**Biology Curriculum Revision**

**Semester 1**

**LS2: Ecosystems: Interactions, Energy, and Dynamics**

***How and why do organisms interact with their environments and what are the effects of these interactions?***

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| **LS2.A: Interdependent Relationships in Ecosystems**  ***Essential Question: How do organisms interact with the living and nonliving environments to obtain matter and energy?***  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),(HS- LS2-2)  **LS2.B: Cycles of Matter and Energy Transfer in Ecosystems**  ***Essential Question: How do matter and energy move through an ecosystem?***  Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. (HS-LS2-3)  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. (HS-LS2-4)  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. (HS-LS2-5)  **LS2.C: Ecosystem Dynamics, Functioning, and Resilience**  ***Essential Question: what happens to ecosystems when the environment changes?***  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)  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. (HS-LS2-7)  **LS4.D: Biodiversity and Humans**  ***Essential Question: What is biodiversity, how do humans affect it, and how does it affect humans?***  Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). *(secondary to HS- LS2-7)*  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, 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. *(secondary to HS-LS2-7) (Note: This Disciplinary Core Idea is also addressed by HS-LS4-6.)*  **PS3.D: Energy in Chemical Processes**  ***Essential Question: How do food and fuel provide energy? If energy is conserved, why do people say it is produced or used?***  The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis. *(secondary to HS-LS2-5)*  **ETS1.B: Developing Possible Solutions**  ***Essential Question: What is the process for developing potential design solutions?***  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. *(secondary to HS-LS2-7)* | | | | | | |
| **Topics** | **Performance Expectation** | **Disciplinary Core Ideas** | **Science & Engineering Practice** | **Crosscutting Concepts** | **General Biology Resources, Explanation & Links** | **HONORS Resources, Explanation & Links**  **Honors Biology will meet or exceed the Assessment Boundary** |
| Population  Carrying capacity  Competition Histograms  Exponential growth  Logistical growth  Density- dependent limiting factors  Density- independent limiting factors  Immigration  Emigration | **LS2-1**  Use mathematical  and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.  ***Assessment Boundary: Assessment does not include deriving mathematical equations to make comparisons.*** | **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 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. | **Using Mathematics and Computational Thinking Mathematical**  Use mathematical and/or computational representations of phenomena or design solutions to support explanations. | **Scale, Proportion, and Quantity**  The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. | Biology textbook: 14.4  Give students a set of data with predator numbers and prey numbers and have them graph and compare numbers.  Bring in a fish and wildlife expert to talk about the benefits of hunting to our ecosystem here in Nevada.  Youth Wildlife Conservation Experience field trip.  Students should construct a histogram of a given set of data and interpret trends. | Calculate population size  Collect and graph data for different species. Interpret this data and hypothesize reasons for data.  Interpret human population histogram and analyze reasons for the data. |
| Averages  Trends  Graphical comparisons  Primary succession  Secondary succession | **LS2-2**  Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.  ***Assessment Boundary: Assessment is limited to provided data.*** | **LS2.A: Interdependent Relationships in Ecosystems**  [Ecosystems have carrying capacities,](http://www.nap.edu/openbook.php?record_id=13165&amp;page=150) [which are limits to the numbers of](http://www.nap.edu/openbook.php?record_id=13165&amp;page=150) [organisms and populations they can](http://www.nap.edu/openbook.php?record_id=13165&amp;page=150) [support. These limits result from such](http://www.nap.edu/openbook.php?record_id=13165&amp;page=150) [factors as the availability of living and](http://www.nap.edu/openbook.php?record_id=13165&amp;page=150) [nonliving resources and from such](http://www.nap.edu/openbook.php?record_id=13165&amp;page=150) [challenges such as predation,](http://www.nap.edu/openbook.php?record_id=13165&amp;page=150) [competition, and disease. Organisms](http://www.nap.edu/openbook.php?record_id=13165&amp;page=150) [would have the capacity to produce](http://www.nap.edu/openbook.php?record_id=13165&amp;page=150) [populations of great size were it not](http://www.nap.edu/openbook.php?record_id=13165&amp;page=150) [for the fact that environments and](http://www.nap.edu/openbook.php?record_id=13165&amp;page=150) [resources are finite. This fundamental](http://www.nap.edu/openbook.php?record_id=13165&amp;page=150) [tension affects the abundance](http://www.nap.edu/openbook.php?record_id=13165&amp;page=150) [(number of individuals) of species in](http://www.nap.edu/openbook.php?record_id=13165&amp;page=150) [any given ecosystem. (HS-LS2-1), (HS-LS2-2)](http://www.nap.edu/openbook.php?record_id=13165&amp;page=150)  **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) | **Using Mathematics and Computational Thinking**  Use mathematical representations of phenomena or design solutions to support and revise explanations. | **Scale, Proportion, and Quantity**  Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale | Conduct an investigation using sampling techniques to gather data availability, precipitations, climate- determine the biotic relationships.  Introduce a disturbance and discuss hypothetical changes in this ecosystem. | Utilizing several set of data for different species, food availability, precipitations, climate- determine the biotic relationships.  Introduce a disturbance and discuss hypothetical changes in this ecosystem. |
| Carbon cycle  Aerobic and anaerobic respiration  Chemosynthesis | **LS2-3**  Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.  ***Assessment Boundary: Assessment does not include the specific chemical processes of either aerobic or anaerobic respiration.*** | **LS2.B: Cycles of Matter and Energy Transfer in Ecosystems** [Photosynthesis and cellular](http://www.nap.edu/openbook.php?record_id=13165&amp;page=152) [respiration (including anaerobic](http://www.nap.edu/openbook.php?record_id=13165&amp;page=152) [processes) provide most of the](http://www.nap.edu/openbook.php?record_id=13165&amp;page=152) [energy for life processes. (HS-LS2-3)](http://www.nap.edu/openbook.php?record_id=13165&amp;page=152) | **Constructing Explanations and designing solutions** Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students investigations, models, theories, simulations, peer review) 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. | **Energy and Matter**  Energy drives the cycling of matter within and between systems. | Biology book: 13.5, 4.4, 4.6  Conduct an investigation in which students weigh soil before growing a plant and then weigh soil after to show that carbon from the atmosphere is where the mass of the plant comes from.  Chemosynthesis?  Fermentation? | Describe/diagram the difference between fermentation and cellular respiration (difference between aerobic and anaerobic respiration). |
| Producer Autotroph Consumer Heterotrophs Food web Tropic level  Hydrologic cycle  Biogeo-  chemical cycle  Energy pyramid  Biomass | **LS2-4**  Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.  ***Assessment Boundary: Assessment is limited to proportional reasoning to describe the cycling of matter and flow of energy.*** | **LS2.B: Cycles of Matter and Energy Transfer in Ecosystems**  [Plants or algae form the lowest level](http://www.nap.edu/openbook.php?record_id=13165&amp;page=152) [of the food web. At each link upward](http://www.nap.edu/openbook.php?record_id=13165&amp;page=152) [in a food web, only a small fraction of](http://www.nap.edu/openbook.php?record_id=13165&amp;page=152) [the matter consumed at the lower](http://www.nap.edu/openbook.php?record_id=13165&amp;page=152) [level is transferred upward, to](http://www.nap.edu/openbook.php?record_id=13165&amp;page=152) [produce growth and release energy in](http://www.nap.edu/openbook.php?record_id=13165&amp;page=152) [cellular respiration at the higher level.](http://www.nap.edu/openbook.php?record_id=13165&amp;page=152) [Given this inefficiency, there are](http://www.nap.edu/openbook.php?record_id=13165&amp;page=152) [generally fewer organisms at higher](http://www.nap.edu/openbook.php?record_id=13165&amp;page=152) [levels of a food web. Some matter](http://www.nap.edu/openbook.php?record_id=13165&amp;page=152) [reacts to release energy for life](http://www.nap.edu/openbook.php?record_id=13165&amp;page=152) [functions, some matter is stored in](http://www.nap.edu/openbook.php?record_id=13165&amp;page=152) [newly made structures, and much is](http://www.nap.edu/openbook.php?record_id=13165&amp;page=152) [discarded. The chemical elements](http://www.nap.edu/openbook.php?record_id=13165&amp;page=152) [that make up the molecules of](http://www.nap.edu/openbook.php?record_id=13165&amp;page=152) [organisms pass through food webs](http://www.nap.edu/openbook.php?record_id=13165&amp;page=152) [and into and out of the atmosphere](http://www.nap.edu/openbook.php?record_id=13165&amp;page=152) [and soil, and they are combined and](http://www.nap.edu/openbook.php?record_id=13165&amp;page=152) [recombined in different ways. At each](http://www.nap.edu/openbook.php?record_id=13165&amp;page=152) [link in an ecosystem, matter and](http://www.nap.edu/openbook.php?record_id=13165&amp;page=152) [energy are conserved. (HS-LS2-4)](http://www.nap.edu/openbook.php?record_id=13165&amp;page=152) | **Using Mathematics and Computational Thinking:** Use mathematical representations of phenomena or design solutions to support claims | **Energy and Matter:** Energy cannot be created or destroyed-it only moves between one place and another place, between objects and/or fields, or between systems | Biology book: 13.3, 13.4, 13.5, 13.6  Watch “fast food chain” video found on YouTube and diagram the food chain represented.  Popcorn pyramid activity - search on google - should be scaled up for high school and for honors. Maybe add a writing component.  Write the life story from the perspective of one of the four main molecules of a biogeochemical cycles.  Food web activity: [http://www.riverventure.org/charlest](http://www.riverventure.org/charleston/resources/pdf/food%20web%20game.pdf)  [on/resources/pdf/food%20web%20](http://www.riverventure.org/charleston/resources/pdf/food%20web%20game.pdf)  [game.pdf](http://www.riverventure.org/charleston/resources/pdf/food%20web%20game.pdf) | Mathematically calculate the energy flow from producers to higher levels |
| Photosynthesis  Cellular respiration  Carbon cycle | **LS2-5**  Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.  ***Assessment Boundary: Assessment does not include the specific chemical steps of photosynthesis and respiration.*** | **LS2.B: Cycles of Matter and Energy Transfer in Ecosystems** 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. (HS-LS2-5)  **PS3.D: Energy in the Chemical Processes**  The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis. *(secondary to HS-LS2-5)* | **Developing and Using Models:** Develop a model based on evidence to illustrate the relationships between systems or components of a system | **Systems and System Models:** Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions- including energy, matter, and information flows- within and between systems at different scales | Conduct an investigation using a plant with a consumer (snail) and a control group (just plant) to show the interaction between photosynthesis and cellular respiration. (bottle biology)  Biology book: 13.5, 4.2, 4.4 | Determine the specific chemical steps of photosynthesis and respiration  Given differing levels of oxygen at different lake levels, calculate primary productivity. Relate primary productivity to the trophic levels. |
| Symbiosis  Predation  Keystone species | **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.  ***No Assessment Boundary*** | **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) | **Engaging in Argument from Evidence** Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. | **Stability and Change**  Much of science deals with constructing explanations of how things change and how they remain stable. | Chapters 14.1-14.2  Grow plants in different makeshift environments in the classroom to compare how different climates support growth of different types of plants.  "Limiting nutrients for algae" lab from textbook |  |
| Biodiversity  Limiting factors  Human impact  Greenhouse effect | **LS2-7**  Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.  ***No Assessment Boundary*** | **LS2.C: Ecosystem Dynamics, Functioning, and Resilience** 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. (HS-LS2-7)  **LS4.D: Biodiversity and Humans** Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). *(secondary to HS-LS2-7)* 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, 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. *(secondary to HS-LS2-7),(HS-LS4-6.)*  **ETS1.B: Developing Possible Solutions**  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. *(secondary to HS-LS2-7),(secondary to HS-LS4-6)* Both physical models and computers can be used in various ways to aid in the engineering design process.  Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. *(secondary to HS-LS4-6)* | **Constructing Explanations and Designing Solutions** Design, evaluate, and refine a solution to a complex real- world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations | **Stability and Change** Much of science deals with constructing explanations of how things change and how they remain stable | myfootprint.org Have students take quiz and discuss how many Earths it would take if everyone lived like them.  6 Degrees Could Change The World Video: <http://youtu.be/R_pb1G2wIoA>  Investigate local invasive species such as tall white top.  Chapter 16 |  |

Access to standards online that show connects to Clarification Statements, CCSS ELA and Math:

<http://www.nextgenscience.org/hsls2-ecosystems-interactions-energy-dynamics>

A framework for K-12 Science Education:

Life Science overview begins on page 139 and goes to 142

[http://www.nap.edu/openbook.php?record\_id=13165&page=139](http://www.nap.edu/openbook.php?record_id=13165&amp;page=139)

For LS2 – Ecosystems: Interactions, Energy, and Dynamics, it begins on page 150 and goes 157 [**http://www.nap.edu/openbook.php?record\_id=13165&page=150**](http://www.nap.edu/openbook.php?record_id=13165&page=150)