

AP/ECE ENVIRONMENTAL SCIENCE CURRICULUM



Grade Level(s): 11-12

Curriculum Author(s): Kathleen Yocis

Course Description: *The AP Environmental Science course is designed to be the equivalent of a one-semester, introductory college course in environmental science, through which students engage with the scientific principles, concepts, and methodologies required to understand the interrelationships within the natural world. Students cultivate their understanding of the interrelationships of the natural world through inquiry-based lab investigations and field work as they explore concepts like the four Big Ideas; energy transfer, interactions between earth systems, interactions between different species and the environment, and sustainability. The course requires that students identify and analyze natural and human-made environmental problems, evaluate the relative risks associated with these problems, and examine alternative solutions for resolving or preventing them. Environmental science is interdisciplinary, embracing topics from geology, biology, environmental studies, environmental science, chemistry, and geography.*

Year At A Glance

Unit Title	Overarching Essential Question	Overarching Enduring Understanding	Vision of A Learner Attribute and Indicator
Unit 1: The Living World: Ecosystems (4 weeks)	What is environmental science and why is it important?	Ecosystems are the result of biotic and abiotic interactions.	TCC1(9-12); CCE1(9-12); TCC4(9-12)
Unit 2: The Living World: Biodiversity (3-4 weeks)	How do scientists define biodiversity at different scales and how biodiversity at each scale affects responses to environmental stressors?	Ecosystems have structure and diversity that change over time.	CCE1(9-12); CCE4(9-12); TCC1(9-12); TCC2(9-12)
Unit 3: Populations (3-4 weeks)	How do populations change over time in reaction to a variety of ecosystem factors, including the impacts of and differences between generalist and specialist species and how each excels in specific types of habitats?	Populations change over time in reaction to a variety of factors.	TCC4(9-12); CCE2(9-12)
Unit 4: Earth Systems and Resources (3-4 weeks)	How does the scale of the biosphere affect the various systems of the Earth, including the different layers inside our planet, the formation of soils, the compositions of our atmosphere, and the global patterns of air circulation that drives global weather?	Earth's systems interact, resulting in a state of balance over time.	TCC1(9-12); TCC3(9-12); CCE2(9-12); DE2(9-12)
Unit 5: Land and Water Use (4-5 weeks)	How are public lands used and misused and how can sustainability practices improve	When humans use natural resources, they alter natural systems.	TCC1(9-12); TCC3(9-12); CCE2(9-12); CCE4(9-12)



	our ecological footprint?		
Unit 6: Energy Resources and Consumption (3-4 weeks)	What are the energy resources that we currently use and their environmental impact and how can conservation and efficiency help reduce energy use?	Humans use energy from a variety of sources, resulting in positive and negative consequences.	TCC1(9-12); TCC3(9-12); TCC4(9-12); TI4(9-12)
Unit 7: Atmospheric Pollution (3-4 weeks)	What are air pollutants and how can they affect the environment and overall health?	Human activities have physical, chemical, and biological consequences for the atmosphere.	TCC1(9-12); TCC4(9-12); CCE1(9-12); CCE4(9-12)
Unit 8: Aquatic and Terrestrial Pollution (3-4 weeks)	How can we determine the impacts of aquatic and terrestrial pollutants on the environment and human health?	Human activities, including the use of resources, have physical, chemical, and biological consequences for ecosystems.	TCC1(9-12); CCE2(9-12); TCC3(9-12)
Unit 9: Global Change (3-4 weeks)	How have humans altered the world's atmosphere and climate and what are the underlying causes of these changes?	Local and regional human activities can have impacts at the global level.	AA4(9-12); TCC1(9-12); CCE2(9-12); TCC3(9-12)
Post AP Exam - ECE Final Unit	How can we be more aware of our impact on the environment and make changes in our daily lives to improve our ecological footprint?	Our daily activities have an environmental impact and we need to recognize this and work at adjusting our behavior to help conserve our ecosystem.	AA4(9-12); TCC1(9-12); CCE2(9-12); TCC3(9-12)

Unit 1 - The Living World: Ecosystems

Desired Results

Established Goals:

Common Core State Standards:

RI.9-10.1: Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

MP.4: Model with mathematics

W.9-10.2: Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.

HSN-Q.A.2: Define appropriate quantities for the purpose of descriptive modeling.

HSS-1C.B.6: Evaluate reports based on data.

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

NGSS Standards:

HS-LS2-4: Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.

HS-LS2-5: Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.

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 the conditions may result in a new ecosystem.

HS-LS4-5: Evaluate the evidence supporting claims that changes in the environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.

HS-ESS2-6: Develop a quantitative model to describe the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.

HS-ESS3-1: Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

HS-ESS3-4: Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

Vision of A Learner Attributes: Students will be able to independently use their learning to...

TCC1(9-12): I can ask purposeful, insightful questions to find a variety of innovative solutions. (*Nitrogen cycle STEM Study*)

TCC2(9-12): I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions. (*ScrAPEbook article reviews-run various times of the year*)

TCC4(9-12): I can integrate my learning to adapt to experiences in the classroom, career and life. (*Nitrogen cycle STEM Study*)

CCE4(9-12): I can communicate and express my understanding in an authentic, respectful and relevant way, using the most effective mode of expression. (*Legislation Presentations run throughout year assigned in Unit#1*)

CCE1(9-12): I can initiate discussions with my peers and teachers about a variety of topics, respecting differing viewpoints, actively listening to others, and responding thoughtfully with peer-reviewed evidence that is free of bias. (*Legislation Presentations run throughout year assigned in Unit#1*)

Understandings: Students will understand that...

- The availability of resources is a fundamental driver of species interactions in ecosystems, influencing competition, predation, mutualism, disease dynamics, community structure, and overall ecosystem functioning.
- Terrestrial biomes are large-scale ecological communities characterized by distinct climates, vegetation types, and adapted organisms. They are primarily classified based on climate (temperature and precipitation) and vegetation structure.
- Aquatic biomes encompass diverse ecosystems based on their physical characteristics, including salinity, depth, temperature, and flow.
- The carbon cycle is a dynamic process where carbon moves through these interconnected reservoirs, driven by biological, geological, and physical processes. Human activities, particularly the burning of fossil fuels and deforestation, have significantly altered the carbon cycle, leading to increased CO₂ levels in the atmosphere and contributing to global climate change.
- The nitrogen cycle describes the movement of nitrogen through various reservoirs on Earth, involving both biotic (living organisms) and abiotic (non-living) processes. Nitrogen is essential for the synthesis of proteins and nucleic acids in living organisms and plays a critical role in ecosystem functioning.
- The phosphorus cycle describes the movement of phosphorus through the Earth's lithosphere, hydrosphere, and biosphere. Phosphorus is an essential element for life, being a key component of DNA, RNA, ATP (energy currency of cells), and phospholipids (cell membranes). Unlike carbon and nitrogen, phosphorus does not have a significant atmospheric component and primarily cycles through terrestrial and aquatic ecosystems.
- The hydrologic cycle, also known as the water cycle, describes

Essential Questions:

- How does the availability of resources influence species interactions?
- Describe the global distribution and principal environmental aspects of terrestrial biomes.
- Describe the global distribution and principal environmental aspects of aquatic biomes.
- Explain the steps and reservoir interactions in the carbon cycle.
- Explain the steps and reservoir interactions in the nitrogen cycle.
- Explain the steps and reservoir interactions in the phosphorus cycle.
- Explain the steps and reservoir interactions in the hydrologic cycle.
- How is solar energy acquired and transferred by living organisms?
- How does energy flow and matter cycle through trophic levels?
- How does the energy decrease as it flows through ecosystems?
- Describe food chains and food webs, and their constituent members by trophic level.

<p>the continuous movement of water on, above, and below the surface of the Earth. It involves various processes that cycle water between different reservoirs, driven primarily by solar energy.</p> <ul style="list-style-type: none"> • Solar energy acquisition through photosynthesis is fundamental to life on Earth, supporting biological processes and sustaining ecosystems. • Energy flows and matter cycles through trophic levels and is crucial for ecosystem management, conservation, and understanding the impacts of human activities on natural systems. Maintaining balanced nutrient cycling and energy flow supports biodiversity and ecosystem resilience in the face of environmental changes. • Energy decreases as it flows through ecosystems primarily due to inefficiencies in energy conversion, metabolic processes, heat loss, and inefficiencies in energy transfer between trophic levels. • Food chains and webs provide essential frameworks for understanding the complex interactions and energy flow within ecosystems, highlighting the interconnectedness of organisms and the importance of maintaining balanced trophic relationships for ecosystem health and stability. 	
<p>Students will know...</p> <ul style="list-style-type: none"> • How to define the field of environmental science and discuss its importance. • Ways in which humans have altered and continue to alter our environment. • The scientific method and its application to the study of environmental problems. • The components and states of matter. • Human beings depend on sustainable practice. • Ecosystem boundaries are not clearly defined. • Photosynthesis captures energy and respiration releases energy. • Energy captured by producers moves through many trophic levels. 	<p>Students will be able to...</p> <ul style="list-style-type: none"> • Measure sustainability using the ecological footprint. • Describe some of the unique challenges and limitations of environmental science. • Describe key environmental indicators that help us evaluate the health of the planet. • Define systems within the context of environmental science. • Define sustainability and explain how it can be measured using the ecological footprint. • Explain the concept of ecosystem boundaries. • Describe the processes of photosynthesis and cellular respiration. • Distinguish among the trophic levels that exist in food chains and food webs.

- Some ecosystems are more productive than others.
- The efficiency of energy transfer affects the energy present in each trophic level.
- The hydrologic cycle moves water through the biosphere.
- The carbon cycle moves carbon between air, water and land.
- The nitrogen cycle includes many chemical transformations.
- The phosphorus cycle moves between land and water.
- Calcium, magnesium, potassium and sulfur also cycle in ecosystems.
- Earth's atmosphere is composed of layers.
- The amount of solar energy reaching the Earth varies with location.
- Earth's tilt causes seasonal changes in the climate.
- Terrestrial biomes are defined by the dominant plant growth forms.
- Climate diagrams illustrate patterns of annual temperature and precipitation.
- Terrestrial biomes range from tundra to tropical forests.
- Freshwater biomes have low salinity.
- Marine biomes have high salinity.

- Quantify ecosystem productivity.
- Explain energy transfer efficiency and trophic pyramids.
- Describe how water cycles within ecosystems.
- Explain how carbon cycles within ecosystems.
- Describe how nitrogen cycles within ecosystems.
- Explain how phosphorus cycles within ecosystems.
- Discuss the movement of calcium, magnesium, potassium and sulfur within ecosystems.
- Identify the five layers of the atmosphere.
- Discuss the factors that cause unequal heating of the Earth.
- Describe how the Earth's tilt affects seasonal differences in temperatures.
- Explain how we define terrestrial biomes.
- Interpret climate diagrams.
- Identify the nine terrestrial biomes.
- Identify the major freshwater biomes.
- Identify the major marine biomes.

Key Vocabulary: *Ecosystem, environmentalism, biotic, abiotic, environmental indicator, habitat, niche, predator, prey, symbiotic interactions, competitive interactions, mutualism, commensalism, parasitism, limiting resource, intraspecific competition, interspecific competition, competitive exclusion principle, keystone species, indicator species, range of tolerance, invasive species, resource partitioning, trophic cascade, biodiversity, photosynthesis, cellular respiration, herbivores, omnivores, carnivores, detritivores, decomposers, biomass, consumers, heterotrophs, autotrophs, food chain, food web, food pyramid, atmosphere, biosphere, hydrosphere, lithosphere, source, sink, transpiration, reservoirs, aquifers, urban island heat, carbon cycle, enteric digestion, anthropogenic, vector-borne disease, fracking, nitrogen fixation, ammonification, nitrification, assimilation, denitrification, tilling, nitrogen cycle, phosphorus cycle, eutrophication, photochemical smog, dead zone, biome, tropical rainforest, savannah (tropical grassland), desert, temperate rainforest, temperate grasslands, temperate deciduous forest, coniferous forest (taiga), chaparral, tundra, primary productivity, net primary productivity, gross primary productivity, marsh, swamp, bog, estuary, intertidal, mangroves, watershed, salinity, saltwater intrusion, intertidal zone, pelagic zone, hydrothermal vent, abyssal zone, coral bleaching, bycatch, ocean acidification*

Assessment Evidence

Performance Tasks:

- Barnacle Lab & keystone species investigation
- Pond Food Web Activity
- The Water Cycle Lab
- The Carbon Cycle Drawing
- Nitrogen Cycle game and review.
- Phosphorus Cycle diagram
- Human Impact on Aquatic Ecosystems Project

Other Evidence:

- Introduction to ecology worksheet
- Fill-in notes
- Biomes of the World Guide
- AP weekly Quizzes
- Study Guide
- AP sample FRQs and MCQs

Learning Plan

VOL Common Assessments:

THINK CRITICALLY AND CREATIVELY

TCC1(9-12): I can ask purposeful, insightful questions to find a variety of innovative solutions.

- Biomes of the World Project

TCC3(9-12): I can integrate relevant information to produce multiple valid solutions.

- Owl Pellet Lab

TCC4: Transfer new learning and skills to other contexts and settings beyond the classroom.

- Owl Pellet Lab

COLLABORATE AND COMMUNICATE EFFECTIVELY

CCE1(9-12): I can initiate discussions with my peers and teachers about a variety of topics, respecting differing viewpoints, actively listening to others, and responding thoughtfully with peer-reviewed evidence that is free of bias.

- Biome Project: Use discussion and debate to determine what qualities fit specific biomes

Teacher Resources:

College Board AP Central: Environmental Science; <https://apcentral.collegeboard.org/courses/ap-environmental-science>

Environmental Science for the AP Course text 3rd edition by Andrew Friedland and Rick Relyea, 2019

UConn Early College Experience guidelines for Environmental Science; www.ece.uconn.edu



Unit 2 - The Living World: Biodiversity

Desired Results

Established Goals:

Common Core State Standards:

RI.9-10.1: Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

MP.4: Model with mathematics

W.9-10.2: Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.

HSN-Q.A.2: Define appropriate quantities for the purpose of descriptive modeling.

HSS-1C.B.6: Evaluate reports based on data.

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

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.

NGSS Standards:

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.

HS-LS2-7: Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

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 the conditions may result in a new ecosystem.

HS-LS4-5: Evaluate the evidence supporting claims that changes in the environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.

HS-LS2-8: Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.

HS-LS4-6: Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.

HS-LS3-3: Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.

HS-LS4-2: Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.

HS-LS4-3: Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.

HS-LS4-4: Construct an explanation based on evidence for how natural selection leads to adaptation of populations.

Vision of A Learner Attributes: Students will be able to independently use their learning to...

TCC1(9-12): I can ask purposeful, insightful questions to find a variety of innovative solutions. (*Parking Lot Diversity Lab & Ecosystems Services Project*)

TCC2(9-12): I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions. (*Ecosystems Services Project*)

CCE2(9-12): I can give and receive actionable and relevant feedback with openness to be able to determine meaningful revisions for success.

TI3(9-12): I can formulate and investigate probing questions to further my learning. (*Ecosystems Services Project*)

Understandings: Students will understand that...

- Biodiversity in an ecosystem includes genetic, species, and habitat diversity and the more genetically diverse a population is, the better it can respond to environmental stressors.
- There are four categories of ecosystem services: provisioning, regulating, cultural, and supporting. Human activities can disrupt these services, potentially resulting in economic and ecological consequences.
- Island biogeography is the study of the ecological relationships and distribution of organisms on islands, and many island species have evolved to be specialists versus generalists because of the limited resources, such as food and territory, on most islands; therefore, invasive species can have an adverse effect on these ecosystems.
- Ecological tolerance refers to the range of conditions, such as temperature, salinity, flow rate, and sunlight that an organism can endure before injury or death results.
- Natural disruptions to ecosystems have environmental consequences that may, for a given occurrence, be as great as, or greater than, many human-made disruptions.
- Organisms adapt to their environment over time, both in short- and long-term scales, via incremental changes at the genetic level.
- Succession in a disturbed ecosystem will affect the total biomass, species richness, and net productivity over time.

Essential Questions:

- What are the levels of biodiversity and their importance to ecosystems?
- What are the results of human disruptions to ecosystem services?
- What is the role of island biogeography in evolution?
- What is ecological tolerance?
- How can natural disruptions, both short and long-term, impact an ecosystem?
- How can organisms adapt to their environment?
- What is the effect of ecological succession on ecosystems?

Students will know...

- It is difficult to estimate the number of species on Earth.
- We can measure biodiversity in terms of species richness and species evenness.

Students will be able to...

- Understand how we estimate the number of species living on Earth.
- Quantify biodiversity.

<ul style="list-style-type: none"> Genetic diversity is created through mutation and recombination. Evolution can occur through artificial selection. Evolution can occur through natural selection. Evolution can also occur through random processes. Speciation can be allopatric or sympatric. The pace of evolution depends on several factors. Every species has a niche. Environmental change can alter species distribution. Environmental change can cause species extinctions. 	<ul style="list-style-type: none"> Identify the processes that cause genetic diversity. Explain how evolution can occur through artificial selection. Explain how evolution can occur through natural selection. Explain how evolution can occur through random processes. Explain the process of allopatric and sympatric speciation. Understand the factors that affect the pace of evolution. Explain the difference between the fundamental and realized niche. Describe how environmental change can alter species distributions. Describe how environmental change can cause species extinctions.
<p>Key Vocabulary: Biodiversity, genetic diversity, population bottleneck, species diversity, habitat diversity, specialists, generalists, ecosystem diversity, species richness, species evenness, ecosystem services, provision, aquaculture, island biogeography, species-area curve, ecological tolerance, realized niche, geographic range, mass extinction, periodic disruption, episodic disruption, random disruption, resistance, resilience, intermediate disturbance hypothesis, evolution, microevolution, macroevolution, evolution by artificial selection, evolution by natural selection, fitness, adaptation, evolution by random processes, allopatric speciation, sympatric speciation, genetically modified organisms, ecological succession, primary succession, pioneer species, secondary succession, climax community, keystone species, indicator species, endemic species, biodiversity hotspots.</p>	
<p style="text-align: center;">Assessment Evidence</p>	
<p>Performance Tasks:</p> <ul style="list-style-type: none"> Parking Lot diversity Lab Ecosystem services project Island Biogeography Lab Human Impact on Biodiversity Activity Galapagos Finch Beak Lab 	<p>Other Evidence:</p> <ul style="list-style-type: none"> Fill-in notes Ecological Succession Activity AP weekly Quizzes Study Guide AP sample FRQs and MCQs
<p style="text-align: center;">Learning Plan</p>	
<p>VOL Common Assessments: THINK CRITICALLY AND CREATIVELY TCC1(9-12): I can ask purposeful, insightful questions to find a variety of innovative solutions.</p>	

- Parking Lot Diversity Lab

TCC2(9-12): I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions.

- Parking Lot Diversity Lab
- Ecosystem Services Project

TAKE INITIATIVE

TI2(9-12): I can evaluate my objectives and a variety of credible resources to find the best solutions for any challenge.

- Legislation Presentation Project

COLLABORATE AND COMMUNICATE EFFECTIVELY

CCE1(9-12): I can initiate discussions with my peers and teachers about a variety of topics, respecting differing viewpoints, actively listening to others, and responding thoughtfully with peer-reviewed evidence that is free of bias.

- Legislation Presentation Project

CCE4(9-12): I can communicate and express my understanding in an authentic, respectful and relevant way, using the most effective mode of expression.

- Legislation Presentation Project

Teacher Resources:

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Unit 3 - Populations

Desired Results

Established Goals:

Common Core State Standards:

RI.9-10.1: Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

MP.4: Model with mathematics

W.9-10.2: Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.

HSN-Q.A.2: Define appropriate quantities for the purpose of descriptive modeling.

HSS-1C.B.6: Evaluate reports based on data.

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

NGSS Standards:

HS-LS2-1. Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.

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.

HS-ESS3-3. Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.

Vision of A Learner Attributes: Students will be able to independently use their learning to...

TCC1(9-12): I can ask purposeful, insightful questions to find a variety of innovative solutions.

CCE2(9-12): I can give and receive actionable and relevant feedback with openness to be able to determine meaningful revisions for success.

TCC4(9-12): I can integrate my learning to adapt to experiences in the classroom, career and life

Understandings: Students will understand that...

- Specialist species tend to be advantaged in habitats that remain constant, while generalist species tend to be advantaged in habitats that are changing.
- A survivorship curve is a line that displays the relative survival rates of a cohort—a group of individuals of the same age—in a population, from birth to the maximum age reached by any one cohort member. There are Type I, Type II, and Type III curves
- Each environment has a carrying capacity, the maximum number of individuals that can be supported sustainably. This capacity is influenced by the availability of resources and the presence of limiting factors.
- Human activities, including habitat destruction, pollution, and climate change, can profoundly affect populations and communities, leading to biodiversity loss and altered ecosystem functions.
- Total fertility rate (TFR) is affected by the age at which females have their first child, educational opportunities for females, access to family planning, and government acts and policies.
- Populations can grow exponentially under ideal conditions with unlimited resources, leading to rapid increases in population

Essential Questions:

- Identify differences between generalist and specialist species.
- Explain survivorship curves.
- What are the key factors that determine the carrying capacity of an environment for a given species?
- How do changes in population and community ecology affect ecosystem services that are vital to human well-being?
- Explain factors that affect total fertility rate in human populations.
- How do different population growth models (e.g., exponential, logistic) describe the growth patterns of populations, and what factors influence these models?
- How can population pyramids be used to analyze the age distribution and growth trends of a population?
- What are the implications of different age structures (e.g., youthful, stable, declining) for a population's future growth and socio-economic development?
- How do birth rates, death rates, and migration patterns influence population growth and the shape of population pyramids?
- How do environmental conditions influence whether a species is K-selected or r-selected?

<p>size. Populations often exhibit logistic growth when resources are limited, leading to a leveling off of growth as the population reaches the environment's carrying capacity.</p> <ul style="list-style-type: none"> • Population pyramids provide a visual representation of the age and sex distribution of a population, allowing for analysis of current demographics and predictions of future trends. • These rates directly influence population growth and the shape of population pyramids. High birth rates can lead to a youthful population structure, while high death rates can cause a decline in population size. • Major events like wars, pandemics, and economic shifts can cause significant changes in population growth patterns and demographic structures. • K-selected species are often found in stable environments where competition and resource availability are constant, allowing them to invest in long-term survival. In contrast, r-selected species thrive in unstable or unpredictable environments where rapid reproduction can exploit temporary opportunities. 	
<p>Students will know...</p> <ul style="list-style-type: none"> • Nature exists at several levels of complexity. • Populations have distinctive characteristics. • Population size is affected by density-dependent and density-independent factors. • The exponential growth model describes populations that continuously increase. • The logistic growth model describes populations that experience a carrying capacity. • Species have different reproductive strategies and distinct survivorship curves. • K-selected species are often found in stable environments and r-selected species thrive in unstable or unpredictable environments. • Population pyramids provide a visual representation of the age and sex distribution of a population, allowing for analysis of current demographics and predictions of future trends. 	<p>Students will be able to...</p> <ul style="list-style-type: none"> • Explain how nature exists at several levels of complexity. • Discuss characteristics of populations. • Contrast the effects of density-dependent and density-independent factors on population growth. • Explain the exponential growth models of populations, which produces a J-shaped curve. • Describe how the logistic growth model incorporates a carrying capacity and produces an S-shaped curve. • Compare reproductive strategies and survivorship curves of different species. • Explain the difference between K-selected and r-selected species. • Explain how population pyramids can be used to analyze the age distribution and growth trends of a population?

Key Vocabulary: Population growth rate (intrinsic growth rate), biotic potential, K-selected species, carrying capacity, r-selected species, overshoot, dieback, survivorship curve (Types I, II & III), density-dependent factor, density-independent factor, population growth model, fecundity, exponential growth model, J-shaped curve, logistic growth model, S-shaped curve, limiting resource, demography, demographer, immigration, emigration, crude birth rate (CBR), crude death rate (CDR), net migration rate, life expectancy, infant mortality, child mortality, environmental justice, age structure diagram, population pyramid, developing countries, developed countries, population momentum, total fertility rate (FTR), family planning, replacement-level fertility, doubling time, Rule of 70, Theory of demographic transition, IPAT equation

Assessment Evidence

Performance Tasks:

- Introduction to Population Lab
- Population Growth Activity Lab
- Humans Come and Humans Go: Population Math Practice
- Cemetery Lab
- A Tale of Two Countries Online Exploration Lab
- Bubble Survivorship Lab

Other Evidence:

- Fill-in notes
- Population Ecology
- AP weekly Quizzes
- Study Guide
- AP sample FRQs and MCQs

Learning Plan

VOL Common Assessments:

THINK CRITICALLY AND CREATIVELY

TCC2(9-12): I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions.

- Bubble Survivorship Lab

TCC4(9-12): I can integrate my learning to adapt to experiences in the classroom, career and life.

- ScrAPESbook Article Review
- Bubble Survivorship Lab

CCE2(9-12): I can give and receive actionable and relevant feedback with openness to be able to determine meaningful revisions for success.

- Humans Come & Humans Go Math Practice

Teacher Resources:

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Unit 4 - Earth Systems and Resources

Desired Results

Established Goals:

Common Core State Standards:

RI.9-10.1: Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

MP.4: Model with mathematics

W.9-10.2: Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.

HSN-Q.A.2: Define appropriate quantities for the purpose of descriptive modeling.

HSS-1C.B.6: Evaluate reports based on data.

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

NGSS Standards:

HS-ESS1-5. Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.

HS-ESS2-1. Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.

HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.

HS-ESS2-3. Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.

HS-ESS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

HS-ESS2-4. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.

HS-ESS3-5. Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.

Vision of A Learner Attributes: Students will be able to independently use their learning to...

TCC1(9-12): I can ask purposeful, insightful questions to find a variety of innovative solutions.

TCC3(9-12): I can integrate relevant information to produce multiple valid solutions.

CCE2(9-12): I can give and receive actionable and relevant feedback with openness to be able to determine meaningful revisions for success.

DE2(9-12): I can honor my own feelings and show empathy toward others through my actions.

Understandings: Students will understand that...

- Maps that show the global distribution of plate boundaries can

Essential Questions:

- What are the geological changes and events that occur at

<p>be used to determine the location of volcanoes, island arcs, earthquakes, hot spots, and faults.</p> <ul style="list-style-type: none"> • Soils are formed when parent material is weathered, transported, and deposited. Soils are generally categorized by horizons based on their composition and organic material. • Water holding capacity—the total amount of water soil can hold—varies with different soil types. Water retention contributes to land productivity and fertility of soils. • The layers of the atmosphere are based on temperature gradients and include the troposphere, stratosphere, mesosphere, thermosphere, and exosphere. • Global wind patterns primarily result from the most intense solar radiation arriving at the equator, resulting in density differences and the Coriolis effect. • Characteristics of a given watershed include its area, length, slope, soil, vegetation types, and divides with adjoining watersheds. • Incoming solar radiation (insolation) is the Earth’s main source of energy and is dependent on season and latitude. • Weather and climate are affected not only by the sun’s energy but by geologic and geographic factors, such as mountains and ocean temperature. • El Niño and La Niña are phenomena associated with changing ocean surface temperatures in the Pacific Ocean. These phenomena can cause global changes to rainfall, wind, and ocean circulation patterns. 	<p>convergent, divergent, and transform plate boundaries?</p> <ul style="list-style-type: none"> • What are the characteristics and formation of soil? • What are some similarities and differences between properties of different soil types? • What is the structure and composition of the Earth’s atmosphere? • How can environmental factors result in atmospheric circulation? • What are the characteristics of a watershed? • How does the sun’s energy affect the Earth’s surface? • How does the Earth’s geography affect weather and climate? • What are the environmental changes and effects that result from El Niño or La Niña events (El Niño–Southern Oscillation)?
<p>Students will know...</p> <ul style="list-style-type: none"> • The availability of Earth’s resources was determined when the planet was formed. • The theory of plate tectonics describes the movement of the lithosphere. • The rock cycle recycles scarce minerals and elements. • The processes of weathering and erosion contribute to the recycling of elements. • Soil links the rock cycle and the biosphere. 	<p>Students will be able to...</p> <ul style="list-style-type: none"> • Describe the formation of Earth and the distribution of critical elements in Earth. • Define the theory of plate tectonics and discuss its relevance to the study of the environment. • Describe the rock cycle and discuss its importance in environmental science. • Understand how weathering and erosion occur and how they contribute to element cycling and soil formation.

<ul style="list-style-type: none"> • The distribution of mineral resources on Earth has social and environmental consequences. • Watersheds are characterized by their area, length, slope, soils, and vegetation. • Humans impact watersheds by altering water flow and inputting excess nutrients and soil. • Solar radiation varies due to the Earth's curvature and tilted axis. • The atmosphere is dominated by nitrogen and oxygen gasses. • Air circulates in the atmosphere as a result of changing density, water vapor capacity, and temperature. • Atmospheric convection currents are driven by solar radiation at the equator. • The Earth's rotation causes the Coriolis effect, which deflects global wind patterns. • Ocean currents are driven by unequal heating, gravity, wind, salinity, and the location of continents. • Rain shadows cause mountains to be dry on one side. • The El Nino-Southern Oscillation is caused by a shift in prevailing winds and ocean currents that alters global weather. 	<ul style="list-style-type: none"> • Explain how soil forms and describe its characteristics. • Describe how humans extract elements and minerals and the social and environmental consequences of these activities. • Describe the characteristics of a watershed. • Explain the impacts that humans have on watersheds. • Explain why the amount of solar radiation varies at latitudes and the seasons. • Identify the major gasses and layers in Earth's atmosphere. • Describe how the properties of air determine patterns of air circulation. • Explain what drives convection currents. • Explain how the Coriolis effect alters global wind directions. • Describe how ocean circulation affects weather and global climates. • Explain how mountains interrupt ocean airflow to cause rain shadows. • Identify the causes and consequences of El Nino and La Nina events.
<p>Key Vocabulary: Core, mantle, magma, asthenosphere, lithosphere, plate tectonics, earthquake, hot spot, volcano, tsunami, divergent boundary, seafloor spreading, convergent boundary, subduction, island arc, collision zone, transform boundary, fault, igneous rock, sedimentary rock, metamorphic rock, rock cycle, physical weathering, chemical weathering, acid rain, erosion, parent material, horizon, O horizon, humus, A-horizon (topsoil), E-horizon, B-horizon, C-horizon, porosity, water holding capacity, permeability, cation exchange capacity (CEC), base saturation, watershed, insolation, albedo, troposphere, stratosphere, ozone, mesosphere, thermosphere, exosphere, saturation point, adiabatic cooling, adiabatic heating, latent heat release, atmospheric convection current, Hadley cell, intertropical convergence zone, polar cell, Ferrell cell, Coriolis effect, Gyre, upwelling, Thermohaline circulation, rain shadow, El Nino-Southern Oscillation (ENSO), La Nina, carbon sequestration, aqueducts</p>	
<p style="text-align: center;">Assessment Evidence</p>	
<p>Performance Tasks:</p> <ul style="list-style-type: none"> • Tectonic Plate Activity • Soil Lab 	<p>Other Evidence:</p> <ul style="list-style-type: none"> • Quizzes • Formative assessments - exit slips, classwork

<ul style="list-style-type: none"> • Earth Rotation Lab • Albedo effect Lab • Soil Salinization Lab • Ecological Footprint Lab 	<ul style="list-style-type: none"> • Class Discussion
<p style="text-align: center;">Learning Plan</p>	
<p>VOL Common Assessments:</p> <p>TCC1(9-12): I can ask purposeful, insightful questions to find a variety of innovative solutions.</p> <ul style="list-style-type: none"> • Soil Lab <p>TCC3(9-12): I can integrate relevant information to produce multiple valid solutions.</p> <ul style="list-style-type: none"> • Albedo Effect Lab <p>CCE2(9-12): I can give and receive actionable and relevant feedback with openness to be able to determine meaningful revisions for success.</p> <ul style="list-style-type: none"> • Measuring Your Ecological Footprint <p>DE2(9-12): I can honor my own feelings and show empathy toward others through my actions.</p> <ul style="list-style-type: none"> • Measuring Your Ecological Footprint 	
<p>Teacher Resources:</p> <p>College Board AP Central: Environmental Science; https://apcentral.collegeboard.org/courses/ap-environmental-science</p> <p>Environmental Science for the AP Course text 3rd edition by Andrew Friedland and Rick Relyea, 2019</p> <p>UConn Early College Experience guidelines for Environmental Science; www.ece.uconn.edu</p>	

Unit 5 - Land and Water Use

Desired Results

Established Goals:

Common Core State Standards:

RI.9-10.1: Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

MP.4: Model with mathematics

W.9-10.2: Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.

WHST.9-12.1 Write arguments focused on discipline-specific content.

WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation

HSN-Q.A.2: Define appropriate quantities for the purpose of descriptive modeling.

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.

NGSS Standards:

HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

HS-LS4-6. Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.

HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems

HS-ESS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

HS-ESS2-7. Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.

Vision of A Learner Attributes: Students will be able to independently use their learning to...

TCC1(9-12): I can ask purposeful, insightful questions to find a variety of innovative solutions.

CCE2(9-12): I can give and receive actionable and relevant feedback with openness to be able to determine meaningful revisions for success.

TCC3(9-12): I can integrate relevant information to produce multiple valid solutions.

CCE4: Express ideas in a variety of ways, according to context, purpose, and audience.

Understandings: Students will understand that...

- The tragedy of the commons suggests that individuals will use shared resources in their own self-interest rather than in keeping

Essential Questions:

- What is the concept of the tragedy of the commons?
- What is the effect of clearcutting on forests?

with the common good, thereby depleting the resources.

- Clearcutting can be economically advantageous but leads to soil erosion, increased soil and stream temperatures, and flooding.
- The Green Revolution started a shift to new agricultural strategies and practices in order to increase food production, with both positive and negative results. Some of these strategies and methods are mechanization, genetically modified organisms (GMOs), fertilization, irrigation, and the use of pesticides.
- Agricultural practices that can cause environmental damage include tilling, slash and-burn farming, and the use of fertilizers.
- Types of irrigation include drip irrigation, flood irrigation, furrow irrigation, drip irrigation, and spray irrigation.
- Waterlogging occurs when too much water is left to sit in the soil, which raises the water table of groundwater and inhibits plants' ability to absorb oxygen through their roots.
- One consequence of using common pest-control methods such as pesticides, herbicides, fungicides, rodenticides, and insecticides is that organisms can become resistant to them through artificial selection. Pest control decreases crop damage by pests and increases crop yields.
- Methods of meat production include concentrated animal feeding operations (CAFOs), also called feedlots, and free-range grazing.
- Meat production is less efficient than agriculture; it takes approximately 20 times more land to produce the same amount of calories from meat as from plants.
- Overfishing has led to the extreme scarcity of some fish species, which can lessen biodiversity in aquatic systems and harm people who depend on fishing for food and commerce.
- As the more accessible ores are mined to depletion, mining operations are forced to access lower grade ores. Accessing these ores requires increased use of resources that can cause increased waste and pollution.
- Mining wastes include the soil and rocks that are moved to gain access to the ore and the waste, called slag and tailings that remain when the minerals have been removed from the ore. Mining helps to provide low cost energy and material necessary

- What are some changes in agricultural practices?
- What are some agricultural practices that cause environmental damage?
- What are the different methods of irrigation?
- What are the benefits and drawbacks of different methods of irrigation?
- What are the benefits and drawbacks of different methods of pest control?
- What are the different methods of meat production?
- What are the benefits and drawbacks of different methods of meat production?
- What are the causes of and problems related to overfishing?
- What natural resources are extracted through mining?
- What are the ecological and economic impacts of natural resource extraction through mining?
- What are the effects of urbanization on the environment?
- What is measured in an ecological footprint?
- What is the concept of sustainability?
- What are some methods for mitigating problems related to urban runoff?
- What is integrated pest management?
- What are the benefits and drawbacks of integrated pest management (IPM)?
- What are sustainable agricultural and food production practices?
- What are the benefits and drawbacks of aquaculture?
- What are the methods for mitigating human impact on forests?

<p>to make products. The mining of coal can destroy habitats, contaminate groundwater, and release dust particles and methane.</p> <ul style="list-style-type: none"> • Urbanization can lead to depletion of resources and saltwater intrusion in the hydrologic cycle. • Ecological footprints compare resource demands and waste production required for an individual or a society. • Sustainable yield is the amount of a renewable resource that can be taken without reducing the available supply. • Methods to increase water infiltration include replacing traditional pavement with permeable pavement, planting trees, increased use of public transportation, and building up, not out. • Integrated pest management (IPM) is a combination of methods used to effectively control pest species while minimizing the disruption to the environment. These methods include biological, physical, and limited chemical methods such as biocontrol, intercropping, crop rotation, and natural predators of the pests. • The use of integrated pest management (IPM) reduces the risk that pesticides pose to wildlife, water supplies, and human health. • The goal of soil conservation is to prevent soil erosion. Different methods of soil conservation include contour plowing, windbreaks, perennial crops, terracing, no-till agriculture, and strip cropping. • Aquaculture has expanded because it is highly efficient, requires only small areas of water, and requires little fuel. • Some of the methods for mitigating deforestation include reforestation, using and buying wood harvested by ecologically sustainable forestry techniques, and reusing wood. 	
<p>Students will know...</p> <ul style="list-style-type: none"> • The Tragedy of Commons describes the harm that can occur to public and shared resources. • Land management differs in rangeland and forest land management. • Clear-cutting can adversely impact soils, streams, and 	<p>Students will be able to...</p> <ul style="list-style-type: none"> • Explain the Tragedy of the Commons • Describe rangeland and forest land management. • Explain the environmental impact of clear-cutting. • Describe the changes in agricultural practices that have occurred throughout human civilization.

<ul style="list-style-type: none"> atmospheric carbon dioxide concentrations. • Agriculture has undergone a number of transformations over time. • The Green Revolution led to a greater food production. • The Green Revolution led to advances in mechanization, fertilization, irrigation, and the use of pesticides. • Genetic engineering and the introduction of genetically modified organisms are revolutionizing agriculture. • Mechanization results in the energy subsidy in agriculture. • Plowing and tilling reverse succession and mobilize organic matter. • Slash-and-burn farming causes short term gains and long term losses. • Fertilizer use affects the soil and water. • Groundwater and surface water are used for irrigation. • Crop irrigation can be done by furrow, flood, spray, and drip irrigation. • There are major adverse consequences of irrigation. • Pesticides reduce pests but have some adverse consequences. • Organisms can become pesticide resistant. • Concentrated animal feeding operations and free-range grazing each have their advantages and disadvantages. • Harvesting fish can result in fishery decline. • The distribution of mineral resources on Earth has social and environmental consequences. • Mining impacts our ecosystems and human safety. • Urbanization is an increase in population density that has many environmental implications. • A variety of methods can reduce urban runoff. • The ecological footprint is an environmental impact assessment tool. • The carbon footprint calculates carbon dioxide emitted into the atmosphere. • Sustainability is a comprehensive assessment of the environment that includes five global-scale indicators. • Integrated pest management increases agricultural output while minimizing environmental harm. 	<ul style="list-style-type: none"> • Explain changes that developed as a result of the Green Revolution. • Identify the benefits and consequences of Green Revolution innovations. • Identify specific benefits and consequences of GMOs • Describe the resulting efficiency and fossil fuel impacts of mechanizations. • Explain how plowing and tilling interfere with the natural progression of ecosystems. • Identify the consequences of slash-and-burn farming. • Describe the effects of fertilizer use. • Describe the sources and locations of water used for irrigation. • Explain the different types of irrigation. • Describe how irrigation can cause waterlogging, salinization, and aquifer depletion. • Identify the advantages and consequences of pest control methods. • Describe pesticide resistance and the impacts of genetic engineering on crops. • Describe the benefits and consequences of different meat production methods. • Describe the cause and consequences of overfishing. • Describe how natural resources are extracted from the Earth through mining. • Identify the ecological and economic impacts of mining. • Explain urbanization and its effects on the environment. • Describe the methods used to reduce urban runoff. • Explain the ecological footprint, how to calculate it, and what it tells us. • Describe the carbon footprint and how it differs from the ecological footprint. • Explain sustainability and describe some environmental indicators of sustainability. • Describe the goals and techniques of integrated pest management (IPM). • Explain the objectives of sustainable agricultural practices. • Explain the environmental benefits and consequences of
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<ul style="list-style-type: none"> Sustainable agriculture reduces environmental impact. Sustainable forestry will minimize the effects of logging. 	<ul style="list-style-type: none"> aquaculture. Describe the methods of reducing human impact on forest tree removal.
<p>Key Vocabulary: <i>Tragedy of the Commons, externality, rangelands, forest, clear-cutting, selective cutting, ecologically sustainable forestry, tree plantation, Endangered Species Act, subsistence farming, agribusiness, Green Revolution, Economics of scale, organic fertilizer, synthetic fertilizer, waterlogging, salinization, pesticide, insecticide, herbicide, broad-spectrum pesticide, selective pesticide, monocropping, energy subsidy, plowing, tilling, Slash-and-burn agriculture, aquifer, unconfined aquifer, confined aquifer, water table, groundwater recharge, spring, artesian well, water footprint, furrow irrigation, flood irrigation, spray irrigation, drip irrigation, cone of depression, fungicide, rodenticide, persistent pesticides, nonpersistent pesticides, Integrated Pest Management (IPM), pesticide resistance, Concentrated animal feeding operation (CAFO), manure lagoon, free range grazing, nomadic grazing, overgrazing, desertification, fishery, fishery collapse, bycatch, crustal abundance, ore, metal, reserve, strip mining, mine tailings, open-pit mining, mountaintop removal, placer mining, subsurface mining, urbanization, urban area, suburbs, exurbs, saltwater intrusion, impervious surface, urban sprawl, urban blight, Sense of place, urban runoff, ecological footprint, carbon footprint, sustainability, sustainable development, maximum sustainable yield (MSY), environmental indicators, anthropogenic, crop rotation, intercropping, biocontrol, natural predators, sustainable agriculture, soil conservation, agroforestry, windbreaks, strip cropping, contour plowing, terracing, perennial plants, no-till agriculture, green manure, limestone, rotational grazing, organic agriculture, Delaney Clause, reforestation, sustainable forestry, prescribed burn.</i></p>	
<p style="text-align: center;">Assessment Evidence</p>	
<p>Performance Tasks:</p> <ul style="list-style-type: none"> Forestry Management WebQuest Cookie Mining Lab Urbanization & Sustainable Urban Planning Eating at a Lower Trophic Level 	<p>Other Evidence:</p> <ul style="list-style-type: none"> Origin of Food
<p style="text-align: center;">Learning Plan</p>	
<p>VOL Common Assessments: TCC1(9-12): I can ask purposeful, insightful questions to find a variety of innovative solutions.</p> <ul style="list-style-type: none"> Soil Salinization Lab <p>TCC3(9-12): I can integrate relevant information to produce multiple valid solutions.</p> <ul style="list-style-type: none"> Cookie Mining Lab <p>CCE2(9-12): I can give and receive actionable and relevant feedback with openness to be able to determine meaningful revisions for success.</p> <ul style="list-style-type: none"> APES Impact Poster Project 	

CCE4: Express ideas in a variety of ways, according to context, purpose, and audience.

- APES Impact Poster Project

Teacher Resources:

College Board AP Central: Environmental Science; <https://apcentral.collegeboard.org/courses/ap-environmental-science>

Environmental Science for the AP Course text 3rd edition by Andrew Friedland and Rick Relyea, 2019

UConn Early College Experience guidelines for Environmental Science; www.ece.uconn.edu



Unit 6 - Energy Resources and Consumption

Desired Results

Established Goals:

Common Core State Standards:

MP.4: Model with mathematics

MP.2 Reason abstractly and quantitatively.

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.

WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation

HSN-Q.A.2: Define appropriate quantities for the purpose of descriptive modeling.

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.

HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

NGSS Standards:

HS-PS3-2. Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects).

HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

HS-PS4-5. Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.

HS-LS1-5. Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.

HS-LS2-4. Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.

HS-LS2-5. Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.

HS-ESS3-2. Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.

HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

Vision of A Learner Attributes: Students will be able to independently use their learning to...

TCC3(9-12): I can integrate relevant information to produce multiple valid solutions.

TCC4(9-12): I can integrate my learning to adapt to experiences in the classroom, career and life.

TI4(9-12): I can apply my strengths and anticipate challenges to reach my current and future goals.

Understandings: Students will understand that...

- Nonrenewable energy sources are those that exist in a fixed amount and involve energy transformation that cannot be easily replaced, but renewable sources can be replenished.
- Availability, price, and governmental regulations influence which energy sources people use and how they use them.
- The most common fuel types are fossil fuels such as natural gas, peat, coal and wood.
- The global distribution of natural energy resources, such as ores, coal, crude oil, and gas, is not uniform and depends on regions' geologic history.
- Humans use a variety of methods to extract fossil fuels from the earth for energy generation which has an environmental impact.
- Nuclear power is generated through fission, where atoms of Uranium-235, which are stored in fuel rods, are split into smaller parts after being struck by a neutron.
- Three Mile Island, Chernobyl, and Fukushima are three cases where accidents or natural disasters led to the release of radiation. These releases have had short- and long-term impacts on the environment.
- Burning of biomass produces heat for energy at a relatively low cost, but it also produces carbon dioxide, carbon monoxide, nitrogen oxides, particulates, and volatile organic compounds.
- Photovoltaic solar cells capture light energy from the sun and transform it directly into electrical energy. Solar energy systems have low environmental impact and produce clean energy, but they can be expensive.
- Moving water can be used to spin a turbine, but construction of the power plants can be expensive, and there may be a loss of or change in habitats.
- Geothermal energy is obtained by using the heat stored in the Earth's interior to heat up water, which is brought back to the surface as steam to use for energy. This is often cost prohibitive or not accessible and may produce hydrogen sulfide.
- Hydrogen fuel cells use hydrogen as fuel, combining the hydrogen and oxygen in the air to form water and release energy (electricity) in the process, but can be too expensive and

Essential Questions:

- What are the differences between nonrenewable and renewable energy sources?
- What are some trends in energy consumption?
- What are some different types of fuels and their uses?
- Where do natural energy resources occur?
- What are the uses and methods of fossil fuels in power generation and how do they affect the environment?
- How is nuclear energy used in power generation?
- What are the effects of the use of nuclear energy on the environment?
- What are the effects of the use of biomass in power generation on the environment?
- How is solar energy used in power generation and what are the effects on the environment?
- How is hydroelectricity used in power generation and what are the effects on the environment?
- How is geothermal energy used in power generation and what are the effects on the environment?
- How are hydrogen fuel cells used in power generation and what are the effects on the environment?
- How is wind used in power generation and what are the effects on the environment?
- What are some methods for conserving energy?

<ul style="list-style-type: none"> hydrogen can be dangerous. • Wind turbines use the kinetic energy of moving air to spin a turbine, which in turn converts the mechanical energy of the turbine into electricity, but they may disrupt birds habitat and can cause noise pollution. • Methods for conserving energy on a large scale include improving fuel economy for vehicles, using BEVs (battery electric vehicles) and hybrid vehicles, using public transportation, and implementing green building design features. 	
<p>Students will know...</p> <ul style="list-style-type: none"> • Nonrenewable energy resources are finite and renewable energy resources are infinite. • Trends in energy use are changing around the world and in the U.S. • We can use less energy through conservation and increased efficiency. • The Sun is the ultimate source of many of the fuels that we use. • Each fuel has specific optimal applications. • Fossil fuels have specialized uses for motor vehicles and electricity. • Generation and cogeneration convert fuels to electricity. • Fossil fuel and ore distribution around the globe depends on the geology of the region. • Fossil fuels have many advantages and disadvantages. • Fuel is converted to electricity and releases carbon dioxide and heat energy. • Nuclear reactors use fission to generate electricity which does not produce carbon dioxide but the small amount of nuclear waste that is generated needs to be stored and any accident in the reactor could be devastating. • Biomass energy resources are derived from biological material and can displace fossil fuels. • The energy of the Sun can be captured passively and actively. • The kinetic energy of water can generate electricity but there are consequences. • Geothermal energy is using the Earth's internal heat and 	<p>Students will be able to...</p> <ul style="list-style-type: none"> • Describe nonrenewable and renewable energy resource characteristics. • Describe the trends of energy use worldwide and in the United States. • Explain the importance of energy efficiency and conservation. • Explain the role of the Sun in fuel sources. • Describe major fuel types and how they are used. • Identify other uses of fossil fuel. • Describe electricity generation and cogeneration. • Explain why fossil fuels and ores are found only in certain locations. • Describe the advantages and disadvantages of fossil fuels including oil extraction and fracking. • Describe how fossil fuels are used for electricity generation. • Explain how nuclear energy is used to generate energy and identify some advantages and disadvantages of its use. • Explain the positive and negative consequences of biomass energy resources. • Describe the various types of solar energy systems. • Explain how hydroelectric power is generated and describe its environmental effects. • Explain how humans harness geothermal energy. • Describe the hydrogen fuel cell and its potential for providing electricity. • Describe the benefits and impacts of wind energy. • Explain the methods of conserving energy.

<p>transferring it to water to use for heating or electricity generation.</p> <ul style="list-style-type: none"> Hydrogen fuel cells use hydrogen as an energy source and are almost pollution free. Wind energy is the most rapidly growing source of electricity. We can use less, and use different technologies to conserve energy. 	
<p>Key Vocabulary: <i>Fossil fuels, nonrenewable energy resource, renewable energy resource, potentially renewable, nondepletable, commercial energy resources, subsistence energy resources, energy intensity, fossil fuel combustion, Hubbert curve, Peak oil, energy conservation, energy efficiency, energy return on energy investment (EROEI), biofuel, modern carbon, fossil carbon, carbon neutral, coal, peat, lignite, bituminous coal, anthracite, natural gas, crude oil, tar sands, energy carrier, combined cycle, capacity, capacity factor, cogeneration, fracking, Volatile organic compounds (VOCs), turbine, electrical grid, energy quality, nuclear power, radioactivity, fission, fuel rod, control rod, radioactive decay, half-life, radioactive waste, Becquerel (Bq), curie, biomass, charcoal, particulates, carbon monoxide, nitrogen oxides, carbon dioxide, biofuel, ethanol, biodiesel, passive solar, active solar energy, photovoltaic solar cells, hydroelectricity, water impoundment, run-of-the-river, tidal energy, siltation, geothermal energy, ground source heat pump, fuel cells, electrolysis, wind energy, wind turbine, phantom loads, peak demand, passive solar design, thermal mass smart grid, oxygenated fuel, cellulosic ethanol</i></p>	
<p style="text-align: center;">Assessment Evidence</p>	
<p>Performance Tasks:</p> <ul style="list-style-type: none"> Personal Energy Use Audit Nuclear Decay Lab Ohmani Energy Project 	<p>Other Evidence:</p> <ul style="list-style-type: none"> Energy Math Practice Carbon Neutrality Game Radioactive Wolves Case
<p style="text-align: center;">Learning Plan</p>	
<p>VOL Common Assessments:</p> <p>TCC3(9-12): I can integrate relevant information to produce multiple valid solutions.</p> <ul style="list-style-type: none"> Ohmani Energy Project <p>TCC4(9-12): I can integrate my learning to adapt to experiences in the classroom, career and life.</p> <ul style="list-style-type: none"> Personal Energy Use Audit <p>TI4(9-12): I can apply my strengths and anticipate challenges to reach my current and future goals.</p> <ul style="list-style-type: none"> Personal Energy Use Audit 	

Teacher Resources:

College Board AP Central: Environmental Science; <https://apcentral.collegeboard.org/courses/ap-environmental-science>

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UConn Early College Experience guidelines for Environmental Science; www.ece.uconn.edu



Unit 7 - Atmospheric Pollution

Desired Results

Established Goals:

Common Core State Standards:

MP.4: Model with mathematics

MP.2 Reason abstractly and quantitatively.

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.

HSN-Q.A.2: Define appropriate quantities for the purpose of descriptive modeling.

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.

HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

NGSS Standards:

HS-LS2-5. Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.

HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

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.

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.

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.

Vision of A Learner Attributes: Students will be able to independently use their learning to...

TCC1(9-12): I can ask purposeful, insightful questions to find a variety of innovative solutions.

CCE2(9-12): I can give and receive actionable and relevant feedback with openness to be able to determine meaningful revisions for success.

TCC3(9-12): I can integrate relevant information to produce multiple valid solutions.

TCC4(9-12): I can integrate my learning to adapt to experiences in the classroom, career and life.

CCE4(9-12): I can communicate and express my understanding in an authentic, respectful and relevant way, using the most effective mode of expression.

CCE1(9-12): I can initiate discussions with my peers and teachers about a variety of topics, respecting differing viewpoints, actively listening to others, and responding thoughtfully with peer-reviewed evidence that is free of bias.

Understandings: Students will understand that...

Essential Questions:

<ul style="list-style-type: none"> • The combustion of fossil fuels releases air pollutants into the atmosphere. Air pollutants can be primary or secondary pollutants. • Many environmental factors affect the formation of photochemical smog, which is when nitrogen oxides and volatile organic hydrocarbons react with heat and sunlight to produce a variety of pollutants. • During a thermal inversion, the normal temperature gradient in the atmosphere is altered as the air temperature at the Earth's surface is cooler than the air at higher altitudes and it may trap pollution close to the ground, especially smog and particulates. • CO₂ appears naturally in the atmosphere from sources such as respiration, decomposition, and volcanic eruptions. • Indoor air pollutants can be classified as particulates, natural source pollutants, or human-made indoor air pollutants. • Methods to reduce air pollutants include regulatory practices, conservation practices, and alternative fuels. • Acid rain and deposition is due to nitrogen oxides and sulfur oxides from anthropogenic and natural sources in the atmosphere and can lead to the acidification of soils and bodies of water and corrosion of human-made structures. • Noise pollution is sound at levels high enough to cause physiological stress and the effects of noise pollution on animals in ecological systems include stress, the masking of sounds used to communicate or hunt, damaged hearing, and causing changes to migratory routes. 	<ul style="list-style-type: none"> • What are the sources and effects of air pollutants? • What are the causes and effects of photochemical smog and methods to reduce it? • What is thermal inversion and its relationship with pollution? • What are some natural sources of CO₂ and particulates? • What are indoor air pollutants? • How can air pollutants be reduced at the source? • What is acid rain and what are the effects of acid deposition on the environment? • What human activities result in noise pollution and how do they affect the environment?
<p>Students will know...</p> <ul style="list-style-type: none"> • Air pollution sources are widespread and their effects vary. • Primary (originates at source) and secondary (have been transformed to pollutants by another resource) pollutants have decreased over time. • Photochemical smog is a complex combination of compounds and it can be reduced by decreasing emissions of its precursors. • Thermal inversions trap air pollutants close to the Earth's surface. • Volcanoes, forest fires, respiration, and decomposition are 	<p>Students will be able to...</p> <ul style="list-style-type: none"> • Identify the sources and effects of major air pollutants. • Describe primary and secondary pollutants and how they change over time. • Explain photochemical smog and how to reduce it. • Describe thermal inversions and how they relate to air pollution. • Describe the natural sources of particulates and CO₂ • Identify the major indoor air pollutants and where they come from. • Describe indoor air pollution differences in the developing and

<p>natural processes responsible for particulate emissions and carbon dioxide.</p> <ul style="list-style-type: none"> Indoor air pollutants come from natural, human-made, and combustion sources. Indoor air pollution in the developing world comes mostly from indoor combustion while in the developed world tightly sealed buildings and VOCs are a bigger problem. Air pollution can be controlled by prevention, conservation, fuel switching, and regulatory practices. Control devices convert pollutants to less harmful compounds or remove them from the exhaust stream. Acid rain is acidified precipitation derived from air pollutants, which adversely affects terrestrial and aquatic systems and buildings. Noise pollution in the air can affect human health and behavior; noise pollution in water may interfere with animal communication. 	<p>developed world.</p> <ul style="list-style-type: none"> Explain how air pollutants can be reduced. Describe the various air pollution control devices and how they are used. Describe acid rain and its effects. Explain the sources and effects of noise pollution.
<p>Key Vocabulary: <i>Air pollution, sulfur dioxide, haze, photochemical oxidant, smog, lead, hydrocarbons, primary pollutant, secondary pollutant, photochemical smog (brown smog L.A.), sulfurous smog (gray smog), evaporate, sublimate, formaldehyde, thermal inversion, inversion layer, PM₁₀, PM_{2.5}, indoor air pollutants, asbestos, radon-222, Sick building syndrome, vapor recovery nozzle, catalytic converter, scrubber, electrostatic precipitator, pH, acid, base, acid rain, noise pollution, decibel A scale (dbA).</i></p>	
<p style="text-align: center;">Assessment Evidence</p>	
<p>Performance Tasks:</p> <ul style="list-style-type: none"> Airborne Particulate Lab Photochemical Smog & Thermal Inversion Lab Car Use Audit 	<p>Other Evidence:</p> <ul style="list-style-type: none"> Open Note AP Quiz Practice Math for AP Test FRQ practice and corrections
<p style="text-align: center;">Learning Plan</p>	
<p>VOL Common Assessments: TCC1(9-12): I can ask purposeful, insightful questions to find a variety of innovative solutions.</p>	

- Photochemical Smog & Thermal Inversion Lab

TCC3(9-12): I can integrate relevant information to produce multiple valid solutions.

- Airborne Particulate Lab

TCC4(9-12): I can integrate my learning to adapt to experiences in the classroom, career and life.

- Photochemical Smog & Thermal Inversion Lab
- Airborne Particulate Lab

CCE4(9-12): I can communicate and express my understanding in an authentic, respectful and relevant way, using the most effective mode of expression.

- Car Use Audit

CCE1(9-12): I can initiate discussions with my peers and teachers about a variety of topics, respecting differing viewpoints, actively listening to others, and responding thoughtfully with peer-reviewed evidence that is free of bias.

- Car Use Audit

Teacher Resources:

College Board AP Central: Environmental Science; <https://apcentral.collegeboard.org/courses/ap-environmental-science>

Environmental Science for the AP Course text 3rd edition by Andrew Friedland and Rick Relyea, 2019

UConn Early College Experience guidelines for Environmental Science; www.ece.uconn.edu

Unit 8 - Aquatic and Terrestrial Pollution

Desired Results

Established Goals:

Common Core State Standards:

RI.9-10.1: Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

MP.4: Model with mathematics

W.9-10.2: Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.

WHST.9-12.1 Write arguments focused on discipline-specific content.

WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation

HSN-Q.A.2: Define appropriate quantities for the purpose of descriptive modeling.

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.

NGSS Standards:

HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

HS-LS4-6. Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.

HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems

HS-ESS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

HS-ESS2-7. Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.

Vision of A Learner Attributes: Students will be able to independently use their learning to...

TCC1(9-12): I can ask purposeful, insightful questions to find a variety of innovative solutions.

CCE2(9-12): I can give and receive actionable and relevant feedback with openness to be able to determine meaningful revisions for success.

TCC3(9-12): I can integrate relevant information to produce multiple valid solutions.

Understandings: Students will understand that...

- A point source refers to a single, identifiable source of a pollutant, and nonpoint sources of pollution are diffused and can therefore be difficult to identify.

Essential Questions:

- What are the differences between point and nonpoint sources of pollution?
- What are the impacts of human activities on aquatic

- Organisms have a range of tolerance for various pollutants. Organisms have an optimum range for each factor where they can maintain homeostasis. Outside of this range, organisms may experience physiological stress, limited growth, reduced reproduction, and in extreme cases, death.
- Endocrine disruptors are chemicals that can interfere with the endocrine system of animals and they can lead to birth defects, developmental disorders, and gender imbalances in fish and other species.
- Threats to wetlands and mangroves include commercial development, dam construction, overfishing, and pollutants from agriculture and industrial waste.
- The increase in nutrients in eutrophic aquatic environments causes an algal bloom. When the algal bloom dies, microbes digest the algae, along with the oxygen in the water, leading to a decrease in the dissolved oxygen levels in the water
- Thermal pollution occurs when heat released into the water produces negative effects to the organisms in that ecosystem.
- Persistent organic pollutants (POPs) do not easily break down in the environment because they are synthetic, carbon-based molecules (such as DDT and PCBs).
- Bioaccumulation is the selective absorption and concentration of elements or compounds by cells in a living organism, and biomagnification is the increase in concentration of substances per unit of body tissue that occurs in successively higher trophic levels of a food chain or in a food web.
- Solid waste is any discarded material that is not a liquid or gas and factors in landfill decomposition include the composition of the trash and conditions needed for microbial decomposition of the waste.
- Recycling is a process by which certain solid waste materials are processed and converted into new products.
- Prior to discharge, the treated water is exposed to one or more disinfectants (usually, chlorine, ozone, or UV light) to kill bacteria.
- Lethal dose 50% (LD50) is the dose of a chemical that is lethal to 50% of the population of a particular species.

ecosystems?

- What are endocrine disruptors and what are the effects of endocrine disruptors on ecosystems?
- What are the impacts of human activity on wetlands and mangroves?
- What are the environmental effects of excessive use of fertilizers and detergents on aquatic ecosystems?
- What are the effects of thermal pollution on aquatic ecosystems?
- What are the effects of persistent organic pollutants (POPs) on ecosystems?
- What are bioaccumulation and biomagnification?
- What are solid waste disposal methods and what are the effects of solid waste disposal methods?
- What are some changes to current practices that could reduce the amount of generated waste and their associated benefits and drawbacks?
- What are the best practices in sewage treatment?
- What is the lethal dose 50% (LD50)?
- What are dose response curves?
- What are some sources of human health issues that are linked to pollution?
- How do human pathogens cycle through the environment?

<ul style="list-style-type: none"> • A dose response curve describes the effect on an organism or mortality rate in a population based on the dose of a particular toxin or drug. • It can be difficult to establish a cause and effect between pollutants and human health issues because humans experience exposure to a variety of chemicals and pollutants. • Pathogens adapt to take advantage of new opportunities to infect and spread through human populations. 	
<p>Students will know...</p> <ul style="list-style-type: none"> • Point sources of pollution have single locations while nonpoint sources have diffuse locations. • Organisms differ in their tolerance to various pollutants. • Chemical pollutants include heavy metals and synthetic compounds that are produced naturally and by human activities. • Chemical pollutant impacts can be categorized as neurotoxins, carcinogens, teratogens, allergens, or endocrine disruptors. • Oil pollution comes from multiple sources. • Humans are altering the availability of water by controlling its movements and they are converting some salt water into fresh water by desalination. • Humans are impacting wetlands and mangroves through development, dams, overfishing and pollutants. • Aquatic systems are being harmed by eutrophication and sediment inputs. • Thermal pollution comes from warming water bodies while noise pollution comes from human sounds. • Some chemicals can persist in nature and harm ecosystems for years. • Concentrations of chemicals experienced by organisms depend on routes of exposure and solubility. • Bioaccumulation and biomagnification can dramatically increase the concentration of a chemical in organisms by storing them in fat. • Solid waste pollution has increased over time from residences, businesses, industries, and agricultural activities. • Landfills are the primary destination for municipal solid waste. 	<p>Students will be able to...</p> <ul style="list-style-type: none"> • Identify the difference between point and nonpoint sources of pollution. • Explain why species differ in their tolerance of pollutants. • Identify the major groups of chemical pollutants and where they come from. • Describe the impacts of chemical pollutants. • Identify the source of oil pollutants. • Describe the human impacts on water availability. • Explain the human impacts on wetlands and mangroves. • Explain the causes and consequences of eutrophication and sediments. • Describe the sources of thermal and noise pollution. • Describe how persistent organic pollutants affect ecosystems. • Explain how routes of exposure and solubility determine the concentrations of chemicals that organisms experience. • Explain how bioaccumulation and biomagnification can increase concentrations of chemicals in organisms. • Describe how solid waste production has changed over time and identify the sources. • Explain how landfills are used to dispose of municipal solid waste. • Describe how incineration is used to dispose of municipal solid waste. • Explain why some municipal solid waste does not get to landfills or incinerators. • Identify how hazardous waste is safely disposed of. • Describe the three R's that divert materials from the waste

- Incinerators reduce solid waste by burning it.
- A lot of solid waste ends up in the ocean.
- Hazardous waste requires proper handling and disposal.
- The three R's: reduce, reuse, recycle.
- Composting reduces food and yard trimmings in the waste stream and enhances soil quality.
- New ways to think about municipal solid waste.
- Wastewater pollution is caused by oxygen demand, nutrient release, and disease-causing organisms.
- We have modern technologies used to treat wastewater.
- Scientists can determine the concentrations of chemicals that harm organisms by using dose-response curves.
- We can estimate potential harm by using risk assessment, risk acceptance and risk management.
- Worldwide standards of risk are guided by two different philosophies.
- We can establish cause and effect between pollutants and human health using retrospective and prospective studies.
- Human diseases can be infectious or noninfectious.
- Many pathogens have been historically important.
- Emergent infectious diseases pose new risks to humans.
- Laws exist to protect human health from pollutants and pathogens.

stream.

- Explain how composting reduces materials entering the waste stream.
- Explain how life-cycle analysis and integrated waste management reduce municipal solid waste.
- Describe the three major problems caused by wastewater pollution.
- Explain how we treat wastewater to prevent pollution.
- Explain how dose-response curves are used to estimate lethal doses of chemicals.
- Identify how we estimate potential harm of chemicals in the environment.
- Describe the major philosophies of regulating chemicals in the environment.
- Describe how we establish cause and effect between pollutants and human health.
- Describe the different types of human diseases.
- Identify historic human pathogens that have cycled through the environment.
- Identify the major emergent infectious diseases in humans.
- Identify the laws that protect human health from pollutants and pathogens.

Key Vocabulary: Point source, nonpoint source, homeostasis, polychlorinated biphenyls (PCBs), neurotoxin, carcinogen, mutagen, teratogen, allergen, endocrine disruptor, wastewater, levee, dikes, dam, reservoir, fish ladder, desalination, distillation, reverse osmosis, eutrophication, oxygen sag curve, thermal pollution, thermal shock, persistence, persistence organic pollutants (POPs), route of exposure, solubility, bioaccumulation, biomagnification, solid waste, municipal solid waste (MSW), waste stream, leachate, sanitary landfill, tipping fee, incineration, ash, waste-to-energy, hazardous waste, Superfund Act, Brownfields, Reduce, Reuse, Recycle, source reduction, closed-loop recycling, open-loop recycling, composting, life-cycle analysis (cradle-to-grave), integrated waste management, biochemical oxygen demand (BOD), cultural eutrophication, fecal coliform bacteria, septic system, septic tank, sludge, septage, leach field, dose-response study, acute study, chronic study, LD₅₀, sublethal effect, ED₅₀, no-observed-effect level (NOEL), environmental hazard, Innocent-until-proven-guilty, precautionary principle, Stockholm convention, REACH, retrospective study, prospective study, synergistic interaction, disease, infectious disease, acute disease, chronic disease, epidemic, pandemic, dysentery, plague, malaria, tuberculosis, emergent infectious disease, Acquired Immune Deficiency Syndrome, Human Immunodeficiency Virus, Ebola hemorrhagic fever, Mad Cow disease, prion, swine flu, bird flu, severe acute respiratory syndrome (SARS), MERS-CoV, SARS-CoV-2, West Nile virus, Lyme disease, Zika virus disease, Clean Water Act, Safe Drinking Water Act, Maximum contaminant level (MCL).

Assessment Evidence

Performance Tasks:

- *Oil Spill Lab*
- *Biomagnification Lab*
- *Water Quality Lab*

Other Evidence:

- LD50 Lab
- Waste-free World: The Story of Stuff
- Wastewater Treatment Activity or visit

Learning Plan

VOL Common Assessments:

TCC1(9-12): I can ask purposeful, insightful questions to find a variety of innovative solutions.

- Oil Spill Lab

TCC2(9-12): I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions.

- Water Quality Lab

TCC3(9-12): I can integrate relevant information to produce multiple valid solutions.

- Biomagnification Lab

CCE2(9-12): I can give and receive actionable and relevant feedback with openness to be able to determine meaningful revisions for success.

- Biomagnification Lab

Teacher Resources:

College Board AP Central: Environmental Science; <https://apcentral.collegeboard.org/courses/ap-environmental-science>

Environmental Science for the AP Course text 3rd edition by Andrew Friedland and Rick Relyea, 2019

UConn Early College Experience guidelines for Environmental Science; www.ece.uconn.edu

Unit 9 - Global Change

Desired Results

Established Goals:

Common Core State Standards:

MP.4: Model with mathematics

MP.2 Reason abstractly and quantitatively.

HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (

NGSS Standards:

HS-ESS2-4. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.

HS-ESS3-5. Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.

HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.

Vision of A Learner Attributes: Students will be able to independently use their learning to...

AA4(9-12): I can create opportunities to extend my learning by remaining open-minded in any situation.

TCC1(9-12): I can ask purposeful, insightful questions to find a variety of innovative solutions.

CCE2(9-12): I can give and receive actionable and relevant feedback with openness to be able to determine meaningful revisions for success.

TCC3(9-12): I can integrate relevant information to produce multiple valid solutions.

Understandings: Students will understand that...

- The stratospheric ozone layer is important to the evolution of life on Earth and the continued health and survival of life on Earth because a decrease in stratospheric ozone increases the UV rays that reach the Earth's surface..
- Ozone depletion can be mitigated by replacing ozone-depleting chemicals with substitutes that do not deplete the ozone layer. Hydrofluorocarbons (HFCs) are one such replacement, but some are strong greenhouse gasses.

Essential Questions:

- Why is stratospheric ozone important to life on Earth?
- What are chemicals used to substitute for chlorofluorocarbons (CFCs)?
- What are greenhouse gasses and the sources and potency of them?
- What are the threats to human health and the environment posed by an increase in greenhouse gasses?
- How can changes in climate cause both short- and long term,

<ul style="list-style-type: none"> • The principal greenhouse gasses are carbon dioxide, methane, water vapor, nitrous oxide, and chlorofluorocarbons (CFCs). Carbon dioxide is used as a reference point for the comparison of different greenhouse gasses. • Global climate change, caused by excess greenhouse gases in the atmosphere, can lead to a variety of environmental problems including rising sea levels resulting from melting ice sheets and ocean water expansion, and disease vectors spreading from the tropics toward the poles. These problems can lead to changes in population dynamics and population movements in response. • Effects of climate change include rising temperatures, melting permafrost and sea ice, rising sea levels, and displacement of coastal populations. • Ocean warming is caused by the increase in greenhouse gasses in the atmosphere and can affect marine species in a variety of ways, including loss of habitat, and metabolic and reproductive changes. • Ocean acidification is the decrease in pH of the oceans, primarily due to increased CO₂ concentrations in the atmosphere, and can be expressed as chemical equations. • Invasive species are often generalist, r-selected species and therefore may outcompete native species for resources and they can be controlled through a variety of human interventions. • A variety of factors can lead to a species becoming threatened with extinction, such as being extensively hunted, having limited diet, being outcompeted by invasive species, or having specific and limited habitat requirements. Strategies to protect animal populations include criminalizing poaching, protecting animal habitats, and legislation. • Global climate change can cause habitat loss via changes in temperature, precipitation, and sea level rise. Some ways humans can mitigate the impact of loss of biodiversity include creating protected areas, use of habitat corridors, promoting sustainable land use practices, and restoring lost habitats. 	<p>impact ecosystems?</p> <ul style="list-style-type: none"> • What are the causes and effects of ocean warming? • What are the causes and effects of ocean acidification? • What are the environmental problems associated with invasive species and strategies to control them? • How do species become endangered and what are strategies used to combat the problem? • How are human activities affecting biodiversity and what are some strategies to combat the problem?
<p>Students will know...</p> <ul style="list-style-type: none"> • Stratospheric ozone is beneficial to the health and survival of life 	<p>Students will be able to...</p> <ul style="list-style-type: none"> • Explain how stratospheric ozone forms and the benefits it

<p>on Earth.</p> <ul style="list-style-type: none"> • Humans have depleted the ozone layer through the use of CFCs. • Nations around the world have agreed to reduce CFC production to reduce ozone depletion. • Global change includes global climate change and global warming. • Solar radiation and greenhouse gasses make our planet warm. • Sources of greenhouse gasses are both natural and anthropogenic. • CO₂ concentrations have increased for the past 7 decades. • Global temperatures and greenhouse gasses have dramatically increased over the past two centuries. • Global climate change is causing ice to melt and sea levels to rise. • Global climate change is affecting the timing and performance of plants and animals. • Ocean warming is affecting a variety of marine species. • Increasing CO₂ concentrations are causing ocean acidification. • International agreements include the Kyoto Protocol and the Paris Agreement. • Invasive species can negatively impact native species, ecosystems, and human activities. • Plants and animals are becoming endangered due to human activities. • Human activities are causing declines in genetic biodiversity. • Declining biodiversity has a wide variety of causes. • To conserve biodiversity, we need to reduce threats. 	<p>provides.</p> <ul style="list-style-type: none"> • Identify the cause of depleted stratospheric ozone. • Describe efforts made to reduce ozone depletion. • Describe how we can distinguish between global change, global climate change, and global warming. • Explain the process underlying the greenhouse effect. • Identify the sources of greenhouse gasses. • Explain how CO₂ concentrations have changed over the past 7 decades. • Describe how temperatures and greenhouse gasses have varied historically. • Describe how global climate change has affected the environment. • Explain how global climate change is affecting populations. • Describe how ocean warming is altering ocean ecosystems. • Explain how climate change affects ocean pH. • Explain the international agreements on global climate change. • Identify the threats posed by invasive species. • Describe why species are becoming endangered. • Identify how human activities are affecting genetic biodiversity. • Explain the causes of declining biodiversity. • Identify how we can conserve biodiversity.
<p>Key Vocabulary: <i>Chlorofluorocarbons (CFCs), Montreal Protocol, Global change, global climate change, Greenhouse effect, Greenhouse warming potential (GWP), ocean acidification, Kyoto Protocol, Paris Climate Agreement, Endangered species, Lacey Act, Marine Mammal Protection Act, Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)</i></p>	
<p style="text-align: center;">Assessment Evidence</p>	
<p>Performance Tasks:</p>	<p>Other Evidence:</p>

<ul style="list-style-type: none"> • Exploration of Coral Bleaching STEM Activity • Stratospheric Ozone Activity 	<ul style="list-style-type: none"> • Endangered Species Project • Infectious Disease Pamphlet
Learning Plan	
<p>VOL Common Assessments:</p> <p>AA4(9-12): I can create opportunities to extend my learning by remaining open-minded in any situation.</p> <ul style="list-style-type: none"> • Exploration of Coral Bleaching STEM Activity <p>TCC1(9-12): I can ask purposeful, insightful questions to find a variety of innovative solutions.</p> <ul style="list-style-type: none"> • Stratospheric Ozone Activity <p>TCC3(9-12): I can integrate relevant information to produce multiple valid solutions.</p> <ul style="list-style-type: none"> • Exploration of Coral Bleaching STEM Activity 	
<p>Teacher Resources:</p> <p>College Board AP Central: <i>Environmental Science</i>; https://apcentral.collegeboard.org/courses/ap-environmental-science</p> <p><i>Environmental Science for the AP Course</i> text 3rd edition by Andrew Friedland and Rick Relyea, 2019</p> <p>UConn Early College Experience guidelines for <i>Environmental Science</i>; www.ece.uconn.edu</p>	

Post AP exam - ECE Final Unit

Desired Results - Students will recognize the benefits and consequences of human activity on the environment.

Established Goals:

Common Core State Standards:

RI.9-10.1: Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

MP.4: Model with mathematics

W.9-10.2: Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.

HSN-Q.A.2: Define appropriate quantities for the purpose of descriptive modeling.

HSS-1C.B.6: Evaluate reports based on data.

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

NGSS Standards:

HS-LS2-4: Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.

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 the conditions may result in a new ecosystem.

HS-LS4-5: Evaluate the evidence supporting claims that changes in the environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.

HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

Vision of A Learner Attributes: Students will be able to independently use their learning to...

AA4(9-12): I can create opportunities to extend my learning by remaining open-minded in any situation.

TCC1(9-12): I can ask purposeful, insightful questions to find a variety of innovative solutions.

CCE2(9-12): I can give and receive actionable and relevant feedback with openness to be able to determine meaningful revisions for success.

TCC3(9-12): I can integrate relevant information to produce multiple valid solutions.

Understandings: Students will understand that...

- Invasive species are located in Connecticut and are out-competing some native species.
- Infectious diseases are becoming more prevalent due to climate

Essential Questions:

- Is there a local impact from invasive species?
- What are some infectious diseases and how does the environment affect the overall impact of them?

change. <ul style="list-style-type: none"> Every item that we purchase has an environmental impact from “cradle to grave” and should be considered. 	<ul style="list-style-type: none"> What is the total environmental cost of things that we purchase?
Students will know... <ul style="list-style-type: none"> what invasive species are located in the U.S. what infectious diseases are on the rise due to environmental changes or issues. what their personal impact is on the environment. what environmental cost the production of things we want has. 	Students will be able to... <ul style="list-style-type: none"> identify local invasive species. identify infectious diseases that are affected by changes in the environment. determine their ecological footprint. determine if the environmental cost of “things” is worth it.
Key Vocabulary: Invasive species, infectious diseases, ecological footprint.	
Assessment Evidence	
Performance Tasks: <ul style="list-style-type: none"> Environmental Scavenger Hunt: Students will explore the area on the Nonnewaug High School campus to identify something found in nature and then offer an explanation or connection to an environmental science theme or topic. ECE UConn Final Exam Poster Project: Students will choose an item that they utilize and enjoy and trace the environmental impact of that item from creation to disposal. 	Other Evidence: (To vary year to year) <ul style="list-style-type: none"> Invasive species Wanted Poster Infectious Disease Flyer Endangered Species Pamphlet Natural Areas Project
Learning Plan	
VOL Common Assessments: AA4(9-12): I can create opportunities to extend my learning by remaining open-minded in any situation. <ul style="list-style-type: none"> ECE Poster Project “From Cradle to Grave” TCC1(9-12): I can ask purposeful, insightful questions to find a variety of innovative solutions. <ul style="list-style-type: none"> Scavenger Hunt ECE Poster Project “From Cradle to Grave” CCE2(9-12): I can give and receive actionable and relevant feedback with openness to be able to determine meaningful revisions for success. <ul style="list-style-type: none"> ECE Poster Project “From Cradle to Grave” 	

TCC3(9-12): I can integrate relevant information to produce multiple valid solutions.

- Invasive species Wanted Poster
- Infectious Disease Flyer
- Endangered Species Pamphlet
- Natural Areas Project

Teacher Resources:

College Board AP Central: Environmental Science; <https://apcentral.collegeboard.org/courses/ap-environmental-science>

Environmental Science for the AP Course text 3rd edition by Andrew Friedland and Rick Relyea, 2019

UConn Early College Experience guidelines for Environmental Science; www.ece.uconn.edu

