08 Aquatic and Terrestrial Pollution

Content Area: **Science**
Course(s): **AP Environment**
Time Period: **Semester 2**
Length: **2 weeks**
Status: **Published**

Standards

CCC.1	Patterns.
CCC.1.1	students observe patterns in systems at different scales and cite patterns as empirical evidence for causality in supporting their explanations of phenomena. They recognize classifications or explanations used at one scale may not be useful or need revision using a different scale; thus requiring improved investigations and experiments. They use mathematical representations to identify certain patterns and analyze patterns of performance in order to reengineer and improve a designed system.
CCC.2	Cause and effect: Mechanism and explanation.
CCC.2.1	students understand that empirical evidence is required to differentiate between cause and correlation and to make claims about specific causes and effects. They suggest cause and effect relationships to explain and predict behaviors in complex natural and designed systems. They also propose causal relationships by examining what is known about smaller scale mechanisms within the system. They recognize changes in systems may have various causes that may not have equal effects.
CCC.3	Scale, proportion, and quantity.
CCC.3.1	students understand the significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. They recognize patterns observable at one scale may not be observable or exist at other scales, and some systems can only be studied indirectly as they are too small, too large, too fast, or too slow to observe directly. Students use orders of magnitude to understand how a model at one scale relates to a model at another scale. They use algebraic thinking to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).
CCC.4	Systems and system models.
CCC.4.1	students can investigate or analyze a system by defining its boundaries and initial conditions, as well as its inputs and outputs. They can use models (e.g., physical, mathematical, computer models) to simulate the flow of energy, matter, and interactions within and between systems at different scales. They can also use models and simulations to predict the behavior of a system, and recognize that these predictions have limited precision and reliability due to the assumptions and approximations inherent in the models. They can also design systems to do specific tasks.
SEP.2	Developing and Using Models
CCC.5	Energy and matter: Flows, cycles, and conservation.
CCC.5.1	students learn that the total amount of energy and matter in closed systems is conserved. They can describe changes of energy and matter in a system in terms of energy and matter flows into, out of, and within that system. They also learn that energy cannot be created or destroyed. It only moves between one place and another place, between objects and/or fields, or between systems. Energy drives the cycling of matter within and between systems. In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.
SEP.3	Planning and Carrying Out Investigations
SEP.4	Analyzing and Interpreting Data

SEP.5	Using Mathematics and Computational Thinking
SEP.6	Constructing Explanations and Designing Solutions

Enduring Understandings

Human activities, including the use of resources, have physical, chemical, and biological consequences for ecosystems.

Pollutants can have both direct and indirect impacts on the health of organisms, including humans.

Essential Questions

: How do human actions and resource usage cause negative impacts on the natural systems of Earth and create risks to sustainable human civilization?

Knowledge and Skills

Unit 8 Aquatic and Terrestrial Pollution

Topic 8.1 Sources of Pollution

Knowledge

- A point source refers to a single, identifiable source of a pollutant, such as a smokestack or waste discharge pipe.
- Nonpoint sources of pollution are diffused and can therefore be difficult to identify, such as pesticide spraying or urban runoff.

Skills

- Describe environmental concepts and processes.

Topic 8.2 Human Impacts on Ecosystems

Knowledge

- 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.
- Coral reefs have been suffering damage due to a variety of factors, including increasing ocean temperature, sediment runoff, and destructive fishing practices.

- Oil spills in marine waters cause organisms to die from the hydrocarbons in oil. Oil that floats on the surface of water can coat the feathers of birds and fur of marine mammals. Some components of oil sink to the ocean floor, killing some bottom-dwelling organisms.
- Oil that washes up on the beach can have economic consequences on the fishing and tourism industries.
- Oceanic dead zones are areas of low oxygen in the world's oceans caused by increased nutrient pollution.
- An oxygen sag curve is a plot of dissolved oxygen levels versus the distance from a source of pollution, usually excess nutrients and biological refuse.
- Heavy metals used for industry, especially mining and burning of fossil fuels, can reach the groundwater, impacting the drinking water supply.
- Litter that reaches aquatic ecosystems, besides being unsightly, can create intestinal blockage and choking hazards for wildlife and introduce toxic substances to the food chain.
- Increased sediment in waterways can reduce light infiltration, which can affect primary producers and visual predators. Sediment can also settle, disrupting habitats.
- When elemental sources of mercury enter aquatic environments, bacteria in the water convert it to highly toxic methylmercury

Skills

- Apply appropriate mathematical relationships to solve a problem, with work shown (e.g., dimensional analysis).

Topic 8.3 Endocrine Disruptors

Knowledge

- Endocrine disruptors are chemicals that can interfere with the endocrine system of animals.
- Endocrine disruptors can lead to birth defects, developmental disorders, and gender imbalances in fish and other species.

Skills

- Describe environmental concepts and processes.

Topic 8.4 Human Impacts on Wetlands and Mangroves

Knowledge

- Wetlands are areas where water covers the soil, either part or all of the time.
- Wetlands provide a variety of ecological services, including water purification, flood protection, water

filtration, and habitat.
- Threats to wetlands and mangroves include commercial development, dam construction, overfishing, and pollutants from agriculture and industrial waste.

Skills

- Describe potential responses or approaches to environmental problems.

Topic 8.5 Eutrophication

Knowledge

- Eutrophication occurs when a body of water is enriched in nutrients.
- 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. The lack of dissolved oxygen can result in large die-offs of fish and other aquatic organisms.
- Hypoxic waterways are those bodies of water that are low in dissolved oxygen.
- Compared to eutrophic waterways, oligotrophic waterways have very low amounts of nutrients, stable algae populations, and high dissolved oxygen.
- Anthropogenic causes of eutrophication are agricultural runoff and wastewater release.

Skills

- Explain how environmental concepts and processes represented visually relate to broader environmental issues.

Topic 8.6 Thermal Pollution

Knowledge

- Thermal pollution occurs when heat released into the water produces negative effects to the organisms in that ecosystem.
- Variations in water temperature affect the concentration of dissolved oxygen because warm water does not contain as much oxygen as cold water.

Skills

- Explain environmental concepts, processes, or models in applied contexts.

Topic 8.7 Persistent Organic Pollutants (POPs)

Knowledge

- Persistent organic pollutants (POPs) do not easily break down in the environment because they are synthetic, carbon-based molecules (such as DDT and PCBs).
- Persistent organic pollutants (POPs) can be toxic to organisms because they are soluble in fat, which allows them to accumulate in organisms' fatty tissues.
- Persistent organic pollutants (POPs) can travel over long distances via wind and water before being redeposited.

Skills

- Explain environmental concepts and processes.

Topic 8.8 Bioaccumulation and Biomagnification

Knowledge

- Bioaccumulation is the selective absorption and concentration of elements or compounds by cells in a living organism, most commonly fat-soluble compounds.
- 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.
- Some effects that can occur in an ecosystem when a persistent substance is biomagnified in a food chain include eggshell thinning and developmental deformities in top carnivores of the higher trophic levels.
- Humans also experience harmful effects from biomagnification, including issues with the reproductive, nervous, and circulatory systems.
- DDT, mercury, and PCBs are substances that bioaccumulate and have significant environmental impacts.

Skills

- Identify a testable hypothesis or scientific question for an investigation.

Topic 8.9 Solid Waste Disposal

Knowledge

- Solid waste is any discarded material that is not a liquid or gas. It is generated in domestic, industrial, business, and agricultural sectors.

- Solid waste is most often disposed of in landfills. Landfills can contaminate groundwater and release harmful gases.
- Electronic waste, or e-waste, is composed of discarded electronic devices including televisions, cell phones, and computers.
- A sanitary municipal landfill consists of a bottom liner (plastic or clay), a storm water collection system, a leachate collection system, a cap, and a methane collection system. Factors in landfill decomposition include the composition of the trash and conditions needed for microbial decomposition of the waste. Solid waste can also be disposed of through incineration, where waste is burned at high temperatures. This method significantly reduces the volume of solid waste but releases air pollutants.
- Some items are not accepted in sanitary landfills and may be disposed of illegally, leading to environmental problems. One example is used rubber tires, which when left in piles can become breeding grounds for mosquitoes that can spread disease.
- Some countries dispose of their waste by dumping it in the ocean. This practice, along with other sources of plastic, has led to large floating islands of trash in the oceans. Additionally, wildlife can become entangled in the waste, as well as ingest it.

Skills

- Use data and evidence to support a potential solution.

Topic 8.10 Waste Reduction Methods

Knowledge

- Recycling is a process by which certain solid waste materials are processed and converted into new products.
- Recycling is one way to reduce the current global demand on minerals, but this process is energy-intensive and can be costly.
- Composting is the process of organic matter such as food scraps, paper, and yard waste decomposing. The product of this decomposition can be used as fertilizer. Drawbacks to composting include odor and rodents.
- E-waste can be reduced by recycling and reuse. E-wastes may contain hazardous chemicals, including heavy metals such as lead and mercury, which can leach from landfills into groundwater if they are not disposed of properly.
- Landfill mitigation strategies range from burning waste for energy to restoring habitat on former landfills for use as parks
- The combustion of gases produced from decomposition of organic material in landfills can be used to turn turbines and generate electricity. This process reduces landfill volume

Skills

- Apply appropriate mathematical relationships to solve a problem, with work shown (e.g., dimensional analysis).

Topic 8.11 Sewage Treatment

Knowledge

- Primary treatment of sewage is the physical removal of large objects, often through the use of screens and grates, followed by the settling of solid waste in the bottom of a tank.
- Secondary treatment is a biological process in which bacteria break down organic matter into carbon dioxide and inorganic sludge, which settles in the bottom of a tank. The tank is aerated to increase the rate at which the bacteria break down the organic matter.
- Tertiary treatment is the use of ecological or chemical processes to remove any pollutants left in the water after primary and secondary treatment.
- Prior to discharge, the treated water is exposed to one or more disinfectants (usually, chlorine, ozone, or UV light) to kill bacteria.

Skills

- Describe characteristics of an environmental concept, process, or model represented visually

Topic 8.12 Lethal Dose 50% (LD50)

Knowledge

- Lethal dose 50% (LD50) is the dose of a chemical that is lethal to 50% of the population of a particular species.

Skills

- Determine an approach or method aligned with the problem to be solved.

Topic 8.13 Dose Response Curve

Knowledge

- 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.

Skills

- Explain what the data implies or illustrates about environmental issues.

Topic 8.14 Pollution and Human Health

Knowledge

- 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.
- Dysentery is caused by untreated sewage in streams and rivers.
- Mesothelioma is a type of cancer caused mainly by exposure to asbestos
- Respiratory problems and overall lung function can be impacted by elevated levels of tropospheric ozone.

Skills

- Describe an aspect of a research method, design, and/or measure used.

Topic 8.15 Pathogens and Infectious Diseases

Knowledge

- Pathogens adapt to take advantage of new opportunities to infect and spread through human populations.
- Specific pathogens can occur in many environments regardless of the appearance of sanitary conditions.
- As equatorial-type climate zones spread north and south in to what are currently subtropical and temperate climate zones, pathogens, infectious diseases, and any associated vectors are spreading into these areas where the disease has not previously been known to occur.
- Poverty-stricken, low-income areas often lack sanitary waste disposal and have contaminated drinking water supplies, leading to havens and opportunities for the spread of infectious diseases.
- Plague is a disease carried by organisms infected with the plague bacteria. It is transferred to humans via the bite of an infected organism or through contact with contaminated fluids or tissues.
- Tuberculosis is a bacterial infection that typically attacks the lungs. It is spread by breathing in the bacteria from the bodily fluids of an infected person.
- Malaria is a parasitic disease caused by bites from infected mosquitoes. It is most often found in sub-Saharan Africa.
- West Nile virus is transmitted to humans via bites from infected mosquitoes.
- Severe acute respiratory syndrome (SARS) is a form of pneumonia. It is transferred by inhaling or touching infected fluids.
- Middle East Respiratory Syndrome (MERS) is a viral respiratory illness that is transferred from animals to humans.
- Zika is a virus caused by bites from infected mosquitoes. It can be transmitted through sexual contact.

- Cholera is a bacterial disease that is contracted from infected water.

Skills

- Explain relationships between different characteristics of environmental concepts, processes, or models represented visually

Key vocabulary you need to know

point source

Safe Drinking Water Act

E-waste

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

Resource Conservation and Recovery Act (RCRA)

Delaney Clause of the Federal Food

Lethal Dose 50% (LD50)

Dead zone/Hypoxic zone

Nutrient runoff/pollution

Neurotoxin: mercury, lead,

Wastewater/ Sewage treatment

Eutrophication

nonpoint source

biochemical oxygen demand (BOD)

endocrine disruptors/ HAA - hormonally active agents/gender benders

Maximum Contaminant Level (MCL)

Clean Water Act

Bioaccumulation

reduce, reuse, recycle

Sanitary landfill

dose response curve

Oxygen sag curve

MERS

Hormonally active agents

Anthropogenic

indicator species

oxygen sag curve

thermal pollution

primary, secondary, and tertiary treatment

persistent organic pollutants (POPs)

Biomagnification

integrated waste management

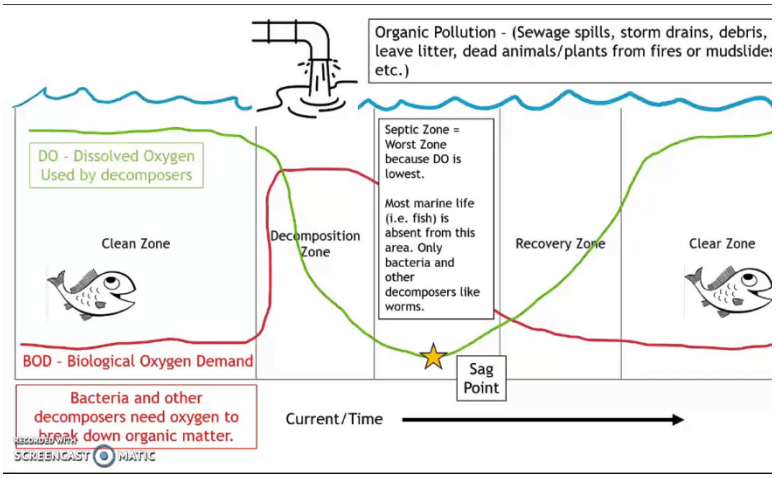
Sedimentation

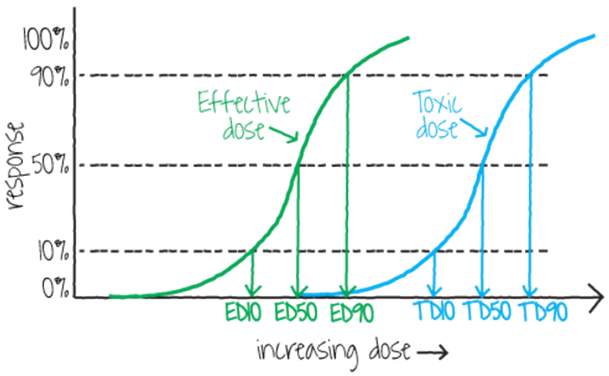
Wetlands

Cholera

Dissolved oxygen

Figures/ Equations to know





Transfer Goals

Understand the impact of human activities on creating and reducing pollution.

Relate pollution to different biological threats.

Interpret models of pollution.

Assessments

https://docs.google.com/document/d/1wR7bQF-8AQoRrt0g4C3hKja0yjwDjC9_BiAmONWbTcI/edit?usp=sharing

Modifications

https://docs.google.com/document/d/1ODqaPP69YkcFiyG72fIT8XsUIe3K1VSG7nxuc4CpCec/edit?usp=shar

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