Northwest Atlantic Fisheries Organization

Serial No. N2346 NAFO SCR DOC. 93/134

SCIENTIFIC COUNCIL MEETING - November 1993

Assessment of Shrimp in the Denmark Strait

by

U. Skúladóttir[1], M. Andersen[2], D.M. Carlsson[3], P. Kanneworff[3], and H. Siegstad[2].

[1] Marine Research Institute, Skúlagata 4, P.O. Box 1390, 121 Reykjavik Iceland.

[2] Greenland Fisheries Research Institute, P.O. Box 570, DK-3900 Nuuk, Greenland.

[3] Greenland Fisheries Research Institute, Tagensvej 135, 1, DK-2200 Copenhagen N., Denmark.

1. INTRODUCTION

The fishery in Denmark Strait began in 1978 with a catch of about 360 tons and subsequently increased to around 12,500 tons in 1988. In 1989 and 1990 the nominal catch decreased to less than 11,000 tons and in 1991 and 1992 declined further to 8,600 and 7,200 tons, respectively. Vessels from Denmark, Faroe Islands, France, Greenland, Iceland and Norway were active in the fishery from 1980 to 1991, inclusive. No fishing was reported from France since 1991. Reported catches and TACs throughout the history of the fishery are given in Table 1.

The shrimp fishery in the Denmark Strait occurs primarily in the area of Strede- and Dohrn Banks as well as on the slopes of Storfjord Deep (Fig. 1). Two new areas which were discovered in 1989 by Greenland (Lehmann, 1990) but not found profitable at the time have now been fished after the opening of the whole of the socalled redfish box where some 900 tons were caught in 1993. The new areas lie south of 65°N and are shown on Fig. 2 along with the traditional area. The traditional area extends from approximately 65°00'N to 67°30'N and between 26°W and 34°W. For the sake of comparison the catch and effort data of the new area are kept separate from those of the traditional area as it is considered possible that the shrimp here belongs to a different stock.

2. INPUT DATA

2.1. COMMERCIAL FISHERY DATA (SCR Doc. 93/131, 93/133)

2.1.1 Trends in catch and effort

Catch and effort data were available from logbooks from Greenland, Norway, Iceland, France, Faroe Islands and Denmark since 1980, and from Catches and corresponding effort were compiled by month and by fleet. CPUEs were calculated by month and the mean weighted CPUE of two periods of the year (January to June and July to December) was then applied to the total catch of the period to estimate the total effort.

Total catches increased rapidly from 1978 to 1980, decreased in 1981 and remained stable to 1983. Catches increased steadily from 1983 to 1988 and then decreased to 1992 (Fig. 3). Total effort values show about the same pattern as catch. Between 1980 and 1989, effort increased from about 35,000 hours to 108,000 hours, declining thereafter to about 70,000 hours in 1993 in the area north of 65°N. As these figures are only provisional it is quite likely that both catch and effort will end up being about the same as in 1992.

2.1.2 Trends in catch rates

Abundance indices have been calculated previously from both unstandardized and standardized series (Skuladottir *et al.*, 1993). The unstandardized overall CPUE has been calculated for all countries and set against removals as catch from the stock in every 3 previous years (Fig. 4) showing the decline in CPUE as more shrimp is caught. In spite of considerable decline in the average catch of the years 1990-1992 of some 8,700 tons there is no increase in CPUE in the fourth year, i.e. in 1993. Also the unstandardized catch rate indices for all countries combined is shown (Fig. 5) using 1993 as a reference point.

Unstandardized catch rates were without trend from 1981 to 1987 followed by a substantial decline to 1989. Values for 1990, 1991, and 1992 were similar to the low 1989 level. The 1989-92 level was about 50% of the level seen from the early to mid-1980s period.

2.1.3 Standardization of the catch rates

The catch and effort data from Greenland from 1987 to 1993 were analyzed using SAS multiple regression procedures to account for the vessel size and seasonality (months) of the fishery both the total catch and the proportion of shrimp >8.5 g of weight (Fig. 6). The results for both showed that all years were significantly higher than the 1992 estimate, whereas 1993 was similar to 1992.

Standardized catch rate series have previously been calculated (Skuladottir *et al*, 1993) for the period 1987 to 1992 for the other two countries Norway and Iceland as well. The Norwegian catch rates declined from 1987 to 1989 to remain stable thereafter. The Icelandic catch rate has remained relatively stable between 1987 and 1989, increased substantially between 1989 and 1991, remaining stable between 1991 and 1992.

2.2 COMMERCIAL BIOLOGICAL DATA (SCR Doc. 93/65, 93/131)

2.2.1 Icelandic fishery data

The Icelandic samples (Fig. 7) (Skúladóttir, 1993a) taken in the fall of 1987 and 1988 show that the catches east of the midline were comprised mainly of female shrimp with a distinct mode at 30 mm CL. The 1990 fall samples show the increased importance of the male component (about 50% compared to 32 and 26% in 1987 and 1988). The 1991, 1992 and 1993 samples taken in spring show that male shrimp dominated at this time in all three years.

The occurrence of a component of female shrimp with a mode at 26 mm in the 1990 samples suggested that sex change occurred earlier than normal. A study of female maturity ogives in Icelandic samples in the years 1985 to 1992 (Skuladottir, 1993b) suggested a drop in the values of L_{50} for the year 1990 only.

2.2.2 Greenlandic fishery data

The samples from the Greenlandic fishery in 1993 (Fig. 8 and 9) come from a wide area and cover also the time of the period February to April when the fishery is mostly taking place. In the traditional area north of 65°N (strata 580, 630, 631 and 680 were composed primarily of large shrimp with a modal length of 26-27 mm CL. Samples taken just south of 65°N (strata 486 and 487) showed the occurrence of a broad size range whereas those taken between 62° an 63°N (strata 191, 240 ,241 and 290) contained shrimp with modal length of 22-23 mm. In 1989 when Lehmann (1990) was searching for new shrimp grounds the L_{50} of mature females appeared to be at about 24 mm in the southern area where as the L_{50} of the shrimp in the area just south of 65°N was in 1989 about 29 mm
thus resembling the size at maturity of females of the traditional area (Skuladottir, 1993b)

2.3 RESEARCH SURVEY DATA (SCR Doc. 93/63)

2.3.1 Biomass estimates

A stratified-random trawl survey was conducted by Greenland in Denmark Strait in October, 1992. The biomass estimate of 1,044 tons was lower than the 1990 estimate for the same area (1,860) tons. The Norwegian surveys from 1985 to 1989 produced much higher estimates between 25,000 and 50,000 tons. Investigations show that differences in survey design should cause the Greenlandic survey (stratified random) to provide biomass estimates of only 20-30% of the Norwegian (fixed station) results.

2.3.2 Demographic structure

Greenland survey samples from 1989, 1990 and 1992 (Fig. 10) showed an increase in the proportion of males over the period which is consistent with a trend evident from the 1985 to 1989 Norwegian surveys. However overall abundance, declined, especially for females.

	Percent males							
	1985	1986	1987	1988	1989	1990	1991	1992
Norway	43.8	41.4	53.5	58.5	58.0			
Greenland					63.1	62.5	-	78.3

The data also showed that males in 1990 and 1992 did not attain the large sizes evident in 1989. Further, the proportion of small females was higher in 1992, suggesting the possibility of sex change occurring at an earlier age or migration of shrimp from Icelandic stocks.

The survey data showed an increase in the total numbers in the western part of the survey area in 1992. Both males and females deceased by a factor of 10 in the stratum with highest abundance in 1990 while abundance increased in the area of the mid-line between Greenland and Iceland.

3. SUMMARY OF ALL INDICES

Trends in catches

Increase from 1978 to 1980.
Decrease in 1981 and stabilization in 82 and 83 at around 4,700 tons.
Steady increase from 1983 to 1988 to 12,500 tons.

Decrease from 1988 to 1993.

Trends in effort

General increase from 1979 to 1989.
Decrease from 1989 to 1993.

Trends in catch rates

Overall declining trend in the unstandardized catch rate from 1980 to 1991.
A steady decrease for the standardized catch rate from 1987 to 1992 for Greenland.
A decline in standardized catch rate from 1987 to 1989 for Norway.
A relative stability in standardized catch rate between 1987 to 1989 to increase substantially between 1989 and 1991 for Iceland.
Decrease in large and total shrimp indices from Greenlandic data.

Biomass estimates from research surveys

Biomass in 1992 lowest observed. No survey in 1993.

Demographic structure from research surveys

After 1988, increasing proportions of male shrimp (<28 mm) in Icelandic samples.
Indications of earlier sex change occurred between 1989 and 1990, and the condition has not reversed.
Increase in proportion of males since 1985.
Differences in distribution of size groups over the survey area between years.

4. SUMMARY OF ADVICE FROM PREVIOUS YEARS

The interpretation of the effects of fishing on the stock in the Denmark Strait has changed since the first assessment was conducted in 1980. In 1981, it was thought that the decreases observed in the spring catch rates were due to heavy exploitation. Also, it was considered that the stock was at the northern limit of the species distribution range, and as such, could be more sensitive to exploitation. Therefore, a cautious approach for the exploitation was recommended, and the TAC was set at 4,200 tons (the estimated MSY). By 1985, it was interpreted that the stock was stable and the TAC of 5,000 tons (average catch 81-84) was advised.

No TAC advice was provided for 1986, 1987 or 88 because the catch rates could not be interpreted as an index of stock abundance. In 1988, it was observed that increased catches over the previous several years had no apparent effect on the resource and catch levels at around 10,000 tons were recommended as an exploratory level for several years.

Catch rates declined in 1987 and 1988, however catch composition and biomass estimates from 1985 to 1989 suggested that the stock was stable and in 1990 it was recommended that the TAC remain at 10,000 tons. The 1989 Norwegian survey showed that the stock was dispersed and the sexes well-mixed. In 1991, the catch rate series was standardized to account for changes in seasonality and fleet composition and it was interpreted that the stock in 1989-90 was substantially lower than in the period of stabilized catch rates. Also more males appeared in the catches and there were indications of earlier sex change. These concerns resulted in an arbitrary reduction of the TAC from 10,000 to 8,000 tons. The depressed conditions were still evident in the 1991 data and, in 1992 a further reduction to 5,000 tons was advised for 1993 and several years thereafter in an attempt to protect the spawning biomass and rebuild the stock.

5. STATUS OF THE RESOURCE

As interpreted in recent years, the abundance of the resource on the fishing grounds is thought to be at a lower level than it was during the first half of the 1980s. Decrease of CPUE associated with an increasing proportion of male shrimp in the survey data reflects a decrease in the abundance of the females. The recent inferences for a decrease in the size at sex reversal might indicate a response to a decrease in population abundance or environmental influences.

Standardized catch rates showed different trends for the Icelandic, Norwegian and Greenlandic fleets over the period 1987-1992. The Norwegian data suggest stability since 1989, the Icelandic an increase since 1988, whereas the Greenlandic data show a declining trend from 1987 to 1992 but a stabilization between 1992 and 1993. Therefore it is possible that the stock has now stabilized at a low level. But as yet there are no signs of a recovery neither as an increase in catch rate nor as a higher proportion of females as compared to previous years.

6. PROGNOSIS

Given the current low level of the shrimp stock abundance in Denmark Strait, catches should be 5,000 tons and maintained at that level for a couple of years in an attempt to increase the catch rates and prevent a possible over exploitation of the apparently low spawning biomass.

7. REFERENCES

Carlsson, D. M., and P. Kanneworff. 1993a. Stratified-random trawl survey for shrimp (*Pandalus borealis*) in Denmark Strait in 1992. *NAFO SCR Doc.*, No. 66, Serial No. N2250, 13 p.

1993b. The commercial shrimp fishery in Denmark Strait January to October 1993. *NAFO SCR Doc.*, No. 131, Serial No. N2343, 24 p.

Lehmann, K.M. 1990. Report on a commercial trial fishery for shrimp (*Pandalus borealis*) off Southwest, Southeast and East Greenland. *NAFO SCR Doc.*, No. 62, Serial No. N1784, 6 p.

Skúladóttir, U. 1993a. The Icelandic shrimp fishery (*Pandalus borealis*) in the Denmark Strait in 1992 and early 1993. *NAFO SCR Doc.*, No. 51, Serial No. N2232, 7 p.

1993b. The sexual maturity of female shrimp (*Pandalus borealis*) in the Denmark Strait in the years 1985-1992 and a comparison to the nearest Icelandic shrimp stocks in 1992. *NAFO SCR Doc.*, No. 65, Serial No. N2249, 7 p.

1993c. The catch statistics of the shrimp fishery (*Pandalus borealis*) in the Denmark Strait in the years 1980-1993. *NAFO SCR Doc.*, No. 133; Serial No. N2344, 12 p.

Skúladóttir, U., and M. Andersen, D. M. Carlsson, P. Kanneworff, D.G. Parsons, and H. Siegstad. 1993. Assessment of shrimp in the Denmark Strait. *NAFO SCR Doc.*, No. 84, Serial No. N2269, 10 p.

Table 1. Nominal catch (tons) of shrimp in the Denmark Strait.

Country	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993 ***	1994
Denmark	-	-	702	581	740	204	443	353	500	555	444	366	390	358	160	145	
Faroe Islands	-	-	4233	713	737	443	668	674	727	595	679	595	843	1007	1095	709	
France	-	-	50	353	414	291	500	642	780	1030	494	381	51	118	-	-	
Greenland	-	-	200	1004	1115	1467	2250	2596	5781	6627	7456	5976	6211	4202	2012	2235	
Iceland	363	485	759	125	0	43	742	1794	1150	1330	1424	1326	281	465	1432	2586	
Norway	-	800	2461	2016	1896	1727	2128	2051	2026	2041	2052	2098	2500	2504	2500	1644	
Total catch	363	1285	8405	4792	4902	4175	6731	8110	10964	12178	12549	10742	10276	8654	7199	7319	
Total catch eastern side	363	485	759	125	0	43	742	1794	1150	1330	1424	1326	281	465	1432	2586	
Total catch western side	0	800	7646	4667	4902	4132	5989	6316	9814	10848	11125	9416	9995	8189	5767	4733	
Adviced TAC	-	-	-	-	4200	4200	4200	5000	-	-	-	10000*	10000*	10000*	8000	5000	5000
Effective TAC western side	-	-	-	8000	4500	5725	5245	6090	7525**	7725**	8725**	9025**	14100	14500	13000	9563	

* Adviced for a few years as a precautionary measure.

** Not including Greenland fishery north of 66° 30' N.

*** Provisional.

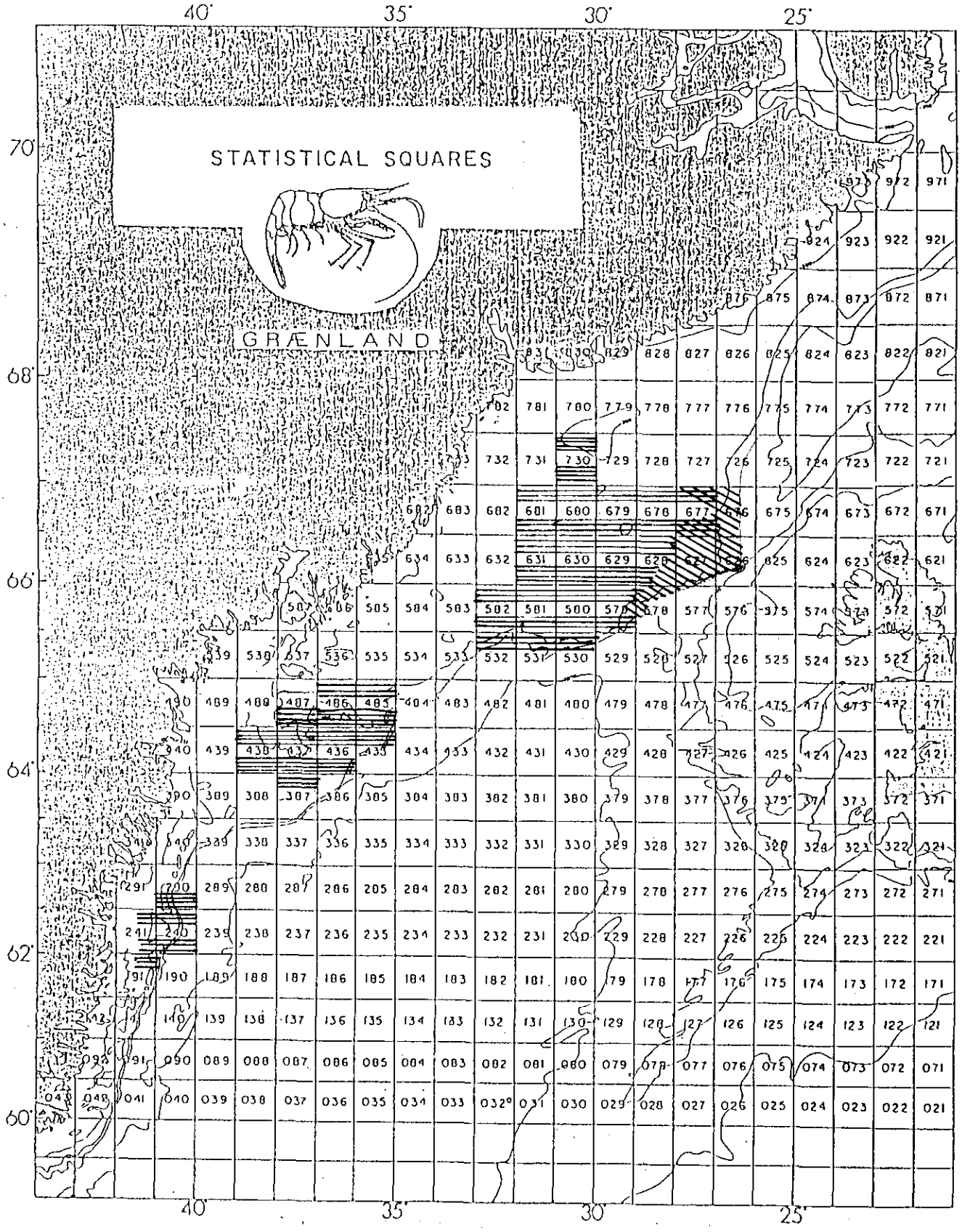

Fig. 1. The strata numbers in the Denmark Strait. The fishery areas are shaded.

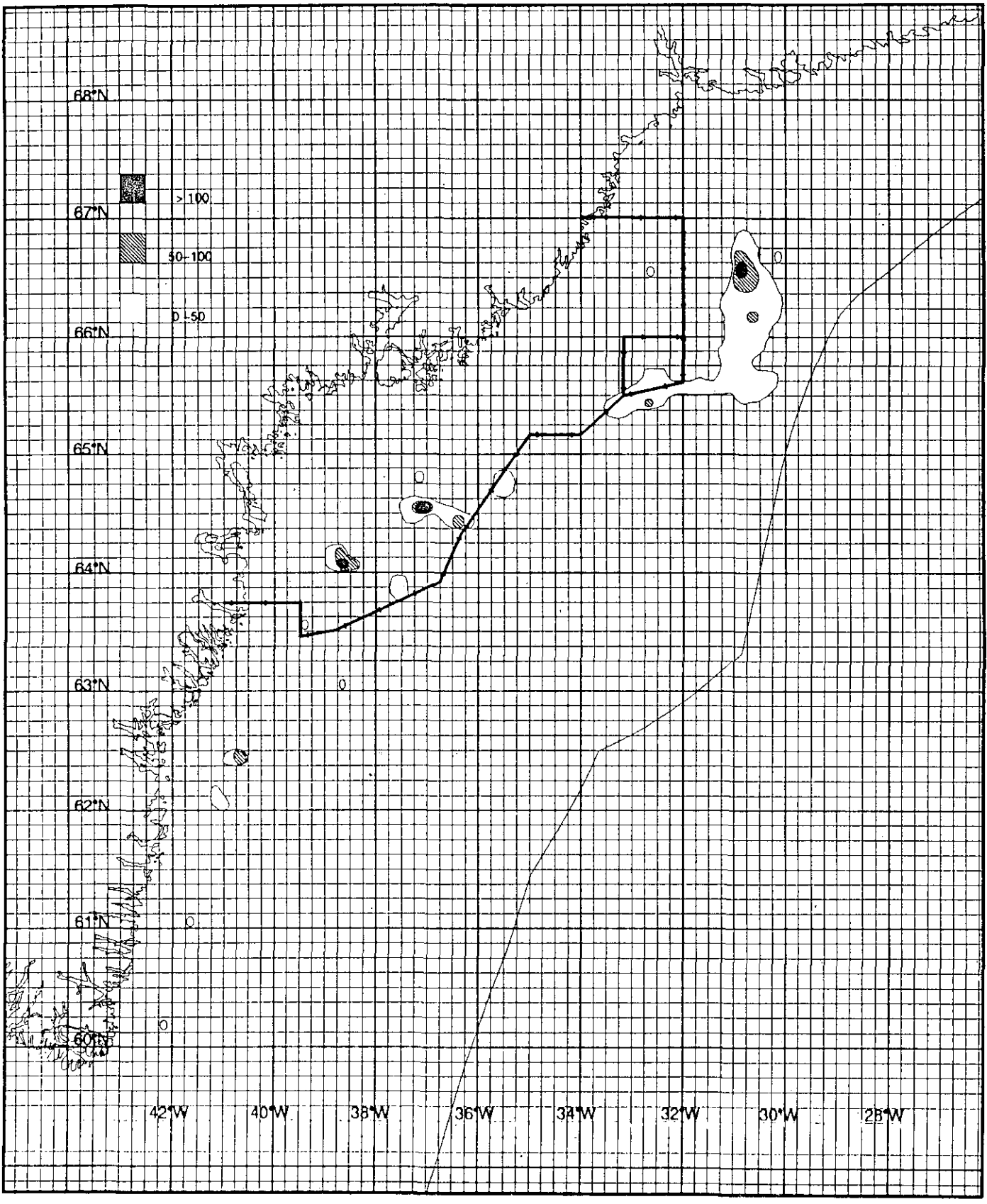

Figure 2. Distribution of catches of shrimp (tons per statistical unit) in the fishery in Denmark Strait in January-October 1993, based on logbooks from the Greenland fishery. The area delimited by a dotted line is the 'redfish' box (see text) opened to the fishery in 1993. The small area south of 66°N was opened from 1990.

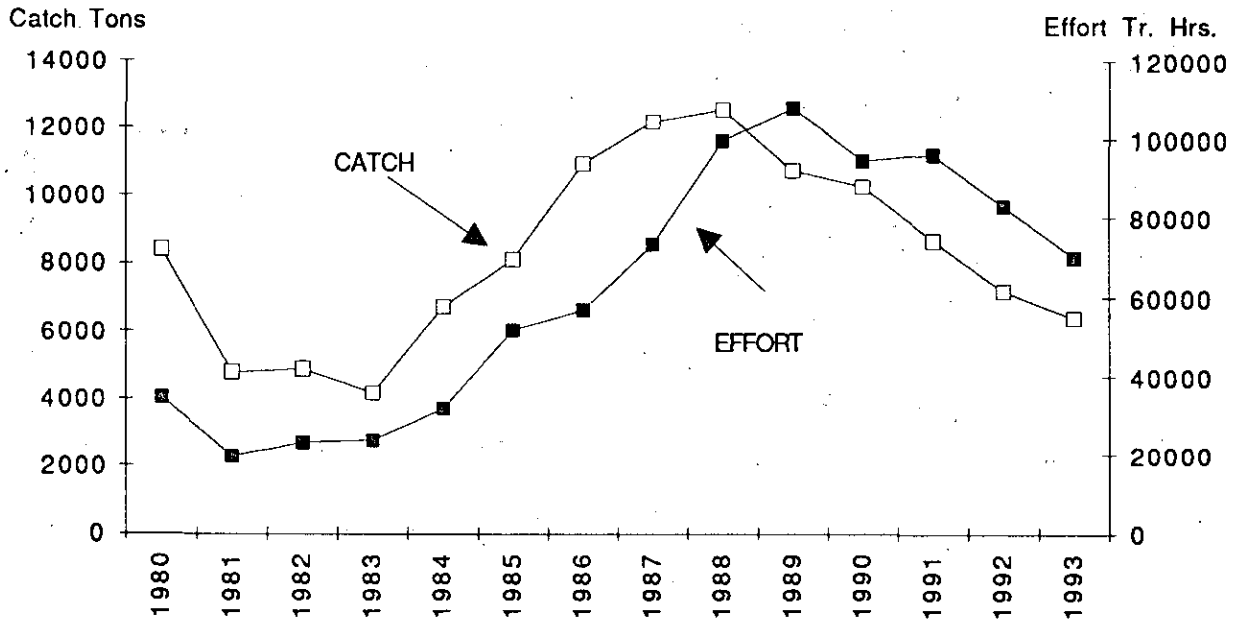

Fig. 3. Catch and effort from the logbooks weighted by nominal catches from the area north of 65° N.

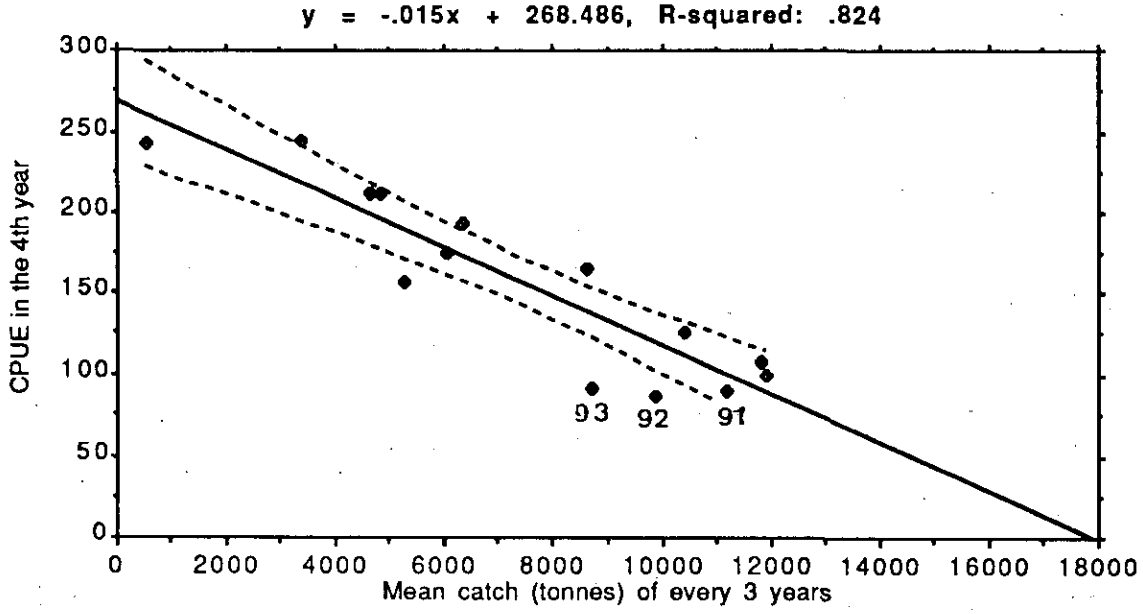

Figure 4. The mean catch of shrimp every 3 years against unstandardized CPUE in the fourth year; denoted by that year.

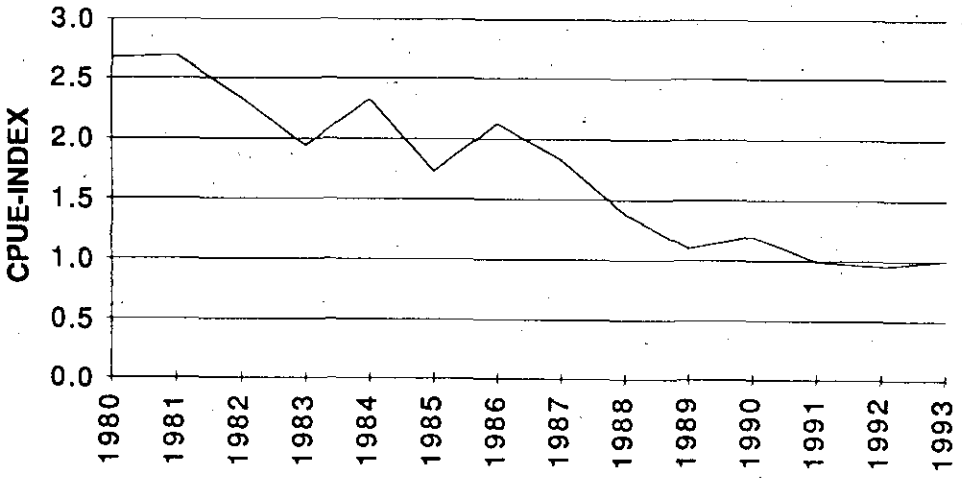

Fig. 5. The unstandardized catch rate indices of all countries combined.

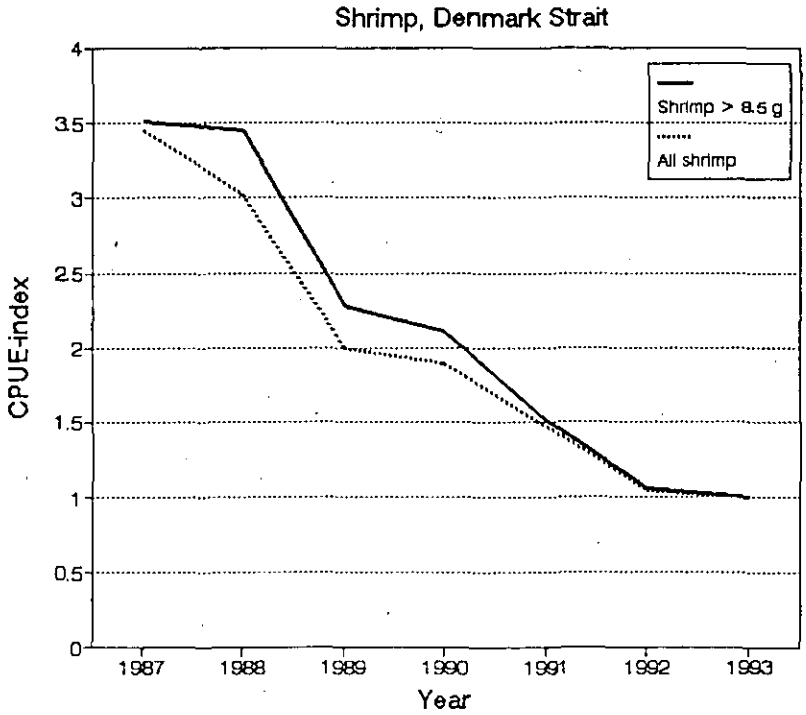

Fig. 6. The standardized CPUE-indices calculated for shrimp >8.5 g and for total catch by 27 Greenland trawlers in Denmark Strait from 1987 to 1993.

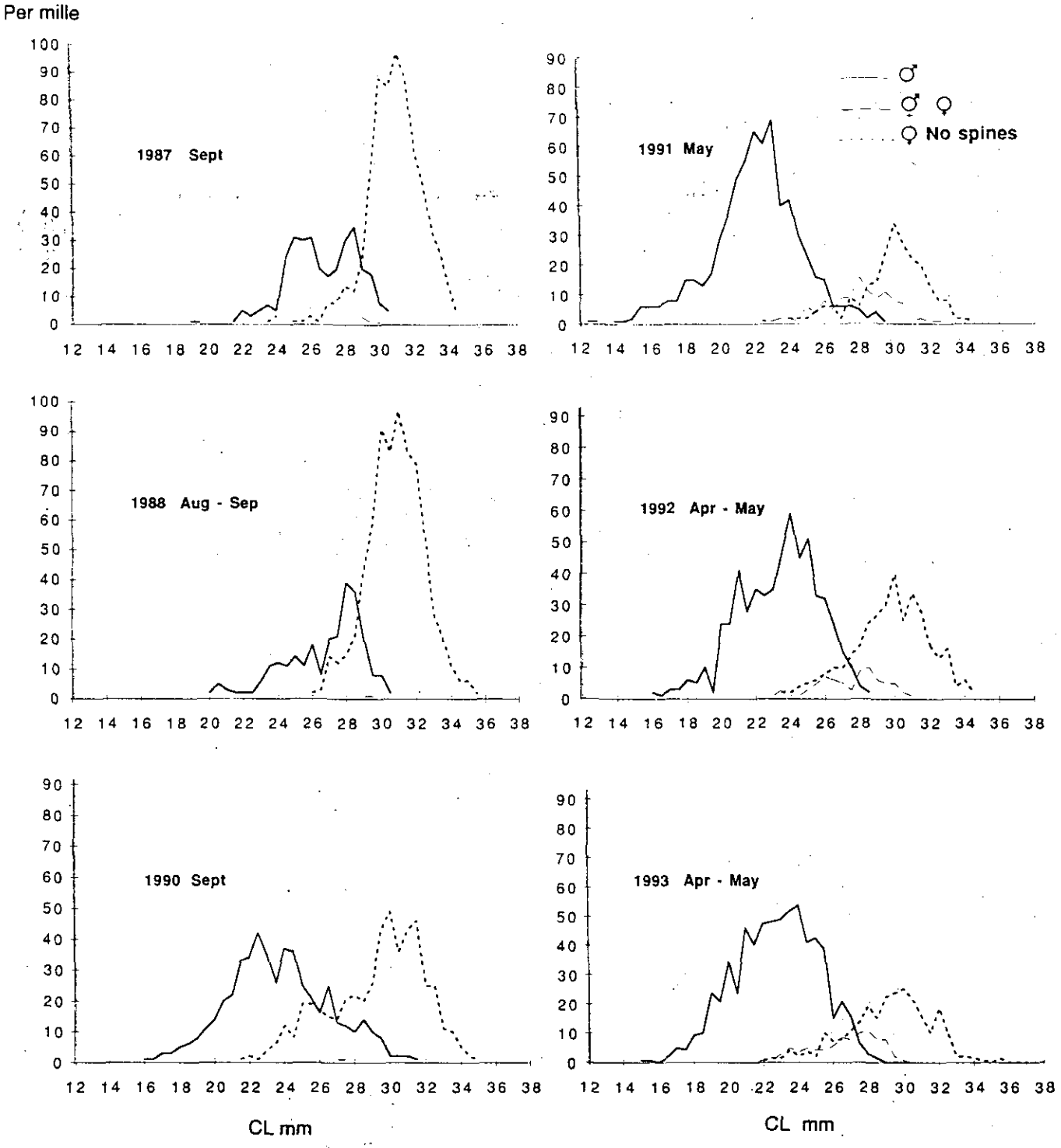

Fig. 7. The Icelandic samples in the years 1987, 1990 to 1993 in the eastern part of the area.

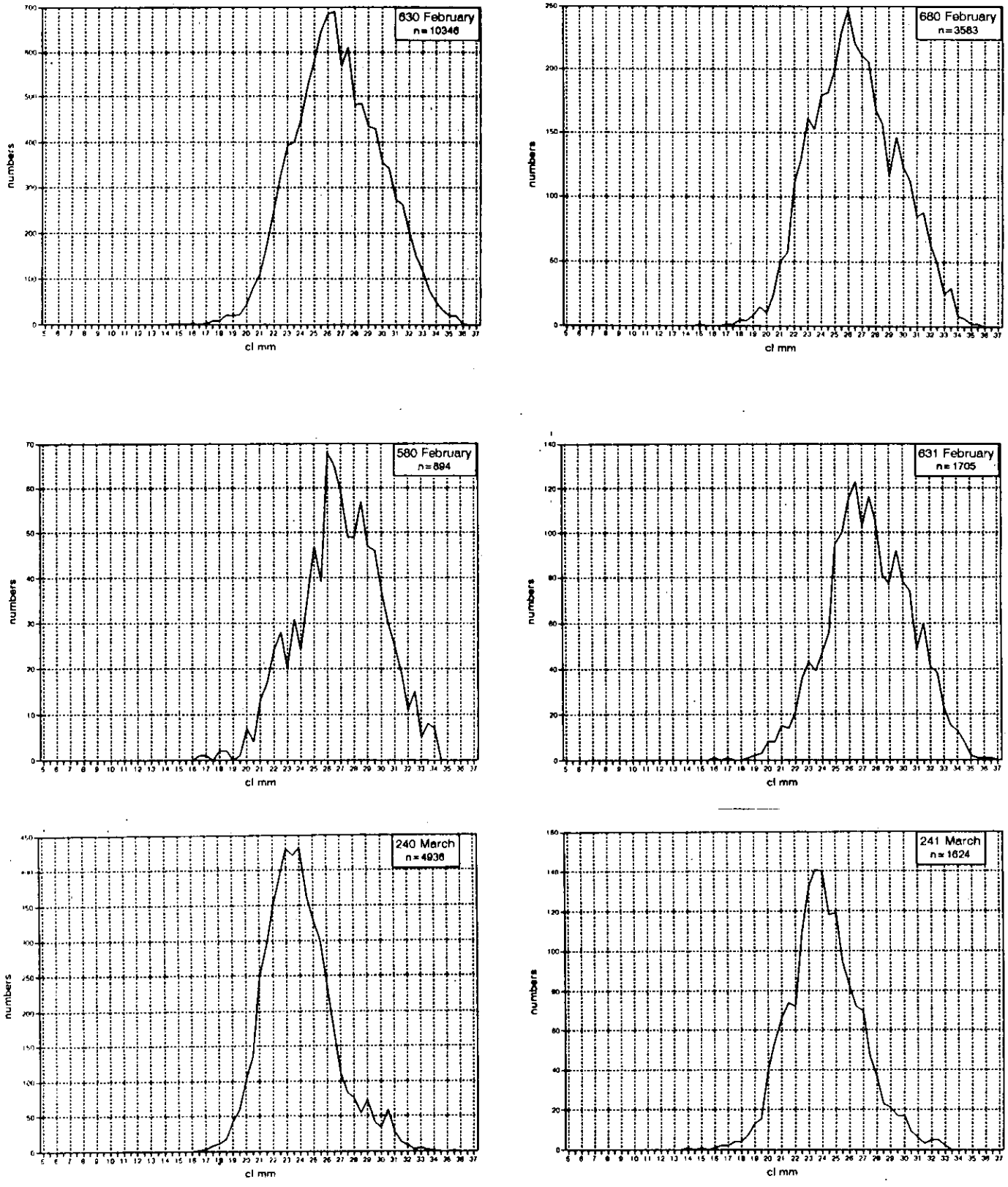

Fig. 8. Pooled 1993 shrimp samples from the traditional area in February (strata 580, 630, 631 and 680) and from the southernmost area in March (strata 240 and 241) where Greenland caught about 2% of its catch in 1993.

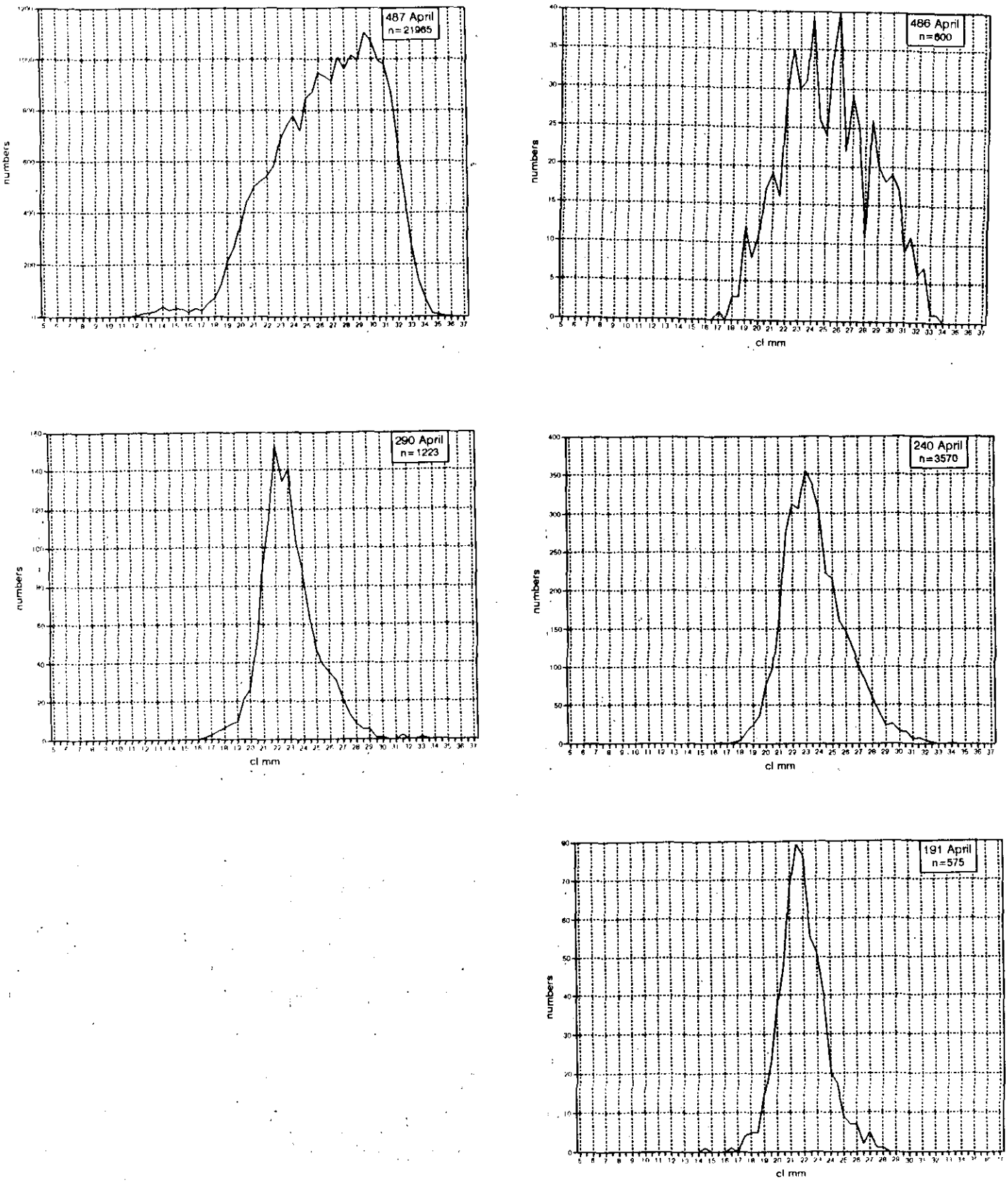

Fig. 9. Pooled shrimp samples in April 1993 from the area just south of 65°N (strata 486 and 487) where Greenland caught 23% of its catch in 1993, and from the southernmost area (strata 191, 240 and 290) where Greenland caught about 2% of its catch in 1993.

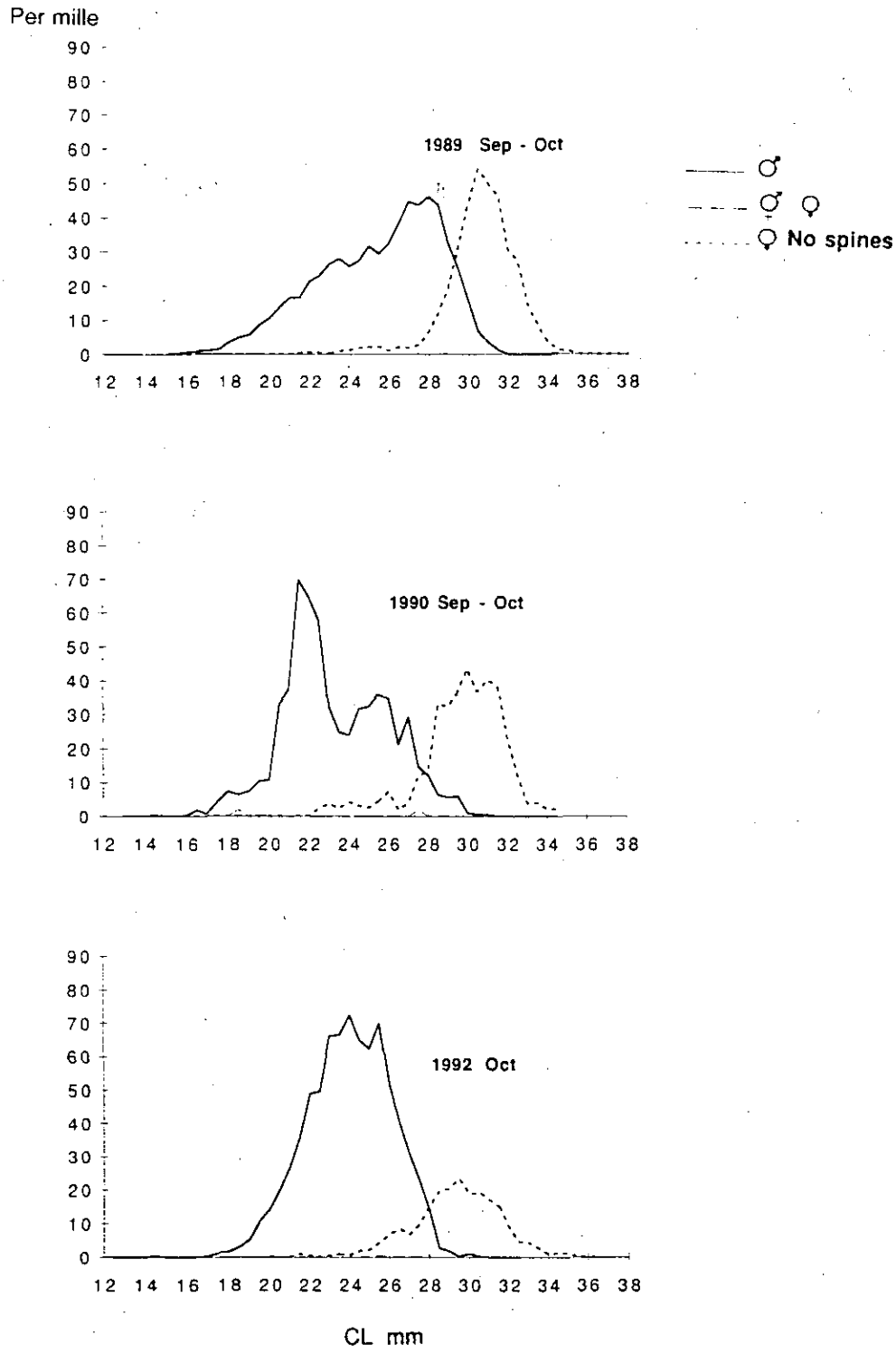

Fig. 10. The Greenlandic survey samples in the year 1989, 1990 and 1992 in the Denmark Strait area. In pooling the samples were weighted by catch and stratum area.