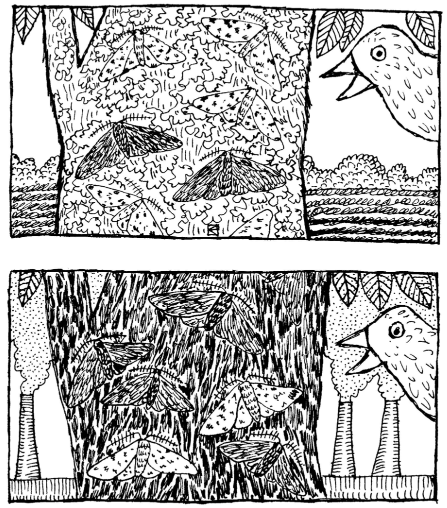
Science Curriculum



Grade Seven Unit One:
FOSS Populations & Ecosystems

Course Description

The students in the seventh grade Science course will develop a conceptual understanding of Science topics using hands-on instruction, interactive notebooking, observations of and interactions with natural phenomena and the use of engineering and design processes to identify problems, plan, test and revise possible solutions. In Life Science, students will explore how organisms exchange energy within and across ecosystems and the critical role of all living and nonliving elements of an ecosystem to its overall health. In Physical Science, students will explore the unique properties of matter and how these properties cause matter to interact to create unique substances. In Earth Science, students will explore how geologic events and systems have shaped both Earth's physical structures and life forms.

Teachers may choose from a variety of instructional approaches that are aligned with 3 dimensional learning to achieve this goal. These approaches include:

Inquiry Kit Instruction (modified)	**Challenge Based Instruction**	**5 E Instructional Model (BSCS)**	**Culturally Relevant Instruction**
Project-Based Instruction	**Tinkering Pedagogy**	**Learning Progressions**	**Knowledge Integration**
Model-based Reasoning	**Place-based Instruction**	**Meaningful Expertise Instruction**	**Emergent Investigations (RSS)**

ESL Framework

This ESL framework was designed to be used by bilingual, dual language, ESL and general education teachers. Bilingual and dual language programs use the home language and a second language for instruction. ESL teachers and general education or bilingual teachers may use this document to collaborate on unit and lesson planning to decide who will address certain components of the SLO and language objective. ESL teachers may use the appropriate leveled language objective to build lessons for ELLs which reflects what is covered in the general education program. In this way, whether it is a pull-out or push-in model, all teachers are working on the same Student Learning Objective connected to the Common Core standard. The design of language objectives are based on the alignment of the World-Class Instructional Design Assessment (WIDA) Consortium’s English Language Development (ELD) standards with the Common Core State Standards (CCSS). WIDA’s ELD standards advance academic language development across content areas ultimately leading to academic achievement for English learners. As English learners are progressing through the six developmental linguistic stages, this framework will assist all teachers who work with English learners to appropriately identify the language needed to meet the requirements of the content standard. At the same time, the language objectives recognize the cognitive demand required to complete educational tasks. Even though listening and reading (receptive) skills differ from speaking and writing (expressive) skills across proficiency levels the cognitive function should not be diminished. For example, an Entering Level One student only has the linguistic ability to respond in single words in English with significant support from their home language. However, they could complete a Venn diagram with single words which demonstrates that they understand how the elements compare and contrast with each other or they could respond with the support of their home language (L1) with assistance from a teacher, para-professional, peer or a technology program.

http://www.state.nj.us/education/modelcurriculum/ela/ELLOverview.pdf

Grade Seven Pacing Chart Please note that pacing is based upon 240 minutes per 6 day cycle.		
	Student Learning Objective	**Instruction**
Unit 1	FOSS Populations and Ecosystems	55 days
	PBL Task with Integrated Science & Engineering Practices	5 days
Unit 2	FOSS Chemical Interactions	60 days
	PBL Task with Integrated Science & Engineering Practices	5 days
Unit 3	FOSS Earth History	50 days
Final Assessment		5 days

Science (NGSS)Framework

The National Research Council's (NRC) *Framework* describes a vision of what it means to be proficient in science; it rests on a view of science as both a body of knowledge and an evidence-based, model and theory building enterprise that continually extends, refines, and revises knowledge. It presents three dimensions that will be combined to form each standard:

Dimension 1: Practices

The practices describe behaviors that scientists engage in as they investigate and build models and theories about the natural world and the key set of engineering practices that engineers use as they design and build models and systems. The NRC uses the term practices instead of a term like "skills" to emphasize that engaging in scientific investigation requires not only skill but also knowledge that is specific to each practice. Part of the NRC's intent is to better explain and extend what is meant by "inquiry" in science and the range of cognitive, social, and physical practices that it requires.

Although engineering design is similar to scientific inquiry, there are significant differences. For example, scientific inquiry involves the formulation of a question that can be answered through investigation, while engineering design involves the formulation of a problem that can be solved through design. Strengthening the engineering aspects of the Next Generation Science Standards will clarify for students the relevance of science, technology, engineering and mathematics (the four STEM fields) to everyday life.

Dimension 2: Crosscutting Concepts

Crosscutting concepts have application across all domains of science. As such, they are a way of linking the different domains of science. They include: Patterns, similarity, and diversity; Cause and effect; Scale, proportion and quantity; Systems and system models; Energy and matter; Structure and function; Stability and change. The Framework emphasizes that these concepts need to be made explicit for students because they provide an organizational schema for interrelating knowledge from various science fields into a coherent and scientifically-based view of the world.

Dimension 3: Disciplinary Core Ideas

Disciplinary core ideas have the power to focus K–12 science curriculum, instruction and assessments on the most important aspects of science. To be considered core, the ideas should meet at least two of the following criteria and ideally all four:

- Have **broad importance** across multiple sciences or engineering disciplines or be a **key organizing concept** of a single discipline;
- Provide a **key tool** for understanding or investigating more complex ideas and solving problems;
- Relate to the **interests and life experiences of students** or be connected to **societal or personal concerns** that require scientific or technological knowledge;
- Be **teachable** and **learnable** over multiple grades at increasing levels of depth and sophistication.

Disciplinary ideas are grouped in four domains: the physical sciences; the life sciences; the earth and space sciences; and engineering, technology and applications of science.

Effective Pedagogical Routines/Instructional Strategies	
• Collaborative Problem Solving • Connect Previous Knowledge to New Learning • Making Thinking Visible • Develop and Demonstrate Mathematical Practices • Inquiry-Oriented and Exploratory Approach • Multiple Solution Paths and Strategies • Use of Multiple Representations • Explain the Rationale of your Math Work • Quick Writes • Pair/Trio Sharing • Turn and Talk • Charting • Gallery Walks • Small Group and Whole Class Discussions • Student Modeling	• Analyze Student Work • Identify Student's Mathematical Understanding • Identify Student's Mathematical Misunderstanding • Interviews • Role Playing • Diagrams, Charts, Tables, and Graphs • Anticipate Likely and Possible Student Response • Collect Different Student Approaches • Multiple Response Strategies • Asking Assessing and Advancing Questions • Revoicing • Marking • Recapping • Challenging • Pressing for Accuracy and Reasoning • Maintain the Cognitive Demand

Educational Technology
Standards
8.1.8.A.1, 8.1.8.A.5, 8.1.8.D.1, 8.1.8.E.1, 8.2.8.B.1

Technology Operations and Concepts

- Create professional documents (e.g., newsletter, personalized learning plan, business letter or flyer) using advanced features of a word processing program.
- Select and use appropriate tools and digital resources to accomplish a variety of tasks and to solve problems.

Digital Citizenship

- Model appropriate online behaviors related to cyber safety, cyber bullying, cyber security, and cyber ethics.

Research and Information Literacy

- Gather and analyze findings to produce a possible solution for a content-related or real world problem using data collection technology.

Design: Critical Thinking, Problem Solving, and Decision Making

- Design and create a product using the design process that addresses a real world problem with specific criteria and constraints.

Career Ready Practices
Career Ready Practices describe the career-ready skills that all educators in all content areas should seek to develop in their students. They are practices that have been linked to increase college, career, and life success. Career Ready Practices should be taught and reinforced in all career exploration and preparation programs with increasingly higher levels of complexity and expectation as a student advances through a program of study**.**
CRP1, CRP3, CRP5, CRP8, CRP10, CRP12

- **CRP1. Act as a responsible and contributing citizen and employee**
  Career-ready individuals understand the obligations and responsibilities of being a member of a community, and they demonstrate this understanding every day through their interactions with others. They are conscientious of the impacts of their decisions on others and the environment around them. They think about the near-term and long-term consequences of their actions and seek to act in ways that contribute to the betterment of their teams, families, community and workplace. They are reliable and consistent in going beyond the minimum expectation and in participating in activities that serve the greater good.

  Example:
  - follow rules, regulations, polices, procedures.
  - Seek regularity, punctuality, attendance.
  - Awareness of one's action impacts others
  - Apply knowledge and skills to enhance productivity.

- **CRP3. Attend to personal health and financial well-being.**
  Career-ready individuals understand the relationship between personal health, workplace performance and personal well-being; they act on that understanding to regularly practice healthy diet, exercise and mental health activities. Career-ready individuals also take regular action to contribute to their personal financial wellbeing, understanding that personal financial security provides the peace of mind required to contribute more fully to their own career success.

  Example:
  - Attend to personal health

- Seek ways to become financially independent.

- **CRP5. Consider the environmental, social and economic impacts of decisions.**
  Career-ready individuals understand the interrelated nature of their actions and regularly make decisions that positively impact and/or mitigate negative impact on other people, organization, and the environment. They are aware of and utilize new technologies, understandings, procedures, materials, and regulations affecting the nature of their work as it relates to the impact on the social condition, the environment and the profitability of the organization.

  Example:
  - Employ environmentally friendly and positive practices holistically.
  - Utilize technology towards the benefit of society.
  - Optimize resources to provide social, environmental equity.

- **CRP8. Utilize critical thinking to make sense of problems and persevere in solving them.**
  Career-ready individuals readily recognize problems in the workplace, understand the nature of the problem, and devise effective plans to solve the problem. They are aware of problems when they occur and take action quickly to address the problem; they thoughtfully investigate the root cause of the problem prior to introducing solutions. They carefully consider the options to solve the problem. Once a solution is agreed upon, they follow through to ensure the problem is solved, whether through their own actions or the actions of others.

  Example:
  - Get to the root cause of problems.
  - interpret and represent scientific data in various forms
  - apply relevant scientific study to situations
  - propose solutions to problems.

- **CRP10. Plan education and career paths aligned to personal goals**.
  Career-ready individuals take personal ownership of their own education and career goals, and they regularly act on a plan to attain these goals. They understand their own career interests, preferences, goals, and requirements. They have perspective regarding the pathways available to them and the time, effort, experience and other requirements to pursue each, including a path of entrepreneurship. They recognize the value of each step in the education and experiential process, and they recognize that nearly all career paths

require ongoing education and experience. They seek counselors, mentors, and other experts to assist in the planning and execution of career and personal goals.

Example:

- seek opportunities for personal development (courses, workshops, industrial visits).
- evaluate new technologies and their capabilities to better living standards.

- **CRP12. Work productively in teams while using cultural global competence.**

  Career-ready individuals positively contribute to every team, whether formal or informal. They apply an awareness of cultural difference to avoid barriers to productive and positive interaction. They find ways to increase the engagement and contribution of all team members. They plan and facilitate effective team meetings.

  Example:

  - teamwork to create collegial relationships for increase productivity.
  - lead and instill good work ethics with discipline, tolerance and productivity.

http://www.state.nj.us/education/aps/cccs/career/CareerReadyPractices.pdf

WIDA Proficiency Levels

At the given level of English language proficiency, English language learners will process, understand, produce or use.

6- Reaching	● Specialized or technical language reflective of the content areas at grade level ● A variety of sentence lengths of varying linguistic complexity in extended oral or written discourse as required by the specified grade level ● Oral or written communication in English comparable to proficient English peers
5- Bridging	● Specialized or technical language of the content areas ● A variety of sentence lengths of varying linguistic complexity in extended oral or written discourse, including stories, essays or reports ● Oral or written language approaching comparability to that of proficient English peers when presented with grade level material.
4- Expanding	● Specific and some technical language of the content areas ● A variety of sentence lengths of varying linguistic complexity in oral discourse or multiple, related sentences or paragraphs ● Oral or written language with minimal phonological, syntactic or semantic errors that may impede the communication, but retain much of its meaning, when presented with oral or written connected discourse, with sensory, graphic or interactive support
3- Developing	● General and some specific language of the content areas ● Expanded sentences in oral interaction or written paragraphs ● Oral or written language with phonological, syntactic or semantic errors that may impede the communication, but retain much of its meaning, when presented with oral or written, narrative or expository descriptions with sensory, graphic or interactive support
2- Beginning	● General language related to the content area ● Phrases or short sentences ● Oral or written language with phonological, syntactic, or semantic errors that often impede of the communication when presented with one to multiple-step commands, directions, or a series of statements with sensory, graphic or interactive support
1- Entering	● Pictorial or graphic representation of the language of the content areas ● Words, phrases or chunks of language when presented with one-step commands directions, WH-, choice or yes/no questions, or statements with sensory, graphic or interactive support

Language Development Supports For English Language Learners To Increase Comprehension and Communication Skills

Environment

- Welcoming and stress-free
- Respectful of linguistic and cultural diversity
- Honors students' background knowledge
- Sets clear and high expectations
- Includes routines and norms
- Is thinking focused vs. answer seeking
- Offers multiple modalities to engage in content learning and to demonstrate understanding
- Includes explicit instruction of specific language targets
- Provides participation techniques to include all learners
- Integrates learning centers and games in a meaningful way
- Provides opportunities to practice and refine receptive and productive skills in English as a new language
- Integrates meaning and purposeful tasks/activities that:
    - Are accessible by all students through multiple entry points
    - Are relevant to students' lives and cultural experiences
    - Build on prior mathematical learning
    - Demonstrate high cognitive demand
    - Offer multiple strategies for solutions
    - Allow for a language learning experience in addition to content

Sensory Supports*	Graphic Supports*	Interactive Supports*	Verbal and Textual Supports
• Real-life objects (realia) or concrete objects • Physical models • Manipulatives • Pictures & photographs • Visual representations or models such as diagrams or drawings • Videos & films • Newspapers or magazines • Gestures • Physical movements • Music & songs	• Graphs • Charts • Timelines • Number lines • Graphic organizers • Graphing paper	• In a whole group • In a small group • With a partner such as *Turn and Talk* • In pairs as a group (first, two pairs work independently, then they form a group of four) • In triads • Cooperative learning structures such as *Think Pair Share* • Interactive websites or software • With a mentor or coach	• Labeling • Students' native language • Modeling • Repetitions • Paraphrasing • Summarizing • Guiding questions • Clarifying questions • Probing questions • Leveled questions such as *What? When? Where? How? Why?* • Questioning prompts & cues • Word Banks • Sentence starters • Sentence frames • Discussion frames • Talk moves, including *Wait Time*

*from *Understanding the WIDA English Language Proficiency Standards. A Resource Guide.* 2007 Edition.. Board of Regents of the University of Wisconsin System, on behalf of the WIDA Consortium—www.wida.us.

BUILDING EQUITY IN YOUR TEACHING PRACTICE

How do the essential questions highlight the connection between the big ideas of the unit and equity in your teaching practice?

CONTENT INTEGRATION	KNOWLEDGE CONSTRUCTION	PREJUDICE REDUCTION	EQUITABLE PEDAGOGY	EMPOWERING SCHOOL CULTURE
Teachers use examples and content from a variety of cultures & groups.	Teachers help students understand how knowledge is created and influenced by cultural assumptions, perspectives & biases.	Teachers implement lessons and activities to assert positive images of ethnic groups & improve intergroup relations.	Teachers modify techniques and methods to facilitate the academic achievement of students from diverse backgrounds.	Using the other four dimensions to create a safe and healthy educational environment for all.
This unit / lesson is connected to other topics explored with students. There are multiple viewpoints reflected in the content of this unit / lesson. The materials and resources are reflective of the diverse identities and experiences of students. The content affirms students, as well as exposes them to experiences other than their own.	This unit / lesson provides context to the history of privilege and oppression. This unit / lesson addresses power relationships. This unit / lesson help students to develop research and critical thinking skills. This curriculum creates windows and mirrors* for students.	This unit / lesson help students question and unpack biases & stereotypes. This unit / lesson help students examine, research and question information and sources. The curriculum encourage discussion and understanding about the groups of people being represented. This unit / lesson challenges dominant perspectives.	The instruction has been modified to meet the needs of each student. Students feel respected and their cultural identities are valued. Additional supports have been provided for students to become successful and independent learners. Opportunities are provided for student to reflect on their learning and provide feedback.	There are opportunities for students to connect with the community. My classroom is welcoming and supportive for all students? I am aware of and sensitive to the needs of my students and their families. There are effective parent communication systems established. Parents can talk to me about issues as they arise in my classroom.

Developed by Karla E. Vigil. Adapted with permission from James A. Banks, CULTURAL DIVERSITY AND EDUCATION: FOUNDATIONS, CURRICULUM, AND TEACHING (6th edition). New York: Routledge, 2016, page 5 and Gordon School Institute on Multicultural Practice.

Culturally Relevant Pedagogy Examples
Relationships: Learn about your students' individual cultures.   Adapt your teaching to the way your students learn Develop a connection with challenging students Communicate and work with parents/guardians on a regular basis (email distribution, newsletter, phone calls, notes, meetings, etc.)   **Curriculum:**   Incorporate student- centered stories, vocabulary and examples. Incorporate relatable aspects of students' lives Create lessons that connect the content to your students' culture and daily lives. Incorporate instructional materials that relate to a variety of cultures   **Instructional Delivery:**   Establish an interactive dialogue to engage all students Continuously interact with students and provide frequent feedback Use frequent questioning as a means to keep students involved Intentionally address visual, tactile, and auditory learners Present relatable real world problems

Differentiated Instruction			
Accommodate Based on Students Individual Needs: Strategies			
Time/General	**Processing**	**Comprehension**	**Recall**
• Extra time for assigned tasks • Adjust length of assignment • Timeline with due dates for reports and projects • Communication system between home and school • Provide lecture notes/outline	• Extra Response time • Have students verbalize steps • Repeat, clarify or reword directions • Mini-breaks between tasks • Provide a warning for transitions • Partnering	• Precise processes for conceptual model • Short manageable tasks • Brief and concrete directions • Provide immediate feedback • Small group instruction • Emphasize multi-sensory learning	• Teacher-made checklist • Use visual graphic organizers • Reference resources to promote independence • Visual and verbal reminders • Graphic organizers
Assistive Technology	**Tests/Quizzes/Grading**	**Behavior/Attention**	**Organization**
• Computer/whiteboard • Tape recorder • Video Tape	• Extended time • Study guides • Shortened tests • Read directions aloud	• Consistent daily structured routine • Simple and clear classroom rules • Frequent feedback	• Individual daily planner • Display a written agenda • Note-taking assistance • Color code materials

Digital Assessment Routledge Pub 2017.		
<u>Suggested Formative/Summative Digital Assessments</u>		
3-d modeling/printing/scanning Animation Blogging/forum Broadcasting channel Case studies on website Collaborating Database Data visualization Digital audio/podcast Digital game creating Digital storytelling Digital portfolio Digital video Drawing E-publication Entrepreneurial plan Fact checking repository (snopes.com)	Film study/critique Forecasting/projecting Global forums virtual Graphics/images Graphics organizers Graphing Grant proposal Infographics Info database searches Interactive simulation Internet researching Mashing/remixing Mathematical modeling Media critiques Music e-composition Photo blogging Playlist- annotated Podcast-audio Presentation Prezi	Programming/coding Project planning tool Prototypes Researching/vetting tool RSS feeding Screencasting Screenplay Sketch-noting with tools Spreadsheets analysis Station hosting-podcast Storyboarding Survey design Timeline interactive/virtual Video hosting Web authoring/curation Webinar event hosting Work processor Work recognition Video/image synthesizing

Interdisciplinary Connections

Model interdisciplinary thinking to expose students to other disciplines.

Connections to NJSLS—English Language Arts

- **RST.6-8.1** Cite specific textual evidence to support analysis of science and technical texts.
- **RST.6-8.7** Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).
- **RST.6-8.8** Distinguish among facts, reasoned judgment based on research findings, and speculation in a text.
- **RI.8.8** Trace and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient to support the claims.
- **WHST.6-8.1** Write arguments to support claims with clear reasons and relevant evidence.
- **WHST.6-8.2** Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.
- **WHST.6-8.9** Draw evidence from literary or informational texts to support analysis, reflection, and research.
- **SL.8.1** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly.
- **SL.8.4** Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation.)
- **SL.8.5** Integrate multimedia and visual displays in presentations to clarify information, strengthen claims and evidence, and add interest.

Examples:

- **Following the procedures on the notebook sheets.**
- **Reading complex text in the FOSS student resource books.**
- **Completing graphic organizers while reading to organize information, thoughts and questions.**
- **Responding to the focus question using evidence from the data collection, notebook recordings and informational text.**
- **FOSS multimedia videos**
- **Word walls**
- **Discussion Circles**
- **Classroom Notebook**

Connections to NJSLS—Mathematics

- **MP.4** Model with mathematics.
- **6.RP.A.3** Use ratio and rate reasoning to solve real-world and mathematical problems.

- **6.EE.C.9** Use variables to represent two quantities in a real-world problem that change in relationship to one another; write an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable. Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation.
- **6.SP.B.5** Summarize numerical data sets in relation to their context.

Examples:

- **Recording, calculating, analyzing and interpreting data on the notebook sheets.**
- **Using mathematical and computational thinking with models**
- **Using formulas and equations to measure the states, properties and behavior of matter.**
- **Math Extensions (if available)**

Enrichment

What is the purpose of Enrichment?

- The purpose of enrichment is to provide extended learning opportunities and challenges to students who have already mastered, or can quickly master, the basic curriculum. Enrichment gives the student more time to study concepts with greater depth, breadth, and complexity.
- Enrichment also provides opportunities for students to pursue learning in their own areas of interest and strengths.
- Enrichment keeps advanced students engaged and supports their accelerated academic needs.
- Enrichment provides the most appropriate answer to the question, “What do you do when the student already knows it?”

Enrichment is…

- Planned and purposeful
- *Different*, or differentiated, work – not just *more* work
- Responsive to students’ needs and situations
- A promotion of high-level thinking skills and making connections within content
- The ability to apply different or multiple strategies to the content
- The ability to synthesize concepts and make real world and cross-curricular connections.
- Elevated contextual complexity
- Sometimes independent activities, sometimes direct instruction
- Inquiry based or open ended assignments and projects
- Using supplementary materials in addition to the normal range of resources.
- Choices for students
- Tiered/Multi-level activities with Flexible groups (may change daily or weekly)

Enrichment is not…

- Just for gifted students (some gifted students may need intervention in some areas just as some other students may need frequent enrichment)
- Worksheets that are more of the same (busywork)
- Random assignments, games, or puzzles not connected to the content areas or areas of student interest
- Extra homework
- A package that is the same for everyone
- Thinking skills taught in isolation
- Unstructured free time

Assessments
<u>Suggested Formative/Summative Classroom Assessments</u> Describe Learning Vertically Identify Key Building Blocks Make Connections (between and among key building blocks) Short/Extended Constructed Response Items Multiple-Choice Items (where multiple answer choices may be correct) Drag and Drop Items Use of Equation Editor Quizzes Journal Entries/Reflections/Quick-Writes Accountable talk Projects Portfolio Observation Graphic Organizers/ Concept Mapping Presentations Role Playing Teacher-Student and Student-Student Conferencing Homework

Standards for the Course

MS-LS1: From Molecules to Organisms: Structures and Processes
MS-LS2: Ecosystems: Interactions, Energy, and Dynamics
MS-ESS: Earth and Human Activity
MS-ETS1: Engineering Design

Students who demonstrate understanding can:

- **MS-LS1-6** Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms. [Clarification Statement: Emphasis is on tracing movement of matter and flow of energy.] [Assessment Boundary: Assessment does not include the biochemical mechanisms of photosynthesis.]
- **MS-LS1-7** Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism. [Clarification Statement: Emphasis is on describing that molecules are broken apart and put back together and that in this process, energy is released.] [Assessment Boundary: Assessment does not include details of the chemical reactions for photosynthesis or respiration.]

- **MS-LS2-1** Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. [Clarification Statement: Emphasis is on cause and effect relationships between resources and growth of individual organisms and the numbers of organisms in ecosystems during periods of abundant and scarce resources.]

- **MS-LS2-2** Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. [Clarification Statement: Emphasis is on predicting consistent patterns of interactions in different ecosystems in terms of the relationships among and between organisms and abiotic components of ecosystems. Examples of types of interactions could include competitive, predatory, and mutually beneficial.]

- **MS-LS2-3** Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. [Clarification Statement: Emphasis is on describing the conservation of matter and flow of energy into and out of various ecosystems, and on defining the boundaries of the system.] [Assessment Boundary: Assessment does not include the use of chemical reactions to describe the processes.]

- **MS-LS2-4** Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. [Clarification Statement: Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations, and on evaluating empirical evidence supporting arguments about changes to ecosystems.]

- **MS-LS2-5** Evaluate competing design solutions for maintaining biodiversity and ecosystem services. [Clarification Statement: Examples of ecosystem services could include water purification, nutrient recycling, and prevention of soil erosion. Examples of design solution constraints could include scientific, economic, and social considerations.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. ▪ Develop a model to describe phenomena. (MS-LS2-3) **Analyzing and Interpreting Data** Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to	**LS2.A: Interdependent Relationships in Ecosystems** ▪ Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1) ▪ In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their	**Patterns** ▪ Patterns can be used to identify cause and effect relationships. (MS-LS2-2) **Cause and Effect** ▪ Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-LS2-1) **Energy and Matter** ▪ The transfer of energy can be tracked as energy flows through a natural system. (MS-LS2-3)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. ▪ Analyze and interpret data to provide evidence for phenomena. (MS-LS2-1) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. ▪ Construct an explanation that includes qualitative or quantitative relationships between variables that predict phenomena. (MS-LS2-2) **Engaging in Argument from Evidence** Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s). ▪ Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MS-LS2-4) ▪ Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (MS-LS2-5)	growth and reproduction. (MS-LS2-1) ▪ Growth of organisms and population increases are limited by access to resources. (MS-LS2-1) ▪ Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared. (MS-LS2-2) **LS2.B: Cycle of Matter and Energy Transfer in Ecosystems** ▪ Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. (MS-LS2-3) **LS2.C: Ecosystem Dynamics, Functioning, and Resilience** ▪ Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an	**Stability and Change** ▪ Small changes in one part of a system might cause large changes in another part. (MS-LS2-4), (MS-LS2-5) ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering, and Technology on Society and the Natural World** ▪ The use of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus, technology use varies from region to region and over time. (MS-LS2-5) ***Connections to Nature of Science*** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** ▪ Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation. (MS-LS2-3) **Science Addresses Questions About the Natural and Material World** ▪ Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes. (MS-LS2-5) ***Connections to Nature of Science*** **Scientific Knowledge is Based on Empirical Evidence**

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
	ecosystem can lead to shifts in all its populations. (MS-LS2-4) ▪ Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health. (MS-LS2-5) **LS4.D: Biodiversity and Humans** ▪ Changes in biodiversity can influence humans' resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on—for example, water purification and recycling. (*secondary to MS-LS2-5*) **ETS1.B: Developing Possible Solutions** ▪ There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. *(secondary to MS-LS2-5)*	▪ Science disciplines share common rules of obtaining and evaluating empirical evidence. (MS-LS2-4)

Connections to other DCIs in grades 6–8:

- **MS.PS3.D** (MS-PS1-2), (MS-PS1-6)
- **MS.LS1.C** (MS-PS1-2), (MS-PS1-5)
- **MS.LS2.A** (MS-PS1-3)
- **MS.LS2.B** (MS-PS1-5)
- **MS.LS4.D** (MS-PS1-3)
- **MS.ESS2.A** (MS-PS1-2), (MS-PS1-5)
- **MS.ESS2.C** (MS-PS1-1), (MS-PS1-4)
- **MS.ESS3.A** (MS-PS1-3)
- **MS.ESS3.C** (MS-PS1-3)

Articulation of DCIs across grade levels:

- **5.PS1.A** (MS-PS1-1)
- **5.PS1.B** (MS-PS1-2), (MS-PS1-5)
- **HS.PS1** (MS-PS1-1), (MS-PS1-3), (MS-PS1-4), (MS-PS1-6)
- **HS.PS1.B** (MS-PS1-2), (MS-PS1-4), (MS-PS1-5), (MS-PS1-6)
- **HS.PS3.A** (MS-PS1-4), (MS-PS1-6)
- **HS.PS3.B** (MS-PS1-6)
- **HS.PS3.D** (MS-PS1-6)
- **HS.LS2.A** (MS-PS1-3)
- **HS.LS4.D** (MS-PS1-3)
- **HS.ESS1.A** (MS-PS1-1)
- **HS.ESS3.A** (MS-PS1-3)

MS-ESS3: Earth and Human Activity

Students who demonstrate understanding can:

- **MS-ESS3-1** Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes. [Clarification Statement: Emphasis is on how these resources are limited and typically non-renewable, and how their distributions are significantly changing as a result of removal by humans. Examples of uneven distributions of resources as a result of past processes include but are not limited to petroleum (locations of the burial of organic marine sediments and subsequent geologic traps), metal ores (locations of past volcanic and hydrothermal activity associated with subduction zones), and soil (locations of active weathering and/or deposition of rock).]
- **MS-ESS3-2** Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.
  [Clarification Statement: Emphasis is on how some natural hazards, such as volcanic eruptions and severe weather, are preceded by phenomena that allow for reliable predictions, but others, such as earthquakes, occur suddenly and with no notice, and thus are not yet predictable. Examples of natural hazards can be taken from interior processes (such as earthquakes and volcanic eruptions), surface processes (such as mass wasting and tsunamis), or severe weather events (such as hurricanes, tornadoes, and floods). Examples of data can include the locations, magnitudes, and frequencies of the natural hazards. Examples of technologies can be global (such as satellite systems to monitor hurricanes or forest fires) or local (such as building basements in tornado-prone regions or reservoirs to mitigate droughts).]
- **MS-ESS3-3** Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
  [Clarification Statement: Examples of the design process include examining human environmental impacts, assessing the kinds of solutions that are feasible, and designing and evaluating solutions that could reduce that impact. Examples of human impacts can include water usage (such as the withdrawal of water from streams and aquifers or the construction of dams and levees), land usage (such as urban development, agriculture, or the removal of wetlands), and pollution (such as of the air, water, or land).]
- **MS-ESS3-4** Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.
  [Clarification Statement: Examples of evidence include grade-appropriate databases on human populations and the rates of consumption of food and natural resources (such as freshwater, mineral, and energy). Examples of impacts can include changes to the appearance, composition, and structure of Earth's systems as well as the rates at which they change. The consequences of increases in human populations and consumption of natural resources are described by science, but science does not make the decisions for the actions society takes.]
- **MS-ESS3-5.** Ask questions to clarify evidence of the factors that have caused climate change over the past century. [Clarification Statement: Examples of factors include human activities (such as fossil fuel combustion, cement production, and agricultural activity) and natural processes (such as changes in incoming solar radiation or volcanic activity). Examples of evidence can include tables, graphs, and maps of global and regional temperatures, atmospheric levels of gases such as carbon dioxide and methane, and the rates of human activities. Emphasis is on the major role that human activities play in causing the rise in global temperatures.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems Asking questions and defining problems in grades 6–8 builds on grades K–5 experiences and progresses to specifying relationships between variables and clarifying arguments and models. ▪ Ask questions to identify and clarify evidence of an argument. (MS-ESS3-5) **Analyzing and Interpreting Data** Analyzing data 6–8 builds on grades K–5 and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. ▪ Analyze and interpret data to determine similarities and differences in findings. (MS-ESS3-2) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 6–8 builds on grades K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. ▪ Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will	**ESS3.A: Natural Resources** ▪ Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes. (MS-ESS3-1) **ESS3.B: Natural Hazards** ▪ Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces can help forecast the locations and likelihoods of future events. (MS-ESS3-2) **ESS3.C: Human Impacts on Earth Systems** ▪ Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. (MS-ESS3-3) ▪ Typically, as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. (MS-ESS3-3), (MS-ESS3-4)	**Patterns** ▪ Graphs, charts, and images can be used to identify patterns in data. (MS-ESS3-2) **Cause and Effect** ▪ Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. (MS-ESS3-3) ▪ Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-ESS3-1), (MS-ESS3-4) **Stability and Change** ▪ Stability might be disturbed either by sudden events or gradual changes that accumulate over time. (MS-ESS3-5) ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering, and Technology on Society and the Natural World** ▪ All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. (MS-ESS3-1), (MS-ESS3-4) ▪ The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus, technology use varies from region

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
continue to do so in the future. (MS-ESS3-1) ▪ Apply scientific principles to design an object, tool, process or system. (MS-ESS3-3) **Engaging in Argument from Evidence** Engaging in argument from evidence in 6–8 builds on grades K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s). ▪ Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MS-ESS3-4)	**ESS3.D: Global Climate Change** ▪ Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities. (MS-ESS3-5)	to region and over time. (MS-ESS3-2), (MS-ESS3-3) ***Connections to Nature of Science*** **Science Addresses Questions About the Natural and Material World** ▪ Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes. (MS-ESS3-4)

Connections to other DCIs in grades 6–8:

- **MS.PS1.A** (MS-ESS3-1)
- **MS.PS1.B** (MS-ESS3-1)
- **MS.PS3.A** (MS-ESS3-5)
- **MS.PS3.C** (MS-ESS3-2)
- **MS.LS2.A** (MS-ESS3-3), (MS-ESS3-4)
- **MS.LS2.C** (MS-ESS3-3), (MS-ESS3-4)
- **MS.LS4.D** (MS-ESS3-3), (MS-ESS3-4)
- **MS.ESS2.D** (MS-ESS3-1)

Articulation of DCIs across grade levels:

- **3.LS2.C** (MS-ESS3-3), (MS-ESS3-4)
- **3.LS4.D** (MS-ESS3-3), (MS-ESS3-4)
- **3.ESS3.B** (MS-ESS3-2)
- **4.PS3.D** (MS-ESS3-1)
- **4.ESS3.A** (MS-ESS3-1)
- **4.ESS3.B** (MS-ESS3-2)
- **5.ESS3.C** (MS-ESS3-3), (MS-ESS3-4)
- **HS.PS3.B** (MS-ESS3-1), (MS-ESS3-5)
- **HS.PS4.B** (MS-ESS3-5)
- **HS.LS1.C** (MS-ESS3-1)
- **HS.LS2.A** (MS-ESS3-4)
- **HS.LS2.C** (MS-ESS3-3), (MS-ESS3-4)
- **HS.LS4.C** (MS-ESS3-3), (MS-ESS3-4)
- **HS.LS4.D** (MS-ESS3-3), (MS-ESS3-4)
- **HS.ESS2.A** (MS-ESS3-1), (MS-ESS3-5)
- **HS.ESS2.B** (MS-ESS3-1), (MS-ESS3-2)
- **HS.ESS2.C** (MS-ESS3-1), (MS-ESS3-3)
- **HS.ESS2.D** (MS-ESS3-2), (MS-ESS3-3), (MS-ESS3-5)

- **HS.ESS2.E** (MS-ESS3-3), (MS-ESS3-4)
- **HS.ESS3.A** (MS-ESS3-1), (MS-ESS3-4)
- **HS.ESS3.B** (MS-ESS3-2)
- **HS.ESS3.C** (MS-ESS3-3), (MS-ESS3-4), (MS-ESS3-5)
- **HS.ESS3.D** (MS-ESS3-2); (MS-ESS3-3), (MS-ESS3-5)

Connections to NJSLS – English Language Arts

- **RST.6-8.1** Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS3-1), (MS-ESS3-2), (MS-ESS3-4), (MS-ESS3-5)
- **RST.6-8.7** Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-ESS3-2)
- **WHST.6-8.1** Write arguments focused on discipline content. (MS-ESS3-4)
- **WHST.6-8.2** Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (MS-ESS3-1)
- **WHST.6-8.7** Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-ESS3-3)
- **WHST.6-8.8** Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. (MS-ESS3-3)
- **WHST.6-8.9** Draw evidence from informational texts to support analysis, reflection, and research. (MS-ESS3-1), (MS-ESS3-4)

Connections to NJSLS – Mathematics

- **MP.2** Reason abstractly and quantitatively. (MS-ESS3-2), (MS-ESS3-5)
- **6.RP.A.1** Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (MS-ESS3-3), (MS-ESS3-4)
- **7.RP.A.2** Recognize and represent proportional relationships between quantities. (MS-ESS3-3), (MS-ESS3-4)
- **6.EE.B.6** Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. (MS-ESS3-1), (MS-ESS3-2), (MS-ESS3-3), (MS-ESS3-4), (MS-ESS3-5)
- **7.EE.B.4** Use variables to represent quantities in a real-world or mathematical problem and construct simple equations and inequalities to solve problems by reasoning about the quantities. (MS-ESS3-1), (MS-ESS3-2), (MS-ESS3-3), (MS-ESS3-4), (MS-ESS3-5)

MS-ETS1: Engineering Design

Students who demonstrate understanding can:

- **MS-ETS1-1** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
- **MS-ETS1-2** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- **MS-ETS1-3** Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
- **MS-ETS1-4** Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems Asking questions and defining problems in grades 6–8 builds on K–5 experiences and progresses to specifying relationships between variables and clarifying arguments and models. ▪ Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions. (MS-ETS1-1) **Developing and Using Models** Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. ▪ Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs. (MS-ETS1-4)	**ETS1.A: Defining and Delimiting Engineering Problems** ▪ The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions. (MS-ETS1-1) **ETS1.B: Developing Possible Solutions** ▪ A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4) ▪ There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2), (MS-ETS1-3) ▪ Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3) ▪ Models of all kinds are important for testing solutions. (MS-ETS1-4)	**Influence of Science, Engineering, and Technology on Society and the Natural World** ▪ All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. (MS-ETS1-1) ▪ The uses of technologies and limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. (MS-ETS1-1)

Connections to other DCIs in grades 6–8:

- **MS.LS1.A** (MS-LS3-1)
- **MS.LS4.A** (MS-LS3-1)

Articulation of DCIs across grade levels:

- **3.LS3.A** (MS-LS3-1), (MS-LS3-2)
- **3.LS3.B** (MS-LS3-1), (MS-LS3-2)
- **HS.LS1.A** (MS-LS3-1)
- **HS.LS1.B** (MS-LS3-1), (MS-LS3-2)
- **HS.LS3.A** (MS-LS3-1), (MS-LS3-2)
- **HS.LS3-B** (MS-LS3-1), (MS-LS3-2)

Connections to NJSLS – English Language Arts

- **RST.6-8.1** Cite specific textual evidence to support analysis of science and technical texts. (MS-LS3-1), (MS-LS3-2)
- **RST.6-8.4** 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 6-8 texts and topics. (MS-LS3-1), (MS-LS3-2)
- **RST.6-8.7** Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-LS3-1), (MS-LS3-2)
- **SL.8.5** Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-LS3-1), (MS-LS3-2)

Connections to NJSLS – Mathematics

- **MP.4** Model with mathematics. (MS-LS3-2)
- **6.SP.B.5** Summarize numerical data sets in relation to their context. (MS-LS3-2)

Course: Life Science	Unit: 1	Topic: Population and Ecosystem

Storyline: *How do organisms change over time in response to changes in the environment?*

Unit Summary: ***How and why do organisms interact with their environment and what the effects of these interactions?***

Students *analyze and interpret data, develop models, construct arguments*, and demonstrate a deeper understanding of the cycling of matter, the flow of energy, and resources in ecosystems. They are able to study patterns of interactions among organisms within an ecosystem. They consider biotic and abiotic factors in an ecosystem and the effects these factors have on populations. They also understand that the limits of resources influence the growth of organisms and populations, which may result in competition for those limited resources. The crosscutting concepts of *matter and energy*, *systems and system models*, *patterns*, and *cause and effect* provide a framework for understanding the disciplinary core ideas. Students demonstrate grade-appropriate proficiency in analyzing and interpreting data, developing models, and constructing arguments. Students are also expected to use these practices to demonstrate an understanding of the core ideas.

Students build on their understanding of the transfer of matter and energy as they study patterns of interactions among organisms within an ecosystem. They construct explanations for the interactions in ecosystems and the scientific, economic, political, and social justifications used in making decisions about maintaining biodiversity in ecosystems. The crosscutting concept of stability and change provide a framework for understanding the disciplinary core ideas.

This unit includes a two-stage engineering design process. Students first evaluate different engineering ideas that have been proposed using a systematic method, such as a tradeoff matrix, to determine which solutions are most promising. They then test different solutions, and combine the best ideas into a new solution that may be better than any of the preliminary ideas. Students demonstrate grade appropriate proficiency in asking questions, designing solutions, engaging in argument from evidence, developing and using models, and designing solutions. Students are also expected to use these practices to demonstrate an understanding of the core ideas.

Standards

NJSLS:

MS-LS2-1. Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. [Clarification Statement: Emphasis is on cause and effect relationships between resources and growth of individual organisms and the numbers of organisms in ecosystems during periods of abundant and scarce resources.]

MS-LS2-2. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. [Clarification Statement: Emphasis is on predicting consistent patterns of interactions in different ecosystems in terms of the relationships among and between organisms and abiotic components of ecosystems. Examples of types of interactions could include competitive, predatory, and mutually beneficial.]

MS-LS 2-3. Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. [Clarification Statement: Emphasis is on describing the conservation of matter and flow of energy into and out of various ecosystems, and on defining the boundaries of the system.] [Assessment Boundary: Assessment does not include the use of chemical reactions to describe the processes.]

MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. [Clarification Statement: Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations, and on evaluating empirical evidence supporting arguments about changes to ecosystems.]

MS-LS2-5. **Evaluate competing design solutions for maintaining biodiversity and ecosystem services. *** [Clarification Statement: Examples of ecosystem services could include water purification, nutrient recycling, and prevention of soil erosion. Examples of design solution constraints could include scientific, economic, and social considerations.]

MS-LS1-6. Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms. [Clarification Statement: Emphasis is on tracing movement of matter and flow of energy.] [Assessment Boundary: Assessment does not include the biochemical mechanisms of photosynthesis.]

MS-LS1-7. Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism. [Clarification Statement: Emphasis is on describing that molecules are broken apart and put back together and that in this process, energy is released.] [Assessment Boundary: Assessment does not include details of the chemical reactions for photosynthesis or respiration.]

MS-ESS3-3.Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. [Clarification Statement: Examples of the design process include examining human environmental impacts, assessing the kinds of solutions that are feasible, and designing and evaluating) solutions that could reduce that impact. Examples of human impacts can include water usage (such as the withdrawal of water from streams and aquifers or the construction of dams and levees), land usage (such as urban development, agriculture, or the removal of wetlands), and pollution (such as air, water, or land).]

MS-ESS3-4. Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems. [Clarification Statement: Examples of evidence include grade-appropriate databases on human populations and the rates of consumption of food and natural resources (such as freshwater, mineral, and energy). Examples of impacts can include changes to the appearance, composition, and structure of Earth's systems as well as the rate at which they change. The consequences of increases in human populations and consumption of natural resources are described by science, but science does not make the decisions for the actions society takes.]

MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data • Analyze and interpret data to provide evidence for phenomena. (MS-LS2-1) • Analyze and interpret data to determine similarities and differences in findings. (MS-ETS1-3) **Constructing Explanations and Designing Solutions** • Construct an explanation that includes qualitative or quantitative relationships between variables that predict phenomena. (MS-LS2-2) • Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MS-LS2-4) **Developing and Using Models** • Develop a model to describe phenomena. (MS-LS2-3)	**LS2.A: Interdependent Relationships in Ecosystems** • Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and nonliving factors. (MS-LS2-1) • In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (MS-LS2-1) • Growth of organisms and population increases are limited by access to resources. (MS-LS2-1) • Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their	**Patterns** • Patterns can be used to identify cause and effect relationships. (MS-LS2-2) **Cause and Effect** • Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-LS2-1) **Energy and Matter** • The transfer of energy can be tracked as energy flows through a natural system. (MS-LS2-3) **Stability and Change** • Small changes in one part of a system might cause large changes in another part. (MS-LS2-4),(MS-LS2-5) - ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering, and Technology on Society and the Natural World** • The use of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time. (MS-LS2-5) -

	environments, both living and nonliving, are shared. (MS-LS2-2) **LS2.B: Cycle of Matter and Energy Transfer in Ecosystems** • Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. (MS-LS2-3) **LS2.C: Ecosystem Dynamics, Functioning, and Resilience** • Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological components of an ecosystem can lead to shifts in all its populations. (MS-LS2-4) • Biodiversity describes the variety of species found in Earth’s terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem’s biodiversity is often used as a measure of its health. (MS-LS2-5)	***Connections to Nature of Science*** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** • Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation. (MS-LS2-3) **Scientific Knowledge is Based on Empirical Evidence** • Science disciplines share common rules of obtaining and evaluating empirical evidence. (MS-LS2-4) **Science Addresses Questions About the Natural and Material World** • Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes. (MS-LS2-5)

	LS4.D: Biodiversity and Humans • Changes in biodiversity can influence humans' resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on—for example, water purification and recycling. (secondary to MS-LS2-5) **ETS1.B: Developing Possible Solutions** • There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem.*(secondary to MS-LS2-5)* **ETS1.A: Defining and Delimiting Engineering Problems** • The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions. (MS-ETS1-1) **ETS1.B: Developing Possible Solutions** • A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4) • There are systematic processes for evaluating solutions with respect to how well they meet the criteria and	

	constraints of a problem. (MS-ETS1-2), (MS-ETS1-3) • Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3) • Models of all kinds are important for testing solutions. (MS-ETS1-4) **ETS1.C: Optimizing the Design Solution** • Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of those characteristics may be incorporated into the new design. (MS-ETS1-3)	

*Student Learning Objective:	Essential Questions	Skills, Strategies & Concepts	Sample Activities	Resources
1. *Investigation 1: Introducing Milkweed Bugs* Students determine the factors that are necessary for survival for a milkweed bug population. MS-LS2-1	What does a population of milkweed bugs need to survive in a classroom?	• An organism is any living thing. • An organism's habitat is where it lives—the place where it can meet all of its requirements for life. • A kind of organism that is different from all other kinds of organisms is called a species. • A population is all the individuals of a species in an area at a specified time..	Part 1 Introducing Milkweed Bugs **Introducing Milkweed Bugs** Introducing Milkweed Bugs Students are introduced to adult milkweed bugs. They observe the milkweed bugs carefully in order to discover gender differences.	Science Resources Book: "Milkweed Bugs" Benchmark Assessment Survey
2. *Investigation 1: Milkweed Bug Habitat* Students plan and construct milkweed bug habitats based upon their survival needs. MS-LS2-1	What needs to be considered when building a habitat for milkweed bugs?		Part 2 Milkweed Bug Habitat **Milkweed--Bug Habitat** Students assemble zip--bag habitats to house milkweed bugs during the reproduction study. Each class completes one task in the assembly project. The last class of the day puts the milkweed bugs into the finished habitat. Students are also introduced to the class worm habitat and what they will do to maintain the redworm population.	Habitat setups
3. *Investigation 1: Observing Milkweed-Bug Habitats* Students observe milkweed bugs' physical characteristics and behaviors	How do milkweed bugs reproduce and grow?	• An individual is one single organism. • A community is all the interacting populations in a specified area. • An ecosystem is a system of interacting organisms and	Part 3 Observing Milkweed-Bug Habitats **Observing Milkweed--Bug Habitats** For several weeks students observe and record events in the milkweed--bug habitats. Students should observe feeding and drinking, movement, mating, egg	Science Resources Book: "Observations and Inferences"

that promote survival in their habitat. [MS-LS2-1](#)		nonliving factors in a specified area. • Biotic factors are living factors in an ecosystem; abiotic factors are nonliving factors. • Ecosystems around the world have different sets of biotic and abiotic factors. • Ecosystems provide ecosystem services for humans. • Biomes are large areas on Earth with similar abiotic factors.	laying, hatching, and molting. After 6–8 weeks, students have observed the entire milkweed--bug life cycle and have seen a multitude of offspring.	
4. ***Investigation 2: Ecosystem Card Sort*** Students develop a model to explain relationships within ecosystems. **MS-LS2-1, MS-LS2-2**	What is the relationship between individuals, populations, communities, and abiotic factors in an ecosystem?	• An individual is one single organism. • A community is all the interacting populations in a specified area. • An ecosystem is a system of interacting organisms and nonliving factors in a specified area. • Biotic factors are living factors in an ecosystem; abiotic factors are nonliving factors. • Ecosystems around the world have different sets of	Part 1 Ecosystem Card Sort **Ecosystem Card Sort** Students are introduced to basic definitions used in ecological studies: individual, population, community, ecosystem, and biotic/abiotic factors. They deepen their understanding by sorting the picture cards into categories based on the definitions. After discussing the sorting activity, students record their results in their notebooks.	Science Resources Book: “Life in a Community” (optional) Ecosystem Cards

		biotic and abiotic factors. • Ecosystems provide ecosystem services for humans. • Biomes are large areas on Earth with similar abiotic factors.		
5. ***Investigation 2: Video Population Study*** Students identify biotic and abiotic interactions in the Gombe ecosystem and compare them to their milkweed bug habitats. Students can differentiate between an observational study and a controlled experiment. **MS-LS2-1, MS-LS2-2**	How is the milkweed-bug-habitat study similar to and different from Jane Goodall's population study?	• A community is all the interacting populations in a specified area. • An ecosystem is a system of interacting organisms and nonliving factors in a specified area.	Part 2 Video Population Study **Video Population Study** Students watch a video of Jane Goodall's experience developing her population field study on chimpanzees. Students answer questions about Goodall's experience.	Video: *Among the Wild Chimpanzees*
6. ***Investigation 2: Ecoscenarios*** Students gather research regarding the defining	What are the defining characteristics of your ecosystem?	• A community is all the interacting populations in a specified area. • An ecosystem is a system of interacting organisms and	Part 3 Ecoscenarios **Ecoscenarios** Students are introduced to ten ecoscenarios representing major biomes of North America. Each group begins the study of a different ecosystem by identifying	Science Resources Book: "Ecoscenario Introductions" (optional) "Defining a Biome" Online Activities: "Ecoscenarios" "Biomes"

characteristics of their ecosystem. **MS-LS2-1, MS-LS2-2**		nonliving factors in a specified area. • Biotic factors are living factors in an ecosystem; abiotic factors are nonliving factors. • Ecosystems around the world have different sets of biotic and abiotic factors. • Ecosystems provide ecosystem services for humans. • Biomes are large areas on Earth with similar abiotic factors.	its populations and the abiotic factors that defined the region.	
7. ***Investigation 3: A Visit to Mono Lake*** Students identify major abiotic factors and organisms that impact the Mono Lake ecosystem. Students can describe the feeding relationship between major organism populations.	What are the different biotic and abiotic components of the Mono Lake ecosystem?	• Mono Lake is an example of an alkaline-lake ecosystem. • A sequence of organisms that eat one another is a food chain. • All the feeding relationships in an ecosystem define the food web for that ecosystem. • The Mono Lake ecosystem is defined	Part 1 A Visit to Mono Lake **A Visit to Mono Lake** Students are introduced to a new ecosystem, alkaline lakes. They begin an in--depth study of the Mono Lake ecosystem. They identify relationships between the organisms and abiotic factors.	Science Resources Book: "An Introduction to Mono Lake" Video *The Mono Lake Story*

[MS-LS2-2, MS-LS2-3](#)		by the interactions among organisms and abiotic factors that exist in the Mono Lake basin. • All ecosystems are defined by the interactions among organisms and abiotic factors that exist in the region.		
8. ***Investigation 3: Mono Lake Food Web*** Students will create models to describe the flow of energy through the Mono Lake ecosystem. [MS-LS2-2, MS-LS2-3](#)	How do the organisms at Mono Lake interact?		Part 2 Mono Lake Food Web **Mono Lake Food Web** Students study the natural history of the major organisms in Mono Lake through feeding relationships and interactions. The concepts of food chains and more complex food webs are introduced. Students learn the ecological roles played by organisms in an ecosystem—producer, consumer, and decomposer—and reorganize the Mono Lake organisms into layers with producers at the base and consumers above.	Online Activities: “Mono Lake Interactive Food Web”
9. ***Investigation 3: Ecoscenario Food Webs*** Students will create models to describe the flow of energy through their ecoscenarios. [MS-LS2-2, MS-LS2-3](#)	How do the organisms in your ecoscenario interact?	• The path that food takes as one organism is eaten by another is a food chain. • The feeding relationships in an ecosystem can be represented as a food web. • All ecosystems are defined by the interactions among the organisms and abiotic factors that exist in the region.	Part 3 Ecoscenario Food Webs **Ecoscenario Food Webs** Students return to their assigned ecoscenario from Investigation 2. They identify and chart the feeding relationships for their ecoscenario.	Online Activities: “Ecoscenarios”
10. ***Investigation 4: The Physical Environment***	What abiotic factors should be considered when setting up	• An aquatic ecosystem functions in water.	Part 1 The Physical Environment **The Physical Environment**	Science Resources Book: “Mini Habitat Organisms” “Biosphere 2: An Experiment in Isolation” (optional)

Students will plan and construct a mini habitat that takes into consideration the abiotic needs of each organism that is included. **MS-LS2-1, MS-LS2-4**	terrestrial and aquatic habitats?	• A terrestrial ecosystem functions on land.	Students categorize organisms into two sets, based on the kind of physical environment in which the organisms might live: aquatic or terrestrial. They assemble an aquarium and a terrarium in preparation for introducing organisms in Part 2.	
11. ***Investigation 4: Introducing Life*** Students will collect accurate and detailed data regarding organisms in their mini habitats. Students make accurate measurements of organisms. Students identify food and predators of all organisms. **MS-LS2-1, MS-LS2-4**	What interactions are likely for the organisms in the mini habitat?		Part 2 Introducing Life **Introducing Life** Students observe aquatic organisms and terrestrial organisms in isolation and record observations. They predict how the organisms will interact when they are placed in their minihabitats.	Science Resources Book: "Mini Habitat Organisms"
12. ***Investigation 4: Observing Mini Habitats*** Students will develop a model to describe the flow of energy through their mini	What changes have taken place in terrariums and the class aquariums?	• An aquatic ecosystem functions in water. • A terrestrial ecosystem functions on land. • Organisms depend on the abiotic elements in their	Part 3 Observing Mini Habitats **Observing Mini Habitats** Students begin a long--term observation of the minihabitats. They attend to basic maintenance procedures like removing dead organisms and feeding, and discuss the interactions that they observe.	Online Activity: "Mini Habitat Organisms"

habitats based upon their collected data. **MS-LS2-1, MS-LS2-4**		• ecosystem.		
13. ***Investigation 5: Growing Producers*** Students will compare plant growth when light levels are changed. **MS-LS1-6, MS-LS1-7, MS-LS2-3** Note: This will be a recurring objective throughout this investigation.	What is the effect of light on producers?	• Photosynthesis is the process by which energy-rich molecules (food) are made from water, carbon dioxide, and light. • Producers increase the biomass of an ecosystem through photosynthesis. • Photosynthesis and aerobic cellular respiration make stored energy available to organisms. • Ecosystems are defined by the producers present. • Food is energy-rich organic matter that organisms need to conduct life processes. • Energy transferred from food is measured in kilocalories.	Part 1 Growing Producers **Growing Producers** Students plant seeds in light and dark conditions. They monitor and compare the seed growth over ten days to determine the role of light in biomass production. Students go on to complete the investigation while the plants grow.	
14. ***Investigation 5: Biomass and Producers*** Students will gather data to support a claim regarding the conditions required to best increase plant biomass. Students will identify the essential components of photosynthesis.	What do producers need to grow and increase biomass?		Part 2 Biomass and Producers **Biomass and Producers** Students inquire into where food energy comes from. They process data from a hypothetical experiment to discover the conditions under which plants add biomass. They learn that photosynthesis is the process that produces new energy--rich biomass that can be used as food.	Science Resources Book "Energy and Life" "Where Does Food Come From?" (optional)

MS-LS1-6, MS-LS1-7, MS-LS2-3				
15. ***Investigation 5: Ecoscenario Producers*** Students will identify the roles of specific producers within an ecosystem. **MS-LS1-6, MS-LS1-7, MS-LS2-3**	What are the roles of specific producers in the ecosystem?		Part 3 Ecoscenario Producers **Ecoscenario Producers** Students investigate the producers in their ecoscenario and the biomes they represent. They outline the roles played by these producers and identify the ecosystem services they provide.	Online Activities "Ecoscenarios" (optional) "Biomes" (optional)
16. ***Investigation 5: Energy Transfer from Food*** Students will use a model to describe how energy is transferred from food when it is metabolized by the body. Students will calculate energy transfer in calories. **MS-LS1-6, MS-LS1-7, MS-LS2-3**	How can we model and measure energy transfer from food?		Part 4 Energy Transfer from Food **Energy Transfer from Food** Students use a model to investigate energy transfer in food. They burn snack foods to confirm that there is stored potential energy in food. They use the burning food to heat water in order to quantify food energy and calculate the calories. They learn the difference between small calories and kilocalories used to measure the energy in food. The discuss the limitations of the model.	Science Resources Book "What Does Water Do?" (optional) " Wangari Maathai: Being a Hummingbird" (optional)
17. ***Investigation 6: Using Energy*** Students will uncover patterns that can be categorized regarding the	What are the kinds of work you do that require energy?	• Every activity undertaken by living organisms involves expenditure of energy.	Part 1 Using Energy **Using Energy** Students think of the ways organisms use energy to do work and make things happen.	Benchmark Assessment Investigations 6 I-Check

manner in which organisms use energy. MS-LS1-6, MS-LS2-1, MS-LS2-2, MS-LS2-3		• Feeding relationships identify trophic roles: producers, consumers, and decomposers. • Biomass moves through an ecosystem from one trophic level to the next. • Only a small fraction of the biomass consumed at a trophic level is used to produce biomass at that level—much is used for energy and much is lost to the environment. • Decomposers recycle food molecules to basic particles for use by organisms in the ecosystem.	They sort energy--use strips into categories: maintenance, growth/reproduction, waste, and movement. They learn that all organism functions require energy.	
18. ***Investigation 6: Food-Chain Game*** Students will model the dynamics of energy transfer in an ecosystem. Students will model and explain bioaccumulation in an ecosystem. MS-LS1-6, MS-LS2-1, MS-LS2-2, MS-LS2-3	What is needed to sustain a food chain?		Part 2 Food-Chain Game **Food-Chain Game** Students act out the roles in a food chain from Mono Lake. They develop a model for a sustainable food chain and consider the concept of bioaccumulation.	Science Resources Book: "Rachel Carson and Silent Spring" (optional)
19. ***Investigation 6: Trophic Levels*** Students will model biomass and energy flow through an ecosystem. MS-LS1-6, MS-LS2-1, MS-LS2-2, MS-LS2-3	How does biomass and energy flow through an ecosystem?		Part 3 Trophic Levels **Trophic Levels** Students learn a convention, called trophic levels, for describing the movement of food energy from organism to organism in a food web. They trace food through Mono Lake trophic levels, and learn about the efficiency of transfer across levels.	Science Resources Book: "Trophic Levels"
20. ***Investigation 6: Decomposers***	What happens to the energy stored in the biomass of an		Part 4 Decomposers **Decomposers**	Science Resources Book: "Decomposers" (optional)

Students will gather evidence regarding the role decomposers play in ecosystems. Students will predict what will happen in an ecosystem that lacks decomposers. **MS-LS1-6, MS-LS2-1, MS-LS2-2, MS-LS2-3**	organism when it dies?		Students investigate the role of decomposers in the ecosystem by adding a small amount of fruit to their minihabitat and monitoring changes to the fruit. They also look at the worm habitat established in Investigation 1 to see what effect decomposers have had in that ecosystem.	
21. ***Investigation 7: Reproductive Potential*** Students will calculate reproductive potential of milkweed bugs. Students will determine the effects of various limiting factors on milkweed bug populations. **MS-LS2-1, MS-LS2-2, MS-LS2-4**	How many milkweed bugs could be in your habitat at the end of a year?	• Reproductive potential is the theoretical unlimited growth of a population over time. • A limiting factor is any biotic or abiotic component of the ecosystem that controls the size of a population. • Both lab experimentation and field observation contribute to the study of populations. • Biotic and abiotic factors can limit population size.	Part 1 Reproductive Potential **Reproductive Potential** After observing their milkweed--bug populations, students calculate the potential population growth at 2--month intervals for a year. They use a computer simulation to learn about population limiting factors, and analyze the results of a laboratory study to determine the limiting effects of three abiotic factors	Online Activities "Milkweed Bugs, Unlimited" "Milkweed Bugs, Limited"
22. ***Investigation 7: Population Dynamics*** Students will compare predicted growth	What are the limiting factors that affect algae and brine shrimp populations at Mono Lake?		Part 2 Limiting Factors	Science Resources Book "Limiting Factors" "Algae and Brine Shrimp Experiments"

to actual growth data for organisms in Mono Lake. **MS-LS2-1, MS-LS2-2, MS-LS2-4**				
Students will identify biotic and abiotic limiting factors in Mono Lake and argue from evidence regarding why they are necessary for the overall health of the ecosystem. **MS-LS2-1, MS-LS2-2, MS-LS2-4**	How does predicted population growth compare to actual population growth?		Part 3 Population Dynamics **Population Dynamics** Students review field data acquired by ecologists working at Mono Lake. They determine that the changes in population sizes of the organisms can be attributed to both abiotic and biotic factors. They find that feeding relationships play an important role in population size. Students learn that population fluctuation is not necessarily an indication that an ecosystem is unhealthy or weak.	Science Resources Book: "Mono Lake throughout the Year" "Mono Lake Data"
23. ***Investigation 8: Biodiversity*** Students will conduct a field survey of the diversity of an ecosystem. Students will calculate the biodiversity index for given organisms. Students will use gathered evidence to develop an argument regarding the	Why is biodiversity important in an ecosystem?	• Biodiversity is the variety of organisms in an ecosystem. • A biodiversity index is a measure of the health of an ecosystem. A healthy ecosystem is resilient to change. • Introduced species compete with native species in an ecosystem. • If an introduced species has no consumers in a new	Part 1 Biodiversity **Biodiversity** Students learn about the concept of biodiversity and how it relates to the health of an ecosystem. They conduct a biodiversity study of their schoolyard to determine the health of the schoolyard ecosystem.	Science Resources Book "Biodiversity" Note: This can be completed using a simulation activity if unit scheduling does not permit outdoor exploration. See http://www.virtualbiologylab.org/Biodiversity.htm

importance of biodiversity to an ecosystem. **MS-LS2-4, MS-ESS3-3, MS-ESS3-4**		ecosystem, it can thrive and become invasive. • Humans affect ecosystems in both positive and negative ways.		
24. ***Investigation 8: Invasive Species*** Students will gather evidence to support the claim that invasive species are dangerous to an ecosystem. **MS-LS2-4, MS-ESS3-3, MS-ESS3-4**	What can happen when a species is introduced to an ecosystem?		Part 2 Invasive Species **Invasive Species** Students are introduced to the Hawaiian ecosystem and learn how humans have affected it for thousands of years. They consider the effect of introduced species on native species and identify invasive species.	Science Resources Book "Invasive Species" (optional) Video *Hawaii: Strangers in Paradise*
25. ***Investigation 8: Mono Lake Revisited*** Students will describe both positive and negative human impacts on the Mono Lake ecosystem. **MS-LS2-4, MS-ESS3-3, MS-ESS3-4**	What impact have people had on Mono Lake?		Part 3 Mono Lake Revisited **Mono Lake Revisited** Students return to the study of Mono Lake. This time, they explore the positive and negative impacts of humans on this unique ecosystem, and consider the decisions that must be made to preserve ecosystem services.	Science Resources Book "Mono Lake in the Spotlight" Video *The Mono Lake Story*

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<td>26. Investigation 9: Human Involvement

Students will conduct research regarding human impacts on ecoscenarios.

MS-LS2-4, MS-LS2-5, MS-ESS3-3, MS-ESS3-4, MS-ETS1-1, MS-ETS1-2</td>
<td>How have humans affected your ecoscenario, and what efforts have humans made to lessen this impact?</td>
<td rowspan="2">• Humans rely on ecosystems for ecosystem services (provisioning, regulating, cultural, and supporting systems).
• Ecosystems are dynamic systems of complex interactions.
• Disruptions to abiotic factors in ecosystems can cause shifts in populations.
• Changes in ecosystems can affect services essential to humans.
• Solutions can be engineered and implemented to mitigate human impact.</td>
<td>Part 1 Human Involvement

Human Involvement
Students work together to summarize the factors that define the ecosystem of each ecoscenario and how humans have affected the ecosystems. Students become familiar with a major problem facing the ecoscenario due to human impact, and explore how it was caused.</td>
<td>Science Resources Book
“Ecoscenario Introductions”

Online Activity
“Ecoscenario Research Center”
• Understanding the Situation</td>
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<td>27. Investigation 9: Evaluating Solutions

Students will conduct research regarding possible solutions to human impacts on ecoscenarios. Students will evaluate the effectiveness of various solutions and use research to develop presentations regarding their ecoscenario.

MS-LS2-4, MS-LS2-5, MS-ESS3-3, MS-ESS3-4, MS-ETS1-1, MS-ETS1-2</td>
<td>How have humans affected your ecoscenario, and what efforts have humans made to lessen this impact?</td>
<td>Part 2 Evaluating Solutions

Evaluating Solutions
Each team examines how people have tried to solve their ecoscenario’s problem by designing and engineering solutions that benefit the ecosystem while respecting humans’ need for resources. Students consider aspects of both ecology and engineering to select a solution that helps balance the health of the ecosystem and the needs of humans that depend on the ecosystem.</td>
<td>Science Resources Book
“Ecoscenario Introductions”

Online Activity
“Ecoscenario Research Center”
• Ecoscenario Solutions
• Images for Posters</td>
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28. ***Investigation 9: Presentations*** Students will present their research findings and assess peer presentations using an assessment tool. **MS-LS2-4, MS-LS2-5, MS-ESS3-3, MS-ESS3-4, MS-ETS1-1, MS-ETS1-2**	How have humans affected your ecoscenario, and what efforts have humans made to lessen this impact?		Part 3 Presentations **Presentations** Each team presents the information from Parts 1 and 2 in a final synthesis of course information. All team members should be able to present and answer all questions.	
PBL Tasks **(5 days)**	**Topics** Ecosystems and Environmental Science	**Skills** Science & Engineering Practices, Creativity, and Digital Technology	**Suggestions** • Botanist: Photosynthesis and the Rainforest • Wildlife Biologists: Bats • Building an Aquatic Habitat • Designing a Playground with Mathematics Principles ***(see Gr. 6-8 Google Classroom for ideas) Code: 3zgfzmb***	**Resources** Defined Learning (STEM) PBS Learning Media

* ***In some cases, the student learning objective cannot be used as your daily lesson objective. The SLO may be so extensive that it will require unpacking into smaller parts. Based on the lesson, you will need to create an objective that is aligned to the content you will teach in a science period or in a block.***

Vocabulary		
clutch	first-level consumer	mass
habitat	food chain	photosynthesis
inference	food web	bioaccumulation
instar	migratory	carnivore
molt	primary consumer	herbivore
nymph	producer	omnivore
observation	secondary consumer	sustainable
organism	second-level consumer	trophic level interdependent
population	tertiary consumer	limiting factor
species	third-level consumer aquatic	migrate
abiotic	predator	reproductive potential
biome	prey	biodiversity
biotic	terrestrial	biodiversity index
community	aerobic cellular respiration	introduced species
controlled experiment	autotroph	invasive species
ecosystem	biomass	native species
ecosystem service	calorie	sampling
individual	carbohydrate	unbiased
observational study	control	cultural service
population study	energy	provisioning service
decomposer	food	regulating service
detritivore	heterotroph	supporting service
detritus	kilocalorie	

References & Suggested Instructional Websites

FOSSweb
www.fossweb.com
Defined (STEM) Learning
https://www.definedlearning.com/
The Concord Consortium
https://concord.org/ngss/ and https://concord.org/resources
Newsela
www.newsela.com
Readworks.org
https://www.readworks.org/
PBS Learning Media
http://pbslearningmedia.org
OpenSciEd
https://www.openscied.org/
Education.com
https://www.education.com/
Natural Inventions Hall of Fame
https://www.invent.org/at-home-learning-resources

Field Trip Ideas

Liberty Science Center, Jersey City, NJ
https://lsc.org/
The American Museum of Natural History, New York, NJ
https://www.amnh.org/
Franklin Institute Science Museum Philadelphia, PA
https://www.fi.edu/

What It Looks Like in the Classroom
Within this unit, students raise milkweed bugs in a supportive habitat to study the insect's reproductive biology. The information from this study is used to study milkweed-bug population dynamics in Investigation 7. Students use ecosystem sorting cards to reflect on organizing concepts in ecology and develop the vocabulary associated with those concepts. Through a Jane Goodall video, students become familiar with a specific population study of chimpanzees. Students are introduced to one of ten ecoscenarios representing major biomes of Earth that will be studied throughout the course. Students use Mono Lake, an important alkaline lake, as a simple ecosystem case study. Students study the functional roles of populations to construct a food web. Students construct a food web for their ecoscenario. Students construct aquatic and terrestrial ecosystems in the classroom and observe them over time to understand ecosystem interactions. They use a scientific log to observe, describe, and monitor changes in biotic and abiotic factors. Students explore the effect of light on photosynthesis by studying wheat plants. Students learn that through photosynthesis, producers increase the biomass of an ecosystem. Students investigate the producers in specific ecosystems and identify their roles. Students model and measure the energy transferred from food. Students learn how energy provided by producers is used by all organisms. They explore how food energy moves from one trophic level to another through feeding relationships. Students simulate feeding relationships and determine what is needed to sustain a food chain. They investigate the role of decomposers in ecosystems. Students explore some of the variables in an ecosystem that limit population size. Based on their milkweed-bug study, they predict what the population would be in 12 months. Students use simulations to explore population interactions and outcomes. Students explore the importance of biodiversity on the health of the ecosystem. They investigate how humans have interacted with the ecosystem and put stress on biodiversity. Students then learn how humans can reverse these stresses and help restore ecosystems. Students return to their ecoscenarios and use the knowledge developed in previous investigations to analyze the effects of human interactions in their ecosystem. They are given several engineering solutions and evaluate which they feel is the best solution to preserve or restore the ecosystem.