# Biology: Interdependent Relationship in Ecosystems

## Stage 1 Desired Results

ESTABLISHED GOALS:

*Competencies:*

- **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.
- **Nature of Science:** Student will demonstrate the ability to work collaboratively and individually to generate testable questions or define problems, plan and conduct investigations using a variety of research methods in a various settings, analyze and interpret data, reason with evidence to construct explanations in light of existing theory and previous research, and effectively communicate the research processes and conclusions.
- ***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.***

*Content Standards:*

• HS-LS2-1 Use mathematical and/or computational

### *Transfer*

*Students will be able to independently use their learning to* ***make informed ecological decisions based upon their knowledge of interdependent relationships in ecosystems.***

### *Meaning*

ENDURING UNDERSTANDINGS

*Students will understand that…*

• empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

• the significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.

• 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.

• when investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.

• 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.

• algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g. linear growth vs. exponential growth)

ESSENTIAL QUESTIONS

• *Is there ever really an ecosystem in balance?* • *Do the needs of humans supercede the needs of other species?*

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-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks 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 relationships are being modified due to human activity.

## ***Acquisition***

*Students will know…*

- that ecosystems have carrying capacities, 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, moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species.
- that biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction).
- that humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation,

*Students will be skilled at…*

- using mathematical and/or computational representations.
- evaluating claims, evidence, and reasoning.
- designing, evaluating, and refining a solution.
- creating or revising a simulation to test a solution.
- developing and using models.
- analyzing data.
- planning and conducting an investigation.
- constructing an explanation based on evidence.
- creating a computational simulation to illustrate relationships.

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| | habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value.<br>• that when evaluating solutions it is important to take into account a range of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts.<br>• that Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes.<br>• that changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate.<br>• that the foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space.<br>• that, though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts.<br>• that current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of human generated greenhouse gasses added to the atmosphere each year and by the ways in which these gasses are absorbed by the ocean and biosphere.<br>that all forms of energy production and other resource extraction have associated economic, | |

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| | social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors.<br>• that the sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. • that scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation.<br>• that through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities.<br>• that when evaluating solutions it is important to take into account a range of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts.<br>• that plants or 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 food 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.<br>• 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. | |

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| | *<u>vocabulary:</u>* biotic, abiotic, biomes (list all), energy flow, trophic levels, food web,food chain, ecological pyramids, evaporation, atmosphere, precipitation, condensation, evapotranspiration, ground water, aquifer, runoff, combustion, Photosynthesis, Cell respiration, fossil fuels, decomposition, nitrogen fixing bacteria, ammonia, denitrification, nitrate, geologic upthrust, organism, population, community, ecosystem, biosphere, predator, prey, host, parasitism, mutualism, commensalism, symbiosis, carrying capacity, exponential, logistic, biogeochemical cycle, competitive exclusion principle, niche, habitat, biodiversity, limiting growth factors, anthropogenic, biodiversity, extinction, speciation, carbon cycle, nitrogen cycle, hydrologic cycle, greenhouse gas, albedo, global warming/ climate change, ocean acidification, sustainability, natural resource, ecosystem services, pollution. | |

| *Content Area Literacy Standards* | *21st Century Skills* |
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| • RST.9-10.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.<br>• RST.9-10.2 Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.<br>• RST.9-10.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.<br>• RST.9-10.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.<br>• RST.9-10.5 Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).<br>• RST.9-10.7 Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.<br>• RST.9-10.8 Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.<br>• RST.9-10.9 Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.<br>• WHST.9-10.1 Write arguments focused on discipline-specific content.<br>• WHST.9-10.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.<br>• WHST.9-10.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.<br>• WHST.9-10.6 Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically. • WHST.9-10.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.<br>• WHST.9-10.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.<br>• WHST.9-10.9 Draw evidence from informational texts to support analysis, reflection, and research. | • *collaborative with others*<br>• *make judgements and decisions*<br>• *solve problems*<br>• *communicate clearly*<br>• *implement innovations* |

| Stage 2 - Evidence | |
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| *Evaluative Criteria* | *Assessment Evidence* |
| | PERFORMANCE TASK(S): |
| | OTHER EVIDENCE: |

| Stage 3 – Learning Plan | |
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| *Summary of Key Learning Events and Instruction* | |
| • Language Arts Integration | *Mathematics Integration* |
| • | • 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<br>• 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.<br>• HSS-IC.A.1 - Understand statistics as a process for making inferences about population parameters based on a random sample from that population<br>• HSS-IC.B.6 - Evaluate reports based on data.<br>• 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.<br>• MP.4 - Model with mathematics. |
| *Technology Integration* | *District Materials* |
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| *Science and Engineering Practices* | |
| S&EP 2. Developing and using models<br>S&EP 4. Analyzing and interpreting data<br>S&EP 5. Using mathematics and computational thinking<br>S&EP 6. Constructing explanations (for science) and designing solutions (for engineering)<br>S&EP 7. Engaging in argument from evidence<br>S&EP 8. Obtaining, evaluating, and communicating information | |