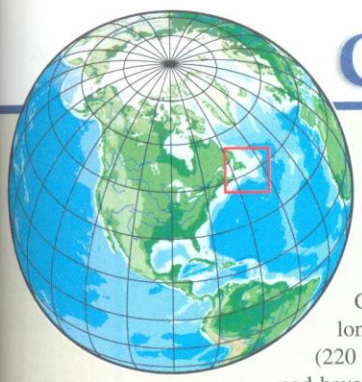

Case Study How Many Fish in the Sea?

When John Cabot discovered Newfoundland in 1497, cod (*Gadus morhua*) were so abundant that sailors could simply scoop them up in baskets. Growing up to 2 meters (6 feet) long, weighing as much as 100 kg (220 lbs) and living up to 25 years, cod have been a major food resource for Europeans for more than 500 years. Because the firm, white flesh of the cod has little fat, it can be salted and dried to produce a long-lasting food that can be stored or shipped to distant markets.

No one knows how many cod there may have once been in the ocean. Coastal people recognized centuries ago that huge schools would gather to spawn on shoals and rocky reefs from Massachusetts around the North Atlantic to the British Isles. In 1990, Canadian researchers watched on sonar as a school estimated to contain several hundred million fish spawned on the Gorges Bank off Newfoundland. Because a single mature female cod can lay up to 10 million eggs in a spawning, a school like this—only one of many in the ocean—might have produced a quadrillion eggs.

It seems that such an abundant and fecund an animal could never be threatened by humans. In 1883, Thomas Huxley, the eminent biologist and friend of Charles Darwin, said, "I believe that the cod fishery . . . and probably all the great sea fisheries are inexhaustible . . . Nothing we do seriously affects the number of fish." But in Huxley's time, most cod were caught on handlines by fishermen in small wooden dories. He couldn't have imagined the size and efficiency of modern fishing fleets. Following World War II, fishing boats grew larger, more powerful, and more numerous, while their fish-finding and harvesting technology grew tremendously more effective.

Modern trawlers now pull nets with mouths large enough to engulf a dozen jumbo jets at a time. Heavy metal doors, connected by a thick metal chain, hold the net down on the ocean floor, where it crushes bottom-dwelling organisms and reduces habitat to rubble. A single pass of the trawler not only can scoop up millions of fish, it leaves a devastated community that may take decades to repair. Some environmental groups have called for a complete ban on trawling everywhere in the world.

It's difficult to know how many fish are in the ocean. We can't see them easily, and often we don't even know where they are. Our estimates of population size often are based on the harvest brought in by fishing boats. Biologists warn that many marine species are overfished and in danger of catastrophic population crashes. Research shows that 90 percent of large predators such as tuna, marlin, swordfish, sharks, cod, and halibut are gone from the ocean.

Fish and seafood (including freshwater species) contribute more than 140 million metric tons of highly valued food every year, and are the main animal protein source for about one-quarter of the world population. Marine biologists note, however, that we're "fishing down the food chain." First we pursued the top predators and ground fish until they were commercially extinct, then we went after smaller fish, such as pilchard, capelin, pollock, and eels. When they became scarce, we turned to squid, skates, and other species once discarded as unwanted by-catch. Finally, we've begun harvesting invertebrates, such as sea cucumbers and krill, that many people regard as inedible.

In 2006, an international team of researchers predicted that all the world's major fish and seafood populations will collapse by 2048 if current trends in overfishing and habitat destruction continue. Marine biodiversity, they found, has declined dramatically, particularly since the 1950s. Three-fourths of all major marine fisheries are reported to be fully exploited, overfished, or severely depleted. About one-third of those species are already in collapse—defined as having catches decline 90 percent from the maximum catch. Nevertheless, scientists say, it's not too late to turn this situation around. Many fish stocks can recover quickly if we change destructive fishing practices.

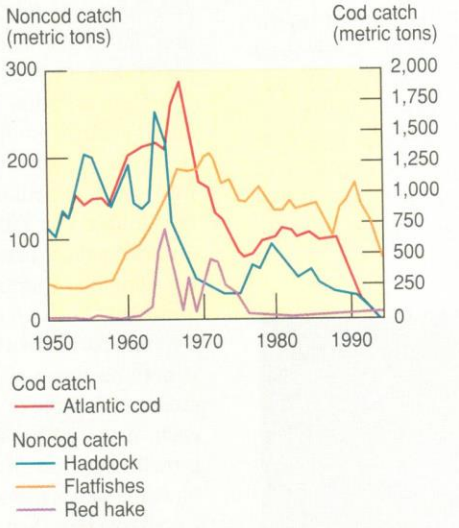

FIGURE 6.1 Commercial harvests in the Northwest Atlantic of some important ground (bottom) fish, 1950–1995.
Source: World Resources Institute, 2000.

Some governments already have heeded warnings about declining marine fisheries. In 1972, Iceland unilaterally declared a 200 nautical mile (370 km) exclusive economic zone that excluded all foreign fishing boats. In 2003 the Canadian government, in response to declining populations of prized ground fish (fig. 6.1) banned all trawling in the Gulf of St. Lawrence and in the Atlantic Ocean northeast of Newfoundland and Labrador. More than 40,000 Canadians lost their jobs, and many fishing towns were decimated. Marine scientists have called for similar bans in European portions of the North Atlantic, but governments there have been reluctant to impose draconian regulations. They've closed specific fisheries, such as anchovy harvest in the Bay of Biscay and sand eel fishing off Scotland, but they've only gradually reduced quotas for fisheries, such as cod, despite growing evidence of population declines.

Industry trade groups deny that there's a problem with marine fish populations. If restrictions were lifted, they argue, they could catch plenty of fish. It's true that some cod stocks, including the Barents Sea and the Atlantic around Iceland, are stable or even increasing. Establishing marine preserves, like the one around Apo Island in the Philippines, described in chapter 5, can quickly replenish many species if enough fish are available for breeding.

It's questionable, however, if some areas will ever recover their former productivity. It appears that overharvesting may have irreversibly disrupted marine ecosystems and food webs. On the Gorges Bank off the coast of Newfoundland, trillions of tiny tentacled organisms called hydroids now prey on both the organisms that once fed young cod as well as the juvenile cod themselves. Although hydroids have probably always been present, they once were held in check by adult fish. Now not enough fish survive to regulate hydroid populations. Is this a shift to a permanent new state, or just a temporary situation?

This case study illustrates some of the complexities and importance of population biology. How can we predict the impacts of human actions and environmental change on different kinds organisms? What are acceptable harvest limits and minimum viable population sizes? In this chapter, we'll look at some of the factors that affect population dynamics of biological organisms. For related resources, including Google Earth™ placemarks that show locations where these issues can be seen, visit http://EnvironmentalScience-Cunningham.blogspot.com.