

Wildlife in a Changing Climate: 6th-12th

- Students learn the mechanisms by which humans are causing global climate change.
- Students learn some of the diverse impacts climate change has on the globe including increasing temperatures, drought, and fires.
- Students learn how many of the impacts of climate change can harm animals with a focus on local wildlife.
- Students will learn that global climate change is an anthropogenic problem and humans can change their actions to prevent and mitigate climate change. Some places like California have already committed to carbon neutrality in the near future.

Grade	NGSS Disciplinary Core Idea	Examples
6th-8th	LS1.C: Organization for Matter and Energy Flow in Organisms - Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. (MS-LS1- 6) PS3.D: Energy in Chemical Processes and Everyday Life - The chemical reaction by which plants produce complex food molecules (sugars) requires an energy input (i.e., from sunlight) to occur. In this reaction, carbon dioxide and water combine to form carbon-based organic molecules and release oxygen. (secondary to MS-LS1-6) - Cellular respiration in plants and animals involve chemical reactions with oxygen that release stored energy. In these processes, complex molecules containing carbon react with oxygen to produce carbon dioxide and other materials. (secondary to MS-LS1-7)	LS1.C: <i>Students will learn that fossil fuels originate with photosynthetic plants that have been fossilized over time.</i> PS3.D: <i>Students will learn that plants contain carbon in their tissues obtained from atmospheric carbon dioxide. The burning of fossil fuels releases carbon dioxide because fossil fuels are fossilized carbon from plant tissues.</i> LS2.C: <i>Students will learn that the Desert Tortoise is a keystone species, and if they go extinct due to the many threats they face, the ecosystem will suffer. Other animals rely on their burrows to regulate their temperature in</i>

LS2.C: Ecosystem Dynamics, Functioning, and Resilience - Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. (MS-LS2-4) Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health. (MS-LS2-4) LS4.C: Adaptation - Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common. Thus, the distribution of traits in a population changes. (MS-LS1-4) ESS3.C: Human Impacts on Earth Systems - Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. (MS-ESS3-3) ESS3.A: Natural Resources - Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes. (MS-ESS3-1) ESS3.C: Human Impacts on Earth Systems - Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. (MS-ESS3-3) Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. (MSESS3-3),(MS-ESS3-4) ESS3.D: Global Climate Change - Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). Reducing the level of climate change and reducing human	<i>the desert temperature extremes.</i> LS4.C: <i>Students will learn that animals like the Desert Tortoise are highly adapted to live in a desert environment. Their eggs have adapted to hatch as male or female depending on the temperatures the eggs experience.</i> ESS3.C: <i>Students will learn how humans are causing damage to the global ecosystem via climate change. These alterations can lead to the extinction of some species. For example, if climate change continues to worsen, Desert Tortoise populations could go extinct from a lack of male offspring. Other species, like the Virginia Opossum, can benefit from climatic changes and expand their ranges.</i> ESS3.A: <i>Students will learn that fossil fuels come from the fossilization of ancient plants and are a limited resource for humans that is not renewable over human lifetimes.</i> ESS3.C: <i>Students will learn how anthropogenic climate change is causing significant changes to Earth's climate and endangering species like the Western Pond Turtle. To combat climate change, humans need to focus on decreasing their per capita resource use.</i> ESS3.D: <i>Students will learn the science basics behind climate change and learn how to make better choices to support reducing personal carbon emissions.</i>
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	vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities. (MS-ESS3-5)	
9th-12th	PS3.D: Energy in Chemical Processes - Solar cells are human-made devices that likewise capture the sun's energy and produce electrical energy. (secondary to HS-PS4-5) LS2.B: Cycles of Matter and Energy Transfer in Ecosystems - Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. (HS-LS2-3) Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web. Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved. (HS-LS2-4) Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes. (HS-LS2-5) LS2.C: Ecosystem Dynamics, Functioning, and Resilience - A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. (HS-LS2-2),(HS-LS2-6) Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat	PS3.D: <i>Students will learn that humans can get energy directly from the sun using solar panels that capture the sun's energy and convert it to electrical energy.</i> LS2.B: <i>Students will learn that plants contain carbon in their tissues obtained from atmospheric carbon dioxide. The burning of fossil fuels releases carbon dioxide because fossil fuels are fossilized carbon from plant tissues. By burning fossil fuels, humans are disrupting the carbon cycle and putting pressure on carbon sinks globally.</i> LS2.C: <i>Students will learn that the Desert Tortoise is a keystone species, and if they go extinct due to the many threats they face, the ecosystem will suffer. Their burrows provide respite from the extreme temperatures in the desert.</i> LS4.D: <i>Students will learn that ecosystems are in danger from anthropogenic climate change and the changes to the climate are damaging ecosystems globally. This harms the ecosystems' abilities to provide many services for humans, including clean water, flood protection, and carbon capture.</i> PS3.D: <i>Students will learn how the energy within fossil fuels originates with photosynthesis.</i>

destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species. (HS-LS2-7) LS4.D: Biodiversity and Humans - Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). (secondary to HSL2-7) Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. (secondary to HS-LS2-7) (Note: This Disciplinary Core Idea is also addressed by HS-LS4-6.) PS3.D: Energy in Chemical Processes - The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis. (secondary to HS-LS2-5) LS4.C: Adaptation - Adaptation also means that the distribution of traits in a population can change when conditions change. (HS-LS4-3) Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline—and sometimes the extinction—of some species. (HS-LS4-5),(HS-LS4-6)Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost. (HS-LS4-5) ESS1.B: Earth and the Solar System - Cyclical changes in the shape of Earth's orbit around the sun, together with changes in the tilt of the planet's axis of rotation, both occurring over hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on the earth. These phenomena cause a cycle of ice ages and other gradual climate changes. (secondary to HS-ESS2-4)	LS4.C: <i>Students will learn that animals like the Desert Tortoise are highly adapted to live in a desert environment. Their eggs have adapted to hatch as male or female depending on the temperatures the eggs experience. Anthropogenic climate change could cause the extinction of Desert Tortoises due to increased temperatures making all eggs female.</i> ESS1.B: <i>Students will learn that if climate trends were continuing on a path not altered by humans, Earth would be cooling. Any warming of the climate in current times is due to anthropogenic inputs.</i> ESS2.D: <i>Students will learn that climate change is caused by humans burning fossil fuels. Increased carbon dioxide in the atmosphere is causing planetary warming that will continue to get more extreme if humans do not make changes.</i> ESS3.A: <i>Students will learn that fossil fuels come from the fossilization of ancient plants and are a limited resource for humans that is not renewable over human lifetimes.</i> ESS3.C: <i>Students will learn how anthropogenic climate change is causing significant changes to Earth's climate and endangering species like the Western Pond Turtle. To combat climate change, humans need to immediately make changes on a personal and a global level.</i>
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ESS2.D: Weather and Climate - The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space. (HS-ESS2-2),(HS-ESS2-4) Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS-ESS2-6),(HS-ESS2-7) Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS-ESS2- 6),(HS-ESS2-4) Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere. (secondary to HSESS3-6) ESS3.A: Natural Resources - Resource availability has guided the development of human society. (HS-ESS3-1) All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors. (HS-ESS3-2) ESS3.C: Human Impacts on Earth Systems - The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. (HS-ESS3-3) Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. (HS-ESS3-4) ESS3.D: Global Climate Change - Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts. (HS-ESS3-5) Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities. (HS-ESS3-6)	ESS3.D: <i>Students will learn that the changing climate is caused by humans, and humans are able to use models to predict climate outcomes based on different emission levels. Humans will continue to study and monitor climatic changes to see how different parts of the biosphere will react.</i>
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