Foreign Fisheries in the Gulf of Alaska, 1977-78

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ABSTRACT—*During 1977-78, 50 U.S. observers sampled on 61 foreign vessels in the Gulf of Alaska, covering 8.3 percent of the foreign effort in 1977 and 14.7 percent in 1978. Observer data were used in estimating a total foreign groundfish catch of nearly 200,000 t in 1977 and about 165,000 t in 1978. The predominant species caught both years and by all nations was walleye pollock,* Theragra chalcogramma, *which made up 58-59 percent of the total foreign catch. Other species and species groups of importance were Atka mackerel,* Pleurogrammus monopterygius; *Pacific ocean perch,* Sebastes alutus; *flounders (various species), sablefish,* Anoplopoma fimbria; *and Pacific cod,* Gadus macrocephalus. *Estimates were also made of the incidental catches of species whose retention was prohibited: Pacific halibut,* Hippoglossoides stenolepis; *Pacific salmon,* Oncorhynchus *spp., king crab,* Paralithodes *and* Lithodes *spp.; and snow (Tanner) crab,* Chionoecetes *spp. In 1977, catch estimates of halibut and salmon were 413,000 and 5,270, respectively. The 1978 estimates were 293,000 halibut, 45,600 salmon, 94,000 king crab, and 24,000 snow crab.*

Introduction

The Gulf of Alaska, as described here, encompasses the area between the eastern Aleutian Islands at long. 170°W and Dixon Entrance at long. 132°40′W. (Fig. 1), and covers 160,000 square miles of continental shelf. Enactment of the Fishery Conservation and Management Act of 1976 (FCMA) placed the management of the fishery resources of the region, as well as that of other areas within the 200-mile fishery conservation zone (FCZ), under the jurisdiction of the United States. One of the provisions of the act requires that any foreign vessel permitted to fish within the FCZ must accept, and provide accommodations for, U.S. fishery observers.

During 1977-78, the first 2 years of fishery management under FCMA, 50 observers sampled on 61 different foreign fishing vessels in the Gulf of Alaska. They collected data which allowed the United States to estimate the foreign catch and help assess the biological status of various stocks of fish. Information on the kinds of data obtained by observers is given by Nelson et al. (1981).

This report provides a brief history and description of the foreign groundfish fisheries in the Gulf of Alaska, reviews the history of the observer program, describes the sampling methods of the observers, and summarizes the data collected by observers in the Gulf of Alaska during 1977-78.

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The Foreign Groundfish Fishery

Although the foreign groundfish fishery had begun as early as 1933 in the Bering Sea with a Japanese fishery for yellowfin sole, *Limanda aspera,* it was not until 1960 that both Japan and the U.S.S.R. first sent exploratory fishing expeditions into the Gulf of Alaska. Detailed descriptions of the historical development of the foreign fisheries are given by Chitwood (1969), Forrester et al. (1978), and the Fisheries Management Plan for the Gulf of Alaska Groundfish Fishery[1].

In 1962, a fleet of 70 Soviet trawlers and support vessels entered the Gulf of Alaska and began fishing for Pacific ocean perch, *Sebastes alutus,* just south of the Shumagin Islands, and on Albatross and Portlock Banks off Kodiak Island (Chitwood, 1969). By the end of 1965, Soviet ocean perch catches east of long. 175°W reached a peak of 384,000 t and the year-round fishery had extended as far south as Dixon Entrance, British Columbia (Forrester et al., 1978). In subsequent years, declining rockfish catches resulted in the reduction of the Soviet trawling effort in the Gulf (Table 1) and a diversification in target species to include walleye pollock, *Theragra chalcogramma,* and Atka mackerel, *Pleurogrammus monopterygius,* (Fig. 2).

Following preliminary explorations in the Gulf of Alaska in 1960 and 1962, Japanese fishing operations began on a commercial scale in 1963 with a fleet of four independent trawlers, a mothership, and three catcher vessels using sunken gill nets (Forrester et al., 1978). The bottom gill-netting operation was discontinued after the first year, but the trawl fishery continued with a gradual increase in the number of vessels. According to Forrester et al. (1978), side trawlers, factory trawlers, small trawlers, and Danish seiners were all used to harvest a variety of groundfish species, of which rockfish (predominately Pacific ocean perch)

[1]North Pacific Fishery Management Council. 1978 Fishery Management Plan for the Gulf of Alaska groundfish fishery. Unpubl. manuscr., North Pac. Fish. Manage. Counc., Suite 32, 333 W. 4th Ave., Anchorage, AK 99510.

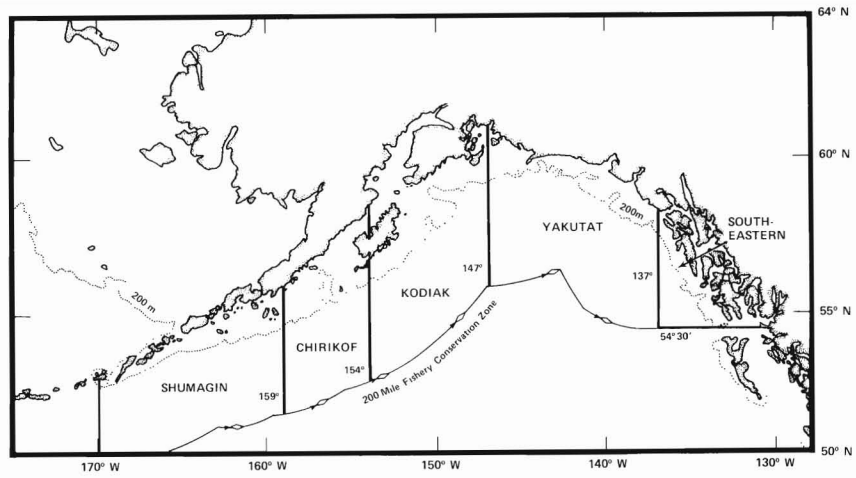

Figure 1.—Statistical reporting areas of the Gulf of Alaska.

Table 1.—The range in number of fishing vessels present in the Gulf of Alaska during any one month, 1962-78[1].

	Japan		U.S.S.R.	Korea		Taiwan		Poland
Year	Trawlers	Longline vessels	Trawlers	Trawlers	Longline vessels	Trawlers	Longline vessels	Trawlers
1962	0-2	—	0-70	—	—	—	—	—
1963	[2]0-6	—	0-200	—	—	—	—	—
1964	0-6	0-8	0-150	—	—	—	—	—
1965	0-11	0-8	10-130	—	—	—	—	—
1966	3-13	2-9	4-140	—	—	—	—	—
1967	3-14	2-11	5-55	—	—	—	—	—
1968	2-12	1-9	0-20	—	—	—	—	—
1969	1-20	2-9	0-15	0-2	—	—	—	—
1970	1-15	2-12	0-15	—	—	—	—	—
1971	1-15	2-13	0-16	—	—	—	—	—
1972	4-26	2-10	4-25	0-2	—	—	—	—
1973	6-16	5-11	4-36	0-2	—	—	—	[3]0-1
1974	6-12	7-12	1-39	0-3	—	—	—	0-1
1975	6-11	7-12	5-20	0-5	1-3	—	0-1	0-2
1976	5-11	4-14	2-21	0-19	0-8	0-1	0-4	—
1977	4-16	6-16	0-25	0-6	0-5	—	0-1	0-2
1978	0-20	0-20	0-21	0-5	0-2	—	—	0-5

[1]Data obtained from National Marine Fisheries Service Enforcement Division, Juneau, Alaska.
[2]Exploratory fishing by trawlers and gill-netters; comparable figures for 1960-61 exploratory surveys are not available.
[3]Exploratory fishing by one stern trawler from Poland.

constituted the greatest proportion of the total weight through 1970. The longline fishery began in 1964 (U.S. Fish and Wildlife Service[2]), although at that time, because of concern for incidental catches of Pacific halibut, *Hippoglossus stenolepis,* it was restricted to fishing for sablefish, *Anoplopoma fimbria,* in depths greater than 500 m.

It was not until the 1970's that fishing vessels of other nations joined those of the U.S.S.R. and Japan in the Gulf of Alaska. Korean setline vessels began targeting on sablefish in 1972 and in 1976 a few trawlers entered the fishery. Poland began exploratory trawling in the Gulf in 1973 and conducted small fisheries for pollock, Atka mackerel, and rockfish in 1974 and 1975. A Taiwanese longline vessel began fishing in the Gulf in 1975 and by July 1976, three longline vessels and one stern trawler from Taiwan had been observed there (footnote 1).

On 1 March 1977, the FCMA was implemented, which placed licensing, catch, and area restrictions on all foreign vessels fishing within the U.S. 200-mile FCZ. Groundfish allocations in the Gulf of Alaska were given to Japan, the U.S.S.R., the Republic of Korea, Poland, and the Republic of China (Taiwan), i.e., all of the nations (except Canada) that had previously fished in that region. In addition, in 1978 an allocation was given to Mexico, but no ships of that nation appeared on the fishing grounds. The largest allocations of groundfish in 1977-78 were given to Japan and the U.S.S.R., which together received 82.5 and 72.6 percent of the foreign allowable catch in those years, respectively.

Japan was allocated 106,822 t in the Gulf of Alaska in 1977 and 101,735 t for the period January through November 1978. During 1977 and 1978, fishing for the Japanese allotment was conducted by longline vessels and three types of stern trawlers: Large freezer trawlers, a large "surimi" trawler, and small freezer trawlers. These vessels are described by Nelson et al. (1981).

In the fall of 1978, one ship classified as a large surimi trawler fished in the Gulf of Alaska. Vessels of this type were distinguished from large freezer trawlers in their capability to make the minced fish product known as surimi in addition to the frozen fish and meal produced on the freezer trawlers. The surimi trawlers targeted on pollock whereas the large trawlers fished for either pollock or rockfish.

In recent years a fleet of small freezer trawlers has fished in the Gulf of Alaska (Fig. 3). Pollock, as well as a variety of rockfish and flatfish species, were frozen whole or headed and gutted by hand on these ships. As the small trawlers did not have fish meal or fish oil plants on board, nontarget species of low value were frequently discarded. Unlike the larger trawlers, small freezer trawlers usually did not refuel at sea or deliver their catches to cargo vessels but returned to Japan to unload and resupply after a cruise of 75-90 days.

[2]U.S. Fish and Wildlife Service. 1965. Foreign fishing activities, Bering Sea and Gulf of Alaska, 1964. Unpubl. manuscr., 57 p. U.S. Dep. Inter., U.S. Fish Wildl. Serv., Bur. Commer. Fish., Off. Enforcement and Surveillance, Juneau, Alaska.

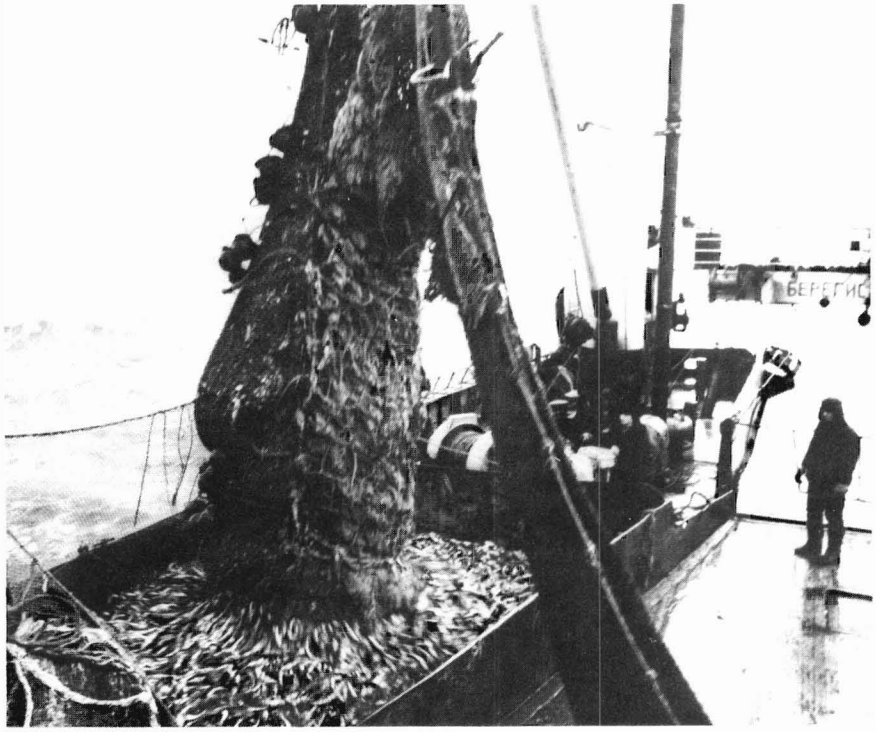

Figure 2.—A codend of Atka mackerel is dumped in a deck bin of a Soviet trawler.

Figure 3.—The *Ryujin Maru No. 8,* typical of the class of small Japanese freezer trawlers that fish in the Gulf of Alaska.

The Japanese longline vessels fished for sablefish at depths greater than 500 m and for Pacific cod, *Gadus macrocephalus,* in shallower waters. Figure 4 illustrates the preparation of the gear prior to making a longline set. The sablefish, cod, and bycatches of rockfish and flatfish were normally headed and gutted by hand before being frozen. At times, the ovaries, testes, stomachs, and a portion of the throat or pectoral girdle of the target species were kept and frozen separately. No observers have been placed on either Taiwanese or Korean longline vessels, but these ships are thought to be similar to the Japanese longline vessels in configuration and operation.

The Soviet Union was allocated 110,364 t of groundfish in 1977 and 103,156 t for the period January through November 1978. In recent years the Soviet fleet has been almost entirely composed of large freezer trawlers of two types—BMRT and RTM stern trawlers (Nelson et al., 1981). The majority of the Soviet vessels that were observed in the Gulf of Alaska were of the BMRT class. On both types of ships, pollock, Pacific cod, and rockfish were usually headed and gutted or filleted before they were frozen. Atka mackerel, flatfish, and sometimes rockfish were frozen whole.

The Republic of Korea was allocated 37,826 t of groundfish in 1977 and 36,564 t in 1978. The stern trawlers in the Korean fleet were similar in size and horsepower to the large Japanese freezer trawlers; but, in general, the factories were much less mechanized and the vessels carried larger crews (85-165, of whom 9-17 were officers). Minced fish products were not produced on the South Korean ships. Most of the groundfish were frozen in the round, although occasionally large pollock and Pacific cod were filleted.

Polish stern trawlers, somewhat similar in size and configuration to their Soviet counterparts, were 79-90 m in length, 2,300-2,500 GRT, had propulsion engines of 2,400 to 3,600 hp, and a crew of 78 to 91. Processing

machinery on board these vessels was used to produce skinless fillets from pollock and cod of a given size range; other sizes and species such as rockfish and sablefish were headed and gutted by hand.

In November 1978, a U.S.-Korean joint-venture fishery took place in the Shumagin area in which a Korean stern trawler served as a processing ship for the catches of pollock and cod made from a single U.S. fishing boat. Bad weather plagued the venture, however, and catches were delivered to the processing vessel on only 4 out of the 20 days of the operation.

The size and type of fishing gear used by the foreign fleet varied considerably depending on the nationality and size of the vessel and the type of fishery in which it was engaged. Table 2 gives the general specifications of the trawl nets and longline gear observed in use in the Gulf of Alaska during 1977-78.

Historical Groundfish Catches

The total foreign groundfish catches from the Gulf of Alaska for 1963-78 are listed by nation in Table 3. Since the initiation of experimental fishing in 1962, the total annual catch grew rapidly to a high of 394,000 t in 1965 when the U.S.S.R. took 340,000 t. After the peak in 1965, the annual foreign groundfish catch has generally fluctuated between 100,000 and 200,000 t.

The species composition of the catch has changed over the years. Rockfish, largely Pacific ocean perch, comprised 97-98 percent of the total reported catch during the first years of the fishery and only 6 percent of the catch in 1978. As the abundance of Pacific ocean perch declined, other species made up increasing proportions of the catch (Fig. 5). Walleye pollock, which comprised only 0.4 percent of the catch in 1964, made up 58-59 percent of the total foreign groundfish catch in 1977-78. Catches of sablefish, flatfish, Atka mackerel, and other species have also increased, making up the remaining portion of the catches in recent years.

Figure 4.—A crew member on a longline vessel prepares the units of the gear, called "hachi."

Table 2.—Summary of gear dimensions used by foreign vessels fishing in the Gulf of Alaska, 1977-78. (U.S. observer data.)

Nation and vessel type	Headrope (m)	Groundrope (m)	Codend mesh size (mm)	Otterboard Size	Otterboard Shape	Material
Trawlers						
Japan						
Large surimi vessels	50-58.6	59-64.8	90-100	2.2x4.4 to 2.7x3.6	Rectangular	Iron or steel
Large freezer trawlers	50-58.6	59-64.8	90-100	2.7x4.4 to 2.7x3.6	Rectangular	Iron or steel
Small freezer trawlers	22-74.2	21-88.8	90-120	1.9x3.8 to 2.4x3.0	Rectangular	Steel or wood and steel
U.S.S.R.						
Large freezer trawlers						
Pelagic trawl	77.4	77.4	60-120	5.5-6m^2	Concave circular, elliptical, or	Steel
Bottom trawl	30-50	24-48.8	60-120	5.5-6m^2	rectangular	Steel
Republic of Korea	60-80	81-103	90-105	1.5x2.5 to 3.0x5.0	Rectangular	Steel
Poland	121.8	121.8	100	2x4	Rectangular	Steel

Longline vessels	Hachi (m)	No. hachi per set	No. hooks per hachi	Gangion (m)	Bait
Japan	75-100	390-420	36-58	1.0-1.7	Squid and pollock

Regulation of the Foreign Fishery

Prior to FCMA enactment, foreign fisheries were regulated by treaty and bilateral agreements. These agreements normally were in the form of mutual concessions in which the United States granted permission to fish or carry out support activities within the 12-mile contiguous fishing zone (CFZ) in exchange for agreements to follow certain restrictions on fishing outside the CFZ. The earliest

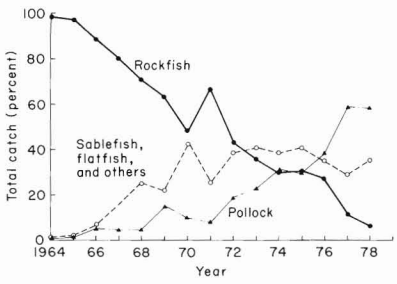

Figure 5.—Percentage composition of major species groups in foreign reported catches of the Gulf of Alaska, 1964-78. Data from "All nation removals of groundfish, herring, and shrimp from the eastern Bering Sea and Northeast Pacific Ocean," 1964-78, compiled by Sueto Murai, Harold Gangmark, and Robert French, Northwest and Alaska Fisheries Center, Natl. Mar. Fish. Serv., Seattle, Wash. Unpubl. manuscr.

Table 3.—Foreign reported annual groundfish catches in metric tons by foreign nations in the Gulf of Alaska, 1962-78[1]. (Groundfish catches by Canada and shrimp catch data are not included.)

Year	Japan	U.S.S.R.	Republic of Korea	Poland	Republic of China (Taiwan)	Total
1962	[2]0	na[3]	0	0		
1963	10,733	na	0	0		10,733
1964	17,451	230,000	0	0		247,451
1965	54,120	340,000	0	0		394,120
1966	88,929	83,000	0	0		171,929
1967	78,350	76,937	0	0		155,287
1968	84,223	59,422	0	0		143,645
1969	97,293	20,015	280	0		117,588
1970	85,295	9,336	0	0		94,631
1971	87,672	30,719	0	0		118,391
1972	112,759	68,864	4,042	0		185,665
1973	114,011	59,522	4,332	na		177,865
1974	112,306	77,942	5,237	na		195,485
1975	91,142	95,465	~13,988	2,132	~150	~202,877
1976	89,938	79,873	37,414	0	na	207,225
1977	100,079	64,700	37,826	1,465	na	204,070
1978	64,187	62,927	36,564	1,269		164,947

[1]Catch statistics for 1963 are from Forrester et al., 1978. Catches for 1964 through 1978 were compiled from data on file at the Northwest and Alaska Fisheries Center, National Marine Fisheries Service. See "All nation removals of groundfish, herring, and shrimp from the eastern Bering Sea and Northeast Pacific Ocean, 1964-1978". Compiled by Sueto Murai, Harold Gangmark, and Robert French. Northwest and Alaska Fisheries Center, Natl. Mar. Fish. Serv., Seattle, Wash. Unpubl. manuscr., 34 p.
[2]Zero indicates that there was no fishing by vessels of that nationality that year.
[3]na = not available.

restrictions placed on foreign fishing were designed to minimize gear conflicts between foreign trawls and domestic crab pots or halibut longlines. Later, regulations were devised by the International North Pacific Fisheries Commission (INPFC), which were intended to help prevent the deterioration of certain commercially important fish stocks, such as Pacific halibut, sablefish, and Pacific ocean perch. Enforcement of these regulations was carried out by the government of the violator vessels. While the measures designed to reduce gear conflicts were highly successful, the conservation regulations were considerably less so, partly because of the great length of time required to institute them (footnote 1).

In 1976, the FCMA was passed, which extended jurisdiction over fisheries resources and authorized federal management of those resources between the 3- and 200-mile limits. Under the Act, foreign nations are allowed to harvest that portion of the total allowable catch in the FCZ (established by the regional fisheries management council) which is not taken by U.S. fishermen. The Act authorizes the establishment of fees and permits for the licensing of foreign vessels, the setting of catch allocations and charges for the fish caught, the requirement for the submission of detailed catch and effort data, the placement of U.S. observers on any foreign vessel, and the establishment and enforcement of various time, area, and gear restrictions on the fishing by foreign vessels as deemed appropriate by the councils.

Foreign Fisheries Observer Program

With the initiation of foreign fishing off the Alaskan coasts, interest was expressed by U.S. fishermen and fishery managers about the effect these vessels might have on the fishery resources of the continental shelf. There was particular concern over the decreased catch of Pacific halibut by U.S. and Canadian setline vessels during the late 1960's and early 1970's (Miller et al., 1976). It was suspected that the incidental catch of halibut by the foreign trawlers was at least partially responsible for the decline, but insufficient data were available at that time.

Negotiations with the Japanese government led to an agreement by Japan in 1973 to allow U.S. observers aboard a limited number of Japanese vessels throughout the year to determine the incidental catch rate of halibut and crab. In the Gulf of Alaska it was agreed that observers could be placed on two trawlers per quarter commencing in 1975.

As the result of similar bilateral agreements with the U.S.S.R., a limited number of U.S. fishery observers were allowed to sample aboard Soviet trawlers for 2-week periods, beginning with a trip in the Gulf of Alaska in November 1974. Although Korean, Polish, and Taiwanese vessels fished in the Gulf of Alaska, no observers had boarded any of those ships before FCMA was implemented.

Due to the concern for the incidental catch, the primary duties of the observers during the first years of the observer program were to determine the incidental catch rates of Pacific halibut; Pacific salmon, *Oncorhynchus* spp.; king crab, *Paralithodes camtschatica;* and snow (Tanner) crab, *Chionoecetes* spp.; and to collect size and mortality data on these species. Additional duties included determining the species composition of the catch, gathering length and age data on the commercially important groundfish, collecting catch statistics, and reporting on observations of marine mammals. As there was limited observer coverage on numbers

and types of ships, no attempt was made to use the observer data to make independent estimates of the total groundfish catch by the foreign fleets.

After the implementation of FCMA, the observer program was seen as part of a plan to help insure compliance with fishery regulations. The determination of the species composition of the catches became increasingly important as the data collected by observers were used to compile an ongoing estimate of the foreign catch by species throughout the fishing season. Observers were also asked to make independent estimates of the trawl hauls and longline catches that they observed, and these were compared with the estimates made by ship personnel. Any suspected violations of fishing regulations seen by observers were reported upon their return.

Once the acceptance of observers became a requirement of fishing in the FCZ and it was no longer necessary to seek permission from the foreign nations to place an observer on a fishing vessel, the number of observer trips in the Gulf in Alaska increased fivefold from 12 in 1976 to 63 in 1978. Not only was increased observer coverage considered important in insuring compliance with the regulations, but the biological data the observers collected became useful to fishery managers in determining the status of the fishery resources. Table 4 lists the observer coverages for the various nationalities and vessel classes which are calculated as a percentage of observer months to vessel months on the fishing grounds. Observer coverage ranged from 0 to 26 percent for any given nationality/vessel class, and the overall coverage increased from 8.3 percent in 1977 to 14.7 percent in 1978.

For the most part, U.S. fishery observers of the northeast Pacific region were university students or graduates in fisheries or related biological fields; some of them also had experience in commercial fisheries. Sampling procedures (Fig. 6, 7) in the Gulf of Alaska were generally similar to those of observers on Bering Sea vessels and are described by Nelson et al. (1981).

Table 4.—Summary of observer effort, foreign vessel effort, and observer coverage (observer month/foreign effort x 100) in the Gulf of Alaska, 1977-78[1].

Nation and vessel type	1977			1978		
	Observer months	Vessel months	Percent coverage	Observer months	Vessel months	Percent coverage
Japan						
Small freezer trawlers[2]				9.3	57.0	16.3
Large freezer and surimi trawlers	12.2	97.2	12.6	10.7	41.1	26.0
Longline vessels	6.2	95.8	6.5	15.1	93.4	16.2
U.S.S.R.						
Large freezer trawlers	7.5	80.8	9.3	4.3	61.9	7.0
Republic of Korea						
Large freezer trawlers	0.0	13.7	0.0	2.4	19.1	12.6
Longline vessels	0.0	22.3	0.0	0.0	9.1	0.0
Poland						
Large freezer trawlers	0.0	2.1	0.0	0.0	3.0	14.7
Total	25.9	311.9	8.3	41.8	284.6	14.7

[1]One vessel or observer month is equal to 28 days.
[2]Effort data for large and small trawlers was not separated for 1977.

Figure 6.—Aboard a small Japanese freezer trawler, a U.S. fishery observer gathers a sample of the catch.

Results of Observer Sampling in 1977-78

Foreign Groundfish Catch Estimates

An important part of the observer program at the Northwest and Alaska Fisheries Center was the technique of estimating foreign fleet catches based on observer sampling of a portion of the vessels in a fleet. After a day of sampling, an observer extrapolated the species composition of the samples to the total catch weight estimated by vessel officers to have

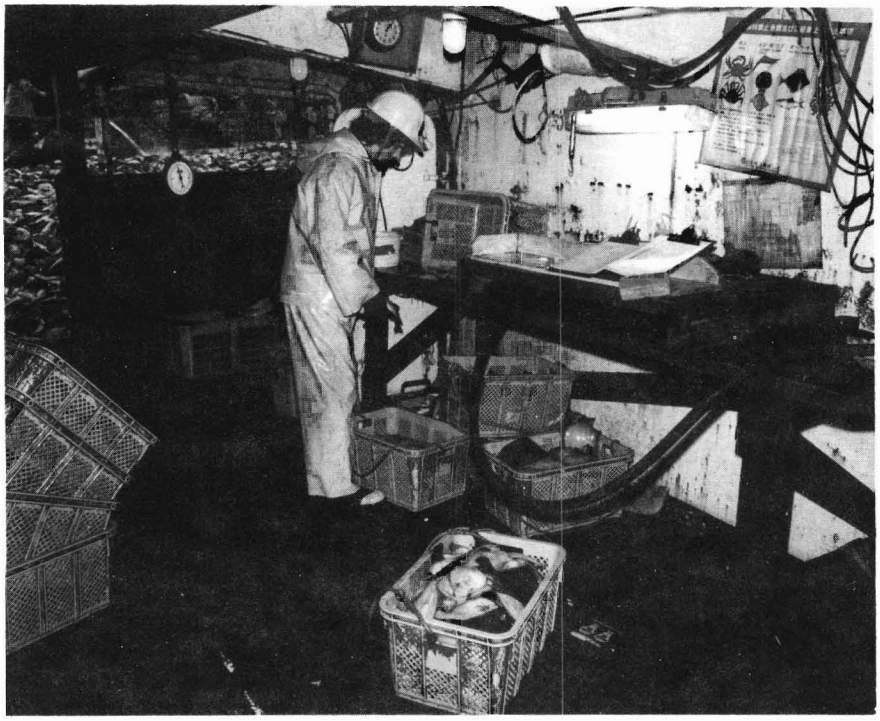

Figure 7.—A U.S. fishery observer sorts samples of the catch at his below-deck work station.

Table 5.—The estimated catch in metric tons of allocated species taken by foreign ships[1] in the Gulf of Alaska, 1977-78. (Based on U.S. observer data.)

Year and nation	Pollock	Squid	Flounders	Pacific cod	Sablefish	Atka mackerel	Pacific ocean perch	Other rockfish	Other fish	All groundfish
1977										
Japan	41,174	NA[2]	15,462	1,248	14,356	NA	17,943	3,221	3,524	96,928
U.S.S.R.	39,571	NA	582	744	9	19,246	1,683	140	1,108	63,083
S. Korea	35,838	NA	NA	NA	1,600	NA	603	NA	100	38,141
	1,256	NA	NA	0	0	209	NA	NA	0	1,465
Total	117,839		16,044	1,992	15,965	19,455	20,229	3,361	4,732	199,617
Percent	59.0		8.0	1.0	8.0	9.8	10.1	1.7	2.4	100.0
1978										
Japan	26,093	186	13,809	8,846	6,458	1,136	4,548	1,277	3,919	66,272
U.S.S.R.	41,956	2	196	1,140	4	18,387	570	1	381	62,637
S. Korea	27,052	133	296	1,369	665	63	3,049	609	1,687	34,923
Poland	1,227	1	13	14	0	0	4	9	0	1,268
Total	96,328	322	14,314	1,369	7,127	19,586	8,171	1,896	5,987	165,100
Percent	58.4	0.2	8.7	6.9	4.3	11.9	5.0	1.2	3.6	100.2

[1]This table does not include catch statistics of the Taiwanese ships which fished in the Gulf of Alaska in 1977 before 1 March, the effective date of the FCMA.
[2]NA = no allocation was given in 1977 to that nation for that species.

been landed on the ship that day. At the end of the week (midnight Saturday, Greenwich Mean Time), each observer summed the estimates of the daily catches by species and fishing area. This information, along with the number of days the ship spent in each area, was sent by radio-telegram to the National Marine Fisheries Service (NMFS) in Seattle via the U.S. Coast Guard receiving stations in Alaska. These data, tabulated by nation, vessel class, area, and species, were combined and an average catch per day was calculated. The average catch per day was then multiplied by the number of vessel days on the ground to give the estimated catch by species for that nation, vessel class, area, and week.

Data on fishing effort in vessel days on the grounds were obtained from the U.S. Coast Guard/NMFS check-in and check-out system which required all foreign vessels to report the date, time, and position of their entry into or departure from the 200-mile FCZ. During 1978, vessels were also required to report changes in fishing area within the 200-mile zone, but in 1977 the number of vessel days in each of the five statistical areas in the Gulf of Alaska was determined by apportioning the foreign effort in the Gulf through the use of vessel sightings made by the U.S. Coast Guard or NMFS enforcement agents.

As catch estimates based solely on U.S. data might not be representative of a particular segment of the fleet when observer coverage of that portion is low, provisions were made to utilize foreign reported catch statistics in those instances. A catch report by species from each foreign ship which fished in the FCZ was submitted weekly in a format compatible with the observer radio messages. When observer coverage of a vessel class for an area/week was 20 percent or greater, extrapolated observer data were used in the calculation of the U.S. "best estimate" of the foreign catch. Conversely, foreign reported statistics were used when observer coverage of a nation/vessel class/area/week was less than 20 percent.

The 1977-78 estimates of the Gulf of Alaska foreign groundfish catches made through the use of this best estimate technique are shown in Table 5 by nation and species. The total 1977 groundfish catch was nearly 200,000 t, and the 1978 estimate was about 165,000 t, approximately 83 percent of the 1977 catch. The predominant species in the catches of both years was walleye pollock, which made up 58-59 percent of the total foreign catch. Atka mackerel, which

was taken primarily by the U.S.S.R., constituted only 9.8 and 11.8 percent of the total groundfish catch in 1977 and 1978, respectively, but it comprised approximately 30 percent of the Soviet landings. Japanese vessels took the greatest amounts of the other major species and species groups: Pacific ocean perch, flounders, sablefish, and Pacific cod.

Incidence and Incidental Catch of Pacific Halibut, Pacific Salmon, King Crab, and Snow Crab

An important part of the observer program in the Gulf of Alaska has been the estimation of the numbers and tonnages of Pacific halibut, salmon, king crab, and snow crab taken incidentally in the foreign groundfish fishery. The data collected by the observers on these species included the number of fish/crab observed per metric ton of catch sampled and their average weights. The calculations used to estimate the incidence and average weight per individual for a given area and time period are the same as shown by Nelson et al. (1981).

Due to limited observer coverage in 1977 and the resultant large number of nonsampled month/area cells, annual incidence means and average weights were used to make estimates of the incidental catches for that year. No king crab or snow crab catch estimates were made for 1977 because of the lack of observer coverage and low crab incidence rates. In 1978, increased levels of sampling allowed estimates to be made using observer data on incidence rates for individual months. Where monthly incidence rates were lacking, the annual mean for the appropriate area and vessel class was used. In those instances where no incidence data were available for a particular nation or vessel class, judgment was made to substitute the rates from another nation or vessel class whose fishery was similar to the one without data. No estimates were made for the 1977 Japanese and Korean longline incidental catches since observers did not begin to sample on longline vessels until the fall of that year.

Pacific halibut

Although Pacific halibut have long been taken in the traditional setline fishery in the eastern Bering Sea and northeastern Pacific Ocean by U.S. and Canadian fishermen, they are also taken during trawling directed at groundfish species other than halibut and in foreign longline fisheries for Pacific cod and sablefish. The incidental catch of Pacific halibut by foreign trawlers in the Gulf of Alaska for 1962-74 was described by Hoag and French (1976) and estimated to range from around 208,000 to 1,200,000 fish annually or from about 1,300 to 9,100 t. The estimated halibut catch given in that paper, however, included 11,000-82,000 fish taken in the Aleutian Islands area.

During 1975-76, the United States first placed observers on Japanese and Soviet vessels fishing in the Gulf of Alaska, and data were collected on the incidence of halibut in the landings. The number of observers placed on foreign vessels was low (about two or three per quarter) and coverage was limited to only a few vessels. Because of lack of data for all area/month blocks (there were a possible 60 data cells—5 areas times 12 months), the average incidence data that were available for the area/blocks and for Japanese and U.S.S.R. vessels were combined. In all, data were available for 23 area/month blocks in 1975 and 27 in 1976. The average annual incidence rate for halibut was 2.498 fish per metric ton of catch in 1975 and 1.594 fish in 1976. Average weights of halibut for the 2 years were 8.36 kg and 9.74 kg, respectively. These rates and average weights were applied to the foreign catch to produce an estimated incidental catch of 486,697 halibut (4,069 t) in 1975 and 312,382 halibut (3,043 t) in 1976. These estimated incidental catches by foreign trawlers were within the range of catches as reported for earlier years.

During 1977-78, following implementation of FCMA, observer coverage was greatly increased over that of former years and data were available from a greater number of area/month blocks than previously. The annual summary of the incidence of halibut by area for the 2 years is shown in Table 6. The average incidence combined for areas and nations (excluding Japanese longline vessels) was 0.908 in 1977 and 1.476 in 1978, rates somewhat reduced from those obtained in 1975 and 1976. In both 1977 and 1978 at least some halibut were observed in trawl catches in each area and each month in which sampling occurred. In 1977 the average incidence of halibut in catches of the small trawlers (1.324 fish/t of catch) was greater than that of the large stern trawlers (0.800 fish/t) and the average incidence of halibut for all Japanese vessels (1.035), excluding longline vessels, was similar to that on Soviet vessels (0.933). In 1978 the average incidence rate of the small trawlers was similar to that of the large trawlers and the incidence rate on Soviet and Korean vessels was generally similar to that of the Japanese trawlers. The overall average incidence of halibut in trawl catches varied by area but there appeared to be no definitive pattern. The largest incidence occurred in the Shumagin area.

The incidence rate of halibut on Japanese longline vessels varied considerably between 1977 and 1978. This difference was related to depth of fishing. In 1977 the vessel carrying observers targeted on sablefish and fished at depths of over 600 m where the incidence of halibut was low, ranging from 0 to 0.018 fish/t. In 1978 the longline vessels often targeted on Pacific cod at depths ranging from 100 to 300 m where the incidence of halibut was generally higher than when vessels targeted on sablefish. When fishing in shallow waters the incidence of halibut was about 1.400 to 2.700 fish/t in the Shumagin and Chirikof areas, respectively. When fishing deep waters in those areas, the incidence of halibut

Table 6.—Average annual incidence (number per metric ton of catch) and average weight (kg) of Pacific halibut in foreign trawl and longline catches, by areas and vessel class in the Gulf of Alaska, 1977-78. (U.S. observer data.)

Nation and vessel class	Shumagin		Chirikof		Kodiak		Yakutat		Southeastern	
	Avg. incidence	Avg. wt.	Avg. incidence	Avg wt	Avg. incidence	Avg. wt.	Avg. incidence	Avg. wt.	Avg. incidence	Avg. wt.
1977										
Japan[1]										
Small freezer trawlers	—	—	0.934	5.35	1.288	10.28	0.890	19.82	0.616	8.97
Large freezer trawlers	—	—	0.401	8.02	0.814	6.45	1.363	10.73	1.558	9.60
Longline vessels	0	—	—	—	0	—	0.018	7.40	0	—
U.S.S.R.										
Large freezer trawlers	0.144	16.38	0.525	12.42	1.063	11.68	—	—	—	—
1978										
Japan										
Small freezer trawlers	3.548	3.90	2.131	3.70	1.017	9.30	3.157	10.57	—	—
Large freezer trawlers	5.099	4.29	1.934	3.36	0.676	9.96	2.880	8.78	0.970	8.76
Large surimi trawlers	1.320	6.52	0.417	5.35	0.329	6.51	—	—	—	—
Longline vessels	1.261	3.69	2.269	3.74	0.146	3.36	0.125	10.12	—	—
U.S.S.R.										
Large freezer trawlers	10.944	4.06	0.672	1.88	0.185	8.40	—	—	—	—
Korea										
Large freezer trawlers	3.185	2.48	2.522	3.65	—	—	—	—	—	—

[1]Small freezer trawlers were classified as under 1,500 gross tons and large freezer and surimi trawlers were over 1,500 gross tons. Large freezer trawlers processed the catch by dressing and freezing it, whereas large surimi trawlers targeted on pollock from which surimi, a fish cake, was produced.

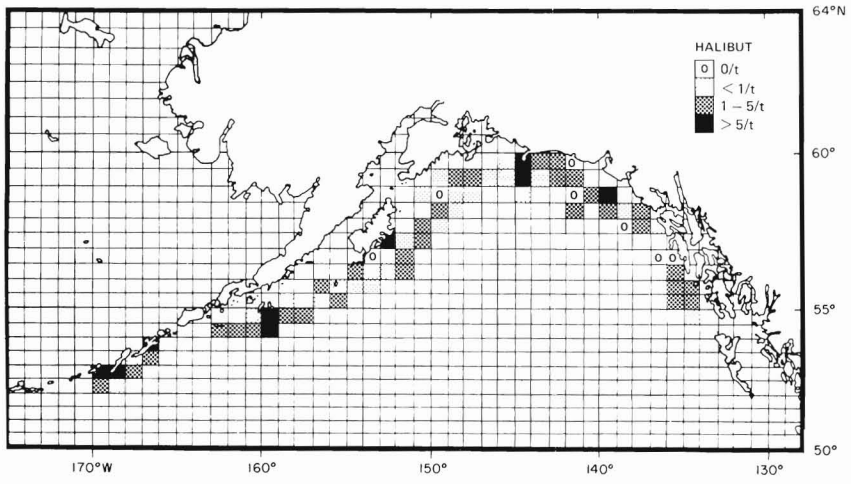

Figure 8.—Average incidence of Pacific halibut (number per metric ton of catch) by 1° long. and ½° lat. areas in the Gulf of Alaska. Observer data for stern trawlers of all nations and 1977-78 were combined.

was from 0.400 to 0.500 fish/t. The incidence of halibut on longline vessels in the Kodiak and Yakutat areas was somewhat less than in the areas to the west.

The average weight of the incidentally caught halibut varied by area but generally the fish were larger in the eastern areas—Kodiak, Yakutat, and Southeastern—compared with the fish in the western areas. The overall average weight of halibut (weighted by the estimated number of fish caught) was 5.3 kg in 1977 and 4.8 kg in 1978.

The incidence of halibut by small statistical areas (1° long. by ½° lat.) for nations, all stern trawlers, and 1977-78 combined is shown in Figure 8. The areas of largest incidence of halibut (over five fish/t of catch) occurred in various places from the northeastern Gulf of Alaska to long. 170°W. Halibut were taken in varying quantities in most of the Gulf of Alaska from long. 134°W to 170°W.

As was mentioned earlier, the estimated incidental catch of halibut by foreign fishing vessels was determined by multiplying average incidence rates for each month/area by the appropriate estimated catch. In 1977, because of relatively low sampling effort by observers, the average incidence rates were combined by vessel class for each area, and separate incidence rates for winter (December-May) and summer (June-November) were applied to the respective foreign catch. It was observed that the incidence of halibut was greater during the winter than during the summer months. To estimate the incidental catch of halibut by Korean and Polish vessels, for which observer data were not available, we used the average incidence rates obtained from Japanese and Soviet vessels. In 1978, when better coverage of vessels was obtained than in 1977, the estimated incidental catch of halibut was determined by applying the average incidence of halibut for each month/area to the appropriate catch. For missing data for any month/area, the average annual incidence rate for that area was applied. Incidence data from Soviet trawlers and Japanese longline vessels were used to estimate catches by Polish trawlers and Korean longline vessels, respectively, for which observer data were not available.

The total estimated incidental catch of halibut (Table 7) was about 413,000 fish (2,205 t) in 1977 and 293,000 fish (1,289 t) in 1978. These totals were not greatly different from those of previous years. In both years the greatest number of fish were taken in the western areas—Kodiak, Chirikof, and Shumagin—although the total for the Kodiak area in 1978 was reduced because of the reduced fishing effort and groundfish catch in that area by the Soviets. In 1977,

Table 7.—Estimated incidental catches of halibut (in numbers of fish and metric tons) by foreign groundfish vessels in the Gulf of Alaska, 1977-78. (Based on U.S. observer data.)

Nation and vessel class	Shumagin		Chirikof		Kodiak		Yakutat		Southeastern		Totals	
	No.	t	No	t	No.	t	No.	t	No.	t	No.	t
1977												
Japan[1]												
Large surimi and freezer trawlers	73,543	332	48,609	161	18,347	142	10,165	123	14,161	119	164,825	877
Small freezer trawlers	5,093	23	1,250	5	11,027	100	9,396	194	640	6	27,406	328
U.S.S.R.												
Large freezer trawlers	3,247	42	27,375	131	147,914	596	3,507	9	31	T[1]	182,074	778
South Korea												
Large freezer trawlers	34,534	198	3,387	13	—	—	—	—	—	—	37,921	211
Poland												
Large freezer trawlers	—	—	—	—	783	11	—	—	—	—	783	11
Total	116,417	595	80,621	310	178,071	849	23,068	326	14,832	125	413,009	2,200
1978												
Japan												
Large surimi and freezer trawlers	23,446	95	14,090	61	8,362	85	5,480	51	5,097	45	56,475	336
Small freezer trawlers	6,866	28	996	4	5,141	58	12,811	145	57	1	25,871	235
Longliners	5,683	20	10,379	38	1,667	6	591	5	—	—	18,320	70
U.S.S.R.												
Large freezer trawlers	21,405	87	45,075	85	803	7	20	T	8	T	67,311	179
South Korea												
Large freezer trawlers	122,480	457	2,210	8	—	—	—	—	3	T	124,693	465
Longliners	280	1	139	1	—	—	T	T	—	—	470	2
Poland												
Large freezer trawlers	—	—	—	—	234	2	—	—	—	—	234	2
Total	180,160	688	72,889	197	16,258	158	18,902	201	5,165	46	293,374	1,259

[1]T = trace: Less than 0.5 fish or less than 0.5 t.

Table 8.—Average annual incidence (number per metric ton of catch) and average weight (kg) of salmon in foreign trawl and longline catches by areas and vessel class in the Gulf of Alaska, 1977-78. (U.S. observer data.)

Nation and vessel class	Shumagin		Chirikof		Kodiak		Yakutat		Southeastern	
	Avg. incidence	Avg. wt.	Avg. incidence	Avg. wt.	Avg. incidence	Avg. wt.	Avg. incidence	Avg. wt.	Avg. incidence	Avg. wt.
1977										
Japan										
Small freezer trawlers	0.032	2.2	0.020	0.3	0.021	3.2	0.049	2.4	0.068	2.6
Large freezer trawlers	—	—	0.002	4.2	0.017	4.1	0.228	2.7	0.043	2.7
Longline vessels	0	—	—	—	0	—	0	—	0	—
U.S.S.R.										
Large freezer trawlers	0.001	12.2	0.013	3.9	0.148	3.9	—	—	—	—
1978										
Japan										
Small freezer trawlers	0.163	2.6	0.068	3.4	0.100	2.9	0.052	4.2	—	—
Large freezer trawlers	0.252	3.1	0.178	3.1	0.029	2.5	0.003	2.1	0.024	3.9
Large surimi trawlers	0	—	0.020	4.9	0.091	3.0	—	—	—	—
Longline vessels	0.002	2.6	0.060	1.8	0	—	0.009	0.3	—	—
U.S.S.R.										
Large freezer trawlers	0.166	3.6	0.089	2.4	0.200	2.1	—	—	—	—
Korea										
Large freezer trawlers	0.421	3.0	0.006	3.4	—	—	—	—	—	—

Japan took the majority of the incidental halibut catch, but in 1978, because of a large incidence of halibut on Korean vessels in the Shumagin area, that nation took a larger part of the total catch than the other nations.

Pacific salmon

In the Gulf of Alaska salmon fishing areas, Pacific salmon are traditionally caught with gill nets, purse seines, trolling gear, and a few remaining fish traps in certain areas of southeastern Alaska. The catch of salmon by trawls is strictly an incidental catch to targets of groundfish species, but at various times and places fair numbers of salmon may appear in trawl catches (French et al., 1981). By placing observers on the foreign fishing vessels, NMFS was able to determine incidence rates of Pacific salmon and to estimate the total incidental catch of the species.

The average annual incidence rates of salmon determined for 1977-78 by area and vessel class are shown in Table 8. Salmon were taken incidentally in most of the areas fished with the incidence varying from 0 to about 0.023 fish/t of catch in 1977 and from 0 to 0.421 fish/t in 1978. The incidence of salmon on Japanese vessels was generally similar among vessel classes in 1977, and there was no appreciable difference between incidence rates on Japanese and Soviet trawlers. Where data were available for comparison, the incidence of salmon was also generally similar among areas. No salmon were observed on longline gear in 1977.

In 1978 the incidence of salmon varied by nation and vessel class, with the highest average incidence occurring on Korean vessels in the Shumagin area. The incidence on Japanese small trawlers was generally similar to that of Japan's large trawlers, with some variation occurring between areas. The highest incidence rates occurred on Korean and Japanese large trawlers (freezer and surimi trawlers combined) during November and February. The catch of salmon on Japanese longline vessels was infrequent and occurred only during summer months.

The overall incidence rate of salmon by area, nation, and vessel class (excluding longline vessels) combined was 0.059 fish/t in 1977 and

0.133 fish/t in 1978. Average weights of the salmon were 3.38 kg and 2.90 kg, respectively, for the 2 years.

The incidence of salmon by small statistical areas, 1° long. by ½° lat., for nations and years combined is shown in Figure 9. Areas of the largest catches tended to be in the western half of the Gulf of Alaska, west of long. 148°W. The incidence in the eastern part of the Gulf of Alaska was generally less than in the western Gulf. The area of highest incidence of salmon was centered around the Shumagin Islands, long. 160° to 161°W and lat. 54° to 55°N.

In 1977 the incidental salmon observed consisted of 91 percent chinook salmon, *Oncorhynchus tshawytscha,* and 9 percent chum salmon, *O. keta,* averaging 4.3 and 3.9 kg, respectively. All five species of Pacific salmon occurred in the incidental catches in 1978, but chinook salmon greatly predominated, 93 percent, as they did in 1977. Other species made up 1-2 percent of the catch. The size of the chinook salmon (ranging from about 2 to 12 kg) indicated that the catch was probably made up of maturing and immature fish—those that would have returned to spawn in the year of capture and those that would have remained at sea for 1 or more years.

Table 9 indicates a total estimated catch of 5,272 salmon (19.3 t) in 1977 and 45,603 salmon (131.3 t) in 1978. The largest catches of salmon in 1977 were in the Kodiak and Shumagin areas, and Soviet trawlers took about 56 percent of the catch. In 1978 the largest catch by far was made by Korean stern trawlers in the Shumagin area. The high catch resulted from a relatively high incidence rate in October and November at a time when the estimated total groundfish catch was substantial—over 21,000 t. Thus, of the total salmon catch, about 32,000 fish (71 percent) were accounted for by Korean trawlers in the Shumagin area during October and November. Primarily because of the very large catch attributed to Korea, the total of about 45,000 salmon in 1978 was about 8 times the total of around 5,300 salmon estimated for 1977. Aside from the Korean catch, the estimated salmon catch by Japan and the U.S.S.R. in 1978, about 12,000 fish, is over twice that estimated for those two countries in 1977. The main

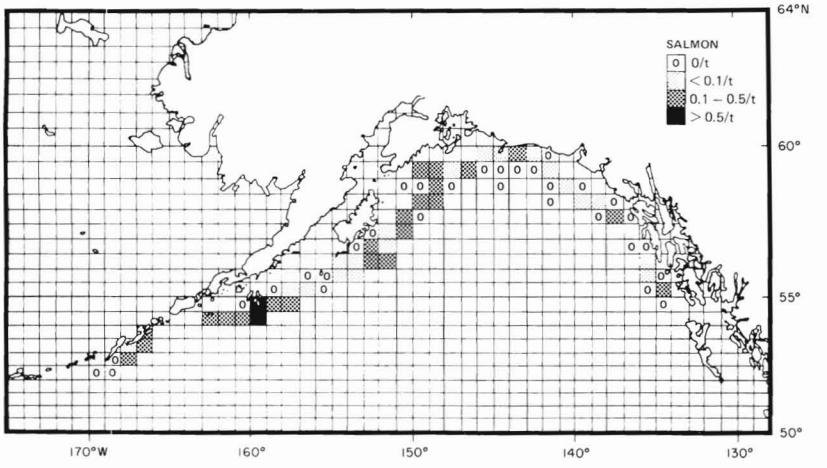

Figure 9.—Average incidence of salmon (number per metric ton of catch) by 1° long. and ½° lat. areas in the Gulf of Alaska. Observer data for stern trawlers of all nations and 1977-78 were combined.

Table 9.—Estimated incidental catches of salmon (in numbers of fish and metric tons) by foreign groundfish vessels in the Gulf of Alaska, 1977-78. (Based on U.S. observer data.)

Nation and vessel class	Shumagin		Chirikof		Kodiak		Yakutat		Southeastern		Totals	
	No.	t	No.	t	No.	t	No.	t	No.	t	No.	t
1977												
Japan[1]												
Large surimi and freezer trawlers	740	2.87	14	0.04	250	0.97	294	0.78	234	0.63	1,532	5.29
Small freezer trawlers	107	0.41	1	T[1]	123	0.48	277	0.74	10	0.03	518	1.66
U.S.S.R.												
Large freezer trawlers	15	0.06	144	0.42	2,748	10.69	36	0.10	—	—	2,943	11.27
South Korea												
Large freezer trawlers	209	0.81	7	0.02	—	—	—	—	—	—	216	0.83
Poland												
Large freezer trawlers	—	—	—	—	63	0.25	—	—	—	—	63	0.25
Total	1,071	4.15	166	0.48	3,184	12.39	607	1.62	244	0.66	5,272	19.30
1978												
Japan												
Large surimi and freezer trawlers	955	3.01	1,291	4.13	725	1.98	6	0.01	127	0.50	3,104	9.63
Small freezer trawlers	319	0.85	30	0.10	471	1.34	295	1.21	1	T	1,116	3.50
Longliners	4	0.01	225	0.41	—	—	20	T	—	—	249	0.42
U.S.S.R.												
Large freezer trawlers	325	1.18	6,538	15.14	869	1.79	T	T	T	T	7,732	18.11
South Korea												
Large freezer trawlers	33,139	99.06	5	0.02	—	—	—	—	T	T	33,144	99.08
Longliners	1	T	4	0.01	0	—	T	T	—	—	5	0.01
Poland												
Large freezer trawlers	—	—	—	—	253	0.52	—	—	—	—	—	—
Total	34,743	104.11	8,093	19.81	2,318	5.63	321	1.22	128	0.50	45,603	131.27

[1]T = trace: Less than 0.5 fish or less than 0.005 t.

reason for the increase was the generally increased incidence rates observed in 1978 compared with 1977.

King crab

No catch estimates of king crab were made for 1977 due to relatively low observer coverage and because the data available indicated a very low incidence. Observers in the Gulf of Alaska in 1977 recorded a total of 96 king crab found in 4,850 t of groundfish.

In 1978, observers sampled on Korean vessels fishing in the Gulf of Alaska for the first time, and there was greater overall observer coverage of the various foreign fleets and vessel classes. The incidence of king crab on Korean trawlers in the Shumagin area in the summer of 1978 proved to be unusually high, and the annual average for the region was around 10 crab (average of 1.4 kg) per metric ton of catch (Table 10). This incidence rate was much larger than noted for trawlers of other nations in the same area. Examination of the incidence rates by 1° long. by ½° lat. areas indicated that the highest king crab incidence rates for the Korean vessels occurred just south of Unalaska Island in the eastern Aleutian Islands (lat. 52°30′ to 53°30′N by long. 166° to 168°W).

Also observed in 1978 was the average incidence of about 0.5 king crab per metric ton of catch by Japanese longline vessels. Presumably the crab grab the bait and become entangled with the hooks as they are hauled. Normally they are easily dislodged from the hooks as the gear reaches the vessel and are allowed to drop back into the water relatively unharmed.

Table 11 gives the total estimated incidental take of king crab for 1978 as about 94,000 crab, of which 89,000 or 95 percent were caught by Korean trawlers. Approximately 3,200 king crab were taken incidentally by Japanese longline vessels. By area, the largest catches came from the Shumagin area which produced 97 percent of the total landed. Again, this was due primarily to the high incidence rates on the observed Korean trawlers which were used to estimate total catch.

Table 10.—Incidence (number per metric ton of catch) and average weight (kg) of king crab taken by the foreign groundfish fishery in the Gulf of Alaska, 1978. (U.S. observer data.)

Nation and vessel class	Shumagin		Chirikof		Kodiak		Yakutat		Southeastern	
	Avg. incidence	Avg. wt.	Avg. incidence	Avg. wt.	Avg. incidence	Avg. wt.	Avg. incidence	Avg. wt.	Avg. incidence	Avg. wt.
Japan										
Small trawlers	0.019	1.88	0	—	0.004	2.10	0.099	1.19	—	—
Large freezer and surimi trawlers	0.066	2.31	0	—	0.004	2.69	0.034	1.40	0	—
Longline vessels	0.531	1.01	0.030	1.21	0.196	0.87	0.265	0.72	—	—
U.S.S.R.										
Large freezer trawlers	0	—	0	—	0	—	—	—	—	—
Republic of Korea										
Large freezer trawlers	10.081	1.42	0	—	—	—	—	—	—	—

Table 11.—Estimated incidental catches of king crab (in numbers of crab and metric tons) by foreign groundfish vessels in the Gulf of Alaska, 1978. (Based on U.S. observer data.)

Nation and vessel class	Shumagin		Chirikof		Kodiak		Yakutat		Southeastern		Totals	
	No.	t	No.	t	No.	t	No.	t	No.	t	No.	t
Japan												
Large surimi and freezer trawlers	463	1.07	0	—	44	0.11	72	0.10	0	—	579	1.28
Small freezer trawlers	36	0.07	0	—	55	0.11	678	0.73	0	—	769	0.91
Longline vessels	1,518	1.38	139	0.16	648	0.53	923	0.67	0	—	3,228	2.74
U.S.S.R.												
Large freezer trawlers	0	—	0	—	0	—	T[1]	—	0	—	T	—
South Korea												
Large freezer trawlers	89,193	130.29	0	—	—	—	—	—	0	—	89,193	130.29
Longline vessels	34	0.03	2	T	69	0.06	1	T	—	—	106	0.09
Poland												
Large freezer trawlers	—	—	—	—	0	—	—	—	—	—	—	—
Total	91,244	132.84	141	0.16	816	0.81	1,674	1.50	0	0	93,875	135.31

[1]T = trace: Less than 0.5 crab or less than 0.005 t.

The incidental king crab taken by Korean trawlers differed markedly in species composition from those taken by Japanese vessels. Observer data indicate that red king crab, *Paralithodes camtschatica,* made up 100 percent of the king crab caught by Korean ships. The Japanese catch of king crab was composed of 62 percent golden, *Lithodes aequispina,* 37 percent red, and 1 percent blue king crab, *Paralithodes platypus.* The overall species composition was 97 percent red king crab, 3 percent golden, and a trace of blue king crab.

Snow crab

In the Gulf of Alaska, snow crab usually form only a small incidental catch for foreign trawlers targeting on groundfish. No catch estimates of snow crab were made for 1977 due to relatively low observer coverage and because the data available indicated a relatively low incidence. Observers in the Gulf of Alaska in 1977 counted 589 snow crab in a sample weight of 4,850 t of groundfish; of those, 420 or 71 percent were observed on small Japanese trawlers in the Yakutat area where the annual incidence rate was 1.58 crab/t.

Data on the incidence of snow crab obtained by observers were summarized for 1978 to illustrate the size of the incidental catch and indicate where most of them were taken. From the annual incidence data in Table 12, the highest rates have occurred on Japanese longline vessels (2.9 crab/t) and small trawlers (1.3 crab/t) in the Yakutat area.

The total estimated incidental take of snow crab in 1978 was about 24,000 (14 t) (Table 13). These were

Table 12.—Incidence (number per metric ton of catch) and average weight (kg) of snow crab taken by the foreign groundfish fishery in the Gulf of Alaska, 1978. (U.S. observer data.)

Nation and vessel class	Shumagin		Chirikof		Kodiak		Yakutat		Southeastern	
	Incidence	Avg. wt.	Incidence	Avg. wt.	Incidence	Avg. wt.	Incidence	Avg. wt.	Incidence	Avg. wt.
Japan										
Small trawlers	0	—	0	—	0.064	0.40	1.297	0.49	—	—
Large freezer and surimi trawlers	0	—	0.002	0.07	0.002	0.57	0.007	0.60	0	—
Longline vessels	0.052	0.99	0.058	0.93	0.209	0.78	2.890	0.79	—	—
U.S.S.R.										
Large freezer trawlers	0	—	0	—	0	—	—	—	—	—
Republic of Korea										
Large freezer trawlers	0.275	0.45	0	—	—	—	—	—	—	—

Table 13.—Estimated incidental catches of snow crab (in numbers of crab and metric tons) by foreign groundfish vessels in the Gulf of Alaska, 1978. (Based on U.S. observer data.)

Nation and vessel class	Shumagin		Chirikof		Kodiak		Yakutat		Southeastern		Totals	
	No.	t	No.	t	No.	t	No.	t	No.	t	No.	t
Japan												
Large surimi and freezer trawlers	0	—	14	T[1]	29	0.02	15	0.01	0	—	58	0.03
Small freezer trawlers	0	—	0	—	308	0.15	7,506	3.88	0	—	7,814	4.03
Longline vessels	767	0.79	238	0.22	580	0.44	7,656	5.69	—	—	9,241	7.14
U.S.S.R.												
Large freezer trawlers	0	—	—	0	0	—	T	T	0	—	T	T
South Korea												
Large freezer trawlers	6,757	2.88	0	—	—	—	—	—	0	—	6,757	2.88
Longline vessels	12	0.01	4	T	73	0.06	10	0.01	—	—	99	0.08
Poland												
Large freezer trawlers	—	—	—	—	0	—	—	—	—	—	—	—
Total	7,536	3.68	256	0.22	990	0.67	15,187	9.59	0	0	23,969	14.16

[1]T = trace: Less than 0.5 crab or less than 0.005 t.

taken primarily by Japanese longline vessels, small Japanese trawlers, and large freezer trawlers from Korea. Over half of the incidental catch (63 percent) was taken in the Yakutat area and most of the remainder in the Shumagin area. Two species of snow crab were represented in the catches: *Chionoecetes bairdi* composed roughly 65 percent of the total snow crab catch and *C. opilio* made up the remaining 35 percent.

Species Composition and Estimated Catch of Rockfish and Flatfish

Foreign nations were required by the United States under FCMA regulations to report the catch of Pacific ocean perch separately but to combine the catch data for all other rockfish. Similarly, in the Gulf of Alaska, statistics on all foreign-caught flatfish species were grouped as "flounders." Observers, however, during sampling for the species composition of the catch, identified and reported on the catch of the individual rockfish and flatfish species.

Estimates of the 1977-78 rockfish and flatfish catches by species were made by applying the annual species composition (percentage of catch by weight) computed from U.S. observer data and stratified by nation, vessel class, and area to the corresponding total catches of rockfish and flatfish. The 1977 observer data were extrapolated to the foreign reported catches of rockfish and flatfish, whereas the 1978 species composition data were applied to the U.S. estimates of the rockfish and flatfish catches. In cases in which no species composition data were available for a particular data cell, a substitution was made with the species composition from another nation, area, or vessel class which was judged to best reflect the expected catch composition. As nations which did not receive a 1977 rockfish or flatfish allocation did not report catches of those species groups, it was not possible to make corresponding catch estimates by species. The 1977 estimates also do not include the catch by species of rockfish or flatfish on Japanese longline vessels because of lack of observer species composition data on that vessel class.

Rockfish catches

The total estimated rockfish catch by species is given in Table 14. In 1977, approximately 23,600 t of rockfish were estimated to have been taken by foreign fishing vessels in the Gulf of Alaska and in 1978 only about 10,000 t, or 43 percent of the 1977 tonnage. Thirty different species of *Sebastes* and *Sebastolobus* were identified by observers as appearing in foreign catches in those years, but because ready recognition of rockfish comes only with long study, errors in identification may have occurred.

Pacific ocean perch was the predominant rockfish species, making up 61.9 percent of the total rockfish landings in 1977 and 81.2 percent in 1978. This species also made up the greatest percentage of the rockfish catch taken by trawlers of all nations and vessel classes, but shortspine thornyhead, *Sebastolobus alascanus,* predominated in the 1978 incidental rockfish catch taken by Japanese longline vessels targeting on Pacific cod or sablefish.

Japanese small and large freezer trawlers frequently target on rockfish in the Gulf of Alaska and land the greatest portion of the total rockfish catch. For each of the 12 rockfish species most commonly taken on those vessels, Table 15 gives the percentage of weight of the catch of that species that was taken at each of five depth intervals. One species, the

northern rockfish, *Sebastes polyspinis,* was found to occur mainly at the relatively shallow depths of 100-199 m. Nearly 64 percent of the Pacific ocean perch, however, were caught at the 200-299 m depth stratum, and this also was the depth at which the majority (62 percent) of the total rockfish catch by weight occurred. Within the 300-399 m depth stratum, substantial percentages of five rockfish species were taken:: Pacific ocean perch (26.2 percent); rougheye, *S. aleutianus,* (58.4 percent); shortraker, *S. borealis,* (50.9 percent); shortspine thornyhead (45.7 percent); and yelloweye, *S. ruberrimus,* (66.9 percent). Only a small fraction of the rockfish catch occurred in depths over 400 m.

Geographical range limitations of the rockfish species also affect the species composition. In the Southeastern statistical area, a larger number of rockfish species are found in the foreign catches than in the statistical areas farther west. In addition, species other than Pacific ocean perch make up a greater percentage of the catch, composing approximately 49 percent of the rockfish catch in Southeastern whereas these species constitute only 9 percent of the rockfish in the Shumagin area.

Flatfish catches

Table 16 lists the total estimated catch of flatfish by species. Approximately 18,600 t of flatfish were estimated to have been taken by foreign fishing vessels in the Gulf of Alaska in 1977 (including the catch by longline vessels) and in 1978 about 14,300 t were taken, 77 percent of the 1977 tonnage. Fourteen species of flatfish were identified by observers as appearing in the foreign catches in those years, but some species were seen in only small quantities and not all 14 species were observed during both years.

Arrowtooth flounder, *Atheresthes stomias,* was the predominant flatfish species, comprising 81-82 percent of the total flatfish landings in 1977-78. This species also made up the greatest percentage of the flatfish catch for

Table 14.—Estimated catch of rockfish (*Sebastes* and *Sebastolobus* spp.) by species taken in the Gulf of Alaska, 1977[1] and 1978. (U.S. observer data.)

Common name	Scientific name	1977 catch		1978 catch	
		Metric tons	Percent	Metric tons	Percent
Dusky	*Sebastes ciliatus*	388.3	1.6	162.1	1.6
Harlequin	*S. variegatus*	737.1	3.1	47.1	.5
Northern	*S. polyspinis*	624.8	2.6	553.4	5.5
Pacific ocean perch	*S. alutus*	14,587.8	61.9	8,165.3	81.2
Redstripe	*S. proriger*	2,416.0	10.2	41.5	.4
Rougheye	*S. aleutianus*	832.7	3.5	137.8	1.4
Sharpchin	*S. zacentrus*	737.3	3.1	25.4	.3
Shortraker	*S. borealis*	828.9	3.5	219.8	2.1
Shortspine thornyhead	*Sebastolobus alascanus*	1,363.7	5.8	442.1	4.4
Silvergray	*Sebastes brevispinis*	411.1	1.7	6.0	1
Yelloweye	*S. ruberrimus*	294.1	1.2	38.4	.4
Yellowmouth	*S. reedi*	86.0	.4	2.3	<.1
Other rockfishes[2]		269.6	1.1	217.0	2.2
Total		23,577.4	99.7	*10,058.2*	100.1

[1]The 1977 estimates do not include the catch of rockfish on Japanese longline vessels because no species composition data on the catches of those ships were available at that time.
[2]The group "other rockfish" is made up of the following list of species which were identified by observers during 1977 and 1978. Within this group the possibility of misidentification exists and the occurrence of species not previously reported from the Gulf of Alaska should be noted with caution. The species are: Aurora, *Sebastes aurora;* Black, *S. melanops;* Blue, *S. mystinus;* Bocaccio, *S. paucispinis;* Canary, *S. pinniger;* Chilipepper, *S. goodei;* Darkblotched, *S. crameri;* Greenstriped, *S. elongatus;* Longspine thornyhead, *Sebastolobus altivelis;* Pygmy, *Sebastes wilsoni;* Redbanded, *S. babcocki;* Rosethorn, *S. helvomaculatus;* Splitnose, *S. diploproa;* Stripetail, *S. saxicola;* Tiger, *S. nigrocinctus;* Vermillion, *S. miniatus;* Widow, *S. entomelas;* and Yellowtail, *S. flavidus.*

Table 15.—Distribution by depth of twelve species of rockfish taken by Japanese large and small freezer trawlers in the Gulf of Alaska. (Observer data from 1977-78 combined.)

Common name	Scientific name	Depth intervals (m)				
		100-199	200-299	300-399	400-499	500-599
		Percent				
Darkblotched	*Sebastes crameri*	36.4	51.5	12.1	—	—
Dusky	*S. ciliatus*	41.8	55.5	2.4	—	—
Harlequin	*S. variegatus*	46.4	50.9	2.5	0.2	—
Northern	*S. polyspinis*	63.3	36.0	0.7	—	—
Pacific ocean perch	*S. alutus*	9.7	63.7	26.2	0.3	T[1]
Redstripe	*S. proriger*	16.7	81.5	1.7	0.1	—
Rougheye	*S. aleutianus*	1.0	38.8	58.4	1.9	T
Sharpchin	*S. zacentrus*	7.0	90.1	2.6	0.2	—
Shortraker	*S. borealis*	1.4	29.1	50.9	17.3	1.4
Shortspine thornyhead	*Sebastolobus alascanus*	2.6	45.5	45.7	5.5	0.7
Silvergray	*Sebastes brevispinis*	3.0	96.1	0.6	0.3	—
Yelloweye	*S. ruberrimus*	0.5	32.1	66.9	0.5	—
Total		11.3	62.1	25.1	1.4	0.1

[1]T = Trace, less than 0.05 percent.

Table 16.—estimated catch of flatfish by species taken in the Gulf of Alaska, 1977[1] and 1978. (U.S. observer data.)

Common name	Scientific name	1977		1978	
		Metric tons	Percent	Metric tons	Percent
Alaska plaice	*Pleuronectes quadrituberculatus*	—	—	0.5	T[2]
Arrowtooth flounder	*Atheresthes stomias*	14,994.1	81.1	11,708.4	81.8
Butter sole	*Isopsetta isolepis*	—	—	1.4	T
Deepsea sole	*Embassichthys bathybius*	—	—	4.9	T
Dover sole	*Microstomus pacificus*	1,279.1	6.9	826.5	5.8
English sole	*Parophrys vetulus*	2.5	T	4.4	T
Flathead sole	*Hippoglossoides elassodon*	57.8	0.3	284.6	2.0
Greenland turbot	*Reinhardtius hippoglossoides*	75.7	0.4	51.4	0.4
Petrale sole	*Eopsetta jordani*	30.5	0.2	28.0	0.2
Rex sole	*Glyptocephalus zachirus*	1,574.6	8.5	1,256.6	8.8
Rock sole	*Lepidopsetta bilineata*	483.0	2.6	130.6	0.9
Slender sole	*Lyopsetta exilis*	0.1	T	—	—
Starry flounder	*Platichthys stellatus*	—	—	0.5	T
Yellowfin sole	*Limanda aspera*	1.0	T	12.6	0.1
Total		18,498.4		14,310.4	

[1]The 1977 estimates do not include the catch on Japanese longline vessels because no species composition data on the catches of those ships were available at that time.
[2]T = trace: the catch of that species made up less than 0.05 percent by weight of the total flatfish landed.

Table 17.—Distribution by depth of four species of flatfish taken by Japanese trawlers in the Gulf of Alaska. (Observer data from 1977-78 combined.)

Common name		Depth intervals (m)					
		0-99	100-199	200-299	300-399	400-499	500-599
		Percent					
Arrowtooth flounder	*Atheresthes stomias*	0.5	5.7	42.0	46.6	4.9	0.4
Dover sole	*Microstomus pacificus*	—	2.5	29.1	56.8	8.2	3.5
Rex sole	*Glyptocephalus zachirus*	T[1]	5.7	31.6	53.9	8.6	0.1
Rock sole	*Lepidopsetta bilineata*	—	70.4	24.7	5.0	—	—
Total		0.4	5.5	39.4	48.4	5.7	0.7

[1]T = Trace, <0.05 percent.

each vessel type in nearly every area, constituting 64-97 percent of the flatfish taken. The only exception occurred in the 1978 catches of Japanese small trawlers in the Chirikof area, where rex sole, *Glyptocephalus zachirus,* predominated and arrowtooth was second in percentage by weight.

Japanese vessels frequently target on flatfish in the Gulf of Alaska, and consequently land the greatest portion of the total flatfish catch. The four most commonly taken flatfish species in 1977-78 were arrowtooth flounder, Dover sole, *Microstomus pacificus,* rex sole, and rock sole, *Lepidopsetta bilineata.* For each of those species, Table 17 gives the percentage by weight of the catch of that species that was taken at each of six depth intervals. Only one species, rock sole, was found to occur mainly at the relatively shallow depths of 100-199 m. Approximately equal percentages of arrowtooth flounder were caught at the 200-299 m and the 300-399 m depth strata: the depths at which the majority (88.6 percent) of the arrowtooth flounder and the greatest portion of the overall flatfish catch occurred. A relatively small fraction of the flatfish catch occurred at depths over 400 m.

Summary

Foreign groundfish fisheries in the Gulf of Alaska expanded rapidly from the first exploratory expeditions by the U.S.S.R. and Japan in 1960 to a peak catch in 1965 of nearly 400,000 t. Since then, annual catches have fluctuated between 100,000 and 200,000 t; the primary target species of the fishery has changed from Pacific ocean perch to walleye pollock. The Republic of Korea, Poland, and the Republic of Taiwan later joined the U.S.S.R. and Japan in harvesting the groundfish resources of the Gulf.

Concern expressed by U.S. fishermen and fishery managers about the effect the foreign vessels might have on the fishery resources, especially the stocks of Pacific halibut, led to agreements with Japan and the Soviet Union to permit a limited number of U.S. observers aboard some of the vessels to monitor the catch. Data were collected on the incidental catch rates of Pacific halibut, Pacific salmon, king crab, and snow crab as well as on species composition of the catches and length/age information of the commercially important groundfish species.

With the enactment of FCMA, the foreign fishery observer program was greatly expanded, and the data collected by observers on species composition were used to compile an ongoing estimate of the foreign catches by species throughout the season. As the sampling effort was increased, the biological data collected by the observers also became increasingly useful to fishery managers in determining the status of the fishery resources.

During 1977-78, 50 observers sampled on 61 foreign vessels, covering 8.3 percent of the foreign effort in 1977 and 14.7 percent in 1978. Observer data were used in estimating a total foreign groundfish catch of nearly 200,000 t in 1977 and about 165,000 t in 1978. The predominant species in the catches of both years and all nations was walleye pollock, which made up 58 to 59 percent of the total foreign catch. Other species and species groups of importance were Atka mackerel, Pacific ocean perch, flounders, sablefish, and Pacific cod.

Data collected by observers on the incidence (number/t of groundfish catch) of Pacific halibut, Pacific salmon, king crab, and snow crab were used to estimate the total incidental catch of these species by the foreign groundfish fleets. In 1977, the estimated number of Pacific halibut taken in the Gulf of Alaska was approximately 413,000 (2,205 t); in 1978 it was 293,000 (1,289 t). In both years, the greatest numbers were taken in the western statistical areas of Shumagin, Chirikof, and Kodiak. The estimated catch of Pacific salmon increased over eightfold, from about 5,270 salmon (19.3 t) in 1977 to 45,600 (131.3 t) in 1978. High incidental catch rates of salmon on Korean trawlers in the Shumagin area during October and November were responsible for 32,000 (71 percent) of the 1978 estimate. No catch estimates of king or snow crab were made in 1977, but the calculated take of these species groups in 1978 was nearly 94,000 (135 t) and 24,000 (14 t), respectively.

Species composition data gathered by observers were used to estimate the foreign catch of rockfish and flatfish by species. Although 30 rockfish species were identified in the catches, one species (Pacific ocean perch) made up the greatest percentage of the total rockfish catch—61.9 percent in 1977 and 81.2 percent in 1978. Analysis of the catches by depth indicated that nearly 90 percent of the Pacific ocean perch by weight taken on Japanese large and small freezer trawlers were caught at depths between 200 and 400 m. Arrowtooth flounder composed 81-82 percent of the total flatfish landings in 1977 and 1978. This species was also found to be caught primarily at depths between 200 and 400 m.

In 1977-78, the first 2 years of fisheries management under FCMA,

a wealth of information was gathered by U.S. observers on the foreign fishing vessels in the Gulf of Alaska. As long as the foreign fleets continue to take a large percentage of the groundfish catch of this region, it is expected that the observer program will serve as an ongoing source of data useful in making fisheries management decisions.

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