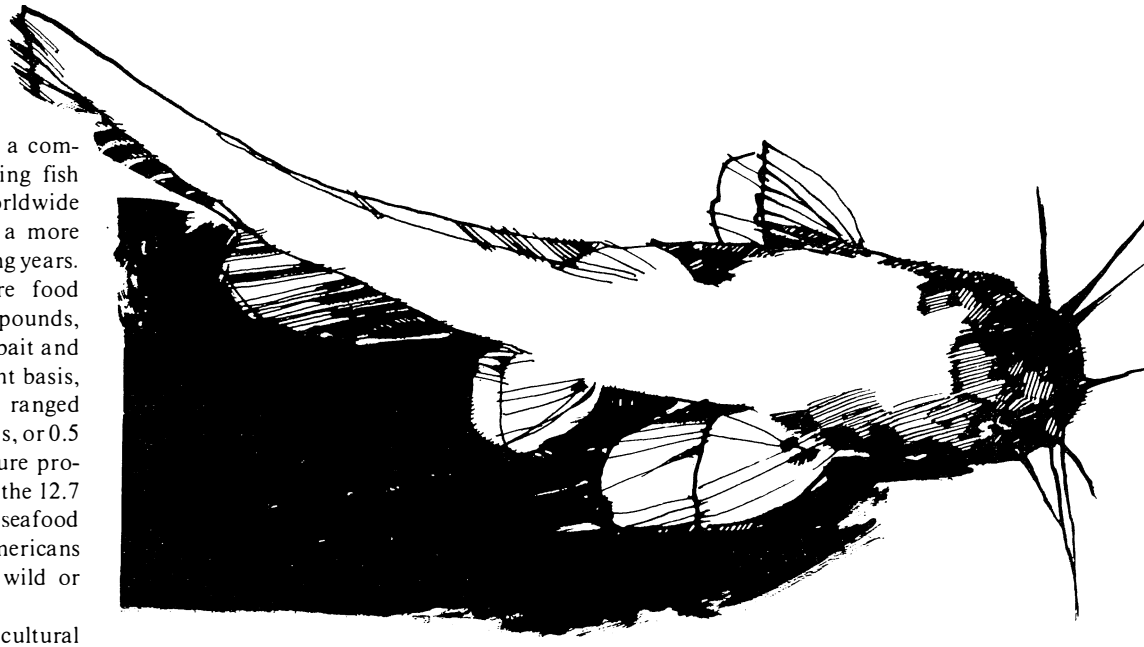
U.S. Aquaculture as a Food Source: Its Status and Potential

Michael Stellmacher
(202) 447-7290



Aquaculture—"fish farming" is a common example—fueled by rising fish and seafood prices and limited worldwide production capacity, may become a more important U.S. food source in coming years.

In 1980, total U.S. aquaculture food production exceeded 200 million pounds, not including 30 million pounds of bait and ornamental fish. On a dressed weight basis, U.S. consumption of cultured fish ranged from about 120 to 140 million pounds, or 0.5 to 0.6 pounds per capita. Aquaculture production comprised 4 to 5 percent of the 12.7 pounds per person of fish and seafood (excluding game fish) eaten by Americans that year. The rest was harvested wild or imported.

Worldwide, the Food and Agricultural Organization of the United Nations (FAO) estimated aquaculture output at more than 6 million metric tons in 1975, compared with 60 million tons harvested wild. Asia, with an ancient tradition of aquaculture, accounted for 5 million metric tons—China, the world's largest aquaculture producer, at about 2 1/2 million metric tons, depends on aquaculture for about 25 percent of its fish supply; the worldwide average is 10 percent.

Aquaculture goes far beyond fish farming. It's defined as the controlled cultivation of animals and plants, including finfish, crustaceans, mollusks, seaweeds, and vegetables. In the U.S., aquaculture primarily produces fish for human consumption, but it also provides stock for commercial and sport fisheries and raises bait fish and high-valued ornamental fish. The 1980 U.S. aquaculture harvest was valued at around $225 million. Included in this harvest were several major species:

U.S. Production and Consumption of Cultured Foodfish, 1980

Species	Production[1]		Consumption[2]		Consumption per capita	Value[4]
	Reported	Estimated[3]	Reported	Estimated[3]		
	(million pounds)				(pounds)	(million dollars)
Catfish	76.7	80-90	46.0	48-54	.20-.24	$53.6
Trout	48.0	55-60	36.0	41.3-48	.16-.21	37.5
Crawfish	27.5	30	4.1	4.5	.02	23.5
Oysters	23.0	23.0	23.0	23.0	.10	37.1
Salmon	7.6	10	5.7	7.5	.03	3.4
Clams	3.9	3.9	3.9	3.9	.02	10.4
Shrimp	0.3	0.3	0.3	0.3	*	1.2
Other	—	0.5-1.5	—	0.3-0.9	*	0.9
TOTAL	187.0	202.7-218.7	119.0	128.8-142.1	.53-.63	167.6

[1]Round (live) weight except for oysters and clams (meat weight basis).
[2]Dressed (edible) weight.
[3]Data estimated to account for production in nonsurveyed States or of other species not specifically listed.
[4]Value of sales to producers; best estimate used where reported data unavailable.
*Less than 0.005 pounds.

Catfish. Catfish aquaculture has been centered in the South Central States since it began in the early 1960s. Strong regional demand, suitable environmental factors (climate, water supply, topography, soil), and industrious labor force, enabled producers and processors to overcome large risks and make catfish the largest U.S. aquaculture industry.

Catfish farmers in the 11 surveyed States accounted for at least 90 percent of production and sold nearly 77 million pounds of foodsize fish during 1980, of which Mississippi (74 percent of the total), Alabama (11 percent), and Arkansas (11 percent) produced 73 million.

As of July 1, 1981, 1,069 producers in 15 surveyed States had nearly 69,000 pond acres in commercial catfish production, in contrast with only 2,400 acres in 1963. Over the past several years, farm prices for catfish have generally been significantly above production costs, boosting the rapid growth in the industry.

During 1980, the farm price for catfish averaged 70 cents per pound, compared with production costs of about 50 cents per pound for a large, established producer in the Mississippi Delta. Feed (with corn, soybean meal, and fish meal as primary ingredients) and fingerlings account for 75 to 80 percent of operating expenses in catfish production. Catfish farmers market over four-fifths of their production to processors; a tenth is sold to commercial recreational pond operators and live haulers who buy live fish at the farm for resale; and about 7 percent is sold directly to consumers and retailers.

Aggressive marketing has more than tripled the processors' sales from 10.3 million pounds dressed weight in 1975 to 35.1 million pounds in 1981. Demand is spreading so that farm-raised catfish are now sold everywhere but Northeast and Northwest States—areas where ocean fish are preferred.

Processors marketed 60 percent of the catfish fresh (packed in ice) during 1975-80, but increased sales of frozen fish cut that portion to about 55 percent last year. Increased sales of frozen fish which are prebreaded and portion-controlled to hotels, restaurants, and institutions have been largely responsible for increased sales. Processors sell about one-third of their output to each of three outlets: catfish specialty restaurants, food service firms, and retail grocers.

During 1975-79, processed production of catfish harvested wild averaged 4.1 million pounds. (Processors of farm-raised catfish do not handle wild catfish.) Throughout its evolution, the U.S. catfish industry has encountered competition from imports, almost all from Brazil, which peaked at 18.4 million pounds in 1978. Last year, imports probably reached only 10 million pounds. Rising consumer acceptance of farm-raised catfish—despite higher prices—and falling Brazilian production have cut into imports. (Brazilian catfish are harvested wild and marketed as frozen steaks.)

Trout. Trout culture has the longest history amoung U.S. aquaculture crops, primarily due to its popularity as a sportfish. The need to replenish stocks depleted by fishing and other human activities has led government agencies to cultivate trout. Commercial attempts at trout aquaculture go back half a century.

During 1980, nearly 200 commercial trout farmers harvested 48 million pounds of foodsize trout valued at $37.4 million. Idaho trout producers, who accounted for 90 percent of this harvest, are typically vertically integrated—in addition to the production facilities they operate hatcheries, feed mills, and processing plants. Other trout-producing areas include the Northwest, the Appalachian and Ozark Mountain regions, and Wisconsin.

Idaho owes its dominance of the trout industry to the Southern Idaho Aquifer, which provides ideal water for trout propagation. Trout in that State are almost exclusively reared in concrete raceways, where flowing water removes wastes and replenishes oxygen, allowing intensive trout production.

Virtually all freshwater trout marketed in the U.S. come from aquaculture. Trout producers in surveyed States (Alabama, Arkansas, California, Georgia, Idaho,

U.S. Annual Per Capita Consumption of Commercial Fish and Shellfish[1]

Year	Fresh and frozen	Canned	Cured	Total
		(Pounds)		
1960	5.7	4.0	0.6	10.3
1965	6.0	4.3	0.5	10.8
1970	6.9	4.5	0.4	11.8
1971	6.7	4.3	0.5	11.5
1972	7.1	4.9	0.5	12.5
1973	7.4	5.0	0.4	12.8
1974	6.9	4.7	0.5	12.1
1975	7.5	4.3	0.4	12.2
1976	8.2	4.2	0.5	12.9
1977	7.7	4.6	0.4	12.7
1978	8.1	5.0	0.3	13.4
1979	7.8	4.8	0.4	13.0
1980	7.9	4.5	0.3	12.7

[1]Edible weight; excludes game fish consumption.

Missouri, Pennsylvania, Washington, and Wisconsin) sold nearly 90 percent of their output to processors. Almost all trout processing occurred in Idaho, as fish produced in other States are usually marketed to fee fish-out operations, live haulers, and consumers. Idaho processors market most of their output as frozen to allow easier and less costly shipment to distant markets.

The processing segment of the farm-raised trout industry is traditionally production oriented, so aggressive marketing hasn't been pursued to expand demand. As a result, low farm prices in recent years gave little incentive to expand production. The price received by Idaho producers during the year ending September 1, 1981 averaged 63 cents a pound, compared with an average 65 cents during the first seven months of 1980. Also, the number of commercial operations in Idaho declined from 31 on August 1, 1980 to 18 on September 1, 1981.

Crawfish. Culture of crawfish occurs mainly in Louisiana and Texas. It began around 1950. Crawfish are a regional and a European delicacy as well as a high-valued bait. The wild harvest, primarily from the Atchafalaya Basin in Louisiana, varies greatly from year to year due to water level fluctuations. Crawfish culture exploits rising demand and dampens effects of yearly and seasonal variations in supply of the wild harvest.

All totalled, there are probably between 60,000 and 70,000 pond acres in crawfish production in Louisiana and Texas. This includes wooded and open-water ponds, as well as land used for rice and crawfish production—either jointly or in rotation.

Although no precise data are available, crawfish farmers in Louisiana and Texas produced an estimated 31 to 34 million pounds last season. Because of an almost total failure of the wild crawfish harvest in the Atchafalaya basin last season, Louisiana producers, who account for 90 percent of the output, received record prices, an average of about 90 to 95 cents per pound.

An advantage to crawfish farmers is the relatively low overhead involved with production. Crawfish generally propagate themselves after the first year, which eliminates the need for costly hatchery operations. Also, in contrast with catfish and trout, crawfish do not require prepared feeds, and can live on pond vegetation, pasture grass, or rice.

Crawfish are gaining acceptance outside the South, with strong markets for processed crawfish tails in New York, Chicago, and Cleveland. Producers most often market crawfish live directly to restaurants and grocers, who then sell them whole, cooked and spiced.

Although most sales are live, the share of frozen sales is slowly gaining as processing technology improves. Processors cook the fish, pick the tailmeat, and package it for distribution. Treatment with citric acid now prevents fat in the tail from turning purple during freezing—an effect that detracted from product appearance, but not taste. A new mechanical tail picker should improve productivity, once marketing problems are resolved: meat is blanched, not cooked, so it has a slightly different appearance that long-time consumers notice.

Despite such obstacles, price incentive is high: $10 or more a pound for peeled and cooked tailmeat isn't uncommon. In Louisiana last season, whole crawfish, spiced and cooked, typically sold for about $2 a pound.

Oysters. Oyster aquaculture occurs through manipulation of the shellfish or its environment to increase production. This includes such bottom-culture practices as scattering cleaned oyster shells on the ocean floor for spat (young oysters) to settle on, culturing spat in hatcheries, collecting and moving spat to grow-out areas, providing bottom-culture environments with silt and predator controls, and off-bottom culture techniques such as growing oysters on strings suspended from rafts, which allows much denser production.

Intensively managed bottom culture can yield about 4,500 pounds per acre, compared with 9 to 90 pounds in public beds with litte or no management. In 1980, oyster aquaculture accounted for nearly half of the 49.1 million pounds of U.S. oyster harvest. Most oysters harvested on the West Coast, in Louisiana, and in New York come from private beds.

While cultured oysters taste the same as those harvested from public beds, they enjoy an advantage when sold for consumption raw on the halfshell. Regularly shaped oysters, with shells free of fouling organisms, are more desirable. While such oysters are rare in nature, this uniformity can be readily produced in aquaculture.

Clams. Aquaculture production of hard clams totaled 3.9 million pounds during 1980, or about 30 percent of total U.S. commercial landings. Clam aquaculture has been encouraged by a chronic shortage of high-valued cherrystone and little neck clams as output declined in traditional production areas. In addition, clams can be grown in virtually any marine bottom they can burrow into, as well as at relatively high densities.

Prices nearly doubled between 1976 and 1980. Cultured clams, generally higher-valued varieties, are usually sold in the shell for consumption raw, steamed, or as specialty items such as clam casino or deviled clams.

Salmon. Aquaculture by Federal and State hatcheries of Pacific salmon supports the second most valuable U.S. commercial fishing industry, as well as an important sport fishery. The U.S. salmon industry harvested 614 million pounds of fish worth $353 million (ex-vessel value) during 1980. Public hatcheries provide about 40 percent of all chinook salmon, and 46 percent of coho—about a tenth of the U.S. salmon supply. During 1980, private aquaculture harvested 7.6 million pounds of salmon worth $3.4 million.

Commercial salmon aquaculture is done by ocean ranching and net-pen rearing. With ocean ranching, firms raise salmon to migratory size in freshwater hatcheries, then release them into a river or estuary. These fish swim to the ocean, graze on natural food for 2 to 5 years, then return to their point of release where they are harvested and processed for market. Commercial net-pen rearing cultures young salmon in freshwater hatcheries, then transfers them to floating seawater pens for continued intensive rearing using formulated feed. The fish are harvested and marketed after 9 to 12 months when their weight reaches 1 to 2 pounds.

Marketing varies considerably according to culture method. Salmon produced through ocean ranching—usually weighing 10 to 40 pounds—are marketed similarly to the wild catch. Most are canned, while some are sold fresh as steaks or smoked. In contrast, the much smaller net-pen reared

salmon are sold as fresh or frozen pan-sized fish, competing with rainbow trout.

Consumption

Consumer demand for aquaculture products is growing. Annual per capita consumption of fish and seafood increased from 10.3 pounds in 1960 to 12.7 pounds in 1980. This trend primarily reflects growing sales of food away from home and higher disposable consumer income. About two-thirds of consumer expenditures for fish and seafood occur at restaurants and institutions. In 1980, 62 percent of per capita consumption of fish and seafood was fresh and frozen, 35 percent was canned, and 3 percent was cured.

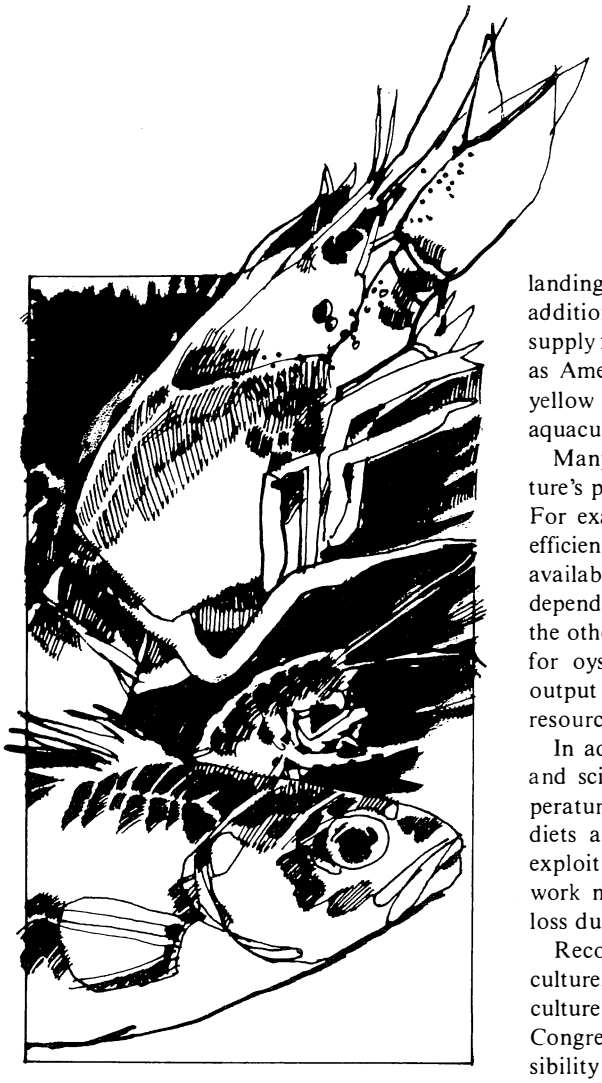
Future of U.S. Aquaculture

This increased consumer demand for fish and seafood comes when many U.S. commercial fisheries—as well as those throughout the world—are at or near their maximum sustainable yields. Future rises in fish and seafood supplies will likely have to come from larger imports, greater use of other species, or through aquaculture. Aquaculture has good potential to meet any increased fish and seafood demand by Americans, as evidenced by the successes of commercial oyster aquaculture, and farm-raised catfish and trout industries.

Two economic trends have strong implications for the future of aquaculture. The retail price index of fish and seafood increased 180 percent from 1970 to 1980, compared with rises of 112 percent for red meats and 76 percent for poultry. The second trend is less positive: per capita fish consumption peaked at 13.4 pounds in 1978, falling to 12.7 pounds in 1980. It appears to have stabilized at around 13 pounds.

If Americans' per person demand for fish and seafood has peaked, this could tend to limit future demand for cultured fish. However, even with a steady per capita consumption, population increases would require greater production—a need which seems to translate into greater aquaculture production. Moreover, a change in consumer preference for cultured fish over wild and imported fish or red meats and poultry would also stimulate production.

The significantly larger increases in retail prices of fish and seafood compared with red meats and poultry may have contributed to leveling off of per capita consumption. But such price rises also suggest that fish and seafood are luxury items for which people are willing to pay premium prices. This offers economic incentive to aquaculture producers to expand production.



A final implication of the price and consumption patterns is that fish consumption is related to general economic conditions. The sluggish economy and higher gasoline prices in recent years seem to have dampened away-from-home consumption where most fish is eaten, perhaps contributing to the stabilizing of per capita consumption. If so, then favorable economic conditions in the future might increase demand for cultured fish.

Meanwhile, other cultured species may be introduced in the United States soon. Commercial shrimp and freshwater prawn aquaculture in the United States is close to becoming a reality: U.S. firms are already producing such crops in Central and South America. Shrimp is America's most valuable fish and seafood product, with commercial landings worth $403 million in 1980. In addition, there is strong demand and limited supply for several finfish and shellfish—such as American lobster, abalone, mussels, and yellow perch—which could create new aquaculture industries.

Many obstacles remain before aquaculture's potential as a food source is realized. For example, technology for economically efficient production of catfish and trout is available, but future output gains will depend on wider consumer acceptance. On the other hand, markets are well-established for oysters, hard clams, and salmon, but output is limited by competing uses of water resources and environmental regulations.

In addition, producers lack the technical and scientific knowledge about water temperature and quality, seed stock availability, diets and nutirition, and other factors to exploit aquaculture's potential. Also, more work needs to be done in preventing death loss due to disease and parasites.

Recognizing the potential of U.S. aquaculture, Congress passed the National Aquaculture Act in September 1980. Although Congress declared that the principal responsibility for aquacultural development rests with the private sector, the Act mandated the establishment and implementation of a national aquaculture development plan by U.S. agencies (primarily the Departments of Agriculture, Commerce, and Interior). It also encouraged government and private sector activities and programs relating to aquaculture development. ■

Sources

Bardach, John E., John H. Ryther, and William O. McLarney, *Aquaculture: The Farming and Husbandry of Freshwater and Marine Organisms.* (New York: Wiley-Interscience, 1972).

Brown, E. Evan, *World Fish Farming: Cultivation and Economics.* (Westport, Connecticut: AVI Publishing Company, Inc., 1977).

Brown, E. Evan and J. B. Gratzek, *Fish Farming Handbook.* (Westport, Connecticut: AVI Publishing Company, Inc., 1980).

U.S. Department of Agriculture, Economic Research Service, *Aquaculture Outlook and Situation,* AS-1 (April 1981) and AS-2 (September 1981).