HIGH SCHOOL LIFE SCIENCE: ECOSYSTEM RESOURCES

Standards Bundle

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

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. (SEP: 6; DCI: ESS3.A, ESS3.B; CCC: Cause/Effect) [Clarification Statement: Examples of key natural resources include access to fresh water (such as rivers, lakes, and groundwater), regions of fertile soils such as river deltas, and high concentrations of minerals and fossil fuels. Examples of natural hazards can be from interior processes (such as volcanic eruptions and earthquakes), surface processes (such as tsunamis, mass wasting, and soil erosion), and severe weather (such as hurricanes, floods, and droughts). Examples of the results of changes in climate that can affect populations or drive mass migrations include changes to sea level, regional patterns of temperature and precipitation, and the types of crops and livestock that can be raised.]

HS-ESS3-3 Create a computational simulation to illustrate the relationships among the management of natural resources, the sustainability of human populations, and biodiversity. (SEP: 5; DCI: ESS3.C; CCC: Stability/Change) [Clarification Statement: Examples of factors that affect the management of natural resources include costs of resource extraction and waste management, per-capita consumption, and the development of new technologies. Examples of factors that affect human sustainability include agricultural efficiency, levels of conservation, and urban planning.] [Assessment Boundary: Assessment for computational simulations is limited to using provided multi-parameter programs or constructing simplified spreadsheet calculations.]

HS-ESS3-4 Evaluate or refine a technological solution that reduces the impacts of human activities on natural systems. (SEP: 6; DCI: ESS3.C, ETS1.B; CCC: Stability/Change) Alignment may include HS-ETS1-3 [Clarification Statement: Examples of data on the impacts of human activities could include the quantities and types of pollutants released, changes to biomass and species diversity, or areal changes in land surface use (such as for urban development, agriculture, livestock, or surface mining). Examples for limiting future impacts could range from local efforts (such as reducing, reusing, and recycling resources) to large-scale geoengineering design solutions (such as altering global temperatures by making large changes to the atmosphere or ocean).]

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. (SEP: 5; DCI: ESS2.D, ESS3.D; CCC: Systems) [Clarification Statement: Examples of Earth systems to be considered are the hydrosphere, atmosphere, cryosphere, geosphere, and/or biosphere. An example of the far-reaching impacts of human activity is how an increase in atmospheric carbon dioxide results in an increase in photosynthetic biomass on land and an increase in ocean acidification, with resulting impacts on sea organism health and marine populations.] [Assessment Boundary: Assessment does not include running computational representations but is limited to using the published results of scientific computational models.]

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

Humans and other organisms depend on Earth, air, and water, as well as each other, for resources necessary for life. Availability of these resources influences

the location and growth of not only human but other organism populations and thus must be managed in a sustainable way. Natural disasters and other geologic events also affect human development, and risks increase as populations grow. Management must take place on many different levels: local, state, and global.

Producing energy and obtaining resources from Earth (e.g., metals, fertilizers) all come with benefits as well as risks. One of these risks is climate change. Anything that affects the reflection, absorption, storage, reradiation into space, and redistribution of energy among Earth's systems has the potential for widespread climate change. New technologies must be evaluated for their effects on Earth's systems and continually developed to help solve the problems we already have.   Human activities can contribute to natural hazards, too.

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.

- World map showing human populations predominantly located by water.
- Video of the human population through time.
- Photos of sandbagging in South Dakota due to flooding.
- Channelized vs unchannelized stream maps from South Dakota.
- Location of dams in South Dakota
- Time lapse maps of arctic ice and polar bear numbers.
- Graph of average temperatures over a long period.
- Graph of dissolved oceanic CO2 levels.
- Depth data for a local lake over time.
- Long-term dissolved nutrient levels for a lake undergoing eutrophication along with pictures.
- Pictures of cut banks on a stream and evidence of sedimentation build-up.
- Map of tornado frequency by year.
- A comparison of energy-generating methods (e.g., coal, oil, wind, solar) and carbon dioxide output.
- Video or photos of the evolution of automobile engines.
- Data/maps of Black Hills National Forest Tree density with dates.
- Photos of and locations of sinkholes.
- Photos of the Palm Jumeirah - man-made land.
- Poster on ocean acidification.
- Sea turtles getting "lost" and not making it out to sea.
- Data showing that marine populations are declining.
- Map of human skin color by latitude.
- Map of the state showing drought conditions.

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
Constructing Explanations and Designing Solutions ● Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' investigations, models, theories, simulations, and 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. ● Design or refine a solution to a complex real-world problem based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. **Using Mathematics and Computational Thinking** ● Create a computational model or simulation of a phenomenon, designed device, process, or system. ● Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations.	**ESS2.D: Weather and Climate** ● 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 gases added to the atmosphere each year and how these gases are absorbed by the ocean and biosphere. (Secondary) **ESS3.A: Natural Resources** ● Resource availability has guided the development of human society. **ESS3.B: Natural Hazards** ● Natural hazards and other geologic events have shaped the course of human history; [they] have significantly altered the sizes of human populations and have driven human migrations. **ESS3.C: Human Impacts on Earth Systems** ● The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. ● Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation.	**Cause and Effect** ● Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. **Stability and Change** ● Change and rates of change can be quantified and modeled over very short or very long periods. Some system changes are irreversible. ● Feedback (negative or positive) can stabilize or destabilize a system. **Systems and System Models** ● 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.

| | **ESS3.D: Global Climate Change** | |
| | ● 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. | |

In this standard bundle, students will use processes common to and between the Earth's systems (e.g., biosphere, atmosphere, geosphere, and hydrosphere) to help explain and design solutions to enable a sustainable environment. Natural hazards such as tornadoes and flooding, climate change, and resource availability (e.g., clean water) can be affected by human activities. Students will construct explanations on how these hazards can affect populations' size and location, both human and other organisms. Likewise, they should also be able to explain how humans contribute to and can help remediate these hazards. Large populations, in turn, can negatively affect sustainability. Students will be able to discuss these problems and propose possible solutions. Present and emerging technologies can have positive and negative effects, so students should construct explanations including the trade-offs. Simulations can be used to generate evidence for their explanations and to test possible solutions. Systems can be designed to test and to help explain both the problems as well as proposed solutions paying attention to the interactions on several different scales from local to worldwide, puddle to ocean.

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 Constructing Explanations and Designing Solutions
- Describe a design approach to ease the effects of river flooding during heavy rain periods.
- Explain how carbon dioxide in solution can cause acidification of the ocean's waters and the effects.
- Sketch or design a possible prototype to reduce seaside lighting from shining outwards thereby misdirecting sea turtles trying to find their way out to sea.
- Given a map of skin color by latitude, explain the patterns shown using biological knowledge of the processes as well as purposes of melanin and vitamin D production in humans.
- Discuss the many sources of phosphates in eutrophic waters and possible ways to remediate or reduce them.

SEP Using Mathematics and Computational Thinking
- When presented with maps showing land uses and water boundaries before and after the building of a dam(s), construct a quantitative analysis of the changing land uses.
- Given population density, disaster locations, damage costs, and mortality rates, students will construct mathematical relationships between population size and locations and the effects of such disasters.
- After engaging in a simulation on climate change, students will be able to cite specific relationships between water vapor, carbon dioxide, and

landforms on climate.
- Given timelines of major technological advances along with human population numbers, determine the relationship between the two graphs and explain why those relationships exist.

CCC Systems and System Models
- Presented with a news report of a natural disaster event, indicating the boundaries and parts of the ecosystem that were affected by and also affected by the event.
- Discuss how the boundaries of a man-made lake change with the building of dams to include the formation of different ecosystems within those boundaries.
- Draw a representation of the carbon cycle to include the biosphere, atmosphere, geosphere, and hydrosphere as well as technology (e.g., combustion engines).

CCC Stability and Change
- During stream channelization, what factors remain the same, and which change?
- What factors cause areas where fracking occurs to become unstable and possibly result in the formation of sinkholes?

CCC Cause and Effect
- Explain how the use of oil has affected the growth of cities and human populations while also discussing the possible drawbacks.
- Discuss how rising carbon dioxide levels contribute to rising average temperatures.

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 **multiple resources,** such as a world map showing the location of the world's population locations and major resources, construct an explanation of the *factors that affect* where populations tend to grow and why.
- **Design possible solutions** to *reduce* flooding from rivers when there are times of high precipitation or snow melt.
- **Construct a model** wind turbine that could be used to power a model home or electrical device and would provide a *stable* energy source.
- **Discuss the necessary requirements** for the placement of wind turbines to include possible side effects on the immediate *ecosystem*.
- After viewing time-lapse **video** of receding arctic ice and polar bear **numbers, construct explanations** for the widespread *effects* the receding ice will have on other life forms.
- After **reading accounts** of how sea turtle hatchlings wander along the beach instead of going out to sea, **propose modifications** to lighting that would *reduce this effect.*
- **Create mathematical comparisons** of and discuss renewable and nonrenewable energy sources according to their ability to produce carbon dioxide and *exacerbate* climate change.
- After manipulating factors in a climate **simulation, discuss** the *effects* of natural and man-made factors on climate.
- **Given data** on average temperatures during winter and summer, **create a graphical model of average** temperatures and discuss *patterns* as well as

causes for those changes.
- When **presented with data** on the availability of common metals and the costs of mining versus recycling, **create a plan** for the sustainable use of a chosen metal to include a discussion of the *costs and benefits* of their program for human society.
- **Investigate** different building *models and materials* that would enable humans to sustain the forces of some natural disaster such as a tornado or hurricanes.
- **Investigate** factors that would affect water retention in soil specifically during drought conditions.
- **Given data** on nutrients in a body of water and land use practices in its *watershed*, propose solutions to reduce the runoff of nutrients into the water.
- **Research** the products of fossil fuel combustion and **construct an explanation** for the multiple *effects*, both good and bad, it will have on a defined *ecosystem*.
- After being presented with **numerical data** on declining marine populations, discuss the *causes* for the decline in numbers as well as the widespread *effects* on the human population.