Aquaculture: A Diverse Industry Poised For Growth

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Aquaculture has become a prominent industry, encompassing such products as mussels, abalone, catfish, sturgeon, alligators, ornamental fish, and aquatic plants. Domestic producers raised over 800 million pounds of aquacultural products in 1990, four times over that produced in 1980. With many fish and shellfish species being caught in the wild at close to maximum rates and with better aquacultural production methods, further increases look promising. But a variety of resource constraints, environmental issues, and food safety concerns will make continued expansion more of a challenge. In addition, per capita consumption has not grown in the United States over the past few years—despite all the publicity recommending fish for better health and diets.

Technological advances in hatchery operations and improved feeds have made production of the two most valuable seafood species in the international market—shrimp and salmon—economically possible. Most aquacultural production is targeted at high-income consumers in the United States, Japan, and the European Community (EC). Aquaculture has benefited from both U.S. and foreign governments' eagerness to develop the industry to boost export earnings and to improve local rural economies.

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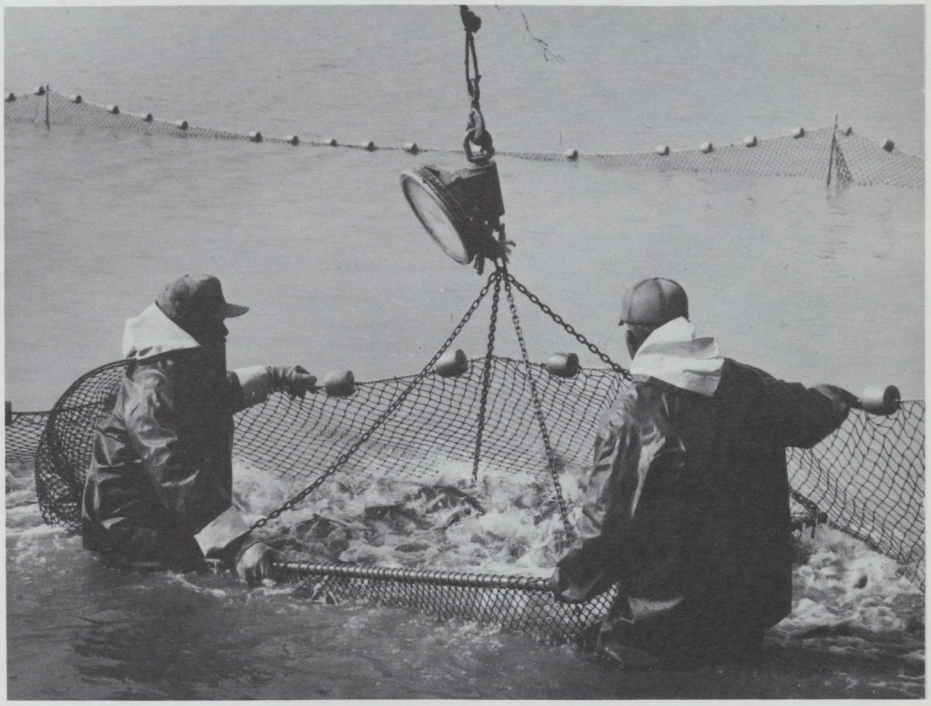
U.S. Aquaculture Concentrated, But Evolving Rapidly

For each aquacultural species grown in the United States, a single State or region dominates. For example, Mississippi is by far the largest catfish producing State, growing 70 percent of the Nation's output. But, catfish production is



The harvest from the catfish industry—by far the largest sector of U.S. aquaculture—reached a record 391 million pounds in 1991.

expanding into adjacent States. Production will probably end up concentrated in a crescent-shaped area in the Southeastern United States, extending from North Carolina down through Florida and as far west as eastern Texas. For crawfish, Louisiana provides the overwhelming majority of production, with only small amounts produced elsewhere. And while trout is grown in many States, Idaho's production is by far the largest at around 75 percent. Other production leaders are:

- Pen-raised salmon—Maine and Washington, with about 85 percent;
- Oysters—Washington, with over 50 percent;
- Tropical fish—Florida, with over 90 percent; and
- Alligators—Louisiana and Florida, at almost 100 percent (see box).

Many other species are produced, but output is so small or new that it is hard to identify leading producers.

Production concentrates in areas with the lowest-cost combination of water resources and climate, and with producers willing to diversify into new enterprises. In most cases, the species being grown (or a closely related species) were native to the area.

Production systems range from only slight modifications of the natural environment for crawfish and mussels, to highly sophisticated systems monitoring and manipulating a number of environmental parameters, such as dissolved oxygen and ammonia levels used for tilapia or sturgeon. These complex systems include indoor water-recirculation and hatchery production. The level of sophistication used may vary from one phase of the life cycle to another. Most production systems are evolving, as new developments in optimal farm size, aeration techniques, waste management, feeding schedules, and harvesting systems are adopted.

Alligator Farming: A Growing Industry

Alligator farming is one growing sector of domestic aquaculture. Alligator farms are concentrated mainly in Louisiana and Florida. An estimated 67,000 alligators were produced in Louisiana and 16,000 in Florida in 1989, up from only a fraction of this level a decade earlier.

Farmed alligators are hatched from eggs taken from both wild and captive populations. Some of the hatchlings are returned to swamps to maintain the wild population. The rest are raised in heated, enclosed barns. Heated barns are used to speed growth—at a rate that doubles that of wild animals. After 15-18 months on a diet of dry grain products, nutria (muskrat-like rodents), fish, beef, chicken, or horse meat, farm-raised alligators reach a market size of around 4 feet.

Alligators are raised primarily for their hides. A farm-raised 4-foot alligator hide ranges in price from $30 to $40 per foot, depending on quality. Tanners prefer large hides, so farm-raised hides usually sell at less per foot than wild-harvested hides. Still, the higher price does not offset the higher cost of growing alligators to a larger size.

The meat is a valuable byproduct, sold chiefly to specialty retailers and restaurants. Many compare the taste and consistency to chicken.

In the future, the domestic industry will face increased competition from farms in Asia, Africa, and South America. Wild-harvest alligators will also be a rising source of competition to U.S. alligator farmers. Conservation measures put in place in the 1960's to protect alligators have been so successful that the populations have risen rapidly, and limited wild harvesting is now allowed.

Industry Marked by Diversity

The diversity of products allows aquacultural production to take place in a wide variety of locations. Some species of fish, shellfish, or aquatic plants are possible candidates for production in almost any area of the country. Arctic char and oysters can be raised in very cold waters, while tilapia and alligators require very warm temperatures for maximum growth rates.

However, this diversity may have slowed research to improve production efficiency. Only a few species generate enough revenue to warrant large research expenditures. And while some research developments may be transferred or adapted from one species to another, the diversity of organisms and growing systems in aquaculture makes this only a limited possibility. For example, research in selective breeding is not transferable from one species to another. Breeding programs are especially important to many new aquaculture species, because producers are starting with essentially wild stock.

Commercial Production, Not Wild Harvest, Will Have To Meet Future Consumption

The Food and Agriculture Organization of the United Nations estimates that the United States is in the odd position of being the world's largest exporter of seafood products while still being a net importer. In 1990, the United States exported $2.8 billion worth of edible seafood and imported $5.2 billion worth. Seafood imports were the second-largest source (after petroleum) of the U.S. trade deficit among nonmanufactured products.

U.S. per capita seafood consumption grew over 20 percent between 1980 and 1987. But after peaking in 1987 at 16.2 pounds (edible weight), consumption fell to 15.5 pounds in 1990—the same as in 1986. Domestic landings have increased greatly since 1985, but most of the increase has been in pollock landings, which yield only 15-20 pounds of edible weight per 100 pounds of fish. In terms of edible weights, domestic landings have not kept pace with exports. That, coupled with steady imports, means domestic fish supplies over the last several years have fallen.

While media reports have extolled the health benefits of fish consumption, the slowing economy has probably worked against higher fish consumption. Many seafood products are relatively more expensive than competing protein products, such as poultry. Over the last 5 years, retail seafood prices have risen faster than prices for beef, pork, and poultry. But those kinds of comparisons are not made on an edible-weight basis.

These changes do not mean that the demand for aquaculture products will fall. Even without increases in consumption rates, U.S. population growth means an increase in demand of around 40 million pounds per year of edible product, or 80 million pounds of farm sales. By 2000, U.S. demand for seafood would be higher: almost 400 million more pounds of edible product per year and 800 million more pounds in farm sales.

The export market for aquaculture products can also expand. While Japan is by far the largest export market for U.S. seafood, the EC could become a growth market for aquacultural products. Landings of wild-catch seafood in the EC have remained flat over the last decade. Also, the European market has a larger population than the United States, a relatively high standard of living, and higher overall seafood consumption.

It is doubtful that the domestic wild harvest industry can supply significant additional amounts without hurting its longrun survival. Therefore, if demand increases, much of the additional product will have to come either from higher domestic aquacultural production or from increased imports.

Aquaculture Will Face More Foreign Competition

International competition in the sale of aquacultural products should increase further. While the United States is a major producer of some aquacultural commodities, many countries strongly support fish-farming research and development. Competition for domestic fish farmers will come from two basic types of producers. First are the countries using systems with advanced technologies, such as Taiwan, Canada, Japan, and Norway. These countries will use advances

Onions May Replace Insecticides for Some British Fish Farmers

While most salmon farmers use insecticides to control sea lice, onions show promise as a natural control.

The Economist reports that Shetland Island farmers, who raise a third of Britain's farmed salmon, are starting to use onions to control sea lice. Sea lice prey on the salmon, impairing their appearance and, thus, value. Sometimes, sea lice even kill salmon.

One farmer reportedly eliminated the problem of sea lice by throwing 7 kilograms of onions into his fish cages each week. The Shetland Salmon Farmer's Association has started a research project to test the efficiency of onions as lice prey, and to find exactly how/why the salmon become lice-free when onions are introduced. The phenolic compounds in onions are already known to be toxic to fungi.

Wrasse is another natural control of sea lice. This small fish eats the lice off the salmon's skin. Wrasse are collected from the wild. Since they are so small, finer meshes must be used to prevent the wrasse from escaping the salmon cages. This has limited their use in controlling sea lice.

—Stephen L. Ott

in production techniques to raise the productivity of existing industries. The techniques can also be used to diversify into culturing new species where there is less competition. Second are countries that use low-technology methods of cultivation which rely on the advantages of low land and labor costs, more favorable climate, and fewer environmental constraints for cost competitiveness.

Aquaculture Can Enhance Wild Stocks

Aquacultural production can help wild species recover from over-harvesting. Mortality rates for fish are highest at the very beginning of their life cycles. Hatchery techniques have been developed to grow salmon until they reach a size where their survival chances are much greater. The release of large numbers of fingerlings would permit higher annual harvests.

However, it is more difficult to carry out a stock-enhancement program with species that do not return to spawn in clearly defined areas. A second stumbling block is funding for the hatcheries. Many fisheries' stocks are regarded as

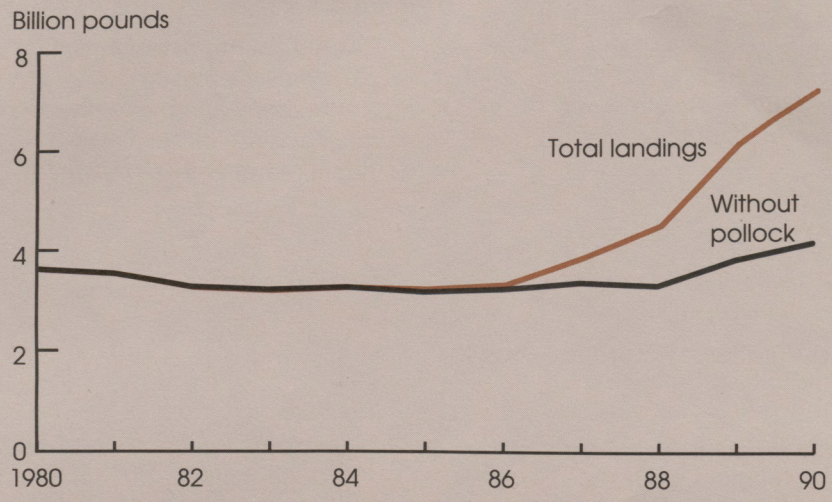
Pollock Pushes Up U.S. Fish Harvests

Increased landings of Alaska pollock are dramatically boosting domestic seafood landings. Pollock landings were 3.2 billion pounds in 1990, 480 percent higher than in 1987. Pollock accounts for one-third of all domestic landings.

Pollock is a major ingredient in processed fish products and is the fish often used in surimi (imitation crabmeat or lobster).

Increased pollock landings have stemmed from lower fishing quotas given to foreign countries in U.S. waters. Rapid growth in landings, however, could be ending as pollock is being harvested at close to maximum sustainable rates.

Without Pollock, U.S. Landings of Edible Fish Would Be 43 Percent Smaller



common property resources. Unless funding for the hatcheries were through general tax revenues, some method of taxing those harvesting the affected species would have to be developed.

New Technologies Will Help

Research projects now under way are aimed at helping growers either reduce production costs or improve product quality. The list of areas where growers are changing production practices to incorporate new developments is extensive. Some areas include attempts to increase the efficiency of feeding practices, harvesting techniques, oxygen-delivery systems, and water- recirculation systems.

Efforts also are under way in a number of countries to develop deep-water ocean farming pens. Effective deep-water farming techniques would greatly increase the available space for marine aquaculture. Offshore sites would also reduce bottom fouling and visual pollution problems, two of the major problems with current ocean net-pen aquacultural projects. Researchers are also examining better methods of controlling or managing predators and using production sites where low-cost heat sources are available, such as near power generating facilities or geothermal sources.

Aside from improvements in production systems, the aquaculture industry is looking to improve the productivity of the fish and shellfish. Many of these changes stem from genetics or biotechnology. New developments are coming very rapidly in the areas of spawning behavior, gene transfer, and disease control.

One area is the development of hormones to control spawning behavior. Hormonal controls are being developed in three areas. One area is the developing of hormones to achieve spawning in species that will not normally spawn in captivity. Another is using hormones and other techniques to get species to spawn more than once a year. A third area is using hormones or other techniques to achieve sex reversals or to sterilize populations. Sex reversal techniques are used to convert all the members of a population to the faster growing sex. Sterilized populations are used for two reasons. First, to either make a

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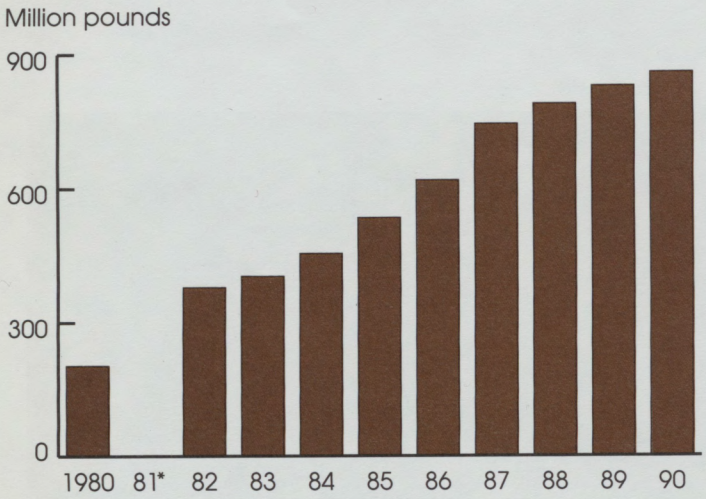
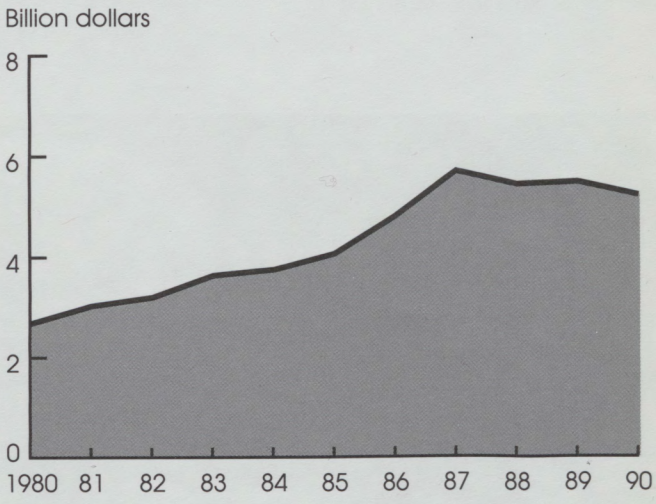
Domestic production steadily increased over the decade. . .



*Note: No data for 1981.

. . . Yet so did imports



Catfish May Be on Fast Food Menus

After a successful test promotion, catfish sandwiches may be returning to the menus of McDonald's in the Memphis region in the spring of 1992, reports the *Catfish Journal*. The sandwiches were test-marketed in February-March 1991. The new sandwich will consist of a 2.8-ounce fillet and coleslaw.

Test marketing may be expanded to the New Orleans region. While the sandwich would only be available on a regional basis, acceptance at McDonald's could represent an important new market for catfish at other fast food outlets.

species acceptable for growout in States that normally restrict nonnative species. Second, sterile fish or shellfish use energy for gains in size and weight instead of sexual development.

Researchers are also developing new therapeutic drugs to combat diseases affecting fish. However, there are questions of whether the market for many aquacultural products will be large enough to justify the product development and testing expenses.

The transfer of genes from one species to another is also a promising area of development. Research now underway is investigating the possibility of transferring genes that produce growth hormones to develop faster growing strains of fish. However, it may be some time before such developments can be used on a commercial basis.

Much of the media interest in the changes affecting aquaculture have focused on such high-tech issues as biotechnology and gene transfer. But there are still a great deal of productivity gains to be achieved through better nutritional programs. There are only a few basic kinds of fish feeds presently available—those developed for catfish and those developed for trout and salmon. Growers of other species are essentially using one of these two types of feeds or ones that have been only slightly modified.

Gains in nutritional advances will come on many fronts. First, development of feeds specifically tailored to the needs of new species will increase the productivity of those species. Second, new feeding strategies will promote better growth or cut down the amount of fat in the product. Third, experimental trials are under way to develop feed formulations that use lower cost ingredients or byproducts from other industries. Fourth, strategies will develop a product providing more health benefits for consumers. For example, studies are assessing ways to increase the percentage of omega-3 fatty acids in farm-raised fish by using special finishing diets. Consumption of omega-3 fatty acids has been linked with reduced incidence of heart disease. ■