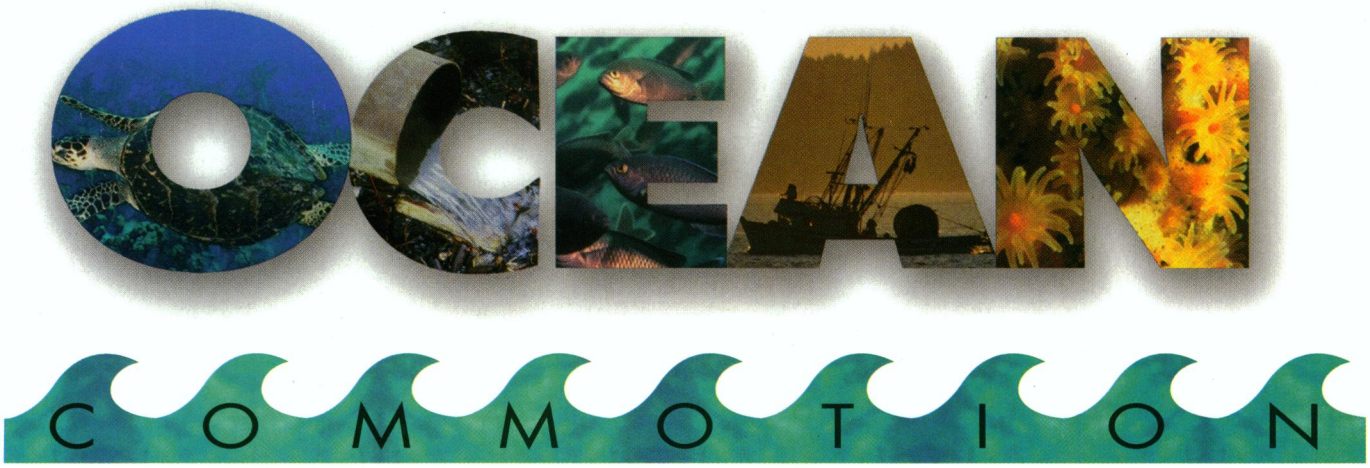


Joseph Tart

A story about the sea and its fading riches is told in various ways in coastal communities around the world. It is the story of people who ruin the natural wealth that sustained them for generations. Nowhere is this tale more tragic than in some impoverished nations of the South Pacific and eastern Caribbean, where local people have killed off their fisheries by blowing up coral reefs. "People in very poor, remote areas use dynamite to kill fish, destroying entire reefs," says William Fenical, an oceanographer at the University of California, San Diego. "In Martinique, they have become so effective in removing resources from reefs that there are no sizable fish left. People are reduced to trapping fish two inches long."

Similar exploitation of fisheries has occurred from Asia to North America, from Africa to Australia. Once-vast populations of herring, salmon, menhaden, pollock, cod, several species of tuna, flounder, weakfish, snapper, and redfish have been depleted by overfishing. Now 70% of the world's fish stocks are fully exploited, overfished, or rebuilding from past overfishing, according to the United Nations Food and Agriculture Organization (FAO).

Meanwhile, sprawling coastal cities continue to experience rapid growth, polluting and destroying marine habitats. Fourteen of the world's 15 largest metropolitan areas—with 10 million people or more—are near coastal waters. These urban settlements, along with modern agriculture, send huge amounts of pollutants into coastal waters, including sewage, persistent organic pollutants, radioactive substances, heavy metals, oils, sediments, and nutrients. Other major threats to the ocean are introductions of alien species, declining species diversity, and climate change.

These threats, moreover, are coalescing, with dangerous results for both ecosystem and human health. "We are starting to see the effects of multiple assaults on ecosystems, and synergies among these multiple assaults," says Paul Epstein of the Harvard University School of Public Health. Numerous coastal bays and sounds, pummeled by overfishing, pollution, and habitat destruction, have become breeding grounds for toxic algal blooms and water-borne disease.

Too Many Fish in the Nets

Commercial fishing was the economic and cultural lifeblood of cities such as Gloucester, Massachusetts, for centuries. Off the shores of New England, vast schools of cod, haddock, and flounder made the Georges Bank one of the world's greatest fishery regions. Fishermen worked in seas that seemed to have unlimited resources.

Commercial fishing began to change in the 1950s and 1960s, however. Advances in navigational equipment, gear, and harvesting techniques made fishing safer and far more productive. But to keep up with competitors, fishermen had to invest in expensive ships and giant trawl nets. As their costs rose, fishermen sought catch with increased aggressiveness.

NMFS/NEFSC Woods Hole Historical Photo Archive

One fish, two fish, redfish . . . . Gloucester fishermen in the 1930s take in a redfish catch.

By 1970, the peak year for Atlantic cod, fishermen caught about 3 million pounds. But by 1993, the catch had shrunk to only 1.1 million pounds, a collapse caused by overexploitation. As a result of similar collapses of haddock, flounder, and other species, the New England fishing industry lost about 20,000 jobs.

Fishing is still the mainstay of thousands of coastal communities, employing 15–20 million people worldwide. But since the early 1990s, more than 100,000 fishermen have lost jobs. In particular, small coastal towns and villages rely on fishing, but as fish populations continue to stagnate or decline, so will many local economies and cultures.

The largest single pressure on major commercial and recreational fisheries is overexploitation. The world's fish catch exploded from 22 million tons in 1950 to 89 million tons in 1989, where it has hovered ever since. Nine of the world's 17 major fisheries are in serious decline, and four others are classified as "commercially depleted" by the FAO. In short, current fishing has reached or exceeded sustainable yields in most of the important fishing grounds of the world.

As the global catch has peaked, the human population has continued to grow, with a seemingly insatiable appetite for seafood. The world's population has grown from 1.6 billion to 5.7 billion in 95 years, with 1.7 billion added in the past 20 years. That surge is driving most of the increasing demand for fish, according to Robert Engelman, director of the Population and Environment Program of Population Action International in Washington, DC. This demand is greatest in impoverished coastal and island nations that rely on fisheries to supplement diets and incomes. "Seafood is a high-quality source of food protein," says Engelman. "But as population growth has increased the demand for fish, the price has

gone up, leading to lower consumption levels, especially for the poor." To make matters worse, world population could reach between 7.9 billion and 11.9 billion by the year 2050, according to United Nations figures. A large portion of this growth will occur in coastal zones.

Fish Farming

Clearly, wild catches alone can not increase significantly enough to feed the hungry, but some say that aquaculture could be further developed to make up some of the difference. "The only way to meet increasing demand is to boost output by raising fish just as farmers produce livestock, poultry, and plants, in addition to better managing fish resources," says Ismail Serageldin, World Bank vice president for environmentally sustainable development, in a May 1995 press release.

Today, aquaculturists raise salmon, trout, catfish, scallops, giant clams, carp, tilapia, and other species. With 16 million tons produced worldwide, aquaculture already outproduces wild catches from inland waters. By the year 2010, aquaculture could provide nearly 40% of all fish for human consumption, according to the Consultative Group on International Agriculture Research.

But intensive aquaculture also requires large amounts of fresh water, which is becoming increasingly scarce. Shrimp, moreover, has become the biggest aquaculture crop because "shrimp farming is where the bucks are—it's a valuable export commodity," says Conner Bailey, a rural sociologist at Auburn University who has done field work on the impact of intensive aquaculture in Indonesia and the Phillipines. "There is nothing inherently wrong with coastal aquaculture," says Bailey. "It all depends on how you do it. Low-intensity, sustainable aquaculture has continued for hundreds of years in Indonesia. But now we are seeing a major problem with very intensive shrimp aquaculture, which harms the resources that local people depend on."

To build shrimp ponds along coastlines, some aquaculturists have cut down mangroves in several nations in Asia and Latin America, Bailey says. Since the early 1980s, 40% of total mangrove forest cover in Ecuador has been cut down for shrimp ponds. In other cases, aquaculturists have built ponds in salt flats behind mangroves. But these ponds, with shrimp densely packed (up to 75 per square meter), generate large amounts of waste that drain into canals that can flow into the ocean. In Thailand, shrimp-pond bottoms in salt flats have become so polluted with muck from decomposed food and feces, that after 2–4 years, the farmers can no longer use the sites to grow shrimp. So aquaculturists move to new sites along the coast that are also soon ruined. "This is a kind of slash-and-burn aquaculture," says Bailey.

1992 Changes in Fish Catch around the World (metric tons)

Catches by economic group, region, country or continent	1987	1988	1990	1992	Change in catch between peak year and 1992
Developed countries or areas	45,417,309	46,033,308	40,979,444	36,378,970	-21%
North America	9,624,413	9,570,723	9,529,876	8,636,666	-10%
Central and southern Europe	91,444	81,926	75,204	56,501	-38%
Former USSR	10,160,100	10,329,400	9,400,600	6,182,300	-40%
Canada	1,565,212	1,610,266	1,624,335	1,251,018	-23%
Ukraine	1,054,077	1,144,339	1,048,360	453,865	-60%

Adapted from the *ZPG Reporter*, January/February 1996. Source: UNFAO, *Yearbook of Fishery Statistics, Catches and Landings 1993* and fisheries databases (FISHSTAT-PC), FAO Fisheries Statistics Division, Rome, 1994.

A Bloated Fleet

Too many ships are chasing too few fish. Between 1970 and 1990 the world's fishing fleet doubled from 585,000 to 1.2 million commercial boats, not including millions of small fishing craft. "As a result, the excess fishing capacity has reached alarming proportions," says a 1994 FAO report entitled *World Review of Highly Migratory Species and Straddling Stocks.*

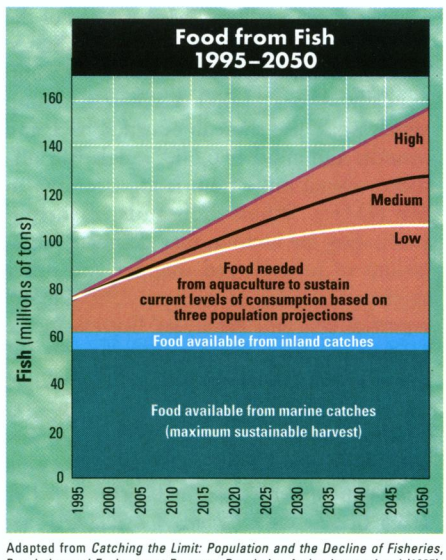
Numerous nations, including the United States, the former Soviet Union, most European countries, and Japan, have subsidized their fishing industries through low- or no-interest loans and payments. The FAO estimates that in 1993, government subsidies were $54 billion a year; and to rehabilitate fishery stocks to 1970 levels, nations would have to remove 23% of the world's fishing fleet at a cost of $73 billion.

Furthermore, fishing on the high seas—international waters outside nations' Exclusive Economic Zones (EEZs), which extend 200 nautical miles (230 miles) from coastlines—is lightly regulated. "Few states have implemented legislation governing the rights and obligations of their vessels fishing on the high seas," states the FAO. In addition, of the governing bodies that regulate fisheries, "international institutions are generally weak compared with national and local governments," states the report *Global Marine Biological Diversity: A Strategy for Building Conservation into Decision Making*, a 1993 plan sponsored by the Center for Marine Conservation, the World Bank, the UN Environment Programme, and others.

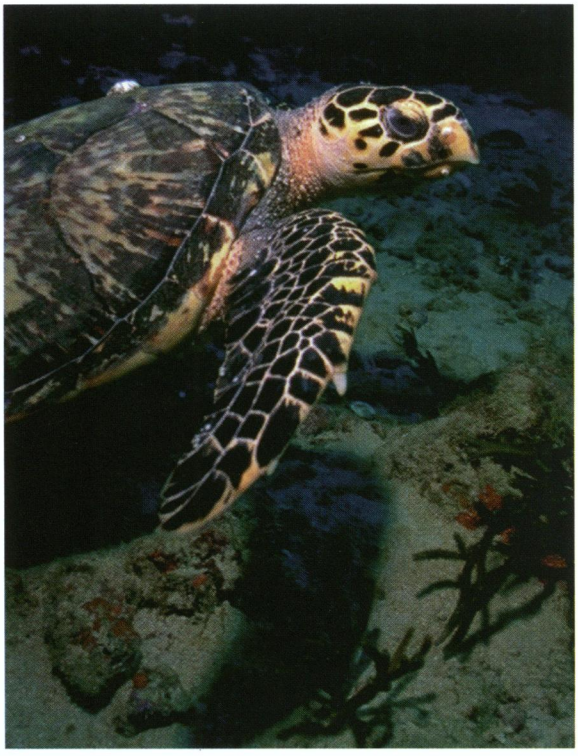
But even within nations' EEZs, catch quotas are often guided by economic interests rather than scientific recommendations. Many governments are unwilling to take measures that would drive fishermen into bankruptcy and unemployment lines. For example, to prevent overfishing by foreign trawlers in the American EEZ, the U.S. Congress passed the Magnuson Fishery Conservation and Management Act in 1975, which created eight regional management councils composed primarily of state officials and commercial and recreational fishermen. The councils recommend limits on fishing and allocate catches among competing fishermen. Then, the councils offer their recommendations to the National Marine Fisheries Service and the Secretary of Commerce, who make the final determinations on fishing regulations.

Because fisheries biology is imprecise, scientists usually give resource managers a range of fish population estimates, which are used to recommend catch quotas. Some managers take an optimistic approach, choosing the high range in the population estimate when recommending a catch quota, and as a result too many fish may be caught, says Eugene H. Buck, Congressional Research Service (CRS) senior analyst. Fishermen are "worried about paying their bills. So managers want to maximize the economic benefit of the resource, but it's a short-term view," he said.

Other fishery managers are more cautious, using the lower range of population



Adapted from *Catching the Limit: Population and the Decline of Fisheries*, Population and Environment Program, Population Action International (1995). Source: UN Food and Agriculture Organization.



Beautiful bycatch. Sea turtles and other marine creatures are too often the "waste products" of commercial fishing.

estimates. "Many times we are given a range of estimates for a fishery," says Chris Oliver, deputy director of the North Pacific Fishery Management Council, which regulates fisheries in federal waters off Alaska. "But we have chosen to err on the lower side of the estimate to protect the resource."

But sometimes politicians have intervened in the process, says Richard Gutting, Jr., vice president of government relations at the National Fisheries Institute, a lobbying and advocacy organization for the seafood industry. "Politicians have put pressure on the councils and the Secretary of Commerce, saying, 'You can't take our fishermen out of business.'"

In one instance, a regional council allowed U.S. fishermen to have virtual open access to federal fisheries. In the late 1970s, the New England groundfish fishery—including cod, haddock, and other important species—was starting to recover from overfishing by foreign trawlers, yet the New England Fishery Management Council dropped quotas and allowed the U.S. groundfish fleet to double, driving these stocks to record low levels, according to the Global Marine Biological Diversity plan. In other cases, fishing groups have pressured councils to change quota recommendations. Prior to the 1994 season, the Mid-Atlantic Fishery Management Council recommended conservative catch quotas for summer flounder. But the Fishermen's Dock Cooperative, Inc., challenged this recommendation in federal court and won. Now this case is being appealed in the fourth Circuit Court of Appeals.

"For a long time, we have understood the short-term consequences of stopping overfishing," says Charlotte de Fontaubert, marine specialist at the Center for International Environmental Law in Washington, DC. "It would mean the loss of 20–40% of the nation's fishing fleet and the destruction of coastal communities. But we haven't been willing to face the social impacts and costs of what we need to do. This is not just a problem in the United States; you see the same problem elsewhere, including Europe."

Overfishing has major impacts on the equilibrium of marine areas, scientists say. The fish species most favored by consumers are carnivores—predators such as tuna and swordfish that are comparable to a lion or an eagle in a terrestrial system. "When you take a top-level predator from an ecosystem, you harm its balance because lower predators abound and overconsume the next group down the food chain," says Fenical. "Overfishing can have an amazingly negative impact on the ocean."

Waste of marine resources is also rampant. Nearly one-fourth of fish catch is lost to spoilage or thrown overboard as "bycatch." This includes fish species that fishermen don't want or can't legally catch, plus sea turtles and marine mammals drowned unintentionally in nets.

The shrimp industry has been one of the most valuable fisheries in the United States, landing almost $500 million worth of shrimp annually. About 11,000 commercial shrimp vessels work near shore in estuaries, bays, and sounds, and another 6,500 vessels fish offshore, several miles from land, according to the NMFS. When thousands of shrimp trawls drag the bottom, they decimate populations of juvenile red snapper and other species. According to an April 1995 NMFS report to congress shrimpers' bycatch in the Gulf of Mexico kills 35 million juvenile red snapper annually, making that the principal cause of death for red snapper before age one.

Sylvia Earle is a marine biologist and former chief scientist of the National Oceanic and Atmospheric Administration. In her 1995 book, *Sea Change: A Message of the Oceans*, she asserts that commercial shrimpers waste 8–9 pounds of fish for each pound of shrimp they catch in the Gulf of Mexico. The shrimping industry, though, argues that today's shrimp trawlers are required to use Turtle Excluder Devices (TEDs), which allow endangered turtles and many species of fish to swim through the holes in the nets. The NMFS report notes that a typical trawl using a TED in the Gulf of Mexico will yield an average of 4.3 pounds of fish for each pound of shrimp.

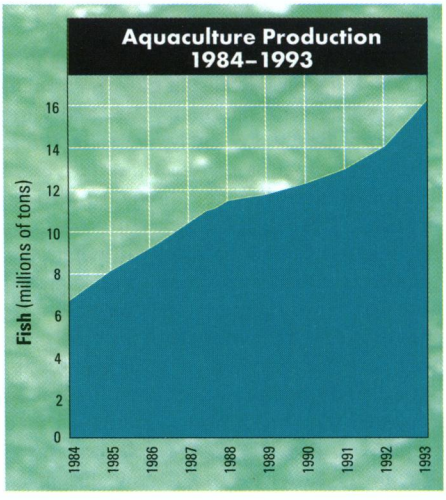
Even so, Earle writes, tons of plants and animals destroyed by shrimp trawls are not even considered important enough to be reported as bycatch, including starfish, sand dollars, crabs, sponges, coral, sea squirts, horse conchs, "and whatever else constitutes the sea-floor communities that are in the path of the nets."

Contaminants and Their Effects

Giant oil spills from tankers such as the one from the *Exxon Valdez* in Alaska get banner headlines and lead stories on the evening news. Actually, though, these spills cause relatively minor problems for fish populations and the marine environment when compared to other sources of contamination.

"The number of very large oil spills is relatively small and has gotten smaller," says Elliott Norse, a senior scientist with the Center for Marine Conservation. "Oil spills are not nearly as devastating as other pollution problems." That's because organisms start to thrive quickly after the oil is cleaned up, evaporated, or otherwise inactivated. In contrast, chronic pollution, including toxic substances and nutrients, causes more widespread, longer-lasting effects.

Although toxic chemicals kill marine organisms, the chemicals that cause the most concern, scientists say, are those that are persistent, bioaccumulated, and widely dispersed, such as polychlorinated biphenyls



Adapted from *Catching the Limit: Population and the Decline of Fisheries*, Population and Environment Program, Population Action International (1995). Source: UN Food and Agriculture Organization.

(PCBs) and dioxins, and chemicals with sublethal effects including diseases, lesions, and deformities, that can weaken fish and make them more susceptible to predators.

Fish and other marine species are often significantly smaller in polluted areas than in clean ones, says Jeffrey Levinton, ecologist at the State University of New York at Stony Brook. Toxic substances affect the nutrient levels of plant life in some polluted environments, making it difficult for fish to find enough food.

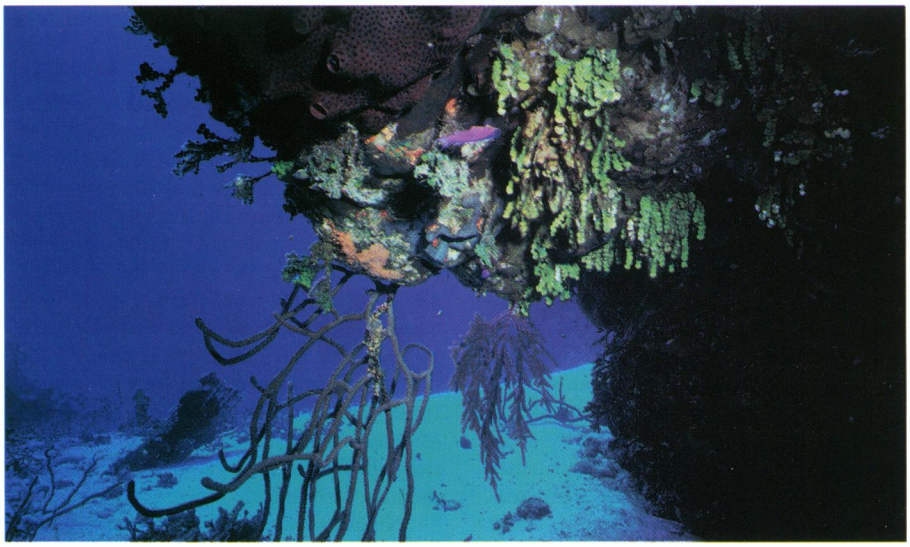
Fish, moreover, are adapting to polluted environments by evolving to reproduce earlier. "Because fish won't live as long in a heavily polluted area, they put a lot of energy into reaching maturity faster and producing young rather than in their own rate of growth," says Levinton. "But fish that invest in early reproduction also will not live as long because reproduction takes so much energy."

Fish in polluted estuaries swim through chemicals from "point" sources such as industrial and sewage-treatment pipes. But more troublesome is the array of virtually unregulated "nonpoint" sources such as farm and urban runoff and leaking septic tanks. The EPA estimates that nonpoint pollution is responsible for at least 60% of the water-quality standards violations in the United States, and that agricultural sources contribute 80% of the violations from nonpoint sources.

Scientists are faced with the daunting task of discerning how a complex mixture of pollutants can harm a fish population in a specific water body, while excluding impacts from natural variations such as changes in temperature, currents, and salinity, and other major impacts including wetland destruction and harvesting. "We know the effects of chemicals and combinations of chemicals in the laboratory," says Daniel J. Grosse, a fisheries biologist with Rifkin & Associates, a consulting company based in Baltimore. "But you have such complexity in the field."

In most cases, scientists still cannot prove that pollution is a clearly defined cause of a fish population's decline, says Grosse. In the early 1980s, for instance, striped bass populations collapsed along the U.S. Atlantic Coast. "Scientists suspected that overfishing was part of the problem, but we also believed that it could have been pollution-related," says John Boreman, a University of Massachusetts fisheries biologist. Laboratory studies show that "the contaminant cocktail" in stripedbass estuarine habitat harms development of the species' eggs and larvae. However, Boreman notes, field studies do not indicate a clear linkage between pollution and declines in striped bass population levels, "but that doesn't mean that the influence is not there; pollution may be an underlying cause of decline. You still have to rely on laboratory work to show a linkage between pollutants and their effects on eggs and larvae."

By contrast, scientists have plenty of evidence that overfishing has major impacts on fish populations. So to rebuild the striped bass stock, resource managers cut harvesting of the species along the Atlantic coast by 55% in 1984. Today striped bass is abundant, and fishing has been opened up again. But Boreman suspects that reducing fishing could be just a stopgap for striped bass. "In the long run, if pollution is the underlying cause of the decline, and if there is a trend of increasing pollution and another decline of striped bass occurs, next time the species might not recover."



UC-San Diego

Coral catastrophe. Tropical coral reefs, home to one-fourth of all marine species, are falling prey to pollution, commercialization, and climate changes.

Habitat Loss

Coastal wetlands—salt marshes and tidal flats in temperate areas, mangrove forests in tropical regions—provide food, habitat, or nurseries for 80–90% of the world's marine fish and shellfish. Many species spawn in the near-shore ocean. Their young migrate into estuaries, where the larvae feed on wetland detritus, and later, as adults, they migrate back to the coastal ocean. As a consequence, young fish and estuary-dependent species are most affected by pollution.

But damage to coastal wetlands, mangrove forests, and estuaries can also alter the base of the ocean's food web, which affects all marine species. About twice each day, ebb tides send nutrients from estuaries into the coastal ocean. These nutrients nourish plankton and other plant life that, in turn, are food for smaller fish that make up the diets of predatory marine fish sought by fishermen. Over the past 200 years, a large percentage of marshes along some temperate coastlines have been destroyed. From the 1780s to the 1980s, for instance, California lost 91% of its original wetlands, Connecticut lost 74%, Maryland lost 73%, and New York lost 60%, according to the U.S. Fish and Wildlife Service.

Fish that migrate up rivers to spawn have been especially harmed by alterations to habitat. In the Pacific Northwest, hydropower dams, logging, mining, and urban development have displaced wild salmon and steelhead fisheries. Almost half of the 214 native stocks of salmon and steelhead are at high risk of becoming extinct, according to a 1991 study by the American Fisheries Society.

Tropical coral reefs, which supply habitat for about one-fourth of all marine species, are also endangered. In the past, after periodic pounding from hurricanes, typhoons, and other big storms, reefs would simply grow back. But under assaults from toxic pollution, overharvesting, untreated sewage, coral mining, and grounding of freighters, many reefs have not rebounded.

Climate changes in particular have battered coral reefs, which are highly sensitive to relatively small changes in hot or cold. For example, El Niño, a weather phenomenon that heats water currents starting in the equatorial eastern Pacific Ocean and then spreading throughout the tropics and subtropics, spawns heavy rainfall and intense storms. When water temperatures rise and waves crash into a coral reef during an El Niño storm, algae that live in the coral apparently die off. Without this algae, the coral cannot calcify and build its own foundation, so the coral skeletal structure soon decays, and the system dies. The 1982–1983 El Niño, the strongest on record, destroyed up to 98% of the coral communities in the eastern Pacific. Later, this El Niño killed reefs in the central and eastern Pacific, the Persian Gulf, and the

tropical western Atlantic, with reef mortality reaching 70–90% in some areas.

Since the early 1990s, these delicate systems have lacked enough time to convalesce. The El Niño phenomenon reappears on average every four years and lasts 12–18 months, but the longest running El Niño on record began in 1991 and lasted until mid-1995.

Scientific Losses

In tropical rainforests that have been burned for crops or cut for timber, researchers may have lost the chance to study rare medicinal plants. Similarly, a rich field of study could be in jeopardy if marine species are lost to pollution or habitat destruction. Ironically, while polluting and overfishing have increased over the past 20 years, the ocean has also become a growing frontier for scientific research.

At laboratories and universities, researchers are examining marine organisms to learn how they react to the effects of contaminants, using fish as models for assessments of environmental health. And scientists are studying the sea's life forms to find better methods of treating disease.

Many diseases affecting human cardiovascular, neurological, and immune systems, for example, are poorly controlled by existing drugs, so there is a great need for better medicines, says Robert S. Jacobs, a pharmacologist at the University of California-Santa Barbara, who is working with a team of scientists including Fenical. The researchers hunt for new anti-inflammatory drugs in tropical coral reefs, where they collect marine sponges, mollusks, and other invertebrates, and identify their molecular structure in the laboratory. They have found, for example, that chemicals that help soft corals ward off predators also have anti-inflammatory properties.

But now researchers are finding that animals such as soft coral are dying from "all forms of abuse," says Fenical. Adds Jacobs, "We're very worried about the disappearance of species representing exotic chemicals."

Nutrient Pollution

Fifteen years ago, North Carolina's Pamlico River estuary teemed with oysters, flounder, white shad, blue crab, and shrimp, says Etles Henries, Jr., who operates Carolina Seafood near Aurora with his father. "You had people working year-round [catching and processing seafood]," Henries says. But now the mouth of the river is virtually dead for commercial and recreational fishing, with only blue crab being processed at Carolina Seafood four months a year.

As North Carolina's economy has grown, booming cities and industrial-scale agriculture have poured heavy doses of nutrients into waterways that flow to coastal sounds. About 15% of the nutrients that flow into the Pamlico River—primarily nitrogen and phosphorus—come from municipal sewage plants and industry. But the rest of the nutrients, about 85%, flow from forestry operations, urban and farm runoff, and livestock waste ponds. This nutrient overenrichment has depleted dissolved oxygen and stimulated toxic algal blooms in coastal rivers and sounds, causing massive fish kills. "If pollution kills fish by the millions, you can't catch them by the hundreds," says Henries.

Nutrient overenrichment gets relatively little public attention, but creates perhaps the greatest havoc in the marine environment. In 1990, the United Nations' Group of Experts on the Scientific Aspects of Marine Pollution identified nutrients as the most damaging class of pollutants in the marine realm.

Excess nutrients can cause dramatic changes in the ocean's food web, altering the kinds of microorganisms that predominate, says the Center for Marine Conservation's Norse. "Excess nutrients can change the marine system because you're changing the primary producers." Nutrients in human sewage for example, apparently favor the growth of toxic microorganisms in warm water, including certain species of dinoflagellates, over nontoxic algae. "Red tides," blooms of these toxic dinoflagellates, can poison shellfish and cause people who eat them to have diarrhea or even memory loss. In rare cases, people have died after eating shellfish contaminated by toxic dinoflagellates.

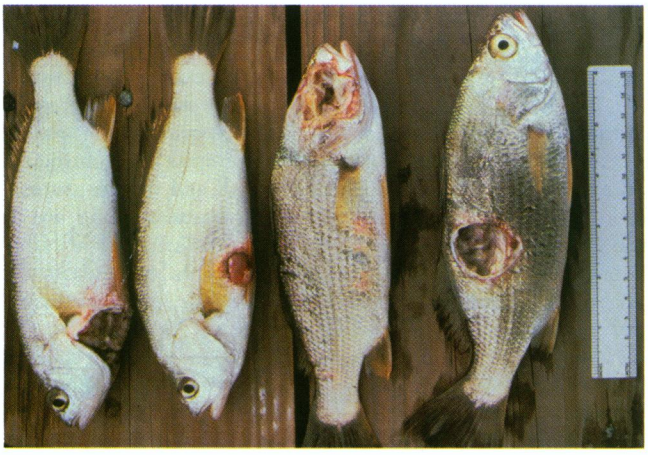
In recent years, the number and intensity of toxic algal blooms seem to be growing, scientists say. In an unusual case during the summer and early fall of 1995, fishermen saw vast numbers of dead fish, many with raw sores, floating in several North Carolina coastal rivers. These sores were caused by a toxic dinoflagellate called *Pfiesteria piscicida*. In rich coastal waters, *P. piscicida*—a single-celled ancient life form that belongs to both plant and animal kingdoms—mostly feeds on algae. But when plankton grow rapidly, the dinoflagellate is stimulated, like "cows getting stimulated by an abundance of grass to eat," says aquatic botanist JoAnn Burkholder of North Carolina State University. Her colleague Edward Noga, professor of aquatic medicine, first located this dinoflagellate in a fish tank in his laboratory in 1988.

Unlike other species of dinoflagellate that infect shellfish, this species directly kills fish. In the water column, *P. piscicida* releases a poison that paralyzes fish. The dinoflagellate then attaches to the fish's flesh and sucks it away. Next, like sharks sensing blood, large numbers of *P. piscicida* are attracted to the kill, leaving dead fish with red, weeping wounds.

Major fish kills during the summer and fall of 1995 were reported in North Carolina's New, Black, and Roanoke rivers. The majority of fish killed were menhaden, a small fish that schools in large numbers. But the toxic blooms also killed striped bass, southern flounder, eel, blue crab, and bay scallop. Adding insult to injury, along 10 miles of the Neuse River where it opens into Pamlico Sound, an outbreak of *P. piscicida* closed commercial fishing for five weeks in October and November 1995.

P. piscicida has also been found in sediments and water from the mid-Atlantic to Florida. In addition, toxic algal blooms have affected fish and shellfish in virtually every coastal state, according to a December 1995 report, *The Ecology and Oceanography of Harmful Algal Blooms*, published by the Woods Hole Oceanographic Institution. Moreover, the report says, "the U.S. is not alone in this respect, as nations throughout the world are faced with a bewildering array of toxic or harmful species and impacts."

Ordinary algal blooms are a growing problem, too, with serious consequences for human health in some regions. Over the past decade, nutrient overenrichment has combined with the El Niño phenomenon to create larger, more frequent plankton blooms worldwide, according to Rita Colwell, president of the Maryland Biotechnology Institute in College Park. In addition, overharvesting of fisheries that feed on plankton, and the destruction of wetlands that filter nitrogen and phosphorus, also contribute to algal blooms. Employing satellite images, scientists



NCSU College of Veterinary Medicine

Toxic attack. Nutrient overenrichment in coastal rivers promotes growth of toxic dinoflagellates that kill fish by feeding on their flesh.

Clean Oceans '96

World leaders on ocean issues will gather for the first annual international conference, "Clean Oceans '96," in Kauai, Hawaii to celebrate Oceans Day. The conference, sponsored by the NGO, Save Our Seas, will be held June 7–8, 1996. The theme of the conference is awareness.

Oceans Day is an international holiday that was established in 1992 at the United Nations Conference on the Environment and Development held in Rio de Janeiro, Brazil. The main objective of Oceans Day is to raise public awareness about the importance of clean oceans through educating people about managing human activities related to oceans; strengthening existing ocean networks, databases, and information exchanges; and promoting ocean law and policy development.

The conference will bring together representatives of commercial and recreational ocean users, leaders in recycling and waste disposal, and advocates of clean oceans. Attendees will work to identify sources of ocean pollution, propose solutions, and draft international agreements.

Conference programs will include guest speakers, discussion sessions, a visit to Anini Coral Reef, and an Internet session, which will connect conference attendees to speakers throughout the world. Information about the conference can be found on the Internet at http://www.aloha.net/~sos/cleanocean96.html.

have documented increases in the size and scope of plankton blooms during the 1980s and early 1990s, with vast algal blooms reported from California to Thailand, and Japan to Guatamala.

In the early 1980s, Colwell and colleagues in Bangladesh discovered that a naturally occurring El Tor *Vibrio* strain of cholera, while hibernating in algae, could reduce in size 150–300 times to tolerate cold or changes in the ocean's salinity or nutrients. But when the sea, fertilized by nutrients in sewage and stormwater runoff, was heated up by El Niño, algal blooms would grow—and so would the cholera strain. "What triggers the cholera *Vibrio* to become abundant are large blooms," says Colwell. "If you have certain climate conditions that create blooms of zooplankton, you will see increased numbers of cholera *Vibrio*."

In Peru, during the summer (January) of 1991, warm Pacific Ocean currents triggered algal blooms. The El Tor *Vibrio*, which likely had been introduced to Peruvian waters via ship ballast from Asia, infected local shellfish, which was then eaten by local people. The bacterium also entered Lima's mostly unchlorinated water system. Cholera outbreaks occurred in three coastal Peruvian cities. Soon the El Tor *Vibrio* bacterium was carried by currents and ship ballast from port to port in Latin America. In 1991, there were about 350,000 reported cases of cholera in Latin America and 3,602 deaths. But public health officials estimate that only about one in ten cases of cholera were reported, so there were likely 3–4 million cases on the continent, says Colwell.

New Measures

Although the Clean Water Act is meant to prevent the kind of pollution that damages coastal rivers and sounds, some contend that the law has a giant loophole that provides minimal regulation of stormwater runoff and other forms of nonpoint source pollution. The Clinton administration and some Democrats in Congress have signaled that the act should be rewritten to tighten rules on nonpoint source pollution.

In 1995, however, under the leadership of the new Republican majority, the 104th Congress charged in the opposite direction. In May, the House of Representatives passed a Clean Water Act revision that environmentalists contend would cut wetlands protection and provide pollution waivers to industries and municipalities. The program requiring all states and cities to begin managing stormwater runoff would still exist, but effectively without enforcement power. And any new regulations intended to improve water quality could be stalled until regulators could show that the social, economic, and health benefits are worth the dollars spent.

Other so-called regulatory reform bills introduced in the Senate and House would similarly affect all environmental laws, not just the Clean Water Act. "We want increased accountability by agencies and a check on excessive regulatory activity," says Jonathan Adler, director of environmental studies at the Competitive Enterprise Institute, a free-market think tank in Washington, DC.

Environmentalists, however, generally approve of a bill to reauthorize the Magnuson Fisheries Conservation and Management Act that passed the House of Representatives in October 1995. This rewrite would direct the eight regional councils that oversee fisheries to reduce bycatch, and would set up a revolving fund for the councils to purchase excess fishing vessels. Most important though, the bill would bar regional councils from allowing overfishing for short-term economic reasons.

On a global front, the international community has adopted a plan to reduce the leading sources of marine pollution. The Washington Action Program on Protection of the Marine Environment from Land-Based Activities was endorsed at the conclusion of an October 23–November 3 meeting under the auspices of the United Nations Environment Programme. The program will address methods of reducing a wide range of pollution, with priority on addressing persistent organic pollutants and improving treatment of waste. However, the plan is voluntary and has no method of regulatory enforcement.

By contrast, a United Nations draft treaty, entitled *Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks* addresses high seas fisheries, which exist beyond national jurisdiction. On 4 December 1995, in New York, the agreement was signed by 26 countries including the United States, and will enter into force 30 days after its ratification by 30 signatories, a process expected to take two years, according to the *Earth Negotiations Bulletin*, published by the International Institute for Sustainable Development. At the signing ceremony, Senator Ted Stevens (D-Alaska) said he will work within the U.S. Senate to obtain ratification, the bulletin reports.

Perhaps most important, the treaty says that fishery managers should protect stocks by becoming "more cautious when information is uncertain, unreliable or inadequate." That is, resource managers should take the "precautionary approach" and assume that conservative estimates of fish populations are likely more accurate than higher ones. "Rather than exploiting fish stocks at excessive levels, the precautionary approach espouses conservative catch quotas," writes Buck in a 5 January 1996 CRS report, *Agreements to Promote Fishery Conservation and Management in International Waters*. The precautionary approach "will promote the restoration of depleted stocks and ensure that they are maintained at healthy levels." But Buck adds that "this approach will demand reductions in catch quotas and could displace fishermen."

A growing worldwide population will need healthy fisheries and marine ecosystems in the next century. This treaty is a first step toward helping some depleted stocks rebound and reducing the increasing pressure on marine ecosystems. But the treaty will address only the small percentage of fisheries outside the coastal oceans. The next challenge will be for nations to aggressively protect the invaluable marine resources within their own waters.

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