NORTHWEST FISHERIES CENTER
PROCESSED REPORT
NOVEMBER 1974

Preliminary Results of an Industry-Government Venture on Alaska Groundfish

Chartered trawler, Anna Marie, unloading groundfish at Kodiak.

Compiled by staffs of:

Alaska Regional Office, Juneau
Northwest Regional Office, Seattle
Pacific Utilization Research Center, Seattle
Northwest Fisheries Center, Seattle

NOTICE

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INTRODUCTION

This report provides information on the results of a joint venture by industry and government to better determine the prospects for a domestic fishery for Alaska groundfish. The venture was conceived in the summer of 1973; plans and financing were formulated in the fall and winter of 1973-1974; and production fishing trials were carried out in the spring-summer of 1974. Preliminary information is provided here on the results of the fishing trials, technological characteristics of potential target species, results of processing trials and marketing surveys, and a first analysis of economic factors. Each of these subjects will be covered in more detail in reports to be furnished later; however, we believe there is need now to quickly apprise industry and government of the salient features and conclusions which have emerged from the venture to date; hence, the basis for this report.

Impetus for the venture was the realization that a series of events was affecting the opportunities for domestic utilization of Alaska groundfish, yet industry and government lacked timely information on which to base investment, management, and other decisions. Factors increasing the potential profitability of a domestic fishery for groundfish in Alaska included: (1) an increasing number of vessels from other U.S. fisheries, such as king and snow crab, which would be available to participate in a fishery for groundfish; (2) new technology of processing products such as minced fish; (3) increasing world demand for groundfish products; (4) static or decreasing supply of certain traditional groundfish species as a result of overfishing; and (5) Law of the Sea developments favoring extended jurisdiction by coastal nations. On the other hand, depletion by foreign fleets of groundfish resources off Alaska would decrease the opportunity for U.S. participation. Profitability of a U.S. fishery also would depend on such factors as the competitive position of fish versus meat and poultry in the market and the economics of the fishing operations.

After the venture was launched, two developments occurred which must be considered in evaluating the short term potential profitability of a U.S. fishery. First was a drop in the price of meat, which has reduced the price advantage fish had enjoyed when the venture was conceived. Second was the development of a petroleum shortage, which has increased fishing as well as other costs.

An important factor in deciding to launch the venture was the realization that waters off Alaska contained one of the largest groundfish resources available to U.S. industry. Foreign fishermen have taken an annual harvest of over two million

metric tons of groundfish from waters off Alaska in recent years (Table 1 and Figure 1), and an increasing part of these catches has been ending up in the U.S. market.

Table 1.--Estimated landings of groundfish, herring, and shrimp from waters off Alaska by Japan, USSR, and Republic of Korea, 1954-1972.

YEAR	JAPAN	USSR	SOUTH KOREA	TOTAL
		-- Metric Tons --		
1954	12,562	-	-	12,562
1955	14,690	-	-	14,690
1956	24,697	-	-	24,697
1957	24,145	-	-	24,145
1958	46,597	-	-	46,597
1959	160,121	62,000	-	222,121
1960	449,932	110,000	-	559,932
1961	526,970	245,000	-	771,970
1962	498,600	310,000	-	808,600
1963	324,287	260,000	-	584,287
1964	432,779	320,000	-	752,779
1965	443,386	210,000	-	653,386
1966	526,250	100,000	-	626,250
1967	852,001	265,676	005	1,117,682
1968	1,051,712	218,412	800	1,270,924
1969	1,228,644	308,381	4,000	1,541,025
1970	1,566,296	362,620	5,000	1,933,916
1971	1,837,672 1/	455,741	5,000	2,298,413
1972	1,775,697 1/	538,064	13,000	2,326,761

1/ January through October.

The foreign fisheries not only have a great impact on pollock, cod, Pacific ocean perch, sablefish, flounders, and other target species, but also impact on non-target species such as crabs and halibut. An important part of this venture, therefore, was to document the incidental catches of halibut, crab, and other species which support existing U.S. fisheries as well as to ascertain the characteristics of the principle target species.

The concept of the venture evolved from meetings held by a "Bering Sea Groundfish Committee," whose membership from industry included fishermen, vessel owners, processors, and distributors; and from government was comprised of representatives of the National Marine Fisheries Service in the Pacific Northwest and Alaska; and from the Alaska Department of Fish and Game. An essential part of the concept was

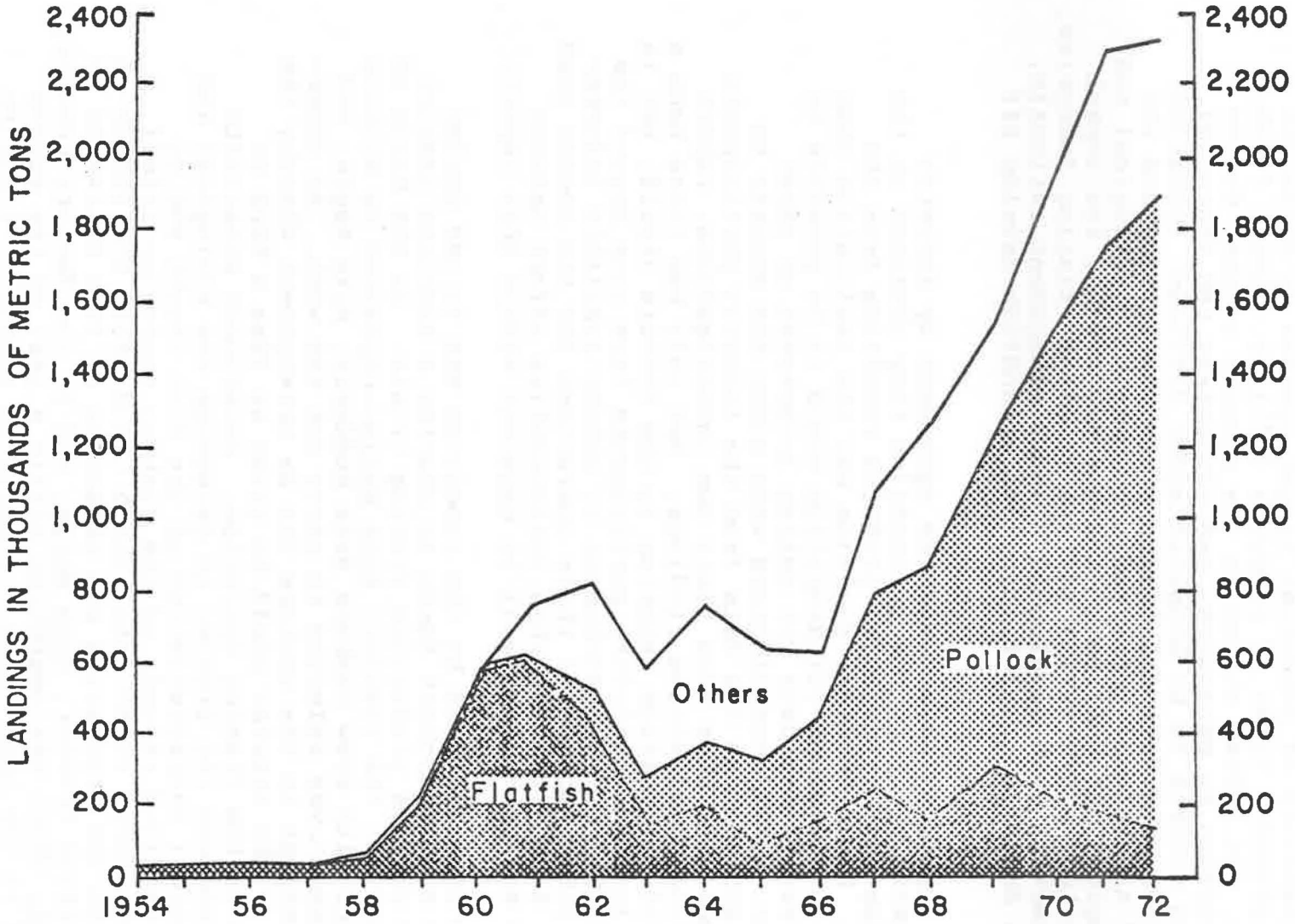

Figure 1.--Estimated landings of flatfish, pollock, and other groundfish (including herring and shrimp) from waters off Alaska by Japan, USSR, and South Korea, 1954-1972.

the pooling of industry and government funds and expertise to answer a number of specific questions. Questions for which industry needed answers largely were concerned with the availability of potential target species on different fishing grounds, types of products (fillets, minced flesh, fishmeal, etc.) best suited to the species caught, degree of infestation by parasites, and ultimately the financial costs and returns to be expected under different operating conditions. The National Marine Fisheries Service and the State of Alaska were concerned with obtaining biological and technological information on the species caught, the impact of a developing groundfish fishery on other existing fisheries, and ultimately with developing a sound management rationale, should a domestic trawl fishery for groundfish develop off Alaska.

Another important aspect was the agreement by industry participants to share the information they obtained on the processing and marketing of products resulting from the venture. Basis for this decision was the realization that only by this type of collaboration would it be possible to acquire sufficient data for making investment or other decisions. NMFS investigators were given the mandate to collect and analyze the data from the industry participants and, along with that from their own investigations, report back on their collective findings. Not only has there been a sharing of information relating to the venture itself, but in several instances industry participants have gone beyond the terms of the original agreement by making available information on other aspects of their operations for the common good of all. Some fruits of this collaborative effort between industry and government will be apparent within this report.

An early decision made by the committee was to use pooled industry and government funds to charter a highline trawler to carry out the production fishing trials. On the basis of bids received, the trawler, Anna Marie--captained by Wilhelm Jensen and with crew members Matt Hoddevik, Mike Angle, and Chris Hansen--was selected to carry out the work. An underlining precept to the venture was an arrangement whereby the captain of the trawler would be given as free a hand as possible in the fishing operation. Government scientists would accompany the trawler to determine the biological and technological characteristics of the fish caught and to compile detailed records of the fishing operation itself. Other government scientists ashore would carry out follow-up studies on the processing and marketing of fish delivered by the chartered trawler, Anna Marie, and by the factory trawler, Royal Sea, which was operating within a part of the survey assigned to the Anna Marie. Insofar as possible, industry would make available its facilities in the area of operation.

Funds expended for the operation of the chartered trawler amounted to $143,471. They were derived and expended as follows:

	Source of Funds		
Expended for:	Industry	NMFS	Totals
Charter of vessel	49,500	84,406	133,906
Trawl nets and rigging	--	2,621	2,621
Fuel	--	6,944	6,944
	49,500	93,971	143,471

The above does not include salaries, travel, and other costs associated with the venture, which, for the NMFS, are estimated to total approximately $50,000 as of November 1, 1974. Contributors from industry to the financing of this venture are listed below.

Contributors from industry:

Alaska Packers Association

Alaska Shell, Inc.

Bellingham Cold Storage

Columbia Wards Packing Company

Flohr Metal Fabricators

Ivar Wendt, Inc.

Marine Construction and Design

New England Fish Company

North Pacific Fishing Vessel Owners Association

Pan-Alaska Fisheries, Inc.

Petersburg Fisheries, Inc.

Sea-Land Services, Inc.

Vita-Food Products, Inc.

Wakefield Seafoods, Inc.

Washington Fish and Oyster Company

VESSEL AND FISHING GEAR EMPLOYED

The 86-foot trawler, Anna Marie, built in 1970, was chartered by competitive bid for the survey work. The vessel is a house-forward type, typical of west-coast trawlers, and has a diesel-propulsion engine of 650-h.p. continuous rating. Electronic fishing and navigation aids included radar, Loran A and C, automatic pilot, echosounders, and radios. Gear-handling deck equipment consisted of a hydraulically-powered split trawling winch, with 600 fathoms of 3/4-inch diameter wire and a double-net drum.

The trawling gear was selected after consultations with several highline-trawler skippers and gear manufacturers and consideration of the probable size of the vessel to be chartered. Because of the lead time required to construct and obtain the gear, it was necessary to decide on the specifications prior to knowing what vessel would be used for the survey. The gear consisted of 6x9-foot, V-type otterboards weighing about 2,000 pounds each, and trawl nets of two designs in common use in the Pacific Northwest bottom-fish fishery. One design selected was an 83-foot headrope Eastern, and the other an 88-foot Norwegian type. Specifications of these nets are given in Figures 2 and 3. The Eastern, which was fished on hard or rough bottom or where bottom conditions were questionable, was rigged with bobbins. The bobbins were assembled with 18- and 14-inch diameter bobbins in the middle of the footrope, and 10-inch diameter wheels on the wings. The bobbin line was about 10 inches shorter than the footrope. The Norwegian net was rigged with a rubber-disc footrope and fished on smooth or soft bottom.

Both trawls were constructed of lighter webbing than desired, but the short time between availability of funds, when gear could be ordered, and the initial target sailing date was inadequate to obtain web of the desired twine sizes and materials. Consequently, it was necessary to use what materials were available in stock. The light construction resulted in more gear damage than normal and a consequent increase in workload for the crew; however, this problem did not result in delay of survey activities.

SURVEY AND SAMPLING METHODS

Locations surveyed and fishing procedures were determined by Captain Jensen of the Anna Marie in consultation with the NMFS Field Party Chief aboard the vessel according to broad guidelines provided by the industry-government steering committee. Intent of the guidelines was to insure that the

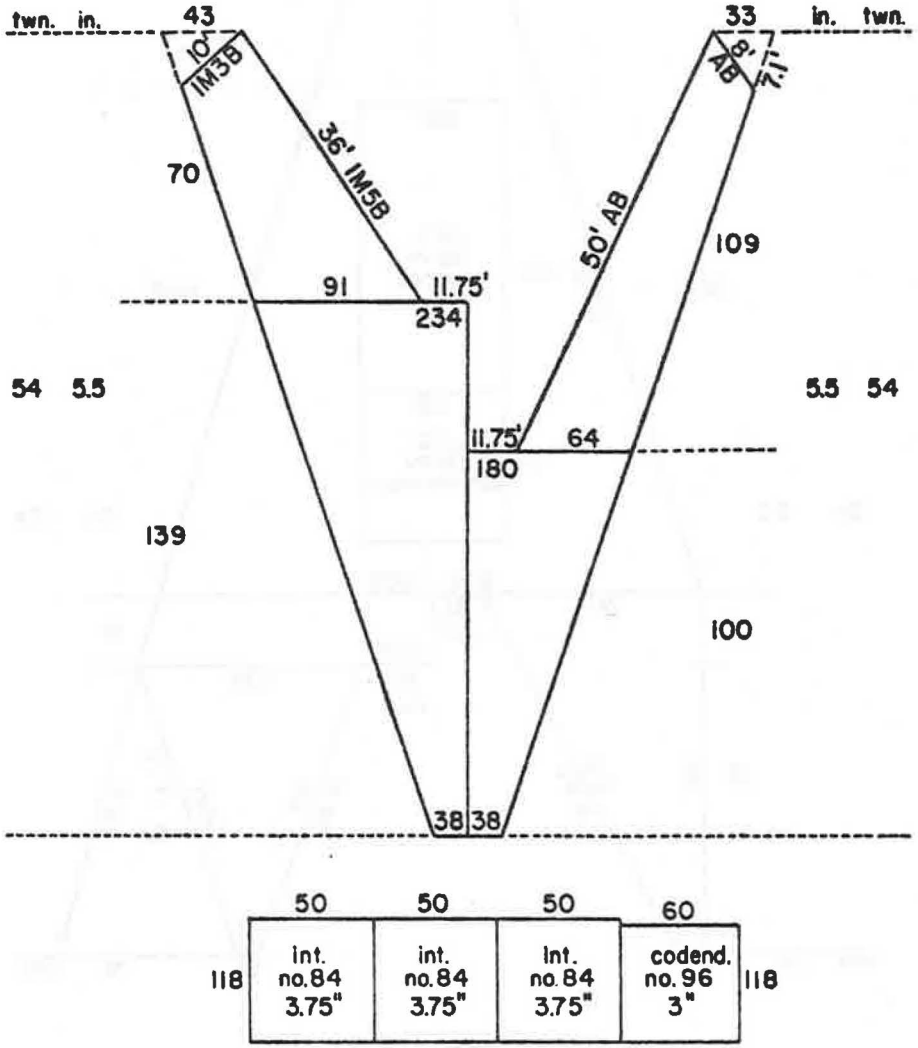

Figure 2.--MODIFIED EASTERN TRAWL NET

Netting: Dacron polyester body and wings, nylon intermediate and codend.

Headrope: 83 ft., ½-in. 6x19 galv. wire rope wrapped with 5/16-in. polypropylene rope.

Footrope: 111.8 ft., 5/8-in. dia. 6x19 galv. wire rope wrapped with 5/16-in. polypropylene rope.

Groundrope: 111 ft., 5/8-in. dia., 6x19 galv. wire rope, strung with 4-in. dia. rubber discs.

Breastlines: ½-in. dia. braided nylon, 18 ft. long.

Riblines: ½-in. dia. braided nylon, extending length of first intermediate (webbing hung-in).

Flotation: 41-8 in. and 3-10 in. aluminum floats.

Dandylines: Single - 30 fath., 3/4-in. dia., double - 15 fath., one 3/4-in., one 5/8-in.

Otterboards: 6x9 ft. Vee.

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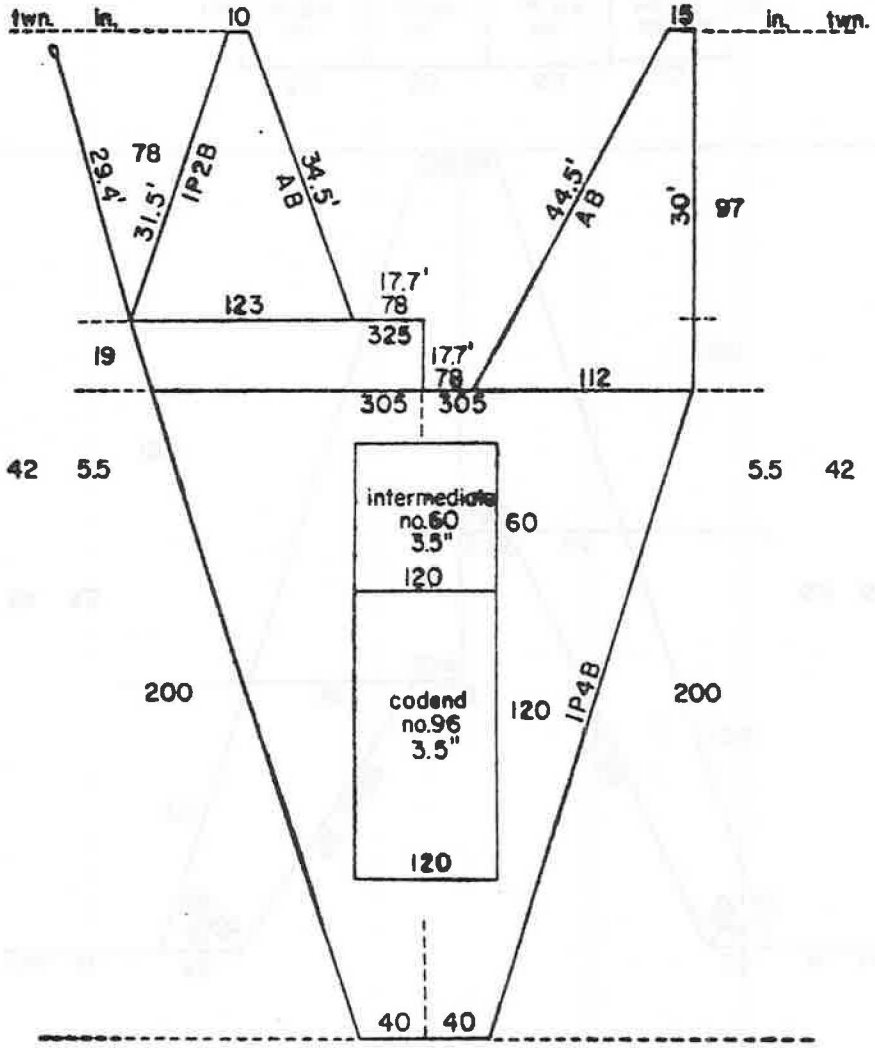


Figure 3.--NORWEGIAN TRAWL NET

Netting: Preshrunk nylon.

Headrope: 88 ft. of ½-in. dia. 6x19 galv. wire rope wrapped with 5/16-in. polypropylene rope.

Footrope: 108 ft. of ½-in. dia. 6x19 galv. wire rope wrapped with 5/16-in. dia. polypropylene rope.

Groundrope: 107 ft. of 5/8-in. dia. 6x19 galv. wire rope strung with 4-in. dia. rubber discs.

Breastlines: 3/4-in. dia. double braided polyester; top - 31.5 ft., bottom - 30 ft.

Flotation: 15, 8-in. aluminum (5.5 lbs.) and 20, 8-in. plastic (7.2 lbs.); total buoyancy - 226 lbs.

Riblines: 3/4-in. dia. double braided polyester, hung stretched.

Dandylines: Single - 30 fath., 3/4-in. dia.; triple - 15 fath., one 3/4-in., two 5/8-in.

Otterboards: 6x9 ft. Vee.

SCALE 1/200

fishing trials by the Anna Marie corresponded as closely as possible to what would be expected from a commercial operation. Accordingly, no predetermined station pattern was followed, and it was therefore possible to concentrate efforts on grounds and species which appeared to offer the highest commercial potential. However, use was made of the results of previous surveys and of knowledge concerning foreign fishing operations in narrowing down the grounds and species to be surveyed. This was aided by a careful inspection of nautical charts to pinpoint grounds of depths and bottom features known to favor the presence of potential target species. Most of the trawling was conducted along the edge of the continental shelf and in gullies or submarine canyons where the sediment on the sea floor was mud or other soft material. Large areas of uneven sea floor, where trawling would be difficult or damaging to gear, were avoided or passed over as quickly as possible.

Two kinds of survey procedures were followed. The first was of an exploratory nature where new grounds were acoustically sounded, and short-trawl hauls were made where favorable fish signs were observed. The trawl hauls were necessary to identify the showing on the echosounder and to obtain a rough idea of species occurrence and abundance. These explorations were followed, often on the same day, with commercial-type operations whereby rather extensive trawling was carried out on the most promising grounds. This procedure was viewed as being optimal in terms of covering the large survey area assigned to the Anna Marie while at the same time obtaining an estimate of the production potentials of important target species on those grounds where substantial concentrations of fish were found.

Whenever feasible, deliveries of groundfish were made to companies which had expressed an interest in obtaining samples for processing and marketing studies.

In addition to using fish for deliveries and holding samples under iced, slush ice, and refrigerated seawater conditions to determine keeping qualities, catches were processed for collection of biological data. This normally entailed the removal of a 1,500-3,000-pound sample of the total catch with a cargo net which was placed in the bottom of the fish bin. The sample was placed in a sorting table and separated by species for weighing to determine the species composition of catches. Commercially-valuable species were also measured to determine their size composition. Otoliths were collected from pollock and halibut to determine age composition for studies of year-class strength, growth, and mortality. Species were also examined for parasites in fillets. The weight of total catches was estimated by Captain Jensen.

RESULTS OF FISHING TRIALS

ANNA MARIE OPERATIONS

Fishing trials during May and June, 1974, were conducted in continental shelf and slope waters from the Shumagin Islands to Adak, along the Bering Sea side of Unalaska east to Unimak, and along the edge of the shelf and slope between Dutch Harbor and the Pribilof Islands. During late-July and early-August, operations were conducted in the Gulf of Alaska between the Semedi Islands and Montague Island. Approximately 1,400 linear miles of prospective grounds were surveyed acoustically, and trawl hauls were made when increasing fish signs were observed. A total of 131 tows were made, of which 122 were successful and the other 9 resulted in serious gear damage or snags. The total catch was 696,466 pounds, of which 91,280 pounds of groundfish were delivered to the industry; and 17,504 pounds were retained by NMFS for marketing and technological studies. Table 2 summarizes the species and quantities of fish provided to industry and retained by NMFS.

In general, good fish concentrations were located at depths of 70-120 fathoms on mud, sand, or gravel bottom; and consisted mostly of pollock and Pacific cod, with lesser amounts of Pacific ocean perch and flatfishes. Pollock, cod, and ocean perch were generally large in size and of good quality while, with few exceptions, a substantial percentage of the flatfishes caught was too small for filleting (less than 12 inches long).

For convenience in presenting results, the survey region was divided into nine major areas (Figure 4). Table 3 summarizes catch results for each of these areas. In areas where major groundfish concentrations were located, catch data is presented for the range of depths where these concentrations occurred. Thus, the catch rates and species compositions reported for these areas are more indicative of fishing potentials than if all tows, including those from non-productive depths, were included. As an example, 18 tows were completed in the southeast Akutan area at depths of 74-307 fathoms; groundfish concentrations were only encountered at depths of 74-122 fathoms. Thus, the four tows which were completed at depths beyond 122 fathoms were excluded from the analysis. Only the remaining 14 tows are included in Table 2. For areas where no substantial fish concentrations were located (the Shumagin Islands for example), all tows are included in the analysis.

Table 2.--Summary of groundfish deliveries for test processing and marketing, and fish retained by NMFS for similar studies during the joint industry-government charter.

Company	Species	Pounds Landed	Number Days Held on Vessel	Method Held on Vessel
Wakefield (Sand Point)	Cod	500	3	Iced
	Yellowfin sole	250	2	Iced
Pan-Alaska (Royal Sea)	Pollock	47,275	1	Deck
	Cod	5,975	1	Deck
Alaska Pacific (Kodiak)	Cod	7,172	1	Iced
	Perch	1,506	1	Iced
Petersburg (Seward)	Mixed	14,523	2	Iced
	Pollock	9,812	3	Iced
	Cod	1,232	3	Iced
	Rock sole	978	3	Iced
	Perch	804	3	Iced
NEFCO	Pollock	1,698	2-3	Iced
	Flathead sole	40	6	Iced
	Dover sole	45	6	Iced
	TOTAL	91,810		
NMFS Samples Frozen by Industry	Pollock	7,149	2-3	RSW,Slush Ice,Iced
	Cod	4,630	2-5	Slush Ice,Iced
	Perch	900	2	Iced
	Rock sole	1,500	2	Iced
	Yellowfin sole	200	2	Iced
	Rex sole	2,000	2	Iced
	Flathead sole	40	6	Iced
	Dover sole	45	6	Iced
	Sablefish	580	3	Iced
	TOTAL	17,044		

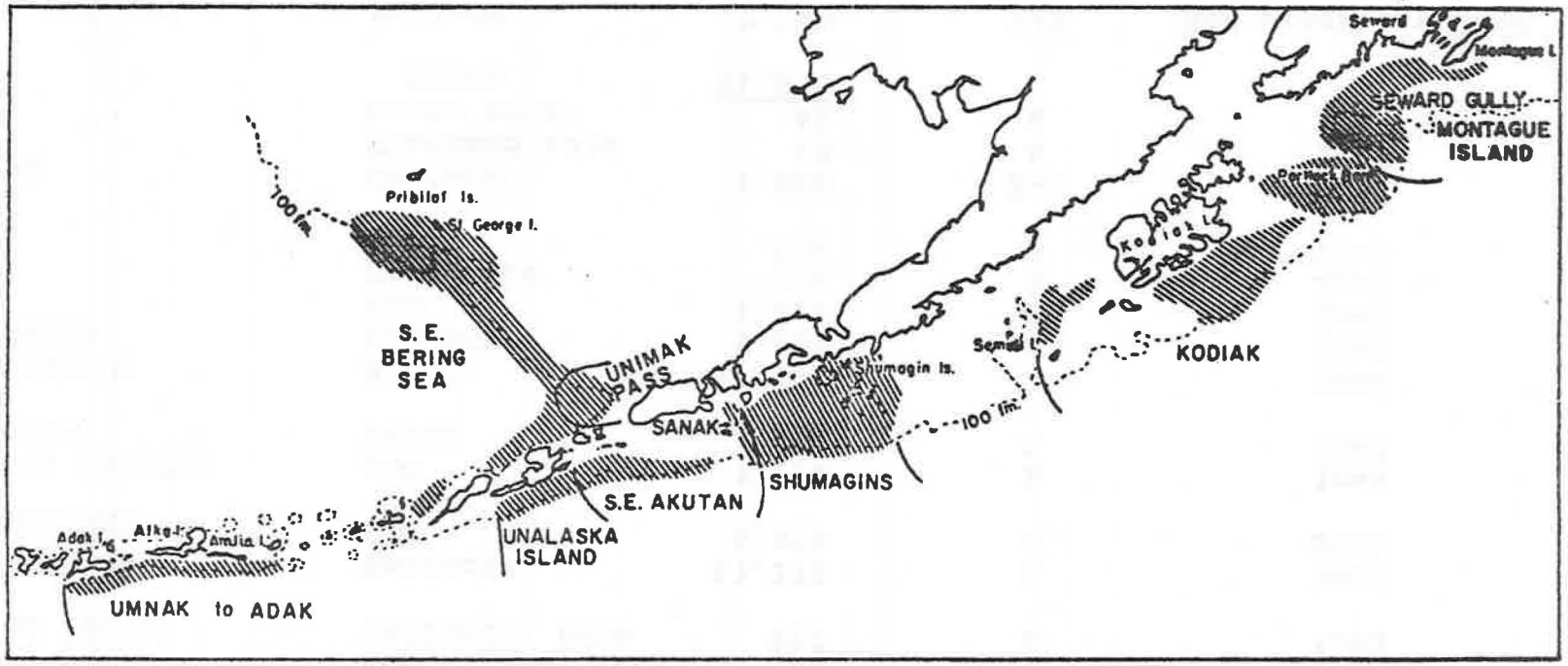


Figure 4.--Gulf of Alaska and southeast Bering Sea areas surveyed during the joint industry-government groundfish investigations, 1974.

Table 3.--Summary of catch magnitudes and species composition in areas fished during the joint industry-government charter.

Area	Depth Range (fm)	No. Tows	Total Catch (lbs)	AVERAGE POUNDS PER HOUR TRAWLED						
				All Species	Pollock	Cod	Perch	Rex Sole	Rock Sole	Flathead Sole
Shumagins 1/	44-209	13	31,183	2,309	83	505	--	--	--	50
Sanak 2/	79-89	6	37,605	4,531	368	4,000	--	--	--	--
S.E. Akutan 2/	74-122	14	174,349	7,758	5,721	847	--	512	--	--
S. Unalaska 2/	67-113	11	62,377	4,455	2,402	819	412	21	548	--
Umnak to Adak 1/	110-150	6	15,570	2,511	576	185	1,439	--	--	--
Unimak Bight 2/	72-132	10	95,938	6,853	4,428	349	--	--	--	--
S.E. Bering Sea 1/	44-254	20	47,485	2,129	1,256	312	--	--	--	--
Kodiak 2/	54-95	14	131,025	7,893	4,622	881	130	--	245	717
Seward Gully to Montague 1/	57-98	10	25,075	2,985	1,780	54	--	--	--	757
		104	620,607	4,609	2,360	883	220	63	88	169

1/ No commercial concentrations of groundfish were located in this area and data presented is based on all tows successfully completed.

2/ Commercial concentrations of groundfish were located in this area within the indicated depth range and data presented is based on all tows successfully completed within that range only.

Shumagins

Grounds around the Shumagin Islands between 157 degrees to 162 degrees W. longitude were surveyed between May 7-12, 1974. Although considerable searching effort was expended in this area at depths of 40-250 fathoms, no substantial groundfish concentrations were located. The sea floor around the Shumagins was generally hard, and numerous large areas of non-trawlable grounds were encountered. Eighteen tows were attempted, and 13 were successfully completed. The average total catch per hour for these successful tows was 2,310 pounds. The species composition was generally of a highly-mixed nature. Snow (Tanner) crab and flatfishes less than 12 inches in length (rock, yellowfin, and flathead sole) dominated catches at depths less than 100 fathoms while turbot, small Dover sole, and rattails dominated catches at greater depths. Catches of Pacific cod in the Shumagins rarely exceeded 500 pounds per hour, and pollock were less abundant.

The largest single catch in the Shumagin area was 12,000 pounds in a one-hour tow made at a depth of 208 fathoms. Turbot accounted for most of the catch (56 percent by weight), followed by rattails (20 percent), halibut (7 percent), Dover sole (5 percent), and spinycheeked or "idiot" rockfish (5 percent).

Sanak

Rocky and very irregular bottom persisted westerly from the Shumagins to about 164 degrees W. longitude at depths of 100-160 fathoms. Between May 11-16, fishing was conducted on Sanak Bank, in the gut between the north side of Sanak and Sandman Reefs, and around Marzhovoi Bay. Explorations were not made on Davidson Bank or at depths greater than 160 fathoms south of Sanak.

Four tows completed on Sanak Bank and near Canton Island produced catches of less than 1,000 pounds which mainly consisted of cod, small flatfishes, and sculpins. Similar catches were obtained in two tows made outside Morzhovoi Bay, and one tow inside the bay resulted in a net-full of mud and kelp. Flatfishes, primarily yellowfin sole, were 75 percent undersized for filleting (less than 12 inches long). Immediately outside the bay, in 65 fathoms, 261 pounds of snow crab (average weight--2.4 pounds per crab) were taken in a one-hour tow.

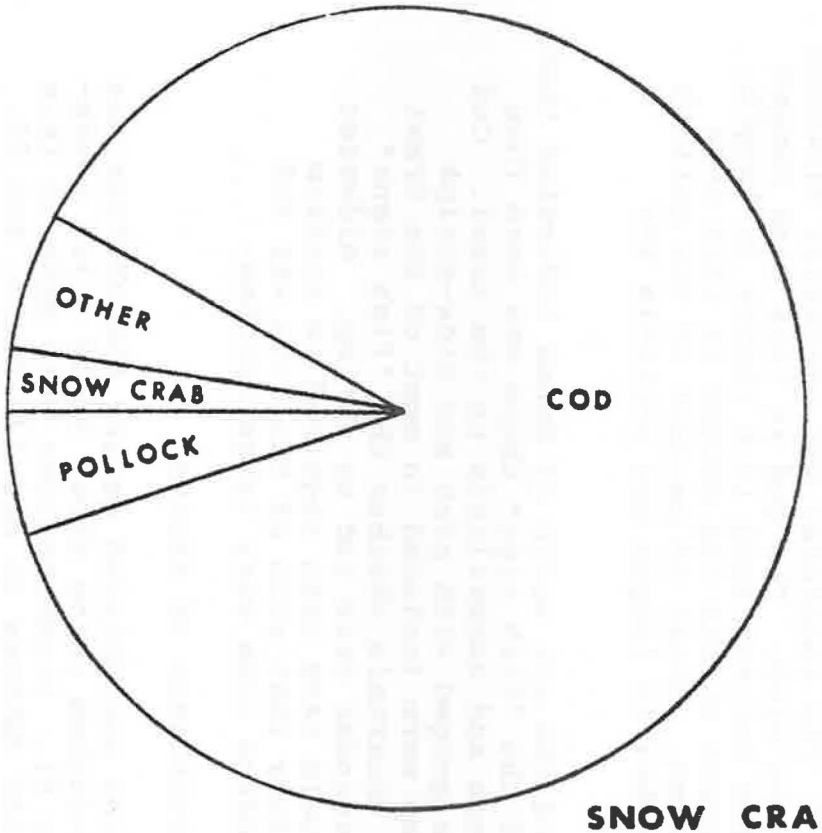
Six tows (8.3 hours of fishing) completed in the gut north of Sanak produced 37,605 pounds of groundfish including 32,000 pounds of cod (Figure 5). The average catch per hour was 4,531 pounds and was dominated by cod (87 percent) followed

Depths 79 - 89 fm.

Total catch 37,605 lbs.

Hours trawled 8.3

Avg. catch / hr. 4,531 lbs.



COD
4,000 lbs / hr.
19.6 inches
99 % marketable

POLLOCK
368 lbs / hr.
16.9 inches
80 % marketable

SNOW CRAB
111 lbs / hr.

KING CRAB
53 lbs / hr.

HALIBUT
16 lbs / hr.
15.7 inches

Figure 5.--Total catch, catch rates, and species composition from depths where commercial concentrations of groundfish were located in the shaded area near Sanak Island, May 1974. Sizes of fish indicate the average length and percentage of marketable fish by weight.

by pollock (5 percent). The remainder was primarily flathead sole, rock sole, and snow crab. The cod in this area ranged from 11.5 to 29.1 inches and averaged 19.6 inches in length. By weight, over 99 percent of the cod caught in this area were of a marketable size. About 80 percent of the pollock were larger than 12 inches in length and suitable for filleting.

Acoustical soundings of the gut north of Sanak indicated that at least 90 percent of the "fish sign" there was more than three fathoms off bottom and unavailable to the trawl. Cod taken in the area were gorged with pink and side-stripe shrimp; and some shrimp were included in most of the trawl catches. Thus, it is uncertain whether the "fish signs" observed on the echo sounder were cod or shrimp. Midwater trawling capability would have been required to confirm Captain Jensen's feelings that much of the sign was cod and would probably produce some very large catches.

Southeast of Akutan

The most productive area encountered during the charter was located along the 100-fathom curve about 30-50 miles southeast of Akutan (Figure 6). Eighteen tows were made in this area at depths of 74-307 fathoms on May 17-19, 21, and 25. Good concentrations of pollock, rex sole, and cod were found at depths of 74-122 fathoms while catches from deeper water were small and consisted primarily of turbot at depths less than 200 fathoms; and rattails and turbot at depths greater than 200 fathoms. Ten tows were completed at depths of 74-122 fathoms on May 17-19, and 21, producing 142,980 pounds of groundfish.

Catches ranged from a low of 4,500 pounds in 1.5 hours to a high of 20,000 pounds in 1.0 hour. The average catch per hour of trawling for these ten tows was 9,596 pounds. Weight of catches was 80-percent pollock, 7-percent rex sole, 5-percent cod, and 8-percent other species. Pollock, rex sole, and cod were large; and 95-100 percent marketable. Pollock ranged from 10.6-24.4 inches and averaged 20.4 inches in length. The rex sole were extremely large, ranging from 11.4-19.6 inches and averaging 15.0 inches in length. Some ocean perch were also taken in this area; however, they were rather small, ranging from 9.8-16.1 inches and averaging 13.3 inches in length.

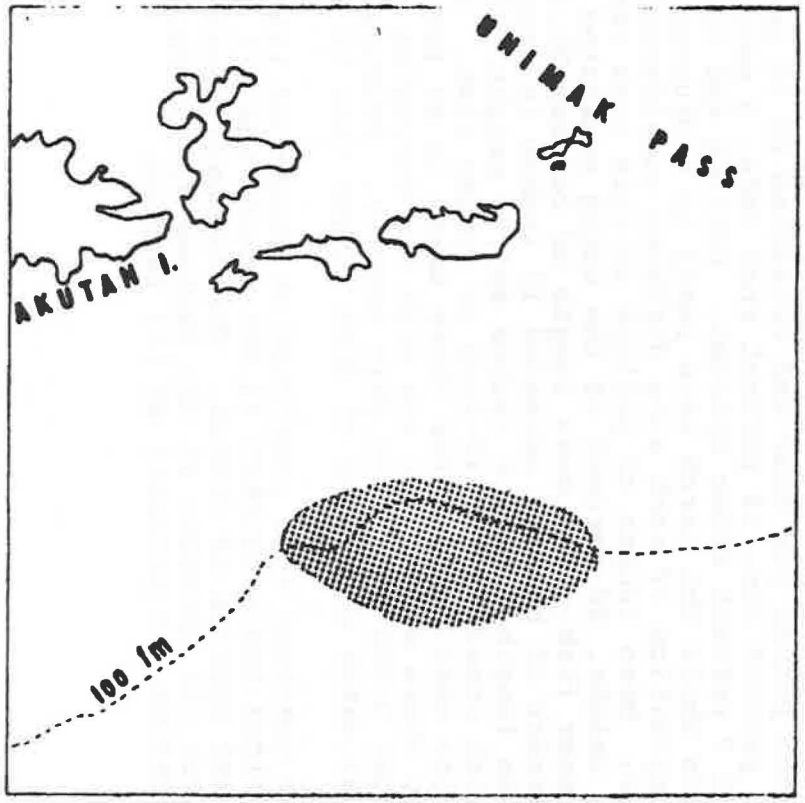
The species composition of individual catches showed some variation within the depth range of 74-120 fathoms. Catches consisted of nearly-equal amounts of pollock and cod at 74-90 fathoms, and up to 95-percent pollock at depths over 100 fathoms. Fish concentrations in this area were typically on-bottom during the daylight hours, dispersing upward from

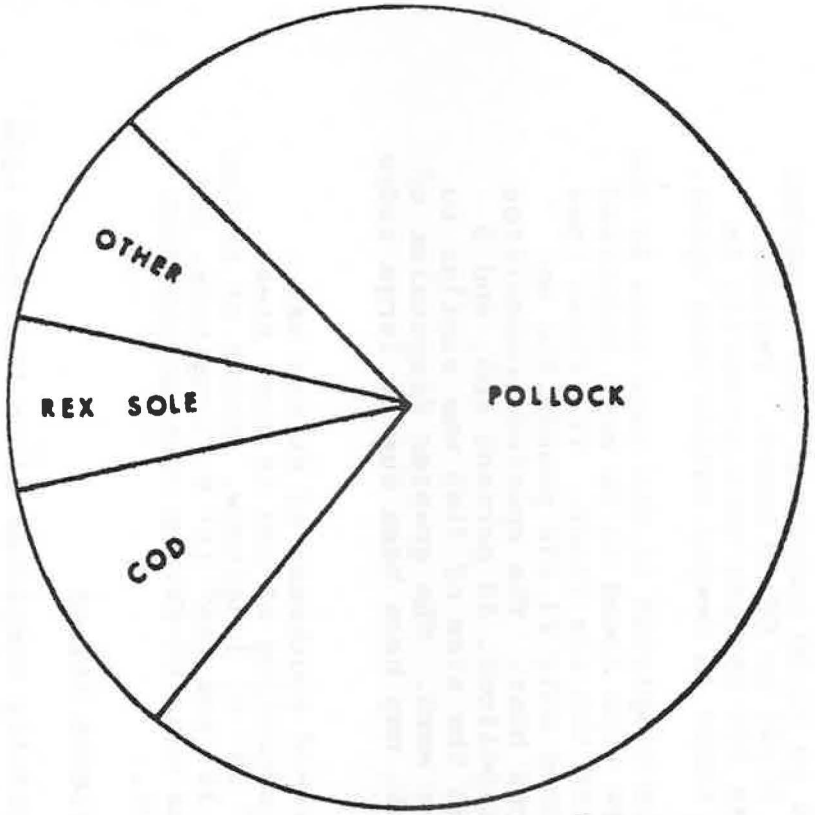
Depths 74-129 fm.

Total catch 174,349

Hours trawled 21.4

Avg. catch/hr. 7,758





POLLOCK
5,721 lbs/hr.
20.4 inches
98% marketable

COD
841 lbs/hr.
22.0 inches
99% marketable

SNOW CRAB
0 lbs/hr.

KING CRAB
0 lbs/hr.

REX SOLE
512 lbs/hr.
15.0 inches
95% marketable

HALIBUT
95 lbs/hr.
20.5 inches

Figure 6.--Total catch, catch rates, and species composition from depths where commercial concentrations of groundfish were located in the shaded area southeast of Akutan Island, May 1974. Sizes of fish indicate the average length and percentage of marketable fish by weight.

the sea floor about 20:00 to 21:00 hours and then reconcentrating on the bottom at 07:00 to 08:00 hours. Pollock caught at depths less than 100 fathoms were primarily in spawning condition while those in deeper waters were spent.

On May 25, three tows were completed in the same area as the above ten tows. Fish were then found to be more dispersed and loosely associated with the sea floor. The three tows (6.5 hours fishing) produced only 23,330 pounds, for an average of 3,573 pounds per hour. The species composition had changed to 38 percent pollock, 40 percent cod, and 5 percent rex sole, although the size of fish was similar to that found in the previous week. The greater dispersion of fish, particularly pollock, may have been due to large tides occurring at that time.

The sea floor in areas fished southeast of Akutan was excellent for trawling, consisting of mud in most areas between 164° 58' and 165° 36' W. longitude. South of Akutan in the area between 165° 36' and 166° 15' W. longitude, the sea floor became hard near the 100-fathom contour, and fish concentrations were absent.

Unalaska Island

Thirteen tows were successfully completed along the south side of Unalaska, primarily in waters from Usof Bay to the western end of the island (Figure 7). Fishing depths ranged from 67-171 fathoms. A total of 64,374 pounds was caught in 16.0 hours of trawling, for an average catch of 4,023 pounds per hour. Fish concentrations in this area were located between 67 and 113 fathoms. At these depths, catch rates averaged 4,455 pounds per hour and consisted of 54 percent pollock, 18 percent cod, 12 percent rock sole, 9 percent ocean perch, and 7 percent other species. Pollock and cod were large in size while the perch were small to medium-sized. The size composition of rock sole differed considerably from tow to tow. Mean length of pollock in this area was 17.7 inches and, by weight, 98 percent of the catch consisted of 12-inch or longer fish. The mean length of cod was 21.6 inches, and 100 percent of the cod exceeded 12 inches in length. Ocean perch mean length was 13.6 inches and, by weight, 72 percent of the catch consisted of 12-inch or longer fish. Rock sole were quite small except for those taken in 67 fathoms SSE of Usof Bay where a one-hour tow with the Norwegian trawl produced about 5,000 pounds of this species. Seventy-two percent of that catch consisted of fish longer than 12 inches.

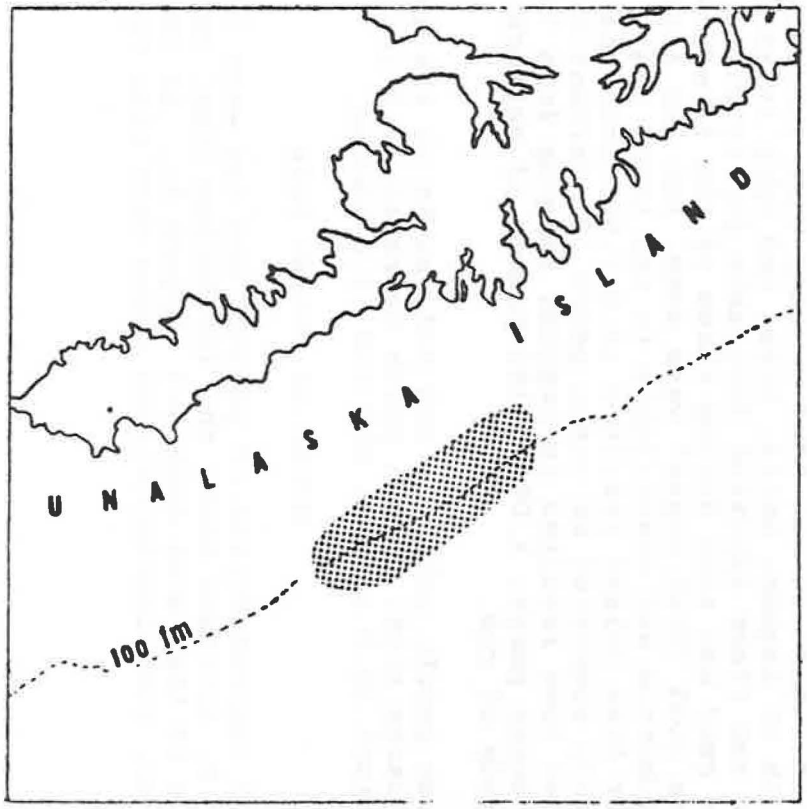
Two one-hour tows completed at depths of 125 and 171 fathoms yielded small catches (1,386 pounds and 611 pounds) of highly-mixed species of fishes. The dominant species was ocean perch (22 percent) at 125 fathoms and spinycheeked or "idiot" rockfish (47 percent) at 171 fathoms.

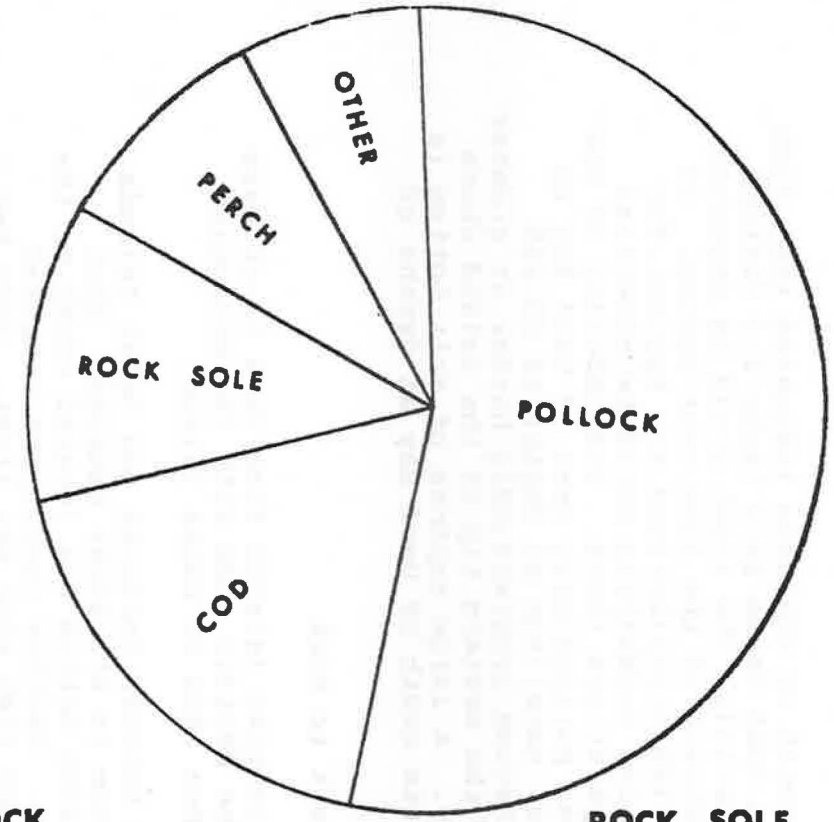
Depths 67-113 fm.

Total catch 62,377 lbs.

Hours trawled 14.0

Avg. catch / hr. 4,455 lbs.





POLLOCK
2,402 lbs/hr.
17.7 inches
98% marketable

COD
819 lbs/hr.
21.6 inches
100% marketable

SNOW CRAB
0 lbs/hr.

KING CRAB
0 lbs/hr.

ROCK SOLE
548 lbs/hr.
13.3 inches
61% marketable

PERCH
412 lbs/hr.
13.6 inches
72% marketable

HALIBUT
117 lbs/hr.
16.5 inches

Figure 7.--Total catch, catch rates, and species composition from depths where commercial concentrations of groundfish were located in the shaded area south of Unalaska Island, May 1974. Sizes of fish indicate the average length and percentage of marketable fish by weight.

Echo soundings in areas south of Unalaska indicated that fish concentrations were often most dense in a layer 2-5 fathoms above the sea floor. Generally, the trawl could be expected to encounter only 5-20 percent of the fish near-bottom. If the observed off-bottom fish distributions are typical for this area, midwater trawling capability would be essential for successful fishing operations there. Trawlability of the grounds south of Unalaska, particularly west of Usof Bay to 167° 00' W. longitude, was excellent at depths of 80-210 fathoms. The sea floor became progressively harder at greater depths and in areas near the western tip of the island where the shelf narrows rapidly. A large expanse of soft bottom is also available on the flats south of Usof Bay at depths of 60-70 fathoms.

Umnak to Adak

Explorations along the Aleutian Islands from June 12-18 were conducted primarily on the Pacific side with the exception of waters on the Bering Sea side of Umnak Island.

No fishing was attempted between Unalaska and Umnak Islands due to non-trawlable bottom in all areas sounded. What appeared to be good trawling bottom was located south of the Islands of Four Mountains. Weather conditions hampered operations in this area, and fish sign was light. Only two tows were attempted--one tow hung up and the second produced 1,000 pounds of pollock, 896 pounds of cod, and 1,548 pounds of other species.

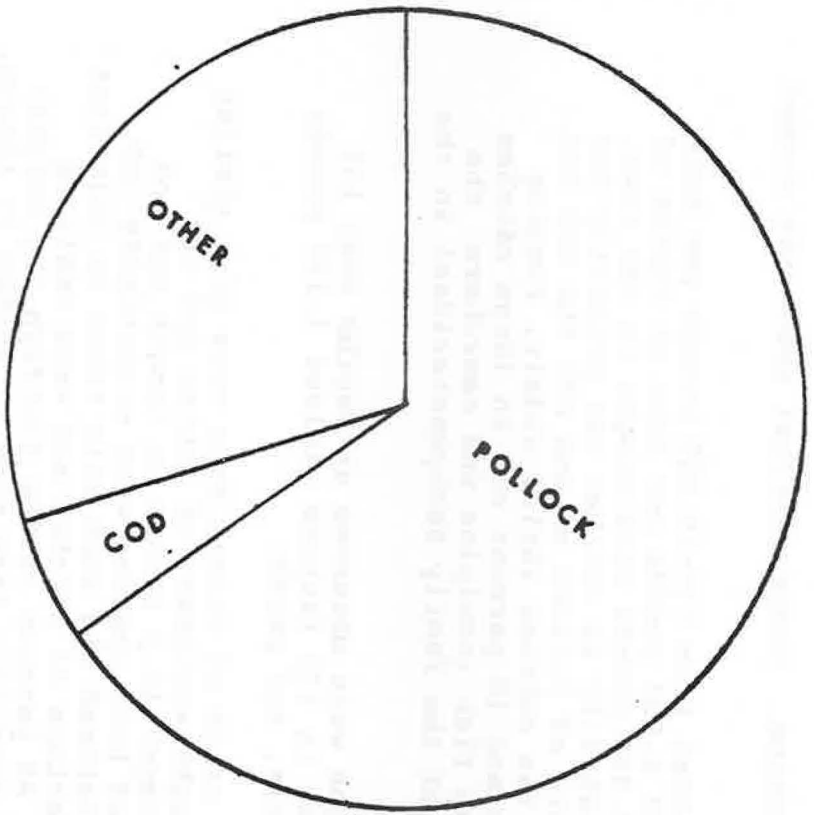
"Fish signs" on the echo sounder were generally poor in areas south of Seguam, Amlia, Atka, and Adak Islands. Although the sea floor appeared favorable for trawling in many areas, the gear was torn during three of the five tows attempted. Some good "fish signs" were seen, but the fish were usually off-bottom and unavailable to the trawl gear. An hour tow near Atka Island resulted in a 7,500-pound catch which mainly consisted of ocean perch (81 percent by weight). Other tows resulted in catches ranging from 787-4,000 pounds of ocean perch, 1,043-1,146 pounds of pollock, and 107-324 pounds of cod.

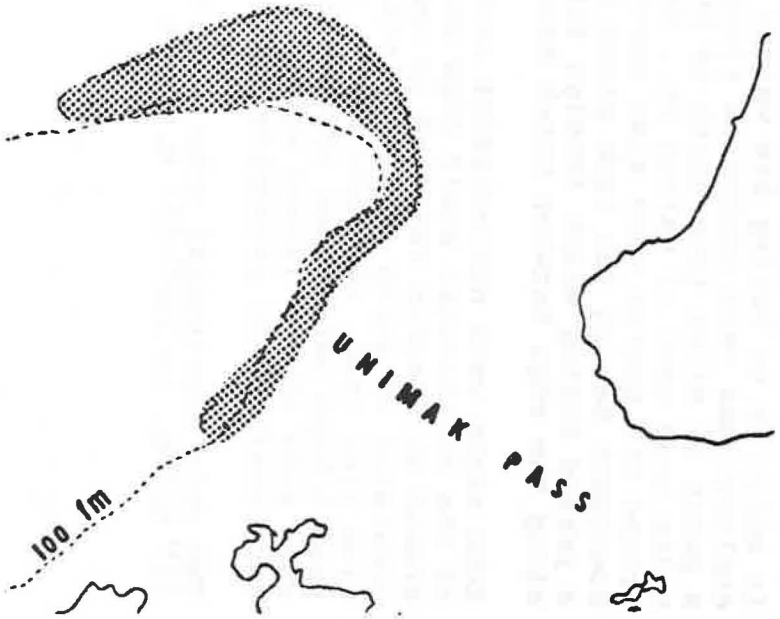
Ocean perch, pollock, and cod caught in the above areas were of large size. Ocean perch averaged 14.0 inches in length, pollock 18.0 inches, and cod 19.0 inches.

North of Unimak Pass

Good concentrations of pollock and cod were located about 54° 30' N. latitude along the 100-fathom line, and 11 tows were made in that area June 7-9 (Figure 8). In common with other areas, fish concentrations there were also typically most

Depths	72-132 fm.
Total catch	95,938 lbs.
Hours trawled	14.0
Avg. catch/hr	6,938 lbs.





POLLOCK
4,428 lbs/hr
18.0 inches
99% marketable

COD
349 lbs/hr
21.0 inches
99 % marketable

SNOW CRAB
93 lbs/hr

KING CRAB
8 lbs/hr

HALIBUT
10 lbs/hr
18.0 inches

Figure 8.--Total catch, catch rates, and species composition from depths where commercial concentrations of groundfish were located in the shaded area north of Unimak Pass, June 1974. Sizes of fish indicate the average length and percentage of marketable fish by weight.

dense 2-5 fathoms off-bottom. Their vertical movements seemed unpredictable.

Catches in this area ranged from 875-18,000 pounds per hour of trawling and averaged 6,853 pounds per hour at depths of 72-132 fathoms where 95,938 pounds were caught in ten tows. The high degree of variability in catches was primarily due to the frequent movements of pollock on and off the sea bed. Species composition of the catches varied widely, ranging from 75 percent pollock and 10 percent cod in large catches to over 80 percent scrap fish (sculpins and searchers, the latter being a ronquil of the family Bathymasteridae) in the smaller tows.

No substantial fish signs were observed at depths over 132 fathoms. A one-hour tow in 178 fathoms yielded 1,192 pounds of Greenland turbot, sole, and perch.

Pollock and cod caught north of Unimak Pass were of a similar large size to those caught southeast of Akutan and off Unalaska. Pollock averaged 18.0 inches in length and cod 21.0 inches. Catches of both species were essentially 100 percent marketable. Flathead and rock sole taken in this area comprised a small percentage of catches and were small in size. On the average, 60 percent of the flatfish (by weight) were comprised of fish measuring less than 12 inches in length.

No snags were encountered in the area north of Unimak Pass. The sea floor was soft and ideal for trawling.

Southeast Bering Sea

In addition to Bering Sea waters immediately west of Sarachef, explorations were conducted along the edge of the shelf from a point 60 miles true north of Dutch Harbor to a point 91 miles true west of Dalnoi Pt., St. George Island. Waters around St. George were also surveyed. Operations in the southeast Bering Sea took place between May 30 and June 4, a period during which foreign fishing would normally be heavy along the edge between Dutch Harbor and the Pribilofs.

Echo signs were non-existent around St. George and along most of the continental shelf edge surveyed. Four tows completed around St. George resulted in small catches which primarily consisted of scrap fish (sculpins and very small flatfishes), blue king crab, and snow crab. It was interesting to note that a high percentage of the blue king crab were soft on the east side of the island while those on the north side were hard-shelled and primarily skip-molts.

The only substantial echo sign on the edge was located at 55° 42' N. to 168° 45' W. where a Korean fleet of 16 pair

trawlers and the mothership, Yu Sin, was working. Four tows were completed among the pair trawlers. Catches ranged from 1,000 pounds to 14,000 pounds in two hour tows. The modified Eastern trawl was employed for the first tow and produced a catch of 5,000 pounds in an hour. The fish sign was excellent during this tow, indicating that the catch should probably have been in the order of 15,000-20,000 pounds. However, in examining the catch, it was noted that about 10 percent of the pollock were less than 10 inches in length, leading us to believe that much of the observed sign was small pollock which readily passed through the meshes of the trawl. This supposition was further substantiated by observing catches of the Korean vessels which were using trawl constructed of 2-3/4-inch mesh. To better evaluate the size composition of pollock supporting the Korean fishery, a shrimp net of 1½-inch mesh was fished for the next three tows. By number, 30-60 percent of the fish taken by the shrimp trawl were juveniles less than 12 inches in length, and substantial numbers of 4-6-inch pollock were included.

Cod was the only other species captured in notable amounts in this area with catches ranging from 5-45-percent cod. While the size composition of cod was comparable with Pacific areas (average length 21.4 inches), pollock were much smaller, averaging 13.7 inches long.

The Japanese and Soviet pollock fleets were not encountered while the Anna Marie was operating in the southeastern Bering Sea. Three Soviet side-trawlers were observed fishing near the edge in 200-250 fathoms. Tows beside these vessels and other tows at similar depths yielded catches of 1,000-2,000 pounds per hour consisting primarily of large, red rockfish ("buoy kegs"), Greenland turbot, and blackcod.

A one-hour tow was also made in Unalaska, Akutan, and Makushin Bays. The catch in Unalaska Bay was 2,166 pounds and mainly consisted of juvenile pollock, halibut, snow crab, and juvenile sole. In Akutan Bay, the catch from the one-hour tow was 12,000 pounds, and 98 percent by weight was king crab. Females out-numbered males 3:1. The Makushin Bay tow produced 724 pounds of assorted species including 27 pounds of large sidestripe shrimp. Considering the large mesh size of the trawl being used, this was a good showing of shrimp.

The need for midwater trawling capability in the southeastern Bering Sea was also very apparent. Fish concentrations were commonly 3-5 fathoms off bottom. The 14,000-pound catch was obtained primarily during a one-hour period when the fish concentrations moved down to the sea floor.

Trawling conditions in the portion of the southeastern Bering Sea surveyed from the Anna Marie were excellent, with the sea floor being soft and usually level.

Kodiak Island

Survey effort in the Kodiak area was limited to the 5-day period from July 30 to August 3. This only allowed a quick look in the gullies along the southeast side of Kodiak, Shelikof Gully between Alatak and the Semedi Islands, and along the east side of Afognak Island.

A total of 14 tows was completed in these areas at depths of 54-95 fathoms, and one tow was made in 200 fathoms off southeast Kodiak (Figure 9). The total catch at depths of 54-95 fathoms was 131,025 pounds in 16.6 hours of trawling for an average catch rate of 7,893 pounds per hour. By weight, catches were comprised of 59-percent pollock, 11-percent cod, 9-percent flathead sole, 7-percent turbot, and 14-percent other species including king and snow crab. The catch of 200 fathoms in 1.5 hours of trawling was 5,000 pounds and primarily consisted of turbot (58 percent), Dover sole (16 percent), and rex sole (10 percent).

Contrary to summer periods of 1972 and 1973, when good echo signs of fish were observed from NOAA vessel, John N. Cobb, near-bottom in Chiniak, Barnabus, and Two-Headed Gullies, the signs observed from the Anna Marie in the gullies were generally poor. While individual catches of 13,000 pounds in hour tows were achieved, echo signs were scattered. A large concentration of pollock and cod was found in Shelikof Gully in an area 40 miles west of Alatak and about 30 miles east of the Semedi Islands. Fishing in this area was conducted at depths of 68-95 fathoms, and catches which ranged from 5,000-13,000 pounds per hour of trawling were 80-90-percent pollock and cod.

One large school of pollock was encountered on the west corner of Portlock Bank in 54 fathoms. A one-hour tow there yielded 30-35,000 pounds which was the largest single catch of the charter. The pollock were not large fish, about 80 percent of them being from 12-14 inches in length. This catch also included 3,000 pounds of rock sole which were large in size compared to those caught in most other areas surveyed. Although the rock sole were not measured, it was estimated that 80 percent of them were 12 inches or longer in size.

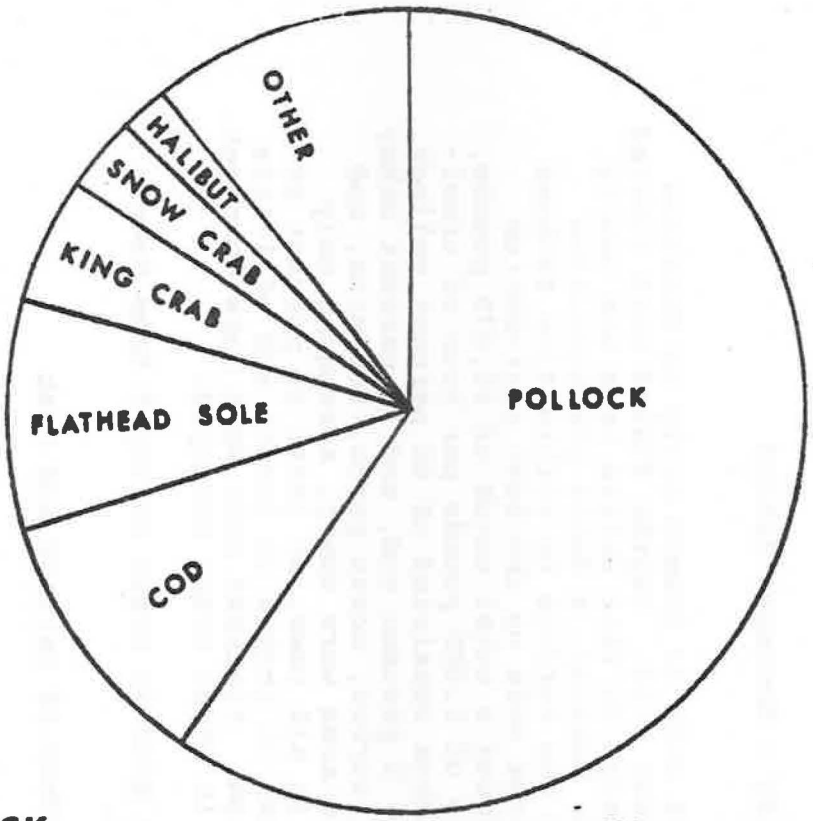
Pollock caught in the Kodiak area averaged 16.5 inches in length, being slightly smaller than those taken in Pacific waters west of the Shumagins. Ninety-one percent of the pollock were 12 inches or longer. Cod caught around Kodiak were comparable in size to those from other Pacific waters west of the Shumagins. Average length of the cod was 20.5 inches, with 99 percent of them being 12 inches or longer.

Depths 54-95 fm

Total catch 131,025 lbs.

Hours trawled 16.6

Avg. catch / hr. 7,893



POLLOCK
4,622 lbs / hr.
16.5 inches
91 % marketable

COD
881 lbs / hr.
20.5 inches
99 % marketable

FLATHEAD SOLE
757 lbs / hr.
11.2 inches
51 % marketable

KING CRAB
389 lbs / hr

SNOW CRAB
230 lbs / hr.

HALIBUT
138 lbs / hr.
47.0 inches

Figure 9.--Total catch, catch rates, and species composition from depths where commercial concentrations of groundfish were located in the shaded area near Kodiak Island, July-August 1974. Sizes of fish indicate the average length and percentage of marketable fish by weight.

Seward Gully - Montague Island

The grounds from the west side of Seward Gully to Montague Island were surveyed August 6-10. Depths fished were limited to 57-98 fathoms. Echo sign in this entire area was nearly non-existent near bottom; however, a dense plankton-like sign often extended from the surface to within five fathoms of the sea floor. Ten tows made on the best near-bottom showing in the area produced a total catch of 25,075 pounds, for an average catch rate of 2,985 pounds per hour of trawling. By weight, the catches consisted of 60 percent pollock, 25 percent flathead sole, 2 percent cod, and 17 percent other species (primarily small turbot, ocean perch, sculpins, and skates). Pollock in this area were small, averaging only 13.5 inches in length. In all tows, at least 50 percent of the pollock were less than 12 inches in length and of little value except for reduction. Flathead sole were more abundant and larger in size than in other areas surveyed.

Trawling conditions were good in areas surveyed from Seward Gully to Montague Island.

Incidental Catches of Halibut and Crab

Because halibut and crab are susceptible to conventional trawl gear, an important phase of this study was to gain insight into what effect a domestic groundfish fishery in Alaska might have on the halibut and crab resources. Thus, special efforts were made to determine the number, weight, and size of halibut, king crab, and snow crab encountered. In several areas where halibut or crab were particularly plentiful, tows were made with both the Norwegian trawl and Eastern trawl (bobbin net) to determine what effect the use of bobbins might have on catch rates of halibut and crab.

In analyzing the catch data, halibut and crab incidence was determined for each of the areas previously discussed. Within these areas, information was compiled to determine halibut and crab catches from depth zones where production fishing was carried out. Thus, the data on incidental catches of halibut and crab is more representative of a commercial fishing operation than a survey of all depths including those which would not support a fishery. In areas where no substantial groundfish concentrations were located (Shumagin, southeast Bering Sea, and Seward Gully-Montague Island), data from all successful hauls were included in the analysis.

Table 4 summarizes halibut, king crab, and snow crab catches by fishing areas. For each area, the total catch from the indicated depth range is presented along with numbers and pounds of halibut and crab caught, and their catch weights are expressed as percentages of the total catch. Several important features are apparent in this data. Halibut were caught

Table 4.--Incidence of halibut, king crab and Snow (Tanner) crab in catches taken during the joint industry-government charter.

Area	Depth Range (fm)	No. Tows	Total Catch (lbs)	HALIBUT			KING CRAB			SNOW CRAB		
				No. Caught	Pounds Caught	%Total Catch	No. Caught	Pounds Caught	%Total Catch	No. Caught	Pounds Caught	%Total Catch
Shumagins	44-209	13	31,183	285	1,201	3.8	151	645	2.0	3,909	4,677	15.0
Sanak	79-89	6	37,605	94	134	0.4	56	439	1.2	600	922	2.4
S.E. Akutan	74-122	14	174,349	781	2,047	1.2	0	0	0	0	0	0
S. Unalaska	67-113	11	62,377	393	1,634	2.6	0	0	0	0	0	0
Umnak to Adak	110-150	6	15,570	38	196	1.3	---	83	0.5	0	0	0
N. of Unimak Pass	72-132	10	95,938	29	143	0.1	32	109	0.1	1,973	1,301	1.3
S.E. Bering Sea	44-254	20	47,485	105	516	0.8	---	2,881	4.8	---	2,571	4.3
Kodiak	54-95	14	131,025	49	2,284	1.7	---	6,456	4.9	---	3,823	2.9
Seward Gully-Montague	57-98	10	25,075	23	395	1.6	0	0	0	---	300	1.2

in all areas fished and by weight comprised from 0.1 percent of the total catch north of Unimak Pass to 3.8 percent in the Shumagin area. Because of their small size, substantial numbers of halibut were involved in these catches. In areas west of Kodiak, the average weight per halibut caught ranged from 1.4 pounds per fish near Sanak to 5.1 pounds per fish in the Umnak-Adak area. This was in sharp contrast to the Kodiak and Seward Gully-Montague Island areas where halibut averaged 49.0 and 17.0 pounds per fish respectively.

Both king and snow crab were caught in six of the nine areas fished. By weight, king crab comprised from zero percent of the total catches in the southeast Akutan, south Unalaska, and Seward Gully-Montague areas to 4.9 percent of the total catch in the Kodiak area. Snow crab comprised from zero percent of the total catches in the southeast Akutan, south Unalaska, and Umnak-Adak areas to 15 percent in the Shumagin Island area. King crab appeared more localized than snow crab which were spread over a greater range of depths and occurred in a higher percentage of the tows.

Observations on halibut and crab viability were made through, out the charter. When captured during one-hour tows,and catches were prepared for icing immediately after capture, it was estimated that 80 percent of the halibut weighing less than 10 pounds were alive and swam vigorously when returned to the sea. Virtually all halibut larger than 10 pounds were alive and also appeared to be capable of returning to the bottom when quickly returned to the sea. During two-hour tows, the percentage of viable halibut weighing less than 10 pounds decreased to 25-30 percent, and 50-70 percent for larger fish. Obviously, the percentage of dead halibut will increase substantially if catches are not attended to rapidly or if catches are extremely large and require a lengthy sorting process, such as is often the case with foreign fishing operations.

Crab viability was extremely variable due primarily to shell condition and size of catches rather than length of tow or size of crab. Thus, any generalizations as to their viability could be misleading. Only a small percentage of soft-shell king and snow crabs appeared to be capable of surviving even when quickly returned to the sea, particularly when catches were large. On the other hand, survival appeared to be good among hard-shell snow and male king crab. Female egg bearing king crab tended to be soft and more susceptible to damage.

Effect on the incidental catches of halibut and crab from using bobbin gear were quite apparent. Results of seven sets of comparative tows are presented in Table 5. Although fishing conditions are never exactly equal during such tests, the catch data strongly suggest that the use of bobbins substan-

Table 5.--Comparative total catches (all species) and catches of halibut, king crab, and Snow crab with the modified Eastern trawl rigged with bobbins and the Norwegian trawl without bobbins.

Gear Type	Total Catch (lbs)	Halibut Catch (lbs)	Halibut Catch No.	King Crab Catch (lbs)	King Crab Catch No.	Snow Crab Catch (lbs)	Snow Crab Catch No.
Eastern and bobbins	1,305	100	20	0	0	8	8
Norwegian	1,340	100	21	0	0	253	173
Eastern and bobbins	6,250	25	25	0	0	20	20
Norwegian	8,000	22	22	0	0	205	120
Eastern and bobbins	20,000	50	10	0	0	0	0
Norwegian	10,000	287	101	0	0	0	0
Eastern and bobbins	7,000	172	39	0	0	0	0
Norwegian	7,128	199	113	0	0	0	0
Eastern and bobbins	6,000	6	1	126	19	0	0
Norwegian	5,500	43	32	961	131	0	0
Eastern and bobbins	864	24	2	145	18	56	40
Norwegian	5,000	6	6	1,433	--	1,800	--
Eastern and bobbins	11,650	100	--	300	--	50	--
Norwegian	13,000	500	--	4,000	--	500	--
Eastern and bobbins	11,700	300	--	400	--	75	--

tially reduce the catches of king and snow crab and also tended to lower the incidence of halibut in the catches. The variability in halibut catches with the two nets may be partly caused by the bottom-type. When on very soft bottom, the bobbins apparently sink, which reduces their effectiveness in raising the net. Also of interest was the fact that halibut caught in the Norwegian trawl averaged 2.2 pounds each, while those taken in the Eastern trawl equipped with bobbins averaged 3.9 pounds each. As might be expected, such data may indicate that the reduction in halibut catch is primarily due to smaller fish moving under the trawl equipped with bobbins.

ROYAL SEA OPERATIONS

Pan-Alaska's 295-foot stern trawler, Royal Sea, fished for groundfish in waters southeast of Akutan during June 7-29, 1974. These fishing trials were conducted near the area fished southeast of Akutan by the Anna Marie on May 17-19, 21, and 25.

The Royal Sea completed 54 of 56 tows attempted and caught 699,000 pounds of groundfish in 162 hours of successful fishing effort. Individual catches ranged from a low of 3,000 pounds in a 4.0 hour tow to a high of 70,000 pounds in a 3.1 hour tow. The average total catch per hour of trawling was 4,315 pounds, considerably lower than the 7,758 pounds per hour caught by the Anna Marie in this area.

COMPARISON OF RESULTS TO OTHER SURVEYS

Comparing the results of this operation with surveys in the Gulf of Alaska during the 1950-1960's, it appears that the abundance of three species has changed dramatically during the last decade. The abundance of Pacific ocean perch and blackcod appears to have declined while pollock abundance has increased. The decrease in the abundance of blackcod and ocean perch stocks coincide with the development of foreign fisheries. Reasons for the increase in abundance of pollock are unknown, but may be compensatory to the reduction in other species or may be associated with changes in the natural environment. Relative to previous years (Alverson, Pruter, and Ronholt[1] and Hughes[2]), ocean perch stocks appear badly

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[1] Alverson, Dayton L., A.T. Pruter and Lael L. Ronholt. 1962. A study of demersal fishes and fisheries of the northeastern Pacific Ocean. Inst. of Fish., Univ. of B.C., Vancouver, B.C.: 190 pp.

[2] Hughes, Steven E. 1974. Demersal fish and crab resources in the Gulf of

depleted around Kodiak and east throughout the Seward area.

Groundfish surveys by the NOAA vessel, John N. Cobb, around Kodiak in 1972-1973 (Hughes and Alton[3]), showed fish to be abundant along southeast Kodiak and in Shelikof Gully. These findings are in agreement with results of the Anna Marie surveys in the Kodiak area. One notable difference was a lower abundance of pollock in Chiniak, Barnabus, and Two-Headed Gullies during the short period that the Anna Marie worked these areas in 1974 compared to the Cobb's findings in 1973.

A groundfish resource assessment survey by the Cobb was completed in waters from Sanak to the western tip of Unalaska in July-August 1974, shortly after the Anna Marie surveyed the area. While the fishing strategy, gear, and some objectives of the Cobb cruise were different from those of the Anna Marie, results of the Cobb's survey are extremely valuable in that they provide a seasonal extension of the Anna Marie's operation. The Cobb's survey area during July and August, 1974, is shown in Figure 10. Smaller areas called sampling strata, which coincide with 50-fathom depth intervals, are indicated within the survey area. Predetermined stations within each strata were fished for one-half hour using a standard 400 Eastern trawl. The trawl was equipped with a 1½-inch codend liner, and bobbin gear was not used.

Average catch rates for each strat shown in Figure 10 are given in Table 6. Table 7 shows the size composition of commercially-important species caught in each strata. Concentrations of cod encountered by the Anna Marie in Sanak gut (Strata 40) in May were nearly absent during the Cobb's survey in July. Pollock catches in this area were very small in May, but were substantial during July when they represented 66 percent of the Cobb's total catch. However, as shown in Table 6, these fish were primarily juveniles, averaging only 9.4 inches in length.

Southeast of Akutan and along Unalaska Island, it appears that groundfish abundance in July and August was at least as high and perhaps much higher than in May and June. Seasonal coverage by the Cobb in the Kodiak area during 1973 indicated

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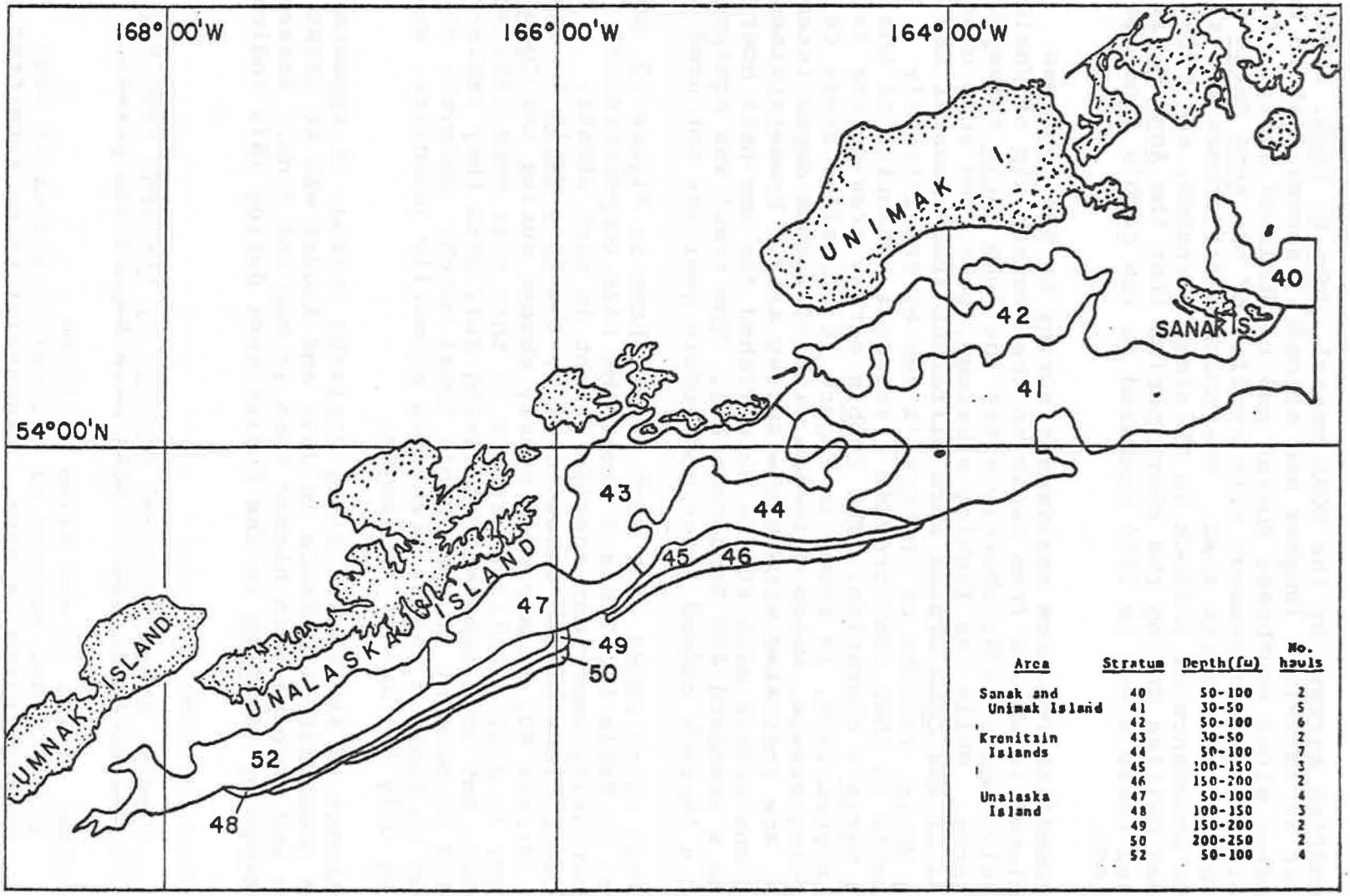
Alaska, based on trawl surveys by the IPHC from May 1961 to April 1963. NOAA Data Report (in press).

[3] Hughes, Steven E. and Miles S. Alton 1973. Trawl surveys of groundfish resources near Kodiak Island, Alaska. Manuscript being submitted for publication.



Area	Stratum	Depth(fa)	No. hauls
Sanak and Unimak Island	40	50-100	2
	41	30-50	5
	42	50-100	6
Krenitzin Islands	43	30-50	2
	44	50-100	7
	45	100-150	3
	46	150-200	2
Unalaska Island	47	50-100	4
	48	100-150	3
	49	150-200	2
	50	200-250	2
	52	50-100	4

Figure 10.--Sampling strata within the area surveyed by the John N. Cobb during July and August 1974.

Table 6.--Total catches and catches of principal species by the John N. Cobb during July and August, 1974.

Area	Strata	Depth Range (fm)	No. Tows	AVERAGE POUNDS PER HOUR TRAWLED						
				All Species	Pollock	Cod	Rex Sole	Rock Sole	Flathead Sole	Turbot
Sanak &	41	38-50	5	1,406	328	90	4	562	8	92
Unimak	40	78-80	2	4,389	2,946	142	0	4	608	56
	42	54-61	6	1,358	82	462	2	8	258	86
S.E.	43	46-50	2	2,412	864	58	2	788	16	334
Akutan	44	55-88	7	5,763	4,484	104	272	192	8	366
	45	114-132	3	6,035	3,138	192	256	0	24	2,102
	46	172-183	2	1,965	0	0	260	0	2	138
Unalaska	47	59-95	4	5,450	4,280	190	34	162	208	320
Island	48	105-128	3	7,135	5,170	376	208	98	74	314
	49	162-172	2	1,008	0	12	312	0	0	84
	50	210-243	2	1,347	0	0	122	0	0	32
	52	53-81	4	2,210	12	298	4	1,080	2	102

Table 7.--Length data (unweighted mean and range) for pollock and other commercially important groundfish species obtained during the trawl survey by the John N. Cobb in July and August, 1974.

Species	Area	Depth (fm)	No. of lengths	Mean length cm	Mean length inches	Length range cm	Length range inches
Pollock	Sanak & Unimak Island	50	357	31.0	12.2	26-53	10.2-20.9
		78-80	748	24.0	9.4	19-34	7.4-13.4
		56-60	167	39.9	15.7	17-63	6.7-24.8
	Krenitzin Island	51	471	29.3	11.5	20-38	7.9-15.0
		55-88	1,439	41.6	16.4	26-64	10.2-25.2
		114-132	489	47.3	18.6	38-61	15.0-24.0
		172-183	—	--	--	—	—
	Unalaska Island	59-95	548	43.3	17.0	17-61	6.7-24.0
		105-128	569	45.6	18.0	31-61	12.2-24.0
		162-172	--	--	--	--	--
		210-243	--	--	--	—	--
		61	41	32.5	12.8	28-53	11.0-20.9
Flathead sole	Sanak & Unimak Islands	50	42	27.7	10.9	17-39	6.7-15.4
		59-80	1,825	22.5	8.9	7-42	2.8-16.6
	Krenitzin Islands	126	30	36.6	14.4	30-41	11.8-16.1
	Unalaska Island	73	216	29.1	11.5	19-48	7.5-18.9
		127	52	36.5	14.4	29-44	11.4-17.3
Turbot	Sanak & Unimak Islands	38-44	297	25.9	10.2	12-43	4.7-16.9
		58-78	266	27.7	10.9	12-42	4.7-16.6
	Krenitzin Islands	46-51	275	27.2	10.7	13-46	5.1-18.1
		55-88	560	35.2	13.9	13-65	5.1-25.6
		114-132	376	44.3	17.4	30-67	11.8-26.4
	Unalaska Island	56-81	450	33.6	13.2	11-61	4.3-24.0
		105-128	98	42.7	16.8	26-65	10.2-25.6
		162	14	56.1	22.1	41-65	16.1-25.6
Rock sole	Sanak & Unimak Island	38-50	1,481	23.1	9.1	9-44	3.5-17.3
		58	40	24.7	9.7	17-33	6.7-13.0
	Krenitzin Islands	46-50	369	25.2	9.9	11-39	4.3-15.4
		55-64	453	26.0	10.2	15.41	5.9-16.1
	Unalaska Island	53-81	921	27.5	10.8	14-43	5.5-16.9
		105	48	33.6	13.2	27-43	10.6-16.9

Table 7.--Continued

Species	Area	Depth (fm)	No. of lengths	Mean length cm	Mean length inches	Length range cm	Length range inches
Rex sole	Krenitzin Islands	75-88	295	35.7	14.1	23-47	9.1-18.5
		114-126	285	36.0	14.2	20-48	7.9-18.9
		172-183	189	35.1	13.8	20-44	7.9-17.3
	Unalaska Island	127	82	36.4	14.3	28-50	11.0-19.7
		162-172	110	38.5	15.2	25-48	9.8-18.9
Dover sole	Krenitzin Island	183	46	41.1	16.2	28-54	11.0-21.3
	Unalaska Island	172	31	42.1	16.6	32-63	12.6-24.8
		210-243	134	41.5	16.3	30-57	11.8-22.4
Pacific cod	Sanak & Unimak Island	44	134	39.4	15.5	24-57	9.4-22.4
		54-78	301	44.7	17.6	34-72	13.4-28.4
	Krenitzin Islands	55-84	79	45.1	17.8	35-70	13.8-27.6
		114	17	57.0	22.4	44-80	17.3-31.5
	Unalaska Island	56-81	220	46.4	18.3	31.90	12.2-34.5
		105	23	63.9	25.2	38-85	15.0-33.5

highest abundance during the summer, and a similar pattern may exist southeast of Akutan and along Unalaska. Species and size composition of the Cobb's catches in Strata 44, 45, 47, and 48 also indicated the presence of primarily large pollock with some large cod and rex sole. More turbot were caught in these areas during the summer, which is probably due to their inshore distribution then. A fair showing of rock sole encountered by the Anna Marie south of Unalaska was also located by the Cobb in Strata 52.

SUMMARY OF FISHING POTENTIALS BY AREA

In summary, potentials determined during the survey periods for developing a groundfish trawl fishery were found to be extremely poor around the Shumagin Islands, in much of the southeastern Bering Sea, and in the Seward area from Seward Gully to Montaque Island. A low abundance of desirable groundfish species was common to these areas. Two additional potential problems were encountered in the Shumagin area. The first was a high abundance of snow crabs which could pose a conflict with that area's snow crab fishery. The second was very hard and often irregular seabed around the Shumagins. Such bottom conditions created excessive wear and damage to fishing gear. Trawling conditions in the other areas were generally good, and the primary problem was simply lack of fish.

Groundfish potentials remain questionable along the Aleutian Chain west of Unalaska. While it was apparent that Pacific ocean perch were available in this area, fishing was not usually successful due to the off-bottom distribution of fish.

Potentials for the development of a U.S. groundfish trawl fishery do exist near Sanak, southeast of Akutan, south of Unalaska, north of Unimak Pass, and in the Kodiak area. Except for Sanak, where cod dominated catches, the other areas showed similar groundfish resources being composed of 65-80 percent pollock, 5-15 percent cod, and lesser amounts of perch and sole. Catches in the Kodiak area were generally composed of slightly smaller fish and contained a higher percentage of small sole and crab than in the areas farther west. Thus, while the total average catch per hour was higher near Kodiak than in other areas surveyed, the average catch per hour of usable fish was considerably higher southeast of Akutan than in any other area. Catch rates of usable fish near Sanak, Unalaska, and north of Unimak Pass were somewhat lower than near Kodiak; however, this may be offset by cleaner catches and less conflict with crab.

PROCESSING ASPECTS

CHARACTERISTICS OF THE FRESH FISH

Early in the charter, from the Semidi Island to Unimak Island, the catch of most species yielded very small individuals not useful for fillet production. Pacific cod was an exception. In some catches this species was available in good quantity, size, and condition. Cod would offer excellent possibilities for a marketable product if handled properly. In some catches, particularly near Sanak Island, cod were gorged with shrimp feed and consequently could be expected to belly-burn very rapidly unless gutted. Parasites were observed in all size ranges in the gut. Larger cod usually hosted 2-4 in the flesh in each fillet.

In the area from Davidson Bank to Usof Bay, Unalaska Island, the catches showed better promise for both fillet and minced flesh operations. Fish from these areas were used for processing aboard the Royal Sea. Pollock of good size were taken southwest of Kodiak Island. The remaining areas fished around Kodiak were, for the most part, rather poor from the standpoint of size of catch, as well as size of fish taken.

The results of the Kodiak to Seward effort were extremely poor, with the exception of a single good catch on the Portlock Bank.

Keeping Qualities

An important aspect in evaluating the useful potential of the fish species available to a developing fishery is information on their keeping quality in the fresh state. For this purpose, representative sample lots of several species were preserved in crushed ice, slush ice, and refrigerated seawater and examined periodically.

Pollock

Pollock was the most abundant species available in all areas fished. Because of its reputation for poor keeping quality, major emphasis was placed on its storage properties. Pollock were held iced, in refrigerated seawater, and in slush ice for periods up to 6 days. Generally, pollock was found to have rather poor storage quality regardless of the method of holding. The fish deteriorated rapidly if held at ambient temperature, and autolysis in the visceral cavity (belly-burn) was a major problem even during storage in ice. If the air temperature was 45 degrees F. or lower, the fish could be held a maximum of approximately 24 hours without ice. Immediate chilling to below 35 degrees F. significantly delayed both bacterial and autolytic spoilage.

Iced storage -- Pollock that were left in the round, but were well-iced immediately following capture, remained in excellent condition for about three days. At three days, some fish showed "belly-burn," but the edible portion was not seriously affected at this time. Between the third and sixth days, the color, odor, and texture of the flesh were noticeably affected. By the end of the six days, nearly all of the fish were "belly-burned," and some showed significant deterioration of the edible flesh. Flesh color of the fresh fish varied from grey-white to brownish-grey and became darker when exposed to air. By the sixth day of iced storage, the odor was metallic-like to fishy, and the texture was soft and flaccid. Very little of the original good quality remained.

RSW -- Pollock caught on May 23 south of Usof Bay, Unalaska Island, were held in the round in refrigerated seawater (RSW) at 30 degrees F. for periods of three, four, and five days. The fish were generally superior to iced fish in outward appearance. The eyes were bright and the fish firm after five days. The odor of the fish was excellent at that time; however, the flesh was a creamy-tan color compared to a more grey-white color in iced fish. Samples of frozen fillets prepared from fish held in RSW four days will be evaluated at the Pacific Utilization Research Center, NMFS, to determine the significance of these changes following freezing and storage.

Slush ice -- Samples of pollock were held in slush ice made up by combining freshwater ice and seawater in a fiberglass tank identical to that used in the RSW experiment. The temperature was 31 degrees F. during the entire 7-day holding period. Fish were from the same lot used in the RSW experiment and were equal in appearance to those held five days in RSW.

Slush ice appears to be a very practical holding method if the catching vessel is equipped with water-tight tanks. In our opinion, fish held in slush ice or RSW may not be suitable for processing into minced flesh due to their tendency to slough off pigmented skin particles during passage through the flesh separator (see section on Minced Fish Blocks).

Flatfish

Flathead sole captured in the area near the Shumagin Islands on May 8 were held in refrigerated seawater and on ice. After three days in RSW, malfunction of the equipment caused the experiment to be terminated. At that time, the fish were excellent in quality and showed no deterioration due to storage. On the fourth day, the iced fish were evaluated. These fish were also in excellent condition. All of these

fish were very small and hardly suitable for filleting.

On May 12, yellowfin sole taken just outside Morzhovoi Bay were iced for later freezing at Sandpoint. Although the fish were sorted and only the larger specimens retained, the lot was generally smaller than is considered desirable for use in filleting. Samples of these fish were brine-frozen at Sandpoint for later evaluation.

Pacific Cod

Iced storage -- Pacific cod taken throughout the charter were in excellent condition. There is no reason to believe that the storage properties of these fish are different from those of cod taken in the traditional Pacific Northwest fishery. In the area near Sanak Island, fish gorged on shrimp presented a serious preservation problem due to "belly-burn" caused by shrimp feed in the stomach. Fish not gorged with shrimp showed normal properties when held in ice for seven days. Gutted fish were generally superior to fish iced in the round for the same period of time.

RSW -- When cod that had been feeding on shrimp were placed in refrigerated seawater, the stomach contents contaminated the water. The result was a putrid odor in the chill tank, presumably accompanied by a high bacterial count and conditions that would have resulted in rapid decomposition of the fish. To preclude this, the seawater was discharged after about 18 hours, the fish were rinsed with clean seawater, and the tank was refilled with RSW. The sample lot was examined after a total holding time of seven days. Although the gills were severely bleached due to exposure to seawater and the eyes were opaque, the fish were in acceptable condition. Temperature during storage was 30 degrees F. $\pm$ 1 degree F.

Parasites

Pollock

Based on observations made during the charter, parasites do not appear to be a critical factor limiting the utilization of groundfish in the Gulf of Alaska. Observations were necessarily limited to the areas from which fish were taken. Generally in smaller pollock (under 40 cm), the edible flesh was nearly free of visible worms or larvae. A greater percentage of fish over approximately 40 cm in length were parasitized, but even they seldom had more than one or two parasites (worms) per fillet in those cases when any worms were present.

Examination of 350 pollock fillets during processing aboard the Royal Sea resulted in a total finding of 11 worms in nine fillets or an incidence of about 3 percent. However, a total of 34 fillets contained infestations (cysts) that have an

outward appearance similar to that of maggots. The numbers varied from one per fillet to well over 50 in one fillet. Removal of the cyst-like parasites during processing would be more difficult than removal of the more familiar worm-like parasite.

In general, these observations are in agreement with those published in the Soviet literature. Soviet scientists have reported lower parasite incidence in the Gulf of Alaska than in the Bering Sea. They speculate that the reason may be related to a lack of intermediate hosts in the Gulf or possibly because of the greater depth (140-300 m) from which the specimens they examined were captured.

The incidence of worms in pollock taken in the Kodiak Island to Seward areas was approximately the same as that observed in the westward area. Examination of 76 fillets from fish caught August 9 showed a total of three worms and two cysts. Another lot of 87 pollock from the same catch was free of parasites in the edible portion.

In all cases, the visceral cavity of pollock was found to be moderately-to-heavily infested with parasites. Migration to the flesh may take place during prolonged holding of whole fish on deck or in iced storage; however, this seems not to be a problem when storage is only a few days, and if the fish are iced or refrigerated promptly.

Flatfish

Examination aboard vessel of yellowfin, flathead, rock, rex, and Dover sole did not show parasites to be a problem. Samples of frozen fish held in storage will be examined later to verify this observation.

Pacific Cod

Cod taken in all areas were typical of cod in general and were heavily-infested with parasites in the visceral cavity. In addition, the larger fish usually had a few parasites in the edible flesh.

Proximate Composition

Samples of pollock, Pacific cod, and several species of flatfishes are being held in frozen storage for further quality studies and determination of proximate composition.

A review of the composition data available on these species from previous studies by NMFS and the Pacific Scientific Research Institute of Marine Fisheries and Oceanography (TINRO) of the Soviet Union is provided in Table 8. A perusal

Table 8. Proximate composition of the flesh of important species of bottomfish of the North Pacific, Bering Sea, and North Atlantic.

Species	Region	Moisture, %	Oil, %	Protein, %	Ash, %
Pacific cod (Gadus macrocephalus)	Pacific NW[1/]	81.5	0.6	17.9	1.2
	North Pacific[2/]	77.7-82.3	0.1-0.9	15.5-19.5	0.8-1.8
Atlantic Cod (Gadus morhua)	New England[3/]	80.9	0.09	17.9	1.1
	North Atlantic[2/]	79.0-82.6	0.2-0.6	13.9-18.9	0.8-1.8
Pacific or Walleye Pollock (Theragra chalcogramma)	Bering Sea[4/]	81.6	1.0	18.4	1.4
	North Pacific[2/]	80.0-86.2	0.2-1.2	12.7-18.0	0.8-2.2
" "	Southeast Alaska[5/]	82.5	0.7	16.8	1.1
Rock Sole (Lepidopsetta bilineata)	Bering Sea[4/]	80.7	1.3	19.5	1.3
" "	Pacific Northwest[6/]	78.8-83.3	0.5-1.0	17.1-19.7	1.1-1.2
Flathead Sole (Hippoglossoides elassodon)	Bering Sea[4/]	80.9	1.2	18.8	1.1
	Pacific Northwest[6/]	79.8-83.9	0.8-1.5	14.9-18.3	1.0-1.2
Yellowfin Sole (Limanda aspera)	Bering Sea[4/]	82.7	1.2	16.9	1.5
	North Pacific[2/]	72.9-83.7	1.0-5.0	11.6-19.6	1.0-3.3

1/ Thurston, C. E. 1961. Proximate Composition and Sodium and Potassium Contents of Four Species of Bottom Fish. Jour. Food Sci., Vol. 26, No. 5:495-498.

2/ Kizevetter, I.V. 1973. Tables 246, 257, and 381. Chemistry and Technology of Pacific Fish (Transl. from Russian) TT72-50019, U.S. Dept. of Commerce, National Technical and Information Service, Springfield, VA., 22151.

3/ Sohn, B. I., J. H. Carver and G. F. Mangan. 1961. Composition of Commercially-Important Fish from New England Waters, Part 1. Comml. Fish. Rev. V. 23, No 2:7-10.

4/ NMFS. 1950. Unpublished data, analyses of frozen fillets processed on factory vessel S. S. Pacific Explorer , during Bering Sea operations in 1948, Pacific Utilization Research Center, Seattle, WA 98112.

5/ Landgraf, R. G., Jr. 1953. Technical Note No. 27 - Alaska Pollock: Proximate Composition; Amino Acid, Thiamine, and Riboflavin Content; Use as Mink Feed. Comml. Fish. Rev. V. 15, No. 7:20-22.

6/ Thurston, C. E. 1961. Proximate Composition of Nine Species of Sole and Flounder. Agric. and Food Chem., V. 9, No. 4:313-316.

of the data for moisture and protein contents of the species indicates the wide range of values found in fish taken at various seasons and locations. The Soviet composition data are listed as ranges and are useful to show the limitation of the single mean values reported in NMFS and other studies.

For example, Pacific cod flesh is frequently said to be more moist than Atlantic cod because of its different texture. A comparison of the tabulated data indicates that there is a slightly higher mean moisture level in Pacific cod, but on the basis of the range values, the difference is not significant. Other technological observations suggest that this texture difference between Pacific and Atlantic cod is probably more related to intrinsic factors in the biochemistry of the muscle that may also relate to the time and place of catch and to the manner of handling and preservation. Further studies on these quality differences in cod in relation to catch area in the Pacific would be desirable.

Another factor related to moisture that can be verified by the table is the relatively wide-range and high-content of moisture in Pacific pollock. The highest single moisture content in the North Pacific groundfish occurs in pollock. The wide-range of protein values in pollock is also clear; however, the protein values of yellowfin sole are the most variable, from a low of 11.6 percent to a high of 19.6 percent in the Soviet data. Three samples of pollock taken in the current study have been analyzed for moisture content, to date. The average moisture content of these was 83 percent, a high value for the flesh of most species of groundfish. Tests will be conducted to determine whether pollock exhibits a tendency to spatter and lose breading during frying as frequently occurs in fish that have a high moisture content.

RESULTS OF PROCESSING TRIALS

The NMFS processing trials were carried out aboard the vessel, Royal Sea, and at the Seward Fisheries plant, Seward, Alaska. Also, fish were made available to various companies for processing trials by industry; the results of their findings will be reported later. The NMFS trials are reported here under: (1) Minced Fish Blocks, (2) Fillets, and (3) Whole Fish.

Minced Fish Blocks

Pollock

The Japanese are producing frozen, minced Alaska pollock blocks and marketing them in the U.S. The generally poor quality

of these blocks has resulted in consumer resistance and a sharp drop in their use by U.S. food processors during 1974. With this in mind, the primary emphasis in our experimental work with minced fish was to investigate some of the handling and processing variables that could affect both the quality and cold storage characteristics of the minced fish blocks.

The variables in the studies included: preservation methods used to hold the pollock prior to processing (crushed ice, slush ice, or refrigerated seawater), effect of washing the minced flesh, and the incorporation of various stabilizing ingredients with the minced fish.

Minced flesh yield -- The yield of minced flesh from Alaska pollock was determined using fish from Portlock Bank caught August 5. Alaska pollock that averaged 0.85 pounds in round weight were headed, gutted, and split by hand to remove the backbone to simulate one form in which pollock is processed into minced blocks by Japanese processors. These fish were passed through the Bibum flesh-separator equipped with a drum having 5mm diameter holes and with the belt set at medium pressure. The minced flesh yield was 35.7 percent based on the weight of the whole fish. An additional minced flesh yield of 6.0 percent was obtained by passing the "waste" from the first-pass through the flesh-separator machine, again through the machine. This second-pass minced flesh was much darker in color than the first-pass flesh and was not considered suitable for making fish sticks and breaded portions.

Comparison of preservation methods -- Using fish from the area south of Usof Bay, Unalaska Island, caught May 23, minced Alaska pollock blocks were prepared from fish held for five days in ice, slush ice, or refrigerated seawater. The minced blocks prepared from fish held in ice were of acceptable quality, as described in the following section. Minced blocks prepared from fish held in slush ice or refrigerated seawater for five days had a greyish off-color caused, in part, by pigmented particles sloughing off from the skin as the flesh was removed in the flesh-separating machine.

Effect of time whole fish held in ice -- Minced pollock blocks were prepared from whole fish held in ice for three, four, and six days following capture on May 23 south of Usof Bay, Unalaska Island. These are now being tested for frozen storage life at 0 degrees F. The initial examination was conducted about three months after the blocks were prepared. At that time, there were no significant differences in flavor, texture, or appearance due to holding time of the fish. Additional examinations for quality differences are scheduled after six and 12 months of storage.

Effect of washing the minced flesh -- Frozen blocks were prepared from minced flesh that had been washed once with cold water (ratio 4 parts water to 1 part fish) for later

comparison with blocks made from unwashed, minced flesh. At the initial examination, the frozen blocks made with washed flesh were lighter in color than those made with unwashed flesh. Samples that were battered, breaded, and deep-fat fried showed no significant differences in texture and appearance between those made from washed and unwashed minced flesh blocks; however, the lack of flavor of the samples made with washed, minced flesh resulted in slightly lower flavor ratings than those made with the unwashed, minced flesh. Unless the washed, minced flesh blocks demonstrate significantly better cold-storage characteristics compared to the unwashed blocks after six months or longer, washing of the minced flesh appears to be unnecessary.

Effect of using other food ingredients -- The effect of stabilizing ingredients such as salt, sugar, and tripolyphosphate on keeping-quality during storage will be evaluated after additional storage of the blocks at 0 degrees F.

Rock Sole

Minced blocks prepared from rock sole caught May 24 southeast of Usof Bay, Unalaska Island, that were held in ice for five days, were unacceptable due to an "iodoform-like," off-flavor in the cooked product. This type of off-flavor is often found in English sole and, less frequently, in some of the other species of soles caught off the coast of Washington. Since this strong, off-flavor was not observed in rock sole frozen at sea in earlier studies of groundfish in the Gulf of Alaska, additional sampling will be required to assess the extent of this problem.

In our experiments, we headed and gutted the rock sole by hand, but this would not be an economically-practical means of preparing the fish for the flesh-separator machines. Unless specialized equipment can be developed and applied at a reasonable cost for heading and gutting rock sole and other flatfish, the alternatives for processing flatfish will be either conventional filleting or use of a method similar to the rex sole "trim." The rex sole "trim" consists of a guillotine-cut that trims the head, tail, and dorsal and ventral fins from the whole fish leaving the edible flesh with its skin attached to the main ventral frame. If the fish could be separated into convenient size groups, the desired "trim" probably could be cut by machine with a single guillotine-like stroke. These "trimmed" fish could be individually frozen and bulk-packed or frozen into blocks.

Fillets

Pollock and Pacific cod were filleted aboard the Royal Sea with assistance from the ship's processing crew.

Pollock

Pollock taken May 23 south of Usof Bay, Unalaska Island, and held in ice for three days were used to prepare IQF fillets and fillet blocks. Individually-frozen pollock fillets from the same catch were also prepared from fish held in refrigerated seawater and slush ice four days. IQF fillets were prepared also from pollock gutted prior to iced storage. Filleting pollock by hand is made difficult because bones protrude almost perpendicularly from the backbone, as in hake. This is reflected in the relatively low-yield of fillets--25-31 percent.

Samples of three-day-iced pollock fillets frozen individually were evaluated following 3½ months of storage at 0 degrees F. Even though the fillets were not protected by ice glaze, the test panel did not detect abnormal flavors (no rancidity) and rated the flavor good. Color was excellent. The samples were considered to be slightly-to-moderately tough by most taste judges.

Pacific Cod

Pacific cod from the area south of Usof Bay, Unalaska Island, were sorted from the catch on May 23 for use in preparing fillet blocks and IQF aboard the Royal Sea. The fish were held in ice until the time of processing. Evaluation of the frozen samples will be done after a storage period of about six months.

Whole Fish

Pollock

Pollock in the round were frozen by three methods: (1) brine immersion, (2) vertical plate freezer, and (3) shelf freezer in 35-pound capacity pans. The brine-immersion technique as well as the vertical plate freezer had a serious drawback in common; the individual fish took on grotesque shapes during the loading and freezing process. Although this might be prevented by more careful handling during loading of the freezer, it was not practical to take the additional time during these tests. Whether or not the odd shapes will affect the quality of the thawed fish has not yet been determined. It is expected that stresses will cause some tearing of the fillet.

Samples of these fish will be used to determine frozen storage quality, fillet yield, composition, and overall acceptability.

Other Species

Pacific cod, rex sole, rock sole, yellowfin sole, flathead sole, and ocean perch were also frozen whole for later processing and evaluation.

Discussion

During the charter, there was an opportunity to briefly look at the keeping-quality of pollock and several flatfish species, as well as observe some of the processing characteristics of each.

Generally, pollock is a difficult fish to handle. It is subject to rapid deterioration, and it is difficult to fillet by hand. These problems can be overcome by careful handling and processing. Rapid chilling, followed by storage at proper temperature in either ice or seawater, will permit a holding time of up to six days. Machine filleting and/or mincing by machine avoids the hand-filleting problem. The flesh firms up during frozen storage so that the original, soft texture is not a serious problem in frozen products. Pollock can be quite acceptable, especially when served as a deep-fat fried product.

The flatfish species encountered--flathead sole, yellowfin sole, rock sole, and rex sole--are all acceptable from the standpoint of keeping quality and edibility. Rex sole is an excellent fish, comparable to the best sole or flounder available anywhere.

The most promising possibility is a combination fillet-freezing and minced-flesh operation. Alaska pollock is the most easily handled; and sorting to separate large fish for fillet blocks and using all the small fish for mincing appears to be practical. The small sole, a substantial portion of the catch, cannot be handled by a minced-flesh operation. In fact, with present technology, there is doubt that any sole, regardless of size, will be suitable for minced block production until mechanized heading and gutting equipment for sole is developed.

Fishing with selective gear, such as mid-water trawl, that would result in substantial catches of a single species per unit of effort, could make the Alaska pollock fishery more attractive. Apparently, the Japanese are able to conduct the Bering Sea operation so that the catch is mainly the target species sought. This would definitely improve the outlook for a minced-flesh operation.

In general, all of the fish taken by the charter can be considered potentially valuable for future utilization. Catches can be sorted to segregate desirable species and marketable size individuals for either fillet production or minced-flesh operations. Practical means of preserving the catch include ice, slush ice, and refrigerated seawater. The maximum holding time aboard the vessel would be about six days, and the normal should be limited to about four days in order to provide a good-quality product.

Samples frozen during the charter are to be evaluated from the standpoint of their potential for freezing whole fish at sea or in a plant close to the fishing grounds followed by completion of processing closer to the market place. Previous research has indicated this is technically feasible.

MARKETING ASPECTS

A responsibility of the NMFS in the industry-government cooperative Alaska groundfish venture was an analysis of market conditions and trends of groundfish products in U.S. and foreign markets, and forecasts of volumes and prices as applied to potential Alaska groundfish production.

Information on U.S. market conditions are relatively easy to come by through contacts with seafood buyers and distributors. Trends and forecasts are another matter. No sophisticated economic model was used to arrive at the results presented here, but rather an interpretative analysis was made from interviews with seafood purchasing agents, distributors, wholesalers and brokers, and from statistical data. We feel confident, however, that this empirical approach provides much practical information of use to Alaska producers.

There was neither time nor funds enough to make other than a very cursory examination of foreign markets. U.S. and Alaska seafood markets, however, are strongly influenced by what is happening in the European and Asian seafood trade and, to an increasing extent, on imports from India, South America, and Africa. Because the U.S. is so dependent upon foreign seafood imports, Alaska groundfish producers, with their relatively small initial production, will be extensively influenced by developments in world markets.

Sources of data for these reports include: personal contacts; NMFS fisheries statistics, market news and special reports; American Embassy, Tokyo, reports; and other sources. Special mention and thanks is given to Dr. G.L. Grant, Chairman, Fisheries Prices Support Board of Canada, for use of material from "Supply and Demand Outlook, 1974, for Groundfish."

U.S. GROUNDFISH MARKET CONDITIONS, 1974

Sixty-seven seafood purchasing agents, processors of fish sticks and portions, distributors and wholesalers who buy for or sell to supermarkets, brokers, fresh and frozen fish retailers, food caterers, and restaurant and institutional users in 13 cities were personally contacted in June 1974. The 13 cities

where interviews were held are:

Seattle	Salt Lake City	Chicago
Portland	Denver	Cleveland
San Francisco	Kansas City	Boston
Los Angeles (area)	St. Louis	Gloucester
Oakland		

A summary of information which resulted from the market survey is presented here.

General Status and Trends of Seafood Market

The study got underway when inventories of frozen fish and shellfish were at an all-time high, largely because of consumer resistance to high prices and because of falling prices on beef, poultry, and other competing proteins. Importers of fishery products placed large orders in the fall in anticipation of continued heavy demand because of the then record prices for meats and poultry. When the stocks began to arrive, prices for meats and poultry had already begun to drop, and consumers were switching back to those items. As a result, seafood sales were in a slump that continues at the date of this writing. Most of the respondents felt that seafood prices were too high in comparison with those of competing products. To illustrate the point, the seafood buyer of a major retail chain brought out a current meat-seafood price list that showed twelve meat items priced at under $1.00, while only two fish items were in that category.

By mid-October 1974, groundfish prices appeared to have stabilized, although inventories were still high then. Cod prices were up some. It was felt by some distributors that it would be another six months before inventories and prices would return to "normal." Most distributors were optimistic concerning longer-range (2-3 year) seafood markets in the U.S.

What Are the Major Competitive Products for Alaska Groundfish?

Poultry, hamburger, bologna, vegetable proteins, other low-cost fish such as whiting, Atlantic ocean perch, and local fresh species, are major competitors in the market--almost any protein food under $1.00 per pound retail. Imported substitutes for cod, such as whiting and pollock, will be major competitors for Alaska-produced pollock.

When Would Buyers Increase Use of Groundfish Products?

Most buyers indicated that a reduction in price of seafood items would stimulate sales. Retail price-drops of five to

fifteen cents per pound would be needed. Others suggested drops of twenty cents per pound. Some indicated a 25-percent cut in price is needed, depending on the item. Seafoods are running 10-30 percent over their historic price relationship to beef and poultry.

Improvement in quality was a factor frequently mentioned. Other conditions noted for increased use of groundfish products were: reliable supply source, consistent market promotion, consumer education in preparation and value of seafoods, and market-acceptable names for species.

What are Major Problems in Using More Groundfish Products?

-- Current oversupply of seafoods;

-- High price in relation to beef and poultry;

-- Consumer resistance to poor quality caused by a number of factors--poor original quality, prolonged shelf storage, prolonged cold storage, poor merchandising practice, worms, high breading content, etc.;

-- "Chisel Packs"--short weights, overglazing, etc.;

-- Adverse publicity--botulism, red tides, mercury, etc.;

-- Pacific cod, Pacific ocean perch, and Alaska pollock present problems in breading adherence to sticks and portions;

-- Acceptance of Alaska pollock is impaired by inclusion of dark, fatty sections and black peritoneal tissue in products--much product development and improvement are needed; and

-- A common name is needed, acceptable to consumers, for some species. California Department of Fish and Game recently passed legislation naming 12 kinds of rockfishes as "Pacific red snapper." More of this type of legislation is needed.

Are Buyers Familiar With Alaska Groundfish Products?

Buyers were familiar with Alaska pollock in all forms. Most were familiar with Pacific cod and Pacific ocean perch. Flathead sole, rock sole, and yellowfin sole were not as familiar to many buyers. Starry flounder was even less known, and those familiar with it said the quality was variable, depending on the area and time of year it was caught. Consumer and trade education is needed for arrowtooth sole.

Most processors were more familiar with and interested in blocks. Most were familiar with IQF and shatter-pack fillets, both being well-accepted. Fresh sablefish fillets were attractive to the fresh-fish merchant while Japanese-style, dressed sablefish were preferred by the fish smoker because of better yield. Most buyers familiar with Alaska products obtained their knowledge of them through the purchase of supplies from Japanese sources.

What is the Interest in Alaska Groundfish for Future Use?

The response to this question was generally positive, but not unanimously so. Much would depend on price, quality, and reliability of supply. One east-coast firm would be willing to provide processing technology to an Alaska firm in return for a guaranteed supply of sole fillets. Other eastern and midwest buyers indicated strong interest in fillet-of-sole products. Interest in pollock fillets and blocks was spotty, but acceptance is increasing as quality improves. The quality of pollock fillets and blocks from Japan was said to be improving. U.S. processing technology will have to equal or better these products to find ready-acceptance.

What are the Uses and Market Trends for Minced Fish Products?

The poor quality of minced fish marketed in the U.S. has given this product a bad reputation. Because of its initial low price, it has been sold largely for use in school lunch programs, to hospitals, and to correctional institutions. School children were reported not to like the fish sticks and portions prepared from minced-pollock blocks. Minced-pollock blocks from Japan and Korea, in particular, were given the "thumbs down" by buyers. Minced-cod products or mixed-species products, however, have found some acceptance. A midwest processor claims to have developed better-quality, minced-fish products, including pollock, which are being offered to U.S. buyers.

Generally, buyers agreed that minced-fish products including Alaska pollock will find a place in markets when quality is greatly improved, and if prices are competitive. Much product development is needed to provide better texture and taste and to extend storage life.

To summarize the attitude of most buyers concerning Alaska seafood products, they would be happy to obtain them from responsible suppliers, particularly those who have provided samples of their products. Many retailers do not wish to be contacted directly, but instead ask that their suppliers be informed of the availability of Alaska products. Buyers are weary of having people call on them with schemes and grand plans for the development of Alaska--someday! They are willing to consider purchases, but are reluctant to listen to

talk of potential. They ask that only serious, established businessmen call on them.

Several buyers stated a preference to buy domestically-produced groundfish products, but would be forced to buy from whatever source offered the best competitive price for comparable quality.

Many respondents pointed out that the consumer will not pay extra for a product solely because it has a "U.S. flag" on it. Some concern was voiced that Japan is fishing off Alaska and selling the fish back to the U.S. at a high price, or else buying from our suppliers and then selling back to the U.S. at much higher prices. Many would prefer to see our own fishermen catch the fish and have it sold domestically at a reasonable cost. Concern was expressed over our dependence on imports for our supplies of fishery products. The competition from Japan and other countries is keen, and some of the contacts questioned whether U.S. fisheries have the inclination and fortitude to compete in this very competitive market. Many suppliers liked the idea of U.S. standards of quality control throughout the processing-marketing system and hoped that Alaska would strive to maintain a reputation and fill a need for consistent, high-quality supplies.

Most respondents are looking for new sources of supply, new species, better methods of processing, and better business methods. If domestically-caught-and-produced Alaska-fishery products were marketed as high-quality items at a fair price, they might account for a large volume of seafood in U.S. markets.

GROUNDFISH MARKET TRENDS AND PROJECTIONS

There are many economic factors which affect the market potential of Alaska-groundfish products. Some of these are as follows.

Factors Influencing Supplies

1. The fuel shortages and inflation have caused escalating production costs at the harvesting, processing, and export-marketing levels. This has also been accompanied by price declines in the U.S. market causing a cost-price squeeze for producers and exporters. These factors also apply to foreign producers of Alaska-pollock blocks as well as cod and other groundfish producers such as the Scandinavian countries.

2. Increased imports of Alaska-pollock blocks, fillets, and minced blocks from Japan, and the emergence of the Republic of Korea as a competitor in the Alaska-pollock fishery.

3. Some foreign-produced fillet and block products are being diverted from U.S. markets into some of the new and increasingly-attractive European markets.

4. The growing strength of salt-cod markets in Europe.

5. Decrease in North Atlantic pollock and cod catches.

Factors Influencing Demands

1. Sluggish U.S. economy.

2. Consumer resistance to high prices and substitution of lower-priced protein foods.

3. Anticipated reduction in U.S. meat supply expected in the winter of 1974 and first half of 1975. This would give fish products a better competitive edge as meat prices rise.

4. Increased future acceptance for blocks produced from alternate species of lower value which are acceptable to consumers.

5. Retail prices of seafood continue relatively high in relationship to falling wholesale prices, which retards movement of seafood.

General Projections

Based on a straight-line projection to 1984 of the upward trend in U.S. consumption of groundfish fillet and block products, which occurred from 1960-1973, it is expected that around 800-million pounds of groundfish fillet and block products will be consumed in 1977, and as much as 950-million pounds in 1983. This would amount to an increase in consumption of around 50-million pounds from 1973-1977, and a 200-million pound increase by 1983. Assuming a recovery rate of 25 percent for fillets, this would be the equivalent to 200- to 800-million pounds, respectively, of whole fish.

Annual per-capita consumption of groundfish products has increased at a much greater rate than consumption for all U.S. fishery products, the latter averaging around 2 percent. The underlying cause of this is probably the increase in prices of shellfish, halibut, flounder, and salmon, and the consumer shift to lower-priced groundfish products in retail stores. Increased use of groundfish may also reflect the convenience of breaded sticks and portion products for use by the consumer.

If past trends in use of groundfish products continue, a five-percent future annual growth rate in consumption may occur over the next ten years. If cod production continues to decline or remain static, it is reasonable to assume much of this five-percent growth could occur in the pollock-block market. Based upon 1973 to early-1974 pollock sales, this could well add an additional five- to ten-million pounds of pollock blocks annually over the next three years. The quantity will depend, in good part, on the price spread

between cod and pollock products and the quality of pollock products. Prices will, in turn, be influenced by the availability of cod supplies. Frozen cod imports in 1973 declined 52-million pounds, or 25.4 percent compared to 1972. In contrast, pollock imports in 1973 increased 49-million pounds over 1972--close to a 40-percent increase.

Demand Projections by Species

Alaska Pollock

The pollock-block market will expand by at least five-million pounds a year through 1977, based on current market indicators discussed above. Additional market information supports this projection. There are, for instance, a number of midwest and east-coast distributors who would be able to market 500,000- to 3.0-million pounds of pollock annually if the product were available to them at a competitive price on a non-contract basis. These firms have difficulty competing with larger firms in price negotiations because they cannot purchase the larger amounts of product necessary for price discounts. They would be excellent, potential purchasers of domestically-produced pollock in smaller quantities. Another factor is that pollock blocks and fillets have been accepted as a substitute for cod by many processors. And cod imports will probably remain static or continue to decrease because of declining catches and the recent trend of increased purchases by European countries.

It is apparent that if the Alaska processors could have produced pollock blocks in 1973 for 45-50 cents per pound, F.O.B. Seattle, there would have been a readily-available market in the midwest and east, particularly among buyers for smaller firms who do not have the ability to contract large shipments of pollock blocks from Japan.

The current outlook for the U.S. to develop a competitive stance in the pollock-block market by 1976 is doubtful unless U.S. production costs can be competitive with Japan and other foreign suppliers in U.S. markets. Pollock-block prices, along with other frozen-fish prices, have declined around 30 percent and apparently will remain depressed for the remainder of 1974.

The Republic of Korea, which is developing its North Pacific pollock fishery, is now competing with Japan in the Alaska pollock-block industry. Korea's pollock-block prices this year averaged ten to twenty cents less per pound than the Japanese product although the quality reportedly was not always as good.

Cod-block prices dipped to the 60 cents per pound level in mid-1974, a factor that caused many U.S. distributors to

shift back to cod in preference to pollock. Cod-block prices strengthened by mid-October. If the trend continues, purchasers will again look favorably at the less-expensive pollock blocks as they did in late-1973 and early-1974 when cod prices were high.

A negative factor for Alaska processors to consider is that, should U.S. market prices for pollock blocks and fillets become attractive enough, Japanese processors can quickly convert from surimi products for domestic use to fillets and blocks for export to the U.S.

There is still resistance to pollock-product purchases by some large U.S. distributors and retailers. Two of the largest carry-out restaurant chains, MacDonalds and Burger King, featured cod on their menus in spite of the high product-cost. Other carry-out chains may want to feature cod in order to offer a competitive product to their consumers. However, some chains may be forced to offer a more competitively-priced product to their customers as cod prices rise.

Flatfish

The market for domestically-produced flatfish should expand by five- to fifteen-million pounds annually through 1977, as indicated by the following market conditions:

- Most of the wholesalers, processors, and retailers interviewed in the midwest and east were optimistic about the prospects for marketing flatfish fillets, in spite of the gloomy seafood-market conditions that prevailed then.

- Imports of Canadian-flounder fillets were down from 46-million pounds in 1972 to 43.6-million pounds in 1973 and declined further in early-1974.

- Demand and prices for flounder-sole fillets have remained comparatively stable. One reason for this is that much of the imported flounder products go into the restaurant trade where purchases have not fallen off as drastically as in retail markets.

Pacific Ocean Perch

We do not now foresee a promising future for Pacific ocean perch marketed in the midwest and east within the next three years. Supplies from Canada, other importers, and U.S. east-coast producers are apparently sufficient to furnish the U.S. with adequate amounts of ocean perch. If Alaskan producers are able to put a Pacific ocean perch product on the market at a competitive price, in-roads can be made into existing markets.

Minced Fish

Minced fish products sold in the U.S. have generally been of poor quality and are currently undergoing market rejection. There are some exceptions, however, of U.S.-produced and -imported minced-cod blocks, which indicates that the product will be accepted if the quality is good and the price competitive. Alaska minced-pollock blocks imported from Japan have been of poor quality. Japanese producers, however, can be expected to improve the quality of minced-pollock blocks exported to the U.S. as they have for Alaska pollock fillets and blocks. The Japanese exported 28.1-million pounds of minced-fish blocks to the U.S. in 1973, and 11.1-million pounds in January-June 1974. These products, however, are very slow in moving out of inventory.

Price Projections by Species

The following price projections are based upon past trends and, obviously, cannot account for unforeseen factors which may occur in the future. The reader is cautioned, therefore, not to accept the following projections as being absolute. Variable factors dictate that market conditions be examined almost daily to keep abreast of current trends.

Table 9.--Projected prices per pound by species

	1975	1976	1977
Alaska pollock blocks	$.39-.45	$.45-.50	$.55-.60
Flatfish fillets	$.85-.95	$0.90-1.00	$1.00-1.10
Flounder blocks	$.65-.70	$.70-.75	$.75-.80
Ocean perch fillets	$.50-.55	$.55-.60	$.60-.65
Minced cod blocks	$.30-.32	$.35-.38	$.40-.45
Minced Alaska pollock blocks	$.22-.26	$.31-.35	$.36-.39

Seafood Retail Prices

According to monthly and sometimes bi-monthly checks of supermarkets in ten cities across the U.S. by NMFS market research staff, average retail prices have increased for cod, flounder, and ocean perch fillets from April 1973 to September 1974. Retail prices have not reflected the drop in seafood wholesale prices. Most seafood retail prices have

ranged at or above $1.00 per pound while ground beef and chicken fryers have ranged near and below $1.00 per pound.

ECONOMIC ASPECTS

PROCESSING COSTS

Factory Trawler Costs

Estimated costs for processing Alaska groundfish are based on data obtained in connection with on-ship production of the Royal Sea. The 290-foot Royal Sea has an estimated processing capacity of 100,000 pounds daily, with raw-fish storage capacity of 150,000 pounds, and product-hold capacity of 1,700,000 pounds. The vessel has fishing as well as processing capability; thus, costs are divided between fishing and processing operations. However, only processing may be undertaken if fish can be purchased from other vessels at favorable prices. Estimated costs for a combined processing-fishing operation are considered in this report.

Processing costs are shown in Table 10 based on one 10-hour processing period (although two shifts are possible) using 33 employees, with estimated production of 90,000 pounds of raw fish. Processing is expected to involve 200 days to process 16,200,000 pounds. Processing labor (excluding salaried personnel) is expected to be used for 180 days, while all other categories of processing expense are expected to occur over the 200-day processing period. This allows for processing delays for repairs or similar activities, but some expenses such as food for the crew or fuel continue. Many expenses, of course, are fixed or annual items (e.g., insurance, salaried labor), and the total cost is not affected by the length of the operating period (i.e., costs for entire year are included).

Table 10.--Projected processing costs for Royal Sea (based on projection of 90,000 pounds raw fish processed daily)

	Cents per lb.
Depreciation	.815
Labor (includes payroll taxes)	1.839
Food expenses	.244
Workman's compensation	.074
Fuel	.123
Insurance	.099
Interest	.593
Maintenance and repair	.154
Miscellaneous	.062
Packaging and handling	1.000
Other (company overhead)	.154
Total	5.157 (per lb. raw fish)

Table 10.--Continued

	Cents per lb. (processed fish)
Fillet or fillet block	
Assuming 25% yield	20.628
Assuming 30% yield	17.190
Minced (i.e., deboned) block	
Assuming 35% yield	14.734
Assuming 40% yield	12.892

The projected processing costs listed above are based on experience gained from 1974 production, but do not reflect the actual results of this trial production period. The actual results were not considered to be an accurate estimate, due to the experimental nature of this processing activity and use of the vessel to process other products.

Since the projected processing costs are based on raw-fish weight, it is useful to convert this to cost per pound of finished product. Based on a 25 percent projected average yield for fillets or fillet blocks, processing costs per pound of product are estimated at approximately 20.6 cents per pound. A similar conversion for minced or mechanically-deboned product, based on a projected yield of 35 percent, is approximately 14.7 cents per pound. These estimated yields are based on a weighted average of the fish species expected (i.e., 65-percent pollock, 15-percent cod, 5-percent flathead sole, 5-percent rock sole, 5-percent rex sole, 5-percent other flatfish). This species composition is based on stock assessment data and information from the Anna Marie charter in the areas surveyed. These yields are probably fairly representative of expectations for Alaska pollock while ocean perch, rockfish, and cod would likely have higher yields. Flatfish yields vary more with size and condition. Sole were often found to be in poor condition; hence had lower yields. Relatively low overall yields may be realistic to reflect the need to cut out parasites and more machine processing. A higher yield level is also included, however, for both fillets and blocks, and for deboned or minced fish, in order to compare yield variation with other cost items in evaluating the feasibility of this fishery.

It is likely that higher-valued species, such as cod, and perhaps larger fish of lower-valued species, such as pollock, might be used for fillets, fillet blocks, etc., while other fish might be mechanically deboned. Although mechanically-deboned products are expected to have substantially lower processing costs per pound of product, the feasibility of this product depends on its relative wholesale price. It is possible that more experience with deboned products will

indicate different relative production costs between these and traditional products. At present, only differences in yield are considered, which implies that all other equipment and labor costs are similar even though more experience will almost certainly reveal that this is not true.

Land-Based Processing Costs

Apparently, inadequate experience exists now to provide additional refinement of production cost differences between on-ship and land-based processing costs. On-ship processing has advantages such as mobility and possibly discharge of waste products. On-ship processing also may produce a higher-quality product if storage time before processing is reduced. Probably somewhat greater efficiency from labor and equipment, and perhaps lower costs for fuel, labor, and other items, exist in a land-based operation. At least one other alternative processing strategy, partial processing in Alaska and shipment to the Pacific Northwest for final processing, also needs to be taken into account. The comparable differences between these methods has not been estimated in this report. Initially, plans for this study called for developing simulated cost data for a land-based and partial Alaska processing operation. Neither industry nor the NMFS food technologists involved in this study feel that adequate experience exists now to provide the technical data for further refinement of comparative processing costs.

Processing costs presented for the Royal Sea provide a basis for preliminary analysis of the feasibility of increased U.S. production of Alaska groundfish. It is likely that initial production of Alaska groundfish, if feasible at all given current market projections, may occur due to special advantages for particular processors. For example, the need to utilize existing equipment more fully may tend to stimulate expansion into these products even though initial returns might be somewhat limited.

Some land-based pilot processing operations have been carried out in Alaska by private industry. Processing costs were much higher, but actual production costs were used while cost data for the Royal Sea are projections based on pilot processing. Available information does not permit adequate comparison of total production costs between land-based and on-ship processing. For the purpose of this report (i.e., evaluating the feasibility of this fishery), it is assumed that a land-based operation would be at least as efficient as on-ship processing. The projected processing costs for the Royal Sea (Table 10) consequently are assumed to represent both land-based and on-ship processing.

Variations in processing costs are probably relatively less critical in determining total production costs than the prices paid for raw fish and wholesale product prices. This is demonstrated in a later section. Before examining total production costs and potential earnings, fishing costs are estimated followed by a summary of market price expectations (which are discussed in detail elsewhere in this report).

FISHING COSTS

Year-Around Operations

Estimated costs for fishing for Alaska groundfish are based on an initial sample of eight larger, newer vessels with good production records. These initial estimates were subsequently corrected, based on personal interviews with vessel owners. The average vessel in the initial sample used as the basis for the following estimates was 80.9 feet in length and produced catches (mainly crab and shrimp) yielding annual gross sales of $366,133 during the four years, 1970-1973. Thus, above-average vessels were selected as the starting point for evaluating fish prices necessary to attract adequate fishing effort to support an effective U.S. fishery for lower-valued Alaska groundfish. Data for an average of 3½ years were available (some vessels were not documented for the entire period, and data were unavailable for all years for some of the vessels).

The vessels included in the initial sample fished mostly for shrimp and crab. Consequently, their costs are not entirely representative for a groundfish fishery without further modification of cost estimates. An additional revision of cost estimates was also made to reflect the sharp increase in fishing costs that have occurred after the period 1970-1973 from which the initial estimates were made. Modification of the original cost and earnings data was accomplished by reviewing the initial estimates with four owners of large vessels who indicated an interest in a potential Alaska groundfish fishery. Table 11 shows the costs and earnings of the vessels in the 1970-1973 sample, and corrections made to reflect costs expected for increased operating and vessel construction costs since 1973, and higher costs for trawling compared to crab fishing. For example, trawling requires greater use of power, and hence more fuel, and causes greater stress on the vessel and equipment than fishing for king crab. The revised estimates shown in Table 11 reflect the views of vessel owners regarding higher projected costs for trawling for Alaska groundfish. Costs of ice and unloading are included in the revised estimates shown in Table 11, although these items might be furnished by the processors. Interest and insurance estimates were increased to reflect the rise in vessel values experienced in recent months. A captain's

Table 11.--Estimated fishing costs and earnings for larger vessels

Cost/Earnings	Average[1/]	Percent of Gross Sales	Revised Estimates Average[2/]	Revised Estimates Percent of Gross Sales
Gross sales	$366,133		$519,527	
Fishing costs:				
Crew labor costs	141,334	38.60	155,858	30.0
Captain (not reported separately in most cases)	10,329	2.82	77,929	15.0
Crew expenses (not reported separately in all cases)	1,319	.36		
Payroll taxes, property taxes, licenses	5,663	1.55	17,740	3.41
Fuel	24,772	6.77	50,000	9.62
Repair and maintenance	19,640	5.36	25,000	4.81
Gear and supplies	7,059	1.93	15,000	2.89
Insurance	20,646	5.64	24,500	4.72
Miscellaneous operating expenses (includes bait)	6,809	1.88	10,000	1.92
Ice			12,000	2.31
Unloading			10,000	1.92
Interest	19,333	5.28	28,500	5.49
Depreciation	48,081	13.13	43,000	8.28
Other	7,087	1.94		
Earnings before taxes	53,972	14.74	50,000	9.62
Total fishing costs and vessel earnings	$366,134		$519,527	

[1/] Based on eight larger, newer vessels from 1970-73 with 3-1/2 years average data.

[2/] Based on review of initial data by four owners of larger, newer vessels.

share is also included. Fuel, labor, and similar items are adjusted to reflect recent trends. The corrected estimates in Table 11 indicate earnings necessary to attract full-time fishing by larger vessels for Alaska groundfish.

Based on fishing results by the Anna Marie during the industry-government venture, it is projected that vessels similar to those described above could produce 200,000 to 250,000 pounds per trip. The average trip would require about ten days including unloading and delays that may occur. Vessels making 25 trips annually, with 200,000-pounds average catch, could realize earnings equivalent to those estimated in Table 11 (revised estimated costs and earnings) at an average market price of 10.39 cents per pound. If vessels averaged 250,000-pounds production for 25 trips (annually), a price of 8.31 cents per pound would be needed to provide this level of net revenue.

Prices paid to fishermen are assumed to represent a weighted average of the expected catch from the projected species composition (i.e., 65-percent pollock, 15-percent cod, 5-percent flathead sole, 5-percent rock sole, 5-percent rex sole, 5-percent other flatfish). Consequently, estimated prices to fishermen would reflect a weighted average that might result even if selective fishing were to occur for higher-priced species.

The foregoing data suggests that an ex-vessel price from six to eight cents per pound (weighted average price for all species) would be needed to attract larger, newer vessels into a year-around fishery for groundfish. In the final analysis, the price required to attract vessels would depend upon such factors as catch rates, pricing arrangements for different species, the degree selective fishing is possible for different species, length of fishing season, etc.

In addition to full-time fishing by larger and newer vessels, smaller or older vessels or less-experienced or less-capable fishermen may also participate. These vessels may have lower costs due to reduced depreciation, insurance, fuel expenses, crew shares, etc.; however, such vessels are also likely to have lower catches and earnings.

The larger crab and shrimp fleet now, compared to 1970-1973, would result in a division of the catch among more participants and, hence, tends to lower individual sales and earnings. Furthermore, good earnings in recent years apparently has resulted in substantial use of the Capital Construction Fund to delay or reduce taxes. This suggests considerable up-grading of the fishing fleet might take place during the next few years. Transfer of vessels from other areas may further increase the size of the crab and shrimp fleets. Entry of new

gear will also be heavily-influenced by fishery policy developments such as the Alaska "limited entry" management program, and the possibility of an extended U.S. fisheries zone. Entry of additional or improved vessels and gear in existing crab, shrimp, and other U.S. fisheries may greatly expand interest in a fishery for Alaskan groundfish even at lower earnings. Extended fisheries jurisdiction could have a similar result. It would be desirable to project entry of new fishing effort and likely adjustments of existing vessels and gear. No attempt was made, however, to develop projections of this type here.

The net earnings per vessel listed above is not necessarily a reflection of net income to the vessel owner. Income for vessel owners can be attributed to their own labor or their investment in the fishing vessel and gear. Thus, the net income to the vessel owner will vary depending on how much capital is borrowed (i.e., interest expense), the amount of time the vessel owner participates in fishing operations, and similar factors. The vessels included in the sample may tend to have high depreciation rates, interest costs, etc., since they are relatively new.

Fishing might occur, at least for several years, under less profitable conditions, but probably would not provide a healthy and progressive fishing sector. In the longer term, either all sectors of the industry will earn an adequate return to attract quality effort or the entire fishery would likely decline or disappear. The costs and earnings presented above are probably a reasonable estimate of prices necessary for a strong fishing sector given the conditions that have been projected. The number of fishing vessels that could achieve higher catch rates would also be limited by harvestable fish stocks. This will be influenced by domestic fishery management policies and foreign fishing effort.

Based on available information, the projected costs and earnings are probably representative of price levels necessary to attract large and modern vessels needed to operate over-extended areas and during adverse weather conditions, and deliver larger fish catches. Smaller or older vessels may be effective in some areas or seasons, particularly on grounds close to landing ports and during summer months.

Seasonal Operations

The initial interest of most vessel owners in groundfish may be largely limited to a seasonal fishery if market prices are relatively low. Thus, a fishery may be feasible for some vessels in certain areas or seasons even though fish prices are not adequate to attract sustained fishing effort throughout the year by a larger number of vessels. Processors may

also be interested in similar seasonal production patterns to increase production through increased plant utilization and expand their output from existing facilities with minimum capital outlay.

Thus, a fishery may at least begin as a seasonal effort to increase earnings for both fishermen and processors. Estimated cost and earnings necessary for a seasonal fishery are based on the assumption that vessel earnings would reflect only the proportional amount of all expenses including interest, depreciation, and insurance. The only return to the vessel owner in this case is in the form of covering fixed expenses such as interest and depreciation. If no other alternative fishery existed, vessel owners might prefer to participate in a groundfish fishery under these conditions in preference to remaining idle. The return to the vessels, in this case, would probably not be adequate to attract a sustained year-around fishery for groundfish, but might support a seasonal fishery. If fishing were to occur during a five-month period between January and July, 50 percent of the annual expenses shown earlier (except return to the vessel) could be covered at a price of 9.39 cents per pound if production was 2,500,000 pounds. If production reached 3,125,000 for this period (250,000-pounds average per 10-day trip), the market price would need to be 7.51 cents per pound.

Vessel owners point out the need for approximately $100,000 additional investment to convert vessels (or construct new vessels) equipped for trawling. Furthermore, the additional power requirements and more rapid depreciation of vessels (e.g., compared to king crab) is likely to restrict interest in a seasonal fishery unless ex-vessel market prices are in this general range. The necessary investment to gear-up for this groundfish fishery, however, may serve to dispel concern expressed by some processors that a seasonal fishery may not have sustained fishing effort from year to year. If fishermen have an especially good year, for example, with king crab, some concern was indicated that there might be less interest in trawling for groundfish than during years of poor prices or poor catch in other fisheries. Vessel owners indicate that anyone investing in the capability for trawling would be likely to fish consistently even in a seasonal fishery in order to utilize this investment.

Royal Sea Operation

Projected costs per pound of fish landed by the Royal Sea (Table 12) are much less than those indicated above for the smaller vessels participating in a seasonal fishery. This is due mostly to the much greater production projected for the Royal Sea and its capability for both fishing and processing. A cost of 2.39 cents per pound was estimated for the Royal Sea.

based on a projected daily catch of 90,000 pounds. Individual components of this cost are shown below. The trawling cost projections for the Royal Sea assume that processing also takes place. Many cost categories such as labor, depreciation, and other items that are needed for both trawling and processing have been distributed to each function. Both the trawling costs shown in Table 12 and the processing costs presented in Table 10 assume that the Royal Sea and necessary salaried personnel are used only for Alaska groundfish production.

Table 12.--Projected trawling costs for the Royal Sea. (Cents per pound of fish landed)

	90,000 lbs. Daily Catch
Labor and payroll taxes	.648
Crew expenses (food)	.073
Fuel	.711
Repair and maintenance	.154
Gear and supplies	.130
Insurance	.100
Miscellaneous	.062
Interest	.296
Depreciation	.062
Other (company overhead)	.154
Total cost per pound of fish landed	2.390 cents

FEASIBILITY ANALYSIS

The feasibility of a U.S. fishery for Alaska groundfish may be examined by comparing the ex-vessel price processors might be able to pay with the price fishermen are likely to need for sustained fishing effort. The price processors may be able to pay depends on projected market prices (discussed in an earlier section) less all projected production costs. Estimated production costs for different ex-vessel prices are summarized in Table 13.

In most cases, the ex-vessel fish prices of Table 13 reflect the various levels of fishing costs estimated in previous sections. Processing costs are the projections based on operation of the Royal Sea. Transportation costs to Seattle represent an average for all areas. Handling and short-term storage (30 days) establishes the basis for comparing production costs with projected market prices (discussed in a previous section) which are summarized in Table 14.

Table 13.--Estimated production costs (all prices are cents per lb.)

	Millions of lbs. production											
	Royal Sea				Seasonal Fishery				Annual Fishery			
Ex-Vessel Price	2.39		6.0		7.51[1]		9.39[2]		8.31[3]		10.39[4]	
Projected yield	30%	25%	30%	25%	30%	25%	30%	25%	30%	25%	30%	25%
Raw fish price	7.97	9.56	20.00	24.00	25.03	30.04	31.30	37.56	27.70	33.24	34.63	41.56
Estimated processing costs (Royal Sea) [5]	17.20	20.60	17.20	20.60	17.20	20.60	17.20	20.60	17.20	20.60	17.20	20.60
Transportation to Seattle	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Handling and short-term storage	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Total production costs	32.47	37.16	44.20	51.60	49.23	57.64	55.50	65.16	51.90	60.84	58.83	69.16

[1] 3.125 million lbs. production expected to result from approximately 12-13 trips of 10 days each (during 5-month period) with landings around 250,000 lbs. per trip (i.e., 12.5 trips of 250,000 lbs. each).

[2] 2.5 million lbs. production--same as above except per-trip landings of 200,000.

[3] 6.25 million lbs. production--based on 25 trips (annually) with 250,000 lbs. per trip.

[4] 5.0 million lbs production--based on 25 trips (annually) with 200,000 lbs. per trip.

[5] From Table 10.

Table 14.--Projected wholesale prices using weighted average of species mix (F.O.B. Seattle--cents per pound)

	Weighted Average Projected Price Range (1975)[1/]	Projected Species Mix	Weighted Average Price
Pollock blocks	42.0	.65	27.300
Flatfish fillets (rex sole and flounder)	90.0	.10	09.000
Cod fillets and blocks	52.5	.15	07.875
Flounder blocks (rock sole, flatfish)	67.5	.10	06.750
			50.925
Less 4% brokerage fee			-02.037
			48.888

[1/] From Table 9.

With a projected net wholesale price (weighted average of species) of about 48.9 cents per pound (Table 14), and the projected production costs shown in Table 13, ex-vessel fish prices would have to be about 6 cents per pound or less with a 30-percent yield, or five cents per pound or less with a 25-percent yield, to permit earnings for processors adequate to sustain a full-time fishery on Alaska groundfish. Earnings prospects may need to be substantially better than this, however, to encourage initial capital investment by either processors or fishermen.

A seasonal fishery may be feasible, based on the information summarized in Tables 13 and 14, if yields near 30 percent are possible. This yield level exceeds that expected by NMFS food technologists, however, who project a 25-percent yield on fillets for the species involved. However, improved quality will likely lead to increased acceptance of "minced" or deboned fish products. If yields can be increased to 35 percent or more, this would improve the attractiveness of potential earnings. Yields of minced pollock, for example, may be around 40 percent, based on projections from pilot operations conducted in conjunction with this research. A combination of minced products and fillets (and related products) may increase overall yields and provide for expanded industry investment. Selective fishing might also improve projected yields, and either fishing or processing costs might be reduced by improved technology or increased production efficiency.

Near-term expansion of U.S. harvest of Alaska groundfish seems likely to involve processors with capability of expanding into this product with minimum additional costs and increased earnings by utilizing existing idle resources. Projected fish prices also suggest the likelihood of a similar situation for vessel owners, probably implying a seasonal fishery when vessels otherwise would be idle and perhaps involving vessels already equipped for trawling. Substantial production may be possible by utilizing opportunities of this type--even though greater expansion of production, and perhaps more stable production, may be feasible only in the more-distant future.

SUMMARY AND DISCUSSION

Basis for this cooperative venture between industry and government was the belief that such collaboration would be most effective in acquiring the kinds of information needed to make timely and informed decisions on the domestic utilization of Alaska groundfish. This belief seems to have been justified in that the venture has contributed much new knowledge in a form that is particularly useful to both industry and government. The knowledge, of course, is confined to the times and places the survey occurred. Additional effort would be required to obtain a more complete picture.

The fishing trials were carried out successfully from the 86-foot trawler, Anna Marie, demonstrating that a vessel of that type and size would be capable of participating in a future commercial fishery. The captain of the Anna Marie was given as free a hand as possible to make the fishing trials closely comparable to commercial fishing operations. Services provided by the captain, crew, and vessel were excellent and fulfilled the highest expectations of the vessel-selection committee.

Several lessons emerged concerning the selection of more appropriate gear for future commercial fishing operations. Although both the Eastern and Norwegian trawls used on the trials were good fishing nets, for future operations the Eastern should be constructed of heavier thread, preferably 60-thread nylon. Breastlines should be made of 3/4-inch polypropylene rather than 5/8-inch nylon, and the riblines should be hung-in more. Improvements to the Norwegian trawl would include 3/4-inch polypropylene breastlines and changing the towing section of the breastlines to 9/16-inch wire rope.

Use of bobbin gear is desirable when trawling on hard or uneven bottoms. While the bobbin gear used on the fishing trials had the desirable effect of substantially reducing the incidental catches of crab and halibut, modifications should be investigated with the objective of further reducing the catches of crab and halibut. In this regard, Captain Jensen of the Anna Marie suggests the use of "light" bobbin gear constructed of about six evenly-spaced bobbins. The purpose would be to lift the trawl footrope 8-10 inches off bottom, and thereby reduce the catches of crab, halibut, and small flatfishes, while at the same time decreasing the possibility of crushing crab with the numerous rollers employed on a full string of bobbin gear. Gear evaluations of this character might show that the same performance could be obtained by using less than six bobbins and that perhaps one large bobbin at each wingtip might be adequate.

The fishing trials conclusively demonstrated the need for midwater trawling capability to catch pollock, cod, Pacific ocean perch, and perhaps other species when they are schooled some distance above the sea floor. On several occasions, it was felt that catches by the Anna Marie would have been much larger, and more selective fishing for desired species such as pollock and cod would have been possible, if midwater trawling capability had existed. Judging from "fish signs" seen on the echo sounder, a midwater trawl should have at least a 22-foot vertical opening. For positioning the midwater trawl to intercept fish, an acoustical net sonde mounted on the headrope would be required and should be capable of sounding at least 100 feet up, 100 feet down, as well as ahead of the net. The transducer should be mounted in a durable case allowing the unit to remain on the headrope at all times. Combination trawl doors could be employed for use with both bottom and midwater trawls. A good choice of nets for future operations would be the Norwegian trawl with a light string of bobbins for fishing on bottom and a midwater trawl of proven design for fishing above the sea floor.

When considering the results of the fishing trials, it is important to remember that they can only be safely assumed to apply to the particular times and grounds surveyed by the Anna Marie. At other times of the year and on other grounds, the distribution and abundance of fish could be quite different. This would be particularly true for fish which make extensive seasonal migrations, such as pollock in the Bering Sea. It would also be true for species which ascend considerable distances above the sea floor with the onset of spawning or for specialized feeding requirements, etc.

The fishing trials demonstrated the presence on some grounds of substantial concentrations of fish at depths of 70-120 fathoms on mud, sand, or gravel bottom. The concentration

mainly consisted of pollock and Pacific cod, with lesser amounts of Pacific ocean perch and flatfishes. Pollock, cod, and ocean perch were generally large and of good quality, but a high proportion of the flatfishes was too small for filleting. Greatest potential was found near Sanak, southeast of Akutan, south of Unalaska, north of Unimak Pass, and in the Kodiak area. Near Sanak, cod dominated the catches; in the other areas, catches consisted of 65-80-percent pollock, and 5-15-percent cod. On some grounds, substantial concentrations of turbot, other flatfishes, and Pacific ocean perch were encountered. Although catches in the Kodiak area were large, they contained more crab and small fish, and there was a greater mix of species than from grounds to the westward.

Considerably poorer fishing results occurred around the Shumagin Islands, in the southeastern Bering Sea, and from Seward Gully to Montague Island. Additional impediments to a potential trawl fishery in the Shumagin Island area were irregular and hard bottom, which caused excessive wear and damage to trawl gear, and the presence of large quantities of snow crabs. Potentials along the Aleutian Chain west of Unalaska remain questionable because much of the fish present were far enough above the sea floor to be unavailable to the trawl gear employed from the Anna Marie.

The problem of incidental catches of crabs and halibut would have to be considered in the selection of fishing grounds and gear. Halibut were caught in all areas fished, and king and snow crab in six of the nine areas fished. King crab appeared to be more localized than snow crab. The fishing trials clearly demonstrated that the use of bobbins substantially reduces the catches of king and snow crab and, to a lesser degree, reduces the catches of halibut. Incidental catches would be minimized with the use of midwater trawls.

The key technological aspects investigated were the quality of the catch, its keeping characteristics aboard vessels, and the best method for processing and utilizing the fish for a good dollar-return. Emphasis in the technological studies was given to pollock because it has the potential for contributing large-volume catches and comprises a very large resource in the North Pacific.

It was not surprising, in light of previous knowledge, to confirm that pollock will have to be sorted and iced or refrigerated promptly if it is to be suitable for producing a quality product, either as fillets or as minced-flesh blocks. However, preliminary evaluation by NMFS personnel of effects of storage on the frozen pollock fillets and blocks obtained from this venture shows that, with proper care, pollock can provide quality products of good storage characteristics and good consumer acceptability. This means that fishermen and processors must adopt high standards in the handling, preservation, and processing of pollock and other species; otherwise, serious quality and market problems will develop.

Research to determine the availability of fishery resources and the application of preservation and processing technology emphasizes the technical feasibility of U.S. participation in harvesting and utilizing Alaska groundfish. The purpose of marketing and economics evaluation, on the other hand, is to estimate economic feasibility, i.e., the potential profits or net revenue from the fishing, processing, and marketing operations.

The principal goals of marketing research in this study were to evaluate current interest and views regarding markets for Alaska groundfish products and to project possible wholesale market prices (F.O.B. Seattle). Using these projected wholesale prices, the economic feasibility was then evaluated by estimating processing and production costs to determine the maximum ex-vessel prices processors might be willing to pay. Fishing costs were estimated to determine the minimum ex-vessel price likely to attract fishing effort. The estimated maximum ex-vessel prices processors might pay were compared with the estimated minimum ex-vessel prices fishermen would likely accept to evaluate the economic feasibility of harvesting Alaska groundfish.

Analysis of marketing aspects was made when inventories of frozen fish and shellfish were at an all-time high and seafood sales were in a slump. This undoubtedly influenced the purchasing agents, distributors, and wholesalers who were questioned concerning their views on the utilization of Alaska groundfish. Despite the unfavorable sales conditions when the interviews were held, most respondents said they were looking for new sources of supply, new species, and better methods of processing. Many were interested in obtaining domestically-produced products from Alaska groundfish, but only if competitively priced and equal in quality to products available from other sources.

Judging from past trends, an increase in U.S. consumption of groundfish products is expected to be around 50-million pounds from 1973-1977, and 200-million pounds by 1983. If domestically caught and produced, Alaska fishery products are marketed as high-quality items; and, at a competitive price, they could capture a significant share of the U.S. market. In view of the growing world demand for protein, it will be increasingly difficult to satisfy U.S. needs by imports. This, along with technological developments in broadening the uses of fish-muscle protein, can be expected to further contribute to the potential profitability of a domestic fishery for Alaska groundfish.

Wholesale market prices (F.O.B. Seattle) were estimated, and the costs of processing and transporting fish to Seattle were projected as the means to estimate ex-vessel prices processors

might be able to pay. Processing costs are based on data obtained from the pilot production operation on the Royal Sea. A cost of approximately 5.2 cents per pound of raw product handled was estimated based on projected costs for each phase of the Royal Sea processing operation. An attempt was made to compare this to similar cost estimates for land-based plants. Some pilot production of this type has been undertaken by Alaska processors. However, inadequate information was available for reliable comparisons. Consequently, the projected processing costs for the Royal Sea were used to represent both on-ship and land-based operations.

Fishing costs were estimated based on costs and earnings of larger, newer vessels landing shrimp and crab during 1970-1973. These costs and earnings were then revised by asking owners of vessels that might be used in an Alaska trawling operation to indicate changes needed to reflect higher costs that have occurred since 1973 and expected differences in trawling costs compared to crab or shrimp fishing. Ex-vessel prices needed to attract vessels for seasonal fishing were also projected. Trawling costs were also projected for the Royal Sea since this vessel is equipped for both processing and fishing.

Based on current projections, processors could not pay more than about 6 cents per pound ex-vessel price if yields are around 30 percent (weighted average of species), or about 5 cents per pound if yields are around 25 percent. NMFS food scientists believe 25-percent yields of fillets from pollock may be more likely. Yields of minced pollock were 36 percent. This yield would be close to 40 percent if butchering were performed by more-experienced people.

Plants could diversify, not only into pollock, but also into other groundfish species. Inclusion of other species seems desirable because of the previously-mentioned problems with pollock which will require time to solve (selective fishing capability, need for careful handling and preservation, variable size and quality). The high quality and abundance on some grounds of species such as cod and rex sole is further evidence that, combined with a pollock catch, a groundfish fishery during the off season for crab and shrimp may be feasible before a year-around fishery develops.

The use of trawlers with freezing capability could have merit in view of the problems in preserving fresh fish at sea and the limited processing facilities and labor force in some areas. Catches could be frozen in the round or dressed aboard the freezer trawlers for later processing to fresh fillets, fillet blocks, minced-flesh blocks, or direct use in a wide variety of products, including precooked fishery items.

With adequate cold storage facilities for stockpiling deliveries of frozen fish, existing plants could schedule the processing of groundfish to best fit in with their operations for other species. This would be a cost-effective way of utilizing existing facilities and plant areas. During the off season for shrimp and crab, the deliveries of frozen groundfish might be supplemented by deliveries of fresh fish by trawlers making short trips to nearby grounds.

Conclusions drawn in this report should be viewed as tentative and based on current conditions. Conditions can change quickly, and several possible developments could improve the prospects for U.S. production of Alaska groundfish.