Unit descriptions

Unit 1 — The Ocean Basins

In this unit, students examine the dynamic nature of ocean basins and the processes that form and continually reshape them. Students investigate sea floor age, depth, and plate tectonic processes. The unit culminates in an exercise evaluating competing hypotheses of the age distribution of the seafloor.

Activity 1.1 — The once and future ocean

Pages 3–6
Engage

In this activity, students discuss their prior knowledge and conceptions of the origins of Earth's surface features and the oceans. They use ArcView to investigate the direction and relative speed of continental movements throughout geologic time and construct projections for the future. They also explore how continental movement may affect the size and shape of ocean basins by examining the Atlantic Ocean in detail.

Activity 1.2 — Changing oceans

Pages 7–14
Explore

In this activity, students learn about the dynamic nature of ocean basins. They use ArcView to explore seafloor age data, determining when significant changes in the ocean basins took place over the course of geologic history and estimating the rate of expansion. Finally, students use their findings to evaluate hypotheses to explain the distinct pattern of young and old rock that characterizes the ocean floor.

Activity 1.3 — Ocean origins

Pages 15–22
Explain

This reading provides students with background information pertinent to the data and concepts they explore throughout the unit. Specifically, it explains how the oceans formed early in Earth's history and describes methods used to determine both continental and seafloor age. The theory of plate tectonics and the principle of isostasy are presented to help students understand the age and relative position of Earth's features.

Activity 1.4 — Beneath the waves

Pages 23–28
Elaborate

In this activity, students use ArcView to map portions of the ocean floor. The students create bathymetric profiles of the Atlantic Ocean basin using an increasing number of data points to discover the importance of data resolution on our ability to map and interpret the geology of the ocean floor over the past four hundred years.

Activity 1.5 Ocean basin features

Pages 29–34
Elaborate

In this activity, students use ArcView to examine the general characteristics of each of the ocean basins including the area, depth, extent of continental shelf, and location of ridges and trenches. They then investigate how these features correlate to the age of the seafloor. Finally, they look at the relative motion of the plates near ridges and trenches to understand the processes responsible for the creation and destruction of ocean floor.

Activity 1.6 Why are oceans young?

Pages 35–36
Evaluate

Using their knowledge of the ages of the ocean floor and continents, students are asked to assess and discuss several hypotheses for generating the observed age distribution of the seafloor.

Unit 2 *Ocean Currents*

In this unit, students examine how wind, temperature, and salinity influence the movement of ocean water in surface and deep-water currents. They also examine the direction, speed, and temperature of surface currents as they seek to uncover patterns in the movement of surface waters in the ocean basins. The unit underscores the importance of currents in distributing energy, nutrients, and dissolved gases around the globe.

Activity 2.1 *A puzzle at 70°N*

Pages 39–42
Engage

This activity takes a multifaceted approach to assess prior knowledge and generate student interest in ocean currents. Prior knowledge is assessed through an exercise in which students are asked to discuss the formation of currents by comparing characteristics of water in the ocean to that of a bathtub. Instructors may wish to alter the assignment to compare ocean water to water in a swimming pool or pond.

To put currents into a social context and generate curiosity, students are provided with important historical observations of the Gulf Stream current and a puzzle involving the disparity in climate between coastal Greenland and Norway. They are asked to use currents to explain the phenomenon, though they should not be expected to provide a complete or accurate explanation at this time. Instructors may wish to re-examine this phenomenon at the end of the unit to assess student understanding of ocean currents.

Activity 2.2 *Oceans in motion*

Pages 43–52
Explore

Students investigate the location and flow direction of the major ocean surface currents in this activity. They identify circulation, temperature, and velocity patterns of the four major surface currents in each ocean basin. Finally, they compare the movement of winds and currents to determine how winds influence the movement of surface waters. This prepares the student to learn more about the forces that drive these patterns.

Activity 2.3 *Current basics*

Pages 53–62
Explain

In this reading, students learn about how solar energy and Earth's rotation drive the horizontal movements of surface currents, and how temperature and salinity drive the vertical movements of ocean water. Students also learn about the role of currents in transporting and distributing heat, nutrients, and dissolved gases around the globe.

Activity 2.4 *Deep-water currents*

Pages 63–70
Elaborate

In this activity, students use ArcView to examine the global distribution of ocean temperature and salinity and its causes. Then, they use their knowledge of the conditions required for downwelling to determine where this vertical movement of water is initiated.

Activity 2.5

Pages 71–72
Evaluate

Stopping the flow

In the final activity of this unit, students are asked to discuss ramifications of a change in ocean circulation patterns on a global scale. Specifically, they must decide how climate might initiate such changes and speculate on its environmental consequences at local, regional, and global scales.

Unit 3 Ocean-Atmosphere Interactions

In this unit, students investigate how the oceans and atmosphere interact to moderate Earth's climate. This includes an exploration of how the distribution of land and ocean influences the transfer of energy in each hemisphere. They also conduct an in-depth case study of the El Niño Southern Oscillation (ENSO), comparing ocean and atmospheric conditions in the equatorial Pacific Ocean during normal, El Niño, and La Niña phases. Finally, students examine the global climatic effects of these events.

Activity 3.1 Moderating global temperature

Pages 75–78
Engage

In this activity, students are asked to generate scenarios outlining potential differences in climate in the absence of ocean circulation. This activity is designed to elicit students' prior knowledge of ocean-atmosphere interactions, promote discussion, and help them generate their own questions. In addition, students use ArcView and other media to outline how variations in ocean temperature impact the climate on the North American continent using familiar coastal cities and maps of surface currents.

Activity 3.2 A Tale of two hemispheres

Pages 79–88
Explore

In this activity, students use ArcView to examine the seasonal temperature patterns at the ocean/atmosphere interface and explore how these systems moderate Earth's climate. Students investigate how the albedo and distribution of land and water influence temperatures globally, and then locally by looking at climate conditions in coastal areas and inland regions.

Activity 3.3 Climate oscillations

Pages 89–96
Explain

This reading examines the global energy balance to further clarify interactions between the ocean and atmosphere. Students learn about the properties of the ocean and land that influence their ability to store and reflect solar energy, and about atmospheric and oceanic processes such as currents and winds that redistribute the energy. Students are also introduced to El Niño, La Niña, and other climate oscillations that produce predictable variations to normal conditions. The discussion of climate oscillations shows how slight changes in oceanic conditions can have significant local and global effects, a point that will be further explored with data in the following activity.

Activity 3.4 El Niño and La Niña

Pages 97–108
Elaborate

Students use ArcView to compare key aspects of atmospheric and oceanic circulation during normal, El Niño, and La Niña years. To better understand the origin of this oscillation, they examine wind speed, ocean temperature, sea level, and surface pressure in the equatorial Pacific. Finally, they examine global precipitation patterns to understand the effects of these oscillations on land areas.

Activity 3.5 Local interactions

Pages 109–112
Evaluate

In this activity, students use ArcView to understand the effects of El Nino and La Nina events on regional climate. Students examine temperature and precipitation anomalies across the United States and for a chosen location such as their hometown. Students conclude the investigation by visiting a NOAA web site to explore current conditions in the equatorial Pacific Ocean and determine whether or not we can anticipate an El Nino or La Nina phase in the near future, and what effect this may have on regional and local weather conditions.

Unit 4 Marine Productivity

In this unit, students compare terrestrial and marine productivity, examining how the availability of key resources dictates the amount of productivity in ocean surface waters. They also assess the biological and societal importance of primary productivity. Finally, a case study of dead zones on both a regional and global scale highlights the severe negative anthropogenic impacts that threaten nearshore waters.

Activity 4.1 Bounty from the sea

Pages 115–118
Engage

In this activity, students are introduced to the concept of primary productivity and the resources needed for photosynthesis. They examine food webs to understand the role of autotrophs and heterotrophs in biological communities. They are also asked to discuss the impact of humans on marine food webs and predict how the distribution of the resources necessary for photosynthesis shape global patterns in primary productivity.

Activity 4.2 The life-giving ocean

Pages 119–124
Explore

In this activity, students use ArcView to document global patterns in terrestrial and marine productivity. They look for geographic patterns to describe areas of high and low productivity, paying special attention to changes with distance from the coastline and seasonality. Then, they examine the distribution of nutrients and solar radiation to explain these patterns.

Activity 4.3 Resources for productivity

Pages 125–130
Explain

In this activity, a brief reading and series of questions are used to provide students with additional background information on primary productivity. Students learn more about the environmental and economical importance of phytoplankton and are introduced to chemosynthetic marine autotrophs. There is further discussion of the origin and distribution of the resources necessary for photosynthesis on land as well as in the ocean and atmosphere. Students also learn about the potential for serious problems when there is too much or too little of a particular resource, such as nutrients.

Activity 4.4 Dead zones

Pages 131–138
Elaborate

In this activity, students use ArcView to investigate the Mississippi River dead zone located in the Gulf of Mexico. Students examine how water use within the associated watershed and annual climatic conditions influence the extent of the dead zone from year to year. Students also briefly compare the Mississippi River dead zone to other dead zones off the coast of the contiguous US. Finally, they explore where dead zones occur elsewhere in the world and conduct analyses of the Gross Domestic Product for different countries to determine whether dead zones are more closely related to population or to the economic productivity of a region.

Activity 4.5 *Searching for solutions*

Pages 139–142
Evaluate

In this culminating activity, students draw upon the knowledge obtained from the entire unit to explain how excess nutrients lead to the formation of dead zones and the impact this has on each link in the food chain. Students will gain a better appreciation for how their actions influence the marine environment by using ArcView to identify the major rivers and watershed transporting runoff from their surroundings to the ocean and discussing how activities in their region may influence the formation of dead zones. Finally, students are asked to conduct research on the Internet and brainstorm solutions to the social, political, and environmental problems that produce dead zones.