# PROGRESS REPORT

# ON

# KING CRAB INVESTIGATIONS

by

King Crab Staff

Pacific Salmon Investigations
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# KING CRAB INVESTIGATION PROGRESS REPORT

## Introduction

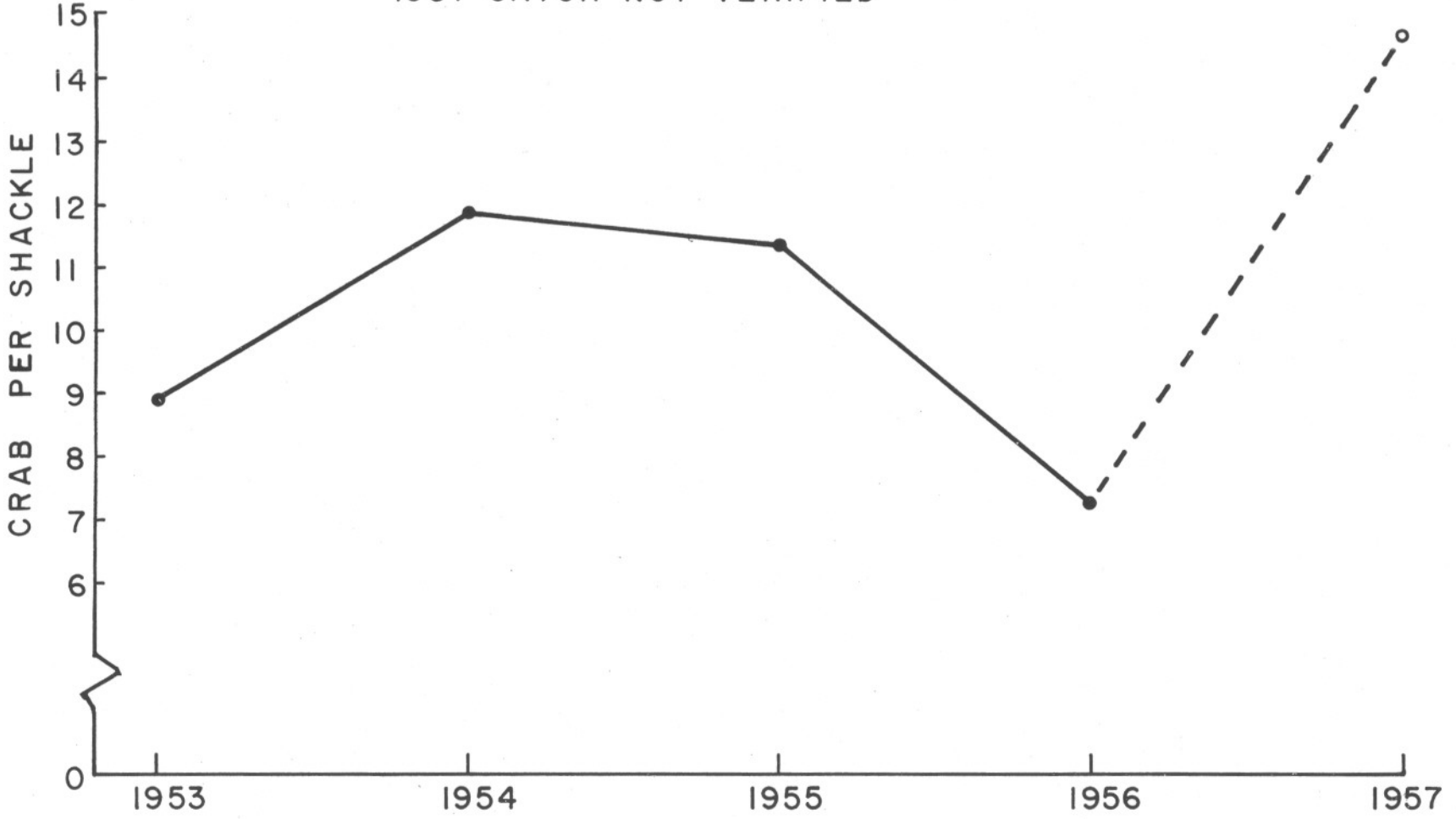
For the past five months work emphasis has been on field phases of the study. The major part has been done from the chartered schooner "MITKOF" which left Seattle for the Bering Sea May 6 and which is expected to return about October 1. The operational plan which was presented last spring has been followed, and the vessel is now engaged in the last part of the work, that of tagging crabs. About 13,300 tagged crabs had been released by the end of August. The total for the season will depend chiefly upon the weather encountered. Under favorable conditions it has been possible to tag from 1,000 to 1,600 crabs per day.

## Trend of Fishery

The king crab fishery in the Bering Sea (and throughout Alaska) has encountered an abundance of crabs in the past year. Preliminary reports indicate that the fishermen found crabs in greater numbers than were encountered in the preceding few years for which we have records. Figure 1 shows the catch of crabs per tangle net set for the years 1953 to 1957. Following the relatively poor fishing of 1956, the increased success of fishing in 1957 is particularly noteworthy. We are certain that the improvement in fishing is real, but it is not known whether there are more crabs present or whether they are simply more available to the fishery.

FIGURE 1. JAPANESE CATCH PER TANGLE NET
(Eastern Bering Sea 1953 - 1957)

1957 CATCH NOT VERIFIED



The catch of king crabs from the Bering Sea has remained practically constant for the past several years. This is to be expected since the bulk of the catch is taken by the Japanese motherships fishery which has operated under a fixed catch of approximately 59,850 cases of canned crab. The mothership operates for a shorter or longer time required to make this catch. The 1957 season was particularly short since fishing was excellent.

Figure 2 shows the Bering Sea and total Alaska king crab production.

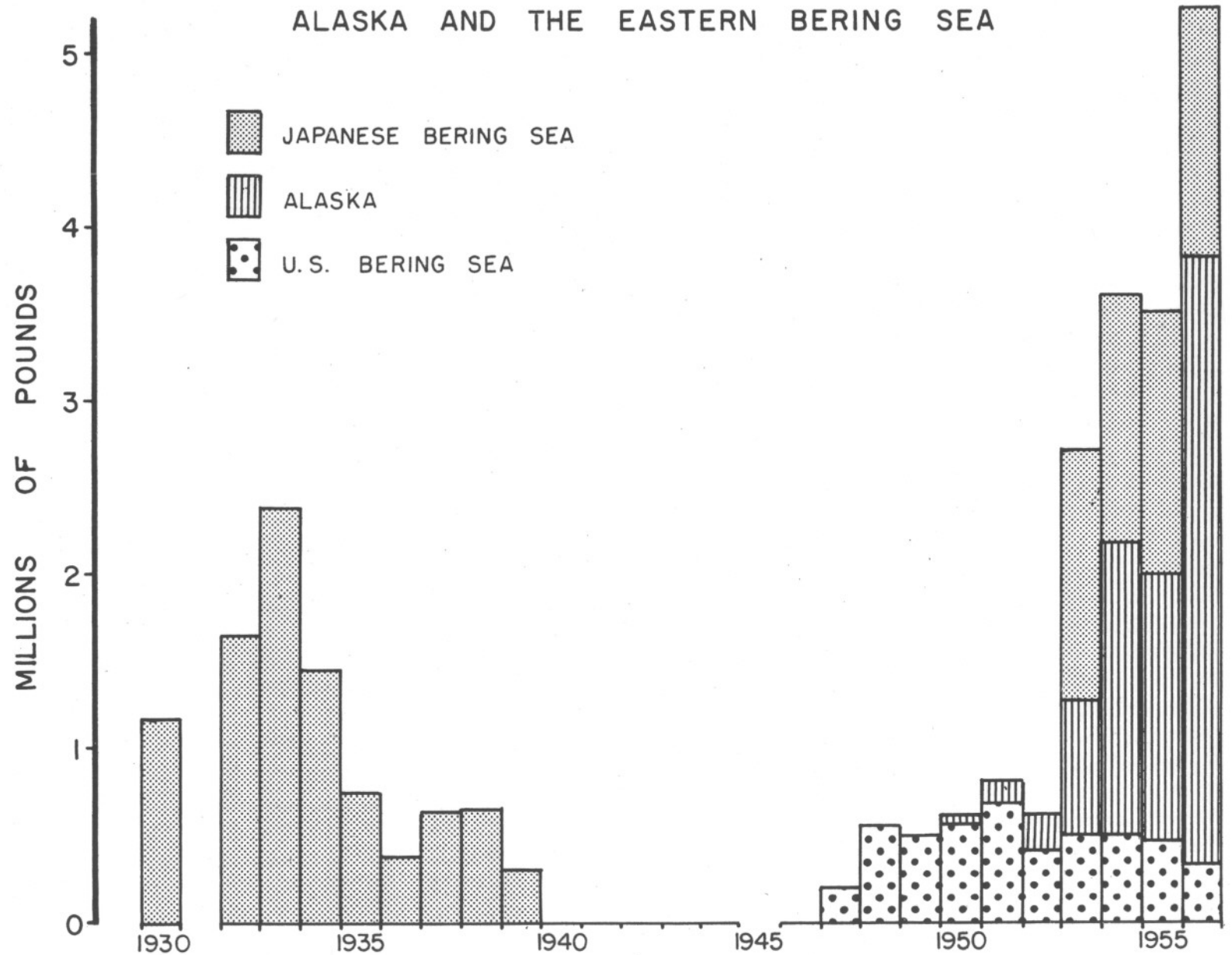
The statistics reflect the recent and continuing growth of the crab fishery as a whole. In the past several years additional vessels have been entering the fishery south of the Alaska Peninsula, and there has been a tendency to expand to unused grounds. While the grounds in the Gulf of Alaska do not appear to be completely developed--there are reports of unexploited areas which support king crabs--the trend indicates that before long we may expect additional fishing pressure on the Bering Sea stocks which will become increasingly important to our fishery.

Growth

The extent of the fishery which the Bering Sea king crabs can support is determined to a large degree by the rate at which they grow. Crabs provide a particularly difficult problem in growth determination for two reasons. First, they do not have scales, otoliths or other hard parts which remain with the body and provide a record of growth seasons as is the case with many fish and shellfish.

FIGURE 2: KING CRAB PRODUCTION

ALASKA AND THE EASTERN BERING SEA

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Being inside a rigid outer skeleton, the crab can only grow by discarding it and forming a new one to fit the new size. They discard all of the rigid portions of the body when they moult. Consequently, there is no direct way of determining age which could be compared with size in the calculation of a growth rate.

Secondly, growth is not a gradual thing in which all crabs participate to some degree within a single year. Their growth is explosive in character. They remain at a fixed size until they moult; the hard shell is then discarded, and the new undershell stretches to accommodate a new size which remains fixed until the next moult. This process occupies only a few hours. The problem then becomes (a) what is the growth at moulting, and (b) how often does a crab of a particular size moult in a year. It is known that the smallest sizes moult a number of times annually. The sizes upon which the fishery operates frequently do not moult at all in a particular year. We had two tags returned this year which were on crabs that had not moulted in three years.

For the crabs of commercial size and smaller (say six inches in width and up) we have reason to believe from shell inspection that we can determine approximately how long it has been since moulting for a particular crab. We have checked our estimates of shell appearance against tagged crabs for which the period since moulting is known, and they seem reliable. During 1956 and 1957 the shell condition (soft,

new, old, very old) was noted for all crabs taken on the survey stations which covered the fishing area. These data enable us to determine the percentage of crabs which have moulted in the past year. Of course, the crabs which showed recent moulting in 1956 had to be placed in the size class to which they belonged before moulting in order to get a comparison of the moulting and non-moulting crabs for each particular size. In 1956 the percentage moulting varied from 100% at 4 inches in carapace length to 0% at 8 inches in length with the 50% level at about 6¼ inches.

From tag recoveries we now have 25 returns which show reliable evidence of moulting. The crabs ranged in size from 109 to 160 millimeters (4 1/3 to 6 1/3 inches) in length at tagging. Figure 3 shows the growth observed in these crabs from a single moult. It changes from about 20 millimeters for the smaller sizes to about 14 millimeters for the larger (0.8 to 0.5 inches). As mentioned above, this is not representative of the growth of the stock as a whole because the larger sizes often do not moult.

Therefore Figure 4 shows two growth rates. The maximum which would result if the crabs moulted annually, and the average, which is the result of combining the growth from tagged crabs with the observed percentages moulting for each size. This figure was constructed by taking the smallest size for which growth had been observed (110 mm.)

FIGURE 3. GROWTH OF KING CRABS FROM TAGS BY CARAPACE LENGTH AT TIME OF TAGGING

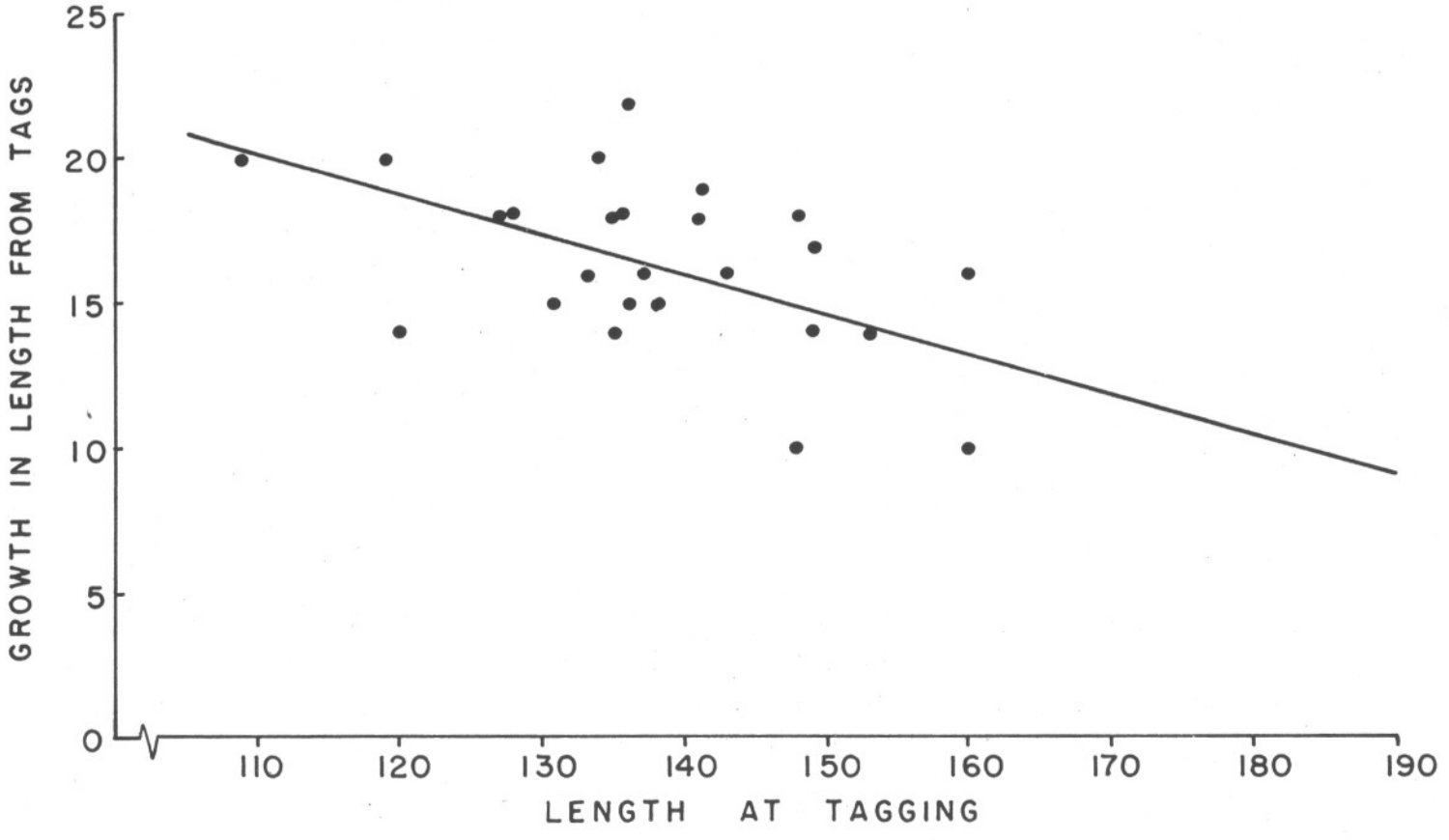
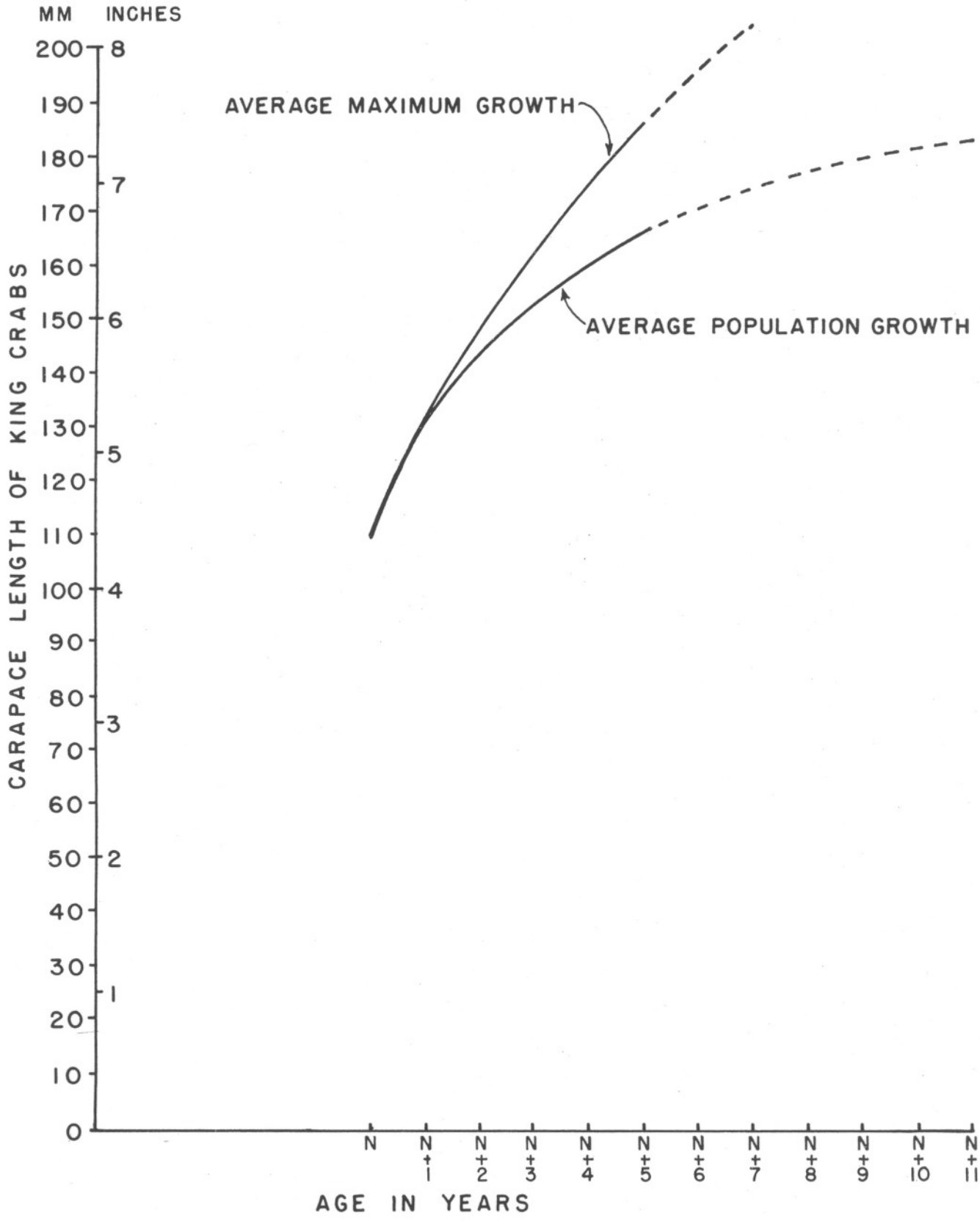


FIG. 4. GROWTH OF BERING SEA KING CRABS FROM TAGS

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and adding to it the calculated growth for each successive moult at the rate of once annually. In the case of average population growth, the annual amount was decreased by the observed percentage of non-moulting crabs of that size. The "maximum growth rate" assumes an annual moult.

Figure 4 should not be taken as a completely accurate depiction of growth rate; it is presented at this time as a demonstration of a method being used and our progress with it. We have as yet too few recoveries showing growth to allow us to establish firmly the amount of increase at shedding, especially for the smaller and larger sizes. We also suspect that the frequency of moulting and therefore growth may not be the same every year. Data also remains to be supplied for sizes smaller than 110 millimeters if the total age is to be established. We have begun to accumulate information for the small crabs.

Abundance

During July a series of 77 fishing stations was occupied (Figure 5) for the purpose of attempting to estimate the number of king crabs of commercial size in the eastern Bering Sea. The pattern covered the ground inhabited by these crabs quite well with the possible exception of the area off Unimak Pass which is too rough to trawl. At each station the width of the trawl was computed from the angle of spread of the towing cables, and the distance trawled was measured by towing a specially designed meter behind the net. The wings of the net were fastened directly to the otter boards so that board spread was

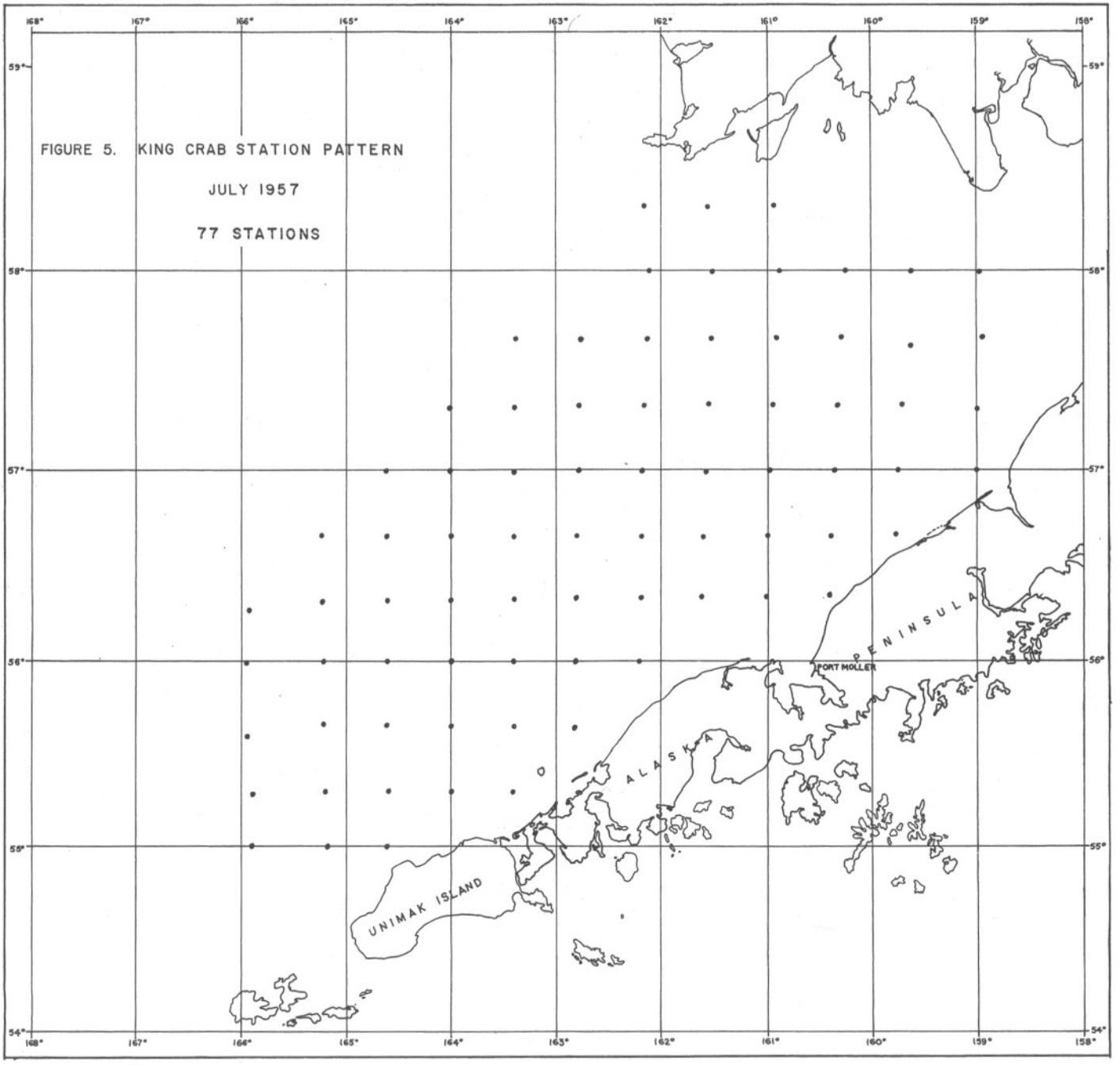
FIGURE 5. KING CRAB STATION PATTERN
JULY 1957
77 STATIONS
168°
167°
166°
165°
164°
163°
162°
161°
160°
159°
158°
59°
58°
57°
56°
55°
54°
PENINSULA
PORT MOLLER
ALASKA
UNIMAK ISLAND

equivalent to net spread. At each station the number, sex and size of crabs caught were recorded.

Knowing the number of square feet covered by the trawl and the number and size of crabs caught, the average density of crabs per unit area was calculated. It was 2.299 crabs per 100,000 square feet. When multiplied by the number of hundreds of thousands of square feet in the 30,000 square nautical miles in the station pattern, the total number of crabs which were more than 135 mm. in carapace length ($6\frac{1}{4}$ inches in width) is estimated to be 25,497,510. Of this number, about 23.5 million were more than $6\frac{1}{2}$ inches in width, and 16.25 million were more than 7 inches wide.

Because of the short time between the field work and preparation of this report, the estimate is of a provisional nature. In fact, the data required for computing efficient confidence limits about the mean estimate are not yet completely available, and further tests of the accuracy of our estimate of net spread are yet to be completed. It is not likely, however, that the general magnitude of the estimate will be changed.

The estimate is probably of a minimal nature, since it is based upon the assumption that the trawl caught all of the crabs in its path. It is unlikely that this is absolutely true, and the greater the degree to which crabs escaped, the lower our estimate is with respect to the actual number present. Further, by the time the survey was made, a 1957 catch in excess of 1,000,000 large crabs had already been taken.

These estimates agree generally with the rate of tag recovery from the fishery. Approximately 5% of the tags released in 1956 have been recovered by the 1957 fishery, and it is believed that relatively few will be returned in the remainder of the year.

Tag Recoveries

Table 1 gives the numbers of tags released and recovered up until September 1, 1957. The release of tags for the current year has not been completed, and it is expected that some returns will be made of these as well as 1956 releases. Very few, if any, further returns are likely for the 1954 and 1955 releases during this season.

Table 1.--Summary of Tag Recoveries to September 1, 1957.

| Tagging Year | Numbers Released | Year Recovered<br>Numbers Recovered (Percent Recovered) | | | | |
|---|---|---|---|---|---|---|
| | | 1954 | 1955 | 1956 | 1957* | Total |
| 1954 | 1,107 | 44 (4.0%) | 60 (5.4%) | 1 (0.1%) | 2 (0.2%) | 107 |
| 1955 | 1,351 | | 32 (2.4%) | 53 (3.9%) | 33 (2.6%) | 118 |
| 1956 | 4,063 | | | 53 (1.3%) | 192 (4.8%)* | 245 |
| 1957 | 13,300* | | | | * | * |
| | TOTAL: | 44 | 92 | 107 | 227 | 470 |

* Incomplete

## Current Studies

The almost total absence of information with respect to the circulation of water in the eastern Bering Sea has been a handicap in determining the origin(s) of the stocks of king crabs. At early stages they are planktonic and drift with the water. During June 1957, observations were made of the direction the water was moving at four of the stations shown in Figure 5. The flow of water was measured by using a current meter at hourly intervals throughout a complete tidal cycle. After the effect of flooding and ebbing tides has been removed, the net transport of water is as shown in Figure 6. Some differences exist between the movement of surface and bottom water, but the net movement seems to be of a counterclockwise nature in the Bristol Bay area. It does not appear that the displacement of crab larvae hatched in the Black Hill-Port Moller locality would be very great if the current studies reflect a general situation.

## Plans

It is intended that the work continue to be directed to answering the Commission's question of what conservation measures are needed in the Bering Sea crab fishery as outlined in the general plan submitted in October, 1956. The studies into growth, recruitment, migration, rate of fishing, and rate of natural death appear to be progressing satisfactorily. The 1955 and 1956 tagging experiments show that the

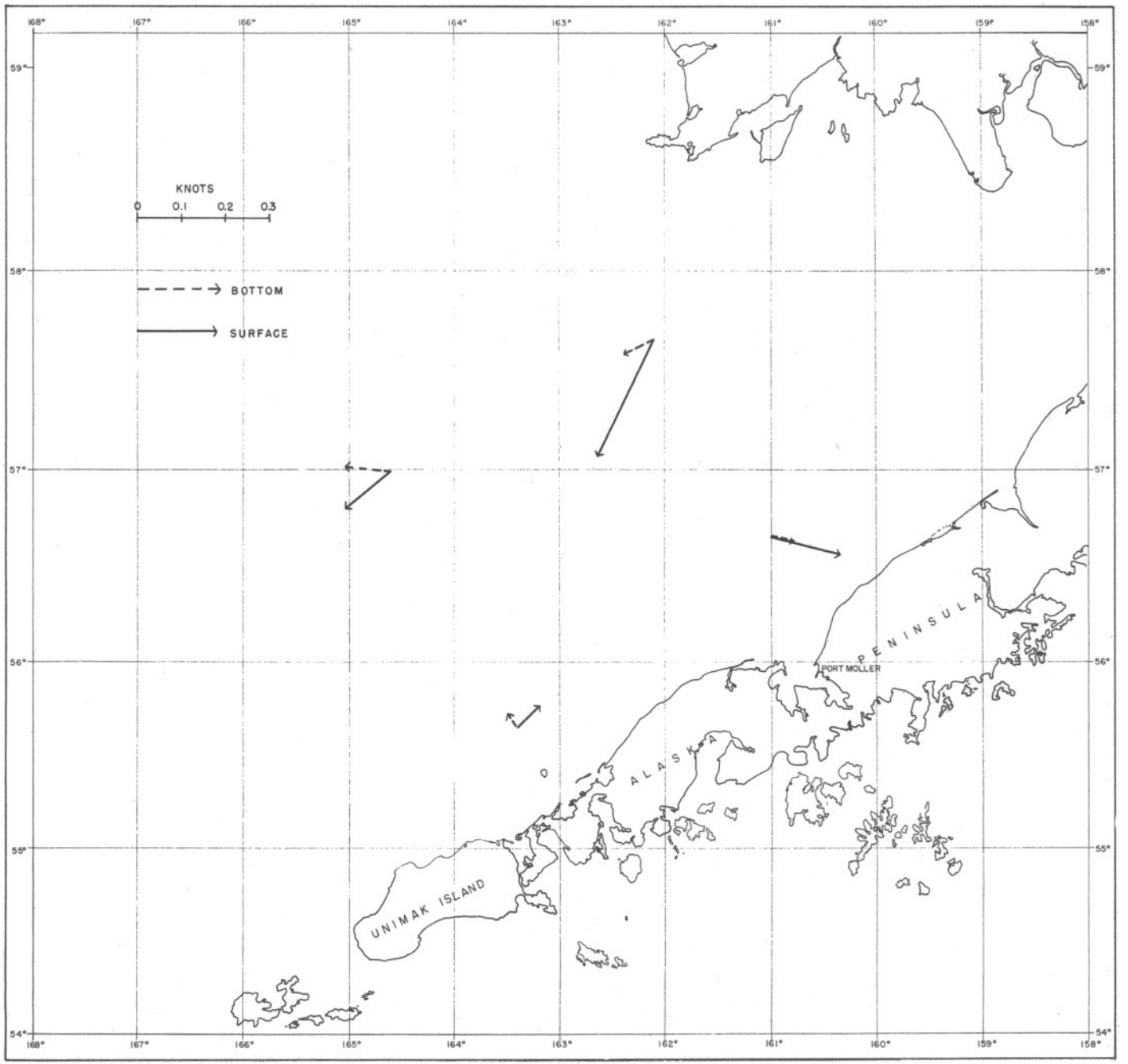


FIGURE 6. NET CURRENT DIRECTION AND VELOCITY AT SURFACE AND BOTTOM

chances are good of measuring growth and death by this means. The 1957 releases should be sufficiently numerous to permit a complete analysis of the resulting recoveries and provide the statistics needed for growth and death rates.

In the calendar year of 1958, analysis of existing data will be accelerated, although much of the important basis for the problem requires time to accumulate.

During the field season of 1958, it is intended that size samples for growth be taken as in the past two years in conjunction with a survey pattern to estimate abundance by the method used in 1957. The vessel work should begin earlier in order that tags released on the station pattern can be used for an estimate of fishing intensity to compare with that derived by other methods. In 1957 the fishery was almost finished by the time the station pattern started. As a consequence, the tags released cannot be used for measuring the 1957 fishery. Further, repeated releases throughout the stocks from early in the season will enable us to trace within-season migrations, which has not been possible until now.

Although detailed planning is not complete for the coming field season, the major change which is being contemplated at this time is to begin vessel operations about a month earlier.