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(6)

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TO: Mr. H. A. Larkins, NWAFC, Seattle

FROM: Mr. Jerry Reeves, NWAFC, Kodiak Facility

SUBJ: Resolution of King Crab TACs with the Alaska Department of Fish and Game

King crab TAC problems have been resolved with ADF&G through discussions with Jerry McCrary. For red king crabs, a confidence interval has been established for the estimated TAC. For blue king crabs, 1976 survey estimates of abundance have been used for recalculating the TAC. A confidence interval has been provided here also. Please note that we have opted to use 1975 survey results for king crab as the best available data, since information from the fishery (CPUE and tag returns) confirming the 1976 abundance estimates is not yet available.

Associated suggested changes to the FMP are attached. In this regard, also note several other changes. (1) The last two sentences in paragraph one of page 33 have been taken out at Joe Greenough's request; (2) The first paragraph on page 35 has been removed. This was meant, I believe, to refer to changes in survey gear leading to underestimates of abundance, which has been discussed in earlier paragraphs (page 33). Somehow natural mortality got into the sentence and it makes no sense.

Attachments

Greenough estimated equilibrium yield for the 1966-70 period to be around 26 million pounds (legal-sized male crabs). Using more recent information on fishing and natural mortality rates, growth rates, and recruitment levels, Balsiger (1976) updated Greenough's work to reflect 1972 conditions in the fishery and stock. His estimate of ~~estimated~~ equilibrium yield was also about 26 million pounds. ~~Balsiger estimated the optimum minimum size to be 136 mm carapace length, as opposed to Greenough's earlier estimate of 150-155 mm. This difference is due primarily to updated values for rates of growth and mortality.~~

There was little change in the apparent abundance of pre-recruit crabs (those that would have entered the fishery after the next molt) during the time span between Greenough's and Balsiger's work. However, since 1972 the level of pre-recruits, thus recruitment to the exploited population, has increased substantially (Table 9). As mentioned earlier, survey gear changes may have introduced an artifact to the data. The gear, however, has remained relatively constant since 1973. Furthermore, U.S. catch statistics indicate an increasing catch/pot-lift in the United States fishery (Table 9). These factors taken together indicate that recruitment has increased.

Since fishing effort has remained relatively constant over the past 7 years (Table 9), and assuming that growth and mortality rates have not changed, the yield-per-recruit multiplier given by Balsiger (4.3) provides an equilibrium yield estimate for legal-sized males of about 75 million pounds. The model described above for the estimates of catch and a confidence interval on the estimate can only be approximated. Assuming no error in the yield per-recruit multiplier, the 95% confidence interval is ± 14% (65-86 million pounds). Assuming a 5% error in the multiplier gives a 95% confidence interval of ± 25% (56-94 million pounds). The error in the multiplier is probably greater than 5%.

There is reason to believe that estimates of the instantaneous rate of natural mortality (q) used to generate the recruitment levels used by Balsiger were too high, leading to an underestimate of MSY.

2. Blue King Crab, P. platypus

Data needed for an MSY analysis similar to that presented for red king crab are not available for blue king crab stocks of the eastern Bering Sea. Thus, an approximation technique has been applied, in which the average exploitation rate derived for mature, male red king crab -- 0.15 (Reeves, 1975; Lechner, InPress) - is applied to current estimates of the abundance of mature male blue king crab. The rationale for this application is that the red king crab stock has held up well at this rate of exploitation and that blue king crab, being closely related to red king crab, are probably quite similar with respect to key population parameters.

Estimates of the abundance of blue king crab are shown in Table 7. Applying the 0.15 rate to the estimated numbers of mature (>109) male P. platypus in 1975 (~~15.5~~ 6.0 million crabs) yields an estimate of MSY of ~~2.3~~ 0.9 million crabs or, using a 7-lb average weight per crab, ~~16~~ 6 million pounds. The confidence interval around this estimate is very wide (±7 million owing to the large sampling variability associated with this stock.

3. Snow (Tanner) Crab, Chionoecetes spp.

Data similar to that used for the MSY analyses of red king crab are not available for the Tanner crab stocks of the eastern Bering Sea. Thus, the same approximation technique used for blue king crab has been applied to these stocks -- that is, multiplying abundance by the exploitation rate for red king crab (0.15).

11/10/76

# Re-analysis of Tanner Crab TACs for the Eastern Bering Sea Stocks

An analysis of total allowable catch (TAC) for Tanner crab stocks in the eastern Bering Sea was presented in the Preliminary Fishery Management Plan for King and Tanner Crabs of the Eastern Bering Sea, August 1976. This analysis was concerned with Tanner crab stocks as far north as 58°N latitude since data on distribution and abundance of crabs was not available farther north. With this limitation, TAC estimates for mature male C. bairdi and C. opilio were calculated by multiplying abundance estimates for these stock components by an exploitation rate of 0.15, which was chosen as a reasonable value based on the historic reaction of the eastern Bering Sea red king crab stock to exploitation. Estimates of TAC for mature male C. bairdi and C. opilio of 95 million and 128 million pounds respectively, were given in the Preliminary Management Plan.

In response to a request for further analyses of data on Tanner crab stocks in the eastern Bering Sea, the following items are addressed in this report:

1. Review of the distribution of U. S. and foreign fishing patterns to evaluate whether a line can be established which would minimize the the impact of Japanese Tanner crab fisheries on U. S. crab operations in the eastern Bering Sea.
2. Examination of the distribution of the two major species of Tanner crabs in the eastern Bering Sea to see if the populations can be geographically separated.

3. Determination of whether or not area quotas for the two species can be established.

4. Presentation of figures on TACs by 5 mm carapace width size groups.

Since the preparation of the Preliminary Management Plan, new data on the distribution and abundance of Tanner crabs in the eastern Bering Sea has become available. The analysis of Outer Continental Shelf (OCS)-related NMFS survey data for 1975 has provided information on the Tanner crab stocks to 62°N latitude. This information is used in this report to re-assess TAC estimates for C. opilio. Additionally, an estimate of the 1976 abundance of C. bairdi is now available from the NMFS Oregon survey and has been used to re-assess the TAC for this species.

Regarding the first item, Figure 1 shows the current distribution of catches for the Japanese and U. S. Tanner crab fisheries in relation to the distribution of the stocks to 62°N latitude. Blackened areas represent grounds fished during the March-October period in 1975 and 1976 by the Japanese under the U. S.-Japan bilateral agreement of 1974. Areas enclosed in the dashed lines represent grounds fished by the U. S. fleet during the 1975 and 1976 seasons (January-July). Cross-hatched portions within the dashed-line bounds represent high-catch areas for the U. S. fleet. From the figure it is apparent that the two fisheries operate in overlapping and adjacent areas in which both species of Tanner crabs occur. The notable exception is the extensive region to the northwest, where 21% of the Japanese Tanner crab quota is taken. One other small area fished by the Japanese fleet is outside the current areas fished by the

U. S., and is located in the southeastern corner of Area "B" of the 1974 bilateral agreement (about 168°W, 56°N). Thus, a straight-forward line to reduce the impact of the mothership fleet on the U. S. fishery does not appear feasible without a northward displacement of the Japanese fishery.

Regarding items two and three, Figure 2 is presented to show the distribution of Tanner crabs by species and one-degree sections of latitude. From this it can be seen that almost all the stock of large male C. bairdi (> 129 mm carapace width) occurs below 58°N latitude and that the stock of large male C. opilio (> 109 mm carapace width) is divided equally by a line at this same degree of latitude. Thus, a line projected from the outer edge of the continental slope eastward into Bristol Bay at 58°N latitude would effectively isolate half the stock of C. opilio from the stock of C. bairdi, assuming that there is little migration of crabs across the line.

Estimates of TAC for C. bairdi and C. opilio are given in Tables 1 and 2. Virtually all large male C. bairdi occur south of 58°N latitude and it is estimated that only about 5% of the small mature male C. bairdi stock are found north of this latitude. Thus, no adjustment in the TAC is needed because of increased survey coverage of the stock. However, 1976 data on abundance is available and is used to estimate a more current TAC than that given in the Preliminary Management Plan. The new estimate, given in Table 1, is 69 million pounds.

The TAC for C. opilio has been re-assessed based on the expanded OCS data and is estimated in Table 2 to be 333 million pounds for the mature male

stock of C. opilio occurring in the OCS survey region northward to 62°N latitude. The relative distribution of male C. opilio smaller than 110 mm carapace width is similar to that shown for large males in Figure 2. Thus, an estimate of the TAC for mature male C. opilio north of 58°N latitude can be obtained by multiplying the value given above for the entire stock of mature males by 0.5, i.e., 167 million pounds (Table 2).

Regarding Item 4, TACs for C. bairdi and C. opilio are presented by 5 mm carapace width groups, and for the mature male populations by 5 mm decrements, in Tables 1 and 2.

Table 1.--Total allowable catch for mature male C. bairdi Tanner crabs in the eastern Bering Sea, calculated from 1976 data from the NMFS RV Oregon survey.

| Width group (mm) | Midpoint (mm) | Population estimate (millions of crabs) | Average individual weight (lbs.) | Population estimate (millions of pounds) | TAC* (millions of pounds) | Percent of total | Accumulated TAC (for crabs ≥ width group) | Percent of total |
|---|---|---|---|---|---|---|---|---|
| 100-104 | 102 | 14 | 0.70 | 10 | 2 | 3 | 69 | 100 |
| 105-109 | 107 | 13 | 0.81 | 11 | 2 | 3 | 67 | 97 |
| 110-114 | 112 | 14 | 0.93 | 13 | 2 | 3 | 65 | 94 |
| 115-119 | 117 | 15 | 1.06 | 16 | 2 | 3 | 63 | 91 |
| 120-124 | 122 | 18 | 1.21 | 22 | 3 | 4 | 61 | 88 |
| 125-129 | 127 | 22 | 1.37 | 30 | 5 | 7 | 58 | 84 |
| 130-134 | 132 | 23 | 1.55 | 36 | 5 | 7 | 53 | 77 |
| 135-139 | 137 | 26 | 1.74 | 45 | 7 | 10 | 48 | 70 |
| 140-144 | 142 | 21 | 1.94 | 41 | 6 | 9 | 41 | 59 |
| 145-149 | 147 | 24 | 2.16 | 52 | 8 | 12 | 35 | 51 |
| 150-154 | 152 | 21 | 2.40 | 50 | 8 | 12 | 27 | 39 |
| 155-159 | 157 | 18 | 2.65 | 48 | 7 | 10 | 19 | 28 |
| 160-164 | 162 | 13 | 2.92 | 38 | 6 | 9 | 12 | 17 |
| 165-169 | 167 | 9 | 3.21 | 29 | 4 | 6 | 6 | 9 |
| 170-174 | 172 | 2 | 3.51 | 7 | 1 | 1 | 2 | 3 |
| 175-179 | 177 | 1 | 3.84 | 4 | 1 | 1 | 1 | 1 |
| 180-184 | 182 | 0 | | | | | | |
| Total | | 254 | | 452 | 69 | | | |

* Population estimate (millions of pounds) X 0.15

Table 2.--Total allowable catch for mature male C. opilio Tanner crabs in the eastern Bering Sea, calculated from data from the 1975 OCS survey.

| Width group (mm) | Midpoint (mm) | Population estimate (millions of crabs) | Average individual weight (lbs.) | Population estimate (millions of pounds) | TAC* (millions of pounds) | Percent of total | Accumulated TAC (for crabs ≥ width group) (millions of pounds) | Percent of total | TAC X .5** (millions of pounds) |
|---|---|---|---|---|---|---|---|---|---|
| 75-79 | 77 | 260 | 0.40 | 104 | 16 | 5 | 333 | 100 | 8.0 |
| 80-84 | 82 | 215 | 0.49 | 105 | 16 | 5 | 317 | 95 | 8.0 |
| 85-89 | 87 | 202 | 0.59 | 119 | 18 | 5 | 301 | 90 | 9.0 |
| 90-94 | 92 | 202 | 0.70 | 141 | 21 | 6 | 283 | 85 | 10.5 |
| 95-99 | 97 | 195 | 0.83 | 162 | 24 | 7 | 262 | 79 | 12.0 |
| 100-104 | 102 | 253 | 0.97 | 245 | 37 | 11 | 238 | 71 | 18.5 |
| 105-109 | 107 | 234 | 1.12 | 262 | 39 | 12 | 201 | 60 | 19.5 |
| 110-114 | 112 | 236 | 1.30 | 307 | 46 | 14 | 162 | 49 | 23.0 |
| 115-119 | 117 | 190 | 1.49 | 283 | 42 | 13 | 116 | 35 | 21.0 |
| 120-124 | 122 | 147 | 1.69 | 248 | 37 | 11 | 74 | 22 | 18.5 |
| 125-129 | 127 | 77 | 1.92 | 148 | 22 | 7 | 37 | 11 | 11.0 |
| 130-134 | 132 | 29 | 2.17 | 63 | 9 | 3 | 15 | 5 | 4.5 |
| 135-139 | 137 | 8 | 2.44 | 20 | 3 | 1 | 6 | 2 | 1.5 |
| 140-144 | 142 | 2 | 2.73 | 5 | 1 | 0 | 3 | 1 | 0.5 |
| 145-149 | 147 | 1 | 3.04 | 3 | 1 | 0 | 2 | 1 | 0.5 |
| 150-154 | 152 | 1 | 3.37 | 3 | 1 | 0 | 1 | 0 | 0.5 |
| 155-159 | 157 | 0 | | | | | | | |
| Total | | 2,252 | | 2,218 | 333 | | | | 167 |

* Population estimate (millions of pounds) X 0.15
** Represents TAC for portion of stock north of 58°N latitude

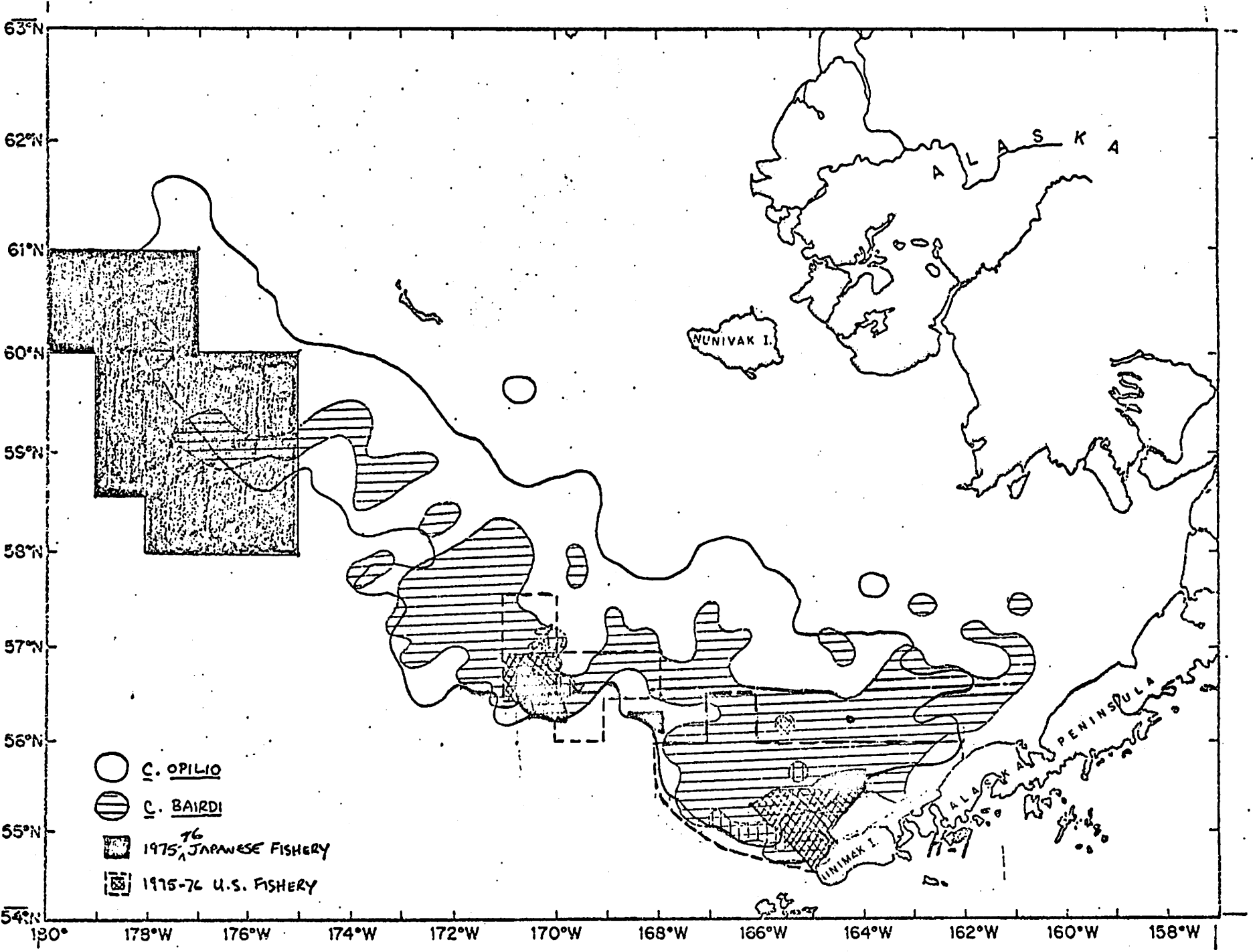


Fig 1 General distribution of large male Tanner crab stocks and Tanner crab fishing fleets in the eastern Bering Sea

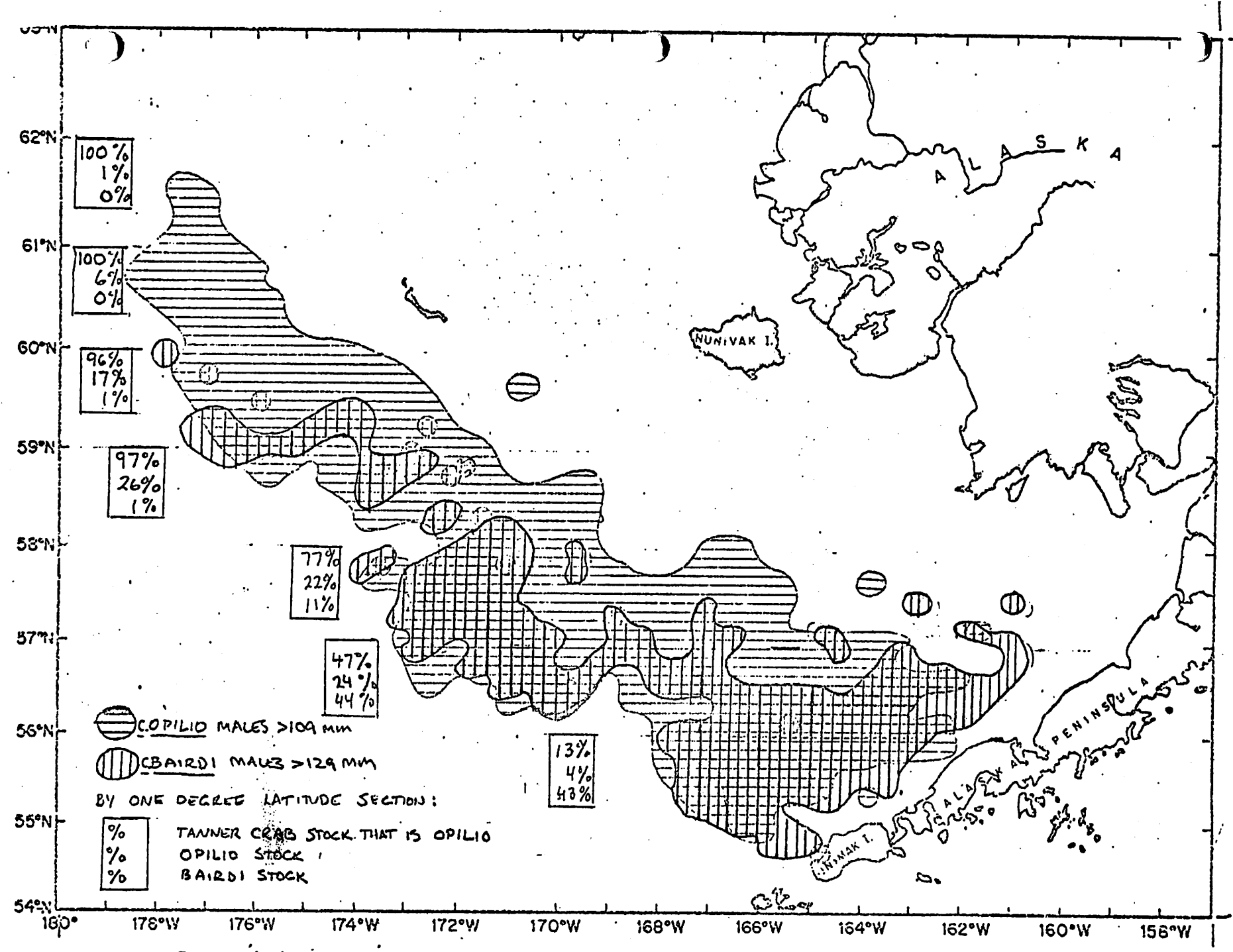


Fig. 2 Composition of Tanner crab stocks by species and sections of one-degree latitude in the eastern Bering Sea.

Figure 1.--General distribution of large male Tanner crab stocks and Tanner crab fishing fleets in the eastern Bering Sea.

Figure 2.--Composition of Tanner crab stocks by species and sections of one-degree latitude in the eastern Bering Sea.