Environmental Science Unit 1: Ecological Footprint

25 instructional days

Content Standards

HS-LS2-1: Use mathematical and/or computational representations to support explanations of factors that affect the carrying capacity of ecosystems at different scales. [Clarification Statement: Emphasis is on quantitative analysis and comparison of the relationships among interdependent factors including boundaries, resources, climate, and competition. Examples of mathematical comparisons could include graphs, charts, histograms, and population changes gathered from simulations or historical data sets.] [Assessment Boundary: Assessment does not include deriving mathematical equations to make comparisons.]

HS-LS2-2: Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales. [Clarification Statement: Examples of mathematical representations include finding the average, determining trends, and using graphical comparisons of multiple sets of data.] [Assessment Boundary: Assessment is limited to provided data.]

HS-LS2-6: Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem. [Clarification Statement: Examples of changes in ecosystem conditions could include modest biological or physical changes, such as moderate hunting or a seasonal flood; and extreme changes, such as volcanic eruption or sea level rise.]

Science and Engineering Practices

Using Mathematics and Computational Thinking

- Use mathematical and/or computational representations of phenomena or design solutions to support explanations. (HS-LS2-1)
- Use mathematical representations of phenomena or design solutions to support and revise explanations. (HS-LS2-2)

Engaging in Argument from Evidence

- Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS2-6)

Scientific Knowledge is Open to Revision in Light of New Evidence

- Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence. (HS-LS2-2)
- Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in revision of an explanation. (HS-LS2-6)

Disciplinary Core Ideas

LS2.A: Interdependent Relationships in Ecosystems

- Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem. (HS-LS2-1),(HS-LS2-2)

LS2.C: Ecosystem Dynamics, Functioning, and Resilience

- A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. (HS-LS2-2),(HS-LS2-6)

Crosscutting Concepts

Scale, Proportion, and Quantity

- The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (HS-LS2-1)
- Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale. (HS-LS2-2)

Stability and Change

- Much of science deals with constructing explanations of how things change and how they remain stable. (HS-LS2-6)

Rationale and Transfer Goals :

In this unit of study, students formulate answers to the question “how and why do organisms interact with each other (biotic factors) and their environment (abiotic factors), and what affects these interactions?” Secondary ideas include the interdependent relationships in ecosystems; dynamics of ecosystems; and functioning, resilience, and social interactions, including group behavior. Students use mathematical reasoning and models to make sense of carrying capacity, factors affecting biodiversity and populations, the cycling of matter and flow of energy through systems. The crosscutting concepts of scale, proportion, and quantity and stability and change are called out as organizing concepts for the disciplinary core ideas. Students are expected to use mathematical reasoning and models to demonstrate proficiency with the disciplinary core ideas.

Enduring Understandings:

- Humans alter the environment in ways that affect other humans and other living things.
- An ecological footprint allows us to compare which people and which countries are doing more damage to the environment by measuring the resources that we use. (food, energy, land, etc.)
- There are limited resources on the Earth. We need to either become sustainable, or start looking for renewable resources in order to ensure that future generations can also survive..
- The environment is facing many problems that affect everybody. Since everybody is connected in nature, we all share responsibility in finding solutions.

Essential Questions:

- When they relocate bears, wolves, or other predators, how do they know that they will survive?
- What limits the number and types of different organisms that live in one place?
- How can a one or two inch rise in sea level devastate an ecosystem?

Content/Objectives		Instructional Actions	
Content ***What students will know***	**Skills** ***What students will be able to do***	**Activities/Strategies** ***How we teach content and skills***	**Evidence (Assessments)** ***How we know students have learned***

● Ecosystems have carrying capacities, which are limits to the number of organisms and populations they can support. ● These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. ● Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (the number of individuals) of species in any given ecosystem. ● The significance of carrying capacity in ecosystems is dependent on the scale proportion	● Compare and contrast ecological footprints for various countries around the world. ● Graph data related to ecological footprints for various countries. ● Examine factors that increase or decrease your own personal footprint. ● Examine ways that the school could reduce its own footprint, by expanding the recycling program. ● Research composting as a way to reduce the ecological footprint. ● Write a persuasive essay encouraging our school to start composting. ● Critique another student's essay, and provide them feedback for their final draft. ● Read a current event that compares tap water vs. bottled water.	● Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community. ● Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling). ● Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tools such as SKYPE, experts from the community helping with a project, journal articles, and biographies). ● Provide multiple grouping opportunities for students	● Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales. ● Use quantitative analysis to compare relationships among interdependent factors and represent their effects on the carrying capacity of ecosystems at different scales. ● Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales. ● Use the concept of orders of magnitude to represent how factors affecting biodiversity and

and quantity at which it occurs. ● Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence. ● This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem. ● Much of science deals with constructing explanations of how things change and how they remain stable. ● A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. ● If a modest biological or physical disturbance to an	● Come up with ways to try and encourage our students to use tap water! ● Research and write about a current event pertaining to env. science and present it to the class. ● Visit Lindenwold Waste Management and interview the supervisor to learn about recycling in Lindenwold. ● Help reduce the school's footprint by doing a fall clean up. ● Continue to model recycling for the school! ● Be able to view a hot topic issue from all sides using the "6 thinking hats" approach.-- Fracking debate. ● Design a picture that you can turn into a mural made of bottle caps or find another project that uses "trash" or recycled	to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences). ● Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understanding. ● Use project-based science learning to connect science with observable phenomena. ● Structure the learning around explaining or solving a social or community-based issue. ● Provide ELL students with multiple literacy strategies. ● Collaborate with after-school programs or clubs to extend learning opportunities.	populations in ecosystems at one scale relate to those factors at another scale. ● Evaluate the claims, evidence, and reasoning that support the contention that complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem. ● Construct explanations of how modest biological or physical changes versus extreme changes affect stability and change in ecosystems. ● Environmental Benchmark #1

ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem) as opposed to becoming a very different ecosystem. ● Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. ● Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in revision of an explanation.	materials. It's art, but it's also reducing waste, and thus reducing our footprint.		

Spiraling for Mastery		
Content or Skill for this Unit	**Spiral Focus from Previous Unit**	**Instructional Activity**
● A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions.	● Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors.	● Resources from the Holt Environmental Science Text: ○ Using the Figure: Life Depends on the Sun ○ Skill Builder: Vocabulary

● Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (the number of individuals) of species in any given ecosystem. ● Ecosystems have carrying capacities, which are limits to the number of organisms and populations they can support. ● These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. ● If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem) as opposed to becoming a very different ecosystem. ● Compare and contrast ecological footprints for various countries around the world. ● Examine factors that increase or decrease your own personal footprint.	● 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. ● Growth of organisms and population increases are limited by access to resources. ● 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	○ MathPractice: A Meal Fit for a Grizzly Bear ○ Case Study: DDT in an Aquatic Food Chain ○ Using the Figure: The Nitrogen Cycle ○ Graphic Organizer: Chain-of-Events Chart ○ Case Study: Communities Maintained by Fire ○ Maps in Action: Doppler Radar Tracking of Bats and Insects in Central Texas ○ Society & the Environment: Eating the Bait

● Read a current event that compares tap water vs. bottled water. ● Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. ● Research composting as a way to reduce the ecological footprint. ● Research and write about a current event pertaining to env. science and present it to the class. ● Much of science deals with constructing explanations of how things change and how they remain stable. ● Visit Lindenwold Waste Management and interview the supervisor to learn about recycling in Lindenwold. ● Examine ways that the school could reduce its own footprint, by expanding the recycling program. ● Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in revision of an explanation.	with their environments, both living and nonliving, are shared. ● Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. ● 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. ● 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. ● 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. ● 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. ● The many dynamic and delicate feedbacks among the biosphere and other Earth systems cause a continual co-evolution of Earth's surface and the life that exists on it.	

	● All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors. ● Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. ● Although the magnitude of human impacts is greater than it has ever been, so too are human abilities to model, predict, and manage current and future impacts. ● Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are	

	modified in response to human activities.	

Key resources:

Bunny Population Growth Activity: Students collect data during a simulation and use it to support their explanation of natural selection in a rabbit population and how populations change over time when biotic or abiotic factors change.
African Lions Activity: Students using the data presented to make a prediction regarding the zebra population during the periods of increased rainfall. Students will create a representation of the data that illustrates both the lion population and zebra population during the same time period
Animal Behavior: Students will make detailed observations of an organism's behavior and then design and execute a controlled experiment to test a hypothesis about a specific case of animal behavior. Students will record observations, make sketches, collect and analyze data, make conclusions, and prepare a formal report.

Biodiversity: Students use this lab to represent how biodiversity stops a disease from spreading.

21st Century Life & Careers:

9.2.12.CAP.2: Develop college and career readiness skills by participating in opportunities such as structured learning experiences, apprenticeships, and dual enrollment programs.

9.2.12.CAP.3: Investigate how continuing education contributes to one's career and personal growth.

9.2.12.CAP.4: Evaluate different careers and develop various plans (e.g., costs of public, private, training schools) and timetables for achieving them, including educational/training requirements, costs, loans, and debt repayment.

Career Readiness, Life Literacies, & Key Skills:

9.4.12.CT.3: Enlist input from a variety of stakeholders (e.g., community members, experts in the field) to design a service learning activity that addresses a local or global issue (e.g., environmental justice).

9.4.12.CT.4: Participate in online strategy and planning sessions for course-based, school-based, or other projects and determine the strategies that contribute to effective outcomes.

9.4.12.GCA.1: Collaborate with individuals to analyze a variety of potential solutions to climate change effects and determine why some solutions (e.g., political. economic, cultural) may work better than others.

9.4.12.IML.2: Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources.

9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions.

9.4.12.IML.4: Assess and critique the appropriateness and impact of existing data visualizations for an intended audience.

9.4.12.IML.5: Evaluate, synthesize, and apply information on climate change from various sources appropriately.

9.4.12.IML.6: Use various types of media to produce and store information on climate change for different purposes and audiences with sensitivity to cultural, gender, and age diversity.

9.4.12.IML.7: Develop an argument to support a claim regarding a current workplace or societal/ethical issue such as climate change.

Interdisciplinary Connections/Companion Standards:

NJSLS Mathematics

HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-LS2-1), (HS-LS2-2)

HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-LS2-1), (HS-LS2-2)

HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-LS2-1), (HS-LS2-2)

HSS-ID.A.1 Represent data with plots on the real number line. (HS-LS2-6)

HSS-IC.A.1 Understand statistics as a process for making inferences about population parameters based on a random sample from that population. (HS-LS2-6)

HSS-IC.B.6 Evaluate reports based on data. (HS-LS2-6)

NJSLS ELA

RST.9-10.8 Determine if the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem. (HS-LS2-6)

RST.11-12.1 Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions. (HS-LS2-1), (HS-LS2-2), (HS-LS2-6)

RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-LS2-6)

RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-LS2-6)

WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-LS2-1), (HS-LS2-2)

Companion Standards for ELA in Science and Technical Subjects: Reading

RST.9-10.8. Determine if the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.

RST.11-12.8. Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information

Companion Standards for ELA in Science and Technical Subjects: Writing

WHST.11-12.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.