

Informational Leaflet

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KING CRAB Paralithodes camtschatica (Tilesius) OFFSHORE
BREEDING STUDY ON MARMOT FLATS, KODIAK ISLAND,
SPRING OF 1967

By:

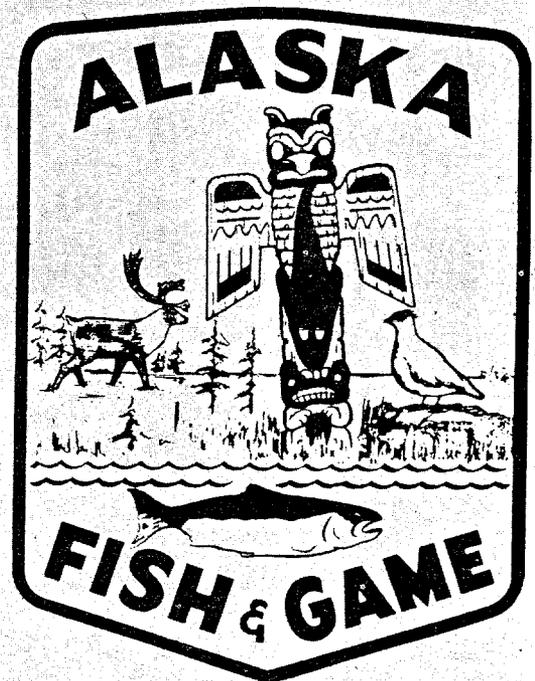
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King Crab Paralithodes camtschatica (Tilesius) Offshore Breeding
Study on Marmot Flats, Kodiak Island, Spring of 1967

By

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INTRODUCTION

King crabs (Paralithodes camtschatica) are creatures of the North Pacific and Bering Sea. Adults breed annually in water depths less than 40 fathoms (Marukawa, 1933; Powell, 1964). King crabs commonly molt and breed in the bays of the Kodiak Island group as described by Wallace, et al., (1949) and Powell and Reynolds (1965). More recently, McMullen (1967) found king crabs molting and breeding in an open ocean environment.

Domestic and foreign fleets fish the Kodiak continental shelf year-round. King crabs have been fished during the breeding month of April, except as regulated by emergency closure. A major portion of Portlock Bank, a known ocean breeding location, has not been subject to regulatory closure which may have resulted in the selective harvest of brood males during past years.

The Kodiak king crab fishery has rapidly increased in value the past years. Landings in the Kodiak District have increased from 3 million pounds in 1955-1956 (Gray, et al., 1965) to 90.75 million pounds in 1966^{1/}. Individuals have invested heavily in the fishery. Crab vessels may cost over \$300,000 each and processing lines have been activated in unprecedented numbers.

Geographical ranges of Kodiak Island king crab stocks should be established, but at the present time this may not be feasible due to the

^{1/} ADF&G unpublished data

vastness of the area and the unwillingness of the fleet to fish on unproven grounds. It is feasible, however, to define Kodiak District king crab breeding locations and the relative importance of each.

The specific objective of the present year's study was to determine if king crabs were molting and breeding on an ocean bank off Kodiak Island. An estimate of king crab numbers was also desired. Other objectives were to determine: sex, size and exoskeletal age composition of all king crabs captured during the study.

METHODS

Sampling Methods

Marmot Flats, off Cape Chiniak, Kodiak Island was chosen as the study area. The study location was in the southwest quarter of the Flats and was 236 square miles in area. The area was divided into 59 four-square mile sampling stations (Figure 1).

A stratified sampling program was adopted which dictated that observations be made at all alternate stations. The sampling plans were sent to our biometrics staff for their approval and for the selection of a statistical method to derive an estimate of king crab abundance in the study location. Replicate sampling, if time allowed, was suggested which would consist of a minimum of two replications in five stations. Additional single observations in originally unsampled stations were also suggested.

A vessel charter contract was let on bids, from which a trawler was contracted. The vessel was required to have the capability of navigating offshore and fishing a standard 400 mesh eastern otter trawl having 71 and 94 foot head and groundlines, respectively. The net was towed a distance of two miles in each selected station using a 3:1 warp-depth ratio. The width of bottom coverage by the standard trawl net was averaged at 40 feet as described by Alverson, et al. (1964).

Processing Collections Aboard Ship

King crabs were separated according to sex, shell age and female ovigerousness upon being taken aboard the vessel. All king crabs were measured, except when large numbers of pre-molt females were caught.

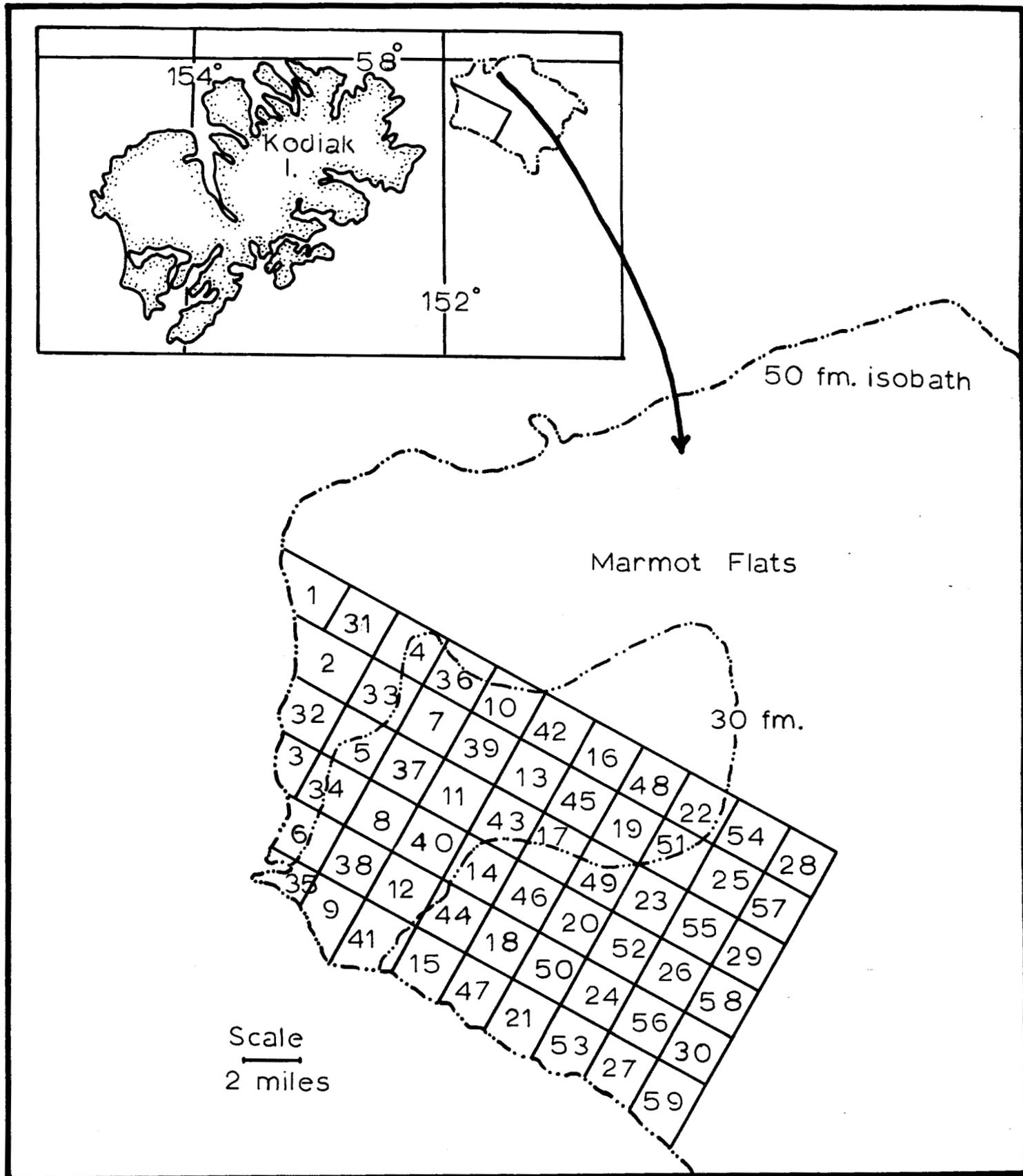


Figure 1. Marmot Flats study area listing numbered locations of trawling observations, spring of 1967.

About two hundred such females were measured and the others enumerated at those times.

Numbers of commercially important fish species were estimated and recorded with all other data on standard forms.

Estimate of Abundance

Sample trawl catches were used to make a non-stratified abundance estimate of king crabs in the Marmot Flats study area. The formulae employed were:

$$P' = (\Sigma A_i) \frac{(\Sigma D_i)}{\Sigma n_i} \quad (1)$$

where:

ΣA_i = total area sampled

ΣD_i = total king crabs captured

Σn_i = total observations

Each sampling station was 4-square nautical miles in area. Each trawl observation encompassed an area 40 feet by 12,160 feet, which was the trawl width times distance towed. The ratio between area sampled and that of each 4-square mile station was 1:304, so the formula for the estimate of total king crabs in the 236-square mile study area was:

$$N' = (P') (304) \quad (2)$$

Variance and confidence interval for the population estimate were also calculated. Three assumptions were made in deriving this estimate of abundance.

1. King crabs were randomly distributed throughout the study area.
2. Movement of king crabs into and out of the study area was equal or non-existent.
3. Otter trawls were non-selective for all sizes of migrating king crabs. The validity of these assumptions will be discussed later.

RESULTS

Trawl Collections

The ocean bank study location contained 59 stations, four-square miles each. One tow, two miles in length, was conducted in each station. Replication of observations was not undertaken because relatively poor weather encountered early in the field program caused some concern about completing the original series of 30 alternately spaced stations. Fair weather during May allowed the completion of 59 individual stations, but replicate observations could not then be made according to statistical procedure.

King crabs totaling 7,670 were caught (Table 1). Individual trawl catches ranged from 1,516 king crabs to seven empty hauls. Six hundred fifty-four males and 7,016 females represented an approximate 1:11 sex ratio. That figure exceeded a male-female sex ratio of 1:2 found 50 miles to the north on Portlock Bank in 1966 (McMullen, 1967). The differing king crab sex ratios for the two areas may be explained by differences in catches taken from the two areas during the past two years. Portlock Bank produced only 19,751 salable king crabs^{2/} in a males-only fishery during the 1965-1966 season immediately before research trawling was conducted there. Marmot Flats produced 1,009,753 king crabs during the same period. Marmot Flats again produced 218,492 king crabs in late winter and spring of 1967 just prior to the conduction of the trawl study there.

The king crab trawl catch on Marmot Flats was dominated by 5,839 females approaching ecdysis. Two hundred sixty-four recently molted females were also caught. Of these, 21 new-shell females carried no new eggs and 9 individuals had spermatophore bands spread around their oviducts (Appendix A).

Nearly all captured female and male king crabs (Table 2) were mature according to the present procedure of designating maturity of northeast Pacific males and females at 100 mm carapace length (Powell and Nickerson, 1965).

Two hundred sixteen (33 percent) of all males captured were of sublegal size. Legal king crabs caught and sold in the Kodiak District must be 7 inches in carapace width which corresponds to a carapace length of 145 mm as used in biological investigations. One hundred forty-seven

^{2/} ADF&G unpublished data

Table 1. Trawl caught king crabs - Marmot Flats, Kodiak Island, spring of 1967.

Date 1967	Number of Trawls	Number of king crabs caught				Grasping Pairs	Totals
		MALES		FEMALES			
		New Shell	Old-Shell	New Shell	Old-Shell		
4/ 6	6	34	4	5	176	0	219
4/ 7	2	10	7	4	481	0	502
4/ 9	1	12	2	0	490	0	504
4/16	2	43	12	9	1,820	0	1,886
4/17	5	49	0	4	7	0	60
4/18	4	68	12	15	963	0	1,058
4/20	2	4	10	2	223	0	239
4/22	3	53	28	48	1,479	6	1,620
4/23	2	4	0	0	0	0	4
4/25	5	107	20	95	991	4	1,221
5/ 3	3	0	0	0	0	0	0
5/ 6	10	47	3	2	3	1	57
5/ 7	1	3	0	28	11	0	42
5/ 8	4	20	16	42	70	3	154
5/ 9	9	49	21	10	20	2	104
Totals	59	503	135	264	6,734	16 x 2	7,670

(33.6 percent) of all legal males captured would be recruits to the 1967 summer fishery. Recruits are defined as molts-of-the-year males with carapace lengths of 145-163 mm. This represents the size range from legal minimum to maximum carapace length obtained by a male king crab during the molt in which he attains legal size (Nickerson, et al., 1965).

Sixteen grasping king crab pairs were caught among ten stations widely dispersed in the study location. All grasping males had not molted in 1967. Other grasping pairs were probably present in the catch but were not designated as such if the male had released his partner aboard the vessel before they were extracted from the other specimens.

Empty king crab exoskeletons were collected in two tows. Shed exoskeletons are indicative of molting, which accompanies mating of female king crabs.

Abundance Estimate

Seven thousand six hundred seventy king crabs of both sexes representing P' of formula 1 were captured in 59 two-mile tows. Variance (s_p^2) of this total was 98,193.379 and the standard deviation was 313.358. P' was surrounded by a confidence interval of ± 523 .

Estimated population size was derived by multiplying total king crab catch by area conversion factor. So:

$$N' = (7670) (304) = 2,331,680$$

and,

$$C. I. (90\%) = (523) (304) = 158,992$$

$$N' = 2,331,680 \pm 158,992, \text{ the population of king crabs in the study area.}$$

DISCUSSION

A total of 59 trawl observations were conducted to complete a stratified sampling program of 236 square miles of Marmot Flats, Kodiak Island. Six hundred fifty-four male king crabs and 7,016 females were captured for an approximate 1:11 sex ratio. A sex ratio of 1:2 in favor of captured females

was found on Portlock Bank during April and May of 1966. The area surrounding Portlock Bank has not been subjected to intense fishing pressure as has Marmot Flats, which may partly account for the differing sex ratios.

Capture of 16 grasping king crab pairs strongly indicate that breeding occurred on Marmot Flats. The pairs were captured at ten widely dispersed locations, indicating that a substantial breeding area may exist on the Flats.

Other indicators of breeding were the capture of nine recently mated females having spermatophore bands spread near their oviducts and 23 newly molted females carrying new eggs. Molted female king crab exoskeletons were collected in two tows which also indicated that molting and probably breeding occurred on Marmot Flats.

Thirty-three percent of all males captured were sublegal and about 34 percent of all legal size males were 1967 recruit crabs. The recruit size class appeared strong compared to other size classes captured, assuming that the otter trawl was non-selective.

A non-stratified abundance estimate of 2,331,680 king crabs with a confidence interval of $\pm 158,992$ crabs was calculated for the 236-square mile study area. This estimate rests upon the assumptions that the trawls were non-selective, crab migration to and from the study area was balanced, and king crabs were randomly distributed in the study area. Unfortunately, the value of the obtained estimate is limited because replicate sampling, which would have made an evaluation of these assumptions possible, was not considered feasible at the time of sampling. Although the validity of the above assumptions may be questioned, the method employed is an acceptable procedure for estimating population abundance and is valid within the framework of statistical sampling theory.

ACKNOWLEDGEMENT

Choice of statistical methods employed in this study and analysis of data while defining their limitations were largely accomplished through the efforts of Mr. Frank Ossiander, biometrician, now with the Bureau of Commercial Fisheries.

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Appendix A. Collections of king crabs by station - Marmot Flats, Kodiak Island, spring of 1967.

Date 1967	Station	MALES			NEW-SHELL FEMALES			OLD-SHELL FEMALES		
		Molted in 1967	Not molted in 1967	Not molted in 1966 and 1967	With eggs	No eggs	With sperma- tophore bands	With eggs	No eggs	Grasping pairs
4-6	1	1	2	-	-	-	-	20	1	-
4-6	2	2	1	-	-	-	-	41	1	-
4-6	3	1	1	-	-	-	-	1	-	-
4-6	4	-	-	-	-	-	-	37	-	-
4-6	5	10	-	-	-	-	-	63	10	-
4-6	6	20	-	-	5	-	-	2	-	-
4-7	7	-	4	3	-	-	-	462	-	-
4-7	8	10	-	-	3	1	-	19	-	-
4-9	9	12	2	-	-	-	-	479	11	-
4-16	10	5	12	-	1	-	-	1279	85	-
4-16	13	38	1	-	1	7	-	435	23	-
4-17	11	29	-	-	4	-	-	4	1	-
4-17	14	8	-	-	-	-	-	-	-	-
4-17	12	4	-	-	-	-	-	-	1	-
4-17	15	3	-	-	-	-	-	-	-	-
4-17	18	5	-	-	-	-	-	1	-	-
4-18	42	50	2	-	13	-	1	5	5	-
4-18	16	2	-	-	-	-	-	-	-	-
4-18	17	3	-	-	-	-	-	-	-	-
4-18	36	13	10	-	1	-	-	925	28	-
4-20	31	3	2	3	2	-	-	104	25	-
4-20	33	1	4	-	-	-	-	89	5	-
4-22	32	1	2	-	1	-	-	1	1	4
4-22	38	38	22	-	45	-	-	1137	272	1
4-22	34	14	4	-	2	-	-	52	16	1
4-23	21	4	-	-	-	-	-	-	-	-
4-23	20	-	-	-	-	-	-	-	-	-
4-25	40	13	1	-	8	-	-	27	29	-
4-25	39	5	2	-	10	-	-	3	8	1
4-25	37	14	2	-	9	1	-	25	17	-
4-25	41	24	4	-	44	3	-	81	77	2
4-25	44	51	11	-	14	4	2	510	214	1
5-3	43	-	-	-	-	-	-	-	-	-
5-3	45	-	-	-	-	-	-	-	-	-
5-3	48	-	-	-	-	-	-	-	-	-
5-6	30	4	1	-	-	-	-	1	1	-

Appendix A (cont.). Collections of king crabs by station - Marmot Flats, Kodiak Island, spring of 1967.

Date 1967	Station	MALES			NEW-SHELL FEMALES			OLD-SHELL FEMALES		
		Molted in 1967	Not molted in 1967	Not molted in 1966 and 1967	With eggs	No eggs	With sperma- tophore bands	With eggs	No eggs	Grasping pairs
5-6	29	13	-	-	-	-	-	-	-	-
5-6	28	1	-	-	-	-	-	-	-	-
5-6	27	-	-	-	-	-	-	-	-	-
5-6	26	5	-	-	-	-	-	-	-	1
5-6	25	15	-	-	-	-	-	-	-	-
5-6	24	3	-	-	-	-	-	-	-	-
5-6	23	2	1	-	2	-	-	-	1	-
5-6	22	-	-	-	-	-	-	-	-	-
5-6	19	4	1	-	-	-	-	-	-	-
5-7	35	3	-	-	27	1	-	2	9	-
5-8	52	4	2	-	1	-	2	1	1	2
5-8	46	2	1	-	1	-	-	-	3	-
5-8	47	1	1	-	-	-	-	1	1	-
5-8	50	13	12	-	32	4	2	29	34	1
5-9	53	1	-	-	-	-	-	-	-	-
5-9	59	1	-	-	1	-	-	-	-	-
5-9	56	-	-	-	-	-	-	-	-	-
5-9	58	-	-	-	1	-	-	-	-	-
5-9	57	6	-	-	-	-	-	-	-	-
5-9	55	7	-	-	-	-	-	-	-	-
5-9	54	2	1	-	-	-	-	1	-	-
5-9	51	8	1	-	1	-	-	-	1	-
5-9	49	24	19	-	5	-	2	2	16	2
Totals		503	129	6	234	21	9	5839	897	16

Total king crabs 7670

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