

Environmental Systems

Format: Digital and Work Text

Course Objective

This semester-length, high school elective introduces students to career opportunities and educational pathways in a wide array of environmental fields. Students examine environmental legislation and regulations, government agencies and organizations, monitoring and testing methods and requirements. They discover the relationship between environmental regulations and careers, and study the issues, history, and current status of air and water quality, soil and atmospheric conditions. In an environmentally challenged world, ESS professionals are critically important. Job outlooks and salary scales reflect this need for educated, dedicated researchers, scientists, engineers, etc.

Course Prerequisites or Corequisites

- Biology (required)

Unit 1: Introduction to Environmental Systems

- Define environmental systems and understand the breadth and limitations of the course.
- Compare how the agricultural revolution, the industrial revolution, and the information/globalization revolutions inform the history of environmental systems.
- Define system and characterize why systems thinking is important when studying the environment.
- Compare and contrast open and closed systems.
- Describe basic economic principles and how they relate to environmental systems.
- Apply the law of supply and demand and a cost-benefit analysis to an environmental problem.
- Understand how the economy of nations affect how the nation as a whole impacts the environment.
- Analyze research as being fact, fiction, or promotional.
- Understand how bias is formed and learn to look for examples of bias in research.
- Describe why sample size is important.
- Understand basic statistics and how it is used to show relationships between two variables.
- Understand how basic field equipment is used.
- Understand how basic lab equipment is used.
- Describe the dos and don'ts of lab safety.
- Define and understand how global positioning and global information systems work.
- Describe and distinguish between 2D and 3D trilateration.

Unit 2: Introduction to the Earth

- Identify the major earth systems and describe specific interactions between the systems.
- Describe and draw the composition of the geosphere.
- Describe how plate tectonics works and analyze the effects of plate tectonics on the geosphere.
- Understand how earthquakes and volcanoes are related to the plate tectonic theory and explain the environmental impacts of each.
- Understand the fundamentals of the hydrosphere and cryosphere.
- Diagram the water cycle.
- Explain how the oceans regulate global temperatures through heat capacity, currents, and storing carbon dioxide.

- Compare and contrast the different types of ice found in the cryosphere.
- Explain how the cryosphere regulates global temperature.
- Model the positive feedback loop of melting polar ice.
- Describe the composition of the atmosphere and how it helps support life.
- Explain how ozone depletion works in Antarctica.
- Diagram the layers of the atmosphere and list what happens in every layer.
- Understand how weather works.
- Compare and contrast conduction, convection, and radiation, and explain how these three types of heat transfer work.
- Describe how atmospheric pressure influences weather.
- Explain the needs and characteristics of life.
- Create a table of the six life kingdoms, depicting cellular organization, cellular type, ways of obtaining energy, and examples.

Unit 3: Ecosystems

- Define ecosystems and differentiate between biotic and abiotic factors in ecosystems.
- Understand how living things in ecosystems are organized.
- Compare and contrast species to populations.
- Show examples of how biomes are determined by temperature, precipitation, and plants.
- Determine which biome a city resides in by looking at temperature and precipitation graphs.
- Name the major biomes and give examples of different species' adaptations for each biome.
- Understand how organisms are classified in aquatic ecosystems.
- Differentiate between freshwater and saltwater ecosystems and list major characteristics for each.
- Diagram how energy flows and transforms through ecosystems.
- Differentiate between food webs and food chains.
- Understand that almost all energy in ecosystems starts with the sun.
- Apply the First and Second Laws of Thermodynamics to energy flow in ecosystems.
- Give examples of keystone species and describe their special role in ecosystems.
- Quantify energy flow through trophic pyramids, number pyramids, and biomass pyramids.
- Describe the different relationships among species in ecosystems.
- Explain why carbon, oxygen, nitrogen, and phosphorous are important elements for living organisms.
- Diagram carbon, nitrogen, and phosphorous cycles and understand how these elements cycle through the atmosphere, biosphere, geosphere, and hydrosphere.
- Describe natural changes in ecosystems.
- Differentiate between primary and secondary succession and list important organisms for each.
- Describe different ways humans change ecosystems.

Unit 4: Populations and Biodiversity

- Understand population basics and how these principles impact ecosystems.
- Calculate growth rates, population density, and carrying capacities of populations.
- Describe factors that contribute to exponential population growth, limiting resources, population crashes, and carrying capacity.
- Define demography and explain why predicting future human population trends is important.
- Describe typical human population experiences and different factors that determine future human population.

- Describe how urbanization and slums impact the environment.
- Explain how an urban heat island works.
- Define biodiversity and understand its importance to ecosystems and people.
- Describe four different ways that biodiversity is threatened and give examples of endangered and threatened species.
- Explain different types of conservation efforts, including the Endangered Species Act, to preserve biodiversity.
- Define and differentiate between native, indigenous, and endemic species.
- Describe ecosystem and economic damage inflicted by invasive species.
- Understand the different characteristics of invasive species.
- Define taxonomy, classify endangered species, and identify native plants.

Unit 5: Human Health and the Environment

- Define environmental health and understand the importance of the environment on human health.
- Differentiate between the four types of environmental hazards.
- Explain why some people, especially children, are at greater risk of environmental hazards.
- Define epidemiology and the role of populations in environmental health.
- Differentiate between infectious, communicable, and noncommunicable diseases.
- Describe the major pathogens and infectious diseases of the world.
- Understand and diagram how emerging diseases come into existence, spread, and potentially cause great harm to humans.
- Explain antibiotic resistance mechanisms in bacteria.
- Give solutions for combatting infectious and emerging diseases.
- Differentiate between the different types of chemical hazards.
- List the most common and damaging indoor and outdoor toxins, and explain why people are more at risk from indoor chemical hazards.
- Diagram bioaccumulation and biomagnification in an ecosystem.
- Understand why persistent organic pollutants are especially harmful in environments.
- Explain how lifestyle choices affect cancer rates, especially regarding tobacco, obesity, and alcohol use.
- Categorize threats from bioterrorism and biological or chemical warfare.
- Understand how different natural disasters affect human health.
- Explain how scientists determine toxicity through lethal doses and median lethal doses.
- Compare the different methods of evaluating a substance's toxicity.
- List the five factors that influence how people see risk.
- Describe the differences in opinion on the regulation of toxic chemicals.
- Describe major legislation for the regulation of chemicals.

Unit 6: Land

- Understand basic sustainability principles including natural capital, sustainable yield, and degradation.
- Graph different types of land use in the United States.
- Describe the properties of soil and understand its importance to the environment.
- Explain different ways that soil is degraded including erosion, salinization, waterlogging, and desertification.
- Differentiate between the different types of forests and describe their importance.
- Describe various logging methods and the impacts they have on ecosystems.

- Analyze different solutions for sustainable management of forests.
- Differentiate between the different types of agriculture and their impacts on the environment.
- Explain the advantages and disadvantages of the green revolution.
- Discuss several practices for sustainable agriculture, including integrated pest management.
- Explain the advantages and disadvantages of feedlots, free-range pastures, and aquaculture.
- Diagram the environmental impact of different livestock animals.
- Understand the different factors that contribute to global food security.
- Discuss the advantages and disadvantages of GMOs.
- Evaluate different viewpoints on the ethics of food production.
- Categorize the major types of minerals and diagram the rock cycle.
- Explain different mining processes and the environmental impacts of mining.
- Describe sustainable mining solutions.
- Create cost-benefit analysis for land resources.
- Understand why pollution prevention is the best management practice.
- Analyze different federal laws for managing land resources in the United States.

Unit 7: Water

- Understand how fresh water is limited.
- Describe how watersheds work and why they are important for water quality.
- Graph the different ways humans use water.
- Describe how aquifers work and differentiate between confined and unconfined aquifers.
- Know that water, except for fossil water, is a renewable resource.
- Understand that humans, organisms, and ecosystems need adequate and healthy waters in order to survive.
- Describe the different parameters that affect water quality.
- Understand the synergistic effect between different water quality parameters.
- Describe the major pollutants and their sources in different aquatic ecosystems.
- Differentiate between point- and nonpoint-source water pollution.
- Describe different ways to treat wastewater.
- Understand that most pathogens enter water through feces.
- Describe different methods for controlling and filtering runoff.
- Understand the different components of water scarcity.
- Describe why water conflict is tied to water scarcity.
- Describe different solutions for water scarcity.
- Understand how agriculture and industry contribute to water scarcity.
- Describe different legislation to improve water quality in the United States.
- List practical ways to reduce water use.

Unit 8: Atmosphere

- Differentiate between primary and secondary air pollutants.
- Understand why indoor pollution is more harmful than outdoor pollution.
- List major air pollutants, their sources, and their effects on human health.
- Differentiate between industrial and photochemical smog.
- Describe the impacts of smog on health.
- Understand the different types of acid deposition and how they affect both structures and ecosystems.
- Describe how natural factors can either decrease or increase air pollution.

- Understand how temperature inversions work and how they impact smog.
- Describe how the Clean Air Act and Montreal Protocol work to promote cleaner air.
- List solutions for reducing emissions of air pollutants.
- Understand the different factors that influence climate.
- Describe how El Niño influences weather and climate.
- Diagram the greenhouse effect and sources of greenhouse gases.
- Understand the main factors that influence climate change.
- Describe how scientists study the climate of the past to understand the climate of today and the future.
- List evidence for a warmer earth.
- Describe both natural and human factors for climate change.
- Understand possible future consequences of climate change.
- Understand different viewpoints on global warming and climate change.
- Understand different solutions and regulations for combating climate change.

Unit 9: Energy

- Describe and define different forms of energy.
- Differentiate between kinetic and potential energy.
- Differentiate between types of fossil fuels.
- Explain the advantages and disadvantages of fossil fuels.
- Describe how nuclear power, hydroelectricity, tidal power, and ocean thermal power work and their advantages and disadvantages.
- Differentiate between active and passive solar heating.
- Describe how electricity is made through photovoltaic cells and solar thermal systems.
- Understand the advantages and disadvantages of solar power.
- Describe how wind power works and its advantages and disadvantages.
- Describe how biomass energy works and its advantages and disadvantages.
- Understand how biofuels work and their advantages and disadvantages.
- Describe how geothermal power works and its advantages and disadvantages.
- Describe how hydrogen power works and understand its limitations.
- List creative ways to solve energy problems.
- Analyze different energy conservation strategies.

Unit 10: Going Green

- Understand why waste is an important environmental issue.
- Distinguish between hazardous, municipal solid, and industrial wastes.
- Describe advantages and disadvantages of sanitary landfills, incinerators, and WTE facilities.
- Define hazardous waste and understand why radioactive wastes need special handling.
- List practical ways to reduce, reuse, and recycle to lessen the impact of waste on the environment.
- Describe how positive environmental change can be influenced through economic principles, environmental policies, and city planning.
- Differentiate between neoclassical, ecological, and environmental economic policies.
- Describe how environmental change can be achieved through a free-market system.
- List the principles that guide environmental policy.
- Describe the steps for creating new environmental policies.
- Understand different factors that create green cities.

- Describe components of a green home.
- Design a green home.
- Differentiate between different types of environmental worldviews.
- Understand how different religious beliefs might influence environmental worldview.
- Describe the problems the Biosphere 2 project faced.
- Create a personal plan to reduce ecological footprint.