HIGH SCHOOL LIFE SCIENCE: ECOSYSTEMS AND CHANGE

Standards Bundle

Standards are listed within the bundle. Bundles are created with potential instructional use in mind, based upon potential for related phenomena that can be used throughout a unit.

HS-LS2-1 Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales. (SEP: 5; DCI: LS2.A; CCC: Scale/Prop.) [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-LS2-6 Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms under stable conditions; however, moderate to extreme fluctuations in conditions may result in new ecosystems. (SEP: 7; DCI: LS2.C; CCC: Stability/Change) [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-LS4-5 Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species. (SEP: 7; DCI: LS4.C; CCC: Cause/Effect) [Clarification Statement: Emphasis is on determining cause and effect relationships for how changes to the environment such as deforestation, fishing, application of fertilizers, drought, flood, and the rate of change of the environment affect distribution or disappearance of traits in species.]

Content Overview

This section provides a generic overview of the content or disciplinary core ideas as an entry point to the standards.

This standards bundle will utilize mathematical and/or computational models to represent the changes in both numbers and types of organisms in an ecosystem because the real process may take too much time. Students should be able to explain those changes at both small (e.g. a pond or plot) and large (e.g. ocean or ecosystem). Those explanations must take into consideration the validity of those claims and evidence, and should include the many interactions that are present in ecosystems. Students must also be able to make predictions as to the degree of change in numbers and kinds of factors within the environment . Using the same line of supporting evidence, students should be able to explain how a population may increase, go extinct, or evolve into an entirely new species.

Phenomena

Phenomena can be used at varying levels of instruction. One could be used to anchor an entire unit, while another might be more supplemental for anchoring just a unit. Please remember that phenomena should allow students to engage in the SEP and use the CCC/DCI to understand and explain the phenomenon.

- Zebra mussels data showing numbers and location in South Dakota waterways

- Select cut forests have less uncontrolled forest fires
- Reintroduction of the black footed ferret in western South Dakota
- Lead shot is being replaced with steel shot
- Photos of birds poisoned from lead.
- The state's buffalo herd is annually culled
- A shift in the color of peppered moths in the industrial era from light to dark in England.
- The wolf population increases with the rising deer population.
- Deer population numbers and disease rates
- A graph of fluctuating pheasant populations in South Dakota.
- Photos of endangered species in South Dakota (e.g. Dakota Skipper, Pallid sturgeon, Topeka shiner, Whooping crane)
- List of endangered or threatened species in South Dakota (from SD Game Fish and Parks)
- Grey wolf numbers in Yellowstone National Park and beaver colony numbers
- Map of jumping carp citings
- Map of zebra mussel locations in South Dakota and surrounding states
- Cutthroat trout story in the Black Hills
- Photos of a natural prairie vs a recently tilled field
- Buffalo numbers over time in the Great Plains
- Hunting regulations for pheasant
- Chart of feeding frequency recommendations for maximum weight gain in cattle
- It takes about 2 acres of land to feed a cow-calf pair for 12 months
- A prairie ecosystem biomass pyramid
- Lake food web diagram
- Mountain vs prairie food web
- Data on CRP (Conservation Reserve Program) land and pheasant numbers
- Fish stocking locations in South Dakota
- Undisturbed prairie has very different plants than a field that has been tilled
- Prescribed burns are used to restore natural grasslands
- SD has a contained breeding program for paddlefish sturgeon
- Graph depicting the deer and predator numbers from the Kaibab Plateau in Arizona both before and after predator controlled hunting
- Pictures of massive fish kills in large lakes vs small ponds
- Fish stocking data
- Rules for catch and release of different species of fish.
- Pheasant numbers in wet and dry years (or a graph of numbers vs average precipitation)
- Photographs of the terrestrial and aquatic iguanas of the Galapagos

- Land that was severely disturbed due to construction at time intervals after the disturbance
- Timber wolf reintroduction in Yellowstone National Park and the numbers/location of beaver, aspen, and vegetation
- Photographs of the different beak types of the Galapagos finches

Storyline

This section aims to decode not only the DCI connections, but also the SEP and CCC in a detailed account of how they possibly fit together in a progression for student learning, including both rationale and context for the bundle.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Using Mathematics and Computational Thinking ● Use mathematical and/or computational representations of phenomena or design solutions to support explanations. (Examples of mathematical comparisons could include graphs, charts, histograms, and population changes gathered from simulations or historical data sets.) **Engaging in Argument from Evidence** ● Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments.	**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. **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. **LS4.C: Adaptation** ● Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under	**Scale, Proportion, and Quantity** ● The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. **Stability and Change** ● Much of science deals with constructing explanations of how things change and how they remain stable. **Cause and Effect** ● Empirical evidence is required to differentiate between cause and correlation

• Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments.	different conditions, and the decline — and sometimes the extinction — of some species. • Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost.	and make claims about specific causes and effects.

In this standards bundle, students will identify and describe the components of given mathematical data in multiple formats (e.g. trends, averages, graphs, spreadsheets) that support their explanations of factors that affect the carrying capacities of ecosystems from small to large in both size and impact. The data can include historical data or simulations and may include numbers and types as well as boundaries, resources, and climate. Discussions and explanations should include the variability in effect the various factors will have. Arguments should also include interrelationships between these factors.

Student arguments from evidence should include the relationships between both biotic factors as well as biotic-abiotic factors. Environmental changes may have little effect and result in a return to the original ecosystem, whereas some changes at a larger scale may result in the formation of a different ecosystem. The same can be said for the environmental and biological factors and their effects on a population of organisms. Small changes may have no effect, whereas larger changes may result in extinction or the formation of a new species.

When engaging in argumentation, students should be able to identify both strengths and weaknesses of their claims as well as the validity of the evidence presented. This may also include identifying additional evidence that would be needed to make a stronger case.

Many environmental problems are caused, in part, by human intervention and thus can be remedied by human intervention. These problems include, but are not limited to, overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive/nonnative species, and climate change. Students will look at the data and evaluate its relevance as well as any other evidence needed. From this, they can propose solutions while paying attention to the cost and safety as well as the social, cultural, and environmental impacts their solutions may have. Plans can further be improved by prioritizing the criteria and evaluating possible trade-offs with the purpose of minimizing further impacts.

Formative Assessment

Formative assessment is crucial because all learners benefit from timely and focused feedback from others. It promotes self-reflection, self-explanation, and social learning. It can also make learning more relevant. Each of the questions below might be used throughout the formative assessment process. Specific prompts may focus on individual practices, core ideas, or crosscutting concepts, but, together, the components need to support inferences about students' three-dimensional science learning as described in a given bundle, standard or lesson-level performance expectation.

SEP Using Mathematics and Computational Thinking

- Perform a simulation on population numbers as organisms interact with each other and their environment to collect data and construct graphs.
- Using graphs showing population numbers of a predator-prey interaction (e.g. timberwolves and beaver numbers in Yellowstone) over time, make predictions as to what would have happened if there had been no limits to the number of predators killed.

SEP Engaging in Argument from Evidence

- Engage in argument from evidence on whether setting aside CRP land is worth the cost and effort.
- Suggest reasons for the different colors of peacocks. Suggest origins of the two colors (blue and green).

CCC Scale, Proportion, and Quantity

- Discuss why bacterial species evolve faster than animals such as elephants or finches.
- Discuss the differences and similarities of local fishing regulations versus commercial ocean fishing regulations.

CCC Stability and Change

- Compare the sustainability of a feedlot versus a pasture for feeding an identical herd of cattle with respects to food, wastes, and water and the results if these things are not properly maintained.
- Given photos and the accounts of arctic and prairie rabbits, foxes, or even brown bears/polar bears and discuss the genetic relationship as well as the advantages or disadvantages of their physical make-up.

CCC Cause and Effect

- Explain the mechanism responsible for the change of the predominant coloring of the peppered moth from a mix of gray and black to predominately black.
- How do you know that misuse of antibiotics leads to the development of resistant strains?

Performance Outcomes

These are statements of how students use knowledge and are similar to the standards in how they blend DCI, SEP, and CCC, but at a smaller grain-size. These are potential outcomes for instruction as it plays out in lessons and activities in the classroom. It is important to also think of these as smaller outcomes that build toward the larger goal of mastering the standards.

- When presented with an ecological disturbance, photo/**data, ask testable questions** regarding the scenario.
- **Given data** for a diminishing organism's population, determine what factors are responsible for those *changes*. From those factors, establish a hierarchy of the *scale of the effects*.
- **Develop a model** of a eutrophic lake *ecosystem* to include all of the possible sources for the problem.
- **When presented with data** on the zebra mussel numbers and location in SD waterways, determine ways to reduce the further migration of those organisms as well as their *effects* on the local vegetation and wildlife.
- **Engage in argumentation** on current fishing and hunting limits to include reasons for limits and the widespread *effects* should the limits not be

enforced.

- When shown two biologically related animals (e.g. arctic hare and prairie cottontail), look for *patterns* to determine the *cause and effect* changing climate has on the selection of certain traits and their protective value.
- **Predict** what would happen to a population of organisms such as colored moths should environmental factors *change* the predominant color of their *surroundings*.
- From **mathematical data on population numbers and density,** determine the *effects* of population density on disease rates.
- Locate several areas using **evidence (e.g. data, maps, photos)** where a natural *system* is undergoing habitat destruction/disruption. Using **evidence** from similar areas, **predict** what would happen to this area and ways to prevent *further destruction*.
- Choose an endangered organism and **devise a plan** to restore that organism's numbers back to sustainable numbers.