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ALASKA SHRIMP EXPLORATIONS, 1962-64

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ABSTRACT

Recognizing the need for more detailed knowledge of potential Alaska shrimp resources, the U. S. Bureau of Commercial Fisheries conducted intensive exploratory fishing with shrimp trawls during the summers of 1962, 1963, and 1964. Waters explored during the 3 years included those of the northern Gulf of Alaska between Cape Suckling (lat. 60° N., long. 144° W.) and Unalaska Island (lat. 54° N., long. 167° W.). Some preliminary explorations were made in portions of the Bering Sea. During the studies, 539 trawl drags (ranging from 30 to 60 minutes each) captured over 100,000 pounds of shrimp. Pink shrimp (Pandalus borealis) made up 72 percent of the total catch, and averaged 90 shrimp per pound. A larger species, side-stripe shrimp (Pandalopsis dispar), made up 18 percent of the catch. Smaller amounts of other species were taken.

The highest average catch rates were made in the general vicinity of the Shumagin Islands where 82 trawl drags of about 30 minutes averaged over 650 pounds per drag.

Observations were made on the occurrence of other species including king, Dungeness, and tanner crabs. During 1963 and 1964, 56 percent of the fish species caught incidentally included various types of flatfish; pollock, rockfish, and other species were important in the remainder.

INTRODUCTION

During recent years, shellfish (including shrimp, crab, lobsters, etc.) have been consumed in increasing quantities in the United States. For example, the total production of U. S.-caught shrimp during 1950 was 191 million pounds. In addition, 40 million pounds of shrimp were imported into the United States for a total supply of 231 million pounds. In 1963, U. S. vessels produced 240 million pounds of shrimp, and an additional 152 million pounds were imported into the United States for a total supply of 392 million pounds (Power 1964). The demand for shrimp has greatly exceeded the domestic supply in recent years. A ready, potential market for shrimp products exists in the United States.

The demand for shrimp products is reflected in the increased landings of Alaska shrimp recently. During the 13-year period 1950-63, the landings increased sevenfold from 2.1 to 15.1 million pounds. Prior to 1958, Alaska shrimp production varied between 1 to 2 million pounds per year. From 1958 to 1963, when the fishery had its greatest growth, shrimp production averaged 12.7 million pounds (Harry 1964). This level of production, however, is probably far below the maximum production because the fishery is now still quite localized.

A primary factor in the greater use of Alaska shrimp has been the development and application of new techniques in processing. Prior to 1957, all Alaska shrimp were peeled by hand and marketed as fresh or frozen shrimp meat. Although hand-peeled shrimp meat continues to be produced, most of the shrimp landed during 1963 were processed by machines. Machine-peeled shrimp meat were marketed canned or frozen in shrimp "logs." Those products, however, did not have the good market demand of hand-picked shrimp products. Further growth of the Alaska shrimp industry would be greatly aided by technological advances in volume storage and in peeling processes to minimize changes in color, flavor, and texture of the product.

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The purpose of this paper is to present a general summary of the relative abundance of pandalid shrimp in the areas of explorations.

PREVIOUS EXPLORATIONS

During 1950-59, Bureau of Commercial Fisheries vessels made 10 exploratory shrimp cruises in Alaska waters. Of the 10 cruises, 4 were made off Southeastern Alaska, 5 off Central Alaska, and 1 off the Alaska Peninsula. The primary aim of the shrimp explorations was to determine the distribution and availability of shrimp in those areas. Large concentrations of shrimp were located in numerous areas around the Kenai Peninsula and Kodiak Island in waters off Central Alaska and around the Shumagin Islands in waters off the Alaska Peninsula. The results of the shrimp exploratory cruises have been incorporated into a summary report by Ronholt (1963). Supplementary information regarding commercial concentrations of shrimp is also available from explorations in Alaska waters by Russian (Ivanov 1962) and Canadian[1/] nationals. Russian explorations delineated concentrations of shrimp around the Shumagin Islands and Kodiak Island. Canadian explorations located large concentrations of shrimp off Kodiak Island.

1962-64 EXPLORATIONS

The investigations were carried out in three stages during the summers of 1962, 1963, and 1964. In 1962, the 6-week period from August 21 to October 4 was spent in exploring the waters off Central Alaska from Nuka Island eastward to Cape St. Elias. During the 9-week period from July 8 to September 11, 1963, the waters off Central Alaska were explored from Montague Island westward to Chrikof Island. During the 1964 cruise, the waters of Central Alaska, Alaska Peninsula, and the Bering Sea were explored from Kodiak Island to Unalaksa Island to Bristol Bay. This cruise extended for a 13-week period from June 16 to September 19. The three cruises were planned to provide more detailed information on the species, size, and abundance of shrimp in the northwestern Gulf of Alaska and Bering Sea. The Bureau of Commercial Fisheries had not previously explored the Bering Sea for shrimp.

Most explorations during the three cruises were made in areas where future development of the fishery appeared logical. Certain phases of the explorations, however, were at locations where no immediate fishery development is anticipated because of a combination of circumstances, particularly the distance from processing centers.

VESSELS

Charter vessels were used. The M/V Yaquina made the 1962 and 1963 cruises; and the M/V Paragon, the 1964 cruise.

The Yaquina (fig. 1) is a typical Pacific Northwest multipurpose purse-seine type vessel with house forward and work deck aft. The registered length is 75.1 feet, and gross tonnage is 109 tons. A 460-hp. diesel engine provides propulsion and drives generators and hydraulic pumps. The vessel is equipped with hydraulic trawl winches and a hydraulic net reel which is used to retrieve and store the trawl net. In most instances the reel was used to haul the shrimp trawl over the stern.

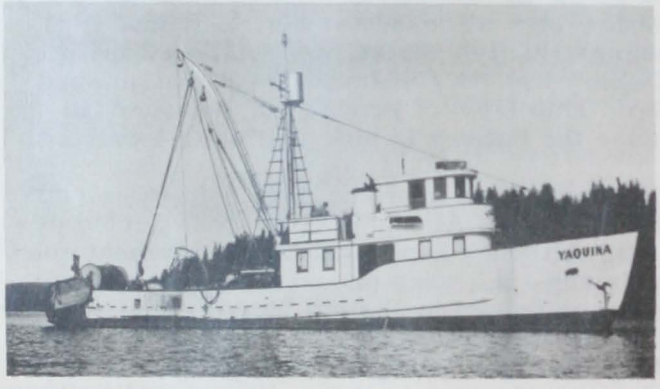

Fig. 1 - M/V Yaquina, chartered by the U.S. Bureau of Commercial Fisheries during summers of 1962 and 1963.

The Paragon (fig. 2) is a Pacific halibut schooner with house aft and well deck amidships. It has a registered length of 80.1 feet and a gross tonnage of 99 tons. Propulsion and trawl winch power are provided by a 390-hp. diesel engine. The trawl winches are mechanically driven. Since the work area on this vessel is amidships, the trawl bag was

1/Cruise Report for the G. B. Reed, Cruise #7, August 20-September 22, 1963. Fisheries Research Board of Canada, Biological Station, Nanaimo, British Columbia, Canada.

ken aboard with boom and tackle after being brought forward on the starboard side to the ell deck by means of a lazy-line.

The vessels Yaquina and Paragon were uipped with a full complement of naviga- nal and fishing aids including loran, radar, diotelephone, automatic pilot, and depth- corder. The depth-recorders were of the hite-line" type with a range of over 500 thoms.

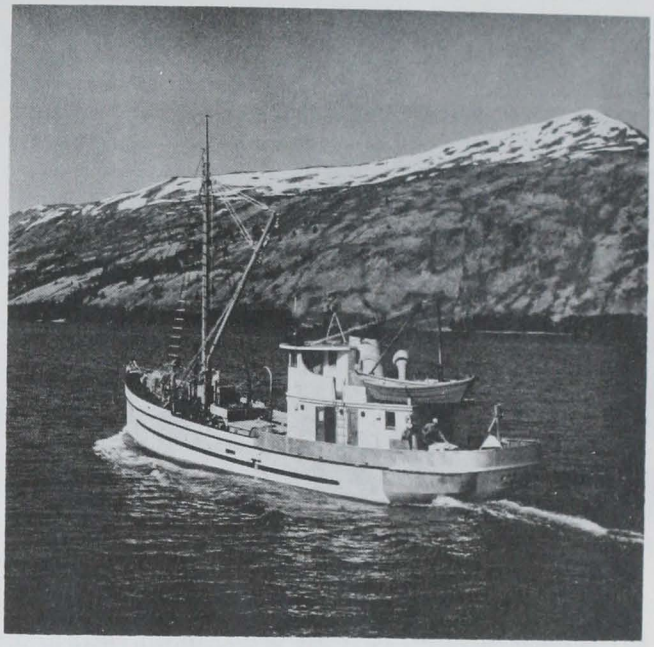

Fig. 2 - M/V Paragon, chartered by the U. S. Bureau of Commercial Fisheries during summer 1964.

GEAR

During the cruises, three types of shrimp awls were used. In 1962, all but two of the awl drags were made with a semiballoon rimp trawl measuring 70 feet along the foot- pe (Greenwood 1959). In 1963, the 40-foot at shrimp trawl was the primary sampling ear, while in 1964, both the 40-foot flat and e 40-foot semiballoon trawls were used uss 1963). All three types of nets were ade of $1\frac{1}{2}$-inch stretched mesh nylon web- ng.

The footropes of the trawls were appro- iately weighted with chain and/or wire rope that the nets would fish more effectively on the bottom. The 70-foot semiballoon trawl, ich had two warps and 7-foot trawl doors, was towed in the same manner as in otter trawl- g. The 40-foot trawls were towed by a single warp with 25-fathom bridles and 5-foot trawl ors.

METHODS

The exploratory techniques used were those developed during previous Bureau of Com- rcial Fisheries shrimp work in the North Pacific (Ronholt 1963) and other regions. Modi- ations were made to satisfy the needs of the local conditions.

DRAG SAMPLING PROCEDURE: In a few instances, fishing stations were occupied ere prior information had indicated that shrimp were concentrated. For the most part, hing stations were completed in areas not previously sampled with shrimp trawls, or ere only limited knowledge of the shrimp resources was available. In those areas, an at- pt was made to fish all the bays with suitable trawling grounds. In the offshore areas, hing was carried on to provide information on the shrimp resources in the gullies and de- essions of the Continental Shelf rather than in the shoal areas.

Selection of areas to be fished was determined after U. S. Coast and Geodetic Survey arts of the region were studied. Fishing effort was concentrated primarily on muddy bot- m areas between 50- and 100-fathom depths, because previous exploration had found those eas most productive of shrimp. As the vessel traveled over the area selected for sampling, high-resolution, low-frequency echo-recorder was used to show the nature of the bottom. drag was usually made if the profile of the bottom was reasonably level and the substrate d a soft consistency. Drags were usually 30 minutes long; timed from the setting of trawl inch brakes to the beginning of hauling the trawl back. Whenever good catches of shrimp ere taken, additional drags were made nearby to delineate the extent of the productive ound.

CATCH SAMPLING PROCEDURE: After the trawl warps were hauled in, the trawl doors ere secured and the net hauled aboard. The contents of the trawl were emptied onto a sort- g table capable of holding 1,000 pounds of shrimp (fig. 3).

An unselected sample of shrimp was taken and separated into component species from which estimates were made of the percentage each species contributed to the total shrimp catch. When the catch was large enough, a sample of each shrimp species was weighed and counted to obtain the number of individua shrimp required to make up 1 pound. Intermittently, samples of pink and side-stripe shrimp were measured and their sex determined.

Fig. 3 - Trawl catch being culled on the sorting table, M/V Yaquina.

The remaining shrimp catch was sorted into wire bushel baskets, and total poundage estimates were made from the number of baskets filled. Poundages of each shrimp species were determined by multiplying the total shrimp catch by the percentage estimates.

Dominant fish species and species groups were also sorted into bushel baskets. Estimates of miscellaneous invertebrate groups and debris were made by eye.

All halibut, plus king, Dungeness, and tanner crabs were sorted from the catch. The total length of each halibut was measured, and the weight estimated. The sex and number of king and Dungeness crabs, and the number of adult tanner crabs were recorded, and their average weights estimated.

ANALYSIS OF DATA

The size of the trawls used for the shrimp explorations varied somewhat from year to year. In these studies, the shrimp catching ability of the 40-foot flat trawl and the 40-foot semiballoon trawl is considered to be identical, and those trawls are taken as the standard unit of gear. Through much of the 1962 explorations, a 70-foot semiballoon trawl was used. We assume that the 40-foot trawl has four-sevenths the spread of the 70-foot trawl. For comparative purposes, therefore, a factor of 0.6 was used to convert the catch of the 70-foot trawl.

The average duration of the drags also varied from year to year. In 1962, the drags were usually 1-hour long; in 1963-64, they were usually 30 minutes. Therefore, the 1962 catch figures have been converted to expected pounds per standard gear per 30 minutes of trawling. The 1963-64 catch figures are actual pounds per standard gear per about 30 minutes of trawling.

A few drags were considered to be ineffective because the absence of bottom organisms suggested that the trawl was not functioning properly. Other drags in which a large portion of the catch was lost due to damage or for other reasons were also considered as ineffective drags.

AREAS

During the 1962-64 shrimp cruises, the perimeter of the Gulf of Alaska from Cape Suckling to Unalaska Island (including parts of Prince William Sound, southern Cook Inlet, and Shelikof Strait) and selected areas of Bering Sea and Bristol Bay were explored (fig. 4). A general description of the Continental Shelf and Slope and the salient oceanographic conditions prevailing throughout that area is given by Alverson, Pruter, and Ronholt (1964).

To facilitate cruise planning and comparative evaluation of catch data, the explored areas were divided into eight geographic entities (fig. 4). These are as follows:

AREA A encompasses the ontinental Shelf from Cape ckling to Nuka Island and ince William Sound. In that ea, much of the Continental elf is over 50 fathoms deep. ince William Sound has few al areas less than 50 fath-s, and much of the area has ths over 100 fathoms. For e most part, areas of less an 50 fathoms have sand, avel, shell, or hard bottoms. the deeper areas, gray mud edominates. The bottoms e generally favorable for awling operations throughout ea A, which was the most tensively covered, with 37 rcent of the total effort.

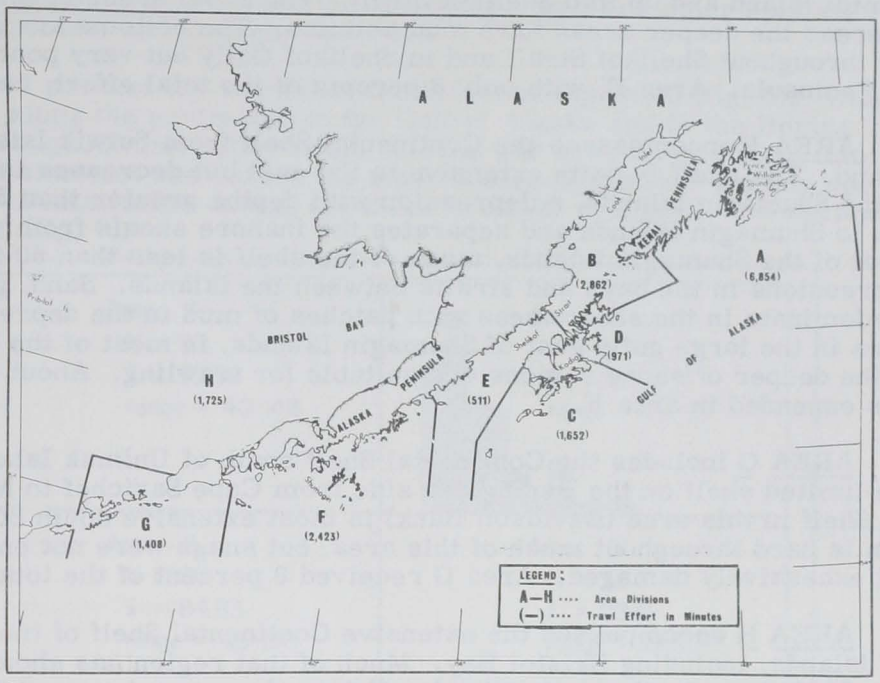

Fig. 4 - Map depicting the area of the Gulf of Alaska and Bering Sea where shrimp explorations were conducted during summers of 1962 through 1964.

AREA B includes the re-ons adjacent to southern enai Peninsula, northern elikof Strait, and southern ook Inlet including Kachemak ay. Cook Inlet and Kachemak Bay are extensive shoal areas less than 50 fathoms, whereas uch of Shelikof Strait is over 100 fathoms deep. Bottom sediments in the shoal areas are edominantly sand, gravel, or shell with mud in the deeper reaches of Shelikof Strait. The bottoms are poor for trawling (fig. 5) between Kenai Peninsula and Afognak Island, but generally favorable for trawling in Cook Inlet, Kachemak Bay, and Shelikof Strait. Area B received 16 percent of the total effort expended.

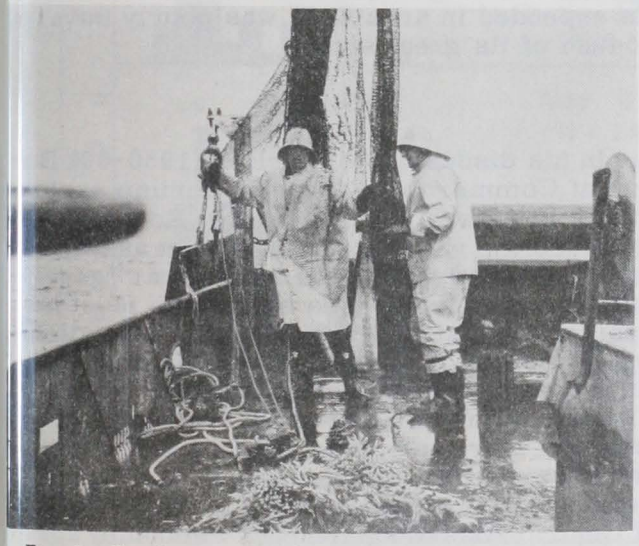

Fig. 5 - Trawl net damaged by towing over coral bottom.

AREA C encompasses the Continental Shelf south of Kodiak Island. Much of the shelf in that area is less than 50 fathoms deep. Sand, gravel, shell, and hard bottoms predominate throughout area C, except for patches of mud bottom in the bays of Kodiak Island and in the gullies of Albatross Bank. Though previous explorations reported poor trawling conditions in that area, our trawls were not damaged. Area C received 9 percent of the total effort.

AREA D includes Marmot and Chiniak Bays and offshore to the 100-fathom depth rve. In that area, Portlock and Chiniak Grounds are extensive shoal areas intersected by pressions and gullies (Marmot Gully, Chiniak Gully). Sand, gravel, shell, and hard bottoms redominate in the shoal areas, with patches of mud occurring in the deeper areas. Nearly l the trawl effort in area D was concentrated in outer Marmot Bay and Marmot and Chiniak ullies. Less than 5 percent of the total effort was expended in area D.

AREA E includes lower Shelikof Strait and extends westward along the Alaska Peninsula Sutwik Island. Shoal areas less than 50 fathoms are not extensive in area E except around midi Islands. A deep gully over 100 fathoms deep extends inshore between Chirikof and

Semidi Island and up into Shelikof Strait. The shoal areas have sand, shell, and hard bottoms, whereas the deeper areas have mud bottoms. The bottoms are generally favorable for trawling throughout Shelikof Strait and in Shelikof Gully but very poor in the shoals along the Alaska Peninsula. Area E, with only 3 percent of the total effort, received the least coverage.

AREA F encompasses the Continental Shelf from Sutwik Island to Cape Pankof on Unimak Island. The shelf is quite extensive to the east but decreases in width to the westward. East of the Shumagin Islands, a depression with depths greater than 50 fathoms extends from Sutwik to Shumagin Islands and separates the inshore shoals from an extensive shoal offshore. West of the Shumagin Islands, much of the shelf is less than 50 fathoms, but with numerous depressions in the bays and straits between the islands. Sand, gravel, shell, and hard bottom predominate in the shoal areas with patches of mud in the depressions and gullies. The bottoms in the large gully east of Shumagin Islands, in most of the bays along the Peninsula, and in the deeper offshore regions are suitable for trawling. About 13 percent of the total effort was expended in area F.

AREA G includes the Continental Shelf south of Unimak Island to eastern Unalaska Island the limited shelf on the Bering Sea side from Cape Sarichef to Makushin Bay. The Continental Shelf in this area (Davidson Bank) is most extensive south of Unimak Island. The sea bottom is hard throughout much of this area, but snags were not encountered and the trawls were not excessively damaged. Area G received 8 percent of the total effort.

AREA H encompasses the extensive Continental Shelf of the Bering Sea south of the Pribilof Islands, including Bristol Bay. Much of that region has shoal areas less than 50 fathoms. The 50-fathom depth curve extends offshore for a maximum of 300 miles from inner Bristol Bay, and the 100-fathom curve is 100 miles farther out at some locations. In Bristol Bay, the bottom is predominantly mud, changing to sand, gravel, and shell in the offshore Bering Sea, and changing again to mud along the edge of the Continental Shelf and Slope. The bottoms are favorable for trawling throughout the Bering Sea. Although 9 percent of the total effort was expended in area G, it was poorly covered because of its great size.

Fig. 6 - "Clean" catch consisting predominantly of pink shrimp.

RESULTS

In his discussion of earlier (1950-60) Bureau of Commercial Fisheries shrimp explorations in Alaska and elsewhere, Ronholt (1963) discusses the validity of his data in assessing total population sizes. He states that "general conclusions of inter-area abundance must be considered relative and perhaps more indicative of availability than of true abundance." While the same generalities apply to our results, sampling during the 1962-64 explorations was more intensive and in a more restricted area than the earlier work. From an overall analysis, the results for the waters off Central Alaska and Alaska Peninsula agree quite closely with those of the 1954-59 explorations. It is strongly suggested, therefore, that the present findings are reasonably accurate measures of the areal abundance of pandalid shrimp in the northern Gulf of Alaska during the "summer" season.

During the 1962-64 cruises 118,200 pounds of shrimp were caught. The principal species were pink (Pandalus borealis), side-stripe (Pan-

alopsis dispar), humpy (Pandalus goniurus), coonstripe (P. hypsinotus), and other species primarily P. montagui, Argis species, and Crangon species).

Pink shrimp accounted for 72 percent (by weight) of the total shrimp catch (fig. 6). This pecies was caught in all areas along the perimeter of the Gulf of Alaska and in the Bering ea, but not in Bristol Bay. Throughout that entire area, catches per drag ranged from 0 to 000. The pink shrimp was the smallest and varied the most in size of the four shrimp spe- es caught in large quantities. Pinks, taken during the three cruises, averaged 90 count and nged from 40 to 297 per pound (fig. 7).

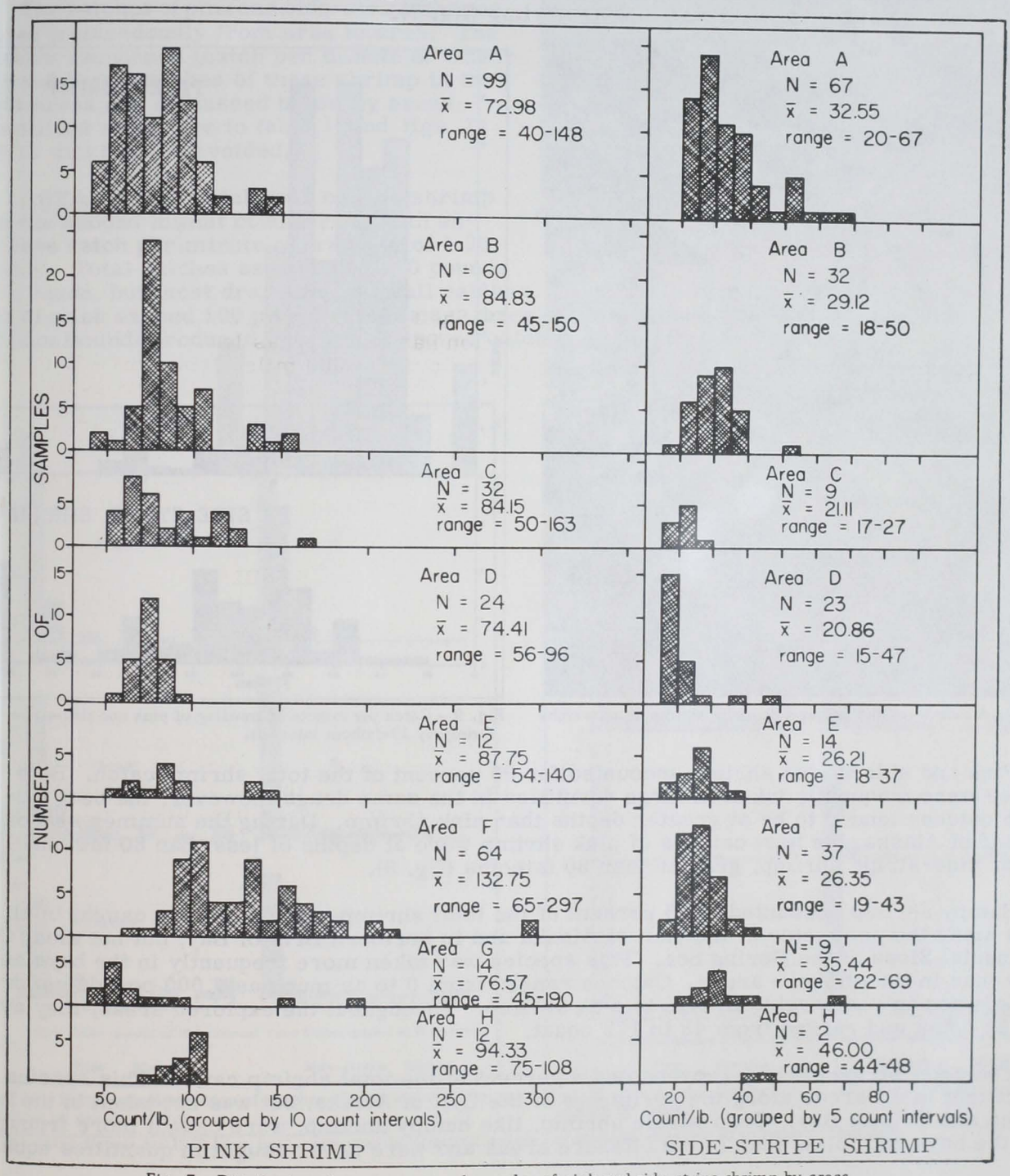

Fig. 7 - Distribution of count per pound samples of pink and side-stripe shrimp by areas.

Side-stripe shrimp was the second most abundant species, representing 18 percent of the total shrimp catch. This species was caught in all areas explored except on the Continental Shelf of the Bering Sea and Bristol Bay. Catches per drag of side-stripe shrimp ranged from 0 to 2,270 pounds.

Although not as abundant as pink shrimp, side-stripe shrimp are of particular interest since they represent a comparatively large pandalid variety which does not now support a sustained commercial fishery in Alaska or elsewhere (fig. 8). Side-stripe shrimp taken during the three cruises averaged 29 count, or three times larger than pink shrimp. Counts per pound of this species ranged from 15 to 67 shrimp (fig. 7).

Fig. 8 - A sample of the larger side-stripe shrimp being weighed.

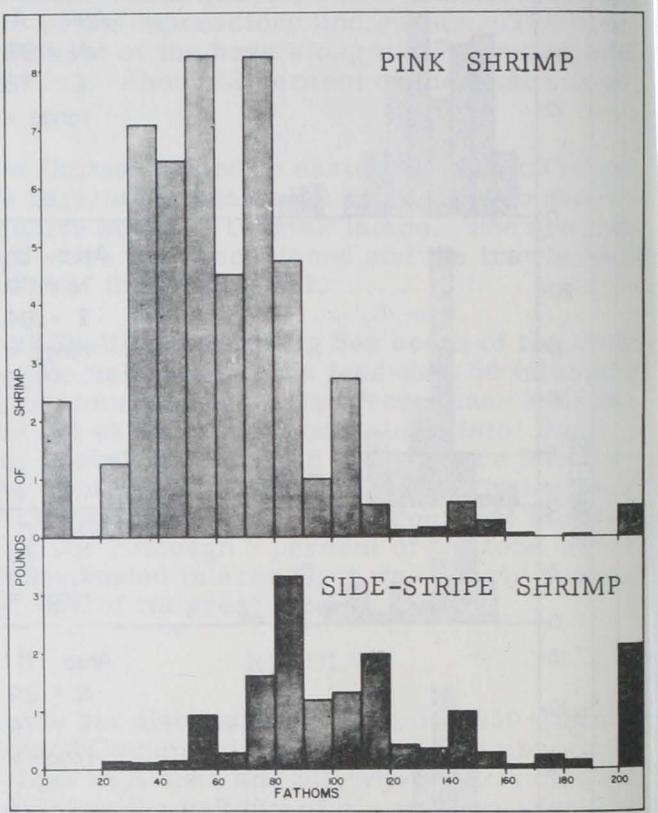

Fig. 9 - Catch per minute of trawling of pink and side-stripe shrimp by 10-fathom intervals.

Pink and side-stripe shrimp accounted for 90 percent of the total shrimp catch. Both species were frequently taken in large quantities in the same drags; however, the best side-stripe catches tended to be at greater depths than pink shrimp. During the summer season in the Gulf of Alaska, the best catches of pink shrimp were at depths of less than 80 fathoms; and for side-stripe shrimp, greater than 80 fathoms (fig. 9).

Humpy shrimp accounted for 6 percent of the total shrimp catch and were caught in all areas along the perimeter of the Gulf of Alaska and in northern Bristol Bay, but not along the Continental Slope of the Bering Sea. This species was taken more frequently in the bays and inlets than in the offshore areas. Catches ranged from 0 to as much as 1,000 pounds per drag. This species is comparable in size to pink shrimp. Throughout the explored areas, they averaged 82 count and ranged from 48 to 172 count.

The coon-stripe shrimp represented 3 percent of the total shrimp catch. This species was caught in all areas along the perimeter of the Gulf of Alaska, but was not taken in the Bering Sea and Bristol Bay. Coon-stripe shrimp, like humpy shrimp, were caught more frequently in the bays and inlets than in the offshore areas and were never caught in quantities equal-

g the catches of the other three common rimp. Catch per drag of coon-stripe shrimp nged from 0 to 320 pounds. Coon-stripe rimp is a species more comparable in size side-stripe shrimp, averaging 38 count roughout the Gulf of Alaska. This species nged from 8 to 99 count, which was much eater than for side-stripe shrimp (fig. 10).

The catches of pink and side-stripe shrimp ried tremendously from area to area. The lative abundance (catch per minute of trawl-g) and large catches of these shrimp in the ght areas are discussed below by areas; petitious reference to table 1 and figs. 11 d 12 will thus be avoided.

Fig. 10 - The larger pandalid species caught in the Gulf of Alaska; left, coon-stripe shrimp; right, spot shrimp; bottom, side-stripe shrimp.

AREA A: The catch rate of pink shrimp as the second lowest of all areas with an verage catch per minute of trawling of 1.25 ounds. Total catches as much as 750 pounds ere made, but most drags made small catches. In only 14 of the 151 drags did the catch of his species exceed 100 pounds. Of those, three drags southeast of Montague Island (Prince William Sound) produced 500- to 750-pound catches during the 1962 cruise.2/

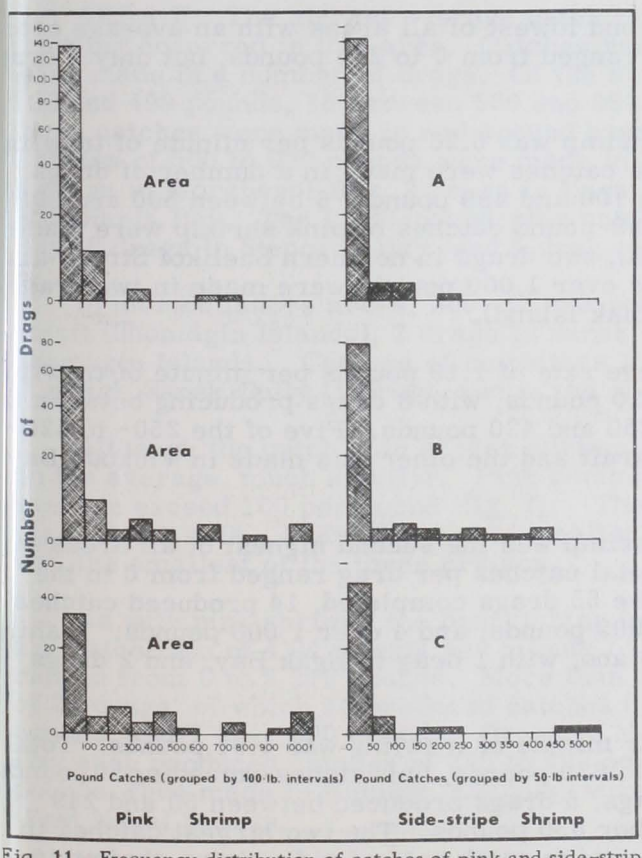

Fig. 11 - Frequency distribution of catches of pink and side-stripe shrimp by areas.

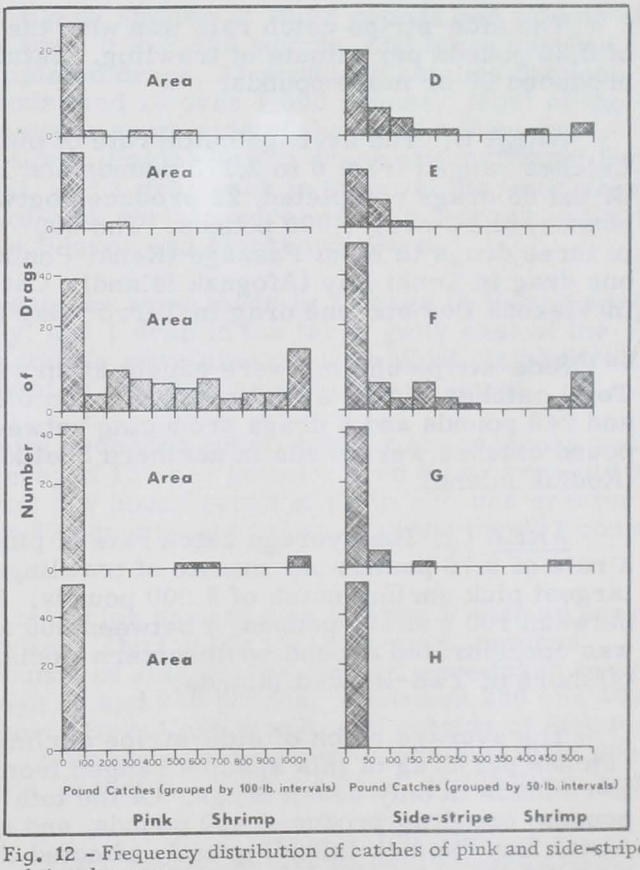

Fig. 12 - Frequency distribution of catches of pink and side-stripe shrimp by areas.

2/ The catch figures for 1962 have been converted to expected pounds per standard gear per 30 minutes of trawling.

Table 1 - Results by Area of the Effort Expended, Total Shrimp Catch, and Catch of Principal Shrimp Species

	Areas							
	A	B	C	D	E	F	G	H
No. drags	151	93	55	33	18	82	48	59
Total min.	6,854	2,862	1,652	971	511	2,423	1,408	1,725
Total lbs.	10,379	20,334	22,671	5,254	884	53,695	4,627	356
Catch/drag	68.73	218.64	412.20	159.21	49.11	654.81	96.40	6.03
Catch/min.	1.51	7.10	13.72	5.41	1.72	22.16	3.99	0.20
Pink shrimp	8,619	14,904	16,039	1,696	325	39,338	3,639	314
Catch/drag	57.07	160.23	291.61	51.39	18.05	479.73	75.81	5.32
Catch/min.	1.25	5.20	9.70	1.74	0.63	16.23	2.58	0.18
Side-stripe shrimp	1,414	3,405	1,681	3,520	543	9,806	854	21
Catch/drag	9.36	36.63	30.56	106.66	30.16	119.58	17.79	0.35
Catch/min.	0.20	1.19	1.01	3.62	1.06	4.04	0.61	0.01
Coon-stripe shrimp	34	1,289	926	25	6	1,527	68	-
Catch/drag	0.22	14.15	16.83	0.75	0.33	18.86	1.42	-
Catch/min	0.00	0.45	0.56	0.02	0.01	0.63	0.05	-
Humpy shrimp	60	660	3,710	5	-	2,878	1	-
Catch/drag	0.39	7.09	67.45	0.15	-	35.09	0.02	-
Catch/min.	0.00	0.23	2.24	0.00	-	1.18	-	-
Other	153	71	274	-	8	126	65	21
Catch/drag	1.01	0.76	4.98	-	0.44	1.53	1.35	0.35
Catch/min.	0.02	0.02	0.30	-	0.01	0.05	0.05	0.01

Pink shrimp in area A were not abundant, but were the largest of any area and averaged 73 count per pound. They ranged from 40 to 148 per pound. The 40-per-pound pink shrimp were the largest taken during the three cruises (fig. 7).

The side-stripe catch rate was also the second lowest of all areas with an average catch of 0.20 pounds per minute of trawling. Catches ranged from 0 to 240 pounds, but only 7 drags produced 50 or more pounds.

AREA B: The average catch rate of pink shrimp was 5.20 pounds per minute of trawling. Catches ranged from 0 to 2,175 pounds and large catches were made in a number of drags. Of the 93 drags completed, 22 produced between 100 and 499 pounds, 6 between 500 and 999 pounds, and 3 over 1,000 pounds. The 500- to 999-pound catches of pink shrimp were made in three drags in Nuka Passage (Kenai Peninsula), two drags in northern Shelikof Strait, and one drag in Tonki Bay (Afognak Island). Catches over 1,000 pounds were made in two drags in Viekoda Bay and one drag in Terror Bay (Kodiak Island).

Side-stripe shrimp were caught at an average rate of 1.19 pounds per minute of trawling. Total catches of this shrimp ranged from 0 to 420 pounds, with 8 drags producing between 50 and 249 pounds and 6 drags producing between 250 and 420 pounds. Five of the 250- to 420-pound catches were made in northern Shelikof Strait and the other was made in Viekoda Bay (Kodiak Island).

AREA C: The average catch rate of pink shrimp was the second highest of all areas with a rate of 9.70 pounds per minute of trawling. Total catches per drag ranged from 0 to the largest pink shrimp catch of 3,000 pounds. Of the 55 drags completed, 14 produced catches between 100 and 499 pounds, 4 between 500 and 999 pounds, and 4 over 1,000 pounds. Fishing was concentrated around southeastern Kodiak Island, with 1 drag in Ugak Bay, and 2 drags offshore of Two-Headed Islands.

The average catch of side-stripe shrimp per minute of trawling was 1.01 pounds. Total catches per drag of this species ranged from 0 to 630 pounds, but catches exceeding 50 pounds were made in only seven drags. Of the total drags, 5 drags produced between 50 and 249 pounds, one drag produced 450 pounds, and another 630 pounds. The two largest catches in Alitak Bay (Kodiak Island) greatly affected the average catch rate of side-stripe shrimp in area C.

Catch rates of humpy shrimp and other species were the highest of any area, with rates of 2.24 and 0.30 pounds, respectively, per minute of trawling.

AREA D: The average catch of pink shrimp was 1.74 pounds per minute of trawling. The range of catches varied from 0 to 510 pounds, but most catches were small. Thirty-three drags were completed in that area; only 2 had catches between 100 and 499 pounds, and another had 510 pounds which were taken in outer Marmot Bay.

The side-stripe catch rate of 3.62 pounds per minute of trawling was the second highest of all areas. Catches per drag ranged from 0 to 1,260 pounds with 13 drags producing catches over 50 pounds. Of those, 11 drags caught between 50 and 249 pounds and 2 others had catches of 540 and 1,260 pounds. The two large catches were made in outer Marmot Bay.

Side-stripe shrimp taken in area D were the largest of any area, averaging slightly less than 21 count per pound. The samples had from 15 to 47 shrimp per pound. The 15-count side-stripe shrimp were the largest taken during the three cruises.

AREA E: The pink shrimp catch rate averaged only 0.63 pounds per minute of trawling. Catches per drag ranged from less than 1 to 200 pounds. The 200-pound catch was the only one over 100 pounds.

In that area, as in area D, the catch rate of side-stripe shrimp exceeded that for pink shrimp. Side-stripe shrimp were caught at an average rate of 1.06 pounds per minute of trawling. Catches in the 18 drags completed in the area ranged from 0 to 100 pounds. Six of the drags caught over 50 pounds.

AREA F: The highest average catch rate for pink shrimp of 16.23 pounds per minute of trawling occurred in this area. Catches ranged from 0 to 2,800 pounds, and large catches were made in a number of drags. Of the 82 completed drags, 22 produced catches between 100 and 499 pounds, 18 between 500 and 999 pounds, and 13 over 1,000 pounds. Most of the large catches were made in and around bays along the south side of the Alaska Peninsula. Catches of 500 to 999 pounds were made in 3 drags in Pavlof Bay, 3 drags around Ivanof Bay, 2 drags in Morzhovoi Bay, 2 drags in Unga Strait, and 1 drag each in Stepovak Bay and around Mitrofania Bay. The 1,000-pound-plus catches of pink shrimp were made in 2 drags in Castle Bay, 5 drags in Stepovak Bay, and 1 drag each in Beaver and Morzhovoi Bays.

In more offshore areas, 500- to 999-pound catches were made in 2 drags in West Nagai Strait (Shumagin Islands), 2 drags in Sanak Gully, and 1 drag in the large gully east of the Shumagin Islands. Catches of more than 1,000 pounds were also made in West Nagai Strait (1 drag), Sanak Gully (1 drag), and in the gully east of the Shumagin Islands (1 drag).

Although the catch rate of pink shrimp greatly exceeded rates in other areas, pinks were, on the average, much smaller. Pink shrimp averaged 132 per pound--in no other area did the average exceed 100 per pound (fig. 7). The count per pound range of 65 to 297 was greater than other areas. Four samples of smaller than 200 count were taken of which the 297 count was the smallest of the three cruises.

As with pink shrimp, the best fishing for side-stripe shrimp was in area F with an average catch rate of 4.04 pounds per minute of trawling. During the three cruises, catches ranged from 0 to 2,270 pounds. More than 50 pounds of side-stripe shrimp were taken in each of 24 drags, of which 14 produced catches between 50 and 249 pounds, 3 between 250 and 499 pounds, and 7 over 500 pounds. Drags in Morzhovoi Bay, Unga Strait, and outside of Stepovak Bay each produced catches of 250 to 499 pounds. Catches of side-stripe shrimp of over 500 pounds were made in Kuiukta, Chignik, Mitrofania, Stepovak (2 drags) Bays, and in Unga and West Nagai Straits.

Humpy shrimp were caught at an average rate of 1.18 pounds per minute of trawling in this area. The largest single catch of 1,000 pounds was made in Belkofski Bay (Alaska Peninsula).

The highest average catch rate for coon-stripe shrimp was in area F, where 0.63 pounds were taken per minute of trawling. The largest catch of 320 pounds was made in Beaver Bay (Alaska Peninsula).

AREA G: The average catch rate of pink shrimp was 2.58 pounds per minute of trawling. Catches ranged from 0 to as much as 1,200 pounds, but only four drags produced catches over 100 pounds: one drag each in Unimak Pass and Beaver Inlet (Unalaska Island) yielded catches between 500 and 999 pounds and one drag each off Cape Pankof (Unimak Island) and in Unalaska Bay (Unalaska Island) took over 1,000 pounds. The four drags greatly increased the average catch rate for area G.

The side-stripe catch rate averaged 0.61 pounds per minute of trawling. Catches in the 48 completed drags ranged from 0 to 430 pounds. Most of the catches were small, however, with only 4 drags taking between 50 and 249 pounds and 1 drag catching 430 pounds. This largest catch was made in Beaver Inlet (Unalaska Island).

AREA H: The pink and side-stripe shrimp catch rates were the lowest of all areas with an average catch per minute of trawling of 0.18 and 0.01 pounds, respectively. The two species were not found in large concentrations in the Bering Sea or Bristol Bay. Catches per drag of pink shrimp ranged from 0 to 49 pounds. Catches of side-stripe shrimp ranged from 0 to 15 pounds.

INCIDENTAL INVERTEBRATE AND FISH CATCHES

Shrimp trawls probably are not effective sampling gear for most organisms other than shrimp because of the limited area covered and the slow speed at which the trawls are towed. Incidental catches of other species in a series of standardized tows, however, will provide indications of relative abundance.

Table 2 - Number of Individuals of Indicated Species Caught during 1963 and 1964

Year	King Crab		Dungeness	Tanner	Halibut
	Male	Female			
1963 . . .	366	317	169	1/800	143
1964 . . .	454	478	18	562	532
Total .	820	795	187	1,362	675

1/Estimated figure derived by dividing pounds of tanner crab caught by 3.

The incidental catches of crabs caught during the summer cruises of 1963 and 1964 are summarized in table 2. Of the three commercial crab species, king crab (Paralithodes camtschatica) was the most commonly encountered. More individuals of both males and females were caught in the area from Kodiak Island to Bristol Bay (1964 cruise) than from Prince William Sound to Kodiak Island (1963 cruise). The second most commonly caught species was adult tanner[3/] crab (Chionoectes species). Although tanner crabs are not now intensively utilized by American nationals, this species may become commercially important. Russians and Japanese have been catching this species. Only occasional Dungeness crabs were taken throughout the explorations; they were especially scarce during the 1964 cruise.

Pacific halibut (Hippoglossus stenolepis) were not taken in great numbers during either 1963 or 1964 (table 2); however, a single catch of 252 immature individuals was made in inner

Table 3 - Pounds of Indicated Fish Species Caught during 1963 and 1964

Year	Catch of Flatfish			Catch of Other Fish				
	Turbot	Flathead	Other[1/] Flatfish	Pollock	Rockfish[2/]	Foodfish	Sculpins	Incidental Species[3/]
1963	3,218	1,403	654	4,145	550	730	807	385
1964	12,178	4,962	3,752	4,642	2,426	2,189	3,280	1,076
Total	15,396	6,365	4,406	8,787	2,976	2,919	4,087	1,461

1/Includes primarily yellowfin, rock, rex, dover, English, lemon soles.
2/Primarily Pacific ocean perch, also rough-eye, northern, sharpchin, dusky rockfishes.
3/Includes true cod, black cod, herring, smelt.

3/Only marketable-size tanner crabs were counted.

Bristol Bay, a known nursery area for halibut. Even when this catch is disregarded, halibut were taken more commonly during the 1964 cruise than in the previous year.

The incidental catches of common fish species and species groups are summarized in Table 3. The 2-year total of incidental catches of fish consisted of 56 percent flatfish and 44 percent other fish.

Arrowtooth flounder (Atheresthes stomias) was the most commonly caught species and accounted for 33 percent of the total fish catch. Catches of that species ranged from 0 to 500 pounds per drag. The next most abundant species was walleye pollock (Theragra chalcogrammus), which constituted 19 percent of the total fish catch. Walleye pollock catches ranged from 0 to 500 pounds per drag. Flathead sole (Hippoglossoides elassodon) was the third most abundant species, constituting 14 percent of the total fish catch, and 0 to 450 pounds per drag were taken.

The remainder of the incidental fish catches is lumped in species groups. Included are other flatfish which contributed 9.5 percent; sculpins, 9 percent; rockfish, 6.5 percent; other food fish, 6 percent; and other fish, 3 percent of the total catch of incidental fish.

RESOURCE POTENTIAL

Explorations by the Bureau of Commercial Fisheries have shown shrimp to be locally abundant in several areas of Alaska, and indications are that the resource could support a sizable fishery. The abundance and commercial potential of the resource are even more dramatically demonstrated by the shrimp landings of commercial vessels in the newly developed fishery. Two commercial vessels operating off southern Kodiak Island averaged over 3,000 pounds of shrimp per hour of trawling after commercial shrimp operations began there (table 4).

Table 4 - Catch Per Hour for Two Vessels Fishing off Kodiak Island

	No. of Drags	Average Length of Drags	Total Catch of Shrimp	Per Hr.
		Minutes	. . . .(Lbs.). . . .	
Vessel A (1963)	94	112	557,500	3,168
Vessel B (1961)	271	79	1,412,000	3,933

The ocean pink shrimp (Pandalus jordani), a species comparable in size to Alaska pink shrimp, has a fishery off the coasts of Washington and Oregon. Magill and Erho (1963) provide data on catch per unit effort of vessels fishing shrimp in that area. Vessels fishing out of Washington averaged catch rates of 730 pounds per hour during 1957, and Oregon vessels averaged 495 pounds per hour in 1958. The figures for 1957 and 1958 are catch rates for the first years that shrimp were landed in any great amounts in Washington and Oregon. They are much less than the catch rates over 3,000 pounds per hour trawling of the two commercial vessels operating off Kodiak Island. The catch rate statistics for the Kodiak area indicate there is a much greater shrimp potential there than off the Washington and Oregon coasts. Furthermore, exploratory fishing cruises have demonstrated that catch rates of other areas exceed those off southern Kodiak Island. Also, although the bulk of the shrimp resource in Alaska is small shrimp, there are significant quantities of shrimp of a size comparable to the small "40-count" shrimp marketed from the Gulf of Mexico fishery. Considering these factors, the as-yet-undeveloped shrimp resources of Alaska waters have an impressive potential.

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Note: Cruise reports and detailed fishing logs of the three shrimp exploratory cruises summarized in this report are available and may be obtained by writing to the U. S. Bureau of Commercial Fisheries Exploratory Fishing and Gear Research Base, Box 2481, Juneau, Alaska 99801.

HADDOCK NEVER HAD IT SO GOOD

The bright, new way to prepare haddock is Haddock Delmonico, created for you by the United States Department of the Interior's Bureau of Commercial Fisheries. In this kitchen-tested recipe, named after the famous New York restaurant; the rich, meaty haddock is combined with lemon juice, grated onion, and hot pepper sauce, then baked just long enough to bring out the full, delicious flavor. The haddock is served with whole cranberry sauce; a colorful, complementary combination that really "goes together."

Haddock fillets are available fresh or frozen throughout the country. They are an easy-to-do, easy-on-the budget specialty, ready to bring the "tang of the sea" flavor to your dinner table.

HADDOCK DELMONICO

2 pounds haddock fillets or other fish fillets, fresh or frozen
$\frac{1}{4}$ cup butter or margarine, melted
2 tablespoons lemon juice
1 teaspoon grated onion
$\frac{1}{4}$ teaspoon salt
$\frac{1}{8}$ teaspoon liquid hot pepper sauce
Dash pepper
Chopped parsley
1 can (1 pound) whole cranberry sauce

Thaw frozen fillets. Skin fillets. Cut into serving-size portions and place in a well greased baking dish, 12 x $7\frac{1}{2}$ x 2 inches. Combine butter, lemon juice, onion, and seasonings; pour over fish. Bake in a moderate oven, 350° F., for 25 to 30 minutes or until fish flakes easily when tested with a fork. Sprinkle with parsley and serve with cranberry sauce. Serves 6.