EarthTrends: Featured Topic

Title:	**Farming Fish: The Aquaculture Boom**
Author(s):	Greg Mock, Robin White, and Amy Wagener
Editor:	Wendy Vanasselt
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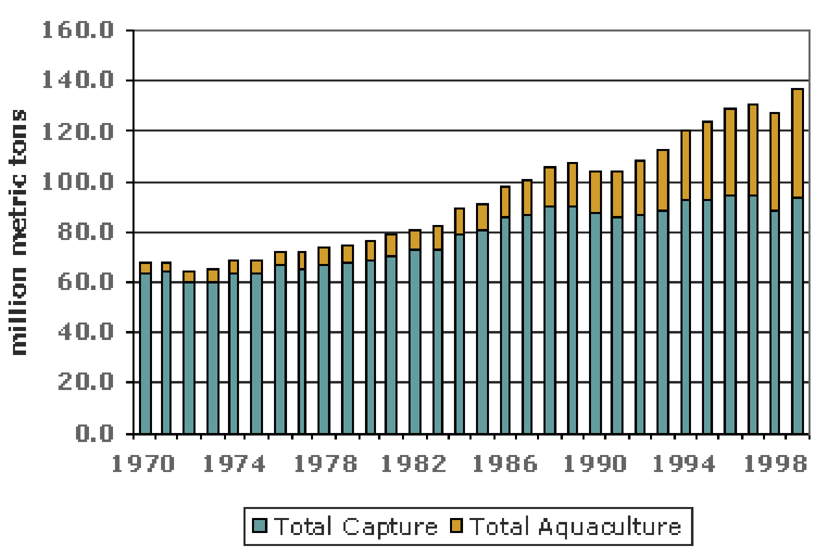
Aquaculture—the farming of fish, shrimp, shellfish, and seaweeds—has been a source of human protein for nearly 4,000 years, especially in Asia (Iwama 1991:176-216). Unprecedented growth in aquaculture production in the last decade, however, has given it increased importance in the modern food supply. World aquaculture production has increased more than 300 percent since 1984, with growth of about 10 percent a year in the 1990s, making it the fastest-growing food production activity (FAO 1997:11; FAO 2000a:3; FAO 2001).

Globally, more than 25 percent of all fish and shellfish production in 1999 was attributable to aquaculture, or about 33 million metric tons (not counting seaweeds) out of 125 million metric tons (FAO 2000a:6). (See Figure 1). Yet this industry's contribution to the human diet is actually greater than the numbers imply. Whereas one-third of the conventional fish catch is used to make fishmeal and fish oil (FAO 1997:4,5; FAO 2000a:6) for animal feeds, virtually all farmed fish are used as human food. Today, nearly one-third of the fish consumed by humans is the product of aquaculture, and that percentage will only increase as aquaculture expands and the world's conventional fish catch from oceans and lakes continues to decline because of overfishing and environmental damage (FAO 2000b:172; OECD 2001:112). As currently practiced, however, aquaculture also causes environmental damage, raising questions about how best to meet food demands and preserve environmental quality.

Farmed Fish Are a Growing Share of the Global Fish Harvest

Figure 1: Aquaculture Production as a Share of Total Marine and Freshwater Fish Harvest, 1970-1999



Source: FISHSTAT 2001.

What Fish Are Farmed and Where?

Asia dominates world aquaculture, producing almost 90 percent of all farmed fish, shrimp, and shellfish (FAO 2000b:173). China is by far the leading producer, contributing nearly 70 percent of 1999 world production, or about 22 million metric tons (FAO 2001). Indeed, aquaculture accounts for more than half of China's total fish production each year (FAO 1997:11-13). India is the second largest producer, with about 6 percent of the world's aquaculture total in 1999 (FAO 2001) (see Figure 2).

Aquaculture products fall into two distinct groups: high-valued species such as shrimp and salmon that are frequently grown for export, and lower-valued species such as carp and tilapia that are consumed primarily locally. China, for instance, raises a substantial amount of shrimp and marine fish like flounder, sea bream, mullet, and puffer fish in intensively managed ponds along its coastline for the lucrative export trade (Gujja and Finger-Stich 1996:12-14, 33; Guo 2000:2). Yet China's total aquaculture production is dominated not by shrimp but by carp raised in relatively low-tech inland ponds for local consumption. The four major carp species—silver carp, grass carp, common carp, and bighead carp—account for more than one-third of world aquaculture production—nearly all of it in China (FAO 1997:11-12).

These carp are raised primarily as a supplementary activity to regular crop agriculture on Chinese farms. Carp are herbivores and can survive on low-cost, readily available feed material, rather than on the high-cost fishmeal that carnivorous species such as shrimp and salmon require to grow; thus carp farming is both more economical and

China Dominates World Aquaculture

Figure 2: Top Nine Countries for Global Aquaculture Production

COUNTRY	SHARE OF GLOBAL PRODUCTION
China	70.2%
India	4.8%
Japan	3.1%
Philippines	2.2%
Korea, Republic of	1.8%
Indonesia	1.6%
Bangladesh	1.4%
Viet Nam	1.4%
Thailand	1.4%
Other countries	12.0%

Source: FISHSTAT 2001.

easier to integrate with other conventional farm activities than are other types of aquaculture. Whereas farmed shrimp tend to grace the tables of consumers in high-income regions like Japan, Europe, and the United States, carp make a direct, significant contribution to the protein needs of less affluent rural Chinese (FAO 1997:59; Holmes 1996:34).

Aquaculture's Limitations

Can continued expansion of aquaculture increase the global fish catch enough to feed the world's growing need for fish protein? Certainly, some growth in world aquaculture can be expected, but just how much is not clear. One analysis projects that global production could nearly double by 2020 to 70 million metric tons (OECD 2001:112-113). Several factors are pushing this growth in both intensive aquaculture and in small-scale, farm-based efforts. Global demand for fish is rising even as many ocean stocks are declining, and aquaculture techniques and technology continue to improve. In addition, small-scale aquaculture offers farmers a ready source of both subsistence food and cash, and these benefits are likely to promote expansion beyond its traditional stronghold in Asia (FAO 1997:24-25).

However, there are also serious constraints on aquaculture's growth. For one, fish farming requires both land and water—two resources already in short supply in many areas. In Thailand both these resources have been diverted in recent years to fuel the growth of the aquaculture industry. For example, nearly half the land now used for shrimp ponds in Thailand was formerly used for rice paddies; in addition, water diversion for shrimp ponds has lowered groundwater levels noticeably in some coastal areas. In China, the concern over loss of arable land has led to restrictions on any further conversion of farmland to aquaculture ponds (Holmes 1996:35-36).

More serious still are the environmental impacts of aquaculture operations, especially the intensive production systems and large-scale facilities used to raise high-value shrimp, salmon, and other premium species. Shrimp farming has taken an especially heavy toll on coastal habitats, with mangrove swamps in

Africa and Southeast Asia being cleared at an alarming rate to make room for shrimp ponds (Gujja and Finger-Stich 1996:12-15, 33-39; Iwama 1991:192-216). In just 6 years, from 1987 to 1993, Thailand lost more than 17 percent of its mangrove forests to shrimp ponds (Holmes 1996:36). Destruction of mangroves leaves coastal areas exposed to erosion and flooding, and has altered natural drainage patterns, increased salt intrusion, and removed a critical habitat for many aquatic species (Iwama 1991:177-216). According to one estimate, for every kilogram of shrimp farmed in Thai shrimp ponds developed in mangroves, 400 g of fish and shrimp are lost from wild captured fisheries (Naylor et al. 2000:6).

Intensive aquaculture operations can also lead to water shortages and pollution. Raising 1 ton of shrimp in a farm requires 50-60 thousand litres of water (Anonymous 1997:109). When that water is flushed from the ponds into surrounding coastal or river waters in exchange for fresh supplies, its heavy concentrations of fish feces, uneaten food, and other organic debris can lead to oxygen depletion and contribute to harmful algal blooms. In Thailand alone, shrimp ponds discharge some 1.3 billion m^3 of effluent into coastal waters each year (Holmes 1996:34-35). In Scotland, producing a ton of farmed salmon results in the release of about 100 kg of nitrogenous compounds, like ammonia, into nearby waters (Roth 2000:38). Nutrient pollution from aquaculture, in turn, can cause declines in aquaculture productivity by promoting outbreaks of disease among the fish (Naylor et al. 2000:8).

Paradoxically, some aquaculture production also puts more pressure on ocean fish stocks, rather than relieving pressure. As noted previously, carnivorous species like salmon and shrimp depend on high-protein feed formulated from fishmeal—a blend of sardines, anchovies, pilchard, and other low-value fish. But it is also becoming more common, especially in Asia, to boost the weights of herbivorous and omnivorous fish by giving them feed that contains as much as 15 percent fish meal and fish oil. There are growing concerns that the addition of extra fish meal and oil could place significant pressure on the pelagic fisheries and marine ecosystems that supply it (Naylor et al. 2000:4, 8). By some estimates, as much as 33 percent of fishmeal is used for aquaculture feeds, and it takes roughly 2 kg of fishmeal to produce a kg of farmed fish or shrimp. The result is a net loss of fish protein (Naylor et al. 2000:4-5).

The Food and Agriculture Organization of the United Nations (FAO) asserts that some progress has been made in reducing the environmental impacts of aquaculture. For example, several countries where salmon are farmed have instituted controls on production to ensure that pollution is kept within acceptable limits (FAO 1997:22). In some cases, new technology has also helped. In Puget Sound, on the west coast of the United States, one salmon farmer is using a giant, floating, semienclosed tub to raise his fish rather than the usual porous pens made of netting. The tub prevents fish wastes from polluting surrounding waters and also keeps fish from escaping and intermingling with wild salmon, which would contaminate the gene pool of the native fish (Christensen 1997:27-29). Integrating the production of fish and other marine products, like seaweed and mussels that grow well in wastewater from intensive farms, can also help reduce the nutrient and particulate loads. In Chile, some salmon are farmed with a red alga that removes nitrogen and phosphorous wastes from the cages. The effluent can also be used to produce a seaweed crop, offsetting the costs of creating the integrated farming system (Naylor 2001:9).

Even in the problematic shrimp-farming industry, there are some initial signs of progress. In South Asia, a major shrimp producer has instituted a temporary ban on new ponds until the government adopts an acceptable social and environmental policy (FAO 1997:22). In some locales in Thailand, farmers are voluntarily coordinating the flushing and filling of ponds to reduce the spread of diseases. In addition, some shrimp farmers are advocating an "ecolabeling" scheme that would certify shrimp grown by producers using more benign farming practices (Christensen 1997:29).

Progress in aquaculture research can also be expected to help in the transition to low-impact, high-productivity fish farming. For example, Chinese researchers are developing a protein supplement based on yeast that can substitute for more than half the fishmeal in aquaculture feed preparations. Further, work on fish breeding has already produced a strain of tilapia that grows 60 percent faster and with higher survival rates than native tilapia (Holmes 1996:34-35).

In the end, aquaculture's contribution to the global food supply will likely turn on how well these and other innovations can help fish farms more closely mimic natural ecosystems, with better recycling of nutrients and less waste generation (Folke and Kautsky 1992:5-24). That will mean fewer inputs and impacts, without eroding aquaculture's profitability and versatility.

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