



Environmental Science Scope and Sequence

Grading Period	Unit Title	Learning Targets
Throughout the School Year		<p>I. Earth Systems and Resources (10–15%)</p> <ul style="list-style-type: none"> A. Earth Science Concepts (Geologic time scale; plate tectonics, earthquakes, volcanism; seasons; solar intensity and latitude) B. The Atmosphere (Composition; structure; weather and climate; atmospheric circulation and the Coriolis Effect; atmosphere–ocean interactions; ENSO) C. Global Water Resources and Use (Freshwater/saltwater; ocean circulation; agricultural, industrial, and domestic use; surface and groundwater issues; global problems; conservation) D. Soil and Soil Dynamics (Rock cycle; formation; composition; physical and chemical properties; main soil types; erosion and other soil problems; soil conservation) <p>II. The Living World (10–15%)</p> <ul style="list-style-type: none"> A. Ecosystem Structure (Biological populations and communities; ecological niches; interactions among species; keystone species; species diversity and edge effects; major terrestrial and aquatic biomes) B. Energy Flow (Photosynthesis and cellular respiration; food webs and trophic levels; ecological pyramids) C. Ecosystem Diversity (Biodiversity; natural selection; evolution; ecosystem services) D. Natural Ecosystem Change (Climate shifts; species movement; ecological succession) E. Natural Biogeochemical Cycles (Carbon, nitrogen, phosphorus, sulfur, water, conservation of matter) <p>III. Population (10–15%)</p> <ul style="list-style-type: none"> A. Population Biology Concepts (Population ecology; carrying capacity; reproductive strategies; survivorship) B. Human Population

1. Human population dynamics (Historical population sizes; distribution; fertility rates; growth rates and doubling times; demographic transition; age-structure diagrams)
2. Population size (Strategies for sustainability; case studies; national policies)
3. Impacts of population growth (Hunger; disease; economic effects; resource use; habitat destruction)

IV. Land and Water Use (10–15%)

A. Agriculture

1. Feeding a growing population (Human nutritional requirements; types of agriculture; Green Revolution; genetic engineering and crop production; deforestation; irrigation; sustainable agriculture)
2. Controlling pests (Types of pesticides; costs and benefits of pesticide use; integrated pest management; relevant laws)

B. Forestry (Tree plantations; old growth forests; forest fires; forest management; national forests)

C. Rangelands (Overgrazing; deforestation; desertification; rangeland management; federal rangelands)

D. Other Land Use

1. Urban land development (Planned development; suburban sprawl; urbanization)
2. Transportation infrastructure (Federal highway system; canals and channels; roadless areas; ecosystem impacts)
3. Public and federal lands (Management; wilderness areas; national parks; wildlife refuges; forests; wetlands)
4. Land conservation options (Preservation; remediation; mitigation; restoration)
5. Sustainable land-use strategies

E. Mining (Mineral formation; extraction; global reserves; relevant laws and treaties)

F. Fishing (Fishing techniques; overfishing; aquaculture; relevant laws and treaties)

G. Global Economics (Globalization; World Bank; Tragedy of the Commons; relevant laws and treaties)

V. Energy Resources and Consumption (10–15%)

A. Energy Concepts (Energy forms; power; units; conversions; Laws of Thermodynamics)

B. Energy Consumption

1. History (Industrial Revolution; exponential growth; energy crisis)
2. Present global energy use
3. Future energy needs

C. Fossil Fuel Resources and Use (Formation of coal, oil, and natural gas; extraction/purification methods; world reserves and global demand; synfuels; environmental advantages/ disadvantages of sources)

D. Nuclear Energy (Nuclear fission process; nuclear fuel; electricity production; nuclear reactor types; environmental advantages/disadvantages; safety issues; radiation and human health; radioactive wastes; nuclear fusion)

E. Hydroelectric Power (Dams; flood control; salmon; silting; other impacts)

F. Energy Conservation (Energy efficiency; CAFE standards; hybrid electric vehicles; mass transit)

G. Renewable Energy (Solar energy; solar electricity; hydrogen fuel cells; biomass; wind energy; small-scale hydroelectric; ocean waves and tidal energy; geothermal; environmental advantages/disadvantages)

VI. Pollution (25–30%)

A. Pollution Types

1. Air pollution (Sources — primary and secondary; major air pollutants; measurement units; smog; acid deposition — causes and effects; heat islands and temperature inversions; indoor air pollution; remediation and reduction strategies; Clean Air Act and other relevant laws)
2. Noise pollution (Sources; effects; control measures)
3. Water pollution (Types; sources, causes, and effects; cultural eutrophication; groundwater pollution; maintaining water quality; water purification; sewage treatment/septic systems; Clean Water Act and other relevant laws)
4. Solid waste (Types; disposal; reduction)

B. Impacts on the Environment and Human Health

1. Hazards to human health (Environmental risk analysis; acute and chronic effects; dose-response relationships; air pollutants; smoking and other risks)
2. Hazardous chemicals in the environment (Types of hazardous waste; treatment/disposal of hazardous waste; cleanup of contaminated sites; biomagnification; relevant laws)

C. Economic Impacts (Cost-benefit analysis; externalities; marginal costs; sustainability)

	<p>VII. Global Change (10–15%)</p> <p>A. Stratospheric Ozone (Formation of stratospheric ozone; ultraviolet radiation; causes of ozone depletion; effects of ozone depletion; strategies for reducing ozone depletion; relevant laws and treaties)</p> <p>B. Global Warming (Greenhouse gases and the greenhouse effect; impacts and consequences of global warming; reducing climate change; relevant laws and treaties)</p> <p>C. Loss of Biodiversity</p> <ol style="list-style-type: none"> 1. Habitat loss; overuse; pollution; introduced species; endangered and extinct species 2. Maintenance through conservation 3. Relevant laws and treaties 	
<p>First Grading Period</p>	<p>Human Population</p>	<ul style="list-style-type: none"> *state the equations for determining the population change of a country, the natural population growth rate, the population growth rate, and the doubling time and solve for each. *state the equation for determining the environmental impact of a population and use it to estimate the relative differences between countries. perform long division and use scientific notation with basic math operations (addition, subtraction, multiplication, and division). *contrast the ways in which density dependent and density independent factors affect population size. *explain the factors that affect population size, density, distribution, and age structure. *discuss how government involvement can affect population growth rate (most notably India and China). *discuss the basics of species reproductive strategies including biotic potential, environmental resistance, and r and K selection. construct and analyze exponential growth curves, logistic growth curves and survivorship curves. *create a graph to illustrate how birth rate, death rate and population growth are related during each phase of the demographic transition, specifically whether each of these factors are increasing, decreasing or remaining steady in each phase and the causes of each. analyze a country's population data and age structure diagram to determine its current phase in the model and predict its future phase in the model. *evaluate the social, economic, and environmental factors that have contributed to decreasing growth rates in many countries. analyze relationships among changes in population size, economic development, and resource consumption at global and local scales. *compare and contrast the impacts of suburban sprawl and urbanization. discuss the use of planned development to counteract the negative environmental effects of urbanization.

	Terrestrial Ecology	<ul style="list-style-type: none"> *List and distinguish among five levels of organization of matter that are the focus of the realm of ecology. *Define abiotic component of an ecosystem. List important physical factors and important chemical factors that have large effects on ecosystems. *Define biotic component of an ecosystem. Distinguish between producers and consumers. List and distinguish four types of consumers. Distinguish among scavengers, detritus feeders and decomposers. Distinguish between aerobic respiration and anaerobic respiration. *Define the roles of keystone species and indicator species. *Summarize the law of tolerance. Know limiting factors in terrestrial ecosystems. *Evaluate which ecosystems show the highest average net primary productivity and which contribute most to global net primary productivity. *Distinguish between primary and secondary succession and give examples of pioneer species, mid-successional species, and late-successional species. Be able to explain the process of succession from pioneer stages to late successional, including the role of disturbance in resetting a climax community. *Explain the concept of tragedy of the commons and list some of the commons found on earth. *Define ecosystem services. List five examples of ecosystem services. Distinguish among three types of biodiversity. Briefly state two principles to sustain ecosystems. *Know the earth's major biomes and their geographic distributions relative to temperature and precipitation regimes. *Name and describe the three major categories of biomes and the subcategories of each. *Briefly describe the historical development and distinguishing features of three approaches ecologists use to learn about ecosystems: field research, laboratory research, and systems analysis. *Apply the second law of thermodynamics to food chains and pyramids of energy, which describe energy flow in ecosystems. *Explain why biomass may not always be represented by a "pyramid," but energy is always displayed as a pyramid. *Distinguish between food chains and food webs; grazing food web and detrital food web.
	Aquatic Ecology	<ul style="list-style-type: none"> *Describe the carbon, nitrogen, phosphorous, sulfur and hydrologic biogeochemical cycles. *Summarize the distribution of light, salt, and temperature in different aquatic biomes. *Describe the ecological functions performed by wetlands; and describe environmental problems associated with coastal and inland wetlands. *Describe the characteristics and ecological significance of coral reefs and describe environmental and economic problems of coral reefs. *List the types of organisms that occur in Aquatic and Marine Biomes and give

		<p>examples.</p> <ul style="list-style-type: none"> *List and compare the four zones of oceans. *Distinguish between photosynthesizers and chemosynthesizers. *List and compare the four zones of a lake; distinguish between oligotrophic and eutrophic lakes; and describe stratification and a turnover in a lake. *List and distinguish the three zones of a river system. *Evaluate the significance of the ecological and economic contributions of aquatic and marine ecosystems. *Be familiar with standardized tests for water quality including physical and chemical methods. *Understand freshwater availability and the challenges associated with its use and distribution. *Understand technologies used to purify water for drinking. *Be familiar with various water use and conservation strategies for water stakeholders in agriculture, industry, municipal and personal use. *Be familiar with efficient irrigation techniques. <p>Understand the complexities of water management policy decisions.</p> <ul style="list-style-type: none"> *Know the definition of and examples of point source and nonpoint source water pollution. *Know how nitrogen and phosphorous pollution can lead to the creation of dead zones, harmful algal blooms and fish kills through eutrophication.
<p>Second Grading Period</p>	<p>Soil</p>	<ul style="list-style-type: none"> *List the five soil horizons and know the physical, chemical and biological properties of each. *Know the relative sizes of particles of clay, silt and sand and how they combine to create soils of different textures. *Read and interpret a soil texture chart. *Know the different soil horizons present in the various terrestrial biomes. *Define weathering and give examples of three main types of this process. *Explain the causes of soil erosion from human activities. *Explain methods to reduce soil erosion. *Explain strategies to maintain and restore soil fertility. *Relate nutrient levels in soils to the process of cultural eutrophication in aquatic systems. *Differentiate between inorganic and organic fertilizers. *Explain the Green Revolution and know its environmental impacts. *Explain ways to move towards sustainable food production. *Define GMO products and know their impact on food production. *Determine the soil type based on texture, porosity and permeability tests. *Determine nutrient levels in soil and prescribe a fertilizer to correct the nutrient levels.

	<p>Pesticides and Toxicology</p>	<ul style="list-style-type: none"> *Name the different types of pests and pesticides (rodenticide, insecticide, etc.) *Describe some of the benefits and risks involved with the use of pesticides in agriculture. *Know federal regulations and acts regarding pesticides, as well as the governing bodies. *Understand and be able to explain the pesticide treadmill and IPM. *Name and describe the groups of toxic chemicals and the health risks involved. *Understand Bioaccumulation and Biomagnification. *Know federal regulations and acts regarding toxic substances. *Know the different types of infectious diseases and how they are caused and spread. *Describe the difference between a transmissible disease and a nontransmissible disease. *Be able to read and interpret an LD₅₀ and ED₅₀ graph, and understand how it is used in product safety testing. *Know the difference between a perceived risk and an actual risk and know the relative risks for common hazards.
	<p>Biodiversity</p>	<ul style="list-style-type: none"> *Explain the concept of biodiversity and how it is measured. *Explain the difference between species richness and species evenness and their importance. *Describe the ways in which evolution can occur (mutation, genetic drift, founder effect, bottleneck effect, natural selection and artificial selection) *Discuss the types of evidence that supports the theory of evolution. *Explain how environmental change affects speciation and extinction. *Explain why mass extinctions and depletions have occurred in the geologic past and relate the current mass extinction (6th) to human activities. *Describe the function, operation, and efficacy of the four major public land management agencies in the United States. *Explain the role of state agencies and non-governmental organizations in public and private land management in Texas and the significance of private landowners to conservation in our state. *Describe the ways in which timber is harvested in U.S. forests and how each compares in terms of their environmental impact. *Explain NEPA and how an Environmental Impact Statement (EIS) is created and used. *Explain the concept of biological Hot spots *Explain the theory of island biogeography and contrast the way it was originally applied with its current application to “habitat islands” of protected habitat in managed areas. *Explain the significance of federal designations such as National Wilderness Areas, Wild and Scenic Rivers, Critical Habitat for endangered species to conservation of biodiversity. *Explain how genetic diversity, species diversity, and ecosystem function are

		<p>changing over time.</p> <ul style="list-style-type: none"> *Identify the causes of declining biodiversity. *Explain the Marine Mammal Protection Act as a single species approach and how the creation of National Marine Sanctuaries serve as a protection mechanism for suites of marine species and habitats *Describe how federal law and international agreements have been designed to regulate and manage the transport and trade of endangered species and their products. *Examples would include the Lacey Act, CITES, and the Convention on Biological Diversity. *Explain the significance of listing threatened and endangered species by state, federal and international law and treaties, i.e. the Red List, state and federal T&E lists, and other global lists of concern.
Third Grading Period	Waste Management	<ul style="list-style-type: none"> *Define waste generation from an ecological perspective. Compare the inputs and outputs of the human solid waste system to those of ecological systems we have studied. *Define waste generation from a systems perspective. Identify the inputs, outputs and internal changes of a human-dominated system and the roles waste plays. *Discuss the concept of a throw-away society and how the municipal solid waste (MSW) generated today has changed over the past century in the United States. Contrast the solid waste stream of a developed and developing country. *Discuss the composition and source of MSW. *Describe how each of the three R's as well as composting can avoid waste generation. *Explain the economic and ecological advantages of source reduction and give examples of personal and institutional source reduction strategies. *Discuss the concept of Reuse and identify the advantages and disadvantages of this waste management strategy. *Compare closed-loop recycling to open-loop recycling. *Interpret data about the trends in recycling of the MSW in the United States over the past half century. *Explain why recycling is the last choice among the three Rs and why reducing is the first choice. *Explain why composting is an important activity in waste management. *Explain the implications of siting, constructing and operating a MSW landfill. *Diagram the features of a modern sanitary landfill. *Explain how siting of a MSW landfill can become an environmental justice issue. *Explain the implications of using incineration as a waste disposal alternative. *Diagram the features of a municipal mass-burn waste-to-energy incinerator. *Characterize the types of hazardous wastes and their sources. *Distinguish between Superfund Sites and Brownfields. Give an example of each and discuss its origin, status and associated environmental consequences. *Describe how federal law and international agreements have been designed to

		<p>regulate and manage the generation and disposal of hazardous waste. Examples would include the Resource Conservation and Recovery Act (RCRA), the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA and its recent amendment SARA), and the Stockholm Convention on Persistent Organic Pollutants (POP's Treaty).</p> <p>*Explain the process of Life-cycle Analysis and how communities can use this to reduce waste generation.</p> <p>*Describe the various strategies used in Integrated Waste Management.</p>
	<p>Energy</p>	<p>*Explain the theories of Continental Drift, seafloor spreading, and plate tectonics, and superposition</p> <p>*Diagram the layers of the Earth</p> <p>*Explain the differences between transform, divergent, and convergent boundaries</p> <p>*Know the various earthquake waves and compare earthquakes based off of the Richter magnitude scale</p> <p>*Describe the three types of rocks found in the rock cycle, know how they are formed, and give examples</p> <p>*Diagram the rock cycle and understand how all of the rocks are related to each other</p> <p>*Distinguish between the three main methods of extraction and know the costs and benefits of each</p> <p>*List the five main forms of surface mining and explain the differences between them</p> <p>*Explain the environmental effects of each step in mining, processing, and use of minerals</p> <p>*List and explain the three laws that have been and currently are in place for mining</p> <p>*Describe the purpose of reclamation</p> <p>*Define nonrenewable energy</p> <p>*Distinguish between a primary energy source, secondary energy source, and cogeneration</p> <p>*Define fossil fuels and explain how they are formed</p> <p>*Explain the differences between oil, coal, and natural gas as well explain how each is extracted and their costs and benefits</p> <p>*Draw a diagram for a typical power plant and explain how a power plant converts the fuel source into electricity using the first law of thermodynamics</p> <p>*Explain the costs and benefits of nuclear energy as well as the fuel source</p> <p>*Distinguish between the four types of coal based on the amount of stored energy and sulfur content</p> <p>*Explain how Chernobyl, 3-Mile Island, and Fukushima's nuclear disasters happened</p> <p>*Calculate any variable in a half-life problem given the other three variables</p> <p>*Give the energy efficiencies of nuclear power, coal power, an internal combustion engine, and an incandescent light bulb and explain them using the second law of thermodynamics</p> <p>*Define renewable energy</p>

		<ul style="list-style-type: none"> *Distinguish between solar power, wind power, biomass, tidal power, water power, geothermal, and wave power as well as give the costs and benefits of each *Explain the types of energy conversions for each renewable energy source by using the first law of thermodynamics *Explain the difference between passive and active solar heating and how they work *Explain how we can cool houses naturally *Do energy calculations to compare savings based on different types of energy uses *Explain what a living roof is and how it works *Know and explain different laws associated with increasing the efficiency of products as well as reduce pollution and emissions generated by energy sources
	<p>Water Pollution</p>	<ul style="list-style-type: none"> *List and briefly define eight categories of water pollutants., including principal sources and methods of remediation for each. *Discuss how sewage is related to eutrophication, biochemical oxygen demand (BOD), and dissolved oxygen (DO). *Contrast point source pollution and nonpoint source pollution in aquatic and marine environments. *Distinguish among the causes and sources of impairment to our streams, rivers, lakes, ponds, reservoirs and bays and estuaries. *Discuss the formation of dead zones in our oceans and the roles nitrogen and phosphorus play in their development. *Distinguish between oligotrophic and eutrophic lakes and explain how humans induce artificial eutrophication. *Describe the primary dangers associated with heavy metals and synthetic compounds in polluted water. *List and describe the major diseases spread by polluted water. *Explain the role of acid deposition in water pollution. *Discuss the natural and anthropogenic releases of oil into the marine environment and the affect of these releases on the ecosystems of the oceans and nearshore environments. *Discuss at least three ways to remediate an oil spill. *Describe the problems associated with less familiar types of water pollutants including solid waste, sediment, heat and noise. *Describe and contrast the two most common ways to treat human wastewater. *Describe the advantages and disadvantages of both septic systems and wastewater treatment plants. *Describe the purpose, construction and treatment process for manure lagoons. *Describe the process provided for in the Clean Water Act to obtain permits for the discharge of wastewater into public waterways and discuss how the contaminant levels allowed for these major pollutants is managed through the permitting process. *Give examples of man-made compounds occurring in our water supply and explain why they are a concern. *Explain the concept of maximum contaminant level (MCL) as established in the

		Safe Drinking Water Act as it relates to harm from contaminants and the feasibility and cost of reaching MCLs.
Fourth Grading Period	Weather and Climate	<ul style="list-style-type: none"> *Explain the difference between weather and climate. *List the five layers of the Earth's atmosphere and explain their characteristics. *Describe the effect that the Earth's rotation has on atmospheric circulation and ocean currents. *Compare and contrast atmospheric and oceanic circulation patterns. *Explain how rain shadows are formed and the effects of them.
	Air Pollution	<ul style="list-style-type: none"> *Define air pollution and list the major air pollutants. *Identify the human-derived sources of the major air pollutants and explain their environmental and health effects and impacts. *Define particulate matter and smog and understand how they are formed. *Distinguish between primary and secondary pollutants. *Give examples of natural emission sources. *Explain how an inversion layer influences air pollution events. *Describe how acid deposition forms and what the effects are on human health, ecosystems and built objects and systems. *Describe how the Clean Air Act regulates anthropogenic emissions. *Explain the purpose of the National Ambient Air Quality Standards. *Describe pollution control methods for sulfur dioxide, nitrogen oxides, and particulates. *Describe how the stratospheric ozone layer forms and why it is beneficial. *Explain the causes and chemistry of ozone depletion. *Describe the steps that are being taken to reduce ozone depletion. *Explain how tropospheric ozone is formed and how it impacts human health and ecosystems. *List the main sources of indoor air pollution in the developing world. *List the main sources of indoor air pollution in the developed world. *Explain the phenomenon of sick building syndrome. *Describe what a greenhouse gas is and list the common greenhouse gases. *List the main natural and anthropogenic sources of greenhouse gases and determine which are the easiest to reduce. *Identify advantages and disadvantages to climate models. *Explain the differences in CO₂ emissions in developed and developing nations. *Describe methods used to determine CO₂ from the past. *Give examples of positive and negative feedback in climate change. *Explain the evidence that global warming is affecting Earth. *Give examples of direct and indirect effects of climate change on humans. *Describe the Kyoto Protocol in terms of developed nations versus developing nations.