

Louisiana coast in September, 1962. The distribution of recaptures indicated limited movement of the marked groups between the two areas and little or no offshore movement. Analysis of the recovery data revealed that during September-November total mortality was 60% per 14-day period. After fitting the von Bertalanffy growth function to the mean weights of the recaptured shrimp (sexes combined), it was estimated that, during the fall of the year, white shrimp in this area required 2 months to increase in size from 54-count, heads-off (120 mm) to about 23-count (159 mm).

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## The Shrimp Fishery of Alaska

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#### Abstract

Until 1958 the shrimp fishery of Alaska was confined to southeastern Alaska where from 1 to 2 million pounds of hand-picked shrimp were packed annually for more than 30 years. In 1958 the shrimp fishery expanded westward, with new plants in Seldovia, Kodiak, and Seward. Alaska has the potential for a much

larger shrimp fishery than exists at present. Four species of shrimp are of commercial importance: *Pandalus borealis*, *P. platyceros*, *P. hypsinotus*, and *Pandalopsis dispar*, with pink shrimp (*P. borealis*) being of greatest importance.

Shrimp fishing by foreign powers in waters off Alaska has been primarily in the Bering Sea. The initial Japanese effort in 1961 took about 19 million pounds of shrimp, and in 1962, 40 million pounds were taken. In 1963 the U. S. Bureau of Commercial Fisheries received reliable reports of Soviet shrimp fishing in the Bering Sea.

A cooperative research program with the Alaska Department of Fish and Game is under way to study the biology and ecology of Alaska shrimp.

Processing problems of Alaska shrimp include loss of color, loss of natural fluids, and changes in flavor and texture. The Bureau of Commercial Fisheries Technological Laboratory at Ketchikan has started an active technological program relating to Alaska shrimp.

### HISTORICAL REVIEW

THE SHRIMP FISHERY of Alaska was permanently established in 1916 at Petersburg by E. N. Ohmer and Karl I. Sifferman under the name of Alaskan Glacier Sea Food Company (Hynes, 1929). This firm is still actively processing Alaska shrimp and is now directed by David Ohmer, son of one of the founders. In 1916, production of shrimp meat began a gradual increase in southeastern Alaska which leveled off to about 500,000 pounds annually between 1924 and 1927. The industry remained almost exclusively in southeastern Alaska until 1958, and from 1 to 2 million pounds of shrimp (heads on) were packed annually. The principal species processed was pink shrimp (*Pandalus borealis*). The meats were picked by hand and then shipped to market refrigerated or, in later years, frozen. Production was limited primarily by the cost of the hand labor involved in processing this small species. Approximately 35 pounds of cooked meats are obtained from 100 pounds of raw whole shrimp, which average about 100 shrimp to the pound.

With the installation of automatic picking machines, landings of whole shrimp in southeastern Alaska rose sharply from 2.4 million pounds in 1957 to 7.6 million pounds in 1958 (Table 1). Landings to the westward in the Gulf of Alaska area increased even more dramatically—from 30,000 pounds

TABLE 1  
ALASKA SHRIMP LANDINGS, 1951-62 (IN THOUSANDS OF POUNDS, HEADS ON)

Year	Area		Total
	Southeastern Alaska	Gulf of Alaska	
1951	1,707	1	1,708
1952	1,944	9	1,953
1953	1,722	12	1,734
1954	1,438	14	1,452
1955	1,777	51	1,828
1956	3,032	12	3,044
1957	2,350	30	2,380
1958	7,606	256	7,862
1959	5,519	7,534	13,053
1960	3,343	4,093	7,436
1961	4,212	11,768	15,980
1962	3,884	13,059	16,943

in 1957 to 7.5 million pounds in 1959, primarily at the ports of Seldovia, Kodiak, and Seward. Total Alaska landings increased from 7.9 million pounds in 1958 to 16.9 million pounds in 1962.

For comparison, 1962 production from other Pacific coast states of *Pandalus jordani*, a species similar to the Alaskan *borealis*, was as follows: Washington, 1.4 million pounds; Oregon, 2.0 million pounds; California, 1.8 million pounds. Alaska's production of 16.9 million pounds during this year placed it far in the lead as the principal producer of shrimp among the Pacific coast states.

### COMMERCIAL SPECIES

The Alaska species of commercial shrimp are members of the family Pandalidae, which has a generally northern distribution, extending along the Pacific coast from California to the Bering Sea. *Pandalus borealis* is by far the most important species with *Pandalopsis dispar* (sidestripe shrimp) second in importance. *Pandalus goniurus* (humpy) and *P. hypsinotus* (coonstripe) are taken in small quantities in trawls, and a fifth species, *Pandalus platyceros* (spot), which is as large as the Gulf of Mexico penaeid shrimp, may readily be caught in pots fished in rocky areas 50 to 60 fathoms deep. Occasional small pot fisheries supply local markets with this species.

### SOUTHEASTERN ALASKA FISHERY

Since its beginning the shrimp fishery of southeastern Alaska has centered in the inside waters near Wrangell and Petersburg. The gear has been exclusively beam trawl, which differs from an otter trawl or Gulf shrimp trawl in that the mouth of the net is held open by a wooden timber rather than being spread by otter boards.

During the summer of 1962, the principal shrimp packing in southeastern Alaska was at Wrangell. Vessels fishing in this area were from 37 to 56 feet long, and the beam holding the net open was 32 to 52 feet long. Usually 1-day trips were made, the vessel leaving early in the morning and returning in the evening. In general, vessels fishing for a hand-picking operation made small catches, seldom exceeding 5,000 pounds a day; while those fishing for machine-picking operations occasionally brought in 10,000 pounds a day.

Three picking machines were in operation in Wrangell in 1962, and in addition, there was a substantial production of hand-picked shrimp. The hand-picked shrimp were cold packed into 1- and 5-pound cans and quick frozen. The machine-picked shrimp were partially cooked, packed into 4½-ounce cans, and pressure cooked.

### GULF OF ALASKA FISHERY

In 1963 three shrimp plants operated in ports on the Gulf of Alaska: Seldovia, Kodiak, and Seward. Most of the shrimp delivered at these ports were taken with otter trawls just southeast of Kodiak Island. The trawl nets have an average width at the mouth of 70 feet, and the mesh in the cod end is from 1¼ to 1½ inches (stretched measure). The trawl is usually fished for about 2 hours and yields up to 12,000 pounds of shrimp. A trip usually lasts 3 days. A total landing of pink shrimp typically weighs about 60,000 pounds, while total landings of humpy and sidestripe shrimp are usually smaller. All of the shrimp taken in the Gulf of Alaska are processed through an automatic picking machine after which they are usually frozen in blocks or canned.

## POTENTIAL SHRIMP FISHING AREAS

The shrimp fishing grounds now under exploitation are only a small proportion of the area in Alaska with commercial potential. Exploratory fishing cruises by the U.S. Bureau of Commercial Fisheries give some idea of the potential for this fishery (Fig. 1). In southeastern Alaska, five cruises were made from 1950 to 1962 to assess shrimp abundance from Dixon Entrance to Cape Spencer (Ellson and Livingstone, 1952; Greenwood, 1958; Schaefers, 1951 and 1953). Commercial quantities of pink shrimp were taken in Idaho Inlet, Stephens Passage, Lynn Canal, Keku Strait, and Glacier Bay.

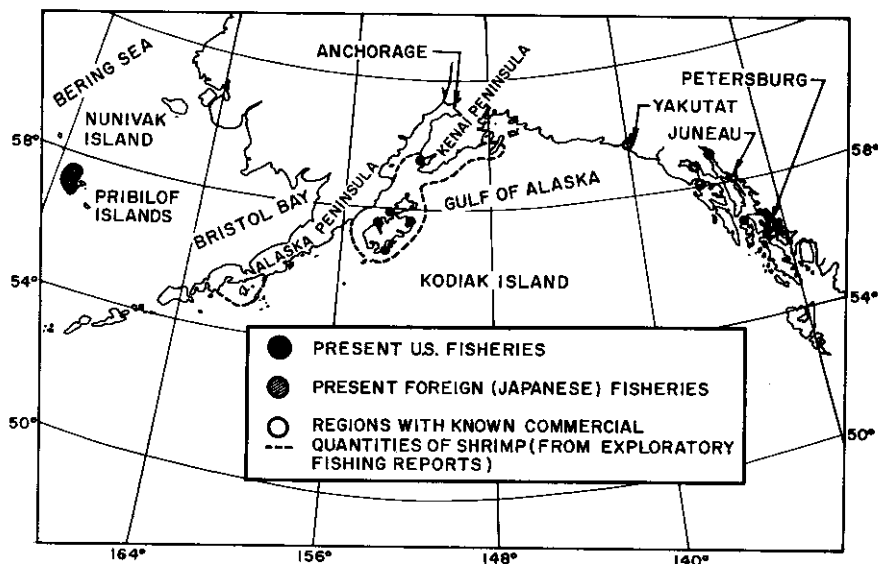


Fig. 1. Actual and potential shrimp fishing areas in Alaska.

Exploratory shrimp operations have also been undertaken in the Gulf of Alaska, five cruises being made from 1953 to 1959 between Cape Spencer and western Kodiak Island (Greenwood, 1959; Schaefers and Smith, 1954; Schaefers, Smith, and Greenwood, 1955; Wathne and Johnson, 1961). Pink shrimp again was the dominant species, and excellent catches were made in lower Cook Inlet and Marmot Bay north of Kodiak Island, as well as in other bays around Kodiak Island. Inside waters of Prince William Sound have not produced large catches of pink shrimp, but this species is quite abundant in Yakutat Bay.

From August to October, 1962, exploratory fishing was conducted near the Kenai Peninsula and Prince William Sound with a semiballoon shrimp trawl measuring 70 feet along the footrope (U.S. Bureau of Commercial Fisheries, 1962). The dominant species was pink shrimp, and the best fishing was east of Montague Island where about 8,000 pounds of shrimp were taken in four 1-hour periods of fishing.

A 9-week cruise to determine shrimp potential between Prince William Sound and Chirikof Island, south of Kodiak Island, was taken in the summer

of 1963 (U.S. Bureau of Commercial Fisheries, 1963). A 40-foot flat shrimp trawl was fished an average period of 30 minutes. In the area near Twoheaded Island immediately southeast of Kodiak Island, 64 fishing periods produced an average catch of more than 350 pounds and maximum catches of more than 3,000 pounds. The lower Cook Inlet-northern Shelikof Strait area also produced good catches of shrimp, with an average of about 220 pounds per half-hour period. Consistently high catches of sidestripe shrimp were made in northern Shelikof Strait. The catches in the area between Prince William Sound and the Kenai Peninsula were poor, less than 25 pounds per half-hour fishing period.

Only one exploratory cruise has been made off the Alaska Peninsula. This was made in 1957 in waters adjacent to the Shumagin Islands and from Stepovak Bay to Unalaska (Johnson, 1959). Catches of up to 3,500 pounds in 30 minutes of fishing were made in Pavlof Bay, and commercial quantities were taken in Beaver Bay, Balboa Bay near Sea Lion Rocks, and Stepovak Bay.

Present knowledge suggests that Alaska shrimp may be most abundant in waters adjacent to the Alaska Peninsula and perhaps along the Aleutian Islands and in the Bering Sea. None of these areas are now being fished by United States vessels. The shrimp potential is without doubt many times greater than present commercial production.

#### FISHING BY FOREIGN NATIONS

Japan began fishing off Alaska in 1933 in the eastern Bering Sea, and through 1937 two fishmeal factory ships operated in this area. There were no further fishing operations in the eastern Bering Sea until 1958 when 20 trawlers and a factory ship utilized groundfish stocks. The initial shrimping operation was in 1961 when Japan took about 19 million pounds of shrimp with catcher boats and one factory ship. In 1962 the approximate composition of the Japanese Bering Sea fleet was as follows: 4 fishmeal factory ships, 4 king crab factory ships, 3 longline factory ships, 2 factory stern trawlers, 3 whale factory ships, 23 support vessels, and 3 shrimp factory ships with 38 trawlers. Almost 40 million pounds of whole shrimp, mostly pink, were taken by the Japanese fleet in 1962. In 1963 two shrimp factory ships with 26 trawlers took about 46 million pounds of shrimp by early July in an area north of the Pribilof Islands.

Also in 1963, Japan sent four trawlers into the area south of the Alaska Peninsula and the Aleutian Islands to determine the abundance of fish and shellfish. An observer from the Bureau of Commercial Fisheries aboard one of these trawlers stated that about 5 or 6 tons of shrimp, mostly pink and sidestripe, were taken each day by a single trawler, and that this was the capacity of the freezing system. This exploratory operation may precede a much larger shrimp fishing effort in 1964 south of the Aleutian Islands and the Alaska Peninsula.

Shrimp are delivered to Japanese factory ships in the Bering Sea by catcher vessels during the day and are processed immediately or held in brine tanks on deck for night processing. Each factory ship has from two to four American-built picking machines. In 1962 the production of a single factory ship was estimated at 300,000 cases (twenty-four 7-ounce cans per case), with some additional amounts frozen in blocks. The United States is Japan's best customer and in 1962 imported about 169,000 cases of shrimp. Japan hopes to export 440,000 cases to the United States in 1963.

The status of the U.S.S.R. shrimp fishery in the Gulf of Alaska and the Bering Sea is not clear at present. The Soviets undertook exploratory shrimping operations in the western Gulf of Alaska in 1961 and made good catches in the vicinity of Sanak and Shumagin Islands. In March, 1963, an unconfirmed report indicated that six Soviet stern ramp trawlers were taking shrimp northwest of the Pribilof Islands.

There are no prospects for immediate exploitation of the Bering Sea shrimp stocks by United States fishermen. The Japanese fishery in this area will continue to produce shrimp in competition with the United States, and quite possibly the exploratory operation in the Gulf of Alaska will expand into another major Japanese fishery.

### BIOLOGICAL STUDIES

The Bureau of Commercial Fisheries initiated a biological research program for shrimp in 1962, and in 1963 this was expanded into a cooperative study with the Alaska Department of Fish and Game. Samples of the commercial catch from southeastern Alaska and the Kodiak area are being taken to determine species, size and sex composition, and the egg-bearing period. Information on the life history of the various shrimp species is being obtained by towing plankton nets to collect the larval stages and fishing with pots and small otter trawls for the adults. Experimentation is under way to develop methods of marking shrimp following the general procedures biologists have developed in the Gulf of Mexico area.

Length composition of the adult pink shrimp indicates that there are four size classes, each of which appears to be an age class. The two age classes of smaller shrimp are males, and then a sex transition takes place, and the larger shrimp are females. The female carries her eggs on the ventral surface of her abdomen until they hatch. Egg-bearing females of the commercial species appear in the catch in the last half of September, and practically all females are egg bearing in January. The eggs hatch in March and April, and larvae are present in the plankton samples through July. Only a bare beginning has been made in an understanding of the life history and population dynamics of Alaska shrimp.

### PROCESSING PROBLEMS

The hand-picked and frozen shrimp from southeastern Alaska make an excellent product with a good market demand. The machine-picking operation, however, is faced with some technological problems. Individual landings of shrimp to be processed by the picking machines are usually much larger than for the hand-picking operation. These large catches have resulted in some problems of proper holding aboard the vessels and storage in plants before processing. For efficient picking, processors have found it necessary to "age" shrimp before picking, and the consequent autolytic changes contribute to loss of color and natural fluids, as well as changes in flavor and texture. The Bureau of Commercial Fisheries Technological Laboratory in Ketchikan is beginning a program of research on these problems. Studies have been completed on holding shrimp in refrigerated sea water before processing, and new studies have started on the characteristics and stability of carotenoid pigments in Alaska shellfish. Other research is planned on the characteristics of the soluble protein and nonprotein nitrogen substances to learn more about the changes in the nitrogen compounds of shrimp that take place during sorting, processing,

and storing. These compounds are intimately involved in texture changes and water binding capacity of shrimp handled in large quantities.

### CONCLUSION

The Alaskan shrimp fishery has expanded rapidly and has a potential for a much greater expansion. The future of this industry is dependent on development of products with consumer demand that can be produced at a competitive price with similar products from other areas in the United States and from foreign countries.

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