HIGH SCHOOL LIFE SCIENCE: BIODIVERSITY

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-LS2-2 Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales. (SEP: 5; DCI: LS2.A, LS2.C; CCC: Scale/Prop.) [Clarification Statement: Examples of mathematical representations include finding the average, determining trends, and using graphical comparisons of multiple sets of data.] *[Assessment Boundary: Assessment is limited to provided data.]*

HS-LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity. (SEP: 6; DCI: LS2.C, LS4.D, ETS1.B; CCC: Stability/Change) [Clarification Statement: Examples of human activities can include urbanization, building dams, and dissemination of invasive species.]

HS-LS4-6 Use a simulation to research and analyze possible solutions for the adverse impacts of human activity on biodiversity. (SEP: 5; DCI: LS4.C, LS4.D, ETS1.B; CCC: Cause/Effect) (Clarification Statement: Emphasis is on testing solutions for a proposed problem related to threatened or endangered species, or to genetic variation of organisms for multiple species.]

Content Overview

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

There a many complex interactions between the organisms in an ecosystem that keep the numbers and kinds of those organisms relatively constant over long periods of time, including interactions with humans. Small changes may cause temporary changes but extreme changes may result in entirely different ecosystems, which may or may not be desirable. When undesirable results are occuring, students should be able to design, evaluate, and redesign their proposed solutions (e.g. overpopulation; overuse of resources; habitat destruction; pollution; invasive species; and changes in climate). They should describe how the proposed solution decreases the negative effects of human activity on the environment and biodiversity and how to get the ecosystem back to a desirable condition. Due to the complex nature and time it sometimes takes for change within ecosystems, simulations or models of ecosystems may be used to research those changes and analyze possible solutions. Students must keep in mind the limitations of using models. They must be mindful of the expected results compared to what the models predict and account for any differences.

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.

- Pictures of a prairie, lake, river, or forest food web from the midwest

- Trophic level pyramid of a simple food chain from a prairie, lake, river, or forest
- An unbalanced food pyramid (wide middle and narrow top and bottom)
- Video clip of a very large mouse population or rabbits (from Australia)
- Photos of extinct or endangered animals from the midwest (e.g. Prairie skipper, stickleback fish, bald eagle (not endangered but protected)
- Graph of yearly CO_2 levels
- Graphs of yearly average temperatures.
- Video of time-lapse of polar ice over several years
- Picture of a polar bear on a lone ice float
- Video of the dust bowl era
- Photos of eutrophic lakes with excess algae and fish kills
- Photos of overpopulated areas such as India or China
- Story of the use of DDT in Panama to control the mosquito population

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 representations of phenomena or design solutions to support and revise explanations. • Create or revise a simulation of a phenomenon, designed device, process, or system. **Constructing Explanations and Designing Solutions**	**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	**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. **Stability and Change** • Much of science

● Design, evaluate, and refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade off considerations.	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. ● 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. **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 different conditions, and the decline — and sometimes the extinction — of some species. **LS4.D: Biodiversity and Humans** ● Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). (secondary) ● 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) (Note: This Disciplinary Core Idea is also addressed by 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. ● 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.	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 and make claims about specific causes and effects.

In this standards bundle, students will use mathematical data and models as evidence to support their explanations for how organisms are limited by their complex interactions with each other as well as their environment on several different scales. These scales can be from a small puddle to an ocean, or from a backyard to a forest.

Changes in the numbers and kinds of organisms present can be explained by changes in the environment. Those changes can be small and the ecosystem returns to stable conditions. Sometimes those changes are so severe that the organisms present either have to adapt or become extinct. Changes in the numbers of one organism can affect the numbers and kinds of other organisms including human beings as we depend on a stable environment for our own survival.

Human beings affect their environment in many ways, such as overpopulation, climate change, and pollution. Students should be able to propose possible solutions to some aspect of these deleterious changes. Their proposals should be changeable in light of new evidence and tools available. Two of those tools available are simulations and models.

Models and simulations are sometimes used because of time and place constraints, such as size of ecosystems studied, climate data over hundreds of years, or life cycles of the organisms involved. The models, just like their proposals, have limitations and the cause and effects predicted may not be the same as those actually experienced. These differences should be discussed for the models used.

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

- Present two different trophic level pyramids of a prairie ecosystem (e.g. prairie grass, rabbits, coyotes). One should have an upright pyramid shape and the other more "diamond" shape with a narrower top and bottom. Describe the differences in mathematical terms.
- Why is there a decrease in organism numbers as one proceeds up a trophic or biomass pyramid? Where is the matter and energy going?
- Create a model to show what would happen to the pheasant population for different types of changes in climate (e.g. higher/lower temperatures, higher/lower average precipitation).
- When presented both written information and data on the Kaibeb Deer phenomena, students will construct graphical representations of the Kaibeb

Deer phenomena.

SEP Constructing Explanations and Designing Solutions (Engineering)

- Construct an explanation for why the rabbit and deer population would increase if there were few coyotes.
- Given a local problem that has, in part, human causes (e.g. lake eutrophication, garbage blowing around, zebra mussels, jumping carp). Model or design a possible solution to a problem (e.g. lake eutrophication, excess garbage, zebra mussels, jumping carp) and explain the scientific idea behind their proposal.

CCC Cause and Effect

- Given data showing pheasant numbers and rainfall, construct a model of a pheasant's ecosystem and discuss possible reasons for the low numbers.
- Present data on paddlefish numbers along with historical data on the channelization and dam construction of the Missouri River. Draw a diagram that shows cause and effect relationships found between the paddlefish and the Missouri River system.

CCC Scale, Proportion, and Quantity

- Investigate a human problem such as pollution of a lake, decrease of native grasses, zebra mussels, or purple loosestrife by describing at what scale an investigation should be conducted and providing justification (e.g river/test tube/pond, entire state/field/plot/pot).
- When presented with climate data and the methods used to collect that data, century vs decade, discuss how the rate of climate change can be tested more accurately? List and discuss additional methods.
- What is the difference between a small amount of phosphate in a lake versus a larger amount of phosphate in the ability of the ecosystem to fully recover?

CCC Stability and Change

- When eliciting information about a prairie ecosystem components and interactions, describe how the components work together.

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.

- **Ask questions** about the *patterns* found in long term data on the pheasant population.
- **Develop and use a model** of a South Dakota ecosystem to enable them to study the *cause and effect* of abiotic changes on the numbers and kinds of organisms present in that ecosystem.
- **Develop mathematical models** for what *stable* trophic or biomass pyramids should look like for a prairie ecosystem.
- **Carry out simulations** on the *effects* of the abundance of food, shelter, and water on a deer population ("Oh Deer") to look for *patterns*.
- **Evaluate mathematical data** on the Kaibeb deer population to discuss the *cause and effect* of the population decline. (This can be substituted with the declining pheasant or a game fish population in a local lake.)
- Given an environmental problem in the state with human impact, **ask questions** about what interactions are present when developing and *defining the*

system for the interactions.