

GEOGRAPHY STANDARD 8: The characteristics and spatial distribution of ecosystems and biomes on Earth's surface



Image credit: James F. Marran

A desert biome near Pinnacle Peak, Arizona supports plant and animal species that have adapted to arid conditions.



Image credit: Lydia J. Lewis

Changes in the amount and patterns of Arctic sea ice may affect living things in fragile polar ecosystems.

The geographically informed person must understand that Earth's surface is home to multiple biophysical communities. All elements of the environment, including the human, are part of many different but nested ecosystems that comprise different biomes. Ecosystems and biomes, defined by specific plant and animal communities interacting with the physical environment, are unevenly distributed on Earth's surface.

Therefore, Standard 8 contains these themes: Components of Ecosystems, Characteristics and Geographic Distribution of Ecosystems, and Characteristics and Geographic Distribution of Biomes.

Ecosystems and biomes are integral parts of the biosphere and interact with the atmosphere, hydrosphere, and lithosphere to form areas varying in size, shape, scale, and complexity. An ecosystem, for example, might be as small as a stand of oak trees or a pond or as large and complex as a vast desert or rainforest. Ecosystems that share similar characteristics of climate and vegetation can be grouped together to form regional-scale regions known as biomes. These biomes include Earth's tropical and temperate forests, savannahs and scrublands, grasslands, deserts, tundra, and oceans.

Changes in one ecosystem can have a ripple effect, with varying degrees of impact, as those changes influence other ecosystems, ultimately affecting the structures of the larger biomes. While ecosystems and biomes create both stability and equilibrium on Earth's surface, they can be altered by large-scale natural events such as volcanic eruptions, increases in surface temperature, or long-term droughts, or by human interventions such as overgrazing grasslands and clearing rainforests that may occur without an understanding of the environmental consequences.

Knowing how ecosystems and biomes function will enable students to make informed decisions about the sustainable uses of the natural world in the future. Global climate change is a reality with the potential of inflicting unimagined outcomes on the planet. The degree to which present and future generations understand the critical role they must play in maintaining healthy ecosystems and biomes will determine, in large measure, the quality of human life on Earth.

Students must understand how ecosystems and biomes form a fragile web of ecological interdependence. Understanding these themes enables students to appreciate our dependence on ecosystems and biomes and understand how we can live in environmentally sustainable ways.

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4th GRADE

the student knows and understands:

Components of Ecosystems

1. The components of ecosystems

Therefore, the student is able to:

- A. Identify the components of different ecosystems, as exemplified by being able to
 - ▶ Identify the three major components of an ecosystem (i.e., biomass, climate, and soil).
 - ▶ Identify examples of each ecosystem component (e.g., pine trees versus grasslands, low versus high rainfall, clay versus sandy soils).
 - ▶ Describe local ecosystems by surveying and recording the properties of their components.

8th GRADE

the student knows and understands:

Components of Ecosystems

1. Components of ecosystems are interdependent

Therefore, the student is able to:

- A. Describe how the components of ecosystems are connected and contribute to the energy of their own cycles, as exemplified by being able to
 - ▶ Describe the flow of energy and the cycling of matter through an ecosystem (e.g., the food chain, photosynthesis).
 - ▶ Identify and describe how carbon can be absorbed and stored in Earth's physical systems (e.g., oceans, tropical forests, vegetation).
 - ▶ Identify and describe the variable components in an ocean ecosystem that influence the interdependencies in an ecosystem (e.g., water temperature, depth, salinity, acidity, plants, fish, and marine mammals in an aquatic ecosystem).
- B. Construct a model to explain how an ecosystem works, as exemplified by being able to
 - ▶ Construct a food chain or web of food chains by sequentially arranging pictures or samples of a variety of living things (e.g., fungi, insects, plants, animals) to identify interactions within ecosystems.
 - ▶ Construct an aquarium or terrarium to explain the interacting components in an ecosystem.
 - ▶ Construct a flow chart to explain the interactions of components within an ecosystem (e.g., water cycle, oxygen and carbon dioxide exchange, producers, consumers, and decomposers).

12th GRADE

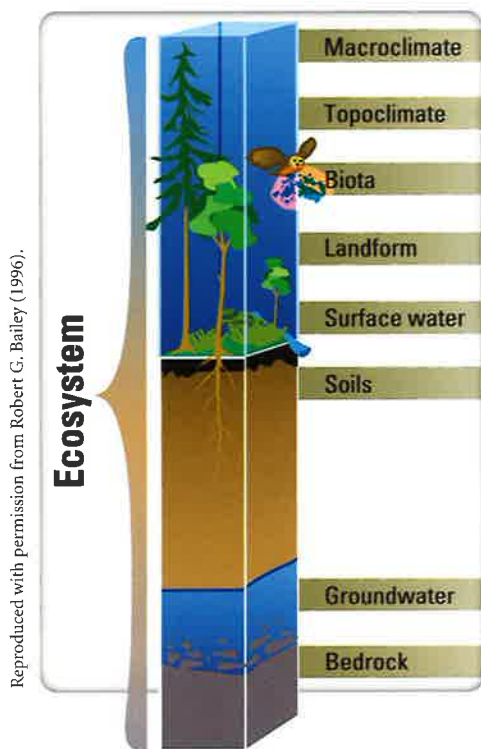
the student knows and understands:

Components of Ecosystems

1. Ecosystems are dynamic and respond to changes in environmental conditions

Therefore, the student is able to:

- A. Explain how there are short-term and long-term changes in ecosystems, as exemplified by being able to
 - ▶ Explain how there are short-term and long-term changes in ecosystems, as exemplified by being able to
 - ▶ Identify the sources of invasive species and explain the consequences for ecosystems (e.g., the impact of introduced species such as zebra mussels in the Great Lakes, Asian carp, Asian swamp eel, the impact of kudzu in the southeastern United States).
 - ▶ Explain the response of ecosystems to stress caused by physical events in terms of their characteristics and capacity to respond (e.g., changes in mangroves by tsunamis, changes in forest flora and fauna after a fire).
 - ▶ Explain how ecosystems respond to long-term changes in the physical environment (e.g., glacial retreat, volcanic eruptions, sea-level rise, increases in sea temperatures).
- B. Explain how local and global changes influence ecosystems, as exemplified by being able to
 - ▶ Explain how global climate change could influence the location and extent of existing ecosystems and the formation of new ones.
 - ▶ Analyze and predict how disruptions in local ecosystems force changes in cycles and sometimes result in new replacement ecosystems (e.g., beetles in pine forests, ecological succession after wildfires, drought, gypsy moth infestations in the eastern United States).
 - ▶ Explain how extreme localized weather events (e.g., hurricanes, tornadoes, wind storms) cause changes in ecosystems.



The vertical structure of an ecosystem, showing the spatial integration of biological and nonliving components.

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4th GRADE*the student knows and understands:***Characteristics and Geographic Distribution of Ecosystems****2. The characteristics of ecosystems***Therefore, the student is able to:*

- A. Identify and describe the characteristics of ecosystems, as exemplified by being able to
- ▶ Identify and describe the characteristics of an ecosystem (specific types of plants, climate, and soil) in which a favorite or interesting creature lives.
 - ▶ Identify and draw pictures of different plants and animals in various local ecosystems (e.g., a pond, forest, city park).
 - ▶ Compare the characteristics of different ecosystems (e.g., pond, deciduous forest, coral reef).

Characteristics and Geographic Distribution of Biomes**3. The characteristics of biomes***Therefore, the student is able to:*

- A. Describe the characteristics of biomes, as exemplified by being able to
- ▶ Describe the defining characteristics of a biome as a large region of ecosystems with similar climate and vegetation characteristics.
 - ▶ Describe the temperature, precipitation, and vegetation characteristics of various biomes, (e.g., deserts, grasslands, savannahs, temperate forests, tropical forests, arctic tundra).
 - ▶ Identify the characteristics in photographs of different types of vegetation and match them to the appropriate sections of a world climate map (e.g., cacti and succulents on a desert climate region, tropical forest trees on a tropical climate region, coral in shallow, tropical marine waters).

8th GRADE*the student knows and understands:***Characteristics and Geographic Distribution of Ecosystems****2. Physical processes determine the characteristics of ecosystems***Therefore, the student is able to:*

- A. Describe and explain how physical processes determine the characteristics of ecosystems, as exemplified by being able to
- ▶ Describe the rain shadow effect of orographic precipitation and identify the different ecosystems on the windward and leeward side of a mountain range or island (e.g., temperate rain forest on the windward side and high desert on the leeward side of the Cascade Mountain Range).
 - ▶ Explain how different locations can have similar ecosystems as a function of temperature, precipitation, elevation, and latitude by using climographs and vegetation maps.
 - ▶ Explain how ocean currents influence the characteristics of ecosystems (e.g., the Peru current and the Atacama Desert, the Benguela current and Namib Desert, East Indian current in the Bay of Bengal and monsoon season in India).

Characteristics and Geographic Distribution of Biomes**3. Climate primarily determines the characteristics and geographic distribution of biomes***Therefore, the student is able to:*

- A. Describe and explain how climate (temperature and rainfall) primarily determines the characteristics and geographic distribution of biomes, as exemplified by being able to
- ▶ Construct climographs (using temperature and precipitation data) for several different biomes to explain the distribution of biomes.
 - ▶ Describe the changing vegetation zones with increasing altitude for a mountain located near the equator (e.g., Mount Kilimanjaro in Tanzania, Mount Chimborazo in Peru).
 - ▶ Explain how biomes do not always follow lines of latitude by identifying the influences of oceans and mountain ranges on the distribution of climate and vegetation.

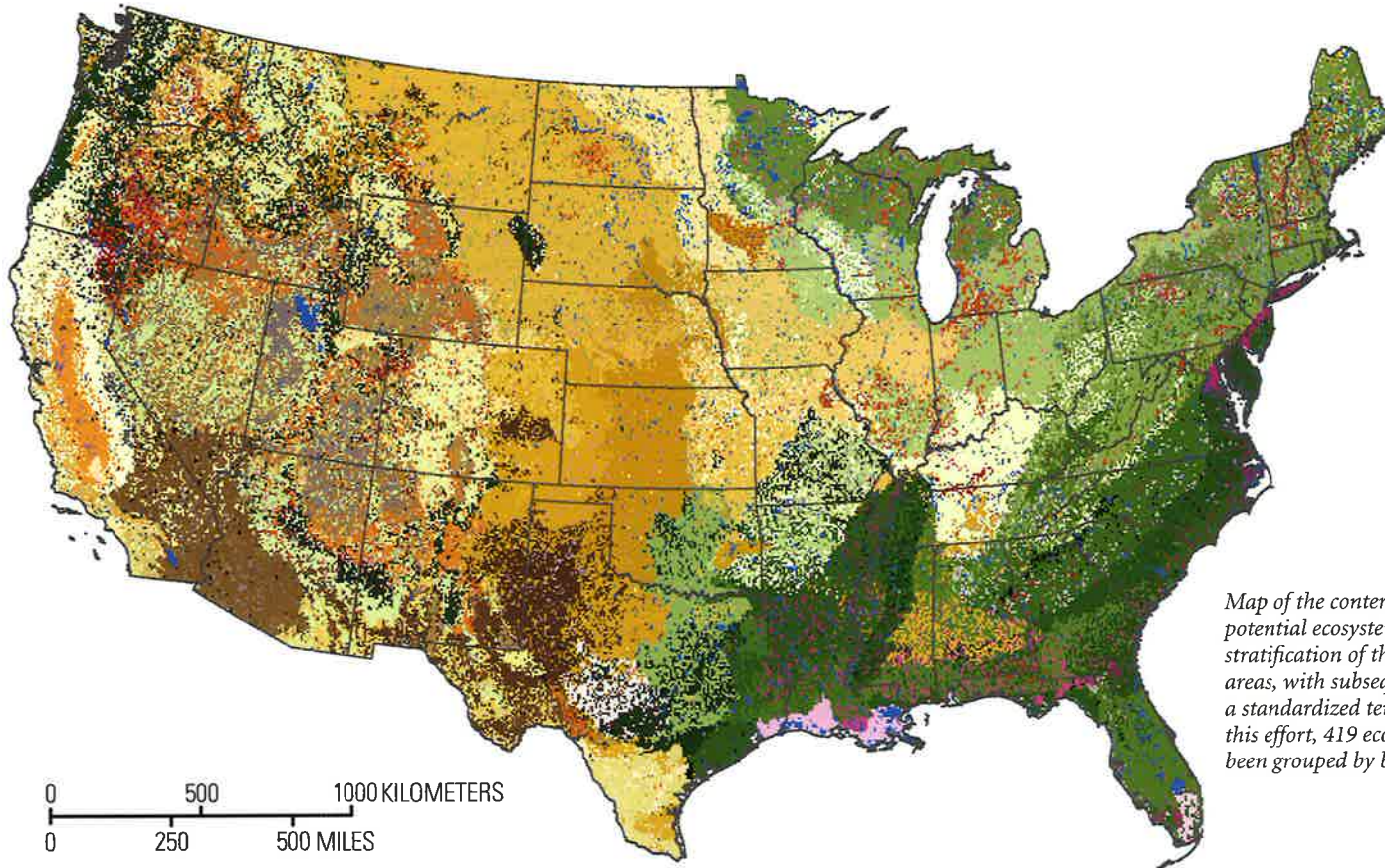
12th GRADE*the student knows and understands:***Characteristics and Geographic Distribution of Ecosystems****2. The characteristics and geographic distribution of ecosystems***Therefore, the student is able to:*

- A. Explain the geographic distribution of ecosystems, as exemplified by being able to
- ▶ Describe and explain the factors that result in the geographic distribution of ecosystems (e.g., movement of tectonic plates creating the Galapagos Islands, Hawaiian Islands, Madagascar).
 - ▶ Analyze the impact of rising sea temperatures on the distribution and survival of coral reef ecosystems.
 - ▶ Analyze the impact of a river meandering or flooding on the distribution of wetlands over time.
- B. Evaluate ecosystems in terms of their biodiversity and productivity, as exemplified by being able to
- ▶ Evaluate ecosystems for their level of biodiversity and productivity (e.g., the low productivity of deserts and the high productivity of estuaries and tropical forests).
 - ▶ Compare the biodiversity and productivity in an ecosystem that is experiencing some form of stress with a similar healthy ecosystem.
 - ▶ Evaluate changes in the biodiversity and productivity of an ecosystem following the loss or introduction of a plant or animal species.

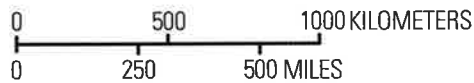
Characteristics and Geographic Distribution of Biomes**3. The distribution and characteristics of biomes change over time***Therefore, the student is able to:*

- A. Explain how climate can influence and change the characteristics and geographic distribution of biomes, as exemplified by being able to
- ▶ Explain how rising global temperatures can cause changes in various biomes (e.g., melting permafrost in tundra, changes in the location of deserts, increases in the length of growing seasons).
 - ▶ Analyze the changes in the biomes of a particular region over time (e.g., the change of the Sahara from a grassland to a desert) and describe the climatic changes that caused these changes to occur.
 - ▶ Construct maps showing the post-Pleistocene changes in biomes in the Northern Hemisphere and explain the reasons for the changes.

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Map of the conterminous United States showing potential ecosystems modeled from a biophysical stratification of the nation into physically distinct areas, with subsequent labeling of these areas using a standardized terrestrial ecosystem classification. In this effort, 419 ecosystems were mapped, and have been grouped by biomes in the legend.



Terrestrial Ecosystems



Map credit: US Geological Survey, 2009