09 Global Change

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.
CCC.7	Stability and change.
CCC.7.1	students understand much of science deals with constructing explanations of how things

	change and how they remain stable. They quantify and model changes in systems over very short or very long periods of time. They see some changes are irreversible, and negative feedback can stabilize a system, while positive feedback can destabilize it. They recognize systems can be designed for greater or lesser stability.
SEP.4	Analyzing and Interpreting Data
SEP.6	Constructing Explanations and Designing Solutions

Enduring Understandings

Local and regional human activities can have impacts at the global level.

The health of a species is closely tied to its ecosystem, and minor environmental changes can have a large impact.

Essential Questions

To what extent are human activities damaging the Earth's atmosphere, climate, and biosphere, and how can we reverse this trend?

Knowledge and Skills

Topic 9.1 Stratospheric Ozone Depletion

Knowledge

- The stratospheric ozone layer is important to the evolution of life on Earth and the continued health and survival of life on Earth.
- Stratospheric ozone depletion is caused by anthropogenic factors, such as chlorofluorocarbons (CFCs), and natural factors, such as the melting of ice crystals in the atmosphere at the beginning of the Antarctic spring.
- A decrease in stratospheric ozone increases the UV rays that reach the Earth's surface. Exposure to UV rays can lead to skin cancer and cataracts in humans.

Skills

- Describe environmental concepts and processes.

Topic 9.2 Reducing Ozone Depletion

Knowledge

- 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 gases.

Skills

- Describe potential responses or approaches to environmental problems.

Topic 9.3 The Greenhouse Effect

Knowledge

- The principal greenhouse gases are carbon dioxide, methane, water vapor, nitrous oxide, and chlorofluorocarbons (CFCs).
- While water vapor is a greenhouse gas, it doesn't contribute significantly to global climate change because it has a short residence time in the atmosphere.
- The greenhouse effect results in the surface temperature necessary for life on Earth to exist.
- Carbon dioxide, which has a global warming potential (GWP) of 1, is used as a reference point for the comparison of different greenhouse gases and their impacts on global climate change. Chlorofluorocarbons (CFCs) have the highest GWP, followed by nitrous oxide, then methane.

Skills

- Explain environmental concepts and processes.

Topic 9.4 Increases in the Greenhouse Gases

Knowledge

- 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.

Skills

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

Topic 9.5 Global Climate Change

Knowledge

- The Earth has undergone climate change throughout geologic time, with major shifts in global

temperatures causing periods of warming and cooling as recorded with CO_2 data and ice cores.
- Effects of climate change include rising temperatures, melting permafrost and sea ice, rising sea levels, and displacement of coastal populations.
- Marine ecosystems are affected by changes in sea level, some positively, such as in newly created habitats on now-flooded continental shelves, and some negatively, such as deeper communities that may no longer be in the photic zone of seawater.
- Winds generated by atmospheric circulation help transport heat throughout the Earth. Climate change may change circulation patterns, as temperature changes may impact Hadley cells and the jet stream
- Oceanic currents, or the ocean conveyor belt, carry heat throughout the world. When these currents change, it can have a big impact on global climate, especially in coastal regions.
- Climate change can affect soil through changes in temperature and rainfall, which can impact soil's viability and potentially increase erosion.
- Earth's polar regions are showing faster response times to global climate change because ice and snow in these regions reflect the most energy back out to space, leading to a positive feedback loop.
- As the Earth warms, this ice and snow melts, meaning less solar energy is radiated back into space and instead is absorbed by the Earth's surface. This in turn causes more warming of the polar regions.
- Global climate change response time in the Arctic is due to positive feedback loops involving melting sea ice and thawing tundra, and the subsequent release of greenhouse gases like methane.
- One consequence of the loss of ice and snow in polar regions is the effect on species that depend on the ice for habitat and food.

Skills

- Interpret experimental data and results in relation to a given hypothesis.

Topic 9.6 Ocean Warming

Knowledge

- Ocean warming is caused by the increase in greenhouse gases in the atmosphere.
- Ocean warming can affect marine species in a variety of ways, including loss of habitat, and metabolic and reproductive changes.
- Ocean warming is causing coral bleaching, which occurs when the loss of algae within corals cause the corals to bleach white. Some corals recover and some die.

Skills

- Describe environmental problems.

Topic 9.7 Ocean Acidification

Knowledge

- Ocean acidification is the decrease in pH of the oceans, primarily due to increased CO_2 concentrations in the atmosphere, and can be expressed as chemical equations.
- As more CO_2 is released into the atmosphere, the oceans, which absorb a large part of that CO_2,

become more acidic.
- Anthropogenic activities that contribute to ocean acidification are those that lead to increased CO_2 concentrations in the atmosphere: burning of fossil fuels, vehicle emissions, and deforestation.
- Ocean acidification damages coral because acidification makes it difficult for them to form shells, due to the loss of calcium carbonate.

Skills

- Explain environmental concepts, processes, or models in applied contexts. EIN-4

Topic 9.8 Invasive Species

Knowledge

- Invasive species are species that can live, and sometimes thrive, outside of their normal habitat. Invasive species can sometimes be beneficial, but they are considered invasive when they threaten native species.
- Invasive species are often generalist, r-selected species and therefore may outcompete native species for resources.
- Invasive species can be controlled through a variety of human interventions.

Skills

Make a claim that proposes a solution to an environmental problem in an applied context.

Topic 9.9 Endangered Species

Knowledge

- 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.
- Not all species will be in danger of extinction when exposed to the same changes in their ecosystem. Species that are able to adapt to changes in their environment or that are able to move to a new environment are less likely to face extinction.
- Selective pressures are any factors that change the behaviors and fitness of organisms within an environment.
- Species in a given ecosystem compete for resources like territory, food, mates, and habitat, and this competition may lead to endangerment or extinction.
- Strategies to protect animal populations include criminalizing poaching, protecting animal habitats, and legislation.

Skills

Use data and evidence to support a potential solution.

9.10 Human Impacts on Biodiversity

Knowledge

- HIPPCO (habitat destruction, invasive species, population growth, pollution, climate change, and over exploitation) describes the main factors leading to a decrease in biodiversity.
- Habitat fragmentation occurs when large habitats are broken into smaller, isolated areas. Causes of habitat fragmentation include the construction of roads and pipelines, clearing for agriculture or development, and logging.
- The scale of habitat fragmentation that has an adverse effect on the inhabitants of a given ecosystem will vary from species to species within that ecosystem.
- Global climate change can cause habitat loss via changes in temperature, precipitation, and sea level rise.
- Some organisms have been somewhat or completely domesticated and are now managed for economic returns, such as honeybee colonies and domestic livestock. This domestication can have a negative impact on the biodiversity of that organism.
- 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.

Skills

- Describe disadvantages, advantages, or unintended consequences for potential solutions.

Key vocabulary you need to know

Nitrogen Oxides	Ozone thinning	
Carbon Oxides	Montreal Protocol	Greenhouse effect
Hydrocarbons	Emissions	Enhanced greenhouse effect
Ozone	Greenhouse gases	Positive Feedback
Stratosphere	Parts per million	Aerosol Effect
Troposphere	Infrared Radiation	Thermal expansion
UV Radiation	Geoengineering	Permafrost
CFC’s	Infrared Radiation	Carbon Capture and Storage/carbon sequestration
Keystone species	Sea level rise	Endangered species
Biodiversity loss	Invasive species	HIPPCO
Ocean Acidification		

Transfer Goals

Relate human population growth to phenomena like decreasing biodiversity.

Explain solutions to climate change, declining biodiversity and other global change.

Justify solutions with evidence.

Assessments

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

Modifications

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