

# The World's Imperiled Fish

*Wild fish cannot survive the onslaught of modern industrial fishing. The collapse of fisheries in many regions shows the danger plainly*

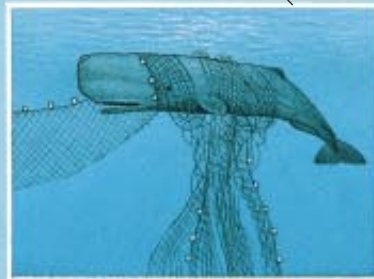
by Carl Safina

The 19th-century naturalist Jean-Baptiste de Lamarck is well known for his theory of the inheritance of acquired characteristics, but he is less remembered for his views on marine fisheries. In pondering the subject, he wrote, "Animals living in... the sea waters... are protected from the destruction of their species by man. Their multiplication is so rapid and their means of evading pursuit or traps are so great, that there is no likelihood of his being able to destroy the entire species of any of these animals." Lamarck was also wrong about evolution.

One can forgive Lamarck for his inability to imagine that humans might catch fish faster than these creatures could reproduce. But many people—including those in professions focused entirely on fisheries—have committed the same error of thinking. Their mistakes have reduced numerous fish populations to extremely low levels, destabilized marine ecosystems and impoverished many coastal communities. Ironically, the drive for short-term profits has cost billions of dollars to businesses and taxpayers, and it has threatened the food security of developing countries around the world. The fundamental folly underlying

**LONG DRIFT NETS** are banned but continue to be used, entangling countless creatures besides their intended catch.

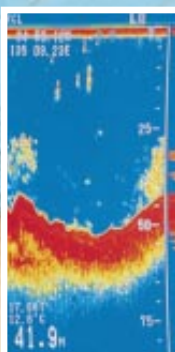
**PAIR TRAWLS** are outlawed in some places because the method collects fish too effectively.



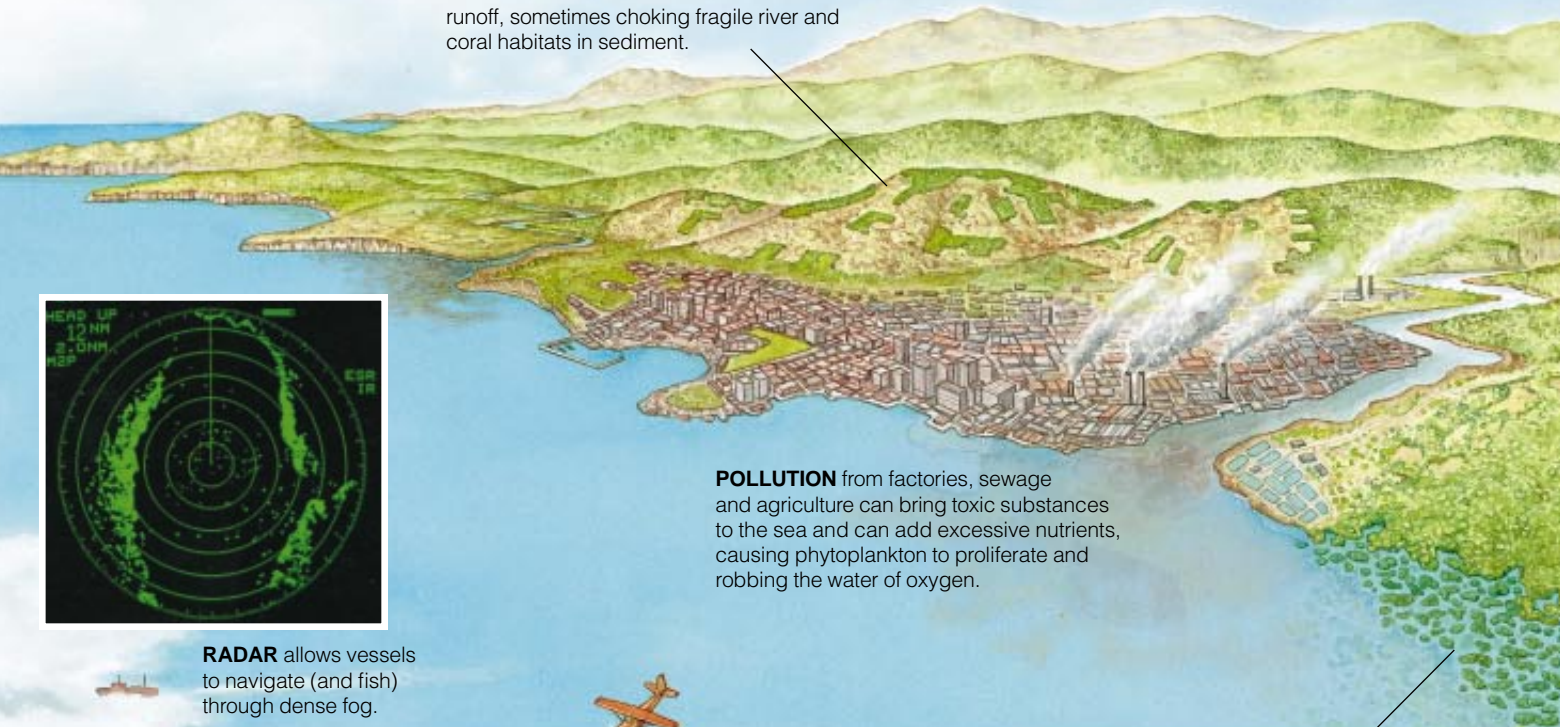
ROBERTO OSTI

**MARINE FISH** face a variety of threats brought on by excessive exploitation by modern fishing fleets and the degradation of their natural habitats.

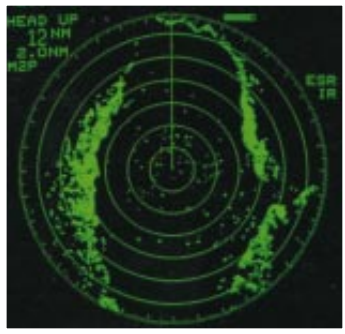
**SONAR** can detect schools of fish directly by their characteristic echoes.



**DEFORESTATION** can increase surface runoff, sometimes choking fragile river and coral habitats in sediment.



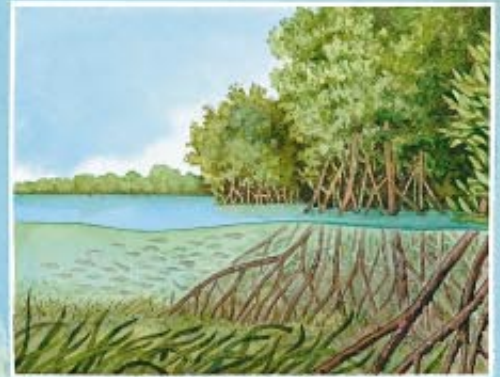
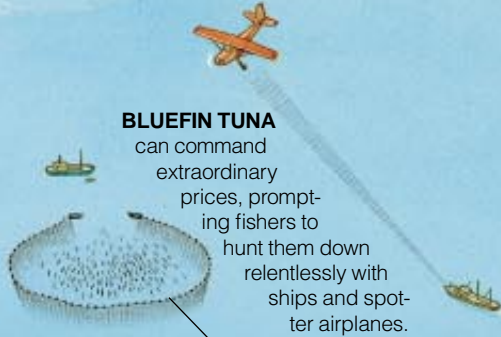
**POLLUTION** from factories, sewage and agriculture can bring toxic substances to the sea and can add excessive nutrients, causing phytoplankton to proliferate and robbing the water of oxygen.



**RADAR** allows vessels to navigate (and fish) through dense fog.



**BLUEFIN TUNA** can command extraordinary prices, prompting fishers to hunt them down relentlessly with ships and spotter airplanes.



**COASTAL MANGROVES** that could otherwise serve as nurseries for young marine fish are often cut down to accommodate aquaculture.

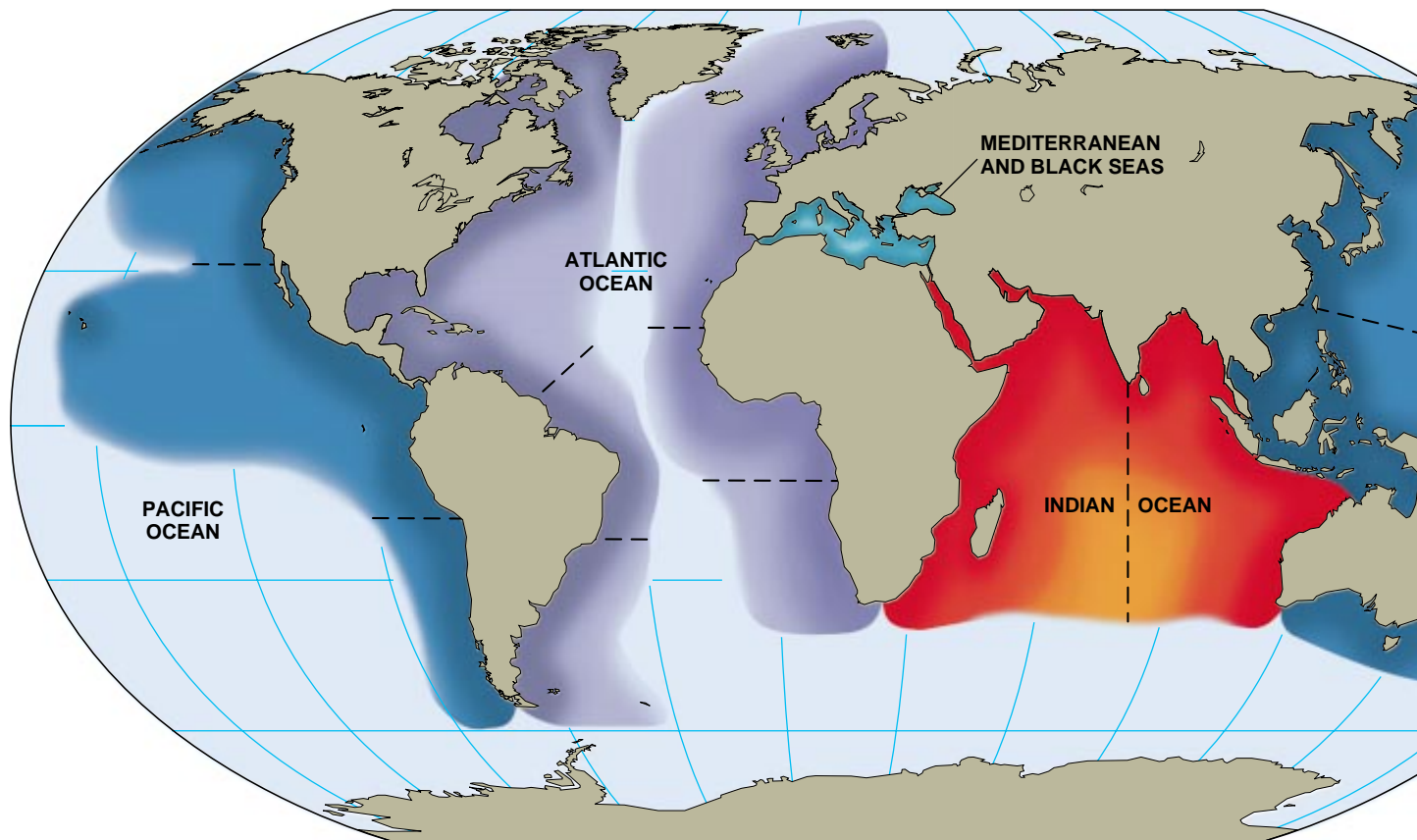
**SATELLITE POSITIONING** enables ships to maneuver precisely to spots where fish are known to congregate and breed.



**LONGLINES** stretching as far as 80 miles contain thousands of baited hooks that often take accidental victims.



## Major Fishing Regions of the World: Changes in Catch



the current decline has been a widespread failure to recognize that fish are wildlife—the only wildlife still hunted on a large scale.

Because wild fish regenerate at rates determined by nature, attempts to increase their supply to the marketplace must eventually run into limits. That threshold seems to have been passed in all parts of the Atlantic, Mediterranean and Pacific: these regions each show dwindling catches. Worldwide, the extraction of wild fish peaked at 82 million metric tons in 1989. Since then, the long-term growth trend has been replaced by stagnation or decline.

In some areas where the catches peaked as long ago as the early 1970s, current landings have decreased by more than 50 percent. Even more disturbingly, some of the world's greatest fishing grounds, including the Grand Banks and Georges Bank of eastern North America, are now essentially closed following their collapse—the formerly dominant fauna have been reduced to a tiny fraction of their previous abundance and are considered commercially extinct.

Recognizing that a basic shift has occurred, the members of the United Na-

tions's Food and Agriculture Organization (a body that encouraged the expansion of large-scale industrial fishing only a decade ago) recently concluded that the operation of the world's fisheries cannot be sustained. They now acknowledge that substantial damage has already been done to the marine environment and to the many economies that depend on this natural resource.

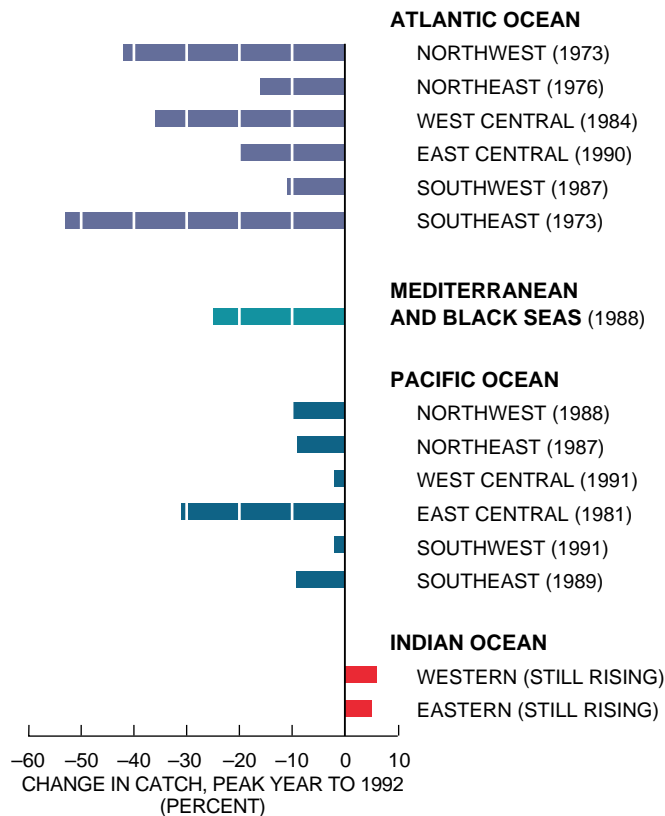
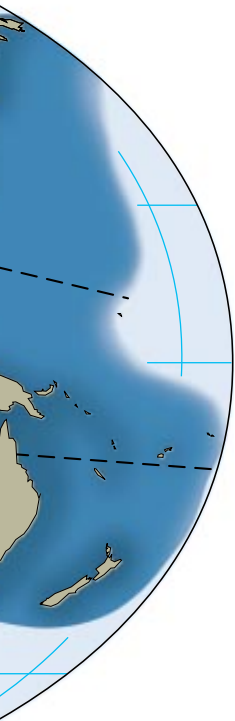
Such sobering assessments are echoed in the U.S. by the National Academy of Sciences. It reported this past April that human actions have caused drastic reductions in many of the preferred species of edible fish and that changes induced in composition and abundance of marine animals and plants are extensive enough to endanger the functioning of marine ecosystems. Although the scientists involved in that study noted that fishing constitutes just one of the many human activities that threaten the oceans, they ranked it as the most serious.

Indeed, the environmental problems facing the seas are in some ways more pressing than those on land. Daniel Pauly of the Fisheries Center at the University of British Columbia and Villy Christensen of the International Center

for Living Aquatic Resources Management in Manila have pointed out that the vast majority of shallow continental shelves have been scarred by fishing, whereas large untouched tracts of rain forest still exist. For those who work with living marine resources, the damage is not at all subtle. Vaughn C. Anthony, a scientist formerly with the National Marine Fisheries Service, has said simply: "Any dumb fool knows there's no fish around."

### A War on Fishes

**H**ow did this collapse happen? An explosion of fishing technologies occurred during the 1950s and 1960s. During that time, fishers adapted various military technologies to hunting on the high seas. Radar allowed boats to navigate in total fog, and sonar made it possible to detect schools of fish deep under the oceans' opaque blanket. Electronic navigation aids such as LORAN (Long-Range Navigation) and satellite positioning systems turned the trackless sea into a grid so that vessels could return to within 50 feet of a chosen location, such as sites where fish gathered and bred. Ships can now receive



SOURCE: Food and Agriculture Organization

**REGIONAL TAKES** of fish have fallen in most areas of the globe, having reached their peak values anywhere from four to 22 years ago. (The year of the peak catch is shown in parentheses.) Only in the Indian Ocean region, where modern mechanized fishing is just now taking hold, have marine catches been on the increase. (Red bars show average annual growth since 1988.)

provides more freshwater fish than do wild fisheries. Saltwater salmon farming also rivals the wild catch, and about half the shrimp now sold are raised in ponds. Overall, aquaculture supplies one fifth of the fish eaten by people.

Unfortunately, the development of aquaculture has not reduced the pressure on wild populations. Strangely, it may do the opposite. Shrimp farming has created a demand for otherwise worthless catch because it can be used as feed. In some countries, shrimp farmers are now investing in trawl nets with fine mesh to catch everything they can for shrimp food, a practice known as biomass fishing. Much of the catch are juveniles of valuable species, and so these fish never have the opportunity to reproduce.

Fish farms can hurt wild populations because the construction of pens along the coast often requires cutting down mangroves—the submerged roots of these salt-tolerant trees provide a natural nursery for shrimp and fish. Peter Weber of the Worldwatch Institute reports that aquaculture is one of the major reasons that half the world's mangroves have been destroyed. Aquaculture also threatens marine fish because

LAURIE GRACE

satellite weather maps of water-temperature fronts, indicating where fish will be traveling. Some vessels work in concert with aircraft used to spot fish.

Many industrial fishing vessels are floating factories deploying gear of enormous proportions: 80 miles of submerged longlines with thousands of baited hooks, bag-shaped trawl nets large enough to engulf 12 jumbo jetliners and 40-mile-long drift nets (still in use by some countries). Pressure from industrial fishing is so intense that 80 to 90 percent of the fish in some populations are removed every year.

For the past two decades, the fishing industry has had increasingly to face the result of extracting fish faster than these populations could reproduce. Fishers have countered loss of preferred fish by switching to species of lesser value, usually those positioned lower in the food web—a practice that robs larger fishes, marine mammals and seabirds of food. During the 1980s, five of the less desirable species made up nearly 30 percent of the world fish catch but

accounted for only 6 percent of its monetary value. Now there are virtually no other marine fish that can be exploited economically.

With the decline of so many species, some people have turned to raising fish to make up for the shortfall. Aquaculture has doubled its output in the past decade, increasing by about 10 million metric tons since 1985. The practice now

**ALBATROSS** are killed in tremendous numbers because they frequently grab at bait on longlines that are being set for tuna. Such losses are threatening the survival of several species of these wide-ranging seabirds.



NIGEL BROTHERS / Parks and Wildlife Service, Tasmania

some of its most valuable products, such as groupers, milkfish and eels, cannot be bred in captivity and are raised from newly hatched fish caught in the wild: the constant loss of young fry then leads these species even further into decline.

Aquaculture also proves a poor replacement for fishing because it requires substantial investment, land ownership and large amounts of clean water. Most of the people living on the crowded coasts of the world lack all these resources. Aquaculture as carried out in many undeveloped nations often produces only shrimp and expensive types of fish for export to richer countries, leaving most of the locals to struggle for their own needs with the oceans' declining resources.

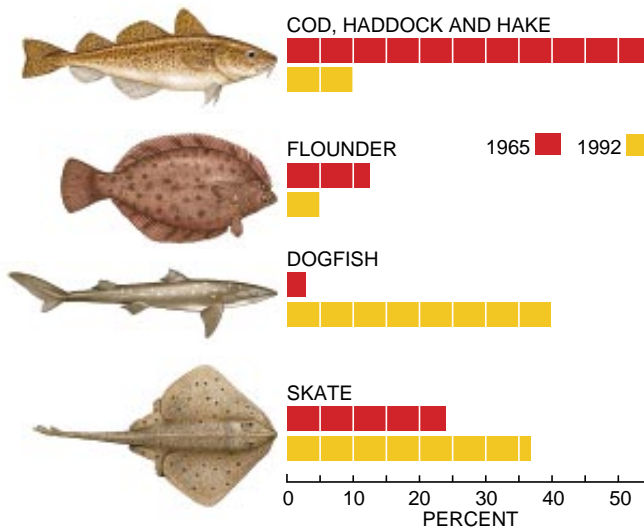
### Madhouse Economics

If the situation is so dire, why are fish so available and, in most developed nations, affordable? Seafood prices have, in fact, risen faster than those for chicken, pork or beef, and the lower cost of these foods tends to constrain the price of fish—people would turn to other meats if the expense of seafood far surpassed them.

Further price increases will also be slowed by imports, by overfishing to keep supplies high (until they crash) and by aquaculture. For instance, the construction of shrimp farms that followed the decline of many wild populations has kept prices in check.

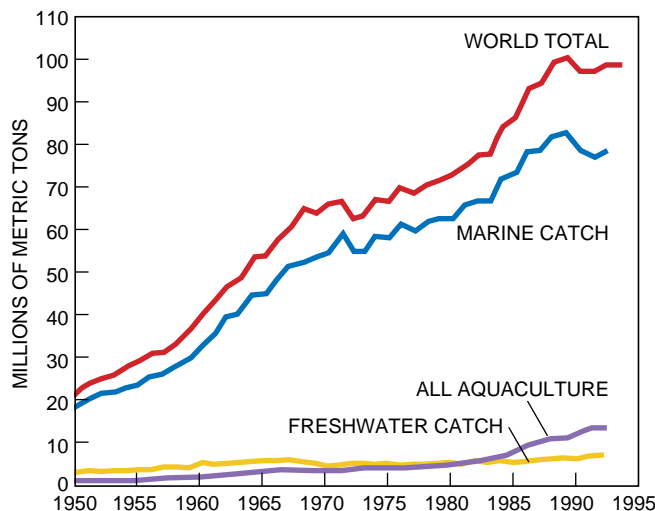
So to some extent, the economic law of supply and demand controls the cost of fish. But no law says fisheries need to be profitable. To catch \$70-billion worth of fish, the fishing industry recently incurred costs totaling \$124 billion annually. Subsidies fill much of the \$54 billion in deficits. These artificial supports include fuel-tax exemptions, price controls, low-interest loans and outright grants for gear or infrastructure. Such massive subsidies arise from the efforts of many governments to preserve employment despite the self-destruction of so many fisheries.

These incentives have for many years enticed investors to finance more fishing



SOURCE: National Marine Fisheries Service

**RELATIVE ABUNDANCE of common fishes in the Gulf of Maine has changed drastically because of overfishing. Bars indicate the level of each of these species in 1965 (red) as compared with 1992 (yellow).**



SOURCE: Worldwatch Institute

**FISH SUPPLIES from aquaculture continue to rise, but marine fisheries (which provide the greatest share of the global yield) peaked in 1989. Total world catch has since entered a period of stagnation or decline.**

ships than the seas' resources could possibly support. Between 1970 and 1990, the world's industrial fishing fleet grew at twice the rate of the global catch, fully doubling in the total tonnage of vessels and in number. This armada finally achieved twice the capacity needed to extract what the oceans could sustainably produce. Economists and managers refer to this situation as overcapitalization. Curiously, fishers would have been able to catch as much with no new vessels at all. One study in the U.S. found that the annual profits of the yellowtail flounder fishery could increase from zero to \$6 million by removing more than 100 boats.

Because this excessive capacity rapidly depletes the amount of fish available, profitability often plummets, reducing the value of ships on the market. Unable to sell their chief asset without major financial loss, owners of these vessels are forced to keep fishing to repay their loans and are caught in an economic trap. They often exercise substantial political pressure so that government regulators will not reduce allowable takes. This common pattern has become widely recognized. Even the U.N. now acknowledges that by enticing too many participants, high levels of subsidy ultimately generate severe economic and environmental hardship.

### A World Growing Hungrier

While the catch of wild marine fish declines, the number of people in the world increases every year by about 100 million, an amount equal to the current population of Mexico. Maintaining the present rate of consumption in the face of such growth will require that by 2010 approximately 19 million additional metric tons of seafood become available every year. To achieve this level, aquaculture would have to double in the next 15 years, and wild fish populations would have to be restored to allow higher sustainable catches.

Technical innovations may also help produce human food from species currently used to feed livestock. But even if all the fish that now go to these animals—a third of the world catch—were eaten by people, today's average consumption could hold for only about 20 years. Beyond that time, even improved conservation of wild fish would not be able to keep pace with human population growth. The next century will therefore witness the heretofore unthinkable exhaustion of the oceans' natural ability to satisfy humanity's demand for food from the seas.

To manage this limited resource in the best way possible will clearly require a solid understanding of marine biology and ecology. But substantial difficulties will undoubtedly arise in fashioning scientific information into intelligent

policies and in translating these regulations into practice. Managers of fisheries as well as policymakers have for the most part ignored the numerous national and international stock assessments done in past years.

Where regulators have set limits, some fishers have not adhered to them. From 1986 to 1992, distant water fleets fishing on the international part of the Grand Banks off the coast of Canada removed 16 times the quotas for cod, flounder and redfish set by the Northwest Atlantic Fisheries Organization. When Canadian officials seized a Spanish fishing boat near the Grand Banks early this year, they found two sets of logbooks—one recording true operations and one faked for the authorities. They also discovered nets with illegally small mesh and 350 metric tons of juvenile Greenland halibut. None of the fish on board were mature enough to have reproduced. Such selfish disregard for regulations helped to destroy the Grand Banks fishery.

Although the U.N. reports that about 70 percent of the world's edible fish, crustaceans and mollusks are in urgent need of managed conservation, no country can be viewed as generally successful in fisheries management. International cooperation has been even harder to come by. If a country objects to the restrictions of a particular agreement, it just ignores them.

In 1991, for instance, several countries arranged to reduce their catches of swordfish from the Atlantic; Spain and the U.S. complied with the limitations (set at 15 percent less than 1988 levels), but Japan's catch rose 70 percent, Portugal's landings increased by 120 percent and Canada's take nearly tripled. Norway has decided unilaterally to resume hunting minke whales despite an international moratorium. Japan's hunting of minke whales, ostensibly for scientific purposes, supplies meat that is sold for food and maintains a market that supports illegal whaling worldwide.

### Innocent Bystanders

In virtually every kind of fishery, people inadvertently capture forms of marine life that, collectively, are known as "bycatch" or "bykill." In the world's commercial fisheries, one of every four animals taken from the sea is unwanted. Fishers simply discard the remains

**WHALE MEAT** sold in Japan includes many different species from all over the world, although the legal catch (taken nominally for scientific purposes) is limited to minke whales.

## No Place Like Home

Although much of my work has been focused on overfishing, I have also come to see that marine habitats are being destroyed or degraded in numerous ways. In many temperate regions the larger, bottom-dwelling animals and plants—which feed and shelter fish—have been heavily damaged by trawling, a form of fishing that rakes nets over the shallow continental shelves. In the tropical Indo-Pacific, many people catch fish by stunning them with cyanide—a poison that kills the coral that makes up the fishes' habitat. Some fishers herd their prey into nets by pounding the corals with stones; a boat fishing in this way can destroy up to a square kilometer of living reef every day.

Marine habitats also suffer assaults from aquaculture, agriculture and clear-cutting for logging. In the Pacific Northwest of the U.S. and Canada, intensive deforestation, hydroelectric dams and water diversion have destroyed thousands of miles of salmon habitat. Most species of sturgeon are also becoming endangered in this way throughout the Northern Hemisphere. Profuse sedimentation following deforestation degrades habitats in many parts of the tropics as well. Sediments can kill coral reefs by clogging them, blocking sunlight and preventing settlement of larvae.

In 1989 the tropical marine ecologist Robert Johannes helped to select the tiny Pacific island country of Palau as one of the world's seven undersea wonders—akin to the seven wonders of the ancient world—because of its spectacular and largely unspoiled coral reefs. When I visited him in Palau early this year, I frequently witnessed long plumes of red sediment bleeding off new, poorly made roads into coral lagoons after every heavy rain. Runoff from intact jungle was, in contrast, as clear as the rain itself. Untreated sewage was also flowing into reefs near the capital's harbor. Such nutrient-rich pollution allows algae to grow at unnatural rates, killing corals by altering their delicate balance with internal symbiotic algae.

—C.S.

of these numerous creatures overboard. Bycatch involves a variety of marine life, such as species without commercial value and young fish too small to sell. In 1990 high-seas drift nets tangled 42 million animals that were not targeted, including diving seabirds and marine mammals. Such massive losses prompt-

ed the U.N. to enact a global ban on large-scale drift nets (those longer than 2.5 kilometers)—although Italy, France and Ireland, among other countries, continue to deploy them.

In some coastal areas, fishing nets set near the sea bottom routinely ensnare small dolphins. Losses to fisheries of



KAKU KURITA Gamma Liaison

## Economies of Scales

Fishing adds only about 1 percent to the global economy, but on a regional basis it can contribute enormously to human survival. Marine fisheries contribute more to the world's supply of protein than beef, poultry or any other animal source.

Fishing typically does not require land ownership, and because it remains, in general, open to all, it is often the employer of last resort in the developing world—an occupation when there are no other options. Worldwide, about 200 million people depend on fishing for their livelihoods. Within Southeast Asia alone, more than five million people fish full-time. In northern Chile 40 percent of the population lives off the ocean. In Newfoundland most employment came from fishing or servicing that industry—until the collapse of the cod fisheries in the early 1990s left tens of thousands of people out of work.

Although debates over the conservation of natural resources are often cast as a conflict between jobs and the environment, the restoration of fish populations would in fact boost employment. Michael P. Sissenwine and Andrew A. Rosenberg of the U.S. National Marine Fisheries Service have estimated that if depleted species were allowed to rebuild to their long-term potential, their sustainable use would add about \$8 billion to the U.S. gross domestic product—and provide some 300,000 jobs. If fish populations were restored and properly managed, about 20 million metric tons could be added to the world's annual catch. But reinstatement of ecological balance, fiscal profitability and economic security will require a sub-



DAVID W. HARP

several marine mammals—the baiji of eastern Asia, the Mexican vaquita (the smallest type of dolphin), Hector's dolphins in the New Zealand region and the Mediterranean monk seal—put those species' survival at risk. Seabirds are also killed when they try to eat the bait attached to fishing lines as these are played out from ships. Rosemary Gales, a research scientist at the Parks and Wildlife Service in Hobart, Tasmania, estimates that in the Southern Hemisphere more than 40,000 albatross are hooked and drowned every year after grabbing at squid used as bait on longlines being set for bluefin tuna. This level of mortality endangers six of the 14 species of these majestic wandering seabirds.

In some fisheries, bykill exceeds target catch. In 1992 in the Bering Sea, fishers discarded 16 million red king crabs, keeping only about three million. Trawling for shrimp produces more bykill than any other type of fishing and accounts for more than a third of the global total. Discarded creatures outnumber shrimp taken by anywhere from 125 to 830 percent. In the Gulf of Mexico shrimp fishery 12 mil-

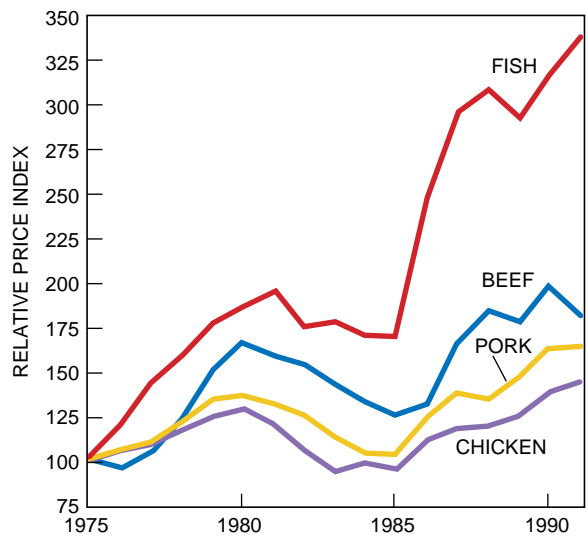
lion juvenile snappers and 2,800 metric tons of sharks are discarded annually. Worldwide, fishers dispose of about six million sharks every year—half of those caught. And these statistics probably underestimate the magnitude of the waste: much bycatch goes unreported.

There remain, however, some glim-

mers of hope. The bykill of sea turtles in shrimp trawls had been a constant plague on these creatures in U.S. waters (the National Research Council estimated that up to 55,000 adult turtles died this way every year). But these deaths are being reduced by recently mandated "excluder devices" that shunt the animals out a trap door in the nets.

Perhaps the best-publicized example of bycatch involved up to 400,000 dolphins killed annually by fishers netting Pacific yellowfin tuna. Over three decades since the tuna industry began using huge nets, the eastern spinner dolphin population fell 80 percent, and the numbers of offshore spotted dolphin plummeted by more than 50 percent. These declines led to the use of so-called dolphin-safe methods (begun in 1990) whereby fishers shifted from netting around dolphin schools to netting around logs and other floating objects.

This approach has been highly successful: dolphin kills went down to 4,000 in 1993. Unfortunately, dolphin-safe netting methods are not safe for immature tuna, billfish, turtle or shark.



SOURCE: Food and Agriculture Organization

**EXPORT PRICES for fish have exceeded those for beef, chicken and pork by a substantial margin over the past two decades. To facilitate comparison, the price of each meat is scaled to 100 for 1975.**



DAVID W. HARP

stantial reduction in the capacity of the commercial fishing industry so that wild populations can recover.

The necessary reductions in fishing power need not come at the expense of jobs. Governments could increase employment and reduce the pressure on fish populations by directing subsidies away from highly mechanized ships. For each \$1 million of investment, industrial-scale fishing operations require only one to five people, whereas small-scale fisheries would employ between 60 and 3,000. Industrial fishing itself threatens tens of millions of fishers working on a small scale by depleting the fish on which they depend for subsistence.

For some fisheries, regulators have purposefully promoted inefficiency as a way to limit excessive catches and maintain the living resource. For example, in the Chesapeake Bay, law requires oyster-dredging boats to be powered by sail (*left*), a restriction on technology that has helped this fishery survive. In New England, regulators outlawed the use of nets pulled between two boats ("pair trawls") because this technique was too effective at catching cod. Managers of the U.S. bluefin-tuna fishery allocate 52 percent of the catch to commercial boats that deploy the least capable gear—handlines or rod and reel—even though the entire allowed amount could easily be extracted with purse-seine nets. In this instance, vessels with the more labor-intensive tackle account for nearly 80 percent of direct employment; those that have large nets provide only 2 percent. Numerous other regulations on sizes and total amount of the catch, as well as allocation and allowable equipment, can be viewed as acknowledgments of the need to curb efficiency in order to achieve wider social and ecological benefits.

—C.S.

On average, for every 1,000 nets set around dolphin herds, fishers inadvertently capture 500 dolphins, 52 billfish, 10 sea turtles and no sharks. In contrast, typical bycatch from the same number of sets around floating objects includes only two dolphins but also 654 billfish, 102 sea turtles and 13,958 sharks. In addition, many juvenile tuna are caught under floating objects.

One solution to the bycatch from nets would be to fish for tuna with poles and lines, as was practiced commercially in the 1950s. That switch would entail hiring back bigger crews, such as those laid off when the fishery first mechanized its operations.

The recent reductions in the bycatch of dolphins and turtles provide a reminder that although the state of the world's fisheries is precarious, there are also reasons for optimism. Scientific grasp of the problems is still developing, yet sufficient knowledge has been amassed to understand how the difficulties can be rectified. Clearly, one of the most important steps that could be taken to prevent overfishing and excessive bycatch is to remove the subsidies for fisheries that would otherwise be financially incapable of existing off the oceans' wildlife—but are now quite capable of depleting it.

Where fishes have been protected,

they have rebounded—along with the social and economic activities they supported. The resurgence of striped bass along the eastern coast of the U.S. is probably the best example in the world of a species that was allowed to recoup through tough management and an intelligent rebuilding plan.

During the past year, the U.N. has been making historic progress in forging new conservation agreements dealing with high-seas fishing. Such measures, along with regional and local efforts to protect the marine environment, should help guide the world toward a sane and sustainable future for life in the oceans.

### The Author

CARL SAFINA earned his doctorate in ecology in 1987 at Rutgers University, where he studied natural dynamics among seabirds, prey fishes and predatory fishes. He founded and now directs the National Audubon Society's Living Oceans Program. He also serves as deputy chair of the World Conservation Union's Shark Specialist Group, is a founding member of the Marine Fish Conservation Network and was formerly on the Mid-Atlantic Fisheries Management Council. Safina received the Pew Charitable Trust's Scholars Award in Conservation and the Environment. He has fished commercially and for sport.

### Further Reading

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