

World Salmon Farming Expected to Climb

The world production of pen-farmed salmon doubled during 1981-83. Of the 24,500 metric tons (t) of farmed salmon produced in 1983, almost 85 percent was Atlantic salmon, *Salmo salar* (Table 1). While the farming of Pacific salmon, *Oncorhynchus* spp., has also been increasing, the 1983 production accounted for only 15 percent of the total world production of pen-farmed salmon.

Salmon are farmed by two common methods. Cage culture involves rearing salmon in enclosures until they are ready for harvesting. The enclosures may be pens, cages, or tanks. Ocean ranching involves releasing immature salmon and harvesting the fish upon their return to the point of release. This report is primarily concerned with cage culture, where the harvest is predictable and can be done according to market demands.

The NMFS Branch of Foreign Fisheries Analysis projects that the production of pen-farmed Atlantic and Pacific salmon may exceed 100,000 t by 1990 (Table 1). Norwegian salmon farmers alone expect to produce 80,000 t of Atlantic salmon, but farmers in other countries also plan to increase their production significantly. These production estimates, however, depend on whether economic and environmental conditions will permit such expansion of salmon farming industries.

Norway is by far the most important producer of pen-farmed salmon. In 1983, the Norwegian production of farmed Atlantic salmon totaled over 17,000 t, or about 70 percent of the estimated world production. Japan is the second largest producer, but the entire 2,900 t of salmon farmed in 1983 was Pacific salmon for domestic consumption. The United Kingdom

(Scotland), which produced 2,500 t of salmon in 1983, is the only country besides Norway with a large and successful Atlantic salmon farming industry. Production of pen-farmed salmon in other countries is not substantial, but continues to expand.

Norway

Norway is the world's most important producer of pen-farmed salmon. Their production in ocean cages has increased dramatically during the past decade, from only 170 t in 1973 to 17,000 t in 1983. During January-May 1984, Norwegian fish farmers produced almost 10,000 t of salmon, or 44 percent more than during the same period in 1983. If production continued to increase at the same rate, Norway would have produced an estimated 24,500 t of farmed salmon in 1984. Future production is also projected to increase to an estimated 50,000 t in 1986 and 80,000 t in 1990.

Norwegian production, however, will depend on several factors including the supply of smolts and competition from other countries which produce farmed salmon. Ironically, Norwegian companies have assisted many of these countries in establishing salmon farms because Norwegian Government regulations limit the size of salmon farms. Since the regulations do not allow the companies to expand operations in their own country, several Norwegian companies have exported their salmon farming technology to other countries where favorable environmental conditions or potential markets exist.

Farmed salmon has become an important Norwegian fishery export. In 1983, Norway exported 15,500 t of farmed salmon, or over 90 percent of its production. During 1982-83, Norwegian farmed salmon exports in-

Table 1.—World production of pen-farmed salmon, 1981-83 and 1990 projections.

Species and nation	Salmon production (t)			
	1981	1982	1983	1990
Atlantic salmon				
Norway	8,907	10,266	17,016	80,000
United Kingdom	1,000	2,100	2,500	8,500
Ireland	80 ¹	103	256	2,000
Canada	35	140	180 ¹	1,000
Faroe Islands	100 ¹	130	160	2,000
Sweden	60 ¹	80 ¹	100 ¹	500
Iceland ²	20 ¹	30	50	300
Finland	30	30	30	200
France	2 ¹	5 ¹	10 ¹	30
Subtotal	10,234 ¹	12,884 ¹	20,302 ¹	94,530
Pacific salmon				
Japan	1,150	2,122	2,900	8,000
United States	450 ¹	680 ¹	900 ¹	1,800
Canada	176	400 ¹	129 ¹	450
Chile	60	80	100	3,000
France	60	80	80	500
New Zealand	2 ¹	5 ¹	10 ¹	50
Subtotal	1,898 ¹	3,392 ¹	4,119 ¹	12,800
Grand total ¹	12,132	16,276	24,421	107,330

¹ NMFS estimates.

² Includes ocean ranching.

Table 2.—Norwegian exports of farmed salmon, by country, 1982-83.

Country	Exports (t)		Change (%)
	1982	1983	
France	2,710	4,293	+ 59
United States	930	2,486	+ 167
Germany (FRG)	1,850	2,466	+ 33
Denmark	1,240	1,957	+ 58
United Kingdom	930	1,381	+ 48
Sweden	590	824	+ 40
Belgium	370	558	+ 51
Switzerland	350	504	+ 44
Spain	270	453	+ 68
Netherlands	120	182	+ 52
Japan	40	134	+ 235
Finland	140	127	- 9
Other	40	94	+ 135
Total	9,412	15,464	+ 64

Source: Royal Norwegian Embassy, Washington, D.C., 1984.

creased from 9,400 t to 15,500 t, or by 4 percent (Table 2). Observers believe that the salmon exports increased because of the high quality of the fish and its year-round availability.

The Norwegian Government is actively assisting and regulating the salmon farming industry. The Government assists small-scale farmers by guaranteeing loans through the Regional Development Fund and the Agricultural Develop-

ment Fund. The Government also provides funds to research institutes studying salmon farming methods and reportedly pays a \$0.50/kg subsidy to airlines for shipping fresh farmed salmon.

The Norwegian Government regulates salmon farming by limiting the maximum size of fish farms. As a result, most Norwegian salmon farms are small; the average annual production of the 301 salmon farms (rainbow trout, *S. gairdneri*, was also produced by 122 of the salmon farms) operating in 1983 was 57 t (Table 3). This policy is intended to ensure that small-scale fish farmers can make a living. Additionally, the many small-scale salmon farming operations maintain an industry and a population in previously underpopulated coastal regions.

Japan

Japan farms only Pacific salmon in ocean cages. Japanese pen farming of salmon began in 1973, when 1 million coho salmon, *O. kisutch*, eggs were imported from the United States for freshwater culture. In 1975, the Japanese switched to marine pen-farming because the salmon grew faster in the ocean.

The Japanese production of pen-farmed cohos has increased from 72 t in 1978 to 2,900 t in 1983. Japanese companies are expected to produce 4,500 t of farmed salmon in 1984 and as much as 8,000 t in 1990. The Nichiro¹ company produced about half of the estimated 1984 production (2,500 t), followed by Taiyo (1,000 t), Nichimo (500 t), and other smaller companies (500 t). Currently, the entire production is consumed domestically and the farmed coho salmon does not compete with Japanese salmon imports from the United States, which are mainly sockeye salmon, *O. nerka*. While future increases in Japanese production are not expected to be exported, salmon farming may eventually reduce Japanese salmon imports, the majori-

¹Mention of trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

Table 3.—Number of Norwegian salmon farms and production, 1975–83.

Year	Number of farms		Production (t)
	Salmon only	Salmon/trout	
1975	18	27	862
1976	33	28	1,431
1977	53	31	2,137
1978	65	51	3,540
1979	72	75	4,389
1980	91	82	4,312
1981	97	118	8,907
1982	136	127	10,266
1983	179	122	17,016

Source: Norwegian Central Bureau of Statistics.

ty of which come from the United States. The Japanese Government does not offer financial incentives to salmon farmers.

United Kingdom

The United Kingdom (U.K.) is the only country outside Norway with a large and commercially successful Atlantic salmon farming industry. All U.K. salmon farming is located in Scotland, mostly in the protected fjord-like regions of the Western Isles and off the northwestern coast. Most salmon is farmed by large companies such as Marine Harvest and Golden Sea Products. Other important producers are McConnell Salmon, Joseph Johnson, Wester Ross, and Lancatch. Many small-scale salmon farms have also started commercial production in the past few years. Farmed salmon production has increased rapidly from only 600 t in 1980 to 2,500 t in 1983 (Table 4). Scottish officials are projecting that production will be about 4,000 t in 1984. Since there is a limited number of suitable sites, the production of farmed salmon is not expected to exceed 8,500 t in 1990.

The Scottish salmon farming industry could eventually expand its production beyond 8,500 t if projects on the more isolated islands prove successful, or if onshore tank culture becomes more profitable. The few tank farms currently operating have been only marginally profitable, but some observers believe that the expan-

Table 4.—U.K. farmed Atlantic salmon production, 1975–1990.

Year	Quantity (t)	Year	Quantity (t)
1975	200 ¹	1983	2,536
1976	400 ¹	1984	4,000 ²
1977	400 ¹	1985	4,300 ²
1978	450 ¹	1986	5,300 ²
1979	520	1987	6,000 ²
1980	598	1988	6,500 ²
1981	1,333	1989	7,500 ²
1982	2,152	1990	8,500 ²

¹ Estimated.

² NMFS projection.

Sources: Highlands and Islands Development Board (1975–79 estimates); Department of Agriculture and Fisheries for Scotland (1979–83 data).

sion of the Scottish salmon industry depends on the future success of these onshore projects.

The British Government provides little assistance to the salmon farms apart from regional development subsidy programs, which together with European Community (EC) assistance, have provided some start-up and working capital. While the Government does have some authority over fish farming (primarily to control fish diseases), there are no regulations preventing large corporations or foreign investors from operating a salmon farm. As a result, many Norwegian companies are playing an increasingly active role in the Scottish salmon industry.

Ireland

Ireland produces farmed Atlantic salmon by ranching and ocean cage methods. In 1983, Ireland produced 256 t of pen-farmed salmon, much of which was marketed in the United Kingdom. Several state-sponsored and private organizations are beginning salmon culture projects. The Irish Government granted the Salmon Research Trust of Ireland nearly \$50,000 in 1984 for studies which included the selective breeding of salmonids. The Irish Government does not, however, provide special incentives for salmon farming.

Canada

Canada is developing salmon ranching and cage farming to aug-

ment both its Atlantic and Pacific salmon catch. Most Canadian ocean cage farming of Atlantic salmon is in the province of New Brunswick, where 140 t was produced in 1982, a 300 percent increase over the 35 t farmed in 1981. Some observers believe that cold water temperatures along the Canadian Atlantic coast limit the potential for farming salmon.

Since 1975, cage-farmed Pacific salmon (pan-sized chinook, *O. tshawytscha*, and coho) have been produced in British Columbia. In 1983, production amounted to 129 t, less than 1981 and 1982 when 176 t and 425 t, respectively, were produced. Only 7 of the 14 salmon farms operating in British Columbia during April 1983-March 1984 reported any production, and one farm alone accounted for more than 50 percent of the total production of farmed Pacific salmon.

The Canadian Government apparently does not offer special incentives for cage farming, but does encourage private initiative in salmon culture. Canadian salmon farmers, however, have had problems obtaining sufficient quantities of smolts. In 1982, only 10 percent of the small 1982 smolt production was earmarked for salmon farmers; the rest was used by Government for salmon enhancement. A Norwegian company announced in 1984 that it plans to build a large smolt hatchery in New Brunswick that will produce 500,000 smolts by 1987.

Denmark (Faroe Islands)

Salmon farming in the Faroe Islands has grown considerably since it first began in 1980. Total production of pen-raised Atlantic salmon was 130 t in 1982 and 160 t in 1983. Marine farm production of Atlantic salmon is expected to approach 1,700 t by 1987. According to some reports, if hatcheries can supply more smolts, Faroese production could be substantially more than the projection.

The Faroese Home Rule Government strongly supports the export potential of salmon by providing technical assistance and giving invest-

ment loans to fish farmers. These preferential loans, provided by the Faroese Industrial Development Fund, are usually given for 10 years with a 2-year grace period and may cover up to 85 percent of the investment. The Government, concerned about the effects of marine fish farming on the environment, strictly regulates salmon cage farming.

Sweden

Sweden produced an estimated 100 t of pre-farmed Atlantic salmon in 1983. Most of the farmed salmon is cultured in the warmer waters off southern Sweden. No information is available on the Swedish Government's assistance to the salmon farming industry.

Chile

Chilean salmon farmers are attempting both ocean cage culture and ranching. Ocean ranching has achieved only marginal results, but the production of pen-farmed salmon is steadily increasing. The pen-raised salmon is produced primarily by two aquaculture development projects, one Japanese and the other U.S.-Chilean. The Canadian International Development Research Center is also studying a possible salmon culture project in Chile.

The production of farmed salmon in Chile increased from 80 t in 1982 to 100 t in 1983. A major feeding error, however, resulted in the loss of about 200 t of fish from the 1983 projected production of 300 t. Chilean salmon farmers estimate that by 1990, production may be as high as 3,000 t.

Chilean salmon farmers plan to market most of their production in the United States and Europe. Some Chilean growers believe that they will be able to profitably deliver fresh salmon to the U.S. market for \$3.00-\$3.50/kg. Because of the reversed seasons in the Southern Hemisphere, Chile will be able to supply fresh Pacific salmon to northern markets when fresh Pacific salmon is not available in the United States. The Chilean Government reportedly does not provide financial incentives for salmon farming.

France

France has been experimenting with ocean cage farming of coho salmon with the assistance of the U.S. Government (NMFS). The project, however, has not been successful in establishing a commercially feasible operation. The estimated production of farmed salmon in France during 1983 was about 80 t. By 1990, the annual production of farmed salmon may amount to 500 t.

The French are also experimenting with farming Atlantic salmon off Canada (St. Pierre and Miquelon) and in the Southern Indian Ocean (Kerguelen Islands). The salmon projects are supported by The French Scientific and Technical Institute of Ocean Fisheries (ISTPM), and are also eligible for subsidies from the European Community.

Iceland

Iceland's small farmed Atlantic salmon production, primarily from ocean ranching, is still in an experimental stage. Ocean cage farming has not been successful because Iceland lacks sufficiently protected fjords, and water temperatures are too cold during the winter. Icelandic scientists are nonetheless continuing efforts to develop the pen farming of Atlantic salmon. Icelandic salmon ranching, however, is expanding and may contribute significantly to future fishery exports. Salmon production by cage farming and ranching increased from 30 t in 1982 to 50 t in 1983. The Icelandic Government projects that the 1984 production will exceed 100 t.

Two companies are currently farming salmon in Iceland. The Icelandic-Norwegian joint venture company (ISNO), which operates Iceland's largest salmon farm, expects to produce about 35 t of farmed salmon in 1984. A U.S. salmon farming company, in a joint venture with an Icelandic investment company, plans to eventually produce 2,100 t of pen-farmed salmon annually in Iceland. The Icelandic Government operates some 40 salmon hatcheries and research stations, but does not provide

financial incentives to salmon farmers.

Finland

Finland's pen-farmed salmonid production is mainly rainbow trout, but some Atlantic salmon is also farmed. Currently only 30 t of farmed salmon is produced annually, but observers believe that Finnish production will increase. Salmon farmers receive no special financial incentives from the Finnish Government. Some salmon farms, however, in the so-called "developing areas" on the northern and northeastern coasts, receive grants and low-interest loans to help cover the high transportation costs.

New Zealand

The New Zealand salmon farming industry is still in the beginning stages. Since commercial fishing for wild salmon is illegal, the New Zealand salmon industry relies exclusively on Pacific salmon produced by ranching and cage farming. Salmon production statistics are not available, but New Zealand trade data show an export of about 7 t of salmon in 1983, of which the United States imported almost 90 percent (6 t).

The Government of New Zealand recently ended restrictive regulations on ocean farming to permit the further expansion of the salmon farming industry. The Government, however, does not provide any special assistance or incentives to prospective salmon farmers. Because salmon farming is considered a "new" industry in New Zealand, salmon farmers receive the same special tax benefits afforded to all new industries.

Australia

Salmon farming experiments in Australia have been successful and a commercial industry is expected shortly. Projects for ocean cage farming of Pacific salmon (chinook) in Victoria and of Atlantic salmon in Tasmania were underway in 1984. The Australian Government tightened regulations for imports of fresh salmon in September 1983 to reduce

the risk of disease in salmon farms. Most of the technology for the Australian salmon farms has been supplied by other countries. According to press reports, a Norwegian company will sign a contract with the Australian Government in the fall of 1984 to farm trout and salmon in Tasmania. The company intends to process the salmon produced according to the high quality standards followed in Norway. (Source: IFR-84/89B.)

Iceland's Fishing Imports and Exports

Iceland depends on its fishing industry for a healthy economy since fishery products account for almost 75 percent of its total exports. In 1983, however, the fishing industry faced severe problems such as declining fish stocks, rising operating costs, stagnant prices, as well as increased competition in important export markets. Even though the Icelandic fisheries catch increased from 783,000 metric tons (t) to 819,000 t during 1982-83, the ex-vessel value of the catch decreased from \$274 million to only \$240 million.

Cod has traditionally been Iceland's most important species, but the catch in 1983 was the smallest since 1948. While the 1983 cod quota was set at 300,000 t, Icelandic fishermen landed only 290,000 tons. The Icelandic capelin fishery was allowed to resume in October 1983 after a 1-year suspension. The increasing capelin catch, however, will not make up for the decreasing cod catch because the value of capelin landings is estimated at only one-tenth that of cod (per unit weight).

Iceland's fishery exports increased in value during 1983 mainly because production was switched from salted and dried fish to higher valued frozen products. Exports of frozen fish in 1983 were valued at \$307 million compared with \$256 million in 1982. The U.S. continued to be Iceland's most important export market for fishery products. In 1983, Iceland exported \$196 million worth of fishery prod-

ucts to the U.S. (mostly frozen fillets and blocks), or 38 percent of Iceland's total fishery exports.

The National Technical Information Service has made available a report on the Icelandic fishing industry in 1983. The 10-page report, prepared by the U.S. Embassy in Reykjavik, includes statistical tables on catch and fisheries trade. U.S. companies can obtain a copy of this report for \$7.00 by requesting report number PB-84-245208 ("The Icelandic Fishery: 1983 Report and 1984 Outlook") from the National Technical Information Service, U.S. Department of Commerce, Springfield, VA 22161. (Source: IFR-84/72-NTIS.)

Panama's Fishing Industry Reviewed

The Panamanian fishing industry rebounded strongly in 1983, as a result of a sharp increase in the anchovy catch. Over 142,000 metric tons (t) of fish and shellfish were landed in 1983, doubling the 1982 catch. Shrimp is Panama's most important fishery and the country's second most important export commodity. The shrimp catch declined slightly in 1983. Many observers believe that shrimp culture will enable Panama to increase its shrimp production substantially. The shrimp industry is expanding and the Government estimates that the area of shrimp ponds may double by 1987.

The U.S. Embassy in Panama has prepared a 42-page report on the Panamanian fishing industry. The report reviews the shrimp industry (both the trawler fishery and pond culture), fish aquaculture, artisanal fishing, and the trout, anchovy, herring, shark, and tuna fisheries. Statistical appendices and lists of government fishery organizations, international organizations, fishery associations, fishing companies, shipyards, and marine equipment suppliers are also included. A copy can be obtained by ordering report number PB-85-100972 from NTIS, Springfield, VA 22161 for \$8.50. (Source: IFR-84/76 NTIS.)

Peru, Belize Promote Culture of Shrimp

Peru and Belize have some of the smallest shrimp fisheries in South and Central America, respectively (Table 1). However, several projects are underway in both nations which could greatly expand their culture and the export of shrimp.

Peruvian Shrimp Development

Peru is currently developing a shrimp culture industry that will enable it to substantially increase production. Almost all of Peru's shrimp culture takes place in the northern province of Tumbes which borders Ecuador, and the species cultured are almost entirely *Penaeus vannamei* and *P. stylirostris*.

Peruvian shrimp culture began in the middle 1970s. One of the leading investment groups to enter the industry was Inversiones Nueva York¹ (INY) which began operations in 1977. INY currently includes six companies which operate 650 hectares of ponds in the La Cruz District of Tumbes Province. INY also operates a processing plant with two plate freezers and one freezing tunnel which, combined, can freeze about 11 metric tons (t) of shrimp in an 8-hour shift. INY exported its first shrimp in 1979, a \$0.3 million shipment to New York, but increased shipments to \$3.2 million by 1982.

Expansion

The Peruvian shrimp culture industry had expanded to about 30 companies by 1983. Most companies are small and only operate about 20-30 hectares of ponds, but a few, like INY, are substantially larger. One estimate by Alejandro Bermejo, editor of Peru's fisheries magazine *Pesca*, suggests that in 1983 there were less than 1,500 hectares of ponds in the entire country. Another more recent estimate by the Ministry of

¹ Mention of trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

Table 1.—Shrimp catch in South and Central America, 1982¹.

Country	Catch (t)	Country	Catch (t)
Brazil	47,530 ²	Chile	3,450
Ecuador	29,500	El Salvador	3,217
Panama	14,732	Honduras	2,686
Argentina	7,814	Nicaragua	2,655
Colombia	6,028	Guatemala	2,490
Venezuela	4,747	Costa Rica	2,270
Guyana	4,005	Peru	460 ⁴
Surinam	3,997 ³	Belize	100 ²

¹ Source: FAO "Yearbook of Fishery Statistics, 1982."

² FAO estimate.

³ Data for 1981.

⁴ Probably does not include cultured shrimp.

Fisheries suggests that there were about 2,000 hectares of ponds in Peru as of early 1984. Data is not available on actual production, but Bermejo estimates that most operators are achieving yields of at least 1 t of shrimp per year for each hectare of pond which would mean that Peru is currently culturing about 1,500-2,000 t of shrimp per year.

Peruvian shrimp culturists face two problems. The most immediate problem, limiting the growth of the country's shrimp culture industry, is a reliable, year-round source of postlarvae. There are no shrimp hatcheries in Peru. All postlarvae used for stocking are collected in the mangrove swamps by artisanal fishermen. As a result, the supply of post larvae is erratic. The availability of postlarvae is seasonal, following the natural life cycles of the shrimp, and the artisanal fishermen cannot distinguish between shrimp species. *P. vannamei* is generally preferred by the pond

operators, but the postlarvae delivered to the pond operators are a mixture of species. Studies of the life cycles of the various species, especially *P. vannamei* and *P. stylirostris* could help the fishermen to adjust their gathering practices so as to collect larger proportions of the desired species. The Government, however, has not yet conducted such studies. A longer term problem is the destruction of the country's mangroves to build ponds and for other purposes. Peruvian authorities, however, do share the concern of Ecuadorean officials over the gradual destruction of the mangroves.

Damage

Peru's shrimp culture industry was severely damaged in 1983 by the flooding which accompanied the 1982-83 El Niño event. Northern Peru was hit by some of the worst floods in the country's history. The serious flooding began in January and, as a result, pond operators could not resume operations until July. Not only were many ponds damaged, but the destruction of roads and bridges brought transportation in Tumbes Province to a standstill. Most companies did not resume exporting until November. Some observers were concerned that the ponds would be impaired for years because of the large quantity of silt and vegetable matter which was washed into them. The same situation reportedly affected the operations of some Ecuadorean ponds. The Peruvians claim, however, that to avoid such problems they contracted a Japanese consultant, and as a result of his suggestions, the ponds are reportedly now functioning better than before the floods.

The Peruvian Government through the Banco Industrial de Peru (BIP) and the Peruvian Development Corporation (COFIDE) have helped pond operators to obtain credits for initial operations. Investors are now asking for additional credits. Local pond operators estimate that 4,000-8,000 hectares of ponds could be built in northern Peru. Industry sources estimate that it costs about

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\$0.25 million per 100 hectares to build ponds. As a result, an additional \$10-20 million are needed to fully develop the area's potential. INY Managing Director, Eduardo Gonzalez, estimates that such an investment could eventually bring Peru \$8 million annually in additional export earnings. Other observers believe that export earnings could eventually exceed \$15 million. Given Peru's difficult financial situation, however, Government assistance is hard to obtain.

Peruvian Exports

Shrimp culture has enabled Peru to increase its shrimp exports in recent years. U.S. import statistics show an unrealistically large increase, from only \$0.9 million in 1977 to \$35.9 million in 1983 (Fig. 1). This data, however, is misleading. No data is available just for cultured shrimp. U.S. imports include shrimp caught by Peruvian trawler fishermen and shrimp smuggled in from Ecuador to avoid that country's export regulations. Unconfirmed reports suggest that most of the sharp 1983 increase was due to the excellent year experienced by the trawler fishermen

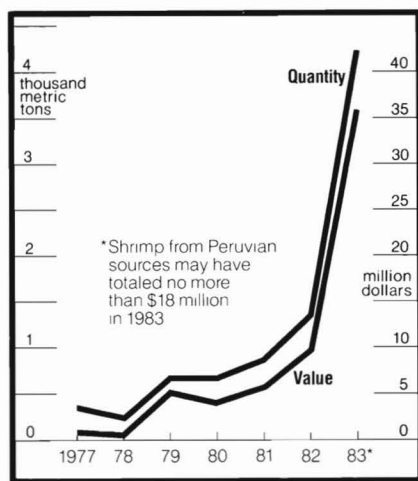


Figure 1. — Peruvian shrimp exports to the United States, 1977-83. Peruvian observers report that the value of shrimp from strictly Peruvian sources, cultured and trawler caught, probably totaled no more than \$18 million in 1983.

and the illegal shipments from Ecuador. These unconfirmed Peruvian reports are probably accurate as the extensive coastal flooding must have caused the production and export of cultured shrimp to have declined in 1983. Recent reports from Peru, however, suggest that the exports of cultured shrimp will increase in 1984. One estimate suggests that about 1,800 t of shrimp worth about \$15 million will be exported in 1984. (Source: IFR-84/39.)

Belizian Shrimp Culture

Belize has the smallest shrimp fishery in Central America (Table 1), with a 1982 harvest of only about 100 t. Some observers believe, however, that the country has the potential to culture sizeable quantities of shrimp, and several projects are underway which could make Belize an important Central American shrimp producer by 1990.

Five groups are currently involved with shrimp culture projects in Belize: Two projects are under construction, two other groups have finalized their plans but are seeking financing, and the remaining project is in the planning stage. The pond operators have not yet cultured any sizeable quantities of shrimp. One of the operators, however, produced about 2.2 t (whole weight) of shrimp in 1983 on 3 hectares of ponds as a pilot project. The shrimp was marketed locally, but because of personnel changes, those ponds have not been used in 1984. There were no exports of cultured shrimp in 1983 and such shipments are unlikely in 1984. Two pond operators plan to begin production in 1984 and hope to begin exporting by 1985. Pond operators are culturing *Penaeus vannamei* and *P. stylirostris*, the same species that are cultured in Ecuador and Peru. Recent reports from Belize indicate that *P. monodon* is being tried. Most operators also plan to experiment with *P. schmitti*, but it may be some time before those trials are conducted.

Pond Construction

One project, under construction near Belize City, will include a hatch-

ery with the capacity of producing over 50 million postlarvae per year in 40 hectares of ponds. Eventually, they plan to build about 400 hectares of ponds, sell postlarvae in the United States, and produce about 70 t of shrimp tails by 1985.

General Shrimp Ltd., managed by John R. Snell, is currently constructing 120 hectares of ponds. General Shrimp also plans a hatchery which, however, may not be capable of fully stocking all the ponds the company plans to build. Snell hopes to produce about 580 t of shrimp per year, but some local observers believe 250 t per year is more likely.

Silver Creek Shrimp Farms, directed by Russ Allen, hopes to begin constructing 200 hectares of ponds at Independence in Stann Creek District by September 1984, and to begin production by 1985. Allen and his partners hope to harvest about 225 t of shrimp in 1985, and rapidly expand production thereafter.

Shrimp Feed

Domestically milled shrimp feed is not yet available in Belize. Feed is currently being imported from the United States and Honduras. A mill for livestock feed is under construction. If Belize's shrimp culture industry expands as expected, the new mill may eventually also produce shrimp feed.

Pond operators do not yet know what yields they will be able to achieve in Belize. Most believe that they will be able to produce 2-3 crops per year and, initially, achieve yields of 0.1-0.2 t of shrimp per hectare for each crop. Most plan to produce primarily mid-sized shrimp (Fig. 2).

Industry Expansion

The rate at which the industry will develop is unclear. The Belizian shrimp culture industry is now limited by a shortage of postlarvae to stock the ponds. The key to the development of the industry will be the production of postlarvae in hatcheries. Once there are operational hatcheries in the country, the industry could expand rapidly. The number of individuals, however, with the necessary

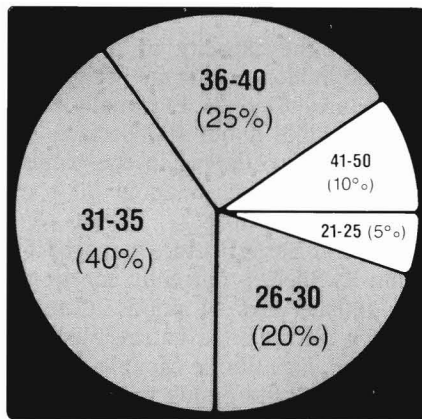


Figure 2. — Projected proportions of Belizean shrimp production (shrimp per pound).

expertise to operate a modern shrimp hatchery, is limited. It is not yet clear whether Belize will be able to attract such individuals. Without hatcheries to supply postlarvae, the growth of the industry will be severely restricted.

Belize does appear to have considerable land which could be devoted to shrimp culture. One estimate suggests that there are over 40,000 hectares of land which could be used for shrimp culture. Belize does have one major disadvantage when compared with shrimp culture operations in Ecuador. The tidal range is only about 0.3 to 0.5 m which will mean that considerable quantities of water will have to be pumped. Other basic data such as soil suitability, availability of freshwater, predation, roads, and infrastructure are not readily available. The companies involved in Belize, however, believe that conditions will support viable commercial operations, but that it could take up to 20 years to fully develop the country's potential.

Companies are beginning to build ponds and it has been projected that there may be as many as 7,200 hectares of ponds in production by 1989 (Table 2). Some optimistic local observers believe that production of cultured shrimp could reach 20,000 t by 1989. At least some of the investors currently proceeding with shrimp culture projects believe that

Table 2.—Projected area of Belizean shrimp ponds, 1985–89.

Project	Pond area (hectares)				
	1985	1986	1987	1988	1989
Bowen & Allen	200	200	400	800	1,200
Zabanch & Allen	80	200	200	400	800
Jackson	40	140	200	300	400
Snell	120	120	200	300	400
Crosby		200	200	400	400
Others	40	80	400	2,000	4,000
Total	480	940	1,600	4,200	7,200

¹ Source: NMFS Branch of Foreign Fisheries Analysis estimates.

they have solved most of the serious technical problems. The difficulties associated with pond building and beginning production in such a large number of new ponds, however, suggest that production will not reach optimal levels during the first few years. It is also unlikely that an adequate number of postlarvae will be available to stock such a large number of ponds.

As a result, while the large number of variables involved makes projecting future production levels difficult, the NMFS Branch of Foreign Fisheries Analysis believes that production is not likely to exceed about 10,000 t by 1990. This would still be a massive increase over the projected 1985 and 1986 production (400 and 1,000 t, respectively) of Belize's small shrimp fishery and would also make the country one of Central America's major shrimp producers. In addition, such production would be achieved using only a small part of the 40,000 hectares potentially available for shrimp culture. (Source: IFR-84/46.)

Mexico Hikes Fines for Illegal Foreign Fishing

The Mexican Government has begun assessing sharply increased fines to foreign fishermen arrested for fishing in Mexico's 200-mile Exclusive Economic Zone (EEZ) without a valid license. The Government has fined foreign fishermen up to 2.5 million pesos (\$12,500) for repeated

offenses.

Mexican newspapers reported in late 1984 that the U.S. shrimp trawler *BBC* was to be fined 2.5 million pesos. The *BBC* was seized 10 October about 4 miles south of the U.S.-Mexican marine border. The newspapers claimed that the Mexican Government assessed the unusually heavy fine because the *BBC* had been previously seized and fined.

The vessel's owner contended that the *BBC* should not have been charged as a repeat offender because a different owner operated the vessel when it was seized in June. The Mexican Government contended that the owners of seized U.S. shrimp trawlers often make paper changes in ownership after their vessels are released. As a result, Mexican officials intend to apply the higher repeat-offender fines if a vessel was previously seized, regardless of the vessel name or identify of the owner.

The Secretariat of Fisheries (SEPESCA) has recommended that the total of all previous fines be doubled when foreign vessels are seized three or more times in the EEZ. SEPESCA is trying to dissuade U.S. fishermen from shrimping in Mexican waters, but would like to avoid the more drastic measure of confiscating the vessels. In the *BBC* case, the Government decided to fine the *BBC* 2.4 million pesos. The fine is double the 1.2 million pesos that the *BBC* was fined after being seized in June.

The Mexican Navy subsequently announced plans to increase surveillance activity off the state of Tamaulipas. Vice Admiral Hector Argudin Estrada told reporters on 8 November that the Navy will redouble efforts to seize U.S. shrimp trawlers off Tamaulipas. Argudin also stated that so far in 1984, the Navy has seized about the same number of U.S. trawlers as in 1983. This statement came as a surprise to some observers. While the Navy has not released a list of seized vessels, only a small number of seizures has been reported by the Mexican press in 1984. During 1983, the press reported the seizure of 68 U.S. shrimp trawlers. (Source: IFR-84/94.)