CASE

Natural Resources and Ecology Expanded Lesson Review

Lesson 1.2 Building Biomes

Concepts	Performance Objectives
Students will know and understand	*Students will learn concepts by doing*
1. Accurate and useful field notes are the result of regular observations of the natural world and are used as a tool in the scientific study of the natural world.	• Record observations of natural artifacts using scientific note taking in their field journal.
2. A biome is a classification of the predominant vegetation present and is largely determined by climate, altitude, and latitude.	• Research a biome and determine the defining characteristics of that biome. • Present biome information using multimedia presentation tools as a team.
3. Diversity of an ecosystem includes both the living and non-living components.	• Observe a local ecosystem and record field notes based on their observations. • Identify and initiate research of a chosen ecosystem to be studied for the remainder of the course.

Next Generation Science Standards Alignment

Science and Engineering Practices	
Obtaining, Evaluating, and Communicating Information	Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs. • Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source. • Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).

Common Core State Standards for English Language Arts

CCSS: English Language Arts Standards » Writing » Grade 9-10	
Production and Distribution of Writing	• **WHST.9-10.4 –** Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. • **WHST.9-10.6 –** Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.
Research to Build and Present Knowledge	• **WHST.9-10.7 –** Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. • **WHST.9-10.8 –** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation. • **WHST.9-10.9 –** Draw evidence from informational texts to support analysis, reflection, and research.
Range of Writing	• **WHST.9-10.10 –** Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Essential Questions

1. What is the biosphere?
2. What is a biome?
3. What types of biomes are there and where are they located in the world?
4. What is the main factor that makes a biome different from other biomes?
5. How should someone observe the natural world?
6. What is the difference between taking notes in a classroom versus taking notes in the field?
7. What is an ecosystem?
8. What is the difference between the biosphere, biome, and ecosystem?
9. How does someone identify an area or region as an ecosystem?
10. What are the elements of an ecosystem?
11. What are the relationships of the elements within an ecosystem?

Lesson 1.2 Building Biomes

Concepts	Performance Objectives
Students will know and understand	*Students will learn concepts by doing*
1. Accurate and useful field notes are the result of regular observations of the natural world and are used as a tool in the scientific study of the natural world.	• Record observations of natural artifacts using scientific note taking in their field journal.
2. A biome is a classification of the predominant vegetation present and is largely determined by climate, altitude, and latitude.	• Research a biome and determine the defining characteristics of that biome. • Present biome information using multimedia presentation tools as a team.
3. Diversity of an ecosystem includes both the living and non-living components.	• Observe a local ecosystem and record field notes based on their observations. • Identify and initiate research of a chosen ecosystem to be studied for the remainder of the course.

Next Generation Science Standards Alignment

Science and Engineering Practices	
Obtaining, Evaluating, and Communicating Information	Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs. • Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source. • Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).

Common Core State Standards for English Language Arts

CCSS: English Language Arts Standards » Writing » Grade 9-10	
Production and Distribution of Writing	• **WHST.9-10.4 –** Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

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Research to Build and Present Knowledge	• **WHST.9-10.7 –** Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. • **WHST.9-10.8 –** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation. • **WHST.9-10.9 –** Draw evidence from informational texts to support analysis, reflection, and research.
Range of Writing	• **WHST.9-10.10 –** Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Essential Questions

1. What is the biosphere?
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10. What are the elements of an ecosystem?
11. What are the relationships of the elements within an ecosystem?

Lesson 2.1 Soils and Land

Concepts	Performance Objectives
Students will know and understand	*Students will learn concepts by doing*
1. Soil formation factors, including climate and parent material, influence soil types and uses.	• Depict the process of soil formation by drawing a comic strip.
2. Soil texture and structure influence soil properties and usability.	• Determine soil texture by feel and ribbon testing. • Describe and sketch the differences in soil structure types.
3. Soil is a natural filter and can collect nutrients and other materials from water.	• Compare the permeability and filtration capacity of different soil types.
4. The development, use, and management of soil as a natural resource are directly related to soil properties.	• Calculate slope of an area of land. • Classify land according to appropriate use based on slope, erosion factors, drainage, and workability.

National AFNR Career Cluster Content Standards Alignment

AFNR: LifeKnowledge® and Cluster Skills Content Standards	
CS.08.	Technical Skills: Use tools, equipment, machinery and technology appropriate to work within areas related to AFNR.

AFNR: Natural Resources Systems Career Pathway Content Standards	
NRS.02.	Apply scientific principles to natural resource management activities.

Next Generation Science Standards Alignment

Science and Engineering Practices	
Using Mathematics and Computational Thinking	Mathematical and computational thinking in 9-12 builds on K-8 and experiences 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, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.

Crosscutting Concepts	
Patterns	Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.
	• 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.
Systems and System Models	A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.
	• 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.
Structure and Function	The way an object is shaped or structured determines many of its properties and functions.
	• The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials.

Understandings about the Nature of Science	
Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena	• Scientists often use hypotheses to develop and test theories and explanations.

Common Core State Standards for High School Mathematics

Modeling standards are indicated by the star symbol (*) throughout other conceptual categories.

CCSS: Conceptual Category – Number and Quantity	
Quantities	• *Reason quantitatively and use units to solve problems.

Common Core State Standards for English Language Arts

CCSS: English Language Arts Standards » Writing » Grade 9-10	
Text Types and Purposes	• **WHST.9-10.2 –** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

Production and Distribution of Writing	• **WHST.9-10.4 –** Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
Research to Build and Present Knowledge	• **WHST.9-10.8 –** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation. • **WHST.9-10.9 –** Draw evidence from informational texts to support analysis, reflection, and research.
Range of Writing	• **WHST.9-10.10 –** Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Essential Questions

1. What is soil?
2. Why is soil considered a natural resource?
3. How is soil formed?
4. How is soil texture influenced by the soil formation process?
5. How can I determine soil texture?
6. What soil characteristics determine soil structure?
7. How does soil serve as a natural filter?
8. How does soil type influence the filtering ability of soil?
9. How does slope contribute to soil properties and characteristics?
10. How is land classified?
11. Why is there a need for Class I and Class II soils?

Lesson 2.2 Reading the Land

Concepts	Performance Objectives
Students will know and understand	*Students will learn concepts by doing*
1. Topographic maps provide information on the configuration of the surface of the Earth.	• Read a topographic map and understand the steepness of slope portrayed in the map.
2. Erosion influences land use and may cause environmental changes in ecosystems.	• Design and conduct an experiment to determine the effects of slope and vegetation on erosion.
3. A soil survey is used as a land use planning tool.	• Use the Web Soil Survey to gather information for land use planning.

National AFNR Career Cluster Content Standards Alignment

AFNR: LifeKnowledge® and Cluster Skills Content Standards	
CS.08.	Technical Skills: Use tools, equipment, machinery and technology appropriate to work within areas related to AFNR.
CS.11.	Scientific Inquiry: Utilize scientific inquiry as an investigative method.

Next Generation Science Standards Alignment

Science and Engineering Practices	
Asking Questions and Defining Problems	Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations. • Ask questions that can be investigated within the scope of the school laboratory, research facilities, or field (e.g., outdoor environment) with available resources and, when appropriate, frame a hypothesis based on a model or theory.
Developing and Using Models	Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s). • Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.
Planning and Carrying Out Investigations	Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models. • Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. • Select appropriate tools to collect, record, analyze, and evaluate data. • Make directional hypotheses that specify what happens to a dependent variable when an independent variable is manipulated.
Using Mathematics and Computational Thinking	Mathematical and computational thinking in 9-12 builds on K-8 and experiences 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, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations. • Apply techniques of algebra and functions to represent and solve scientific and engineering problems.
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 ideas, principles, and theories. • Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.
Obtaining, Evaluating, and Communicating Information	Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs. • Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).

Crosscutting Concepts	
Cause and Effect: Mechanism and Prediction	Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.
	• Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.
Systems and System Models	A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.
	• 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.

Understandings about the Nature of Science	
Scientific Investigations Use a Variety of Methods	• Science investigations use diverse methods and do not always use the same set of procedures to obtain data.

	• Scientific inquiry is characterized by a common set of values that include: logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings.
Scientific Knowledge is Based on Empirical Evidence	• Science knowledge is based on empirical evidence.
Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena	• Scientists often use hypotheses to develop and test theories and explanations.

Common Core State Standards for High School Mathematics

Modeling standards are indicated by the star symbol (*) throughout other conceptual categories.

CCSS: Conceptual Category – Number and Quantity	
Quantities	• *Reason quantitatively and use units to solve problems.

Common Core State Standards for English Language Arts

CCSS: English Language Arts Standards » Science & Technical Subjects » Grade 9-10	
Range of Reading and Level of Text Complexity	• **RST.9-10.10 –** By the end of grade 10, read and comprehend science/technical texts in the grades 9-10 text complexity band independently and proficiently.

CCSS: English Language Arts Standards » Writing » Grade 9-10	
Text Types and Purposes	**WHST.9-10.1 –** Write arguments focused on discipline-specific content. • **WHST.9-10.1.D –** Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. **WHST.9-10.2 –** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. • **WHST.9-10.2.D –** Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.
Production and Distribution of Writing	• **WHST.9-10.4 –** Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. • **WHST.9-10.6 –** Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.
Research to Build and Present Knowledge	• **WHST.9-10.7 –** Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
Range of Writing	• **WHST.9-10.10 –** Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Essential Questions

1. What is topography?
2. What is a topographic map?
3. How do contour lines indicate steep and gentle slopes?
4. What is soil erosion?
5. What causes erosion?
6. How can erosion be controlled or prevented?
7. How does soil erosion influence land use and environmental changes in ecosystems?
8. What is a soil survey?
9. What is a soil survey map?

10. How is the use of topographic maps, soil survey maps, and other information about land used in planning the development and use of land?

Lesson 3.1 Water Basics

Concepts	Performance Objectives
Students will know and understand	*Students will learn concepts by doing*
1. The hydrologic cycle is driven by solar energy resulting in water evaporating into the atmosphere and returning to the surface of the Earth in different forms.	• Diagram the hydrologic cycle and define terms used in describing the movement of water through the cycle.
2. Water is converted into a series of forms as it moves through the environment over time.	• Simulate the movement of water through the hydrologic cycle using a model system.
3. Lakes, rivers, and oceans are three major types of bodies of water that have characteristics influenced by climate, topography, and organisms.	• Identify lakes, rivers, and oceans found in North America and research the characteristics of geography, climate, and elevation that influence those bodies of water. • Investigate an aquatic ecosystem and research the defining characteristics of that ecosystem. • Compare aquatic ecosystems and note differences and similarities.

National AFNR Career Cluster Content Standards Alignment

AFNR: LifeKnowledge® and Cluster Skills Content Standards	
CS.08.	Technical Skills: Use tools, equipment, machinery and technology appropriate to work within areas related to AFNR.
CS.11.	Scientific Inquiry: Utilize scientific inquiry as an investigative method.

Next Generation Science Standards Alignment

Science and Engineering Practices	
Developing and Using Models	Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s). • Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system. • Develop and/or use multiple types of models to provide mechanistic accounts and/or predict phenomena, and move flexibly between model types based on merits and limitations.
Analyzing and Interpreting Data	Analyzing data in 9–12 builds on K–8 experiences 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. • Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.

Crosscutting Concepts	
Energy and Matter: Flows, Cycles, and Conservation	Tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior.
	• The total amount of energy and matter in closed systems is conserved. • Energy drives the cycling of matter within and between systems.

Common Core State Standards for High School Mathematics

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CCSS: Conceptual Category – Number and Quantity	
Quantities	• *Reason quantitatively and use units to solve problems.

CCSS: Conceptual Category – Statistics and Probability	
Interpreting Categorical and Quantitative Data	• *Summarize, represent, and interpret data on a single count or measurement variable.

Common Core State Standards for English Language Arts

Production and Distribution of Writing	• **WHST.9-10.4 –** Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
Research to Build and Present Knowledge	• **WHST.9-10.7 –** Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
Range of Writing	• **WHST.9-10.10 –** Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Essential Questions

1. What is the hydrologic cycle?
2. What are the different stages of the hydrologic cycle and what is their function?
3. What are various forms of water?
4. How does water move within the hydrologic cycle?
5. What are the main types of bodies of water?
6. How does climate influence a body of water?
7. How does topography determine the characteristics of a body of water?
8. What are the differences among arctic, temperate, and tropical lakes?
9. How does an alpine aquatic ecosystem differ from a basin aquatic ecosystem?

Lesson 3.2 Water Function

Concepts	Performance Objectives
Students will know and understand	*Students will learn concepts by doing*
1. The Water Quality Index uses a series of tests, such as temperature, dissolved oxygen, pH, turbidity, and nitrates to indicate the overall quality of a body of water.	• Conduct water quality tests to determine the temperature, pH, turbidity, dissolved oxygen, total solids, biochemical oxygen demand, phosphates, nitrates, and fecal coliform from a local sample of water.
2. Water quality determines potential uses of water, such as for drinking, irrigation for agriculture, industrial use, and recreational use.	• Calculate the quality of local water by completing the Water Quality Index.
3. Water quality is influenced by environmental conditions and human activities.	• Determine the ability of different soils to filter acid rain.

4. The movement of water through watersheds and soil can alter the quality of water.	• Predict and simulate how landforms influence the movement of surface water. • Compare Q-Values and Water Quality Indexes at two river locations and analyze the causes of the changes.

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Next Generation Science Standards Alignment

Disciplinary Core Ideas	
Life Science	
LS2: Ecosystems: Interactions, Energy, and Dynamics	
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.

Science and Engineering Practices	
Developing and Using Models	Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s). • Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.
Planning and Carrying Out Investigations	Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models. • Make directional hypotheses that specify what happens to a dependent variable when an independent variable is manipulated.
Analyzing and Interpreting Data	Analyzing data in 9–12 builds on K–8 experiences 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. • Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. • Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible.
Using Mathematics and Computational Thinking	Mathematical and computational thinking in 9-12 builds on K-8 and experiences 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. • Apply ratios, rates, percentages, and unit conversions in the context of complicated measurement problems involving quantities with derived or compound units (such as mg/mL, kg/m3, acre-feet, etc.).
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 ideas, principles, and theories. • Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables. • Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.

Crosscutting Concepts	
Patterns	Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.
	• 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. • Empirical evidence is needed to identify patterns.
Cause and Effect: Mechanism and Prediction	Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.
	• 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 and System Models	A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.
	• 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.

Common Core State Standards for High School Mathematics

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CCSS: Conceptual Category – Number and Quantity	
Quantities	• *Reason quantitatively and use units to solve problems.

CCSS: Conceptual Category – Algebra	
Arithmetic with Polynomials and Rational Expressions	• Perform arithmetic operations on polynomials.
Reasoning with Equations and Inequalities	• Solve equations and inequalities in one variable.

CCSS: Conceptual Category – Statistics and Probability	
Using Probability to Make Decisions	• *Calculate expected values and use them to solve problems.

Common Core State Standards for English Language Arts

CCSS: English Language Arts Standards » Writing » Grade 9-10	
Range of Writing	• **WHST.9-10.10 –** Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Essential Questions

1. Why is water quality important?
2. What is involved in water quality testing?
3. How does the temperature of water affect water quality?
4. How does the pH of water affect water quality?
5. How does the turbidity of water affect water quality?
6. How does the dissolved oxygen of water affect water quality?
7. How do the total solids in water affect water quality?
8. How does the level of biochemical oxygen demand of water determine water quality?
9. What problems result from a high level of phosphates in water?
10. How does a high or low level of nitrates in water determine water quality?
11. What is harmful about the presence of fecal coliform in water?

12. How do humans influence water quality?
13. How do environmental factors influence water quality
14. How are water resources used?

Lesson 4.1 The Role of Air

Concepts	Performance Objectives
Students will know and understand	*Students will learn concepts by doing*
1. The atmosphere consists of various levels defined by distinct characteristics, such as density, temperature, and chemical composition.	• Develop a graph and diagram depicting the levels of the atmosphere and their defining characteristics.
2. Gases found in the atmosphere, such as oxygen and nitrogen, take different forms as they move through a biogeochemical cycle.	• Compare the movement of atmospheric gases, oxygen and nitrogen, to the water cycle.
3. An important function of the atmosphere is the natural warming of the surface of the Earth.	• Conduct an investigation to determine air temperature at different levels over a 23-hour period.

National AFNR Career Cluster Content Standards Alignment

AFNR: LifeKnowledge® and Cluster Skills Content Standards
CS.11. Scientific Inquiry: Utilize scientific inquiry as an investigative method.

Next Generation Science Standards Alignment

Disciplinary Core Ideas	
Earth and Space Science	
ESS2.E: Biogeology	• The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth's surface and the life that exists on it.

Science and Engineering Practices	
Analyzing and Interpreting Data	Analyzing data in 9–12 builds on K–8 experiences 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. • Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.

Crosscutting Concepts	
Patterns	Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.
	• Empirical evidence is needed to identify patterns.
Energy and Matter: Flows, Cycles, and Conservation	Tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior.
	• 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.

Common Core State Standards for English Language Arts

CCSS: English Language Arts Standards » Science & Technical Subjects » Grade 9-10	
Key Ideas and Details	• **RST.9-10.3 –** Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.
Craft and Structure	• **RST.9-10.4 –** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.
Range of Reading and Level of Text Complexity	• **RST.9-10.10 –** By the end of grade 10, read and comprehend science/technical texts in the grades 9-10 text complexity band independently and proficiently.

CCSS: English Language Arts Standards » Writing » Grade 9-10	
Production and Distribution of Writing	• **WHST.9-10.4 –** Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
Research to Build and Present Knowledge	• **WHST.9-10.9 –** Draw evidence from informational texts to support analysis, reflection, and research.
Range of Writing	• **WHST.9-10.10 –** Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Essential Questions

1. Why is air an important natural resource?
2. What is the atmosphere?
3. What are the layers of the atmosphere?
4. What is the oxygen cycle?
5. What is the nitrogen cycle?
6. How does temperature differ as you move further away from the ground?
7. Why is understanding air temperature and its relation to distance from the surface of the Earth important?

Lesson 4.2 The Smog has Lifted

Concepts	Performance Objectives
Students will know and understand	*Students will learn concepts by doing*
1. Natural occurring processes and human activity influence air quality.	• Monitor carbon dioxide concentrations in a classroom with different levels of ventilation.
2. Air quality is determined by measuring the gases and particulates that are present at various levels.	• Measure the level of particulate matter from the air, the amount and percentage of light blocked by the particulate matter. • Compare air quality levels for different locations, demonstrating understanding of the Air Quality Index.
3. The greenhouse effect theory explains the potential reasons and causes of global warming.	• Simulate the greenhouse effect in a small scale model.

National AFNR Career Cluster Content Standards Alignment

AFNR: LifeKnowledge® and Cluster Skills Content Standards	
CS.08.	Technical Skills: Use tools, equipment, machinery and technology appropriate to work within areas related to AFNR.
CS.11.	Scientific Inquiry: Utilize scientific inquiry as an investigative method.

Next Generation Science Standards Alignment

Disciplinary Core Ideas	
Physical Science	
PS4: Waves and Their Applications in Technologies for Information Transfer	
PS4.B: Electromagnetic Radiation	• When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). Shorter wavelength electromagnetic radiation (ultraviolet, X-rays, gamma rays) can ionize atoms and cause damage to living cells.

Science and Engineering Practices	
Asking Questions and Defining Problems	Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations. • Ask questions that can be investigated within the scope of the school laboratory, research facilities, or field (e.g., outdoor environment) with available resources and, when appropriate, frame a hypothesis based on a model or theory.
Developing and Using Models	Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s). • Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.
Analyzing and Interpreting Data	Analyzing data in 9–12 builds on K–8 experiences 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. • Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.
Using Mathematics and Computational Thinking	Mathematical and computational thinking in 9-12 builds on K-8 and experiences 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, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.

Crosscutting Concepts	
Patterns	Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.
	• Empirical evidence is needed to identify patterns.
Scale, Proportion, and Quantity	In considering phenomena, it is critical to recognize what is relevant at different size, time, and energy scales, and to recognize proportional relationships between different quantities as scales change.
	• Some systems can only be studied indirectly as they are too small, too large, too fast, or too slow to observe directly.
Systems and System Models	A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.
	• 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.
Energy and Matter: Flows, Cycles, and Conservation	Tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior.

	• 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.

Common Core State Standards for High School Mathematics

Modeling standards are indicated by the star symbol (*) throughout other conceptual categories.

CCSS: Conceptual Category – Number and Quantity	
Quantities	• *Reason quantitatively and use units to solve problems.

Common Core State Standards for English Language Arts

CCSS: English Language Arts Standards » Science & Technical Subjects » Grade 9-10	
Key Ideas and Details	• **RST.9-10.3 –** Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

CCSS: English Language Arts Standards » Writing » Grade 9-10	
Range of Writing	• **WHST.9-10.10 –** Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Essential Questions

1. How is air quality measured?
2. What is air pollution?
3. How is carbon dioxide related to indoor air quality?
4. What factors influence indoor carbon dioxide concentrations?
5. What are particulates in the atmosphere?
6. How do particulates affect air quality?
7. How can air particulates be removed?
8. What is the greenhouse effect?
9. How does the greenhouse effect relate to air quality?
10. What is the air quality where I live?

Lesson 5.1 The Energy of Life

Concepts	Performance Objectives
Students will know and understand	*Students will learn concepts by doing*
1. Energy and nutrients flow through trophic levels within an ecosystem.	• Determine the sequence of energy flow of a group of organisms and sketch the food web. • Calculate the percent of energy transfer through the trophic levels of a food chain.
2. The geographic area of an ecosystem influences the complexity and type of organisms present.	• Research their ecosystem of choice and determine a food chain present in that ecosystem. • Use a graphic organizer to depict an energy pyramid and the relationships within that pyramid.

3. The availability of required resources determines the carrying capacity of a given species in an ecosystem.	• Simulate the carrying capacity of a deer population in relation to access to food, water, and shelter. • Determine the habitat area requirements for a group of animals in an ecosystem and the overall area needed to sustain the ecosystem

National AFNR Career Cluster Content Standards Alignment

AFNR: Natural Resources Systems Career Pathway Content Standards	
NRS.01.	Explain interrelationships between natural resources and humans necessary to conduct management activities in natural environments.
NRS.02.	Apply scientific principles to natural resource management activities.

Next Generation Science Standards Alignment

Disciplinary Core Ideas	
Life Science	
LS1: From Molecules to Organisms: Structures and Processes	
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. (HS-LS1-5) • As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products.
LS2: Ecosystems: Interactions, Energy, and Dynamics	
LS2.A: Interdependent Relationships in Ecosystems	• Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem.
LS2.B: Cycles of Matter and Energy Transfer in Ecosystems	• Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. • Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web. Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved.
LS2.C: Ecosystem Dynamics, Functioning, and Resilience	• A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. • 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.
Physical Science	
PS3: Energy	
PS3.B: Conservation of Energy and Energy Transfer	• Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. • Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. • The availability of energy limits what can occur in any system.

PS3.D: Energy in Chemical Processes and Everyday Life	• The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis.

Science and Engineering Practices	
Using Mathematics and Computational Thinking	Mathematical and computational thinking in 9-12 builds on K-8 and experiences 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, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations. • Apply techniques of algebra and functions to represent and solve scientific and engineering problems.
Obtaining, Evaluating, and Communicating Information	Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs. • Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).
Crosscutting Concepts	
Energy and Matter: Flows, Cycles, and Conservation	Tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior.
	• 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—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.

Common Core State Standards for High School Mathematics

Modeling standards are indicated by the star symbol (*) throughout other conceptual categories.

CCSS: Conceptual Category – Number and Quantity	
Quantities	• *Reason quantitatively and use units to solve problems.

CCSS: Conceptual Category – Algebra	
Seeing Structure in Expressions	• *Write expressions in equivalent forms to solve problems.
Arithmetic with Polynomials and Rational Expressions	• Perform arithmetic operations on polynomials.
Reasoning with Equations and Inequalities	• Solve equations and inequalities in one variable.

Common Core State Standards for English Language Arts

CCSS: English Language Arts Standards » Science & Technical Subjects » Grade 9-10	
Key Ideas and Details	• **RST.9-10.3 –** Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.
Craft and Structure	• **RST.9-10.4 –** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.
Integration of Knowledge and Ideas	• **RST.9-10.7 –** Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

CCSS: English Language Arts Standards » Writing » Grade 9-10	
Range of Writing	• **WHST.9-10.10 –** Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Essential Questions

1. What is energy?
2. Why is energy essential to life?
3. What is solar energy?
4. How can solar energy be used to produce food?
5. What is a trophic level?
6. How is energy transferred among trophic levels?
7. Why is some energy unavailable to higher trophic levels?
8. How does a food chain differ from a food web?
9. Why are energy pyramids used to show the relationships among organisms in ecosystems?
10. What is carrying capacity?
11. How does population density relate to carrying capacity?
12. What are the habitat requirements of animals?

Lesson 6.1 All Natural Flora

Concepts	Performance Objectives
Students will know and understand	*Students will learn concepts by doing*
1. Biodiversity refers to the variety of living components in an ecosystem.	• Determine the biodiversity of plants in a given area using a common sampling technique.
2. Plants are scientifically identified using taxonomy and various classification systems.	• Conduct a survey of the vegetation present in a given plot of land and classify the plants according to their features.
3. Vegetation type present in an ecosystem is influenced by the environment and the activity of animals and humans.	• Simulate the process of vegetative succession by role playing in a game.
4. Plant populations shift in response to changes in the environment.	

National AFNR Career Cluster Content Standards Alignment

AFNR: Natural Resources Systems Career Pathway Content Standards	
NRS.01.	Explain interrelationships between natural resources and humans necessary to conduct management activities in natural environments.

Next Generation Science Standards Alignment

Disciplinary Core Ideas	
Life Science	
LS4: Biological Evolution: Unity and Diversity	
LS4.D: Biodiversity and Humans	• Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction).

Science and Engineering Practices	
Developing and Using Models	Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s). • Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.

Crosscutting Concepts	
Patterns	Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.
	• Empirical evidence is needed to identify patterns.
Cause and Effect: Mechanism and Prediction	Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.
	• Changes in systems may have various causes that may not have equal effects.
Stability and Change	For both designed and natural systems, conditions that affect stability and factors that control rates of change are critical elements to consider and understand.
	• Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible.

Understandings about the Nature of Science	
Scientific Investigations Use a Variety of Methods	• Science investigations use diverse methods and do not always use the same set of procedures to obtain data.
Scientific Knowledge is Based on Empirical Evidence	• Science knowledge is based on empirical evidence.

Common Core State Standards for High School Mathematics

Modeling standards are indicated by the star symbol (*) throughout other conceptual categories.

CCSS: Conceptual Category – Number and Quantity	
Quantities	• *Reason quantitatively and use units to solve problems.

CCSS: Conceptual Category – Geometry	
Modeling with Geometry	• *Apply geometric concepts in modeling situations.

CCSS: Conceptual Category – Statistics and Probability	
Interpreting Categorical and Quantitative Data	• *Summarize, represent, and interpret data on a single count or measurement variable.
Making Inferences and Justifying Conclusions	• *Make inferences and justify conclusions from sample surveys, experiments, and observational studies.

Common Core State Standards for English Language Arts

CCSS: English Language Arts Standards » Science & Technical Subjects » Grade 9-10	
Range of Reading and Level of Text Complexity	• **RST.9-10.10 –** By the end of grade 10, read and comprehend science/technical texts in the grades 9-10 text complexity band independently and proficiently.

CCSS: English Language Arts Standards » Writing » Grade 9-10	
Production and Distribution of Writing	• **WHST.9-10.4 –** Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
Research to Build and Present Knowledge	• **WHST.9-10.9 –** Draw evidence from informational texts to support analysis, reflection, and research.
Range of Writing	• **WHST.9-10.10 –** Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Essential Questions

1. What are plant communities?
2. How do plants support ecosystems?
3. What is biodiversity?
4. What is succession?
5. What is primary succession?
6. What is secondary succession?
7. How do the different types of succession determine the type of plants available within an ecosystem?
8. What are the different transitions or stages of a typical succession?
9. How are the transitions or stages of a succession identified?
10. How do biodiversity and ecological succession interact in an ecosystem?

Lesson 6.2 Flourishing Fauna

Concepts	Performance Objectives
Students will know and understand	*Students will learn concepts by doing*
1. Wildlife require habitat, including food, water, shelter, and space, suited to their needs in order to thrive in a community.	• Research the habitat requirements of an animal and write a description of those needs to be used to match an animal with its proper habitat.
2. Organisms use natural processes to adapt to their environments and increase chances of survival.	• Investigate the adaptive nature of an animal, such as the beak of a bird to its environment in order to acquire food for survival.
3. Human pressures of populations cause artificial selection within a population.	• Predict the probability of the occurrence of qualitative traits within an animal species using Punnett Squares
4. Various objectives influence the management of wildlife species.	• Conduct hypothetical wildlife management decisions and identify at least four factors that can affect the size of a wildlife population.
5. Wildlife management includes improving habitat for a focal species.	• Select a focal species in the ecosystem study and make a habitat management plan for that animal.

National AFNR Career Cluster Content Standards Alignment

AFNR: Natural Resources Systems Career Pathway Content Standards	
NRS.01.	Explain interrelationships between natural resources and humans necessary to conduct management activities in natural environments.
NRS.02.	Apply scientific principles to natural resource management activities.
NRS.04.	Demonstrate techniques used to protect natural resources.

Next Generation Science Standards Alignment

Disciplinary Core Ideas	
Life Science	
LS2: Ecosystems: Interactions, Energy, and Dynamics	
LS2.A: Interdependent Relationships in Ecosystems	• Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem.
LS2.C: Ecosystem Dynamics, Functioning, and Resilience	• A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. • 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.
LS3: Heredity: Inheritance and Variation of Traits	
LS3.B: Variation of Traits	• Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors.
LS4: Biological Evolution: Unity and Diversity	
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. • 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. Adaptation also means that the distribution of traits in a population can change when conditions change.

Science and Engineering Practices	
Analyzing and Interpreting Data	Analyzing data in 9–12 builds on K–8 experiences 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. • Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.
Using Mathematics and Computational Thinking	Mathematical and computational thinking in 9-12 builds on K-8 and experiences 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. • Apply techniques of algebra and functions to represent and solve scientific and engineering problems. • Apply ratios, rates, percentages, and unit conversions in the context of complicated measurement problems involving quantities with derived or compound units (such as mg/mL, kg/m3, acre-feet, etc.).

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 ideas, principles, and theories. • Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. • Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.
Crosscutting Concepts	
Patterns	Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.
	• Mathematical representations are needed to identify some patterns.
Systems and System Models	A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.
	• 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. • 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.

Common Core State Standards for High School Mathematics

Modeling standards are indicated by the star symbol (*) throughout other conceptual categories.

CCSS: Conceptual Category – Algebra	
Seeing Structure in Expressions	• *Write expressions in equivalent forms to solve problems.
Arithmetic with Polynomials and Rational Expressions	• Perform arithmetic operations on polynomials.
Creating Equations	• *Create equations that describe numbers or relationships.
Reasoning with Equations and Inequalities	• Understand solving equations as a process of reasoning and explain the reasoning.

CCSS: Conceptual Category – Statistics and Probability	
Interpreting Categorical and Quantitative Data	• *Summarize, represent, and interpret data on a single count or measurement variable.
Making Inferences and Justifying Conclusions	• *Make inferences and justify conclusions from sample surveys, experiments, and observational studies.
Conditional Probability and the Rules of Probability	• *Understand independence and conditional probability and use them to interpret data.
Using Probability to Make Decisions	• *Calculate expected values and use them to solve problems. • *Use probability to evaluate outcomes of decisions.

Common Core State Standards for English Language Arts

CCSS: English Language Arts Standards » Science & Technical Subjects » Grade 9-10	
Range of Reading and Level of Text Complexity	• **RST.9-10.10 –** By the end of grade 10, read and comprehend science/technical texts in the grades 9-10 text complexity band independently and proficiently.

CCSS: English Language Arts Standards » Writing » Grade 9-10	
Text Types and Purposes	**WHST.9-10.1 –** Write arguments focused on discipline-specific content. • **WHST.9-10.1.D –** Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. • **WHST.9-10.1.E –** Provide a concluding statement or section that follows from or supports the argument presented. **WHST.9-10.2 –** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. • **WHST.9-10.2.B –** Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

	• **WHST.9-10.2.D –** Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.
Production and Distribution of Writing	• **WHST.9-10.4 –** Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
Research to Build and Present Knowledge	• **WHST.9-10.7 –** Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. • **WHST.9-10.8 –** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation. • **WHST.9-10.9 –** Draw evidence from informational texts to support analysis, reflection, and research.
Range of Writing	• **WHST.9-10.10 –** Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Essential Questions

1. What is a habitat?
2. How do habitats of animals overlap?
3. What components of a habitat are important?
4. How do habitat needs influence the population density of animals within a habitat?
5. What is an example of an animal's adaptation to its environment?
6. How do adaptations enable species to survive?
7. What processes allow animals to adapt to their environment?
8. What is meant by the phrase 'population pressures'?
9. What is a Punnett Square and how is it used?
10. What are the limitations of using the Punnett Square method when predicting inheritance?
11. What is meant by wildlife management?
12. What are the positive and negative consequences of uncontrolled mating of wildlife populations?

Lesson 7.1 Agricultural Stewardship

Concepts	Performance Objectives
Students will know and understand	*Students will learn concepts by doing*
1. Sustainable agriculture practices include the efficient use of non-renewable and on-farm resources and, where appropriate, integrate natural biological cycles.	• Read a story about non-sustainable use and apply the lessons learned to agricultural land management. • Examine the unstainable practices that led to the Dust Bowl and sustainable practices that are practiced now. • Use the "4R" nutrient stewardship approach to make fertilizer recommendations.
2. Agricultural stewardship balances agriculture productivity and profitability while conserving natural resources.	• Apply skills and knowledge learned regarding stewardship and sustainable agriculture management decisions related to a fictitious property, determine a commodity to raise, apply for a stewardship program,

	and determine the best stewardship practices to implement.

National AFNR Career Cluster Content Standards Alignment

AFNR: LifeKnowledge® and Cluster Skills Content Standards	
CS.03.	Career Success: Demonstrate those qualities, attributes and skills necessary to succeed in, or further prepare for, a chosen career while effectively contributing to society.
CS.09.	Technical Skills: Compare and contrast issues affecting the AFNR industry.

AFNR: Natural Resources Systems Career Pathway Content Standards	
NRS.02.	Apply scientific principles to natural resource management activities.
NRS.03.	Apply knowledge of natural resources to production and processing industries.
NRS.04.	Demonstrate techniques used to protect natural resources.

Next Generation Science Standards Alignment

Engineering, Technology, and the Application of Science	
ETS1: Engineering Design	
ETS1.A: Defining and Delimiting Engineering Problems	• Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities.

Crosscutting Concepts	
Cause and Effect: Mechanism and Prediction	Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.
	• Systems can be designed to cause a desired effect.
Energy and Matter: Flows, Cycles, and Conservation	Tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior.
	• 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—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.
Structure and Function	The way an object is shaped or structured determines many of its properties and functions.
	• Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem. • The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials.

Common Core State Standards for English Language Arts

CCSS: English Language Arts Standards » Science & Technical Subjects » Grade 9-10	
Key Ideas and Details	• **RST.9-10.1 –** Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.
Craft and Structure	• **RST.9-10.4 –** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.

CCSS: English Language Arts Standards » Writing » Grade 9-10	
Research to Build and Present Knowledge	• **WHST.9-10.8 –** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.
Range of Writing	• **WHST.9-10.10 –** Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Essential Questions

1. What is sustainability?
2. What is sustainable development?
3. What is sustainable use?
4. What is meant by the phrase “sustainable agriculture”?
5. What is stewardship and how does it relate to sustainable agriculture?
6. What role do farmers and ranchers have in sustainable use?
7. What is the “4R” nutrient stewardship approach?
8. What might keep farmers and ranchers from applying the “4R” nutrient stewardship approach?
9. What role do consumers have in sustainable use?
10. What is sustainable consumption?

Lesson 7.2 Timber!

Concepts	Performance Objectives
Students will know and understand	*Students will learn concepts by doing*
1. Effective forest management requires identification of goals and proposed uses of the forest, such as aesthetics, recreation, urban values, water, wilderness, wildlife, and wood products.	• Determine the value of a tree using the National Tree Benefit calculator. • Calculate board feet of lumber, timber and estimate the value of local trees
2. Forest management techniques include timber extraction, planting, and replanting of various species, cutting roads and pathways through forests, and fire management.	• Develop a forest management plan summary based on research of an assigned national forest

National AFNR Career Cluster Content Standards Alignment

AFNR: LifeKnowledge® and Cluster Skills Content Standards	
CS.08.	Technical Skills: Use tools, equipment, machinery and technology appropriate to work within areas related to AFNR.

AFNR: Natural Resources Systems Career Pathway Content Standards	
NRS.02.	Apply scientific principles to natural resource management activities.
NRS.03.	Apply knowledge of natural resources to production and processing industries.
NRS.04.	Demonstrate techniques used to protect natural resources.

Next Generation Science Standards Alignment

Disciplinary Core Ideas	
Life Science	
LS4.D: Biodiversity and Humans	• Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). • Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value.

Science and Engineering Practices	
Obtaining, Evaluating, and Communicating Information	Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs. • Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. • Compare, integrate and evaluate sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a scientific question or solve a problem. • Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).

Common Core State Standards for High School Mathematics

Modeling standards are indicated by the star symbol (*) throughout other conceptual categories.

CCSS: Conceptual Category – Number and Quantity	
The Real Number System	• Use properties of rational and irrational numbers.
Quantities	• *Reason quantitatively and use units to solve problems.

CCSS: Conceptual Category – Algebra	
Arithmetic with Polynomials and Rational Expressions	• Perform arithmetic operations on polynomials.
Reasoning with Equations and Inequalities	• Understand solving equations as a process of reasoning and explain the reasoning. • Solve equations and inequalities in one variable.

CCSS: Conceptual Category – Geometry	
Circles	• Understand and apply theorems about circles.
Geometric Measurement and Dimension	• *Explain volume formulas and use them to solve problems.
Modeling with Geometry	• *Apply geometric concepts in modeling situations.

Common Core State Standards for English Language Arts

CCSS: English Language Arts Standards » Science & Technical Subjects » Grade 9-10	
Key Ideas and Details	• **RST.9-10.1 –** Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

Range of Reading and Level of Text Complexity	• **RST.9-10.10 –** By the end of grade 10, read and comprehend science/technical texts in the grades 9-10 text complexity band independently and proficiently.

CSS: English Language Arts Standards » Writing » Grade 9-10	
Production and Distribution of Writing	• **WHST.9-10.4 –** Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. • **WHST.9-10.6 –** Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.
Research to Build and Present Knowledge	• **WHST.9-10.9 –** Draw evidence from informational texts to support analysis, reflection, and research.
Range of Writing	• **WHST.9-10.10 –** Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Essential Questions

1. What is the value of a tree?
2. What is the difference between a tree and a forest?
3. What is the difference between public and private lands?
4. What is involved in forest management?
5. How is the unit board feet used in forestry management?
6. How is a board foot of lumber calculated?
7. Why is estimating board feet of lumber in a tree a useful practice for foresters?
8. Why is there value in storm water runoff and carbon dioxide reduction from trees?
9. What are the factors that may determine the value of trees and increase their value?
10. What are the goals and techniques that determine Best Management Practices? (BMP's)?
11. When determining how a forest should be used, what natural resources must be considered?
12. How are timber, wildlife, recreation and resource conservation goals sustainably balanced in a forest management plan?

Lesson 7.3 Digging and Drilling

Concepts	**Performance Objectives**
Students will know and understand	*Students will learn concepts by doing*
1. Many practices and methods are used to mine important mineral resources	• Synthesize and make connections to the different practices and methods that are used to mine important mineral resources through a mining simulation. • Investigate the process of enhanced oil recovery while considering the resources used to recover the oil. • Investigate methods for cleaning up oil spills. • Design and test an oil water separator.
2. Mining natural resources has positive and negative impacts on the environment and human populations.	• Consider the impact mining has on the environment and natural resources and determine mining practices that are utilized to protect the environment.

	• Characterize the effects of oil spills on ecosystems and humans.

National AFNR Career Cluster Content Standards Alignment

AFNR: LifeKnowledge® and Cluster Skills Content Standards
CS.11. Scientific Inquiry: Utilize scientific inquiry as an investigative method.

AFNR: Natural Resources Systems Career Pathway Content Standards
NRS.02. Apply scientific principles to natural resource management activities.
NRS.03. Apply knowledge of natural resources to production and processing industries.
NRS.04. Demonstrate techniques used to protect natural resources.
NRS.05. Use effective methods and venues to communicate natural resource processes to the public.

Next Generation Science Standards Alignment

Disciplinary Core Ideas	
Life Science	
LS2: Ecosystems: Interactions, Energy, and Dynamics	
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.

Earth and Space Science	
ESS3: Earth and Human Activity	
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.

Engineering, Technology, and the Application of Science	
ETS1: Engineering Design	
ETS1.A: Defining and Delimiting Engineering Problems	• Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities.

Science and Engineering Practices	
Developing and Using Models	Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s). • Develop a complex model that allows for manipulation and testing of a proposed process or system. • Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.
Planning and Carrying Out Investigations	Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models. • Plan an investigation or test a design individually and collaboratively to produce data to serve as the basis for evidence as part of building and revising models, supporting explanations for phenomena, or testing solutions to problems. Consider possible confounding variables or effects and evaluate the investigation's design to ensure variables are controlled.

	• Plan and conduct an investigation or test a design solution in a safe and ethical manner including considerations of environmental, social, and personal impacts.
Obtaining, Evaluating, and Communicating Information	Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs. • Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

Crosscutting Concepts	
Systems and System Models	A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.
	• Systems can be designed to do specific tasks. • When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. • 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. • 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.

Common Core State Standards for High School Mathematics

Modeling standards are indicated by the star symbol (*) throughout other conceptual categories.

CCSS: Conceptual Category – Number and Quantity	
The Real Number System	• Use properties of rational and irrational numbers.
Quantities	• *Reason quantitatively and use units to solve problems.

CCSS: Conceptual Category – Statistics and Probability	
Interpreting Categorical and Quantitative Data	• *Summarize, represent, and interpret data on a single count or measurement variable.

Common Core State Standards for English Language Arts

CCSS: English Language Arts Standards » Science & Technical Subjects » Grade 9-10	
Key Ideas and Details	• **RST.9-10.3 –** Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.
Craft and Structure	• **RST.9-10.4 –** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.
Integration of Knowledge and Ideas	• **RST.9-10.7 –** Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words. •

CCSS: English Language Arts Standards » Writing » Grade 9-10	
Research to Build and Present Knowledge	• **WHST.9-10.7 –** Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. • **WHST.9-10.8 –** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation. • **WHST.9-10.9 –** Draw evidence from informational texts to support analysis, reflection, and research.
Range of Writing	• **WHST.9-10.10 –** Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Essential Questions

1. Why is mining for minerals or other natural resources important?
2. What are the many methods used to mine for natural resources?
3. What are the positive and negative impacts on the environment and human populations when mining for natural resources?
4. What are the practices and methods used to extract petroleum resources?
5. How does and oil spill effect an ecosystem?
6. How does an oil spill effect a human community?
7. How is oil separated from water in an oil separator?

Lesson 8.1 Urban Sprawl

Concepts	Performance Objectives
Students will know and understand	*Students will learn concepts by doing*
1. Human populations and their need for food, fiber, and fuel impact the natural environment.	• Determine their personal carbon footprint and the carbon footprint of their family and consider how to reduce their carbon emission impact on the natural environment.
2. Energy is available from diverse renewable and nonrenewable sources.	• Simulate the buying and selling of energy units from a diverse group of energy producers and discuss how changes in energy prices affect the average consumer.
3. Managing waste impacts society and has environmental costs and benefits.	• Conduct a school recycling inventory and calculate the reduction in carbon dioxide emissions that result.
4. Proper waste management is essential for healthy ecosystems.	• Investigate the positive and negative impacts of waste on the environment and how to improve the environmental costs of waste management.

National AFNR Career Cluster Content Standards Alignment

AFNR: Natural Resources Systems Career Pathway Content Standards	
NRS.02.	Apply scientific principles to natural resource management activities.
NRS.04.	Demonstrate techniques used to protect natural resources.
NRS.05.	Use effective methods and venues to communicate natural resource processes to the public.

Next Generation Science Standards Alignment

Disciplinary Core Ideas	
Earth and Space Science	
ESS3: Earth and Human Activity	
ESS3.A: Natural Resources	• Resource availability has guided the development of human society. • 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.

ESS3.C: Human Impacts on Earth Systems	• The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. • Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation.

Engineering, Technology, and the Application of Science	
ETS1: Engineering Design	
ETS1.A: Defining and Delimiting Engineering Problems	• Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. • Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities.

Science and Engineering Practices	
Developing and Using Models	Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s). • Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.
Planning and Carrying Out Investigations	Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models. • Plan an investigation or test a design individually and collaboratively to produce data to serve as the basis for evidence as part of building and revising models, supporting explanations for phenomena, or testing solutions to problems. Consider possible confounding variables or effects and evaluate the investigation's design to ensure variables are controlled. \
Analyzing and Interpreting Data	Analyzing data in 9–12 builds on K–8 experiences 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. • Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.
Using Mathematics and Computational Thinking	Mathematical and computational thinking in 9-12 builds on K-8 and experiences 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, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.
Obtaining, Evaluating, and Communicating Information	Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs. • Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).

Crosscutting Concepts	
Systems and System Models	A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.
	• Systems can be designed to do specific tasks. • When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. • 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.
Energy and Matter: Flows, Cycles, and Conservation	Tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior.
	• 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.

Common Core State Standards for High School Mathematics

Modeling standards are indicated by the star symbol (*) throughout other conceptual categories.

CCSS: Conceptual Category – Number and Quantity	
The Real Number System	• Use properties of rational and irrational numbers.
Quantities	• *Reason quantitatively and use units to solve problems.

CCSS: Conceptual Category – Algebra	
Arithmetic with Polynomials and Rational Expressions	• Perform arithmetic operations on polynomials.
Reasoning with Equations and Inequalities	• Solve equations and inequalities in one variable.

Common Core State Standards for English Language Arts

CCSS: English Language Arts Standards » Science & Technical Subjects » Grade 9-10	
Key Ideas and Details	• **RST.9-10.3 –** Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.
Range of Reading and Level of Text Complexity	• **RST.9-10.10 –** By the end of grade 10, read and comprehend science/technical texts in the grades 9-10 text complexity band independently and proficiently.

CCSS: English Language Arts Standards » Writing » Grade 9-10	
Text Types and Purposes	**WHST.9-10.2 –** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. • **WHST.9-10.2.D –** Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.
Range of Writing	• **WHST.9-10.10 –** Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Essential Questions

1. What is a carbon footprint and why should I care?
2. What are typical energy sources?
3. What are renewable and non-renewable energy sources?
4. How do the relative price of renewables change according to environmental regulations, renewables' availability, economic infrastructure, and the prices of fossil fuel and nuclear power?
5. How do economic conditions affect the price of renewables?
6. How do changes in energy prices affect the average American consumer?
7. What is meant by the concept of a "level playing field" when it comes to renewables vs. traditional forms of energy sources?
8. How does the recycling program of your school reduce the carbon footprint?
9. How could the school improve recycling efforts?
10. How does society's waste impact the environment?
11. Why is it important to understand how a landfill works or other means to dispose of waste?
12. What steps can be taken to reduce the amount of waste sent to landfills?
13. How do communities and the environment benefit from managing waste?

Lesson 8.2 Walk in the Park

Concepts	Performance Objectives
Students will know and understand	*Students will learn concepts by doing*
1. Human recreational activities impact the natural environment and native species.	• Identify the current uses and the historical states of outdoor recreational areas in their ecosystem and determine how human use has impacted the native species in both beneficial and harmful ways.
2. Protected natural spaces, such as National Parks and Scenic areas, have been designated to preserve landmarks as well as native flora and fauna.	• Research a national park or forest to identify and summarize its history, unique features, and available recreational activities in order to develop a guide.
3. Recreational use of natural resource areas requires the development of skills to ensure the safety of the individual while protecting the integrity of the natural resource.	• Investigate and plan an outdoor experience that incorporates personal interests while leaving the smallest footprint possible in order to protect the integrity of the natural resource.

National AFNR Career Cluster Content Standards Alignment

AFNR: LifeKnowledge® and Cluster Skills Content Standards	
CS.01.	Premier Leadership: Acquire the skills necessary to positively influence others.
CS.06.	Examine the importance of health, safety, and environmental management systems in organizations and their importance to performance and regulatory compliance.

AFNR: Natural Resources Systems Career Pathway Content Standards	
NRS.01.	Explain interrelationships between natural resources and humans necessary to conduct management activities in natural environments.
NRS.02.	Apply scientific principles to natural resource management activities.
NRS.04.	Demonstrate techniques used to protect natural resources.

Next Generation Science Standards Alignment

Disciplinary Core Ideas	
Earth and Space Science	
ESS3.C: Human Impacts on Earth Systems	• The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.

Common Core State Standards for English Language Arts

CCSS: English Language Arts Standards » Writing » Grade 9-10	
Text Types and Purposes	• **WHST.9-10.2 –** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. • **WHST.9-10.2.B –** Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.
Production and Distribution of Writing	• **WHST.9-10.4 –** Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

	• **WHST.9-10.6 –** Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.
Research to Build and Present Knowledge	• **WHST.9-10.8 –** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation. • **WHST.9-10.9 –** Draw evidence from informational texts to support analysis, reflection, and research.
Range of Writing	• **WHST.9-10.10 –** Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Essential Questions

1. How have humans impacted natural sites in positive and negative ways?
2. How can humans minimize impacts of human use in natural areas?
3. What natural features make a national park or forest noticeable or prominent?
4. What recreational activities are available in a national park or forest?
5. How does designating land as a National Park or a National Forest help preserve the environment?
6. How does one plan an outdoor extravaganza that incorporates human interests while leaving the smallest footprint possible?

Lesson 9.1 Policing Our Wilderness

Concepts	Performance Objectives
Students will know and understand	*Students will learn concepts by doing*
1. Environmental policies and regulations, such as the Endangered Species Act and wilderness protection designations, have been established to protect the environment for future generations of wildlife, vegetation, and human use.	• Research species classified as endangered, threatened, sensitive, or extinct and develop an informative flyer.
2. National conservation practices have shifted over time due to changes in environmental perceptions.	• Explore the impact of natural resource and conservation practices and policies in relation to sustainability.
3. Many organizations influence protection of species and the environment.	• Research federal natural resource agencies and identify primary purposes and responsibilities each agency has regarding water contamination. • Argue the role of federal natural resource agencies in a water contamination scenario

National AFNR Career Cluster Content Standards Alignment

AFNR: LifeKnowledge® and Cluster Skills Content Standards	
CS.09.	Technical Skills: Compare and contrast issues affecting the AFNR industry.

AFNR: Natural Resources Systems Career Pathway Content Standards	
NRS.01.	Explain interrelationships between natural resources and humans necessary to conduct management activities in natural environments.

NRS.05.	Use effective methods and venues to communicate natural resource processes to the public.

Next Generation Science Standards Alignment

Disciplinary Core Ideas	
Life Science	
LS4: Biological Evolution: Unity and Diversity	
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. 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.

Science and Engineering Practices	
Engaging in Argument from Evidence	Engaging in argument from evidence in 9–12 builds on 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(s). Arguments may also come from current scientific or historical episodes in science. • Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence.
Obtaining, Evaluating, and Communicating Information	Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs. • Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. • Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).

Common Core State Standards for English Language Arts

CCSS: English Language Arts Standards » Science & Technical Subjects » Grade 9-10	
Integration of Knowledge and Ideas	• **RST.9-10.7 –** Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
Range of Reading and Level of Text Complexity	• **RST.9-10.10 –** By the end of grade 10, read and comprehend science/technical texts in the grades 9-10 text complexity band independently and proficiently.

CCSS: English Language Arts Standards » Writing » Grade 9-10	
Text Types and Purposes	**WHST.9-10.1 –** Write arguments focused on discipline-specific content. **WHST.9-10.2 –** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
Production and Distribution of Writing	• **WHST.9-10.6 –** Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.
Research to Build and Present Knowledge	• **WHST.9-10.7 –** Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. • **WHST.9-10.9 –** Draw evidence from informational texts to support analysis, reflection, and research.
Range of Writing	• **WHST.9-10.10 –** Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Essential Questions

1. What is the difference in threatened, endangered, and extinct species?

2. Why do species become endangered or extinct?
3. What steps should humans take to prevent the endangerment or extinction of species?
4. How have conservation practices shifted over time due to the change in technology?
5. How has environmental awareness influenced conservation practices?
6. How do wildlife, ecosystems, and communities benefit from federal natural resource agencies?
7. How does a federal natural resource agency limit and control fecal coliform water contamination?

Lesson 9.2 What's Next?

Concepts	Performance Objectives
Students will know and understand 1. Balancing the needs of the human population and demands for food, fiber, fuel with maintaining environmental quality is a complex social issue. 2. Ecosystems change over time based upon management decisions.	*Students will learn concepts by doing* • Review their beliefs and opinions on how natural resources should be utilized and write a brief statement summarizing their beliefs. • Develop a multiple use management plan for the ecosystem they have studied throughout the course. • Plan the reuse of a superfund site balancing environmental, community and commercial needs

National AFNR Career Cluster Content Standards Alignment

AFNR: Natural Resources Systems Career Pathway Content Standards	
NRS.01.	Explain interrelationships between natural resources and humans necessary to conduct management activities in natural environments.
NRS.02.	Apply scientific principles to natural resource management activities.

Next Generation Science Standards Alignment

Disciplinary Core Ideas	
Life Science	
LS2: Ecosystems: Interactions, Energy, and Dynamics	
LS2.C: Ecosystem Dynamics, Functioning, and Resilience	• A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. • Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species.
LS4: Biological Evolution: Unity and Diversity	
LS4.D: Biodiversity and Humans	• Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). • Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value.

Earth and Space Science	
ESS3: Earth and Human Activity	
ESS3.C: Human Impacts on Earth Systems	• The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.
Engineering, Technology, and the Application of Science	
ETS1: Engineering Design	
ETS1.A: Defining and Delimiting Engineering Problems	• Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them.
ETS1.B: Developing Possible Solutions	• When evaluating solutions it is important to take into account a range of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts.
ETS1.C: Optimizing the Design Solution	• Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (tradeoffs) may be needed.

Science and Engineering Practices	
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 ideas, principles, and theories. • Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.
Engaging in Argument from Evidence	Engaging in argument from evidence in 9–12 builds on 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(s). Arguments may also come from current scientific or historical episodes in science. • Compare and evaluate competing arguments or design solutions in light of currently accepted explanations, new evidence, limitations (e.g., trade-offs), constraints, and ethical issues. • Respectfully provide and/or receive critiques on scientific arguments by probing reasoning and evidence and challenging ideas and conclusions, responding thoughtfully to diverse perspectives, and determining what additional information is required to resolve contradictions. • Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and/or logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations).
Obtaining, Evaluating, and Communicating Information	Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs. • Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).

Common Core State Standards for English Language Arts

CCSS: English Language Arts Standards » Science & Technical Subjects » Grade 9-10	
Integration of Knowledge and Ideas	• **RST.9-10.7 –** Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

CCSS: English Language Arts Standards » Writing » Grade 9-10	
Production and Distribution of Writing	• **WHST.9-10.4 –** Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
Research to Build and Present Knowledge	• **WHST.9-10.7 –** Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when

	appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
Range of Writing	• **WHST.9-10.10 –** Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Essential Questions

1. How have my perceptions of natural resources changed?
2. What is a multiple use management plan?
3. What factors should be considered when developing a management plan?
4. How do I develop a multiple use management plan?
5. How can the needs of differing community groups be addressed while reclaiming land?