# The U.S.-Canadian Fisheries Trade

## Introduction

Canada and the United States share the world's largest commercial relationship, and the trade turnover between the two countries amounted to over $113 billion in 1984. Bilateral fisheries trade is relatively small—about $1 billion, or less than 1 percent of the total trade, and has fluctuated in recent years. However, the United States is Canada's most important fisheries market, while Canada remains a large market for U.S. fishery products.

Canada is the world's leading exporter of fishery products, shipping over $1.2 billion ($1.6 billion Canadian dollars) of fishery products worldwide in 1984. These exports account for about 7-8 percent of the world fisheries trade. Over half of Canada's fishery exports are shipped to the U.S. market.

Fishery exports to the United States have increased annually since 1980, mostly because of competitive Canadian fishery prices. In 1984, the United States imported $800 million worth of Canadian fishery products, most important being cod, flatfish and other groundfish, salmon, crab, lobster, and scallops. The fastest increasing fishery commodity exports were whole and filleted fresh fish and frozen shellfish (mostly crab and lobster).

Canada is the second largest market (after Japan) for U.S. fishery exports, and it also buys more fishery products from the United States than from any other country. In 1984, the United States exported nearly 38,000 metric tons (t) of edible fishery products worth $122.5 million to Canada. U.S. fishery exports to Canada have consisted mostly of shrimp and salmon and have fluctuated in recent years primarily because of the adverse effects of a strong U.S. dollar. Many U.S. fishery products exported to Canada are processed and reexported elsewhere, often back to the United States. On the other hand, some Canadian fishery products shipped to the United States are processed and reexported back to Canada.

## Canada's Fisheries Market

Canada's domestic fisheries market is relatively small and consumes only about 15 percent of the country's total catch. Canada has a population of 25.4 million and per capita consumption of edible fishery products is only 6.4 kg. The Government is actively promoting increased fish consumption and has designated November as the "Fish and Seafood Month." In January 1984, the Department of Fisheries and Oceans (DFO) launched an extensive advertising campaign to promote increased fish consumption. The 5-year campaign aims at increasing annual fish and shellfish consumption. Despite all these efforts, however, and even if domestic consumption increases, the Canadian fishing industry will remain greatly dependent on export markets.

## Canada's Fisheries Trade

Canada exported $1.2 billion[1] worth of edible fishery products in 1984, about the same as in 1983. The most important export markets, by value, were the United States, Japan, and the European Community (Fig. 1). Expanded exports of canned herring and frozen cod fillets accounted for the incresed shipments of Canadian fishery products to world markets in 1984. Canadian exports to the EC decreased compared with 1983, but expanded to other markets, such as the United States, Japan, and Latin America. In addition to remaining the world's largest exporter of fishery products, Canada also had the largest trade surplus in fishery products—about $860 million.

Canada's fishery imports totaled $380 million in 1984, a 17 percent increase compared with the value of 1983 imports. Major suppliers were the United States, 55 percent; Europe (EC and other countries), 9 percent; Latin America, 8 percent; and Japan, 7 percent. The imports of fresh and frozen shellfish, canned shellfish, and fresh and frozen finfish incrased the most in 1984. Imports from the EC decreased, but imports from other European countries, the United States, Japan, and Latin America all increased.

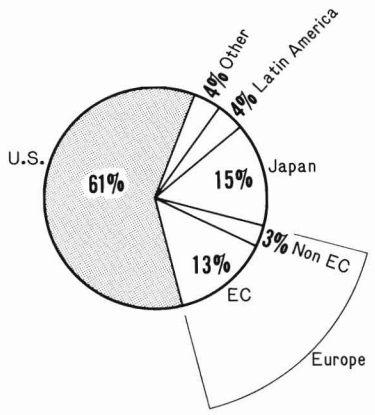


Figure 1.—Canada's fishery exports, by value, 1984 (total = $1.2 billion).

## U.S.-Canadian Fisheries Trade

In recent years, Canadian exports to the United States have increased much faster than U.S. exports to Canada. The value of Canadian exports to the United States (in real dollars) has increased from over $600 million in 1979 to nearly $800 million in 1984, or by 25 percent. However, when the value of these exports is measured after adjusting for the rate of inflation, using the U.S. Department of Commerce Consumer Price Index, a decrease of nearly 9 percent is noted in the value of Canadian fishery exports to the United States from 1979 to 1984 (Fig. 2). Therefore, it is necessary to look more closely at the quantity of Canadian fishery products shipped to the United States during 1979-84.

### Quantities Shipped

Canadian exports (despite smaller harvesting setbacks in 1980 and 1983) have increased from 280,000 t in 1979

[1]All monetary figures are in U.S. dollars.

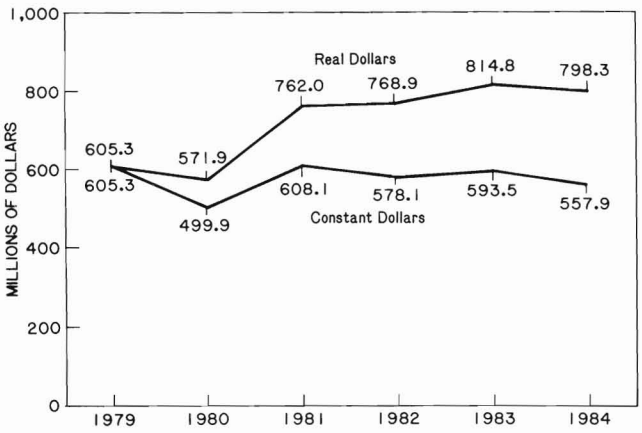


Figure 2.—U.S. fishery imports from Canada, by value in real and constant dollars, 1979-84.

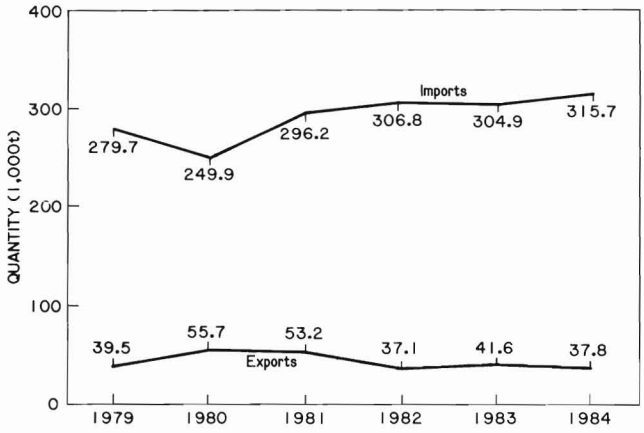


Figure 3.—U.S. fisheries trade with Canada, by quantity, 1979-84.

to nearly 316,000 t in 1984, or by about 11 percent (Fig. 3). Most was due to expanded Canadian exports of Atlantic cod and lobster to the U.S. market. Because Canadian observers expected a decreased Canadian cod harvest in 1985, exports of cod to the U.S. market were also expected to decrease. Canadian lobster stocks, on the other hand, are considered to be quite healthy and a measurable decrease in exports was not anticipated for 1985. During the first 9 months in 1985, Canadian lobstermen reported an incresed lobster harvest.

U.S. fishery exports to Canada have decreased since the early 1980's, mostly because of the strong U.S. dollar. In 1980, U.S. exports hit a record high 55,700 t, worth $148 million. These exports have gradually fallen to 37,800 t, worth only $123 million in 1984. Furthermore, part of U.S. fishery shipments to Canada are not consumed there, but are only processed in Canada and then transshipped elsewhere.

**Table 1.—Canada's edible fishery exports (total to all countries compared with shipments to the United States) by quantity and value, 1979-84[1].**

| Year | Quantity (1,000 t) Total | Quantity (1,000 t) To U.S. | Percent of total | Value (US$million) Total | Value (US$million) To U.S. | Percent of total |
|---|---|---|---|---|---|---|
| 1979 | 472.6 | 243.7 | 51.6 | 1,114.8 | 591.9 | 53.1 |
| 1980 | 478.5 | 218.4 | 45.6 | 1,094.5 | 560.6 | 51.2 |
| 1981 | 515.9 | 263.2 | 51.0 | 1,260.8 | 749.4 | 59.4 |
| 1982 | 530.6 | 277.6 | 52.3 | 1,299.7 | 758.8 | 58.4 |
| 1983 | 479.7 | 276.1 | 57.6 | 1,279.2 | 805.6 | 63.0 |
| 1984 | 460.7 | 273.7 | 59.4 | 1,234.2 | 787.8 | 63.8 |

[1]Sources: NMFS "Fisheries of the United States," various years; Statistics Canada, "Exports by Commodities," December 1984; and FAO "Yearbook of Fishery Statistics," 1983.

## Industry Subsidies

Fisheries trade between Canada and the United States may be greatly affected by recent developments. In December 1984, the U.S. International Trade Commission (ITC) released a report documenting the Canadian Government's subsidies to its fishing industry of nearly $106 million. The U.S. fishing industry has petitioned the ITC and Commerce Department concerning possible injuries suffered from the Canadian subsidies.

One petition, concerning Canadian salted cod competing with the U.S. industry, recently resulted in anti-dumping duties being placed on imports of Canadian skin-on heavily salted cod entering the United States. Another petition sought countervailing duties on fresh Canadian groundfish shipments competing with the New England fishing industry. This petition was submitted to the ITC on 5 August 1985. On 11 September 1985, the five ITC commissioners unanimously decided that there was a reasonable indication that the U.S. fishing industry was being materially injured by allegedly subsidized imports of groundfish from Canada. As a result of this decision, the U.S. Department of Commerce will continue its investigation of the Canadian groundfish industry to determine whether the harvesting, processing, or export of groundfish is being subsidized. A preliminary determination of the existence of subsidies was due on 2 January 1986. If this finding is positive, both the ITC and the Commerce Department will initiate more in-depth investigations leading to final determinations of domestic injury and foreign subsidies. Countervailing duties, equal to the amount of subsidies, will be applied to U.S. imports of groundfish products from Canada if these final determinations are positive. Canadian policy-makers are concerned about the U.S. industry's complaints and were encouraging Canadian groundfish exporters to seek alternative markets.

## U.S. Imports

Canadian fishery exporters depend heavily on the U.S. market. In 1984, about 60 percent of Canada's edible fishery exports were shipped to the United States (Table 1). Although 1984

was the record-high year for the quantity of fishery shipments to the United States, their value was less than in 1983; nearly $800 million of fishery products were shipped to the United States in 1984, a decrease of 2 percent compared with 1983. Canadian exports consisted mainly of whole fresh fish, frozen fillets, and fresh and frozen shellfish in 1984; these shipments accounted for 62 percent of the quantity and nearly 70 percent of the value of total exports to the United States. The remainder of the shipments consisted of cured fish, fishmeal and oil, canned fish and shellfish, and other commodities.

## Commodities

### *Fish Fillets and Whole Fish*

Representing the largest and most valuable Canadian commodity exported to the United States, fresh and frozen fish fillet shipments amounted to 100,000 t worth over $300 million in 1984 and accounted for about 38 percent of the total exports (Tables 2 and 3). Fillet exports have increased since 1979, mostly because Canadian processing capacity increased but also because filleted fish commands higher prices and therefore brings added value to Canadian exports. Shipments of whole fresh and frozen fish have also increased substantially from $60 million in 1979 to over $100 million in 1984. These greatly increased fresh-fish shipments have helped to trigger the countervailing duty petition filed by elements of the U.S. fishing industry in the Northeast.

### *Blocks*

Groundfish blocks (mostly cod) faced a weaker market in 1984 and, as a result, exports decreased to $87 million (compared with $123 million in 1983), considerably below the average level during the previous 6 years. Large Canadian cod block inventories early in 1984 forced prices downward. The high inventories occurred because of increased competition from Denmark, Iceland, and Norway for the U.S. market. For example, Denmark's cod block exports to the United States, offered at low prices and enjoying favorable currency exchange rates and reputation for high quality, grew from $20 million in 1982 to $47 million in 1984, and helped increase Denmark's market share for the cod block market in the United States from 13 to 29 percent. Over the same period, Canada's market share for its frozen blocks decreased from 53 to 43 percent.

### *Shellfish*

Canadian shellfish exports to the United States have increased since 1979 mostly because of greater lobster shipments. Over two-thirds of the exported shellfish is shipped fresh or frozen: The remainder is sent live or canned. Fresh and frozen shellfish shipments decreased to $150 million in 1984, after reaching a record $184 million in 1983. This decrease was mostly caused by falling scallop shipments. The value of live shellfish exports (mostly because of increased Canadian lobster harvests) has

**Table 2.—U.S. fishery imports[1] from Canada by commodity and quantity, 1979-84.**

| | Quantity (t) | | | | | |
|---|---|---|---|---|---|---|
| Commodity | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 |
| Edible | | | | | | |
| Fish | | | | | | |
| Fresh, frozen | | | | | | |
| Whole | 51,646 | 42,927 | 45,073 | 58,847 | 62,493 | 76,102 |
| Fillets | 81,150 | 69,128 | 99,910 | 102,556 | 92,439 | 103,012 |
| Blocks | 56,043 | 54,593 | 53,271 | 49,252 | 56,188 | 45,664 |
| Loins, disks | 11 | | | | 12 | |
| Subtotal | 188,850 | 166,648 | 198,254 | 210,655 | 211,132 | 224,778 |
| Canned | | | | | | |
| In oil | 1,463 | 1,324 | 1,455 | 1,187 | 1,167 | 1,350 |
| Not in oil | 2,569 | 1,985 | 2,163 | 1,965 | 2,814 | 1,538 |
| Subtotal | 4,032 | 3,309 | 3,618 | 3,152 | 3,981 | 2,888 |
| Cured | 26,493 | 23,686 | 30,944 | 29,197 | 27,358 | 26,993 |
| Roe | 178 | 206 | 220 | 235 | 137 | 258 |
| Other | 1,484 | 860 | 903 | 767 | 712 | 779 |
| Subtotal | 221,037 | 194,709 | 233,939 | 244,006 | 243,320 | 255,696 |
| Shellfish | | | | | | |
| Live | 6,530 | 5,467 | 6,938 | 7,724 | 9,199 | 10,688 |
| Fresh, frozen | 15,077 | 14,706 | 20,220 | 21,266 | 21,355 | 19,512 |
| Canned | 1,070 | 1,340 | 1,646 | 2,130 | 1,010 | 444 |
| Subtotal | 22,677 | 21,513 | 28,804 | 31,120 | 31,564 | 30,644 |
| Inedible | | | | | | |
| Meal, scrap | 24,703 | 21,957 | 22,014 | 22,441 | 20,893 | 21,392 |
| Oil | 6,343 | 6,670 | 8,170 | 5,237 | 7,048 | 6,085 |
| Other | 4,924 | 5,038 | 3,316 | 3,988 | 2,061 | 1,929 |
| Subtotal | 35,970 | 33,665 | 33,500 | 31,666 | 30,002 | 29,403 |
| Grand total[2] | 279,684 | 249,887 | 296,243 | 306,792 | 304,886 | 315,746 |

[1]Source: U.S. Department of Commerce, Bureau of the Census.
[2]Totals may not agree because of rounding.

**Table 3.—U.S. fishery imports[1] from Canada by commodity and value, 1979-84.**

| | Value (US$million) | | | | | |
|---|---|---|---|---|---|---|
| Commodity | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 |
| Edible | | | | | | |
| Fish | | | | | | |
| Fresh, frozen | | | | | | |
| Whole | 59.5 | 63.2 | 71.7 | 77.4 | 83.1 | 102.2 |
| Fillets | 208.1 | 179.7 | 276.7 | 293.1 | 270.1 | 301.1 |
| Blocks | 116.2 | 111.9 | 109.5 | 101.2 | 123.4 | 87.2 |
| Subtotal | 383.8 | 354.8 | 457.9 | 471.7 | 476.6 | 490.5 |
| Canned | | | | | | |
| In oil | 3.8 | 3.4 | 3.9 | 3.4 | 3.0 | 3.6 |
| Not in oil | 7.2 | 6.3 | 7.4 | 6.4 | 9.8 | 5.6 |
| Subtotal | 11.0 | 9.7 | 11.3 | 9.8 | 12.8 | 9.2 |
| Cured | 53.2 | 48.6 | 70.6 | 61.4 | 54.3 | 54.1 |
| Roe | 0.7 | 0.9 | 1.2 | 0.9 | 0.7 | 1.6 |
| Other | 3.1 | 1.7 | 2.5 | 1.8 | 1.5 | 1.8 |
| Subtotal | 451.8 | 415.7 | 543.5 | 545.6 | 545.9 | 557.2 |
| Shellfish | | | | | | |
| Live | 33.5 | 31.2 | 44.2 | 48.8 | 61.7 | 76.8 |
| Fresh, frozen | 93.5 | 96.9 | 138.7 | 132.0 | 183.6 | 148.8 |
| Canned | 13.0 | 15.3 | 22.3 | 30.7 | 12.7 | 4.9 |
| Subtotal | 140.0 | 143.4 | 205.2 | 211.5 | 258.0 | 230.5 |
| Inedible | | | | | | |
| Meal, scrap | 8.3 | 7.3 | 8.0 | 7.5 | 6.9 | 7.0 |
| Oil | 2.6 | 2.4 | 2.9 | 1.7 | 2.4 | 2.3 |
| Other | 2.6 | 3.1 | 2.4 | 2.6 | 1.4 | 1.2 |
| Subtotal | 13.5 | 12.8 | 13.3 | 11.8 | 10.7 | 10.5 |
| Grand total[2] | 605.3 | 571.9 | 762.0 | 768.9 | 814.8 | 798.3 |

[1]Source: U.S. Department of Commerce, Bureau of the Census.
[2]Totals may not agree because of rounding.

more than doubled since 1979 and amounted to $77 million in 1984. Canned shellfish exports have fluctuated greatly, increasing from $13 million in 1979 to $31 million in 1982, but in 1984 exports dropped to only $5 million.

## Species

Cod was by far the most important species of fish exported by Canada to the United States in 1984, and totaled 98,200 t worth nearly $226 million (Tables 4 and 5). Other groundfish exports amounted to over $200 million in 1984. Lobster, scallops, crabs, Pacific salmon, and herring were also important species shipped to the United States.

### *Cod*

In the early 1980's, because of the increased availability of cod resources, Canada's cod exports flourished. It appears that these exports—especially to the United States—may level off or even decrease in the future as the resource becomes more regulated and the competition from other cod harvesting nations stiffens. Although Canada exports much of its cod to the United States in fillet or block form, shipments of whole fresh cod greatly increased in 1984. This increase helped spark the recent countervailing duty petition by elements of the U.S. fishing industry.

The Canadian Government, through the Fisheries Price Support Board[2], began to administer a new $11 million program to stabilize frozen cod prices in 1984. The Board purchased 195 t of frozen cod fillets during the summer of 1984, when Canadian processors had marketing problems. The cod fillets were resold to suppliers when prices increased.

[2]The Fisheries Prices Support Board was formed following the 1947 adoption of the Fisheries Prices Support Act by the Canadian Government. The Board is responsible for investigating and recommending actions to support prices for fishery products when economic reverses occur in the fishing industry.

### *Other Finfish*

Species such as haddock, Pacific salmon, and various redfishes and flatfishes are also important exports to the United States (i.e., almost all of Canada's haddock exports were shipped to the United States in 1984). Pacific salmon exports have also increased in recent years, despite the fact that this Canadian fishery suffered reverses during the past 2 years. Early in the 1985 fishing season, Canadian Pacific salmon fishermen reported greatly increased harvests. Various flatfish and rockfish exports (and harvests) have fluctuated.

**Table 4.—U.S. fishery imports[1] from Canada by species and quantity, 1979-84.**

| | Quantity (t) | | | | | |
|---|---|---|---|---|---|---|
| Species | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 |
| Edible | | | | | | |
| Fish | | | | | | |
| Catfish | 1,016 | 784 | 1,400 | 1,400 | 1,458 | 742 |
| Cod | 65,640 | 63,979 | 72,821 | 83,682 | 95,720 | 98,201 |
| Flatfish[2] | 23,255 | 17,194 | 26,791 | 20,785 | 17,018 | 21,294 |
| Groundfish[2] | 31,077 | 29,060 | 43,440 | 39,490 | 38,310 | 40,142 |
| Halibut | 1,464 | 2,627 | 2,465 | 2,795 | 2,638 | 3,602 |
| Herring | 28,980 | 18,276 | 17,703 | 22,614 | 22,432 | 19,412 |
| Mackerel | 2,412 | 2,434 | 1,779 | 1,527 | 1,482 | 3,020 |
| Perch | 18,432 | 11,578 | 18,205 | 20,031 | 15,378 | 19,129 |
| Pollock | 360 | 980 | 874 | 1,166 | 1,743 | 1,286 |
| Salmon | 2,631 | 2,787 | 3,090 | 4,424 | 4,911 | 5,466 |
| Sardines | 1,577 | 1,480 | 1,583 | 1,303 | 1,282 | 1,643 |
| Swordfish | 2 | 121 | 2 | | 237 | 229 |
| Trout | 179 | 318 | 370 | 252 | 340 | 245 |
| Tuna | 109 | 140 | 161 | 207 | 1,997 | 321 |
| Turbot | 7,914 | 8,360 | 7,471 | 5,456 | 4,381 | 5,107 |
| Whitefish | 3,364 | 3,709 | 3,369 | 3,749 | 4,311 | 3,854 |
| Other | 32,551 | 30,849 | 32,350 | 35,020 | 29,624 | 31,888 |
| Subtotal | 220,963 | 194,676 | 233,874 | 243,901 | 243,262 | 255,581 |
| Shellfish | | | | | | |
| Abalone | 44 | 16 | 12 | 36 | 36 | 23 |
| Clams | 2,047 | 1,998 | 3,001 | 3,134 | 3,806 | 4,120 |
| Crabs | 1,392 | 2,405 | 5,330 | 8,545 | 6,711 | 6,524 |
| Lobster | 8,200 | 7,556 | 9,455 | 10,164 | 12,023 | 13,979 |
| Oysters | 11 | 8 | 58 | 86 | 91 | 383 |
| Scallops | 9,037 | 6,929 | 8,666 | 6,796 | 6,266 | 3,940 |
| Shrimp | 520 | 1,069 | 1,104 | 1,686 | 2,026 | 1,276 |
| Other | 1,427 | 1,531 | 1,178 | 674 | 606 | 399 |
| Subtotal | 22,678 | 21,512 | 28,804 | 31,121 | 31,565 | 30,644 |
| Other | 72 | 33 | 65 | 105 | 58 | 113 |
| Total (edible) | 243,713 | 216,221 | 262,743 | 275,127 | 274,885 | 286,338 |
| Inedible | 35,970 | 33,665 | 33,501 | 31,666 | 30,001 | 29,406 |
| Grand total[3] | 279,684 | 249,887 | 296,243 | 306,792 | 304,886 | 315,746 |

[1]Source: U.S. Department of Commerce, Bureau of the Census.
[2]Not otherwise specified.
[3]Totals may not agree because of rounding.

**Table 5.—U.S. fishery imports[1] from Canada by species and value, 1979-84.**

| | Value (US$million) | | | | | |
|---|---|---|---|---|---|---|
| Species | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 |
| Edible | | | | | | |
| Fish | | | | | | |
| Catfish | 2.6 | 1.9 | 3.1 | 3.5 | 4.0 | 2.0 |
| Cod | 144.2 | 143.9 | 172.0 | 202.8 | 239.1 | 225.5 |
| Flatfish[2] | 65.1 | 49.5 | 78.4 | 62.6 | 51.2 | 58.5 |
| Groundfish[2] | 66.6 | 62.2 | 98.6 | 80.9 | 70.5 | 68.2 |
| Halibut | 6.7 | 9.1 | 9.3 | 10.0 | 10.7 | 13.4 |
| Herring | 21.4 | 19.6 | 22.2 | 20.7 | 19.6 | 16.1 |
| Mackerel | 1.5 | 1.5 | 1.2 | 1.0 | 1.2 | 1.3 |
| Perch | 42.1 | 24.2 | 39.6 | 45.0 | 34.2 | 42.3 |
| Pollock | 0.6 | 1.4 | 1.5 | 1.9 | 2.3 | 1.6 |
| Salmon | 13.3 | 15.9 | 17.2 | 19.6 | 21.9 | 27.4 |
| Sardines | 4.1 | 3.8 | 4.3 | 3.7 | 3.3 | 4.4 |
| Swordfish | | 0.3 | | | 1.2 | 1.3 |
| Tuna | | 0.3 | 0.4 | 0.7 | 4.5 | 0.9 |
| Trout | 0.4 | 0.8 | 0.9 | 0.6 | 0.9 | 0.8 |
| Turbot | 15.4 | 15.6 | 16.3 | 15.9 | 11.3 | 13.1 |
| Whitefish | 7.4 | 8.0 | 7.1 | 7.4 | 7.3 | 8.5 |
| Other | 60.0 | 57.6 | 71.0 | 69.1 | 62.8 | 71.7 |
| Subtotal | 451.4 | 415.6 | 543.1 | 545.4 | 546.0 | 557.0 |
| Shellfish | | | | | | |
| Abalone | 0.2 | 0.1 | 0.1 | 0.4 | 0.3 | 0.2 |
| Clams | 3.8 | 4.2 | 6.1 | 6.9 | 8.2 | 10.4 |
| Crabs | 10.7 | 15.2 | 32.6 | 56.6 | 66.1 | 45.8 |
| Lobster | 50.1 | 53.1 | 73.0 | 82.3 | 96.1 | 115.0 |
| Oysters | | | 0.2 | 0.2 | 0.2 | 0.8 |
| Scallops | 70.3 | 63.6 | 86.8 | 56.2 | 75.1 | 48.3 |
| Shrimp | 3.5 | 5.5 | 4.4 | 6.8 | 10.6 | 8.5 |
| Other | 1.5 | 1.8 | 2.1 | 2.2 | 1.4 | 1.5 |
| Subtotal | 140.1 | 143.5 | 205.3 | 211.6 | 258.0 | 230.5 |
| Other | 0.2 | 0.2 | 0.3 | 0.2 | 0.1 | 0.3 |
| Total (edible) | 591.7 | 559.3 | 748.7 | 757.2 | 804.1 | 787.8 |
| Inedible | 13.5 | 12.8 | 13.3 | 11.8 | 10.7 | 10.5 |
| Grand total[3] | 605.3 | 571.9 | 762.0 | 768.9 | 814.8 | 798.3 |

[1]Source: U.S. Department of Commerce, Bureau of the Census.
[2]Not otherwise specified.
[3]Totals may not agree because of rounding.

*Scallops*

Canadian scallop exports to the United States have also fluctuated in recent years. The export value peaked at $87 million in 1981, but dropped to $48 million in 1984. Canada exports over two-thirds of its annual scallop harvest, virtually all to the U.S. market. Exports declined greatly in 1984 because crews on a number of scallop draggers were on strike for several months.

Overall, Canadian scallop landings have decreased substantially (from 89,500 t in 1979 to 34,800 t in 1984) as Government conservation measures proved difficult to implement and enforce. Canadian officials have also found that a meat-count system, used to monitor the industry, was difficult to maintain because of opposition from the fishing industry. Finally, Canadian scallops continue to face stiff competition on the U.S. market from less expensive calico scallop and other scallop species from the southeastern U.S. and South American harvesters.

*Other Shellfish*

The United States annually purchases about 80 percent, by value, of Canada's total shellfish exports. Lobster and crab shipments have especially increased since 1979. Canadian lobster shipments to the United States more than doubled from $50 million in 1979, to $115 million in 1984. Abundant lobster landings, attributed to stricter enforcement practices and the recovery of stocks, and strong markets boosted the value of the Canadian lobster fishery in 1984. Crab exports also increased greatly, from only $11 million in 1979 to $66 million in 1983, but slipped to $46 million in 1984. The Canadian shellfish industry faces increasing competition from "imitation" surimi-based shellfish products from Japanese and, now, U.S. producers. It is not yet known what future impact this competition may have, if any, on the Canadian shellfish industry.

## U.S. Exports

Canada is the second largest market for U.S. fishery products (after Japan) and accounted for 13 percent of the value of U.S. exports in 1984, but only 7 percent of the quantity (Table 6). Part of these imports are simply processed and transshipped elsewhere. Canada is intent upon maintaining good fishery trade relations with the United States, recognizing that it has much more to gain than to lose, and has a rather liberal tariff system for U.S. fishery products (Table 7). The U.S. fishing industry, however, often cannot compete with Canadian products, especially when they benefit from Government financial assistance. In addition, U.S. fishery products currently suffer from unfavorable currency exchange rates when exported to Canada.

### Commodities

Canadian imports of U.S. fishery products totaled $123 million in 1984, a decrease of $12 million from 1983 (Tables 8 and 9). Since 1979, U.S. exports to Canada have fluctuated from a record-high of $148 million in 1981 to a low of $118 million in 1979. Exports of shellfish have dominated U.S. fishery shipments to Canada. The United States also has had success in exporting whole frozen fish and canned fish to Canada.

*Fresh and Frozen Shellfish*

Exports of fresh and frozen shellfish to Canada fell to $53 million in 1984, from $58 million in 1983. Frozen shrimp was by far the most valuable shellfish commodity exported, earning nearly $22 million in 1984. Fresh and frozen shellfish exports, except shrimp, were worth over $13 million.

*Whole Frozen Fish*

Whole frozen fish exports to Canada have fluctuated since 1979. Exports increased from $22 million in 1979 to $41 million in 1981, but decreased to $32 million in 1984. Fresh and frozen salmon exports totaled 8 t worth $18 million. Other species of fresh chilled or frozen fish earned $13 million, Alaska pollock and herring being among the most important.

*Canned Fish*

Canned fishery exports fell to $17 million in 1984 from $25 million in 1983. The value of U.S. canned exports in 1984 was roughly half that of 1980, when $37 million worth of canned fish were shipped. Canned salmon is the chief product in the canned category. However, canned salmon exports decreased from $24 million in 1983 to $15 million in 1984. Much of this canned salmon is probably reexported elsewhere.

**Table 6.—U.S. edible fishery exports to Canada, compared with total exports to all countries, by quantity and value, 1979-84.**

| Year | Amt. (1,000 t) Total | Amt. (1,000 t) To Can. | Percent of total | Value (US$10⁶) Total | Value (US$10⁶) To Can. | Percent of total |
|---|---|---|---|---|---|---|
| 1979 | 355.4 | 37.6 | 10.6 | 1,060.3 | 116.6 | 11.0 |
| 1980 | 466.5 | 53.7 | 11.5 | 993.4 | 144.3 | 14.5 |
| 1981 | 454.3 | 50.4 | 11.1 | 1,142.0 | 146.9 | 12.9 |
| 1982 | 403.3 | 32.4 | 8.0 | 1,032.2 | 116.6 | 11.3 |
| 1983 | 526.5 | 31.1 | 5.9 | 996.7 | 131.6 | 13.2 |
| 1984 | 459.9 | 32.0 | 7.0 | 918.6 | 120.8 | 13.2 |

[1]Source: NMFS "Fisheries of the United States," various years.

**Table 7.—Canada's tariff rates[1] on selected U.S. fishery products, 1984-85.**

| Category | Duty rate (% ad valorem) |
|---|---|
| Edible | |
| Fish | |
| Bonito, preserved in oil | 9.3 |
| Halibut, fresh, salted, or pickeled | Free |
| Herring, fresh, salted, or pickeled | Free |
| Herring, in oil, in sealed containers | 10.0 |
| Herring, kippered, in sealed containers | 7.5 |
| Mackerel, all commodities | Free |
| Salmon, fresh or frozen | Free |
| Salmon, prepared or preserved | 6.4 |
| Trout, fresh or frozen | Free |
| Tuna, frozen, to be processed in Canada | Free |
| Fish, preserved in oil[2] | 15.0 |
| All other fish, prepared or preserved[2] | 11.0 |
| Shellfish | |
| Shrimp | Free |
| Squid, octopus, and cuttlefish | Free |
| Lobster or lobster meat, fresh or boiled | Free |
| Shellfish, fresh[2] | Free |
| Crustaceans, fresh or prepared/preserved[2] | 8.0 |
| Clams, in sealed containers | 10.0 |
| Crabs, in sealed containers | 10.0 |
| Lobsters, in sealed containers | 9.8 |
| Oysters, prepared or preserved | 6.9 |
| Oysters, smoked, whether or not in cans or other airtight containers | 6.4 |
| Shellfish, prepared or preserved[2] | 9.8 |
| Non-edible | |
| Menhaden oil | 12.8 |
| Fishmeal | 8.8 |

[1]Source: FAO and Infofish, "Register of Import Regulations for Fish and Fishery Products," 1984 update.
[2]Not elsewhere specified.

### Species

In 1984, the most important species exported to Canada by the United States were salmon, shrimp, and king crab (Tables 10 and 11). These three species

**Table 8.—U.S. fishery exports[1] to Canada by commodity and quantity, 1979-84.**

| Commodity | Quantity (t) | | | | | |
|---|---|---|---|---|---|---|
| | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 |
| Edible | | | | | | |
| Fish | | | | | | |
| Fresh, frozen | | | | | | |
| Whole | 14,993 | 28,596 | 27,043 | 13,911 | 11,598 | 15,609 |
| Fillets | 2,606 | 3,663 | 4,819 | 2,820 | 2,776 | 2,493 |
| Subtotal | 17,599 | 32,259 | 31,862 | 16,731 | 14,374 | 18,102 |
| Canned | 7,008 | 9,689 | 7,341 | 5,606 | 6,335 | 4,594 |
| Cured | 977 | 189 | 764 | 1,121 | 125 | 78 |
| Roe | 92 | 118 | 153 | 47 | 174 | 198 |
| Other | 232 | 262 | 201 | 174 | 462 | 553 |
| Subtotal | 25,908 | 42,517 | 40,321 | 23,679 | 21,470 | 23,525 |
| Shellfish | | | | | | |
| Fresh, frozen | 9,352 | 8,988 | 8,052 | 7,273 | 7,899 | 7,112 |
| Canned | 2,182 | 2,117 | 1,965 | 1,323 | 1,566 | 1,270 |
| Other | 187 | 125 | 103 | 121 | 138 | 96 |
| Subtotal | 11,721 | 11,230 | 10,120 | 8,717 | 9,603 | 8,478 |
| Total (edible) | 37,629 | 53,747 | 50,441 | 32,396 | 31,073 | 32,003 |
| Inedible | | | | | | |
| Meal | 820 | 917 | 1,618 | 3,132 | 9,232 | 4,704 |
| Oils | 184 | 245 | 192 | 342 | 320 | 268 |
| Other | 824 | 810 | 948 | 1,265 | 1,019 | 858 |
| Total (inedible) | 1,828 | 1,972 | 2,758 | 4,739 | 10,571 | 5,830 |
| Grand total[2] | 39,456 | 55,716 | 53,198 | 37,135 | 41,646 | 37,833 |

[1]Source: U.S. Department of Commerce, Bureau of the Census.
[2]Totals may not agree because of rounding.

**Table 9.—U.S. fishery exports[1] to Canada by commodity and value, 1979-84.**

| Commodity | Value (US$million) | | | | | |
|---|---|---|---|---|---|---|
| | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 |
| Edible | | | | | | |
| Fish | | | | | | |
| Fresh, frozen | | | | | | |
| Whole | 21.7 | 32.3 | 41.1 | 27.2 | 27.8 | 31.6 |
| Fillets | 6.9 | 9.5 | 10.1 | 7.0 | 8.0 | 8.2 |
| Subtotal | 28.6 | 41.8 | 51.2 | 34.2 | 35.8 | 39.8 |
| Canned | 25.1 | 37.3 | 27.9 | 18.6 | 25.0 | 17.1 |
| Cured | 2.1 | 0.4 | 1.1 | 2.7 | 0.9 | 0.5 |
| Roe | 0.7 | 0.7 | 0.6 | 0.5 | 0.5 | 0.8 |
| Other | 1.0 | 0.9 | 0.6 | 0.6 | 1.5 | 1.8 |
| Subtotal | 57.5 | 81.1 | 81.4 | 56.6 | 63.7 | 60.0 |
| Shellfish | | | | | | |
| Fresh, frozen | 48.8 | 48.9 | 53.4 | 52.1 | 58.0 | 52.7 |
| Canned | 9.7 | 13.4 | 11.4 | 7.3 | 9.0 | 7.5 |
| Other | 0.7 | 0.8 | 0.6 | 0.6 | 0.7 | 0.5 |
| Subtotal | 59.2 | 63.1 | 65.4 | 60.0 | 67.7 | 60.7 |
| Total (edible) | 116.7 | 144.2 | 146.8 | 116.6 | 131.4 | 120.7 |
| Inedible | | | | | | |
| Meal | 0.1 | 0.1 | 0.3 | 0.4 | 1.4 | 0.7 |
| Oil | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 |
| Other | 0.4 | 0.6 | 0.8 | 1.0 | 0.9 | 0.8 |
| Total (inedible) | 0.7 | 0.9 | 1.3 | 1.7 | 2.6 | 1.8 |
| Grand total[2] | 117.5 | 145.2 | 148.2 | 118.4 | 134.1 | 122.5 |

[1]Source: U.S. Department of Commerce, Bureau of the Census.
[2]Totals may not agree because of rounding.

**Table 10.—U.S. fishery exports[1] to Canada by species and quantity, 1979-84.**

| Species | Quantity (t) | | | | | |
|---|---|---|---|---|---|---|
| | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 |
| Edible | | | | | | |
| Fish | | | | | | |
| Herring | | | 8,577 | 3,133 | 971 | 287 |
| Mackerel | | | 72 | 89 | 51 | 84 |
| Mullet | | | 37 | | 50 | 10 |
| Alaska pollock | | | 184 | 163 | 165 | 66 |
| Sablefish | | | 23 | 18 | 39 | 14 |
| Salmon | 7,930 | 15,880 | 16,377 | 9,367 | 10,194 | 11,997 |
| Sardines | 1 | | | | 4 | |
| Other | 17,740 | 26,215 | 14,769 | 10,703 | 9,537 | 10,499 |
| Subtotal | 25,671 | 42,095 | 40,039 | 23,473 | 21,011 | 22,957 |
| Shellfish | | | | | | |
| Crabs | 715 | 1,569 | 1,425 | 624 | 476 | 514 |
| Shrimp | 6,942 | 5,579 | 5,090 | 4,452 | 5,196 | 4,226 |
| Squid | 112 | 9 | 327 | 778 | 558 | 451 |
| Other | 3,952 | 4,073 | 3,277 | 2,864 | 3,373 | 3,287 |
| Subtotal | 11,721 | 11,230 | 10,119 | 8,718 | 9,603 | 8,478 |
| Other | 238 | 419 | 282 | 207 | 460 | 568 |
| Total (edible) | 37,630 | 53,744 | 50,440 | 32,398 | 31,074 | 32,003 |
| Inedible | | | | | | |
| Meal | 820 | 917 | 1,618 | 3,132 | 9,232 | 4,704 |
| Oils | 184 | 245 | 192 | 342 | 320 | 268 |
| Other | 824 | 810 | 948 | 1,265 | 1,019 | 858 |
| Subtotal | 1,828 | 1,972 | 2,758 | 4,739 | 10,571 | 5,830 |
| Grand total[2] | 39,456 | 55,716 | 63,198 | 37,135 | 41,646 | 37,833 |

[1]Source: U.S. Department of Commerce, Bureau of Census.
[2]Totals may not agree because of rounding.

**Table 11.—U.S. fishery exports[1] to Canada by species and value, 1979-84.**

| Species | Value (US$million) | | | | | |
|---|---|---|---|---|---|---|
| | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 |
| Edible | | | | | | |
| Fish | | | | | | |
| Herring | | | 3.4 | 1.4 | 1.2 | 0.3 |
| Mackerel | | | | 0.1 | 0.1 | 0.1 |
| Mullet | | | | | 0.1 | |
| Alaska pollock | | | 0.2 | 0.4 | 0.2 | 0.2 |
| Sablefish | | | | | 0.1 | |
| Salmon | 28.3 | 50.4 | 48.1 | 29.9 | 36.7 | 33.6 |
| Sardines | | | | | | |
| Other | 28.2 | 29.5 | 28.8 | 24.1 | 24.0 | 23.9 |
| Subtotal | 56.5 | 79.9 | 80.5 | 55.9 | 62.4 | 581. |
| Shellfish | | | | | | |
| Crabs | 5.0 | 10.0 | 10.4 | 7.4 | 5.3 | 5.1 |
| Shrimp | 38.2 | 36.2 | 36.3 | 34.1 | 40.6 | 33.1 |
| Squid | | | 0.7 | 2.0 | 1.2 | 1.2 |
| Other | 16.0 | 17.0 | 18.0 | 16.4 | 20.6 | 21.3 |
| Subtotal | 59.2 | 63.2 | 65.4 | 59.9 | 67.7 | 60.7 |
| Other | 0.9 | 1.2 | 0.7 | 0.6 | 1.5 | 1.8 |
| Total (edible) | 116.6 | 144.3 | 146.6 | 116.4 | 131.6 | 120.6 |
| Inedible | | | | | | |
| Meal | 0.1 | 0.1 | 0.3 | 0.4 | 1.4 | 0.7 |
| Oils | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 |
| Other | 0.4 | 0.6 | 0.8 | 1.0 | 0.9 | 0.8 |
| Subtotal | 0.7 | 0.9 | 1.3 | 1.7 | 2.6 | 1.8 |
| Grand total[2] | 117.5 | 145.2 | 148.2 | 118.4 | 134.1 | 122.5 |

[1]Source: U.S. Department of Commerce, Bureau of Census.
[2]Totals may not agree because of rounding.

accounted for more than one-half of Canada's fishery imports from the United States.

*Salmon*

Salmon exports to Canada decreased from a high of $50 million in 1980 to $34 million in 1984. The most important exports were chum, pink, and sockeye salmon. Sockeye was the major species in the canned salmon category, worth nearly $10 million, followed by pink, worth about $4 million. Much of this imported salmon was probably reexported elsewhere.

*Shrimp*

U.S. shrimp exports to Canada in 1984 were the lowest by value during 1979-84, at $33 million. Frozen shrimp, at $22 million, accounted for most of the shipments. Canned shrimp exports totaled $7 million, and fresh shrimp earned about $4 million. Despite the decrease in shipments, Canada remained the most important export market for U.S. shrimp.

*King Crab*

Because of a decline in sales to Japan, Canada became the most important market for U.S. exports of king crab in 1983 and 1984. Canada purchased 320 t of king crab, worth $4.1 million, in 1984. King crab exports to Canada are still below previous levels (i.e., Canada purchased $10 million worth in 1981). Source: IFR-85/63.

# Developments in Asian Shrimp Culture

Asian countries produced over 75,000 metric tons (t) of cultured shrimp in 1983, and it is estimated that cultured shrimp production will be nearly 200,000 t by 1990 (Table 1). India, Indonesia, Thailand, and Taiwan are the most important shrimp culturing countries, but several other Asian countries are expected to significantly increase production of cultured shrimp by the end of the decade.

Asia's farmed shrimp is currently only a minor part of that region's total shrimp production. Several important shrimp producing countries in Asia, however, are reporting steady growth in their shrimp culture industries. More importantly, some countries which once had only small shrimp industries are beginning to report sharply higher production owing to expanding harvests of cultured shrimp, and other countries which never produced significant amounts are now considering shrimp culture.

## Species Cultured

Many Asian countries have suitable climates and large areas available for both brackish and freshwater shrimp culture, and several indigenous shrimps have been found suitable for culture. Major species presently cultured include *Penaeus monodon*, *P. indicus*, *P. merguiensis*, *P. japonicus*, *Metapenaeus ensis*, and *Macrobrachium rosenbergii*. Exact data on the species composition of Asian farmed shrimp harvests is not available, but the NMFS Branch of Foreign Fisheries Analysis believes that the most important species is *P. monodon*.

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## Production

Asian countries produced over 75,000 t of cultured shrimp in 1983 (Table 1), or about two-thirds of the total world production. India, Thailand, Indonesia, and Taiwan were the major producers. These countries, as well as the Philippines, have the greatest potential for expanding cultured shrimp production by 1990 (Table 1).

Cultured shrimp production in Asia could reach over 195,000 t in 1990, provided that postlarvae from established or planned shrimp hatcheries is readily available and that better predator control, pond cleaning, aeration, and feeding techniques are used. Many observers believe that the Asian shrimp culture industry may grow at a more rapid rate than the Latin American shrimp farming industry because the technology for producing *P. monodon* postlarvae and other important Asian shrimp species is less complicated than that for Latin American species.

Shrimp farming has a long tradition in Asia, and shrimp farmers currently use extensive, semi-intensive, and intensive methods to culture shrimp. Extensive shrimp farming is utilized throughout developing countries of Southeast Asia and the Indian subcontinent because it requires relatively simple technology and low capital investments. Many extensive shrimp farms in Asia actually involve the polyculture of several fish species in ponds, and little

**Table 1.—Asian cultured shrimp production for 1982, 1983 and 1990 (projected).**

| Country | Production (t) 1982 | 1983 | 1990 | Primary species |
|---|---|---|---|---|
| Indonesia | 11,313 | 11,900E[1] | 40,000 | *Penaeus monodon, P. merguiensis* |
| Thailand | 10,091 | 14,200E | 35,000 | *P. monodon, P. merguiensis* |
| India | 15,000E | 15-20,000E | 30,000 | *P. indicus, P. monodon* |
| Taiwan | 9,575 | 10,941 | 30,000 | *P. monodon* |
| Philippines | 3,900 | 4,250E | 20,000 | *P. monodon* |
| Vietnam | N/A[2] | 10-20,000[3] | 20,000 | *P. monodon* |
| Bangladesh | N/A | 3,000E | 9,000 | *P. monodon* |
| China | 1,400E | 1,600E | 2,800 | *P. orientalis* |
| Japan | 2,000 | 2,000E | 2,600 | *P. japonicus* |
| Malaysia | 157 | 200E | 2,000 | *P. monodon* |
| Sri Lanka | | N/A | 2,000 | *Macrobrachium rosenbergii* |
| Burma | N/A | 500E | 1,500 | *P. monodon* |
| Pakistan | | | 350 | N/A |
| South Korea (ROK) | 109 | 50 | 100 | *P. orientalis* |
| Other nations | 100 | 150E | 250 | N/A |
| Total | 60,000E | 75-80,000E | 196,000 | |

[1]E = Estimate.
[2]N/A = Not available.
[3]Estimated production for 1984.

additional capital investment is necessary to culture shrimp in an already constructed pond.

Some Asian countries have recently begun to apply "semi-intensive" farming methods to increase yields. These improvements include better predator control, fertilizing, feeding, aerating, and dredging ponds. Intensive shrimp farming, developed and utilized primarily in Taiwan and Japan, involves far greater costs of production because the shrimp are carefully monocultured, using various sophisticated techniques.

### Future Production

An accurate prediction of future farmed shrimp production in Asia is impossible at this time. The above estimate for 1990 production is little more than an educated guess, as various economic problems continue to influence shrimp culturing in Asia. Rising production costs for shrimp feed, pond construction and maintenance, processing, fuel, electricity, and shipping, as well as "acts of God[1]", have affected Asian cultured shrimp production. Some Asian countries have also had quality control problems in exporting shrimp to the United States, a difficulty that will have to be overcome to secure a stable market. Another problem for Asian shrimp farmers is that two of the major shrimp species cultured in Asia, *P. monodon* and *P. japonicus*, are not widely consumed in the United States, one of the world's greatest shrimp markets. The export growth potential for these species is therefore limited as long as they are not extensively marketed in the United States.

Another key factor which will affect future shrimp culture production is market prices. Shrimp prices, especially for the medium sizes in the U.S. market, have fallen sharply since early 1983. This is at least partially because of increased production of Latin American farmed shrimp, as most growers find the middle sizes the most profitable to harvest. If prices continue to fall, however, growers will be forced to reevaluate prospects, and production forecasts may have to be altered.

[1]As a result of typhoons, for example, the harvest of farmed shrimp in the Philippines reportedly declined by 30 percent in 1984.

### Indonesia

Indonesia is one of the leading Asian shrimp farming countries, producing over 11,300 t in 1982 (9,100 t of marine species and 2,200 t of freshwater species), and an estimated 11,900 t in 1983 (9,550 t marine; 2,350 t freshwater) (Table 1). Many observers believe that Indonesia will emerge as the principal Asian producer of farmed shrimp by 1990. The major species cultured are *P. monodon*, *P. merguiensis*, *Metapenaeus endeavori*, and *Macrobrachium* spp. Growers use extensive methods and produce about 300 kg/ha of shrimp annually. Six governmental and 24 private hatcheries produced 45 million postlarvae in 1982; another 290 million were gathered from the wild.

The Indonesian Government has promoted the development of the country's shrimp culture industry since the 1970's when the Directorate General of Fisheries established four *Macrobrachium* hatcheries. The Government has instituted a National Shrimp Development Program, designed to utilize 220,000 ha of ponds for shrimp culture by 1989. To implement these goals, the Government plans to establish 85 hatcheries and 3 technical training centers. The Government also extends grants and loans to promote the construction of private hatcheries. The Asian Development Bank (ADB) and U.S. Agency for International Development (AID) have also provided assistance in developing a shrimp culture industry. Much of the shrimp farming technology currently used in Indonesia was developed in Japan.

The major factor limiting the expansion of the Indonesian shrimp culture industry is the availability of postlarvae to stock the ponds. The Indonesian Government hopes that the hatcheries it is financing will overcome this problem. If the Government succeeds in increasing the availability of postlarvae, shrimp production could increase sharply by 1990. One estimate suggests that as much as 220,000 ha could produce 40,000 t of cultured shrimp by 1990. If the present average annual yield rate of 300/ha improves, production by 1990 would be even greater. The Indonesian Government plans to increase shrimp production for *P. monodon* alone to 44,000 t by 1988, but observers believe that this goal is overly optimistic because it relies not on increased postlarvae production but, rather, on construction of new ponds and increased production per hectare.

**Table 2.—Thailand's cultured shrimp production, hectares cultured, number of shrimp farms, and yield per hectare, 1978-83.**

| Year | Production (t) | Hectares cultured | No. of farms | Yield (kg/ha) |
|---|---|---|---|---|
| 1978 | 6,395 | 24,169 | 3,045 | 262 |
| 1979 | 7,064 | 24,676 | 3,378 | 283 |
| 1980 | 8,063 | 26,036 | 3,572 | 308 |
| 1981 | 10,728 | 27,459 | 3,657 | 387 |
| 1982 | 10,091 | 30,792 | 3,943 | 326 |
| 1983 | 14,200[1] | 36,933 | 5,334 | 384 |

[1]Estimate.

### Thailand

Cultured shrimp production in Thailand more than doubled between 1979 and 1983, and exceeded 14,200 t in 1983 (Table 2). The most important species are *P. merguensis*, *Macrobrachium* sp., and *P. monodon*. The Government of Thailand does not provide any financial incentives for shrimp farming, but operates five shrimp hatcheries to supply postlarvae. These hatcheries reportedly produced 32 million *P. merguensis*, 8 million *P. monodon*, and more than 1 million *P. semisulcatus* postlarvae in 1983, and observers believe that this represents only 20 percent of potential postlarvae production capacity. There are also several privately owned hatcheries in Thailand producing an unknown quantity of postlarvae. Most Thai shrimp farmers, however, rely on wild shrimp postlarvae to stock their ponds because the state-run and private hatcheries cannot supply the present demand.

The area devoted to shrimp culture has increased yearly but average yields per hectare have fluctuated (Table 2). In 1983, Thai shrimp farmers utilized about 37,000 ha of ponds with an average yield of 384 kg/ha. Thai officials expect cultured shrimp production to increase to 35,000 t by 1990 if more postlarvae can be obtained from hatcheries and if shrimp farmers increase semi-intensive farming methods (i.e., better

predator control, pond cleaning, aeration, and feed techniques).

## India

India's cultured shrimp production was about 15,000 t in 1982, and 15-20,000 t in 1983 (precise statistics were unavailable from the Indian Government). About 30,000 ha of ponds were in production during 1983, and some Indian observers believe that the area under culture can be increased by 5,000 ha per year over the next decade. There are no commercial hatcheries in India although four experimental hatcheries for *P. monodon* and *P. indicus* reportedly were in operation. Indian observers estimate that over 150 hatcheries, each with a capacity of 1 million postlarvae per year (*P. indicus* and *P. monodon*), will be in operation by 1994.

Recognizing the foreign exchange earning potential of shrimp culture, the Indian Government has encouraged its coastal states to develop a minimum of 500 ha of shrimp ponds each year for 10 years (beginning in 1983). The Indian Government has endorsed shrimp farming efforts to increase both the quantity and quality of the cultured shrimp, and the Ministry of Agriculture provides funds to the State Governments to develop the industry and improve farming methods. Various press reports refer to Government subsidies of 50 percent to develop shrimp hatcheries. The Department of Fisheries in the various states can use these funds to extend subsidies, grants, and technical assistance. Some states have also formed brackishwater fish farming development agencies at the district level. With the availability of postlarvae and with improved technology, observers expect about 30,000 t of cultured shrimp will be harvested from a total pond area of about 55,000 ha by 1990.

## Taiwan

Taiwan is a world leader in shrimp culture research, particularly for *P. monodon*, and Taiwan's shrimp farmers have concentrated most of their efforts on that species (Table 3). Other important species cultured in Taiwan are *M. ensis* and *M. rosenbergii*. Taiwan has more than 400 hatcheries, mostly small family-owned operations.

In 1982, Taiwan produced over 300 million *P. monodon* postlarvae in hatcheries, yielding 6,700 t of marketable shrimp, of which Taiwan exported 2,000 t. Hatcheries also produced 150 million *P. ensis* postlarvae and 20 million *M. rosenbergii* postlarvae, yielding 1,500 t of *P. ensis* and 900 t of *M. rosenbergii*. In 1983, Taiwan harvested 10,941 t of farmed shrimp from over 3,400 ha of shrimp ponds (3,000 brackishwater ponds and 400 freshwater ponds). In addition, Taiwan has about 15,000 ha of brackishwater and freshwater ponds used exclusively in the monoculture of fish and shellfish species other than shrimp.

If Taiwan's fish farmers found shrimp culture profitable, some of these ponds could be converted to shrimp polyculture. Observers estimate that such a development could enable Taiwan to increase shrimp production to 30,000 t per year by 1990. Taiwan's Council for Agriculture Planning and Development has recently suggested that aquaculture output could be promoted by providing assistance to farmers who are willing to convert their rice paddy fields to fish and shrimp culturing ponds for part of the year.

Production cost is one of the keys to the future of Taiwan's shrimp culture industry. Growers report high yields (using semi-intensive and intensive methods) producing high-valued shrimp, but production costs are also very high. Precise production costs are not available, but most pond farmers can produce *P. monodon* for $4.60-5.20/kg excluding the cost of land and the building of ponds. It is yet unclear how Taiwan will be able to compete with the relatively inexpensive shrimp produced by developing countries using extensive methods. Taiwan's leading shrimp aquaculture feed company has recently begun to market its technology in various developing Asian countries.

Table 3.—Taiwan's production of cultured shrimp, 1977-83.

| | Production (t) | | | | | | |
|---|---|---|---|---|---|---|---|
| Species | 1977 | 1978 | 1979 | 1980 | 1981[1] | 1982 | 1983 |
| *P. monodon* | 725 | 1,156 | 4,123 | 2,533 | | 6,713 | 9,178 |
| *M. ensis* | 283 | 693 | 864 | 684 | | 1,576 | 840 |
| *M. rosenbergii* | | | | | | 914 | 680 |
| *P. jaconicus* | | | 81 | | | 59 | 56 |
| Other species | 384 | 371 | 1,264 | 589 | | 313 | 187 |
| Total | 1,392 | 2,220 | 6,332 | 3,806 | | 9,575 | 10,941 |

[1]No data available.

## Philippines

The Philippines is another important Asian shrimp culturing nation with the potential to greatly expand production by 1990. Cultured shrimp production increased from 2,700 t in 1977 to about 4,250 t in 1983, consisting almost entirely of *P. monodon*. In 1982, 56 hatcheries were in operation, 48 privately owned and 8 were government owned. Postlarvae production in these hatcheries during 1982 was reportedly about 40 million, and in 1983 it was about 100 million, representing 73 percent and 83 percent, respectively, of the total postlarvae used in shrimp culture. At least another 15 million postlarvae were caught in the wild in 1982 and 20 million postlarvae were caught in 1983.

Of the approximately 200,000 ha of brackishwater ponds under culture in the Philippines, about 20,000 ha are used for shrimp monoculture or polyculture with milkfish. Most of these ponds are poorly designed for higher shrimp stocking densities because the ponds are too shallow and have inadequate drainage. Currently less than 1,000 ha of ponds are suitable for higher density shrimp culture.

As a result, most shrimp ponds have a low rate of yield. The average annual production in 1981 was reportedly 196 kg/ha using mostly extensive methods. In 1983, three local companies manufactured shrimp feed, but on a limited scale, for semi-intensive farming. One firm used technology from Taiwan; the

other two firms have sought foreign expertise to improve their technology.

The probability that shrimp culture will expand in the Philippines is good, but there are limiting factors. The country has nearly ideal conditions—climate, water quality, and soil characteristics—for shrimp culture. The Philippines already has the infrastructure (roads, electricity, airports, and port facilities) to support a much larger shrimp culture industry, and is close to Japan, a major shrimp market. The Philippine Government, through its Bureau of Fisheries and Aquatic Resources, has actively encouraged shrimp culture ventures through soft loans, training of technical staff, and extension services. In 1984, the ADB approved a $21.8 million loan for milkfish and shrimp culture projects in the Philippines. The loan will finance the construction of 15 hatcheries capable of producing 75 million postlarvae.

Conversely, several factors limit the potential for shrimp culture. Although large areas of brackishwater ponds are available for shrimp culture, significant investments would be required to improve the ponds, making them more suitable for shrimp culture with higher yields (e.g., dredging and improving drainage). The estimated cost for improving brackishwater ponds is reportedly about $3,600/ha based on an exchange rate of 14 Philippine pesos to the U.S. dollar). Technology is at a beginning level of development, particularly in the feed industry. The most important limiting factor for increased production is the inadequate supply of postlarvae. Existing hatcheries are sufficient to meet current needs, but may be unable to do so in the future because they lack skilled technicians. Another limiting factor is the fact that many Philippine shrimp exporters often cannot meet high-quality sanitary standards demanded by the U.S. and Japan.

### Vietnam

Vietnam claims that its shrimp culture production increased greatly in 1984, and that about 90,000 ha of shrimp ponds were in production. One observer estimates that the 1984 production of farmed shrimp was 10-20,000 t. Vietnam reportedly utilized 337,000 ha for fish and shellfish culture in 1984. It is unknown, however, exactly what shrimp species are being farmed, although an observer believes that it is probably *P. monodon*.

### Bangladesh

Information concerning shrimp culture in Bangladesh is scarce, and the information that does exist is often contradictory. For example, one recent report contends that Bangladesh produced about 2,700 t of cultured shrimp in 1983, while another report stated that 8,000 t was produced in 1983. Bangladesh reportedly utilized nearly 41,000 ha for fish and shellfish culture in 1983, but it is not known how many hectares were devoted to shrimp farming. Bangladesh currently lacks shrimp hatcheries, but an ADB Aquaculture Development Project is involved in the construction of a shrimp hatchery and 300 ha of ponds.

### China

Shrimp culture in China is currently limited. Cultured shrimp production was about 1,600 t in 1983, and consisted mostly of *P. orientalis* and small amounts of *P. merguiensis* and *P. monodon*. The total area devoted to shrimp culture is unknown. Because China may wish to obtain foreign export earnings, the production of cultured shrimp, and other high-valued shellfish, will probably increase in the future.

In December 1984, China established a shrimp joint venture with New Zealand, the first joint venture of any kind between the two countries. Chinese shrimp culture technicians were to visit New Zealand in Spring 1985 to study sites for shrimp farming in New Zealand. A company was to be formed, 60 percent owned by New Zealand interests and 40 percent by China, and begin production to supply both New Zealand and foreign markets. The joint venture marked the first time that China utilized, on a commercial basis, its own shrimp farming expertise in a foreign country. In a related development, the first China-Japan joint venture fishing company, the Danyo Fisheries Company[2], is planning shrimp farming operations near Dalian and Shanghai.

### Japan

The Japan Fisheries Agency (JFA) has a 5-year Fish Farming Development Program (1983-87) involving various fish and shellfish species, including shrimp. To enhance the wild shrimp catch, the JFA produces shrimp postlarvae and releases them into the sea to increase coastal stocks available to commercial fishermen; the purpose is not to raise shrimp to commercial size entirely in ponds or cages. The effectiveness of the project, however, has yet to be determined. The JFA budget for postlarvae production and release was $16.3 million in FY 1983 and $17.4 million in FY 1984.

The JFA also provides fiscal incentives to fishery cooperatives engaged in shrimp culture. The JFA offers low interest loans at 6.5 percent annual interest, payable over 20 years. The Ministry of Agriculture, Forestry, and Fisheries Finance Corporation offers similar loans. Commercial firms are not eligible to receive either of these loans.

The Japan Fish Farming Association (a semi-governmental oraganization funded by the JFA) is responsible for the shrimp postlarvae production and operates 12 fish farming centers. The JFA plans to construct one additional center. Prefectural governments operate 37 other fish farming centers. Various universities and corporations are also conducting research and developing new shrimp culture technology. Postlarvae production is expected to increase to 530 million in 1987 from the 490 million postlarvae in 1981.

Japan harvested about 2,000 t of cultured shrimp in 1982 and 1983, and none was exported. Japanese production of cultured shrimp, mostly tiger shrimp, *P. japonicus*, is expected to increase by up to 30 percent over the 1982 production, reaching 2,600 t by 1990. Future cultured shrimp production is limited by the lack of suitable areas for ponds and by the country's climate. Production costs for tiger shrimp are high, reportedly $24-$26/kg, although the market price of the shrimp is also very high.

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

### Malaysia

Malaysia produced 157 t of cultured shrimp (mostly *P. monodon*) in 1982: 149 t of marine species and 8 t freshwater species. In 1983, farmed shrimp production was estimated at about 200 t. About 1,200 ha of shrimp ponds are currently under culture. Four freshwater hatcheries have a capacity of 8 million postlarvae per year; 14 marine hatcheries have a capacity of 134 million postlarvae per year. Actual postlarvae production is unknown. Cultured shrimp production in 1990 could reach 2,000 t. The Malaysian Government assists the shrimp culture industry through the Department of Fisheries which provides advice and technical assistance. Shrimp culture firms are also eligible to receive tax rebates and tax relief which the Malaysian Government provides to most developing industries.

### Pakistan

Pakistan does not currently culture culture shrimp. The Government, however, is promoting the industry's development. The ADB is providing $14.1 million of the $22.1 million total cost for an aquaculture development project and the European Community is contributing an unknown amount. The project involves culturing other species as well as marine shrimp for domestic consumption. The Pakistan Government has targeted $0.5 million for a shrimp culture project which is currently at the pilot plant stage. The project, expected to be completed by 1988, will be capable of producing 60 t of shrimp. The Government does not provide any other incentives. Production of cultured shrimp may total about 350 t, utilizing 380 ha of ponds by 1990.

### Sri Lanka

Sri Lanka, which is just beginning to culture shrimp, has more than 600 ha of ponds under construction. The Government estimates that production (mainly *Macrobrachium*) may total about 300 t by 1986. The Sri Landan Government is currently considering additional shrimp culture projects. The Government is actively promoting shrimp culture by seeking foreign investment and expertise to supplement the dwindling catches of wild shrimp. The ADB approved a $17 million loan to Sri Lanka in 1983 that includes shrimp culture.

### Burma

Burmese shrimp farmers currently culture *P. monodon* in about 4,000 ha of ponds. Estimated production in 1983 was 500 t. Burma reportedly has many sites suitable for brackishwater shrimp farming and is also interested in developing freshwater farming of *Macrobrachium*. Production for both freshwater and saltwater species could reach 1,500 t in 1990.

### Other Nations

Cultured shrimp production in the Republic of Korea has fluctuated between 50 and 125 t since 1977. An increased output of cultured shrimp in coastal brackishwater ponds depends upon coastal reclamation projects to establish pond sites. It is unlikely, however, that this project will be undertaken because of the high investment costs required and because of the Korean climate.

Hong Kong's Department of Agriculture and Fisheries has successfully experimented with *Macrobrachium* culture, but there is little production because there are no sites available in Hong Kong for building ponds. Unsuccessful tank culture experiments have also been made with *P. monodon*.

Singapore's cultured shrimp production was estimated at 60-90 t from 300 ha of shrimp ponds in 1983. Because of Singapore's limited size, cultured shrimp production is not expected to increase in the future, and annual production will probably be less than 100 t by 1990.

## Ecuadorean Shrimp Situation Improves

### Introduction

Ecuadorean shrimp culture has grown rapidly in recent years (Table 1) as a result of the continued construction of shrimp ponds, and shrimp is now Eduador's leading fishery commodity. About 75 percent of Ecuadorean shrimp is produced in ponds, making the country the world's leading producer of cultured shrimp. Shrimp exports have increased more than sixfold since 1975.

Ecuador was the second leading supplier of shrimp to the U.S. market in 1985, even though shipments declined about 5 percent below those of 1984, primarily because postlarval shrimp to stock the ponds were scarce or unavailable during much of 1985. Recent reports from Ecuador indicate that postlarvae have become plentiful off Ecuador and that many shrimp farmers can again stock their ponds. Ecuadorean exporters expected export shipments to continue low through March 1986, but to increase sharply thereafter.

The Ecuadorean Government is concerned about the potential problems caused by the explosive growth of the industry and has recently issued new regulations establishing a seasonal closure on shrimp farming. Fishery officials are also concerned about a reoccurence of the severe shortage of

Table 1.—Ecuador's shrimp trawler catch (T) and cultured shrimp harvests (C), 1975-85[1].

| Year | Harvests (1,000 t) T | C | Total[2] | Year | Harvests (1,000 t) T | C | Total[2] |
|---|---|---|---|---|---|---|---|
| 1975 | NA[3] | NA | 5.8 | 1983 | 8.9 | 35.6 | 44.6[4] |
| 1976 | NA | NA | 7.6 | 1984 | 6.7 | 33.3 | 39.9[5] |
| 1977 | NA | NA | 9.5 | 1985[6] | 9.0[7] | 27.0 | 36.0 |
| 1978 | NA | NA | 10.0 | 1986 | NA | NA | 40.7 |
| 1979 | 7.8 | 4.7 | 12.5 | 1987 | NA | NA | 45.4 |
| 1980 | 7.8 | 9.2 | 17.0 | 1988 | NA | NA | 50.2 |
| 1981 | 8.0 | 12.1 | 20.1 | 1989 | NA | NA | 55.1 |
| 1982 | 8.0 | 21.5 | 29.5 | 1990 | NA | NA | 60.0 |

[1]Sources: FAO "Yearbook of Fishery Statistics," various years (1975-79 data), and the Ecuadorean Direccion General de Pesca (1980-90 data).
[2]Totals may not agree due to rounding.
[3]NA = Not available.
[4]The 1983 figure is sharply higher than that reported by FAO (36,000 t).
[5]Ecuadorean officials believe that actual harvests in 1984 may have been about 20 percent higher than the actual quantities reported.
[6]Data for 1985-90 was projected by the Direccion General de Pesca, 12 June 1985.
[7]Most Ecuadorean observers believe that future trawler catches will vary from about 6,000 to 9,000 t.

shrimp postlarvae which interrupted the expansion of the industry in 1985, and the Government has announced a seasonal closure on postlarvae collection.

## Postlarvae Shortage

In early 1985, Ecuadorean shrimp farmers faced a severe shortage of the postlarval shrimp used to stock the country's estimated 70,000 hectares of marine shrimp ponds. By October 1985, from 50 to 80 percent of those ponds were reportedly inactive because growers could not find postlarvae to stock them. One possible cause cited for the shortage of postlarvae was the abnormally cool water which appeared off Ecuador in March 1985 and persisted until mid-October. The cooler-than-normal sea temperatures reportedly impaired shrimp spawning. Artisanal fishermen (who collect postlarvae for the growers) were not only unable to find significant quantities of postlarvae, many were unable to find any postlarvae. Only in the northern-most province of Esmeraldas did the artisanal fishermen continue to find postlarvae. The resulting price increases to as high as $25 per 1,000 postlarvae, was a record for Ecuador. Even at such high prices, however, many growers were unable to obtain sufficient postlarvae to stock their ponds. Some growers modified their culture strategy by adjusting production to a lower stocking density and were able to keep some ponds in production.

## Regulations

The shortage of postlarvae induced the Ecuadorean Government to issue regulations which it has been preparing for some time. The Ecuadorean Under Secretary of Fisheries, Ricardo Noboa, announced two important regulations affecting the shrimp industry on 27 November 1985.

1) Shrimp fishing closures: Shrimp fishing was closed from 15 December 1985 to 31 January 1986. Companies with hatcheries that required wild-caught gravid females to produce postlarvae received an exemption to continue operating one or two trawlers.

2) Postlarvae collection closure: Collecting shrimp postlarvae and adult broodstock was to be closed from 1 June to 31 July 1986. The Under Secretary reserved to himself the right to extend the postlarval closure for an additional 30 days if necessary.

The new regulations were designed to protect the shrimp resource, a matter of increasing concern to Ecuadorean officials. The scarcity of postlarvae during most of 1985 convinced both shrimp farmers and Government officials of the critical need to protect wild stocks. Some observers, however, were not convinced that the new closures would solve the problem. Many biologists reportedly believe that a more important long-term factor may be the gradual destruction of coastal mangrove estuaries which provide the nursery habitat necessary for marine shrimp[1]. Ecuador has in recent years begun to increasingly develop coastal lands, especially for the construction of shrimp ponds.

Constant requests of shrimp growers, who could not obtain postlarvae to stock their ponds, encouraged the Ecuadorean Government to adopt new import regulations (Decree No. JM-256-85) on 30 May 1985 allowing hatcheries and farmers to import nauplii and postlarvae. The importation of brine shrimp (*Artemia* sp.) eggs, needed by the hatcheries to feed larval shrimp, was also permitted. Some observers believe that brine shrimp can be produced in Ecuador, but the Ecuadorean hatcheries currently depend entirely on imported supplies.

## Shrimp Harvests Decline

Ecuadorean sources report declining pond shrimp harvests, but not as much as some observers had anticipated. In June 1985, Government officials predicted a pond harvest of only 27,000 t of shrimp, almost 20 percent less than the 33,300 t harvested in 1984. Statistical data on the actual 1985 pond production, however, is not yet available, but it appears that the production declines of 20-30 percent made earlier in the year may have to be revised. It is apparent, however, that a variety of factors have prevented pond harvests from declining as much as anticipated. The relative importance of these factors is impossible to assess at this time, but some of the factors which might have caused the shrimp culture harvest to have been better than anticipated are listed below.

Note: Unless otherwise credited, material in this section is from either the Foreign Fishery Information Releases (FFIR) compiled by Sunee C. Sonu, Foreign Reporting Branch, Fishery Development Division, Southwest Region, National Marine Fisheries Service, NOAA, Terminal Island, CA 90731, or the International Fishery Releases (IFR), Language Services Biweekly (LSB) reports, or Language Services News Briefs (LSNB) produced by the Office of International Fisheries Affairs, National Marine Fisheries Service, NOAA, Washington, DC 20235.

[1]There is some uncertainty concerning the extent of mangrove destruction in Ecuador. Some observers believe that large areas have been cleared to build ponds. Other observers believe that the damage to the estuaries has been exaggerated. NMFS shrimp culture expert Cornelius Mock, who has made several trips to Ecuador, reports that he has not observed the large-scale destruction of the marginal mangrove ecosystem reported by some other observers. He reports that ponds built in mangroves would not be conducive to shrimp culture because of the acidic soils. He states, however, that many ponds have been built on the land behind the mangroves.

1) Improved methods: Ecuadorean growers may be improving culture methods more rapidly than commonly believed. Growers able to obtain postlarvae may be achieving better yields than anticipated. Some growers may have been over-stocking postlarvae when they were inexpensive. Lowering stocking densities may have led growers to optimal stocking levels which, for example, could have increased survival rates.

2) Increased pond construction: The continued expansion of the number and area of ponds has increased the total areas of ponds in the country. While the large number of inactive ponds gave the impression of a severe crisis, a large number of growers were able to continue production.

Estimating the extent of production declines is further complicated by other factors. Cooler-than-normal temperatures have reportedly reduced shrimp growth rates. In addition, various practices adopted by growers to keep their ponds in production may have resulted in reduced yields. The new measures include stocking at sharply lower densities and growing the shrimp longer than the 120-day period that many growers average when producing 31-35 count (per pound) shrimp. Growers who opt for the lower stocking densities and longer growing periods would harvest a smaller quantity of shrimp, but the shrimp harvested would be larger, more valuable shrimp. A few growers have reportedly been growing shrimp as long as 240 days and harvesting 15-20 count shrimp. The economics of such shifts in culture strategy would depend on the relative price differences between shrimp of various counts.

Latest reports from Ecuador suggest that December 1985 and January 1986 pond harvests should be about 20 percent below the production levels of a year earlier. Both growers and government officials agree that production levels should begin to increase once more by April 1986.

**Table 2.—Ecuador's frozen shrimp exports to the United States by month and quantity, 1980-85[1].**

| | Exports to U.S. (t) | | | | | |
|---|---|---|---|---|---|---|
| Month | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 |
| Jan. | 375 | 864 | 1,122 | 1,704 | 1,951[2] | 1,349 |
| Feb. | 548 | 349 | 533 | 1,210 | 1,589 | 1,882[2] |
| Mar. | 630 | 1,115 | 1,200 | 1,505 | 1,542 | 1,619[2] |
| Apr. | 664 | 855 | 1,125 | 1,865 | 2,082[2] | 1,803 |
| May | 851 | 926 | 1,792 | 2,527[2] | 1,472 | 1,742 |
| June | 1,068 | 1,237 | 2,009 | 2,382[2] | 1,729 | 1,792 |
| July | 675 | 985 | 1,210 | 2,605[2] | 2,080 | 2,176 |
| Aug. | 651 | 1,165 | 1,726[2] | 1,695 | 1,711 | 1,324 |
| Sept. | 1,033 | 897 | 1,775 | 2,153[2] | 1,927 | 1,916 |
| Oct. | 1,070 | 949 | 1,310 | 2,132[2] | 1,930 | 1,454 |
| Nov. | 735 | 982 | 1,280 | 1,869[2] | 1,601 | 1,521 |
| Dec. | 876 | 916 | 1,334 | 1,702[2] | 1,523 | NA[3] |
| Total[4] | 9,160 | 11,220 | 16,383 | 23,300 | 21,139 | NA[3] |

[1]These data do not include a significant (but variable) quantity of shrimp believed to have been smuggled out of Ecuador, principally through Peru, to avoid Ecuadorean currency controls. It is believed that these illegal shipments declined in 1985 with changes in Ecuadorean export regulations. Source: Bureau of the Census, U.S. Department of Commerce.
[2]Record exports for that month.
[3]NA = Not available.
[4]Totals may not agree due to rounding.

## Shrimp Exports Decline

Ecuadorean projections of declining exports were premature[2]. Despite the postlarval shortage, Ecuadorean shrimp exports continued at high levels through July 1985, but since July were generally below 1983 and 1984 levels (Table 2). Total shrimp shipments to the United States for Jan.-Nov. 1985 were 18,700 t, only 5 percent less than during the same period of 1984. Most observers now believe that exports did not decline as sharply as had been anticipated for several reasons.

1) Inventories: Shrimp inventories may have allowed exporters to continue shipping even when production declined. Some exporters may have drawn down inventories, but because Ecuadorean cold storage holdings are not published it is not possible to determine if this occured.

2) Ecuadorean export policies: New export policies, adopted by the Ecuadorean Government, caused growers to ship more of their product through official channels, thus increasing the amount of shrimp exports included in official statistics. The Ecuadorean Government had required exporters to exchange at least part of their foreign exchange earnings at the low, official exchange rate. This cost the exporters millions of dollars annually. To avoid government exchange controls, many growers and exporters either falsified export documents (underreporting the value and/or the quantity) or smuggled their shrimp out of Ecuador, primarily through Peru. Although no precise data is available, such illegal shipments must have totaled several million dollars. One estimate suggests that official Ecuadorean statistics for 1983 and 1984 shrimp exports may have been as much as 20 percent below actual shipments. In September 1984, the Ecuadorean Government modified its regulations and allowed exporters to exchange their foreign earnings at an amount closer to the free market rate. Rebates (abonos tributarios) which the government pays to exporters were increased to 20 percent of the value of the shipments. In addition, in 1985 the Ecuadorean Government hired a Swiss company to inspect shrimp exports to ensure that they were properly documented. As a result, Under Secretary Noboa claimed in press interviews that his Government's new policies have resolved the country's serious shrimp smuggling problem.

3) Peruvian regulations: The Peruvian Goverment also issued new export regulations in 1985. While Ecuador raised its export subsidies. Peruvian officials cancelled the 35 percent rebates (CERTEX) paid to shrimp exporters. The rebates had enabled Peruvian processors to pay a higher price for shrimp than Ecuadorean processors. The higher price and the chance to avoid Ecuadorean taxes and exchange controls enticed a large number of Ecuadorean growers and exporters to smuggle their shrimp through Peru. When Peru eliminated its rebates while Ecuador raised its rebates, there was less incentive for exporters to smuggle shrimp to Peru. As a result of the new Peruvian and Ecuadorean regulations, the quantity of Ecuadorean shrimp being smuggled through Peru declined in 1984 and 1985.

4) Increased trawler catches: While artisanal fishermen were reporting a poor postlarvae catch, Ecuador's trawler fleet was having an excellent season.

[2]These reports were assessed in the news article "Ecuadorean Shrimp Culture and Exports" *Mar. Fish. Rev.* 47(4):52-55.

Early projections suggested that the 1985 trawler catch could total as much as 9,000 t, about 25 percent more than the 1984 catch of 6,700 t (Table 1). The increased trawler catch made up some of the shortfall caused by the decline in pond production, allowing exporters to maintain the quantity of shipments.

### Postlarvae Situation

Newspaper reports from Ecuador indicate that the postlarvae situation changed dramatically in October 1985. Ecuadorean fishermen were again taking berried females in late September, the first such females harvested since March. The number of berried females continued increasing and, by late October, the postlarvae collectors were experiencing excellent results. One report indicated that 10 million postlarvae were collected between Salinas and Manglaralto during a single weekend in late October. Reports of good availability of postlarvae continued throughout November, December, and January 1986, although other reports suggested that the country's demand for postlarvae was still not being fully met. As late as December 1985, some growers still reported that they were unable to obtain postlarvae. A more recent report, however, indicated that collections during the high tide on 9 January 1986, were spectacularly successful.

With the increased supply of postlarvae, the price reportedly dropped to $8-10 per 1,000 postlarvae in early January 1986 and to $6-8 per 1,000 in late January, less than one-third of the price reported during the peak of the scarcity. Government officials believe that the abundance of postlarvae is due to the warming water temperatures and the newly implemented shrimp fishing closure, which means that more females are surviving to spawn. Growers report that the postlarvae recently collected have had an unusually high concentration of the preferred species, *Penaeus vannamei*, a key factor in assessing the postlarvae collections. One report indicated that many collectors were delivering catches of postlarvae up to 90 percent *P. vannamei*.

As a result, by late October and November 1985, many growers were able to stock some of the ponds they had taken out of production. The number of ponds returned to production, however, is unclear as no official statistics are available. Unconfirmed Ecuadorean reports indicate that even as late as December a large number of ponds had still not been restocked. Many ponds remaining out of production are most likely the marginal ponds which were either not properly designed or were built in poor locations and are thus not as profitable as other ponds.

Another group which is also reportedly having difficulty resuming operations are some those farmers who built ponds during the past few years. The higher initial investment (needed because of rising land values and other factors) required large loans at high interest rates[3]. Some of the investors have had difficulty meeting their loan payments. Both groups of pond owners reportedly had difficulty adjusting to the March-October 1985 period when postlarvae were scarce and expensive. Some pond owners went bankrupt, and many more had to close their farms because they could not meet operating expenses. These owners have found it difficult to resume operations even though the postlarvae are now more available and less expensive. The Ecuadorean Central Bank reported in October 1985 that the total indebtedness of Ecuadorean shrimp farmers was nearly $250 million.

### Future Exports

Ecuador has become the second leading supplier of shrimp to the U.S. market, after Mexico (Table 3). Shipments in the past few years have increased from only 3,900 t in 1977 to 21,100 t in 1984 (Table 3). Export earnings of $185 million in 1984 made fishery products (mostly shrimp) Ecuador's second leading export earner, after petroleum.

Reports from Ecuador suggest that shrimp exports will continue to be affected for several months by the problems Ecuadorean growers experienced with postlarvae supplies. One Ecuadorean Government official reports that exports would continue at low levels through March 1986. By that time, growers should begin to harvest the ponds stocked when the postlarvae began to become more plentiful in October. Given the availability of postlarvae and the large numbers of new ponds authorized in 1984 and 1985, many observers believed that by April 1986, Ecuadorean growers would be harvesting cultured shrimp at above 1985 levels.

Ecuadorean exporters last reported record shipments in March 1985 (Table 2). Undersecretary Noboa believed that by March 1986 exporters would be able to report a "considerable" increase in foreign sales because of projected production increases. Some observers are projecting exports at record levels toward the end of 1985. These optimistic projections, however, will be affected by any significant change in the availability of postlarvae. Some observers caution that these optimistic projections do not

[3]Many of Ecuador's first ponds were built in coastal areas where the land was thought unusuable. Much of this land was leased or purchased for incredibly small investments. Most of the best coastal land, except in the northern province of Esmeraldas, has already been developed. Consequently, land values have increased to several thousand dollars per hectare. Construction costs have also risen, with some growers developing hill land as much as 50 m above sea level. Development costs for the new entrants into the industry could reach $8,000/hectare. Some of the new farms have been built on marginal land and are also experiencing increased operating costs. Farmers with ponds on hilly land, for example, will have higher pumping costs than those farmers with ponds closer to sea level.

**Table 3.—U.S. shrimp imports from selected countries (Jan.-Nov. 1985), and imports from Ecuador, 1977-85[1].**

| Export nation | U.S. imports (1,000 t) | Year | Imports from Ecuador: Amt. (1,000 t) | Imports from Ecuador: Value (US$10$^6$) |
|---|---|---|---|---|
| Mexico | 25.2 | 1977 | 3.9 | 24.0 |
| Ecuador | 18.7 | 1978 | 5.0 | 30.0 |
| Taiwan | 11.7 | 1979 | 6.2 | 54.5 |
| Brazil | 10.8 | 1980 | 9.2 | 68.1 |
| Thailand | 10.5 | 1981 | 11.2 | 80.3 |
| India | 10.3 | 1982 | 16.4 | 136.5 |
| Panama | 8.1 | 1983 | 23.3 | 218.7 |
| Norway | 7.1 | 1984 | 21.1 | 185.5 |
| Other | 46.3 | 1985[2] | 18.7 | 154.7 |
| Total | 148.7 | | | |

[1]Source: Bureau of the Census, U.S. Department of Commerce.
[2]Through November.

allow for any major temperature anomalies or other climatic events which could affect the availability of postlarvae.

## Shrimp Hatcheries

While postlarvae collected in the wild continue to be the primary source of postlarvae for most growers, some growers and other investment groups have been working for several years on the construction of hatcheries to produce a steady supply of postlarvae throughout the year. Many more such groups became interested in hatcheries during 1984 when postlarvae were less abundant and prices increased sharply. The interest in hatcheries expanded explosively in 1985 when many growers could not obtain postlarvae at any price. Postlarvae prices rose to levels that made the economics of hatchery production look very favorable. The Government has been encouraging farmers and processing/exporting companies to build hatcheries. Incentives for hatchery construction include low-interest loans and a 5 percent increase in export rebates for companies which build hatcheries (Acuerdo Interministral No. 353, 1 July 1985).

Rising postlarvae prices and the Government's assistance have enticed many companies and individuals to enter the hatchery business. As a result, an estimated 70-80 hatchery projects are currently planned, or in various stages of completion[4]. The theoretical production capacity of these hatchery projects is an estimated 6-7 billion postlarvae per year. It is still unclear, however, how successful the new hatcheries will be at initiating the regular production of postlarvae in commercial quantities. Many observers are expecting a major increase in hatchery production during 1986, as several large new hatcheries are scheduled to begin production in mid-1986. Production could total as much as 2.4 billion postlarvae (Table 4), which would mean that, for the first time, hatcheries would supply important quantities of postlarvae to growers. Even so, 2.4 billion postlarvae is less than 20 percent of the approximately 14 billion postlarvae that will be needed by Ecuadorean growers in 1986[5]. In 1986, more than 70 percent of the projected postlarvae production will come from only six hatcheries[6]. AQUALAB, CRIDEC, GRANPAC, MACROBIOL, SEMACUA, and one hatchery whose owners asked that it not be identified. Based on the difficulties that established hatcheries continue to report, it will probably be some time before the new hatcheries can begin to supply substantial quantities of postlarvae.

**Table 4.—Ecuador's hatchery production of marine shrimp postlarvae, 1980-86, and projected production by region for 1986[1].**

| Year | Production in billion postlarvae | Region | 1986 Est. production in billion postlarvae |
|---|---|---|---|
| 1980 | Negl. | Esmeraldas | 0.1 |
| 1981 | 0.1 | Bahia de Caraquez | 0.2 |
| 1982 | 0.1 | Manta | 0.4 |
| 1983 | 0.3 | Salinas[2] | 1.7 |
| 1984 | 0.4 | El Oro | Negl. |
| 1985 | 0.7 | | |
| 1986 | 2.4P[3] | Total | 2.4 |

[1]Source: NMFS Office of International Fisheries.
[2]Hatchery row.
[3]P = Optimistic projections by hatchery managers. Actual production will probably be lower

In 1986, the predominant source of hatchery postlarvae will continue to be gravid females captured at sea and spawned in captivity. The production of postlarvae through the full-cycle maturation process in hatcheries will be only a fraction of the projected 1986 production, although several large hatcheries plan to increase production through the maturation process. The actual numbers associated with the commercial-scale production of postlarvae in Ecuador are staggering. To produce even 2.4 billion postlarvae through maturation, Ecuadorean hatcheries would theoretically need to handle about 96,000 females and 50,000 males[7]. In actual operations, a large number of both female and male shrimp would be needed, depending on mortality rates. Few Ecuadorean specialists are able to successfully achieve maturation in experimental runs, let alone in sustained, commercial-scale operations. The actual numbers of gravid females required for the less complex nonmaturation process is also staggering. Hatcheries would need a minimum of 60,000 berried females to produce 2.4 billion postlarvae[8]. Even if the Ecuadorean hatcheries are able to achieve this level of production using the nonmaturation process, it would still mean that the supply of postlarvae will continue to be seasonal and will depend on the natural availability of gravid females. Source: IFR-86/07.

[4]A list of Ecuadorean shrimp hatcheries is available on request from Dennis M. Weidner (F/M321), NMFS, NOAA, Washington, D.C. 20235. Please enclose a stamped, self-addressed, legal-sized envelope.

[5]Estimating postlarvae demand in Ecuador is virtually impossible with any degree of precision as basic data (area of ponds constructed, area of ponds in operation, stocking densitites, survival rates in nursery ponds, number of crops raised, etc.) are not available. The 14 billion postlarvae estimate is based on an estimated 62,500 hectares of active ponds, a stocking density of 50,000 postlarvae per hectare, a survival rate of 50 percent, and an annual average of 2.2 crops per year.

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

[7]This is assuming that each hatchery gets about 100,000 eggs per year out of each female through two spawning cycles and that about 25 percent of the eggs survive to the postlarval stage. In reality, production, survival rates, and methods vary widely from hatchery to hatchery and are treated as confidential data. Some hatcheries are raising their own broodstock, but most maturation production currently tends to be from wild-caught females which are spawned until their egg production declines and then discarded. These estimates should be taken as very rough estimates based on several highly conflicting reports. Some of the hatchery operators in Ecuador claim to have achieved much better results, but their claims have yet to be established with any published papers.

[8]Assuming each female produces an average of 80,000 viable eggs and that about 50 percent survive to the postlarval stage.