Walleye Pollock and Its Utilization and Trade

Introduction

The annual harvest of walleye pollock, *Theragra chalcogramma*, also called Alaska pollock, currently represents the world's largest single-species fishery; catches were between 5 and 6 percent of the total world fisheries harvest in 1984 and amounted to a record high 6.0 million metric tons (t). Although walleye pollock is found throughout the North Pacific, stocks are centered principally within the exclusive economic zones of the United States and the Soviet Union. In addition, there are several pollock stocks located in the Sea of Japan. Four countries (the Soviet Union, Japan, the United States, and the Republic of Korea (ROK)) harvest over 95 percent of the world walleye pollock catch. About one-fourth of this total catch has been harvested within U.S. waters in recent years.

Walleye pollock is marketed throughout the world in various forms and the potential for expanded uses of this groundfish species is great. The most interesting commodity produced from pollock is surimi, a minced product which is used to manufacture such products as imitation crab legs, scallops, shrimps, and other analog foodstuffs. Worldwide pollock surimi production exceeded 400,000 t in 1984 and experiments are being conducted on other marine species to test their commercial viability for surimi production.

Walleye Pollock Harvests

Pollock stocks occur throughout the eastern and western North Pacific Ocean from the Sea of Japan, the Okhotsk and Bering seas, the Gulf of Alaska, and extend into waters off British Columbia. Although fishery biologists are uncertain about walleye pollock stock identification, it is generally accepted that there is a likely amount of migratory mixing among neighboring stocks in certain areas of the North Pacific—especially in the Sea of Japan.

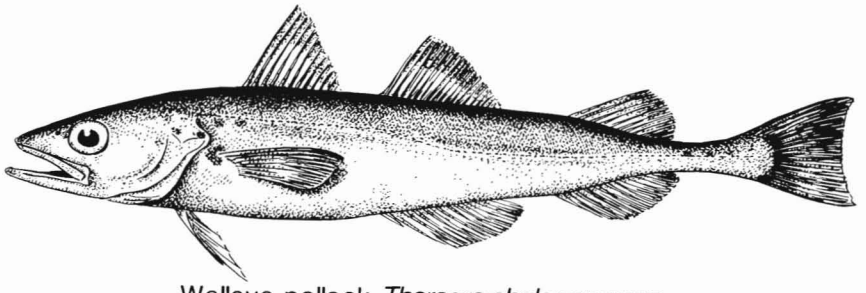
A study made in 1977 suggested that there are at least 12 major pollock stocks in the entire North Pacific. Four of these stocks are located in the Sea of Japan at: 1) Western Hokkaido; 2) northern Japan (Honshu); 3) western Japan (Honshu); and 4) Primorskiy-Korean peninsula. North of Hokkaido there are two more pollock stocks at: 5) Kuril Islands and 6) east and southern Hokkaido. In the Sea of Okhotsk, there are two stocks identified as the: 7) Sakhalin-Hokkaido and 8) northern Okhotsk stocks. Moving east from the Sea of Okhotsk, observers note the 9) Kamchatka peninsula stock.

The three remaining pollock stocks are found around North America in: 10) The eastern Bering Sea; 11) the Gulf of Alaska; and, finally, 12) waters around British Columbia. It should be noted that within these stocks observers report differing genetic characteristics that further subdivide stocks into local groups; details regarding the structure of each stock or local subgroup have not been investigated and analyzed in detail. Some fishery biologists believe that the biomass of all these pollock stocks exceeds that of any other demersal species.

Much of the walleye pollock fishery is conducted by bottom trawling, although gillnetting, longlining, and midwater trawling are also used in the fishery. The length of a mature walleye pollock is between 30 and 60 cm and the weight of an individual averages between 0.2 and 1.4 kg. Walleye pollock is harvested throughout the North Pacific wherever stocks are found, but in recent years greater harvesting efforts have been made in specific fishing areas (Fig. 1). About 75 percent of walleye pollock harvests are made in the eastern North Pacific; the other 25 percent are made west of long. 175°W, primarily in U.S. waters. Although the flesh of walleye pollock is most commonly utilized for human consumption, stocks are often adversely affected by parasites in many fishing regions. In this event, harvests are often used for fishmeal.

Ever since the 1973 El Niño phenomenon decimated the Peruvian anchovy fishery, walleye pollock has been the world's largest single-species fishery. Despite this fact, the pollock fishery is remarkably little known to the general American public, considering that a large segment of it occurs within the 200-mile fisheries zone of the United States. The reason for the lack of information probably stems from the fact that the fishery is only about 20 years old around Alaska and did not involve U.S. commercial fishery participation until recently.

Historically, the North Pacific fishery



Walleye pollock, *Theragra chalcogramma*

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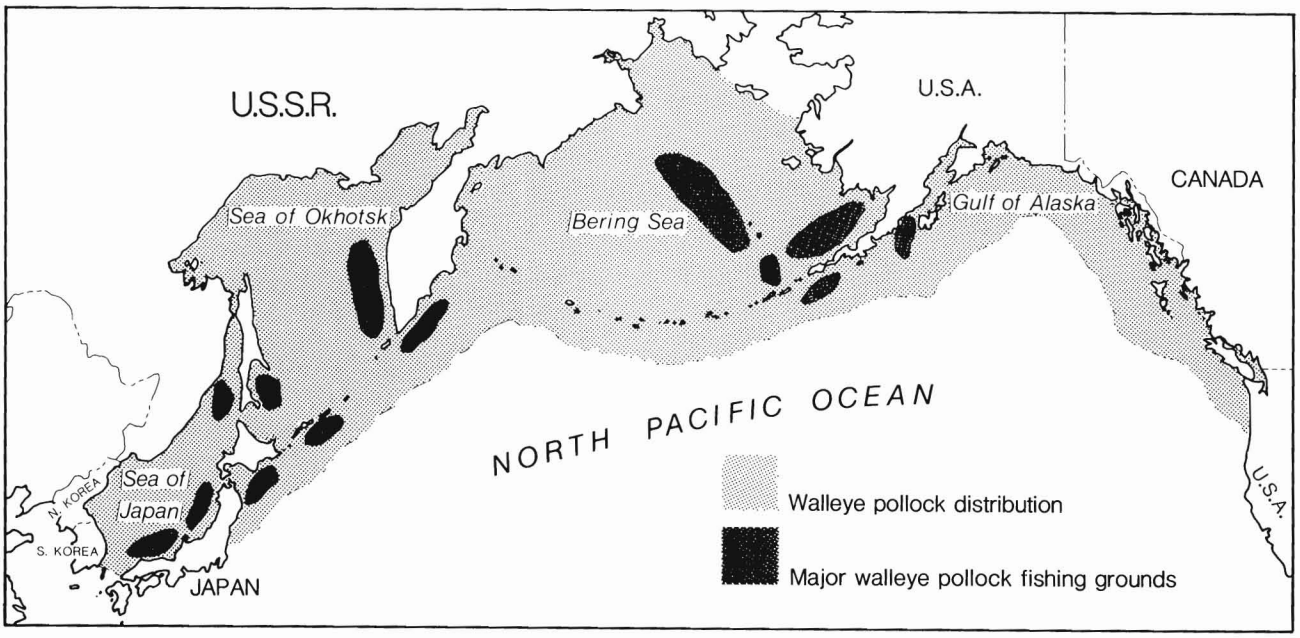

Figure 1.—Distribution and major fishing grounds for walleye pollock.

for walleye pollock was limited to the coastal waters of Japan and Korea until the late 1950's, when it underwent a rapid expansion as a distant-water fishery. Japanese operations, in particular, spread quickly up into the Sea of Okhotsk and across into the Bering Sea during the 1960's. The Japanese harvest of walleye pollock in the Bering Sea increased from 25,800 t in 1960 to over 655,800 t in 1969. At the same time, pollock fishing efforts elsewhere in the North Pacific, particularly by Soviet fishermen, also expanded. During the 1960's, annual pollock harvests increased from 465,000 t in 1961, to nearly 3.6 million tons by 1971.

The annual world catch of walleye pollock was about 5.0 million tons in 1975 (Table 1). Following the establishment of 200-mile fishery zones in the North Pacific in 1977, the catch decreased by over 20 percent. After 1980, when Japan and Korea secured catch allocations within U.S. waters and the Soviet Union increased fishing efforts within their own waters, catches again increased. Harvests exceeded 6.0 million t in 1984, or about 20 percent more than the catches made in 1975. The potential for increased harvests depends upon the size of the walleye pollock biomass, which is not known with any certainty by biologists.

Table 1.—World walleye pollock catch, by country, 1975-84.[1]

	Catch (1,000 t)									
Country	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984[1]
U.S.S.R.	1,958.1	2,090.9	1,975.1	2,011.9	2,048.8	2,111.7	2,137.9	2,497.9	2.747.0	3,449.6
Japan	2,677.4	2,445.4	1,927.6	1,546.1	1,551.1	1,552.4	1,595.3	1,570.4	1,434.4	1,605.9
United States	negl.	0.2	0.3	1.8	3.1	1.4	60.7	130.4	284.5	455.1
S. Korea (ROK)	387.8	532.6	390.6	361.9	297.2	286.2	278.6	262.1	367.4	398.6
Poland	0.5	negl.	1.4	1.2	40.4	61.0	92.9	0.4		53.7
Germany (FRG)						6.0	10.3	16.1	23.7	24.4
Canada		1.3	0.9	2.4	3.4	2.2	1.1	0.9	1.0	0.7
Total[3]	5,023.9	5,070.4	4,295.9	3,925.3	3,944.0	4,020.8	4,176.8	4,478.2	5,047.3	5,986.0

[1]Sources: FAO "Yearbook of Fishery Statistics, various years; NMFS "Fisheries of the United States, 1984"

In an interesting development to the North Pacific pollock fishery, surveys carried out by Japanese research vessels have indicated that substantial schools of large adult-sized Alaska pollock inhabit the surface and midwater layers of the 3,000-4,000 m deep Aleutian basin in the central Bering Sea. Observers believe that these fish are associated with stocks in the area and are not an isolated population. Because a large part of the area in question lies outside the 200-mile zones of the United States and the Soviet Union, vessels from Japan, China, Korea (ROK), and other countries, have reportedly concentrated fishing efforts there in recent months to offset restrictions made by either the United States or the Soviet Union in their respective fishery zones.

Soviet Union

The Soviet Union currently maintains the world's largest walleye pollock fishery (Fig. 2), and harvests annually account for about one-fourth of the total Soviet fisheries catch. Soviet fishermen caught a record-high 3.4 million t in

1984, accounting for 55 percent of the world's pollock harvest. Soviet catches have increased steadily since 1978 because of expanded fishing efforts within domestic waters. Estimates on the biomass of the four pollock stocks located within the Soviet 200-mile zone are unavailable, and observers are not sure whether Soviet stocks can withstand annual harvests of over 3.0 million t on a sustained basis.

The Soviet Government, under terms of a bilateral treaty with Japan, permits Japanese fishermen to harvest pollock within the Soviet 200-mile zone. Annual pollock quotas for Japanese fishermen in the Soviet waters decreased from 290,000 to 250,000 t between 1980 and 1985, and decreased further in 1986, after the Soviet-Japanese annual agreement resulted in a quota of only 150,000 t of pollock for Japanese fishermen. Some observers have speculated that Japan may be forced to pay "cooperation fees" to the Soviets in exchange for harvesting pollock within Soviet waters in future years.

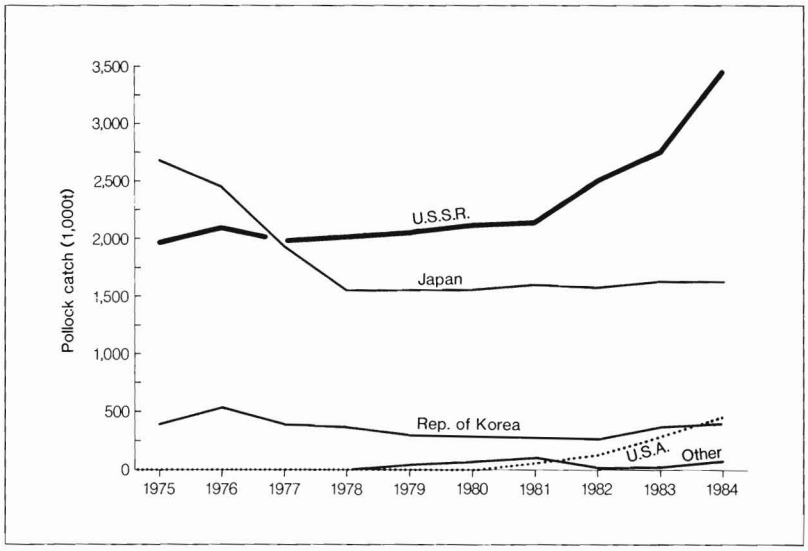

Figure 2.—World walleye pollock catch, 1975-84.

Japan

The Japanese pollock fishery was mostly limited to coastal waters until the 1960's. The fishery became more important to the Japanese after harvests of yellowfin sole in the Bering Sea greatly decreased in the early 1960's. An additional impetus to the pollock fishery occurred in 1967, when Japanese fishery technologists developed a mechanical process to manufacture pollock into a traditional Japanese seafood commodity: Surimi. Harvests by Japanese mothership and large trawlers increased greatly until reaching an apex during 1972 and 1973, when catches exceeded 3.0 million t in both years.

Japan's annual pollock harvest was once that country's largest fishery, accounting for almost one-third of the total fisheries catch. Because of the restrictions placed upon Japanese distant-water trawling after the establishment of 200-mile zones, pollock harvests decreased and the fishery now ranks second in size to the sardine fishery. Over one-half (55 percent) of the Japanese pollock catch made in 1984 was harvested within the 200-mile zones of the United States and the Soviet Union.

Japan's distant-water fishermen are permitted to harvest pollock within both the U.S. and Soviet 200-mile fishery zones under terms of bilateral agreements negotiated by the Japanese Government. As a result of these bilateral arrangements, the Japanese pollock harvest remained relatively stable between 1978 and 1984. This enabled the Japanese distant-water demersal fishing industry to weather socioeconomic disruptions caused by the establishment of 200-mile fishery zones. In addition to receiving allocations from the United States and the Soviet Union, Japanese vessels also participate in pollock joint ventures with U.S. and Soviet fishermen. These joint ventures involve the over-the-side purchase of pollock by Japanese factory trawlers from U.S. and Soviet trawlers.

Because of the interesting capacity of U.S. fishermen to harvest and process pollock, coupled with the fact that the pollock stocks within the U.S. 200-mile fisheries zone have decreased in recent years, it is likely that Japanese harvesting levels will decline during the next few years and result in a greater dependence upon imports and joint venture purchases to meet the domestic demand for pollock. Accordingly, it is likely that Japan's surimi production will slacken in relation to decreased pollock harvests unless the Japanese are able to offset this by importing greater quantities of pollock and pollock-surimi from other nations, or by developing a surimi industry utilizing other marine species, which observers believe is unlikely.

United States

Walleye pollock harvests by U.S. vessels have increased significantly in recent years. U.S. fishermen caught 455,000 t in 1984, compared with only 20 t in 1975. This sharp increase in the pollock catch can be attributed to the increase of joint-venture activities with foreign countries, especially Japan and the Republic of Korea, and increased domestic pollock landings.

Prior to 1977, pollock was harvested primarily by distant-water foreign vessels off the U.S. coast. Since 1977, however, foreign access to U.S. waters has been restricted, thus enabling U.S. fishermen to harvest increasing quantities of all commercially important groundfish species off Alaska. Meanwhile, foreign pollock harvests within U.S. waters decreased from 1.1 million t to 0.8 million t in 1985 (Table 2). The U.S. pollock catch began to increase as a result of increased joint venture arrangements with Japan and the Republic of Korea after 1981; the entire catch resulting from these joint ventures was sold over-the-side to Japanese and Korean processing vessels. U.S. fisher-

Table 2.—Foreign catch of walleye pollock within the 200-mile Exclusive Economic Zone, by country and quantity, 1980-85.[1]

Country	Catch (1,000 t)					
	1980	1981	1982	1983	1984	1985[2]
Japan	870.9	855.2	835.4	732.1	723.5	635.5
Korea (ROK)	141.0	154.6	196.2	217.1	218 4	174.7
Poland	59.2	93.9			55.0	32.0
Germany (FRG)	6.0	10.3	16.1	23 6	24.4	
U.S.S.R.	39.2				11.8	1.5
Taiwan	5.0	3.4	4.2			
Total	1,119.1	1,117.3	1,051.9	972.8	1,033.2	843.7

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

Table 3.—Republic of Korea (ROK) pollock harvests, by quantity, 1970-84.[1]

Year	Harvest (t)		
	Adjacent-water	Distant-water	Total
1970	N/A[2]	N/A	13,400
1971	N/A	N/A	71,300
1972	N/A	N/A	148,500
1973	N/A	N/A	257,000
1974	N/A	N/A	297,218
1975	4,540	327,939	332,479
1976	5,546	444,516	450,062
1977	18,584	267,715	286,299
1978	11,295	257,553	268,848
1979	11,716	217,718	229,434
1980	28,112	189,774	217,886
1981	50,283	228,353	278,636
1982	38,413	223,682	262,095
1983	29,642	337,780	367,422
1984	39,906	358,716	398,622

[1]Source: Korean Ministry of Agriculture and Fisheries, "Yearbook of Fisheries Statistics."
[2]N/A = Not available

men landed only 10,900 t out of the 455,000 t of pollock that they harvested during 1984. In 1985, U.S. fishermen were able to increase domestic landings of pollock greatly, and over 55,000 t were landed at U.S. ports.

Within the past 5 years, U.S. companies have introduced freezer trawlers into the pollock fishery off Alaska. In 1985, some 14 U.S.-owned freezer trawlers were involved in harvesting and high-seas processing of pollock in the Gulf of Alaska and the Bering Sea. The presence of these vessels has enabled the United States to increase domestic pollock landings.

Republic of Korea

Korea has long had an active fishery for walleye pollock. Before World War II, it is estimated that Korean nationals accounted for a major part of world pollock landings. Presumable because of over-capacity within adjacent waters, Korean fishermen, in newly acquired distant-water trawlers ventured to harvest walleye pollock during the 1970's in areas that are now within Soviet or U.S. fishing zones. Between 1970 and 1975, Korean harvests increased from 13,400 to 532,000 t, and were made primarily in waters that are now under the jurisdiction of the Soviet Union. Because of the loss of access to Soviet waters after 1976, Korea sought access to the U.S. 200-mile zone for its trawlers in the eastern Bering Sea and the Gulf of Alaska. A fisheries agreement was arranged between the two countries which has since regulated Korean fishing within U.S. waters. Over 70 percent of Korea's pollock harvests have been made in U.S. waters in recent years.

Korean fishermen harvested nearly 400,000 t of walleye pollock in 1984—mostly in the eastern Bering Sea. The Koreans also maintain an "adjacent-water" fishery for pollock within the Sea of Japan, where about 30 percent of their pollock harvests are made (Table 3). During the early 1980's, Korea's pollock fishery was conducted by about 50 stern trawlers in the North Pacific. It is not known how many vessels are currently involved in the fishery.

Other Countries

Several other nations have harvested walleye pollock on a commercial basis, including Poland, the Federal Republic of Germany, and North Korea. Canadian fishermen also harvest small quantities of pollock, but their catches have never exceeded 3,500 t per year and probably will never develop beyond that level because of insufficient stocks within Canadian waters. Both Polish and West German fishermen were allowed to harvest pollock within U.S. waters in recent years, but the West Germans discontinued fishing after 1984 due to various economic reasons. Poland was prohibited from fishing in U.S. waters after martial law was declared by its government. Polish fishermen were allowed to reenter the pollock fishery in U.S. waters in 1984 after the Polish Government eased martial law restrictions.

North Korea is another significant pollock harvesting nation. Observers report that the North Koreans annually harvest somewhere between 200,000 and 300,000 t of walleye pollock either in the Sea of Japan or in the Soviet 200-mile zone, but more recent information is not available concerning North Korean pollock fishing activities. It is known that one pollock stock, known as the Primorskiy-Korean Peninsula stock, is found in North Korean waters (Fig. 3). Not much is known about this stock, although observers believe that it is probably being intensively exploited by North Korean fishermen.

China is a new entrant into the North Pacific pollock fishery. In 1985, the West Germans sold three stern factory trawlers to China. Following this purchase, the Chinese sought and received

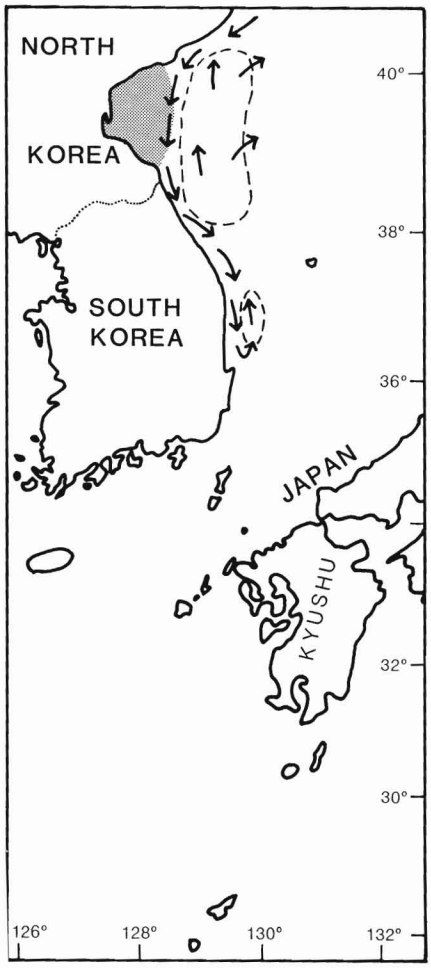

Figure 3.—Location and migration patterns of the Primorskiy-Korean Peninsula pollock stock.

permission from U.S. authorities to fish for surplus pollock in U.S. waters during 1986. In addition, the Chinese have also established over-the-side pollock joint ventures with U.S. fishermen.

Utilization and Trade

The walleye pollock is an extremely versatile fish whose flesh is light-colored, mild-flavored, moist, and firm-textured, with a low fat content. Because the species is such an abundant resource in the North Pacific, it is most widely utilized as surimi; it is also gaining acceptance as a substitute for cod and haddock in international groundfish trade where it is marketed as individual fillets or as fish sticks and portions made from frozen fillet blocks. In addition to the surimi and block markets, pollock roe is also popular in Asian markets.

International trade in the walleye pollock is difficult to quantify and assess because few countries report pollock imports and exports in separate statistical categories. Much of the pollock trade is in the form of blocks or surimi and surimi-based products and is not recorded in trade data by species. Japan, the leading market for pollock, records its pollock imports in a basket category, but recently began recording exports of pollock and other species processed as surimi in an individual category. Trade statistics for the European Community recently began to include pollock in a separate category. Only a limited analysis of world trade in pollock commodities can therefore be done using available statistical information.

The most interesting and expanding use of walleye pollock is for the production of surimi and surimi-based commodities. Although Japan is the world's leading producer of pollock surimi and surimi-based products, the Soviet Union, the United States, and the Republic of Korea, all have fledgling surimi processing industries that presently utilize pollock as a raw material. Several other countries, among them Canada, Norway, the United Kingdom, and the Faeroe Islands, are also involved in developing surimi production using local groundfish and pelagic resources. These industries may expand in the future and intensify competition in the world surimi market.

Table 4.—Japan's estimated walleye pollock supply, 1984.[1]

Source	Amount	
	× 1,000 t	Percent[2]
Imports[3]	60.0E[4]	3.0%
Joint ventures (j/v)		
With U.S.S.R.	50.0E	2.5
With U.S.	341.0	17.0
Subtotal	391.0E	19.5
Harvests		
In U.S.S.R. zone	250.0E	12.0
In U.S. zone	723.5	35.0
Coastal/high seas	631.4E	31.0
Subtotal	1,604.9E	78.0
Supply	2,055.9E	100.0%
Exports subtracted	−30.0E	
Total supply	2,025.9E	

[1]Sources: FAO "Yearbook of Fishery Statistics," Japan Fisheries Association, and personal communications.
[2]Percentage of the total supply.
[3]Japan does not publish pollock import statistics; observers estimated Japan's 1984 pollock imports at 60,000 t.
[4]E = Estimated.

Soviet Union

Most of the Soviet pollock catch is reportedly either consumed domestically or processed into fishmeal; the Soviets also export or barter an unkown amount of pollock commodities, but trade statistics are unavailable. A portion of the Soviet pollock catch is processed into fishmeal because stocks in some fishing areas—such as in the Tatar Strait off of Sakhalin Island—are adversely affected by parasites. Because of the desire to increase earnings of hard currency, the potential for pollock commodity exports from the Soviet Union may intensify competition in the international groundfish market. The Soviet Government, however, may not wish to market pollock commodities abroad because of the great demand for food fish and fishmeal in the Soviet Union. The Soviet Government not only has a desire to increase per capita domestic fish consumption greatly by 1990, it also wishes to expand the domestic output of fishmeal for much-needed use in the agriculture industry. Besides utilizing whole and filleted pollock and fishmeal domestically, the Soviets also use pollock as a major ingredient to make an imitation sausage that is sold under the brand name "Primorskaya". The fish sausage is being produced in the Soviet far east city of Ussuriysk and is reportedly very popular with consumers.

Japan

Pollock is a popular and readily available species in the Japanese seafood diet. Besides being consumed in fresh form, the fish is used to produce a variety of products including: Dried pollock, salted pollock, pickled pollock, and cured pollock roe. But the most widely known use of pollock by Japanese consumers is in surimi end-product form[1]. The most common surimi products include: "Kamaboko", which is semicylindrical and usually steamed on a small wooden pallet; "chikuwa", a slender hollow cylindrical product which is usually roasted; "kanikama" a shellfish analog product which is crab flavored. In addition to these products, there are several other seafood analogs (such as imitation scallops, shrimp, lobster tails, etc.), as well as several food analogs, that are popular in Japan.

Observers estimate that Japan obtained about 1.4 million t or nearly 70 percent, of its apparent total pollock supply from either U.S., Soviet, or Korean sources in 1984 (Tble 4). This supply consisted of allocated harvests made by Japanese fishermen in either the U.S. or Soviet 200-mile zones, joint venture purchases from U.S. and Soviet fishermen, and from pollock imports. The remainder of the supply—650,000 t, or about 30 percent—was harvested by Japanese fishermen either within 200-miles of Japan's coast (either in the Sea of Japan or off the east coast of Hokkaido) or in the high seas (the Bering Sea "doughnut").

Most of Japan's pollock supply is converted into surimi. This fact can be deduced by comparing the total pollock supply with the total production of surimi. Table 4 illustrates Japan's apparent total supply of pollock for 1984, based upon all available sources. From this total estimated supply of pollock, Japan

[1]Most surimi is produced from minced pollock that has been washed, refined to remove impurities, and mixed with cryoprotectants to maintain essential physical properties of the product during frozen storage. As such, surimi is an intermediary product that is not consumed directly, but manufactured into a finished product for consumer use.

produced 400,000 t of surimi during 1984. Because the conversion factor from whole pollock to surimi is between 20 and 25 percent of whole pollock weight, this indicates that Japan converted between 1.6 to 2.0 million t of round-weight pollock in 1984, or almost all of the pollock harvested by Japanese fishermen (1.6 million t), in addition to the pollock that was purchased directly through joint ventures or from foreign processors (0.5 million t). The majority of the surimi produced by Japanese processors goes to the domestic market, although in recent years Japan's exports of surimi-based imitation shellfish products—mostly to the United States—has greatly increased (Table 5).

Japan purchased about 341,000 t of U.S.-harvested pollock under joint venture arrangements with Alaskan fishermen in 1984 (Table 6). This accounted for about 17 percent of Japan's pollock supply that year. In addition to joint venture arrangements with U.S. fishermen, the Japanese also purchased an estimated 50,000 t from Soviet fishermen through a joint venture in 1984. Precise details are not known about the Japanese/Soviet pollock joint venture with regard to prices received by Soviet fishermen, nor is it clear whether or not these joint-venture activities will increase in the future. It is known that the joint venture involved roe pollock purchases

With regard to direct imports of pollock, exclusive of joint venture purchases, only about 3 percent (60,000 t) of Japan's total pollock supply was augmented by imports in 1984. The reason why Japan did not obtain a more significant amount of its pollock from imports in 1984 was due to quantitative restrictions and tariffs (between 7.5 and 16.0 percent ad valorem) which the Government of Japan continued to place upon imports to protect the domestic fishing industry. During 1984, the Japanese Government controlled imports of Alaska pollock through an import quota regime known as the "98-Country Quota on Fish and Shellfish." (A number of marine species are still included in this import quota, including cod, yellowtail, mackerel, sardine, saury, scallops, and others.) This regime regulated imports of certain fish and shellfish species of concern to the domestic fishing industry by announcing semiannual quotas for several different species. A problem in the quota system was that it was impossible to determine an individual commodity's quota because all commodities were lumped together and expressed as a single figure in terms of value. After the United States complained to Japan about the import quota system, the Japanese introduced a new semiannual quota system on 15 June 1985. The new regime is unique because it removed pollock and pollock surimi from the previous quota regime and established a new "global" quota exclusively for these commodities. Unfortunately, however, it is still not possible to distinquish between individual quotas for these two commodities as they are still combined under a single figure in terms of quantity. In addition, the quota is divided among Japanese fishermen, processors, and importers, with the fishermen—who have little interest in importing processed pollock—receiving the largest share (over 90 percent) of the import quota (Table 7). The fishermen's share is used predominately for joint-venture purchases.

The Japanese produce surimi both at sea in factory vessels and at land-based processing plants. Of the 400,000 t of frozen surimi manufactured by Japanese processors in 1984, about 220-225,000 t was produced "at sea" on large surimi processing vessels, while about 185,000 t was produced at land-based processing plants. Top grade factory-vessel pollock surimi sold for about $0.79 a pound in Japan in 1984, while land-based surimi sold for about $0.44 a pound. Land-based surimi from other species, notably croaker, sells for almost twice as much as sea-based pollock surimi (between $1.40-$1.50 a pound). Because the harvest and availability of croaker

Table 5.—Japanese exports of surimi-based imitation crab legs (kanikama), by quantity and destination, 1982-85.[1]

	Exports (t)			
Destination	1982	1983	1984	1985
United States	6,749	13,823	26,756	30,900
Australia	1,751	1,580	1,641	N/A[2]
United Kingdom	348	2,139	1,602	N/A
Canada	26	210	778	N/A
New Zealand	114	309	428	N/A
Netherlands	117	241	269	N/A
Belgium	43	157	216	N/A
Other	182	369	772	N/A
Total	9,330	18,828	32,462	38,987

[1]Source: NMFS Foreign Fishery Information Releases, various issues.
[2]N/A = Not yet available.

Table 6.—Japan's joint venture pollock purchases from U.S. and Soviet fishermen, 1981-85.

	J/v purchases (1,000 t)		
Year	From U.S.	From U.S.S.R.	Total
1981	11	50E	66E
1982	66	50E	116E
1983	212	50E	262E
1984	341	50E	391E
1985	437	50E	487E

[1]The Japan-Soviet joint venture quota between 1981-85 was 65,000 tons per year, but observers do not believe that the quota was annually attained.
[2]E = Estimated.

Table 7.—Japan's pollock and pollock-surimi import quota for the 1985 fiscal year (April 1985 to March 1986),[1] in metric tons.

Recipient/Import commodity	4/85-9/85	10/85-3/86
Fishermen's quota		
Japan Deep Sea Tralwers Association (Joint venture pollock for surimi)	230,000	300,000
Japan Fisheries Association (Joint venture pollock not for surimi)	8,000	7,000
Japan Shore Surimi Manufacturer's Assn. (U.S. processed surimi only)	10,000	10,000
Subtotal	248,000	317,000
User's quota		
Zensui Kakoren (National Federation of Fish Processors) (Frozen pollock from North Korea)	2,500	5,000
Zen Chinren (National Federation of Delicacy Fish Manufacturers) (Frozen pollock from North Korea	2,500	1,000
Zen Kyuhan (Japan School Lunch Federation) Frozen pollock from North Korea)	500	1,000
Zen Kama (All Japan Federation of Kamaboko Manufacturers Cooperative Assns.) (Global surimi)	1,500	1,000
Subtotal	7,000	8,000
Trader's quota		
Global quota on fresh pollock for factory ship processing (Soviet joint venture for roe pollock	0	65,000
Individual Traders (Pollock from U.S.S.R. and South Korea)	15,000	10,000
Subtotal	15,000	75,000
Grand total	270,000	400,000

[1]Japan's fiscal year is from April through March every year. The Alaska pollock and pollock-surimi quota is allocated biannually, the first allocation covering April through September and the second covering October through March. Source: Regional Fisheries Attache, U.S. Embassy, Tokyo.

species is far less than the pollock resource, it is doubtful that croaker can supplant the demand for pollock. However, Japan has a large sardine resource which can possibly be produced into surimi with the present Japanese surimi technology. Observers doubt that sardine surimi can be produced economically along the same lines as pollock because it is an oilier fish with a lower protein percentage in its meat, and the surimi that has been produced is of a darker color than pollock surimi and may prove unacceptable to consumers.

Concerns about decreased supplies of pollock from the U.S. and Soviet 200-mile zones have resulted in Japanese companies increasing efforts to seek other sources of groundfish to process into surimi. For example, Nippon Suisan[2] (Nissui) came to an agreement last year with the Government of the Faeroe Islands to provide surimi technology to the Faeroese fishing industry. The Faeroese will produce surimi at sea aboard the 3,800 t vessel *Lesatender* employing technology supplied by Nissui. The surimi produced by the vessel, using local stocks of blue whiting, will be forwarded to land-based processors on the Faeroes who will then manufacture imitation crab legs (kanikama), reportedly for export to countries in the European Community. A U.K.-based subsidiary of the Japanese company, Kibun Ltd., is building a $4.2 million surimi processing plant in Lanarkshire, Scotland. The plant will be the first of its type in Europe to supply the European surimi market, which observers expect to double in the next 3-5 years from the current estimated annual turnover of $14 million (wholesale value). The company's operations will begin by importing raw pollock surimi for imitation shellfish processing. At a later date, Kibun hopes to produce raw surimi from blue whiting harvested by U.K. fishermen. Observers note that an estimated 5-million t blue whiting stock is found in waters west of the British Isles.

In addition to looking toward the North Atlantic for surimi sources, the Japanese are looking toward the South Pacific. A subsidiary of the world's largest seafood company, Taiyo, was last year granted a 20,000 t allocation of hoki, *Macruronus novaezelandiae*, within New Zealand's 200-mile zone and will conduct a test production of hoki surimi during June 1986. Meanwhile, the Japan Marine Resource Research Center (JAMARC), a quasi-governmental nonprofit organization, was to charter a trawler owned by Nippon Suisan to conduct experimental surimi processing using jack mackerel, *Trachurus murphyi*, stocks harvested off Chile (but outside the Chilean 200-mile zone) during July 1986.

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

United States

Very little of the pollock harvested by U.S. fishermen ends up on the world commodity market. Because pollock has been, until recently, an underutilized species, U.S. fishermen and producers' organizations are now increasing their knowledge of its handling and marketing. The United States has only just begun to explore the possibilities for effective pollock utilization and trade. Virtually all the pollock used for consumption in the United States is in block form that has been supplied by foreign processors. Perhaps this is due to the fact that, unlike other forms of pollock-based products, blocks are not subject to ad valorem duties. Also, transport costs for blocks are considerably lower than for other pollock-based products. U.S. imports of pollock blocks have remained steady over the past 5 years, averaging about 31,000 t annually. In 1984, the United States imported 31,500 t of blocks (over 10 pounds), with 18,900 t coming from the Republic of Korea alone. U.S. imports of pollock-based products from Japan are comprised mostly of surimi. Although only a small fraction (less than 5 percent) of the Alaska pollock caught by Japan is exported to the United States, its value is quite high because it is in surimi form. Of the 35,800 t of surimi exported by Japan in 1984, 27,100 t, valued at $84.5 million, went to the United States. The United States presently has fledgling surimi processing industries, and the outlook for future surimi production is favorable. Potential for domestic production of surimi represents a viable outlet for increased U.S. harvests of pollock. Meanwhile, Japanese companies such as Taiyo, Nichiro, Marubeni, and Nippon Suisan have invested in land-based surimi plants in the United States. In light of the increasing harvests and greater access to surimi technology, the United States appears to be moving toward developing its own place in the world market for pollock products.

Republic of Korea

Pollock has been described as a "traditional" item in the Korean seafood diet. Its availability to Korean consumers has increased since the 1960's, mostly because Korean fishermen have developed distant-water fisheries for pollock. During the 1960's, before Korean trawlers began distant-water pollock fishing near the Kamchatka peninsula and in the eastern Bering Sea, Korean fishermen reported average annual pollock harvests of only 21,000 t. After acquiring distant-water trawlers and fishing expertise in the 1970's, the annual Korean harvest of pollock increased to more than 235,000 t—or more than 10 times annual average harvests during the 1960's.

Korea obtains its pollock supply from three sources: Harvests by domestic fishermen, joint-venture purchases from U.S. fishermen, and imports. From this supply, Korean companies have developed both domestic and export markets for pollock. The domestic market is divided into a market for consumers and a market for the Korean military. It is not known how large these two "submarkets" are in relation to one another, but observers believe that the two markets combined account for about two-thirds of the Korean pollock supply. The other one-third of Korea's pollock supply is exported—primarily to the United States.

Korean companies export pollock to the United States, Japan, and Europe. The most important export market is the United States. In 1985, Korea exported over 18,000 t, valued at $22.7 million, of frozen pollock fillets in block form to the United States. This export represents about one-third of the allocated pollock which Korean fishermen received in the U.S. 200-mile zone during 1985, after a conversion factor from processed to round weight is calculated. Korea is the leading supplier of frozen pollock blocks to the United States, accounting for about two-thirds of U.S.

Table 8.—U.S. imports of pollock blocks by quantity (t) and value (US$1,000), 1980-85.[1]

Country	Pollock imports					
	1980	1981	1982	1983	1984	1985
Korea (ROK)						
Quantity	15,206	14,876	14,297	21,899	18,889	18,111
Value	20,182	23,495	20,387	27,374	24,321	22,741
Japan						
Quantity	1,720	725	858	1,756	811	1,066
Value	2,382	1,220	844	2,319	1,134	1,272
Poland						
Quantity	4,672	6,165	4,281	311		7,557
Value	6,529	9,801	7,060	367		9,120
China						
Quantity			36	36	247	367
Value			54	35	338	458
Taiwan						
Quantity						186
Value						230
Germany (FRG)						
Quantity			20	320	83	
Value			31	422	111	
U.S.S.R.						
Quantity	129	59	52			
Value	114	33	81			
Hong Kong						
Quantity	73					
Value	98					
Grand total						
Quantity	21,800	21,825	19,271	24,322	20,030	27,287
Value	29,305	34,549	28,457	30,517	25,904	33,822

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

Table 9.—European Community (EC) whole, fresh and frozen, pollock imports, by amount (t) and value (1,000 ECU[1]), 1983 and 1984.

Commodity by country	Imports		Commodity by country	Imports	
	Amt.	Value		Amt.	Value
Whole fresh			Whole fresh		
France	465	709	France	720	1,205
U.K.	100	78	Belg.-Lux.	63	73
Netherl.	33	24	U.K.	34	30
Belg.-Lux.	9	15	Netherl.	20	12
Germ. (FRG)	1	2	Germ. (FRG)	19	15
Denmark	1	1	Italy	8	17
	—	—	Greece	2	7
Total, EC	609	829	Denmark	1	1
			Ireland	1	
Whole frozen				—	—
France	373	310	Total, EC	868	1,360
U.K.	131	55			
Germ. (FRG)	32	23	Whole frozen		
Ireland	30	23	France	72	123
Greece	44	52	Italy	69	90
Italy	25	45	Belg.-Lux.	24	19
Belg.-Lux.	17	13	U.K.	17	3
	—	—	Germ. (FRG)	3	3
Total, EC	652	505	Netherl.	1	1
			Ireland	1	
				—	—
			Total, EC	187	258

[1]ECU = European Currency Unit. The average value of 1 ECU equaled $0.89 in 1983 and $0.78 in 1984.

pollock block imports in 1985 (Table 8). Korea's share of the U.S. block import market has fluctuated in recent years depending upon Korean frozen block production and the supplies of pollock blocks that U.S. importers obtain from other sources such as Poland.

The expanding Korean surimi industry has already become a competition concern for Japanese surimi processors. Although Japan imported only 3,000 t of Korean-produced pollock surimi in 1984, the Korean surimi was valued at $1,220 per ton, compared with $1,625-$1,710 per ton for surimi produced in Japan. The Hokkaido-based surimi industry requested that the Japan Fisheries Agency establish import regulations for the Korean-origin surimi, since there was no such category included in the 1984 Japanese import quota of $40 million worth of Korean fishery products. The following year, the Japanese Government introduced the so-called "Global Pollock and Pollock-Product Import Quota", which established a separate import quota regime for pollock and pollock-surimi. This quota system allows the Japanese to better control imports of pollock and pollock-surimi products from Korean processors.

The Koreans intended to import at-sea surimi processing technology from a Japanese company, Mikasa Boeki, and utilize that technology on three factory trawlers which they hoped to operate in the U.S. 200-mile zone. Korea currently employs three factory vessels with a total annual production of 13,000-15,000 t of raw surimi. The addition of the three new vessels will increase Korea's annual surimi production capability to 30,000 t. It is expected that the Koreans will process their increased surimi output into imitation shellfish products for the domestic and export markets. Observers believe that the Koreans will also seek to export greater amounts of raw surimi to the Japanese market while, at the same time, trying to increase exports of imitation shellfish products to the United States.

Other Countries

Although the vast majority of the pollock harvested in the North Pacific is destined for Asian and Soviet consumers, several European countries have recently increased their use of pollock products. This increased use of pollock products has been stimulated by decreased supplies of groundfish, especially cod, to European processors. The European Community (EC) temporarily suspended tariffs for frozen fillets and minced blocks (surimi) of pollock from 18 December 1985 to 28 February 1986. Both commodities are normally assessed an import duty of 15 percent ad valorem, but the EC temporarily suspended tariffs for 4,500 t of imported product. The EC apportioned this quota to three EC-member countries: The Federal Republic of Germany (2,400 t); France (1,100 t); and the United Kingdom (1,000 t). It is not known which countries were supplying the Europeans with pollock during 1983 and 1984, because EC import statistics do not provide the source of the imports (Table 9).

Sources of information on the pollock include: FAO Fish. Tech. Pap. 266, "The Fish Resources of the Northwest Pacific"; Alaska Fisheries Development Foundation, Inc., "Alaska Pollock: Resources, Fisheries, Products and Markets"; NMFS Southeast Region, "Market Trends and Outlook for Surimi-based Foods", by John Vondruska; Alaska Sea Grant Rep. 83-2, "Proceedings of the International Seafood Trade Conference"; Arthur D. Little, Inc., "The Development of a Bottomfish Industry: Strategies for the State of Alaska"; Regional Fisheries Attache, U.S. Embassy, Tokyo; various Japanese and U.S. press reports and personal communications. Special thanks to Paul Niemeier and Michelle Miller, of the NMFS Foreign Fisheries Analysis Branch, for their assistance.

European and American Surimi Developments

Introduction

Japan is the major world producer of surimi and surimi-based foods. Japanese production of surimi-based foods totaled over 980,000 metric tons (t) in 1985,[1] more than 95 percent of the world total. The Japanese have been producing surimi for centuries, but their surimi production expanded sharply in the 1950's and 1960's as a result of several important innovations, especially at-sea production and freezing, which enabled fishermen to use the huge walleye, or Alaska, pollock, *Theragra chalcogramma*, resource to produce high quality surimi.[2]

[1]This amount includes about 420,000 t of actual surimi and 570,000 t of various additives.
[2]The article beginning on page 61 discusses the walleye pollock resource and its use and trade.

High-seas processing enabled the Japanese to process the pollock immediately after catching it, a key factor as pollock deteriorates rapidly after it is caught. Japanese production has declined, however, since the early 1980's because of reduced access to walleye pollock within U.S. and Soviet 200-mile zones, higher prices, and expanding consumption of other foods as part of the increasing affluence of Japanese consumers.

Surimi began to interest international traders when Japan developed the technology in the early 1970's to produce analog products from frozen surimi. Until then surimi was primarily used to produce kamaboko which was almost entirely consumed in Japan's domestic market. With the development of these analog products, which are mostly imitations of high-valued shellfish, Japan has made significant inroads in developing a market for surimi products in the United States and various European countries.

Most of the surimi is marketed as various forms of crab, but smaller quantities are marketed as shrimp and scallops. Japanese businessmen believe that surimi can eventually be used to produce analog products of many other seafoods. Japanese sales of analog products have helped offset reduced sales of other surimi product lines, but accounted for only about 7 percent of total Japanese production in 1985.

U.S. Import Trends

Precise data on the value of U.S. surimi imports are not available, but the NMFS Foreign Fisheries Analysis Branch estimates that these imports in 1985 were about $150 million, making surimi one of the major U.S. fishery import products. Many other countries besides Japan have now begun, or are considering developing, their own surimi industries to replace imports from Japan and other countries.

U.S. import trends are difficult to follow because, until 1985, there was no separate U.S. tariff category for surimi. Current U.S. surimi import categories do not cover all the surimi and surimi-based products currently being imported into the United States. The Foreign Fisheries Analysis Branch estimates that less than half of the surimi and surimi-based products being imported by the United States is currently reflected in U.S. import statistics (Tables 1 and 2). Data available from Japanese sources, however, indicates that the United States imported 36,900 t of surimi in 1985, nearly a 25 percent increase over the 30,000 t imported in 1984.[3] Small shipments were received from eighteen

Table 1.—Recent U.S. surimi imports[1].

	Volume (t)			Value (US$1,000)		
	Jan.-June		Jan.-Dec.	Jan.-June		Jan.-Dec.
Country	1985	1986	1985	1985	1986	1985
Japan[2]	5,357.1	8,403.5	15,000.0	16,819.0	29,773.3	47,348.0
Spain	71.0	38.0	130.6	136.3	105.9	291.0
Canada	22.1	31.8	47.2	95.1	124.5	193.7
Hong Kong	29.2	25.1	32.6	127.8	93.3	154.5
Korea (ROK)	4.1	225.7	28.8	14.1	707.5	73.3
Chile	8.2		9.7	25.4		28.7
Thailand	3.0		3.0	9.8		9.8
Australia	2.4		2.6	10.5		10.5
Switzerland	1.0		2.2	3.7		8.4
Norway		2.5	1.5		3.1	11.1
Denmark	1.3		1.3	2.9		2.9
Taiwan	1.0	10.9	1.3	6.3	42.4	7.4
United Kingdom	1.2	1.0	1.2	2.5	11.2	2.5
Israel			1.1			4.5
Philippines	0.2	4.2	0.7	1.2	6.6	3.5
India	0.5		0.5	1.5		1.5
China	0.5		0.5	4.9		4.9
France	0.2	0.3	0.3	2.3	2.7	3.3
Netherlands		1.0			3.5	
Total[3]	5,503.2	8,744.4[4]	15,265.3	17,263.4	30,873.9[4]	48,160.5

[1]Due to the problems associated with introducing a new tariff category, these statistics represent less than half the surimi and surimi-based foods actually imported. They do, however, give a general indication of the level of activity in various countries. Source: U.S. Bureau of the Census.
[2]Japanese sources indicate that about twice as much surimi is exported to the United States as was reported by the U.S. Census Bureau. Japan reported exports of surimi and surimi-based analogs of about 36,900 t in 1985. Total Japanese shipments probably totaled about $150 million in 1985.
[3]Totals may not agree due to rounding.
[4]Japanese data show a decline in shipments to the United States during the first 6 months of 1986. The increase shown by U.S. statistics may simply reflect the gradual refinement of data. Exchange rate fluctuations may have also been a factor.

Table 2.—U.S. price of imported surimi, 1985-86, in U.S. dollars/kg.[1]

	Jan.-June		Jan.-Dec.
Country	1985	1986	1985
Japan	$3.14	$3.54	$3.16
Spain	1.92	2.79	2.23
Canada	4.30	3.91	4.10
Hong Kong	4.38	3.72	4.74
South Korea (ROK)	3.44	3.13	2.55
Chile	3.10	NA[2]	2.96

[1]Source: U.S. Bureau of the Census.
[2]NA = Not applicable.

other countries, principally Spain, Canada, Hong Kong (a transshipment point), South Korea (ROK), and Chile (Table 1). U.S. imports consist primarily of imitation shellfish, mostly crab analog products. Imports from Japan in 1985 consisted of 32,100 t of shellfish analog products and 4,800 t of surimi blocks.

U.S. Developments

Most observers believe that the U.S. market for surimi and surimi-based foods will significantly expand in coming years. Observers estimate the U.S. market doubled annually between 1981 and 1984. The market will probably continue to expand for the rest of the decade, although at a slower rate. One industry report suggests that by 1990, the U.S. market could require as much as 435,000 t of crab analog products alone. Expansion to this level may require the utilization of other species besides Alaska pollock, which is currently the primary raw material for surimi production.

U.S. companies hope to produce an increasing proportion of that projected total domestically. U.S. companies are planning both shore-based and at-sea surimi projects to replace imports from Japan. Three U.S. companies, all with Japanese participation, are now beginning to produce surimi domestically using shore-based plants for processing from Alaska pollock.[3] At least two U.S. fishing companies are outfitting vessels for high-seas production, and additional companies are planning equity joint ventures with South Korean companies for high-seas production. Another company plans to evaluate menhaden surimi in a pilot project during 1986-87.

Most of the initial production will be marketed domestically, but company officials also hope to export to Japan. There has been considerable discussion in the United States on how to label and market surimi-based foods. Virtually all analog products must be labeled as imitations to comply with a 1985 Food and Drug Administration regulation promulgated under a 1938 law. Crab analogs appear and taste more or less like their natural counterparts, but they have achieved a lower-priced market niche.

[3]Japanese export data indicate that Japan began exporting to the United States in 1978 when about 400 t was shipped. Exports began a spectacular increase in 1982 when over 6,700 t was exported to the United States.

Price Shifts

According to U.S. data, imports of imitation shellfish from Japan averaged $3.54/kg (f.o.b. Japan) in the first 6 months of 1986 (Table 2), 13 percent higher than a year earlier. The Japanese yen price of the intermediate raw material, top grade walleye pollock surimi blocks, also rose about 13 percent at the Tokyo Central Wholesale Market, but this has meant a 60 percent rise in the U.S. dollar price to an average of $2.86/kg in January-June 1986 because of the falling value of the U.S. dollar. U.S. industry sources report paying the higher price for Japanese surimi. Corresponding increases in U.S. dollar prices of Japanese imitation shellfish, however, appear to have been delayed, absorbed, or offset via cost-reducing changes in production, such as shifts to lower priced (non-Japanese) surimi. It is likely that price-cost considerations and the decreased supply of walleye pollock available to Japanese processors helped reduce U.S. imports of Japanese analog shellfish in 1986.

U.S. import data suggest that 1985-86 price levels and directions in some of the other supplying countries may have differed from those in Japan. Apart from possible data problems, any actual differences for prices expressed in U.S. dollars in such countries could be attributed to many factors relating to species used, production, marketing, and exchange rates. Many new companies which have entered the industry are perfecting production and marketing practices. In some cases the relatively high prices reported for surimi products, especially Canadian prices, may reflect additional processing of the intermediate raw material imported from Japan.

Country Developments

Most developments in the surimi industry have centered in Japan. Various groups in other regions have now begun to experiment with, or actually produce, surimi, both for their domestic market and to export. Some of the most important developments elsewhere in the world are reported here.

Western Europe and Canada

Both European and Canadian interest in surimi is a recent phenomena and is due both to the great commercial success of surimi-derived analogs (crab sticks, scallops, etc.) produced in Japan and for the need to develop new fisheries utilizing abundant stocks of underutilized species; this would reduce pressure on traditionally fished groundfish and pelagic stocks. During the past 4 or 5 years, a number of European fishery laboratories have conducted small-scale testing on a variety of local species to identify potential sources of surimi from European waters.

By far, the most successfully tested species has been blue whiting, *Micromesistius poutassou*, which first attracted the interest of the Nippon Suisan company of Japan in the late 1970's when the firm conducted some inconclusive tests on blue whiting in Scotland. A number of small pilot production plants were built in 1985 and 1986, and Europe's first production and processing plants recently opened in the Faeroe Islands and Scotland, with Japanese help. European industry interest, however, is still focused on determining the potential for species found locally, and consumer needs will have to be met by imports for the next few years.

Research carried on in Canada has been basically limited to testing local North Atlantic and Pacific stocks for possible use in surimi production. There appears to be no active research underway by any Canadian universities, but the Canadian Department of Fisheries and Oceans (DFO) and several private firms have expressed interest in producing seafood analogs and are conducting their own testing and marketing research. Two production and processing firms are currently producing seafood analogs on a small-scale basis.

The Faeroe Islands

Faeroese surimi testing, production, and processing has been the most suc-

cessful in Europe so far. Technologists from the Nippon Suisan Company[4] (Nissui) of Japan are working with businessmen from the Faeroese company Blue North, Ltd., to produce surimi aboard the freezer trawler, *Lasetender*, using blue whiting. Preliminary tests by Nippon Suisan suggest that surimi made from blue whiting is superior to that of Alaska pollock. The blue whiting biomass is estimated at 2-3 million t and huge schools of blue whiting spawn off the southwestern coast of the Faeroe Islands from January to May of each year. The catch will be processed into imitation crab ("Blue Sticks", "Blue Flakes", and "Blue Lops") on board the *Lasetender* for export to the European Community.

United Kingdom

Europe's second full-scale surimi processing facility began operations in Lanark, Scotland, in July 1986. The plant, opened with Japan's Kibun Group, is using walleye pollock caught by Japanese trawlers in the North Pacific to produce "Crabsticks" (30 sticks in a vacuum pouch), "SeaSticks" (a smaller crab stock designed for the catering trade), and "Oriental Parcels" (whitefish, shrimp, and vegetables in a pasta shell) for sale to British retail outlets. Kibun is importing several other products ("Prawnies" and "Seafood Choice") from their processing plants in Japan; ultimately these surimi products may be produced at their new factory in Scotland. Kibun plans to launch a major promotional program in the United Kingdom to stimulate consumer buying. If production can be sustained, the company plans to process blue whiting, possibly starting in 1988.

Norway

The Norwegians have focused on the possibility of producing surimi from capelin, *Mallotus villosus*; herring, *Clupea harengus*; mackerel, *Scomber scombrus*; blue whiting, and a few other species. The Government of Norway granted Fideco A/S of Tromso an export license to sell surimi-based meat and fish analogs produced from capelin and herring in 1985. If the experiment is successful, the company plans to build a production facility in Finnmark, Norway. Fideco A/S plans to market its product in the United States.

Iceland

An experimental effort to manufacture surimi in a freezing plant at Rif, on the western Snaefellsnes Peninsula, was started in mid-1985. Experiments are being conducted by the Icelandic Fisheries Laboratories in cooperation with the Coldwater Seafood Corporation and the Icelandic Freezing Plants Corporation. The plant is using trimmings from filleting lines—mostly Atlantic cod, *Gadus morhua*, and small saithe, *Pollachus virens*. Future testing will include silver smelt, *Argentina silus*, and blue herring. The Samband Corporation is also conducting experimental work with surimi.

Denmark

The Danish Fisheries Technological Laboratory at Lyngby has experimented with surimi production from Norway pout, *Trisopterus esmarkii*, and sand eel, *Ammodytes* spp. Earlier experiments on cod produced poor results and discouraged the industry from becoming involved in surimi production.

Sweden and Ireland

Swedish technologists have concentrated on examining ways to use cod, cod trimmings, and herring as raw materials for surimi. The work is still in the experimental stages.

An Irish fisherman has ordered a new freezer stern trawler built in Norway to process blue whiting and silver smelt into minced fish. The vessel is expected to produce about 40 t of minced fish per day when it is completed in October 1987 and press reports indicate that the product will be used to make surimi.

Canada

The Terra Nova Fishery Co., Ltd., of Clarenville, Newfoundland, set up a surimi production plant in 1984 using Japanese processing equipment supplied by Bibun, Inc. The plant is currently producing surimi using Atlantic cod stocks and has begun commercial processing of "crab stick" products. Ocean Delights, Inc., of Vancouver, British Columbia, is also presently producing "crab sticks" on a limited scale using surimi imported from Japan. The DFO's Freshwater Institute in Winnipeg, Manitoba, is conducting research to determine the suitability of freshwater whitefish and tullibee in surimi manufacture.

Latin America

Chile

A Chilean company is producing surimi at a small plant located at Los Rojas along the country's southern coast. The company is using hake, probably *Merluccius gayi*, although one report suggested that the company was also experimenting with mackerel. Most of the production is marketed domestically, but 10 t was shipped to the United States in 1985, the first such shipment from Latin America. The Japanese Marine Fishery Resource Research Center (JAMARC) has experimented with Chilean jack mackerel, *Trachurus murphyi*, as a raw material for surimi. The utilization of high-oil content pelagic species is technically possible, but involves higher costs to remove the oil. Nippon Suisan, using the results of the JAMARC research, is currently conducting high-seas surimi production utilizing the jack mackerel being taken off Chile. The company plans to produce 3 t of surimi per day and hopes to have the product on the Japanese market by October 1986.

Mexico

Unconfirmed reports indicate that a Japanese company, Suzuhiro Kamaboko Gogyo, plans to build a small pilot surimi plant near the Pacific port of Mazatlan. The plant's estimated annual production would be about 350 t. Productos Pesqueros Mexicanos (PPM), the state fishing company, has previously marketed a minced fish product called "Pepepez," a product requiring some of the same processes as surimi. PPM is not currently producing Pepepez, but it plans to eventually resume production when a new plant is completed. Government officials are cur-

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

rently studying the possibility of producing surimi.

Peru

Several Peruvian companies have expressed an interest in surimi. The Instituto Tecnologico Pesquero (ITP) in Callao has done considerable work on surimi and fish paste products. ITP is currently working with the Empresa Publica de Servicios Pesqueros (EPSEP) to market fish hamburgers made from sardines. Peru's state fishmeal company, Pesca Peru, operates an experimental marine beef plant and plans to build a larger plant. Much of the machinery and processing procedures to produce marine beef and surimi are similar. Some Peruvian observers believe that Pesca Peru should redirect its efforts to surimi which may prove more commercially successful. Any major Peruvian entrance into the surimi industry, however, will probably be delayed until the economics of utilizing pelagic species has been established.

Argentina

The Latin American country with the greatest potential for surimi production is Argentina. The substantial demersal resources of hake and other species off the southern coast could provide Argentina with enough raw material to support a major surimi industry. The country's Instituto Nacional de Desarollo Pesquero (INIDEP) has reportedly done some research on surimi, and several Argentine companies have contacted Japanese companies concerning surimi. The development of a significant surimi industry, however, is probably several years off. Many of the country's major fishing companies are badly in debt. Fluctuations in squid and shrimp fisheries, the inability of Argentine fishermen to operate off the Falklands, and competition with distant-water fishermen operating in the South Atlantic have all hurt the country's fishing industry. Few Argentine companies currently have the capital to finance the production and marketing of a major new product. Some Argentine companies, however, are already producing minced fish. The United States imported about 300 t of minced fish blocks from Argentina in 1985.

Uruguay

Like neighboring Argentina, there are no known Uruguayan surimi projects, but Bero, S.A., a fish processing company is looking for a partner to launch a surimi project. Uruguayan companies already produce minced fish. The U.S. imported over 500 t of minced fish blocks from Uruguay in 1985. (Source: IFR-86/52.)

The Latin American Scallop Fisheries, 1980-86

Introduction

The development of a major scallop fishery in Peru made Latin America the largest exporter of scallops to the U.S. market in 1985. Latin American shipments totaled 5,500 metric tons (t) valued at $24 million, and scallops have become the fourth most important, Latin American fishery export to the United States. More than 10 species are harvested (Table 1), though only two contribute greatly to the exports, the Peruvian and Pacific calico scallops.

Development of the fishery and exports are based on events in two countries, Peru and Panama. Most observers believe that the rapid development of the Peruvian fishery was linked to the 1982-83 El Niño event. In 1986, Peruvian catches declined, but Panama began to report significant scallop exports. Officials in both countries are unsure of the long-term trend. Peruvian officials closed the fishery for most of 1986, except for some limited artisanal fishing. Panamanian officials have been studying possible management measures.

Export Trends

Latin American scallop exports to the United States were negligible in 1982. But as a result of climatic changes off Peru, scallops flourished, harvests increased, and shipments expanded to

Table 1.—Latin American scallop species harvested.

Country	Species harvested[1] Scientific name	English name	Local Spanish name	Average size (cm)
Argentina	*Argopecten tehuelchus*	Tehuelche	Pecten tehuelche	7.5
	Chlamys felipponei	Felippone	Felipone	7.4
	C. lischkei	Lischke's	Patria[2]	7.3[3]
	Pecten patagonicus	Patagonian	Patagonico	8.0
Brazil	N.A.		Vieiras	N.A
Chile	*A. purpuratus*	Peruvian calico	Ostion del norte	7.0
	C. lischkei	Lischke's	Ostion de las canales/concha	7.0[3]
	P. patagonicus	Patagonian	Patagonian/ostion de Magallanes	8.0
Panama	*A. circularis*	Pacific calico	Peine volador/conchuela	6.0
Peru	*A. purpuratus*	Peruvian calico	Concha de albanico/escalope	7.0

[1]Small quantities of several other species are also taken.
[2]Also vieira patria.
[3]It is now known why the average size of this species is different off Argentina than Chile.

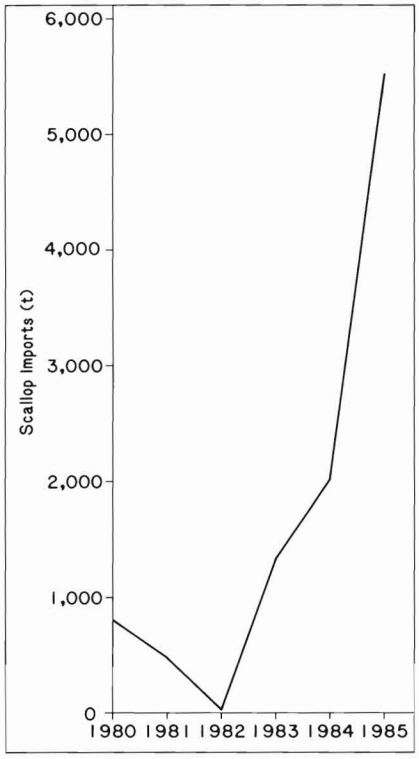

Figure 1.—U.S. scallop imports from Latin America, 1980-85.

1,300 t in 1983 (Fig. 1). Shipments expanded rapidly and reached 5,500 t in 1985. The value of the 1985 shipments were $24 million, the fourth most important edible fishery product exported to the United States by Latin American countries. (Table 2).

Latin American scallop shipments continued to increase during the first half of 1986. Latin American shipments totaled 3,200 t, an increase of 30 percent from the 2,500 t exported during the same period of 1985 (Table 3). Declining Peruvian shipments were more than replaced by the sudden increase in shipments from Panama. Reports from both countries, however, suggest that shipments during the second half of 1986 were declining. As a result, 1986 year-end results from Latin America may not exceed 1985 levels.

The sharp fluctuations in scallop exports are not fully understood. Scallop catches, even in established fisheries, tend to fluctuate sharply. Sedentary

Table 2.—U.S. fishery import values, by product, 1985, in millions of U.S. dollars.

Product	Import values	
	Latin America	World
Shrimp	$766.1	$1,154.0
Lobster	128.5	471.3
Tuna	76.7	425.3
Cod	Negl.	419.1
Scallops	24.0	147.1

shellfish species, like scallops, are subject to irregular recruitment patterns, often cyclical in nature. Climatic factors such as water temperatures can powerfully affect annual recruitment.

Scallop species are extremely fecund. One gravid female can produce anywhere from 2-20 million eggs. If ambient conditions are optimal, a small spawning stock can produce a large harvestable crop, sometines called a bloom. After a good set, intensive fishing effort, however, can shorten the duration of periods of high abundance and lengthen the period between successful sets.

Observers are not in total agreement over the development of the Peruvian fishery. Most biologists believe that the scallop stocks were affected by the 1982-83 El Niño event. The warmer El Niño water temperatures provided an ideal medium for the existing scallop stock and, at the same time, adversely affected many predators and competitors. Some biologists believe that there has always been a large scallop population off Peru, but that not only did the El Niño improve environmental conditions, the warmer water caused the scallops to successfully set in shallow water where they were more accessible to the fishermen. There may also be some migration of stocks, but this has not yet been demonstrated. A similar debate is now underway in Panama.

Regional Importance

Latin American countries emerged for the first time in 1985 as the most important source for U.S. scallop imports. U.S. imports from Latin America were 5,500 t, slightly more than the 5,400 imported from North American (Canada)

Table 3.—U.S. scallop imports from Latin America, January-June, 1985-86.

Country	Jan.-June imports (t)	
	1985	1986
Panama	1.4	1,705.5
Peru	2,365.6	1,189.2
Chile	102.0	161.6
Mexico	1.0	73.4
Ecuador	8.9	18.7
Costa Rica	3.2	6.0
Honduras	1.0	4.6
Turks and Caicos		3.4
Belize		1.3
Bolivia		1.0
Argentina	31.7	0.9
Venezuela	1.9	0.7
Brazil	0.1	
Total[1]	2,516.8	3,166.3

[1]Totals may not agree due to rounding.

Table 4.—U.S. scallop imports, by region, 1980-85.

Region	Imports (1,000 t)					
	1980	1981	1982	1983	1984	1985
Lat. America	0.8	0.5	Negl.	1.3	2.0	5.5
N. America	6.9	8.7	6.8	6.3	3.9	5.4
Asia	0.1	0.4	0.5	3.6	3.4	5.1
Europe, W.	1.5	1.9	1.7	2.8	2.3	2.6
Oceania	0.2	0.5	0.4	1.6	0.7	0.5
Europe, E.						Negl.
Africa			Negl.	Negl.	Negl.	Negl.
Middle East						
Total[1]	9.5	11.9	9.5	15.5	12.4	19.1

[1]Totals may not agree due to rounding.

and 5,100 t from Asian sources (Table 4). The U.S. imported a record 19,100 t of scallops worldwide in 1985, of that total nearly 30 percent were from Latin American countries. The economic importance, however, was less as the smaller Latin American species commanded a lower price on the U.S. market.

Species

Latin American fishermen catch small quantities of more than 10 different species of scallops (Table 1). The vast quantity of catches are composed of two species, the Peruvian calico scallop taken in Peru and Chile, and the Pacific calico scallop taken in Panama and other Central American countries. These two species and the other Latin American species are similar to the

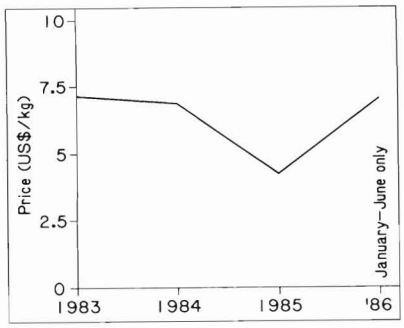

Figure 2.—U.S. import prices for Peruvian scallops, 1983-86.

Table 5.—U.S. scallop prices, by region, 1985.

Region	1985 Quantity (1,000 t)	1985 Value (US$ million)	1985 Price (US$/kg)
North America	5.4	58.7	10.87
Asia	5.1	44.4	8.70
Oceania	0.5	4.3	8.60
Western Europe	2.6	15.5	5.96
Latin America	5.5	24.0	4.36
Total[1]	9.5	147.1	6.46

[1]Totals may not agree due to rounding.

Table 6.—U.S. prices of scallops imported from Latin America, 1983-86.

Country	Prices (US$/kg) 1983	1984	1985	1986[1]
Argentina	9.88	6.41	5.88	8.94
Chile	8.30	7.47	6.47	7.23
Panama		9.57	5.11	5.89
Peru	7.13	6.84	4.24	7.02

[1]January to June.

Table 7.—U.S. scallop imports from Latin America by country, 1980-85.

Country	Imports (t) 1980	1981	1982	1983	1984	1985
Peru	4.5	4.4	Negl.	928.1	1,319.4	5,154.2
Chile			12.2	86.1	382.5	156.2
Argentina	2.4			192.5	285.3	136.9
Panama		26.1	3.9		1.4	41.0
Ecuador					5.5	8.9
Brazil	785.0	433.7	1.5	4.0		7.9
Mexico	5.4	15.2	13.6	122.3	20.5	6.1
Costa Rica	8.1					5.4
Honduras						2.9
Venezuela	2.0				0.6	1.9
Uruguay						1.5
Turks and Caicos					1.8	
Total[1]	807.5	479.4	31.2	1,333.0	2,017.2	5,522.9

[1]Totals may not agree due to rounding.

calico scallop, *A. gibbus*, taken off Florida. The meats are substantially smaller than those of the longer-lived cold water Atlantic sea scallop, *Placopecten magellanicus*, taken off the northeastern U.S. coast or imported from Canada.

Prices

Latin American scallops generally sell for substantially less on the U.S. market than scallops imported from other countries. In 1985, for example Latin American scallops sold for only about $4.35/kg, while North American and Asian scallops were selling for $10.90 and $8.70 per kilogram respectively (Table 5). The major reason for this difference is reportedly the small size of the Latin American scallops which are similar to the Florida calico scallops and follow the same market patterns. Peruvian observers also believe that intense competition among Peruvian exporters depressed prices. In 1986, the falling availability of the Peruvian scallops and the improving market conditions in the United States has resulted in a sharp price increase for the Peruvian product. Prices for Peruvian scallops averaged about $7.00/kg during the first 6 months of 1986 (Fig. 2, Table 6). The sharply increased production from Panama, however, has not shared the price increase achieved by Peruvian exporters, perhaps because the sudden increase in the catch has not allowed Panamanian exporters to develop adequate market channels for their newly acquired product. Panamanian scallops during the first 6 months of 1986 sold for only about $5.90/kg.

Major Countries

The Latin American scallop fisheries are dominated by Peru (Table 7). Peruvian shipments of 5,200 t accounted for 95 percent of the 5,500 t of Latin American scallops shipped to the United States in 1985. Panama reported significant shipments to the United States in early 1986. Brazil shipped sizeable quantities to the United States in 1980 and 1981, but current shipments are negligible. Several other countries (Chile, Argentina, and Mexico) have shipped small quantities to the United States. Shipments from other Latin American countries have been negligible. Recent developments in individual Latin American countries have been as follows.

Peru

Peruvian fishermen have conducted a scallop fishery since the pre-Columbian period. Archaeologists have discovered large deposits of shells dating back to 600 A.D. Catches in recent years have been small, averaging about 500 t per year. Fishermen began to report unusually large scallop catches after the El Niño event which devasted coastal areas in 1982 and 1983. One report, for example, estimated a phenomenal 1983 catch of nearly 20,000 t.

Biologists theorize that the warm water which appeared off the coast speeded scallop growth while it retarded the growth of competitors and predators. Competitors such as mussels, clams, crabs, limpets, Chilean abalone, and sea urchins were all adversely affected by the unusually warm El Niño water. Reproductive activity was apparently fostered by the warmer water temperatures and caused a higher survival rate among the resulting larvae. More larvae survived because the warmer water speeded their development rate, thus

Table 8.—U.S. scallop imports from Peru, by month 1983-86.

Month	Imports (t)			
	1983	1984	1985	1986
January		254.1	272.0	283.3[1]
February		246.8	318.3	599.0
March		248.5	497.5	236.6
April		100.2	301.9	43.1
May		76.5	344.7	20.7
June		101.6	631.1	6.4
July		16.8[2]	764.8	13.7[3]
August	6.9	3.2	507.5	N.A.[4]
September	66.3	4.7	633.5[5]	N.A.
October	179.9	19.6	691.0	N.A.
November	257.2	103.9	125.8[2]	N.A.
December	418.0	143.5	66.1	N.A.
Total[6]	928.1	1319.4	5,154.2	N.A.

[1]Fishing closed 11 January, originally until 14 May, but the closure was later extended. The closure was reportedly widely violated.
[2]Scallop season closed.
[3]The fishery was opened 15 July but at sharply reduced levels.
[4]Fishing was again closed August 31
[5]Fishing restricted on 9 September
[6]Totals may not agree to rounding.

reducing their vulnerability to predators and their chances of drifting away from the scallop banks where they could set.

A major scallop fishery soon developed in the Paracas area near Pisco along Peru's Central Coast. The scallops are harvested by artisanal divers from small boats. The Instituto del Mar (IMARPE) reports that over 1,000 small boats and 5,000 fishermen have entered the fishery. Another 6,000 people are employed on shore to process the catch. The unusually large catch in 1984 could not be handled by existing processing plants, so much work was done in makeshift plants or in the homes of the fishermen, initially giving rise to quality control problems. Improved processing was reported for the record 1985 catches when shipments to the United States exceeded 5,000 t (Table 8).

Some fishermen began to seed small scallops in the shallow areas of Paracas Bay. One report estimates that in 1984 there were 150 growers who had seeded 400 hectares of the Bay. Two groups are reportedly planning to build a hatchery. These culture efforts have met with mixed success. One massive kill in February 1985 was particularly damaging to the industry. The Government is concerned about declining catches and since March 1986 has closed the fishery, allowing only small artisanal catches. Most of the catch is marketed in the United States where only the adductor muscle (white meat) can be sold.

Exporters are also seeking European markets where the reproductive organs can be marketed along with the adductor muscle, substantially increasing the potential value of the catch. Peruvian 1986 shipments will be substantially below 1985 shipments. The Ministry of Fisheries closed the scallop fishery from January to June, but the regulations were widely violated. Many fishermen landed scallops, claiming they were cultured, which would exempt them from the closure. The fishermen were allowed to fish in July and August and reported good catches, mostly 40/60 and 60/80 count scallops. The sizes of the scallops caught in 1986 have been generally smaller than the scallops caught in 1986. The decline may be partially due to the intensive fishing effort, but larger populations of sea stars and saury as well as cooler water temperatures have also affected the scallop population. Unfished scallops populations have been found in deeper water. Peruvian scources reported the deaths of at least three divers in 1986, as the fishermen are diving in deeper water further from the coast. The Ministry closed the fishery again on 31 August 1986, for an indefinite period. IMARPE has begun a new project to repopulate grounds and is concentrating on banks to the north of Callao.

Panama

A major development in Panamanian fisheries during late 1985 and 1986 has been a sudden surge in scallop catches. Scallop fishing has been conducted by artisanal fishermen operating close to the coast for several years. Significant catches were reported in the 1960's, but Panamanian scallop exporters were not able to meet U.S. sanitary requirements. Since then, catches have been very small. Those fishermen began to report unusually good scallop catches in October 1985. Catches were particularly good in the Pacific coast area between Veracruz and Rio Hata, at depths from 3-20 m. In late 1985, some of the Panamanian companies, noting the artisanal fishing activity, began to deploy shrimp trawlers on the scallop beds. The Panamanian Government granted 13 licenses to shrimp trawlers. Catches surged to record levels.

Table 9.—U.S. scallop imports from Panama, 1981-86.

Month	Imports (t)				
	1981	1982	1984	1985	1986
January	9.8				84.5
February	10.5				157.6
March	3.8				284.2
April	1.9	0.2			282.2
May					405.7
June				1.4	491.2
July					344.1
August					N.A.[1]
September					N.A.[1]
October				1.5	N.A.
November		1.6	1.4	8.3	N.A.
December		0.8		29.8	N.A.
Total	26.1	3.9	1.4	41.0	2,049.5[2]

[1]Data not available, but imports reportedly continuing at high levels.
[2]Through July.

Panamanian catch data is not available, but most of the catch is exported to the United States. U.S. import data shows that imports are at record levels with shipments in June 1986 setting a single month record of 490 tons (Table 9). Shipments for the first 6 months of 1986 totaled 1,700 t valued at $10 million, with some of the product being airshipped to the United States. The commercial vessels are basd in Puerto Vacamonte and Rio Hato. Two plants have been opened at Vacamonte to process scallops.

Biologists are uncertain about the duration or reason for the scallops appearance off Panama. Some biologists see a 5 to 7 year cycle in which large populations periodically thrive and then decline. Others believe that a commercially exploitable stock is permanently there, but they only set in the more accessible shallow water when the environmental conditions are right. Commercial fishermen have noted scallops with considerable barnacle growth, however, suggesting that they may have been up to 2 years old at the time of harvest. The Director of the Panamanian Direccion General de Recursos Marinos, Armando Martinez, believes that temperature is the key factor determining abundance.

Panama first launched a scallop fishery in the 1960's when 15 shrimp trawlers were rigged for scallop fishing. The fishermen, however, could not find sustainable stocks on which to fish. Fishing has continued as a primarily artisanal activity, currently providing nearly 35,000 jobs. The current entry of the commercial fishermen has caused a major confrontation between the two groups. The artisanal fishermen, led by Napoleon Velasquez who is President of the Asociacion de Pescadores Artesanales (APROPA) has asked the government to restrict commercial fishing on coastal grounds where the artisanal fishermen harvest scallops. The only current restriction is one which prohibits commercial fishing within 3 miles of the coast.

Brazil

Brazil is the only other Latin American country to have conducted an important scallop fishery. The commercial fishery was launched in 1972 and Brazilian companies began to export in 1973. Two groups with Japanese backing were active in the preliminary stages of the fishery. Export shipments reached 450 t in 1974. The Brazilian scallop beds were located off the coast of Parana and Sao Paulo. Some Brazilian officials believed that scallop exports could eventually rival shrimp and lobster shipments, the mainstays of the country's fishing industry.

In 1981, U.S. scallop fishermen were brought in to conduct exploratory fishing for new grounds. The Brazilian fishery, however, has since dwindled. U.S. companies imported 785 t of scallops from Brazil in 1980, but this declined to only 435 t in 1981. Since 1982, U.S. importers have not purchased more than 10 t of scallops annually in Brazil. This drastic decline is unexplained. Local observers, however, believe that commercial stocks of scallops exist off Brazil and Caribbean countries, but will require more resource surveys to locate exploitable commercial beds. (Source: IFR-86/51.)

Australian Fishing, 1985

The Australian fishing industry contributed A$445 million (US$313 million) to the nation's GNP in 1985, making it the country's seventh largest rural industry. Australia's fishing industry is small (relative to the size of its fishing zone) and employs about 25,000 people in the harvest sector. Only about 10,000 fishing vessels are in operation and most are less than 20 m long. The Australian Government provides little or no subsidies or tariff protection to the fishing industry, so it has had to remain efficient in order to survive. Although the country's fishery resources are generally promising, Australia's traditional fisheries (shrimp, rock lobsters, scallops, abalone, bluefin tuna, and shark) are well developed with limited potential for future expansion. Growth of the fishing industry will be dependent on new fishing grounds and species. Northern fishing grounds hold promise for underexploited squid, skipjack and other tunas, and other pelagic fish resources.

Shrimp and rock lobsters are Australia's most important fishery exports, accounting for about 70 percent of the value of all fishery exports in 1985. Australia exported almost 6,000 metric tons (t) of shrimp, valued at A$91.3 million ($64.3 million), to major markets in Japan, the United States, and South Africa. Australia is also the world's largest producer of rock lobster, exporting 1,000 t valued at A$28.2 million ($19.9 million) in 1985. The United States is the major importer of this commodity, although Australia is also beginning to develop lobster export markets in Japan and Southeast Asia.

The U.S. Embassy in Australia has prepared a 12-page report on Australia's fishing industry in 1985. This report briefly reviews the Australian market, fisheries, and trade. Interested U.S. companies can obtain a copy of this report for $9.95 (personal check or money order) by ordering report number PB87-130258/AS from: National Technical Information Service, U.S. Department of Commerce, Springfield, VA 22161. Please enclose a handling fee of $3.00 per order.

Ecuadorean Shrimp Culture

The marine shrimp culture industry has dramatically transformed much of the coast of southern Ecuador. Over 60,000 hectares of ponds have been built and both the ecology and the economy of the coast have been significantly altered. After 2 years of diminishing harvests, shrimp farmers are poised for production increases and higher earnings. Ecuadorean observers are predicting sharp increases in Ecuadorean 1987 shrimp exports made possible by the economic reforms instituted by the Ecuadorean Government in August 1986. Significantly increased production will require more postlarvae to stock the ponds. A postlarvae shortage severely affected farmed shrimp production in 1985, but postlarvae were in good supply during 1986. Government officials estimate that 24,500 metrict tons (t) of shrimp was exported in 1986 and project those shipments to increase to over 27,000 t in 1987, or by more than 10 percent.

The Foreign Commercial Service at the U.S. Consulate General in Guayaquil has prepared a 10-page report reviewing the current status of Ecuador's shrimp culture industry. The report covers the Ecuadorean Government economic reforms, shrimp production and exports, pond construction and operations, economic considerations, and hatcheries. The report also includes statistical tables. U.S. companies can obtain a copy of "Ecuadorean Shrimp Aquaculture Production, 1985-87" for $9.95 and a $3 handling fee (total $12.25, personal checks or money orders only) by ordering report PB87-139333/GBA from NTIS, Springfield, VA 22161.