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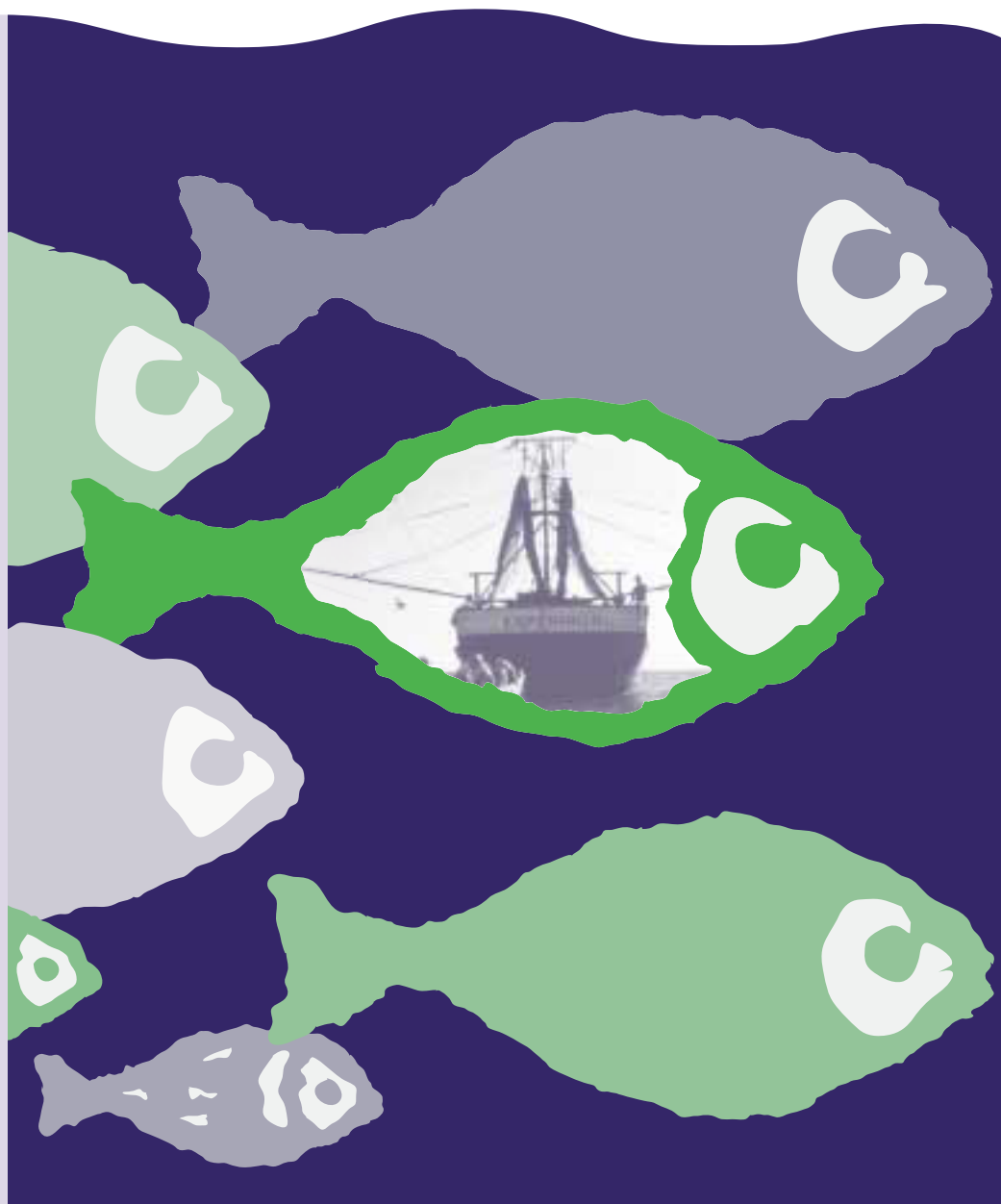
Fish for All

# THE FUTURE OF FISH

## Issues and Trends to 2020

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**T**he supplies of fish in the world's vast oceans once seemed inexhaustible. Not any more. In the past three decades, production and consumption of fish have risen so dramatically that the world's wild fisheries may fall victim to their own success. Meanwhile, the growing aquaculture industry has attempted to fill the gap between supply and demand. But as the global appetite for fish continues to increase, current trends in the fish sector pose serious risks to the environment, to the well-being of poor people, and to the viability of the fish sector itself.





**What is the outlook for fish in a globalizing food economy, and how will trends in the fish sector affect the poor and the environment during the next two decades? A new book from IFPRI and the WorldFish Center, *Fish to 2020: Supply and Demand in Changing Global Markets*, and an accompanying food policy report, *Outlook for Fish to 2020: Meeting Global Demand*, examine changes in the fish sector; the forces driving these changes; and the implications of the changes for fish consumption, production, prices, trade, the environment, and the world's poor.**

## SURGING FISH CONSUMPTION, PRODUCTION, AND TRADE

**G**lobal consumption of fish has doubled since 1973, and the developing world has been responsible for nearly all of this growth. Countries with rapid population growth, rapid income growth, and urbanization tend to have the greatest increases in consumption of animal products, including fish products, and the developing world has experienced all three trends. China, where income growth and urbanization have been major factors, dominates consumption of fish products. It accounted for about 36 percent of global consumption in 1997, compared with only 11 percent in 1973 (Figure 1). India and Southeast Asia together accounted for another 17 percent in 1997, with total consumption doubling since 1973. Although total fish consumption declined somewhat in the developed countries, this decline was dwarfed by the increases in the developing world.

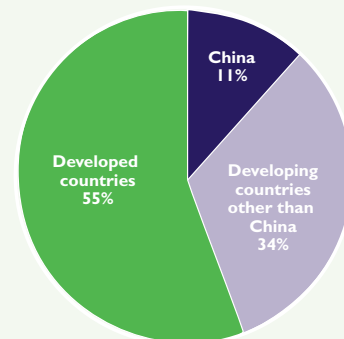
Besides being used as food, fish is also increasingly demanded for use as feed. Nearly one-third of the world's wild-caught fish are "reduced" to fishmeal and fish oil, which are then used in feeds for livestock like poultry and pigs and in feeds for farmed carnivorous fish. Because aquaculture is likely to grow quickly over the next 20 years, some experts are concerned that rising demand for fishmeal and fish oil could place heavier fishing pressure on already threatened stocks of fish used for feed.

To meet the burgeoning demand for fish, production has soared. The growth in production, like that in consumption, comes almost entirely from developing countries (Figure 2), which now produce nearly three times as much fish as developed countries.

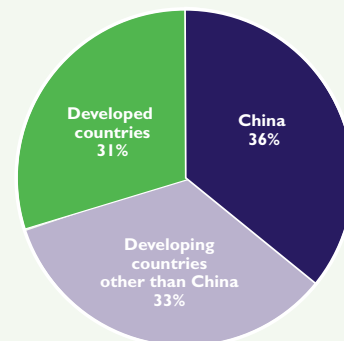
Exploitation of wild fish stocks rose rapidly during the 1970s and 1980s, thanks to expanded fishing fleets, new fishing technologies, and increased investments in the fishing sector. Global capture of fish for food jumped from 44 million tons in 1973 to 65 million tons in 1997. By the late 1980s, however, the stocks fished by many wild-fishing operations were fully exploited and even overexploited. Since then, despite increases in investment and fishing capacity, fish production from wild fisheries has slowed or stagnated.

**Figure 1** Changing share of developing countries in fish consumption, 1973 and 1997

Share of global fish consumption, 1973



Share of global fish consumption, 1997



**SOURCE:** Calculated by authors from FAO statistical databases, [www.apps.fao.org/subscriber](http://www.apps.fao.org/subscriber) (accessed January 2002).

**NOTE:** Data are three-year averages centered on 1973 and 1997, respectively.

Developing countries have taken the lead in producing fish from wild fisheries since the 1980s, partly because of the establishment of 200-mile exclusive economic zones (EEZs) around coastal nations. Whereas developed-country production from wild fisheries exceeded developing-country production by 6.6 million tons in 1973, by 1997 the developing countries were producing twice as much as the developed countries.

Because most wild fisheries are near their maximum sustainable exploitation levels, production from these fisheries will likely grow only slowly to 2020. Although fishers could probably produce more by targeting underexploited species that have been in lower demand, it is not clear that consumers will accept these species. More important, such a change could cause large shifts in species composition and indirectly harm predator species, with severe consequences for the environment.

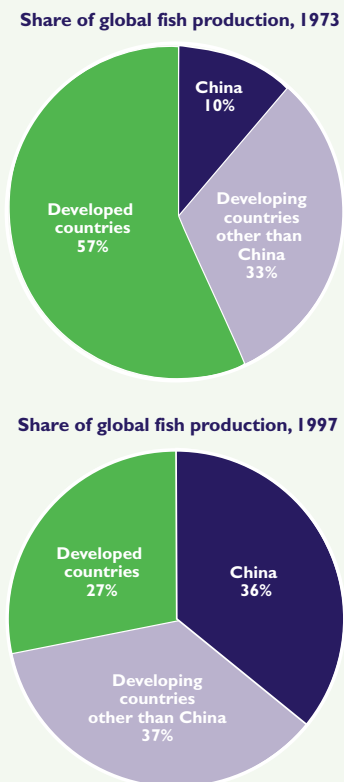
With wild fish production stagnating, growth in overall fish production has come almost entirely from the global boom in aquaculture, especially in developing countries. Aquaculture now represents more than 30 percent of total food fish production, and Asia accounts for 87

percent of global aquaculture production by weight. In the coming decades aquaculture will likely be the greatest source of increased fish production as fish farmers expand the water surface area under cultivation and increase yields per unit of area cultivated. But the sector must overcome several major challenges if it is to sustain the rapid growth of the past 20 years. It will face competition from other users for land and water. Disease and the scarcity of fishmeal and fish oil derived from wild-caught fish may also constrain aquaculture production. Growth in aquaculture production will also depend heavily on the level of public and private investment in the sector. Because of the slow growth in wild fisheries, the level of aquaculture production will play a large role in determining the relative prices of fish commodities.

Fish products are a heavily traded commodity—roughly 40 percent of global fish output by value in 1998 was traded across international borders—and the enormous rise in fish production in developing countries has caused an about-face in the direction of trade in fish products since the early 1970s. In 1973 the developed world was a net exporter of 818,000 tons of food fish, but by 1997 these countries were net importers of 4,045,000 tons of food fish. By the late 1990s more than 50 percent of fish exports came from developing countries.

As a consequence of rising demand and slower-growing production, the real prices of most fresh and frozen fish have risen since World War II, in contrast to prices of most animal-origin foods, which have declined steeply over the past several decades. Exceptions to the general rise in fish prices are canned finfish, which have declined in popularity in developed countries since the

**Figure 2** Changing share of developing countries in the production of fish for food, 1973 and 1997



**SOURCE:** Calculated by authors from FAO, Fishstat Plus: Universal Software for Fishery Statistical Time Series (Rome: FAO Fisheries Department, Fishery Information, Data and Statistics Unit, 2002).

**NOTE:** Data are three-year averages centered on 1973 and 1997, respectively.

## CHINA: A POWERHOUSE FISH PRODUCER OF UNCERTAIN PROPORTIONS

One of the most striking trends in the capture of fish for food has been China's emergence as the largest producer and the simultaneous decline of Japan's production. Whereas Japan's production fell from 18 percent of world production in 1973 to 7 percent in 1997, China increased its share from 9 percent to 21 percent. But China's astonishing growth during the 1990s in fish production, and the contrast between reported production data and household consumption survey data, has raised suspicions about the accuracy of reported totals. One study concluded that Chinese fishery production—including aquaculture—was overestimated by 43 percent in 1995. If China has indeed overreported its fish production (possibly because of institutional incentives), global fish production trends are much less rosy than they otherwise appear.

early 1970s, and some individual commodities like shrimp and salmon, which have seen large gains in production owing to aquaculture.

## PROJECTIONS AND SCENARIOS TO 2020

To help clarify the consequences of different policy and environmental scenarios for the fish sector, IFPRI researchers drew on a tool called the International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT). This model projects fish (and other food items) supply, demand, and trade not only for a baseline (or most likely) scenario in 2020, but also for alternative scenarios, such as slower or faster aquaculture expansion, lower Chinese production, more efficient use of fish feed, and ecological collapse of wild fisheries.

Fish are highly likely to continue becoming more expensive to consumers compared with other food products over the next two decades, according to the model. Prices for food fish, fishmeal, and fish oil are likely to rise under nearly all scenarios. Faster aquaculture expansion is the only scenario leading to a drop in the projected real prices of low-value food fish, though it would also cause a significant rise in the price of fishmeal. The one scenario that leads to slightly lower real fishmeal prices is the one that improves efficiency in fishmeal and fish oil conversion through rapid technological progress.

People in the developing world will increase their total consumption of food fish, whereas total consumption will remain static in the developed world. Even under the ecological collapse scenario, global per capita consumption declines only a small amount—from 17.1 kilograms per year under the baseline scenario to 14.2 kilograms. This is largely because producers respond to resulting major price increases for fish products by pursuing greater aquaculture production.

The rapid growth in fish production is also likely to continue, with developing countries producing an ever-

increasing share. More and more fish production will come from aquaculture, whose share in worldwide fish production is projected to increase from 31 to 41 percent in 2020 in the baseline scenario.

Assumptions about investment in aquaculture are crucial for production results in other scenarios. For instance, faster aquaculture expansion would produce 25 million metric tons more fish than slower aquaculture expansion. Technology also matters greatly. Making fishmeal more efficient in its effects on the growth of farmed fish reduces fishmeal production by 1 million tons compared with the baseline, a result that would reduce fishing pressure on fish used as feed.

Net exports from the developing world are projected to continue through 2020, though at a lower level than presently. This is mainly because of rising domestic demand within developing countries for fish because of population growth, income growth, and urbanization.

## FISHERIES AND THE NATURAL ENVIRONMENT

A healthy natural environment is essential to maintaining fish harvest levels in the face of increasing demand. Unfortunately, fishing activities around the world often cause large-scale damage to the aquatic environment.

Most environmental damage stems from wild fisheries, where overfishing poses by far the greatest environmental threat. Overinvestment in fishing and the resulting overcapacity have led to excessive exploitation of fish stocks, especially by developed-country fleets. During the 1970s and 1980s fleet size increased twice as fast as fish harvests. Most stocks of wild fish today are classified as fully exploited, and an increasing number are overexploited, in decline, or in recovery. Moreover, wild-fishing operations capture, kill, and discard a massive quantity of bycatch—fish that are the wrong size, the wrong species, or otherwise undesirable. Global discarded bycatch of fish and other marine organisms is currently estimated at more than 20 million tons a year, nearly one-quarter of the world fish catch.

Some fishing practices—like bottom trawling, blast fishing, and poison fishing—destroy marine habitats. Fishing itself can also harm ecosystems by removing massive quantities of a species and leading to wholesale changes in the food web dynamics of those systems.

Many people hope aquaculture can sustainably ease pressure on threatened wild stocks, but it has environmental problems of its own. As aquaculture production



has become more widespread and intensive, the movement of live aquatic animals and products has increased, making the accidental spread of disease more likely. Effluent from aquaculture ponds and pens, like fertilizer, undigested feed, and biological waste, is often released directly into surrounding waterways. And rapidly increasing demand for fishmeal and fish oil may place pressure on the wild stocks from which these products are derived.

Over the past few decades coastal aquaculture development, especially shrimp farming, has caused the destruction of hundreds of thousands of hectares of mangrove forests, which are crucial for filtering nutrients, cleansing water, and protecting ecosystems from floods and storms. In addition, farmed fish that escape into the wild can threaten native species by acting as predators, competing for food and habitat, or interbreeding and changing the genetic pools of wild organisms. Concern over escaped species is likely to intensify in coming years as genetically modified fish are developed for aquaculture.

## FISH IN THE LIVES OF POOR PEOPLE

Poor people are facing new barriers in both their production and consumption of fish. Even by the standards of developing countries, landless fish workers and artisanal fishers are often among the poorest of people, and they generally operate at a small scale and use traditional fishing practices. Yet new technologies and environmental requirements may favor large-scale, capital-intensive operations at the expense of traditional and small-scale commercial fishers.

The rising importance of fish trade also raises barriers to poor producers. Developed countries have erected nontariff barriers in response to consumers' concerns about the food safety of fish. Meeting the new requirements for documenting the safe handling, processing, and origin of fish products requires considerable experience, skill, and investment. Developing countries that can address new hygiene and food safety requirements, fair labor practices, and environmental needs will have the opportunity to capture more of the lucrative export market. But if the poor are to benefit from this potentially profitable activity, policymakers will need to find ways of including smaller-scale producers in these arrangements.

In addition, the rising cost of low-value food fish to the poor is a real policy concern. Even a small amount of fish is an important dietary supplement for poor peo-

ple who cannot easily afford animal protein and who rely mainly on starch diets. But over the past 30 years fish has become more expensive relative to other food items because fish demand, primarily from relatively wealthy consumers in developing countries themselves, is outstripping supply.

## NEW TECHNOLOGIES NEEDED

As demand for fisheries products grows during the next several years, technology must play a crucial role in helping suppliers keep pace in a sustainable way.

### REDUCING PRESSURE ON WILD FISHERIES

Nearly one-third of the world's wild-caught fish are not consumed directly by humans but rather are "reduced" to fishmeal and fish oil and consumed in feed by farm-raised animals, such as chickens, pigs, and other fish. This situation has raised concerns that demand for fishmeal and fish oil from the burgeoning aquaculture sector will raise prices for these commodities and place increasingly heavy pressure on wild fisheries to produce fish for feed.

Technology can reduce the risks of higher prices and overfishing by providing alternatives to fishmeal and fish oil in aquafeeds, such as protein-rich oilseed and grain byproduct meals. For a variety of reasons, vegetable meals are not ideal substitutes for fishmeal in aquafeeds, so research is needed to help overcome this problem.

### IMPROVING MANAGEMENT OF WILD FISHERIES

Technological advances that improve information and management methods are now needed more than advances to increase fishing capacity. Satellite remote sensing and other information technologies can help provide better information about wild fish stocks as well as help monitor fishing activity and improve consumer information about the condition and origin of fish products. But successful management of the world's wild-fishing operations will depend on the coordination of technology and policy. One example is a vessel monitoring system, which employs satellite tracking to allow onshore tracking of vessel movements, thereby enhancing the enforcement of regulations.

Technology is also crucial to avoiding the environmental damage and waste caused by certain fishing practices. Although some types of fishing gear may be banned altogether, others may be modified. Bycatch reduction devices, or BRDs, are increasingly used in fish-



ing operations to lower the amount of unintended catch. But without policy incentives to encourage their use, along with training and extension, BRDs will remain unused or ineffectively used.

## RAISING PRODUCTIVITY IN AQUACULTURE

Breeding technology in aquaculture is in its relative infancy. Breeders have significantly raised productivity for a few commercial species such as salmon, trout, and tilapia, but the successful cultivation and breeding of other species such as cod and bluefin tuna would be a tremendous boost to high-value aquaculture.

Genetic modification and biotechnology also hold tremendous potential to improve the quality and quantity of fish reared in aquaculture, although not without significant controversy and risk. Biotechnology has the potential to enhance reproduction and the early developmental success of cultured organisms. The possible environmental effects of genetically modified aquatic organisms are not well understood, however, and concerns exist over possible human health risks. The documented escapes of farmed salmon and their threat to native wild populations demonstrate that caution should be employed when considering the introduction of a new species into an ecosystem.

## INTENSIFYING AQUACULTURE SUSTAINABLY

Although intensification of aquaculture can potentially generate high levels of environmental problems, capital-intensive production systems often give producers more control over problems like effluent pollution and the spread of disease. Technology may in fact present economies of scale in the control of environmental problems.

Intensification can raise the risk of disease. Management techniques such as rotation of cultured species and lower-density stocking of organisms can partially address this risk, but antibiotics and water control technologies like aerators and water recirculation sys-

tems can also mitigate the stress caused by high concentrations of organisms.

Technologies based on local knowledge systems and different political and cultural contexts can also help develop aquaculture in underexploited water bodies, such as rice paddies, irrigation canals, reservoirs, and seasonal or perennial ponds in developing countries. Some technologies long employed in traditional aquaculture systems can also be useful in addressing concerns raised by water management, effluent control, disease control, and land use in intensified aquaculture.

# THE ROLE OF POLICY IN THE FISH SECTOR

In both developing and developed countries, policymakers can establish policies and promote institutions that will lead to more sustainable management of fish resources while also ensuring the survival of small-scale producers. One basic step is simply seeing to it that the sector gets the policy attention it deserves.

To improve policy outcomes in the developing countries, policymakers in the developed countries should rationalize their food safety systems for seafood imports, harmonize and modernize tariff classifications, and offer technical assistance in eco-labeling and food safety to small-scale, developing-country fish exporters.

Finally, the focus of demand-side policies in developing countries should be to facilitate South-South trade, to provide public goods to assure domestic food safety, and to help ensure that fish products reach those in developing countries who need them the most from a nutritional standpoint.

By taking account of the major shifts taking place in the fish sector and combining forward-looking policies with useful new technologies, policymakers can help ensure that the fish sector remains environmentally sustainable as well as beneficial for the world's poor people.



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Future of Fish Feed (F3) is trying to change that at least in the aquaculture feed sector. According to F3, the amount of fish-free aquafeed (using plants, insects, algae and bacteria as a base) sold during the contest was roughly equivalent to 100 million forage fish from the ocean. The second contest, which ends Sept. 15, will award \$200,000 to the company that develops and sells the most fish-free fish oil. Scaling Up Fish-Free Feed. There are industry groups that challenge F3's vision of a fish-free feed future, including the Marine Ingredients Organization (IFFO), which published a scathing rebuttal to the contest. And there's bound to be concern down the road about whether t On a projection screen in front of a packed room in a coastal Maine town, computer-animated salmon swim energetically through a massive oval tank. A narrator's voice soothingly points out water currents that promote fish exercise and ideal meat texture, along with vertical mesh screens that optimize fish densities and tank volume. The screens also make dead fish easy to remove, the narrator cheerily adds. The video is part of a pitch made earlier this year for an ambitious \$500-million salmon farm that Norway-based firm, Nordic Aquafarms, plans to build in Belfast, Maine, complete with what You'd use your cell phone but clearly there's no service. Oh look, there's a cute little family. Are they fishing? I said about a mother and her children wading in the paltry river. Trying to make this experience more interesting than it really was. Did they lose something in there? Are they migrants? If they catch any fish, I hope they don't eat it. At least at the end of this trail there'll be a brewery, a cool local brewery where we can quench our thirst before resting our bones at the table by the window, just like that mother and daughter I saw. Except then we were greeted by a dead end, and a lot of really industrial type buildings. It looked like Waco. I've only been to Waco once and that's what it looked like. We were less than half a mile from the brewery but it was nowhere in sight. The future of fish. We all know by now that cod and haddock have had their chips. But what exactly are these strange new fish we're told we should be eating? J is for Jonah Crab harvested from the carefully managed fisheries of Maine/Rhode Island. Prized for their meaty claws. K is for King Mackerel most of these silver-green fish from the Atlantic and Gulf of Mexico are caught with hook and line. L is for Lythe aka Pollock, and a great alternative to cod. Try to buy line-caught, and avoid between January and April.