*Unit 2 - Interdependent Relationships in Ecosystems

Content Area: **Science**
Course(s): **Biology CP, Biology Honors, STEM Biology Honors**
Time Period: **September**
Length: **~8 - 10 Blocks**
Status: **Published**

Unit Summary

In this unit of study, students formulate answers to the question "how and why do organisms interact with each other (biotic factors) and their environment (abiotic factors), and what affects these interactions?" Secondary ideas include the interdependent relationships in ecosystems; dynamics of ecosystems; and functioning, resilience, and social interactions, including group behavior. Students use mathematical reasoning and models to make sense of carrying capacity, factors affecting biodiversity and populations, the cycling of matter and flow of energy through systems. The crosscutting concepts of scale, proportion, and quantity and stability and change are called out as organizing concepts for the disciplinary core ideas. Students are expected to use mathematical reasoning and models to demonstrate proficiency with the disciplinary core ideas.

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Enduring Understandings

Earths living and nonliving parts interact and affect the survival of organisms.

Essential Questions

- How does the movement of energy through a food web differ from the movement of nutrients through a food web?
- How many organisms can an ecosystem support?
- Why might the interactions that exist in an ecosystem change?
- How do Earth's systems and life on earth affect one another?

Student Learning Objectives (PE, SEP, DCI, CCC) & Aligned Standards

Performance Expecations

Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales. *[Clarification Statement: Emphasis is on quantitative analysis and comparison of the relationships among interdependent factors including boundaries, resources,*

climate and competition. Examples of mathematical comparisons could include graphs, charts, histograms, and population changes gathered from simulations or historical data sets.] [Assessment Boundary: Assessment does not include deriving mathematical equations to make comparisons.] **(HS-LS2-1)**

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. *[Clarification Statement: Examples of changes in ecosystem conditions could include modest biological or physical changes, such as moderate hunting or a seasonal flood; and extreme changes, such as volcanic eruption or sea level rise.]* **(HS-LS2-6)**

Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth. *[Clarification Statement: Emphasis is on the dynamic causes, effects, and feedbacks between the biosphere and Earth's other systems, whereby geoscience factors control the evolution of life, which in turn continuously alters Earth's surface. Examples include how photosynthetic life altered the atmosphere through the production of oxygen, which in turn increased weathering rates and allowed for the evolution of animal life; how microbial life on land increased the formation of soil, which in turn allowed for the evolution of land plants; or how the evolution of corals created reefs that altered patterns of erosion and deposition along coastlines and provided habitats for the evolution of new life forms.] [Assessment Boundary: Assessment does not include a comprehensive understanding of the mechanisms of how the biosphere interacts with all of Earth's other systems.]* **(HS-ESS2-7)**

Science and Engineering Practices

Using Mathematics and Computational Thinking

- Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. Use mathematical and/or computational representations of phenomena or design solutions to support explanations. (HSLS2-1)
- Create or revise a simulation of a phenomenon, designedUse mathematical and/or computational representations of phenomena or design solutions to support explanations. (HS-LS2-1)

Engaging in Argument from Evidence

- Engaging in argument from evidence in 9–12 builds from K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.
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  Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to

determine the merits of arguments. (HS-LS2-6)

- Construct an oral and written argument or counter-arguments based on data and evidence.

Asking Questions and Defining Problems

1. Analyze complex real-world problems by specifying criteria and constraints for successful solutions. (HS-ETS1-1)

Disciplinary Core Ideas

LS2.A: Interdependent Relationships in Ecosystems

- 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. (HS-LS2-1)

LS2.C: Ecosystem Dynamics, Functioning, and Resilience

- 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. (HS-LS2-2),(HS-LS2-6)

ESS3.C: Human Impacts on Earth Systems

- The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. (HS-ESS3-3)

ESS2.D: Weather and Climate

Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS - ESS2-D).

ESS2.E Biogeology

The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual coevolution of Earth's surface and the life that exists on it. (ESSS2. E)

Crosscutting Concepts

Scale, Proportion, and Quantity

- The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (HS-LS2-1)

Stability and Change

- Much of science deals with constructing explanations of how things change and how they remain stable. (HS-LS2-6)

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Concepts & Formative Assessment

Interdependent Relationships

Part A: How do Earthś living and nonliving parts interact and affect the survival of organisms?

Concepts

- Ecosystems have carrying capacities, which are limits to the number 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, completion, 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 (the number of individuals) of species in any given ecosystem.
- The significance of carrying capacity in ecosystems is dependent on the scale proportion and quantity at which it occurs.
- Quantitative analysis can be used to compare and determine relationships among interdependent factors that affect the carrying capacity of ecosystems at different scales.

Formative Assessment

Students who understand the concepts are able to:

- Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.

- Use quantitative analysis to compare relationships among interdependent factors and represent their effects on the carrying capacity of ecosystems at different scales.

Part B: ***What limits the number and types of different organisms that live in one place?***

Concepts

- Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence.
- Ecosystems have carrying capacities, which are limits to the number 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, completion, 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
- 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.
- Using the concept of orders of magnitude allows one to understand how a model of factors affecting biodiversity and populations in ecosystems at one scale relates to a model at another scale.

Formative Assessment

Students who understand the concepts are able to:

- Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
- Use the concept of orders of magnitude to represent how factors affecting biodiversity and populations in ecosystems at one scale relate to those factors at another scale.

Resources

Bunny Population Growth Activity: Students collect data during a simulation and use it to support their explanation of natural selection in a rabbit population and how populations change over time when biotic or abiotic factors change.

African Lions Activity: Students using the data presented to make a prediction regarding the zebra population during the periods of increase rainfall. Students will create a representation of the data that illustrates both the lion population and zebra population during the same time period.

Animal Behavior: Students will make detailed observations of an organism's behavior and then design and

execute a controlled experiment to test a hypothesis about a specific case of animal behavior. Students will record observations, make sketches, collect and analyze data, make conclusions, and prepare a formal report.

One For All: A Natural Resources Game: Identify a strategy that would produce a sustainable use of resources in a simulation game. Draw parallels between the chips used in the game and renewable resources upon which people depend. Draw parallels between the actions of participants in the game and the actions of people or governments in real-world situations.

https://www.nextgenscience.org/

Suggested Assessments

- Use data or simulation to model the effects of abiotic or biotic factors on population growth
- Use data or simulation to model the effects of declining biodiversity in an ecosystem's response to a disturbance. (Let students model stability and resilience or lack thereof)
- Use data or simulation to show ecosystem response in relationship to minor vs. major disturbance
- Vocabulary Assessment and Application of Vocabulary
- Performance Task - Argumentative Prompt

Connecting with English Language Arts Literacy and Mathematics

Connections to English Language Arts/Literacy-

- Cite specific textual evidence to support analysis of science and technical texts supporting explanations of factors that affect carrying capacity of ecosystems at different scales, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
- Develop and write explanations of factors that affect carrying capacity of ecosystems at different scales by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.
- Cite specific textual evidence to support how factors affect biodiversity and populations in ecosystems of different scale, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
- Write explanatory texts based on scientific procedures/experiments to explain how different factors affect biodiversity and populations in ecosystems at different scales.
- Assess the extent to which the claim that complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem, is supported by reasoning and evidence.
- Cite specific textual evidence to support claims that complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
- Integrate and evaluate multiple sources of information presented in diverse formats and media in order to address claims that complex interactions in ecosystems maintain relatively consistent numbers and

types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
- Evaluate the validity of evidence and reasoning that support claims that complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

Connections to Mathematics-

- Represent the factors that affect carrying capacity of ecosystems at different scales symbolically and manipulate the representing symbols. Make sense of quantities and relationships between different factors that affect carrying capacity of ecosystems at different scales.
- Use a mathematical model to describe factors that affect carrying capacity of ecosystems at different scales. Identify important quantities in factors that affect carrying capacity of ecosystems at different scales and map their relationships using tools. Analyze those relationships mathematically to draw conclusions, reflecting on the results and improving the model if it has not served its purpose.
- Use units as a way to understand how factors affect the carrying capacity of ecosystems at different scales. Choose and interpret units consistently in formulas to determine carrying capacity. Choose and interpret the scale and origin in graphs and data displays showing factors that affect carrying capacity of ecosystems at different scales.
- Define appropriate quantities for the purpose of descriptive modeling of factors that affect carrying capacity of ecosystems at different scales.
- Choose a level of accuracy appropriate to limitations on measurement when reporting quantities representing factors that affect carrying capacity of ecosystems at different scales.

Modifications

Teacher Note: Teachers identify the modifications that they will use in the unit. The unneeded modifications can then be deleted from the list.

- Restructure lesson using UDL principals (http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA)
- Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community.
- Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling).
- Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies).
- Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences).
- Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings.
- Use project-based science learning to connect science with observable phenomena.

- Structure the learning around explaining or solving a social or community-based issue.
- Provide ELL students with multiple literacy strategies.
- Collaborate with after-school programs or clubs to extend learning opportunities.

Research on Student Learning

Most high school students seem to know that some kind of cyclical process takes place in ecosystems. Some students see only chains of events and pay little attention to the matter involved in processes such as plant growth or animals eating plants. They think the processes involve creating and destroying matter rather than transforming it from one substance to another. Other students recognize one form of recycling through soil minerals but fail to incorporate water, oxygen, and carbon dioxide into matter cycles. Even after specially designed instruction, students cling to their misinterpretations. Instruction that traces matter through the ecosystem as a basic pattern of thinking may help correct these difficulties (NSDL, 2015).

References

Adapted from the New Jesery NGSS Science Model Curriclum

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Connections to NJSLS

English Language Arts

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.11-12.1** (HS-LS2-1),(HS-LS2-2),(HS-LS2-6)

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.11-12.7**(HS-LS2-6)

Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. **RST.11-12.8** (HS-LS2-6)

Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. **WHST.9-12.2** (HS-LS2-1),(HS-LS2-2)

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. **RST.11-12.9** (HS-ETS1-3).

Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. WHST.9-12.5 (HSLS4-6).

Mathematics

Reason abstractly and quantitatively. **MP.2** (HS-LS2-1),(HS-LS2-2),(HS-LS2-6)

Model with mathematics. **MP.4 (**HS-LS2-1),(HS-LS2-2)

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.1** (HS-LS2-1),(HS-LS2-2)

Define appropriate quantities for the purpose of descriptive modeling. **HSN.Q.A.2** (HS-LS2-1),(HS-LS2-2)

Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. **HSN.Q.A.3** (HS-LS2-1),(HS-LS2-2)

Represent data with plots on the real number line. HSS-ID.A.1 (HS-LS2-6)

Understand statistics as a process for making inferences about population parameters based on a random sample from that population. **HSS-IC.A.1** (HS-LS2-6)