Environmental Science:

Interdependent Relationship in Ecosystems

<table>
<tr><th colspan="3">Stage 1 Desired Results</th></tr>
<tr><td rowspan="6">ESTABLISHED GOALS:

<u>Competencies:</u>
Cause & Effect Students will demonstrate the ability to investigate, explain, and evaluate potential causal relationships by using evidence to support claims and predictions about the mechanisms that drive those relationships.
Scale, Proportion, & Quantity Students will demonstrate the ability to describe and represent the significance of changes in observable and non-observable phenomena in terms of relative scale, proportion, and quantity.
Systems & System Models Students will demonstrate the ability to investigate and analyze a natural or human designed system in terms of its boundaries, inputs, outputs, interactions, and behaviors and use this information to develop a system model that can be used to understand and empirically evaluate the accuracy of models in terms of representing the underlying system.
Energy & Matter in Systems Students will demonstrate the ability to analyze evidence from a variety of sources (investigations, models) to predict, connect and/or evaluate the cycling of matter and flow of energy within and between systems in order to understand, describe, or predict possibilities and limitations of systems.
Students will demonstrate the ability to analyze and summarize text and integrate knowledge to make meaning of discipline-specific materials.
Students will demonstrate the ability to produce coherent and supported writing in order to communicate effectively for a range of discipline-specific tasks, purposes, and audiences.
Students will demonstrate the ability to speak purposefully and effectively by strategically making decisions about content, language use, and discourse style.</td><th colspan="2">Transfer</th></tr>
<tr><td colspan="2">Students will be able to independently use their learning to make informed ecological decisions based upon their knowledge of interdependent relationships in ecosystems.</td></tr>
<tr><th colspan="2">Meaning</th></tr>
<tr><td>ENDURING UNDERSTANDINGS
Students will understand that…
empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.
much of science deals with constructing explanations of how things change and how they remain stable.
change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible.
science knowledge indicates what can happen in natural systems—not what should happen. The latter involves ethics, values, and human decisions about the use of knowledge.
many decisions are not made using science alone, but rely on social and cultural contexts to resolve issues.
energy cannot be created or destroyed-it only moves between one place and another place, between objects and/ or fields, or between systems.</td><td>ESSENTIAL QUESTIONS
Is any ecosystem component more important than another?
Do the needs of humans supercede the needs of other species?</td></tr>
<tr><th colspan="2">Acquisition</th></tr>
<tr><td>Students will know…
that ecosystems have carrying capacities,</td><td>Students will be skilled at…
using mathematical and/or</td></tr>
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__Content Standards:__

- HS-LS2-1 Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
- HS-LS2-2 Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
- HS-LS2-6 Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
- HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity. • HS-LS2-8. Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.
- HS-LS4-6. Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.
- HS-ESS2-1. Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.
- HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedback that cause changes to other Earth systems.
- HS-ESS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.
- HS-ESS2-6. Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.
- HS-ESS2-4. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.
- HS-ESS3-5. Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.
- HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
- HS-ESS3-2. Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost benefit ratios.
- HS-ESS3-3. Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.
- HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
- HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those

which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms.would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem.

- that a complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability.
- that biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction).
- that Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes
- that the abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks.
- that the foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption,

computational representations.

- evaluating claims, evidence, and reasoning.
- designing, evaluating, and refining solutions.
- evaluating evidence.
- creating or revising a simulation to test a solution.
- developing and using models.
- analyzing data.
- planning and conducting investigations.
- constructing an explanation based on evidence.
- evaluating competing design solutions.
- creating a computational simulation.

relationships are being modified due to human activity.	storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space. ● that cyclical changes in the shape of Earth's orbit around the sun, together with changes in the tilt of the planet's axis of rotation, both occurring over hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on the earth. These phenomena cause a cycle of ice ages and other gradual climate changes. ● that the geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long term tectonic cycles. ● that the main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis. ● that the process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. ● that as matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. ● that the main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis. ● that the process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. ● that as matter and energy flow through different organizational levels of living systems, chemical elements are recombined	

	in different ways to form different products. ● that photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. ● that plants of algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a web web. Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved. ● that photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes. ● that energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. ● that at the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. ● that conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system.	

- that energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems.
- that uncontrolled systems always evolve toward more stable states—that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down).
- that although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment.
- that gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen.
- that the many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth's surface and the life that exists on it.

vocabulary:

ecology, community, ecosystem, biome, biosphere, distribution, range, species, primary producer, autotroph, primary consumer, heterotroph, herbivore, secondary consumer, carnivore, omnivore, detrivore, decomposer, tertiary consumer, trophic level, trophic pyramid, logistic growth, carrying capacity, ecological efficiency, predation, symbiosis, competition, GPP (gross Primary Production), NPP (Net Primary Production), evolution, adaption, natural selection, deciduous, coniferous, temperate deciduous forest, taiga (Boreal Coniferous Forest), tropical rainforest, savanna (tropical grassland), desert, alpine chaparral, tundra (polar grassland), deforestation, soil profile, soil horizon (O, A, B, C), soil particle (sand, silt, clay), weathering, leaching, infiltration, mature soil, fertile, acidity, alkalinity, nutrients, coriolis effect, convection cells, greenhouse gasses, volcanic activity, rain shadow, monsoon

Content Area Literacy Standards	21st Century Skills
• RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. • RST.11-12.2 Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. • RST.11-12.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text. • RST.11-12.5 Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas. • RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. • RST.11-12.9 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. • WHST.11-12.1 Write arguments focused on *discipline-specific content*. • WHST.11-12.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. • WHST.11-12.6 Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information. • WHST.11-12.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. • WHST.11-12.9 Draw evidence from informational texts to support analysis, reflection, and research.	• *use systems thinking* • *communicate clearly* • *collaborate with others*

Stage 2 - Evidence

Evaluative Criteria	*Assessment Evidence*
	PERFORMANCE TASK(S):
	OTHER EVIDENCE:

Stage 3 – Learning Plan

Summary of Key Learning Events and Instruction

Language Arts Integration	**_Mathematics Integration_**
• 1.OA.1 Use	• HSN-Q.A.1 - Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays • HSN-Q.A.2 - Define appropriate quantities for the purpose of descriptive modeling. • HSN-Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. • HSS-IC.A.1 - Understand statistics as a process for making inferences about population parameters based on a random sample from that population • HSS-IC.B.6 - Evaluate reports based on data. • HSS-ID.A.1 - Represent data with plots on the real number line (dot plots, histograms, and box plots) • MP.2 - Reason abstractly and quantitatively. • MP.4 - Model with mathematics.
Technology Integration	**_District Materials_**
• 1.OA.1 Use	
Science and Engineering Practices	
S&EP 2. Developing and using models S&EP 4. Analyzing and interpreting data S&EP 5. Using mathematics and computational thinking S&EP 6. Constructing explanations (for science) and designing solutions (for engineering) S&EP 7. Engaging in argument from evidence	