Northwest Atlantic Fisheries Organization

Serial No. N1985 NAFO SCR Doc. 91/96

SCIENTIFIC COUNCIL MEETING - JUNE 1990

Preliminary Assessment of Shrimp in Denmark Strait

by

U. Skuladottir[1], L. Savard[2], K. Lehmann[3], D.G. Parsons[4], and D. M. Carlsson[3]

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

[2] Science Branch, Department of Fisheries and Oceans
Maurice Lamontagne Institute, P. O. Box 1000
Mont-Joli, Quebec, Canada G5H 3Z4

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

[4] Science Branch, Department of Fisheries and Oceans
P. O. Box 5667, St. John's, Newfoundland Canada A1C 5X1

INTRODUCTION

The fishery in this area was initiated in 1978 and increased during the following years to around 12,500 tons in 1988. In 1989 the nominal catch of the Danish, Faroese, French, Greenlandic, Icelandic and Norwegian vessels decreased to about 10,700 tons. In 1990 the total nominal catch of the aforementioned nations amounted to about 10,300 tons. Reported catches and TACs throughout the history of the fishery are given in table 1.

The shrimp fishery in the Denmark Strait takes place primarily in the area of Strede bank and Dohrn Bank as well as on the slopes of Storfjord Deep (Fig. 1). In 1990, fishing for shrimp was allowed for the first time inside the "redfish box", so the fishery was extended somewhat to the west. The available fishing ground at a given time depends heavily on the ice conditions. The main fishing area extends from approximately 65°20'N to 67°30'N and between 27°W and 33°W. During the last 5 years about 60 vessels participated in the fishery on the western side of the midline, and about 30 vessels on the eastern side of the midline.

INPUT DATA

COMMERCIAL FISHERY DATA

Trends in catch and effort

Catch data were available from log books for the six nations fishing shrimp in Denmark Strait while effort data were obtained for only four (Greenland, Norway, Iceland and France) from 1980 to 1990. 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 calculate the total effort.

Total catches increased rapidly from 1978 to 1980, decreased and remained stable in 1981 to 1983, increased steadily from 1984 to 1988 and then decreased again in 1989 and 1990 (Fig. 2). Total effort values show the same pattern as catch. From 1980 to 1990, effort increased from about 35,000 hours to more than 100,000 hours. Effort for the two periods of the year shows also an overall increase from the beginning of the eighties to 1990 (Fig. 3). However, the fall fishery (July-December) has become more important at the end of the eighties, accounting for approximately 50% of the total annual effort.

For the most recent years, more than 85% of the shrimp in Denmark Strait were caught by three nations, Greenland, Norway and Iceland. Effort values corresponding to the activity of the three fleets indicate a variable pattern (Fig. 4). The Greenlandic data show an increase in effort over the years for the two periods of the year while the Norwegian effort was fairly stable during the spring fishery (January-June) and increased substantially since 1986 during the fall fishery. Although the overall pattern over the years is quite variable for the Icelandic fishery, the fall fishery has become more important since the mid 1980's.

Trends in catch rates

The annual CPUEs show an overall declining trend from 1980 to 1990 (Fig. 5A). The 1990 value was at about 50% of the 1980 value. The 1978 and 1979 values correspond to very low effort and therefore, are less reliable.

The declining trend is also seen in the spring CPUE series (Fig. 5B). The catch rates decreased from 1980 to 1990 although those from 1981 to 1987 show a more variable pattern. Fall CPUEs were relatively stable from 1983 to 1988 and then decreased in 1989 and 1990. For both series, the 1990 catch rate was at about the same level as the 1989 CPUE. In general, fall CPUEs were lower than those of the spring fishery and were about 30 to 50% of the spring CPUE for the last four years.

Annual Norwegian and Greenland CPUEs show a decline over the years for both spring and fall fisheries (Fig. 6). Catch rates for the Icelandic fleet were variable during the spring fishery but indicate a decline over the years for the fall fishery. The performance of the three major fleets in Denmark Strait was different over the years. Greenland catch rates in spring were usually higher than those of the two other fleets. Norwegian CPUEs were higher than the Icelandic CPUEs during the spring fishery up to 1987. During the fall fishery, catch rates for both fleets were similar.

Standardization of the catch rates

Because the relative contribution of the fleets and of the spring and fall fisheries to the annual catch rate has changed over the years, it is difficult to interpret the data as an index of abundance over the period. Therefore, all available catch and effort data from 1980 to 1990 were analyzed using SAS multiple regression procedures to account for the seasonality (months: January to December) of the fishery and the relative contribution of the different fleets (fleets: Greenland, Norway, Iceland and France).

The results of the analysis of variance show that the model explains 65% of the total variability with the three variables highly significant (Table 2). The residuals are normally distributed with no obvious outliers (Fig. 7). No interactions between the variables were tested. T-values indicate that the 1988 and 1989 catch rates were not significantly different from the 1990 catch rate (Table 3). The differences between catch rates from December through May were not significant.

Abundance indices were calculated from both unstandardized and standardized series using 1990 as the reference point:

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Unst.	2.2	2.2	1.9	1.6	1.9	1.4	1.8	1.5	1.2	0.9	1.0
Stand.	2.4	1.9	1.8	2.1	1.8	1.7	1.8	1.7	1.1	0.9	1.0

Both series indicate the same decrease between the 1980 CPUE index and the 1990 index (Fig. 8). However, there seems to be a period of relative stability in the standardized index from 1981 to 1987. The decrease between 1987 and 1988 is however more pronounced.

Relationships between catch, CPUE and effort

Relative effort (catch/CPUE index) was calculated for both series in order to compare the variations over the years between catches, CPUE indices and effort. Both series, unstandardized and standardized, show the same pattern: catches increasing with the effort before reaching a plateau at the highest values of effort (Fig. 9A, 10A) and CPUE index decreasing with the effort (Fig. 9B, 10B). However, the values of the last three years are more isolated in the standardized series. The relationships seem less clear with the 1980-1987 catches increasing linearly with the effort and the CPUE index decrease with the effort for the same years being less pronounced.

COMMERCIAL BIOLOGICAL DATA

Norwegian fishery data

The Norwegian observer samples of shrimp are shown in figure 11a. The data are usually obtained in the period March-April. In all years there is a prominent peak at the size of 29-

30 mm Cl. In 1981 and particularly in 1984 there were considerable numbers of smaller animals present. In order to analyse this the length frequencies from all years 1981-1990 were pooled to get a mean length frequency (per mille) distribution (mld), table 1 in the appendix. The deviations in each year from the mld are shown in fig. 11b. The February-March 1990 samples combined, show positive deviations between 18 and 27 mm Cl. The deviations in this size range are unusual but have shown up before in 1981 and especially in 1984. As the deviations are percentiles it follows that in those years the deviations of the bigger shrimp are negative. The occurrence of males in the Norwegian samples are not always stated. In 1984 the males were about 37% in the samples as compared to 10% in 1985 in 1990 the males were about 44% in the samples.

Greenlandic fishery data

The Greenlandic observer data of 1990 and 1991 respectively have also been compared to the Norwegian base (mld) of 1981-1990 in the strata 580-581 on one hand, the same area about which the Norwegian samples were taken, and secondly the data of the more westerly stratum 582 (fig 12). The deviations resemble those of the Norwegian data in 1990 in the occurrence of positive deviations of shrimp of 18-26 mm and large negative deviations in the Cls 27-30. In 1990 there seem to be some large shrimp present in the 31-34 mm Cl range in stratum 582 and in 1991 there are some large shrimps in strata 580-581 combined.

Icelandic fishery data

The Icelandic observer samples (Fig. 13) which are taken in the east in the autumn show the same trend as the Norwegian and Greenlandic observer samples, namely the high peak in the length distribution of shrimp of 30-32 mm Cl in the years 1987 and 1988, and the much lower frequency in 1990 of the large shrimp. In 1990 there is a very high occurrence of males or 50% as compared to 32 and 26% in 1987 and 1988 respectively. Moreover there is also an indication that a large proportion of the male year-class that does not usually change sex until a year later, have already done so. This is indicated by the occurrence of female peaks at 25 and 28 mm in the 1990 samples. This could indicate a response to fishery pressure as indicated by declining catch rates of the past years or there could be an influx from a different area like Icelandic waters were males change sex at a smaller size.

Discards in the shrimp fishery

There was some information on which estimates of shrimp discards for the Denmark Strait fishery could be made. Norwegian observer data indicate a slight increase of the discard rate from 1989 to 1990 (Smedstad and Torheim, 1991). The discard rate estimated from the Norwegian observer data series is as followed:

%	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Mean	14.9	1.7	0.8	3.4	2.3	0.9	3.0	2.2	2.0	3.0
Min.	11.5	1.0	0.0	0.7	0.1	0.0	1.2	1.0	0.0	0.0
Max.	15.7	7.0	2.1	5.9	7.8	1.6	7.2	2.8	5.3	7.6

However, these values correspond to only one vessel fishing in a limited location for a short period of time. This may be not representative of the activities of all fleets in the whole season.

Size distributions of the shrimp catch and of the production onboard Greenlandic trawlers were estimated by sampling. Shrimp discards were estimated by comparing size distributions of the catches with those of all size categories kept. The factory trawler discard of shrimp in Denmark Strait was estimated at a minimum of 1034 tons, or 9% of the catch.

Discard procedure may have changed over the years due to market requirements for larger shrimp and the development of effective grading machines. The high number of vessels in the fishery and vessel quota limitations may have resulted in higher, not reported, amounts of discarded shrimp.

Fish by-catches in the shrimp fishery

Norwegian observer data indicate that the by-catch rate is higher in the last three years relative to the 1982-1987 period (Smedstad and Torheim, 1991) as shown by the number of fish caught per kilo of shrimp:

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Cod	1	23	3	3	3	1	9	0	1	1
G.halibut	86	7	9	120	7	1	2	3	3	24
Redfish	166	53	47	87	74	103	293	421	192	170
Others	77	13	5	3	17	3	12	9	11	7
Fish (n/tow)	330	96	64	213	101	108	316	433	207	202
P.b.(kg/tow)	435	608	346	880	732	410	528	300	246	222
Ratio	0.76	0.16	0.18	0.24	0.13	0.26	0.60	1.44	0.84	0.91

The increase of by-catch rate for the last four years was due to high fish catches while the catch of shrimp was decreasing. However, the decrease of the ratio in 1989 and 1990 from the 1988 level is due to declines in the catches of both fish and shrimp. The major by-catch continues to be redfish. The category others consists of skate, plaice and catfish.

RESEARCH SURVEY DATA

Norwegian surveys

Norwegian surveys were carried out in Denmark Strait every autumn from 1985 to 1989 covering most of the shrimp distribution area (Smedstad, 1990). The survey was not conducted in 1990. In most years, shrimp were found mainly in two general areas: east and west of 31 degree in statistical squares 628, 629, 678, 679 and 581, 582, 583, 584, 631, 632 respectively (Fig. 1). Some changes were noted in 1989 as the biomass was more evenly distributed than previously. Also, the pattern of the spatial distribution of the males and females was different; males and females were more evenly distributed in 1989.

The proportion of males in the western part of the area fluctuated between 36 and 61 percent while in the eastern part, it increased yearly from 33 percent in 1985 to 62 percent in 1989:

% Males

Year	West of 31°W	East of 31°W	Total
1985	50.1	32.8	43.8
1986	36.3	44.0	41.4
1987	47.3	55.3	53.5
1988	61.2	54.8	58.5
1989	55.5	61.5	58.0

In general, for the whole area, the proportion of males was higher in the last three years than in 1985 and 1986. There was no change in the mean length of the largest female component over the years. This component had a minimum carapace length of 26 mm for all years.

Greenlandic surveys

A Greenlandic survey was carried out in 1989 covering a smaller part of the area in which a high proportion of females was expected to be located. In 1990, a larger area was covered which corresponded better to the Norwegian survey area (Fig. 1). However, the Norwegian and the Greenlandic surveys cannot be compared directly because of differences in the methodology used (size of the trawl, duration of the tow). The 1990 Greenlandic survey results show extremely low catches of shrimp and fish by-catches.

In 1990, the proportion of males in the western part was 61 percent which is at the same level as in the 1989 Norwegian survey. The length frequency distributions of some samples collected in the eastern area in 1989 and 1990 show females occurring at smaller sizes in 1990 (Fig. 14). In the 1990 samples, compared to the 1989 samples, there is a stronger component of males at 22 mm, a new component of small females at 25-26 mm and a similar component of females at 31 mm.

ASSESSMENT RESULTS

Catches increased steadily from 1983 to 1988, decreased between 1988 and 1989 and remained at the same level in 1989 and 1990. Effort increased steadily from 1981 to 1989 and showed a slight decrease between 1989 and 1990. The standardized CPUE showed an overall decline between 1980 and 1990. A large decrease in catch rate occurred between 1980 and 1981, followed by a slight decrease or stability between 1981 and 1987, a high decrease between 1987 and 1988 and stability between 1988 and 1990.

The proportion of males, as determined from research survey and commercial fishery data, showed an overall increase from the mid 1980's to 1990. Size at sex reversal decreased

in 1990 from 1989 (Greenlandic surveys) and from 1987-1988 (Icelandic sampling). The modal length of the last component of females has remained stable since 1981 (Norwegian, Icelandic and Greenlandic research and commercial data).

Data from both the commercial fishery and research surveys suggest that shrimp abundance from 1988 - 1990 is substantially lower than in previous years. This might be due to the fishery given the overall decline in CPUE with fishing effort and the apparent changes in sex reversal, indicating a response to a decrease in the female population. Also, the proportion of males in the commercial catches and in the Norwegian survey estimates has increased, suggesting that the fishery, targeted towards the larger animals, has reduced the abundance of females. It is also possible that changes in environmental conditions contribute to these changes in the population, given that by-catches were lower in the last two years and the 1990 Greenlandic survey was unproductive for both shrimp and fish species.

REFERENCES

CARLSSON, D. M., and P. KANNEWORFF. 1991. The commercial shrimp fishery in Denmark Strait in 1990 and early 1991. NAFO SCR Doc., No. 53, Serial No. N1936, 28 p.

HALLGRIMSSON, I., and U. SKÚLADÓTTIR. 1988. The Icelandic shrimp (*Pandalus borealis*) fishery in Denmark Strait in 1987. NAFO SCR Doc. No. 64, Serial No. N1506, 10 p.

JOKOBSEN, T., and S. TORHEIM. 1981. Norwegian investigations on shrimp, *Pandalus borealis*, in East Greenland waters in 1981. NAFO SCR Doc., No. 158, Serial No. N466, 7 p.

1983. Norwegian investigations on shrimp, *Pandalus borealis*, in East Greenland waters in 1982. NAFO SCR Doc., No. 6, Serial No. N643, 7 p.

KANNEWORFF, P., and K. M. LEHMANN. 1991. Report on a stratified-random trawl survey for shrimp (*Pandalus borealis*) in ICES Division XIVb in 1990. NAFO SCR Doc., No. 52, Serial No. N1935, 11 p.

LEHMANN, K., and H. DEGEL. 1991. An estimate of shrimp discard from shrimp factory trawlers in Davis Strait and Denmark Strait. NAFO SCR Doc., No. 40, Serial No. N1920, 12 p.

SKÚLADÓTTIR, U. 1989. The Icelandic shrimp fishery (*Pandalus borealis*) in the Denmark Strait. NAFO SCR Doc., No. 50, Serial No. N1628, 5 p.

1991. The catch statistics of the shrimp fishery (*Pandalus borealis*) in the Denmark Strait in the years 1980-1990. NAFO SCR Doc., No. 58, Serial No. N1942, 16 p.

1991. The Icelandic shrimp fishery (*Pandalus borealis*) in the Denmark Strait in 1989 and 1990. NAFO SCR Doc., No. 72, Serial No. N1956, 16 p.

SMEDSTAD, O. M. 1990. Preliminary report of a cruise with M/T *Håkøy-II* to East Greenland waters in September 1989. NAFO SCR Doc., No. 12, Serial No. N1724, 13 p.

SMEDSTAD, O., and S. TORHEIM. 1984. Norwegian investigations on shrimp, *Pandalus borealis*, in East Greenland waters in 1983. NAFO SCR Doc., No. 1, Serial No. N770, 9 p.

1985. Norwegian investigations on shrimp, *Pandalus borealis*, in East Greenland waters in 1984. NAFO SCR Doc., No. 7, Serial No. N941, 6 p.

1986. Norwegian investigations on shrimp, *Pandalus borealis*, in East Greenland waters in 1985. NAFO SCR Doc., No. 9, Serial No. N1107, 6 p.

1987. Norwegian investigations on shrimp, *Pandalus borealis*, in East Greenland waters in 1986. NAFO SCR Doc., No. 3, Serial No. N1271, 9 p.

1988. Norwegian investigations on shrimp, *Pandalus borealis*, in East Greenland waters in 1987. NAFO SCR Doc., No. 47, Serial No. N1487, 11 p.

1990. Norwegian investigations on shrimp, *Pandalus borealis*, in East Greenland waters in 1989. NAFO SCR Doc., No. 11, Serial No. N1723, 13 p.

1991. Norwegian investigations on shrimp, *Pandalus borealis*, in East Greenland waters in 1990. NAFO SCR Doc., No. 20, Serial No. N1897, 12 p.

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

Nation	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990[3]	1991
Denmark	-	-	702	581	740	204	443	353	500	555	444	366	390	
Faroe Islands	-	-	4,233	713	737	443	668	674	727	595	679	595	843	
France	-	-	50	353	414	291	500	642	780	1,030	494	381	51	
Greenland	-	-	200	1,004	1,115	1,467	2,250	2,596	5,781	6,627	7,456	5,981	6,210	
Iceland	363	485	759	125	-	43	742	1,794	1,150	1,330	1,424	1,326	281	
Norway	-	800	2,461	2,016	1,896	1,727	2,128	2,051	2,026	2,041	2,052	2,098	2,500	
Total	363	1,285	8,405	4,792	4,902	4,175	6,731	8,110	10,964	12,178	12,549	10,747	10,275	
Total catch eastern side	363	485	759	125	0	43	742	1,794	1,150	1,330	1,424	1,326	281	
Total catch western side	0	800	7,646	4,667	4,902	4,132	5,989	6,316	9,814	10,848	11,125	9,421	9,896	
Advised TAC	-	-	-	-	4,200	4,200	4,200	5,000	...	...	...	10,000[1]	10,000[1]	10,000[1]
Effective TAC western side	-	-	-	8,000	4,500	5,725	5,245	6,090	7,525[2]	7,725[2]	8,725[2]	9,025[2]	14,100	14,500

[1] Advised for a few years as a precautionary measure.
[2] Not including Greenland fishery north of 60°30'N.
[3] Preliminary.

Table 2. Results of the analysis of variance from the multiple regression.

General Linear Models Procedure
Class Level Information

Class	Levels	Values
FLEET	4	1 2 3 4
MONTH	12	1 2 3 4 5 6 7 8 9 10 11 12
YEAR	11	1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990

Number of observations in data set = 245

Dependent Variable: LNCPUE

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	24	70.46742696	2.93614279	16.69	0.0001
Error	220	38.70316096	0.17592346		
Corrected Total	244	109.17058792			

R-Square	C.V.	Root MSE	LNCPUE Mean
0.645480	-20.17217	0.419432	-2.0792626

Source	DF	Type III SS	Mean Square	F Value	Pr > F
FLEET	3	11.42099312	3.80699771	21.64	0.0001
MONTH	11	20.17536515	1.83412410	10.43	0.0001
YEAR	10	24.35660103	2.43566010	13.84	0.0001

Table 3. Estimates of the parameters from the multiple regression analysis.
Fleet 1: Greenland
Fleet 2: Norway
Fleet 3: Iceland
Fleet 4: France

Parameter		Estimate		T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT		-1.991284455	B	-11.81	0.0001	0.16854757
FLEET	1	0.053680412	B	0.57	0.5705	0.09447775
	2	-0.389701083	B	-4.22	0.0001	0.09231255
	3	-0.457304028	B	-4.56	0.0001	0.10033292
	4	0.000000000	B	.	.	.
MONTH	1	0.230701302	B	1.33	0.1834	0.17286191
	2	0.083372333	B	0.51	0.6113	0.16381262
	3	0.103767882	B	0.68	0.4989	0.15318114
	4	0.063969391	B	0.43	0.6692	0.14951123
	5	-0.032906549	B	-0.22	0.8246	0.14825781
	6	-0.577188683	B	-3.69	0.0003	0.15649638
	7	-0.621494387	B	-3.75	0.0002	0.16594729
	8	-0.668589249	B	-4.36	0.0001	0.15320257
	9	-0.494445086	B	-3.21	0.0015	0.15398748
	10	-0.496865995	B	-3.29	0.0012	0.15093516
	11	-0.551315938	B	-3.57	0.0004	0.15439454
	12	0.000000000	B	.	.	.
YEAR	1980	0.893112292	B	7.23	0.0001	0.12348897
	1981	0.619649310	B	4.42	0.0001	0.14034266
	1982	0.558165649	B	3.36	0.0009	0.16603013
	1983	0.719423175	B	5.01	0.0001	0.14360797
	1984	0.573800800	B	4.35	0.0001	0.13180259
	1985	0.545842438	B	4.58	0.0001	0.11914934
	1986	0.580209685	B	5.26	0.0001	0.11032400
	1987	0.508629339	B	4.45	0.0001	0.11424728
	1988	0.098996230	B	0.91	0.3654	0.10915294
	1989	-0.129722766	B	-1.19	0.2352	0.10899114
	1990	0.000000000	B	.	.	.

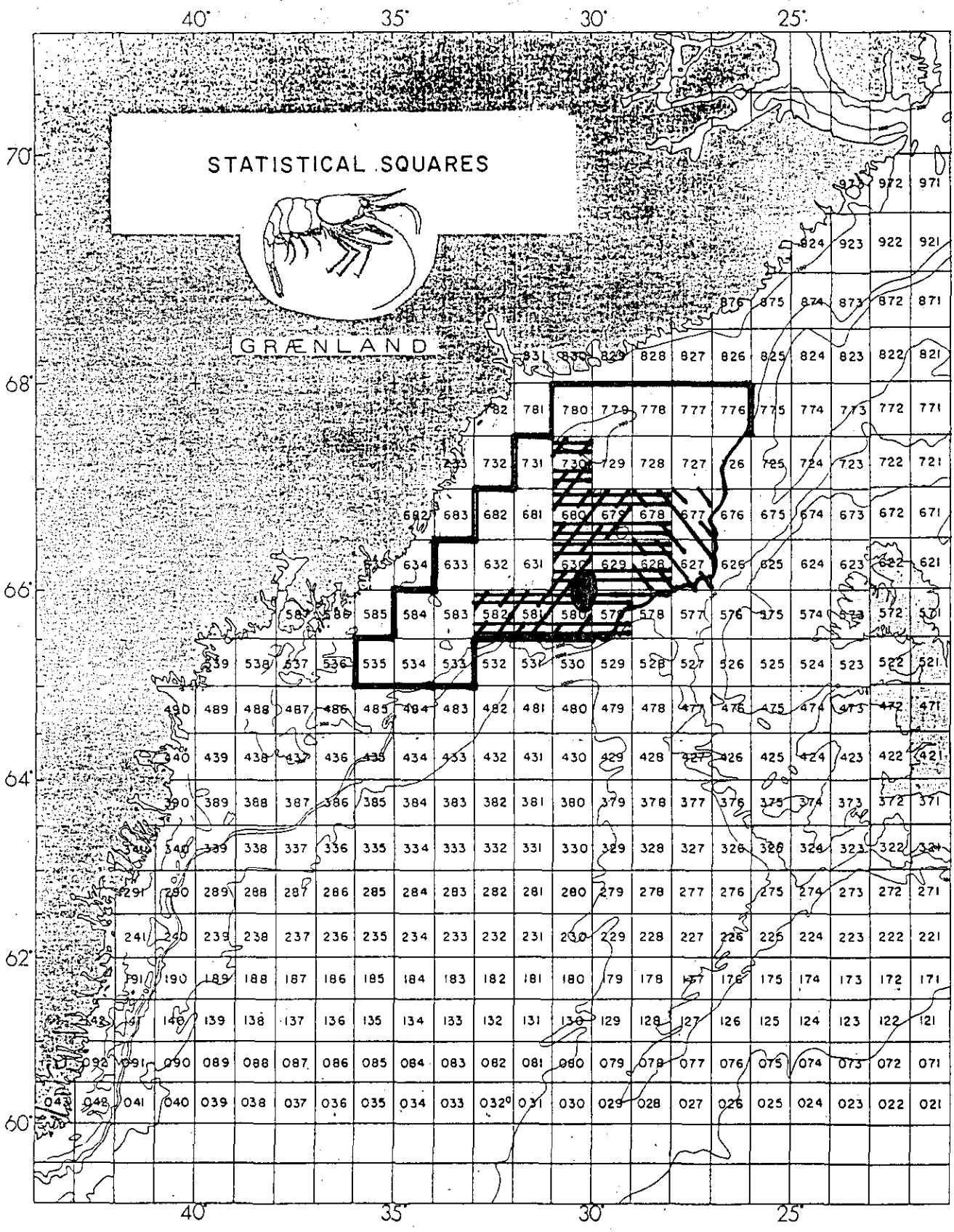


Fig. 1. Map of the shrimp fishing grounds in Denmark Strait in 1990.

NORWAY
ICELAND
GREENLAND

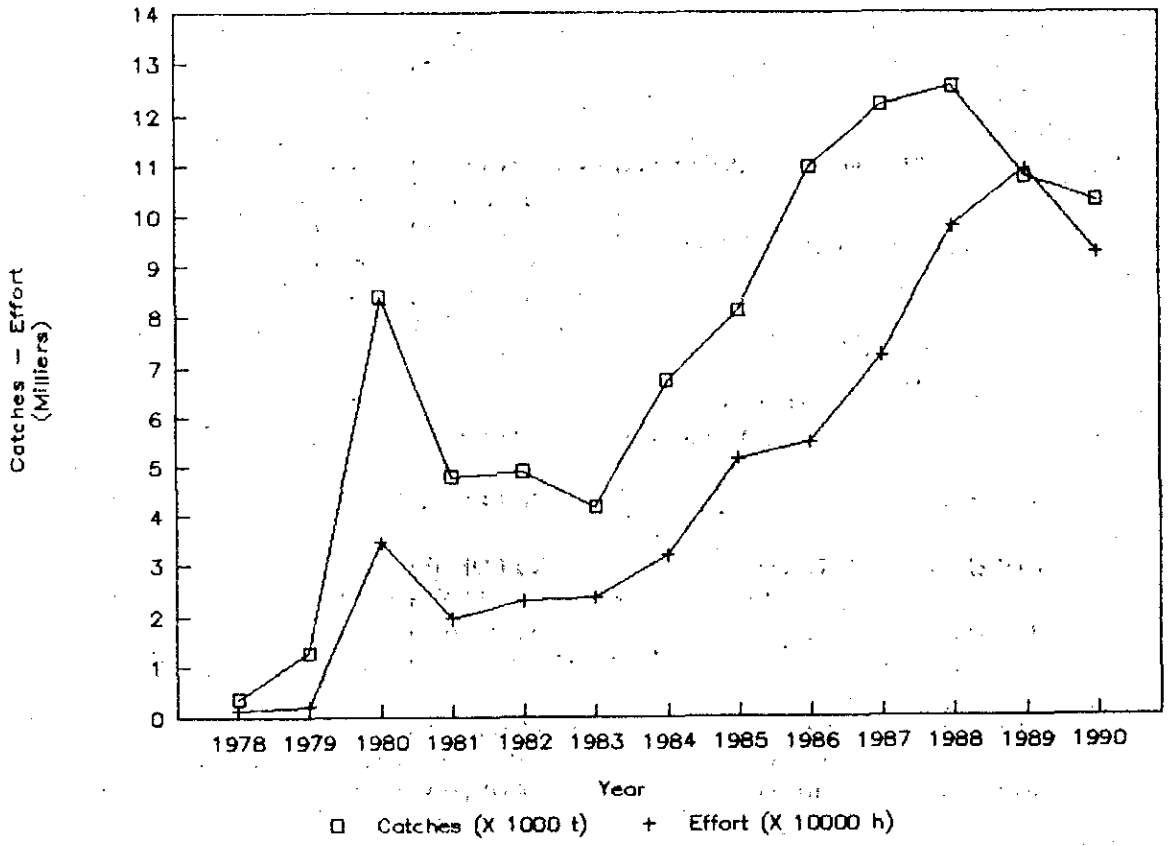


Fig. 2. Annual catches and effort from the shrimp fishery in Denmark Strait.

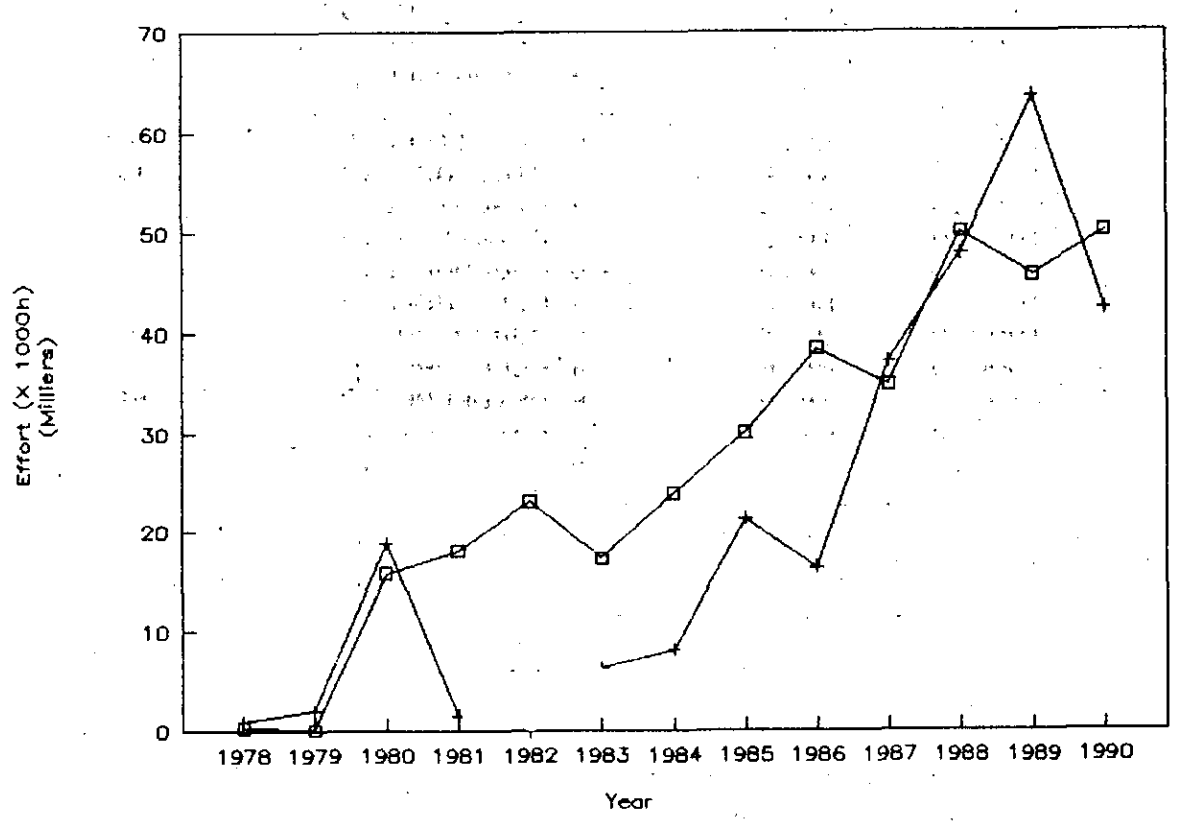
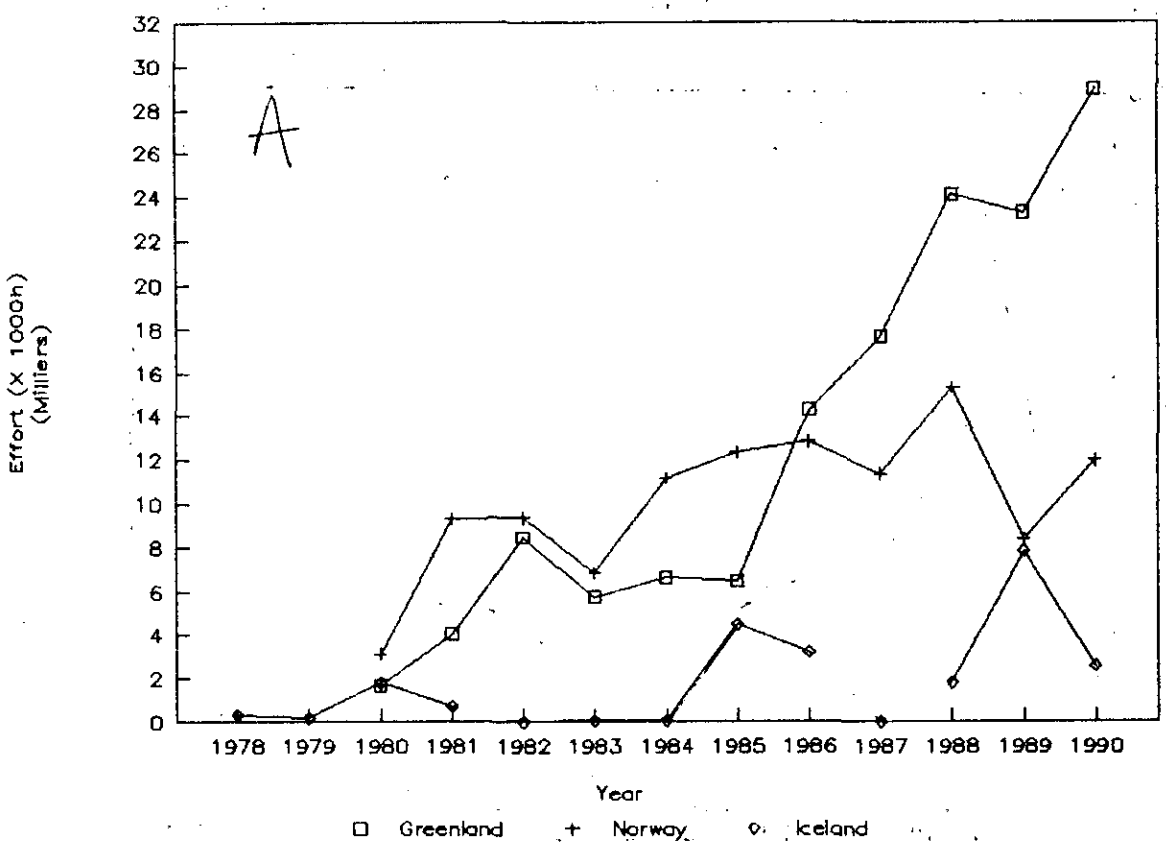


Fig. 3. Effort for two periods of the year from the shrimp fishery in Denmark Strait.



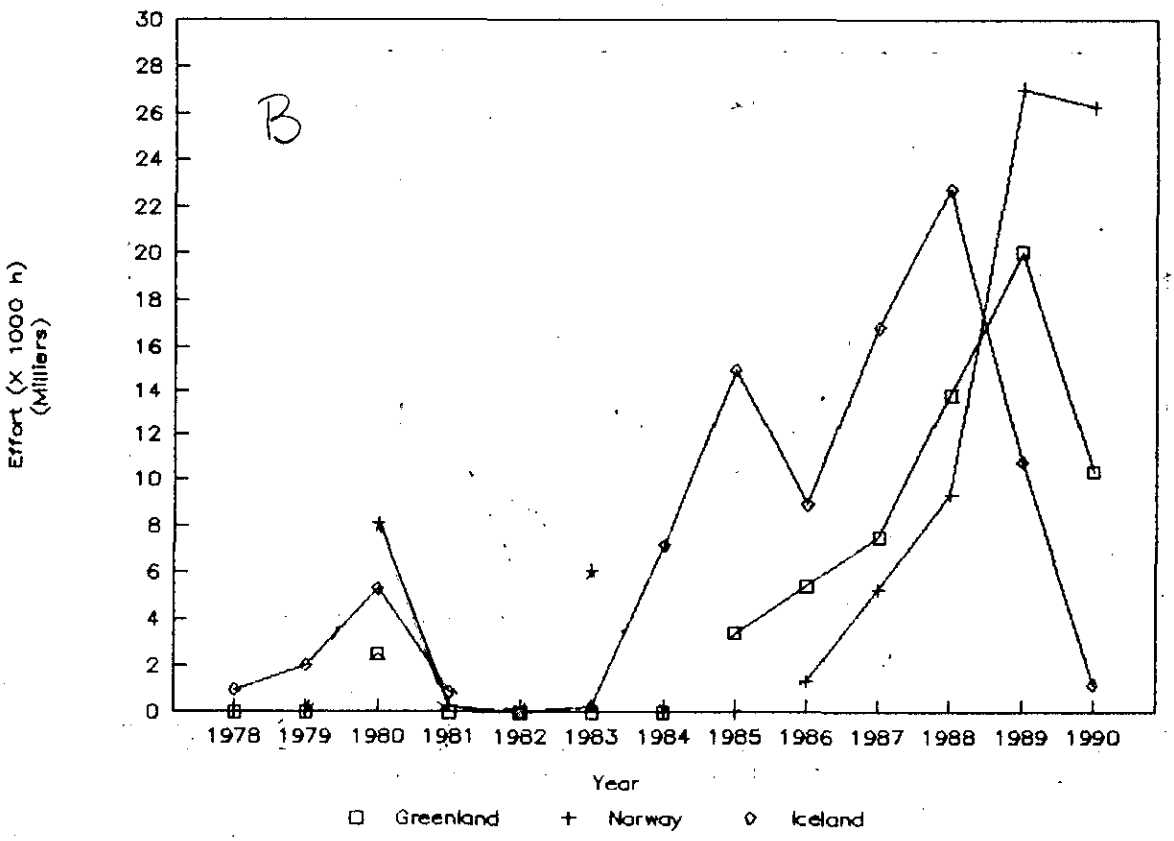
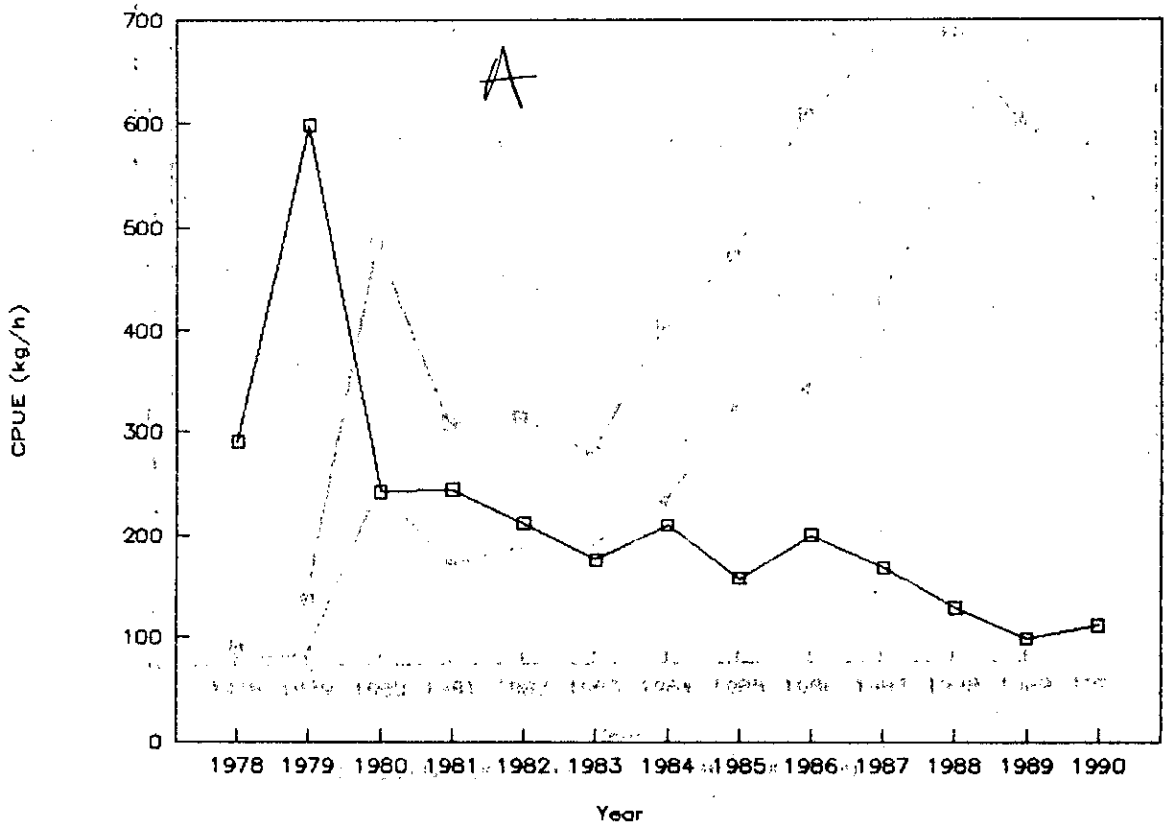


Fig. 4. Effort for Greenland, Norway and Iceland fleets in Denmark Strait.
A: Spring fishery (January to June).
B: Fall fishery (July to December).



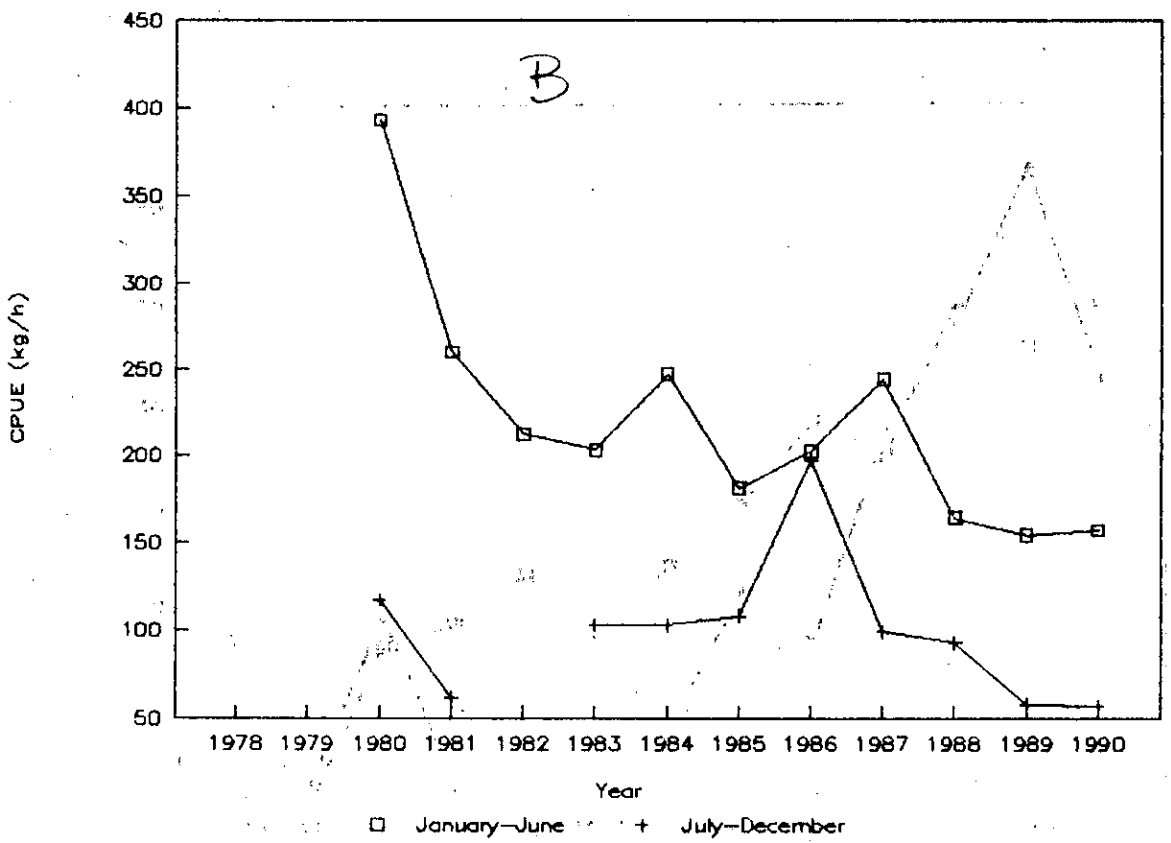
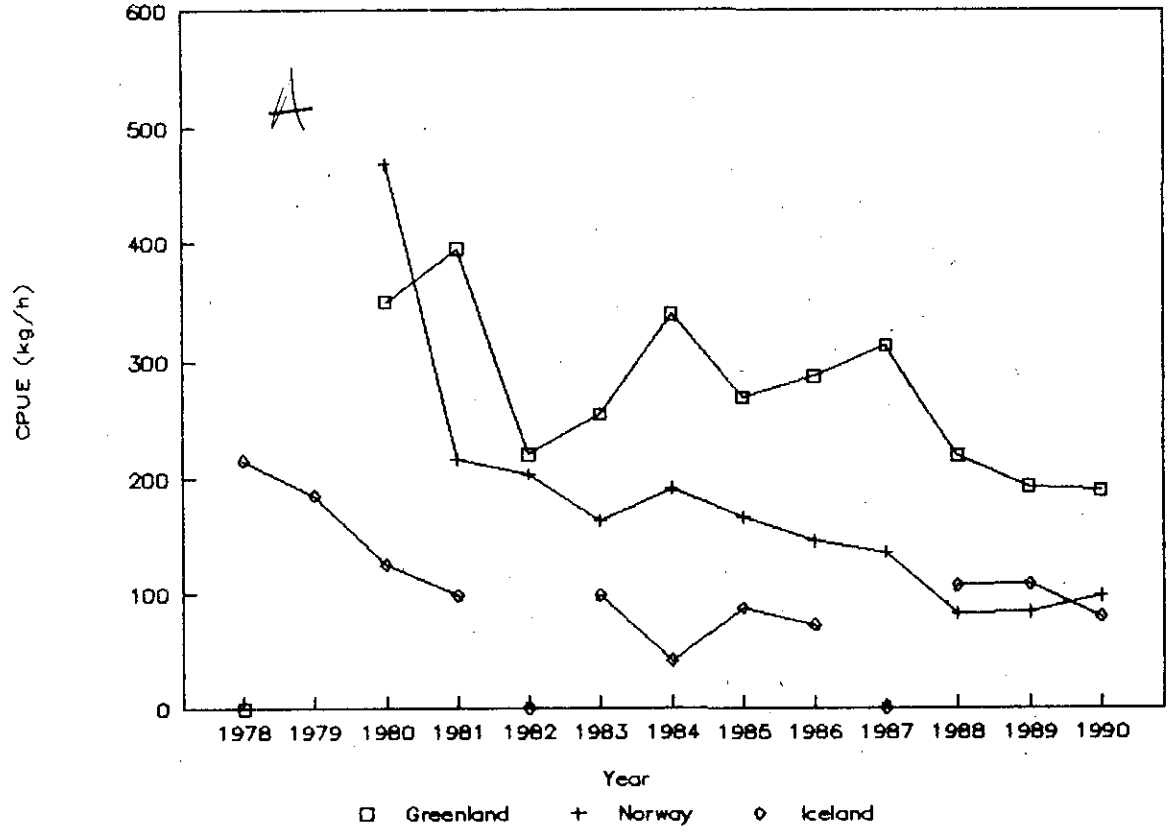


Fig. 5. CPUE from the shrimp fishery in Denmark Strait.
A: Annual CPUE.
B: CPUE for spring and fall fisheries.



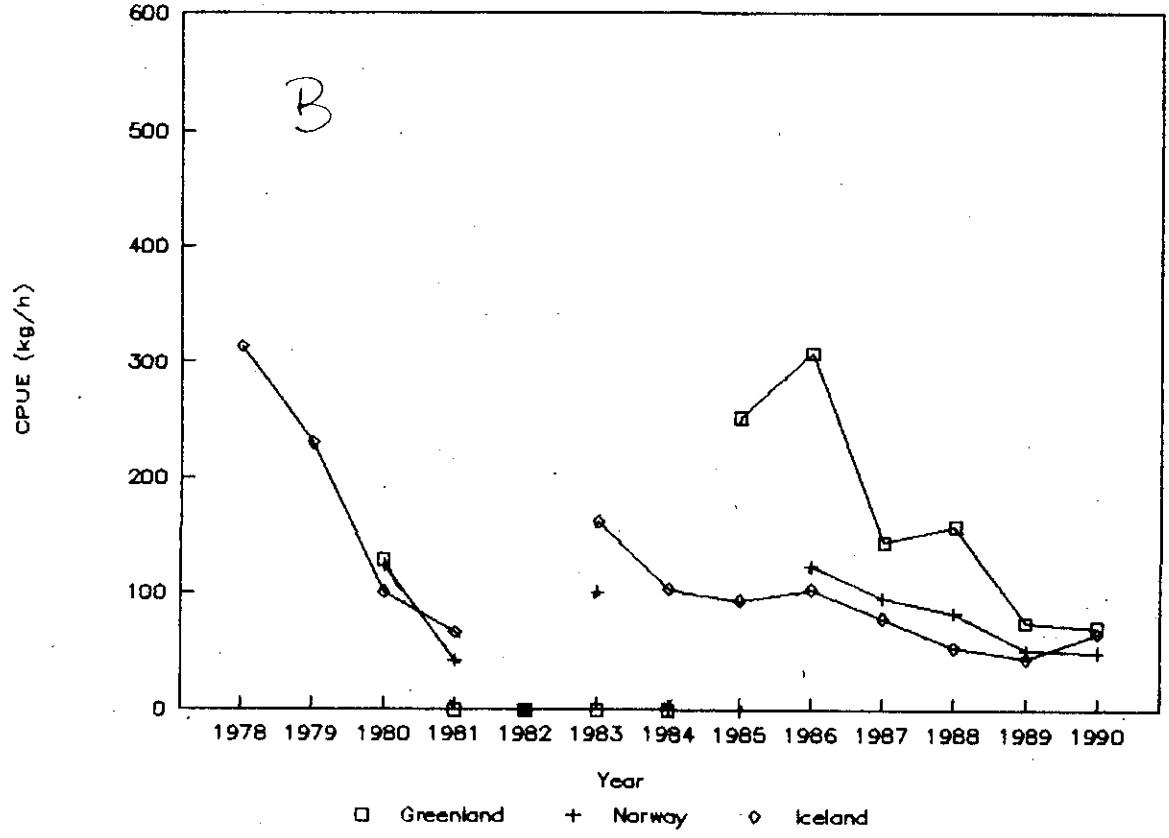
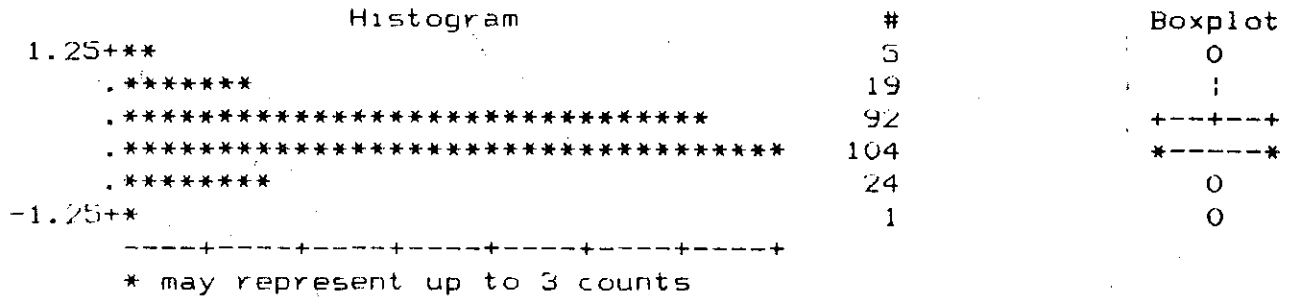
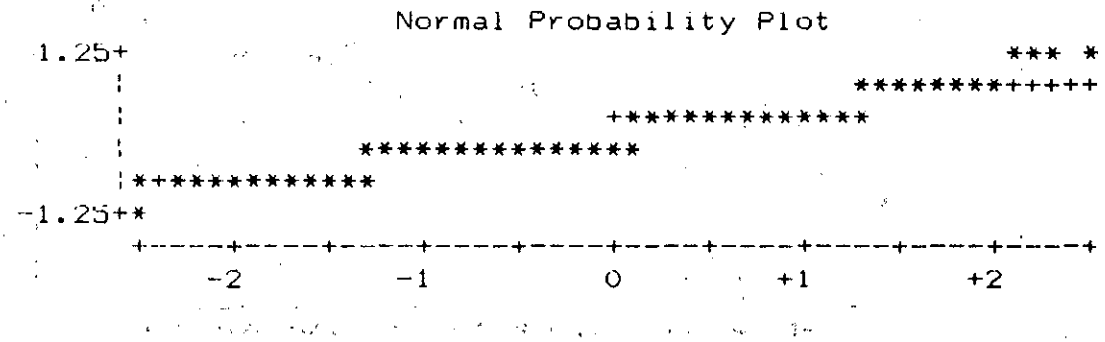


Fig. 6. CPUE for Greenland, Norway and Iceland fleets in Denmark Strait.
A: Spring fishery (January to June).
B: Fall fishery (July to December).





Plot of R*P. Legend: A = 1 obs, B = 2 obs, etc.

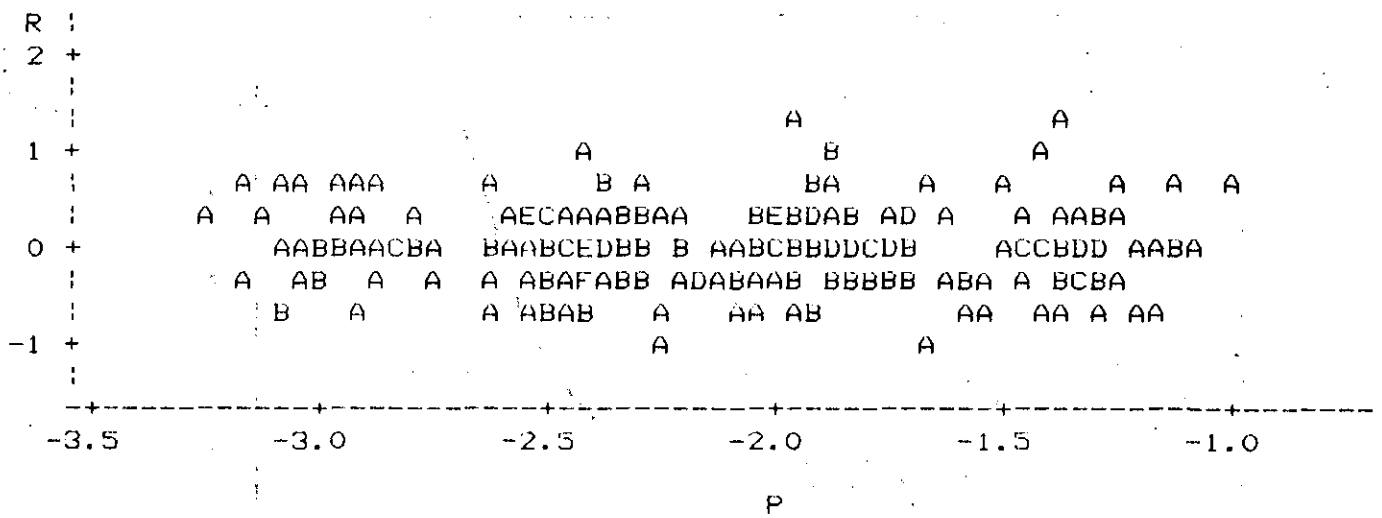


Fig. 7. Plots of the residuals of the multiple regression obtained from the analysis of catch rates in Denmark Strait.

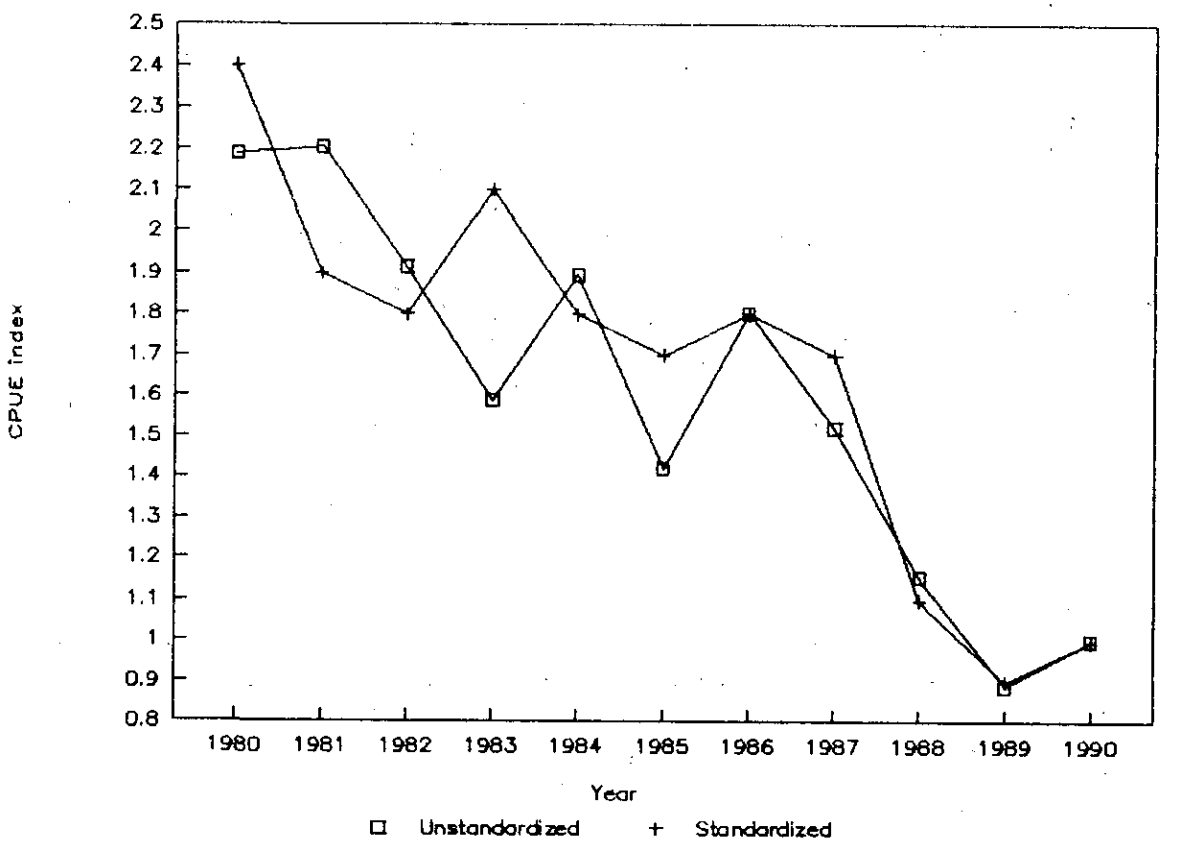


Fig. 8. Unstandardized and standardized catch rate indices by year from the shrimp fishery in Denmark Strait.

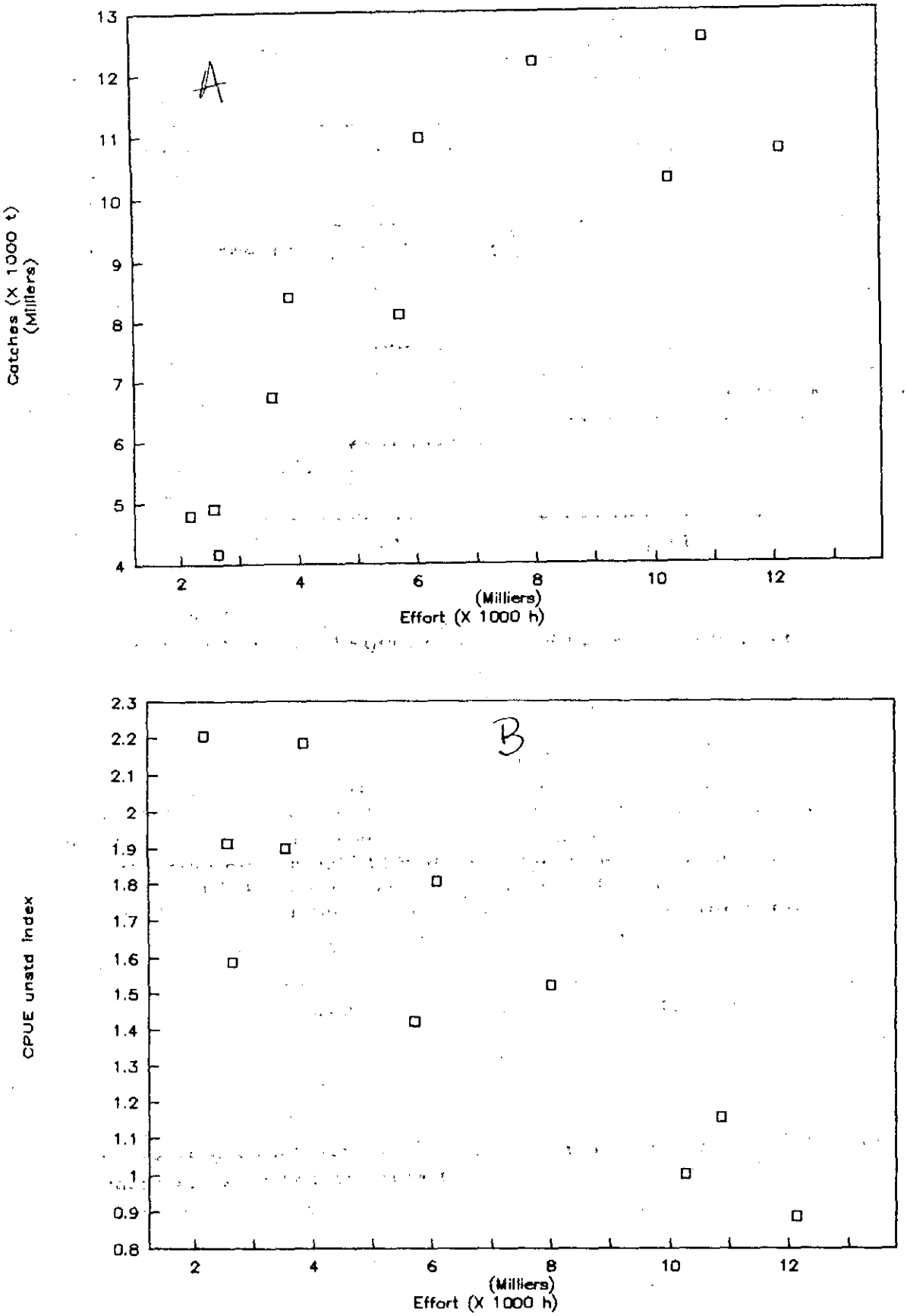


Fig. 9. Catches against unstandardized relative effort (A) and unstandardized catch rate index against unstandardized relative effort (B).

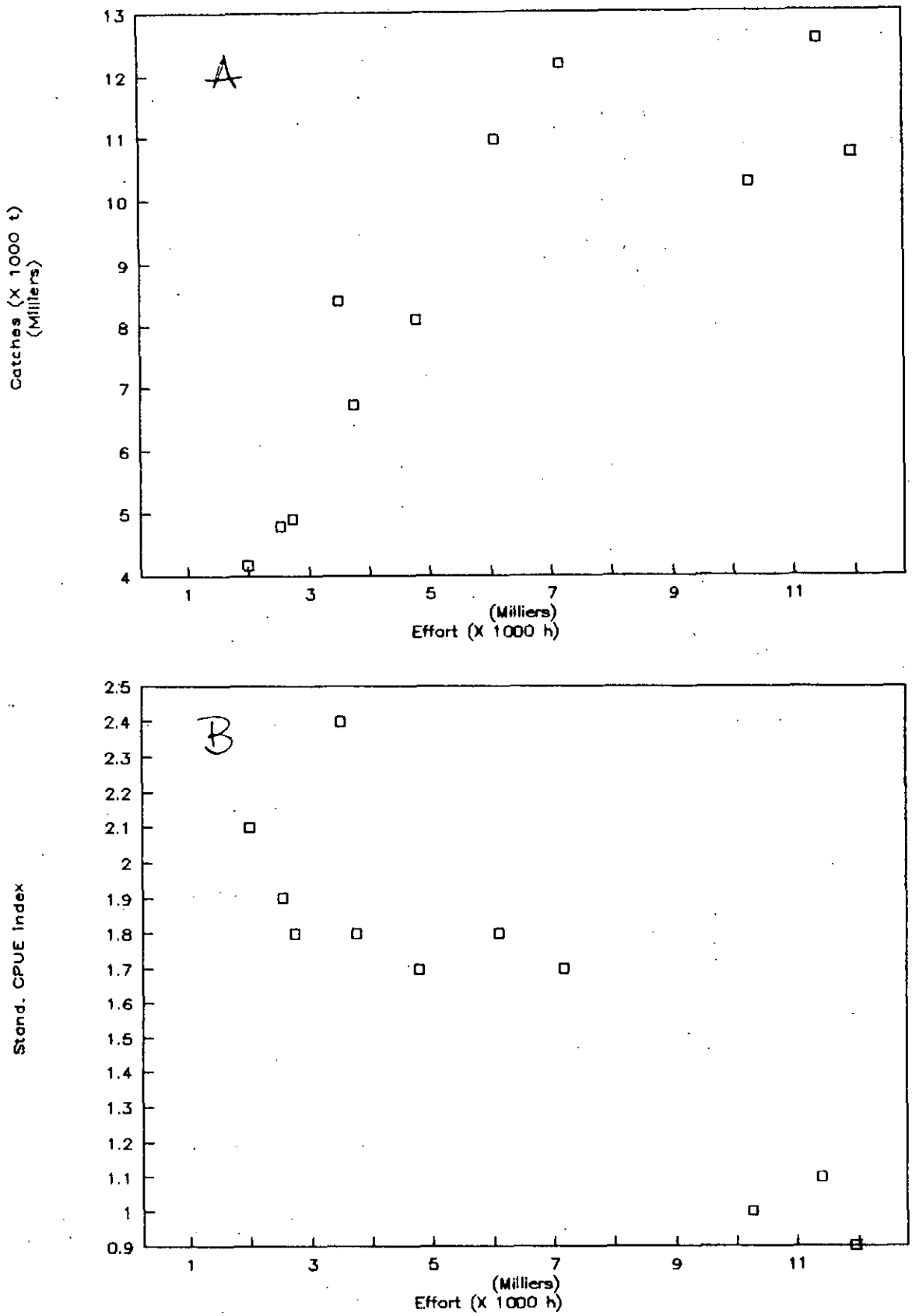


Fig. 10. Catches against standardized relative effort (A) and standardized catch rate index against standardized relative effort (B).

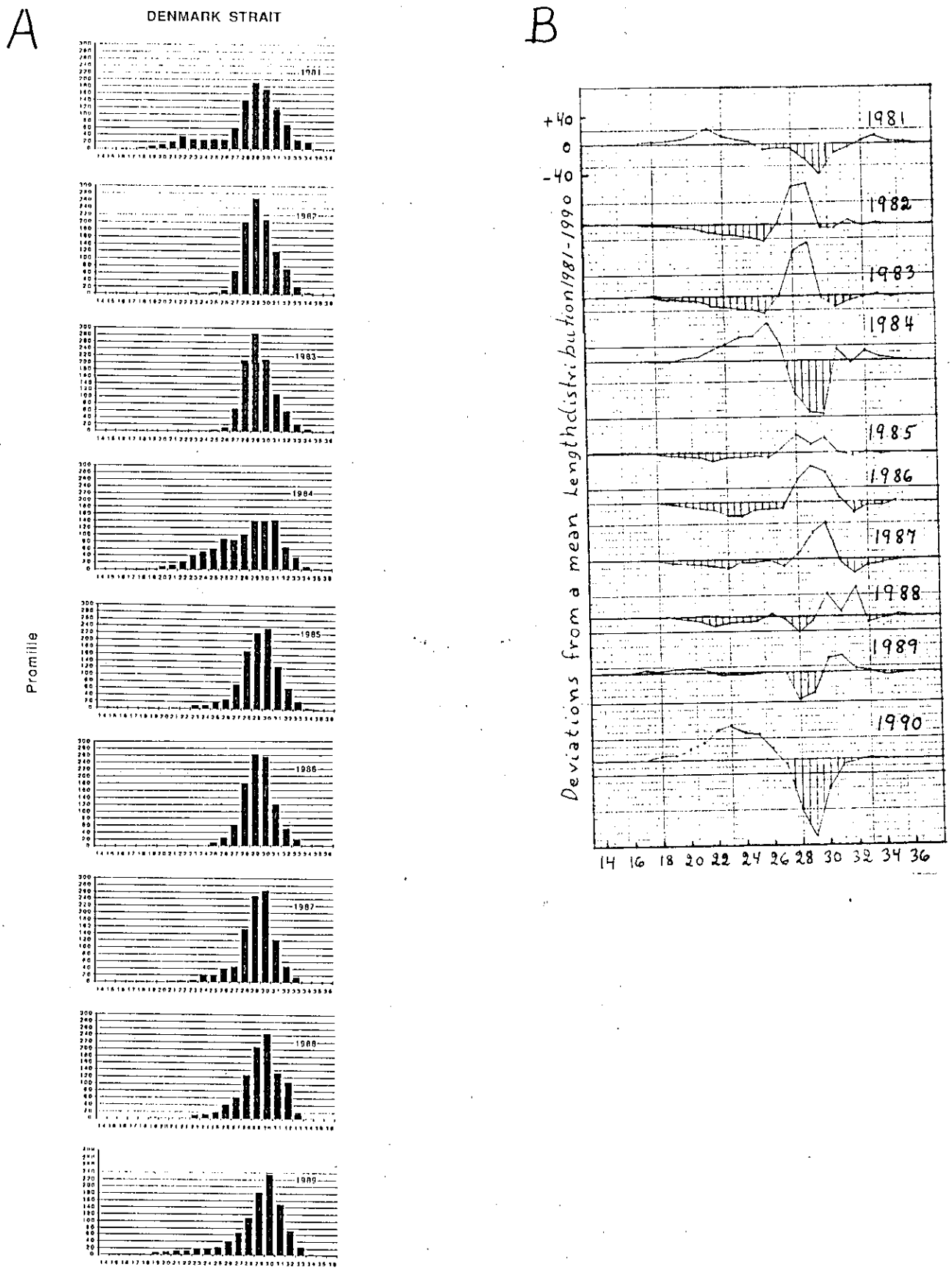


Fig. 11. Length frequency distributions from the Norwegian observer sampling (A) and deviations corresponding to those LFDs (B).

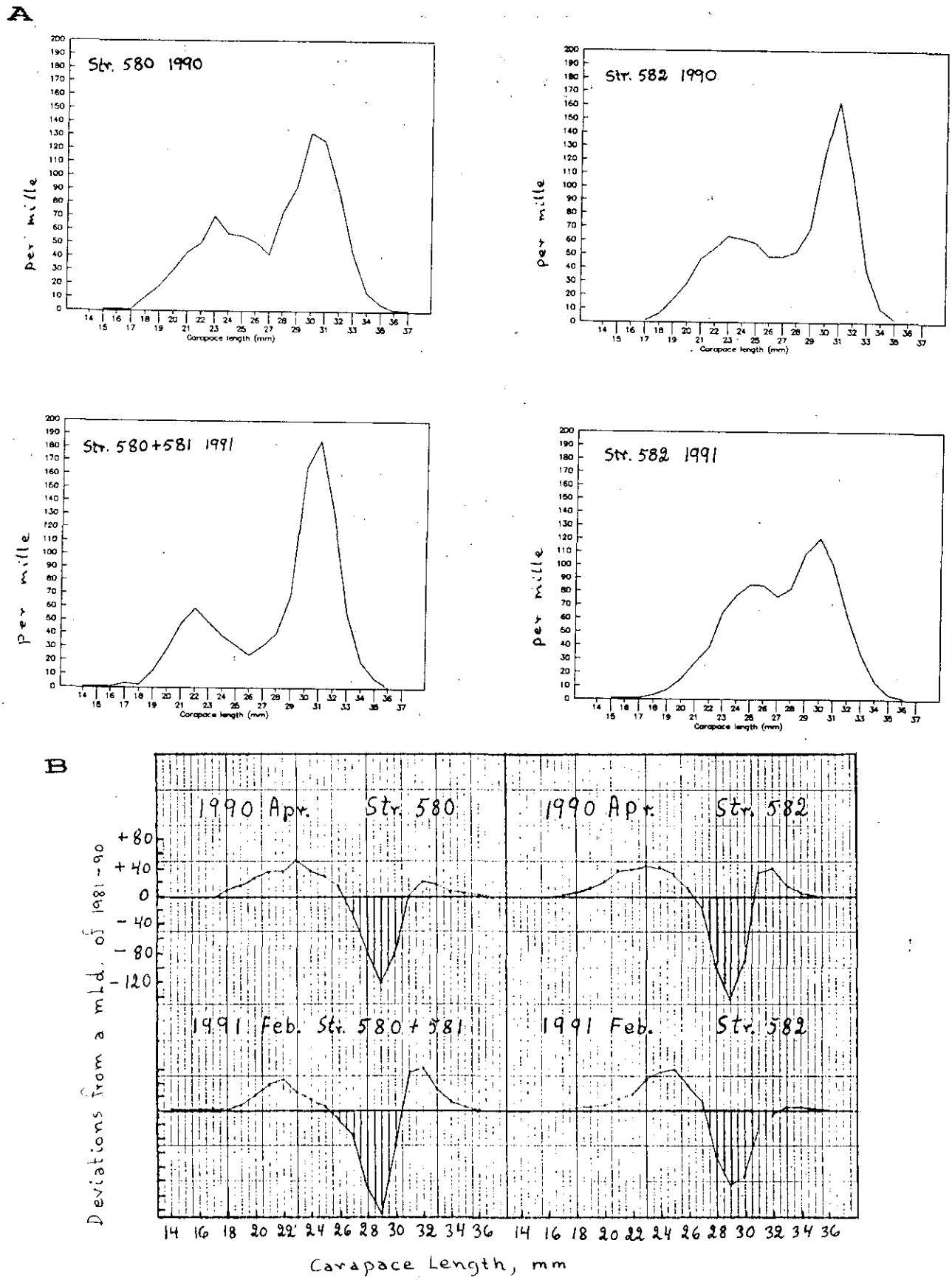


Fig. 12. Length frequency distributions from the Greenlandic commercial sampling (A) and deviations from the Norwegian "base", mld (Table 1 in the appendix.

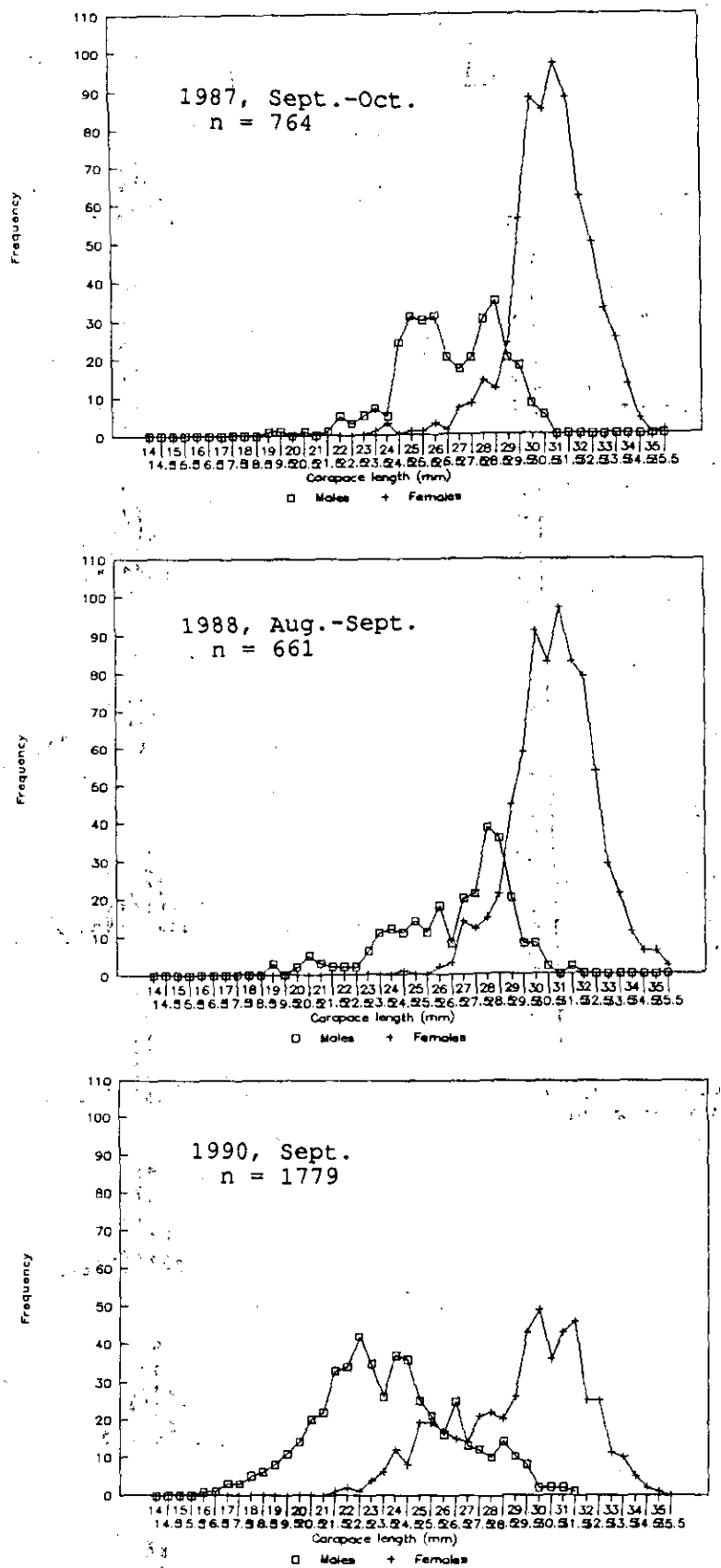


Fig. 13. The Icelandic samples (per milles) in the autumn in the strata 627, 628, 677 and 678 in 1987, 1988 and 1990 (Tables 2-4 in the appendix) . There were less than 1% transitionals + females with sternal spines, so these were omitted from the figure. All females shown were without sternal spines.

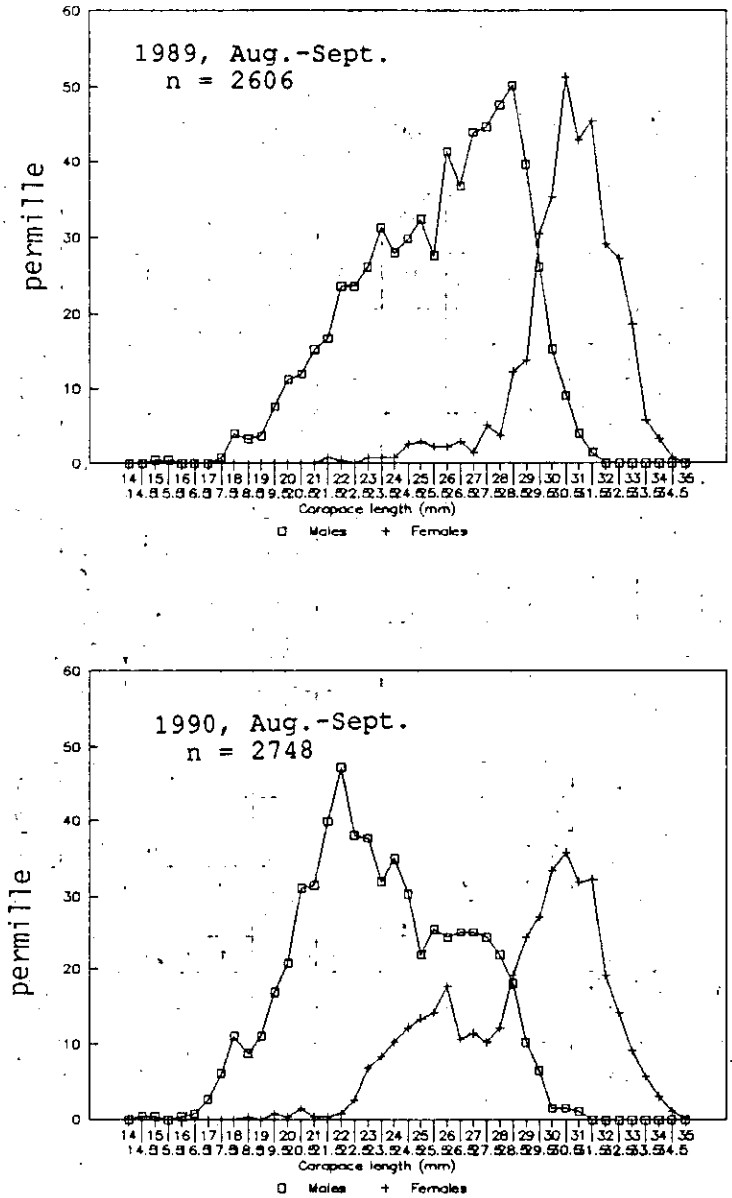


Fig. 14. The Greenlandic survey samples of shrimp in the autumn in the eastern part of the survey area, 1989 A, 1990 B. Females are not broken down in the figure into with and without sternal spines.

APPENDIX

Table 1. The Norwegian observer samples (per milles) in the late winter by years.

	81	82	83	84	85	86	87	88	89	90	Σ/10
S. no.	11	10	10	10	15	2	11	3	21	16	
15	1										0
16									1		0
17	1								3		0
18	4						1		2	5	1
19	9	2		3		2	1	4	8	9	4
20	14			99	1		1	4	10	23	6
21	21	1	1	13	3		3	4	14	32	9
22	37	3		23	4	4	5	4	13	56	15
23	29	5	4	42	12		7	11	18	68	19
24	26	4	3	52	12		18	13	18	59	20
25	28	6	5	57	18	12	22	21	24	61	25
26	28	14	14	88	28	27	38	40	39	53	37
27	59	68	68	85	72	59	46	63	66	59	65
28	140	198	210	98	171	180	154	126	111	77	147
29	192	267	285	139	223	262	250	208	184	105	212
30	173	208	212	137	236	256	265	245	236	174	214
31	115	120	109	143	126	121	124	132	151	119	126
32	71	72	59	65	62	51	47	107	73	66	67
33	29	24	23	36	25	20	16	15	26	58	24
34	18	7	8	9	5		2	4	3	6	6
35	4	1		2	1	2		2		1	1
36	1										0

APPENDIX

Table 2. The Icelandic samples in September and October in 1987 (per milles). n = 764

Cl mm	♂	♂♀	♀ no spines	Σ
19	1			1
19.5	1			1
20				
20.5	1			1
21				
21.5	1			1
22	5			5
22.5	3			3
23	5			5
23.5	7		1	8
24	5		3	8
24.5	24			24
25	31		1	32
25.5	30		1	31
26	31		3	34
26.5	20		1	21
27	17		7	24
27.5	20		8	28
28	30		14	44
28.5	35		12	47
29	20	3	24	47
29.5	18	1	56	75
30	8	1	88	97
30.5	5		85	90
31			97	97
31.5			88	88
32			62	62
32.5			50	50
33			33	33
33.5			25	25
34			13	13
34.5			4	4
35.5			1	1
Σ	319	5	675	1000

Table 3. The Icelandic samples in August and September 1988 combined. n = 661

Cl mm	♂	♂♀	♀ no spines	Σ
19	3			3
19.5				
20	2			2
20.5	5			5
21	3			3
21.5	2			2
22	2			2
22.5	2			2
23	6			6
23.5	11			11
24	12			12
24.5	11		1	12
25	14			14
25.5	11			11
26	18	1	2	21
26.5	8		3	11
27	20		14	34
27.5	21		12	33
28	39	2	15	56
28.5	36		21	57
29	20	1	45	66
29.5	8	1	59	68
30	8		91	99
30.5	2		83	85
31			97	97
31.5	2		83	85
32			79	79
32.5			54	54
33			29	29
33.5			21	21
34			11	11
34			6	6
35			6	6
35.5			2	2
Σ	260	5	734	999

APPENDIX

Table 4. The Icelandic samples in September in 1990. Strata 627, 628, 677 and 678 combined. n = 1779

Cl mm	♂	♀♀	♀ no spines	Σ
16	1			1
16.5	1			1
17	3			3
17.5	3			3
18	5			5
18.5	6			6
19	8			8
19.5	11			11
20	14			14
20.5	20			20
21	22			22
21.5	33		1	34
22	34		2	36
22.5	42		1	43
23	35	1	4	40
23.5	26		6	32
24	37		12	49
24.5	36		8	44
25	25	1	19	45
25.5	21		19	40
26	16		17	33
26.5	25		15	40
27	13	1	14	28
27.5	12		21	33
28	10		22	32
28.5	14		20	34
29	10		26	36
29.5	8		43	51
30	2		49	51
30.5	2		36	38
31	2		43	45
31.5	1		46	47
32			25	25
32.5			25	25
33			11	11
33.5			10	10
34			5	5
34.5			2	2
35			1	1
Σ	496	3	501	1000

Table 5. The Greenlandic survey samples both in numbers and per milles (p/m) in 1989 and 1990 in about the same strata as stated in Table 4.

East Greenland, LFDs

	1989 Greenland survey				1990 Greenland survey			
	M	F	M	F	M	F	M	F
mm	n	n	p/m	p/m	n	n	p/m	p/m
14	0	0	0.0	0.0	0	0	0.0	0.0
14.5	0	0	0.0	0.0	1	0	0.4	0.0
15	1	0	0.4	0.0	1	0	0.4	0.0
15.5	1	0	0.4	0.0	0	0	0.0	0.0
16	0	0	0.0	0.0	1	0	0.4	0.0
16.5	0	0	0.0	0.0	2	0	0.8	0.0
17	0	0	0.0	0.0	7	0	2.7	0.0
17.5	2	0	0.7	0.0	16	0	6.1	0.0
18	11	0	4.0	0.0	29	0	11.1	0.0
18.5	9	0	3.3	0.0	23	1	8.8	0.4
19	10	0	3.6	0.0	29	0	11.1	0.0
19.5	21	0	7.6	0.0	44	2	16.9	0.8
20	31	0	11.3	0.0	54	1	20.7	0.4
20.5	33	0	12.0	0.0	81	4	31.1	1.5
21	42	0	15.3	0.0	82	1	31.5	0.4
21.5	46	2	16.7	0.7	104	1	39.9	0.4
22	65	1	23.6	0.4	123	2	47.2	0.8
22.5	65	0	23.6	0.0	99	7	38.0	2.7
23	72	2	26.2	0.7	98	18	37.6	6.9
23.5	86	2	31.3	0.7	83	22	31.8	8.4
24	77	2	28.0	0.7	91	27	34.9	10.4
24.5	82	7	29.8	2.5	79	32	30.3	12.3
25	89	8	32.3	2.9	57	35	21.9	13.4
25.5	76	6	27.6	2.2	66	37	25.3	14.2
26	114	6	41.4	2.2	63	46	24.2	17.7
26.5	101	8	36.7	2.9	65	28	24.9	10.7
27	121	4	44.0	1.5	65	30	24.9	11.5
27.5	123	14	44.7	5.1	63	27	24.2	10.4
28	131	10	47.6	3.6	57	32	21.9	12.3
28.5	138	34	50.1	12.4	47	50	18.0	19.2
29	109	38	39.6	13.8	27	63	10.4	24.2
29.5	72	84	26.2	30.5	17	71	6.5	27.2
30	42	97	15.3	35.2	4	87	1.5	33.4
30.5	25	141	9.1	51.2	4	93	1.5	35.7
31	11	118	4.0	42.9	3	83	1.2	31.8
31.5	4	125	1.5	45.4	0	84	0.0	32.2
32	0	80	0.0	29.1	0	50	0.0	19.2
32.5	0	75	0.0	27.3	0	37	0.0	14.2
33	0	51	0.0	18.5	0	24	0.0	9.2
33.5	0	16	0.0	5.8	0	15	0.0	5.8
34	0	9	0.0	3.3	0	8	0.0	3.1
34.5	0	2	0.0	0.7	0	3	0.0	1.2
35	0	0	0.0	0.0	0	0	0.0	0.0