U.S. Observers Board Japanese Trawl Vessels in Bering Sea

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INTRODUCTION

The Bering Sea, with its vast continental shelf area, is one of the largest of the world's seas. It is extremely rich in benthos, or bottom-dwelling organisms. The shelf area covers about 1 million km'; in the central and eastern sectors it extends some 600 km offshore (Fig. 1).

Because of its abundance in fish fauna, this area has attracted much interest by foreign fishing fleets with a remarkable increase in fish landings in recent years. In 1971 total catch was nearly 2 million metric tons. Japan and the Union of Soviet Socialist Republics (USSR), with their large modern fishing fleets, harvest most of the catch now landed. The Republic of Korea entered the fishery in 1967 but together with the United States and Canada takes less than 1 percent of the harvest. The important species in the catch are walleye (Alaska) pollock, *Theragra chalcogramma*; yellowfin sole, *Limanda aspera*; Pacific cod, *Gadus macrocephalus*; herring, *Clupea harengus pallasi*; flathead sole, *Hippoglossoides elassodon*; rock sole, *Lepidopsetta bilineata*; and Pacific ocean perch, *Sebastes alutus*.

Of considerable importance to United States and Canadian fishers is the Pacific halibut, *Hippoglossus stenolepis*, the abundance of which has decreased in recent years to the point where it has become unprofitable for North Americans to fish for the species in the Bering Sea. Although halibut are taken in trawls, Japan has agreed, with minor exceptions, not to retain trawl-caught halibut east of long. 175°W. Japanese fishers must, therefore, return to the sea halibut taken incidentally in the trawl fishery. Because of the decline in the catch of halibut by setlines (the principal gear used by North American fishers) and because of the possible deleterious effects of trawling on stocks of halibut, king crab, *Paralithodes* spp., and snow (Tanner) crab, *Chionoecetes* spp., the United States pressed for a program to place U.S. scientists and technicians aboard Japanese fishing vessels.

The objective of this program was to determine the incidence of halibut and crab in trawl catches. These data have been important in devising corrective procedures to reduce the incidental catch of crab and halibut.

From March 1973 through 1974, by agreement with the Government of Japan and the Japanese fishing companies, the United States Government, in a cooperative effort by the National Marine Fisheries Service, International Pacific Halibut Commission (IPHC), and Alaska Department of Fish and Game, placed qualified observers aboard Japanese groundfish vessels operating in the eastern Bering Sea. This report reviews the background and highlights the results of

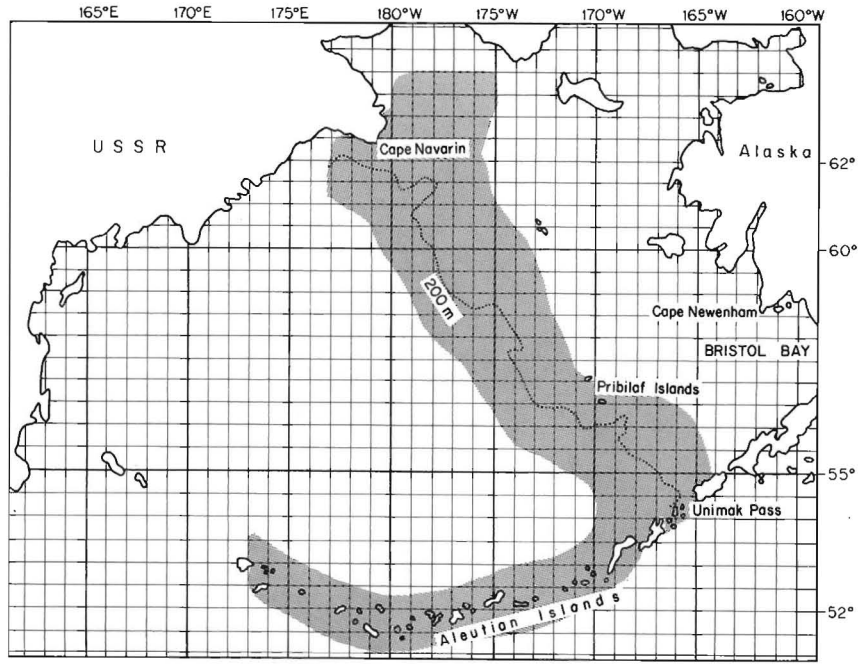

Figure 1.—Fishing area of Japanese groundfish fleet.

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this first comprehensive foreign fisheries observer program in the Bering Sea.

THE JAPANESE BOTTOMFISH FISHERY

Early History and Products

The history of the Japanese bottomfish fishery in the eastern Bering Sea predates World War II (Chitwood, 1969). During the 1930's Japan conducted a relatively minor fishery—walleye pollock was the target species for conversion to fish meal and oil. In the early 1940's before the start of World War II, another mothership-type operation was conducted with emphasis on yellowfin sole, frozen for human consumption. Both of these fleets operated in the southeastern Bering Sea and were interrupted by World War II.

After World War II, the fisheries policy of the Allied Occupational Forces restricted Japanese fishing to waters around Japan. With the signing of the Peace Treaty in 1952, fishing restrictions were removed and Japan resumed fishing for groundfish in the eastern Bering Sea in 1954. The develpment of these operations may be divided into three periods (1954-57; 1958-63; 1964 to present) according to target species, method of processing, and expansion of fishing grounds.

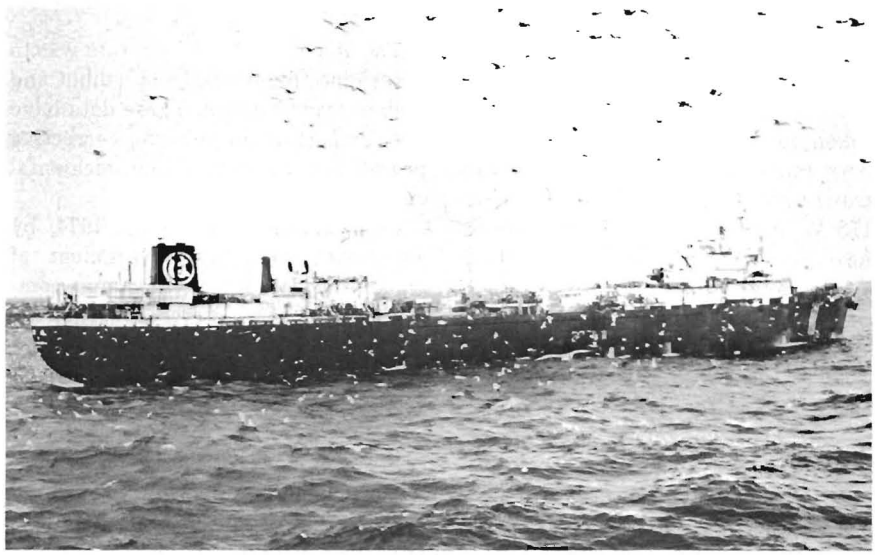


Figure 2.—Mothership *Soyo Maru*, 12,950 gross metric tons.

Figure 3.—Unloading a cod end aboard the mothership *Soyo Maru*.

During 1954-57, yellowfin sole (for the frozen food market) was sought off Bristol Bay between August and October. The total catch of all flatfish amounted to 24,000 metric tons in 1956 and 1957.

During 1958-63, an expansion of the fishery occurred throughout the Bering Sea with a diversification of target species. In the eastern part and later in the central part of the Bering Sea, yellowfin sole and arrowtooth flounder, *Atheresthes stomias*, were taken for the fish meal market. Catches peaked in 1961 at 456,000 metric tons but then declined greatly by 1963 because of overfishing by Japan and the USSR. By 1960 sablefish (black cod), *Anoplopoma fimbria;* Pacific ocean perch, Pacific cod; walleye pollock; and herring were being taken (for the frozen food market) north of the eastern Aleutian Islands.

Under terms of the International North Pacific Fisheries Commission (INPFC) established in 1953, Japan abstained from fishing halibut east of long. 175°W. In May 1963, however, halibut in the eastern Bering were removed from the list of species qualifying for abstention. Japan participated in the setline fishery for halibut that year and caught about 2,100 metric tons. Catches have since been reduced; after 1968 Japan has not fished for halibut east of the abstention line. As stated earlier, Japan agreed not to retain halibut taken in trawls east of long. 175°W, but Japan's land-based dragnet fishery does retain halibut west of long. 175°W.

The expansion of Japan's eastern Bering Sea fisheries after 1964 and the status of resources are described by Pruter (1973). During those years walleye pollock became the target species and in recent years constituted over 80 percent by weight of the total groundfish catch. Changes in fishing and limitations in the data make it impossible to judge how well the catch-per-unit-effort values for Japan's

fisheries reflect actual changes in abundance of various species. The abundance of some species, such as yellowfin sole and Pacific ocean perch, have declined and under uncontrolled fishing probably will remain below optimum levels.

The catch of walleye pollock by Japan greatly increased, primarily because of the development of the technology of preparing "surimi," a semi-processed wet fish protein (Miyauchi, Kudo, and Patashnik, 1973). This product is prepared aboard factory ships from pollock and other species; it is then frozen and returned to Japan for preparing "kamaboko"—a Japanese-style fish cake (Okada, Miyauchi, and Kudo, 1973). Although the frozen surimi industry in Japan started in 1960, it expanded greatly when equipment to produce surimi was installed aboard factory ships operating in the North Pacific Ocean and Bering Sea (Sakai, 1969). Because a major portion of the entire Japanese fish catch is processed into "kamaboko" products, the Bering Sea pollock fishery has assumed increased importance in the Japanese fisheries. Fishing for pollock was conducted mainly along the continental slope in the eastern Bering Sea in all seasons; in summer and fall the fleet increased its fishing in northern areas between the Pribilof Islands and Cape Navarin.

Figure 4.—Typical catch, composed of 90 percent walleye pollock, and 10 percent snow crab, flatfish, and miscellaneous species.

The Fishing Fleet

Four types of bottomfish fleets are licensed by the Fisheries Agency of Japan to fish in the Bering Sea. These are the mothership fishery, independent stern trawlers (North Pacific trawl fishery), the land-based dragnet fishery (which is only licensed to fish waters west of long. 170°W), and the North Pacific longline-gillnet fishery. Support vessels include a variety of refrigerated transports, cargo ships, and tankers (Chitwood, 1969). Observers sampled in the eastern Bering Sea on two types of vessels—motherships and factory stern trawlers. Photographs taken by U.S. observers of some of the vessel types and sampling methods are shown in Figures 2-8. Dickinson (1973) also has an excellent series of photographs of the Japanese fleet.

For the fishing fleets that fish only in

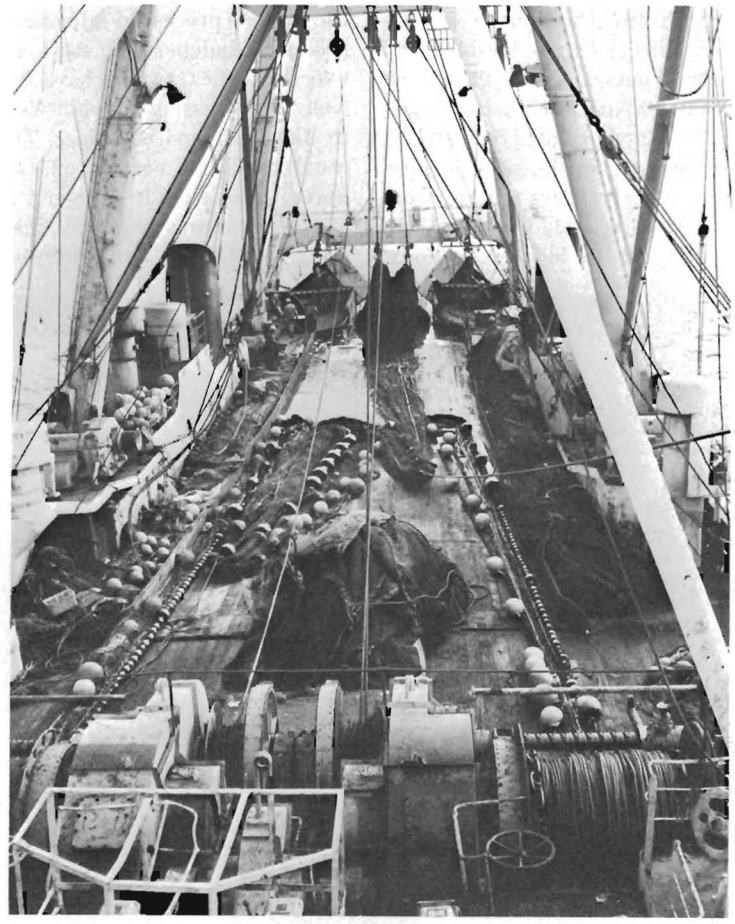


Figure 5.—Hauling net aboard the independent stern trawler *Zuiyo Maru*, 3,860 gross metric tons.

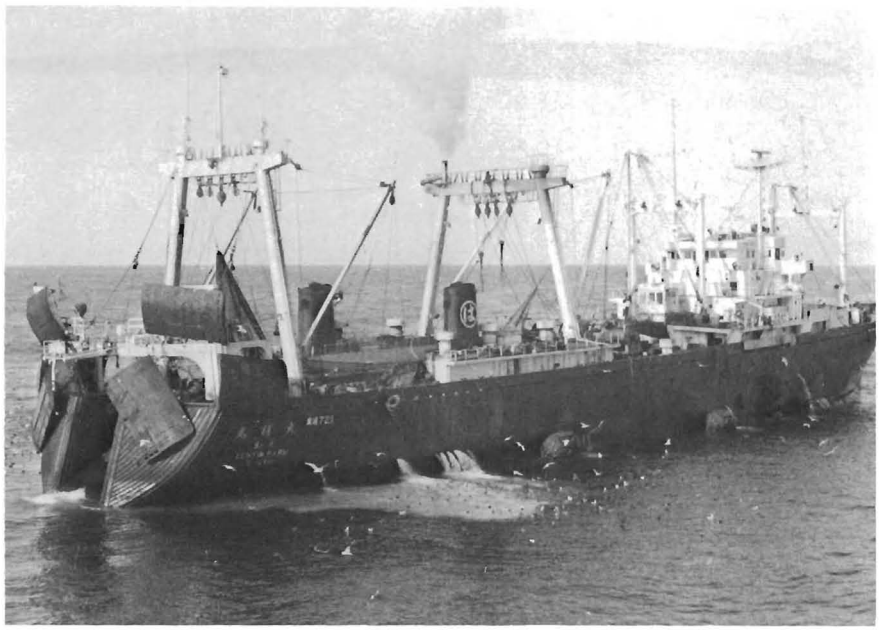


Figure 6.—Independent stern trawler *Tenyo Maru*, 4,220 gross metric tons.

the eastern Bering Sea (mothership, North Pacific trawl, and longline-gillnet fisheries), about 71 percent of the catch in 1971 was made by the mothership fleet; 12 motherships and 206 catcher boats landed 1.25 million metric tons (Japanese Fisheries Yearbook, 1973). Catcher boats consisted of pair trawlers, Danish seiners, and dependent stern trawlers ranging from 30.5 to 58 meters (100-190 feet) in length and 150 to 500 gross tons. Catcher boats make deliveries to the mothership one to several times daily, depending on catcher boat type, where the catch is processed into various fish products. Independent stern trawlers (North Pacific trawlers) have fishing as well as processing capabilities similar to those of motherships. They accounted for 28 percent of the 1971 Bering Sea catch. Less than 1 percent of the catch was made by the North Pacific longline-gillnet fishery.

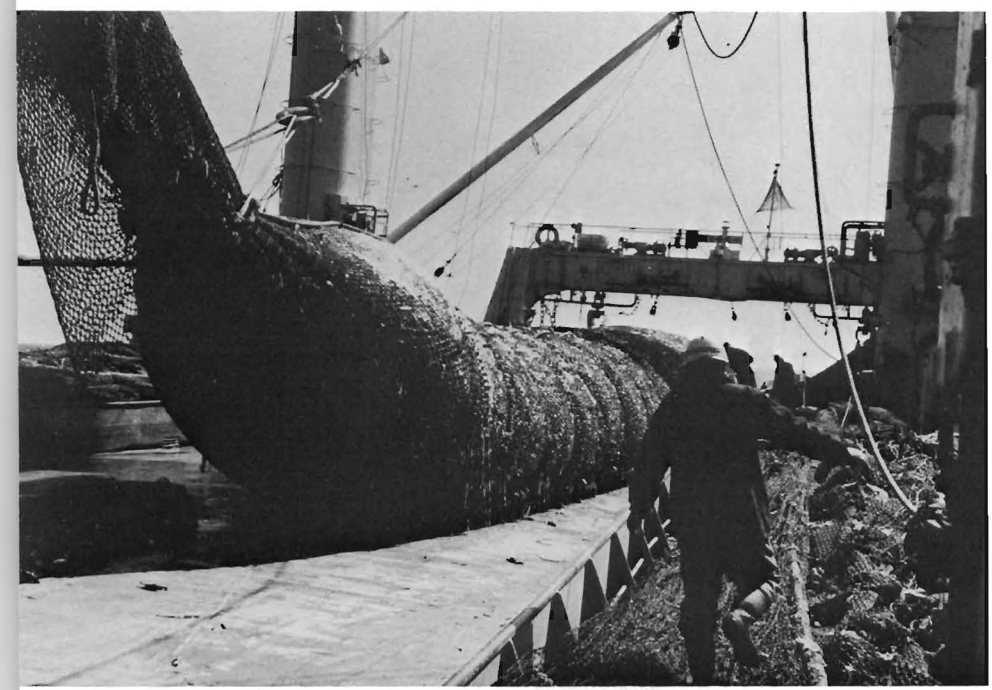


Figure 7.—Estimated 100-metric ton catch of walleye pollock coming aboard independent stern trawler *Yamato Maru*.

In past years the trawl fleet operated in the southeastern Bering Sea near Unimak Pass in the winter, although the fleet extended northwest of the Pribilof Islands during other parts of the year (Fig. 9). Most trawling operations are located along the continental slope and outer shelf areas and have recently expanded northwestward to off Cape Navarin on the Siberian coast. Limited fishing is also conducted along the Aleutian Islands. Fishing is carried out in the Bering Sea during all months of the year, although effort varies by season. A continuous stream of transport ships renew basic provisions of food and fuel for the fishing fleet biweekly and carry processed fish to Japan. Each vessel fishes approximately 10 months out of the year and spends the remaining time en route to and from the fishing grounds and in drydock for refitting and repairs.

THE U.S. OBSERVER PROGRAM

Background and Purpose

Landings of halibut by U.S. and Canadian vessels fishing in the eastern Bering Sea have decreased drastically the past few years. (The halibut fishery is managed by the International Pacific Halibut Commission (IPHC) for the United States and Canada.) From a catch of nearly 5,000 metric tons in 1963 by 104 setline vessels, the catch declined to less than 200 metric tons taken by 10 vessels in 1973. The IPHC contends that the initial decline of the stock was caused by excessive setline fishing by Canada, Japan, and the United States allowed under the quotas established by INPFC (Skud, 1973). Further decline was precipitated by the incidental trawl catch. The large incidental catch in recent years negated restrictions placed on the setline fishery, and reductions in incidental catches are required before any major increase in catch can be expected in the setline fishery.

Japan estimated the incidental catch of halibut at about 1.5 million fish in 1969 (November 1968 through October 1969), but the United States contended that Japan underestimated the catch of

halibut (Fukuhara and Worlund[1]), IPHC[2]. Differences between estimates were primarily due to methods of interpolating the incidental catch in areas and seasons where data was not available. The observer program resolved most of the differences in estimates and more clearly determined the incidental catch in Japanese landings. In 1972, U.S. observers were permitted aboard Japanese vessels for a limited period during the summer. During the 1972 annual meeting of INPFC, an expanded observer program was proposed for 1973. This program, subsequently approved by Japan in January 1973, involved the placement of two observers on each of two motherships and one observer on each of two independent stern trawlers during each quarter of the year. The observation periods were to be for approximately one month. This same type of program was also approved from 1974.

Primary objectives of the groundfish observer program are to: 1) determine the magnitude of the incidental catches of halibut and crab; 2) estimate halibut and crab mortality from trawling operations and handling on the deck of the vessel; 3) obtain biological information on halibut and crab and on target species (pollock and flatfish); and 4) collect statistics on catches.

Observers were provided by the Alaska Department of Fish and Game (11), International Pacific Halibut Commission (8), National Marine Fisheries Service (27), and in one case by the Fisheries Agency of Japan (Table 1). With the exception of the observer from Japan, all observers were trained in species recognition, sampling procedures, and techniques of data collection at the Northwest Fisheries Center of the National Marine Fisheries Service in Seattle. They were sent via commercial aircraft to Tokyo, Japan, where briefings were held with representatives of the Fisheries Agency of Japan and the fishing companies. Transportation to and from the fishing vessels in the Bering Sea was usually via supply vessels although sometimes the schedule of the observer's trip coincided with the departure or arrival of the actual fishing vessel to which the observer was assigned.

Figure 8.—Dumping the walleye pollock catch below deck on independent stern trawler *Yamato Maru*.

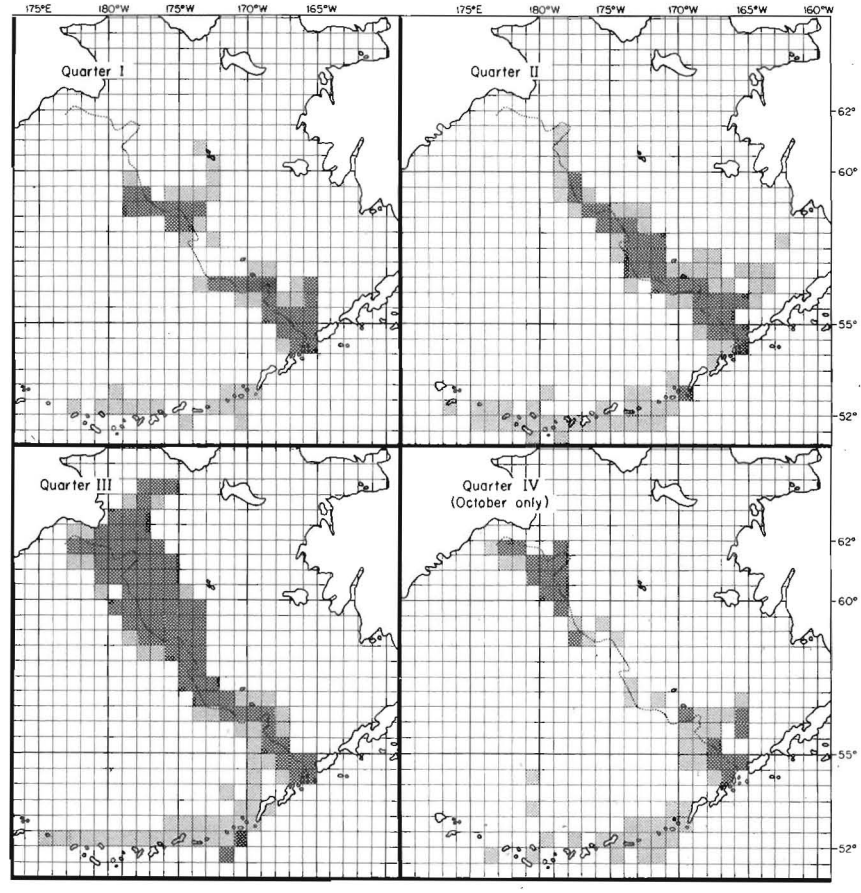


Figure 9.—Groundfish catch (by 1°x½°blocks) of the combined Japanese mothership and stern trawl fishing fleets, by quarters, 1972 (quarter IV includes catches through October only); light shaded blocks = less than 3,000 metric tons; dark blocks = greater than 3,000 metric tons.

[1]Fukuhara, Francis M., and Donald D. Worlund. 1973. Incidence of halibut and Tanner crab in catches by the eastern Bering Sea mothership trawl fishery and independent trawlers. Unpublished manuscript on file at the Northwest Fisheries Center, National Marine Fisheries Service, NOAA, Seattle, WA 98112.

[2]International Pacific Halibut Commission. 1973. The estimated incidental catch of halibut by Japan in the eastern Bering Sea and its effect on the North American setline yield. Unpublished manuscript.

Methods of Collecting Data

Sampling methods were designed to estimate the incidence of halibut and crab and to procure biological data on species in the catch. Although sampling designs aboard the vessel varied due to differences in vessel layout and processing procedures, two basic methods were used. A series of random basket samples were taken daily at different stages of a haul or bin emptying period, prior to any presorting. After each basket was weighed, individual species were sorted, counted, and weighed. Up to 2 tons of catch were sampled daily in this manner. The primary disadvantage of basket sampling was that a relatively small part of the catch was sampled. Relatively scarce species such as halibut frequently never appeared in basket samples, although they were observed in the fish bins.

A second method was to monitor the conveyor belt that transports the catch from the unloading bin to the factory. By counting the number of halibut, king crab, and snow crab passing a point during a given time period, prior to sorting, and estimating the number of tons of fish passing, the observers could estimate the incidence of crab and halibut. From 50 to 150 tons were sampled per day by this method. Because of the volume of fish and speed of the conveyor belt, halibut and crab may at times have been missed, and counts of halibut and crab obtained during conveyor belt monitoring are considered minimum estimates. In each method, numbers and weights of halibut and crab from samples are extrapolated to estimate catches by season, area, and the particular gear fished. Additional biological data (sex, length, and weight) were obtained for target species, halibut, king crab, snow crab, and other abundant species. Observers also collected up to 500 otoliths (small bones from the head which are used in age and growth studies) from dominant fish species and halibut, noted the viability of halibut and crab returned to the sea, and made observations on the number of marine mammals around the vessels and in the catch. These data were tabulated and analyzed through automatic data processing procedures at the Northwest Fisheries Center.

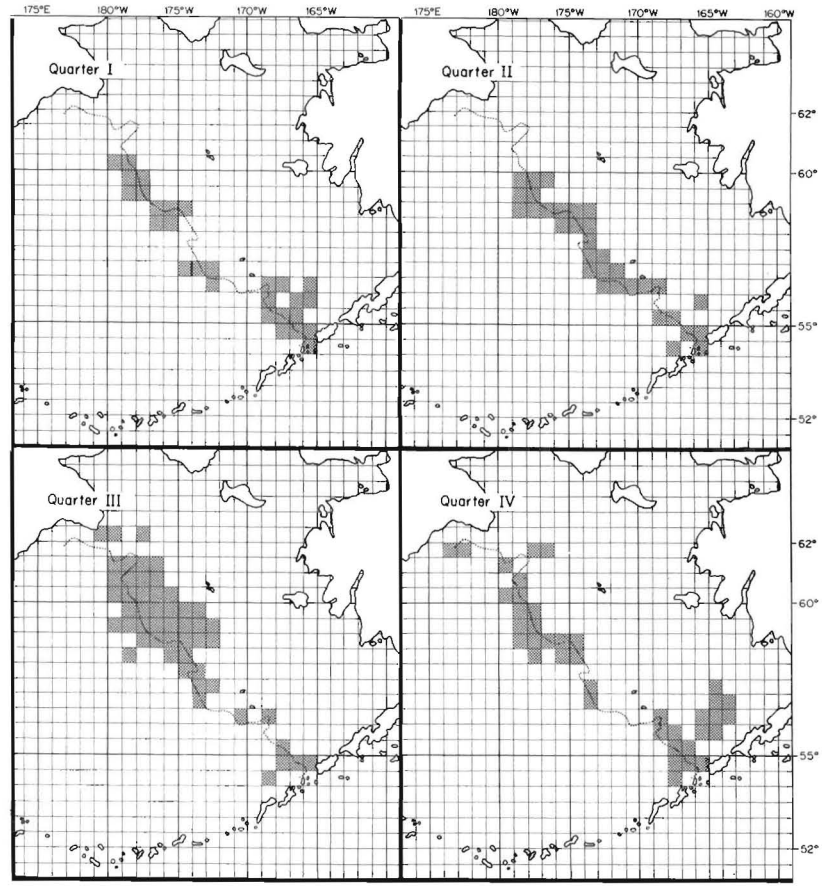


Figure 10.—Areas (1°x½° blocks) in which samplers were aboard Japanese motherships and stern trawlers, by quarter, 1973-74.

Areal Coverage

Although observations were lacking in some critical months and areas, the coverage extended over much of the trawling areas in the central and eastern Bering Sea, and compared favorably with the disposition of the Japanese fleet as represented by their catches in 1972 (Figs. 9 and 10). Approximately 97 percent of the catch was landed near the continental shelf 200-m isobath and 89 percent of the sampling days occurred there. Names of participating vessels, Japanese fishing companies, and the number of days sampled are given in Table 2.

RESULTS OF OBSERVER PROGRAM

Incidental Catch of Halibut

Hoag and French [3] analyzed data supplied by the 1973-74 observer program and the Fisheries Agency of Japan. These data were used to estimate the incidental catch and examine the difference in incidental catch by area, month, and gear type. Results of this work showed the highest incidence of halibut occurred from December to May along the shelf from the eastern Aleutian Islands near Unimak Pass northwestward to the Pribilof Islands—where the target species were pollock and yellowfin sole. Incidence values averaged about five halibut per metric ton of total catch. Incidence for other months and areas was less than one halibut per metric ton of catch. The average incidence of halibut for all quarters combined was slightly higher in catches by motherships (2.2 halibut per metric ton) than by independent stern trawlers (1.9 halibut per metric ton).

Average weights of halibut were generally between 0.5 and 10 kg and were higher in summer than winter. Those taken on independent stern trawlers averaged 2.71 kg; those taken by mothership catcher boats averaged 1.29 kg. Most of the halibut ranged in

[3] Hoag, Stephen H., and Robert French. 1974. The incidental catch of halibut by Japanese trawlers in the Bering Sea. Unpublished manuscript on file at the International Pacific Halibut Commission, Seattle, Wash.

Table 1.—Sampling assignments of observers on Japanese groundfish vessels in 1973-74.

Name	Organization	Vessel
D. Holland	NMFS	*Gyokuei Maru*
R.L. Carlson	NMFS	
S. Hoag	IPHC	*Soyo Maru*
R. Carlson	NMFS	
D. Peacock	IPHC	*Tenyo Maru*
L. Nelson	NMFS	*Yamato Maru*
L. Gwartney	ADFG	*Tsuda Maru*
P. Tata	ADFG	*Gyokuei Maru*
Y. Takahashi	JFA	
J. Garrison	NMFS	*Ohtori Maru*
G. St. Pierre	IPHC	*Hoyo Maru*
L. Landrie	IPHC	
H. Shippen	NMFS	*Soyo Maru*
P. Werdal	NMFS	
P. Novak	ADFG	*Gyokuei Maru*
C. Shimada	ADFG	
S. Moberly	ADFG	*Zuiyo Maru*
I. McGregor	IPHC	*Akebono Maru*
R. Bakkala	NMFS	*Kashima Maru*
P. Werdal	NMFS	
D. Daisy	ADFG	*Rikuzen Maru*
K. Roberson	ADFG	*Tenyo Maru*
L. Nelson	NMFS	*Soyo Maru*
G. Robinson	NMFS	
K. Niggol	NMFS	*Kashima Maru*
T. Dembski	NMFS	
D. Holland	IPHC	*Koyo Maru*
B. Barrett	ADFG	*Tenyo Maru*
J. Mason	NMFS	*Soyo Maru*
R. Bakkala	NMFS	*Chikubu Maru*
W. Bergmann	ADFG	*Gyokuei Maru*
R. Carlson	NMFS	
G. Peltonen	IPHC	*Haruna Maru*
C. Sims	NMFS	*Soyo Maru*
D. Misitano	NMFS	
M. Miller	NMFS	*Hoyo Maru*
T. Chestnut	NMFS	
J. Ploeger	NMFS	*Gyokuei Maru*
E. Kato	NMFS	
P. Werdal	IPHC	*Ohtori Maru*
A. Quimby	ADFG	*Akebono Maru*
R. Bakkala	NMFS	*Tenyo Maru*
R. Major	NMFS	*Soyo Maru*
B. Patten	NMFS	
E. Dawley	NMFS	*Kashima Maru*
R. McNaughton	IPHC	
K. Florey	ADFG	*Haruna Maru*

[1]ADFG = Alaska Department of Fish and Game.
JFA = Japanese Fisheries Agency.
IPHC = International Pacific Halibut Commission.
NMFS = National Marine Fisheries Service.

Table 2.—Names of vessels, Japanese fishing companies, and days sampled by U.S. scientists and technicians[1], March 1973-December 1974.

Company	Vessel type and name	Observer trips on vessel	Catcher boats PT[2]	DS[3]	DST[4]	Days sampled by quarter 1973 I	1973 II	1973 III	1973 IV	1974 I	1974 II	1974 III	1974 IV
	Mothership												
Nippon Suisan Kaisha	*Gyokuei Maru*	1	8	1		23							
		2	8	7	1		13	31					
		2	12	12	2						27	25	
Nippon Suisan Kaisha	*Kashimi Maru*	2	6		2				27	21			
		1	6		1								31
Taiyo Gyogyo	*Soyo Maru*	5			10	23	1	29	14	27	37		30
		1			9						27		
Hokuyo Suisan	*Hoyo Maru*	2	14	7				15				29	
	Independent stern trawlers												
Taiyo Gyogyo	*#3 Tenyo Maru*	2				19	8		17				
Nippon Suisan Kaisha	*Yamato Maru*	1				4	33						
Hoko	*Tsuda Maru*	1					18						
Kuykuyo	*Ohtori Maru*	2						21				23	
Hakodate Kokai	*#3 Zuiyo Maru*	1						17	17				
Nichiro	*72 Akebono Maru*	2						17	13			31	
Nippon Suisan Kaisha	*Rikuzen Maru*	1							30				
Hokuyo Suisan	*#3 Koyo Maru*	1								31			
Taiyo Gyogyo	*#5 Tenyo Maru*	1								22			
Hoko	*Chikubu Maru*	1									29		
Nippon Suisan Kaisha	*Haruna Maru*	2									20		16
Taiyo Kyogyo	*Tenyo Maru*	1										2	26
	Total	32				69	73	130	118	101	140	110	103

[1] Including Canadians through the International Pacific Halibut Commission.
[2] Pair trawlers.
[3] Danish seiners.
[4] Dependent stern trawlers.

length from 30 to 80 cm (Fig. 11). Based on age-length relationships determined by IPHC, the halibut were mainly 4 to 8 years old. They were younger than those caught by the U.S. and Canadian setline fishery whch are predominently 8- to 15-year-olds.

The total individual catch of halibut was estimated by multiplying the incidence observed in each area and month by the respective groundfish catch. The results show that the annual incidental catch increased to about 3 million fish (3,000 metric tons) in the early 1970's.

By agreement, halibut taken incidentally by Japanese trawlers east of long. 175°W are returned to the sea. As noted by observers, however, mortality of halibut, due to crushing in the net, extended exposure to air and cold, and predation by sea lions on return to the sea, has been high—from 60 to 100 percent.

Realizing the importance of the productive trawl fisheries and recognizing that foreign trawling will likely continue, even if national fishery zones are extended, IPHC proposed a scheme to reduce the incidental catch of halibut and also allow a productive trawl fishery. In 1973, IPHC proposed that foreign trawling be prohibited in particular areas in the Bering Sea when the incidence of halibut was high but trawl effort was low. Other areas would be open to trawling year-round and the closed areas would be open to fishing at times when the incidental catch of halibut was low, thereby allowing time and area in which to conduct a productive trawl fishery. The governments of Canada and the United States supported the IPHC proposal and, through negotiations, the Japanese agreed to most of the closures (IPHC, 1973). In response to a second proposal by IPHC in 1974, negotiations continued and Japan agreed to expand the duration and area of the Bering Sea closures for 1975. These closures will reduce the incidental catch of halibut by several thousand metric tons and should improve catches in the setline fishery.

Incidental Catch of Crab

King and snow crab have been harvested in the eastern Bering Sea for many years, although the catch has

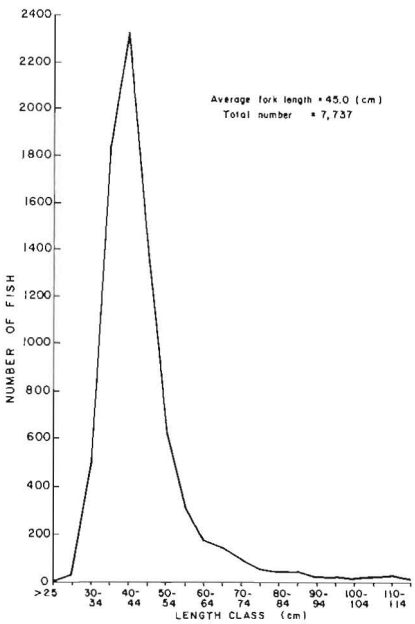


Figure 11.—Length frequency distribution of halibut in Japanese trawls March 1973-June 1974.

varied (Table 3). Japanese king crab landings have decreased in recent years because of quotas and gear restrictions (established through bilateral agreements) while U.S. catches have increased. United States landings of snow crab have not been large, but increased effort for these species is expected in the future.

Table 3.—Commercial crab catch (in thousands) in the eastern Bering Sea by country, 1952-72.

	King crab[1]		Snow crab	
Year	Japan[2]	U.S.	Japan[2]	U.S.
1952	—	355	—	—
1953	1,276	361	—	—
1954	1,061	328	—	—
1955	1,129	313	—	—
1956	1,079	294	—	—
1957	1,171	107	—	—
1958	1,130	1	—	—
1959	1,292	—[3]	—	—
1960	1,949	88	—	—
1961	3,029	62	—	—
1962	4,591	10	—	—
1963	5,476	101	—	—
1964	5,895	123	—	—
1965	4,216	223	1,030	—
1966	4,202	140	1,490	—
1967	3,764	547	8,610	—
1968	3,853	1,505	11,980	6
1969	2,073	1,749	7,590	353
1970	2,080	1,683	18,190	482
1971	886	2,405	15,739	61
1972	874	3,994	15,207	43

[1] Male crab of legal size.
[2] Japanese catch data are used through permission of the Japan Fisheries Agency.
[3] No fishing in 1959.

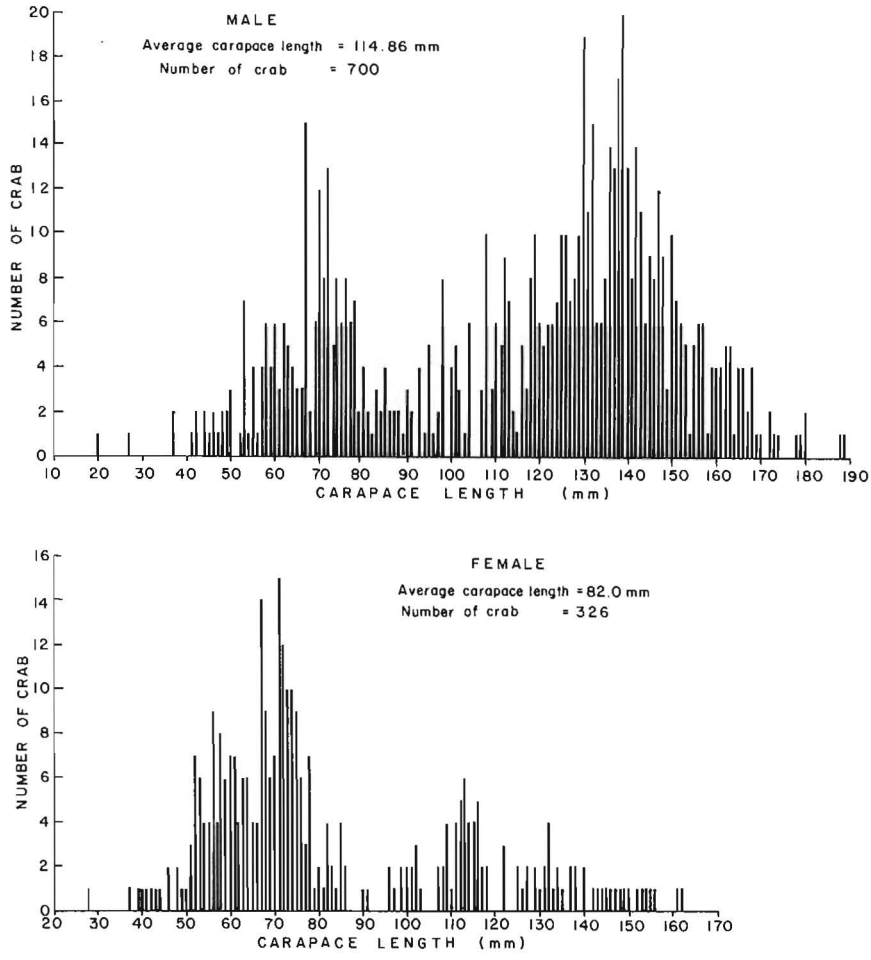


Figure 12.—King crab carapace length frequencies March 1973-June 1974.

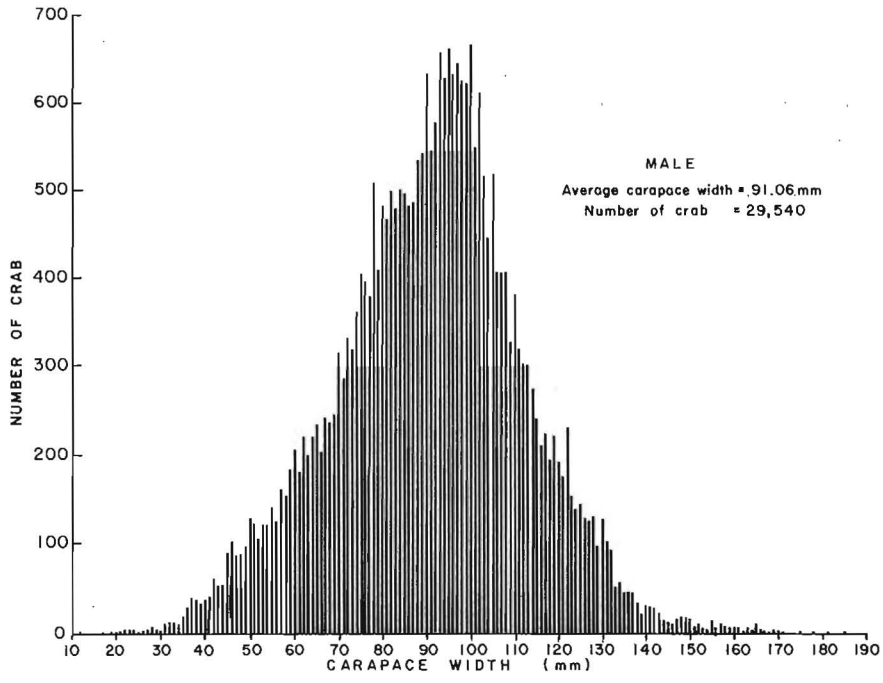
According to observer data, the incidental king crab catch during trawling was relatively low. It ranged from 0 to 2.9 crabs per metric ton of groundfish catch, and was highest north and west of the Pribilof Islands. The average lengths (from the right eye socket to the median posterior of the carapace) of king crab taken by the Japanese groundfish fishery were 82 mm for females and 115 mm for males (Fig. 12). Average weights ranged from 1.24 to 1.54 kg. The king crab taken by the trawl fishery are mainly below commercial size. To compare carapace sizes between the Japanese and U.S. king crab fisheries it is necessary to convert carapace lengths as taken by the observers to carapace width as used in the U.S. commercial crab fishery. The minimum size in 1973 for king crab males, the only sex retained by the U.S. fishery, was 139 and 143 mm in carapace length (159 and 165 mm in carapace width), depending on the season.

Snow crab are much more abundant than king crab in the Japanese trawl catches. These were taken in all areas and seasons, but were most abundant west and north of the Pribilof Islands during fall and winter. Incidence of snow crab ranged from 0 to 180 per metric ton of catch. On the basis of observed snow crab incidence, the Japanese groundfish fishery in the eastern Bering Sea captured about 118 million snow crab during 1972 (Kessler, Somerton, and Schultz[4]). Average weights for incidentally taken snow crab were between 0.45 and 0.60 kg. The average carapace width of the crab was 58.7 mm for females and 91.6 for males (Fig. 13). Although there is no minimum size for snow crab, U.S. processors accept only the males larger than 125 mm in carapace width. Based on the length frequency distribution from observer samples (Fig. 13), a large proportion of snow crab taken by the Japanese trawl fishery was below the minimum U.S. commercial size of 125 mm.

Even though snow crab taken in the Japanese groundfish fishery are returned to the sea, their mortality is high. Observer data indicated that there is 50 percent mortality before the crab are returned to the sea. A similar mortality rate was reported by Hayes[5], who showed that crab survival decreases with increased time on deck, mixture with fish, and subjection to pressure of overlying catches. Simulated fish bin conditions showed a 50 percent mortality after only 6 hours.

[4] Kessler, D. W., D. A. Somerton, and R. D. Schultz. 1974. Incidence of Tanner crab in the groundfish catch of the Japanese eastern Bering Sea trawl fishery. Unpublished manuscript on file at the Northwest Fisheries Center, National Marine Fisheries Service, NOAA, Seattle, WA 98112.

[5] Hayes, Murray L. 1973. Survival of Tanner crabs (*Chioneocetes bairdi*) after capture in trawls and subsequent handling and storage aboard fishing boats. Unpublished manuscript on file at the Northwest Fisheries Center, National Marine Fisheries Service, NOAA, Seattle, WA 98112.



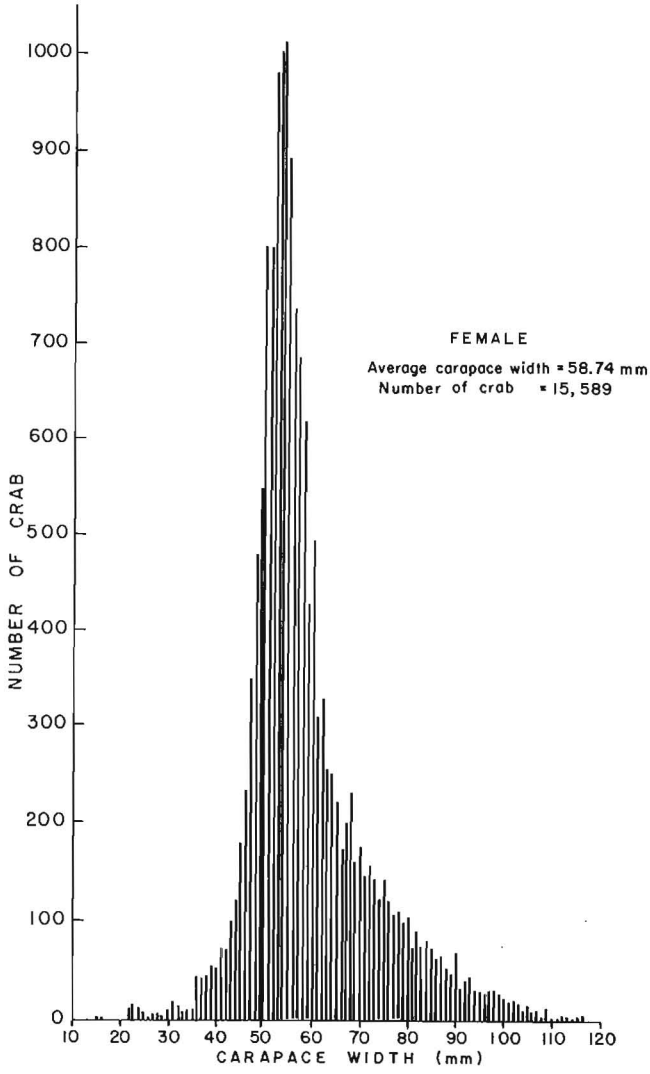


Figure 13.—Snow crab carapace width frequencies March 1973-June 1974.

Species Composition of Catch

Species composition data were combined from the individual observer trips to illustrate the general species composition in the Japanese trawl fishery during the observation period in 1973 and 1974 (Table 4).

Table 4.—Percentage composition by species from basket sampling aboard Japanese groundfish vessels, eastern Bering Sea, 1973-74.

Species	Number observed	Total wt. est. (mt)	% composition
Pacific halibut	1,220	280.483	0.137
Snow (Tanner) crab	25,585	4,808.398	2.353
King crab	372	58.410	0.029
Walleye pollock	642,935	167,585.170	81.999
Yellowfin sole	98,670	14,603.027	7.145
Pacific cod	11,507	7,243.990	3.545
Greenland turbot	21,560	2,687.796	1.315
Flathead sole	8,525	1,433.278	0.701
Rock sole	6,175	1,552.748	0.760
Rex sole	103	2.717	0.001
Alaska plaice	2,503	1,072.720	0.525
Arrowtooth flounder	2,221	950.744	0.465
Sablefish	3,221	111.951	0.055
Atka mackerel	1,006	71.415	0.035
Pacific ocean perch	2,791	323.108	0.158
Sculpin	3,000	1,091.161	0.534
Snailfish	1,736	113.434	0.056
Poacher	124	76.411	0.037
Herring	568	123.540	0.060
Misc. (Broken pieces of shell, starfish, sea urchins, snails, octopus, squid, and shrimp)	—	183.860	0.090
		204,374.361	100%

Walleye pollock were by far the most important species in the catch (81 percent) and represented the target species during most observer trips. Yellowfin sole, the next most important species (7 percent), was the target species on three observer trips.

OUTLOOK

The United States-Japanese observer program aboard Japanese groundfishing vessels in the Bering Sea completed 2 years of data collection in 1975. During this period the observers obtained estimates of the incidental catch of halibut and crab in addition to important biological data on various species. These data have been very useful in international negotiations and have provided the basis for agreements to implement conservation measures for the protection of commercially important species in the Bering Sea.

It is important for the United States

to continue the observer program because accurate and timely information on the effects of trawling on halibut and crab stocks is needed to evaluate remedial measures for conserving the resources. In addition, the acquisition of biological data will be increasingly important in order to study the impact of the large foreign fisheries on the various species of groundfish. In view of possible extended jurisdiction which would require the United States to manage these fisheries, knowledge of stock conditions will be essential. The information gained from the observer program, added to information obtained from our own research vessels, will provide the necessary data base and knowledge for effective conservation of the resource.

ACKNOWLEDGMENTS

The U.S. program of placing scientists and technicians aboard Japanese fishing vessels was accomplished through the cooperation of the Japanese Government and the Japanese fishing companies. The United States Government gratefully acknowledges the kind acceptance of the scientists and technicians, in addition to the many courtesies extended to them by the Japanese Government and the various participating fishing companies listed in Table 2. The authors thank Y. Fukuda, Director, Far Seas Fisheries Research Laboratory, for permitting use of Japanese groundfish and crab catch data.

LITERATURE CITED

Chitwood, P. E. 1969. Japanese, Soviet, and South Korean fisheries off Alaska, development and history through 1966. U.S. Fish Wildl. Serv., Circ. 310, 34 p.

Dickinson, W. R. 1973. Japanese fishing vessels off Alaska. Mar. Fish. Rev. 35(1-2): 18.

International Pacific Halibut Commission. 1973. Int. Pac. Halibut Comm., Annu. Rep. 1973, 52 p.

Japan Fisheries Association. Fisheries of Japan 1973. Tokyo, Japan, 57 p.

Miyauchi, D., G. Kudo, and M. Patashnik. 1973. Surimi—a semi-processed wet fish protein. Mar. Fish Rev. 35(12):7-9.

Okada, M., D. Miyauchi, and G. Kudo. 1973. "Kamaboko"—the giant among Japanese processed fishery products. Mar. Fish. Rev. 35(12):1-6.

Pruter, A. T. 1973. Development and present status of bottomfish resources in the Bering Sea. J. Fish. Res. Board Can. 30:2373-2385.

Sakai, K. 1969. Japanese factory ships meet big demand for minced pollock. Fish. News Int. 8(9):15-16.

Skud, B. E. 1973. Management of the Pacific halibut fishery. J. Fish. Res. Board Can. 30: 2393-2398.

MFR Paper 1181. From Marine Fisheries Review, *Vol. 38, No. 4, April 1976. Copies of this paper, in limited numbers, are available from D825, Technical Information Division, Environmental Science Information Center, NOAA, Washington, DC 20235. Copies of* Marine Fisheries Review *are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402 for $1.10 each.*