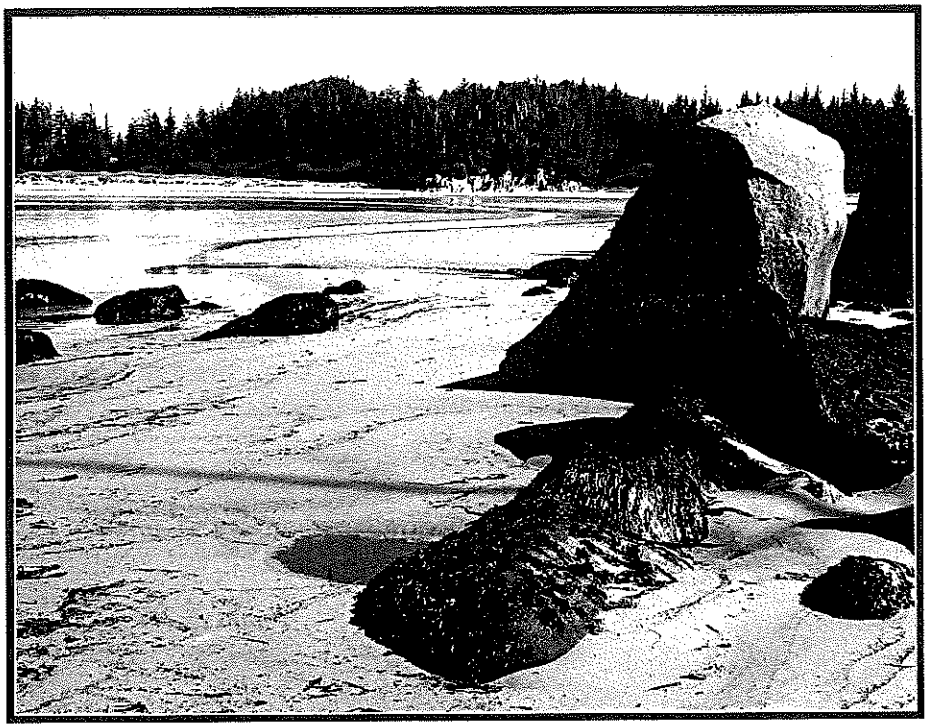
2

Oceans and Coastal Landscapes



West Beach, on the west side of Calvert Island, British Columbia, is part of the Hakai Luxvbalis Conservancy, the largest provincial Marine Protected Area on the British Columbia coast.

"If you go to any fishing village along our coastline you will see, hear, and taste the impact this rich resource has on our lives. No other force has shaped this region, culture, and people so much as the ocean."

"Oceanography in Atlantic Canada," Oceans Canada website

Oceans have historically shaped the Canadian identity and continue to do so. Oceans sustained First Peoples and brought the first European settlers to the country. Looking at a map of Canada, you quickly understand why the country's national motto is *A mari usque ad mare*—"From sea to sea." In large part, Canada is defined by oceans. It borders on three of the world's oceans and has the longest coastline in the world. Off the country's coasts, but not usually seen, are vast sub-sea valleys as deep as the CN tower is tall, plains, and mountains that make Everest seem like a hill. Thousands of wildlife species live here, including walruses, otters, orcas, and bowhead whales. Here also are habitats such as forests of thousand-year-old corals and glass sponge reeds, supporting shellfish, sea birds, and a multitude of sea plants and animals.

This topic examines the role that oceans play in shaping and sustaining the physical environment.

KEY TERMS

- current
- headland
- hydraulic pressure
- tides

Oceans in Motion

Although we usually speak of the oceans as separate bodies of water, they are actually parts of a single, interconnected, global ocean. The five recognized divisions of the global ocean include the Pacific Ocean, the largest and deepest; the Atlantic Ocean; the Indian Ocean; the Southern Ocean; and the Arctic Ocean, the smallest and shallowest.

Average ocean salinity (salt content) is 3.5 percent, or 35 parts per thousand (ppt). The degree of water salinity can affect fishes' ability to reproduce and survive. Although nearly all seawater has a salinity between 32 and 37 ppt, the amount can vary owing to a number of factors:

- the amount of precipitation an area receives;
- the rate of evaporation;
- the amount and composition of river run-off; and
- ice formation.

GEO-FACT

The Black Sea has an average salinity of only 16 ppt because of high amounts of river run-off.

The waters of the oceans are constantly in motion, circulating like rivers. This movement is most noticeable along the shoreline—where land meets sea—with the constant rolling and breaking of the waves against the shore, and the rise and fall of the tides.

Although changes in Earth's shorelines are often so slow that they are almost imperceptible in the short term, the shorelines are constantly being shaped and modified by the motion of the ocean's waters.

Currents

Throughout the world's oceans, river-like **currents** of hot or cold water travel continuously in regular movements (Figure 3.2.1). These ocean currents result from a variety of factors, including wind, planet rotation, temperature, salinity, and the gravitational effect of the Moon. Together, the currents form a global "conveyer belt" that affects the climate of regions all over the world (Figure 3.2.2). If one part of the conveyer belt experiences a change due to such factors as shifts in temperature, wind, or water density, the other parts will also be affected.

Large-scale wind or ocean currents that move in an almost closed circular pattern are called *gyres*. These giant, spinning eddies are the result of currents coming up against continental land masses and can span thousands of kilometres. Because the water in such eddies doesn't mix much with other water, gyres can trap and hold heat, organisms, and even pollutants. Gyres play a key role in pumping heat toward the poles and cooler water back toward the tropics. In this way, they moderate temperatures between the poles and the Equator.

A well-known example of such an ocean current is the Gulf Stream, which carries 4500 times as much water as the Mississippi River and affects climate all along the coasts of North America and western Europe. Figure 3.2.3 shows the Gulf Stream flowing to the northeast off the United States' eastern seaboard. The colours indicate relative water temperatures. Because the Gulf Stream is a warm current, it shows up clearly as a winding rope of orange and yellow against the surrounding cooler waters, shown in green and blue. (Black represents a lack of

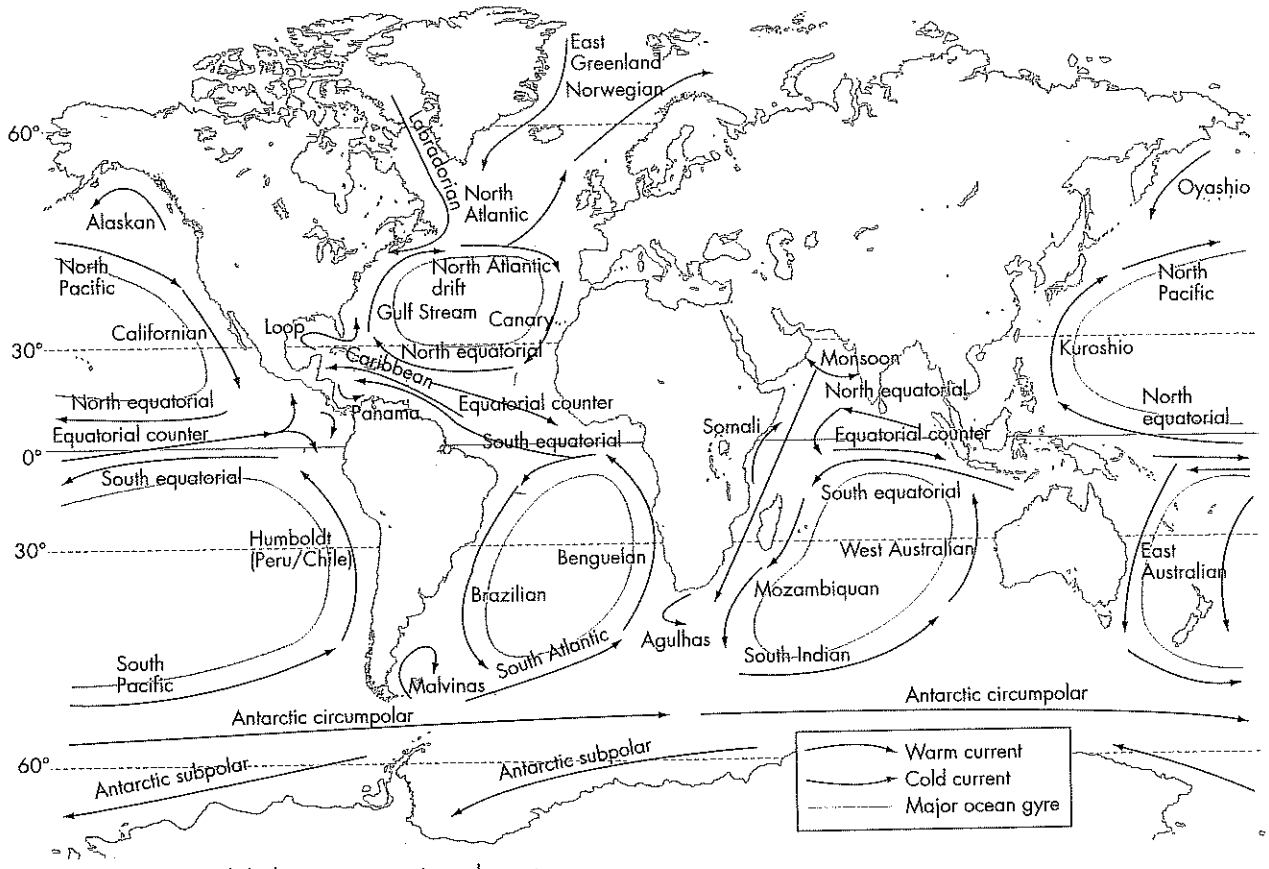


Figure 3.2.1 Global ocean currents and gyres

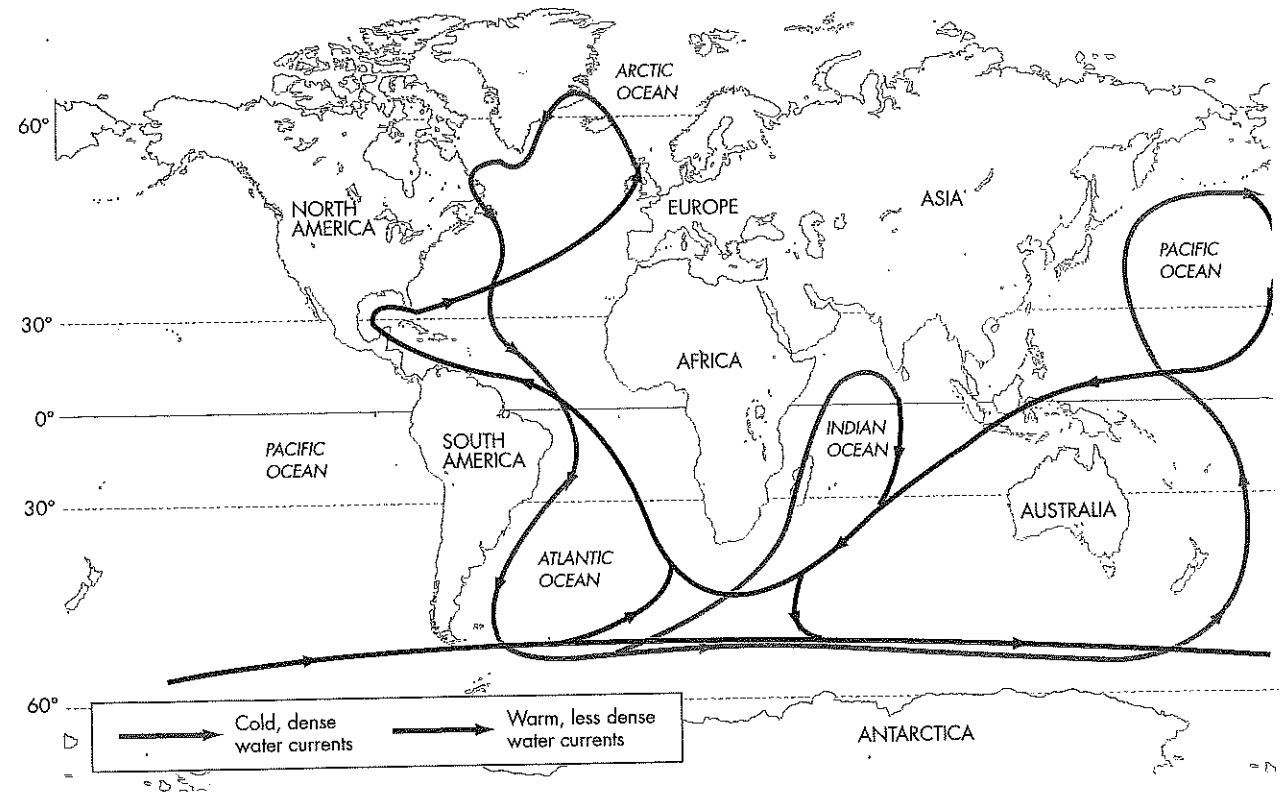
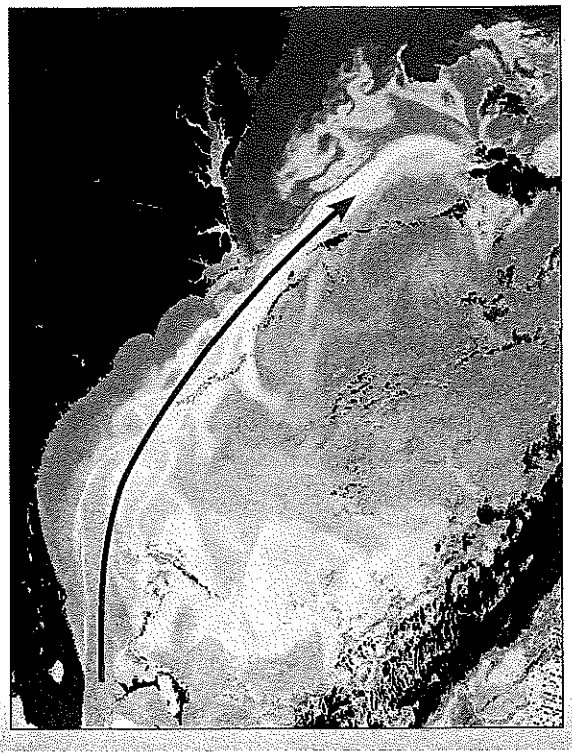


Figure 3.2.2 The global "conveyor belt"



data and is used mostly to represent land.) The warm and fast-moving Gulf Stream starts in the Gulf of Mexico and moves up the Atlantic Ocean to Newfoundland. It then splits in two, with part going toward northern Europe and part toward North Africa. As a result, northern Europe has a more temperate climate than any other area of the same latitude.

Winds can move water both horizontally and vertically in processes called upwelling and downwelling. *Upwelling* occurs when deeper water moves up toward the ocean surface, bringing with it colder temperatures. Conversely, water moving downward creates a *downwelling* current. Since surface waters tend to be more depleted of nutrients important for plant growth, regions with upwelling, where nutrients are brought up from the deeper water, are the most biologically rich.

Figure 3.2.3 The warm Gulf Stream meets the cold Labrador Current off the Grand Banks of Atlantic Canada. How might temperature changes in either current affect the ecosystems of the region?

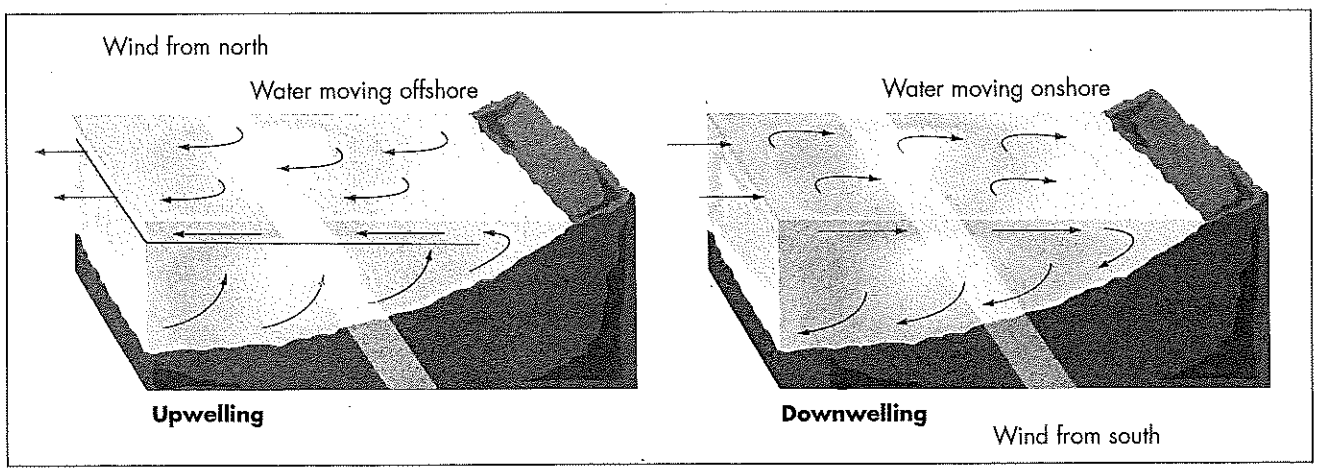


Figure 3.2.4 Upwelling and downwelling of ocean currents

An example of upwelling is the Humboldt Current (also called the Peru Current), in which temperature and density contribute to drive deep, nutrient-rich ocean currents up toward the surface. The Humboldt Current moves from the west coast of South America, all the way from the southern tip of Chile to northern Peru (Figure 3.2.5). It is considered one of most diversely productive marine ecosystems anywhere, and supports the world's largest fisheries. The current also affects the region's climate: it brings cooler water to northern Chile, and the cooler air above the current contributes to drier conditions along the coast of Peru and southern Ecuador.

In some cases, ocean currents can combine with undersea features such as seamounts to create upwelling water rich in nutrients. Seamounts—undersea mountains formed by volcanoes (see the Spotlight feature in Unit 2, Topic 3, page 115)—support a wide range of fish, bird, and other marine species. Upwelling due to ocean currents makes the area around the Bowie Seamount, located west of Haida Gwaii in the northeast Pacific off the coast of British Columbia, highly diverse biologically. As of 2008, the Bowie Seamount was designated a Marine Protected Area of Canada.

Strong tidal currents combined with reefs can also produce a species-rich area, such as the Race Rocks, just southwest of Victoria on Vancouver Island. Already identified as an Ecological Reserve by British Columbia and recommended to become a Marine Protected Area, the Race Rocks are home to nesting colonies of many varieties of sea birds, sea animals including different species of sea lions, seals, porpoises, octopi, sponges, corals, anemones, barnacles, and sea grasses, as well as orcas and grey whales.

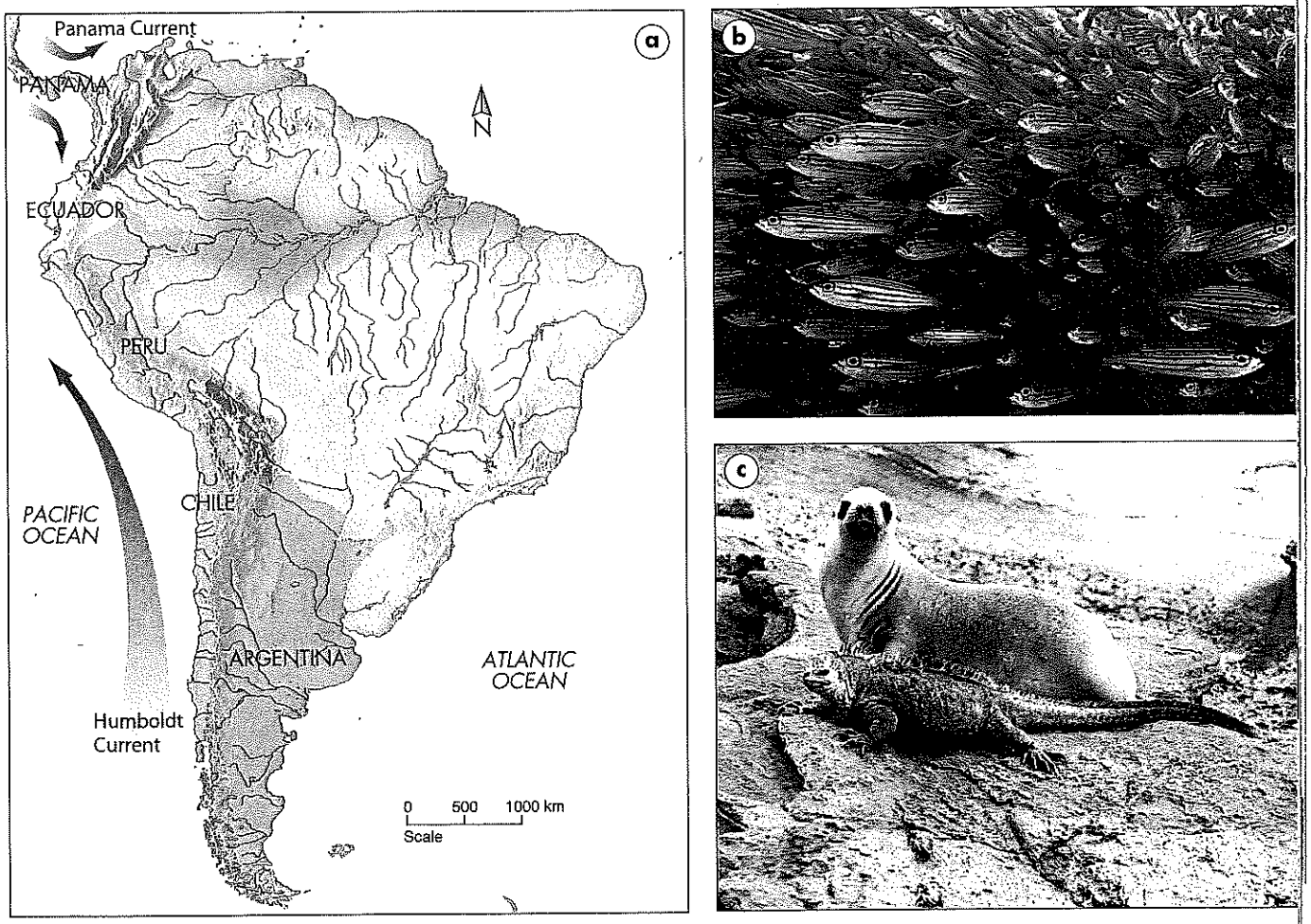


Figure 3.2.5 a) The Humboldt Current provides nutrients that support the rich diversity of marine life in the Galapagos Islands. b) A school of Black-striped Salema, Galapagos Islands. c) A sea lion and a marine iguana sunbathe together in the Galapagos.