

UNIT 1

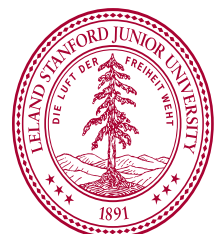
A Balanced Biosphere



How have natural processes and human activities created the ecosystems we see today?

SCALE

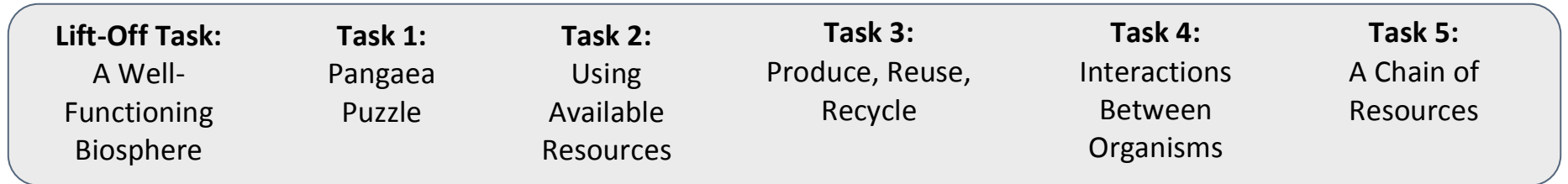
Stanford Center for Assessment,
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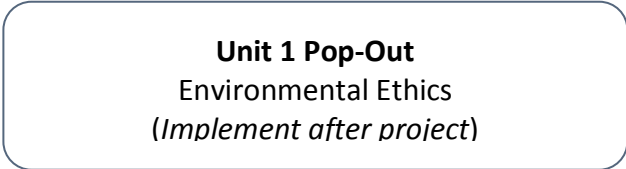
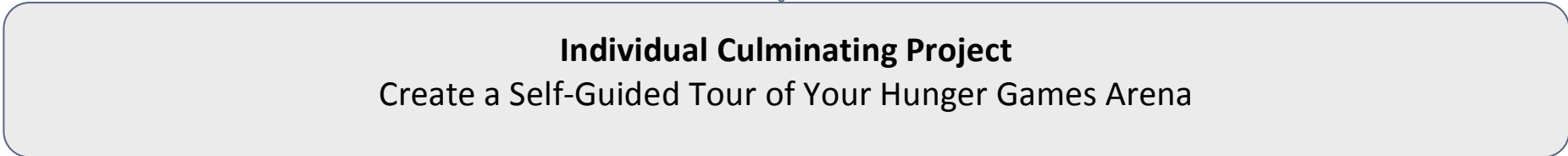
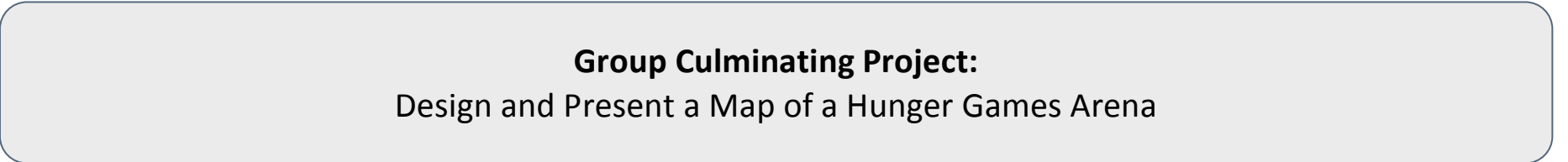
Stanford NGSS Integrated Curriculum: An Exploration of a Multidimensional World
Unit 1: A Balanced Biosphere

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

Total Number of Instructional Days: 35.5 – 36.5



Connect to the Culminating Project using the Project Organizer



7th Grade Science Unit 1: A Balanced Biosphere

Unit Overview

Storyline for Unit 1

Every ecosystem on Earth is unique, with its own set of geologic features, essential natural resources, and interacting plants and animals. In this unit, students learn more about why an ecosystem works the way it does by looking at a complicated history of natural and artificial processes. By the end of the unit, students will be able to develop their own imitation ecosystem in the form of a *Hunger Games* arena for their culminating project.

In the Lift-Off Task, students are introduced to ecosystems with Biosphere 2, an artificial living environment built in Arizona in the 1990's that was meant to be self-sustaining. By looking at the phenomenon of how a biosphere functions, students can begin to generate questions about what an ecosystem is and how it functions. These student-generated questions will guide them throughout this unit as they continue to make sense of this phenomenon and begin to imagine what their culminating project of an imitation ecosystem will look like.

In Task 1, students move to examining ecosystems from a macro perspective: based on plate motions, what geologic features are present in different ecosystems? Students engage with this question by thinking about a real case in scientific history—Alfred Wegener's theory of Pangaea. In this task, students embark on the same journey as Wegener, making sense of the phenomenon of continent movement by collecting an abundance of data that might provide evidence. This will help them identify the geologic features within their own arena based on the continental location they choose.

In Task 2, students learn that some of these same processes also lead to the natural resources that are available in different regions. The question of how natural resources are made and distributed is a very important one for humans because we rely so heavily on them every day. In this task, students explore both the geoscience processes and the human actions that result in an uneven distribution of resources, which will help them to justify the resources they present in their arena.

In Task 3, students continue to consider nonliving things, but also begin to incorporate living organisms into their schema of an ecosystem. Here, students explore how living and nonliving parts of an ecosystem must interact to create a well-functioning ecosystem. Within this task, they construct a model that clearly shows how matter is cycled and energy flows through living and nonliving things. This helps them to envision their culminating project arena as a whole—including the living and nonliving components as well as their interactions.

Task 4 asks students to remember that this is not the only way organisms interact in an ecosystem. Regardless of the type of ecosystem, there are patterns that can be noticed in the way organisms interact with each other. These patterns have been classified into five different relationships: competition, predation, commensalism, mutualism, and parasitism. In this task, students analyze real-life examples in order to find their own patterns and make their own categories to explain interactions among organisms. As students begin to populate their arena with organisms for their culminating project, they will use these relationships to design a challenge for the game contestants.

In Task 5, students use what they have learned about the ways living and nonliving things interact in order to approach environments at a systems level. By engaging with a simulation, students are able to see data of real scenarios that allows them to predict how changing one part of an ecosystem can affect another—in other words, how different resources affect the populations of different organisms. Students will use this data to inform their culminating project, as they consider how removing a resource from their arena would impact the populations of organisms present.

Once students have completed all tasks and their Project Organizers, they can begin work on their culminating project. In this culminating project, student groups design a new *Hunger Games* arena for the upcoming film that mimics, or looks like, an ecosystem they might see on Earth. Each group presents their arena design to the director as a candidate for the next film in the form of a diorama or poster-sized annotated map. Individually, each student then creates a self-guided tour of their group's arena, in the form of a brochure or flyer, so that the director has additional materials to consider as he makes his decision.

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Three-Dimensional Breakdown of the Performance Expectations

This unit was developed to align with, teach, and assess students’ understanding and skills related to these Performance Expectations. Below, we have mapped out the disciplinary core ideas, crosscutting concepts, and science and engineering practices addressed in this unit. Aspects of the dimensions that are not explicitly addressed in this unit are crossed out.

Performance Expectations	Scientific and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<p>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.]</p>	<p>Analyzing and Interpreting Data</p> <ul style="list-style-type: none"> Analyze and interpret data to provide evidence for phenomena. 	<p>LS2.A: Interdependent Relationships in Ecosystems</p> <ul style="list-style-type: none"> 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. 	<p>Cause and Effect</p> <ul style="list-style-type: none"> Cause and effect relationships may be used to predict phenomena in natural or designed systems.
<p>MS-LS2-2. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. [Clarification Statement: Emphasis is on predicting consistent patterns of interactions in different ecosystems in terms of the relationships among and between organisms and abiotic components of ecosystems. Examples of types of interactions could include competitive, predatory, and mutually beneficial.]</p>	<p>Constructing Explanations</p> <ul style="list-style-type: none"> Construct an explanation that includes qualitative or quantitative relationships between variables that predict phenomena. 	<p>LS2.A: Interdependent Relationships in Ecosystems</p> <ul style="list-style-type: none"> Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species 	<p>Patterns</p> <ul style="list-style-type: none"> Patterns can be used to identify cause and effect relationships.

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		involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared.	
<p>MS-LS2-3. Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. [Clarification Statement: Emphasis is on describing the conservation of matter and flow of energy into and out of various ecosystems, and on defining the boundaries of the system.] [Assessment Boundary: Assessment does not include the use of chemical reactions to describe the processes.]</p>	<p>Developing and Using Models</p> <ul style="list-style-type: none"> Develop a model to describe phenomena. 	<p>LS2.B: Cycles of Matter and Energy Transfer in Ecosystems</p> <ul style="list-style-type: none"> Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. 	<p>Energy and Matter</p> <ul style="list-style-type: none"> The transfer of energy can be tracked as energy flows through a natural system.
<p>MS-ESS2-3. Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions. [Clarification Statement: Examples of data include similarities of rock and fossil types on different continents, the shapes of the continents (including continental</p>	<p>Analyzing and Interpreting Data</p> <ul style="list-style-type: none"> Analyze and interpret data to provide evidence for phenomena. 	<p>ESS2.B: Plate Tectonics and Large-Scale System Interactions</p> <ul style="list-style-type: none"> Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth’s plates have moved great distances, collided, and spread apart. 	<p>Patterns</p> <ul style="list-style-type: none"> Patterns in rates of change and other numerical relationships can provide information about natural systems.

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<p>shelves), and the locations of ocean structures (such as ridges, fracture zones, and trenches).] [Assessment Boundary: Paleomagnetic anomalies in oceanic and continental crust are not assessed.]</p>			
<p>MS-ESS3-1. Construct a scientific explanation based on evidence for how the uneven distributions of Earth’s mineral, energy, and groundwater resources are the result of past and current geoscience processes. [Clarification Statement: Emphasis is on how these resources are limited and typically non-renewable, and how their distributions are significantly changing as a result of removal by humans. Examples of uneven distributions of resources as a result of past processes include but are not limited to petroleum (locations of the burial of organic marine sediments and subsequent geologic traps), metal ores (locations of past volcanic and hydrothermal activity associated with subduction zones), and soil (locations of active weathering and/or deposition of rock).]</p>	<p>Constructing Explanations</p> <ul style="list-style-type: none"> Construct a scientific explanation based on 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. 	<p>ESS3.A: Natural Resources</p> <ul style="list-style-type: none"> Humans depend on Earth’s land, ocean, atmosphere, and biosphere for many different resources. Minerals, freshwater, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes. 	<p>Cause and Effect</p> <ul style="list-style-type: none"> Cause and effect relationships may be used to predict phenomena in natural or designed systems.

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Connections to Common Core Math and ELA Standards:

Over the course of this unit, students will gain knowledge and skills in science, as well as in math and English-language arts. Below we list the Common Core ELA and Math standards for middle school and 7th grade that are relevant to the curriculum tasks in this unit. Within the curriculum, there are opportunities to incorporate components of the following ELA and Math Standards:

Middle School Common Core ELA Standards		Unit Task
Key Ideas and Details	CCSS.ELA-Literacy.RST.6-8.1: Cite specific textual evidence to support analysis of science and technical texts.	Task 2 Culminating Project
Integration of Knowledge and Ideas	CCSS.ELA-Literacy.RST.6-8.7: Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).	Task 2 Task 3 Culminating Project
	CCSS.ELA-Literacy.RST.6-8.9: Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.	Task 2
Research to Build and Present Knowledge	CCSS.ELA-Literacy.WHST.6-8.9: Draw evidence from informational texts to support analysis, reflection, and research.	Task 2 Task 3 Culminating Project
Comprehension and Collaboration	CCSS.ELA-Literacy.SL.8.1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade [7] topics, texts, and issues, building on others' ideas and expressing their own clearly.	All Tasks Culminating Project
Presentation of Knowledge and Ideas	CCSS.ELA-Literacy.SL.8.4: Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation.	Task 1 Task 3 Culminating Project
	CCSS.ELA-Literacy.SL.8.5: Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest.	Task 1 Task 3 Culminating Project

Middle School and 7th Grade Common Core Math Standards		Unit Task
Mathematical Practice	CCSS.MATH.MP.2: Reason abstractly and quantitatively.	Task 5
	CCSS.MATH.MP.4: Model with mathematics.	Task 5

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Connections to English Language Development (ELD) Standards:

We acknowledge that language development is a key component of disciplinary understanding and helps to support more rigorous and equitable outcomes for diverse students. This curriculum thus takes into account both the receptive and productive language demands of the culminating projects and strives to increase accessibility by including scaffolds for language development and pedagogical strategies throughout learning tasks. We aim to support language acquisition through the development of concept maps; utilizing sentence frames; implementing the Critique, Correct, Clarify technique; employing the Stronger Clearer strategy; and fostering large and small group discussions.

The California ELD Standards are comprised of two sections: the standards and a rubric. Outlined below are the standards from Section One that are met within this curriculum. For additional information, please refer to: https://www.pausd.org/sites/default/files/pdf-faqs/attachments/SS_ELD_7.pdf.

7th Grade ELD Standards		
Part I: Interacting in Meaningful Ways	A: Collaborative	1. Exchanging information and ideas with others through oral collaborative discussions on a range of social and academic topics
		2. Interacting with others in written English in various communicative forms (print, communicative technology, and multimedia)
		3. Offering and justifying options, negotiating with and persuading others in communicative exchanges
		4. Adapting language choices to various contexts (based on task, purpose, audience, and text type)
	B: Interpretive	5. Listening actively to spoken English in a range of social and academic contexts
		6. Reading closely literary and informational texts and viewing multimedia to determine how meaning is conveyed explicitly and implicitly through language
		7. Evaluating how well writers and speakers use language to support ideas and arguments with details or evidence depending on modality, text type, purpose, audience, topic, and content area
		8. Analyze how writers and speakers use vocabulary and other language resources for specific purposes (to explain, persuade, entertain, etc.) depending on modality, text type, purpose, audience, topic, and content area
	C: Productive	9. Expressing information and ideas in formal oral presentations on academic topics
		10. Writing literary and informational texts to present, describe, and explain ideas and information, using appropriate technology
		11. Justifying own arguments and evaluating others' arguments in writing
		12. Selecting and applying varied and precise vocabulary and other language resources to effectively convey ideas
Part II: Learning About How English Works	A: Structuring Cohesive Texts	1. Understanding text structure
		2. Understanding cohesion
	B: Expanding and Enriching Ideas	3. Using verbs and verb phrases
		4. Using nouns and noun phrases
		5. Modifying to add details
	C: Connecting and Condensing Ideas	6. Connecting ideas
		7. Condensing ideas

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Connections to Environmental Awareness:

Over the course of this curriculum, students will explore content related to various environmental principles and concepts that examine the interactions and interdependence of human societies and natural systems. In accordance with the *Education and the Environment Initiative (EEI)*, tasks throughout this curriculum explore many of *California’s Approved Environmental Principles and Concepts*. The principles relevant to this unit are outlined in the chart below:

Unit Task	EEI Principle	EEI Concept
Task 2 Task 3 Culminating Project	Principle I: The continuation and health of individual human lives and of human communities and societies depend on the health of the natural systems that provide essential goods and ecosystem services.	Concept A: The goods produced by natural systems are essential to human life and to the functioning of our economies and cultures.
		Concept B: The ecosystem services provided by natural systems are essential to human life and to the functioning of our economies and cultures.
		Concept C: The quality, quantity, and reliability of the goods and ecosystem services provided by natural systems are directly affected by the health of those systems.
Task 2 Task 5 Culminating Project	Principle II: The long-term functioning and health of terrestrial, freshwater, coastal and marine ecosystems are influenced by their relationships with human societies.	Concept A: Direct and indirect changes to natural systems due to the growth of human populations and their consumption rates influence the geographic extent, composition, biological diversity, and viability of natural systems.
		Concept B: Methods used to extract, harvest, transport and consume natural resources influence the geographic extent, composition, biological diversity, and viability of natural systems.
Task 2 Task 3 Culminating Project	Principle III: Natural systems change in ways that people benefit from and can influence.	Concept A: Natural systems proceed through cycles and processes that are required for their functioning.
		Concept B: Human practices depend upon and benefit from the cycles and processes that operate within natural systems.
Task 2 Culminating Project	Principle IV: The exchange of matter between natural systems and human societies affects the long-term functioning of both.	Concept B: The byproducts of human activity are not readily prevented from entering natural systems and may be beneficial, neutral, or detrimental in their effect.

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Teacher Materials List

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

Overall Unit – All Tasks

- Unit 1, Task Cards Student Version, Lift-Off and Tasks 1 through 5
- Culminating Project Student Task Card
- Project Organizer
- Projector with Audio (for video or images, whenever needed)

Lift-Off Task (2 days)

Per Student

- Task Card Student Version: Lift-Off
- Post-Its (Optional)
- Task Card Student Version: Culminating Project
- Project Organizer

Per Group

- Poster paper and markers

Whole Class

- Poster paper and markers
- *See Instructions in Lift-Off for other optional materials to use for the class concept map

Task 1 (5.5 days)

Per Student

- Task Card Student Version: Task 1
- Project Organizer

Per Group

- Continent Pieces: Two continent pieces per group (enlarge, print, cut, and laminate)
 - <https://pubs.usgs.gov/imap/2800/>
- Envelope of Evidence Cards: Look at the list below for the relevant evidence cards for each pair of continents. Cut them into continent pieces, label the backs with the type of evidence, laminate, and put into an envelope. *Note: Evidence cards must be in color for students to see evidence.*
 - South America and Africa: Mountain Ranges, Rock, Glacial Deposits, Fossils
 - South America and North America: Coal, Fossils
 - North America and Europe/Asia: Mountain Ranges, Coal, Rock, Fossils
 - North America and Africa: Mountain Ranges, Fossils
 - Europe/Asia and Africa: Mountain Ranges, Fossils
 - Antarctica and Australia: Glacial Deposits, Fossils
 - Antarctica and Africa: Glacial Deposits, Fossils

Whole Class

- Projector and Speakers (for video)

Task 2 (4 days)

Per Student

- Task Card Student Version: Task 2

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Teacher Materials List**

- Project Organizer

Per Group or Pair

- Resource Cards in sheet protectors
- 4 Graham Crackers
- Cake Frosting
- Wax Paper
- Plastic Knife
- Cup of Water
- Computer

Task 3 (4 days)

Per Student

- Task Card Student Version: Task 3
- Project Organizer
- Optional: Post-Its

Per Group

- Poster Paper
- Ecosystem Cards (1 per group)
- Scissors (1 per group)
- Pencils
- Glue
- Markers

Task 4 (4 days)

Per Student

- Task Card Student Version: Task 4
- Project Organizer

Per Station

- Station Cards in sheet protectors (2-3 at each station)

Per Group

- Interaction Cards (laminated, cut, and put in an envelope per group)

Task 5 (4-5 days)

Per Student

- Task Card Student Version: Task 5
- Project Organizer

Per Group

- Computers for [computer simulation \(linked here\)](#)

Whole Class

- Projector and Speakers (for videos)

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Teacher Materials List****Culminating Project (9 days)**

Poster-sized Map

- Poster Paper
- Color pencils/markers or computer graphics
- Computers with internet capabilities

Diorama (Optional)

- Shoebox
- Colored cardstock
- Sandpaper
- Glue
- Paint
- Brushes
- Scissors
- Pipe cleaners
- Etc.

Self-Guided Tour (Brochure or Flyer)

- Blank Paper or Computer Program
- Color pencils/markers or computer graphics

Unit 1 Pop-Out (3 days)

Per Student

- Student Version: Unit 1 Pop-Out
- Unit 1, Pop-Out Case Study – Wolves in Yellowstone
- Unit 1, Pop-Out Case Study – Zebra Mussels

Per Pair

- Computer or tablet

7th Grade Science Unit 1: A Balanced Biosphere
Building on Prior Knowledge

This seventh grade curriculum begins with a unit that connects two of the three disciplines—life science and earth science. In this unit, students use their knowledge of ecosystems to think more deeply about how natural processes and human activities have shaped Earth’s ecosystems. In this culminating project, students are asked to design an arena that mimics a natural environment, keeping these concepts in mind.

The integrated model requires students to access and use a wide range of ideas from prior grades. This content knowledge spans four different Disciplinary Core Ideas: LS2.A. Interdependent Relationships in Ecosystems, LS2.B. Cycles of Matter and Energy Transfer in Ecosystems, ESS2.B. Plate Tectonics and Large Scale System Interactions, and ESS3.A. Natural Resources.

As students explore these core ideas, they build on their skills in the following science and engineering practices: Developing and Using Models, Analyzing and Interpreting Data, and Constructing Explanations. In addition to science and engineering practices, students also continue to build on their knowledge of the following crosscutting concepts: Patterns, Cause and Effect, Systems and System Models, and Energy and Matter.

*This summary is based on information found in the NGSS Framework.

K-8 Progression of Disciplinary Core Ideas, Science and Engineering Practices, and Crosscutting Concepts for Unit 1

Disciplinary Core Ideas	K-2	3-5	6-8
LS2.A Interdependent Relationships in Ecosystems	Plants depend on water and light to grow and also depend on animals for pollination or to move their seeds around.	The food of almost any animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants, while decomposers restore some materials back to the soil.	Organisms and populations are dependent on their environmental interactions both with other living things and with nonliving factors, any of which can limit their growth. Competitive, predatory, and mutually beneficial interactions vary across ecosystems but the patterns are shared.
LS2.B Cycles of Matter and Energy Transfer in Ecosystems	N/A	Matter cycles between the air and soil and among organisms as they live and die.	The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. Food webs model how matter and energy are transferred among producers, consumers, and decomposers as the three groups interact within an ecosystem.
ESS2.B Plate Tectonics and Large Scale System Interactions	Maps show where things are located. One can map the shapes and kinds of land and water in any area.	Earth’s physical features occur in patterns, as do earthquakes and volcanoes. Maps can be used to locate features and determine patterns in those events.	Plate tectonics is the unifying theory that explains movements of rocks at Earth’s surface and geological history. Maps are used to display evidence of plate movement.

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<p>ESS3.A Natural Resources</p>	<p>Living things need water, air, and resources from the land, and they live in places that have the things they need. Humans use natural resources for everything they do.</p>	<p>Energy and fuels humans use are derived from natural sources and their use affects the environment. Some resources are renewable over time, others are not.</p>	<p>Humans depend on Earth’s land, ocean, atmosphere, and biosphere for different resources, many of which are limited or not renewable. Resources are distributed unevenly around the planet as a result of past geologic processes.</p>
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<p>Science and Engineering Practices</p>	<p>K-2</p>	<p>3-5</p>	<p>6-8</p>
<p>Developing and Using Models*</p>	<p>Modeling in K-2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, or storyboard) that represent concrete events or design solutions.</p> <ul style="list-style-type: none"> Develop and/or use a model to represent amounts, relationships, relative scales (bigger/smaller), and/or patterns in the natural and designed world(s). 	<p>Modeling in 3-5 builds on prior experiences and progresses to building and revising simple models and using models to represent events and design solutions.</p> <ul style="list-style-type: none"> Develop and/or use models to describe and/or predict phenomena. 	<p>Modeling in 6-8 builds on prior experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.</p> <ul style="list-style-type: none"> Develop a model to predict and/or describe phenomena.
<p>Analyzing and Interpreting Data*</p>	<p>Analyzing data in K-2 builds on prior experiences and progresses to collecting, recording, and sharing observations.</p> <ul style="list-style-type: none"> Record information (observations, thoughts, and ideas). Use observations (firsthand or from media) to describe patterns and/or relationships in the natural and designed world(s) in order to answer scientific questions and solve problems. 	<p>Analyzing data in 3-5 builds on prior experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used.</p> <ul style="list-style-type: none"> Represent data in tables and/or various graphical displays (bar graphs, pictographs, and/or pie charts) to reveal patterns that indicate relationships. Analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics, and/or computation. 	<p>Analyzing data in 6-8 builds on prior experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.</p> <ul style="list-style-type: none"> Analyze and interpret data to provide evidence of a phenomenon.

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<p>Constructing Explanations*</p>	<p>Constructing Explanations in K-2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena.</p> <ul style="list-style-type: none"> Use information from observations (firsthand and from media) to construct an evidence-based account for natural phenomena. 	<p>Constructing Explanations in 3-5 builds on prior experiences and progresses to the use of evidence and ideas in constructing explanations that specify variables that describe and predict phenomena.</p> <ul style="list-style-type: none"> Construct an explanation of observed relationships (e.g., the distribution of plants in the back yard). Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem. 	<p>Constructing Explanations in 6-8 builds on prior experiences and progresses to include constructing explanations supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.</p> <ul style="list-style-type: none"> Construct an explanation that includes qualitative or quantitative relationships between variables that predict phenomena. Construct a scientific explanation based on 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.
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*These SEPs are summatively assessed using the Culminating Project.

Crosscutting Concepts	K-2	3-5	6-8
<p>Patterns*</p>	<p>Students recognize that patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.</p> <ul style="list-style-type: none"> Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence. 	<p>Students identify similarities and differences in order to sort and classify natural objects and designed products. They identify patterns related to time, including simple rates of change and cycles, and to use these patterns to make predictions.</p> <ul style="list-style-type: none"> Similarities and differences in patterns can be used to sort, classify, communicate and analyze simple rates of change for natural phenomena and designed products. Patterns of change can be used to make predictions. Patterns can be used as evidence to support an explanation. 	<p>Students recognize that macroscopic patterns are related to the nature of microscopic and atomic-level structure. They identify patterns in rates of change and other numerical relationships that provide information about natural and human designed systems. They use patterns to identify cause and effect relationships, and use graphs and charts to identify patterns in data.</p> <ul style="list-style-type: none"> Patterns in rates of change and other numerical relationships can provide information about natural systems. Patterns can be used to identify cause-and-effect relationships.

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<p>Cause and Effect*</p>	<p>Students learn that events have causes that generate observable patterns. They design simple tests to gather evidence to support or refute their own ideas about causes.</p> <ul style="list-style-type: none"> Events have causes that generate observable patterns. 	<p>Students routinely identify and test causal relationships and use these relationships to explain change. They understand events that occur together with regularity might or might not signify a cause and effect relationship.</p> <ul style="list-style-type: none"> Cause and effect relationships are routinely identified, tested, and used to explain change. 	<p>Students classify relationships as causal or correlational, and recognize that correlation does not necessarily imply causation. They use cause and effect relationships to predict phenomena in natural or designed systems. They also understand that phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.</p> <ul style="list-style-type: none"> Cause and effect relationships may be used to predict phenomena in natural or designed systems.
<p>Systems and System Models*</p>	<p>Students understand objects and organisms can be described in terms of their parts; and systems in the natural and designed world have parts that work together.</p> <ul style="list-style-type: none"> Objects and organisms can be described in terms of their parts. Systems in the natural and designed world have parts that work together. 	<p>Students understand that a system is a group of related parts that make up a whole and can carry out functions its individual parts cannot. They can also describe a system in terms of its components and their interactions.</p> <ul style="list-style-type: none"> A system is a group of related parts that make up a whole and can carry out functions its individual parts cannot. A system can be described in terms of its components and their interactions. 	<p>Students can understand that systems may interact with other systems; they may have sub-systems and be a part of larger complex systems. They can use models to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems. They can also learn that models are limited in that they only represent certain aspects of the system under study.</p> <ul style="list-style-type: none"> Systems may interact with other systems; they may have sub-systems and be a part of a larger complex system. Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy and matter flows within systems.
<p>Energy and Matter*</p>	<p>Students observe objects may break into smaller pieces, be put together into larger pieces, or change shapes.</p> <ul style="list-style-type: none"> Objects may break into smaller pieces, be put together into larger pieces, or change shapes. 	<p>Students learn matter is made of particles and energy can be transferred in various ways and between objects. Students observe the conservation of matter by tracking matter flows and cycles before and after processes and recognizing the total weight of substances does not change.</p> <ul style="list-style-type: none"> Matter is made of particles. 	<p>Students learn matter is conserved because atoms are conserved in physical and chemical processes. They also learn that within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter.</p> <ul style="list-style-type: none"> The transfer of energy can be tracked as energy flows through a natural system

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		<ul style="list-style-type: none"> • Matter is transported into, out of, and within systems. • Energy can be transferred in various ways and between objects. 	
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*These CCCs are summatively assessed using the Culminating Project.

Progression of Knowledge from Kindergarten – 8th grade

LS2.A. Interdependent Relationships in Ecosystems: In Kindergarten - second grade, students begin to think about the different living things in an environment, the matter that plants need to grow, and one example of how plants and animals interact. At this stage, the knowledge is context specific and does not connect these pieces within an ecosystem as a whole. In third – fifth grade, students begin to make these connections as they consider the interactions between four broad parts of the environment. Rather than apply these ideas within specific contexts, students begin to form concepts that can be generalized to most environments. This sets the foundation for this seventh grade unit, in which students will engage with generalizable phenomena within most ecosystems, explaining the different interactions between organisms, including how resources affect populations. From kindergarten – fifth grade, students are building their understanding of Cause and Effect and Systems and System Models to organize these concepts, as well as Developing and Using Models to help them demonstrate understanding of the core ideas. By this seventh grade unit, they are moving towards gathering evidence of these phenomena in order to construct explanations.

The following is the progression of the Performance Expectations for this DCI:

- 2-LS2-1** Plan and conduct an investigation to determine if plants need sunlight and water to grow.
- 2-LS2-2** Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.
- 5-LS2-1** Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.
- 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.
- MS-LS2-2** Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

LS2.B. Cycles of Matter and Energy Transfer in Ecosystems: In Kindergarten - second grade, students do not explicitly touch on this DCI, but do explore parts and interactions within environments, which lays the foundation for this DCI (see LS2.A above). In third – fifth grade, students begin to conceptualize the environment as whole, exploring interactions as movement of matter. This provides a clear and easy progression into this seventh grade unit, in which students engage with all the interactions within an ecosystem, modeling not only how matter cycles, but also how energy flows through an ecosystem. In both fifth grade and seventh grade, students use the skill of Developing and Using Models to help them

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demonstrate this understanding. As students progress from fifth to seventh grade, they move from using Systems and System Models to organize these concepts to also considering how Energy and Matter are at play within an ecosystem.

The following is the progression of the Performance Expectations for this DCI:

5-LS2-1 Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.

MS-LS2-3 Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.

ESS2.B. Plate Tectonics and Large Scale System Interactions: Kindergarten - second grade introduces students to map representations of geographic features in general, such as the kind of land and bodies of water in an area. At this stage, questions that students explore are generic, such as “How does land change and what are some things that cause it to change?” In third – fifth grade, students take this a step further by analyzing and interpreting actual data from maps in order to describe patterns in Earth’s features. These patterns will then be used in this seventh grade unit, as students look at one specific set of patterns in data—those that provide evidence of past plate motions. Thus, students gradually move from identifying features on Earth to explaining the processes that resulted in those features. While students begin to explore these concepts in Kindergarten – second grade by Developing Models, they later progress to Analyzing and Interpreting actual Data, a skill they will need in this 7th grade unit. At all grade levels, students are building their ability to see Patterns amongst Earth’s features in order to draw conclusions.

The following is the progression of the Performance Expectations for this DCI:

2-ESS2-2 Develop a model to represent the shapes and kinds of land and bodies of water in an area.

4-ESS2-2 Analyze and interpret data from maps to describe patterns of Earth’s features.

MS-ESS2-3 Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions.

ESS3.A. Earth’s Natural Resources: In Kindergarten - second grade, students begin to consider how the needs of plants and animals (including animals) affect the places in which they live. This lays the foundation for students to consider a particular context in third – fifth grade: how energy and fuels are derived from natural resources and their uses can affect the environment. Here, students move from a more general push-and-pull relationship between organism and environment to specifically thinking about humans are negatively impacting environments through use of fuels. This seventh grade unit takes that a step further by exploring the human *and* natural causes that lead to an uneven distribution of many types of resources, not just fuels. While science and engineering practices related to this DCI vary throughout grade levels, students consistently use the crosscutting concept of Cause and Effect to consider effects on environment.

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The following is the progression of the Performance Expectations for this DCI:

- K-ESS3-1** Use a model to represent the relationship between the needs of different plants or animals (including humans) and the places they live.
- 4-ESS3-1** Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses can affect the environment.
- MS-ESS3-1** Construct a scientific explanation based on evidence for how the uneven distributions of Earth’s mineral, energy, and groundwater resources are the result of past and current geoscience processes.

**7th Grade Science Unit 1: A Balanced Biosphere
Culminating Project**



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

Introduction

Every ecosystem on Earth is unique, with its own set of geologic features, essential natural resources, and interacting plants and animals. Each ecosystem is unique because of a complicated history of natural geologic processes, like plate movements, and human activities, such as resource use and removal. We can better understand why an ecosystem works the way it does by looking at these important processes.

Many students have seen the movie or read the book, *The Hunger Games*. This book is about a country where children from 12 districts are selected to participate in a mandatory televised death match called *The Hunger Games*. In this movie, gamemakers in the powerful district create an arena that mimics, or looks like, many parts of a natural ecosystem. The context for this unit’s culminating project is that a new film based off *The Hunger Games* is coming out next year. Each group of students is tasked with using what they learn about how Earth’s ecosystems are formed in order to design a new arena for the film that is like the biosphere they observed in the Lift-Off; in other words, it mimics, or looks like, an ecosystem they might see on Earth. As a group of arena designers, they will decide how its geological structures were made, what natural resources it has, and how its organisms will interact. Each group then presents their arena design to the director as a candidate for the next film. They have the option of presenting their arena as a diorama or poster-sized annotated map. Individually, each student will then create a self-guided tour of their group’s arena, in the form of a brochure or flyer, so that the director has additional materials to consider as she makes her decision.

3-Dimensional Assessment

LS2.A: Interdependent Relationships in Ecosystems

- Organisms are dependent on their environmental interactions both with other living things and with nonliving factors, any of which can limit their growth. Competitive, predatory, and mutually beneficial interactions vary across ecosystems but the patterns are shared.

LS2.B: Cycles of Matter and Energy Transfer in Ecosystems

- The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. Food webs model how matter and energy are transferred among producers, consumers, and decomposers as the three groups interact.

ESS2.B: Plate Tectonics and Large Scale System Interactions

- Plate tectonics is the unifying theory that explains movements of rocks at Earth’s surface and geological history. Maps are used to display evidence of plate movement.

ESS3.A: Natural Resources

- Humans depend on Earth’s land, ocean, atmosphere, and biosphere for different resources, many of which are limited or nonrenewable. Resources are distributed unevenly around the planet as a result of past geoscience processes.

Science and Engineering Practices

Disciplinary Core Ideas

Crosscutting Concepts

Developing and Using Models

- Develop a model to describe phenomena.

Analyzing and Interpreting Data

- Analyze and interpret data to provide evidence for phenomena.

Constructing Explanations

- Construct an explanation that includes qualitative or quantitative relationships between variables that predict phenomena.
- Construct a scientific explanation based on valid and reliable evidence obtained from sources 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.

Patterns

- Patterns can be used to identify cause and effect relationships.
- Patterns in rates of change and other numerical relationships can provide information about natural systems.

Cause and Effect

- Cause and effect relationships may be used to predict phenomena in natural and designed systems.

Systems and System Models

- Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy and matter flows within systems.
- Systems may interact with other systems; they may have sub-systems and be part of a larger complex system.

Energy and Matter

- The transfer of energy can be tracked as energy flows through a natural system.

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Culminating Project

Time Needed (Based on 45-Minute Periods)

9 days at end of unit

- Group Project: 4 periods (includes 1 presentation day)
- Individual Project: 5 periods
 - First draft: 3 periods
 - Feedback: 1 period
 - Revision: 1 period

Materials

Poster-sized Map

- Poster Paper
- Color pencils/markers or computer graphics
- Computers with internet capabilities

Diorama (Optional)

- Shoebox
- Colored cardstock
- Sandpaper
- Glue
- Paint
- Brushes
- Scissors
- Pipe cleaners
- Etc.

Self-Guided Tour (Brochure or Flyer)

- Blank Paper or Computer Program
- Color pencils/markers or computer graphics

Instructions for the Culminating Project

1. Introduce the Culminating Project at the end of the Lift-Off task, including both group and individual components outlined in the Challenge.
2. Read over the Culminating Project Task Card with the students. We recommend only reading the Challenge, and Group Project Criteria for Success at this time in order to not overwhelm students with information.
 - Take questions for clarification.
 - Optional: You may want to take a student volunteer to give a more detailed description of *The Hunger Games* for students who are interested but have not read the book or seen the movie; this is however, not necessary for success on the Culminating Project.
 - Optional: Show a clip from the first Hunger Games movie that shows the arena and a clip that shows the digitized map of the arena.
3. Remind students that as they go through the Project Organizer, they will be planning pieces of their arena and recording scientific concepts they will likely need for their individual project. However, there is nothing wrong with going back and changing their ideas over the course of the unit. The students won't fully design

**7th Grade Science Unit 1: A Balanced Biosphere
Culminating Project**

their arena until the end of the unit, so change during the imaginative and creative time is acceptable and often experienced.

4. Make sure the students fill out the Project Organizer after each task, which will help the students think about different parts of their arena along the way. This process allows students to both apply and document relevant scientific concepts as they move throughout the unit. This will inform both their group and individual projects.
 - We recommend that students complete the Project Organizer individually, with the exception of choosing a location as a group after Task 1. They might discuss ideas first as a group, but should then respond individually. This allows students time to process concepts on their own and generate their own ideas, which can be used later when it comes to developing their group project.
5. The table below summarizes how the Project Organizer guides the students through developing different components of their arena and self-guided tour brochure or flyer.

Task	Project Organizer	Group and Individual Culminating Project
Lift Off A Well-Functioning Biosphere	<ul style="list-style-type: none"> • What parts of an ecosystem should you be thinking about including in your arena? 	<ul style="list-style-type: none"> • None
Task 1 Pangaea Puzzle	<ul style="list-style-type: none"> • On what continent would your arena be located? • What features would you find (mountain ranges, types of rock, glaciers, etc)? • How can you use plate motions to explain these features? 	<ul style="list-style-type: none"> • Map of arena shows where arena is located and geographic features present • Self-guided tour uses patterns in data to explain how plate motions led to the geographic features in the arena
Task 2 Using Available Resources	<ul style="list-style-type: none"> • What natural resources will your arena have the most and least of? • What geoscience processes will have caused these resources to be available in your arena? • What evidence is there for why these resources are unevenly distributed? 	<ul style="list-style-type: none"> • Map of arena shows which natural resources are available • Self-guided tour uses evidence to explain how geoscience processes and current human activities affect which resources are available in the arena
Task 3 Produce, Reuse, Recycle	<ul style="list-style-type: none"> • Draw a visual diagram showing how non-living matter will cycle through your environment. 	<ul style="list-style-type: none"> • Map of arena shows the non-living things needed to support life in the arena • Self-guided tour models and explains how matter and energy are cycled in the arena ecosystem
Task 4 Interactions Between Organisms	<ul style="list-style-type: none"> • Identify what plants and animals you will include in the arena. • Create a flowchart, tracing one organism to another using at least two 	<ul style="list-style-type: none"> • Map of arena shows the contestant challenge to locate a specific plant/animal by using information about another plant/animal

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Culminating Project**



	different organism interactions studied.	<ul style="list-style-type: none"> Self-guided tour describes how the contestant challenge works, including at least two different organism interactions
Task 5 A Chain of Resources	<ul style="list-style-type: none"> If budget constraints resulted in removal of one main resource, predict what will happen to the populations of different organisms in your arena. 	<ul style="list-style-type: none"> Self-guided tour uses past data to predict the potential effects on the entire ecosystem if budget constraints lead to the removal of a major resource

6. After all the learning tasks are completed, and all the Project Organizers are completed, the students can start to design the poster-sized map or diorama of their arena. Students will then create a presentation that explains all the components of their arena and meets all the criteria in the student handout. The Project Organizers and Group Project Criteria for Success should be used as reference for the students to remind them of all components of their arena.
 - o As always, we recommend the use of group roles for Culminating Project work time (See “How to Use This Curriculum” for details). We recommend changing the roles every work day.
7. Options: Group presentations of arenas can be done as whole-class or gallery walk presentations. We recommend gallery walk presentations if you are short on time.
8. Once the arena maps are designed and presented, students are ready to move on to their individual project. Students will create a self-guided tour in the form of a brochure or flyer that explains all the parts of their arena and meets all the criteria in the student handout. An optional template for students is provided at the end of this document.
9. Conduct a peer review of the self-guided tours after students have completed a first draft.
 - Copy the Self-Guided Tour Peer Review Feedback form found in the Student Instructions. Another option is to use the Student 3-Dimensional Individual Project Rubric.
 - Assign each student a partner, preferably a partner from a different group.
 - Students switch drafts and assess them using the peer review feedback form.
 - o Remind each student to give one positive comment and one constructive comment for each section on the checklist.
 - o Allow students time to present their feedback to their partner, so their partner may ask clarifying questions if needed.
10. After receiving feedback, allow students time to complete a final draft based on the feedback they received.

Assessment

The Project Organizer can be formatively assessed using:

- *Criteria of your choice.* We recommend using the 3-Dimensional Assessment matrix from the Unit Overview to inform your criteria.

The Group Culminating Project will be summatively assessed using:

- The *Group Project Criteria for Success* Checklist

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Culminating Project

The Individual Culminating Project will be summatively assessed using:

- The *3-Dimensional Individual Project Rubric*.
- Keep in mind that the Proficient level indicates that the student has successfully demonstrated understanding of the criteria. Because we are in the early stages of NGSS adoption, it may take multiple opportunities throughout the course of the year for students to reach Proficient.
- If you wish to give students a numeric score, you could take the average score of all of their rubrics or add up rubric scores to give students a summation out of the total. Because of the note above, this scoring may not correlate to traditional grading systems.
- While we recommend scoring all of the project criteria with the rubrics for each student, we understand the burden of that level of scoring.
 - One option is to select the rubrics that you wish to focus on for this project and use those to assess each student's individual project.
 - Another option is to review the Proficient level of each of the project's rubrics and use the descriptions to generally analyze all student work for trends.

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Culminating Project**

Digital Template for Self-Guided Arena Tour

Welcome to the Next Hunger Games Arena!

Geologic Features

Paste photo of arena map here and identify geologic features

Explain how plate motions led to the geologic features in your arena. Describe the patterns in data from Task 1 that provide evidence for these past plate motions.

Natural Resources

Paste photo of arena map here and identify where natural resources are found.

Explain how geoscience processes and current human activities affect which resources are available in your arena. Use evidence from Task 2 to support your explanation.

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Culminating Project****Non-Living Things**

Draw a model (including arrows and labels) that shows how matter and energy are cycled within your arena ecosystem.

Explain how you can track the flow of energy through your arena's ecosystem.

Living Organisms

Paste a photo of arena map here or draw a flowchart to show how the contestant challenge works.

Explain how each plant or animal leads the contestant to the next plant or animal. In your contestant challenge, you should utilize and identify at least two different types of organism interactions, based on patterns you observed in Task 4.

Human Impact

Describe the potential effects on the entire ecosystem if budget constraints result in the removal of one major resource from your arena. Give examples of populations of organisms that may be affected in order to explain why removing a resource can result in a chain of effects. Describe data from Task 5 that allows you to predict this outcome.

Thank you for your consideration!

**7th Grade Science Unit 1: A Balanced Biosphere
3-Dimensional Individual Project Rubric**

Overview: The following rubrics can be used to assess the individual project: a self-guided tour of an arena. Each rubric is aligned to one section of the *Individual Project Criteria for Success*, located on the Culminating Project Student Instructions. *If student provides no assessable evidence (e.g., “I don’t know” or leaves answer blank), then that student response cannot be evaluated using the rubric and should be scored as a zero.

Below we provide an alignment table that details the dimensions assessed for each criterion.

	Student Criteria for Success	Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
1	<input type="checkbox"/> Geographic Features <ul style="list-style-type: none"> ○ Identify the geographic features in your arena based on its location. ○ Explain how plate motions led to the geographic features in your arena. <ul style="list-style-type: none"> ▪ Describe the patterns in <u>data</u> from Task 1 that provide evidence for past plate motions. 	Analyzing and Interpreting Data <ul style="list-style-type: none"> ● Analyze and interpret data to provide evidence for phenomena. 	ESS2.B: Plate Tectonics and Large-Scale System Interactions <ul style="list-style-type: none"> ● Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth’s plates have moved great distances, collided, and spread apart. 	Patterns <ul style="list-style-type: none"> ● Patterns in rates of change and other numerical relationships can provide information about natural systems.
2	<input type="checkbox"/> Natural Resources <ul style="list-style-type: none"> ○ Identify the natural resources available in your arena. ○ Explain how geoscience processes and current human activities affect which resources are available in your arena. <ul style="list-style-type: none"> ○ Use <u>evidence</u> from Task 2 to support your explanation. 	Constructing Explanations <ul style="list-style-type: none"> ● Construct a scientific explanation based on 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. 	ESS3.A: Natural Resources <ul style="list-style-type: none"> ● Humans depend on Earth’s land, ocean, atmosphere, and biosphere for many different resources. Minerals, freshwater, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes. 	Cause and Effect <ul style="list-style-type: none"> ● Cause and effect relationships may be used to predict phenomena in natural or designed systems.
3	<input type="checkbox"/> Non-Living Things <ul style="list-style-type: none"> ○ Draw a model (including arrows and labels) that shows how matter and energy are cycled within your arena ecosystem. 	Developing and Using Models <ul style="list-style-type: none"> ● Develop a model to describe phenomena. 	LS2.B: Cycles of Matter and Energy Transfer in Ecosystems <ul style="list-style-type: none"> ● Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the 	Systems and System Models <ul style="list-style-type: none"> ● Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy and

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3-Dimensional Individual Project Rubric**

			three groups interact within an ecosystem. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem.	matter flows within systems.
4	<input type="checkbox"/> Non-Living Things <ul style="list-style-type: none"> ○ Explain how you can track the flow of energy through your arena’s ecosystem. 	N/A	LS2.B: Cycles of Matter and Energy Transfer in Ecosystems <ul style="list-style-type: none"> • Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. 	Energy and Matter <ul style="list-style-type: none"> • The transfer of energy can be tracked as energy flows through a natural system.
5	<input type="checkbox"/> Living Organisms <ul style="list-style-type: none"> ○ Describe how the contestant challenge works: Explain how each plant or animal leads the contestant to the next plant or animal. <ul style="list-style-type: none"> ○ In your contestant challenge, you should use <u>at least two</u> different organism interactions, based on patterns you observed in Task 4. 	Constructing Explanations <ul style="list-style-type: none"> • Construct an explanation that includes qualitative or quantitative relationships between variables that predict phenomena. 	LS2.A: Interdependent Relationships in Ecosystems <ul style="list-style-type: none"> • Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared. 	Patterns <ul style="list-style-type: none"> • Patterns can be used to identify cause and effect relationships.

**7th Grade Science Unit 1: A Balanced Biosphere
3-Dimensional Individual Project Rubric**



<p>6</p>	<p><input type="checkbox"/> Human Impact</p> <ul style="list-style-type: none"> ○ Describe the potential effects on the entire ecosystem if budget constraints result in the removal of one major resource from your arena. ○ Give examples of populations of organisms that may be affected in order to explain why removing a resource can result in a chain of effects. 	<p>N/A</p>	<p>LS2.A: Interdependent Relationships in Ecosystems</p> <ul style="list-style-type: none"> ● 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. 	<p>Systems and System Models</p> <ul style="list-style-type: none"> ● Systems may interact with other systems; they may have sub-systems and be a part of a larger complex system.
<p>7</p>	<p><input type="checkbox"/> Human Impact</p> <ul style="list-style-type: none"> ○ Describe <u>data</u> from Task 5 that allows you to predict this outcome. 	<p>Analyzing and Interpreting Data</p> <ul style="list-style-type: none"> ● Analyze and interpret data to provide evidence for phenomena. 	<p>LS2.A: Interdependent Relationships in Ecosystems</p> <ul style="list-style-type: none"> ● 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. 	<p>Cause and Effect</p> <ul style="list-style-type: none"> ● Cause and effect relationships may be used to predict phenomena in natural or designed systems.

**7th Grade Science Unit 1: A Balanced Biosphere
3-Dimensional Individual Project Rubric**

Rubric 1: Student describes patterns in data as evidence to explain how plate motions have led to the geographic features in the arena.

- Dimensions Assessed: SEP – Analyzing and Interpreting Data, DCI – ESS2.B: Plate Tectonics and Large Scale System Interactions, CCC - Patterns

Emerging (1)	Developing (2)	Proficient (3)	Advanced (4)
Student inaccurately explains how plate motions have led to the geographic features in the arena.	Student describes no patterns in data as evidence to generally explain how plate motions have led to the geographic features in the arena.	Student describes partial patterns in data as evidence to accurately explain how plate motions have led to the geographic features in the arena.	Student describes multiple patterns in data as evidence to accurately explain how plate motions have led to the geographic features in the arena.
<p>Look Fors:</p> <ul style="list-style-type: none"> • Student shows what continent the arena is located on, but identifies geographic features that are not relevant to the location. For example, a student shows the arena on the east coast of South America, but identifies coal deposits as a geographic feature, which is incorrect. Because geographic features are incorrect, the explanation is inaccurate. • OR student identifies relevant geographic features, but explanation of why they are present is inaccurate or missing. 	<p>Look Fors:</p> <ul style="list-style-type: none"> • Student shows what continent the arena is located on and identifies geographic features relevant to the location. See Look-For examples in the <i>Advanced</i>. • Student accurately explains that plate motions caused these geographic features, but references no data from Task 1 as evidence. 	<p>Look Fors:</p> <ul style="list-style-type: none"> • Student shows what continent the arena is located on and identifies some or all geographic features relevant to the location. For example, if a student shows their arena on the east coast of South America, they might identify mountain ranges and glacial deposits as the geographic features present. • Student accurately explains that plate motions caused these geographic features, but references only one pattern in data from Task 1 as evidence. For example, a student may explain the presence of glacial deposits on the southern tips of South America and Africa, which implies the continents were previously joined. Student does not use data to explain other features. 	<p>Look Fors:</p> <ul style="list-style-type: none"> • Student shows what continent the arena is located on and identifies all geographic features relevant to the location. For example, if a student shows their arena on the east coast of South America, they might identify mountain ranges and glacial deposits as the geographic features present. • Student accurately explains that plate motions caused the geographic features and references multiple patterns in data from Task 1 as evidence. For example, a student may explain the presence of mountain ranges with the map from Task 1 that showed mountain ranges on the coasts of South America and Africa, where continents were previously joined.

**7th Grade Science Unit 1: A Balanced Biosphere
3-Dimensional Individual Project Rubric**

Rubric 2: Student uses evidence and cause-and-effect relationships to explain why only certain resources are available in the arena.

- Dimensions Assessed: SEP – Constructing Explanations, DCI – ESS3.A: Earth’s Natural Resources, CCC – Cause and Effect

Emerging (1)	Developing (2)	Proficient (3)	Advanced (4)
<p>Student inaccurately explains why only certain resources are available in the arena.</p>	<p>Student uses no evidence, but does use cause-and-effect relationships to generally explain why only certain resources are available in the arena.</p>	<p>Student uses accurate evidence and cause-and-effect relationships to partially explain why only certain resources are available in the arena.</p>	<p>Student uses accurate evidence and cause-and-effect relationships to completely explain why only certain resources are available in the arena.</p>
<p>Look Fors:</p> <ul style="list-style-type: none"> • Student identifies at least one relevant resource available in their arena, but does not accurately explain why it is present because of past and current geoscience processes. <p>OR</p> <ul style="list-style-type: none"> • Student identifies a resource in their arena that is irrelevant because of its location. For example, coal in an arena location on Antarctica. 	<p>Look Fors:</p> <ul style="list-style-type: none"> • Student identifies at least one relevant resource available in their arena. For example, coal. • Student provides a general explanation that resources are available because of past geoscience processes and current human extraction, but gives no specific evidence related to the resource they identify. Students may or may not include the human impact component. • For example, “My arena has a lot of coal because certain earth processes make it only available in some regions of the world.” 	<p>Look Fors:</p> <ul style="list-style-type: none"> • Student identifies at least one relevant resource available in their arena. For example, oil. • Student accurately uses cause and effect relationships (related to geoscience processes and current human activity) and evidence from Task 2 in order to explain why certain resources are available in the arena. However, some aspects are missing in their explanation, such as the current human impact component. • For example, “My arena has a fair amount of oil because it is right next to a plate boundary. In Task 2, the article said that oil fields are present where one plate subducts under another, creating ocean basins that fill with tiny dead organisms, which eventually become oil.” 	<p>Look Fors:</p> <ul style="list-style-type: none"> • Student identifies at least one relevant resource available in their arena. For example, oil. • Student accurately uses cause and effect relationships (related to geoscience processes and current human activity) and evidence from Task 2 in order to explain why certain resources are available in the arena. • For example, “My arena has a fair amount of oil because it is right next to a plate boundary. In Task 2, the article said that oil fields are present where one plate subducts under another, creating ocean basins that fill with tiny dead organisms, which eventually become oil. However, humans are harvesting too much oil at a rate too fast to replenish, so there is less oil in the arena than there could be.”

**7th Grade Science Unit 1: A Balanced Biosphere
3-Dimensional Individual Project Rubric**

Rubric 3: Student develops a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.

- Dimensions Assessed: SEP – Developing and Using Models, DCI – LS2.B: Cycles of Matter and Energy Transfer in Ecosystems, CCC – Systems and System Models

Emerging (1)	Developing (2)	Proficient (3)	Advanced (4)
<p>Student develops an incomplete model to inaccurately describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.</p>	<p>Student develops a partial model to partially describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.</p>	<p>Student develops a mostly complete model to partially describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.</p>	<p>Student develops a complete model to accurately describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.</p>
<p>Look Fors:</p> <ul style="list-style-type: none"> • Student develops an incomplete model with only a few relevant living and nonliving components present. Connections are limited or not present. <p>OR</p> <ul style="list-style-type: none"> • Student develops an incomplete model that describes interactions between living and nonliving things with many inaccuracies. For example, “The animals drink water to make energy.” 	<p>Look Fors:</p> <ul style="list-style-type: none"> • Student develops a model with some, but not all relevant living and nonliving components. For example, student may omit the sun and decomposers. • Some components are accurately connected using arrows or another symbol in order to show some interactions within the system. • Model accurately describes (using labels) some, but not all interactions—such as inputs, processes, outputs—and energy and matter flows within their arena ecosystem. For example: Plants use carbon dioxide and water to grow, releasing oxygen. Animals eat these plants and use the oxygen to create their own energy, releasing water and carbon dioxide, which cycles back to be used by plants.” This is missing the energy input from the sun, as well as the role of decomposers. 	<p>Look Fors:</p> <ul style="list-style-type: none"> • Student develops a model with all relevant living and nonliving components (oxygen, carbon dioxide, sunlight, water, soil, plants, animals, decomposers). • Most components are accurately connected using arrows or another symbol in order to show most interactions within the system. • Model accurately describes (using labels) most, but not all interactions—such as inputs, processes, outputs—and energy and matter flows within their arena ecosystem. For example: Plants use carbon dioxide and water to grow, releasing oxygen. Animals eat these plants and use the oxygen to create their own energy, releasing water and carbon dioxide, which cycles back to be used by plants. This description is missing the energy input from the sun, as well as the role of decomposers. 	<p>Look Fors:</p> <ul style="list-style-type: none"> • Student develops a model with all relevant living and nonliving components (oxygen, carbon dioxide, sunlight, water, soil, plants, animals, decomposers). • All components are accurately connected using arrows or another symbol in order to show interactions within the system. • Model accurately describes (using labels) all interactions—such as inputs, processes, outputs—and energy and matter flows within their arena ecosystem. For example: Plants use energy from the sun, as well as carbon dioxide from air and water from soil, to grow. This creates oxygen. Animals eat these plants and use the oxygen to create their own energy, releasing water and carbon dioxide, which cycles back to be used by plants. Decomposers recycle nutrients from dead plants and animals back into the soil to be used by plants.”

**7th Grade Science Unit 1: A Balanced Biosphere
3-Dimensional Individual Project Rubric**

Rubric 4: Student explains how they can track the flow of energy through the arena ecosystem.

- Dimensions Assessed: DCI – LS2.B: Cycles of Matter and Energy Transfer in Ecosystems, CCC – Energy and Matter

Emerging (1)	Developing (2)	Proficient (3)	Advanced (4)
Student inaccurately explains how they can track the flow of energy through the arena ecosystem.	Student generally explains how they can track the flow of energy through the arena ecosystem.	Student partially explains how they can track the flow of energy through the arena ecosystem.	Student completely explains how they can track the flow of energy through the arena ecosystem.
<p>Look Fors:</p> <ul style="list-style-type: none"> • Student inaccurately explains how energy flows in an ecosystem. • For example, “Plants get their energy from the soil, so they can grow. Animals make their own energy by eating.” 	<p>Look Fors:</p> <ul style="list-style-type: none"> • Student generally explains how energy flows in an ecosystem, but doesn’t specifically track the flow of energy within the arena ecosystem. • For example, “All of the ecosystem’s energy comes from the sun, which is transferred when organisms eat one another.” 	<p>Look Fors:</p> <ul style="list-style-type: none"> • Student accurately but only partially tracks the flow of energy within the arena ecosystem from sunlight to various plants, animals, and decomposers. • For example, “Energy from the sun provides all the energy for the arena ecosystem. Plants capture it so they can make their own food. Then animals eat the plants, which gives them energy.” Decomposers and other animals are missing from this explanation. 	<p>Look Fors:</p> <ul style="list-style-type: none"> • Student accurately and completely tracks the flow of energy within the arena ecosystem from sunlight to various plants, animals, and decomposers. • For example, “Energy from the sun provides all the energy for the arena ecosystem. Plants capture it so they can make their own food. Then animals eat the plants, which gives them energy. Then carnivorous animals eat those animals for energy. Various plants and animals use this energy to survive, grow, and do daily activities. When they die, they are consumed by decomposers, which use them for energy.”

**7th Grade Science Unit 1: A Balanced Biosphere
3-Dimensional Individual Project Rubric**

Rubric 5: Student uses patterns of interactions among organisms to explain a contestant challenge within the arena ecosystem.

- Dimensions Assessed: SEP – Constructing Explanations, DCI – LS2.A: Interdependent Relationships in Ecosystems, CCC – Patterns

Emerging (1)	Developing (2)	Proficient (3)	Advanced (4)
Student uses no patterns of interaction among organisms to inaccurately explain a contestant challenge within the arena ecosystem.	Student uses one pattern of interaction among organisms to partially or completely explain a contestant challenge within the arena ecosystem.	Student uses multiple patterns of interactions among organisms to partially explain a contestant challenge within the arena ecosystem.	Student uses multiple patterns of interactions among organisms to completely explain a contestant challenge within the arena ecosystem.
<p>Look Fors:</p> <ul style="list-style-type: none"> • Student describes a contestant challenge that does not include any types of organism interactions. For example, “The contestant will follow a path of wildflowers, which will lead it to the pond, which will lead it to the turtle on the other side of the pond.” 	<p>Look Fors:</p> <ul style="list-style-type: none"> • Student describes a contestant challenge that includes only one accurate type of organism interaction (ie. commensalism, competition, predation, parasitism, etc). • The interactions are accurately described but they utilize the same type of interaction. For example. “The grass is eaten by the insect, which is then eaten by the egret. Both are examples of predation.” 	<p>Look-Fors</p> <ul style="list-style-type: none"> • Student describes a contestant challenge that includes at least two types of organism interactions (ie. commensalism, competition, predation, parasitism, etc). • These interactions are partially described. For example. “The bee pollinates the plant. The plant is then eaten by the cow.” The type of interaction is missing. 	<p>Look Fors:</p> <ul style="list-style-type: none"> • Student describes a contestant challenge that includes at least two types of organism interactions (ie. commensalism, competition, predation, parasitism, etc). • These interactions are accurately described in detail. For example. “The bee pollinates the plant, which is an example of commensalism. The plant is then eaten by the cow, which is an example of predation.”

**7th Grade Science Unit 1: A Balanced Biosphere
3-Dimensional Individual Project Rubric**

Rubric 6: Student predicts how removing a resource might affect populations of organisms and explains why by making connections between sub-systems in the larger arena ecosystem.

- Dimensions Assessed: DCI – LS2.A: Interdependent Relationships in Ecosystems, CCC – Systems and System Models

Emerging (1)	Developing (2)	Proficient (3)	Advanced (4)
Student predicts how removing a resource might affect irrelevant populations of organisms.	Student predicts how removing a resource might affect one relevant population of organisms and explains why without making connections between sub-systems in the larger arena ecosystem.	Student predicts how removing a resource might affect multiple relevant populations of organisms and explains why without making connections between sub-systems in the larger arena ecosystem.	Student predicts how removing a resource might affect multiple relevant populations of organisms and explains why by making connections between sub-systems in the larger arena ecosystem.
<p>Look Fors:</p> <ul style="list-style-type: none"> • Student identifies the removal of one major resource in their arena – for example, coal. • Student attempts to describe an effect on a population of organisms, but the organism is irrelevant. For example, “If coal is removed from the arena, then more plants will die, causing more animals to die.” 	<p>Look Fors:</p> <ul style="list-style-type: none"> • Student identifies the removal of one major resource in their arena – for example, grass. • Student then gives an example of a relevant population that will be affected. However, because only one example is given, no chain of events or interactions of sub-systems is apparent. For example, “When grass is removed, the rabbits have nothing to eat, so their population decreases.” 	<p>Look Fors:</p> <ul style="list-style-type: none"> • Student identifies the removal of one major resource in their arena – for example, sagebrush. • Student then gives examples of multiple relevant populations that will be affected. However, the examples do not show interactions of sub-systems as part of a larger ecosystem. For example, “When sagebrush is removed, the deer have nothing to eat, so they can decrease in population. The cows also eat sagebrush, so they can decrease in population.” 	<p>Look Fors:</p> <ul style="list-style-type: none"> • Student identifies the removal of one major resource in their arena – for example, sagebrush. • Student then gives examples of multiple relevant populations that will be affected. The examples show a chain of events that showcases the interactions of sub-systems as part of a larger ecosystem. For example, “When sagebrush is removed, the deer have nothing to eat, so they can decrease in population. This makes more sunlight and water resources available for cheatgrass to grow and increase in population. Since elk eat cheatgrass, their population increases.”

**7th Grade Science Unit 1: A Balanced Biosphere
3-Dimensional Individual Project Rubric**

Rubric 7: Student cites data that provides evidence of a cause-and-effect relationship between resource availability and populations of organisms.

- Dimensions Assessed: SEP – Analyzing and Interpreting Data, DCI – LS2.A: Interdependent Relationships in Ecosystems, CCC – Cause and Effect

Emerging (1)	Developing (2)	Proficient (3)	Advanced (4)
<p>Student describes an inaccurate cause-and-effect relationship between resource availability and populations of organisms.</p>	<p>Student cites no data to provide evidence of an accurate cause-and-effect relationship between resource availability and populations of organisms.</p>	<p>Student cites a relevant data point that provides evidence of an accurate cause-and-effect relationship between resource availability and populations of organisms.</p>	<p>Student cites multiple relevant data points that provide evidence of an accurate cause-and-effect relationship between resource availability and populations of organisms.</p>
<p>Look Fors:</p> <ul style="list-style-type: none"> • Within Criteria 6, student may have identified the removal of one important resource in their arena, but no cause-and-effect relationship is explained accurately. For example, “If the main plant dies, more plants would die.” 	<p>Look Fors:</p> <ul style="list-style-type: none"> • Within Criteria 6, student has already identified the removal of one major resource in their arena and described at least one relevant effect. • Student does not cite any data but does explain the cause-and-effect relationship that allowed them to predict those effects. For example, “When one organism is removed, it often frees up resources for another population of organisms to increase.” 	<p>Look Fors:</p> <ul style="list-style-type: none"> • Within Criteria 6, student has already identified the removal of one major resource in their arena and described multiple effects. • Student then cites one data point to provide evidence of the cause-and-effect relationship that allowed them to predict those effects. For example, “In Simulation 2, we see that the removal of one plant frees up resources for another population of plant to increase.” 	<p>Look Fors:</p> <ul style="list-style-type: none"> • Within Criteria 6, student has already identified the removal of one major resource in their arena and described a chain of effects. • Student then cites multiple sources of data to provide evidence of the cause-and-effect relationship that allowed them to predict those effects. For example, “In Simulation 2, we see that the removal of one plant frees up resources for another population of plant to increase. We also see in this simulation that when more food is available for an organism, its population increases, like with the bunny.”

**7th Grade Science Unit 1: A Balanced Biosphere
Project Organizer**



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

You will be creating an arena that mimics an environment you may see on Earth. After each task, you will return to the table below to organize what you learn as you go through the unit. By the end of the five tasks, you will have all this information to use for your culminating project. For each activity, be sure to include answers to **ALL** the questions provided.

<p>Lift-Off Task: A Well-Functioning Biosphere</p>	<p>Your arena will be very similar to a biosphere in that you are designing your own ecosystem. Using your prior knowledge of ecosystems,</p> <ul style="list-style-type: none"> <input type="checkbox"/> What parts of an ecosystem should you be thinking about including in your arena? Make a list or draw a diagram of an ecosystem with parts labeled.
<p>Task 1: Pangaea Puzzle</p>	<p>Over the course of this task, you gathered evidence of how past plate motions have led to some geologic features you see on Earth. <u>As a group</u>, decide on a location for your arena that would have the geologic features you want. Then <u>individually</u>,</p> <ul style="list-style-type: none"> <input type="checkbox"/> Draw a map showing your arena location on Earth as well as any relevant surrounding continents, making captions that answer the questions below: <ul style="list-style-type: none"> ○ On what continent would your arena be located? Why are you locating it there? ○ What features would you find (mountain ranges, types of rock, glaciers, etc)? ○ How can you use plate motions to explain these features?

**7th Grade Science Unit 1: A Balanced Biosphere
Project Organizer**



<p>Task 2: Using Available Resources</p>	<p>Every arena needs certain resources to function. Now that you have discovered how resources have been distributed on our own Earth, decide which resources your arena will have.</p> <ul style="list-style-type: none"> <input type="checkbox"/> What natural resources will your arena have the most and least of? <input type="checkbox"/> What geoscience processes will have caused these resources to be available in your arena? <input type="checkbox"/> What evidence is there for why these resources are unevenly distributed?
<p>Task 3: Produce, Reuse, Recycle</p>	<p>Your arena already has its main geological features, but as we learned today, there are also other non-living factors and living factors that make up an environment. Design the landscape of your arena, focusing on the non-living things that will be needed to support life.</p> <ul style="list-style-type: none"> <input type="checkbox"/> Draw a visual diagram showing how this non-living matter will cycle through your environment (You do not need to pick specific plants and animals for your arena yet; you can just draw example plants and animals for this diagram). <ul style="list-style-type: none"> o Be sure to label the examples of living and non-living matter and use arrows to show where they go.

**7th Grade Science Unit 1: A Balanced Biosphere
Project Organizer**



<p>Task 4: Interactions Between Organisms</p>	<p>In your arena, you will be creating a challenge for your contestants, so the winner may win additional supplies. The challenge will be to locate a specific plant/animal by using information about another plant/animal. The contestants will use their knowledge of ecosystem interactions to connect the known plant/animal to the unknown plant/animal.</p> <ul style="list-style-type: none"> <input type="checkbox"/> Identify what plants and animals you will include in your arena. <input type="checkbox"/> Design this challenge by making a flowchart tracing one organism to another using <u>at least two</u> different organism interactions we have studied. <input type="checkbox"/> Explain how each plant/animal leads the contestant to the next plant/animal by describing the organism interactions.
<p>Task 5: A Chain of Resources</p>	<p>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:</p> <ul style="list-style-type: none"> <input type="checkbox"/> If budget constraints resulted in removal of one main resource, predict what will happen to the populations of different organisms in your arena. <input type="checkbox"/> 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.

7th Grade Science Unit 1: A Balanced Biosphere

Lift-Off Task: A Well-Functioning Biosphere

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

Introduction

In the 1990's a group of scientists designed and built an artificial living environment called Biosphere 2 in Arizona. The purpose of the project was to construct a self-sustaining environment that would allow 8 people to live and survive for two years without ever leaving the building. Scientists planned to use what they learned from this "experiment" to design and build artificial living environments on Mars. For Biosphere 2, scientists constructed a series of dome-shaped areas representing different ecosystems, including an ocean with a coral reef, mangrove wetlands, tropical rainforests, savanna grasslands, desert, and a human living space. Biosphere 2 was constructed with the goal of providing people with the basic ingredients in order to live for two years. By looking at the phenomenon of a biosphere, students can begin to generate questions about what an ecosystem is and how it functions. The questions they generate will guide them throughout the unit as they continue to make sense of this phenomenon and begin to imagine what their culminating project of an imitation ecosystem will look like.

Alignment Table

Because the Lift-Off tasks focus on student-generated questions, we do not identify specific Disciplinary Core Ideas or Science and Engineering Practices in this table.

Crosscutting Concepts (*depending upon student-generated questions)

- Patterns
 - Patterns in rates of change and other numerical relationships can provide information about natural systems.
 - Patterns can be used to identify cause-and-effect relationships.
- Cause and Effect
 - Cause and effect relationships may be used to predict phenomena in natural or designed systems.
- Systems and System Models
 - Systems may interact with other systems; they may have sub-systems and be a part of a larger complex system.
 - Models can be used to represent systems and their interactions—such as inputs, processes, and outputs—and energy and matter flow within systems.
- Energy and Matter
 - The transfer of energy can be tracked as energy flows through a natural system.

Equity and Groupwork

- Share and listen to broad and diverse student contributions.
- Make connections between each other's ideas.
- Work together to co-construct a concept map.

Language

- Use connector words to link ideas.
- Generate and write questions about the phenomenon.
- Organize key questions in a concept map.

7th Grade Science Unit 1: A Balanced Biosphere
Lift-Off Task: A Well-Functioning Biosphere

Learning Goals

This learning task introduces students to the phenomenon of biospheres and begins generating questions that will guide them through the unit. More specifically, the purpose is to:

- Individually generate a list of questions about biospheres, using observations from the video and an outdoor exploration.
- Make connections between related questions.
- Generate possible answers to questions, using prior knowledge.
- Apply prior knowledge of ecosystems to make a list of the components that might be included in the final project arena.

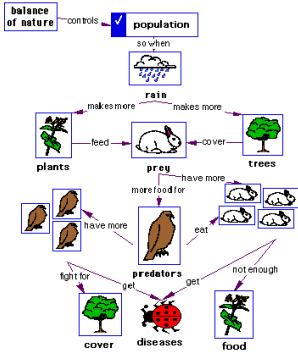
Content Background for Teachers

An ecosystem is a biological community of interacting organisms and their physical environment. This Lift-Off Task serves to introduce students to what this definition really means and what they should expect to find in any given ecosystem. All the living parts of an ecosystem are known as biotic factors, although this term is not necessary to teach at this level. Living, or biotic factors, include animals, plants, fungi, etc. The rest of the environment, in which these organisms reside, are known as abiotic factors, or non-living factors. These include physical factors such as temperature, light, water, nutrients, soil, rocks, oxygen, carbon dioxide, etc. An ecosystem is thus the total of all living and non-living factors in a region.



These living and non-living parts are inseparably intertwined because they constantly exchange materials. Energy and materials flow constantly within an ecosystem. For example, animals, which are living factors, use up oxygen, which is a non-living factor, when they need to create energy from the food they eat. They also expel carbon dioxide, another non-living factor, in the process. There are multiple examples of these connections within an ecosystem, which students will examine throughout the unit.

In this task, students create a concept map, which is a graphical tool that helps to organize and represent knowledge and questions, and is a successful academic language instruction tool. In this task, students will likely add only basic terms relating to an ecosystem, mostly living and non-living factors. As students learn more about the geoscience processes that have led to different ecosystems, the flow of energy and matter within ecosystems, and the organism interactions within ecosystems, they will add more complex questions and ideas to this concept map. If your students have not had previous experience making concept maps, please see the instructions in Part B below for strategies on teaching this skill.



Academic Vocabulary

- Ecosystem
- Biosphere
- Environment

*Additional academic vocabulary will vary by class

7th Grade Science Unit 1: A Balanced Biosphere

Lift-Off Task: A Well-Functioning Biosphere

Time Needed (Based on 45-Minute Periods)

2 Days

- Introduction, Part A and Part B: 1 period
- Class Concept Map, Project Overview, and Project Organizer: 1 period

Materials

- Unit 1, Lift-Off Task Student Version
- Projector and Speaker (for video)

Part B

- Poster paper and markers
- Post-Its (Optional)

Part C

- Class Poster Paper and markers
- *See Instructions below for other optional materials to use for the class concept map

Connecting to the Culminating Project

- Culminating Project Handout
- Project Organizer Handout

Instructions

1. Introduce students to the unit by reading or projecting the Unit Essential Question aloud.
2. Tell students that by the end of this unit, they will be designing their own artificial environment.
 - Read or summarize the paragraph on page 1 of the student guide aloud, which gives an overview of the artificial living environment known as Biosphere 2.
 - Then watch the video clip (see link in slide deck) about Jane Poynter, who spent time in the Biosphere in Arizona. (Note: Near the end of the video the audio is intentionally deleted so that students can see the various components of the Biosphere without the detailed explanations.)
 - Ask students to take a moment and reflect about what they saw in the Biosphere.
 - Conduct this as a think-pair-share and then share out a few responses class-wide, using equity sticks for a more equitable discussion (See “How to Use This Curriculum” for more details).
 - There are no right answers. This just gives an opportunity to begin thinking about biospheres and generating ideas and questions.
3. Take the students outside for 5-10 minutes. Let them quietly observe the ecosystem around them, encouraging them to think about the following questions:
 - What things do you see?
 - And what things do you not see in the schoolyard but you might see in another ecosystem?

Part A

1. In this Lift-Off task, students will be generating questions to help them make sense of the phenomenon. In this section of the task, students will work to generate questions about how Biospheres (and ecosystems in general) function.

7th Grade Science Unit 1: A Balanced Biosphere**Lift-Off Task: A Well-Functioning Biosphere**

2. Have students complete this section individually in their student guide.
 - For students who need more support, encourage them to think of the Biosphere images they observed, visualize a picture of other ecosystems such as the schoolyard, and consider any questions they have.
 - Here is a list of some potential questions students might generate: “What other things are in the biospheres that we can’t see? What did scientists learn from the Biosphere 2 project? How does energy or matter go through biospheres (or other ecosystems)? What do we need to maintain a healthy biosphere (or other ecosystem)? Why is it called a biosphere? How is a biosphere different from an ecosystem? Did the plants and animals in Biosphere 2 survive? Why or why not?”

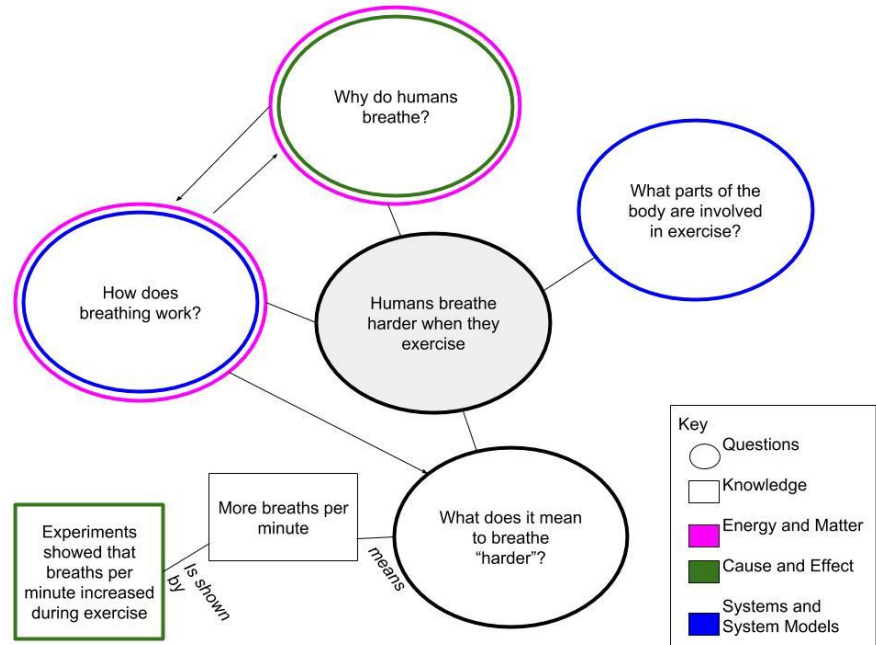
Part B:

1. In this part of the task, students create a concept map as a group.
 - Remind students to refer to the directions on their student guide to help them make their concept map. First, students should compare each member’s list of questions and record/connect key questions on a piece of poster paper. They will then draft possible answers to the questions, using prior knowledge.
 - Remind students that there are no right or wrong questions or predictions, so students feel encouraged to contribute any and all questions and ideas they think of.
 - 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).
2. Students will post their posters on a wall and then walk around and look at each group’s ideas. One suggestion for gallery walks is for students to interact with the posters in some way. For example, students are required to initial or leave post-its on three questions that they are also excited about on other posters.

7th Grade Science Unit 1: A Balanced Biosphere
Lift-Off Task: A Well-Functioning Biosphere

How to Concept Map

For students who have not had a lot of experience making concept maps, we have detailed a strategy below for introducing concept mapping using more familiar content. An example is also provided, but this will vary depending on what your students come up with as you make your own model.



1. Write the phenomenon in the middle of the poster, in this case “Humans breathe harder when they exercise.”
2. Ask students to share questions they might ask to make sense of this phenomenon and make a list of these questions on the board.
3. Model the process of reviewing the list and finding similarities amongst the questions.
 - Place these key questions on the concept map poster, modeling how to put similar questions near each other on the poster. Circle these to signify that these are questions, not content knowledge.
4. Ask students to look at the key questions and see if any of the questions are connected: Would answering one question lead to one of the other questions? Model making these connections by drawing arrows between the circles.
5. In this Lift-Off task, students will only be drafting possible answers to the questions, not actually gathering and recording learned concepts. However, throughout the unit, they will be adding content they have learned. Model this by recording a student’s prior knowledge to one of the questions, using boxes to signify that these are pieces of content knowledge rather than questions.
 - Use connector words to identify the relationships between the content boxes (See image above for an example).
6. Optional: To emphasize crosscutting concepts using a concept map, make a key of different colors for the crosscutting concepts emphasized in this unit. Identify questions that clearly show evidence of the different crosscutting concepts and circle them with the corresponding colors. Explain to students how you made that choice by pointing out the language that hints at that crosscutting concept. *Note: not all boxes and circles will necessarily have a crosscutting concept.

7th Grade Science Unit 1: A Balanced Biosphere

Lift-Off Task: A Well-Functioning Biosphere

Part C

1. Construct a whole-class concept map that begins to help students make sense of the phenomenon of a Well-Functioning Biosphere.
 - Start with the phenomenon in the middle.
 - Then ask students to share out the questions that were most common across all the posters in the classroom. As you record questions on the poster, organize them based on connections you see. Draw circles around each question (as you add to the concept map throughout the unit, you'll also be adding concepts learned, which can be written in boxes to distinguish them from the questions).
 - Ask students to identify any connections they see between the questions and record these as lines between the questions.
 - Recommended: Give pairs of students think time to come up with 1-2 connections to add to the class concept map and call on pairs using equity sticks. This encourages more equitable participation in this class-wide activity.
 - 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.
 - This whole class concept map will be revisited at the end of each task, asking students questions like: Are there any new questions you have about the phenomenon? Are there any connections you want to add or change? What is your reason for that addition/revision? Are there more connections we can make between the questions/ideas already on the map? Do you want to add any new ideas/concepts to the map?
2. Because this concept map will be added to and revised throughout the unit, here are some practical options for implementation.
 - If you have access to white board paper, we encourage you to use these for class posters since it will allow you and your students to make revisions throughout the unit.
 - Another option is to use smaller pieces of paper for each class and project using a document camera; this will save space as opposed to doing large class posters.
 - We highly recommend students keep their own version of this concept map in their notebooks, adding questions and concepts as they go through the unit.
3. Once the draft concept map is complete, introduce students to the crosscutting concepts for this unit. We recommend posting posters of each crosscutting concept in your classroom (See beginning of teacher guide for templates).
 - The crosscutting concepts for this unit are: Patterns; Cause and Effect; Systems and System Models; and Energy and Matter. Assign a color for each crosscutting concept that can be used throughout the unit.
 - Have students analyze the class concept map for as many examples of the crosscutting concepts as they can find. Depending on the questions they have, they may be able to find an example of each of the crosscutting concepts or perhaps just some.

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- We recommend modeling this process by picking a question, identifying the crosscutting concept, and tracing the circle in the corresponding color. Explain the key words that helped you identify the crosscutting concept in this question. Some identifying words that students might look for are:
 - **Patterns:** These could be phrases such as, “is the same as”, “has in common with”, “is similar to”, “shares” etc.
 - **Cause and Effect:** These could be phrases such as, “that results in,” “that causes,” “that explains why,” “is due to,” etc.
 - **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.
 - **Energy and Matter:** These could be phrases such as, “energy is transferred/flows,” “is conserved,” “is important for,” “is needed,” etc.

Connecting to the Culminating Project

1. Hand out the Culminating Project Task Card and read the Challenge and Group Project Criteria for Success aloud as a class.
 - Take questions for clarification.
 - Optional: You may want to take a student volunteer to give a more detailed description of *The Hunger Games* for students who are interested but have not read the book or seen the movie; this is however, not necessary for success on the Culminating Project.
 - Optional: Show a clip from the first *Hunger Games* movie that shows the arena and a clip that shows the digitized map of the arena.
2. Pass out their Project Organizer and explain that they will complete a section of this after each task in class. Students should independently complete the Lift-Off Task section of the Project Organizer in class. Revisions can be done for homework, depending upon student’s needs and/or class scheduling.
 - Students have been tasked with creating a Hunger Games arena that mimics an environment they might see on earth. The student prompt is as follows: Your arena will be very similar to a Biosphere in that you are designing your own ecosystem. Using your prior knowledge,
 - What parts of an ecosystem should you be thinking about including in your arena? Make a list or draw a diagram of an ecosystem with parts labeled.

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 made a list of all the questions you have about biospheres. Look back at your list: after learning from your peers, how can you add to your list? What kinds of things did you initially leave out? Use the class concept map to help you.
 - In this unit, we will be focusing on four crosscutting concepts: **Patterns:** Patterns can be used to identify cause and effect relationships and provide information about natural systems; **Cause and Effect:** Cause and effect relationships may be used to predict phenomena; **Systems and System Models:** Models can be used to represent systems and their interactions within and between systems; and **Energy and Matter:** The flow of matter and energy can be tracked through a natural

7th Grade Science Unit 1: A Balanced Biosphere**Lift-Off Task: A Well-Functioning Biosphere**

- system. Looking at your class concept map, give one example of how a crosscutting concept came up in today's task.
- Now that you understand what project you'll be working on over the course of this unit, what else do you need to know? What additional questions do you have?
2. There are no right answers but encourage students to look back at their initial lists and their class concept map. They should not change their initial responses, but rather use this reflection space to add to their questions and ideas 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 the gathering of knowledge and skills for their final project.

7th Grade Science Unit 1: A Balanced Biosphere

Task 1: Pangaea Puzzle

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

Introduction

In the Lift-Off task, students were introduced to Biosphere 2 and began to generate questions about how well-functioning ecosystems/biospheres work. In this task, students begin to examine ecosystems from a macro perspective: based on plate motions, what geographic features are present in different ecosystems? Students engage with this question by thinking about a real case in scientific history. In the early 1900s, a meteorologist named Alfred Wegener developed a theory: in looking at the shape of the continents, he proposed that the continents had once formed a single landmass and have since drifted apart. At the time, no one accepted his idea, but since then, much more evidence has been collected that suggests that Wegener was most likely correct. In this task, students embark on this journey on their own, making sense of the phenomenon of continent movement by collecting an abundance of data to provide evidence of plate movement over time. By the end of this task, students will be able to write a CER report agreeing or disagreeing with Wegener’s theory. This will then inform their culminating project by helping them identify geographic features within their arena based on the continental location they choose.

Alignment Table

Performance Expectations	Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<p>MS-ESS2-3. Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions. [Clarification Statement: Examples of data include similarities of rock and fossil types on different continents, the shapes of the continents (including continental shelves), and the locations of ocean structures (such as ridges, fracture zones, and trenches).] [Assessment Boundary: Paleomagnetic anomalies in oceanic and continental crust are not assessed.]</p>	<p>Analyzing and Interpreting Data</p> <ul style="list-style-type: none"> Analyze and interpret data to provide evidence for phenomena. 	<p>ESS2.B: Plate Tectonics and Large-Scale System Interactions</p> <ul style="list-style-type: none"> Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth’s plates have moved great distances, collided, and spread apart. 	<p>Patterns</p> <ul style="list-style-type: none"> Patterns in rates of change and other numerical relationships can provide information about natural systems.
<p>Supplementary Science and Engineering Practices</p> <ul style="list-style-type: none"> Constructing Explanations <ul style="list-style-type: none"> Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students’ own experiments) and the assumption that theories and laws that 			

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describe the natural world operate today as they did in the past and will continue to do so in the future.
<p>Supplementary Crosscutting Concepts</p> <ul style="list-style-type: none"> Systems and System Models <ul style="list-style-type: none"> Systems may interact with other systems; they may have sub-systems and be a part of a larger complex system.
<p>Equity and Groupwork</p> <ul style="list-style-type: none"> Contribute information to a class-wide model by playing an assigned role. Discuss how continents are arranged and collaborate on a visual model.
<p>Language</p> <ul style="list-style-type: none"> Annotate a drawing. Orally present evidence of plate motions. Record evidence from oral presentations. Construct an explanation about continental drift. Use the Stronger Clearer protocol to strengthen an explanation.

Learning Goals

This learning task introduces students to the concept of past plate motions and highlights the skills of analyzing and interpreting data to provide evidence. More specifically, the purpose is to:

- Engage prior knowledge of continent arrangement based on observation skills.
- Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures.
- Explain plate movement, using evidence collected to justify a claim.
- Participate in the Stronger Clearer protocol to strengthen an explanation.
- Apply knowledge of how geologic features have developed in order to design their own “imitation” environment.

Content Background for Teachers

Earth’s outer layer, the crust, is divided into a set of large moving plates. These are called tectonic plates. Mounting evidence from satellites in the 1960s suggested that these tectonic plates are actually moving at a very slow rate. This is because of convection currents in the layer below the crust, known as the mantle. Hot mantle rock rises from the core and moves along under the crust until it grows cool and heavy and sinks down again. This causes the plates to move and can result in tectonic events along the plate boundaries, such as earthquakes and volcanoes.

The focus of this task is not on current plate motions, however, but rather on evidence for the larger past plate motions as a whole. The idea that plates have been moving is not a new one. In 1920, Alfred Wegener took a look at the shape of the continental plates and suggested that they may once have been connected in one landmass—a concept known as Pangaea. While unaccepted at the time, this idea is now accepted in light of many different sources of evidence that have been collected.



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In looking at the evidence, one can see that mountain ranges on different continents line up, such as those on the coasts of Africa and South America. Similarly, European coal fields match up with coal fields in North America. Furthermore, fossils and rocks found on different continents provide evidence that the continents were once joined together in a single landmass. In the resource cards provided, students will see examples of similar fossils and types of rock found across different continents. For more information on these pieces of evidence, reference the resource cards associated with this task.

Academic Vocabulary

- Continent
- Plate
- Fossil
- Climate
- Glacier
- Pangea

Time Needed (Based on 45-Minute Periods)

5.5 Days

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

Materials

- Unit 1, Task 1 Student Version

Explore

- Continent Pieces: Two continent pieces per group (enlarge, print, cut, and laminate)
 - <https://pubs.usgs.gov/imap/2800/>
 - Suggested Groupings:
 - South America and Africa
 - South America and North America
 - North America and Europe/Asia
 - North America and Africa
 - Europe/Asia and Africa
 - Antarctica and Australia
 - Antarctica and Africa
- Envelope of Evidence Cards (1 per group): Look at the list below for the relevant evidence cards for each pair of continents. Cut them into continent pieces, label the backs with the type of evidence, laminate, and put into an envelope. *Note: Evidence cards must be in color for students to see evidence.*
 - South America and Africa: Mountain Ranges, Rock, Glacial Deposits, Fossils
 - South America and North America: Coal, Fossils
 - North America and Europe/Asia: Mountain Ranges, Coal, Rock, Fossils
 - North America and Africa: Mountain Ranges, Fossils

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- Europe/Asia and Africa: Mountain Ranges, Fossils
- Antarctica and Australia: Glacial Deposits, Fossils
- Antarctica and Africa: Glacial Deposits, Fossils

Explain

- Projector and Speaker (for video)

Evaluate

- Project Organizer Handout

Instructions**Engage**

1. Introduce Task 1: In the Lift-Off task, we looked at an artificial environment. 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 1: However, your arena should be designed to be built on real land in a real location, so you will have to take into account the large geologic features that might be there. To get a full understanding of your arena location, today we will explore geologic features around the world and how they were made.
 - Now pass out their Task 1 student guide.
3. Students begin this task by using their prior knowledge to make a prediction about where continents may have been located hundreds of millions of years ago. Students should draw arrows directly on the map in their student guide. They then explain why they drew what they drew. This activity can be done in pairs.
 - Share out a few different possibilities that students come up with. There are no right answers. Most students will reference the borders and shapes of continents as their reasoning for their prediction.

Explore

1. In the early 1900s, a meteorologist named Alfred Wegener also thought about this question and suggested that the continents were once joined together, but moved over time to where they are today. In this activity, students will analyze various pieces of evidence to decide if they agree or disagree with Wegener's idea.
 - This gives students practice at **Analyzing and Interpreting Data** to provide evidence of the phenomenon of continental drift.
2. Assign roles to each group. You may use whatever roles you prefer. We recommend the use of the Facilitator, Materials Manager, Harmonizer, and Reporter.
 - Ask Facilitator to read the directions and to make sure everyone understands the task.
 - Ask the Materials Manager to gather the materials needed to complete the task.

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- Ask the Harmonizer to make sure that everyone contributes their ideas and that everyone's voice is heard.
 - Ask the Reporter to make sure the group is prepared for the presentation.
3. Assign each group two continent pieces and distribute the enlarged continent pieces and the envelopes of relevant evidence cards (as laid out in the materials section above).
- Ask students to examine the evidence cards provided for their two assigned continents.
 - Walk around and listen to the kind of evidence students are discussing.
 - Try not to provide too much guidance - let the group decide what information they will use to make sense of the two continent pieces they are working with.
 - Students should fill out the data collection table in their student guide in order to record and organize the evidence they have to justify the placement of their continent pieces.
 - Once students have had time to collect their own data, remind them that they need to prepare to present their information out to the class.
 - In this activity, students are beginning to explore these ideas through the lens of **Systems and System Models** by considering the smaller sub-system of two continents, which they will then apply to the larger continental system in a class-wide discussion.
4. Conduct a presentation for all groups to share their analysis about their assigned continents. The purpose of these presentations is for students to engage in an authentic scientific process in which they learn about evidence from other groups. In doing so, they are able to identify **patterns** across different groups of evidence to form a more cohesive picture of continental drift on Earth. This also continues their exploration of the crosscutting concept of **Systems and System Models**, as student groups situate their own two continents within the larger continental system.
- Project a map of the world to set context: <https://pubs.usgs.gov/imap/2800/>
 - Ask each group to come to the front of the room and:
 - Explain whether they think the continents were once in a different location than they are now, citing all relevant evidence that justifies their claim.
 - Tape their two continent pieces to the board to illustrate how they think the two continents might have been arranged in the past.
 - Ask each new group to add their continent pieces to the first group's pieces and share their evidence that justifies their choice.
 - Ask each group follow-up questions about their evidence when connections are not explicit. For example, "You said there are coal deposits on both continents. How is that evidence of movement? Can you point it out on your continent pieces?"
 - Students may want to bring up their evidence card cut-outs so they can reference the evidence as needed.
 - As students listen, they should be documenting other groups' evidence in the chart on their student guide. This will be used to write their CER report in the next section.
 - You may want to model this type of note-taking using one pattern of evidence. For example, in the first row, you might write: "Group 1 found that there were mountain ranges on the east side of ____ and the west side of ____."
 - Here is a suggested sequence for having groups present

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Task 1: Pangaea Puzzle

- South America and Africa
- South America and North America
- North America and Europe/Asia
- North America and Africa
- Europe/Asia and Africa
- Antarctica and Australia
- Antarctica and Africa

5. After each group has completed their presentation, conduct a whole group discussion of whether the class thinks the continents have moved over time and what type of evidence was the most convincing.
- Possible sentence stems to provide are: “I think the continents have moved over time because...” and “The most convincing type of evidence is ____ because...”
 - Students can then draw a complete class model of all the continents in their student guide. This practice continues to highlight the crosscutting concept of **Systems and System Models** by allowing students to take individual components and bring them together within one whole Earth system.

Sample Student Evidence Chart

Type of Evidence	Specific Examples
Mountain Ranges	<ul style="list-style-type: none"> • The lower tip of Africa and the eastern side of South America both have mountain ranges. • The eastern side of North America and the northwestern tip of Africa both have mountain ranges. • The northeastern side of North America and the western side of Europe/Asia both have mountain ranges. • The southeastern side of Europe/Asia and the northwestern tip of Africa both have mountain ranges.
Coal Distribution	<ul style="list-style-type: none"> • Lots of coal deposits are found in both the top of South America and the bottom of North America. • Lots of coal deposits are found in both North America and Europe/Asia.
Types of Rock	<ul style="list-style-type: none"> • Large deposits of Archian Rock are found in both North America and South America. • Large deposits of Archian Rock are found in both South America and Africa. There are also other matching rock types between these two continents. • Large deposits of Archian Rock are found in both North America and Europe/Asia. There are also other matching rock types between these two continents.
Distribution of Glacier Deposits	<ul style="list-style-type: none"> • Glacial deposits are found in the tip of Africa and all of Antarctica. • Glacial deposits are found in the bottom half of Australia and all of Antarctica. • Glacial deposits are found in both southern tips of Africa and South America.
Distribution of Fossils	<ul style="list-style-type: none"> • The Kannemeyrid fossil is found in both North America and Europe/Asia. • The Kannemeyrid fossil is found in both North America and South America. • The Kannemeyrid fossil is found in both North America and Africa.

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	<ul style="list-style-type: none"> • The Kannemeyrid fossil is found in both Africa and Europe/Asia. • The Kannemeyrid, Mesosaurus, Glossopteris fossil are found in both South America and Africa. • The Labyrinthodont and Lystrosaurus fossil is found in Africa and Antarctica. • The Labyrinthodont fossil is found in Australia and Antarctica.
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Explain

1. At the beginning of the Explore, students were introduced to Alfred Wegener’s theory. In this section, students will agree or disagree with his theory, using the evidence from the Explore.

2. Project the following video about Alfred Wegener’s theory on the board:
 - <https://www.youtube.com/watch?v=RgJZ0ySEKYg>
 - Stop the video at 4:40.
 - Have students answer the discussion questions in pairs, which help them to process the ideas in the video and prepare to construct their explanation.
 - Debrief as a class. The use of equity sticks is encouraged for more equitable participation in class-wide discussions (See “How To Use This Curriculum” for more details).

3. Students then individually construct an explanation agreeing or disagreeing with Wegener’s theory and answering the following question: Based on your data analysis, do you think the continents have always been arranged the way they are today or do you think the continents have moved over time?
 - They should use the evidence chart from the *Explore* to help them. This allows students explicit practice in the skill of **Constructing Explanations** as they use evidence to support a claim.
 - Optional scaffold: Write a claim together as a class and brainstorm an example of a piece of evidence from student presentations that could be used to support the claim.

Optional Sentence Stems to Provide:

Do you agree or disagree with Wegener’s theory?	<p>I agree/disagree with Wegener’s theory...</p> <p>Evidence from many different sources suggests that...</p>
What evidence do you have to support your position?	<p>There are many different sources of evidence, such as...</p> <p>First, we can see ...</p> <p>One piece of evidence is...</p> <p>Similarly, _____ evidence shows that...</p> <p>For example...</p> <p>This is also shown in the case of...</p> <p>Lastly, _____ evidence suggests that...</p> <p>All of these pieces of evidence show that...</p> <p>Because of _____, this suggests...</p> <p>This is possible because...</p>

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Task 1: Pangaea Puzzle

Sample Explanation

Do you agree or disagree with Wegener’s theory?	I agree with Wegener’s theory. Evidence from many different sources suggests that continents have not always been arranged the way they are today, but have actually moved over time.
What evidence do you have to support your position?	First, we can see from matching mountain ranges along continents like North America and Europe/Asia that certain continents were once connected. This is also shown through the common types of rock and glacial deposits we see between continents. For example, we see similar glacial deposits on the southern tip of Africa as well as the western end of Australia, implying these areas were once connected. Similarly, Archian rocks can be found in both eastern South America and western Africa, implying a previous connection there. Fossil evidence also suggests that continents were once connected. For example, the Labyrinthodont fossil is found in both Antarctica and Australia. Lastly, coal deposits, are found in both North America and Europe/Asia areas, suggesting that that continents may have once been in similar locations. All of these pieces of evidence show that continents may have once been connected in one larger continent, called Pangaea, but have since moved because of plate motions.

Elaborate

1. Students will now participate in a language routine known as *Stronger Clearer*. This activity gives students the opportunity to share their ideas, gather feedback, and revise their explanations. This protocol is especially useful since their explanation required the cognitively challenging task of integrating many pieces of evidence.
2. Students will share with three different partners, allowing them to discuss feedback and record any notes each time. Once complete, students should be given time to individually revise their explanations based on their discussions. A protocol is provided in their student guide.
3. This revised explanation can be a good option for formative assessment. Collect student work to identify trends in students’ ability to use evidence to support an explanation. See “How to Use This Curriculum” for strategies on utilizing formative assessment data to provide feedback to students and inform classroom instruction.
4. Return to the whole-class 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).
 - 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?

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- Draw circles around each question and boxes around each concept.
- Write connector words to describe connections between the concept boxes.
- For this task, students may begin to connect some of their previous question circles to concept boxes about the following: evidence of past plate motions and the geologic features present in certain areas of the world.
- 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:
 - **Patterns:** These could be phrases such as, “has in common with” “shares,” “is also shown in,” “is the same as,” “looks the same as,” etc.
 - **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. Usually, we recommend that students independently complete their project organizer. However, at this point, it is important that the group make a decision about WHERE the arena will be located. Students should work with their group to fill out the Task 1 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: Over the course of this task, you gathered evidence of how past plate motions have led to some geologic features you see on Earth. As a group, decide on a location for your arena that would have the geologic features you want. Then individually,
 - Draw a map showing your arena location on Earth as well as any relevant surrounding continents, making captions that answer the questions below:
 - On what continent would your arena be located? Why are you locating it there?
 - What features would you find (mountain ranges, types of rock, glaciers, etc.)?
 - How can you use plate motions to explain these features?

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 hypothesis about how continents may have once been connected. Look back at your hypothesis: after collecting all the evidence today, how would you change or add to your hypothesis? Use evidence from the task to justify your changes or additions and record below.

7th Grade Science Unit 1: A Balanced Biosphere**Task 1: Pangaea Puzzle**

- In this task, we focused on the crosscutting concepts of **Patterns**: Patterns can be used to identify cause and effect relationships and provide information about natural systems, 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 **Patterns** and **Systems and System Models** in this task?
 - Now that you have learned more about the evidence for past plate motions, what questions do you still have?
2. 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

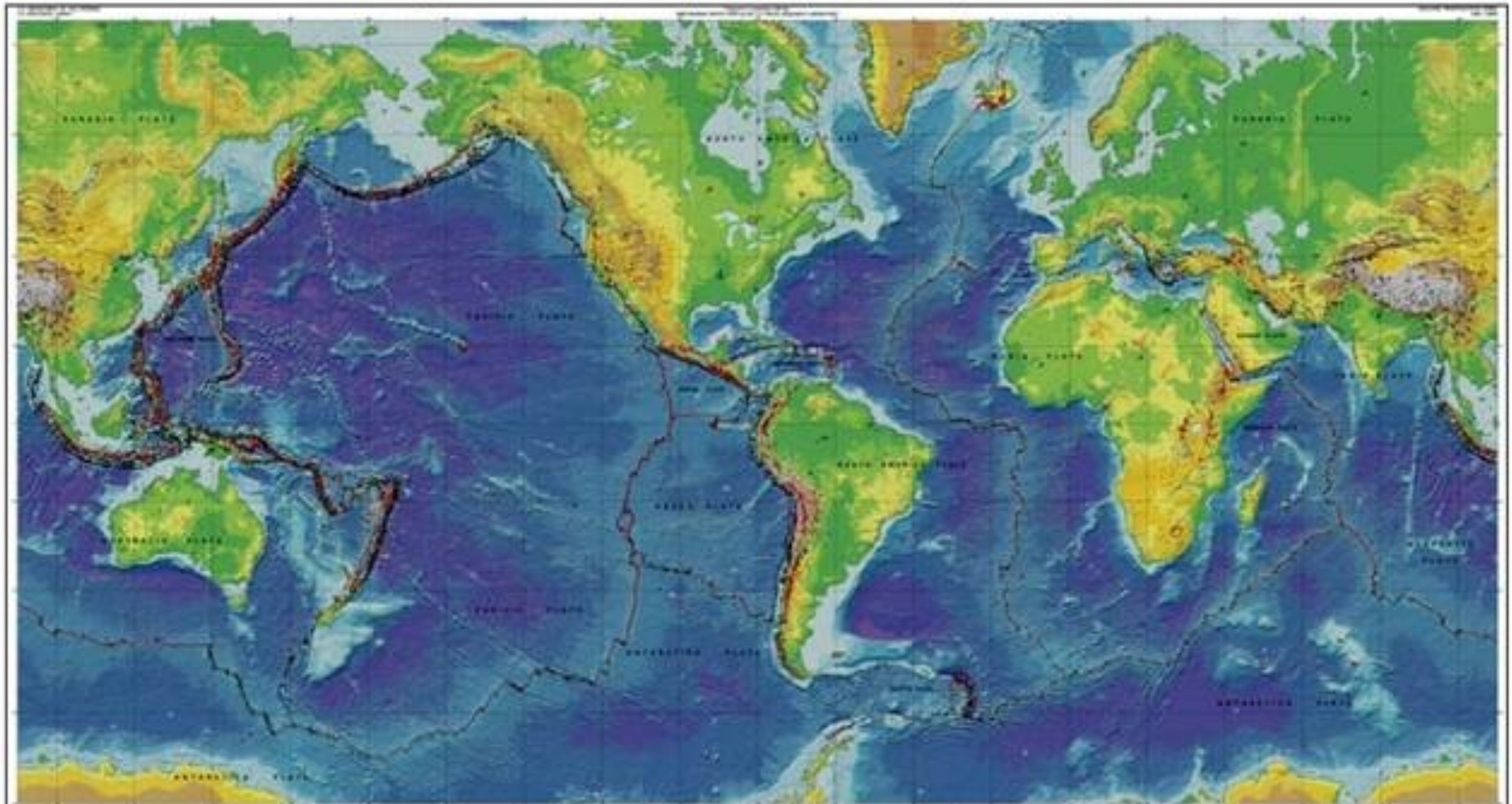
1. You may collect students' Project Organizer and assess using:
 - *Criteria of your choice*. We recommend using the 3-Dimensional Assessment matrix at the beginning of this document to inform your criteria.
 - This can be a formative tool to periodically look for trends in student understanding after 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.

Continent Pieces

Explore

This Dynamic Planet

World Map of Volcanoes, Earthquakes, Impact Craters, and Plate Tectonics



Evidence Cards

Explore



Figure 1: Mountain Ranges

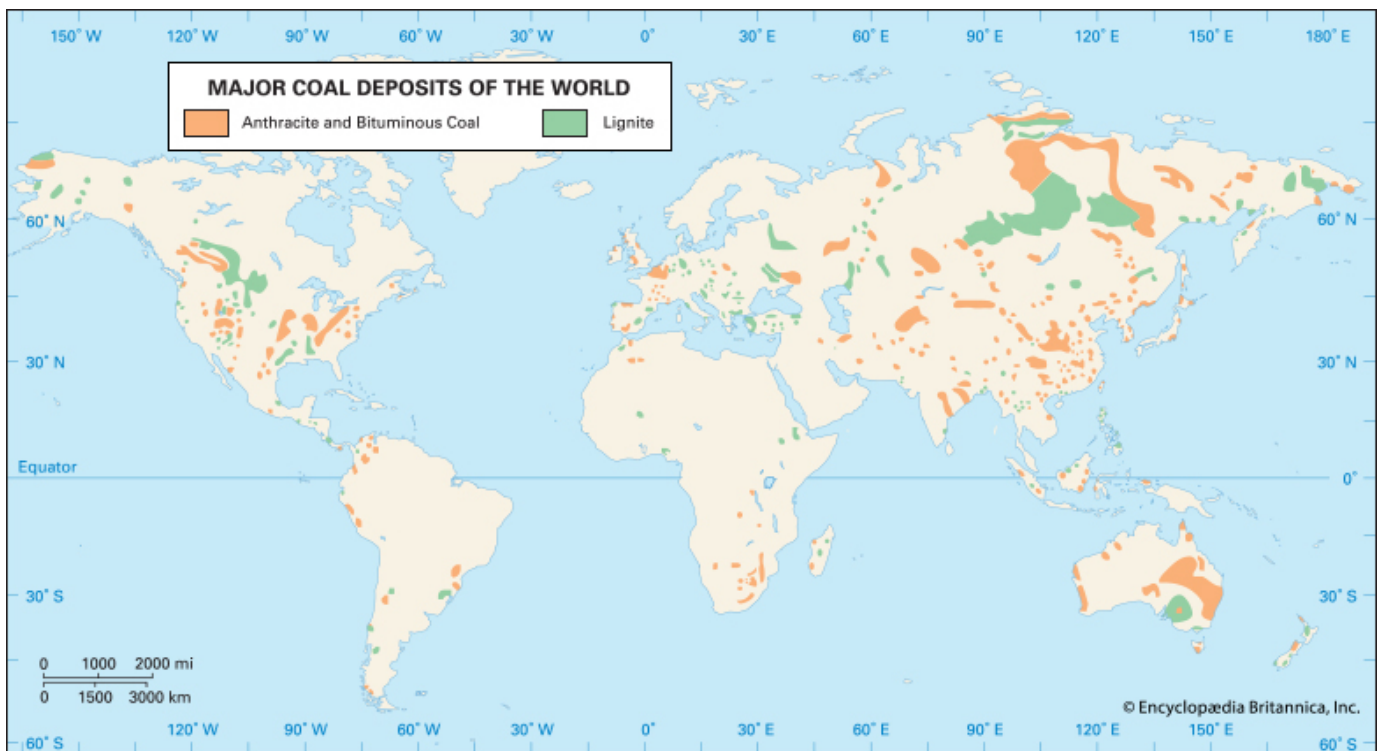


Figure 2 Coal Deposits across the continents

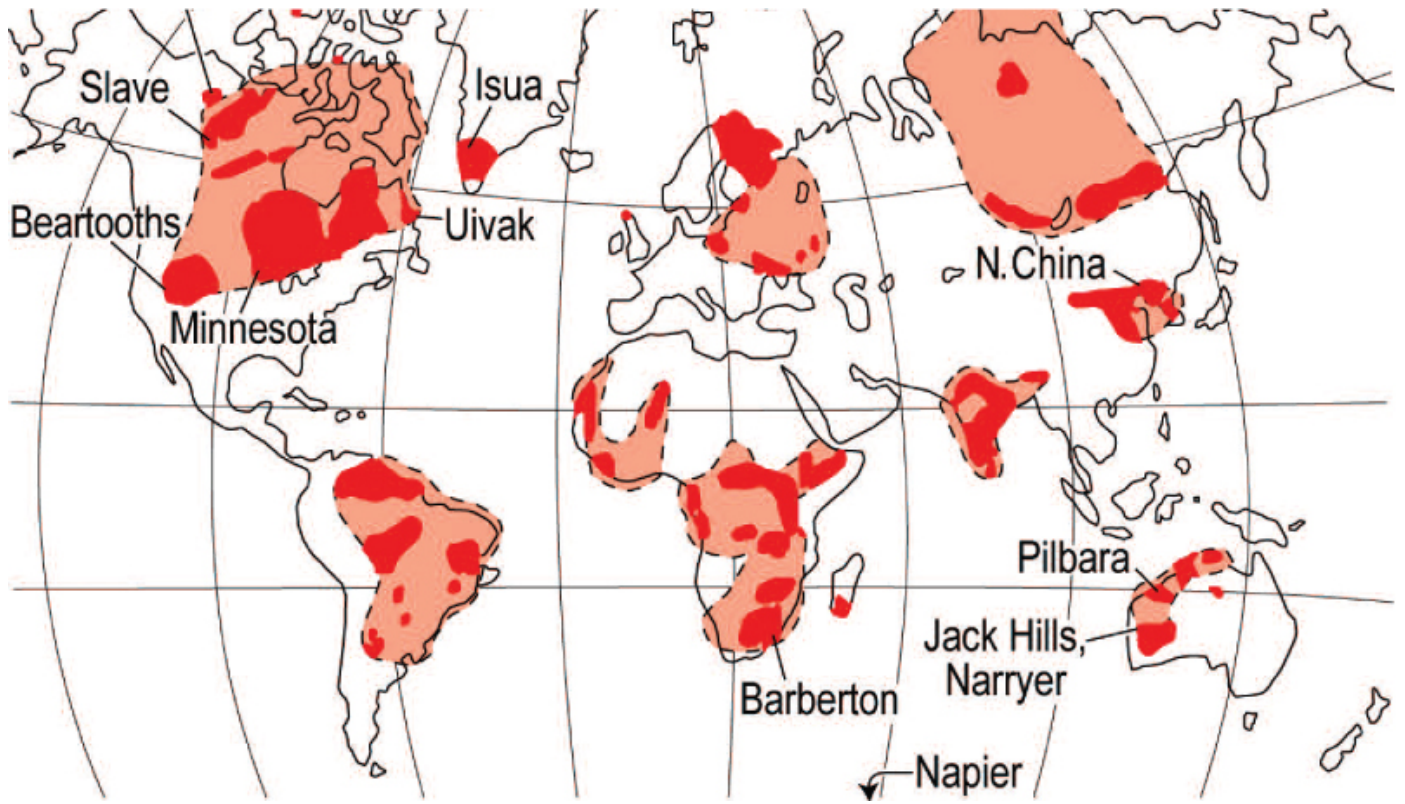


Figure 3 Archaean Rock Distribution

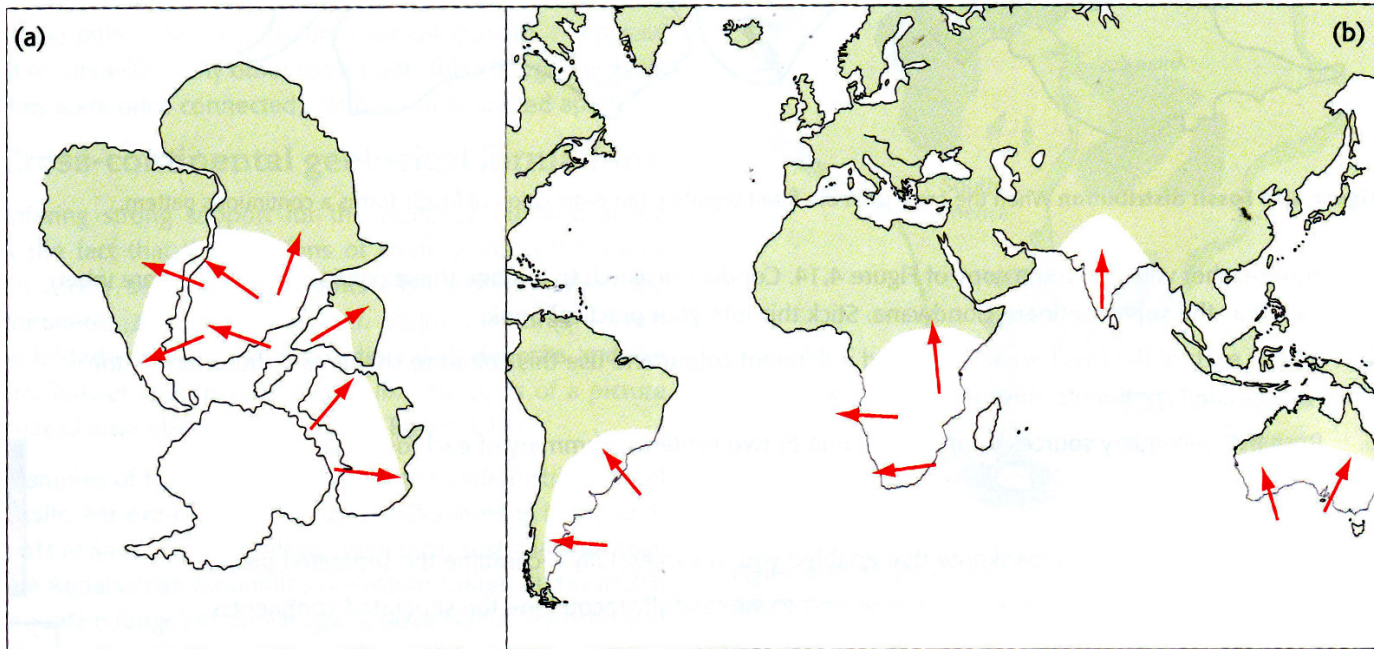


Figure 4 Distribution of Glacier Deposits



Figure 5 Distribution of Fossils

7th Grade Science Unit 1: A Balanced Biosphere

Task 2: Using Available Resources



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

Introduction

In Task 1, students learned about how plate motions have led to the geological world they experience. In this task, students learn that some of these same processes also lead to the natural resources that are available in different regions. The question of how natural resources are made and distributed is a very important one for humans because we rely so heavily on them every day. In this task, students explore both the geoscience processes and the human actions that result in an uneven distribution of resources—which is a cause for major conflict around the globe. In their culminating project, this knowledge will help them to justify the resources they present in their arena.

Alignment Table

Performance Expectations	Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<p>MS-ESS3-1. Construct a scientific explanation based on evidence for how the uneven distributions of Earth’s mineral, energy, and groundwater resources are the result of past and current geoscience processes. [Clarification Statement: Emphasis is on how these resources are limited and typically non-renewable, and how their distributions are significantly changing as a result of removal by humans. Examples of uneven distributions of resources as a result of past processes include but are not limited to petroleum (locations of the burial of organic marine sediments and subsequent geologic traps), metal ores (locations of past volcanic and hydrothermal activity associated with subduction zones), and soil (locations of</p>	<p>Constructing Explanations</p> <ul style="list-style-type: none"> Construct a scientific explanation based on 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. 	<p>ESS3.A: Natural Resources</p> <ul style="list-style-type: none"> Humans depend on Earth’s land, ocean, atmosphere, and biosphere for many different resources. Minerals, freshwater, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes. 	<p>Cause and Effect</p> <ul style="list-style-type: none"> Cause and effect relationships may be used to predict phenomena in natural or designed systems.

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active weathering and/or deposition of rock).]			
Supplementary Science and Engineering Practices <ul style="list-style-type: none"> • Developing and Using Models <ul style="list-style-type: none"> ○ Develop and/or use a model to predict and/or describe phenomena. 			
Equity and Groupwork <ul style="list-style-type: none"> • Pairs participate in group roles to model plate tectonics. • Share ideas about various resources. 			
Language <ul style="list-style-type: none"> • Read and discuss information on resources. • Write a CER report. 			

Learning Goals:

This learning task asks students to explain how Earth’s resources are unevenly distributed on Earth because of past and current geoscience processes. More specifically, students will:

- Activate prior knowledge about natural resources in the world via news headlines.
- Model how plate tectonics create geologic features.
- Analyze research to learn how geoscience processes form oil and natural gas.
- Apply understanding of one resource to predict distribution of another resource.
- Apply knowledge of uneven distribution of resources to their own imitation arena.

Content Background for Teachers

Uneven distribution of resources is one of the foremost politically charged environmental issues of today, as evidenced by the newspaper headlines provided in the Engage portion of this task. Both past and current geoscience processes as well as current human removal practices cause the uneven distribution of natural resources.

In the last task, students learned about plate motions leading to the geological world they currently experience. This task asks students to delve deeper into this concept by thinking about why many natural resources are limited and unevenly distributed. To do this, they first model plate tectonics and the different plate interactions that can occur. Tectonic plates move. Thus, at their boundaries, they can bang into, dive under, split further apart, or slide along each other. The driving force behind plate tectonics is convection in the mantle, causing plate movement.

- When two plates spread apart, this creates a divergent boundary, and this is where seafloor-spreading ridges or continental rift zones can occur.
- When two plates slide along each other, this forms a transform boundary, and can often result in earthquakes.
- When two plates come together, this is known as a convergent boundary, and one of two things can happen. If both plates uplift, this can create mountain ranges. If one plate subducts under another, this can create ocean trenches (also known as ocean basins) or volcanoes.

This relates to natural resources because plate tectonics are heavily involved in the creation of some of these nonrenewable resources. The examples specifically discussed in this task are oil and natural gas. As noted in



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the student resource card, oil and gas are formed mostly from the rapid burial of dead microorganisms in environments where oxygen is so limited that they do not decompose. These were most likely in swamps, river deltas, and mild climates. Ocean basins developed by plate subduction provide just the right conditions for rapid burial of the dead microorganisms that will one day become oil. The movement of plates also shifts these deposits around the world and is why we see some of the largest oil and gas reservoirs in deserts and arctic areas. Lastly, collisions between tectonic plates can free the mature oil and gas from deep within ocean basins and then trap oil and gas in reservoirs before they escape to the Earth's surface. We know these reservoirs as oil and gas fields.

This task also explores another natural resource that was already introduced in Task 1—coal. Coal is another important energy resource and is created in a similar process to oil formation. Tropical swamp forests of Europe and North America provided much of the organic material that was buried and compressed in sediments to form coal. Thus, locations, such as today's Appalachian Mountain region, that supported these Carboniferous swamp forests have more of the unevenly distributed coal.

These are only three examples of natural resources that are unevenly distributed throughout the world. In Unit 2, students will return to this Performance Expectation and explore more examples. Students will later be introduced to mineral resources, such as gold, copper, and other metal ores, which are brought to the surface by similar volcanic and uplift processes. For example, a prospector's shout that "there's gold in them thar hills" directly connects gold distribution with the plate tectonics that created "them thar hills." Groundwater is another unevenly distributed resource, determined by the amount of precipitation in that area and the permeability of the soil and rocks in that region. For more information on any of these topics, please reference the resource cards from Unit 1, Task 2 and Unit 2, Task 2.

Academic Vocabulary

- Natural Resource
- Tectonic Plates
- Oil
- Natural Gas
- Nonrenewable
- Reservoir
- Deposit
- Divergent
- Convergent
- Subduction
- Transform
- Coal
- Geoscience Process

Time Needed (Based on 45-Minute Periods)

4 Days

- Engage: 0.5 periods
- Explore: 1.5 periods
- Explain: 0.5 period

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- Elaborate: 0.5 period
- Evaluate and Reflection: 1 period

Materials

- Unit 1, Task 2 Student Version

Explore (per group or pair)

- Resource Cards in sheet protectors
- 4 Graham Crackers
- Cake Frosting
- Wax Paper
- Plastic Knife
- Cup of Water
- Computer

Evaluate

- Project Organizer Handout

Instructions**Engage**

1. Introduce Task 2: In Task 1, you learned about how plate motions lead to the geological world you currently experience. 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 2: But how does this also affect which resources are available in a region? This question is very important to us, as humans, because we take many different substances from the Earth—such as water, minerals, timber, and oil—and put them to our own uses.
 - Now pass out their Task 1 student guide.
3. Because we use natural resources so much, we will often see them written about in the news. In this activity, students analyze a few real news headlines from different time periods, shown in their student guide.
 - We recommend projecting the news headlines on the board and popcorn reading them aloud, but students may also consider them silently.
4. We also recommend taking students through the discussion questions as a whole-class facilitated discussion. First have students discuss the question in pairs and then share out as a class. Make sure to provide wait time for students to write and collect their thoughts.
 - When calling on students, it is recommended that you give pairs of students time to discuss questions and then call on pairs using equity sticks. This encourages more equitable participation in class-wide discussions (See “How to Use This Curriculum” for more details).

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5. Below are some sample responses to the four discussion questions:
- Question 1: This question is intended to elicit prior knowledge of natural resources and collectively come up with a definition. Students should eventually arise at a definition similar to the following: Natural resources are substances that come from nature and that humans use.
 - Question 2: This question links this task to the last task. Students may remember that the last task used coal distribution as evidence of past plate motions, and coal is a natural resource. Some may already know that many natural resources come from plate tectonic processes.
 - Question 3: Possible responses are gold, oil, diamonds, and water. If students are struggling, you can point their attention back to the headlines and ask them to identify the resources in the headlines.
 - Question 4: Students may use the headlines as evidence that certain resources are in certain places, so America may not have all of the resources within their own land. When there is a limited amount of something that everyone needs, this often causes conflict. Students can use their own experiences of this phenomenon to explain this (ie. When there are only a few cookies left, but lots of kids want them).
6. Optional: The following video is another great way to give students background on what natural resources are and how much we rely on them in our daily lives - https://www.youtube.com/watch?v=8Lfd_EKze2M.

Explore

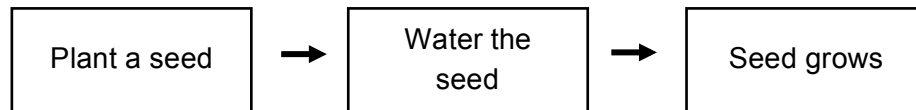
1. In the last task, students learned that plate motions have led to the geological world around them. However, the news headlines in the Engage showed them that these processes occur in different places in the world and lead to different results. How does the Earth actually make these resources? In this activity, students will explore what plate movements have to do with all of this.
2. Give students a brief overview of tectonic plates (provided in student guide), which they have likely learned about in earlier grades. This provides the foundation for them to think about the events that occur at plate boundaries, which they will model in this activity.
3. Distribute materials to pairs of students for the Graham Cracker Plate Modeling Activity. We recommend assigning roles to each group. You may use whatever roles you prefer. We recommend the use of the Materials Manager, Facilitator, Harmonizer, and Recorder.
 - Ask the Materials Manager to handle any resources needed to complete the task.
 - Ask the Facilitator to read the directions, make sure everyone understands the task, and facilitate discussion.
 - Ask the Harmonizer to make sure that everyone contributes their ideas and that everyone's voice is heard.
 - Ask the Recorder to make sure the group is drawing their diagrams and recording observations in their student guides.
4. This activity emphasizes the crosscutting concept of **Cause and Effect** as students use the cause-and-effect relationship between geoscience processes and geologic features to make predictions about resource formation. It also utilizes the science and engineering practice of **Developing and Using Models**,

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as students make a model with graham crackers to describe the phenomenon of plate tectonics forming resources over time.

- Options: Have students use the resource card to do this activity in groups OR guide them through each step of the modeling process as a class, reading directions aloud.
 - After each model, students should diagram what they made and explain what potential results there might be.
5. Once students finish the modeling activity, emphasize to students that not only are geologic features created, but also natural resources are formed that humans then extract from the Earth.
- Distribute the “How Is Oil Made?” resource card to each group or pair of students and have them read about oil formation in order to apply it to one or a few of their models.
 - Students should fill in the flowchart in their student guides to explain the oil formation process and then identify which type(s) of plate interactions help to make oil. Again, students are using the same **Cause and Effect** relationship to predict and explain how oil is made around the world.
 - You may need to describe for students what a “flowchart” is and model a simple one as an example:



- The last question in this section asks students to use their prior knowledge as well as evidence from the *Engage* and the article to consider how humans are also affecting distribution of resources. This asks students to push past just the geoscience processes and consider how humans’ mass removal of these nonrenewable resources is also having a large effect.

Explain

1. This section of the task puts all the information together so students can come to a generalized conclusion. It focuses on the crosscutting concept of **Cause and Effect**, using the relationship between plate tectonics and oil to predict how geologic processes and human activity distribute most resources around the world.
 - Students summarize their understanding by writing a CER report that answers the question: Are all resources distributed evenly throughout the world? Why or why not? They should use evidence from the *Engage and Explore* to justify their response, thus explicitly practicing the skill of **Constructing Explanations**.

Optional Sentence Stems to Provide

Claim	Resources are/are not (pick one) distributed evenly throughout the world because... Humans are also...
Evidence	<ul style="list-style-type: none"> • There are areas in the world... • For example...
Reasoning	<ul style="list-style-type: none"> • A long time ago, organisms_____. • The plate movement leads to ... •, which causes _____.

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Sample Student Response

Claim	Resources are not evenly distributed throughout the world because the geoscience processes that have created these resources happen in different parts of the world. Humans are also extracting them at different rates in different areas.
Evidence	There are areas in the world where you can get a lot of oil and gas and other areas where there is none.
Reasoning	This is because there are certain areas where fossils ended up deep down in the earth. Then plate movement ended up moving these fossils to different places around the world. Humans also remove them at different rates.

2. This CER paragraph can be a good option for formative assessment. Collect student work to identify trends in students' ability to use evidence to support an explanation. See "How to Use This Curriculum" for strategies on utilizing formative assessment data to provide feedback to students and inform classroom instruction.

Elaborate

1. At this point, students have identified a pattern that certain geoscience processes lead to certain resources. They have also seen in the cases of oil and natural gas that these geoscience processes happen in specific places and thus oil and gas are specific to these locations.
 - This section of the task asks students to use this knowledge and their understanding of the crosscutting concept of **Cause and Effect** to make a prediction about coal distribution.
 - Students read the description of how coal is created and decide whether they think coal is evenly or unevenly distributed throughout the world. It is important that they explain why within the context of the cause-and-effect relationship they have identified from the rest of the task.
2. Return to the whole-class 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).
 - 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?
 - Draw circles around each question and boxes around each concept.
 - Write connector words to describe connections between the concept boxes.
 - For this task, students may begin to connect some of their previous question circles to concept boxes about the following: how geologic processes and human activity lead to the uneven distribution of natural resources.
 - 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

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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:

- **Cause and Effect.** These could be phrases such as, “which results in,” “which causes,” “that explains why,” “is due to,” 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 2 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. The student prompt is as follows: Every arena needs certain resources to function. Now that you have discovered how resources have been distributed on our own Earth, decide which resources your arena will have.
 - What natural resources will your arena have the most and least of?
 - What geoscience processes will have caused these resources to be available in your arena?
 - What evidence is there for why these resources are unevenly distributed?

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 looked at different news headlines and hypothesized as to why certain resources are associated with specific regions. Look back at your responses: after learning everything you have about resources, how can you add to your answers? Use information from the task to better explain why America can’t just get all of its resources within its own borders.
 - In this task, we focused on the crosscutting concept of **Cause and Effect**: cause and effect relationships may be used to predict phenomena. Where did you see examples of **Cause and Effect** in this task?
 - Now that you have learned more about how natural resources are distributed, what questions do you still have?
2. 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.

7th Grade Science Unit 1: A Balanced Biosphere**Task 2: Using Available Resources****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.

Resource Card - Graham Cracker Modeling*Explore*Materials:

- 4 Graham Crackers
- Cake Frosting
- Wax Paper
- Plastic Knife
- Cup of Water

Procedure

Part 1

1. Break a whole cracker into two rectangular pieces by following the perforations on the cracker.
2. Using the plastic knife or spoon, spread a thin amount of frosting in the center of the wax paper.
3. Lay two pieces of graham cracker against one another on the top of the frosting.
4. Press down lightly on the crackers as you slowly push them in opposite directions (apart), less than a centimeter.
5. Record.

Part 2a

1. Break a whole cracker into two rectangular pieces by following the perforations on the cracker.
2. Dip one end of **one** of the two graham crackers two centimeters (one inch) into a cup of water. Immediately remove the cracker and lay both crackers end-to-end on the frosting with the wet edge nearly touching the dry edge of the other cracker.
3. Slowly push the two crackers together.
4. Record.

Part 2b

1. Break a whole cracker into two rectangular pieces by following the perforations on the cracker.
2. Dip one end of each of the two graham crackers two centimeters (one inch) into a cup of water. Immediately remove the crackers and lay them end-to-end on the frosting with the wet edges nearly touching.
3. Slowly push the two crackers together. The wet ends of the crackers will curl and fold upwards as the crackers are pushed together.
4. Record.

Part 3

1. Break a whole cracker into two rectangular pieces by following the perforations on the cracker.
2. Place one hand on each of the cracker pieces and push them together by applying steady, moderate pressure. At the same time, also push one of the pieces away from you while you are pulling the other toward you.
3. Record.

Resource Card – How is Oil Made?*Explore*Instructions:

1. Pick one of the following resources to learn about how oil is formed:
 - Video: <https://www.youtube.com/watch?v=8YHsxXEVb1M>
 - Interactive: <http://www.adventuresinenergy.org/What-are-Oil-and-Natural-Gas/How-Are-Oil-Natural-Gas-Formed.html>
2. Draw a flowchart in your student guide to show how oil and natural gas are formed.
3. Read the article below to help you discover the types of plate interactions that help to form oil and natural gas.

Plate tectonics affect the location of oil and gas reservoirs. Most of the oil and gas in the world today are found in deserts, arctic areas, river deltas, and edges of the continents where it meets the ocean.

As you know, most of the oil we are getting from the earth now was formed from tiny dead organisms from tens of millions of years ago. Most likely, these tiny organisms were originally deposited in swamps, river deltas, and mild climates. Then, tectonic plates moved, subducted, and collided which moved around those tiny dead organisms from where they were originally to where we find oil now.

Lastly, plate movements are also responsible for creating the "pressure cooker" that slowly matures the dead organisms into oil and gas. This process usually takes millions of years, giving the oil and gas deposits plenty of time to migrate around the globe on the back of plate movements. Sometimes, collisions between tectonic plates can free the mature oil and gas from deep within the ocean and leave it in reservoirs. We call these reservoirs "oil and gas fields."

As you can tell by this description, the process of creating oil and natural gas takes a very long time! To keep up with demand, humans are removing oil and natural gas from the Earth at a very fast rate—too fast for Earth to replenish, or renew, the supply. This is why we call these nonrenewable resources. At this rate, scientists are certain that we will soon run out of these precious natural resources.

Source: Adapted from *Scientific American* article, "Why is oil usually found in deserts and arctic areas?" by Roger N. Anderson.

7th Grade Science Unit 1: A Balanced Biosphere

Task 3: Produce, Reuse, Recycle

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

Introduction

In the last two tasks, students have been focused on nonliving parts of ecosystems, such as the geologic features or natural resources present in a region. In this task, students continue to consider non-living things, but begin to incorporate living organisms into their schema of an ecosystem. Beginning with the mystery of “The Year Without Summer”, students explore how living and nonliving parts of an ecosystem must interact to create a well-functioning ecosystem. Students first use their own prior knowledge of ecosystems to form an idea of how parts of an ecosystem interact; they then read an article to construct a revised model that clearly shows how matter is cycled and energy flows through living and nonliving things. By the end of this task, students will not only be able to explain the initial mystery of “The Year Without Summer”, they will also be able to envision their culminating project arena as a whole—both the living and nonliving components as well as their interactions.

Alignment Table

Performance Expectations	Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<p>MS-LS2-3. Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. [Clarification Statement: Emphasis is on describing the conservation of matter and flow of energy into and out of various ecosystems, and on defining the boundaries of the system.] [Assessment Boundary: Assessment does not include the use of chemical reactions to describe the processes.]</p>	<p>Developing and Using Models</p> <ul style="list-style-type: none"> Develop a model to describe phenomena. 	<p>LS2.B: Cycles of Matter and Energy Transfer in Ecosystems</p> <ul style="list-style-type: none"> Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an 	<p>Energy and Matter</p> <ul style="list-style-type: none"> The transfer of energy can be tracked as energy flows through a natural system.

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Task 3: Produce, Reuse, Recycle



		ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem.	
<p>Supplementary Crosscutting Concepts</p> <ul style="list-style-type: none"> ○ System and System Models <ul style="list-style-type: none"> ○ Systems may interact with other systems; they may have sub-systems and be part of a larger complex system. ○ Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy and matter flows within systems. 			
<p>Equity and Groupwork</p> <ul style="list-style-type: none"> • Work in group roles to co-construct a model. 			
<p>Language</p> <ul style="list-style-type: none"> • Read and annotate a text. • Construct a model using new scientific vocabulary. • Write a paragraph or draw a flowchart to demonstrate conceptual understanding. 			

Learning Goals

This learning task asks students to explore how matter and energy are cycled through an ecosystem by living things. More specifically, the purpose is to:

- Engage prior knowledge to make a hypothesis about the case of the Mount Tambora eruption.
- Use prior knowledge to co-construct a model of ecosystem interactions.
- Read and annotate an article about parts of ecosystems and their interactions.
- Revise and finalize a model that shows flow of energy and cycling of matter in an ecosystem.
- Use new knowledge to explain the case of the Mount Tambora eruption.
- Apply knowledge of cycling of matter and energy to inform the arena design.

Content Background for Teachers

In this task, students are asked to consider the cycle of matter and energy transfer in ecosystems. Students already know that living things, like plants and animals, need certain things in order to survive. This task helps them to explore how these essential non-living things are constantly cycled amongst living organisms to keep an ecosystem functioning properly.

In an ecosystem, there are producers, consumers, and decomposers. Producers create all the energy for the ecosystem by converting sunlight into energy the plant can use. Primary consumers then eat these plants to get the energy they need to survive and grow. Secondary consumers then get their energy by eating these primary consumers, and so on. Decomposers, an essential but often forgot about category of organisms, recycle all the nutrients from dead plant or animal matter back to the soil so it can be reused by plants. Thus, students not only see how living things cycle matter throughout an ecosystem, they can also track the flow of energy that drives these processes.

7th Grade Science Unit 1: A Balanced Biosphere**Task 3: Produce, Reuse, Recycle**

By only talking about energy and consumption, however, this leaves out other crucial types of nonliving matter that are cycling in an ecosystem. In order to do photosynthesis, plants also use carbon dioxide and water from their environment and release oxygen back into the air. Animals can then use this oxygen, as well as the glucose they get from plants, to create energy through cellular respiration. This process releases water and carbon dioxide back into the environment, which can then again be used by plants.

In order for students to represent all these complex interactions, it is helpful for them to create a model that is not just a food web (which only shows living organisms and feeding relationships). In this task, students take the food webs model a step further to include other non-living matter and energy sources that are significant to the functioning of an ecosystem. For more information on these concepts, reference the article used in the *Explain* portion of this task.

Academic Vocabulary

- Ecosystem
- Non-living
- Living
- Organism
- Matter
- Energy
- Producer
- Consumer
- Decomposer
- Food Web
- Oxygen
- Carbon Dioxide

Time Needed (Based on 45-Minute Periods)

4 Days

- Engage: 0.5 period
- Explore: 0.5 period
- Explain: 1.5 periods
- Elaborate: 0.5 period
- Evaluate and Reflection: 1 period

Materials

- Unit 1, Task 3 Student Version

Explore

- Poster Paper
- Ecosystem Cards (1 per group)
- Scissors (1 per group)
- Pencils

Explore

- Poster Paper (if needed for new drafts)

7th Grade Science Unit 1: A Balanced Biosphere**Task 3: Produce, Reuse, Recycle**

- Glue
- Markers
- Optional: Post-Its

Evaluate

- Project Organizer Handout

Instructions**Engage**

1. Introduce Task 3: In the last two tasks, we learned about non-living parts of an ecosystem, such as geologic features like mountains and natural resources like coal. 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 3: However, every ecosystem also has living parts as well, like plants and animals. In this task, we will ask the question: How do all these different parts interact to keep the ecosystem functioning as a whole?
 - Now pass out their Task 3 student guide.
3. Students begin this task by thinking about the case study of the Mount Tambora eruption and “The Year Without Summer”. We recommend reading the case study aloud as an introduction. Then in pairs, students should discuss the case study and write a hypothesis for why they think so many plants and animals died.
 - This allows students to begin to engage with the crosscutting concept of **Systems and System Models** as they consider how plants and animals may be separate sub-systems that interact as part of a larger complex system.
 - Because this is just a hypothesis, there are no correct answers, but students should explain their reasoning.
 - Share out a few hypotheses, using equity sticks to encourage more equitable participation (See “How To Use This Curriculum” for more details).

Explore

1. In order to understand what happened in the case of the Mount Tambora eruption, it is helpful for students to explore what a well-functioning ecosystem looks like. In this activity, students will begin to construct a preliminary model that shows parts of an ecosystem and their interactions.
 - This asks students to begin practicing the science and engineering practice of **Developing and Using Models**, as they start to develop a model to describe cycling of matter and energy in an ecosystem.

7th Grade Science Unit 1: A Balanced Biosphere**Task 3: Produce, Reuse, Recycle**

2. Distribute a set of Ecosystem Cards, a pair of scissors, and poster paper to each group. Because this is a group activity, we recommend assigning roles to each group. You may use whatever roles you prefer. We recommend the use of the Facilitator, Materials Manager, Harmonizer, and Reporter.
 - Ask the Facilitator to read the directions and to make sure everyone understands the task.
 - Ask the Materials Manager to gather the materials needed to complete the task.
 - Ask the Harmonizer to make sure that everyone contributes their ideas and that everyone's voice is heard.
 - Ask the Reporter to make sure the group is reporting ideas on the group poster.
3. Once groups have cut apart and analyzed the Ecosystem Cards provided, they should use the questions on their student guides to discuss how the different parts of the ecosystem interact.
 - The discussion questions provided specifically emphasize the crosscutting concepts of **Energy and Matter** as students try to brainstorm how energy flows through the ecosystem and how non-living matter is used and released by living organisms.
4. Using whatever prior knowledge they have, they will then arrange the Ecosystem Cards and draw arrows and labels to describe interactions.
 - Remind students to do this activity in **pencil** and to not glue down any pieces because they will be revising their poster once they gather more information in the Explain.
 - By creating a model of an ecosystem that shows interactions and energy and matter flows, students are using the crosscutting concept of **Systems and System Models**.

Explain

1. In this section of the task, students individually read and annotate an article that tells them more about ecosystem interactions, which they will use to revise and finalize their initial models from the *Explore*.
 - We recommend provided whatever annotation strategy students use most in your classroom. However, if you do not have an established strategy, an option is provided in the "How to Use This Curriculum" document.
2. Student groups are then ready to revise and create a final poster of their model. Distribute necessary materials for the final poster, including glue and markers.
 - Because this is a group activity, we again recommend assigning roles to each group. You may use the same roles as the *Explore*, but switch up which student occupies each role.
3. Because students are revisiting their model from the *Explore*, this activity emphasizes the same science and engineering practice (**Developing and Using Models**) and the same crosscutting concepts (**Systems and System Models** and **Energy and Matter**) as above. See above for details on how these dimensions are addressed through this modeling activity.
4. We highly recommend conducting a gallery walk after groups have finished their poster models. Hang the posters around the room and have students view their peers' work. Provide each student with two post-its so they can leave one positive comment and one "I wonder..." on one of the poster models around the room.

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- These poster models are great options for formative assessment. Collect the posters to identify trends in students' ability to develop models that show cycling of matter and flow of energy. See "How to Use This Curriculum" for strategies on utilizing formative assessment data to provide feedback to students and inform classroom instruction

Elaborate

1. Now that students have a solid understanding of ecosystem interactions, they are ready to return to the case study of the Mount Tambora eruption. In this section, students individually explain why so many plants and animals died, using what they have learned throughout the task. They may write a paragraph or draw a flowchart to explain their ideas.
 - This explanation asks students to continue to use the lens of **Systems and System Models** to think about how different sub-systems (solar, plants, animals) interact as part of a larger, more complex system.
 - Sample student response: When Mount Tambora erupted, there was a lot of ash in the air, which blocked the sun. When plants don't have sun, they can't make energy and survive. Since they are the producers of energy for the whole ecosystem, this causes big problems. If plants die, then many of the animals that eat those plants don't get their energy and they can die. This was the case for thousands of animals, including humans.
2. Optional: Give pairs of students time to discuss their explanations and then call on students using equity sticks to share out ideas. This encourages more equitable participation in class-wide discussions (See "How To Use This Curriculum" for more details).
3. Return to the whole-class 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).
 - 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?
 - Draw circles around each question and boxes around each concept.
 - Write connector words to describe connections between the concept boxes.
 - For this task, students may begin to connect some of their previous question circles to concept boxes about the following: how matter is cycled and energy flows through living matter in 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:

7th Grade Science Unit 1: A Balanced Biosphere**Task 3: Produce, Reuse, Recycle**

- **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.
- **Energy and Matter:** These could be phrases such as, “energy is transferred/flows,” “is conserved,” “is important for,” “is needed,” 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 3 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: Your arena already has its main geological features, but as we learned today, there are also other non-living factors and living factors that make up an environment. Design the landscape of your arena, focusing on the non-living things that will be needed to support life.
 - Draw a visual diagram showing how this non-living matter will cycle through your environment (you do not need to pick specific plants and animals for your arena yet; you can just draw example plants and animals for this diagram).
 - Be sure to label the examples of living and non-living matter and use arrows to show where they go.

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 wrote a hypothesis for the case of the Mount Tambora eruption. Look back at your initial response: were you correct? After learning everything you have about cycling of energy and matter, how could you revise or add to your hypothesis?
 - In this task, we focused on the crosscutting concepts of **Systems and System Models:** Models can be used to represent systems and their interactions within and between systems; and **Energy and Matter:** The flow of matter and energy can be tracked through a natural system. Where did you see examples of **Systems and System Models** and **Energy and Matter** in this task?
 - Now that you have learned more about how matter and energy cycle among living and nonliving parts of an ecosystem, what questions do you still have?
2. 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.

7th Grade Science Unit 1: A Balanced Biosphere**Task 3: Produce, Reuse, Recycle****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.

Parts of an Ecosystem Cards

Explore



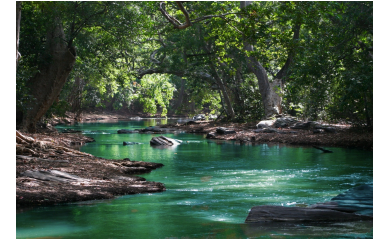
Grass



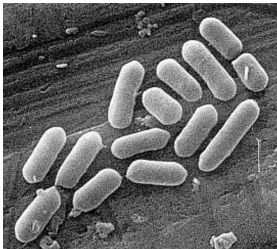
Insects



Animals (eats other animals)



Water



Bacteria



Fungi



Trees



Sunlight



Animals (eats plants)



Carbon Dioxide (Air)



Soil



Oxygen (Air)

A Well-Functioning Ecosystem: How Do Living Things Help Cycle Matter and Energy in an Ecosystem?

Explain

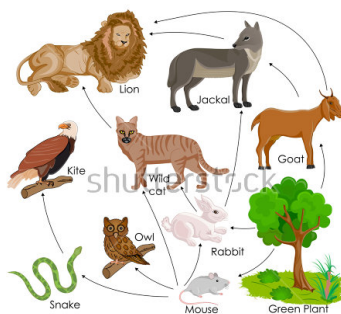
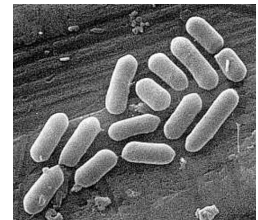
Every living organism needs certain things to survive, grow, and do their daily activities.

The most important part in an ecosystem is sunlight. Plants capture energy from the sun to grow and make their own energy. This is why we call plants producers—they *produce* the energy for the entire ecosystem. However, plants don't only need sunlight to survive and grow. They also need nutrients and water from the soil and carbon dioxide from the air. In this process that plants use to create their own energy from the sun, they also release oxygen back into the air.



Unlike plants, animals do not create their own energy. They eat plants and other animals to get their energy. This is why we call them consumers—they *consume* other organisms for energy. Animals that eat only plants are called herbivores. Animals that eat other animals are called carnivores. Other animals, like many humans, that eat both plants and animals are called omnivores. Like plants, animals need extra things in order to survive and grow. They also need water and oxygen from the air in order to convert what they eat into energy they can use. As a result of this process, they also release carbon dioxide back into the air.

There is also a third category of organisms that are very important to the functioning of an ecosystem, but they are rarely talked about. Decomposers are organisms that recycle nutrients from dead plants and animals and return them to the soil to be used again by new plants.



As you can see, plants and animals in an ecosystem all rely on each other to live! Scientists sometimes describe these interactions using a food web. Food webs are models that show how matter and energy are transferred between different living things in an ecosystem. In a food web, arrows are drawn in the direction that matter or energy is flowing; in other words, towards the organism that is doing the consuming. In today's task, you will be making a model that is similar to a food web, but also includes non-living matter, rather than just living organisms.

7th Grade Science Unit 1: A Balanced Biosphere

Task 4: Interactions Between Organisms



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

Introduction

In the last task, students thought about how animals and plants interact when they cycle through nonliving matter. In this task, students remember that this is not the only way organisms interact in an ecosystem. In every ecosystem, there are a large variety of organisms that interact in certain ways, maintaining the delicate balance of that ecosystem. Regardless of the type of ecosystem, there are patterns that can be noticed in the way organisms interact with each other. These patterns have been classified into five different relationships: competition, predation, commensalism, mutualism, and parasitism. In this task, students will analyze real-life examples in order to find their own patterns and make their own categories to explain interactions among organisms. They will then be able to use these patterns to identify causal relationships within other real ecosystems. As students begin to populate their arena with organisms for their culminating project, they will use these relationships to design a challenge for the game contestants.

Alignment Table

Performance Expectations	Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<p>MS-LS2-2. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. [Clarification Statement: Emphasis is on predicting consistent patterns of interactions in different ecosystems in terms of the relationships among and between organisms and abiotic components of ecosystems. Examples of types of interactions could include competitive, predatory, and mutually beneficial.]</p>	<p>Constructing Explanations</p> <ul style="list-style-type: none"> Construct an explanation that includes qualitative or quantitative relationships between variables that predict phenomena. 	<p>LS2.A: Interdependent Relationships in Ecosystems</p> <ul style="list-style-type: none"> Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared. 	<p>Patterns</p> <ul style="list-style-type: none"> Patterns can be used to identify cause and effect relationships.

7th Grade Science Unit 1: A Balanced Biosphere**Task 4: Interactions Between Organisms****Equity and Groupwork**

- Share ideas to analyze photos.
- Come to consensus to cluster and label organism interactions.

Language

- Write descriptions of photograph scenarios.
- Create classification labels.

Learning Goals

This learning task asks students to identify patterns of interactions among organisms in different ecosystems. More specifically, the purpose is to:

- Engage prior knowledge of how organisms interact in ecosystems.
- Explore examples of organisms interacting in different types of ecosystems.
- Cluster scenarios and explain any patterns of organism interactions across ecosystems.
- Apply patterns of organism interactions to identify causal relationships within real ecosystems.
- Apply knowledge of organism interactions to design a challenge for arena contestants.

Content Background for Teachers

No organism exists in a vacuum; organisms are constantly interacting with both the nonliving matter and the living organisms around them. These interactions allow the organism to survive and the ecosystem to flourish.

In the last task, students learned about how plants and animals interact as they cycle energy and matter. Refer back to the background section of Task 3 for more information on this content. In discussing cycling of matter, one of the relationships between organisms that students explored was the feeding relationship. This type of relationship is the most common type of organism interaction that comes to mind when people think about ways organisms interact. This interaction is also known as predation. Examples of predation are owls that eat mice or lions that eat gazelles.

However, there are many other ways that organisms interact in an environment. When two organisms fight over a resource, such as food, water, or territory, this interaction is known as competition. This can happen within a species or between species. For example, male deer fight each other for mates. Also, lions and hyenas compete with each for prey.

Another relationship that occurs amongst organisms is known as commensalism, where one organism benefits while the other is neither helped nor harmed. For example, barnacles grow on whales, which gives the barnacles more access to feeding opportunities, but does not affect the whale at all.

When one organism benefits and the other organism is harmed in the relationship, this is called parasitism. A common example of this is ticks on dogs or mosquitos on humans; the ticks and mosquitos survive off the blood, but the humans and dogs can get diseases and other negative symptoms.

7th Grade Science Unit 1: A Balanced Biosphere**Task 4: Interactions Between Organisms**

Lastly, there is mutualism, in which both species benefit. Bees and flowers are an excellent example of this; bees are able to extract nectar from the flowers and the flowers get their pollen spread by the bees, producing more flowers.

As students know from Task 3, decomposers also play an essential role in every ecosystem in cycling matter throughout an ecosystem. However, they were not included in this task because decomposers can fit into many of the previously described relationship categories, depending on the type of decomposer. For example, different fungi can be parasitic, mutualistic, or commensalistic!

Academic Vocabulary

- Organism
- Interaction
- Competition
- Predation
- Commensalism
- Parasitism
- Mutualism

Time Needed (Based on 45-Minute Periods)

4 Days

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

Materials

- Unit 1, Task 4 Student Version

Explore

- Station Cards in sheet protectors (2-3 at each station)

Explain

- Interaction Cards (laminated, cut, and put in an envelope per group)

Evaluate

- Project Organizer Handout

Instructions**Engage**

1. Introduce Task 4: In the last task, we saw how matter and energy are cycled through ecosystems by plants and animals. 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?

7th Grade Science Unit 1: A Balanced Biosphere**Task 4: Interactions Between Organisms**

- 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 4: However, exchanging nonliving matter is not the only way plants and animals interact in an ecosystem. In this task, we will ask the question: In what other ways do organisms interact?
 - Now pass out their Task 4 student guide.
 3. In this activity, students imagine any kind of ecosystem, including the types of plants and animals they would find there. After individually brainstorming at least three ways that organisms might interact in this environment, they create a drawing that shows the environment, the organisms, and their interactions.
 - All students should be able to imagine and draw an ecosystem of their choice. For example, a rainforest, a river, an ocean, a deciduous forest, etc.
 - While most students will describe predator-prey relationships, encourage students to think outside that category with facilitating questions, like: What other ways can you see animals and plants interacting besides eating? What if two animals eat the same food? Drink water at the same source? Etc.
 4. Then have students share their pictures with a partner that has a different ecosystem than they have.
 - The purpose of this exercise is for students to begin to recognize patterns of similar interactions drawn even if the ecosystems are different. It will also expose students to interactions they may not have thought of themselves.
 - This starts students thinking about the crosscutting concept of **Patterns**, as they identify similar interactions across ecosystems.
 - Students should record these similarities in their student guide. Share out a few similarities as a class, using equity sticks (See “How to Use this Curriculum” for more details).

Explore

1. Even though students drew different environments in the *Engage*, many of the drawings depicted similar interactions amongst organisms. In this section of the task, students explore real-life examples of different ways organisms interact.
 - Here, students are continuing to approach organism interactions through the lens of **Patterns**, as they identify patterns across different ecosystems. They will then be able to use these patterns to identify causal relationships in other ecosystems later in the task.
2. Set up 10 small stations around the room with 2-3 of each station card available for students to look at.
 - Optional: For a more advanced option, leave out the captions on each station card.
3. Give students 1-2 minutes per station to make observations about what they see happening in the picture and record this in their student guide.
 - We recommend the use of timers to signal students to move to the next station.
 - Continue until they have visited every station.

7th Grade Science Unit 1: A Balanced Biosphere**Task 4: Interactions Between Organisms**

- *You will notice that each station has a short description of what is going on in the picture. These descriptions highlight the fact that every one is happening in a different type of ecosystem. In their student guide, students will describe characteristics of each ecosystem to highlight this aspect of the Performance Expectation.

Explain

1. In this part of the task, students return to their group to try to make sense of what they saw. Students will work together to cluster the different interactions they saw into groups of ones that seemed similar.
 - Again, students are using the crosscutting concept of **Patterns** to identify similarities across ecosystems and cluster pairs of organisms accordingly. As students describe the qualitative relationships between organisms that are common across ecosystems, they are also utilizing the science and engineering practice of **Constructing Explanations**.
2. We recommend reviewing the instructions as a class and taking clarifying questions before students begin. Provide each group with Interaction Cards that show the situations they just viewed in the stations. You may also want to model the process with a few of the Interaction Cards.
 - Students kinesthetically manipulate the scenarios as they make sense of their interaction groupings.
 - Once students have clustered their Interaction Cards into groups according to the patterns they noticed, they should record these groups in their student guide. They will cite relevant example pairs of organisms and also assign their own labels to represent the patterns they see.
 - These labels should not be scientifically accurate, but should represent the patterns they see. For example, they may label predation as “feeding” or mutualism as “both benefit” etc.
3. Because this is a collaborative task, we recommend assigning roles to each group. You may use whatever roles you prefer. We recommend the use of the Facilitator, Materials Manager, Harmonizer, and Recorder.
 - Ask the Facilitator to read the directions and to make sure everyone understands the task.
 - Ask the Materials Manager to gather the materials needed to complete the task.
 - Ask the Harmonizer to make sure that everyone contributes their ideas and that everyone’s voice is heard.
 - Ask the Recorder to make sure the group is recording all groupings in their student guides.
4. When all students are finished grouping scenarios and assigning their labels, assign each group a few Interaction Cards that they will be responsible for.
 - Call one group up at a time to place their Interaction Cards on the board. As groups come up, they should add their Interaction Cards to other groupings or start new groupings as they see fit.
 - Analyze the class groupings as a class.
 - Ask pairs of students to discuss if they disagree with any of the classifications on the board and why. Then share these disagreements out.
 - Continue the class discussion and modify the groupings on the board until a general consensus is reached.

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Task 4: Interactions Between Organisms

- Use facilitating questions to encourage students to get to the five scientific groupings that you know, but students don't know at this point.
 - Just like students found patterns, made groups, and assigned categories, so did scientists! Next to the interaction card groups, write the corresponding scientific names on the board. Have students write these in their student guide, matching the scientific names to their own labels.

Station Cards Explained

Interaction	Description	Examples
Competition	Two organisms fight over a resource, such as food, water, or territory.	<ul style="list-style-type: none"> • Squirrels: Squirrels fight over food resources, like acorns. • Plants: Plants fight over sunlight resources to grow.
Parasitism	One organism lives on or inside another organism and harms it in the process.	<ul style="list-style-type: none"> • Mosquitos and humans: mosquitos feed off the blood of humans and can give them diseases. • Ticks and dogs: ticks feed off the blood of dogs and can give them diseases.
Mutualism	Both species benefit from the relationship.	<ul style="list-style-type: none"> • Bees and plants: The bees pollinate the flowers to help them reproduce and the flowers provide the bees with nectar. • Sea anemone and clownfish: The sea anemone protects the clownfish with its poisonous tentacles and the clownfish helps to lure in prey.
Predation	A predator feeds on its prey.	<ul style="list-style-type: none"> • Wolves and deer: Wolves hunt and eat deer. • Lion and zebra: Lions hunt and eat zebra.
Commensalism	One member of the relationship benefits and the other is neither helped nor harmed.	<ul style="list-style-type: none"> • Barnacles and whales: Barnacles don't help the whale, but they do benefit by the movement of water delivering food particles to them. • Cattle Egrets and Livestock: Cattle egrets follow cattle around and eat up the insects that get stirred up from vegetation as the cattle walks through it.

Elaborate

1. Now that students understand the relationships between organisms, they can use these interactions to identify cause and effect relationships in real ecosystems. This continues to build students' understanding of **Patterns**, as they use the patterns they have identified throughout the task to identify causal relationships within other real ecosystems.
2. Students should individually read each of the scenarios provided on their student guide and respond to the questions. Possible answers are provided below:
 - Question 1: The zebras are eating all the Red Grass, so many small animals don't have a home. In order to prevent their extinction, we could introduce more lions into the Savannah, which will hunt the zebras. This will lead to less zebra, more Red Grass, and more homes for the small animals.

7th Grade Science Unit 1: A Balanced Biosphere**Task 4: Interactions Between Organisms**

- Question 2: Since people are buying too many clownfish, there are not enough clownfish to help lure prey into the sea anemones, causing them to die out. We must restrict the number of clownfish able to be bought from the ocean or breed them in facilities. That way, there will be more clownfish to help lure prey to the sea anemones and keep them alive.
 - This can be a good option for formative assessment. Collect student work to identify trends in students' ability to use patterns of organism interactions to identify causal relationships in other ecosystems. See "How to Use This Curriculum" for strategies on utilizing formative assessment data to provide feedback to students and inform classroom instruction.
3. Return to the whole-class 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).
 - 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?
 - Draw circles around each question and boxes around each concept.
 - Write connector words to describe connections between the concept boxes.
 - For this task, students may begin to connect some of their previous question circles to concept boxes about the following: how organisms interact across different ecosystems.
 - 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:
 - **Patterns:** These could be phrases such as, "is the same as", "has in common with", "is similar to", "shares" 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 4 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: In your arena, you will be creating a challenge for your contestants, so the

7th Grade Science Unit 1: A Balanced Biosphere**Task 4: Interactions Between Organisms**

winner may win additional supplies. The challenge will be to locate a specific plant/animal by using information about another plant/animal. The contestants will use their knowledge of ecosystem interactions to connect the known plant/animal to the unknown plant/animal.

- Identify what plants and animals you will include in your arena.
 - Design this challenge by making a flowchart tracing one organism to another using at least two different organism interactions we have studied.
 - Explain how each plant/animal leads the contestant to the next plant/animal by describing the organism interactions.
3. Example contestant challenge: A contestant could be asked to start with a bee and in order to win, would end up at the cow. This is because the bee pollinates a plant as it eats its nectar (commensalism), and the plant is then eaten by a cow (predation).

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 brainstorm three ways you could imagine organisms interacting in an ecosystem. Look back at your brainstorm: after visiting all the stations today, how would you add to your brainstorm? What types of interactions were you missing?
 - In this task, we focused on the crosscutting concept of **Patterns**: patterns can be used to identify cause and effect relationships and provide information about natural systems. Where did you see examples of **Patterns** in this task?
 - Now that you have learned more about how organisms interact in an ecosystem, what questions do you still have?
2. 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

7th Grade Science Unit 1: A Balanced Biosphere**Task 4: Interactions Between Organisms**

- 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.

Station Cards

Explore

1. Wolves and Deer



Wolves hunt deer in Yellowstone, Wyoming.

2. Squirrels



Squirrels fight over an acorn in New England, USA.

3. Lion and Zebra



A lion hunts a zebra in the savannahs of Africa.

4. Mosquito and Human



A mosquito sucks blood from a human host in Italy.

5. Barnacles and Whale



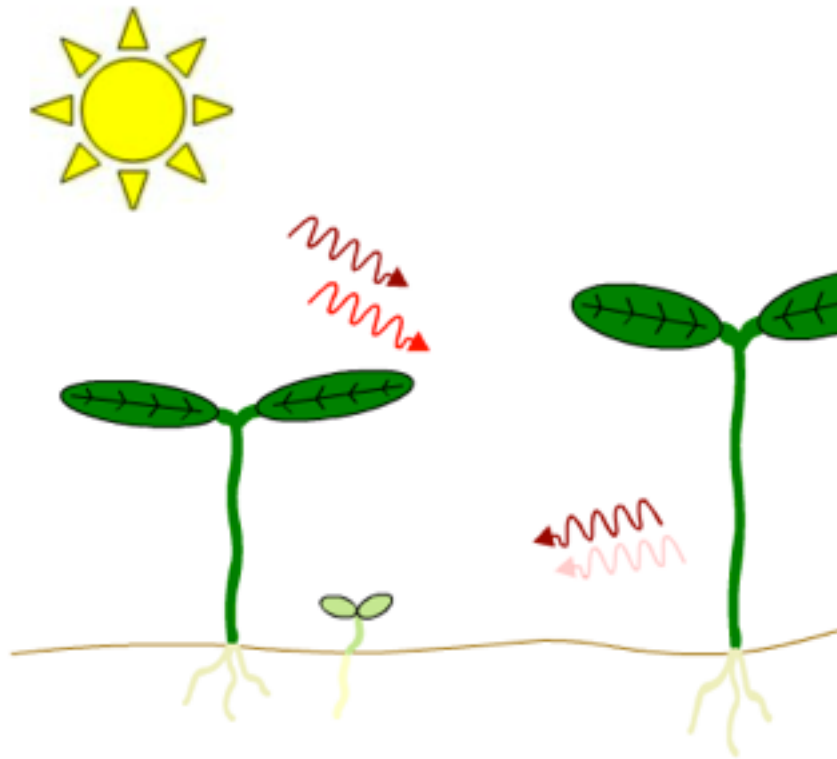
Barnacles attach to a whale in the ocean so they can eat the food particles that pass by them in the water.

**6. Clownfish and Sea Anemone
(Hint: think Finding Nemo)**



The sea anemone protects the clownfish with its stinging tentacles, while the clownfish lures in prey from the ocean.

7. Plants



Plants in the Amazon rainforest grow taller to get more access to sunlight.

8. Tick and Dog



Ticks feed off the blood of dogs.

9. Bees and Plants



Bees feed off the nectar of flowers, while delivering pollen to help the flower reproduce.

10. Cattle Egret and Cow



Cattle egrets follow cattle around and eat up the insects that the cows stir up from the grass.

Sources:

- <http://mrmitchellsbiology.weebly.com/symbiotic-relationships.html>
- <http://wolfwars-immy.blogspot.com/>
- <http://zaneandjackproject.weebly.com/short-term-relationships.html>
- <http://photobiology.info/Franklin-NLE.html>
- <http://www.buzzle.com/articles/examples-of-commensalism.html>
- <https://thegardendiaries.wordpress.com/2014/04/18/sex-in-the-garden/>

Interaction Cards

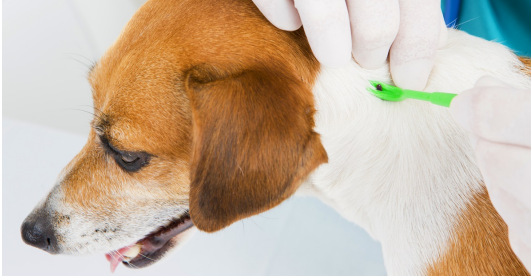
Explain



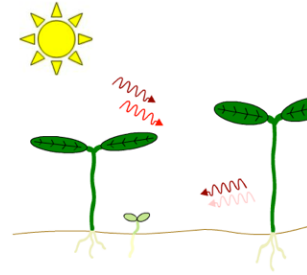
Cattle Egret and Cow



Bee and Plant



Dog and Tick



Plants



Clownfish and Sea Anemone



Barnacles and Whale



Mosquito and Human



Lion and Zebra



Wolf and Deer



Squirrels

7th Grade Science Unit 1: A Balanced Biosphere

Task 5: A Chain of Resources

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

Performance Expectations	Scientific and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<p>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.]</p>	<p>Analyzing and Interpreting Data</p> <ul style="list-style-type: none"> Analyze and interpret data to provide evidence for phenomena. 	<p>LS2.A: Interdependent Relationships in Ecosystems</p> <ul style="list-style-type: none"> 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 	<p>Cause and Effect</p> <ul style="list-style-type: none"> Cause and effect relationships may be used to predict phenomena in natural or designed systems.

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		reproduction. • Growth of organisms and population increases are limited by access to resources.	
Supplementary Science and Engineering Practices <ul style="list-style-type: none"> • Constructing Explanations <ul style="list-style-type: none"> ○ 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 <ul style="list-style-type: none"> • Systems and System Models <ul style="list-style-type: none"> ○ Models can be used to represent systems and their interactions—such as inputs, processes, and outputs—and matter flows within systems. 			
Equity and Groupwork <ul style="list-style-type: none"> • Discuss simulation observations with group members. • Come to consensus on a rule about resource availability and populations. 			
Language <ul style="list-style-type: none"> • 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

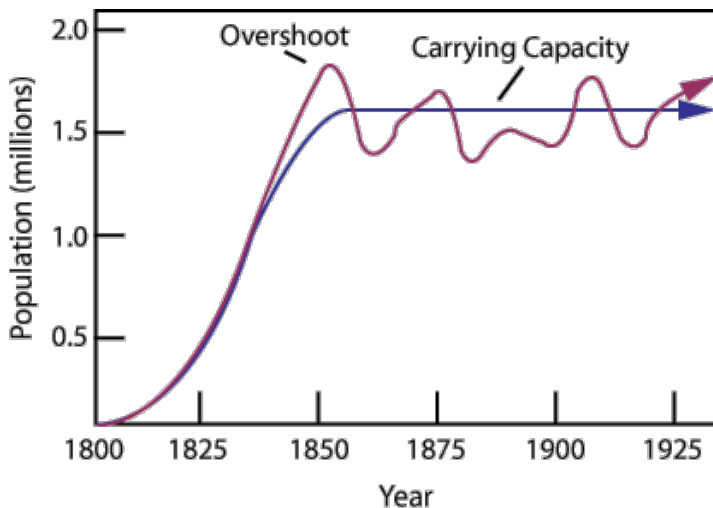


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more access to sunlight, the population of plants in that region will grow until access to sunlight runs out. If multiple organisms need the same resources, this will affect the population of those organisms, likely causing one of the species to decrease 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

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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.

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Task 5: A Chain of Resources

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**.
2. 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.
3. 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.
4. 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.

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Task 5: A Chain of Resources

Sample Student Data Collection Tables

Simulation 1

Organisms in Ecosystem	Observations
Plant A Plant B	<i>Plant B died out and Plant A increased in population.</i>
Plant B Plant C	<i>Plant C died out and Plant B increased in population.</i>

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)	<i>Plant B increases and then levels off. Plant A decreases and then levels off. The bunny population increases and then levels off.</i>

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.

2. 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.

3. 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.

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Simulation 3

Organisms in Ecosystem	Observations
Plant C Deer (Herbivore C who eats Plant C) Wolf (Top Predator who eats Deer)	<i>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.</i>
Plant C Deer (Herbivore C who eats Plant C)	<i>Plant C increased and then decreased to level off. The deer increased and decreased slightly, then leveled off.</i>

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.

2. 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 they use 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.

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

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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=hIU9NEcJyg>
 - 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).

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- i. 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?
 - ii. Draw circles around each question and boxes around each concept.
 - iii. Write connector words to describe connections between the concept boxes.
 - iv. 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:
 - i. **Cause and Effect.** These could be phrases such as, "which results in," "which causes," "that explains why," "is due to," etc.
 - ii. **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:

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- 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?
2. 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.