Seventy percent of Earth's surface is covered by ocean and in some places it is deeper than the highest mountains. From the icy water of the poles to the warm tropical waters around the Equator, its vastness affects many global processes; it is home to an array of extraordinary life forms and has long fascinated humans.

Biological processes in the ocean

Virtually all life on Earth is sustained by the energy from the Sun. In the ocean, light penetrates down to around 600 feet (180 m). This is called the photic zone, where literally billions of microscopic plants (phytoplankton) convert light energy into food by photosynthesis—a process of harnessing the Sun's light energy to produce carbohydrates (sugars). Phytoplankton are consumed by tiny plant-eating animals (zooplankton) which are, in turn, preyed upon by other animals, from those not much bigger than themselves to planktivorous (plankton-eating) whales and sharks. Thus, phytoplankton is the basis of almost all the life in the ocean.

Life in the depths

When the plants and animals at the surface die, they sink, creating "marine snow." This shower of organic matter provides food to the organisms below and delivers carbon to the ocean depths. The average depth of oceanic basins is around 10,000 feet (3,000 m), and life in the deep often relies on life from above.

Deeper in the ocean, as the light diminishes, the twilight zone begins, and deeper still, at around 1,000 feet (3,000 m), where no light can penetrate, is the dark zone. Here, animals tolerate cold temperatures, high pressure, and the dark, and possess specialized physical adaptations. Many are thin, transparent, or red or black in color, which helps them to hide from predators; others have big eyes, and large mouths and teeth for hunting. Some even produce their own light, called bioluminescence—an internal chemical process—to attract prey or to find a mate.

Right: The giant kelp (*Macrocystis pyrifera*) is found along the Pacific coast of North America. It begins life on the ocean floor, but can grow up to 200 ft (60 m) long, the topmost fronds forming a canopy at the surface. This is then known as a kelp forest.

Right: Plankton range in size from microscopic organisms to jellyfish, and play a critical role in the marine food chain. Plankton is made up of plants and animals. The name comes from the Greek "planktos," which means "drifting."

Below: By studying the biological processes in the ocean, as well as the physical and chemical processes involved when air and water interact, scientists hope to come to a better understanding of global warming.

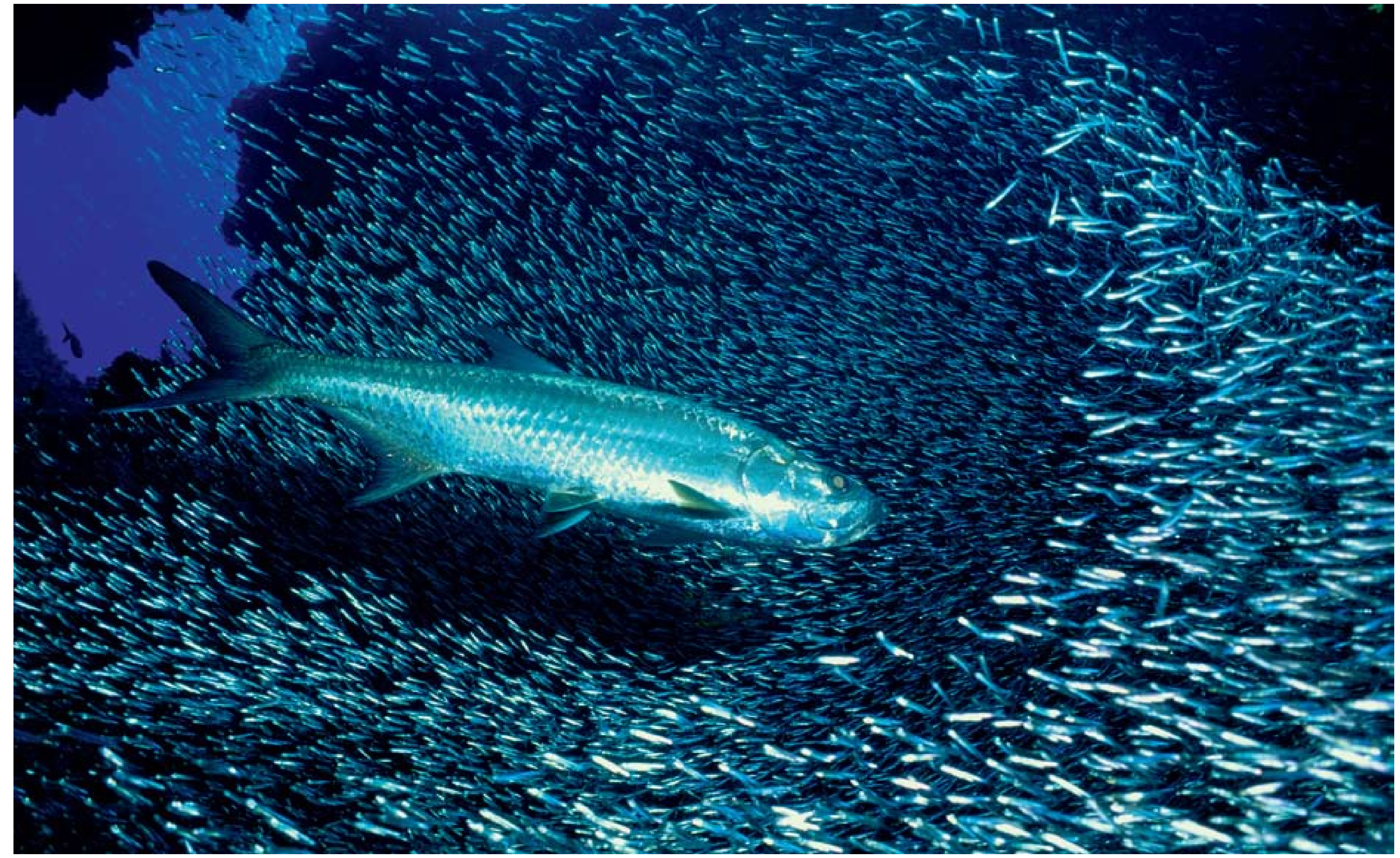
The sea, once it casts its spell, holds one in its net of wonder forever.

Jacques Cousteau, undersea explorer, 1908–1997

Ocean circulation: Currents and carbon

As well as providing a habitat for a multitude of plants and animals, the ocean is also a vital part of Earth's cycling processes, upon which all life depends. Interactions between the ocean and the atmosphere drive global ocean circulation, affecting heat transfer, productivity, and the movement of carbon, all of which influence the global weather patterns (see also pagess 412–415).

We tend to think of ocean currents as moving horizontally across the surface, but large masses of water also move vertically, sinking slowly and spreading across the ocean floor. Winds create currents, moving warm water from the Equator towards the poles, where it cools—often freezing—leaving the water dense with salt. As the water becomes heavy it gradually sinks, pushing on the water below.



Above: A tarpon (*Megalops atlanticus*) invades a school of silversides. The small fish eat zooplankton, and are eaten by larger fish such as the tarpon. Large fish are prey for seals, which in turn are prey for killer whales. This biological interaction is known as the food chain.

These deep-water masses move away from the poles until they return to the surface via a process called upwelling, usually at the Equator and along coasts where colder water replaces warm shallow water.

Upwelling is one of the most important processes to life on our planet, because it supplies nutrient-rich water to the surface in which phytoplankton flourish.

Carbon naturally cycles between the ocean, atmosphere, biosphere, and lithosphere, entering the ocean mostly as carbon dioxide gas. As phytoplankton use the carbon dioxide to photosynthesize, carbon moves from the surface to the ocean depths, hence any changes in atmospheric carbon dioxide will effect concentrations in the ocean and consequently, all life within it.

Left: There are almost 100 species of deep sea anglerfish, all living in the photic zone of the ocean. These fish rely on bioluminesence and sensitive feelers to locate their prey.

EXPLORING THE OCEAN

The ancient Greeks and Romans greatly contributed to early knowledge of the ocean, while the voyages of the Arabs, Vikings, Spanish, and English added to what is now well-known oceanographic knowledge.

Although marine scientists had collected animals from the ocean floor since the early 1800s, it was thought that no life existed in the deep ocean due to the high pressure and absence of light. In 1934 the first manned submersible, created by zoologist William Beebe, pictured below in the center, was lowered from a ship to a depth of 3,027 feet (920 m). Later development of manned and unmanned deep-sea submersibles has enabled depths of 35,000 feet (10,600 m) to be reached and the secret life of the ocean to be revealed. For example, complex biological communities have been discovered living in hot chemical-infused water around deep-sea thermal vents (see page 418).