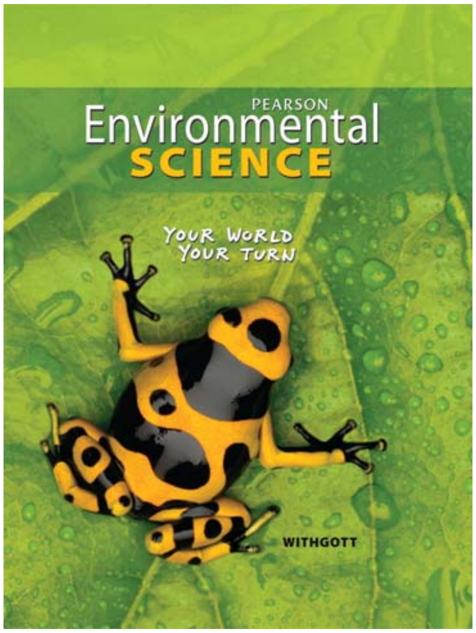
A Correlation of

Pearson

Environmental Science

Your World, Your Turn



To the

Next Generation Science Standards

Life Science Standards
Earth & Space Science Standards

DRAFT, MAY 2012

Grades 9-12

Dear Educator,

As we embark upon a new and exciting science journey, Pearson is committed to offering its complete support as classrooms transition to the new Next Generation Science Standards (NGSS). Ready-to-use solutions for today and a forward-thinking plan for tomorrow connect teacher education and development, curriculum content and instruction, assessment, and information and school design and improvement. We'll be here every step of the way to provide the easiest possible transition to the NGSS with a coherent, phased approach to implementation.

Pearson has long-standing relationships with contributors and authors who have been involved with the development and review of the Next Generation Science Frameworks and subsequent Next Generation Science Standards. As such, the spirit and pedagogical approach of the NGSS initiative is embedded in all of our programs, such as ***Environmental Science: Your World, Your Turn.***

The planning and development of Pearson's ***Environmental Science: Your World, Your Turn*** was informed by the same foundational research as the NGSS Framework. Specifically, our development teams used Project 2061, the National Science Education Standards (1996) developed by the National Research Council, as well as the Science Anchors Project 2009 developed by the National Science Teachers Association to inform the development of this program. As a result, students make connections throughout the program to concepts that cross disciplines, practice science and engineering skills, and build on their foundational knowledge of key science ideas.

Real Issues. Real Data. Real Choices.

Pearson's ***Environmental Science: Your World, Your Turn*** is based on real, current, and relevant content that brings the world of environmental science to life. All while making it personal and actionable for every student.

Exploring Real Issues through an Integrated Case-Study Approach

Opening every chapter, and integrated throughout the text and support materials both online and in print, the Central Case provides a consistent and engaging path for teaching core environmental science principles.

Based on the Most Current Data Available

A science program is only as good as the data. ***Environmental Science: Your World, Your Turn*** provides the most up-to-date data available from a wide-range of trusted sources. Maps, graphs, yesterday's news articles…and more.

Motivates Students to Make Choices

Environmental Science: Your World, Your Turn empowers students to draw their own conclusions and encourages them to think and act on both local and global levels. They will build the critical thinking skills that they will need long after the class ends.

The following document demonstrates how ***Environmental Science: Your World, Your Turn*** **©2011,** supports the first draft of the Next Generation Science Standards (NGSS) for Grades 9-12. Correlation references are to the Student Editions, Teacher Editions, and Teacher Lab Resources

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A Correlation of
Environmental Science: Your World, Your Turn ©2011
to the Next Generation Science Standards – DRAFT, May 2012
Grades 9-12

LIFE SCIENCE

HS.LS-MEOE.a Matter and Energy in Organisms and Ecosystems

Students who demonstrate understanding can:

a. **Construct a model to support explanations of the process of photosynthesis by which light energy is converted to stored chemical energy.** **[Clarification Statement: Models may include diagrams and chemical equations. The focus should be on the flow of matter and energy through plants.] [*Assessment Boundary: Limited to the inputs and outputs of photosynthesis and chemosynthesis, not the specific biochemical steps involved.*]**

ENVIRONMENTAL SCIENCE: YOUR WORLD, YOUR TURN: The citations below indicate areas in ***Environmental Science: Your World, Your Turn*** where this idea is introduced.

Students are presented with the definition and basic photosynthesis equation on SE/TE: 84 and again on SE/TE: 142.

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Developing and Using Models Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and constructing models to predict and explain relationships between systems and their components in the natural and designed world. • Use multiple types of models to represent and explain phenomena and move flexibly between model types based on merits and limitations. • Construct, revise, and use models to predict and explain relationships between systems and their components. • Examine merits and limitations of various models in order to select or revise a model that best fits the evidence or the design criteria.	**LS1.C: Organization for Matter and Energy Flow in Organisms** • The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used for example to form new cells. **Related content SE/TE:** 84, Producers 141, Producers and Consumers 142, Energy from the Sun 142, Figure 19: Energy From the Sun	**Energy and Matter** The total amount of energy and matter in closed systems is conserved. Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. Energy drives the cycling of matter within and between systems. In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. **Related content SE/TE:** 141, Producers and Consumers

HS.LS-MEOE.b Matter and Energy in Organisms and Ecosystems		
Students who demonstrate understanding can: **b. Construct an explanation of how sugar molecules that contain carbon, hydrogen, and oxygen are combined with other elements to form amino acids and other large carbon-based molecules.** **[Clarification Statement: Explanations should include descriptions of how the cycling of these elements provide evidence of matter conservation.] [*Assessment Boundary: Focus is on conceptual understanding of the cycling of matter and the basic building blocks of organic compounds, not the actual process.*]** **ENVIRONMENTAL SCIENCE: YOUR WORLD, YOUR TURN:** The focus of this program is to enable all students to comprehend and connect environmental topics and concepts to their daily lives. This expectation falls outside of the program scope and sequence. See ***Miller & Levine Biology***, isbn: 978-013-361465-7, Chapter 2.		
The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:		
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific knowledge, principles, and theories. • Construct and revise explanations and arguments based on evidence obtained from a variety of sources (e.g., scientific principles, models, theories) and peer review.	**LS1.C: Organization for Matter and Energy Flow in Organisms** • The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used for example to form new cells. • As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. **LS2.B: Cycles of Matter and Energy Transfer in Ecosystems** • Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded.	**Energy and Matter** The total amount of energy and matter in closed systems is conserved. Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. Energy drives the cycling of matter within and between systems. In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.

HS.LS-MEOE.c Matter and Energy in Organisms and Ecosystems

Students who demonstrate understanding can:

c. Use a model to explain cellular respiration as a chemical process whereby the bonds of food molecules and oxygen molecules are broken and bonds in new compounds are formed that result in a net transfer of energy. [***Assessment Boundary: Limited to the conceptual understanding of the inputs and outputs of metabolism, not the specific steps.***]

ENVIRONMENTAL SCIENCE: YOUR WORLD, YOUR TURN: The citations below indicate areas in ***Environmental Science: Your World, Your Turn*** where this idea is introduced.

Students obtain information about basic cellular respiration equation on SE/TE: 85 and SE/TE: 143.

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Developing and Using Models	LS1.C: Organization for Matter and Energy Flow in Organisms	Energy and Matter
Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and constructing models to predict and explain relationships between systems and their components in the natural and designed world. • Use multiple types of models to represent and explain phenomena and move flexibly between model types based on merits and limitations. • Construct, revise, and use models to predict and explain relationships between systems and their components. • Examine merits and limitations of various models in order to select or revise a model that best fits the evidence or the design criteria.	• As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. **Related content SE/TE:** 85, Cellular Respiration 142-143, Consumers • As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. For example, aerobic (in the presence of oxygen) cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. **Related content SE/TE:** 85, Cellular Respiration 142-143, Consumers • Cellular respiration also releases the energy needed to maintain body temperature despite ongoing energy loss to the surrounding environment. **Related content SE/TE:** 85, Cellular Respiration 142-143, Consumers	The total amount of energy and matter in closed systems is conserved. Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. Energy drives the cycling of matter within and between systems. In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. **Related content SE/TE:** 141, Producers and Consumers

	LS2.B: Cycles of Matter and Energy Transfer in Ecosystems Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. **Related content SE / TE:** 84, Producers 85, Cellular Respiration 141, Primary Production 142, Energy from the Sun 142-143, Consumers	

HS.LS-MEOE.d Matter and Energy in Organisms and Ecosystems		
Students who demonstrate understanding can: **d. Evaluate data to compare the energy efficiency of aerobic and anaerobic respiration within organisms.** **[*Assessment Boundary: Limited to a comparison of ATP input and output.*]** **ENVIRONMENTAL SCIENCE: YOUR WORLD, YOUR TURN:** The citations below indicate areas in ***Environmental Science: Your World, Your Turn*** where this idea is introduced. Aerobic respiration is explored on SE/TE: 85, and again on SE/TE: 143.		
The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:		
Analyzing and Interpreting Data Analyzing data in 9–12 builds on K–8 and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. • Use tools, technologies, and/or models (e.g., computational, mathematical) to generate and analyze data in order to make valid and reliable scientific claims or determine an optimal design solution.	**LS1.C: Organization for Matter and Energy Flow in Organisms** As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. For example, aerobic (in the presence of oxygen) cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. Anaerobic (without oxygen) cellular respiration follows a different and less efficient chemical pathway to provide energy in cells. **Related content SE/TE:** 85, Cellular Respiration 142-143, Consumers	**Energy and Matter** The total amount of energy and matter in closed systems is conserved. Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. Energy drives the cycling of matter within and between systems. In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.

HS.LS-MEOE.e Matter and Energy in Organisms and Ecosystems		
Students who demonstrate understanding can: **e. Use data to develop mathematical models to describe the flow of matter and energy between organisms and the ecosystem.** [*Assessment Boundary: Use data on energy stored in biomass that is transferred from one trophic level to another.*] **ENVIRONMENTAL SCIENCE: YOUR WORLD, YOUR TURN:** The citations below indicate areas in ***Environmental Science: Your World, Your Turn*** where this idea is introduced. Students **obtain information** about ecological communities and the flow of matter and energy between organisms, trophic levels, and the ecosystem in Chapter 5, Lesson 3, SE/TE: 141-148.		
The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:		
Developing and Using Models Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and constructing models to predict and explain relationships between systems and their components in the natural and designed world. • Use multiple types of models to represent and explain phenomena and move flexibly between model types based on merits and limitations. • Use models (including mathematical and computational) to generate data to explain and predict phenomena, analyze systems, and solve problems. **Related Content SE/TE:** 144, Real Data: Energy Flow in Communities 145, Figure 22: Pyramid of Energy 161, Chapter Assessment #29-32	**LS2.B: Cycles of Matter and Energy Transfer in Ecosystems** • Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. **Related content SE/TE:** 84, Producers 85, Cellular Respiration 141, Primary Production 142, Energy from the Sun 142-143, Consumers • 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, and there is a limit to the number of organisms that an ecosystem can sustain. **Related Content SE/TE:** 141, Primary Production 141, Figure 18, Primary Producers 144, Real Data: Energy Flow in Communities 144-145, Energy and Biomass 145, Figure 22: Pyramid of Energy, Figure 23: Pyramids of Numbers and Biomass • Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. **Related Content SE/TE:** 144-145, Energy in Communities	**Energy and Matter** The total amount of energy and matter in closed systems is conserved. Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. Energy drives the cycling of matter within and between systems. In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. **Related Content SE/TE:** 141, Producers and Consumers

HS.LS-MEOE.f Matter and Energy in Organisms and Ecosystems

Students who demonstrate understanding can:

f. Communicate descriptions of the roles of photosynthesis and cellular respiration in the carbon cycle specific to the carbon exchanges among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes.

ENVIRONMENTAL SCIENCE: YOUR WORLD, YOUR TURN: The citations below indicate areas in ***Environmental Science: Your World, Your Turn*** where this idea is introduced.

The carbon cycle is introduced in Chapter 3, Lesson 4, SE/TE: 83-85. For comprehensive coverage please see ***Miller & Levine Biology***, isbn: 978-013-361465-7, Chapters 3, 8, and 9.

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Obtaining, Evaluating, and Communicating Information	LS2.B: Cycles of Matter and Energy Transfer in Ecosystems	Systems and System Models
Obtaining, evaluating, and communicating information in 9-12 builds on 6-8 and progresses to evaluating the validity and reliability of the claims, methods, and designs. • Critically read scientific literature adapted for classroom use to identify key ideas and major points and to evaluate the validity and reliability of the claims, methods, and designs. • Generate, synthesize, communicate, and critique claims, methods, and designs that appear in scientific and technical texts or media reports.	• Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged between the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes. **Related Content SE/TE:** 83-85, The Carbon Cycle 84, Figure 21: Carbon Cycle	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. **Related Content SE/TE:** 84, Carbon Cycle 84, Figure 21: Carbon Cycle

HS.LS-MEOE.g Matter and Energy in Organisms and Ecosystems		
Students who demonstrate understanding can: **g. Provide evidence to support explanations of how elements and energy are conserved as they cycle through ecosystems and how organisms compete for matter and energy.** **[Clarification Statement: Elements included can include carbon, oxygen, hydrogen, and nitrogen.]** **ENVIRONMENTAL SCIENCE: YOUR WORLD, YOUR TURN:** Conservation of matter is presented on SE/TE: 83. Students learn about conservation of energy on SE/TE: 144. Students **explain** what happens to energy that is not passed to the next trophic level in Reading Checkpoint, SE/TE: 145.		
The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:		
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific knowledge, principles, and theories. • Make quantitative claims regarding the relationship between dependent and independent variables. • Apply scientific reasoning, theory, and models to link evidence to claims and show why the data are adequate for the explanation or conclusion. • Construct and revise explanations and arguments based on evidence obtained from a variety of sources (e.g., scientific principles, models, theories) and peer review.	**LS1.C: Organization for Matter and Energy Flow in Organisms** • The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used for example to form new cells. **SE / TE:** 84, Producers 141, Producers and Consumers 142, Energy from the Sun • Matter and energy are conserved in each change. This is true of all biological systems, from individual cells to ecosystems. **SE / TE:** 83, Nutrient Cycling 85, The Missing Carbon Sink 144, Energy in Communities **LS2.B: Cycles of Matter and Energy Transfer in Ecosystems** • 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; **SE / TE:** 83, Nutrient Cycling 83-85, The Carbon Cycle	**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. **SE / TE:** 145, Figure 22: Pyramid of Energy

	86, The Phosphorous Cycle 87-89, The Nitrogen Cycle 146, Food Webs and Keystone Species 146, Figure 24: Food Chain 147, Figure 26, Food Web • Competition among species is ultimately competition for the matter and energy needed for life. **SE / TE:** 134-135, Competition	

HS.LS-IRE.a. Interdependent Relationships in Ecosystems

Students who demonstrate understanding can:

a. **Evaluate data to explain resource availability and other environmental factors that affect carrying capacity of ecosystems.** **[Clarification Statement: The explanation could be based on computational or mathematical models. Environmental factors should include availability of living and nonliving resources and from challenges (e.g., predation, competition, disease).]**

ENVIRONMENTAL SCIENCE: YOUR WORLD, YOUR TURN: The concepts of carrying capacity and limiting factors are presented in Chapter 4, Lesson 3, Population Growth on SE/TE: 115-117. Species interactions, including competition, predation, and parasitism, are described in Chapter 5, Lesson 2, Species Interactions on SE/TE: 133-140. Students **learn** about ecological succession and invasive species in Chapter 5, Lesson 3, Community Stability on SE/TE: 149-155. The effects of climate change on carry capacity of ecosystems are explored in Chapter 16, Lesson 3 on SE/TE: 497-499.

Students **evaluate** data relating to golden toads and **make a conclusion** about the causes of species decline in the Write About It feature on SE/TE: 118-119. Students **evaluate data** from a fruit fly experiment in Chapter Assessment #28-31 on SE/TE: 123.

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Obtaining, Evaluating, and Communicating Information	LS2.A: Interdependent Relationships in Ecosystems	Cause and Effect
Obtaining, evaluating, and communicating information in 9-12 builds on 6-8 and progresses to evaluating the validity and reliability of the claims, methods, and designs. • Critically read scientific literature adapted for classroom use to identify key ideas and major points and to evaluate the validity and reliability of the claims, methods, and designs. **SE / TE:** 118-119, The Cloudless Forest 119, Write About It 156-157, A Broken Mutualism • Generate, synthesize, communicate, and critique claims, methods, and designs that appear in scientific and technical texts or media reports. **SE / TE:** 118-119, The Cloudless Forest 119, Write About It 125, Black and White, and Spread All Over 156-157, A Broken Mutualism	• 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. **SE / TE:** 115, Logistic Growth, Figure 12: Logistic Growth; Population Growth in Nature; Figure 13: Population Growth in Nature 116, Limiting Factors and Biotic Potential, Figure 14: Density Dependence 134, Competition 136, Predation, Figure 10: Predator-Prey Cycles **LS2.C: Ecosystem Dynamics, Functioning, and Resilience** • Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability.	Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. Systems can be designed to cause a desired effect. Changes in systems may have various causes that may not have equal effects. **SE / TE:** 136, Figure 10: Predator-Prey Cycles 156-157, A Broken Mutualism

	SE / TE: 115, Population Growth in Nature 116, Density-Dependent Factors Density-Independent Factors 497-499, Effects on Ecosystems and Organisms	

HS.LS-IRE.b. Interdependent Relationships in Ecosystems		
Students who demonstrate understanding can: **b. Design solutions for creating or maintaining the sustainability of local ecosystems.** **ENVIRONMENTAL SCIENCE: YOUR WORLD, YOUR TURN:** Land use and sustainable development are presented in Chapter 10, Urbanization on SE/TE: 292-313. Students **design** a plan for an urban area that balances peoples' needs with the needs of the environment and **write** paragraphs describing the plan in Chapter 10 Assessment #36 on SE/TE: 319. Students **collaborate** to create a **design** plan for making their local community more sustainable in the Unit 3 Project: Charette for Sustainability on SE/TE: 320.		
The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:		
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific knowledge, principles, and theories. • Make quantitative claims regarding the relationship between dependent and independent variables. • Apply scientific knowledge to solve design problems by taking into account possible unanticipated effects. **SE / TE:** 320, Unit 3 Project: Charette for Sustainability	**LS4.D: Biodiversity and Humans** • 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. These problems have the potential to cause a major wave of biological extinctions—as many species or populations of a given species, unable to survive in changed environments, die out—and the effects may be harmful to humans and other living things. 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. **SE / TE:** 292-298, Land Use and Urbanization 299-304, Sprawl 305-313, Sustainable Cities	**Stability and Change** Much of science deals with constructing explanations of how things change and how they remain stable. Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. Feedback (negative or positive) can stabilize or destabilize a system. Systems can be designed for greater or lesser stability. **SE / TE:** 292, Continuing Urbanization 299-304, Sprawl

HS.LS-IRE.c. Interdependent Relationships in Ecosystems

Students who demonstrate understanding can:

c. Construct and use a model to communicate how complex sets of interactions in ecosystems maintain relatively consistent numbers and types of organisms for long periods of time when conditions are stable.

ENVIRONMENTAL SCIENCE: YOUR WORLD, YOUR TURN: The citations below indicate areas in ***Environmental Science: Your World, Your Turn*** where this idea is introduced.

Population growth and stability and carrying capacity are presented in Chapter 4, Lesson 3, Population Growth, on SE/TE: 110-117. Students **obtain information** about niche, competition, predation, parasitism, herbivory, mutualism, and commensalism are in the Species Interactions Lesson, on SE/TE: 133-140. Ecological succession and invasive species are explored in Chapter 5, Lesson 4, Community Stability, on SE/TE: 149-155.

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Developing and Using Models	LS2.C: Ecosystem Dynamics, Functioning, and Resilience	Stability and Change
Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and constructing models to predict and explain relationships between systems and their components in the natural and designed world. • Construct, revise, and use models to predict and explain relationships between systems and their components. • Use models (including mathematical and computational) to generate data to explain and predict phenomena, analyze systems, and solve problems. **Related Content SE/TE:** 161, Analyze Data	• 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. **Related Content SE/TE:** 110-113, Factors That Determine Population Growth 114-115, How Populations Grow 116-117, Limiting Factors and Biotic Potential 133-135, The Niche and Competition 136-138, Predation, Parasitism, and Herbivory 139-140, Mutualism, and Commensalism 149-153, Ecological Succession	Much of science deals with constructing explanations of how things change and how they remain stable. Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. Feedback (negative or positive) can stabilize or destabilize a system. Systems can be designed for greater or lesser stability. **Related Content SE/TE:** 111, Figure 8: Survivorship Curves 115, Population Growth in Nature 116-117, Limiting Factors and Biotic Potential 136, Figure 10: Wolf and Moose Populations on Isle Royale, Michigan 149-153, Ecological Succession 150, Figure 29, Primary Succession 151, Figure 30: Secondary Succession 161, Analyze Data

HS.LS-IRE.d. Interdependent Relationships in Ecosystems

Students who demonstrate understanding can:

d. Construct arguments from evidence about the effects of natural biological or physical disturbances in terms of the time needed to reestablish a stable ecosystem and how the new system differs from the original system. [Clarification Statement: Computational models could be used to collect evidence to support the argument.]

ENVIRONMENTAL SCIENCE: YOUR WORLD, YOUR TURN: Speciation and extinction are presented in Chapter 4, Lesson 1 on SE/TE: 131-132. Students **learn** about community stability in Chapter 5, Lesson 4 on SE/TE: 149-155. Ecological succession is explored on SE/TE: 149-153.

Students **discuss** interaction between organisms and the environment in the event of a disturbance in Big Question on TE: 150. Students **compare** primary and secondary succession and their different time scales in Reading Checkpoint on SE/TE: 151. Students **model** succession in a jar of water and **draw conclusions** about succession in Quick Lab on SE/TE: 152.

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Engaging in Argument from Evidence	LS2.C: Ecosystem Dynamics, Functioning, and Resilience	Stability and Change
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. Arguments may also come from current scientific or historical episodes in science. • Evaluate the claims, evidence, and reasoning of currently accepted explanations or solutions as a basis for the merits of arguments.	• 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. **SE / TE:** 149-153, Ecological Succession 150, Figure 29: Primary Succession 151, Figure 30: Secondary Succession 152, Figure 31, Aquatic Succession • Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. **SE / TE:** 119, Write About It 131-132, Speciation / Extinction 131, Allopatric Speciation 156-157, A Broken Mutualism **LS4.D: Biodiversity and Humans** • Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). Biological extinction, being irreversible, is a critical factor in reducing the planet's natural capital. **SE / TE:** 118-119, The Cloudless Forest 131-132, Speciation / Extinction 132, Figure 5: Mass Extinction 156-157, A Broken Mutualism	Much of science deals with constructing explanations of how things change and how they remain stable. Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. Feedback (negative or positive) can stabilize or destabilize a system. Systems can be designed for greater or lesser stability. **SE / TE:** 131-132, Speciation and Extinction 131, Allopatric Speciation 149-153, Ecological Succession 150, Figure 29: Primary Succession 151, Figure 30: Secondary Succession 152, Figure 31, Aquatic Succession

HS.LS-IRE.e. Interdependent Relationships in Ecosystems		
Students who demonstrate understanding can: **e. Use evidence to construct explanations and design solutions for the impact of human activities on the environment and ways to sustain biodiversity and maintain the planet's natural capital. [Clarification Statement: Explanations and solutions should include anthropogenic changes (e.g., habitat destruction, pollution, introduction of invasive species, overexploitation, climate change).]** **ENVIRONMENTAL SCIENCE: YOUR WORLD, YOUR TURN:** The impact of invasive species that have been introduced by humans is explored on SE/TE: 153-155. Students **learn** about the impacts of anthropogenic habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change in Causes of Biodiversity Loss on SE/TE: 209-211. Ways to sustain biodiversity are presented in Protecting Biodiversity on SE/TE: 212-217. Students **obtain information** about case studies of programs to sustain biodiversity in A Couple of Birds Make Big Comebacks, SE/TE: 218-219. The impacts from climate change are presented in Effects on Ecosystems and Organisms on SE/TE: 497-499. Students **use evidence** from the text to **explain** positive and negative aspects of invasive species in What Do You Think? on SE/TE: 153. They **explain** the effects of invasive species on biodiversity in Reading Checkpoint, SE/TE: 210. Students **discuss** the major factors affecting biodiversity today in Lesson 2 Assessment #2 on SE/TE: 211. Students **explain** the effect of human development and habitat fragmentation on biodiversity in Lesson 2 Assessment #3. Students **write** a report on the effect on an invasive species in the Ecology Unit Project on SE/TE: 224. They **explain** the impact of increases in atmospheric temperature on the migration of some bird species in the Reading Checkpoint on SE/TE: 498. Students **explain** the effects of climate change on corals in Lesson 3 Assessment #1 on SE/TE: 501.		
The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:		
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific knowledge, principles, and theories. • Make quantitative claims regarding the relationship between dependent and independent variables. • Apply scientific reasoning, theory, and models to link evidence to claims and show why the data are adequate for the explanation or conclusion. **SE/TE:** 224, Ecology Unit Project • Construct and revise explanations and arguments based on evidence obtained from a variety of sources (e.g., scientific principles, models, theories) and peer review.	**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. **SE/TE:** 118-119, The Cloudless Forest 125, Black and White, and Spread All Over 153-155, Invasive Species 156-157, A Broken Mutualism 199, Saving the Siberian Tiger 209, Habitat Change or Loss 210, Invasive Species, Pollution Overharvesting 211, Climate Change 218-219, A Couple of Birds Make Big Comebacks 497-499, Effects on Ecosystems and Organisms	**Stability and Change** Much of science deals with constructing explanations of how things change and how they remain stable. Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. Feedback (negative or positive) can stabilize or destabilize a system. Systems can be designed for greater or lesser stability. **SE/TE:** 118-119, The Cloudless Forest 153-155, Invasive Species 125, Black and White, and Spread All Over 156-157, A Broken Mutualism 209, Habitat Change or Loss 210, Invasive Species 210, Pollution 210, Overharvesting 211, Climate Change 218-219, A Couple of Birds Make Big Comebacks 491-496, Climate Change 497-501, Effects of climate Change

SE / TE: 224, Ecology Unit Project • Apply scientific knowledge to solve design problems by taking into account possible unanticipated effects.	**LS4.D: Biodiversity and Humans** • Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). Biological extinction, being irreversible, is a critical factor in reducing the planet's natural capital. **SE / TE:** 118-119, The Cloudless Forest 125, Black and White, and Spread All Over 131-132, Speciation and Extinction 156-157, A Broken Mutualism 208, A Sixth Mass Extinction? 208, Figure 8: The Living Planet Index • 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. These problems have the potential to cause a major wave of biological extinctions—as many species or populations of a given species, unable to survive in changed environments, die out—and the effects may be harmful to humans and other living things. 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. **SE / TE:** 125, Black and White, and Spread All Over 204, Biodiversity and Ecosystem Function; What Do You Think? 204, Figure 5: Ecosystem Goods and Services 205, Biodiversity and Agriculture 205, Biodiversity and Medicine 206, Biodiversity, Tourism, and Recreation 208, A Sixth Mass Extinction212- 212-217, Protecting Biodiversity	

HS.LS-IRE.f. Interdependent Relationships in Ecosystems		
Students who demonstrate understanding can: **f. Argue from evidence obtained from scientific literature the role group behavior has in increasing the chances of survival for individuals and their genetic relatives.** **ENVIRONMENTAL SCIENCE: YOUR WORLD, YOUR TURN:** The citations below indicate areas in ***Environmental Science: Your World, Your Turn*** where this idea is introduced. The role of population density and distribution in the survival of a species is presented in The Decline of the Passenger Pigeon on SE/TE: 105 and in Population Density on SE/TE: 106. Students **learn** about Population Distribution on SE/TE: 107.		
The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:		
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. Arguments may also come from current scientific or historical episodes in science. • Evaluate the claims, evidence, and reasoning of currently accepted explanations or solutions as a basis for the merits of arguments.	**LS2.D: Social Interactions and Group Behavior** • Animals, including humans, having a strong drive for social affiliation with members of their own species and will suffer, behaviorally as well as physiologically, if reared in isolation, even if all their physical needs are met. Some forms of affiliation arise from the bonds between offspring and parents. Other groups form among peers. Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives. **Related Content SE/TE:** 105, The Decline of the Passenger Pigeon 106, Population Density 107, Population Distribution	**Cause and Effect** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. Systems can be designed to cause a desired effect. Changes in systems may have various causes that may not have equal effects.

HS.LS-IRE.g. Interdependent Relationships in Ecosystems		
Students who demonstrate understanding can: **g. Plan and carry out investigations to make mathematical comparisons of the populations and biodiversities of two similar ecosystems at different scales.** **[Clarification Statement: Students compare, mathematically, the biodiversity of a small ecosystem to a large ecosystem (e.g., woodlot to a forest, small pond near a city to a wetland estuary).]** **ENVIRONMENTAL SCIENCE: YOUR WORLD, YOUR TURN:** The citations below indicate areas in ***Environmental Science: Your World, Your Turn*** where this idea is introduced. The population distribution of ants at two different scales is contrasted in Clumped Distribution on SE/TE: 107.		
The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:		
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in 9–12 builds on K–8 experiences and progresses to include investigations that build, test, and revise conceptual, mathematical, physical, and empirical models. • Plan and carry out investigations individually and collaboratively and test designs as part of building and revising models, explaining phenomena, or testing solutions to problems. Consider possible confounding variables or effects and ensure the investigation's design has controlled for them.	**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.	**Scale, Proportion, and Quantity** The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. Some systems can only be studied indirectly as they are too small, too large, too fast, or too slow to observe directly. Patterns observable at one scale may not be observable or exist at other scales. Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale. **Related Content SE/TE:** 107, Clumped Distribution

HS.LS-NSE.a. Natural Selection and Evolution		
Students who demonstrate understanding can: **a. Use models to explain how the process of natural selection is the result of four factors: (1) the potential for a species to increase in number, (2) the genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the selection of those organisms that are better able to survive and reproduce in the environment. [Clarification Statement: Mathematical models may be used to communicate the explanation or to generate evidence supporting the explanation.]** **ENVIRONMENTAL SCIENCE: YOUR WORLD, YOUR TURN:** The citations below indicate areas in ***Environmental Science: Your World, Your Turn*** where this idea is introduced. **Related Content:** Natural selection and evolution are presented in Chapter 5, Lesson 1, SE/TE: 126-129. Students **learn** the four factors of the natural selection process on SE/TE: 128-129.		
The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:		
Developing and Using Models Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and constructing models to predict and explain relationships between systems and their components in the natural and designed world. • Use multiple types of models to represent and explain phenomena and move flexibly between model types based on merits and limitations.	**LS4.B: Natural Selection** • Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals. **Related Content SE/TE:** 127, Mechanisms of Biological Evolution 128-129, Conditions of Natural Selection 128, Figure 2: Natural Selection **LS4.C: Adaptation** • Natural selection is the result of four factors: (1) the potential for a species to increase in number, (2) the genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for an environment's limited supply of the resources that individuals need in order to survive and reproduce, and (4) the ensuing proliferation of those organisms that are better able to survive and reproduce in that environment. **Related Content SE/TE:** 128-129, Conditions of Natural Selection 128, Figure 2: Natural Selection	**Cause and Effect** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. Systems can be designed to cause a desired effect. Changes in systems may have various causes that may not have equal effects. **Related Content SE/TE:** 137, Coevolution and Evolutionary "Arms Races"

HS.LS-NSE.b. Natural Selection and Evolution

Students who demonstrate understanding can:

b. Use evidence to explain the process by which natural selection leads to adaptations that result in populations dominated by organisms that are anatomically, behaviorally, and physiologically able to survive and/or reproduce in a specific environment. [*Assessment Boundary: Evidence should center on survival advantages of selected traits for different environmental changes such as temperature, climate, acidity, light.*]

ENVIRONMENTAL SCIENCE: YOUR WORLD, YOUR TURN: Chapter 5, Lesson 1 explores the process by which natural selection leads to adaptations that result in populations dominated by organisms able to survive in an environment on SE/TE: 127-129.

Students **predict** what would happen in a specific environmental change to a population of fish in Lesson 1 Assessment #1 on SE/TE: 132. They **apply concepts** of adaptation to species living in the intertidal zone in Lesson Assessment #4 on SE/TE: 191. Students **write** about evolution, environment, and adaptation in Chapter 6 Assessment #33 on SE/TE: 197.

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Constructing Explanations and Designing Solutions	LS4.B: Natural Selection	Cause and Effect
Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific knowledge, principles, and theories. • Apply scientific reasoning, theory, and models to link evidence to claims and show why the data are adequate for the explanation or conclusion. • Construct and revise explanations and arguments based on evidence obtained from a variety of sources (e.g., scientific principles, models, theories) and peer review. **SE / TE:** 167, Lesson 1 Assessment #3 • Base casual explanations on valid and reliable empirical evidence from multiple sources and the assumption that natural laws operate today as they did in the past and will continue to do so in the future.	• The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population. **SE / TE:** 127, Mechanisms of Biological Evolution; Figure 1: Biological Evolution 128-129, Conditions of Natural Selection 128-129, Figure 2: Natural Selection **LS4.C: Adaptation** • Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not. **SE / TE:** 128-129, Conditions of Natural Selection; Figure 2: Natural Selection	Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. Systems can be designed to cause a desired effect. Changes in systems may have various causes that may not have equal effects. **SE / TE:** 127, Mechanisms of Biological Evolution; Figure 1: Biological Evolution 128-129, Conditions of Natural Selection; Figure 2: Natural Selection

HS.LS-NSE.c. Natural Selection and Evolution		
Students who demonstrate understanding can: **c. Analyze and interpret data to explain the process by which organisms with an advantageous heritable trait tend to increase in numbers in future generations but organisms that lack an advantageous heritable trait tend to decrease in numbers in future generations.** **ENVIRONMENTAL SCIENCE: YOUR WORLD, YOUR TURN:** The citations below indicate areas in ***Environmental Science: Your World, Your Turn*** where this idea is introduced. Evolution and natural selection are introduced in Chapter 5, Lesson 1, on SE/TE: 126-129. The concept of increases or decreases in the number of organisms possessing or lacking advantageous heritable traits is illustrated qualitatively in SE/TE: 128, Figure 2: Natural Selection. Students learn about coevolution and evolutionary "arms races" on SE/TE: 137. .		
The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:		
Analyzing and Interpreting Data Analyzing data in 9–12 builds on K–8 and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. • Use tools, technologies, and/or models (e.g., computational, mathematical) to generate and analyze data in order to make valid and reliable scientific claims or determine an optimal design solution. • Consider limitations (e.g., measurement error, sample selection) when analyzing and interpreting data. • Compare and contrast various types of data sets (e.g., self-generated, archival) to examine consistency of measurements and observations.	**LS4.B: Natural Selection** • Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals. **Related Content SE/TE:** 128, Condition 2: Individuals of a species vary in their characteristics • The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population. **Related Content SE/TE:** 128-129, Conditions of Natural Selection; Figure 2: Natural Selection 137, Coevolution and Evolutionary "Arms Races" **LS4.C: Adaptation** • Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the	**Patterns** Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. Classifications or explanations used at one scale may fail or need revision when information from smaller or larger scales is introduced thus requiring improved investigations and experiments. Patterns of performance of designed systems can be analyzed and interpreted to reengineer and improve the system. **Related Content SE/TE:** 128-129, Conditions of Natural Selection; Figure 2: Natural Selection 137, Coevolution and Evolutionary "Arms Races"

	proportion of individuals that do not. **Related Content SE/TE:** 128-129, Conditions of Natural Selection; Figure 2: Natural Selection 137, Coevolution and Evolutionary "Arms Races"	

HS.LS-NSE.d. Natural Selection and Evolution
Students who demonstrate understanding can: **d. Obtain and communicate information describing how changes in environmental conditions can affect the distribution of traits in a population and cause increases in the numbers of some species, the emergence of new species, and the extinction of other species.** **ENVIRONMENTAL SCIENCE: YOUR WORLD, YOUR TURN:** Evolution and natural selection are introduced in Chapter 5, Lesson 1, on SE/TE: 126-129. Allopatric speciation is explored on SE/TE: 131. Students **learn** about extinction on SE/TE: 132. Co-evolution is explored in Coevolution and Evolutionary "Arms Races" on SE/TE: 137. Students **explain** a hypothetical change in the distribution of traits in a species in Lesson 1 Assessment on SE/TE: 132. They **describe** allopatric speciation in Chapter 5 Assessment #18 on SE/TE: 160.

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Obtaining, Evaluating, and Communicating Information	**LS4.B: Natural Selection**	**Cause and Effect**
Obtaining, evaluating, and communicating information in 9–12 builds on 6–8 and progresses to evaluating the validity and reliability of the claims, methods, and designs. • Critically read scientific literature adapted for classroom use to identify key ideas and major points and to evaluate the validity and reliability of the claims, methods, and designs. **SE / TE:** 118-119, The Cloudless Forest 125 Black and White and Spread All Over 156-157, A Broken Mutualism • Generate, synthesize, communicate, and critique claims, methods, and designs that appear in scientific and technical texts or media reports. **SE / TE:** 118-119, The Cloudless Forest 125 Black and White and Spread All Over 156-157, A Broken Mutualism	• The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population. **SE / TE:** 128-129, Conditions of Natural Selection 128-129, Figure 2: Natural Selection 131, Speciation **LS4.C: Adaptation** • Adaptation also means that the distribution of traits in a population can change when conditions change. **SE / TE:** 137, Coevolution and Evolutionary "Arms Races" • 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. **SE / TE:** 118-119, The Cloudless Forest 125 Black and White and Spread All Over 127, Mechanisms of Biological Evolution 127, Figure 1: Biological Evolution 128-129, Conditions of Natural Selection	Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. Systems can be designed to cause a desired effect. Changes in systems may have various causes that may not have equal effects. **SE / TE:** 128-129, Conditions of Natural Selection 128-129, Figure 2: Natural Selection 131, Speciation

	128-129, Figure 2: Natural Selection 131, Speciation and Extinction 137, Coevolution and Evolutionary "Arms Races" 199 Saving the Siberian Tiger 208, A Sixth Mass Extinction? 209-211, Causes of Biodiversity Loss 497-499, Effects on Ecosystems and Organisms • 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. **SE / TE:** 132, Extinction 132, Figure 5: Mass Extinction 209-211, Causes of Biodiversity Loss	

HS.LS-NSE.e. Natural Selection and Evolution
Students who demonstrate understanding can: **e. Use evidence obtained from new technologies to compare similarity in DNA sequences, anatomical structures, and embryological appearance as evidence to support multiple lines of descent in evolution.** **ENVIRONMENTAL SCIENCE: YOUR WORLD, YOUR TURN:** The focus of this program is to enable all students to comprehend and connect environmental topics and concepts to their daily lives. This expectation falls outside of the program scope and sequence. See ***Miller & Levine Biology***, isbn: 978-013-361465-7, Chapter 18, Lesson 2 and 3.

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:		
Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in 9–12 builds on 6–8 and progresses to evaluating the validity and reliability of the claims, methods, and designs. • Critically read scientific literature adapted for classroom use to identify key ideas and major points and to evaluate the validity and reliability of the claims, methods, and designs. • Generate, synthesize, communicate, and critique claims, methods, and designs that appear in scientific and technical texts or media reports.	**LS4.A: Evidence of Common Ancestry and Diversity** • Genetic information, like the fossil record, also provides evidence of evolution. DNA sequences vary among species, but there are many overlaps • in fact, the ongoing branching that produces multiple lines of descent can be inferred by comparing the DNA sequences of different organisms. Such information is also derivable from the similarities and differences in amino acid sequences and from anatomical and embryological evidence.	**Patterns** Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. Classifications or explanations used at one scale may fail or need revision when information from smaller or larger scales is introduced thus requiring improved investigations and experiments. Patterns of performance of designed systems can be analyzed and interpreted to reengineer and improve the system.

HS.LS-NSE.f. Natural Selection and Evolution
Students who demonstrate understanding can: **f. Plan and carry out investigations to gather evidence of patterns in the relationship between natural selection and changes in the environment. [Clarification Statement: A possible investigation could be to study fruit flies and the number or eggs, larvae, and flies that hatch in response to environmental changes such as temperature, moisture, and acidity.]** **ENVIRONMENTAL SCIENCE: YOUR WORLD, YOUR TURN:** The focus of this program is to enable all students to comprehend and connect environmental topics and concepts to their daily lives. This expectation falls outside of the program scope and sequence. See ***Miller & Levine Biology***, isbn: 978-013-361465-7, Chapter 16, Lessons 3 and 4, Chapter 17, Lesson 3.
The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Planning and Carrying Out Investigations	**LS4.B: Natural Selection**	**Patterns**
Planning and carrying out investigations to answer questions or test solutions to problems in 9–12 builds on K–8 experiences and progresses to include investigations that build, test, and revise conceptual, mathematical, physical and empirical models. • Evaluate various methods of collecting data (e.g., field study, experimental design, simulations) and analyze components of the design in terms of various aspects of the study. Decide types, how much, and accuracy of data needed to produce reliable measurement and consider any limitations on the precision of the data (e.g., number of trials, cost, risk, time).	• The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population. **LS4.C: Adaptation** • Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not.	Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. Classifications or explanations used at one scale may fail or need revision when information from smaller or larger scales is introduced thus requiring improved investigations and experiments. Patterns of performance of designed systems can be analyzed and interpreted to reengineer and improve the system.

A Correlation of
Environmental Science: Your World, Your Turn ©2011
to the Next Generation Science Standards – DRAFT, May 2012
Grades 9-12

EARTH / SPACE SCIENCE

HS.ESS.ES.a. Earth's Systems
Students who demonstrate understanding can: **a. Apply scientific reasoning to explain how geophysical, geochemical, and geothermal evidence was used to develop the current model of the Earth's interior. [Clarification Statement: Evidence should include drill cores, gravity, seismic waves, and laboratory experiments on Earth materials.]** **ENVIRONMENTAL SCIENCE: YOUR WORLD, YOUR TURN:** The focus of this program is to enable all students to comprehend and connect environmental topics and concepts to their daily lives. This expectation falls outside of the program scope and sequence. See ***Earth Science***, isbn: 978-013-316392-6, Chapter 8, Section 4.
The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Constructing Explanations and Designing Solutions	**ESS2.A: Earth Materials and Systems**	**Systems and System Models**
Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific knowledge, principles, and theories. • Apply scientific reasoning, theory, and models to link evidence to claims and show why the data are adequate for the explanation or conclusion.	• Evidence from drill cores, gravity, seismic waves, and laboratory experiments on Earth materials, reconstructions of historical changes in Earth's surface and its magnetic field, and an understanding of geophysical and geochemical processes lead to a model of Earth with a hot but solid inner core, a liquid outer core, and a solid mantle and crust.	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. .

HS.ESS.ES.b. Earth's Systems		
Students who demonstrate understanding can: **b. Use a model of Earth's interior and the mechanisms of thermal convection to explain the cycling of matter and the impact of plate tectonics on Earth's surface. [*Assessment Boundary: Convection mechanisms should include heat from radioactive decay and gravity acting on materials of different densities as the drivers of convection and tectonic activity.*]** **ENVIRONMENTAL SCIENCE: YOUR WORLD, YOUR TURN:** The focus of this program is to enable all students to comprehend and connect environmental topics and concepts to their daily lives. This expectation falls outside of the program scope and sequence. See ***Earth Science***, isbn: 978-013-316392-6, Chapter 9, Section 4		
The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:		
Developing and Using Models Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and constructing models to predict and explain relationships between systems and their components in the natural and designed world. • Use models (including mathematical and computational) to generate data to explain and predict phenomena, analyze systems, and solve problems.	**ESS2.A: Earth Materials and Systems** • Motions of the mantle and its plates occur primarily through thermal convection, which involves the cycling of matter due to the outward flow of energy from Earth's interior and the increased downward gravitational pull on denser mantle material. **ESS2.B: Plate Tectonics and Large-Scale System Interactions** • The radioactive decay of unstable isotopes continually generates new energy within Earth's crust and mantle, providing the primary source of the heat that drives mantle convection. Plate tectonics can be viewed as the surface expression of mantle convection.	**Energy and Matter** The total amount of energy and matter in closed systems is conserved. Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. Energy drives the cycling of matter within and between systems. In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.

HS.ESS.ES.c. Earth's Systems		
Students who demonstrate understanding can: **c. Analyze the impact of water on the flow of energy and the cycling of matter within and among Earth systems. [*Assessment Boundary: Should explore the unique physical and chemical properties of water, such as the polar nature of the molecule and water's ability to absorb/store/release energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks.*]** **ENVIRONMENTAL SCIENCE: YOUR WORLD, YOUR TURN:** The citations below indicate areas in ***Environmental Science: Your World, Your Turn*** where this idea is introduced. For more comprehensive coverage, please see ***Earth Science***, isbn: 978-013-316392-6, Chapter 5, Section 1; Chapter 18, Section 1; and Chapter 21, Section 1.		
The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:		
Analyzing and Interpreting Data Analyzing data in 9–12 builds on K–8 and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. • Use tools, technologies, and/or models (e.g., computational, mathematical) to generate and analyze data in order to make valid and reliable scientific claims or determine an optimal design solution.	**ESS2.C: The Roles of Water in Earth's Surface Processes** • The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb/store/release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks. **Related Content SE/TE:** 69-71, Properties of Water	**Energy and Matter** The total amount of energy and matter in closed systems is conserved. Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. Energy drives the cycling of matter within and between systems. In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.

HS.ESS.ES.d. Earth's Systems		
Students who demonstrate understanding can: **d. Use Earth system models to explain how Earth's internal and surface processes work together at different spatial and temporal scales to form landscapes and sea floor features.** **ENVIRONMENTAL SCIENCE: YOUR WORLD, YOUR TURN:** The focus of this program is to enable all students to comprehend and connect environmental topics and concepts to their daily lives. This expectation falls outside of the program scope and sequence. See ***Earth Science***, isbn: 978-013-316392-6, Chapters 6, 9, 10, 11, 14, and 16.		
The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:		
Developing and Using Models Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and constructing models to predict and explain relationships between systems and their components in the natural and designed world. • Use models (including mathematical and computational) to generate data to explain and predict phenomena, analyze systems, and solve problems.	**ESS2.A: Earth Materials and Systems** • Earth's systems interact over a wide range of temporal and spatial scales and continually react to changing influences, including those from human activities. Components of Earth's systems may appear stable, change slowly over long periods of time, or change abruptly. Changes in part of one system can cause dynamic feedbacks that can increase or decrease the original changes, further changing that system or other systems in ways that are often surprising and complex.	**Systems and System Models** Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models.

HS.ESS.ES.e. Earth's Systems

Students who demonstrate understanding can:

e. Construct an evidence-based claim about how a change to one part of an Earth system creates feedbacks that causes changes in other systems (e.g., coastal dynamics, watersheds and reservoirs, stream flow and erosion rates, changes in ecosystems).

ENVIRONMENTAL SCIENCE: YOUR WORLD, YOUR TURN: Interacting Earth systems are introduced in Chapter 3, Lesson 2 on SE/TE: 72-74. Students **learn** about the concepts of interdependence, inputs and outputs, and positive and negative feedback loops. They **gain understanding** of the predator and prey relationship as an example of a negative feedback loop; erosion is an example of a positive feedback loop. Chapter 16, Lesson 2, SE/TE: 491-496, presents global climate change in relationship to positive feedbacks. The effects of global climate change on ecosystems and organisms are explored in Chapter 16, Lesson 3 on SE/TE: 497-501.

Students **explain** the positive feedback which occurs when snow melts in Lesson 2, Assessment #3 on SE/TE: 75. Students **describe** how deforestation affects climate change in Lesson 2, Assessment #3 on SE/TE: 496. Students **construct** evidence-based claims about how climate change creates feedbacks that affect other systems in Lesson 3, Assessment #1, 2, and 4 on SE/TE: 501.

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Constructing Explanations and Designing Solutions	**ESS2.A: Earth Materials and Systems**	**Systems and System Models**
Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific knowledge, principles, and theories. • Construct and revise explanations and arguments based on evidence obtained from a variety of sources (e.g., scientific principles, models, theories) and peer review.	• Earth's systems interact over a wide range of temporal and spatial scales and continually react to changing influences, including those from human activities. Components of Earth's systems may appear stable, change slowly over long periods of time, or change abruptly. Changes in part of one system can cause dynamic feedbacks that can increase or decrease the original changes, further changing that system or other systems in ways that are often surprising and complex. **SE / TE:** 72, Interacting Systems 74, Figure 13: Positive Feedback Loop	Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models. **SE / TE:** 72, Interacting Systems 75, Figure 14: Earth's Spheres 491-496, Climate Change 495, Figure 9: Climate Model 497-501, Effect of Climate Change

HS.ESS.ES.f. Earth's Systems
Students who demonstrate understanding can: **f. Use mathematical expressions of phenomena to simulate how temperature, relative humidity, air pressure, and the dew point vary from the windward to the leeward side of a mountain range.** **[Clarification Statement: The phenomena include latent heat, adiabatic heating/cooling, absolute/relative humidity, and dew point.]** **ENVIRONMENTAL SCIENCE: YOUR WORLD, YOUR TURN:** The citations below indicate areas in ***Environmental Science: Your World, Your Turn*** where this idea is introduced. Variations in temperature and precipitation from the windward to leeward side of mountains are introduced in Topography, SE/TE: 489.

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Using Mathematics and Computational Thinking	**ESS2.A: Earth Materials and Systems**	**Energy and Matter**
Mathematical and computational thinking at the 9–12 level builds on K–8 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 expressions to represent phenomena or design solutions in order to solve algebraically for desired quantities.	• Weather is driven by interactions of the geosphere, hydrosphere, and atmosphere. **Related Content SE/TE:** 489, Topography	The total amount of energy and matter in closed systems is conserved. Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. Energy drives the cycling of matter within and between systems. In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.

HS.ESS.ES.g. Earth's Systems

Students who demonstrate understanding can:

g. Use models to analyze data to make claims about how energy from the sun is redistributed throughout the atmosphere. [Clarification Statement: Unequal heating of the atmosphere results in high and low pressure systems
air moves from areas of high pressure to low pressure clockwise and counter-clockwise atmospheric circulations develop in response to Earth's rotation (the Coriolis Effect).]

ENVIRONMENTAL SCIENCE: YOUR WORLD, YOUR TURN: The citations below indicate areas in ***Environmental Science: Your World, Your Turn*** where this idea is introduced.

The distribution of energy from the sun throughout the atmosphere is explored in Energy From the Sun on SE/TE: 484-486. Students obtain information about wind patterns in the atmosphere on SE/TE: 487.

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Developing and Using Models	ESS2.A: Earth Materials and Systems	Energy and Matter
Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and constructing models to predict and explain relationships between systems and their components in the natural and designed world. • Use models (including mathematical and computational) to generate data to explain and predict phenomena, analyze systems, and solve problems. **Related Content SE/TE:** 487, Figure 3: Prevailing Winds 488, Figure 4: El Niño	• Weather is driven by interactions of the geosphere, hydrosphere, and atmosphere. **Related Content SE/TE:** 485-486, Energy From the Sun 487, Wind Patterns in the Atmosphere	The total amount of energy and matter in closed systems is conserved. Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. Energy drives the cycling of matter within and between systems. In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.

HS.ESS.CC.a. Climate Change		
Students who demonstrate understanding can: **a. Evaluate and communicate the climate changes that can occur when certain components of the climate system are altered. [Clarification Statement: For example, evaluate variations in incoming solar radiation as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems.]** **ENVIRONMENTAL SCIENCE: YOUR WORLD, YOUR TURN:** Chapter 16, Lesson 1, SE/TE: 484-490, explores the components of climate, including the greenhouse effect, variations in solar energy input including solar and orbital cycles, the effect of latitude, wind and ocean patterns, water, topology, volcanoes, and vegetation. Students **hypothesize** the climate on a planet with very little atmosphere and therefore a weak greenhouse effect in Lesson 1 Assessment #5 on SE/TE: 490. They **explain** the connection between deforestation and climate change in Lesson 2 Assessment #3 on SE/TE: 496.		
The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:		
Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in 9–12 builds on 6–8 and progresses to evaluate the validity and reliability of the claims, methods, and designs. • Critically read scientific literature adapted for classroom use to identify key ideas and major points and to evaluate the validity and reliability of the claims, methods, and designs. **SE/TE:** 483, Rising Seas May Flood the Maldive Islands 508-509, Science Behind the Stories	**ESS2.D: Weather and Climate** • The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space. Climate change can occur when certain parts of these systems are altered. **SE/TE:** 484-487: Energy From the Sun 487, Wind Patterns in the Atmosphere 488-489,The Oceans and Climate 489-490, Other Factors That Affect climate 495-496, Finding the Cause of Climate Change	**Stability and Change** Much of science deals with constructing explanations of how things change and how they remain stable. Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. Feedback (negative or positive) can stabilize or destabilize a system. Systems can be designed for greater or lesser stability. **SE/TE:** 495-496, Finding the Cause of Climate Change

HS.ESS.CC.b. Climate Change		
Students who demonstrate understanding can: **b. Construct a scientific argument showing that changes to any one of many different Earth and Solar System processes can affect global and regional climates.** **[Clarification Statement: Examples of these processes include the sun's energy output, Earth's orbit and axis orientation, tectonic events, ocean circulation, volcanic activity, glacial activity, the biosphere, and human activities.] [*Assessment Boundary: Use evidence from the geologic record only*.]** **ENVIRONMENTAL SCIENCE YOUR WORLD, YOUR TURN:** Students **obtain information** about the components of climate; the greenhouse effect, variations in solar energy input including solar and orbital cycles, the effect of latitude, wind and ocean patterns, water, topology, volcanoes, and vegetation in Chapter 16, Lesson 1, on SE/TE: 484-490. The evidence of climate change and its connections to human activity is presented in Lesson 2 on SE/TE: 491-496. Students **explain** the connection between deforestation and climate change in Lesson 2 Assessment #3 on SE/TE: 496.		
The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:		
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. Arguments may also come from current scientific or historical episodes in science. • Evaluate the claims, evidence, and reasoning of currently accepted explanations or solutions as a basis for the merits of the arguments. **SE/TE:** 493, Real Data: Changing Temperature of the Atmosphere 508-509, Science Behind the Stories	**ESS2.D: Weather and Climate** • The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles. **SE/TE:** 484-487: Energy From the Sun 487, Wind Patterns in the Atmosphere 488-489,The Oceans and Climate 489-490, Other Factors That Affect Climate 495-496, Finding the Cause of Climate Change Geologic evidence indicates that past climate changes were either sudden changes caused by alterations in the atmosphere, longer-term changes (e.g., ice ages) due to variations in solar output, Earth's orbit, or the orientation of its axis or even more graduate atmospheric changes due to plants and other organisms that captured carbon dioxide and released oxygen. The time scales of these changes varied from a few to millions of years. Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate (link to ESS3.D). **SE/TE:** 493, Real Data: Changing Temperature of the Atmosphere 495-496, Finding the Cause of Climate Change	**Stability and Change** Much of science deals with constructing explanations of how things change and how they remain stable. Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. Feedback (negative or positive) can stabilize or destabilize a system. Systems can be designed for greater or lesser stability. **SE/TE:** 495-496, Finding the Cause of Climate Change

HS.ESS.CC.c. Climate Change

Students who demonstrate understanding can:

c. Analyze geologic evidence that past climate changes have occurred over a wide range of time scales. **[Clarification Statement: Examples of evidence are ice core data, the fossil record, sea level fluctuations, glacial features.]**

ENVIRONMENTAL SCIENCE: YOUR WORLD, YOUR TURN: The citations below indicate areas in ***Environmental Science: Your World, Your Turn*** where this idea is introduced.

Geologic evidence for past climate changes are presented in Clues in Sediments, SE/TE: 494.

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Analyzing and Interpreting Data	ESS2.D: Weather and Climate	Stability and Change
Analyzing data in 9–12 builds on K–8 and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. • Use tools, technologies, and/or models (e.g., computational, mathematical) to generate and analyze data in order to make valid and reliable scientific claims or determine an optimal design solution.	• The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles. **Related Content SE/TE:** 494, Clues in Sediments • Geologic evidence indicates that past climate changes were either sudden changes caused by alterations in the atmosphere • longer-term changes (e.g., ice ages) due to variations in solar output, Earth's orbit, or the orientation of its axis • or even more graduate atmospheric changes due to plants and other organisms that captured carbon dioxide and released oxygen. The time scales of these changes varied from a few to millions of years. Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate (link to ESS3.D).	Much of science deals with constructing explanations of how things change and how they remain stable. Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. Feedback (negative or positive) can stabilize or destabilize a system. Systems can be designed for greater or lesser stability. **Related Content SE/TE:** 484-487: Energy From the Sun 487, Wind Patterns in the Atmosphere 488-489,The Oceans and Climate 489-490, Other Factors That Affect climate

HS.ESS.CC.d. Climate Change		
Students who demonstrate understanding can: **d. Engage in critical reading of scientific literature about causes of climate change over 10s-100s of years, 10s-100s of thousands of years, or 10s-100s of millions of years. [Clarification Statement: Examples of causes are changes in solar output, ocean circulation, volcanic activity (10s-100s of years) changes to Earth's orbit and the orientation of its axis (10s-100s of thousands of years) or long-term changes in atmospheric composition (10s-100s of millions of years).]** **ENVIRONMENTAL SCIENCE: YOUR WORLD, YOUR TURN:** The citations below indicate areas in ***Environmental Science: Your World, Your Turn*** where this idea is introduced. Chapter 16, Lesson 1 explores causes of climate change that affect various time scales, such as sunspot cycles, SE/TE: 487, the cyclic changes in the Earth's orbit and axis orientation, SE/TE: 490, and greenhouse gases, SE/TE: 495.		
The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:		
Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in 9–12 builds on 6–8 and progresses to evaluate the validity and reliability of the claims, methods, and designs. • Critically read scientific literature adapted for classroom use to identify key ideas and major points and to evaluate the validity and reliability of the claims, methods, and designs. **Related Content SE/TE:** 508-509, Science Behind the Stories	**ESS2.D: Weather and Climate** • The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles. **Related Content SE/TE:** 484-487: Energy From the Sun 487, Wind Patterns in the Atmosphere 488-489,The Oceans and Climate 489-490, Other Factors That Affect climate • Geologic evidence indicates that past climate changes were either sudden changes caused by alterations in the atmosphere • longer-term changes (e.g., ice ages) due to variations in solar output, Earth's orbit, or the orientation of its axis • or even more graduate atmospheric changes due to plants and other organisms that captured carbon dioxide and released oxygen. The time scales of these changes varied from a few to millions of years. Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate (link to ESS3.D).	**Stability and Change** Much of science deals with constructing explanations of how things change and how they remain stable. Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. Feedback (negative or positive) can stabilize or destabilize a system. Systems can be designed for greater or lesser stability. **Related Content SE/TE:** 484-487: Energy From the Sun 487, Wind Patterns in the Atmosphere 488-489,The Oceans and Climate 489-490, Other Factors That Affect Climate

HS.ESS.CC.e. Climate Change		
Students who demonstrate understanding can: **e. Use global climate models in combination with other geologic data to predict and explain how human activities and natural phenomena affect climate, providing the scientific basis for planning for humanity's future needs.** **[Clarification Statement: For example, use global climate models together with topographic maps to investigate effects of sea level change or combine global climate models with precipitation maps to investigate locations where new water supplies will be needed.]** **ENVIRONMENTAL SCIENCE: YOUR WORLD, YOUR TURN:** The citations below indicate areas in ***Environmental Science: Your World, Your Turn*** where this idea is introduced. Students **learn** about climate models in Chapter 16, Lesson 2 on SE/TE: 494-495.		
The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:		
Developing and Using Models Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and constructing models to predict and explain relationships between systems and their components in the natural and designed world. • Use models (including mathematical and computational) to generate data to explain and predict phenomena, analyze systems, and solve problems.	**ESS2.D: Weather and Climate** • Global climate models are often used to understand the process of climate change because these changes are complex and can occur slowly over Earth's history. Global climate models incorporate scientists' best knowledge of the physical and chemical processes and of the interactions of relevant systems. They are tested by their ability to fit past climate variations. **Related Content SE/TE:** 494-495, Climate Models 495, Figure 9: Climate Models	**Cause and Effect** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. Systems can be designed to cause a desired effect. Changes in systems may have various causes that may not have equal effects. **Related Content SE/TE:** 494-495, Models: Predicting the Future

HS.ESS.CC.f. Climate Change
Students who demonstrate understanding can: **f. Apply scientific knowledge to investigate how humans may predict and modify their impacts on future global climate systems (e.g., investigating the feasibility of geoengineering design solutions to global temperature changes).** **ENVIRONMENTAL SCIENCE: YOUR WORLD, YOUR TURN:** The citations below indicate areas in ***Environmental Science: Your World, Your Turn*** where this idea is introduced. Climate change mitigation methods are presented in Chapter 16, Lesson 4: Responding to Climate Change on SE/TE: 502-507.

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Constructing Explanations and Designing Solutions	**ESS2.D: Weather and Climate**	**Connections to Engineering, Technology, and Applications of Science**
Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific knowledge, principles, and theories. • Apply scientific reasoning, theory, and models to link evidence to claims and show why the data are adequate for the explanation or conclusion.	• 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 by the ways in which these gases are absorbed by the ocean and biosphere. Hence the outcomes depend on human behaviors (link to ESS3.D) as well as on natural factors that involve complex feedbacks among Earth's systems (link to ESS3.A).	**Influence of Engineering, Technology, and Science on Society and the Natural World** Modern civilization depends on major technological systems, such as agriculture, health, water, energy, transportation, manufacturing, construction, and communications. Engineers continuously modify these systems to increase benefits while decreasing costs and risks. New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. **Related Content SE/TE:** 502-507, Responding to Climate Change

HS.ESS.CC.g. Climate Change		
Students who demonstrate understanding can: **g. Use models of the flow of energy between the sun and Earth's atmosphere and surface to explain how different wavelengths of energy are absorbed and retained by various greenhouse gases in Earth's atmosphere, thereby affecting Earth's radiative balance. [Clarification Statement: Students will work with absorption spectra of different Earth materials.]** **ENVIRONMENTAL SCIENCE: YOUR WORLD, YOUR TURN:** The citations below indicate areas in ***Environmental Science: Your World, Your Turn*** where this idea is introduced. The greenhouse effect is presented qualitatively in Chapter 16, Lesson 1 on SE/TE: 484-485.		
The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:		
Developing and Using Models Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and constructing models to predict and explain relationships between systems and their components in the natural and designed world. • Use models (including mathematical and computational) to generate data to explain and predict phenomena, analyze systems, and solve problems.	**ESS3.D: Global Climate Change** • Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts. • Thus science and engineering will be essential both to understanding the possible impacts of global climate change and to informing decisions about how to slow its rate and consequences–for humanity as well as for the rest of the planet.	**Cause and Effect** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. Systems can be designed to cause a desired effect. Changes in systems may have various causes that may not have equal effects. **Related Content SE/TE:** 484-485, Energy From the Sun

HS.ESS-HS.a. Human Sustainability
Students who demonstrate understanding can: **a. Construct arguments for how the developments of human societies have been influenced by natural resource availability including: locations of streams, deltas, and high concentrations of minerals, ores, coal, and hydrocarbons.** **ENVIRONMENTAL SCIENCE: YOUR WORLD, YOUR TURN:** The citations below indicate areas in ***Environmental Science: Your World, Your Turn*** where this idea is introduced. The idea that the first permanent settlements were next to water sources is explored in Selective Breeding and Settlement on SE/TE: 366.

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:		
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 natural and designed world. Arguments may also come from current scientific or historical episodes in science. • Evaluate the claims, evidence, and reasoning of currently accepted explanations or solutions as a basis for the merits of the arguments.	**ESS3.A: Natural Resources** • Resource availability has guided the development of human society. Resource availability affects geopolitical relationships and can limit development. **Related Content SE/TE:** 366, Selective Breeding and Settlement	***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering, and Technology on Society and the Natural World** Modern civilization depends on major technological systems, such as agriculture, health, water, energy, transportation, manufacturing, construction, and communications. Engineers continuously modify these systems to increase benefits while decreasing costs and risks. New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. **Related Content SE/TE:** 366, Selective Breeding and Settlement 366, Traditional Agriculture 367-368, Industrial Agriculture

HS.ESS-HS.b. Human Sustainability

Students who demonstrate understanding can:

b. Reflect on and revise design solutions for local resource development that would increase the ratio of benefits to costs and risks to the community and its environment. **[Clarification Statement: Examples of local resource development include soil use for agriculture, water use, mining for coal and minerals, pumping for oil and natural gas.]**

ENVIRONMENTAL SCIENCE: YOUR WORLD, YOUR TURN: The citations below indicate areas in ***Environmental Science: Your World, Your Turn*** where this idea is introduced.

The benefits and costs of energy production and resource extraction are presented in several places within the text. Mining is explored in Chapter 13, Lesson 2 on SE/TE page 398-404; impacts from mining on communities in, Lesson 3 on SE/TE page 405-411. Students **learn** about the impacts of fossil fuels in Chapter 17, Lesson 2 on SE/TE: 530-533. Nuclear energy is discussed in Chapter 17, Lesson 3 on SE/TE: 539-540. Students **obtain information** about the benefits and costs of alternative forms of energy in Chapter 18 on SE/TE: 553, 555, 558, and 560.

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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 natural and designed world. Arguments may also come from current scientific or historical episodes in science. • Criticize and evaluate arguments and design solutions in light of new evidence, limitations (e.g., trade-offs), constraints, and ethical issues. **Related Content SE/TE:** 409, What Do You Think? **Related Content TE Only:** 407, Big Question	**ESS3.A: Natural Resources** • All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors. **Related Content SE/TE:** 399-402, Mining Methods 400, Figure 8: Open Pit Mining 401, Figure 9: Mountaintop Removal 401, Figure 10: Solution Mining for Salt 405-408, Negative Impacts of Mining 406, Figure 15: Acid Drainage 407, Figure 16: Infrastructure Damage 530-531, Pollution From Fossil fuels 532-533, Damage Caused by Extracting Fuels 539-540, Benefits and costs of Nuclear Power 550-551, The Reasons for Alternative Energy 553, Benefits of Biomass Energy 553, Costs of Biomass Energy 555, Benefits and Costs of Geothermal Energy 558, Benefits of Hydropower 558, Costs of Hydropower 560, Costs and Benefits	***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering, and Technology on Society and the Natural World** Modern civilization depends on major technological systems, such as agriculture, health, water, energy, transportation, manufacturing, construction, and communications. Engineers continuously modify these systems to increase benefits while decreasing costs and risks. New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. **Related Content SE/TE:** 405-408, Negative Impacts of Mining 530-531, Pollution From Fossil fuels 532-533, Damage Caused by Extracting Fuels 539-540, Benefits and costs of Nuclear Power 550-551, The Reasons for Alternative Energy 553, Benefits of Biomass Energy 553, Costs of Biomass Energy 555, Benefits and Costs of Geothermal Energy 558, Benefits of Hydropower 558, Costs of Hydropower 560, Costs and Benefits

HS.ESS-HS.c. Human Sustainability

Students who demonstrate understanding can:

c. Construct scientific claims for how increases in the value of water, mineral, and fossil fuel resources due to increases in population and rates of consumption have sometimes led to the development of new technologies to retrieve resources previously thought to be economically or technologically unattainable.

ENVIRONMENTAL SCIENCE: YOUR WORLD, YOUR TURN: The citations below indicate areas in ***Environmental Science: Your World, Your Turn*** where this idea is introduced.

The development of new sources of water due to rising demand and due to increased consumption and population which is made possible by rising prices is presented in Solutions That Increase Supply on SE/TE: 432-433. Students **learn** about the development of new sources of fossil fuels in The Supply of Fossil Fuels on SE/TE: 527-528. Research to develop ocean thermal energy conversion as an energy source is explored in Thermal Energy from the Ocean on SE/TE: 560.

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Constructing Explanations and Designing Solutions	ESS3.A: Natural Resources	Connections to Engineering, Technology, and Applications of Science
Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific knowledge, principles, and theories. • Construct and revise explanations and arguments based on evidence obtained from a variety of sources (e.g., scientific principles, models, theories) and peer review.	• As the global human population increases and people's demands for better living conditions increase, resources considered readily available in the past, such as land for agriculture or drinkable water, are becoming scarcer and more valued. **Related Content SE/TE:** 432-433, Solutions That Increase Supply 527-529, The Supply of Fossil Fuels 560, Thermal Energy From the Ocean	**Interdependence of Science, Engineering, and Technology** Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise.

HS.ESS-HS.d. Human Sustainability		
Students who demonstrate understanding can: **d. Construct scientific arguments from evidence to support claims that natural hazards and other geologic events have influenced the course of human history. [Clarification Statement: Famines that result from reduced global temperatures can follow large historic volcanic eruptions. Large earthquakes and tsunamis can destroy cities, and there is a strong correlation between historic climate changes and the number of wars.]** **ENVIRONMENTAL SCIENCE: YOUR WORLD, YOUR TURN:** The citations below indicate areas in ***Environmental Science: Your World, Your Turn*** where this idea is introduced. Earthquakes, tsunamis, and volcanoes are explored in Chapter 9, Lesson 4 on SE/TE: 277-279. Students **obtain information** about the January 2010 Haiti earthquake and December 2004 earthquake and resulting tsunami that affected South Asia.		
The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:		
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific knowledge, principles, and theories. • Construct and revise explanations and arguments based on evidence obtained from a variety of sources (e.g., scientific principles, models, theories) and peer review.	**ESS3.B: Natural Hazards** • Natural hazards and other geologic events have shaped the course of human history by destroying buildings and cities, eroding land, changing the courses of rivers, and reducing the amount of arable land. These events have significantly altered the sizes of human populations and have driven human migrations. **Related Content SE/TE:** 277-283, Natural Disasters	**Cause and Effect** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. Systems can be designed to cause a desired effect. Changes in systems may have various causes that may not have equal effects.

HS.ESS-HS.e. Human Sustainability		
Students who demonstrate understanding can: **e. Construct scientific claims about the impacts of human activities on the frequency and intensity of some natural hazards.** **[Clarification Statement: Natural hazards to include floods, droughts, forest fires, landslides, etc.]** **ENVIRONMENTAL SCIENCE: YOUR WORLD, YOUR TURN:** Natural disasters are presented in Chapter 9: Natural Disasters on SE/TEz; 277-283. Increase in flooding as a result of deforestation is covered in Land Clearing on SE/TE: 244. Students **learn** about the increase in forest fires because of human activities in Fire Policies on SE/TE: 340-342. Anthropogenic climate change, including increases in the frequency and intensity of floods, droughts, heat waves, storms, and forest fires is explored in Chapter 16, Lessons 2 and 3. Droughts and floods are presented in Changes in Precipitation on SE/TE: 492. Students obtain information about droughts, heat waves, forest fires, and storms on SE/TE: page 500. Students **role play** reporters from fifty years in the future and **write** about a specific natural hazard caused by climate change in Big Question on TE: 500.		
The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:		
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific knowledge, principles, and theories. • Construct and revise explanations and arguments based on evidence obtained from a variety of sources (e.g., scientific principles, models, theories) and peer review. **TE Only:** 500, Big Question	**ESS3.B: Natural Hazards** • Natural hazards can be local, regional, or global in origin, and their risks increase as populations grow. Human activities can contribute to the frequency and intensity of some natural hazards. **SE / TE:** 244, Land Clearing 277-283, Natural Disasters 340-342, Fire Policies 500, Impact on People Right Now	***Connections to Engineering, Technology, and Applications of Science*** Influence of Science, Engineering, and Technology on Society and the Natural World Modern civilization depends on major technological systems, such as agriculture, health, water, energy, transportation, manufacturing, construction, and communications. Engineers continuously modify these systems to increase benefits while decreasing costs and risks. New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. **SE / TE:** 500, Impact on People Right Now

HS.ESS-HS.f. Human Sustainability		
Students who demonstrate understanding can: **f. Identify mathematical relationships using data on the rates of production and consumption of natural resources in order to assess the global sustainability of human society.** [***Assessment Boundary: Students construct equations for linear relationships, but not expected to construct equations for non-linear relationships.***] **ENVIRONMENTAL SCIENCE: YOUR WORLD, YOUR TURN:** The citations below indicate areas in ***Environmental Science: Your World, Your Turn*** where this idea is introduced. Peak oil and the remaining supply of oil vs. global demand are presented in The Supply of Fossil Fuels on SE/TE: 527-528.		
The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:		
Using Mathematics and Computational Thinking Mathematical and computational thinking at the 9–12 level builds on K–8 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. Students also use and create simple computational simulations based on mathematical models of basic assumptions. • Use mathematical expressions to represent phenomena or design solutions in order to solve algebraically for desired quantities.	**ESS3.C: Human Impacts on Earth Systems** • The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. **Related Content SE/TE:** 527-528, The Supply of Fossil Fuels 527, Figure 10: World Consumption of Fossil Fuels 1980-2006 Figure 11: Oil Production	***Connections to Engineering, Technology, and Applications of Science*** Influence of Science, Engineering, and Technology on Society and the Natural World Modern civilization depends on major technological systems, such as agriculture, health, water, energy, transportation, manufacturing, construction, and communications. Engineers continuously modify these systems to increase benefits while decreasing costs and risks. New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.

HS.ESS-HS.g. Human Sustainability

Students who demonstrate understanding can:

g. Construct arguments about how engineering solutions have been and could be designed and implemented to mitigate local or global environmental impacts. **[Clarification Statement: Environmental impacts to include acid rain, water pollution, the ozone hole, etc.]**

ENVIRONMENTAL SCIENCE: YOUR WORLD, YOUR TURN: Germany's adoption of renewable energy sources to decrease greenhouse emissions is explored on SE/TE: 549. Students **learn** about biomass and geothermal energy as ways to create energy with less environmental damage in Chapter 18, Lesson 1 on SE/TE: 550-555. Hydroelectric power and new ways of generating energy in the ocean are presented in Chapter 18, Lesson 2, on SE/TE: 557-560. Solar and wind power are covered in Chapter 18, Lesson 3, on SE/TE: 562-564 and 566-567.

Students **describe** geothermal energy production in Lesson 1 Assessment #3 on SE/TE: 555. They **construct** arguments about hydroelectric power in the Big Question on TE: 558. Students **describe** the implementation process of a hydroelectric project and its effect on people in the area in Find Out More on TE: 560. Students **explain** how flat-plate solar collectors work in the Reading Connection on SE/TE: 562. Students **describe** the difference between passive and active solar heating in Lesson 3 Assessment #1 on SE/TE: 569.

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Constructing Explanations and Designing Solutions	ESS3.C: Human Impacts on Earth Systems	*Connections to Engineering, Technology, and Applications of Science*
Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific knowledge, principles, and theories. • Construct and revise explanations and arguments based on evidence obtained from a variety of sources (e.g., scientific principles, models, theories) and peer review. **SE / TE:** 555, Lesson 1 Assessment #3 562, Reading Connection 569, Lesson 3 Assessment #1 **TE Only:** 558, Big Question 560, Find Out More	• Scientists and engineers can make major contributions–for example, by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. When the source of an environmental problem is understood and international agreement can be reached, human activities can be regulated to mitigate global impacts (e.g., acid rain and the ozone hole over Antarctica). **SE / TE:** 549, Germany's Big Bet on Renewable Energy 550-555, Biomass and Geothermal Energy 557-558, Generating Electricity With Hydropower 559-560, Energy From the Ocean 562-564, Harnessing Solar Energy 566-567, Harnessing Wind Power	**Influence of Science, Engineering, and Technology on Society and the Natural World** Modern civilization depends on major technological systems, such as agriculture, health, water, energy, transportation, manufacturing, construction, and communications. Engineers continuously modify these systems to increase benefits while decreasing costs and risks. New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. **SE / TE:** 549, Germany's Big Bet on Renewable Energy 550-555, Biomass and Geothermal Energy 557-558, Generating Electricity With Hydropower 559-560, Energy From the Ocean 562-564, Harnessing Solar Energy 565-566, Benefits and Costs of solar Power 566-567, Harnessing Wind Power 568-569, Benefits and Costs of Wind Power

HS.ESS-HS.h. Human Sustainability		
Students who demonstrate understanding can: **h. Use results from computational General Circulation Models (GCMs) to investigate how the hydrosphere, atmosphere, geosphere, and biosphere are being modified in response to human activities.** **ENVIRONMENTAL SCIENCE: YOUR WORLD, YOUR TURN:** The citations below indicate areas in ***Environmental Science: Your World, Your Turn*** where this idea is introduced. Climate models are introduced qualitatively in Chapter 16, Lesson 2 on SE/TE: 494-495.		
The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:		
Analyzing and Interpreting Data Analyzing data in 9–12 builds on K–8 and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. • Use tools, technologies, and/or models (e.g., computational, mathematical) to generate and analyze data in order to make valid and reliable scientific claims or determine an optimal design solution.	**ESS3.C: Human Impacts on Earth Systems** • Through computer simulations and other studies, important discoveries are still being made about how the ocean, atmosphere, and biosphere interact and are modified in response to human activities and changes in human activities. **Related Content SE/TE:** 494-495, Models: Predicting the Future	**Cause and Effect** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. Systems can be designed to cause a desired effect. Changes in systems may have various causes that may not have equal effects.