Segment Progression: The Distribution of Earth's Resources

Integrated Phenomenon: At Yasuni National Park, forests can be so dense they are difficult to walk through. But at Big Bend National Park, there are vast open stretches of dry land.

Segment Progression: In this integrated segment, students take a look at the distribution of Earth's resources. Students are introduced to the integrated phenomenon by comparing Yasuni National Park's dense forests to Big Bend National Park's vast open stretches of dry land. Students create a model of this phenomenon and revise it as they gain more knowledge. To understand the processes that distribute Earth's resources, students first investigate the movement of Earth's tectonic plates, including continental drift, mountain ranges, and creation of the supercontinent Pangaea. Students explore the rock cycle and water cycle. In the first Engineering Challenge, students build, test, and improve a solar distiller as they examine renewable and nonrenewable resources. Next, students find out about resources in living systems and observe interactions among organisms in various ecosystems. In the second Engineering Challenge, students build a sound shield to protect acoustic interactions of frog and bats from disruptive highway noise. Students discover how the many interactions within an ecosystem cause even small changes to lead to other large changes. Students predict states of matter and examine the motion of particles as they relate it to heat, temperature, and state changes. Last, students write a letter explaining the natural phenomena of states of matter. Using what they know, how will students explain why Earth's resources are unevenly distributed as in the cases of Yasuni's forests and Big Bend's desert?

Performance Expectations: MS-ESS2-1, MS-ESS2-2, MS-ESS2-3, MS-ESS2-4, MS-ESS3-1, MS-PS1-4, MS-PS1.A, MS-PS3.A, MS-LS2-1, MS-LS2-2, MS-LS2-4, MS-ETS1-1, MS-ETS1-4

3D Learning Sequence

Lesson *Phenomenon*	DCI	CCC	SEP	PE	Connection to Segment Phenomenon
Earth's Tectonic Plates *Fossils of plants that had broad, flat leaves are found in Antarctica.*	Students observe how fossil patterns of plant life in Antarctica do not match Antarctica's climate. Students use their understanding of plate tectonics and large-scale system interactions to explain this phenomenon. (ESS2.B) (ESS1.C)	Looking for patterns in rates of change, students record data on the distribution of fossils and rocks that support Wegener's Continental Drift hypothesis. Then students cut up and reassemble a world map into Pangea to see how Wegener analyzed evidence that supported his hypothesis.	Exploring how plate tectonic theory works, students develop and use models to construct a scientific explanation for how tectonic processes change Earth's surface.	MS-ESS2-2 MS-ESS2-3	Students find patterns in the distribution of fossils, mountain ranges, volcanoes, earthquakes, the shapes of continents, and seafloor structures. They create a model of the integrated phenomenon.

The Rock Cycle *Some rock types can be found in a community, but not others.*	Why are some rock types found in a community while others are not? Students answer this question by exploring Earth's materials and systems including finding out the ways rock form, identifying rocks, and modeling the rock cycle. (ESS2.A)	Exploring the ways rocks form, students describe and compare six rock forming processes by examining the changes over time and processes at different scales. Students then use a variety of tools to examine and classify 12 different types of rocks.	Students are challenged to evaluate a sample Rock Cycle diagram and then to develop and use their own improved model.	MS-ESS2-1	Since igneous, sedimentary, and metamorphic processes influence how rocks change over time, the distribution of volcanoes, water, high mountain peaks, and tectonic plate edges influence what type of rock forms across Earth. Rock can break down into sand due to factors like energy from the sun and gravity causing weathering and erosion. Due to the rock cycle, one National Park can change its features over time.
The Water Cycle *During the first week of January, New York was covered in four feet of snow, but by the end of May the streets were bare.*	Students consider how snow on the streets of New York disappears within months. To explain this phenomenon, students use their understanding of the roles of water in Earth's surface processes. (ESS2.C)	Understanding that the transfer of energy drives the cycling of matter, students develop a concept map to record their ideas of how water transfers from one place to another. Next, they observe processes of the water cycle, and use those processes to improve their concept map.	Students use a model when they work with a selection of models to show how energy drives the cycling of water in the water cycle.	MS-ESS2-4	Water evaporates when heat from the sun makes molecules move faster and collide. Water vapor condenses or crystallizes when it cools. Climate and terrain have a big impact on how much water is found in a specific area like a National Park. Terrain can impact how water pools since gravity pulls water downward.
Engineering Challenge *Build, test, and improve a solar distiller.*	Students build and improve a solar distiller and use data to explain the rates of evaporation, condensation, and precipitation of the water in the distiller as they conclude that a solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (ESS2.C) (ETS1.B)	Challenged by structure and function, students construct and test a solar distiller in order to evaluate the distiller performance. Students then work in teams to plan improvements to the solar distiller design using classroom materials.	Students retest their design, and then use data from the iterative testing to propose modifications and to test ideas about phenomena in designed systems such as the solar distiller.	MS-ESS2-4 MS-ETS1-4	Students get an opportunity to design a system that uses renewable natural resources.

Earth's Natural Resources *Every device contains parts that are made from natural resources.*	Which natural resources make up everyday items? Students ask questions about the different natural resources that are used to create various devices and objects. (ESS3.A)	In the game, Resource Roundup, students evaluate cause and effect relationships as they compete to predict the most likely locations of natural resources.	Using mathematics and computational thinking, students analyze patterns of data from the Resource Roundup game using a chart to describe the limited nature of natural resources.	MS-ESS3-1	Water availability is influenced by the amount of precipitation in the region as well as the type of rock, and the amount of human water use. The amount of soil is impacted by the rate of weathering in different locations, and soil fertility depends on the amount of minerals, nutrients, and water there. Where forests occur depends on climate, soil fertility, and human activities.
Performance Assessment	Students evaluate the natural resource needs of companies using their understanding of Earth's natural resources and how they are unevenly distributed across communities. Students then decide which company should move into their region.	Working on the Board of Natural Resource Development, students use cause and effect relationships to prepare an argument for or against company proposals to set up business in their region. In their arguments, students identify the presence or absence of natural resources in their region from map evidence.	Students construct an explanation of the geoscience processes that resulted in the formation of natural resources over time. Students use use what they know of the presence or absence of natural resources, and the geoscience processes, to support their arguments.	MS-ESS2-1 MS-ESS2-2 MS-ESS2-3 MS-ESS2-4 MS-ESS3-1	What patterns do scientists see across landforms on Planet Earth that support the idea that the continents have moved around? Do you think the rocks making up Earth's surface in one National Park change over time? What influences how much water is found in different National Parks? What influences whether forests grow in a National Park? Students should review their answers to these questions to summarize their findings and make revisions to their model of the integrated phenomenon.

Resources in Living Systems *Poison dart frogs kept in captivity lose their toxicity over time so they are no longer poisonous.*	After students observe how captive poison dart frogs lose their toxicity over time, students set up a simple model pond ecosystem and track resources needed by living things to show that organisms are dependent on their environmental interactions both with other living things and with nonliving factors. (LS2.A)	Students use patterns to predict how resource availability impacts species distribution by playing a game modeling resource needs.	Students use graphs to analyze and interpret data on how resources impact populations. Students then present case studies and make general statements about the relationship between resources and populations.	MS-LS2-1 MS-LS2-2	Living things need living and nonliving resources that provide food and water and meet needs for air and sunlight. The distribution of limited resources in an area determines what species can live there. Factors like the amount of fertile soil, the temperature, and the amount of rainfall really impact what resources are available, and what species live in an area.
Interactions Among Organisms *Acacia trees produce a nectar that does not help the tree itself, but is eaten by stinging ants that live on the tree.*	Students observe the close relationship between ants and acacia trees and, using their knowledge of interdependent relationships in ecosystems, explain the relationship between the two organisms. Students choreograph dances to represent the interactions between living things. Students then evaluate each performance to classify interactions. (LS2.A)	Examining patterns in predation, students act out the predator-prey relationship to determine why these populations cycle over time.	Students construct explanations and design solutions by focusing on an interaction between two organisms and researching that interaction using reliable resources.	MS-LS2-1 MS-LS2-2 MS-ETS1-1	In predation, one organism uses another as a food resource. In commensalism and parasitism, one organism uses another as a resource. In mutualism, two organisms use each other as a resource.
Engineering Challenge *Build a sound shield to protect acoustic interactions from highway noise.*	Students examine acoustic interactions between frogs and bats and then design a sound shield that preserves those interactions near a noisy highway, as they explore the influence of engineering, technology, and science on the natural world. (LS2.A)	Understanding how structures can be designed to serve particular functions, students create a sound shield using materials provided. Students test their design solution to see if it meets the criteria they chose.	Students ask questions and define a design problem that preserves the organisms' interactions and identify criteria and constraints. Students improve their sound shield designs after receiving more scientific information from a rainforest ecologist.	MS-ETS1-1	Students discover how scientists studied the details of frog-bat interactions in order to preserve an ecosystem and its populations.

Changing Ecosystems *Although the 1980 eruption of Mt. St. Helens destroyed all life near the eruption, the area is now covered in green and full of life.*	Students observe how ecosystems change over time by seeing how the area devoid of life around Mt. St. Helens from the eruption is now full of life. Students brainstorm different types of ecosystem changes due to ecosystems being dynamic in nature. (LS2.C)	Students track the impact of a biological and a physical change made to the model ecosystems as they explore how stability might be disturbed by sudden events.	Students assess three case studies, present their data analysis, and construct explanations for how changes impact populations while predicting ecosystem changes.	MS-LS2-4	Slow changes occur in predictable timelines with ecological succession. Sudden changes occur with major events like volcanoes or strong storms. Change in the living or nonliving resources in an ecosystem cause changes in the populations that depend on those resources.
Performance Assessment	As students observe captive cichlid behavior, they summarize how populations use resources, how species in interdependent relationships in ecosystems interact, and how ecosystems change over time. Students use this knowledge to find a solution to save the fish.	Understanding stability and change and cause and effect, students determine why an ecosystem change is causing some fish populations in a zoo to decline. Students figure out how to solve the problem by meeting the fishes' resource needs and present their solution at a conference.	Students analyze and interpret data on behavioral changes by examining graphs about the 12 species of cichlid fish in a shared tank. Students compare fish behavior before and after changing tanks.	MS-LS2-1 MS-LS2-2 MS-LS2-4	What determines which species can live in an area like a National Park? When is a living thing itself a resource that can impact the distribution of other living things? How does a change in an ecosystem's resources impact living things? Students should review their answers to these questions to summarize their findings and make revisions to their model of the integrated phenomenon.
The Motion of Particles *Drops of food coloring dissolve into water at very different rates depending on the temperature of the water.*	Students observe that drops of food coloring dissolve into water at very different rates depending on the temperature of the water. Students predict state changes as a result of pressure and temperature changes. (PS1.A)	Students analyze the cause and effect of pressure and temperature on particle motion.	Students describe macroscopic particle motion and temperature changes in a system and develop a model that predicts and describes changes in particle motion, temperature, and states of a pure substance under given conditions.	MS-PS1-4	Matter changes from solid to liquid to gas as it increases in temperature, although different substances change state at different temperatures. Water is liquid at room temperature, frozen at cold temperatures near the poles, and evaporates quickly in hot climates.

Heat, Temperature, and State Changes *In a warm room, water droplets form on a can of cold liquid.*	After observing how water droplets appear on a cold can of liquid in a warm room, students apply their understanding of the transference of energy due to temperature differences between two objects. (PS3.A)	Students deepen their understanding of cause and effect and how state changes occur as they differentiate between a substance's thermal energy and the heat it gains or loses while predicting the direction of heat flow between two objects.	Students develop a model that predicts and describes phenomena while allowing for qualitative comparison of thermal energy of two objects and the associated motions of particles as a result of the objects coming into contact with each other. Students also describe the macroscopic changes in a system in terms of heat, thermal energy, temperature, and thermal equilibrium.	MS-PS1-4	Gaining thermal energy causes an object to melt or evaporate. Losing thermal energy causes an object to condense or freeze. Since trees need water in liquid form to survive, they can only grow where liquid water is found. They need ice to melt, liquid not to completely evaporate, water vapor to condense, and liquid not to freeze.
Performance Assessment	Concluding that a substance's state of matter changes depending on the temperature and pressure of the environment it is in, students write a letter that explains the structure and properties of matter using the motion of particles and how thermal energy affects the state of matter.	Students write letters that describe the cause-and-effect relationships between melting and boiling points of dihydrogen monoxide (water) on our planet as well as the motions of the particles of water as a solid, liquid and gas.	Students develop a conceptual non-visual model in the form of a letter that describes components, their interactions, and their relation to the real world.	MS-PS1-4	How does temperature affect the state of matter? How does temperature affect water? Why would trees in a forest care if water melted, evaporated, condensed, or froze? Answering these questions helps students to summarize their findings and make the final revisions to their model. Students use their completed model to support their explanation of the integrated phenomenon.

Integrated Phenomenon:

At Yasuni National Park, forests can be so dense they are difficult to walk through. But at Big Bend National Park, there are vast open stretches of dry land.

Sample Explanation:

The distribution of resources such as rock, water, soil, and living things resulting from tectonic processes and climate differences is such that forests only grow in certain places on Earth. An abundance of fertile soil depends on the rate of weathering and the amount of minerals, nutrients, and water found there. Yasuni must be located in an area with more minerals, nutrients, water, and soil. Growing plants need water in order to survive. The climate in Yasuni must include more abundant precipitation. High temperatures can lead water to evaporate. When it's hot in Big Bend, what water is there will evaporate quickly, leaving little water for growing plants.