**Unit Essential Question:** *How have natural processes and human activities created the ecosystems we see today?*

**Introduction**

Students know that the more resources provided in an environment, the more it will flourish. They also know from previous tasks that resources are not infinite but are rather limited within each ecosystem. This task plays off students’ prior knowledge and asks them to analyze data that examines this concept in more complex scenarios. What will happen when two competing plants are introduced into an environment with limited resources? What happens when you introduce an animal that eats only one of those types of plants? What happens to the ecosystem when your top predator goes extinct? By getting more comfortable with data based on real-life scenarios, students can think of environments at a system level and better predict how changing one part of an ecosystem can affect another—in other words, *how different resources affect the populations of different organisms*. In light of the tremendous impact humans are currently having on the environment, this skill is more important than ever. A metaphor for this human impact will then play out in their culminating project, as they consider how removing a resource from their arena would impact the populations of organisms present.

**Alignment Table**

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| --- | --- | --- | --- |
| **Performance Expectations** | **Scientific and Engineering Practices** | **Disciplinary Core Ideas** | **Crosscutting Concepts** |
| **MS-LS2-1. Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.** [Clarification Statement: Emphasis is on cause and effect relationships between resources and growth of individual organisms and the numbers of organisms in ecosystems during periods of abundant and scarce resources.] | **Analyzing and Interpreting Data**   * Analyze and interpret data to provide evidence for phenomena. | **LS2.A: Interdependent Relationships in Ecosystems**   * Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. * In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. * Growth of organisms and population increases are limited by access to resources. | **Cause and Effect**   * Cause and effect relationships may be used to predict phenomena in natural or designed systems. |
| **Supplementary Science and Engineering Practices**   * Constructing Explanations   + Construct a scientific explanation based on a valid and reliable evidence obtained from sources (including the students’ own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. | | | |
| **Supplementary Crosscutting Concepts**   * Systems and System Models   + Models can be used to represent systems and their interactions—such as inputs, processes, and outputs—and matter flows within systems. | | | |
| **Equity and Groupwork**   * Discuss simulation observations with group members. * Come to consensus on a rule about resource availability and populations. | | | |
| **Language**   * Record simulation observations. * Write a rule about the relationship between resource availability and populations. | | | |

**Learning Goals**

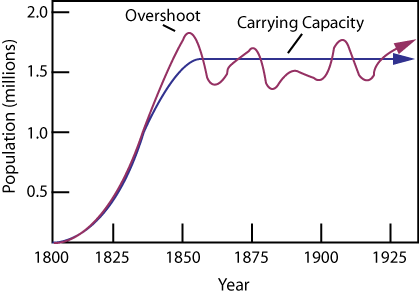
This learning task asks students to analyze data to provide evidence of the effects of resource availability on populations of organisms in an ecosystem. More specifically it asks students to:

* Engage prior knowledge of cause and effect within the context of ecosystems.
* Analyze and interpret computer simulation data regarding resources and organism populations.
* Use evidence to draw conclusions about population and resource availability.
* Apply their understanding of the resource-population relationship to a real-life ecological problem.
* Apply knowledge of resources and population to their arena design.

**Content Background for Teachers**

Every ecosystem is a complex system with many intertwining components. All of these components interact with and influence each other. In previous tasks, students have discovered how different organisms interact: in cycling non-living materials, in competing with each other, in helping each other, in harming each other, and more. In this task, students look at the ecosystem as a whole and make a general connection between available resources and population size.

An ecosystem is comprised of plants, animals, and other organisms—all of which require specific resources to survive. Depending on the organism, the necessary resources can vary. Plants need space, water, sunlight, and nutrients. Animals need food, space, shelter, water, and more. However, these resources come in limited quantities, which affects the amount of organisms an ecosystem can hold. For example, if plants have more access to sunlight, the population of plants in that region will grow until access to sunlight runs out. If multiple organisms need the same resources, this will affect the population of those organisms, likely causing one of the species to decrease in population.

 By looking at three different scenarios, students will come to the generalized conclusion that when there are more resources available, the population of organisms will increase. When there are fewer resources available, the population of organisms will decrease. Because every ecosystem has limited natural resources, there is a maximum population that species will level out at. This is known as carrying capacity, or the number of living organisms a region can sustainably support. While students are not required to know this term, this is one of the concepts they are seeing through the lab simulation. This is of particular importance as we globally consider this question as a human race. Our impact on the planet is already overwhelming, so we must begin to consider what the carrying capacity is for human life on our planet. Students will get to explore this context as they revisit this Performance Expectation in Unit 2.

**Academic Vocabulary**

* Organism
* Ecosystem
* Herbivore
* Predator
* Resources
* Population
* Deforestation
* Simulation

**Time Needed (Based on 45-Minute Periods)**

4-5 Days

* Engage: 0.5 period
* Explore: 1-2 periods
* Explain: 0.5 period
* Elaborate: 1 period
* Evaluate and Reflection: 1 period

**Materials**

* Unit 1, Task 5 Student Version
* Projector and Speakers for Videos

Explore

* Computers to access simulation: <https://www.learner.org/wp-content/interactive/envsci/ecology/ecology.html> or search “Annenberg Learner Ecology Lab”

Elaborate

* Projector and Speakers for Videos

Evaluate

* Project Organizer Handout

**Instructions**

**Engage**

1. Introduction to Task 5: In Task 4, you learned that ecosystems often have a large variety of organisms that interact in certain ways, maintaining the delicate balance of that ecosystem. We have also learned in this unit that all organisms need certain resources to survive. Think about what you were still wondering about at the end of the last task (look back if you need to). What questions do you still have?
   * Before you pass out their student guide, give students time to reflect individually or with a partner about the questions they recorded at the end of the last task. Share a few of these out as a class, using facilitating questions to guide students toward questions that relate to this task.
2. Transition to Task 5: Knowing this can help us make predictions about how changing one part of an ecosystem can affect another part.
   * Now pass out their Task 5 student guide.
3. In this Engage, students are asked to use their observation skills and consider what they have learned so far to make predictions. Project the following video about rainforests: <https://www.youtube.com/watch?v=LHPuo0rwM1w>.
4. Have students discuss the questions in pairs.
   * Question 1: These could be anything from different plants, animals, water, sunlight, rain, etc.
   * Question 2: asks students to consider what would happen if we took one of the essential resources away: water. Students should think of the many effects this will have on the rainforest. For example, without water the plants would die and without plants, the animals that eat them would die, etc.
     + As groups discuss, some facilitating questions you could ask are: What is water needed for? Who needs the plants to stay alive? Is the rainwater used by anything else besides plants? Etc.
5. We recommend sharing out responses to the second question using equity sticks for a more equitable discussion (See “How to Use This Curriculum” for more details).
   * In this discussion, emphasize how students can use the **Cause and Effect** relationship between water and organisms to predict the chain of events that can occur in an ecosystem.

**Explore**

1. In the Engage, students considered how changing one aspect of an environment can create a chain of cause-and-effect events. In this activity, they use a computer simulation to model these processes.

* As students discuss the questions that follow each simulation, they are engaging in the practice of **Analyzing and Interpreting Data** to provide evidence of how resources affect populations of organisms**.**
* All of these individual simulations deal with the crosscutting concept of **Cause and Effect,** as students identify cause-and-effect relationships that they can use to make predictions about related phenomena. However, putting it all together asks students to consider a model of these interactions within the larger context of **Systems and Systems Models**.

1. Hand out computers to each table group. Students will follow the instructions on their student guide to run specific parts of the simulation, recording in the data collection tables on their student guide as they go. Because this is a collaborative task, it is recommended that you remind students of group work norms and assign group roles, such as Resource Manager, Facilitator, Recorder, and Harmonizer (See “How to Use this Curriculum” for more details).
   * They are, of course, welcome to play with their own settings on the simulation, but encourage them to do the directed activities first. The directed activities highlight different ways in which resource availability affects various organisms and allows them to make connections between these different situations to understand the system as a whole.
   * Note: simulations are often very difficult for kids to use, so make sure you are circulating and checking in with kids constantly to make sure they understand the instructions.
     + You may want to project the website and model the first simulation as an example.
2. Students complete three directed simulations, according to the procedures on their student guide.
   * They do not have to record exact numbers but rather qualitative observations in their student guide.
   * They also have discussion questions to discuss and answer in their student guide, which will help facilitate their analysis of these simulations.
3. The main ideas of each simulation are outlined below:
   * Simulation 1: When the ecosystem contains two different types of plant, one species of plant out-competes the other plant for resources, such as water and nutrients. This decreases the population of one species of plants until it eventually dies off. The other species, with access to more resources, increases in population.
   * Simulation 2: In Simulation 1, Plant A used up all the resources, so Plant B died out. In this simulation, we introduce the herbivore bunny to eat Plant A; this decreases the population of Plant A, freeing up more resources for Plant B to survive and reproduce. This causes Plant B to increase in population.
   * Simulation 3: In the first part of Simulation 3, students observe that the populations of plant, herbivore, and the top predator stay stable when all three are included. When the top predator is taken away, this leads to an increase in the herbivore population, decreasing the population of Plant C.

Sample Student Data Collection Tables

Simulation 1

|  |  |
| --- | --- |
| **Organisms in Ecosystem** | **Observations** |
| Plant A  Plant B | *Plant B died out and Plant A increased in population.* |
| Plant B  Plant C | *Plant C died out and Plant B increased in population.* |
| **Analyzing and Interpreting Data**:   * What do the graphs tell you about the interaction between the plants?   *When the ecosystem contains two different types of plant, one species of plant out-competes the other plant for resources, such as water and nutrients. This decreases the population of one species of plants until it eventually dies off. The other species, with access to more resources, increases in population.* | |

Simulation 2

|  |  |
| --- | --- |
| **Organisms in Ecosystem** | **Observations** |
| Plant A  Plant B  Bunny (who eats Plant A) | *Plant B increases and then levels off. Plant A decreases and then levels off. The bunny population increases and then levels off.* |
| **Analyzing and Interpreting Data**:   1. Why do you think the results are different than Simulation 1?   *In Simulation 1, Plant A used up all the resources, so Plant B died out. In this simulation, we introduce the herbivore bunny to eat Plant A; this decreases the population of Plant A, freeing up more space for Plant B to survive and reproduce. This causes Plant B to increase in population.*   1. How did the amount of Plant A change? How did this affect the population of Plant B?   *The bunny was eating Plant A so it went down. This allowed the population of Plant B to increase.*   1. Look at the graph in the bottom half of the page. The orange line represents Herbivore A (the bunny). It shows an increase in the bunny population at first, but then decreases and levels off in a straight line. How could you explain this?   *The bunny population first had a lot of resources so it increased in population until it used up all of the resources, causing some to die out. This happened until they reached a steady stable amount of bunnies that matched the amount of resources.* | |

Simulation 3

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| --- | --- |
| **Organisms in Ecosystem** | **Observations** |
| Plant C  Deer (Herbivore C who eats Plant C)  Wolf (Top Predator who eats Deer) | *Plant C increased, decreased, and then increased until leveling off. The deer increased and then decreased before leveling off. The wolf increased slightly before leveling off.* |
| Plant C  Deer (Herbivore C who eats Plant C) | *Plant C increased and then decreased to level off. The deer increased and decreased slightly, then leveled off.* |
| **Analyzing and Interpreting Data**:   1. How did taking out the Top Predator (wolf) affect this ecosystem? Why?   *It caused an increase in the deer population, which ate a lot more Plant C, decreasing the population of Plant C.*   1. What are some other effects that you think might occur in this ecosystem because of this?   *Less plants can cause more soil erosion because of the lack of roots.* | |

**Explain**

1. In the Explore, students gathered data and began to analyze it in individual pieces. This section of the task asks students to make a general conclusion about this data, focusing on 1) the crosscutting concept of **Cause and Effect** to predict what will happen in most ecosystems, and 2) the science and engineering practice of **Constructing Explanations** as theyuse valid and reliable evidence to support their conclusion. Students frame their rule within the question: How do available resources affect the population of different organisms in an ecosystem?
   * Their rule will not only be one sentence, but likely multiple sentences. They should use at least one example from the data to justify their rule.
   * Sentence stems are provided in the student guide to help students get started.
2. Because this is a difficult task, we recommend students do this section in pairs or small groups.
   * Optional: exchange rules with partner groups, get feedback, and make revisions.
   * This revised paragraph can also be a great option for formative assessment as it summarizes learning from the task. Collect student work to identify trends in students’ ability to use cause-and-effect relationships to predict how availability of resources affects most ecosystems. See “How to Use This Curriculum” for strategies on utilizing formative assessment data to provide feedback to students and inform classroom instruction.

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| Sample Student Response |
| The amount of resources available in an ecosystem greatly affects the populations of different organisms in that ecosystem. When there are more resources available to a particular organism, this results in an increase in that organism’s population. For example, in Simulation 2, when the bunnies ate lots of Plant A, this gave more resources for Plant B to increase its population. When there are fewer resources available, like when Plant A used them all in Simulation 1, this results in a decrease in population (for Plant B). |

**Elaborate**

1. This part of the task asks students to apply their new knowledge to a real-life situation and focus on the fact that human’s reliance on natural resources can cause very negative environmental impacts. This scenario focuses heavily on the crosscutting concept of **Cause and Effect,** as students use cause-and-effect relationships they have already identified in order to predict the chain of effects in the Amazon rainforest if deforestation continues.
2. Project the first video, which is a time-lapse of deforestation in the Amazon rainforest: <https://www.youtube.com/watch?v=hllU9NEcJyg>
   * We recommend giving them time to discuss and answer the discussion questions with their partner after the video.
3. Then project the second video, which gives a more broad overview of deforestation, including causes and effects: <https://www.youtube.com/watch?v=M4jhjt1_eyM>
   * Again, we recommend giving them time to discuss and answer the discussion questions with their partner after the video.
4. We recommend conducting a class-wide discussion that summarizes the concepts discussed through the questions. As usual, use equity sticks to conduct a more equitable discussion (See “How To Use This Curriculum” for more details). Possible responses are below:
   * 1: Trees and plants
   * 2: Trees and plants provide food and habitats for all kinds of organisms.
   * 3: Humans are cutting down trees for the land itself, to use for agriculture and residences. They are also cutting down trees for firewood and other industrial uses.
   * 4: As stated above, deforestation destroys habitats and food sources, leading to the endangerment or extinction of many animals. (A secondary effect is the effect on global climate change, though including this is not necessary for the purposes of this task).
   * 5: Answers will vary, but students may talk about recycling paper materials, using less firewood fuel, creating protected national parks, etc.
5. Optional: For students who want to know more or need to see that there are solutions, here is a resource on conservation of rainforests: <https://newsela.com/articles/amazonbasin-conservation/id/13877/>.
6. Return to the whole-class ecosystem concept map from the Lift-Off Task.
   * In small groups, have students brainstorm new concepts and new connections that they have learned in this task, as well as any new questions that have come up for them. Then have groups share these aloud in a class-wide discussion and add to the class concept map. The use of equity sticks is encouraged for more equitable participation in class-wide discussions (See “How To Use This Curriculum” for more details).
     1. Some facilitating questions to ask students are: What new ideas/concepts do you want to add to the map? What connections do you want to add or change? What is your reason for that addition/revision? What connections can we make between the questions/ideas already on the map? What new questions do you have about the phenomenon?
     2. Draw circles around each question and boxes around each concept.
     3. Write connector words to describe connections between the concept boxes.
     4. For this task, students may begin to connect some of their previous question circles to concept boxes about the following: the effect of resources on populations and the connections between parts of an ecosystem.
   * Have students analyze the additions to the class concept map for as many examples of this task’s crosscutting concept as they can find. Once a student has identified the crosscutting concept, you can trace the circle in the corresponding color (decided on in the Lift-Off task). We recommend asking students to share key words that helped them identify the crosscutting concept for that concept or question. Some identifying words students might look for are:
     1. **Cause and Effect**. These could be phrases such as, “which results in,” “which causes,” “that explains why,” “is due to,” etc.
     2. **Systems and Systems Models**: These could be phrases such as, “is a part of” “connects to,” “interacts with,” “is made up of,” “works together with,” etc.
   * Once again, the purpose of this concept map is to facilitate generation of student questions, promote language development, and support understanding of the science content throughout the unit. Allowing students to ask their own questions and use their own words to make meaning of the concepts will not only help them make deep connections about science content, but will also help their oral and written language development.

**Evaluate: Connecting to the Culminating Project**

1. Students independently complete the Task 5 section of the Unit 1 Project Organizer in class. Revisions can be done for homework, depending upon student’s needs and/or class scheduling.
2. Students have been tasked with creating an arena that mimics an environment they may see on Earth. Their prompt is as follows: Reflect back on the last two responses in your Project Organizer. Think about what key resources are needed in order to accommodate the organisms you have chosen. Based on these key resources, prepare for the worst:
   * If budget constraints resulted in removal of one main resource, predict what will happen to the populations of different organisms in your arena.
   * Figure out as many effects as you can and explain them in a flowchart or paragraph format. Use data from the task to justify your predictions.
3. Note: These resources do not have to be the same natural resources identified in the Task 2 Evaluate. These can be other resources students know are necessary to organisms, such as water, trees, grass, etc.

**Reflection**

1. At the end of the task, ask students to reflect on what they have learned over the course of this task by answering the following three questions in their student guide:

* At the beginning of this task, you were asked to make a prediction about what would happen if you took away rainwater from the rainforest. Look back at your prediction: after collecting data evidence today, how would you change or add to your prediction? Are there any additional effects to any populations you may not have initially thought of?
* In this task, we focused on the crosscutting concepts of **Cause and Effect**: how cause and effect relationships can be used to make predictions, and **Systems and System Models**: Models can be used to represent systems and their interactions within and between systems. Where did you see examples of **Cause and Effect** and **Systems and System Models** in this task?
* Now that you have learned more about how availability of different resources affects the populations of different organisms, what questions do you still have?

1. There are no right answers, but encourage students to look back at their student guides and their class concept map. They should not change their initial responses, but rather use this reflection space to add to their ideas and questions based on what they have learned through this task. By generating more of their own questions, students continue to engage in sense-making of the phenomenon and gathering knowledge and skills for their final projects.

**Assessment**

1. You may collect students’ Project Organizer and assess using:
   * *Criteria of your choice.* We recommend using the 3-Dimensional Assessment matrix at the beginning of this document to inform your criteria.
   * This can be a formative tool to periodically look for trends in student understanding after the completion of a task. You can then use this formative data to inform any re-teaching as necessary.
2. You may also give students time to make revisions with one of the two options:

* Students may make changes to their Project Organizer according to your comments OR
* Ask students to exchange Project Organizers with a partner and give partners 5 minutes to give written feedback. Then allow students time to make changes to their work according to the feedback.