Unit 2: Populations and Biodiversity

Content Area:	**Science**
Course(s):	
Time Period:	**MP1**
Length:	**25 days**
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NJSLS - Science

9-12.HS-ESS3-3	Create a computational simulation to illustrate the relationships among the management of natural resources, the sustainability of human populations, and biodiversity.
9-12.HS-ETS1-1	Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
9-12.HS-ETS1-4	Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.
9-12.HS-ETS1-2	Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
9-12.HS-ETS1-3	Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.
9-12.HS-LS2-7	Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
9-12.HS-LS4-6	Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.

Science and Engineering Practices

Using Mathematics and Computational Thinking

Create a computational model or simulation of a phenomenon, designed device, process, or system. (HS-ESS3-3)

Create or revise a simulation of a phenomenon, designed device, process, or system. (HS-LS4-6)

Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems. (HS-ETS1-4)

Constructing Explanations and Designing Soluons

Design, evaluate, and refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-LS2-7, HS-ETS1-2)

Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-3)

Asking Questions and Defining Problems

Analyze complex real-world problems by specifying criteria and constraints for successful solutions. (HS-ETS1-1)

Disciplinary Core Ideas

ESS3.C: Human Impacts on Earth Systems

The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. (HS-ESS3-3)

LS2.C: Ecosystem Dynamics, Functioning, and Resilience

Moreover, anthropogenic changes (induced by human acvity) in the environment—including habitat destruction, pollution, the introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species. (HS-LS2-7)

LS4.C: Adaptation

Changes in the physical environment, whether naturally occurring or human-induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline–and sometimes the extinction–of some species. (HS-LS4-5),(HS-LS4-6)

LS4.D: Biodiversity and Humans

Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). (secondary to HS-LS2-7)

ETS1.A: Defining and Delimiting Engineering Problems

Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk migration into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (HS-ETS1-1)

Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. (HS-ETS1-1)

ETS1.B: Developing Possible Solutions

When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3)

Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. (HS-ETS1-4)

ETS1.C: Optimizing the Design Solution

Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (HS-ETS1-2)

Crosscutting Concepts

Stability and Change

Change and rates of change can be quantified and modeled over very short or very long periods. Some system changes are irreversible. (HS-ESS3-3)

Much of science deals with constructing explanations of how things change and how they remain stable. (HS-LS2-7)

Cause and Effect

Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS4-6)

Systems and System Models

Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows— within and between systems at different scales. (HS-ETS1-)

Rationale and Transfer Goals

All populations are affected by several factors: birth and death rate, immigration and emigration, reproductive potential of the female, limiting factors in the environment (such as space or availability of food), and density-dependent (disease) factors and independent factors (like a hurricane). Human populations are affected by these things as well. In addition, human populations are affected by social factors, such as wealth distribution, literacy, and social structure. The study of human populations in particular is called demography. Students will look at various demographic information for different countries to conclude population growth. The last section in the unit is on biodiversity and endangered species. This correlates with the other sections on population growth because there is a direct link to the increasing human population and decreasing biodiversity in the world today. Students should see that as human populations continue to grow at an exponential rate, and use up finite resources, this leaves less for other populations. Having high biodiversity is a sign of a healthy environment. There will be a focus on endangered species, and some of the laws that have been put in place to help save them.

Enduring Understandings

- All populations follow patterns and are limited or influenced by factors in the environment.
- Population growth can be graphed and can be exponential or logistic.
- Human populations are affected by the same factors that affect other populations, in addition to social and economic influences.
- Human population growth in particular has an impact on other populations of organisms, as we use up more resources.
- As our population continues to increase, biodiversity continues to decrease.
- Decreased biodiversity is a sign of an unhealthy environment.
- As other populations decrease, some may reach the point where they are endangered.
- Endangered species have protection under federal law. We believe the # of endangered species today is at a critically high number.

Essential Questions

- How might we change habits if we replaced the word “environment” with the word “life support system”?
- Does reducing human impacts on our global life support system require social engineering or mechanical engineering?
- Is the damage done to the global life support system permanent?

Content - What will students know?

- The sustainability of human societies and the biodiversity that supports them require responsible management of natural resources.
- Change and rates of change can be quantified and modeled over very short or very long periods.

- Some system changes are irreversible.
- Modern civilization depends on major technological systems.
- New technologies can have deep impacts on society and the environment including some that are not anticipated.
- Scientific knowledge is a result of human endeavors imagination and creativity.
- Anthropogenic changes (induced by human acvity) in the environment—including habitat destruction, pollution, the introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species.
- Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction).
- Humans depend on the living world for the resources and other benefits provided by biodiversity. But human acvity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, the introduction of invasive species, and climate change.
- Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth.
- Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value.
- Much of science deals with constructing explanations of how things change and how they remain stable.
- When evaluating solutions, it is important to take into account a range of constraints-- including costs, safety, reliability, and aesthetics-- and to consider social, cultural, and environmental impacts.
- Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed.
- New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of cost and benefits is critical.
- Changes in the physical environment, whether naturally occurring or human-induced, have contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline-- and sometimes the extinction-- of some species.
- Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change.
- Thus sustaining biodiversity so that ecosystems' functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value.
- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.
- When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts
- Both physical models and computers can be used in various ways to aid the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test ways of solving a problem or to see which one is most efficient or economical, and in making a persuasive presentation to a client about how a given design will meet his or her needs.
- Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed.
- New technologies can have deep impacts on society and the environment, including some that were not anticipated.
- Analysis of costs and benefits is a critical aspect of decisions about technology.

Skills - What will students be able to do?

- Have an understanding of how a complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of me under stable conditions.
- Explore human dependence on Earth's resources and the nature and effects of human interactions with their environment.
- Know that the sustainability of human societies and the biodiversity that supports them require responsible management of natural resources.
- Synthesize information from multiple sources and evaluate claims about the impacts of human acvity on biodiversity based on analysis of evidence.
- Create a computational simulation or mathematical model illustrating the relationships among the management of natural resources, the sustainability of human populations, and biodiversity.
- Symbolically and quantitively represent natural resource management, sustainability of human populations, and biodiversity.
- Map relationships discovered, considering limitations on measurement when reporting quantities or data.
- Understand that sustaining biodiversity is critical to maintaining functional ecosystems.
- Collect data on growth paerns (exponential, logistic) and carrying capacity using bacterial populations in a petri dish, status of local fish and mollusk populations in Narragansett Bay, erosion of eelgrass beds, or continued Quonset Point dredging.
- Use data to make informed decisions about how environmental issues affect their communities politically, economically, and ecologically.
- Connect scientific knowledge to human endeavors, imagination, and creativity using conceptual simulations that illustrate relationships such as those between the management of natural resources in local New England fisheries or the lobster harvesting industry, the needs of the human population, and the effect on marine diversity.
- Use data collected to model changes in marine animal populations to better understand the relationship between the management of natural resources, biodiversity, and the sustainability of human populations
- Investigate and research the major contributions of scientists and engineers who have developed technologies to produce less pollution and waste to prevent ecosystem degradation. Synthesize information from multiple sources to construct explanations and verify claims about how the environment and biodiversity change and stay the same when affected by human acvity.
- Designing and evaluating a solution for a proposed problem related to threatened or endangered species or to genetic variation of organisms for multiple species.
- Determine long- and short-term goals of a potential solution, while considering that new technologies can have deep impacts on society and the environment, including some that were not anticipated.
- Use empirical evidence of decreasing bird populations to differentiate between specific causes and effects.
- Use physical models and computer simulations to aid in the engineering process, test potential soluons, and refine designs.
- Consider the cost, benefits, and risks of systems created by engineers.
- Analyze data for positive and negative feedback within natural systems to predict if there would be

stabilization or destabilization of greenhouse gas concentrations.

Activities - How will we teach the content and skills?

- Structure lessons around questions that are authentic, and relate to students ' interests, social/ family background, and knowledge of their community.
- Provide students with multiple choices for how they can represent their understanding.
- Provide opportunities for students to connect with people of similar backgrounds.
- Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures.
- Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understanding.

Evidence/Assessments - How will we know what students have learned?

- **Assessments can be reviewed for each course inthis folder.**

- Use mathematical and/or computational representations to support explanations of factors that affect the 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 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

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	• Organisms, and populations of organisms, are dependent on their environmental interactions both with other living	• Resources from the Holt Environmental Science Text: ○ Using the Figure: Life Depends on

constant over long periods of me under stable conditions • 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 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 the ecological footprints of various countries around the world. • Examine factors that increase or decrease your footprint • Read a current event that compares tap water vs. bottled water. ● Extreme fluctuaons in condions or the size of any populaon, however, can challenge the funconing of ecosystems in terms of resources and habitat availability. ● Research composng as a way to reduce the	things and with nonliving factors. • 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 compeve, predatory, and mutually beneficial interactions vary across ecosystems, the paerns of interactions of organisms with their environments, both living and nonliving, are shared. • Ecosystems are dynamic; their characteristics can vary over me. 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	the Sun o Skill Builder: Vocabulary o MathPractice: A Meal Fit for a Grizzly Bear o Case Study: DDT in an Aquac Food Chain o Using the Figure: The Nitrogen Cycle o Graphic Organizer: Chain-of-Events Chart o Case Study: Communies Maintained by Fire o Maps in Acon: Doppler Radar Tracking of Bats and Insects in Central Texas o Society & the Environment: Eang the Bait

ecological footprint. ● Research and write about a current event pertaining to env. science and present it to the class. ● Much of science deals with construcng explanaons 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. ● Scienfic argumentaon is a mode of logical discourse used to clarify the strength of relaonships between ideas and evidence that may result in revision of an explanaon.	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 environment can have different impacts (negative and positive) on 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 me when biotic or abiotic factors change.

African Lions Acvity: Students use the data presented to predict the zebra population during periods of increased rainfall. Students will create a representation of the data that illustrates both the lion population and zebra population during the same 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

Career Readiness, Life Literacies, & Key Skills

TECH.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).
TECH.9.4.12.CT.4	Participate in online strategy and planning sessions for course-based, school-based, or other project and determine the strategies that contribute to effective outcomes.
TECH.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 (e.g., SL.11-12.1., HS-ETS1-1, HS-ETS1-2, HS-ETS1-4, 6.3.12.GeoGI.1, 7.1.IH.IPERS.6, 7.1.IL.IPERS.7, 8.2.12.ETW.3).
TECH.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 (e.g., NJSLSA.W8, Social Studies Practice: Gathering and Evaluating Sources.
TECH.9.4.12.IML.3	Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions (e.g., S-ID.B.6a., 8.1.12.DA.5, 7.1.IH.IPRET.8).
TECH.9.4.12.IML.4	Assess and critique the appropriateness and impact of existing data visualizations for an intended audience (e.g., S-ID.B.6b, HS-LS2-4).
TECH.9.4.12.IML.5	Evaluate, synthesize, and apply information on climate change from various sources appropriately (e.g., 2.1.12.CHSS.6, S.IC.B.4, S.IC.B.6, 8.1.12.DA.1, 6.1.12.GeoHE.14.a, 7.1.AL.PRSNT.2).
TECH.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 (e.g., NJSLSA.SL5).
TECH.9.4.12.IML.7	Develop an argument to support a claim regarding a current workplace or societal/ethical issue such as climate change (e.g., NJSLSA.W1, 7.1.AL.PRSNT.4).

Interdisciplinary Connections/Companion Standards