

# Informational Leaflet 126

## INVESTIGATION OF KING CRAB OCEAN REPRODUCTION AND BROOD STOCK COMPOSITION, KODIAK ISLAND

By:

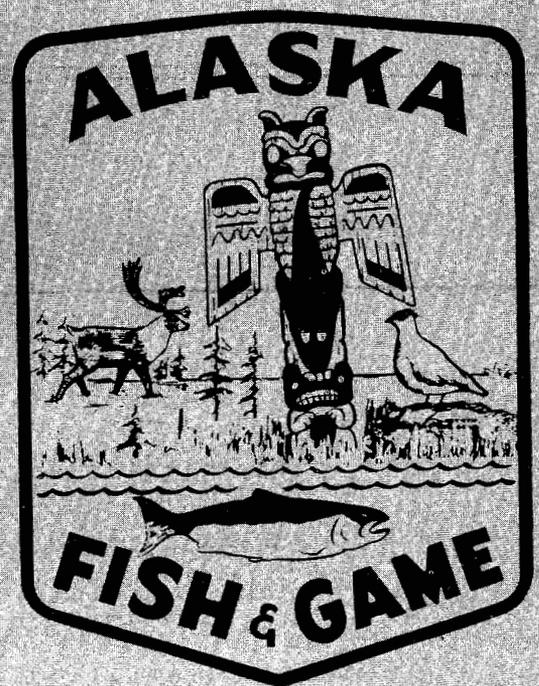
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INVESTIGATION OF KING CRAB OCEAN REPRODUCTION  
AND BROOD STOCK COMPOSITION , KODIAK ISLAND

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## TABLE OF CONTENTS

	Page
INTRODUCTION . . . . .	1
OBJECTIVES . . . . .	2
METHODS . . . . .	2
Offshore Trawling . . . . .	2
Stock Condition . . . . .	3
RESULTS . . . . .	3
General . . . . .	3
Indicators of Breeding . . . . .	5
Length Frequencies . . . . .	5
Performance of Otter and Beam Trawls . . . . .	7
Stock Condition . . . . .	7
DISCUSSION . . . . .	10
Offshore Trawling . . . . .	10
Length Frequencies . . . . .	12
Stock Condition . . . . .	13
RECOMMENDATIONS . . . . .	14
LITERATURE CITED . . . . .	15
APPENDIX A . . . . .	16

LIST OF FIGURES

	Page
Figure 1. Ocean bank study areas occupied during April and May, 1968. Stations trawled are identified with crosses . . . . .	4

LIST OF TABLES

Table 1. Trawl-caught king crabs, Kodiak, Island, spring of 1968 . . . . .	6
Table 2. Length-frequency measurements of female king crabs captured by trawling on (I) Albatross Bank, (II) Marmot Flats, and (III) Portlock Bank east of Kodiak Island, spring of 1968 . . . . .	8
Table 3. Length-frequency measurements of male king crabs captured by trawling on (I) Albatross Bank, (II) Marmot Flats, and (III) Portlock Bank east of Kodiak Island, spring of 1968 . . . . .	9
Table 4. Assessment of king crab brood stock condition along east inshore side of Kodiak Island, April 27 to May 20, 1968 . . . . .	11
Appendix A. Locations of ocean bank stations trawled by M/V SOGN during April and May, 1968 . . . . .	16

Investigation of King Crab Ocean Reproduction  
and Brood Stock Composition, Kodiak Island

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INTRODUCTION

King crabs, Paralithodes camtschatica (Tilesius), inhabit the North Pacific and Bering Sea. A large fishery is centered in the Kodiak Island area, where landings reached a peak of nearly 91 million pounds in 1966. Kodiak king crab production decreased to 62 million pounds for calendar year 1967<sup>1/</sup>; and the 1968 spring fishery showed a further decline producing about 5 million pounds of king crabs as compared with a catch of about 23 million pounds the preceding spring. Prices paid to fishermen are helping offset the reduction in catch. Processors agreed to pay 11 cents per pound for king crabs in 1967, a raise of one cent over the preceding year. The reduction in pounds landed during the spring of 1968 pushed the price per pound to 16 cents in the round. This price probably will not be reduced and an increase to 20 cents per pound may soon be commonplace.

The Kodiak king crab season was to open on June 16, 1968 but the presence of soft male and female crabs in test fishing catches influenced the staff and board members of the Alaska Department of Fish and Game to close the season until August 1, 1968.

The 1968 spring season had been closed on March 31, 1968, a month earlier than the year previous, to protect molting and mating king crabs. King crabs annually migrate to waters of less than 50 fathoms to breed. Migration begins during the winter and breeding occurs during late winter and spring.

<sup>1/</sup> ADF&G, unpublished data.

Kodiak Island shoreline serves as an extensive king crab breeding area, as described by Wallace, et al, (1949) and Powell and Reynolds (1965). More recently McMullen (1967c) described Portlock Bank and Marmot Flats, east of Kodiak Island, as king crab breeding areas. Females normally but not necessarily molt while being grasped by a male after which breeding takes place (Marukawa, 1933; Powell and Nickerson, 1964). Mature females are almost always bred and subsequently the presence of eggless or non-ovigerous females in an unexploited stock is rare (Wallace, et al, 1949; Weber, 1967). Frequent reports by fishermen during the 1967 season indicated the presence of non-ovigerous females along the east and south sides of Kodiak Island.

## OBJECTIVES

The primary objective of this study was to determine if king crabs were molting and breeding on Albatross Bank east of Kodiak Island. Trawls fished from a chartered vessel were used to sample pre-selected areas. Breeding locations, if present, were to be defined so they might be closed to the commercial fishery if the need arises. Knowledge of offshore breeding areas is also advantageous when entering into international fisheries agreements with nations utilizing the fishes of the Kodiak Continental Shelf.

The secondary objective was the examination of king crabs on inshore breeding grounds along the east side of Kodiak Island for the presence of unmated, new-shell females. Poor condition of king crab stocks may be indicated by the presence of these individuals and/or the absence of adequate numbers of brood males with the females. Inshore trawling was performed as time permitted or poor weather postponed offshore fishing.

## METHODS

### Offshore trawling

Trawl stations on Albatross Bank were selected from past experience in locating molting and breeding king crabs on Portlock Bank and Marmot Flats (McMullen, 1967a, 1967b). Ocean depths of less than 35 fathoms over a sand or mud substrate were generally sought. See Appendix Table A for trawl locations.

Sampling gear consisted of: (1) a standard 400 mesh eastern otter trawl with a 94-foot ground line and 71-foot head line and (2) a 20-foot beam trawl, which was to be used in rocky areas where the otter trawl could not be fished.

Tows one mile in length were conducted from the 74-foot chartered vessel SOGN using a 3:1 warp-depth ratio. Trawl stations were found through the use of radar and loran navigation.

Aboard ship king crabs were sexed, exoskeletal ages recorded, and the presence of eggs noted on females. Associated species were counted or their numbers estimated and recorded.

Presence of breeding grounds was determined by collecting grasping king crab pairs, females in various stages of ecdysis, soft females with spermatophore bands spread around their oviducts or with non-water hardened new eggs, and shed exoskeletons.

Trawling accomplished during this project in 1966 and 1967 located molting and breeding king crabs on Portlock Bank and Marmot Flats, respectively. Several trawl stations on each bank were re-evaluated to determine if king crabs were again molting and breeding there in 1968.

King crab catches on Portlock Bank and Marmot Flats were compared with those made on Albatross Bank to determine the relative importance of the latter as a breeding site.

### Stock condition

Inshore trawling was conducted along the east side of Kodiak Island to assess king crab stock condition as described earlier. Large catches of king crabs were not individually measured, but the size range of female king crabs was determined. Sexual maturity was determined by viewing ripe internal eggs through translucent abdominal membranes. Numbers and percentages of new-shell females without eggs were recorded.

## RESULTS

### General

Seventeen one-mile tows were conducted on Albatross Bank (Figure 1).

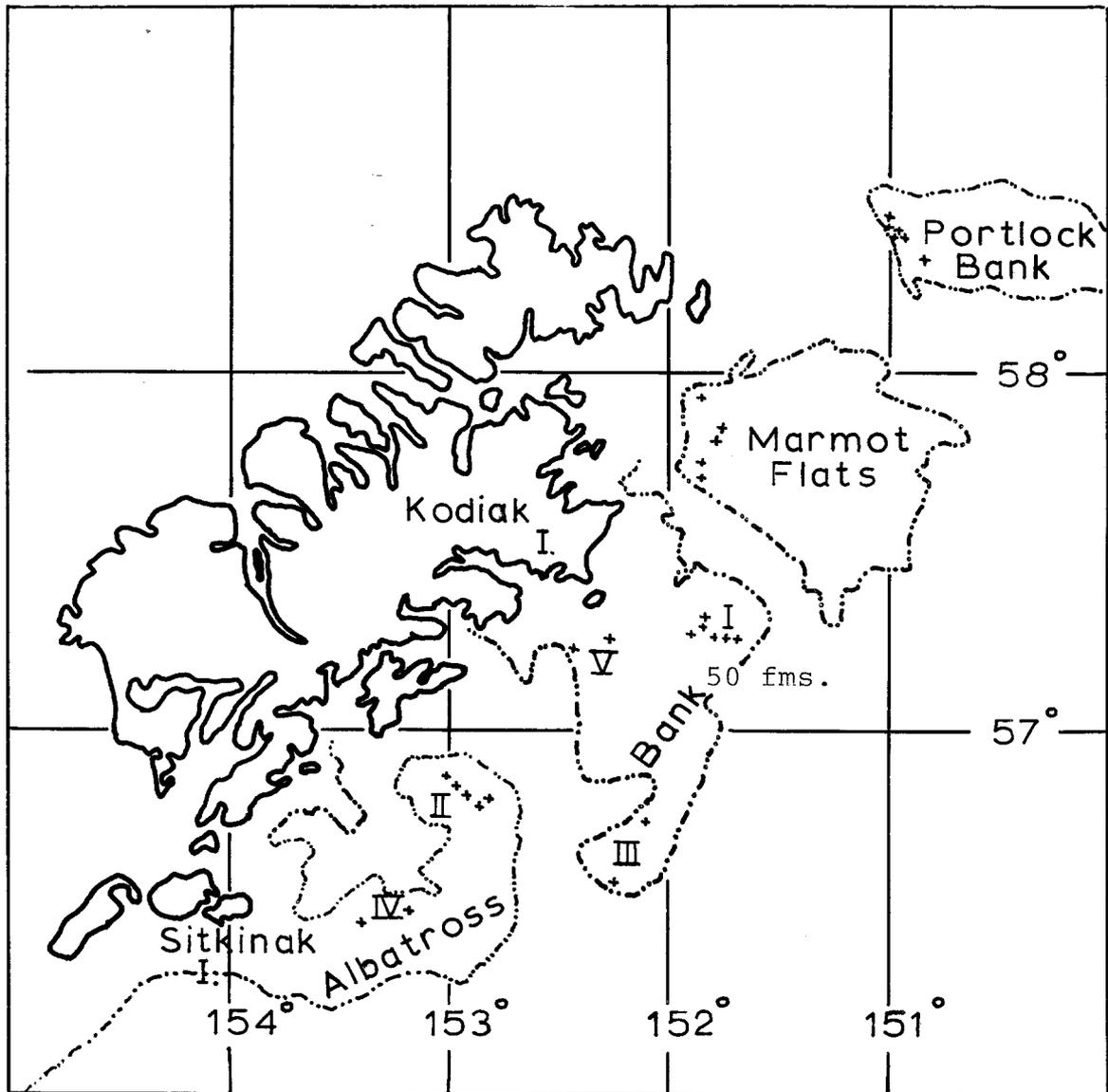


Figure 1. Ocean bank study areas occupied during April and May, 1968. Stations trawled are identified with crosses and general Albatross Bank areas are denoted with Roman numerals.

Sixteen additional stations were sounded with the recording fathometer, but were too rocky to trawl. Only 149 king crabs were caught on Albatross Bank. Two tows at the southern inshore edge of the bank yielded 131 of the total (Table 1). Catches were made in about 40 fathoms of water on sand and mud substrata. Two new-shell male king crabs were the only individuals caught on Albatross Bank proper.

Six and five stations were trawled on Portlock Bank and Marmot Flats respectively. Three Portlock Bank stations had been trawled in 1966 during this project. Nearly 2,000 king crabs were caught at that time. The three Portlock Bank stations re-trawled and three others in the near vicinity yielded 46 males and 83 female king crabs (Table 1). Twenty-three, or 50 percent of the males were of sublegal size.

Four of the Marmot Flats stations had been trawled during the spring of 1967, and had yielded 3,464 king crabs. Five tows on Marmot Flats in 1968 caught 263 king crabs (Table 1), 25 of which were males.

#### Indicators of breeding

King crabs were captured in six different tows on Albatross Bank. No grasping pairs were collected. One new-shell female with spermatophore bands spread around her oviducts was captured at station IV-1a, at the southern inshore edge of the study area. Several very soft new-shell females with new eggs were captured at the same station.

One grasping pair of king crabs were caught on Marmot Flats. One hundred sixty-four females were caught in one tow at the northwest corner of the Flats. They were mixed pre- and post-molts with very soft to firm exoskeletons. Twenty-one shed exoskeletons, indicators of ecdysis, were collected in four tows.

One grasping pair of king crabs was caught on Portlock Bank. Six tows conducted there collected both pre- and post-molt female king crabs. Three new-shell females were very soft, having molted within hours of capture. Ten molted exoskeletons were collected in three hauls.

#### Length frequencies

King crabs did not appear to be numerous on the ocean banks, despite the fact that stations selected on all banks were in areas where good catches were expected.

Table 1. Trawl-caught king crabs, Kodiak Island, spring of 1968

Location	Date 1968	Number of trawls	Males			Females		old-shell	grasping pairs
			new-shell legal	sub-legal	old-shell	new-shell with eggs	no eggs		
Albatross Bank	4/19	5	1	-	-	-	-	-	-
	5/2	4	1	-	-	-	-	-	-
	5/3	2	-	-	-	-	-	-	-
	5/10	2	-	-	-	-	-	-	-
	5/12	2	7	14	5	91	1	14	-
	5/13	2	14	1	-	1	-	-	-
Area totals		17	23	15	5	92	1	14	0
Marmot Flats	4/27	3	12	4	2	31	2 1/	34	-
	4/28	1	4	1	0	4	-	3	1
	5/14	1	0	0	2	98	58	8	-
	Area totals		5	16	5	4	133	60	45
Portlock Bank	5/8	3	3	11	12	19	-	23	1
	5/15	3	1	12	7	31	1	9	-
	Area totals		6	4	23	19	50	1	32

1/ Females flaccid - just molted.

Tables 2 and 3 present the length-frequency distributions for trawl-caught king crabs from Albatross and Portlock Banks and Marmot Flats, spring of 1968.

Females caught offshore ranged from 110-184 mm carapace length, which are mature size. Females without eggs appeared to be of the same size classes as those with eggs. Old age or immaturity appeared not to be dominant reasons for non-ovigerousness in those new-shell females.

Data presented in Table 2 indicate that the average size of females increased in a northerly direction along Kodiak Island's east side.

Males ranged from 100-221 mm carapace length and were predominantly newly molted individuals. Very old males (triennial molters) were present only in Portlock Bank catches.

#### Performance of otter and beam trawls

Otter trawls tended to hang up on rocky bottom, which usually resulted in considerable damage to the underside of the net.

Two 20-foot beam trawls were purchased by this project for use in sampling rocky areas on ocean banks. One beam trawl frame was ruined while gear handling and fishing exercises were being carried on in inshore waters during windy weather. The second trawl was reinforced with bridging along the top and back side of the beam.

The otter trawl hung up on Albatross station III-4 although the vessel's recording fathometer indicated the ocean bottom there was flat. The otter trawl was exchanged for the beam trawl after being brought aboard and the beam trawl was used to cover remainder of station III-4. The rigid beam was bent into an acute angle when the trawl was brought aboard, and the otter trawl was used for the remainder of the survey.

#### Stock condition

Many bays along the east side of Kodiak Island are utilized as molting and breeding areas by king crabs. Migration of crabs to these areas in winter and spring have been documented by Powell and Reynolds (1965). In the present studies, trawling was conducted in five bays on the east side of Kodiak Island to assess king crab egg production after large numbers of males

Table 2. Length-frequency measurements of female king crabs captured by trawling on (I) Albatross Bank, (II) Marmot Flats, and (III) Portlock Bank east of Kodiak Island, spring of 1968.

size group mm	New-shell females						Old-shell females					
	with eggs or sper- matophore bands			no eggs			with eggs			no eggs		
	I	II	III	I	II	III	I	II	III	I	II	III
110-114	2		1									1
115-119	6	1	-				1					-
120-124	12	-	-				-			1	1	-
125-129	21	3	-				1			2	-	-
130-134	23	4	3		3		3	2		2	-	2
135-139	23	16	4	1	7		-	7		3	3	-
140-144	6	22	3	-	14		-	5			5	1
145-149	1	31	6	1	19	1	-	10			2	3
150-154	2	35	11		12		-	4			2	4
155-159		11	10		6		1	1	1		2	2
160-164		5	4		2			1	3		1	4
165-169		4	4		1			1	-		1	2
170-174			2		-				2		1	6
175-179			1		-				-			2
180-184					1				1			3
Totals	96	132	49	2	65	1	6	31	7	8	18	30

Table 3. Length-frequency measurements of male king crabs captured by trawling on (I) Albatross Bank, (II) Marmot Flats, and (III) Portlock Bank east of Kodiak Island, spring of 1968.

size group mm	New-shell males			Old-shell males			Very old-shell males		
	I	II	III	I	II	III	I	II	III
100-104			1						
105-109		2	3						
110-114		-	1						
115-119		1	4	1					
120-124		-	3	-					
125-129	4	-	3	-					
130-134	3	-	5	-					
135-139	5	-	1	-					
140-144	3	1	1	-	1				
145-149	2	1	1	-	-				
150-154	5	4	3	1	-				
155-159	3	3	-	-	-				
160-164	4	4	-	1	-				
165-169	3	4	-	1	-	1			
170-174	2	1	-	1	-	2			
175-179	2		-	1	1	2			
180-184	2		-	-	1	1			1
185-189			1	1	-	1			2
190-194					-	4			1
195-199					1	2			2
200-204									1
205-209									-
210-214									-
215-219									-
220-224									1 <u>1/</u>
Totals	38	21	27	7	4	13			8

1/ 221 mm carapace length.

had been removed by the commercial fishery over the past several years. One trawl observation was made in Kaguyak Bay, at the southern end of the designated study area and near an area of intense commercial utilization northeast of Sitkinak Island. Six hundred fifty-one new-shell female king crabs were caught along with nine males (Table 4). Females ranged in exoskeletal condition from very soft to firm. Four hundred ninety-six or 76.1 percent of all new-shell females were not carrying eggs and had not been mated. Ocean Bay, at Sitkalidak Island, is a king crab breeding area. Four hundred seventy-four individuals were caught in one tow on May 12, 1968. Two hundred sixty-five (60%) of 441 mature new-shell females had not been mated at ecdysis and were without new eggs. Only eleven males were captured along with 22 old-shell females.

Fifty-three and 164 new-shell females were caught inside of Cape Chiniak in Kalsin and Middle Bays, respectively. Only one new-shell female without eggs was present in each sample despite the fact these areas have been fished intensely for several years as have those areas along the east side of Kodiak Island.

Only one new-shell female without eggs was caught on each of Albatross and Portlock Banks, as was shown in Table 1. Sixty or 31 percent of all mature new-shell females collected on Marmot Flats were not carrying eggs and had not been mated at ecdysis. One tow on the Flats caught 156 new-shell females of which 58 were non-ovigerous.

## DISCUSSION

### Offshore trawling

Trawling was conducted on Albatross Bank east of Kodiak Island during April and May 1968 to determine if king crabs were molting and breeding there. Seventeen one-mile tows were completed and 149 king crabs were caught. Two tows on the southern inner edge of the bank accounted for 89 percent of the king crabs caught there. One tow on the inner bank caught a very new-shell female king crab without eggs, but with spermatophore bands spread around her oviducts. She had probably mated at that location within hours of capture. Several other soft new-shell females with new eggs captured in the same tow also indicated that molting and mating were occurring there. Only 18 king crabs were captured on the remainder of the bank.

Table 4. -- Assessment of king crab brood stock condition along east in-shore side of Kodiak Island, April 27 to May 20, 1968.

Location	Total males	Size range mm	New-shell females				Percent without eggs	Total old-shell females
			with eggs totals	size range mm	without eggs totals	size range mm		
Kaguyak Bay	9	133-181	155	110-162	496	112-150	76.1	35 <u>1/</u>
Ocean Bay	11	137-187	176	118-150	265	119-162	60.0	22
Santa Flavia Bay	4	135-174	7	114-172	-	-	-	-
Kalsin Bay	7	126-177	53	114-174	1	155	1.9	5
Middle Bay	16	107-168	164	108-160	1	144	0.6	37

1/ Estimate, for all individuals not counted.

11

It is felt that all potential king crab breeding areas were examined despite the fact that only 17 trawls were made. Albatross Bank is extremely rocky with relatively little sand or sand-mud substrata that molting and breeding king crabs seem to prefer. The presence of breeding stocks on outer Albatross Bank was not indicated.

King crab breeding areas appear to be found only on the southern end of Albatross Bank. Those breeders may not be an ocean-bank associated group, but may be members of a stock occupying the Sitkinak Island shallows for breeding purposes.

Sixteen Albatross Bank stations were sounded with a recording fathometer, but were too rocky to trawl. Rocky substrata probably is not utilized by king crabs for molting and mating purposes, for all marginal rocky and gravelly areas trawled on Portlock Bank and Marmot Flats produced few or no king crabs and no indications of molting and mating female crabs. Similar results were obtained on Albatross Bank during the study discussed here.

Limited numbers of trawls were conducted on Portlock Bank and Marmot Flats with total catches of 131 and 265 king crabs, respectively. One grasping pair was captured on each Portlock Bank and Marmot Flats to indicate that breeding was occurring as it had in 1966 and 1967. Pre- and post-molt king crabs were present in both banks to indicate that stocks had migrated there to molt and breed. Three newly molted females with eggs were caught in one tow on Portlock Bank and a total of ten shed exoskeletons were collected in three hauls to give evidence that king crabs were molting and breeding there.

Molting and mating on Marmot Flats were further evidenced by the presence of post-molt females with very soft to firm exoskeletons and the collection of 21 shed exoskeletons.

King crabs appeared to be molting and breeding on Portlock Bank and Marmot Flats in 1968 as opposed to Albatross Bank.

#### Length frequencies

Male and female king crabs of 100-221 mm carapace length were caught trawling on the ocean bank east of Kodiak Island during the spring of 1968. It appears evident that young and old crabs alike reside in offshore waters. Very old shell males were found only on Portlock Bank, which has been subjected to less fishing effort to date than Marmot Flats or Albatross Bank.

Trawl catches were small despite the selection of known king crab breeding areas for examination. Fewer king crabs or a change in timing of molting may be indicated.

Average sizes of female king crabs appear to increase in a northerly direction and away from southern Albatross Bank. This may indicate a gradual migration northward from a population center at the southern end of Kodiak Island. Older, larger crabs would be found farthest away from the population center.

### Stock condition

Trawling to determine condition of king crab brood stocks was conducted in bays along the east side of Kodiak Island. One tow in Kaguyak Bay inside Two-headed Island collected nearly 700 king crabs of which only nine were males. Six hundred fifty-one mature new-shell females were caught, 76.1 percent of which were without eggs and had not been bred. Female king crabs normally, but not necessarily molt and then mate while being grasped by a male. Grasping may occur several days before the female molts. The grasping pair mates immediately following the female's molt after which they separate. In this way, males may service four or five females during one mating season.

The presence of non-ovigerous, mature female king crabs in a natural environment is rare in the histories of the Bering Sea and eastern Pacific fisheries. The presence of so high a percentage of unbred individuals strongly suggests that an unfavorable sex ratio between king crab sexes exists. Large numbers of unmated new-shell females may be the result of an intensive males-only commercial fishery.

Similar results were obtained at Ocean Bay, Sitkalidak Island. Sixty percent of 441 new-shell mature females were without eggs and had not been bred. Eleven males were present with the females. There appeared to be little chance that the non-ovigerous females would be bred if it is assumed that the trawl was non-selective and the king crab sex ratio on the sampled breeding grounds was as indicated.

Marmot Flats was the only other area sampled where a large percentage of non-ovigerous new-shell females was caught. Thirty-one percent of 193 mature individuals exhibited that condition. One hundred fifty-six new-shell females were caught in one tow, 58 of which were non-ovigerous. This area has been subjected to an intense commercial fishery as has the entire east side of Kodiak Island.

Small king crab catches per tow were made on Albatross and Portlock Banks and Kalsin and Middle Bays. One non-ovigerous new-shell female was captured in each area, which represented no apparent deviation from a healthy stock condition.

The absence of mature males on breeding grounds was very evident where large concentrations of molting female king crabs were located. There, as many as 75 percent of the captured females had molted in the absence of males and had not yet mated. Few non-ovigerous females were located where individuals were apparently scattered throughout the sampling area.

#### RECOMMENDATIONS

Surveys to locate and define offshore king crab breeding areas should be continued in the Trinity Island - Chirikof Island areas. A supplementary trawl program to determine brood-stock conditions in the vicinities of Trinity Islands, Geese Islands and Alitak Bay should be outlined and performed as time and poor offshore weather will permit. This may develop into a long-term annual program to determine changes in incidences of unbred female king crabs.

Declining king crab production and sex ratios as imbalanced as .013:1 in favor of females in brood stocks indicate that present fishing regulations in the Kodiak area may be too unrestrictive. A shorter fishing season may be required which would further restrict the March 31 closure regulated in 1968. Ocean bank and inshore brood stocks require more protection. All known Kodiak area breeding areas inside 50 to 40 fathoms might be classified as sanctuaries from the commercial fishery.

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Appendix A. Locations of ocean bank stations trawled by M/V Sogn during April and May, 1968.

Albatross Bank

<u>Station</u>	<u>Location</u>	
I-1	56°53N	153°00W
I-2	56°51N	152°57W
I-3	56°49N	152°53W
I-4	56°48N	152°50W
I-5	56°48N	152°47W
II-1	57°22N	151°42W
II-2	57°20N	151°43W
II-3	57°18N	151°44W
II-4	57°15N	151°45W
II-5	57°17N	151°51W
II-6	57°17N	151°47W
III-1	56°45N	152°06W
III-4	56°39N	152°11W
IV-1a	56°30N	153°21W
IV-2	56°31N	153°11W
V-1	57°14N	152°24W
V-2	57°17N	152°15W

Marmot Flats

<u>Station</u>	<u>Location</u>	
1	57°56N	151°51W
38	57°44N	151°51W
7	57°49N	151°44W
36	57°51N	151°41W
9	57°42N	151°51W

Portlock Bank

<u>Station</u>	<u>Location</u>	
I-22	58°23N	151°00W
P- 2	58°19N	150°58W
I-28	58°17N	150°55W
P- 4	58°23N	151°03W
P- 5	58°26N	151°03W
P- 6	58°24N	151°05W

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