PROGRESS REPORT
ON
KING CRAB INVESTIGATIONS

by

King Crab Staff

Pacific Salmon Investigations
Bureau of Commercial Fisheries
Seattle 2, Washington
September, 1958
KING CRAB INVESTIGATIONS

INTRODUCTION

The objective of the Pacific Salmon Investigation's king crab studies is to provide the International North Pacific Fisheries Commission with the facts necessary to determine need for joint conservation measures of the eastern Bering Sea king crab stock(s). This resource has been exploited to varying degrees by both United States and Japanese nationals but in recent years the catch, predominantly by the Japanese, has been stabilized at about one to one and one-half million crabs.

Figure 1 shows in terms of pounds of picked meat, the catch by Japanese and U. S. fishermen in the eastern Bering Sea and the U. S. catch in areas south of the Alaska Peninsula.

Catch statistics for the 1958 season are not yet available but it is expected that the Japanese caught approximately the same number of crabs as they did in each year since 1953. Although three U. S. fishing vessels supplying a mothership operated in the Bering Sea in April of this year, they fished only a limited time and if they fish no more, the U. S. catch from this area will show a decline from 1957. However, in view of the relative size of the Japanese and U. S. catch, the general magnitude of the catch will not change appreciably.

The extent of fishing that this stock can support on a maximum yield basis is dependent upon the abundance of the exploitable sizes of male crabs, the recruitment into and the growth within these sizes, and upon the rate of natural mortality. The data needed for understanding
Figure I. King Crab production in pounds of picked meat from Alaska and the Bering Sea.
these as well as other related facets of the population are being collected along lines presented in previous reports. Basically the field work, done from chartered vessels, features trawling at a series of evenly spaced stations, which provides us with data needed to determine abundance and growth. The crabs caught are for the most part tagged and released, thus providing uniform tag distribution throughout the area.

Although the 1958 field season was marked by extremely adverse weather conditions, the chartered fishing vessel TORDENSKJOLD was able to fish at 68 stations in late April and May and at 63 stations during June and the first half of July. (see Figure 2 for station pattern.) In addition to fishing at every station, the biologists took approximately 160 hydrographic casts. Throughout the 1958 station pattern 9,859 crabs were tagged and released for growth, migration and mortality studies. Table 1 summarizes the tagging efforts and numbers released and recovered by years.

Table 1.--Summary of tag recoveries

<table>
<thead>
<tr>
<th>Tagging year</th>
<th>Number released</th>
<th>Recoveries for 1954</th>
<th>1955</th>
<th>1956</th>
<th>1957</th>
<th>1958</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1954</td>
<td>1107</td>
<td>44</td>
<td>60</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>108</td>
</tr>
<tr>
<td>1955</td>
<td>1351</td>
<td>32</td>
<td>53</td>
<td>35</td>
<td>18</td>
<td>138</td>
<td></td>
</tr>
<tr>
<td>1956</td>
<td>4063</td>
<td>53</td>
<td>197</td>
<td>14</td>
<td>364</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1957</td>
<td>13962</td>
<td>42</td>
<td>190</td>
<td>232</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1958</td>
<td>9859</td>
<td></td>
<td></td>
<td>39</td>
<td>39</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>30342</td>
<td>44</td>
<td>92</td>
<td>107</td>
<td>276</td>
<td>362</td>
<td>881</td>
</tr>
</tbody>
</table>
FIGURE 2  KING CRAB STATION PATTERN
1958
68 STATIONS
The data collected have been tabulated but because of the short time between the field work and preparation of this report, the analysis is not complete. In fact, personnel are still in the field sampling in connection with growth studies. The results reported here must therefore be preliminary in nature.

**GROWTH**

The tag recoveries summarized above include 88 returns which show evidence of having grown and thus provide a method of estimating growth rates. Growth per moult as indicated by these recoveries, for crabs of about 110 millimeters in carapace length, is about 15 millimeters, decreasing slightly as size increases.

By means of shell appearance it is possible to say with reasonable accuracy whether a crab has moulted within the current year, and during the 1956 through 1958 field seasons, the biologists recorded the shell appearance of every crab. Using this information, we calculated the growth rates from the three years data and plotted the results in Figure 3, beginning with the smallest crab for which growth has been observed, and adding to it the increment for each size, reduced by the percentage of non-moult ing crabs of each size observed during the year. For comparison, a rate of "average maximum growth" is included, which is the calculated growth if all crabs moult annually.

That the incidence of non-moult ing crabs was higher in 1957 than the year preceding and following is quite evident; the reason for this difference, however, is not known although there is no reason to expect that frequency of moult ing should remain the same every year.
Figure 3. Growth of Bering Sea King Crabs from tags.
As mentioned previously, our estimate of growth per moult is based on 88 recoveries. However, as 76 of these are crabs ranging in length from 110 to 155 millimeters, it is evident that we need more recoveries showing growth, particularly of the smaller sizes.

The need for more information is further accentuated if total age is to be determined and we are therefore attempting to obtain growth rates by a second method. Using skin diving equipment our personnel caught 879 small crabs near Unalaska Island during late April and May. An additional 26 were caught by other means for a total of 905 crabs of the sizes shown in Figure 4. Skin divers are again sampling for crabs in the same area for the purpose of determining the progression of these modes through the season as a means of testing whether (1) the mode at 13 mm represents crabs of one year age and/or (2) the two modes represent successive year classes.

The progression of modes through the sizes is also being examined for all crabs caught during the station pattern. Also, we are exchanging additional size frequency data with the Japanese, and although we are experiencing some difficulties, probably due to inadequate sample sizes, in general the method appears usable and it is hoped that another year or two of measuring will provide the necessary progressions from which we can estimate growth rates and recruitment from the smaller sizes.
Figure 4. Size frequency of Unalaska King Crabs 1958
ABUNDANCE

In order to determine the abundance of crabs, the area fished by the trawl at each station was calculated by measuring the distance and width of each trawl effort. Distance was measured with a specially designed meter towed behind the net and the width of the net was calculated by measuring the angle between and the distance to two balls fastened to the otter boards and trailing on the surface. The wings of the experimental net were extended and attached directly to the otter boards so that board spread was equivalent to net spread. At each station the catch was recorded and an average density per unit area calculated. These were then expanded by the total units in the station pattern.

The abundance of male king crabs larger than 135 millimeters in carapace length (6½ inches in carapace width) was calculated to be twenty-two million in the 27,200 square miles covered by the first round of the 1958 survey and 18 million in the 25,200 square miles in the second round. This compares with our estimate of 19 million in the 30,000 square miles sampled during the 1957 field season.

As mentioned in previous reports, the estimates are of a minimal nature, since they are based on the assumption that all crabs in the path of the trawl are caught, and the greater the degree to which crabs escape, the lower our estimate is with respect to the actual abundance.
MEAT CONTENT

Because meat yield varies, presumably with the moulting cycle, in evaluating maximum yield we must consider the condition of the crab at the time caught. Samples of crabs ranging in carapace length from 160 to 180 (average 166.8 mm) were weighed, boiled, and the meat extracted. The difference in recoverable meat varied from 19 percent of the live weight of crabs with newly formed shells to 30 percent of the live weight of crabs with old or very old shells. The actual average weight of meat recovered from these samples was 26 and 45 ounces respectively.

GEAR SELECTIVITY

In order to determine the segments of the crab population caught by twenty-inch stretch-meshed tangle nets, we borrowed ten shackles from the Japanese mothership and set them in an area where our experimental small-meshed trawl caught an abundance of crabs ranging in size from 70 to 185 millimeters in length. The tangle nets were soaked for eight days and the catch compared with the catch from trawl sets made immediately before and immediately after the tangle net efforts.

If we assume that the mode of the size frequencies indicates the point from which all crabs are caught in proportion to their actual abundance, we find that the experimental five-inch meshed trawl catches all sizes greater than 95 millimeters and that the twenty-inch mesh tangle net catches all crabs larger than 165 millimeters with equal efficiency. In order that we can compare
two size frequencies, we have equated the catches of crabs larger than 165 mm and determined the ratio. We then used this ratio of tangle net to trawl catch for crabs of 165 mm and greater to adjust the remainder of the tangle net catch; a size frequency of this adjusted data is plotted in Figure 5a. The difference between the two size frequency curves illustrates the difference in selectivity; Figure 5b shows the difference in terms of percent retained by sizes for the tangle net. It also shows a relatively stable rate of retention for sizes from 95 to 120 mm where the rate increases gradually and accelerates at 145 mm; at 165 mm, according to our assumption, there is no selectivity.

We are sincerely grateful to Nippon Suisan Co. Ltd. for the use of the tangle nets and for their advice and instruction in their use.

**SUMMARY AND PLAN**

The problem of providing the International North Pacific Fisheries Commission with the facts necessary to determine the need for joint conservation measures is, simply stated, that of determining the most productive rate of fishing and comparing it with the existing fisheries.

A growth rate for the larger sizes has been estimated and although this must be tested and more information collected for the smaller sizes, the prospects appear good that in a year or two these studies will have progressed sufficiently to estimate growth throughout the size range.
Figure 5a. Size frequency of catch by experimental small mesh trawl and tangle nets

Figure 5b. Tangle net selectivity
The abundance estimates presented in this and in previous reports, although preliminary in nature, are probably within the right magnitude, although the estimates calculated from density over a sample area differs from that derived from tag recoveries and further analysis and checking is necessary.

The tagging efforts during the 1958 season resulted in 9,859 tags released and with past years tagging should provide recoveries over a period of years from which mortality rates can be measured.

A study of tangle net efficiency was attempted and the results of this single test showed that about 25 percent of crabs 145 millimeters in carapace length, 50 percent of crabs 150 millimeters, and all of the crabs of 165 mm were caught and retained by the twenty-inch mesh tangle nets.

During the coming year it is hoped that the analysis of the accumulated data will be accelerated. Stomach samples have been collected for food studies and the relation of crabs to hydrography will be examined. Analysis of data relating to migrations and to the degree of mixing of crabs throughout the area is progressing and will be reported upon as results develop.

Detailed plans for the coming year are not yet complete and, for much of the studies, will depend upon the results of analysis now in progress. It is intended that the methods outlined for growth and abundance by sampling in a survey pattern will be continued. We hope that the field season may begin earlier in the year in order to trace within-season migrations, to study the differences in distribution, and to trace the fluctuations in meat content.