The recovery distribution in 1959 of chums tagged as immatures in 1958 is shown in Figure 39. High seas recovery locations in the vicinity of 50°N and 170°E are approximated to reduce the number of intersecting lines. The distribution is similar to that of previous years except for the new results from the Gulf of Alaska. Three chums tagged in the Gulf were recovered in the Bering Sea (high seas, Yukon River, and Bristol Bay). In addition, one chum from the Gulf experiments was recovered on Kodiak Island, and one in Southeast Alaska (Taku River).

The ten chums recovered in 1959 from the immatures tagged in 1957 (Table 18) are not illustrated since all were recovered at sea in the area south and west of the western Aleutian Islands.

The distribution of pink recoveries (Figure 40) is very similar to that seen in 1957 (Figure 21, p. 82 INPFC annual report for 1957). Again, the purse seine catches showed a strong westward movement of pinks in all areas of fishing. Of the 143 returns received through December 15, 1959, 14 were from the Karaginskii area as shown and 129 from the high seas. Because of the large number of high seas returns, locations are shown diagrammatically. The width of the arrows indicates approximately the relative numbers of returns in each general location.

One silver salmon tagged in Area 4C (Figure 35) south of Adak in July, 1959, was recovered in the Kuskokwim River in August, 1959. Another silver tagged in the Gulf of Alaska as an immature in 1958 was recovered by a troll fisherman off Depoe Bay, Oregon, in June, 1959. The latter was a fortuitous recovery since only 3 immature silvers were tagged in 1958.

One steelhead tagged in the Gulf of Alaska in August, 1958, was recovered in the Samish River, Washington, in March of 1959.

Addendum to Tagging Report

Since the preparation of the foregoing report, 55 tags were received from Russia. Table 19 shows the 53 recovered in 1959 by species and by year of tagging. In addition, one tag was returned from a pink salmon tagged and recovered in 1957, and one from a chum tagged in 1957 and recovered in 1958.

The one red salmon recovery is the first return of this species from the Asian coast from our high seas tagging. The fish was tagged June 13, 1958 south of Attu Island, and recovered July 13, 1959 in Kamchatka Bay, East Kamchatka.

The 27 chums recovered in 1959 were from various points along the north and west shores of Okhotsk Sea, from West Kamchatka, and from East Kamchatka. The 25 pinks were from East Kamchatka, mostly from the Karaginskii region. Two pinks were recaptured further north (Lake Maino Pylgino) just west of Cape Navarin (62°20′N).

The additional pink recovered in 1957 was from the Karaginskii area, and the chum recovered in 1958 was from the northern Okhotsk coast.

Table 19. Salmon tags recovered in USSR in 1959 and returned too late for inclusion in preceding figures and tables.

	Red	Chum	Pink	Total
Tagged in 1959	0	11	25	36
Tagged in 1958	1	8	—	9
Tagged in 1957	0	8	—	8
Total	1	27	25	53

KING CRAB INVESTIGATIONS

Research designed to provide the International North Pacific Fisheries Commission with the facts necessary to determine the need for joint conservation measures of the eastern Bering Sea king crab stock is continuing along lines presented in past reports.

The field work, done primarily aboard chartered fishing vessels, featured otter trawling at a series of stations at 20-mile intervals throughout a 25 to 30-thousand square mile area which appears to encompass the major distribution of this stock of crabs (Figure 41). Data relating to growth, abundance, and environmental conditions were collected and the crabs caught were tagged.

During the summer of 1959 the 66-foot-long halibut schooner *Tordenskjold* was chartered jointly for use in king crab and salmon studies. Adverse weather conditions in the spring hindered the king crab program necessitating a reduction in the original 77 stations planned. Forty-two stations were occupied during the period. Following two months of salmon sampling, the *Tordenskjold* was reassigned to the king crab investigation in August. Mass tagging at widely spaced areas was emphasized during the second phase of the 1959 field season.

Tagging operations for growth, migration, abundance and degree of mixing studies have prog-

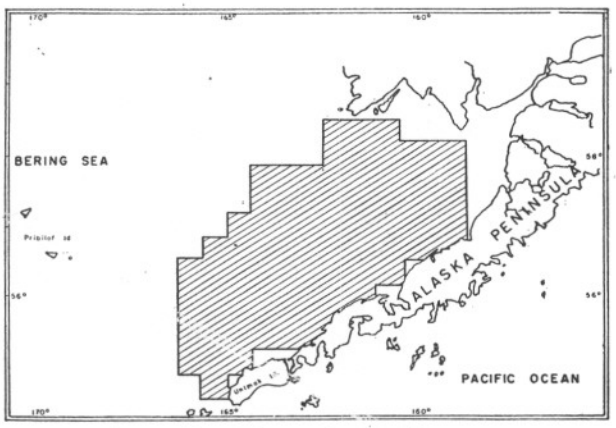

Figure 41. King crab sampling area.

ressed as shown in Table 20.

A major portion of the tag recoveries was made by the Japanese Fisheries Agency and was returned with very complete data. Much appreciation is expressed to Mr. Seiwa Kawasaki, biologist aboard the king crab factory-mothership and to the Japan Fisheries Agency for their cooperation and completeness of recovery information.

Included in the tag returns are 325 male crabs ranging in size from 96 to 169 millimeters in carapace length which show evidence of having moulted. The mean carapace length growth increment per moult was calculated to be slightly less than sixteen millimeters.

Examining the shell condition of every male crab sampled throughout the station pattern provides us with a percentage of crabs of each size that moulted during the sampling year. Then, combining the percentage moulting with the growth increment per moult, we have developed the average growth rate estimates shown graphically in Figure 42.

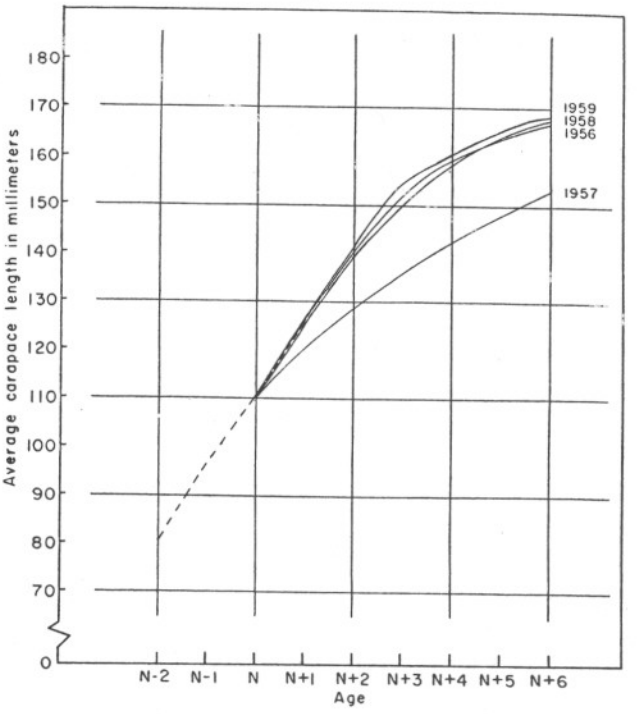

Figure 42. Average growth curves of the adult male king crab for each of the years 1956 through 1959 as determined from modal progression in size frequency distributions (broken line) and population models (solid lines).

The growth curves calculated from the observed proportions moulting in 1956, 1958 and 1959 are quite similar. The 1957 data, however, suggests a much lower rate, principally due to the lesser frequency of new shell crabs observed in the sizes from 110 to 150 millimeters. The cause for this apparent anomaly is not known. However, realizing the possibility of mis-classification of shell condition, we developed more definitive criteria after the 1957 season.

Table 20. Bering Sea king crab tagged and recovered.*

Tagging year	Number released	Recoveries during						
		1954	1955	1956	1957	1958	1959	Total
1954	1,107	44	60	1	2	1	0	108
1955	1,351		32	53	35	18	12	150
1956	4,063			53	197	114	65	429
1957	13,795				39	192	214	445
1958	9,851					40	109	149
1959	4,447						36	36
Total	34,614	44	92	107	273	365	436	1.317

* The table is presented only to show the magnitude of releases and recoveries. Since each year's tagging experiment varied in sexes, sizes and area, the data are not directly comparable.

To supplement growth determination from the above method, and to extend the estimated growth rates to smaller sizes, the progressions of modes in size frequency distributions taken in the past five years were examined.,The extension of the growth curve is included in Figure 42. The results by both methods are encouraging by their similarity and a report describing the growth of the eastern Bering Sea adult male king crabs has been completed.

A report describing the growth of small crabs in Unalaska Bay is also being prepared. Crabs were sampled by skin diving biologists at approximately four-month intervals from May 1958 through May 1959. The growth rate of one and two-year-old crabs was then resolved from the progression of modes in repeated size frequency distribution samples. The data show a mode progressing from 13 to 39 millimeters during the sampling period. Another mode appears at 5 millimeters in September and increases to 12 millimeters in May 1959 (Fig. 43). We interpret the 5 millimeter group sampled in September to be made up of crabs hatched in the spring of 1958. The 12 and 13 millimeter crabs caught in May 1958 and 1959 are interpreted to be of age one, and the 30 millimeter crabs two years of age.

The small crab studies also provided us with 318 moulting observations ranging in carapace length from 4 to 80 millimeters. An average growth increment per moult of 25 percent of their original size was observed and indicated that the previously mentioned progression from 13 to 39 millimeters is the result of five moults.

In general, the growth studies are progressing at an encouraging rate and although effort toward determining the growth of the intermediate sizes will be continued, some of the emphasis may be diverted toward other phases of the investigation.

As in growth studies analysis of data has been emphasized in studies on abundance, distribution, and the effect of environment. The abundance estimates of 18 and 20 million commercial size male crabs presented last year have been re-examined and we are attempting to calculate standard errors of the estimates. The estimates were calculated by expanding the density of king crabs per area fished, by the total area in the station pattern. We plan to verify these estimates by analysis of the tag recoveries. The 1957 estimate and the estimate of abundance determined from tag recoveries in the same year of 1956 tags, provide general agreement. We have recently received the Japanese catch statistics for 1958 and analysis for a similar comparison is now in progress.

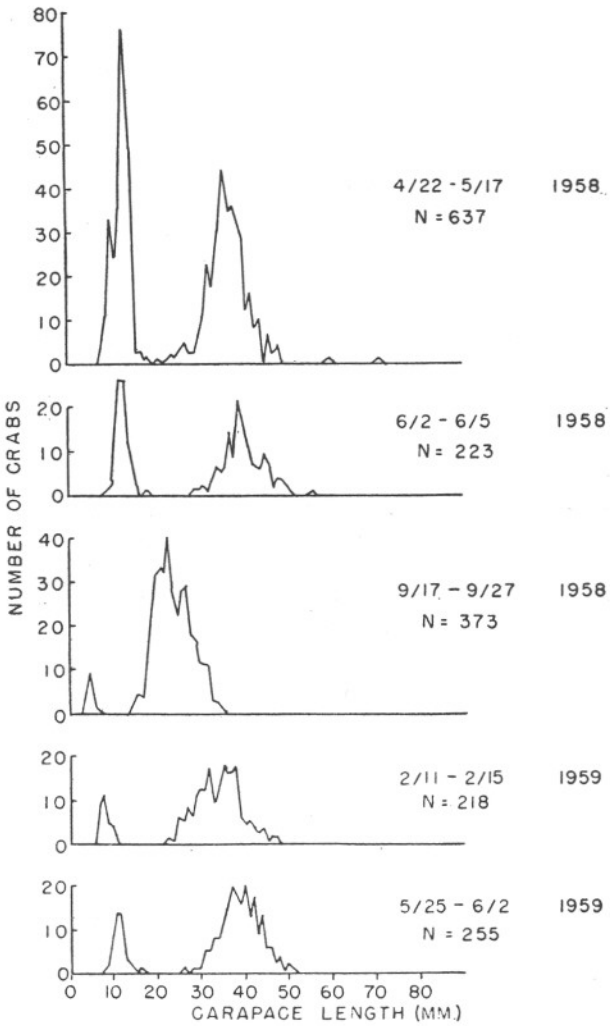

Figure 43. Size frequency distribution of juvenile king crabs taken at Unalaska in 1958 and 1959.

Migration and degree of mixing studies have also resumed after receipt of the Japanese catch and effort data. Examination of the rates of recoveries to date indicate that the magnitude of tag releases may be insufficient to provide recoveries in adequate numbers. Realizing this, our plan during the second phase of the 1959 field work emphasized release of large numbers of tags at three or four widely separated areas.

Continued and probably increased tagging is also indicated by an examination of king crab distribution by size, sex, and shell condition. Catches during

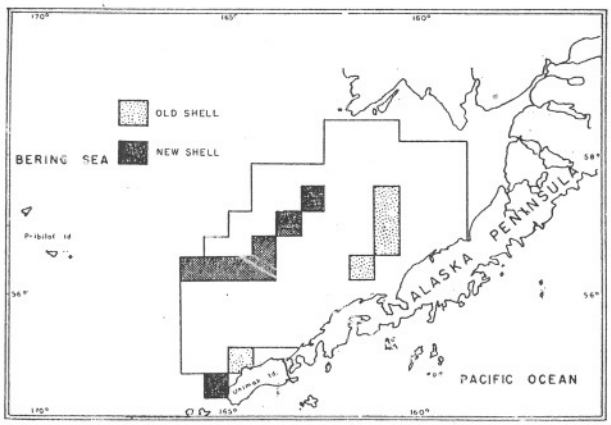

Figure 44. Areas of abundance of commercial size male king crabs by shell types as indicated by otter trawl catches in 1958 (commercial size is 135 mm. and greater in carapace length).

the station pattern sampling surveys show areas of old shell male crab abundance north of Unimak Island and in a large band centered about 56°30′N. and 160°30′W. The new shell males on the other hand exhibit a very different distribution, being found most abundantly in the western and deeper part of the station pattern (Fig. 44). Further examination shows that the distribution and abundance of mature females are highly correlated with the distribution of old shell males. Particularly high association is indicated in the spring and leads us to believe that the old shell males are the mating crabs.

In past discussions we have presented the relationship of a catch of about 1.2 to 1.5 million male crabs against an abundance estimate approximating 20 million commercial size male crabs. Since the fishery continually selects the large old shell male crabs, the numbers available in any year are substantially less and points out the necessity of examining further the relations between the new shell to the old shell mating crabs.