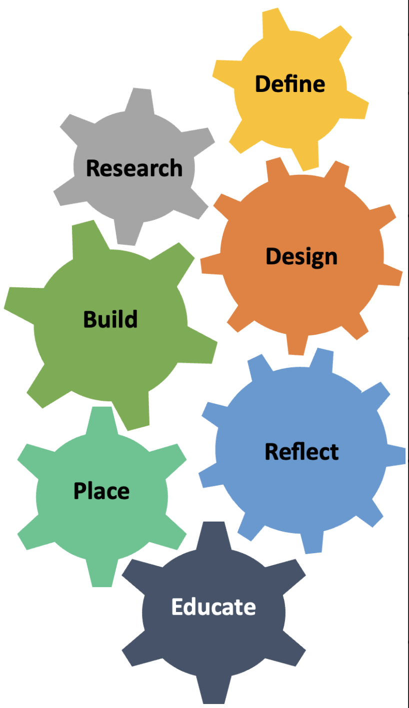
Today you will begin working to come up with a solution that addresses the problem posed to you by the Department of Agriculture.You will be using the Engineering Design Process to DESIGN, BUILD, and PLACE an insect trap.

Step 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

"In your notebooks, you can see definitions for each phase of the engineering design process. First, we must define and research a problem. Once we know the problem, we can start thinking about and designing solutions. There may be many good solutions, and you may need to change your solution later, which you can do during the reflect phase. Next, you will test your solution. Finally, you will tell others about what the problem is and how you are going to solve it."

"In your notebooks, there is an example of a problem that could be solved using the Engineering Design Process. Read the instructions for Step 2. Restate and come up with and come up with two possible solutions to Sparky's problem."



The Engineering Design Process

Define	DEFINE the problem. Determine constraints and criteria to fix the problem
Research	RESEARCH to understand 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	Engineers REFLECT on their 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	The final step in the process is to EDUCATE others. This includes making other people aware of the problem as well as your well-designed solution!

"Review the information on the Engineering Design Process on your own. Then answer the questions in Step 3."

- Can you EDUCATE others before you do your RESEARCH? Why or why not?

No, before you educate others, you must research the problem, design a solution, build the chosen design, reflect on the solution, and place the solution. Educate is the last step.

- 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?

Research spotted lanternflies and change his design to make it attract spotted lanternflies.

"Today we learned that the first step in the Engineering Design Process is to DEFINE your problem. In this unit, we will be working on a solution to a problem described in the letter from the Department of Agriculture. Review the letter with your group, and then in your notebooks, DEFINE the problem that your group is trying to solve." Allow the students time to read the letter and answer the questions.

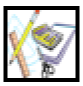
- What is the problem you are trying to solve
  How to reduce the number of invasive insects in my environment.
- Who has the problem
  The Utah Department of Agriculture/The people of Utah
- Why is the problem important?
  The invasive insects are causing harm to plants and animals in Utah.

Lesson 2: RESEARCH an Insect

Daily Overview:

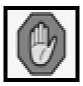
- *Students will brainstorm how they have already begun to work within the engineering design cycle with the things they have done in previous units.*
- *Students will conduct research from several sources about the life cycle, habitat, and behavior of various invasive insects.*
- *Students will complete a portion of the solution plan*

Time: 45 minute class period

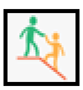


Materials:

4. 1-internet accessible device per student;
5. Life Right Here and Everywhere Notebook (Lesson 2)



Prior to implementation: Check to see if your school internet supports the websites listed as resources and that the links are still active.



Supports: Finding productive information can be difficult. Many websites have more information than what is needed to complete the assignment.

Lesson Plan

<u>Getting Started</u>

Instruct *"Yesterday you learned about the engineering design cycle, which you have a copy of in your Life Right Here and Everywhere Notebook. To help us create our solution plans, we will be going through portions of this design cycle. We have already been working within one of these "gears". Does anyone remember what it was called?"* **Answer: DEFINE.** *"To remind us what we are working towards, let's write some information next to this gear. Next to DEFINE, write what we have been tasked with doing. When we think about designing solutions, what do we need to take into account?* (students should talk about the constraints which are listed in the letter). *While we are going through the next gears, what should we think about as we are designing our solution? What might you want to know to make the "best choices" for your plan?* (Help students to think about the fact they will need to conduct research to learn more about their invasive insect and the trap they will use)*. Researching prior to designing solutions is an important part of engineering. We must think about what is already known and apply this information to our solution plan."*

<u>Begin Research</u>

If the students were not assigned to Insect Groups at the beginning of the curriculum, assign them now. Make sure that different insects are assigned to each group so that all of the insects are dispersed as evenly as possible. There are eight choices: Balsam Wooly Adelgid, Boxelder Bug, Brown Marmorated Stink Bug, Common Silverfish, Elm Seed Bug, Japanese Beetle, Small Hive Beetle, and Velvet Longhorned Beetle

Direct students to their Life Right Here and Everywhere Notebooks. Instruct "*The second phase of the Engineering Design Process RESEARCH. Today you will begin researching your invasive* *species so that you can help design a good trap to reduce the number of that species in our area."*

Pass out or direct students to computers or iPads to complete their research. First, students will start by finding an image of their insect and sketching it in their notebooks. Instruct: "*Now that you are at your computers, log into the ADW pocket guide to view an image of your insect. In the box provided in your Life Right Here and Everywhere Notebooks, write the name of your insect and draw a simple sketch of your insect. Be sure to label at least four parts of the insect."*

"Next you can begin researching characteristics of your insect. Find the list of links in Lesson 2 of Unit 3 of your student notebooks. You can use these links or your own web searches to answer questions about your insect."

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
- Minnesota Department of Agriculture: https://tinyurl.com/MNDOA-vlb
- Cornell University (PDF): https://tinyurl.com/cornell-vlb
- Oxford Academic: https://tinyurl.com/oxford-vlb

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 life cycle of your insect, including the time of year that your insect experiences each stage.
4. Where does your insect live (e.g., tree, ground)?
5. What does your insect eat? Does anything 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 and reduce the insect population?

Unscaffolded Argument Construction

After their research, students will complete an argument in their notebooks. They can use the research they have completed to help them with claim, evidence and reasoning.

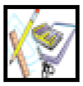
Instructions: Write an argument with a **claim, evidence,** and **reasoning** to address the scientific question: Is your insect invasive to Utah? *Below is one example response.*

Scientific Question: Is your insect invasive to Utah?
Yes, the brown marmorated stink bug is an invasive species. The brown marmorated stink bug kills X trees per year. The brown marmorated stink bug can destroy crops causing loss of money. Invasive insects cause significant biological and economic impacts. They do not have any natural predators and can grow unchecked.

Lesson 3: Trap DESIGN

Daily Overview:
- *Students will finish their research from multiple resources about the insect they were assigned to use in the creation of their solution plans.*
- *Students will complete the first part of their solution plan, which is designing their traps.*

Time: 45 minute class period



Materials:
1. 1 Life Right Here and Everywhere Notebook per student (Lesson 3);
2. 1 internet-accessible device per group;
3. Insect trap pictures (see Appendix) and/or models of real traps

Lesson Plan

Introduction
Instruct: "*Earlier you all did a lot of research about the life cycle, habitat, and behaviors of your insect. Today, we will use this information to think more about our solution plan. First, let's discuss traps. What do you know about different types of traps? Can you describe how any traps work for catching insects?" (Let students discuss what traps they have seen and how they work). Keeping all of this and yesterday's research in mind, today we will begin the process of designing a trap. You will have to think through the materials you will need to construct the traps for your plan. Turn to Unit 3, Lesson 3 in your Life Right Here and Everywhere notebook to complete this section.*"

How Traps Work
With the whole class, ask students for ideas about what kinds of insect traps they've seen and how they work. Draw or type notes on the board or smartboard to summarize student ideas. **Note:** There are some photos of traps in the Appendix. We recommend waiting until students have tried to brainstorm some designs before instructing them to look at these (see Notes About Traps below).

Students should think about the following questions and information:
- What is the purpose of insect traps? (To reduce the number of insects. Some traps kill insects, and some capture them alive so that they can be moved to a different area. Which kind would be best for an invasive species?)
- What kinds of traps are there? (Some examples include sticky traps, "fly in" traps–insects fly in but can't get out, pitfall traps, water traps, etc.)
- What makes an insect attracted to a trap/go in a trap? (Pheromones, sweet scent, food/bait, light, etc.) How can you know you're using a good lure?

Brainstorming
Instruct "*When engineers design a solution, they often brainstorm ideas as park of the design process. In your notebook are some tips for brainstorming. Read these over to get some ideas on how to brainstorm.*"

Tips for Brainstorming

- **Be creative -** Use your imagination!
- **Don't Judge.** There are no bad ideas.
- **Build on ideas.** Think "and" instead of "but."
- **Stay on topic.** The brainstorm is better when it's focused on the topic.
- **One conversation at a time**. Listening can encourage ideas to flow.
- **Aim for quantity**. More designs are better. Don't always go with the first idea.

After giving students a few moments to read the tips for brainstorming, instruct*: "Brainstorm what a good trap design for your insect would look like and how it would work. You will first come up with three sketches by yourself. There are extra blank pages at the end of your notebook if you need them."*

Give the students sufficient time to draw three trap designs by themselves. Emphasize that students should try to come up with three **completely different** designs. Encourage them to come up with different lures and different trapping mechanisms.

Sharing Designs with the Team

"Next, you will share your design with your group. Take turns showing each other your trap designs and explain how the trap works and what materials you will need."

Allow students to discuss options for trap designs. Instruct that the questions on page 56 of the student notebook should help guide their discussion. Give them periodic time checks.

- 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?)

Notes about traps

There are some notes about traps in the Appendix. There are also some examples of traps that previous students have built. You may want to ask your students to review these before making their final design.

Creating the Final Design

After students discuss their individual trap designs, they should come up with a final trap design as a group. This may be similar to a trap that one of the students drew in the first step, a combination of multiple designs, or they may choose to create a completely new design.

Have students draw and label the final trap design on page 57 of their student notebooks. Emphasize that these drawings do not need to be professional, but they should be *clear* and show *how* the trap works. (If there's a part of the trap that falls on the insect, for example, tell students to draw arrows and explain how it works in their drawing.) There is a materials list on the final page of the lesson. Students should be aware that these are the materials that will be provided.

Check each group's design for appropriateness and ask, "*Why did you choose this design?*" Make sure they can provide a solid justification–particularly for the lure and trapping mechanism.

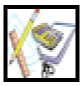
Materials

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	

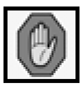
Lesson 4: BUILD Your Trap

Daily Overview:
- *Students will begin building their traps based on their designs.*
- *Students will need to construct a list of desired materials.*
- *Students will begin building their trap using their designs and requested materials*

Time: Two or Three 45 minute class periods (your discretion)



Materials:
1. Life Right Here and Everywhere Notebook (Lesson 4);
2. Group trap design (each group has their own in their notebook);
3. List of materials and prices;
4. Materials listed for building traps (research team will provide these materials);
5. Play money (research team will provide)



Prior to implementation: Make sure trap-making materials are available for student construction.

Lesson Plan

<u>Roles</u>
During this lesson, you may choose to assign roles to encourage participation and good teamwork. This can be done during any step of the process as you see necessary.

<u>Build 1</u>
"The past few days you have been working on researching an invasive species and designing a trap to help reduce the number of that species in the area. Today you are going to build your trap's design. This will be done in two stages.

"First, you'll complete Build 1. This first build should help you determine whether your final design is mechanically functional. You can also use the first build to get feedback from me or other groups."

Allow students time to complete the first build. You may specify that the students only have one or two class periods to complete this build at your discretion.

During the first build, students shouldn't worry about the cost of supplies. Allow students to "check out" materials they need to construct their final design. Explain as they start building their traps they may realize they need different or additional materials. They are allowed to take whatever they need, but they should make sure you (the teacher) knows what they are taking and why. Discourage students from taking materials that they know will not be used in building.

When students "check out" materials for the first build, keep a record of what materials and how many of each material they've taken using the space below or electronically.

Check-out Record

Names of group or students: ____

Materials and quantity used: ____

____

____

____

Names of group or students: ____

Materials and quantity used: ____

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Names of group or students: ____

Materials and quantity used: ____

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Materials and quantity used: ____

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Names of group or students: ____

Materials and quantity used: ____

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____

Build 1 Questions

Direct the students to consider the questions on page 60 of the student notebook regarding Build 1. You may also consider having students give informal peer feedback on the results of Build 1 to different groups.

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

*"While getting ready to build your trap, you will 'purchase' supplies. In Build 1, you checked out materials, but today you will need to calculate the **exact** cost of your completed trap as you are buying supplies. There are plenty of materials listed, but you do not need all these materials for each trap. When you're ready, you will build your trap using the materials you purchased. It is okay to use materials you didn't list previously if you find out that you need them, but you cannot get money back for supplies you have left over. You have a total of $10 to spend on materials!"*

If students have left over supplies from Build 1, they ***may not*** use them without adding them into their final cost.

> Example: A student group checked out 1 ounce of dish soap, 10 dowels, and a cardboard box for Build 1.
>
> For Build 2, the group decides that they will use the dish soap and the dowels they used in Build 2 but will replace the cardboard box with an aluminum baking pan. In this scenario, the students must use three of their $1 bills to officially purchase the soap and the dowels. They do not need to pay for the cardboard box that is no longer a part of their design. They can use their remaining $7 to purchase the aluminum baking pan and other materials such as paint, fruit, etc. for Build 2.

Walk around the class occasionally to help with student questions as they fill in the cost table. When students have finished their work, do a quick check that the cost is within the limits and that the timeline is reasonable for the constraints.

Trap Materials

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	

Final Build
Students will begin constructing their traps based on the materials list that they created. Use your discretion to determine if this section requires more than one day.

Trap Rubric

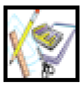
This is a rubric to evaluate the overall quality of the final trap your team built.

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**

Lesson 5: REFLECT

Daily Overview:
- *Students will begin building their traps based on their designs.*
- *Students will need to construct a list of desired materials.*
- *Students will begin building their trap using their designs and requested materials*

Time: 45 minute class period



Materials:
1. Life Right Here and Everywhere Notebook (Lesson 5);
2. Trap design (each group has their own in their notebook);
3. Trap prototype (each group has their own made from materials purchased)

Lesson Plan

Getting Started
Instruct: *"Sometimes when we DESIGN and BUILD solutions and learn that we need to make improvements. The next part of the design process is getting feedback and reflecting on your design. Today you will share your trap design with another group. You will provide each other with feedback on your designs to determine whether or not any changes should be made in your trap design.Then you will reflect on your trap building process."*

"*First, you will need to review your trap design features so that you can present to the other team in an organized way. Using the table in your notebook, reflect on your trap design."*

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.*

Peer Feedback
Select teams who were studying different invasive insects to present to each other. Each group will take turns presenting to the other group.

Instruct: *"Decide which group is going to present first. Using the table that you just completed, you are going to present your trap to another group who has a different invasive insect that you do. Remember to address all of the points listed. After the first group is done, then the second group will also present their trap using their own table."*

Each group will swap notebooks and complete the Peer Evaluation Rubric and the FEEDBACK Form for the other team. The feedback should go in the notebook of the group presenting, not the group writing. *"Now that all groups have presented, it is time to get feedback and reflect on your trap design. Trade notebooks with the group that you presented to. You will complete the Peer evaluation and FEEDBACK Forms in their notebook. Think about any changes or suggestions you might have to improve their traps.* ***All feedback should be constructive,*** *meaning it could help the other group rather than just comment on quality or the people presenting. Be sure to only complete the FEEDBACK section thinking about what the other group presented."*

Feedback Form

Completed by ____

Name of the students 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)

The students should trade notebooks back to the original group so that they can see their peer feedback. *"Trade notebooks again so that you get your original notebook back. Review the FEEDBACK form that was completed by the other team.*

"The goal of the engineering design process isn't necessarily to create the BEST solution to a problem. Instead, it focuses on creating something that works within the given guidelines such as cost, limited materials, deadlines, etc. That's why engineers always reflect on their work. Think about your engineering design process and peer feedback. 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?." Allow students time to share answers to each question.

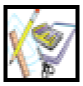
Note: Students may want to make changes to their traps after completing the REFLECT step. You can choose to allow this or not. We suggest letting students make small changes as possible.

Lesson 6: PLACE Your Trap

Daily Overview:

- *Students will research and determine the best place and time to place their traps.*

Time: 45 minute class period



Materials:

1. Life Right Here and Everywhere Notebook (Lesson 6);
2. 1 internet-accessible device;
3. Trap prototype (each group has their own made from materials purchased)

Note: In this lesson, students will research areas where they can place their traps to capture their assigned insect. If you choose, you can actually have them place the traps around your school campus. Another option is to have students take their traps home and place them somewhere in their community. Many traps may contain liquid, so consider this when selecting which option to implement.

Lesson Plan

Choose an Area for Your Trap

Instruct: *"Setting a trap is only helpful if it is located in a good spot. Today you will determine what local area is the best for placing your trap. You can do this using Google maps. Be sure to consult with your group and list multiple possibilities for placement.*

"C*omplete the table on placing your trap that is in your notebook. You can use Google maps (maps.google.com) to help determine places that might be good. Once you have found a few options, you and your group should determine which location would be the best spot to place your trap. When you are ready, circle the location that you think is the best."*

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

Choose When You Will Place Your Traps

Instruct: "*Location is not the only thing to consider when deciding how to place a trap. You must also consider the time of year and day is best for capturing your invasive insect. This can depend on things like what stage your plan on capturing the insect in (egg, adult, etc.), weather, and maintenance of your trap. You may need to review your trap design to determine the time of placement.*

"Using your notebook, be sure to answer the questions provided to justify your trap placement."

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

Lesson 7: EDUCATE

Daily Overview:

- *Students will construct an infographic, powerpoint, poster etc. to share with the class or other local audiences.*

Time: Variable depending on presentations and audience

Materials:

1. Life Right Here and Everywhere Notebook (Lesson 7);
2. 1 internet-accessible device per student group;
3. Trap prototype (each group has their own made from materials "purchased");
4. Colored pencils;
5. Extra paper;
6. Depending on teacher choices for presentations, materials for students to make presentations

Prior to implementation: Select how you would like your students to do their presentations. You may either take volunteers or pre-select the order of presenters. Students will have worked in groups, so depending on the norms of the classroom, the presentation could look very different (one speaker, multiple speakers, etc.) Depending on the number of groups, you will also want to decide on the length of the presentations and whether students will present their entire work, or just a portion.

Optional Support: Students' plan presentation format could be created with Canva (http://canva.com). This is an easy-to-use graphic design tool that will allow you to create a wide variety of graphical formats. Students can use one of Canva's many templates, as well as their extensive library of images and graphics. As the teacher, you may want to familiarize yourself with Canva and how it works.

Lesson Plan

Choosing an Audience

Instruct: ""*During the past week, you have been actively working on different parts of designing a trap; first, you conducted background research of your invasive species, including where they live, their life cycle, what they eat, etc. Then you learned about the function of the traps and where they should be placed. For the rest of the class period you will be working with your groups to construct the final product to EDUCATE others on how to reduce the number of your invasive species in the area."*

Guide students through the process of selecting a person or group to present their solution to.

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, you can educate someone you live with 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?

If possible, invite or have students invite the persons or groups they selected to give their presentations to for the student presentation day. If this is not possible, encourage students to share their trap designs and presentations with their audience at a later time.

If the students' chosen audience cannot be in attendance, it's still recommended to invite another (outside) audience. Suggestions include the principal, students from other classes, other teachers, school admins or staff, etc.

Creating Presentations

Select which format you would like students to use for their presentations. You may choose to give different groups different formats. Here are some suggestions:

- 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)
- Social Media (TikTok, instagram, etc.)

Instruct: "*You will have today [and tomorrow, etc.] to complete your presentations in class. On [Date] you will present this to the class!*"

Below is some information that students could include in their presentation. **All** presentations should include at least the bolded items.

- **Title of presentation**
- **Name of insect**
- Why the insect is not wanted in Utah
- **How the trap works**
- Where and when to place the traps
- **What effect the trap will have**
- Pictures/other elements to make the presentation look good
- How to make the trap
- Any repairs/replacements the trap will need over time
- **Any creative/unique design features**

Student Presentations

Instruct: "*It is now time to share your solution with the person or group you chose earlier. You can find some helpful tips for how to present in your student notebook in Lesson 7.'*"

Discuss the following presentation suggestions and ask students for any questions or comments.

- 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).

Argument: Includes a claim, evidence, reasoning, and a concluding sentence. Scientists use scientific arguments to answer scientific questions.

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.

Invasive Species: A broad term to describe any organism that has been intentionally or unintentionally brought into a geographic region or area.

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 organism 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 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