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UNITED STATES CRAB RESEARCH IN THE
EASTERN BERING SEA DURING 1986

by

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EXECUTIVE SUMMARY

The following is a summary of conclusions presented in this report. All figures given are estimated total numbers of crabs, plus or minus 95% confidence intervals. Estimates for 1986 and 1985 were compared by t-test; values of t greater than 2.0 were defined as significant. See text for descriptions of size ranges.

Red king crab (*Paralithodes camtschatica*)

Legal males: 6.0 million \pm 36%; Significant increase of 140%.
Pre-recruits: No significant change.
Females: Decrease not significant.
Outlook: Fishery stable or increasing in 1986. Long-term picture of recruitment is poor.

Pribilof Islands blue king crab (*P. platypus*)

Legal males: 431,000 \pm 51%; 35% increase, not significant.
Pre-recruits: Significant decrease of 87%.
Females: Increased, not significant.
Outlook: Fishery stable. Recruitment questionable due to inadequate data.

St. Matthew blue king crab (*P. platypus*)

Legal males: 384,000 \pm 50%; significant decline of 64%.
Pre-recruits: No significant change.
Females: No significant change.
Outlook: Significantly declining fishery. Recruitment and reproduction questionable due to inadequate data.

Tanner crab (*Chionoecetes bairdi*)

Legal males: 3.1 million \pm 75%; 30% decrease, not significant.
Pre-recruits: No significant change.
Females: No significant change.
Outlook: Fishery stable or declining. Significantly increased abundance of juveniles but recruitment unpredictable.

Tanner crab (*C. opilio*)

Large males: 117.5 million \pm 19%; no significant change.
Pre-recruits: No significant change.
Females: Significant increase of 240%.
Outlook: Population stable to increasing. Fishery increasing due to expansion of grounds. Significantly increased abundance of juveniles but recruitment unpredictable. Reproduction abnormal in some areas.

Hair crab (*Erimacrus isenbeckii*)

Large males: 1.5 million \pm 48%; 35% decrease, not significant.
Pre-recruits: Inadequate data.
Females: Inadequate data.
Outlook: Declining fishery.

THE SURVEY

The 1986 Eastern Bering Sea crab survey consisted of 383 successful trawl tows and covered an area of approximately 132,000 square nautical miles. The 1986 survey area was essentially identical to that of 1985 and covered the Bering Sea ranges of all commercially exploited crab stocks except for Chionoecetes opilio which extends to the north and west of the survey area. Golden king crab were not surveyed.

The survey was conducted aboard two chartered vessels, the F/V Morning Star and the University of Washington's R/V Alaska between June 4 and August 6. Methodology was similar to that of previous surveys in that most tows were made at the centers of squares defined by a 20 x 20 nautical mile grid. Near St. Matthew Island and the Pribilofs, additional tows were made at the corners of squares. Trawl gear used was identical to that used in 1985, thus we assumed that they behaved similarly. Procedures for estimating abundance were identical to those of previous years. Note that crab sizes are reported as carapace length (cl) for king and hair crabs, and carapace width (cw) for tanner crabs. Biomass estimates are given $\pm 95\%$ confidence intervals.

Following the regular survey, 23 additional stations were towed at 10-mile intervals in the region of greatest red king crab density to verify results obtained earlier. These included 8 stations towed in June plus 15 stations not previously towed.

STATUS OF STOCKS

Red King Crab (Paralithodes camtschatica) Legal (≥ 135 mm cl) male crabs were sparsely distributed in Bristol Bay and their distribution also extended into the Northern District (North of $58^{\circ}39'$, Fig. 1). In Bristol Bay, the 1986 distribution was similar to that of 1985. A few red king crabs were also found near the Pribilof Islands but their contribution to overall abundance in the eastern Bering Sea is negligible.

During the regular survey in June, high densities of crabs were found at two stations, F07 and F08 (Fig. 1). The re-survey included 23 stations at 10 mile intervals, with these two at the center. Relatively high crab densities were again found within 20 n.mi. of these stations, thus verifying our earlier observations and providing enough additional data to greatly improve the precision of the population estimates. The mean estimate of legal male abundance did not change significantly between the original survey and the re-survey.

The estimated abundance of legal male red king crabs increased significantly¹ by a factor of 2.4 from 1985 to 1986 (Table 1). All other segments of the male population showed no significant changes. The size frequency distribution of male crabs shifted to the right by 15-25 mm in length (Fig. 2), an

¹Significance was determined by the use of unpaired t-tests. Values of t greater than 2.0 were defined as significant, with probability less than 0.05.

amount equivalent to about 1 years growth. Thus the increase in abundance of legal males is largely due to growth of crabs which were pre-recruits in 1985, and partly due to decreased mortality of crabs relative to 1985 levels. There is still very little recruitment of juvenile crabs to the population, so future recruitment to the fishery shows no signs of improvement in the next few years.

The abundance of mature-sized (≥ 90 mm cl) females in Bristol Bay decreased slightly but not significantly from 1985 to 1986. The abundance of immature females decreased by about 40%, and this decrease was also not significant due to high variance of the estimates. Among the mature-sized females, approximately 10% were actually immature, 46% had molted and extruded new, uneyed eggs, 11% had molted but not extruded, and 34% had not completed molting. Of the latter group, two-thirds (25% of the total) were initiating or undergoing molting, and the remainder were old shell crabs. Thus it appears that about half of the mature females had reproduced successfully and the majority of the remainder were undergoing delayed molting. Only 14 females were caught during the August re-survey and we could not determine if more spawning had occurred.

The fishery will be opened on September 25, 1986 with a guideline harvest of 6.0 to 13.0 million pounds relative to an estimated stock of 31.5 ± 11.3 million pounds in Bristol Bay (Area T). Harvests are expected to be in the middle portion of the guideline harvest range and relationships between estimated

abundance and catch per pot-lift suggest that the fleet average will be 6 to 11 crabs per pot-lift (Fig. 3).

Pribilof Islands Blue King Crab (*P. platypus*) Legal (≥ 135 mm cl) males were found primarily to the northeast of the islands (Fig. 4). The estimated mean abundance of legal males increased slightly but not significantly from 1985 to 1986 (Table 1). However, very few pre-recruits were caught; their estimated abundance decreased significantly to about 13% of the 1985 estimate. Size-frequency data show declines in almost all segments of the male population over the past three years (Fig. 5).

The estimated abundance of mature (>90 mm cl) females increased greatly. However, this increase was not statistically significant because of the large variance of the female estimates. Historically, estimates of female abundance have been imprecise due to the preference of females for rocky habitat which is not sampled well by trawls. Approximately 83% of the mature females were carrying new, uneyed embryos, but this is not surprising in blue king crab due to their biennial spawning cycle (Somerton and MacIntosh 1985)

The 1986 fishery will open September 25 with a guideline harvest of 0.3 to 0.8 million pounds as compared with an estimated 2.8 (± 1.4) million pounds of legal stock. Relationships between estimated abundance and catch rates suggest that the fleet average will be 1 to 3 crab per pot-lift (Fig. 6).

However, catch-per-unit-effort (CPUE) is usually greater than predicted for this fishery, perhaps because the trawl survey does not adequately sample rocky habitat where blue king crab commonly occur.

St. Matthew Island Blue King Crab (*P. platypus*) Legal (≥ 120 mm cl) males occur primarily south and west of the island (Fig. 4). The area over which they were distributed was similar to that of 1985. The estimated abundance of legal crabs declined significantly to about 36% of its 1985 value (Table 1). Mean pre-recruit abundance showed no significant change. Very few adult females were encountered by the survey, probably because they occur almost exclusively in rocky nearshore habitat. No significant changes were evident for any portion of the female population. Size-frequency data show very little recruitment of juvenile crab, and indicate that the population will probably continue to decline (Fig. 7), although there are indications of successful larval settlement over the past two or three years.

The 1985 fishery opened on September 1 with a guideline harvest of 0.2-0.5 million pounds. Preliminary Alaska Department of Fish and Game (ADF&G) statistics indicate that about 1.0 million pounds were landed by 37 vessels in a one-week season; crabs had an average weight of about 4.4 pounds and the average CPUE was 11 crabs per pot-lift². The estimated exploitation rate was 59%, or about 228,000 crabs out of an estimated legal stock

²Ken Griffin, ADF&G, P.O. Box 508, Dutch Harbor, AK. 99692, pers. commun., September 1986.

of 384,000 crabs. In comparison, during 1985, 79 vessels landed 2.4 million pounds or 485,000 crabs for an estimated exploitation rate of 47% and an average CPUE of 9 crabs per pot-lift. (ADF&G, 1986).

Tanner crab (Chionoecetes bairdi) Although the legal minimum size of 5.5 in cw is equivalent to 140 mm cw, legal crabs are defined in this report as ≥ 135 mm cw to reflect more accurately the size range of crabs landed.

Legal males were sparsely distributed in Bristol Bay and continental slope areas with an area of relatively high abundance in inner Bristol Bay (Fig. 8). The distribution was restricted, relative to that of 1985. The estimated abundance of legal male C. bairdi has been declining since 1975 and is now at a new historic low (Table 2). Over the past year the estimated abundance of legal crabs declined by 30% whereas the estimated abundance of pre-recruits increased by 33%; neither of these changes was significant due to large variance. However, the estimate of juvenile males increased significantly by a factor of 2.6. Size frequency data (Fig. 9) still show a trough in the range of 70-90 mm cw.

The abundance of large mature (≥ 85 mm cw) females showed no significant change. The abundance of immature (< 85 mm) females, however, increased significantly by about 75% over the 1985 estimate. Despite the increased estimate of juvenile abundance, near-term recruitment to the fishery does not show signs of improvement. Over 70% of mature females were carrying new,

uneyed eggs. This figure is slightly lower than in 1985 (90%), suggesting that C. bairdi may have suffered some delayed spawning as did red king crab.

Due to the low estimated abundance of C. bairdi in 1985, the Bristol Bay fishery was not opened in 1986. Current estimates are even lower, with only 7.3 ± 5.5 million lbs. available. Predicted catch rates would be about 5-10 crabs per pot-lift (Fig. 10). The fate of the 1987 fishery has not yet been decided.

Tanner Crab (C. opilio). Although the legal minimum size limit for this species is 78 mm cw, crabs smaller than 110 mm cw were not usually landed prior to 1983. However, market conditions affect the sizes at which crab are landed. Due to the increased acceptability of small crab to processors, the size ranges for male C. opilio currently in use are defined as follows: immature (<78 mm cw); pre-recruits (78-94 mm cw); small (95-109 mm cl); and large (≥ 110 mm). Approximately 85% of the crabs landed in 1985 were in the size range of 95-115 mm cw (ADF&G, 1986).

The distribution of large males showed an area of high concentration in a broad band north and west of the Pribilof Islands (Fig. 11). There were also areas of high abundance in the extreme northwestern portion of the survey area and there are probably some large crab in unsurveyed areas. The distribution of pre-recruits was similar to that of large males except that their areas of highest abundance were slightly to the north.

Prior to 1986, there was very little fishing north of 58°, and estimates of abundance (Table 2) probably included all portions of the stock which were subject to fishing even though an unknown portion of the commercially exploitable stock may be north of the survey area.

The estimated mean abundance of both pre-recruit and recruit male C. opilio remained stable over the past year. However, the estimated abundance of juvenile males (<78 mm cw) increased significantly by a factor of 2.5, similar to C. bairdi. The estimated abundance of female crabs increased also, by a factor of 3.0 for juveniles (<50 mm cw), and by a factor of 3.4 for adults (≥50 mm cw) although only the latter was significant. Size frequency data (Fig. 12) indicate that recruitment to the fishery will probably not improve greatly in the near-term. In the past, large populations of juveniles have been estimated which subsequently failed to recruit (e.g. 1984-1985).

Recruitment patterns in this stock are not entirely clear since recruitment evidently occurs both through localized production and by immigration from unsurveyed areas. Therefore the current situation must be interpreted conservatively. Approximately 46% of all male crabs ≥100 mm cw, i.e. the exploited stock, were found to be softshell, possibly the result of delayed molting. In the 1985 survey, less than 2% of this group were softshell.

An unusual situation occurred regarding the proportion of females with external embryos. North of 58° N. Lat. the width at 50% maturity was in the range of 50-55 mm cw, the normal situation, and similar to 1985. However, south of 58° N. Lat., less than 24% of mature-sized females were found bearing external

clutches. In fact, the majority of these females were coded as being immature. A similar situation was found in the northeast Bering Sea, north of 61° N. Lat in 1985 (Stevens and MacIntosh, 1986). As yet we do not know the cause of this phenomenon.

The 1986 fishery was extended to Aug. 24 in the Northern District. Preliminary 1986 ADF&G statistics indicate that a record high of over 100 million lbs were landed, with an average CPUE of 140 crabs per pot-lift in the combined Bristol Bay and Pribilof Districts. This represents a 50% increase over 1985 when 75 vessels landed 66 million pounds with an average catch rate of 120 crabs per pot. Currently there is an estimated 140 (\pm 26.8) million pounds of exploitable stock (\geq 95 mm cw) within the survey area. Relationships between catch rates and population estimates indicate the catch rates in 1987 could be in excess of 100 crabs per pot (Fig. 13). No guideline harvests for 1987 have been determined.

The 1986 landings might appear excessive compared to the current estimated biomass, or that of 1985 (129 million lbs, \geq 95 mm cw). However, approximately 33% of the 1986 landings came from the Northern District³, whereas that region produced only 13% of the 1985 landings. This increase was largely due to increased fishing pressure in that part of the Bering Sea, much of which lies outside the region covered by the NMFS trawl survey. Thus, our estimates do not include the entire stock that is currently being exploited. In addition, there is reason to

³Dan Urban, ADFG, Box 508, Dutch Harbor, AK 99692, pers. commun. Sept. 1986.

believe that the catchability of C. opilio (and perhaps C. bairdi as well) is less than 1.0, i.e. that they are routinely underestimated by trawls, perhaps much more so than king crabs. At present, the fishery appears to have expanded about as far as possible geographically; landings in 1987 will probably not increase as much as they did in 1986. Despite the high landings and expanding grounds, these factors do not appear to have caused adverse impacts to the Bering Sea stock of C. opilio.

Hair Crab (Erimacrus isenbeckii) The distribution of hair crab shows a major area of relatively high abundance north and east of the Pribilof Islands and a second area immediately north of the Alaska Peninsula (Fig. 14). The abundance of hair crabs has been declining since 1981 (Table 3); a 34% decline in the estimated abundance of large (≥90 mm) male crab (all districts combined) over the past year was determined to be not significant. However, the decrease over the past two years (1984-1986) is significant. Size-frequency data show a single mode in all years (Fig. 15) and provide little information on the abundance of females or pre-recruit males.

Landings are largely incidental to tanner crabbing although there is occasionally some directed effort. Preliminary ADF&G statistics as of September 13, 1986 show no directed effort in 1986, whereas 30,000 pounds were delivered by one vessel in 1985².

Currently there are an estimated 2.7 (± 1.3) million pounds of exploitable stock. The fishery and markets have both been intermittent and probably will remain so during 1987. There are no guideline harvest levels, closed seasons or size limits for hair crab.

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Table 1. -- Population estimates for eastern Bering Sea king crabs from NMFS surveys (millions of crab).

Bristol Bay and Pribilof Red King Crab		
Year	Pre-recruits ¹	Legals ¹
1969	20.3	9.8
1970 ²	8.4	5.3
1972	8.0	5.4
1973	25.9	10.8
1974	31.2	20.9
1975	31.7	21.0
1976	49.3	32.7
1977	63.9	37.6
1978	47.9	46.6
1979	37.2	43.9
1980	23.9	36.1
1981	18.4	11.3
1982	17.1	4.4
1983	10.4	1.5
1984	12.2	2.9
1985	10.1	2.5
1986 ³	12.4	6.0

Year	Pribilof Blue King Crab		St. Matthew Blue King Crab	
	Pre-recruits ¹	Legals ¹	Pre-recruits ⁴	Legals ⁴
1974	3.1	1.9		
1975	8.0	7.5		
1976	2.1	3.9		
1977	2.2	9.4		
1978	5.8	4.3	3.3	1.8
1979	1.5	4.6	3.0	2.2
1980	1.4	4.2	3.0	2.5
1981	1.4	4.2	2.2	3.1
1982	0.7	2.2	3.3	6.8
1983	0.8	1.3	1.9	3.5
1984	0.3	0.6	0.6	1.6
1985	0.16	0.3	0.4	1.1
1986 ³	0.02	0.4	0.4	0.4

¹ The size groups 110-134 mm cl (5.2-6.4 in cw) and \geq 135 mm cl (6.5 in cw) have been used for pre-recruits and legals, respectively.

² Limited survey in 1971, not used for population estimates.

³ Preliminary estimate subject to change upon further analysis.

⁴ The size groups 105-119 mm cl (4.3-5.4 in cw) and \geq 120 mm cl (5.5 in cw) have been used for pre-recruits and legals, respectively.

Table 2. -- Population estimates for eastern Bering Sea tanner crabs from NMFS surveys (millions of crab).

C. bairdi

Bristol Bay and Pribilof		
Year	Pre-recruits ²	Legals ¹
1973	140.5	66.9
1974	255.0	130.5
1975	207.0	209.6
1976	136.6	109.5
1977	116.3	92.1
1978	81.2	45.6
1979	47.7	31.5
1980	65.0	31.0
1981	24.0	14.0
1982	46.9	10.1
1983	32.0	6.7
1984	21.2	5.8
1985	9.4	4.4
1986 ²	12.9	3.1

C. opilio

Year	<u>Bristol Bay and Pribilof</u>		<u>Northern District</u>	
	Small ³	Large ³	Small ³	Large ³
1973	38.7	84.7		
1974	169.2	246.7		
1975	247.4	274.8		
1976	190.4	181.6		
1977	196.6	137.3		
1978	171.6	78.4	8.2	10.5
1979	146.3	106.3	20.8	6.6
1980	99.1	53.6	30.4	4.2
1981	62.7	15.7	17.1	6.5
1982	63.8	10.8	70.4	10.9
1983	91.6	12.9	50.0	9.2
1984	104.1	54.0	66.3	20.0
1985	36.1	27.9	31.3	12.8
1986 ²	37.4	30.7	34.2	15.2

¹ A legal size limit of 5.5 in (140 mm) carapace width was imposed in 1976, but prior to this ≥ 5.0 in was used in the "Legal" column. In parallel, pre-recruit was 85-125 mm cw (3.3-5.0 in) prior to 1976 and 110-134 mm cw (4.3-5.5 in) since.

² Preliminary estimate subject to change upon further analysis.

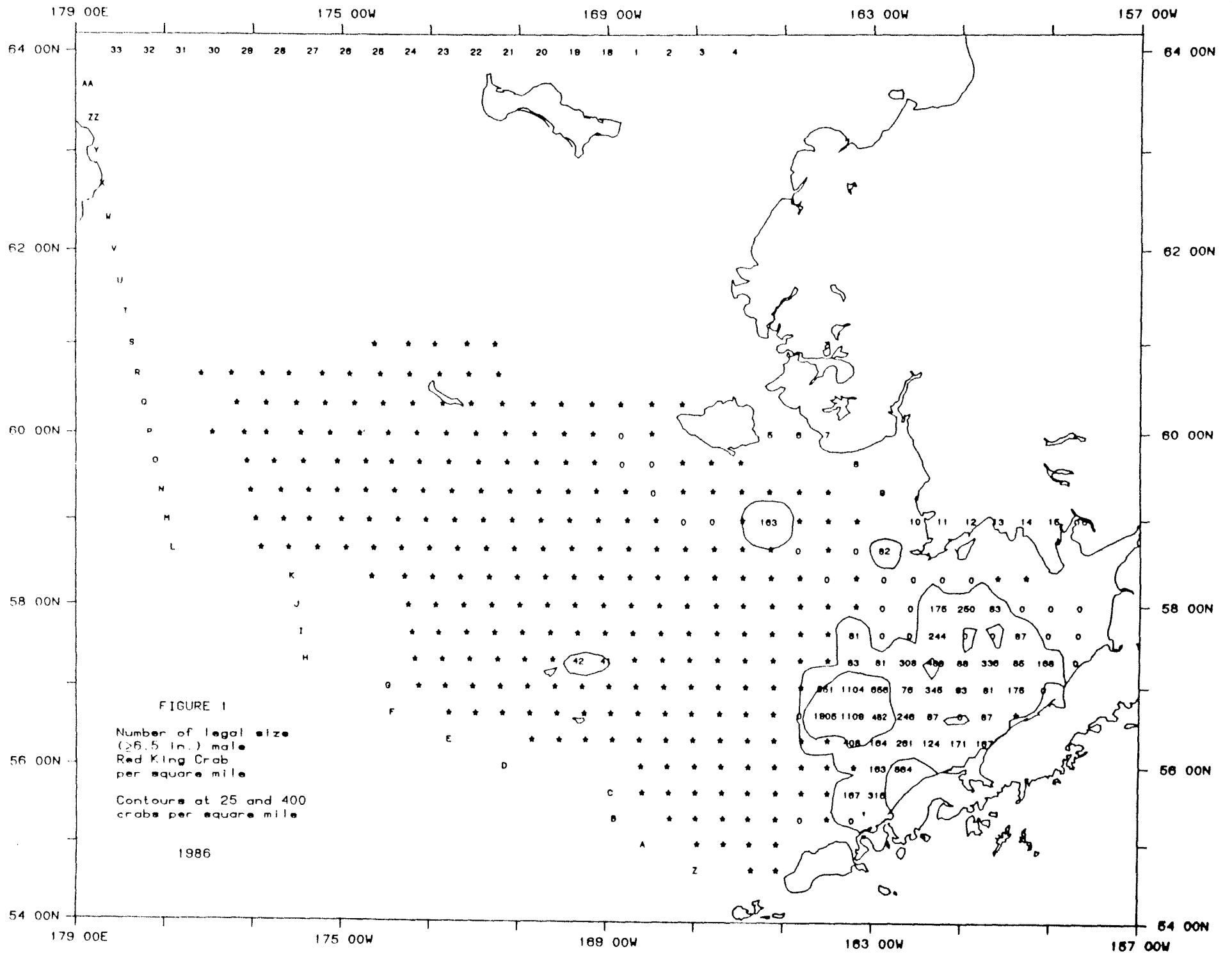
³ "Small" indicates a size range of 95-109 mm cw; "Large" indicates crab ≥ 110 mm cw.

Table 3. -- Population estimates for eastern Bering Sea hair crab from NMFS surveys (millions of crab).

Year	Pre-recruits	Large ¹
1979	4.5	16.1
1980	5.1	13.7
1981	4.8	15.9
1982	1.2	7.7
1983	0.7	4.8
1984	0.6	2.9
1985	0.4	2.2
1986 ²	0.4	1.5

¹ "Large" is 290 mm cw (3.5 in) which is approximately the size at entry into the U. S. fishery; pre-recruit is 75-89 mm cw (3.0-3.4 in).

² Preliminary estimate subject to change upon further analysis.



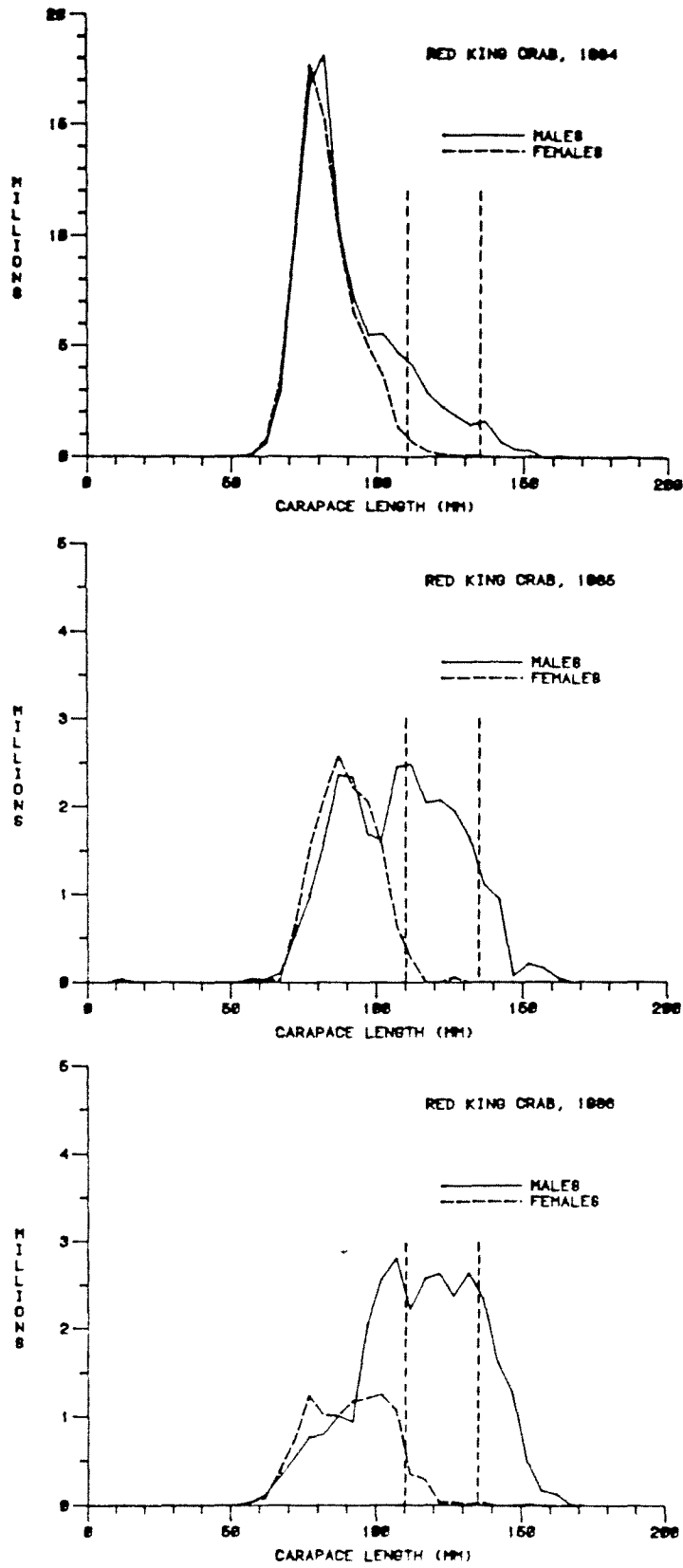


Figure 2. -- Estimates of abundance for male and female Bristol Bay District red king crab (*F. camtschatica*) by 5 mm length classes, 1984-1986. Dashed vertical lines indicate pre-recruit and legal sizes. Note difference in vertical scale for 1984.

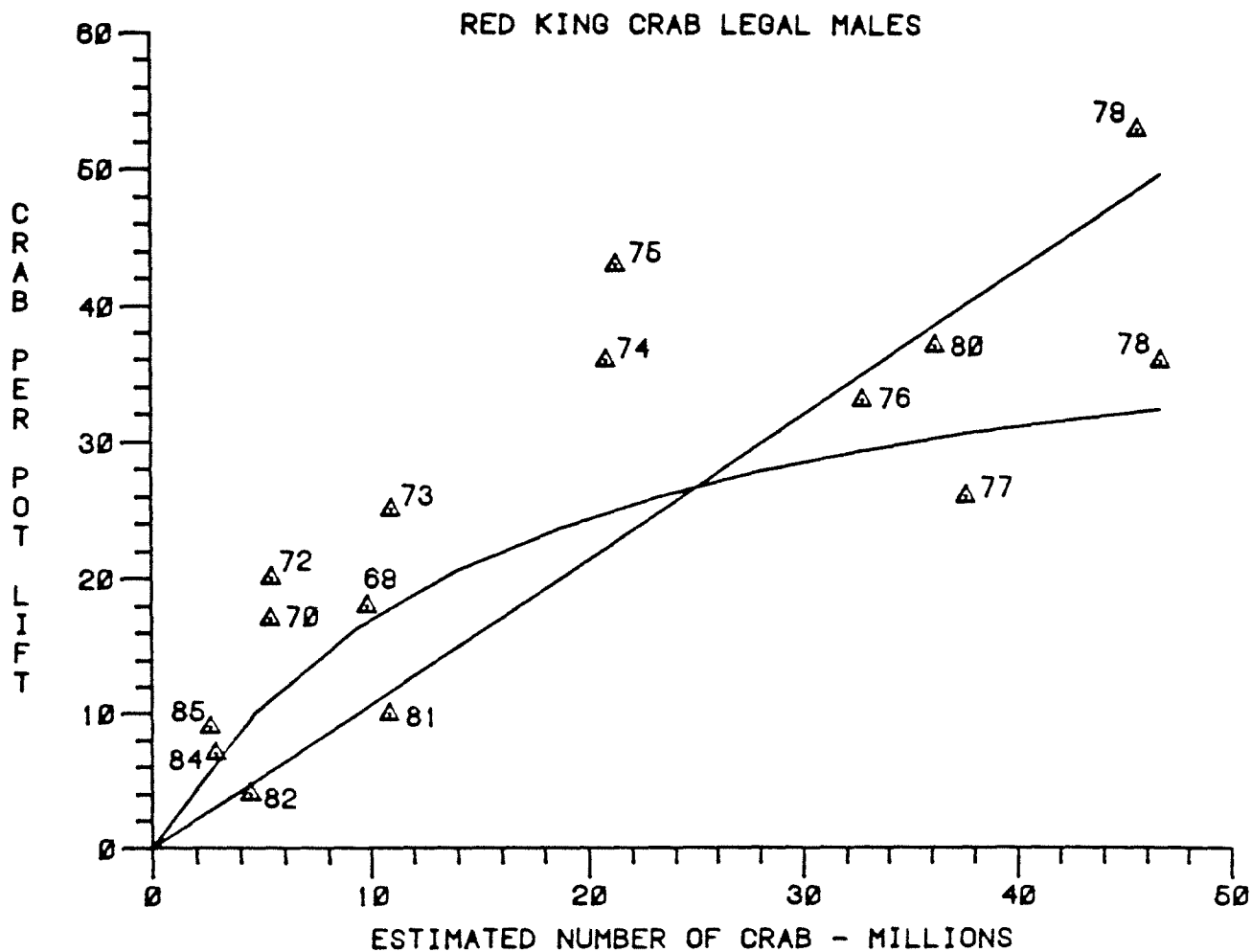
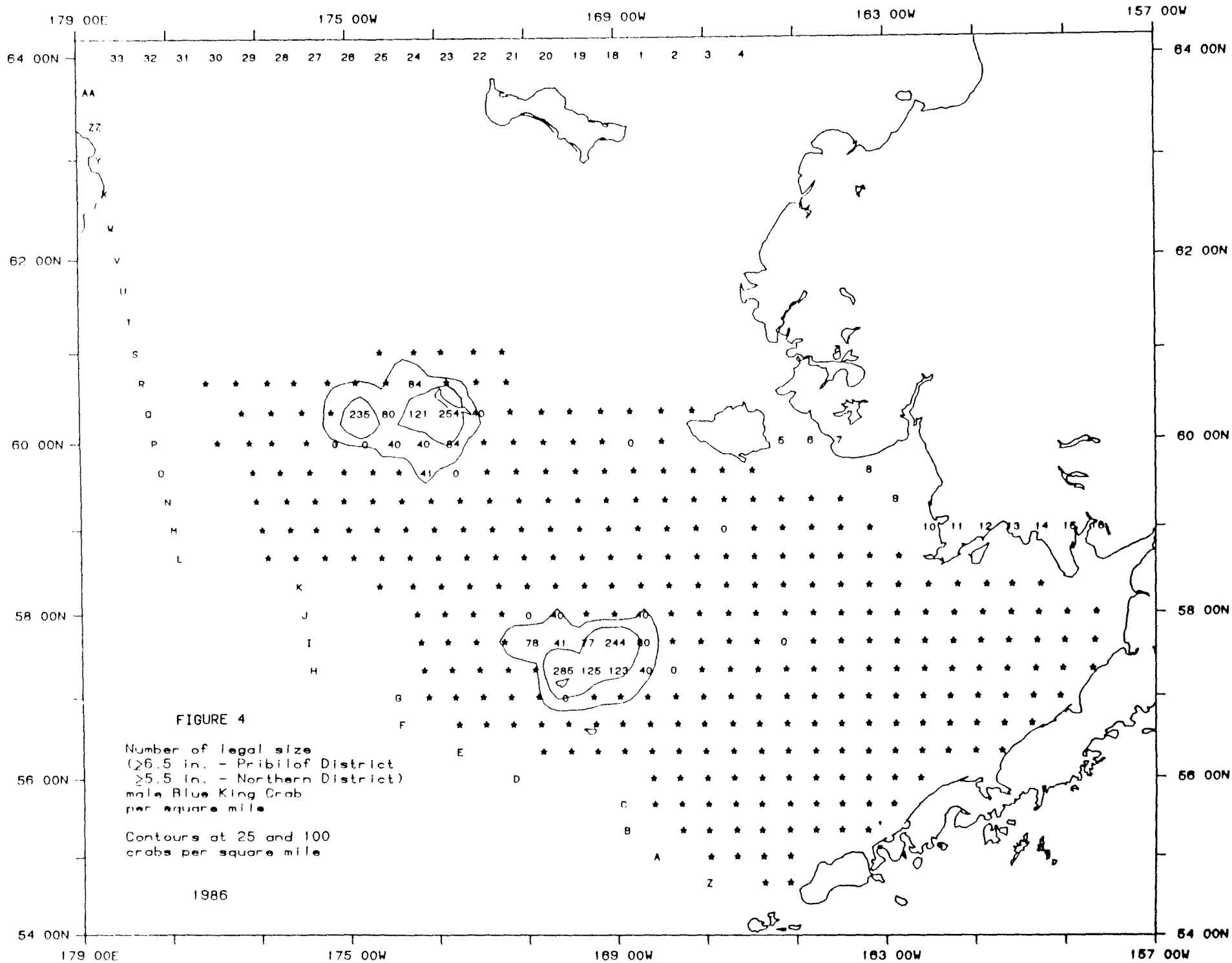


Figure 3. -- Relationship between the average number of red king crab (*Paralithodes camtschatica*) taken per pot in the U.S. fishery (year shown) and estimates of legal stock size from NMFS trawl surveys in the same year. No fishery occurred in 1983. The curved line assumes some limit to the number of crab a pot could catch.



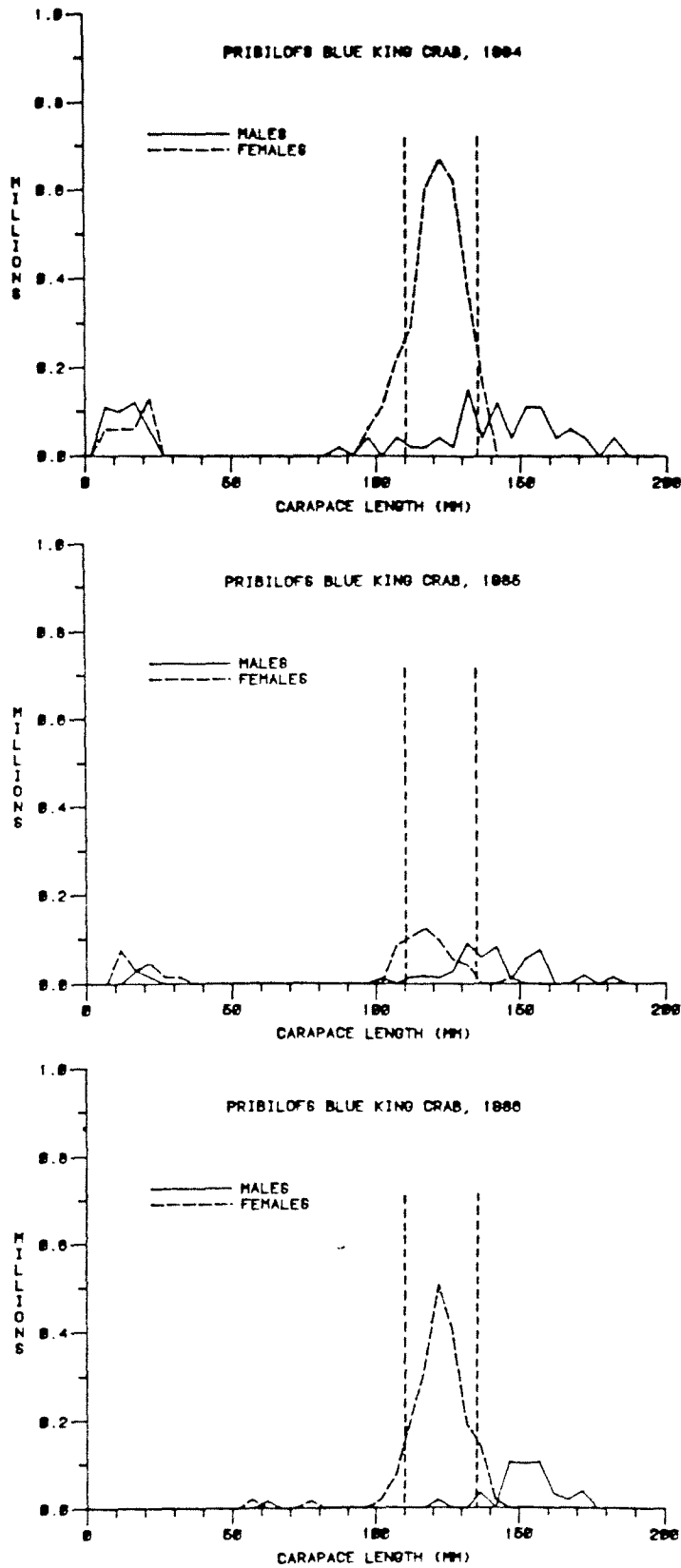


Figure 5. -- Estimates of abundance for male and female Pribilof Islands (Pribilof District) blue king crab (*P. platypus*) by 5 mm length classes, 1984-1986. Dashed vertical lines indicate pre-recruit and legal sizes.

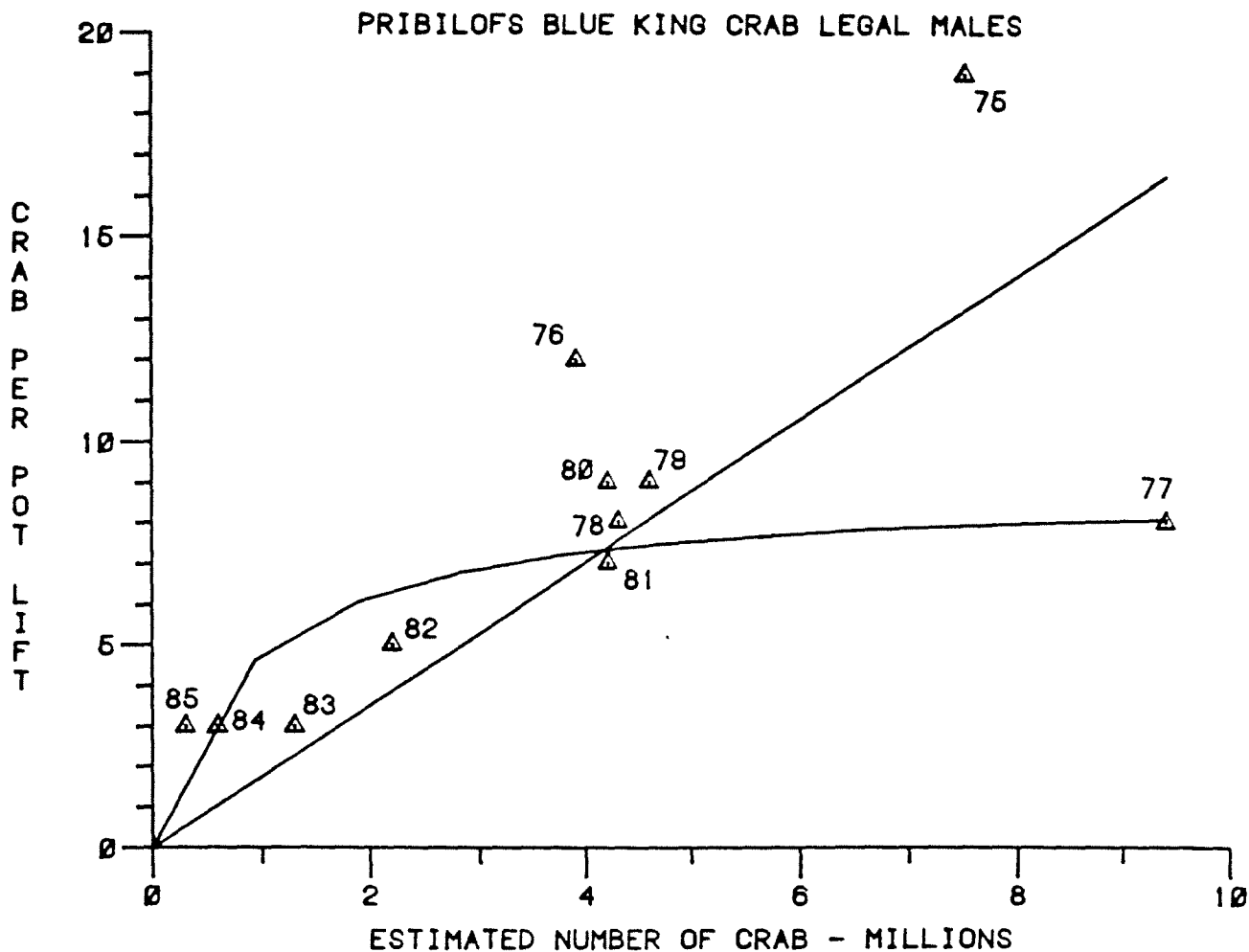


Figure 6. -- Relationship between the average number of Pribilof Island blue king crab (*Paralithodes platypus*) taken per pot in the U.S. fishery (year shown) and estimates of legal stock size from NMFS trawl surveys in the same year. The curved line assumes some limit to the number of crab a pot could catch.

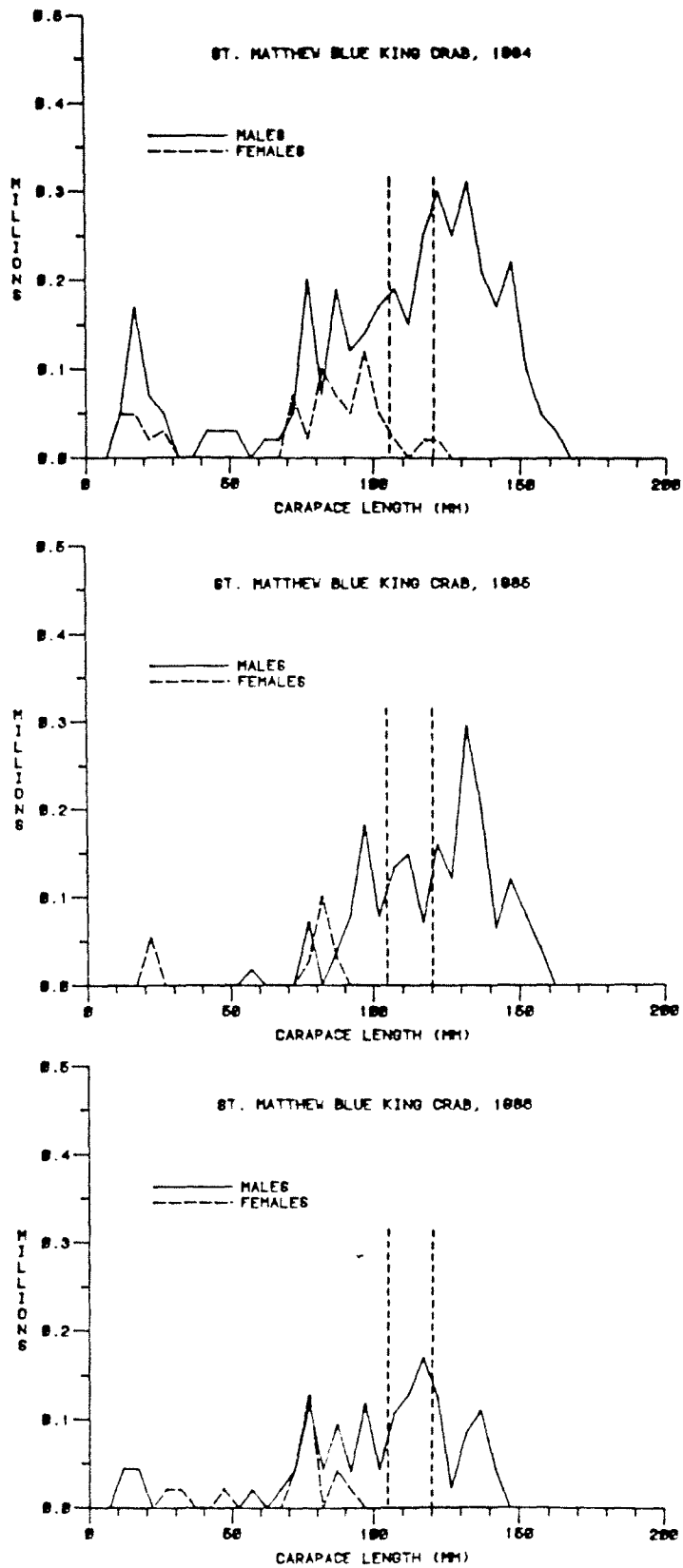


Figure 7. -- Estimates of abundance for male and female St. Matthew Island (Northern District) blue king crab (*P. platypus*) by 5 mm length classes, 1984-1986. Dashed vertical lines indicate pre-recruit and legal sizes.

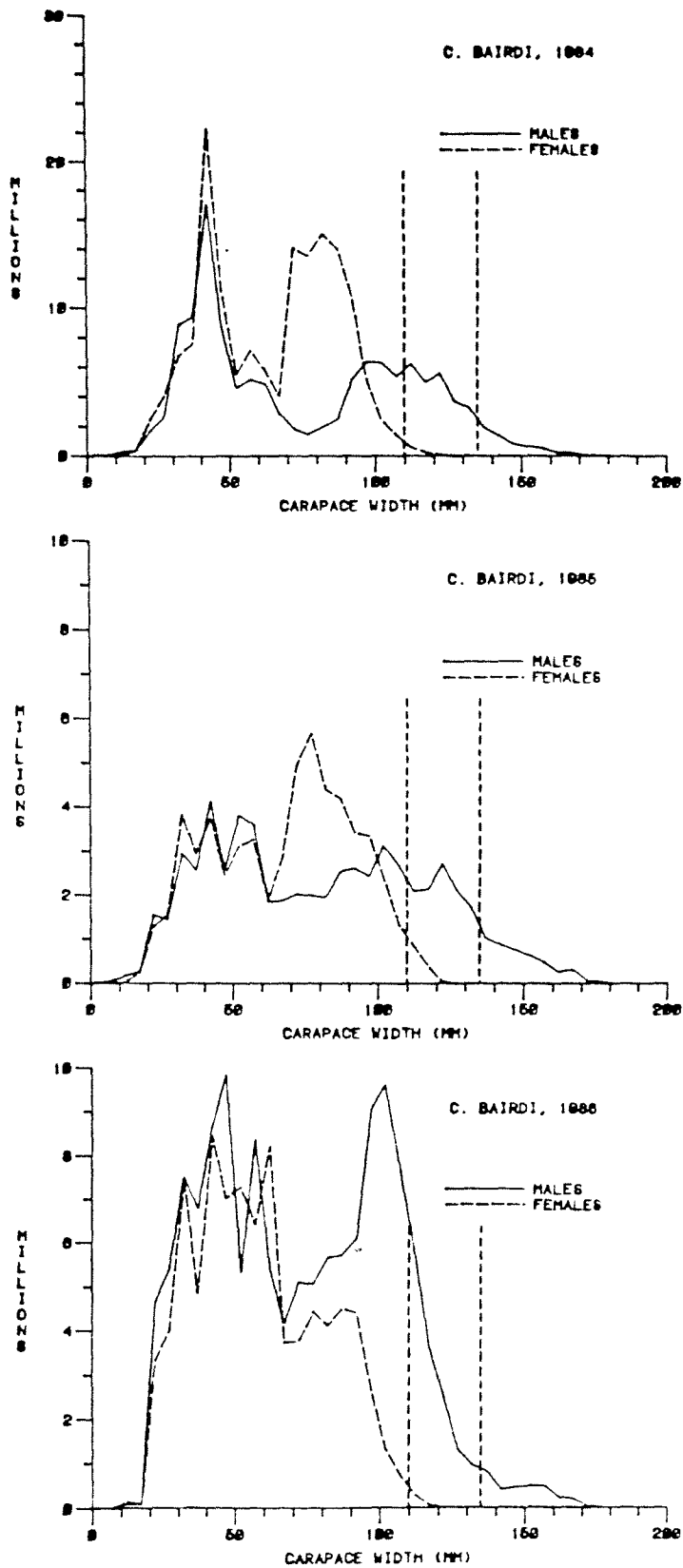


Figure 9. -- Estimates of abundance for male and female *C. bairdi* in the Bristol Bay and Pribilof Districts, by 5 mm width classes, 1984-1986. Dashed vertical lines indicate pre-recruit and legal sizes. Note difference in vertical scale for 1984.

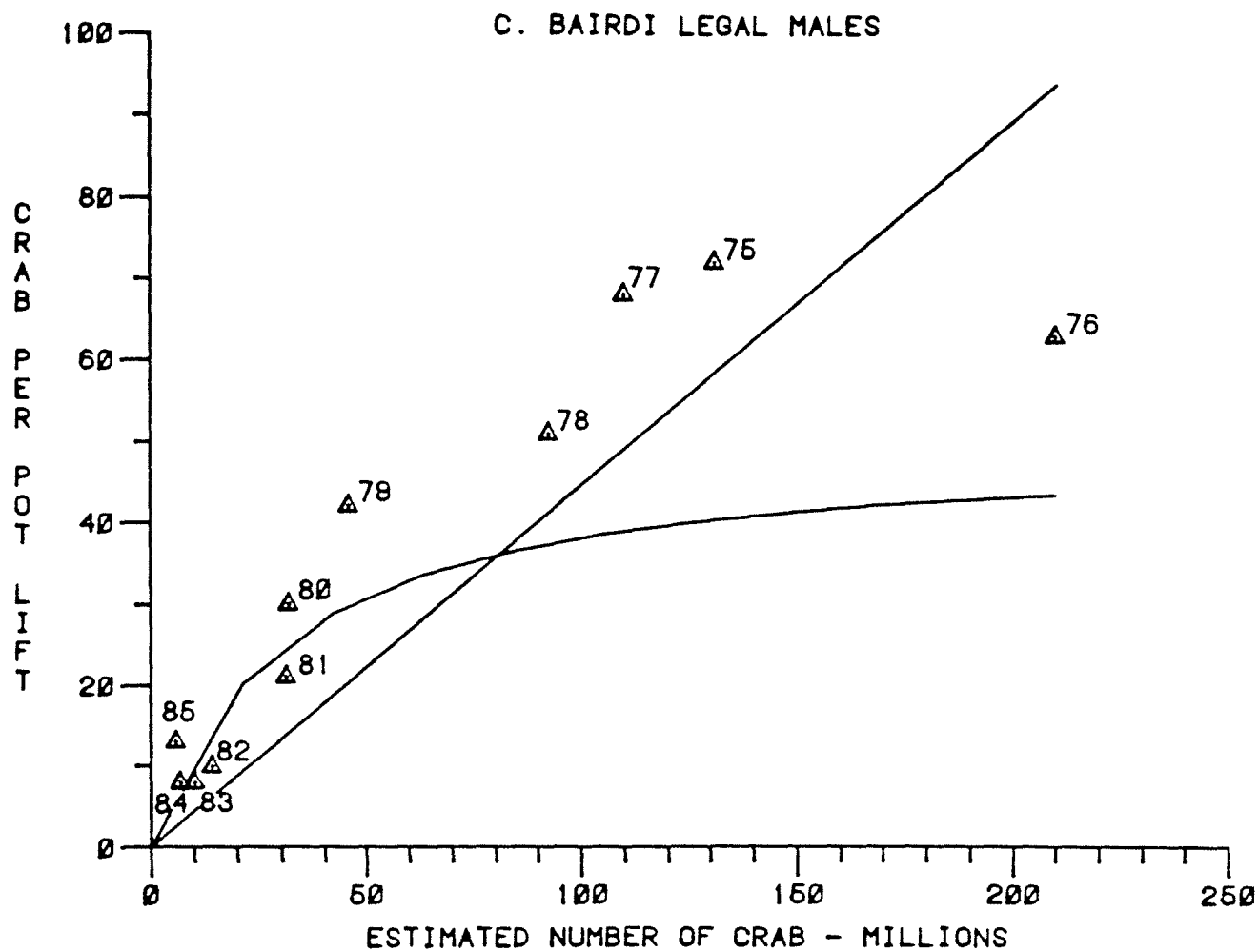


Figure 10. -- Relationship between the average number of tanner crab (*Chionoecetes bairdi*) taken per pot in the U.S. fishery (year shown) and estimates of legal stock size from NMFS trawl surveys in the preceding year. The curved line assumes some limit to the number of crab a pot could catch.

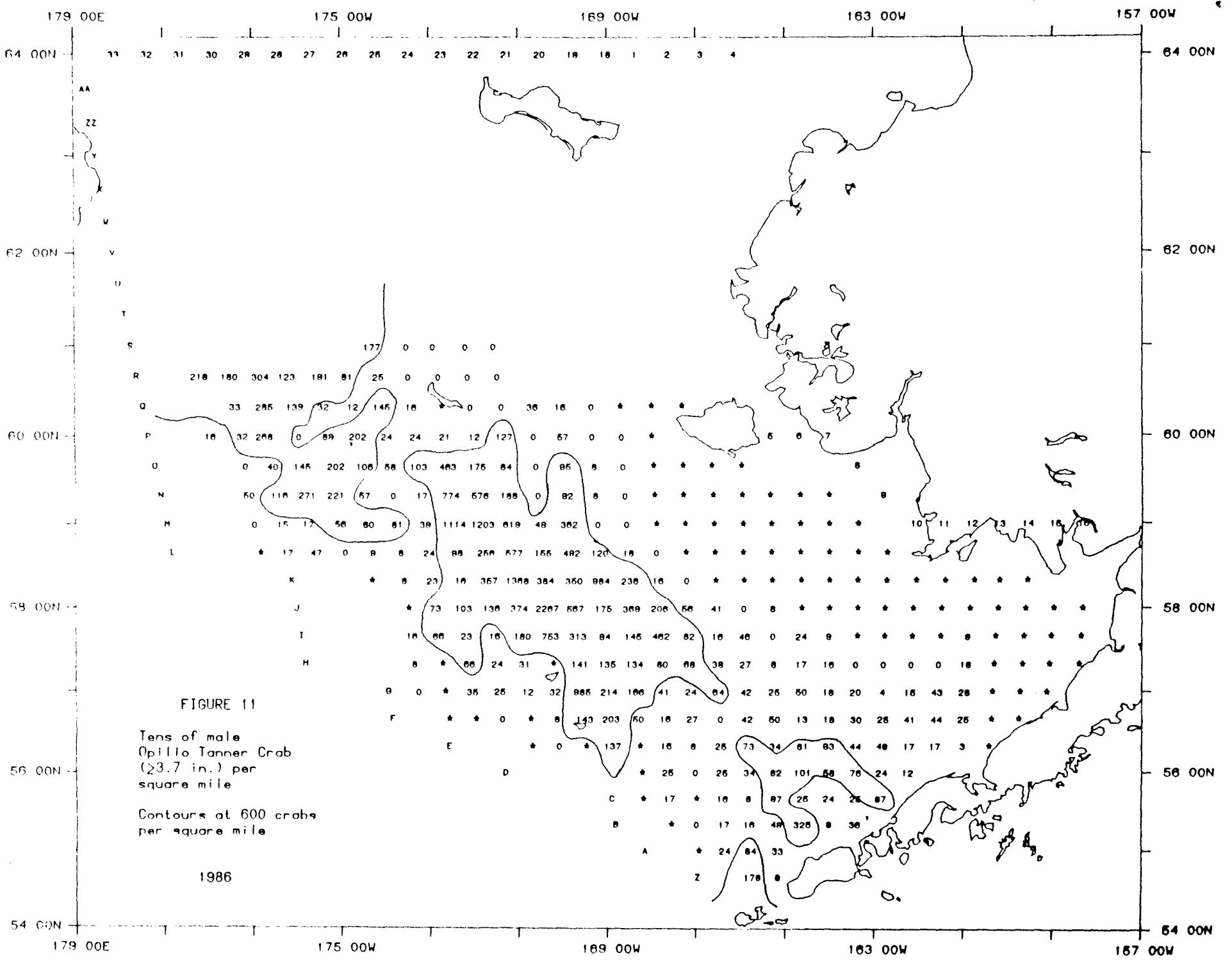


FIGURE 11

Tens of male
Opilio Tanner Crab
(23.7 in.) per
square mile

Contours at 600 crabs
per square mile

1986

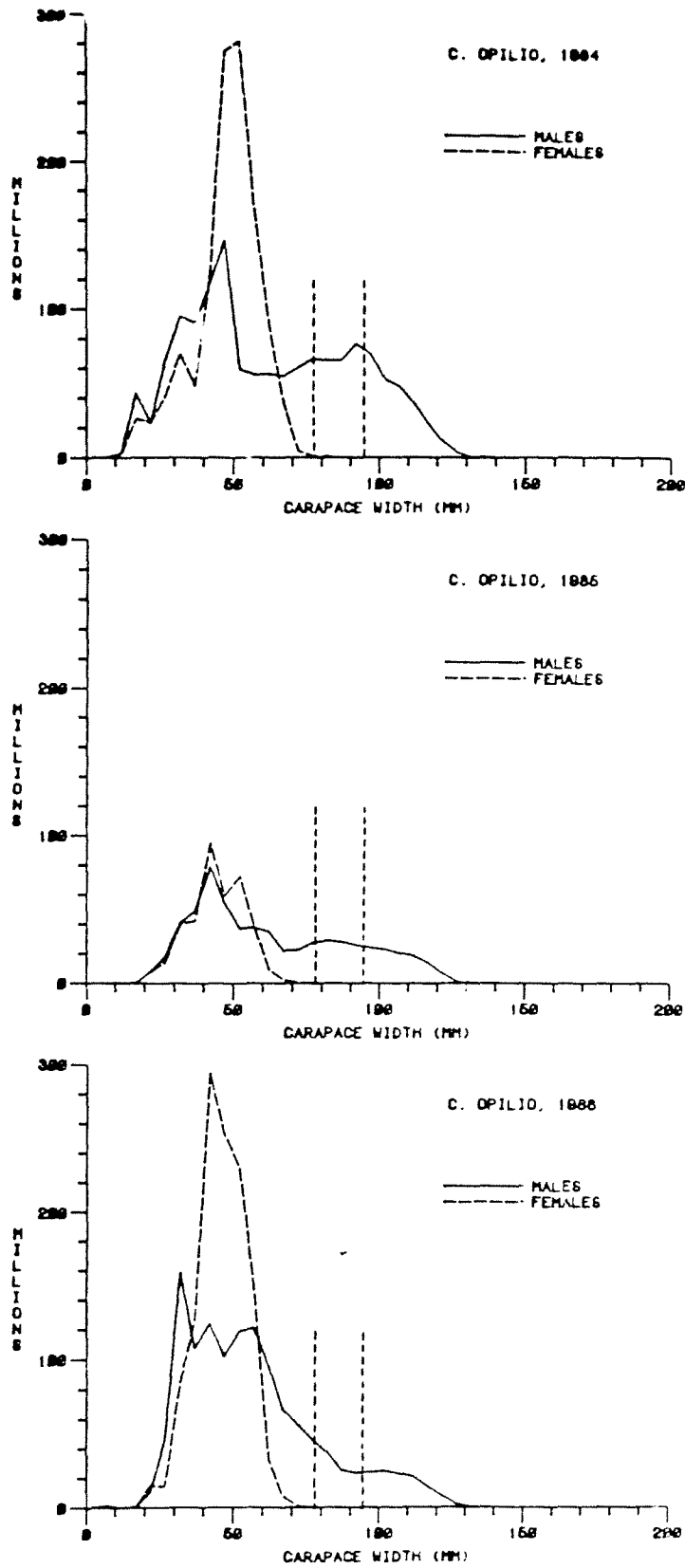


Figure 12. -- Estimates of abundance for male and female *C. opilio* in the combined Northern, Pribilof and Bristol Bay Districts, by 5 mm width classes, 1984-1986. Dashed vertical lines indicate pre-recruit and recruit sizes.

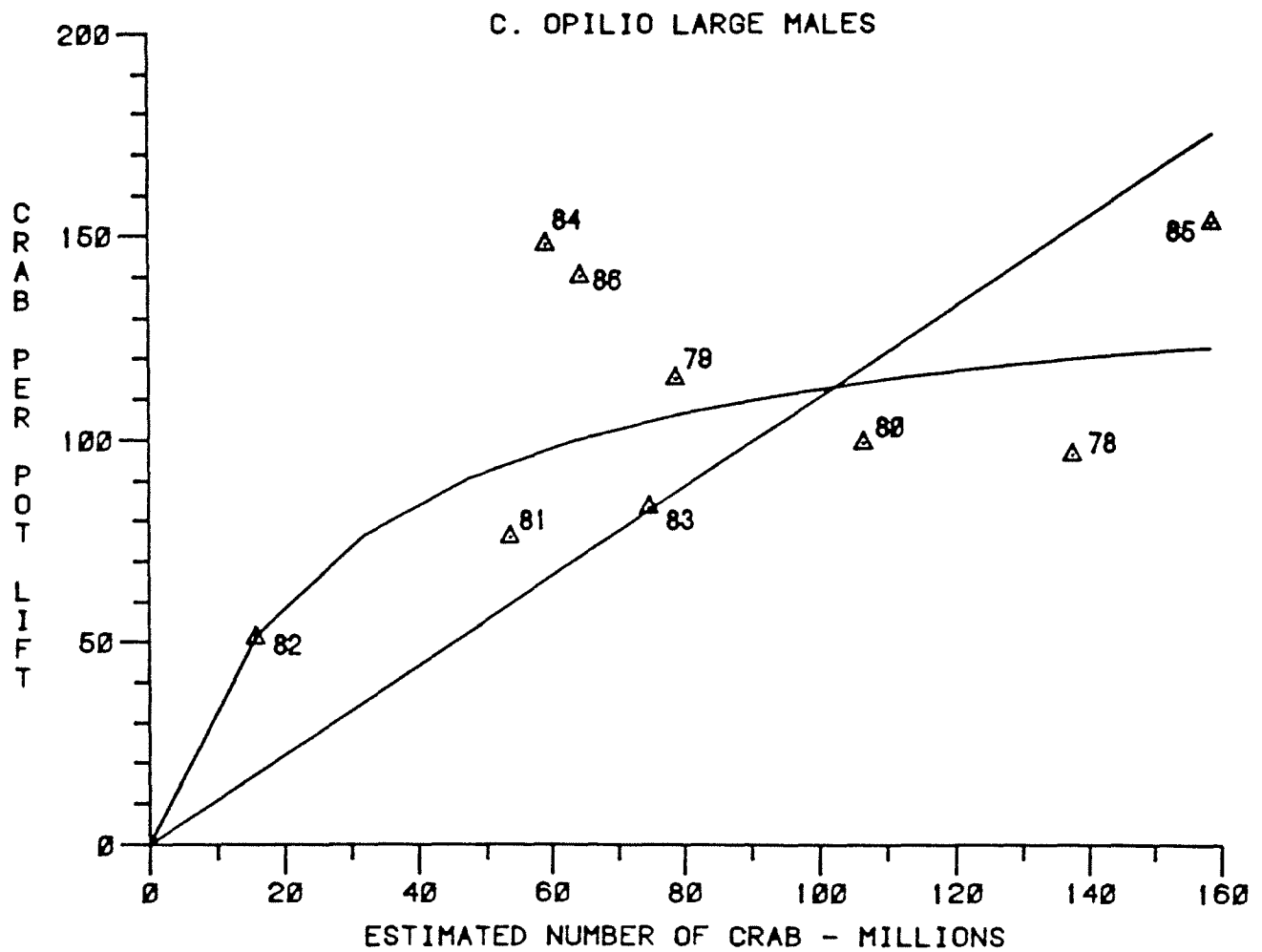


Figure 13. -- Relationship between the average number of tanner crab (*Chionoecetes opilio*) taken per pot in the U.S. fishery (year shown) and estimates of stock size from NMFS trawl surveys in the preceding year. "Large" is >109 mm (4.3 in) from 1978-1983, >95 mm (3.7 in) from 1984 to present, and generally corresponds to minimum harvested size. Data are limited to the Pribilof and Bristol Bay Districts only. The curved line assumes some limit to the number of crab a pot could catch.

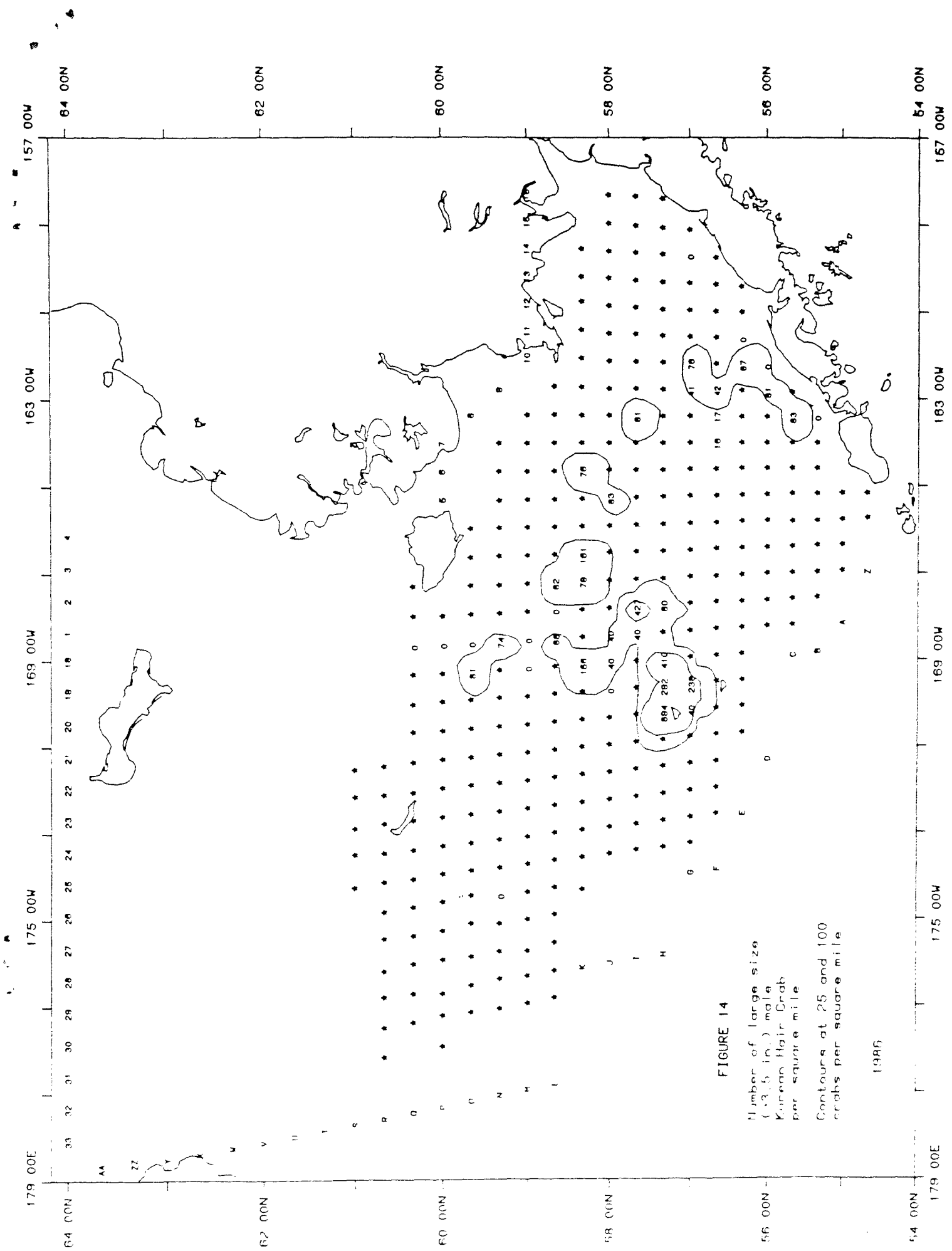


FIGURE 14

Number of large size
(5.5 in.) male
Korean Hair Crab
per square mile

Contours at 25 and 100
crabs per square mile

1986

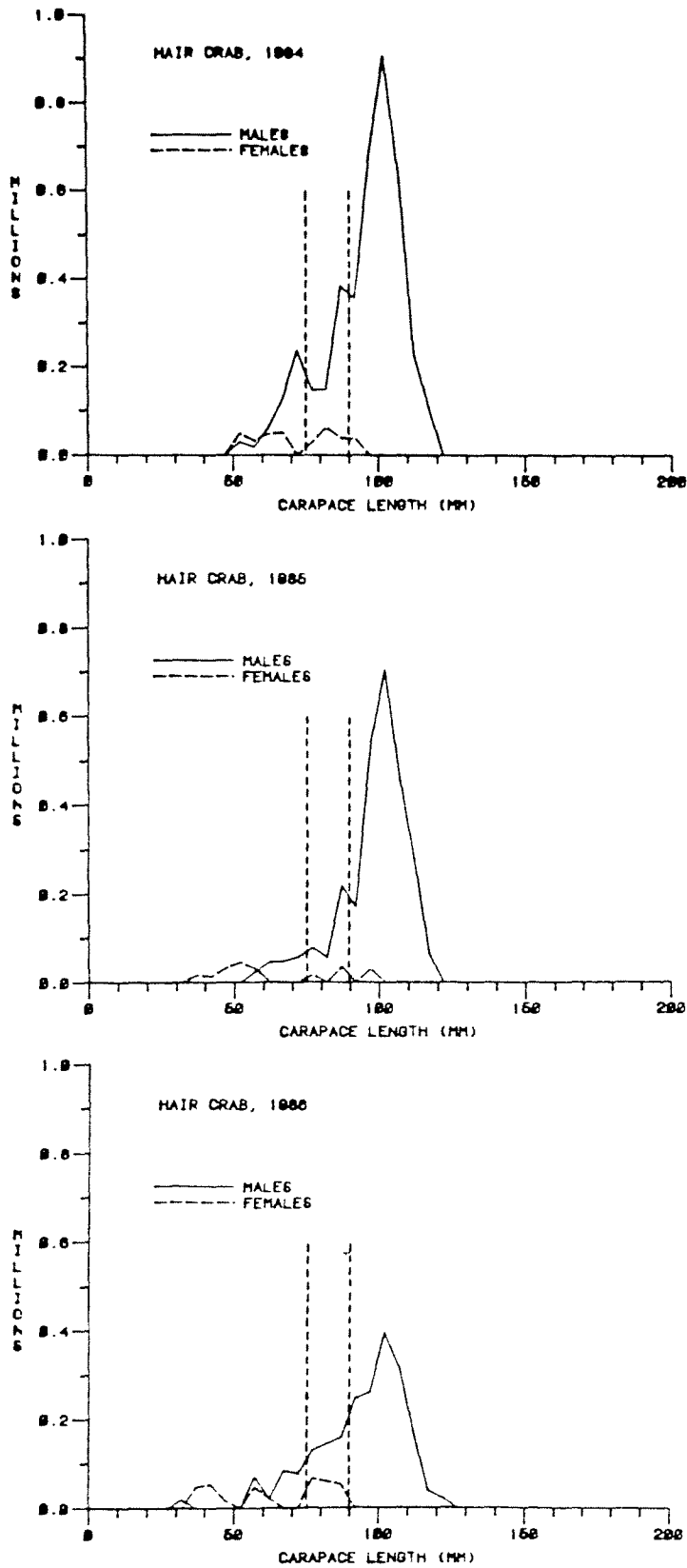


Figure 15. -- Estimates of abundance for male and female hair crab (*Erimacrus isenbeckii*) in the combined Northern, Pribilof and Bristol Bay Districts, by 5 mm length classes, 1984-1986. Dashed vertical lines indicate pre-recruit and large sizes.