Informational Leaflet 52

DEVELOPMENT OF THE KING CRAB FISHERY OFF KODIAK ISLAND

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April 12, 1965

STATE OF ALASKA
WILLIAM A. EGAN - GOVERNOR

DEPARTMENT OF
FISH AND GAME
WALTER KIRKNESS - COMMISSIONER
SUBPORT BUILDING, JUNEAU

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INTRODUCTION

Japan was the first nation to harvest king crabs commercially. The initial processing operation began in 1892 at Hokkaido and consisted of a shore-based cannery supplied by small catcher boats. In 1920 and 1928, the Japanese and Russians respectively, began using floating canneries or factory ships (Simon and Roys, 1960)[1].

The first commercial venture by American king crab processors occurred in 1920 from a shore-based cannery at Seldovia. Until the late 1940's the fishing effort was sporadic, with limited packs at Hoonah, Seldovia, and Kodiak. Factors responsible for late entry into the king crab fishery by the American fishing industry were ignorance of Japanese canning techniques, a weak market at home, and a healthy salmon fishery which left little incentive for winter fishing (Simon, et al. 1960)[2].

In 1938, the 113-foot American factory ship "Tondeleyo", operated in the Kodiak and Shumagin Island areas and in the Eastern Bering Sea. The "Tondeleyo" had fair fishing and produced an excellent pack, but the expense and uncertainty of exploratory fishing made the venture unprofitable (Alaska Department of Fisheries, 1954).

The American fishing industry made no other serious attempts to utilize the king crab resources until after the war. During 1946, exploratory fishing was conducted in the Bering Sea by Wakefield Fisheries using the trawler "Bering Sea", and Libby, McNeil, and Libby using the "Chirikof". Wakefield Fisheries brought

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[1] Simon, Robert J. and Robert S. Roys. 1960. Summary of the king crab fishery. Alaska Department of Fish and Game, Memo No. 3, pp. 1-24.

[2] Op. cit.

the "Deep Sea", which was then the largest trawler built on the west coast, into the Bering Sea in 1947 (Alaska Department of Fisheries, 1954).

Early development of the Kodiak Island king crab industry lagged behind that of the Bering Sea. By 1954, however, Kodiak landings had increased to over 3,000,000 pounds which surpassed American catches in the Bering Sea (Alaska Department of Fisheries, 1954).

Until the late 1950's, Kodiak Island fishermen harvested salmon in the summer and fished king crab in the winter. This fleet was comprised of salmon purse seiners with a maximum length of 58 feet. These vessels were capable of handling tangle nets, (still the Japanese method of harvesting king crabs) and most of them had gypsy winches which allowed the pulling of the modified Dungeness traps or "pots", also used to catch king crabs.

These vessels lacked live tanks to hold the crabs which were subsequently carried on deck or stacked in the hold and not immersed in water. Under normal conditions king crabs will not live out of water for more than 12 hours; hence, the boats were forced to unload their catches daily or place the crabs in underwater pens on the fishing grounds.

Crab fishing usually commenced in September or October and ended during June; at which time the boats rigged for salmon.

By 1960, however, many of these purse seiners continued to fish crab during the summer months. In the summer, king crab move into the deep offshore trenches surrounding Kodiak Island and the fishermen were forced to move out of the shallow bays into deeper water to make good catches (Powell, 1964). Purse seine boats proved unsuitable for offshore fishing due to their small size and lack of live tanks.

In 1961, several converted halibut boats and herring seiners of the 70-foot class arrived in Kodiak to engage in the summer king crab fishery. These vessels had tanks with circulating systems for maintaining a constant flow of sea water which allowed crabs to be held alive for several days.

In exploring the offshore banks surrounding Kodiak Island, these fishermen found large concentrations of king crabs. Catches of 3,000 crabs per day were prevalent during July, August, and September of 1961. Some canneries and factory ships were unable to process the large numbers of crabs being captured and in some instances were forced to limit the number of crabs a boat could unload each trip.

In July of 1962, many additional herring seiners and halibut boats arrived in the Kodiak area to harvest king crabs. The range of the fleet was increased by utilizing live tanks, allowing the vessels to follow the migrating crabs from the shallow inshore banks where most of the winter fishing was conducted to the deep offshore trenches where the crabs spend the summer and fall months. Since the same crab stocks were now being harvested over the entire year rather than just during the winter months, the exploitation rate was greatly increased.

Power scows also made their appearance as king crab vessels at this time. With twin screws and large working space on deck they have become popular.

The largest vessel which has been converted for king crab fishing is a 159-foot naval landing craft. Her tanks have a total capacity of 6,780 cubic feet and will carry approximately 15,000 live eight-pound crabs. An interesting note is that all the vessels used in fishing king crab are conversions. The Alaskan king crab fishery is so new that no vessel design peculiar to it has yet been developed.

TYPES OF FISHING GEAR

The gear used by the American fishery consisted of tangle nets, otter trawls, and pots. The first two types were and still are the most common gear used by Japanese and Russian king crab fishermen.

Tangle Nets

During 1938, tangle nets were first used by American fishermen around Kodiak in operations from the factory ship "Tondeleyo". Although these nets were popular with American fishermen, they were outlawed in 1955.

The major reason for prohibiting tangle nets was their non-selectivity. Only male king crabs are utilized by the American fishery and many females and small males became entangled in the nets. These non-commercial king crabs were difficult to remove from the nets without damaging them (Alaska Department of Fisheries, 1954).

Trawls

Trawls came into common usage in 1943, but their success was limited because they were used during the fall and early winter when king crabs are widely distributed in deep water. By 1952, fishermen had learned that the crabs move into shallow bays in late winter and spring to breed (Powell, 1964). At this time of the year, trawls are effective.

Trawling for king crabs was prohibited in 1960. As in the case of tangle nets their destructive non-selectivity was the reason. Large numbers of females, many of them soft-shelled, were captured on the spawning grounds and injured or killed. Female king crabs had never been legal in the American fishery and biologists feared the stocks would be endangered if large numbers of females were destroyed (Alaska Department of Fisheries, 1954). Outlawing the trawl had little effect on the developing fishery. As early as 1955, trawls were capturing only a small portion of the catch due to the efficiency of traps or "pots" (Stevens, R., 1955)[3].

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[3] Stevens, R. 1955. Unpublished data on file, Alaska Department of Fish and Game, Kodiak Research Center, Kodiak, Alaska.

Pots

Pots captured most of the crabs processed during the early attempts to establish the fishery. The catcher boats fishing for the factory ship "Tondeleyo" in 1938 and the small canneries at Olga and Moser Bays during 1941 to 1944, all used pots (Simon and Roys, 1960)[4].

These early pots were modifications of west coast Dungeness traps. When the efficiency of pots was realized, constant experimentation began. By 1960, a round pot approximately six feet in diameter and 30 inches high became standard. In 1962, the fishery began to shift off shore, where tidal action combined with the use of larger marker buoys and floating polypropylene lines, tended to move these pots. Larger vessels, capable of handling larger and heavier pots, had also entered the fishery and these boats began using square pots 7'x7'x2½'. Such pots have proved effective and catches as high as 294 eight to ten pound crabs per pot have been reported; although catches averaging 50 crabs to the pots are considered good (Allen, 1963).

CATCH STATISTICS

Catch statistics are of vital importance in determining trends in any fishery. They are also important tools for the research biologist if care is taken in guaranteeing their accuracy. Catch statistics were collected almost from the inception of the king crab fishery. No one anticipated the rapid growth of the industry, however, so the early statistics leave much to be desired. In fact, until 1961, all the catch statistics data are of value only as a rough guide. The major reason for the inadequacy of the king crab catch statistic data was the emphasis placed on salmon management and data recording.

Statistical Area Charts

In 1961, the first revision of the statistical area chart used for identifying the catch area was made (Figure 1). This chart was a marked improvement over the earlier reporting methods in that it included the offshore fishing areas; however, these new offshore areas (291 - 257-258-252 series) were extremely large. Even with this improved chart, identifying fishing areas in relation to the stocks being utilized is difficult and in some cases impossible.

Tagging programs in the Chirikof Island area may indicate that catches from areas 257-90 and that portion of 257-82 on the seaward side of Tugidak and Sitkinak Islands should be included with the Twoheaded Island data (Figures 1 and 2). Similar tagging programs have also shown that Chiniak and Marmot Bays could be combined.

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[4] Op. cit.

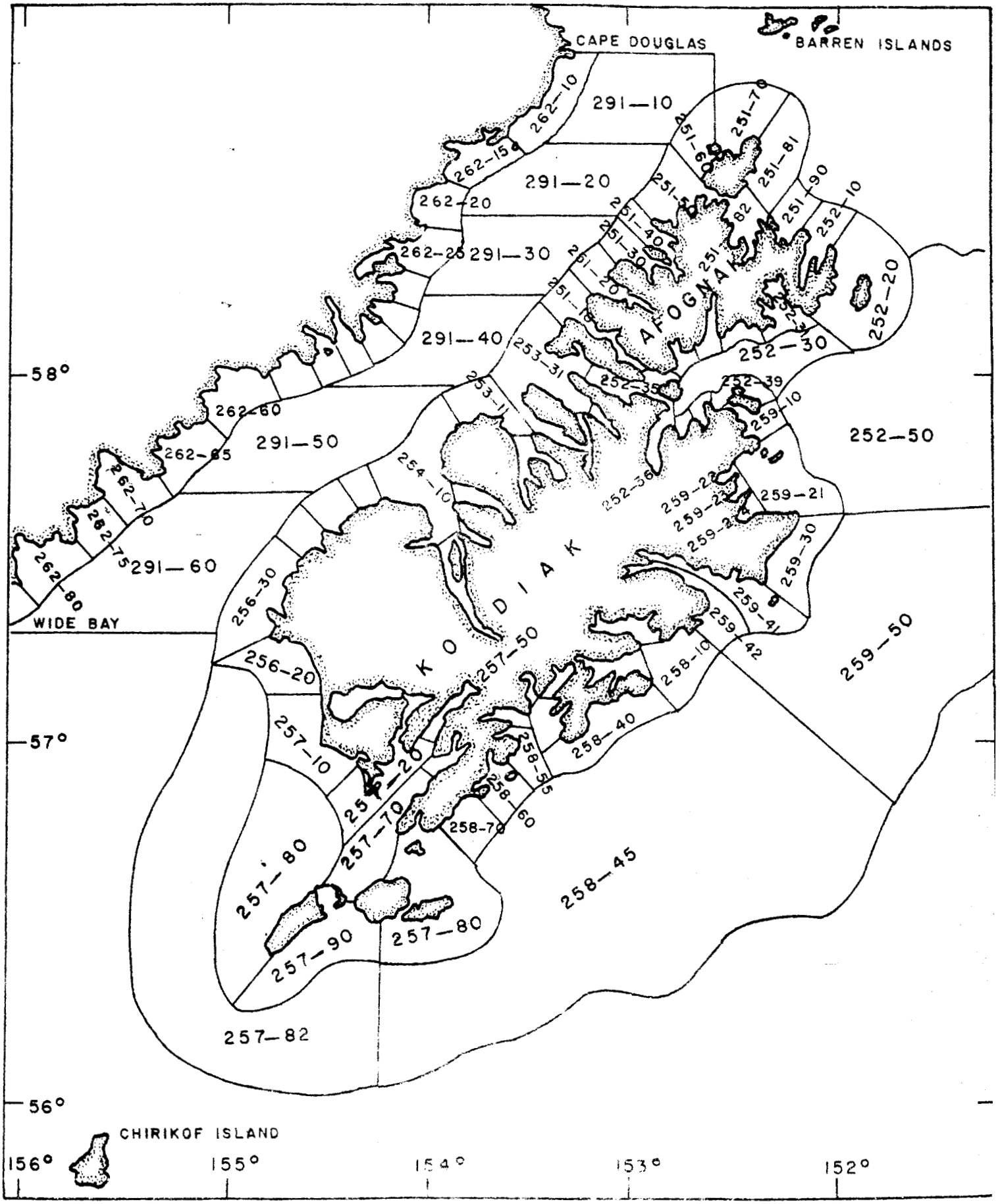

Figure 1. Statistical area chart introduced in 1961 (some of the smaller and less important areas have not been numbered on this example).

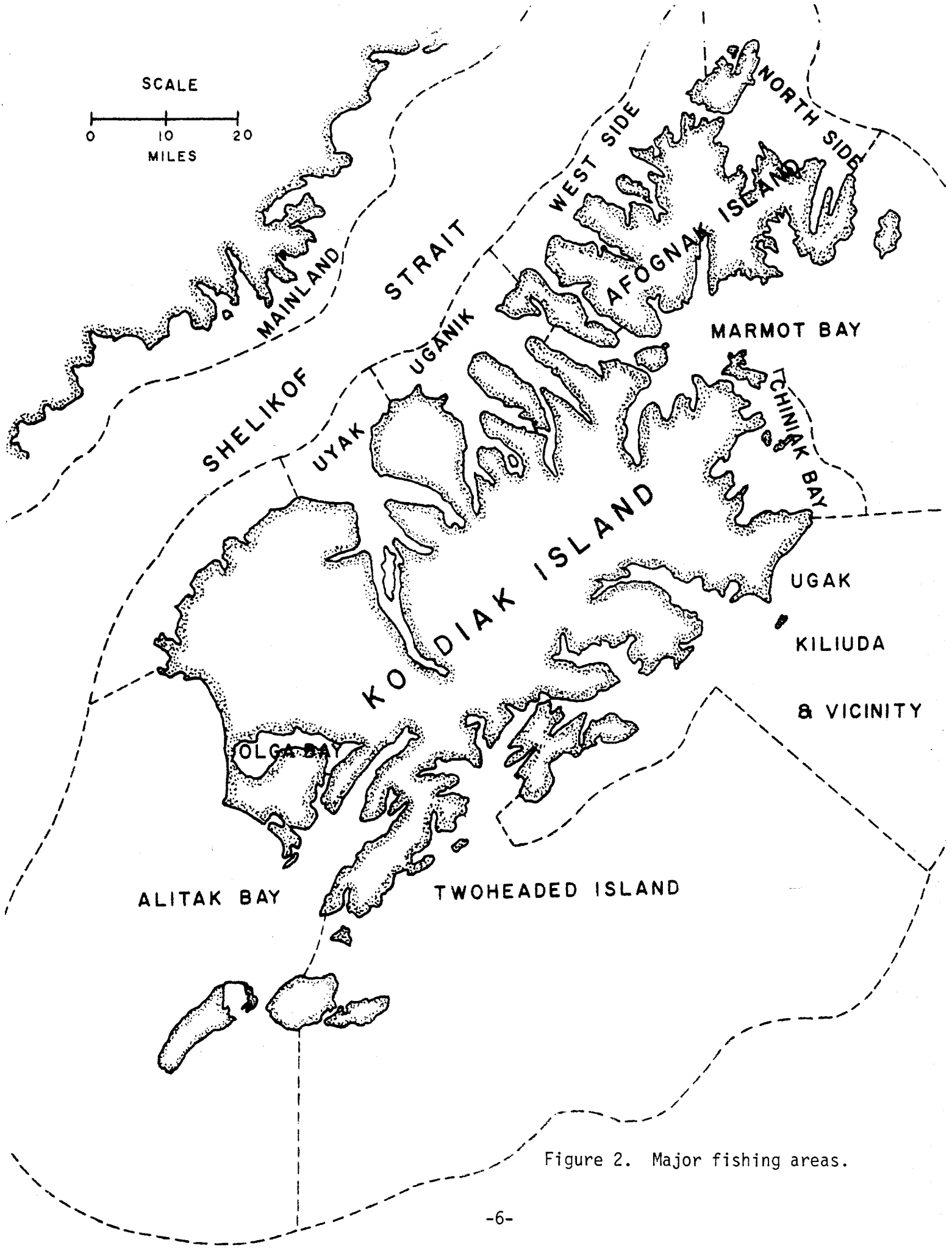

Figure 2. Major fishing areas.

The new statistical area chart, which was prepared in 1963, has taken the recent research results into consideration and in most cases has rectified the inconsistencies in the earlier charts. This revision, which follows depth contour lines, is designed to satisfy the needs of both research and management biologists by dividing the offshore fishing areas into zones of uniform length. This paper deals with catch data collected before this revision, however, and the areas referred to later in the text are fishing areas and not meant to delineate specific stocks or populations of king crabs.

Fish Tickets

A "fish ticket" is used to record the catch statistics for all Alaska fisheries. This "ticket", which is a simple form in triplicate, contains space for the following entries; name of vessel, location of capture, number and total weight, and fishing effort. The processor is required by law to forward these tickets to the Alaska Department of Fish and Game at least once a week where they are analyzed by management personnel and used to evaluate fishery trends.

FISHING INTENSITY

Fishing intensity in the Kodiak Island area increased gradually from the early 1950's until the 1959-60 season (Figure 3). Production did not reach 500,000 crabs a year until the 1956-57 season. During the next two seasons, the catch was between 500,000 and 700,000 crabs a year. During the 1959-60 season the catch exceeded 1,000,000 crabs a year for the first time and the increase during the next 3 seasons was almost 1 million crabs per year.

While the early catch data are not accurate enough to pinpoint the exact areas fished, Chiniak Bay areas 259-23, 259-24, and the inshore portion of 259-21 were probably most heavily utilized (Figures 1 and 2). Monashka Bay, which is the small bay located in area 259-10 was also probably a heavy contributor. It is doubtful that the offshore portion of 259-21 contributed much to the catch due to the small size of the boats. Production from Chiniak Bay has fluctuated very little, and while not an important contributor, it has been utilized continuously since the inception of the Kodiak Island king crab industry.

In Marmot Bay, areas 252-30, 252-36, and 252-39 can be assumed to have been the most heavily utilized areas (Figures 1 and 2). In fact, until the 1953-54 seasons these areas contributed the bulk of the crabs utilized by the industry and were important producers until the 1956-57 season. Production dropped sharply during that fishing year and remained insignificant until the 1961-62 season. The reason for the sudden increase in production from Marmot Bay was the discovery of large schools of king crabs by the larger vessels which had entered the fishery in areas 252-20 and 252-50 (Figure 1). Increased utilization of these stocks is expected to take place in the next few years.

Alitak Bay, which did not contribute significantly to the fishery until 1953, was probably most heavily fished in areas 257-50, 257-20, and 257-70 (Figures 1 and 2). By the 1959-60 season, however, the most intensive effort took place in areas 257-80, 257-10, and 257-20 (Figure 1). During the summer of the 1961-62 season, herring seiners and halibut boats located large numbers of king crabs

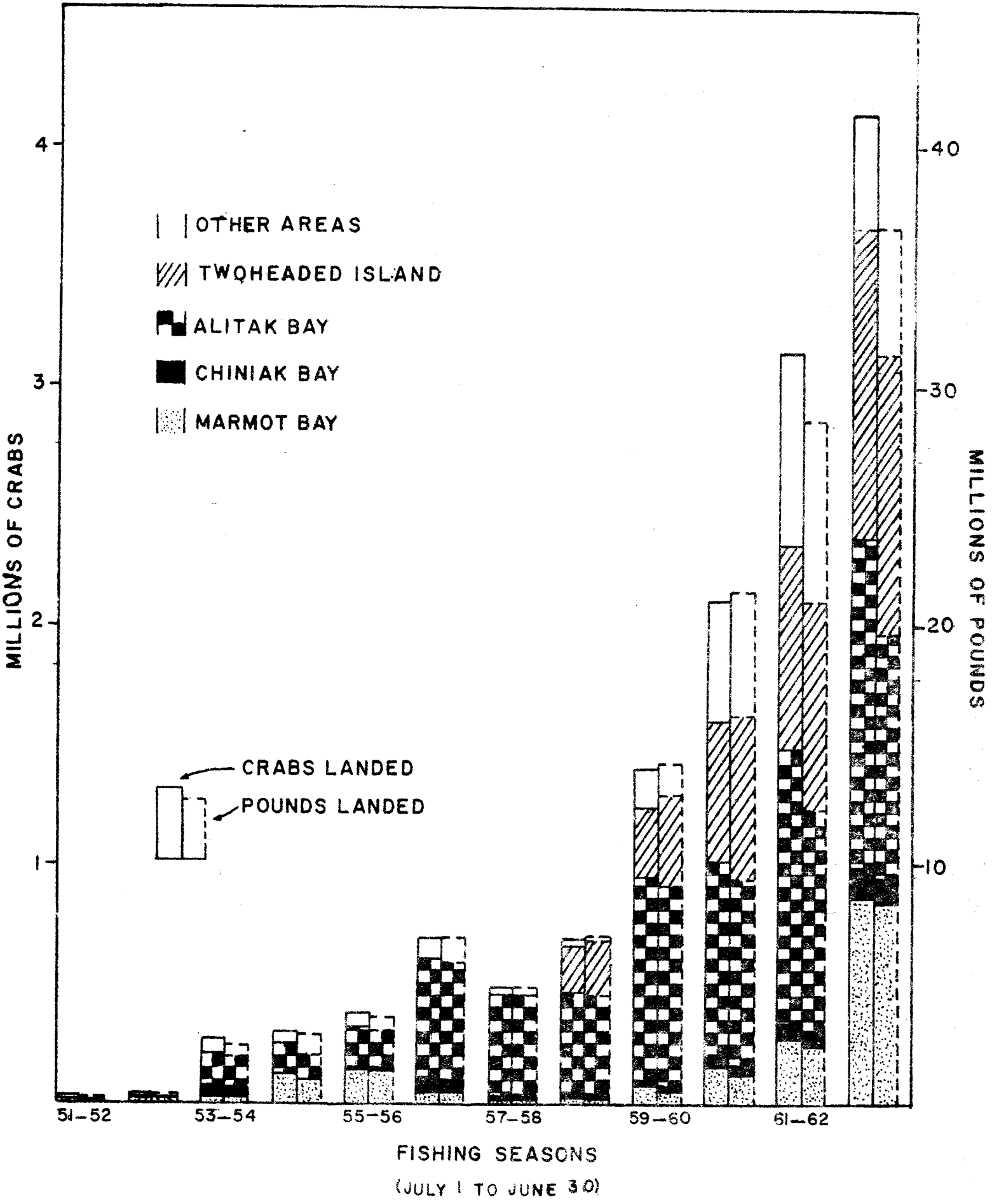

Figure 3. Catch by fishing season, 1951 to 1963.

in 257-82. The discovery of these concentrations was a major factor in the rapid expansion of the industry and forced some of the canneries and factory ships to limit the number of crabs each vessel could unload during the 1961-62 season.

Utilization of the crab stocks in the Twoheaded Island area began in 1959 (Figure 2). Production from this area was immediately higher than any other fishing ground with the exception of Alitak Bay (Figure 3). Twoheaded Island has remained the second most important producer of crabs and, like Alitak Bay, was responsible for some canneries and factory ships placing a limit on the number of crabs a vessel could unload each trip. There has been very little shifting of effort from the original areas fished around Twoheaded Island. The fishery originally developed in areas 258-80, 258-70, and 258-60 and, with the exception of some pressure in area 258-45, is still concentrated in these areas (Figure 1).

AVERAGE WEIGHT

Average weight per crab is a vague index of exploitation, but it does indicate the effects of an intensive fishery on crab stocks. An unexploited population of king crabs will contain a normal distribution of commercially-legal crabs or legal age/size groups. As the population is cropped, the older and larger crabs are harvested first and the distribution of commercially-legal king crabs is no longer normal. In a relatively unexploited king crab population, average weight will normally run between 10 and 12 lbs. Average weight per landing, however, will fluctuate widely due to a tendency of king crabs to segregate into age/size groups.

Until the 1960-61 season, the average weight per crab caught in the Kodiak area was approximately 10 pounds; however, in the next two fishing seasons the average weight per crab declined almost a pound per year (Table 1).

When considering a decline in average weight for a major fishing region, such as the water surrounding Kodiak Island, it must be considered that the effect of intensive utilization is masked in the major producing areas (i.e., Alitak Bay and Twoheaded Island) as catch per unit of effort declines by a shifting of effort to new areas. An area which has been heavily exploited for several years may decline from a 10 to 7 pound average for example, but an area being utilized for the first time will have a ten pound average and raise the overall average weight for the major fishing region involved (i.e., Kodiak Island).

Alitak Bay is an excellent example of the situation described in the preceding statement. The average weight per crab remained well above 9 pounds until the 1961-62 season when it dropped to 8 pounds (Table 1). The 1962 season saw another drop to 7.8 pounds (Table 1). Carapace length frequency distribution of crabs taken in the Alitak Bay area indicate that most of the older age classes have been cropped off and only the annual increment is contributing substantially to the fishery.

The decrease in average weight is even more apparent in the Twoheaded Island area, which is the second largest producer in the Kodiak Island region (Table 1).

Table 1. Kodiak Island king crab catch by area and year[1].

Year (July 1 to June 30)		Area					
		Alitak Bay	Twoheaded Is.	Marmot Bay	Chiniak Bay	Olga Bay	N.S. Afognak
1950	Number	-	-	5,863	6,515	-	508
1951	Pounds	-	-	49,834	55,678	-	4,370
	Average weight	-	-	8.49	8.54	-	8.6
1951	Number	-	-	9,574	9,529	33	3,619
1952	Pounds	-	-	80,547	81,178	280	31,047
	Average weight	-	-	8.43	8.51	8.48	8.57
1952	Number	-	46	11,279	22,438	-	14,139
1953	Pounds	-	391	120,750	221,513	-	142,316
	Average weight	-	8.50	10.70	9.87	-	10.06
1953	Number	148,166	497	34,201	53,468	-	23,751
1954	Pounds	1,353,345	3,854	280,160	488,457	-	241,759
	Average weight	9.13	7.75	8.19	9.13	-	10.17
1954	Number	132,608	-	119,527	16,994	-	45,179
1955	Pounds	1,004,895	-	936,711	130,634	-	364,871
	Average weight	7.57	-	7.83	7.68	-	8.07
1955	Number	162,058	-	143,402	21,337	-	59,125
1956	Pounds	1,520,545	-	1,304,330	210,906	-	638,507
	Average weight	9.38	-	9.09	9.88	-	10.79
1956	Number	502,262	-	48,508	66,574	-	72,377
1957	Pounds	4,993,812	-	473,949	605,193	-	830,942
	Average weight	9.94	-	9.77	9.09	-	11.48
1957	Number	424,360	2,425	13,404	37,672	-	11,050
1958	Pounds	4,244,665	27,431	144,957	415,958	-	143,117
	Average weight	10.00	11.31	10.81	11.04	-	12.95
1958	Number	417,798	173,715	27,495	31,774	7,542	26,777
1959	Pounds	4,054,649	2,102,356	227,442	292,579	70,367	273,945
	Average weight	9.70	12.10	8.27	9.20	9.33	10.23
1959	Number	851,134	301,548	80,223	34,730	36,895	9,991
1960	Pounds	8,348,925	3,657,559	576,720	347,783	255,677	85,144
	Average weight	9.80	12.12	7.18	10.01	8.08	8.52
1960	Number	818,953	605,736	148,843	63,714	19,440	88,080
1961	Pounds	7,673,621	6,850,110	1,265,809	523,500	130,856	839,834
	Average weight	9.37	11.30	8.50	8.21	6.73	9.53
1961	Number	1,141,389	850,262	277,561	79,377	1,910	159,973
1962	Pounds	9,286,779	8,606,444	2,409,702	737,305	14,418	1,564,533
	Average weight	8.13	10.12	8.68	9.28	7.54	9.77
1962	Number	1,360,497	1,325,675	862,660	139,819	2,179	47,881
1963	Pounds	10,713,260	11,893,332	8,372,415	1,282,139	14,668	500,367
	Average weight	7.87	8.97	9.70	9.16	6.73	10.55

-Continued-

Table 1. Kodiak Island king crab catch by area and year[1] (continued).

Year (July 1 to June 30)		Area					
		W.S. Afognak	Ugak, Kiliuda and vicinity	Uganik Bay	Uyak Bay	Mainland	Total
1950	Number	280	14	-	-	34	13,214
1951	Pounds	2,380	119	-	-	289	112,670
	Average weight	8.50	8.50	-	-	8.5	8.52
1951	Number	-	16,460	23	-	-	39,238
1952	Pounds	-	142,090	195	-	-	335,337
	Average weight	-	8.63	8.47	-	-	8.54
1952	Number	1,403	8,688	28	-	-	58,021
1953	Pounds	18,048	76,409	280	-	-	579,707
	Average weight	12.86	8.79	10.00	-	-	9.99
1953	Number	7,189	13,419	130	60	-	281,881
1954	Pounds	50,205	111,387	1,553	400	-	2,531,120
	Average weight	6.98	8.30	11.94	6.66	-	8.97
1954	Number	99	1,995	259	3,201	-	319,862
1955	Pounds	814	15,814	2,650	33,896	-	2,490,285
	Average weight	8.22	7.92	10.23	10.58	-	7.78
1955	Number	387	2,243	1,706	-	-	390,258
1956	Pounds	4,750	21,085	17,022	-	-	3,717,145
	Average weight	12.27	9.40	9.97	-	-	9.52
1956	Number	6,392	-	1,935	1,233	-	699,281
1957	Pounds	75,121	-	20,639	16,332	-	7,015,988
	Average weight	11.75	-	10.66	13.24	-	10.03
1957	Number	4,121	-	2,987	279	-	496,298
1958	Pounds	52,762	-	38,060	3,688	-	5,070,638
	Average weight	12.80	-	12.74	13.21	-	10.21
1958	Number	2,865	-	3,608	589	3,619	695,782
1959	Pounds	34,620	-	38,501	6,649	30,139	7,131,247
	Average weight	12.08	-	10.67	11.28	8.32	10.24
1959	Number	1,474	26,120	8,667	4,611	61,551	1,416,944
1960	Pounds	12,764	298,861	81,842	44,484	639,189	14,348,948
	Average weight	8.65	11.44	9.44	9.64	10.38	10.12
1960	Number	21,497	130,725	15,929	817	237,017	2,150,751
1961	Pounds	202,259	1,443,443	136,697	9,482	2,389,714	21,465,325
	Average weight	9.40	11.04	8.58	11.60	10.08	9.98
1961	Number	44,187	41,402	82,524	6,501	459,095	3,144,181
1962	Pounds	360,693	417,090	719,208	72,919	4,442,250	28,631,341
	Average weight	8.16	10.07	8.71	11.21	9.67	9.11
1962	Number	17,064	67,226	45,071	4,186	270,413	4,142,671
1963	Pounds	152,908	648,442	394,258	39,839	2,667,821	36,679,449
	Average weight	8.96	9.64	8.74	9.51	9.86	8.85

[1] These figures are approximate and are to be used only as estimates of fishing trends.

An 11 pound average was maintained until the 1960-61 season (Table 1). In the following two years the average weight decreased to less than 9 pounds (Table 1).

The Marmot Bay area continues to produce a 9 pound average, but with the increased pressure the average weight per crab will probably follow the pattern set by the Alitak Bay and Twoheaded Island fisheries (Table 1).

No decrease in average weight has been noted in the more lightly-fished areas such as Uyak and Kiluda Bays and around Afognak Island. Crabs caught in these areas will probably continue to maintain a 10 pound average until more pressure is applied to their populations (Table 1).

Although an insignificant producer, Olga Bay is of interest in regard to average weight of crabs caught there. Average weight per crab in this area has rarely exceeded 8 pounds and has been as low as 6 pounds (Table 1). This low average weight is caused by the presence of the blue crab, *Paralithodes platypus* (Brant), which closely resembles but does not attain the size of the king crab. The increase in the size limit from 6-1/2 to 7 inches in 1962 probably has eliminated the fishery in Olga Bay.

SIZE LIMIT

There have been three changes in the size limit in the Kodiak Island area. The first size limit on male crabs was 5-1/2 inches in carapace width and was in effect until 1949. No biological reason for this size limit has been discovered.

In 1949, the size limit was raised to 6-1/2 inches in carapace width. Japanese data was used to support this size increase since little research had been done on the biology of king crabs in American waters.

In Japanese waters, male king crabs 6-1/2 inches in carapace width are believed to have been sexually mature for at least two seasons (Marakawa, 1933). American biologists felt an increase in the size limit to 6-1/2 inches would help protect the breeding stocks of king crabs being utilized by American fishermen.

As growth data in the Kodiak Island area was collected it was realized that king crabs in this region experienced a greater growth increment per molt than king crabs in the Sea of Okhotsk and the Bering Sea (Marakawa, 1933, Weber and Miyahara, 1963, Powell, 1960)[5]. With this information in mind, in 1962 the size limit in the Kodiak area was raised to 7 inches in carapace width.

Two other factors also influenced increasing the size limit. In the Bering Sea, research indicated the only male king crabs which had failed to undergo ecdysis

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[5] Powell, Guy C. 1960. Investigation of the Growth Rates of the King Crab in the Kodiak Area. Alaska Department of Fish and Game. Kodiak, Alaska. 43 pp. (Typewritten).

during the previous molting season contributed greatly to reproduction (T. Miyahara and H. Shippen, undated)[6]. Less than 25 percent of the male king crabs in the Kodiak area fail to molt until after they attain 7 inches in carapace width and the half inch size increase would leave more non-molting males available for reproduction (Powell, 1960)[7].

Serious consideration was also given to the weight gain which would be accrued by allowing an extra molt season. Very few crabs "skip" molts between 6-1/2 and 7 inches in carapace width and the average growth per molt is approximately an inch a year. The weight increase would be approximately 2 pounds total weight for 6-1/2 inch crabs which molt into the 7 inch class and hence recovery of meat per crab processed by the industry would be higher.

OTHER REGULATIONS

Tangle net, trawl, and size limit restrictions were mentioned earlier in this paper and will not be discussed further.

With the outlawing of the trawl in 1960, the question of whether these laws applied outside the three mile limit arose. To offset this problem a landing law was enacted making it illegal to land crabs caught by any other method except by pots in the Kodiak Island area.

Another important type of regulation which is a valuable tool in king crab management is the emergency closure. This regulation allows the closing of isolated fisheries or the entire fishery by field announcement if, in the opinion of the area management biologist, the stocks are being undesirably affected. To date, this form of regulation has only been used in Alitak, Monashka, Puale, and Kizhyuak Bays during the spawning seasons.

Two socio-economic laws are also currently in effect. A 30 pot limit per boat was imposed in 1960. This limit is approximately the number of pots an Alaska limit salmon seiner can haul in one day. The larger boats have partially compensated for the effect of this regulation on efficiency by using larger pots and double-hauling their gear during the summer months.

Area registration is the second socio-economic law in effect. This law prevents vessels registered for fishing in one area from moving to a different area during periods of good fishing.

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[6] Miyahara, Takashi and H. Shippen. Undated. Preliminary report of the effect of varying levels of fishing on eastern Bering Sea king crabs *Paralithodes camtschatica* (Tilesius). Bureau of Commercial Fisheries Biological Laboratory, Seattle, Washington.

[7] Op. cit.

FUTURE OF THE FISHERY

The expansion of the king crab industry has probably been as rapid as that of any fishery in the world. In three years, fleets of large vessels explored and exploited most of the available fishing ground around Kodiak Island and have, in fact, been shifting to the westward. With proper management, the Kodiak Island area will remain a major producer but expansion in the magnitude of 1959-63 seasons is improbable.

However, several populations around Kodiak are capable of further utilization. The crabs which inhabit the banks surrounding Chirikof Island are exploited only during late winter and spring when some enter the fishery around the Trinity Islands. The preceding statement also applies to the crabs which inhabit the offshore Marmot Banks in the summer and move into the shallow flats in Marmot Bay and Chiniak Bay during the winter. Increased American activity in these areas is important to eliminate the threat of further encroachment by Russian tangle net fleets which fished these traditional American fishing grounds in 1963 and 1964.

Exploitation of crabs in other areas, such as Wide Bay, Cape Douglas, and the Barren Islands has been hampered by generally poor weather conditions and strong tides. With the improvement of vessels and gear, however, these areas will undoubtedly contribute a substantial portion of the overall catch in the near future.

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