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Oceans

The Ocean

The ocean is the dominant physical feature of our planet.

There is one ocean with many ocean basins, such as the North Pacific, South Pacific, North Atlantic, South Atlantic, Indian, and Arctic. The ocean covers about 70% of the Earth or about 225 million square kilometers. The ocean can be divided up into three main regions: the *shore*, the *open ocean*, which is the surface layer at the top of the ocean, and the *deep ocean*, which is the area located toward the ocean's floor in deeper waters. A fourth distinctly different, but related, region is the *estuary*. An estuary is an area where fresh water and salty ocean waters mix together. These areas may include bays, mouths of rivers, salt marshes, and lagoons.

Shore

The shore, or the *intertidal zone*, is the area of the ocean where the water meets the land. This area is exposed to the air during low tide and is covered in water during high tide. This part of the ocean receives high exposure to sunlight. This area includes only the part of the ocean floor that lies between tide markers and is alternately submerged and exposed based on the ebb and flow of the tide.

Open Ocean

The open ocean, or *pelagic zone*, is any water in the ocean that is not close to the bottom. This zone includes all of the water in the ocean from the surface almost to the bottom. The pelagic zone can be further divided into layers based on depth.

Deep Ocean
The deep ocean, or *abyssal zone*, ranges from 2,000-6,000 meters in depth. Sunlight cannot penetrate this deep in the ocean, so it is constantly in darkness. Many organisms that live in this layer are blind or have their own sources of light. The organisms that live in this layer must also be able to withstand the extremely high pressure and low temperature of these ocean depths. Since little sunlight can penetrate to the depths of the oceans, photosynthetic organisms cannot survive there. Many organisms in this layer of the ocean survive on whatever falls from above. However, other organisms, living near hydrothermal vents, submarine hot springs, and methane cold seeps survive by performing *chemosynthesis*. Chemosynthesis is the process by which organisms, such as bacteria without access to sunlight, use chemical energy to produce food.

Estuary
An estuary is an area in which fresh water and salty ocean water mix together at salt marshes, mouths of rivers, bays or lagoons. These brackish (salt mixed with fresh) water ecosystems are affected by tides. Each high tide brings a new supply of nutrients and small organisms. Marsh grasses take up these nutrients and thrive in the environment. The dense clumps of plants and their roots create shelter for marine life, birds, and other wildlife. Often, sea animals go to estuaries to breed and produce their young. The young sea animals live within the relative safety of the estuaries during the first parts of their lives, until they are strong enough to survive in the open ocean. Estuaries perform functions that help to promote the health of the environment and human populations. They help protect the environment by filtering sediment and pollutants from river and ocean water. They also produce more plant and animal life than many other types of ecosystems on Earth. Many of the animal species that are fished as human food sources spend at least part of their lives in estuaries.

The Ocean as a Reservoir

Earth's ocean is a reservoir of life forms, minerals, nutrients, and dissolved gases.

Biological Diversity
Earth's ocean is a major reservoir of life forms. About 80% of all of the life forms on Earth live in the ocean or on its floor. Coral reefs, found in shallow ocean waters, are some of the most biologically rich ecosystems in the world, containing thousands of different species of fish, coral, and sponges.

Minerals
The ocean is a major reservoir of salts and minerals. It contains a large amount of sodium chloride (3.5%), resulting in the salty nature of ocean water, which is called *salinity*. Other minerals found in the ocean include potassium, magnesium, sulfur, and calcium. Most elements found in the ocean were carried there in water after the weathering of rocks. This process, along with emissions from underwater volcanoes and hydrothermal vents, help keep the ocean's salinity levels relatively constant. However, humans extract salt from ocean water for use in cooking and manufacturing. Sea salt, as shown in the photo, is obtained from sea water by evaporating the water from holding tanks. Ocean water also contains nutrients such as phosphates and nitrates that are critical to plant growth. In a process called *upwelling*, warm surface water is blown out to sea by prevailing winds and cold, nutrient-rich water from the deep ocean rises to the surface to take its place. Many of the organisms living in areas where upwelling takes place feed off of the nutrients brought to the surface by the upwelling. The presence of these organisms provides scientists with strong proof that deep ocean water is rich in minerals and other nutrients. These nutrients are not only important to the plants and animals found within the ocean, but also to the estuaries near the ocean. Upwelling, ocean currents, tides and surface winds all play a role in distributing gases and nutrients to estuaries and different parts of the ocean.

Microorganisms
Just 100 mL of ocean water contains millions of bacteria and hundreds of thousands of phytoplankton, such as algae. Phytoplankton and many kinds of marine bacteria are photosynthetic producers. These two kinds of producers are at the base of almost every aquatic food web in the world.

Dissolved Gases
The ocean is a major reservoir of gases. The ocean absorbs gases from the atmosphere or gives off gases to the atmosphere to help the concentration of gases to stay in equilibrium. The gases dissolved in the ocean include nitrogen (N), carbon dioxide (CO_2), argon (Ar), and oxygen (O_2). The amount of gases dissolved in ocean water depends on the gas's solubility as well as the water's depth and temperature. The solubility of gases can be determined by looking at the amount and ratio of gases present in the air as compared to the amount and ratio of the same gases dissolved in the surface layer of the ocean. Oxygen and argon appear in approximately the same proportions in ocean surface water as in the air; this indicates high solubility. Contrastingly, there is about half as much nitrogen found in ocean surface water as in the air; this indicates lower solubility of nitrogen than of oxygen and of argon. The amount of dissolved gases in the ocean also changes with distance under the ocean's surface. Plants and other photosynthetic organisms live primarily near the surface of the ocean because that layer of the ocean receives more sunlight than those deeper in the ocean. As plants grow, they take in carbon dioxide and give off oxygen. Therefore, there is more oxygen near the surface of the water, because the plants living there have more sunlight to use for growth. Some of the oxygen stays in the water, and the rest enters the atmosphere. The photosynthetic organisms in the ocean produce 70% to 80% of the world's oxygen. Another property of gases is that they dissolve more easily in cold water than in warm water. Therefore, water in colder regions of the world contains larger amounts of dissolved gases. When the water warms, the ocean releases gases into the atmosphere.

Humans & the Oceans

Earth's ocean is rich in resources, such as minerals, nutrients, and dissolved gases. Many aspects of modern human life depend on resources obtained from the ocean.

The Ocean as a Resource

Earth's ocean is a valuable source of resources. The following list includes some of the ways the ocean influences human lives.

- **Transportation**: For most of human history, the oceans have been the main routes used for exploration, trade and shipping, and even warfare.
- **Air**: Half the oxygen in the entire world is produced in the ocean.
- **Minerals**: Materials that can be extracted from ocean water or mined from the bottom of the ocean include salt, potassium, magnesium, gold, tin, titanium, and diamonds. Salt from the ocean or from old ocean deposits is used in many industries, including textiles and dying, metal processing, rubber manufacturing, oil and gas drilling, paper making, animal hide processing, leather tanning, and soap making.
- **Weather and Climate**: The ocean controls weather patterns across the entire world. It is the site of much of the evaporation that begins the water cycle and provides fresh water for people and animals living on land.
- **Medicines**: The ocean, and coral reefs in particular, are sources of minerals and chemical compounds that may have utility as the active ingredients in medicines.
- **Food**: The ocean is the primary source of food for people in some nations. Some organisms that can be used for food include seaweed, algae, fish, shrimp, and crabs.

Threats to Oceans

The ocean provides natural resources that benefit humans, plants, and animals. The most obvious natural resources from the oceans are the fish and other marine life that provide food for humans and animals. There are several other marine resources that are less obvious, such as sand and gravel for building; salt for seasoning; and tidal motion, oil, and gas for energy production. Many of the ocean's resources, such as electrical energy produced from tidal motion, are renewable. However, even renewable resources such as fish can be over-harvested, or their environments can be polluted, resulting in reduced numbers. Some fish species are now very difficult to find because their numbers are so low. Populations of some types of marine animals—such as turtles, dolphins, and sharks—are also shrinking because the animals get caught in drift nets that are used for fishing. The photo shows a drift net that has accidentally caught a sea turtle. Coral reefs are also being endangered by human activity. Runoff carrying soil eroded as a result of farming and construction enters the ocean and deposits the soil onto coral reefs. This blocks sunlight that the algae living in the coral needs to survive. The ocean plays a vital role in recycling energy and matter; many earth materials and geochemical cycles originate in the ocean. In addition, ocean waters can, to some extent, absorb air and water pollutants produced by human activities. However, the capacity of the ocean to absorb these materials without being affected is limited. When this limit is reached, environmental consequences become apparent. In response to the changes that have been observed and are believed to result from human activities, efforts have been made in the United States to help protect marine animals and create National Marine Sanctuaries with laws protecting natural areas and resources.

Technology for Exploring the Ocean

Sonar

Sonar is a measuring instrument that sends out an acoustic pulse (sound) in water and measures distances in terms of the time for the echo of the pulse to return. Sonar is an acronym that stands for "sound navigation ranging." Sonar is very good for providing underwater explorers with information about the shape or makeup of underwater structures or objects. This information is usually displayed on a computer screen, where it can be interpreted. But sometimes an actual visual image is needed. This can be provided with a submarine or submersible

Submarines

Submarines are watercraft capable of navigating to specific depths beneath the surface of the water. They are used in deep oceanic explorations to not only see the ocean floor but also to see the creatures that live at these great depths. Some of these submarines are capable of holding people, but some are entirely robotic. Many of them have robotic arms that can be used for obtaining samples of sea life from the ocean depths.

LIDAR

LIDAR is a technology that is currently being used to map the bottom of the ocean. LIDAR data is collected by satellite or aircraft by sending a laser beam to the Earth and measuring the depth of the ocean. Computer programs can use this data to map the features of the ocean floor.

directly into a nearby body of water. Regulatory agencies have helped to promote healthy water by setting minimum water quality standards. Water quality standards help to prevent water pollution and to identify water quality problems and correct them. These standards dictate, according to the United States' Clean Water Act, maximum allowable toxicity levels of waste discharge. There are three types of criteria: biological criteria describe the desired aquatic community, based on the populations of organisms expected to be present in a healthy body of water; nutrient criteria protect against over-enrichment of water due to excess nutrients; sediment criteria outline conditions that will avoid detrimental amounts and types of sediments. There are many reasons to strive for improving water quality; however, there are also economic hurdles to addressing water pollution issues. The Clean Water Act tries to protect our clean water, but some individuals and groups find it cost prohibitive to treat wastewater to meet current standards. Sometimes groups or companies can be excused from adhering to water quality standard requirements if they can demonstrate that the cost of the required water treatment will result in significant negative social and economic impact. Individuals, especially those obtaining water for drinking and household use from wells, can take responsibility for maintaining safe water quality. It is recommended to have drinking water tested regularly at a certified lab. Water quality can be affected by either primary contaminants (chemicals/organisms that may cause disease or long-term health problems) or secondary contaminants (contaminants causing bad odors or tastes or other problems that do not pose a health risk).