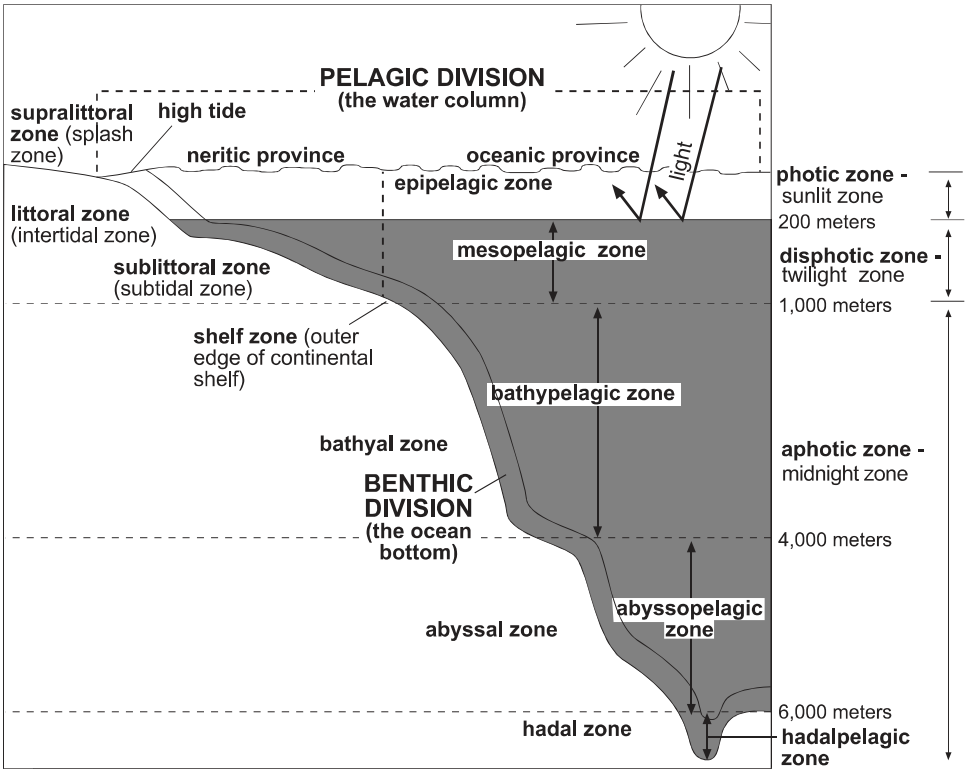
Introduction: Ocean Zones—A Range of Environments

Oceanographers and ecologists have divided up different parts of the marine world according to their location and characteristics. Because each region is a unique environment, or **habitat**, it is better suited for certain types of organisms rather than others. Each of these habitats make up an *ecosystem*: a community of organisms and the nonliving environment with which they interact.

A large-area ecosystem, or environmental unit, with similar characteristics is called a **biome**. There are two biomes in the aquatic, or water, environment. One is the *freshwater* biome of rivers, lakes, ponds, and streams. In this unit we will study the other large-area ecosystem—the *marine* biome—which includes the oceans, bays, and seas, as well as the shores at the edges of the oceans and the ocean floor itself.



marine biome

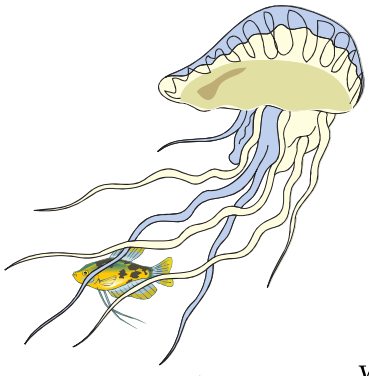
The Marine Biome

The marine biome can be divided into two major *divisions* or regions: the **pelagic**, or water environment, and the **benthic**, or bottom environment. These two divisions are separated by distinct differences in their water

and sediments. Within each division there are several zones. Each of these zones has local organisms that have adapted to its range of environmental changes. For example, organisms living in a particular zone in the pelagic division can withstand its range of temperature, light, salinity, and pressure.

Pelagic Environment: The Largest Region of the Marine World

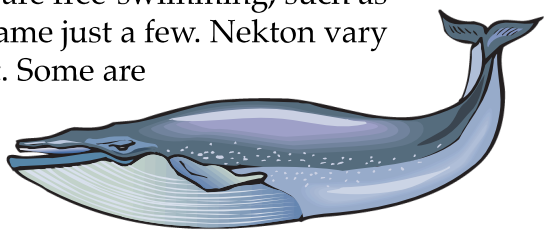
The pelagic environment begins at the shore and includes all the waters of the oceans. The effect of the pelagic environment on the Earth's land is immeasurable: It provides needed oxygen and food, and it influences both climate and weather. Its rich and varied community includes some of the largest—and the most frightening of marine animals. But its food chain is dependent on its smallest organisms, called **plankton**.



Portuguese man-of-war is a large plankton that floats or drifts with the current.

Pelagic Organisms. Pelagic (ocean) organisms are classified in two groups: those that swim (nekton) and those that do not swim (plankton). Most plankton—with the exception of the jellyfish and the Portuguese man-of-war—are very small organisms that float or drift with the currents. There are both plant and animal plankton. Plant plankton (*phytoplankton*) grow only in shallow or surface waters where there is enough sunlight for photosynthesis. Animal plankton (*zooplankton*) are also found in these waters where they can feed on the plant plankton.

The **nekton** are those organisms that are free-swimming, such as fish, squids, sharks, and whales, to name just a few. Nekton vary greatly in the way they move and eat. Some are *herbivores* (plant-eating), some are *carnivores* (meat-eating), and some eat whatever they can find. Nekton populate all the regions of the pelagic environment.



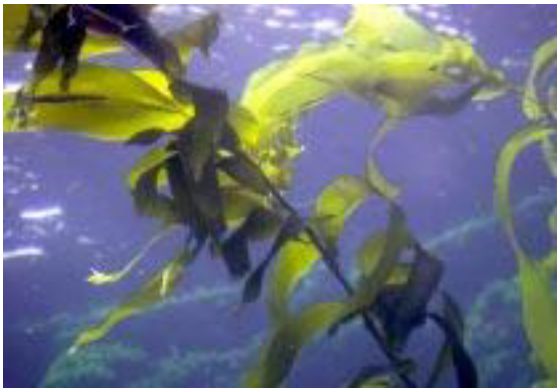
whale

Scientists have divided the pelagic environment into two major **provinces**: the neritic and oceanic. The **neritic province** includes the water and life over the continental shelf, which accounts for about 10 percent of ocean water. The rest of the waters—nearly 90 percent of the ocean's surface—are in the **oceanic province**, or the deep waters away from land.

The Neritic Province Characteristics
• the area above the continental shelf • 10% of the ocean's surface • more productive than adjacent ocean waters • 90+% of the world's commercial fishing • subject to tidal forces that help to mix the water column • higher mixing insures continual supply of nutrients from deeper waters • higher supply of nutrients and sunlight results in greater growth of phytoplankton

Neritic Province. The neritic province is greatly influenced by being near land. Rivers run off into this region's bays and estuaries. This runoff adds large amounts of fresh water, thereby reducing the salinity in areas near the river mouths. In shallow areas, however, heating by the sun may increase evaporation, thus raising the salinity. Waters in the neritic province are shallow enough to be penetrated by light. Light enables plants to carry out photosynthesis and thrive. Consequently, these sun-filled, shallow waters support large areas of plant growth that smaller organisms feed on. Here the temperature of the water changes with the seasons.

Most of the neritic province is in the **photic zone**, or *sunlit zone*. The photic zone is the lighted region of the ocean. Because this zone gets light, plants can carry out *photosynthesis* (food-making), and large numbers of phytoplankton and other marine algae can grow and reproduce. The neritic province is also the only area of the ocean where submerged plants such as seagrasses and seaweeds are found. With so many nutrients and plankton present, these waters may also appear murky or cloudy. Over 90 percent of all organisms sold commercially, such as shrimp, crabs, lobsters, oysters, and fish, are harvested, or caught, in this province.



The neritic province is also the only area of the ocean where submerged plants such as seagrasses and seaweeds are found.

Oceanic Province. The conditions in the open ocean, or oceanic province, are much more stable, or constant, than the conditions over the continental shelf. The temperature and the salinity in these waters do not

change very much. Because the water is clearer due to lack of nutrients, light penetrates farther into this region. Although the photic zone is only a small part of the oceanic province, it contains most of the ocean's life.

Oceanic Province			
zone	**depth** (in meters)	**light**	**organisms**
Epipelagic	0-200	yes—photic zone or sunlit zone	fish, sharks, plankton, jellyfish
Mesopelagic	200-1000	very little—disphotic or twilight zone	octopus, fish, squid, krill
Bathypelagic	1000-4000	none—aphotic zone or midnight zone	fanfin, anglerfish, gulper
Abyssopelagic	4000-6000	none—aphotic or midnight zone	blackdevil, anglerfish, snipe eel
Hadalpelagic	6000+	none—aphotic or midnight zone	rattail fish, isopods, worms

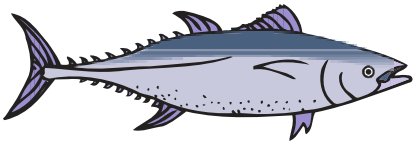
Beneath the photic zone, the water quickly becomes very cold. The temperature decreases with depth—the deeper you go, the colder the water. Beyond 300 meters deep, however, the temperature remains fairly constant—about 4°C, or just a few degrees above freezing. Pressure also increases with depth.

Animals that live in the deep ocean must adapt to low temperatures, high pressures, and very little or no light. Many animals move up to the photic zone to feed. Others live on the dead plants and animals that sink from shallower waters or prey on living animals. Some animals produce their own light and "glow in the dark" to either attract prey and mates or to help them find food.

The oceanic province can be divided into five stacked layers, or zones, based on depth. Each zone supports different types of life.

Some animals produce their own light.

The **epipelagic zone** ranges from the surface to about 200 meters (about 600 feet) deep. This area is in the *photic zone* or sunlit zone. Consequently, phytoplankton thrive and support large numbers of zooplankton

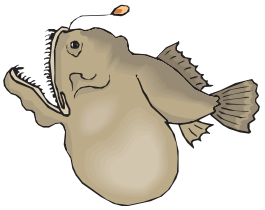


tuna

and fish higher up in the food chain, like tuna. Most fish in this region are *countershaded*—that is, darker on top than on the bottom—which helps them blend in with the lighted waters.

Below this lighted region is the **disphotic zone**, also known as the *twilight zone*. The disphotic or twilight zone corresponds with the **mesopelagic zone**. The mesopelagic zone ranges from 200 meters to 1,000 meters in depth. Life here is less plentiful and varied than in the epipelagic zone because food is scarce and difficult to locate. Most fish in this region have light spots on their bodies or are silvery in order to reflect what little light is present. Many weird-looking fish are also found here with features such as snake-like bodies, needle-sharp teeth, or huge eyes.

Below the twilight zone is the **aphotic zone** or *midnight zone*. The *aphotic zone* is an area where light does not penetrate. Ninety percent of the ocean is in this zone. In the aphotic zone there are deep-ocean regions of total darkness, cold temperatures, high pressure, and limited food. These regions include the **bathypelagic zone** (depths between 1,000 and 4,000 meters), the **abyssopelagic zone** (depths between 4,000 and 6,000 meters), and the **hadalpelagic zone** (waters in the deep-ocean trenches more than 6,000 meters).



The anglerfish attracts prey with a lure that hangs over its mouth.

In these zones, conditions remain constant throughout the year, and food is always scarce. Organisms in these zones have to take advantage of every possible meal. Deep sea fish have adapted to the harsh conditions of the deep. Some deep sea fish have huge mouths and long, sharp teeth to assist them in catching prey in their dark environment. Other deep sea fish have mouths that are pointed upward possibly to assist them in catching scraps of food that fall from the waters above.

The gulper can eat prey much larger than itself.

Some common organisms in these regions that have adapted to the harsh conditions are the anglerfish and the gulper. The anglerfish attracts its prey with a lure that hangs over its mouth, while the gulper fish has a huge mouth and elastic stomach which enables it to eat prey much larger than itself.

Benthic Environment

Regardless of the depth of the water, the benthic environment includes all of the area at the bottom of the ocean. It includes the sediments along the shore, continental shelf, and the ocean basin. It also includes all organisms living along the ocean floor. The makeup of the benthic division will vary depending on the types of sediments present. Scientists have divided the benthic environment into six regions, or locations. See the chart below.

Benthic Environment	
supralittoral	above the high-tide line; splash zone
littoral	between the tides; intertidal zone
sublittoral	below low-tide line on the continental shelf; subtidal zone
bathyal	between 200 and 4,000 meters on continental slope
abyssal	between 4,000 and 6,000 meters on abyssal plains
hadal	below 6,000 meters in deep-ocean trenches

Benthic Environment along the Shoreline. Three of the major zones or regions within the benthic environment are found along the shoreline (see Unit 8). Above the high-tide line is the **supralittoral zone**, also called the *splash zone*, a dry region that only gets wet when splashed by waves. Very few organisms can survive in this zone. Some algae, crabs, and barnacles, however, have adapted to life here.

Closer toward the ocean, there is an area continually covered and uncovered by cycles of the tide—the **littoral zone**. This area, also called the *intertidal zone*, is one of the harshest places for plants and animals to live. To survive here, organisms have to deal with exposure to saltwater and to air, the risk of drying out, and the constant pounding of the waves and tides.

Below the littoral zone lies the **sublittoral zone**. This area is also called the *subtidal zone*. It extends from the low-tide line to the edge of the continental shelf. This area is always under water and provides a stable environment for the largest number of benthic organisms.

Some organisms in the sublittoral zone have structures that help them cling to hard surfaces. These clinging structures prevent the organisms from being swept away by the waves and currents. A "boring" sponge is

an example of a sublittoral organism that has adapted to this environment. This sponge secretes an acid that allows it to drill into rocks and shells. The sponge is protected by the rock's or shell's hard outer covering. You may have found shells on the beach which are pockmarked with holes from the boring sponge.

Another animal that lives in the sublittoral zone is the sea star (starfish). Sea stars cling to rocks and other hard surfaces by means of suction cups located on their tubefeet. The pounding waves cannot dislodge the sea stars from their locations on the rocks. Barnacles also live in the sublittoral zone. (Many also live in upper zones.) These organisms have the strongest method for clinging to hard surfaces. They cement themselves with a type of glue to rocks and other hard surfaces.

Some organisms in the sublittoral zone have flattened bodies. Having a flat body minimizes the animals' exposure to wave impact. The flounder is a flat fish that buries itself in the sand to avoid wave turbulence and to hide from predators.

Plants have also adapted to live in the sublittoral zone. Kelp and rockweed are types of marine algae which anchor themselves to rocky surfaces by a tissue called a *holdfast*. A holdfast is similar to a large root.

Benthic Environment beyond the Continental Shelf. Beyond the edge of the continental shelf, the benthic environment is relatively uniform. The *bathyal zone* covers the area of the continental slope or the region between 200 meters and 4,000 meters in depth. The *abyssal zone* is the region of the ocean floor, including the abyssal plains, that is between 4,000 meters and 6,000 meters in depth. In the sediments of the trenches is the *hadal zone*—the deepest of all.

Benthic Organisms

Because plants need light for photosynthesis, they inhabit only those benthic environments in the neritic zone or along shallow coastal areas and the intertidal zones. Animals, however, inhabit all depths of the benthic environment. Crabs, worms, sea stars (starfish), and bacteria are some common ones. Benthic organisms can be classified by either their movement or their location. Organisms that attach themselves to the seafloor are called **sessile**. Some common sessile benthic animals include oysters, sponges, coral, and barnacles. Sessile organisms feed by using parts of their body to filter out food particles suspended in the water. Most

of these sessile organisms depend on waves and currents to bring them food. Organisms capable of movement are considered to be *mobile*. Mobile scavengers can freely move about in search of prey or to scavenge for a meal of remains from the ocean bottom.

Benthic organisms are also classified according to where they live in the benthic environment. They can either live on the top of the ocean floor or within the sediments. **Epifauna** are those animals that live *on* the surface of the seabed. Some examples include crabs, sea stars, sea urchins, and sea cucumbers. Most epifauna either hunt prey or scavenge for remains. Animals that live *within* the soft sediments are called **infauna**. Common infauna include worms and clams. These animals may feed on other infauna, filter their food from the water, or directly take in sediments from which they filter their food.

Sandy Beach Environment

upper beach

Thinking of a vacation at the beach brings up images of sandy white beaches. Sandy beaches are the most familiar environments along the coast and are composed of sand or loose sediment. Sandy beaches come in a variety of sand types: black lava sand, white quartz sand, or even crushed coral sand. The loose sediment along the coastline is easily shifted and transported by wind and water. Because the sandy beach area is constantly changing, this environment is a harsh place to live for marine plants and animals.

intertidal zone

The upper beach area contains beach plants consisting of trees, bushes, and grass. The roots of these plants play an important role in building beach and dune areas. The plants' roots hold onto the sand and prevent sand erosion from wind and wave action.

The environment on the beach changes as you near the water. The area of wet sand on the beach is the *intertidal zone*

or the *littoral zone*. This area of the beach is sometimes covered with water and at other times not. When the intertidal area is covered with water, it houses a variety of marine animals. When the tide goes out and the intertidal area is exposed, its marine life retreats to deeper waters or burrows in the wet sand.

surf zone

The region of crashing waves along a sandy beach is called the **surf zone**. The surf zone moves with the tide as the tides alternate between high and low. Water in the surf zone is in constant motion. This constant motion moves sand about with each passing wave. Marine life in the surf zone is constantly swept up and down the beach.

The mole crab is an example of a marine organism that has adapted to life in the turbulent surf zone. The mole crab has paddle-like appendages that it uses to dig into the sand as waves approach it. Once buried in the sand, the mole crab then sticks its feather-like appendages above the sand to filter out microscopic food from the water. The body of the mole crab is shaped like a jelly bean and has a smooth exterior. The shape of the mole crab allows it to swim with minimal resistance through the swirling surf.

The Rocky Coast

Shores that are composed of solid rock are called **rocky coasts**. The western coastline of the United States is predominately rocky. Rocks of rocky coasts provide a surface for marine organisms to attach themselves. Just as with sandy beaches, the rocky coast has definite habitat zones.

Shores composed of solid rock are called rocky coasts.

There are four zones of habitats: upper intertidal, mid-intertidal, lower intertidal, and subtidal.

The *upper intertidal zone* is also known as the *splash zone*. This area is above the high tide mark and receives moisture from the ocean spray. The damp rocks provide a perfect environment for the growth of *blue-green bacteria* or *algae*. The periwinkle snail grazes on algae in the upper intertidal zone.

The *mid-intertidal zone* is located below the upper intertidal zone. The mid-intertidal zone is characterized by barnacles, mussels, and seaweeds. Barnacles are attached to the rocks so strongly that even the most powerful wave cannot dislodge them. During high tide, barnacles are covered by water. Barnacles feed on plankton during high tide. Barnacles are filter feeders and whip their feathery appendages called *cirri* to capture food. During low tide when the tide is out, barnacles shut their shells tight to keep from drying out. Barnacles have sharp, overlapping shells that protect them from predators. The dog whelk, a marine snail, is the only predator that can penetrate the tough exterior shell of the barnacle. The dog whelk secretes an acid from its foot. This acid softens the barnacle shell and allows the whelk to drill into the barnacle.

Beneath the mid-intertidal zone is the *lower intertidal zone*. This area of the rocky coast is dominated by seaweeds. During low tide, pockets between the rocks retain water forming small pools called **tide pools**. Tide pools create habitats for a variety of organisms such as algae, small fish, and invertebrates.

The *subtidal zone* is completely underwater and has an abundance of marine life. Sea urchins feed on giant kelp. Sea stars suction themselves to rocks. Sea anemones, crabs, and lobsters hide in the rock crevices in the subtidal zone.

Summary

The marine biome contains two major divisions or regions: *pelagic* (water) and *benthic* (bottom) environments. The pelagic environment begins at the water's edge and includes two major provinces—the neritic province (the water over the continental shelf) and the oceanic province (the open-water zone). The oceanic province is divided into five stacked layers. The benthic environment is divided into six regions, according to their location in or on the sediment on the ocean floor. Organisms in each layer or region differ because they are adapted for the conditions in that specific region.

Crabs and sea star (starfish) are example of epifauna that live on the surface of the seabed.