SUCCESS ACADEMY EDUCATION INSTITUTE

Underwater World: Sustainable Ecosystems

Grade 2

Our Vision of Elementary School Science Excellence

Success Academy's unique commitment to science starts in kindergarten. We strive to cultivate a passion for the sciences early in life, build a comprehensive foundation of knowledge, and teach students to investigate and analyze real-world problems. Our vision of science relies on two related commitments: mastery of a substantive body of scientific knowledge and an inquiry-based approach to accumulating this knowledge. Equipping students with a firm grasp of scientific concepts is central to our model, and students must understand that these concepts aren't simply plucked from the air, but rather arrived at through scientific thinking and experimentation. To that end, our scholars do science to understand that scientific knowledge comes from posing questions, designing experiments, gathering data, and drawing conclusions. Rather than viewing scientific knowledge as etched in stone, they come to understand that ideas about the world change with new evidence. In addition, our program incorporates The Next Generation Science Standards (NGSS) and the BSCS 5E Instructional Model.

We believe excellent science classrooms are ones in which students experience curiosity and joy, and make connections between classroom science and the natural world around them. Embedded in our program is the belief that struggle and student-led inquiry are inherent to the mastery process. Through our progressive approach to learning, students realize that unexpected results do not signal failure, but instead present valuable opportunities for new questions.

Through our science program, students learn that science and engineering are creative and exciting fields. They discover that there are countless, fascinating scientific questions to be asked and engineering challenges to be solved—and will be inspired and equipped to seek out answers and solutions. No matter what path students choose to pursue in life, the SA science program will spark curiosity, sharpen problem-solving capabilities, and fuel passion for knowledge.

Essential Questions

The best questions point to and highlight the big ideas. They serve as doorways through which learners explore the key concepts, themes, theories, issues, and problems that reside within the content, perhaps as yet unseen: it is through the process of actively "interrogating" the content through provocative questions that students deepen their understanding.[1]

Use the essential question to drive the unveiling and mastery of ideas, and ground the unit in an overarching purpose, often as a storyline. Mentioning the essential question or having students answer it at the end of some lessons does not mean the teacher is using it purposefully.

[1] From Wiggins, G., & McTighe, J. (2005). *Understanding by design*. Alexandria, VA: Association for Supervision and Curriculum Development.

Purpose: The Why, What, and How of This Unit

Essential Question: How has the white perch, a fish native to New York, become so successful in the ecosystem of Lake Erie?

Why This Unit?

All organisms have requirements for survival, even us humans! Feeding relationships are a necessity in order to maintain a balance between the flow of energy and matter on Earth. From the producers that use energy from the sun, to the consumers that rely on energy from other organisms, to the decomposers that recycle matter and energy, an ecosystem is composed of necessary parts both living and nonliving. In this unit, scholars will learn the dynamic connections between organisms in an ecosystem and how different resources are provided by an ecosystem to sustain life.

Scholars will explore ecosystems and the multilevel relationships within them through the exciting storyline of determining how the white perch, a native fish to the Hudson River, has come to dominate the ecosystem of Lake Erie, one of the largest lakes in the United States. Over the course of this unit, scholars will need to truly understand the complex relationships in an ecosystem to develop and build a model to help rebalance the Lake Erie ecosystem. They will hone their skills in comparing models of ecosystem components and food webs and use their observations to construct explanations.

What is the bottom line?

Science and Engineering Concepts highlighted in this unit:

- **Big Idea**: Ecosystems are the interactions between living and nonliving things within an environment.
- **Big Idea**: Organisms need energy and resources from the ecosystem to survive. As they obtain and use these resources, energy is passed between organisms in a continuous cycle.
- **Big Idea**: Environmental changes in an ecosystem can affect the populations of organisms living there.

Science and Engineering Practices highlighted in this unit:

- **Construct Explanations and Design Solutions**
    - Using information from observations (firsthand and from media) to construct an evidence-based account for natural phenomena.
- **Develop and Use a Model**
    - Comparing models to identify common features and differences.
    - Developing and/or using a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s).

Note: As with any unit, scholars engage in many practices in a given investigation. These practices are highlighted because they appear in the most lessons, but all high leverage science and engineering practices can be assessed.

How will scholars be assessed?

- Use the following materials to study and score scholar work:

- Grade 2 Underwater World: Sustainable Ecosystems Exemplar Exit Tickets (within each lesson)

Safety

Plan carefully for safety in all lessons. The top safety risks in this unit include:

- Set clear expectations with scholars on how to carefully handle the live organisms. Always have scholars wash their hands after handling the crickets.
- Scissors may cause a safety hazard.
- Handle plastic knives with care.

Unit Outline

Lesson 1: Survival Requirements

The white perch population is growing rapidly in Lake Erie. Scientists are working to determine what makes this species so successful. Today, scholars uncover what the white perch needs to survive.

- **Big Science Idea**: A balanced ecosystem includes relationships between living and nonliving components.
- **Science and Engineering Practice**: Construct Explanations and Design Solutions

Lesson 2: Air Necessity

Scholars concluded that all living things need air, but where does air in Lake Erie for the white perch come from? Today, scholars will uncover an important relationship between animals and plants in an ecosystem.

- **Big Science Idea**: Relationships between plants and animals are essential for survival because they depend on each other to produce the gasses they take in from the air.
- **Science and Engineering Practice**: Develop and Use a Model

Lesson 3: Energizing for Life

Scholars know that the white perch, like every other organism, needs nutrients to survive. But why? What do the perch actually gain from eating other organisms? Scholars investigate and uncover the crucial process of energy transfer between organisms.

- **Big Science Idea**: Organisms rely on energy for survival, which they acquire from their environment and/or other organisms.
- **Science and Engineering Practice**: Develop and Use a Model

Lesson 4: Natural Recyclers

Consumers produce waste when they digest food or die. Where does the waste in an ecosystem go? Today, scholars will dig into Earth's natural recycling system.

- **Big Science Idea**: The remains of formerly living organisms are recycled back into the earth by decomposers.
- **Science and Engineering Practice**: Develop and Use a Model

Lesson 5: Food Web

Consumers, producers, and decomposers all play an integral role in moving energy through an ecosystem. How are these organisms connected? Today, scholars will put the pieces together to learn how energy moves through an ecosystem.

- **Big Science Idea**: Organisms are connected by an intricate web of energy transfers.
- **Science and Engineering Practice**: Construct Explanations and Design Solutions

Lesson 6: Sustainable Ecosystem

Scholars understand that living organisms in an ecosystem rely on other organisms for energy, but how do the types of organisms affect the balance of an ecosystem? In this virtual lab, scholars explore the interactions within the living environment in a mangrove forest as they attempt to sustain a simulated ecosystem. By the end of this lesson, scholars will be questioning whether the white perch is a welcome addition to its new Lake Erie ecosystem.

- **Big Science Idea**: Relations between the living and nonliving components of an ecosystem are dynamic.
- **Science and Engineering Practice**: Construct Explanations and Design Solutions

Lesson 7: Invasive Species

Scholars understand that living organisms in an ecosystem require energy. So what happens to a population when competition for resources increases, and suddenly, there aren't enough sources of energy to go around? Today, scholars will discover what happens to an ecosystem when an invasive species (such as the white perch) is added into the mix.

- **Big Science Idea**: Food webs are impacted by the dynamic relations between organisms and can be disrupted when new organisms are introduced.
- **Science and Engineering Practice**: Develop and Use a Model

Lesson 8: Human Impact

Humans are top predators and require a lot of energy and resources from their environments. How could an increase in the human population affect the Lake Erie ecosystem? Today, scholars explore the effect of a growing human population on the surrounding ecosystem.

- **Big Science Idea**: Food webs can be disrupted by multiple factors including human activity.
- **Science and Engineering Practice**: Construct Explanations and Design Solutions

Lesson 9: Sustainable Ecosystem Planning

The local conservation society of Lake Erie is working to restore balance to the ecosystem after the white perch invasion! Can scholars use their knowledge from the unit to choose from three solutions and restore the balance to the lake's ecosystem before it's too late? Today, scholars will start to draft a solution to improve the balance of the ecosystem.

- **Big Science Idea**: An ecosystem functions as a delicate balance of organisms and nonliving factors.
- **Science and Engineering Practice**: Develop and Use a Model

Lesson 10: Sustainable Ecosystem Building

Today, scholars will bring their designs to life as they choose materials and build their ecosystems. Will the organisms of Lake Erie be saved?

- **Big Science Idea**: A balanced ecosystem is one in which many species can survive and sustain life.
- **Science and Engineering Practice**: Construct Explanations and Design Solutions

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Lesson 1: Survival Requirements

The white perch population is growing rapidly in Lake Erie. Scientists are working to determine what makes this species so successful. Today, scholars uncover what the white perch needs to survive.

Lesson Objectives

- **Big Science Idea**: A balanced ecosystem includes relationships between living and nonliving components.
    - **Key Takeaways**:
        - Organisms depend on their surroundings to get what they need to survive. These things are water, air, food, shelter, and favorable temperatures.
        - An ecosystem is an area where relationships between living and nonliving components exist.
- **Science and Engineering Practice: Construct Explanations and Design Solutions** Scholars engage in this Science and Engineering Practice as they use information from observations (firsthand and from media) to construct an evidence-based account for natural phenomena.

Materials Needed

- For each half table: print out images of a white perch habitat

Prep

- For each half table: print out images of a white perch habitat

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Launch

- Show scholars this picture of a white perch. Tell scholars this is a picture of a white perch. They are native to the Hudson River but have recently been found in Lake Erie!
- Show scholars this map of Lake Erie.
    - How do you think the white perch ended up in Lake Erie?
    - Do you think the white perch will be able to survive in Lake Erie? Why or why not?
- Present the lesson challenge: What does the white perch need in order to survive in their habitat and where do these resources come from? Determine if there is a relationship between the living and nonliving components in a white perch's habitat.

Activity

- Scholars work in half tables to complete the activity to determine what resources a white perch needs to survive.
- **Procedure**:
    - Scholars analyze the white perch habitat and list all of the things that a white perch needs in order to survive based on their observations.
    - Scholars sort their list into two categories: living and nonliving.
    - Scholars write one example of a relationship between a living and nonliving thing in the white perch habitat.
- Press scholars to think about where the items they think the white perch needs come from and why they need them and the relationships between the living and nonliving components they are listing. Take note of the scholars who are making these connections to use during Discourse.

Discourse

- **Debrief activity:** As a whole class, compile a list of resources scholars think the white perch needs in order to survive based on their observations.
    - Use the list to group the items into living and nonliving. Define **living** and **nonliving**.
    - What are the relationships between living and nonliving things?
        - Have scholars describe relationships between the living and nonliving items you have sorted as a whole class and use evidence from the sort to support their claims.
    - What would happen if there were no nonliving items in an area a white perch was trying to live? Define **ecosystem**.
- **Introduce the essential question:** How has the white perch, a fish native to New York, become so successful in the ecosystem of Lake Erie?
- **Make broader connections**: Show scholars this picture of a desert ecosystem.
    - What are the different living and nonliving components?
    - How do these components contribute to the health of the organisms in an ecosystem?

Accountability (Exit Ticket)

This Exit Ticket assesses scholars' understanding of the lesson's Big Science Idea. Scholars must be able to recognize relationships that exist between living and nonliving components in an ecosystem. Scholars will build on this understanding throughout the unit.

Assignment:
A forest ecosystem is shown here.

1. Identify if each component of the ecosystem is living or nonliving by marking an **X** in the table below. [2]

Component	Living (mark an X)	Nonliving (mark an X)
Turtle	X	
Water		X
Air		X
Fish	X	
Deer	X	

2. Check (✓) a relationship between a living and nonliving component of the ecosystem. [1]

_____ A deer eats the grass.

__✓__ A turtle heats itself in the sunlight.

_____ The air blows over a rock.

Scoring:

1. Award points as follows:
    a. Award 1 point for correctly identifying the living components of the ecosystem.
    b. Award 1 point for correctly identifying the nonliving components of the ecosystem.
2. Award 1 point for indicating a turtle heats itself in the sunlight.

Lesson 2: Air Necessity

Scholars concluded that all living things need air, but where does air in Lake Erie for the white perch come from? Today, scholars will uncover an important relationship between animals and plants in an ecosystem.

Lesson Objectives

- **Big Science Idea**: Relationships between plants and animals are essential for survival because they depend on each other to produce the gasses they take in from the air.
    - **Key Takeaways**:
        - Air is an essential nonliving component of an ecosystem required for organisms.
        - Air is composed of many different components; some components important to ecosystem health include oxygen, nitrogen, and carbon dioxide.
        - Animals and plants depend on each other to get the components of air they need to survive.
- **Science and Engineering Practice: Develop and Use a Model** Scholars engage in this Science and Engineering Practice as they develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s).

Materials Needed

- For the teacher: large plant leaves
- For each group: bag of presorted pom-poms (27 blue, 7 red, 1 yellow), leaf, water, cup, Air Composition Key, and photosynthesis diagram

Prep

- The day before the lesson occurs, place a large leaf of an aquatic plant in a cup of water by the window. The plant must have sunlight, so it can photosynthesize and produce small bubbles on the surface of the leaf.
- Create the air composition bags for each half table prior to the lesson.
- Print the Air Composition Key and photosynthesis diagram for each half table.

Launch

- Ask scholars to take a few deep breaths.
    - What are you breathing in? What is air, and where does it come from? Define *air*.
- Present the lesson challenge: Where does the white perch get its air from underwater? Scholars will explore what is in the air, why living things need it, and where it comes from by performing two experiments.

[**Instructional Tip**: Scholars learn about three components of air. There are many additional components of air that exist, but for the purposes of this unit, only oxygen, nitrogen, and carbon dioxide will be discussed. The photosynthesis diagram given is a simplified version of the more complicated process. At this age, scholars do not need to know the cellular details of photosynthesis.]

Activity

- Scholars conduct two experiments as half tables to observe and collect data about air.
- **Procedure**:

    - Activity 1:
        - Scholars observe the model air mixture and determine and record what each color pom-pom represents in the air mixture.
        - Scholars count and record the amount of each color pom-pom in their Lab Notebooks and discuss what air is made of.
        - Scholars determine which components of air plants and animals rely on and why they need each other to survive.
    - Activity 2:
        - Scholars observe a leaf submerged in water, discussing and recording their observations.
- Circulate the classroom, pressing scholars to think about what is in the air around them and where it comes from.

[**Materials Management Tip**: If you are reusing materials for a later class, scholars should not touch or shake the underwater plant. Shaking will compromise the bubbles the plant is generating.]

Discourse

- **Debrief activity:**
    - Is there the same amount of each gas in the air?
    - Where do the different components of air come from?
        - Ensure scholars understand that animals breathe in oxygen and breathe out some of the carbon dioxide found in the atmosphere. Plants take in carbon dioxide from the atmosphere and give out oxygen.
    - How do plants and animals depend on one another for survival? Define *interdependent*.
- **Make connections to the essential question:** How does the white perch get its air underwater? What does this tell us about the ecosystem a white perch needs to live in?
    - Scholars should be discussing that the white perch's ecosystem needs to have plants to provide the white perch with the oxygen it needs to survive.

Accountability (Informal)

Use the lab notebook and scholar responses to determine which scholars to check in with during tomorrow's lesson.

Lesson 3: Energizing for Life

Scholars know that the white perch, like every other organism, needs nutrients to survive. But why? What do the perch actually gain from eating other organisms? Scholars investigate and uncover the crucial process of energy transfer between organisms.

Lesson Objectives

- **Big Science Idea**: Organisms rely on energy for survival, which they acquire from their environment and/or other organisms.
    - **Key Takeaways**:
        - Plants get the energy they need from the Sun and are called producers, and animals get the energy they need by eating other plants and/or animals and are called consumers.
        - The Sun is the starting source of energy for most ecosystems on Earth. The Sun makes life on Earth possible.
- **Science and Engineering Practice: Develop and Use a Model** Scholars engage in this Science and Engineering Practice as they develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s).

Materials Needed

- For each half table: print out pictures of animals and plants in a food chain, blank sheet of paper, and a glue stick

Prep

- Print out the food chain pictures. Cut these out and place them in an envelope for scholars to use.

Launch

- The white perch is adjusting to its new habitat in Lake Erie.
    - What do you think the white perch eats? What would happen if it were to run out of food?
- Show scholars this picture.
- Present the lesson challenge: The white perch has been observed eating other fish and even fish eggs! Today, scholars will explore the relationship between the organisms in an ecosystem to determine what the white perch is gaining from eating other fish!

Activity

- Scholars work in half tables to determine how organisms depend on each other for survival and how we can use this information to determine why the white perch is eating other fish!
- **Procedure**:
    - Scholars work together to determine relationships between the organisms in the pictures and place the arrows.
    - Scholars glue their proposed relations on the blank sheet of paper and record the relationships in their Lab Notebooks, answering the prompt.
- Press scholars to think about the relationships between the organisms in the pictures and how they may use one another for survival.

Discourse

- **Debrief activity:**
  - What do the arrows in our ecosystem represent? Define **energy**.
    - Where does that energy come from?
    - Which directions are the arrows going? Why?
  - Ask scholars to share out what their group described about the relationship between organisms. Define **food chain** and **transfer**.
  - How do organisms in a food chain depend on one another for energy and survival? Define **producer**, **consumer**, **prey**, and **predator**.
    - Using the organisms from the experiment, identify a producer, consumer, prey, and predator within the Lake Erie food chain.
  - What would happen to the organisms in the food chain if the number of hawks went down? What would happen to the population of white perch if the population of plants went down?
    - [**Instructional Tip**: Scholars will further explore the dynamics of an ecosystem and organism populations in following lessons. Chart scholar responses, so they can be revisited later.]
- **Make connections to the Essential Question:** Why does the white perch eat other fish? What does this tell us the white perch needs in the Lake Erie ecosystem?
  - Scholars should be discussing that the white perch needs energy to survive and there must be a large amount of fish that the white perch eats in Lake Erie. Scholars should now understand the relation of the living and nonliving components of the Lake Erie ecosystem the white perch needs to survive.
- **Make broader connections**: Show scholars this diagram.
  - This diagram shows apex predators in North and South America. What do you think an apex predator is?
  - What happens to all of the energy when it reaches the top of a food chain? Where does it go?

Accountability (Exit Ticket)

This Exit Ticket assesses scholars' understanding of the lesson's Big Science Idea. Scholars will revisit this Big Science Idea in Exit Ticket 5. Use data from this Exit Ticket to close gaps in scholar understanding before Lesson 5. Scholars will use models again in Lesson 5, 7, 8, and 9 Exit Tickets.

Assignment:
The food chain below is from a local grassland habitat.

sun→grass→grasshopper→shrew→owl

1. What do the arrows in a food chain represent? Circle the answer. [1]

oxygen carbon dioxide energy

2. What will **most likely** happen if the shrew population was removed from this ecosystem? Fill in the chart for **each** true or false statement. [1]

Statement	True or False?
The owl population will increase because they have more prey and energy.	False
The owl population will decrease because they will have less prey and energy.	True
Since they will have fewer predators, the grasshopper population will increase.	True

Scoring:

1. Award 1 point for circling “energy”.
2. Award 1 point for indicating **all** correct responses.

Lesson 4: Natural Recyclers

Consumers produce waste when they digest food or die. Where does the waste in an ecosystem go? Today, scholars will dig into Earth's natural recycling system.

Lesson Objectives

- **Big Science Idea**: The remains of formerly living organisms are recycled back into the earth by decomposers.
    - **Key Takeaways**:
        - Decomposers play a crucial part in recycling dead and decaying material back into an ecosystem.
- **Science and Engineering Practice: Develop and Use a Model** Scholars engage in this Science and Engineering Practice as they compare models to identify common features and differences.

Launch

- Show scholars this picture of a collection of animal bones. Eventually, in an ecosystem, animals will die or be eaten by others for energy.
    - What happens to these animal remains? And how does an ecosystem get rid of its waste?
- Present the lesson challenge: We know that organisms need energy for survival. In the consumption of other organisms, waste is produced. Where does the waste in an ecosystem go?

Activity

- Scholars watch the time lapse video to determine the role of decomposers.
- **Procedure**:
    - Pause the video at 30 seconds, 60 seconds, and 90 seconds to allow scholars the time to observe and record observations in their Lab Notebooks.
    - Scholars answer questions in their Lab Notebook and record their conclusions about where waste goes in an ecosystem by comparing the data they have collected.
- Circulate the classroom, pressing scholars to explain the changes they are observing.

Discourse

- **Debrief activity:**
    - What could have caused the food to change? Define **decomposer**.
    - What is the purpose of breaking the material down? How could this help an ecosystem? Define *nutrients*. Who could be dependent on or benefit from the broken down material?
- Show scholars a food chain.
    - Why do you think the decomposers are located here in the food chain? Define *recycle*.
- **Make connections to the Essential Question:** If there were no decomposers underwater, what would happen to the ecosystem? Why?
    - Scholars should be discussing that all ecosystems, even those underwater, need decomposers to break down waste.
- **Make broader connections**: Show this video of a compost bin.
    - Yes, we can get rid of our trash, but is there another way this could be beneficial to an ecosystem?
    - Show scholars this video and return to the previous question.

Accountability (Informal)

Use the lab notebook and scholar responses to determine which scholars to check in with during tomorrow's lesson. This lesson's Big Science Idea will be assessed in Lesson 5 Exit Ticket.

Lesson 5: Food Web

Consumers, producers, and decomposers all play an integral role in moving energy through an ecosystem. How are these organisms connected? Today, scholars will put the pieces together to learn how energy moves through an ecosystem.

Lesson Objectives

- **Big Science Idea**: Organisms are connected by an intricate web of energy transfers.
    - **Key Takeaways**:
        - In a balanced ecosystem, there are many organisms that depend on each other for energy. In the consumer group, there are animals that eat other animals called predators and there are animals that get eaten by other animals called prey.
        - Energy transfer is represented by arrows in a food web, and the arrowhead points to the organisms getting the energy.
        - Energy is transferred within a food chain, and a change in a population of organisms or the availability of a resource will affect the rest of the food chain.
- **Science and Engineering Practice: Construct Explanations and Design Solutions** Scholars engage in this Science and Engineering Practice as they use information from observations (firsthand and from media) to construct an evidence-based account for natural phenomena.

Materials Needed

- For each half table: scissors, glue, construction paper, black/red/green markers, and a sheet with images of animals within the same food web

Prep

- Create and print out a colored copy of each food web sheet for each half table.

[**Time Management Tip**: To ensure scholars have the time needed to complete the activity, you may choose to cut out the organisms ahead of time and place them in an envelope for each team.]

Launch

- Show scholars a food chain.
    - Would the owl die if the snakes disappeared from this food chain?
- Explain that organisms in an ecosystem are connected to more than one food chain. Define **food web**.
- Present the lesson challenge: Explore the connections between different organisms in an ecosystem and determine how energy flows through different food chains in Lake Erie to create a food web.

Activity

- Scholars work in half tables to represent the connections between different organisms in a Lake Erie ecosystem.
- **Procedure**:
    - Scholars cut out organisms and glue them down to create a food web, using the black markers to draw arrows.

    - Scholars label if organisms are a producer, consumer, or decomposer in red marker and predator or prey in green marker.
    - For six organisms in the food web, scholars record organisms, the type of organism, and a source of energy for each organism in their Lab Notebooks.
- Circulate the classroom, pressing scholars to think of the multiple relationships that organisms in a food web share and to explain how energy is being transferred in the food web.

Discourse

- **Debrief activity:** Share scholar food webs.
    - Which organisms are consumers? Producers? How did you know?
    - How do you know which way the energy is transferred in your food web? Use specific evidence from your web.
    - If the _____ population decreased, what would happen to the _____ population? Use specific evidence from the food web to support your response. Define **population**.
- **Make connections to the essential question:** The white perch is a new organism in the Lake Erie ecosystem, where did it fit into the food web? How do you think this may affect other organisms?
    - Scholars should be discussing that a white perch is a consumer and is both predator and prey. They should be considering whether or not the addition of the white perch was a welcome or unwelcome addition to the Lake Erie ecosystem.

Accountability (Exit Ticket)

This Exit Ticket assesses scholars' understanding of the lesson's Big Science Idea. Scholars must identify how energy is transferring in an ecosystem and defend their claims with specific evidence and data from the food web diagram. Scholars will be assessed on this Big Science Idea again in Lesson 9 Exit Ticket.

Assignment:
Many types of organisms interact within a forest ecosystem. Show this image to students.

1. Which organism is **both** a predator and prey in this food web? Circle the answer. [1]

2. What is the role of the decomposer? Check (✓) the answer. [1]

_____ Decomposers absorb the energy as it's being transferred from producer to consumer. The decomposer releases it back into the soil for producers to use again.

_____ Decomposers eat both predators and prey. All energy from the food web ends up with the decomposers and stays there.

__✓__ Decomposers cycle the energy back into the food web by breaking down dead materials.

Scoring:

1. Award 1 point for indicating snake.
2. Award 1 point for indicating “Decomposers cycle the energy back into the food web by breaking down dead materials.”

Lesson 6: Sustainable Ecosystem

Scholars understand that living organisms in an ecosystem rely on other organisms for energy, but how do the types of organisms affect the balance of an ecosystem? In this virtual lab, scholars explore the interactions within the living environment in a mangrove forest as they attempt to sustain a simulated ecosystem. By the end of this lesson, scholars will be questioning whether the white perch is a welcome addition to its new Lake Erie ecosystem.

Lesson Objectives

- **Big Science Idea**: Relations between the living and nonliving components of an ecosystem are dynamic.
    - **Key Takeaways**:
        - Ecosystems have a delicate, dynamic balance between organisms and the resources available.
        - A change in the population of a producer or a consumer will affect the populations of other organisms within an ecosystem and potentially disrupt the ecosystem.
- **Science and Engineering Practice: Construct Explanations and Design Solutions** Scholars engage in this Science and Engineering Practice as they use information from observations (firsthand and from media) to construct an evidence-based account for natural phenomena.

Materials Needed

- For each half table: Computer

Prep

- Ensure computers are charged.

[**Materials Management Tip**: This activity can also be completed as a whole class on the rug if individual computers are not available.]

Launch

- Tell scholars that mangroves are a group of different trees that live in coastal, saltwater estuaries. Show scholars a video of a mangrove ecosystem.
    - What components of an ecosystem did we see in this video? Living and nonliving?
- Present the lesson challenge:
    - Explore the connections between different organisms in a mangrove ecosystem and how changes to an ecosystem can affect the organisms. Scholars will conduct at least three trials of a 12-day aquatic system in a mangrove forest where they will note the health of the organisms and attempt to build a sustainable ecosystem.

Activity

- Scholars work in half tables to create a mangrove ecosystem and determine if their ecosystem is balanced.
- **Procedure**:
    - Scholars log onto this Make a Mangrove: Ecosystem Game and play at least three days' worth of trials.

    - Scholars record the organisms they add and record if they are a producer, consumer, or decomposer in their lab notebooks.
    - Scholars record the health of each organism at the end of each day and use their observations to record a conclusion determining if they were able to create a balanced ecosystem in their lab notebooks.
- Circulate the classroom, pressing scholars to think of reasons why organisms in their ecosystem are balanced or unbalanced. Additionally, press scholars to explain and show how energy is being transferred within the ecosystem.

Discourse

- **Debrief activity:**
    - Were scholars able to successfully populate their mangrove with all species?
    - What were some of the interactions scholars noticed among the populations in this lab?
    - What types of organisms made up the greatest portion of the ecosystem in the lab?
        - Consider the transfer of energy: Why might plants make up the greatest population?
    - What connections can you draw between the population changes in the mangrove ecosystem and why the white perch may be so successful in the Lake Erie ecosystem?
- **Make connections to the essential question:** How might the white perch affect the balance of its new ecosystem?
    - Scholars should be discussing that the white perch must have been able to fit into an already existing food web at Lake Erie, meaning there was already a population of organisms there that the white perch could prey on. In addition, scholars should be questioning whether or not the white perch is a welcome addition to the ecosystem.

Accountability (Informal)

Use the lab notebook and scholar responses to determine which scholars to check in with during tomorrow's lesson.

Lesson 7: Invasive Species

Scholars understand that living organisms in an ecosystem require energy. So what happens to a population when competition for resources increases, and suddenly, there aren't enough sources of energy to go around? Today, scholars will discover what happens to an ecosystem when an invasive species (such as the white perch) is added into the mix.

Lesson Objectives

- **Big Science Idea**: Food webs are impacted by the dynamic relations between organisms and can be disrupted when new organisms are introduced.
    - **Key Takeaways**:
        - Introducing a new species can affect the balance in the energy flow of a food web in an ecosystem.
        - Adding a better adapted organism to an environment can severely disrupt the food web and result in a decrease in other species populations.
- **Science and Engineering Practice: Develop and Use a Model** Scholars engage in this Science and Engineering Practice as they develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s).

Materials Needed

- For the teacher: Invasive Species Game Directions
- For each group: 2 plastic knives, 1 plastic spoon, 3 plastic forks, 1 large binder clip, 12 red pom-poms, 14 black pom-poms, 12 white pom-poms, 3 × 3 feet piece of felt, 1 timer, Invasive Species Game Pictures
- For each scholar: 1 cup, 5 bingo chips

[**Materials Tip**: The group materials listed above assume six scholars per group. You must adjust the number of pom-poms according to the number of scholars in each group. Remove 2 pom-poms from each color group for every scholar decrease in group size. For example, a group of five scholars should have 10 red pom-poms, 12 black pom-poms, and 10 white pom-poms.]

Prep

- Put the appropriate number of each color pom-poms in a bag for each table.
- Ensure that each table has a 3 × 3 feet square of felt.
- Print out the fish pictures with information for each group.

[**Materials Management Tip**: There are only four native fish available. Assuming each table will have six scholars, two scholars will need to represent the same fish.]

Launch

- Show scholars a picture of this food web.
    - If the grasshopper population was completely killed off, would the sparrow population also completely disappear? Why or why not?

- Explain that ecosystems can continue to support life even if one of their food energy sources has disappeared. However, there are instances when ecosystems can no longer maintain a balance and become disrupted. Define **compete**.
- Present the lesson challenge: Today, you will imagine you are different organisms in the Lake Erie ecosystem and uncover how the introduction of a new species of fish can change your ability to compete for survival.

Activity

- Scholars work in table groups to complete the game and discover an invasive species.
- **Procedure**:
    - Scholars set up a game.
    - Scholars play each round and record the number of pom-poms they obtained and any additional notes in their lab notebook.
    - Scholars discuss the results of the game and observations made during each play.
- Circulate and press scholars to think about the state of the ecosystem before and after the white perch was introduced.

[**Instructional Tip**: It may take scholars a few rounds to understand how the game is played. You may consider modeling with scholars how to play the game before sending them back to their tables.]

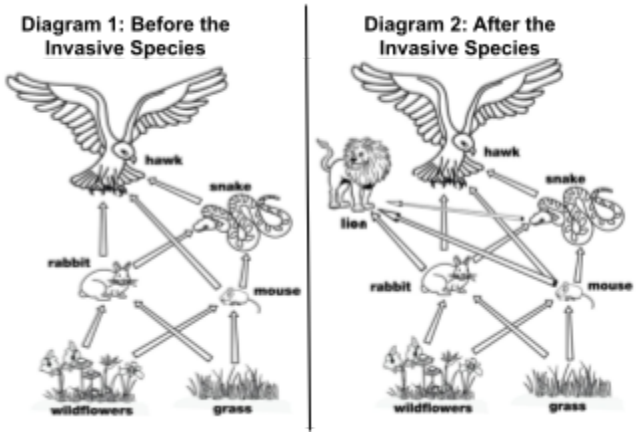
Discourse

- **Debrief activity:**
    - Were you able to compete with the other native species for resources necessary to your survival and reproduction? Support your claim using specific evidence from the activity.
    - What changes occurred when the white perch was introduced? Were you able to get the resources necessary to your survival and reproduction? Why?
        - What made the white perch so successful? Use specific evidence from the activity. Define **invasive species**.
- **Make connections to the essential question:** What could be the consequences of the white perch in the Lake Erie ecosystem?
    - Scholars should be discussing the advantages the white perch species had over the others during the game. In addition, they should be concerned that the white perch is disrupting the native Lake Erie ecosystem.
- **Make broader connections**: Show this video. Alternatively, read this article about invasive plants with scholars after they have had a chance to discuss their initial thoughts.
    - Where do invasive species come from?
    - What effects do invasive species have on ecosystems?

Accountability (Exit Ticket)

This Exit Ticket assesses scholars' understanding of the lesson's Big Science Idea. Scholars must understand how living things are connected in a food web and how invasive species can impact an ecosystem. Scholars will use a model again in Lesson 9 Exit Ticket.

Assignment:
A lion is an invasive species to a desert ecosystem.



1. Check (✓) increase **or** decrease to make **each** statement true about the impact of the invasive species on the ecosystem. [1]

Hawks will have a(n) _____ in available energy sources.	☐ increase	☑ decrease
The population of grass will _____.	☑ increase	☐ decrease
There will be a(n) _____ in snakes.	☐ increase	☑ decrease
There will be a(n) _____ in competition for food.	☑ increase	☐ decrease

Scoring:

1. Award 1 point for selecting **all** correct answers.

Lesson 8: Human Impact

Humans are top predators and require a lot of energy and resources from their environments. How could an increase in the human population affect the Lake Erie ecosystem? Today, scholars explore the effect of a growing human population on the surrounding ecosystem.

Lesson Objectives

- **Big Science Idea**: Food webs can be disrupted by multiple factors including human activity.
    - **Key Takeaways**:
        - Humans impact the balance in ecosystems by using the living and nonliving components to meet their needs.
- **Science and Engineering Practice: Construct Explanations and Design Solutions** Scholars engage in this Science and Engineering Practice as they use information from observations (firsthand and from media) to construct an evidence-based account for natural phenomena.

Materials Needed

- For each group: Game Directions, Human Impact Map, Human Impact Situation Cards, dry erase marker

Prep

- Print out the Game Directions and Human Impact Map. Laminate the map for each group.
- Print out the Human Impact Situation Cards, cut them out, and place them in an envelope.

Launch

- Show this picture of Manhattan before and after humans.
    - How do you think these changes affected the ecosystem and organisms living there?
- Present the lesson challenge: Humans are increasing in population every day. What effect do humans have on the organisms living in the ecosystems?

Activity

- Scholars work in table groups to complete the activity and determine how humans impact ecosystems.
- **Procedure**:
    - Scholars set up and begin the activity, recording their observations in their lab notebooks after picking each scenario card.
    - Scholars discuss and record how humans affect ecosystems.
- Circulate the classroom, listening for and taking note of conversations around human impact and effects on the ecosystem.

Discourse

- **Debrief activity:** Have scholars share their initial observations about the activity.
    - How did humans affect the ecosystem in this activity?
    - What do humans need to be cautious of if they want to sustain balanced ecosystems?
    - Are there suggestions you could provide to help humans maintain sustainable and balanced ecosystems?

Accountability (Exit Ticket)

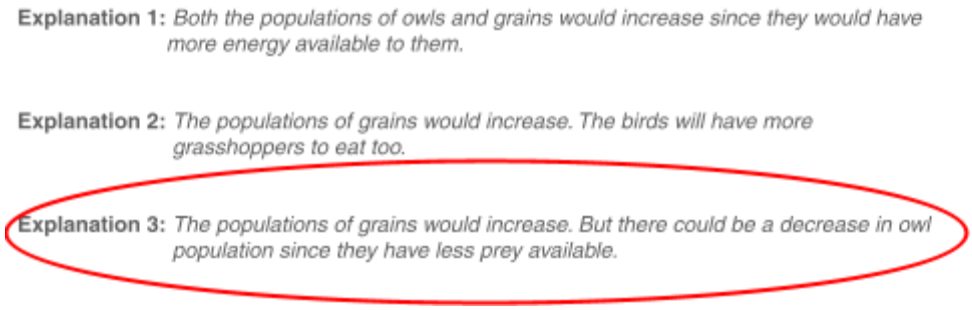
This Exit Ticket assesses scholars' understanding of the lesson's BSI. Scholars must be able to explain how the elimination of the mice population by humans can affect other organisms in the ecosystem.

Assignment:

A farmer notices that mice have been eating all of her sheep's food. She decides to use a chemical, which is harmful to mice, to kill or scare away all of the mice on her farm.

Show students this image.

1. Circle the **best** explanation of how the farm ecosystem will be disrupted, or changed, after the mice leave the ecosystem. [1]



Scoring:

1. Award 1 point for indicating Explanation 3.

Lesson 9: Sustainable Ecosystem Planning

The local conservation society of Lake Erie is working to restore balance to the ecosystem after the white perch invasion! Can scholars use their knowledge from the unit to choose from three solutions and restore the balance to the lake's ecosystem before it's too late? Today, scholars will start to draft a solution to improve the balance of the ecosystem.

Lesson Objectives

- **Big Science Idea**: An ecosystem functions as a delicate balance of organisms and nonliving factors.
    - **Key Takeaways**:
        - A balanced ecosystem has a diverse number of living and nonliving components.
        - The components of an ecosystem work together to provide the necessary means for living things to survive.
- **Science and Engineering Practice: Develop and Use a Model** Scholars engage in this Science and Engineering Practice as they develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s).

Materials Needed

- For each group: Lake Erie Ecosystem, Materials List

Prep

- Print the Materials List and Lake Erie ecosystem image for each group.

Launch

- What have we learned about the Lake Erie ecosystem?
    - What does a white perch need to survive?
    - What makes an ecosystem balanced?
- Present the lesson challenge: The Lake Erie ecosystem is in need of help! Today, you will choose from three solutions the local conservation society has presented to restore balance in the Lake Erie ecosystem. You will choose a solution and plan and design an ecosystem that will restore balance to the Lake Erie ecosystem and allow the organisms to thrive.

Activity

- Scholars work independently to design a balanced ecosystem that can support Lake Erie wildlife.
- **Procedure**:
    - Scholars examine and choose one of the three choices to restore the Lake Erie ecosystem to balance:
        - More predators of the white perch should be added to the existing Lake Erie ecosystem.
        - The white perch should be removed from Lake Erie and be given a new ecosystem to live in.
        - More fishing permits should be given to locals, so the fishing of the white perch increases.

    - Scholars examine the information and consider based on the solution they chose, what materials their ecosystem needs.
    - Scholars analyze and record the materials and amounts they want to use in their ecosystem.
    - Scholars draw and label a plan for their ecosystem in their Lab Notebooks.
    - Scholars share out and discuss their plans with members from their tables, agreeing on one design that they will create in tomorrow's lesson.
- Circulate the classroom, observing scholars' plans and pressing scholars to explain the items they are adding and describe how each will contribute to a balanced ecosystem.

Discourse

- **Debrief activity:** Showcase different plans.
    - How does the design result in a balanced ecosystem? Solve the white perch population problem?
    - Ask the class to evaluate the validity of each ecosystem.
        - Are there parts of this ecosystem that are not sustainable? Why not?
        - What could the scholars add or change about their design to ensure that they will have a balanced ecosystem?
- **Make broader connections**: Show this picture of an aquarium.
    - What do you think the builders had to consider when creating this ecosystem?
    - Do you know of any other man made ecosystems?

Accountability (Exit Ticket)

This Exit Ticket assesses scholars' understanding of the lesson's Big Science Idea and Science and Engineering Practices. Use the data from this Exit Ticket to close gaps in scholar understanding.

Assignment:
The following model shows how a forest ecosystem has changed over the past ten years.

1. Identify one population that has decreased. [1]
   consumers / decomposers

2. How could a decrease in this population affect another population of organisms in the ecosystem? Explain using your knowledge about energy flow in ecosystems. [2]
   If there is a decrease in consumers, there will be an increase in producers. If there are less consumers to eat the producers, there will be more producers.

   If the population of decomposers goes down, then there will be a decrease in populations of producers and consumers. Producers rely on decomposers for nutrients, so if there are less decomposers, there will be less producers. If there are less producers, then there will be less consumers too.

Scoring:

1. Award 1 point for correctly using the model to identify a population that has decreased.
2. Award points as follows:
   - Award 1 point for an accurate claim indicating an increase/decrease in another population of organisms.
   - Award 1 point for accurately explaining why the population will change based on the ecosystem.

Lesson 10: Sustainable Ecosystem Building

Today, scholars will bring their designs to life as they choose materials and build their ecosystems. Will the organisms of Lake Erie be saved?

Lesson Objectives

- **Big Science Idea**: A balanced ecosystem is one in which many species can survive and sustain life.
    - **Key Takeaways**:
        - Living organisms have different relationships within an ecosystem. For an ecosystem to remain stable, a balance must exist between the organisms and the resources in an ecosystem.
- **Science and Engineering Practice: Construct Explanations and Design Solutions** Scholars engage in this Science and Engineering Practice as they use information from observations (firsthand and from media) to construct an evidence-based account for natural phenomena.

Materials Needed

- For each group: Materials List, Lake Erie Ecosystem, tri-fold poster board (optional)

Prep

- Determine if you will have scholars draw the different organisms or cut and paste them onto their ecosystem. If cutting and pasting, print enough copies of the Materials List, so scholars can populate their ecosystems.

Launch

- What are the requirements for a balanced ecosystem?
- What will you need to keep in mind as you build your balanced Lake Erie ecosystems today?
- Present the lesson challenge: Using the plan your team decided on yesterday, construct your ecosystem. When it is completed, you will record a food web with two food chains from your ecosystem in your lab notebooks.

Activity

- Scholars work in whole tables to construct their dynamic ecosystem, restoring balance in Lake Erie.
- **Procedure**:
    - Table teams assign jobs to each member to complete during the activity and create their ecosystems.
    - Scholars answer questions in their lab notebooks and record two food chains to complete a food web based on their ecosystem.
- Press scholars to explain their reasoning behind their designs.

Discourse

- **Debrief activity:** Scholars share ecosystems.
    - What solution did your team choose? Why did this seem like the best solution?
    - Explain the different components of your ecosystem. How does each component contribute to a balanced ecosystem?

    - Allow the class to observe and make initial observations.
        - Is there any constructive feedback you can give the group to improve their ecosystem?
        - Are there any questions you have for the group to help you understand how the ecosystem will be balanced?
- **Make broader connections**: Watch this video of the creation of Biosphere 2.
    - What did the engineers of Biosphere 2 need to think about when building the structure?

Accountability (Lab Notebook)

Use the Lab Notebook to assess scholars' understanding of the lesson's Big Science Idea. This is the last opportunity for you to assess scholars' understanding of and application of food webs.

Scoring:

- For the first section, award 1 point for each correctly identified organism.
- For the food web drawing, award 1 point for each correctly completed food chain.
- For the written response, award points as follows:
    - Award 1 point for a claim about whether their solution has restored balance.
    - Award 1 point for including relevant evidence from observational data.

Unit Vocabulary

Flashcards

- Send home Vocabulary Flashcards for scholars to study.

Vocabulary List

- **living** - needing energy to be alive
- **nonliving** - not needing energy and not alive
- **ecosystem** - a community of interacting organisms and their environment
- **energy** - the ability to do work
- **compete** - to try to gain or get something, like food, before other living things get it
- **consumer** - an organism that gets energy by eating something
- **producer** - an organism that makes its own food (a plant)
- **predator** - an animal that gets food by hunting and eating other animals
- **prey** - an animal that is hunted and eaten by other animals
- **decomposer** - an organism that breaks down and recycles dead plants and animals
- **invasive species** - a type of living thing that is not native to an ecosystem and causes harm
- **food chain** - a diagram that shows how energy is transferred from one living thing to the next. Each organism uses the lower member as a source of food.
- **food web** - a network of connected food chains. It shows how energy is transferred throughout an ecosystem.
- **population** - the number of organisms of the same species that live in a particular area at the same time
- **transfer** - to move from one place to another

Extra Resources

In addition to the resources linked throughout the guide, use the following materials to help you prepare to launch this unit with scholars:

- Lab Notebook
- Unit-Specific Content - Resources to help you understand content at an adult level