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The Greenlandic Fishery for Northern Shrimp (*Pandalus borealis*) in Denmark Strait 1996 and January-October 1997

by

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Introduction

At its meeting in November 1996 STACFIS concluded that there was no biological basis for changing the advised TAC of 1997 from the 1996 value of 5,000 tons. The advised TAC has remained at this level since 1993. Like in 1993-1996 the effective TAC for 1997 in the Greenlandic zone was set to 9,563 tons of which 3,888 tons was allocated to Greenland. No effective TAC is set for the Icelandic zone.

Vessels from Greenland, Denmark, the Faroe Islands and Norway participated in the fishery in the Greenlandic zone in 1996 and 1997. The total catches by these nations as reported to Greenlandic authorities amounted to 9,165 tons in 1996 and 5,334 tons in the period Jan-Oct 1997.

Greenlandic vessels accounted in 1996 for 50% of the total catches amounting to 4,546 tons. By the end of October 1997 Greenlandic vessels had taken 27% of the catches equalling 1,429 tons.

The present paper updates time series of total catch, catch composition, effort, CPUE-indices and geographical distribution of the Greenlandic shrimp fishery in Denmark Strait, Greenlandic zone.

Materials and methods

Based on compulsory weekly reporting to Greenlandic authorities by vessels above 75GRT, total catch and number of vessels in the Greenlandic zone was compiled by nation and month.

Logbook data from the Danish, Faroese and Greenlandic fleets were analysed to show the spatial distribution of the fishery and the overall distribution of catches by year, and of catch, effort and catch rates by month.

Logbook data from 32 Greenlandic trawlers fishing in the traditional fishing area north of 65°N were used in a multiplicative model to calculate standardised catch rate indices for the years 1987-1997. Only vessels with at least three years of continual fishing activity in the area were included in the calculations.

Catch and effort were aggregated by vessel, month and year. All cells in with more than 10% of the catch not being sorted by shrimp size were excluded to avoid the influence of cells with non-sorted catch. Each cell was weighted by the included number of hauls. This is a change to the previous calculation procedure, which used indirect weighting by deleting cells with less than 10 hours of effort. Indices were calculated for total catch and

for catches of shrimp larger than 8.5 g to avoid the influence of unreported discard of smaller shrimp (Carlsson & Lassen, 1991).

Significant interactions between YEAR-MONTH, YEAR-VESSEL and VESSEL-MONTH exist in the data but their contribution to the variation is small in relation to that explained by the main effects (VESSEL, MONTH and YEAR). The final analysis was therefore run with main effects only.

Size compositions of shrimp catches in the areas north and south of 65°N were generated from samples from the Greenlandic fishery. Samples taken by observers before processing were sorted by sexual characteristics (McCrary, 1971) and measured to the nearest 0.1 mm carapace length. The data were then pooled in 0.5 mm length groups and adjusted by ratio of weight to the number caught in the set. Numbers from all sets for the month were totalled and adjusted by weight to the monthly catch reported in vessel logs. The numbers from all months were totalled and adjusted by weight to the total catch of the year in the respective areas.

Annual length frequency distributions of catches in the traditional fishing area north of 65°N from 1991 to 1995 and from the area south of 65°N from 1993-1997 were analysed by modal analysis (Macdonald & Pitcher, 1979) in an attempt to isolate year classes. The number of age components and initial estimates of their mean lengths were unknown and the iterations were allowed to run freely for best fit, except for a fixed coefficient of variation at 0.045.

Results and Discussion

Geographical distribution of the Greenlandic fishery

The fishery for shrimp in Denmark Strait has traditionally taken place at the Dohrn Banke north of 65°N. However, since 1993 the fishing pattern has changed as new fishing grounds were found south of 65°N. Figures 1A-G show the geographical distribution of the Greenlandic catches from 1991 to 1997.

In 1995 the fishery north of 65°N was concentrated between 65°30'N and 67°30'N and between 30°W and 32°W. In 1996 the overall areal distribution of the catches in the traditional area were approximately identical, but contrary to earlier years the area was only fished in January and December. Also in 1997 effort was only allocated to January (data covering Jan.-Oct).

Following the introduction in 1993 the new fishing areas south of 65°N received about 50% of the total effort spent by Greenland in Denmark Strait 1994-1995. In 1996 80% of the effort was spent south of 65°N and the preliminary data for 1997 indicate that this development is continuing (Fig 2B). Most catches were taken between 62°N and 62°30'N, but other concentrations were also located.

Reported catches 1996 - October 1997

Table 1 shows catches by month and nation and the numbers of reporting vessels in the Greenlandic zone in 1996 and 1997. Total reported catch in 1996 was 9,165 tons, and at the same level as the year before. Preliminary catch figures indicate that the total catches of 1997 will be at the 1994-1996 level.

A total of 42 vessels participated in the fishery in 1996 and until October 1997 36 vessels have been registered. The seasonal distribution of the fishery was similar to previous years with minimum activity in the summer period.

Catch, effort and unstandardised CPUE from vessel logs

Monthly, semi-annual and annual catch, effort and mean catch rates based on logbooks from the Greenlandic, Danish and Faroese fishery in the Denmark strait were compiled and are given in details in (Skúladóttir, 1997). Only the data of the Greenlandic fleet is presented in this paper.

The Greenlandic fishery in the traditional area north of 65°N has gradually changed from an all year activity with a minimum in the summer months, to effort only being spent only in December and the first three or four months of the year. This time of year generally produces the highest catch rates. In 1996, however, the northern area was abandoned after a short period of activity in January, presumably due to low catch rates compared to the southern area (Fig. 2C). In December the area was revisited but catch rates were still unsatisfactory and only 52 tons were taken. The preliminary data for 1997 tells the same story: low effort and only in January.

Compared to the late 1980's catch and effort in the area north of 65°N has been reduced by approximately one order of magnitude (Table 2 and Fig. 2A+B). The main explanation for this development is not to be found in declining overall catch rates (Fig. 2C) but in a decline in catch rates of large shrimp (see later), which is the prime target of the Greenlandic fishery in Denmark Strait. Participation in the fishery at Flemish Cap and the development of the new fishery in the southern area of Denmark Strait are also major causes of the traditional area being less attractive.

The fishery in areas south of 65°N began in 1993. No decisive seasonal pattern is yet obvious and effort has been distributed over practically all months. The largest catch is generally taken Nov.-Feb. In spite of catch rates being almost twice as high as north of 65°N (Fig. 2C) only about 20-50% of the Greenlandic effort was spent in the southern area during the first three years - probably due to less favourable bottom conditions for trawling in this area. Following this period of learning about 80-90% of total effort was allocated to the southern area in 1996 and 1997.

Total Greenlandic fishing effort in the Denmark Strait has shown a declining trend from about 43,000 hr's in 1989 to a level of about 15,000 hr's in the mid 1990's (Table 2 and Fig. 2F). The preliminary data for 1997 suggests a fishing effort below that level. The total catches followed the same trend until 1993 when the new fishing grounds south of 65°N enhanced overall catch rates and made catches reach a new level of around 4,000 tons (Fig 2E+F). In 1997 catches will probably be at this level.

Standardised CPUE from Greenlandic vessel logs

Results of the multiple regression analysis to standardise catch rates of both large shrimp (>8.5 g) and total catch (Table 3-4) shows that all main effects were highly significant ($p<0.0001$) and their combined effects explained 73% and 70% of the variation in CPUE respectively. The model diagnostical outputs (residual plots, Cook's D influence statistics, test of normality etc.) indicate that the model and error structures were correct.

All first-order interactions between the effects of YEAR, MONTH and VESSEL were also highly significant, suggesting that the effect of YEAR on CPUE differ from month to month and from vessel to vessel. The contributions of these interactions to the variability within the data set however were small compared to that of the main effects. Thus, the basic model without interactions was considered a good description of the data.

The annual catch rate indices for large shrimp and total catch are presented in Figure 2D. This years index series has been calculated using a different weighting procedure. This meant no changes to the trend of the time series. However, the 1996 data point, that in the previous analysis was the lowest on record is now higher than the 1993 data point.

The two index time series are almost parallel showing a declining trend from 1987 to 1993, succeeded by an increase to a higher level in 1994. This level was maintained through to 1997.

Both in 1996 and 1997 only a small amount of effort was allocated to the northern area. Thus the index values for these years are based on only a few observations and interpretation of these data points as a biomass indices should therefore be done with care.

Length distributions

Besides practical problems collecting samples, adequate sampling in time and space for constructing length distribution of the catches are made difficult by the ongoing changes in fishing pattern. Unsolved problems of population structure further made stratification of the analyses difficult. In this investigation samples taken north and south of 65°N were treated separately. The numbers of samples included are presented in Table 5.

The length frequency distributions of the northern and southern areas are shown in Fig. 3. Modal analysis was applied to the annual length frequency distributions of the Greenlandic catches (Table 6). Runs with 6 age components produced the best fits and estimated reasonable consistent mean lengths from year to year. Skúladóttir (1994) also found 6 age components in a similar analysis. The mean lengths estimated in this study for the northern area show some agreement with her findings. In the southern area the mean length at age turned out a little smaller.

Due to lack of knowledge of shrimp growth in the Denmark Strait assigning of absolute age to the found age components is still a matter of belief. In this paper we assigned age to the year classes as presented by Skúladóttir (1994).

The estimated proportions of each age group in the catch were applied to the total numbers caught to produce a catch-at-age matrix. This matrix was subsequently divided by the standardised fishing effort for the northern area and the unstandardised effort for the southern area to produce age-specific indices of abundance (Table 6). In general catch rates for all year classes indicate increasing abundance up to about age 7, suggesting only partial recruitment to the fishery, at least up to age 7.

In the northern area data is available for 1991-1995. As this short time series represent a period at the lower end of the CPUE index time series (Fig 2D) interpretations of "better" year classes as being good should be done in that context. However, some "good" recruitment of young shrimp seemed on its way in 1995 to enter the fishery in the late 1990's. Generally the situation in 1995 seemed better than the previous four years with "good" representation in practically all age groups. Thus the catch composition of the Greenlandic fishery in the northern area may signal an improvement of both spawning stock and recruitment of shrimp in Denmark Strait within the period 1991-1995.

In the southern area catch rates of the largest shrimp were still very good in 1997, in fact the best of the time series (Table 5). Not only female abundance showed an up-going trend since 1993 (Fig. 4) but also male abundance has increased. It is quite possible, however, that these changes are caused by the changes in fishing pattern since the beginning of this fishery rather than an improvement of stock status.

Conclusion

Total catches in Denmark Strait, Greenlandic zone by all nations will probably be at the same level in 1997 as the 1996 catches of about 9,000 tons.

The overall geographical distribution of the Greenlandic fishery in the Denmark Strait in 1996 was maintained in 1997. However, a substantial reduction of effort spent in the traditional area north of 65° has taken place within the last two years.

Effort spent in the southern area has increased since the beginning of this fishery in 1993 and now accounts for 80-90% of the total Greenlandic effort in Denmark strait.

The overall effort spent by Greenland in Denmark Strait seems to have stabilised at around 15,000 hours following a decline from more than 40,000 hours in 1989. The total catches followed the same downward trend until 1993 when the new fishing grounds south of 65°N enhanced overall catch rates and made catches reach a new level of around 4,000 tons. In 1997 catches will probably be at this level.

The overall unstandardised catch rates have increased by a factor 3 since 1993 mostly due to the high catch rates in the new fishing grounds south of 65°N, but also influenced by an increase in biomass north of 65°N as indicated by the standardised CPUE.

The size structure in the northern area as judged from the 1995 data seemed healthy with good representation of several year classes. There were some indications of good recruitment to enter the fishery in the late 1990's. No data was available for 1996-1997.

In the southern area both male and female abundance has increased since 1993 but the data may be highly influenced by the ongoing development of this new fishery.

References

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Table 1. Catch (tons) and number of vessels fishing in Denmark Strait, Greenland zone by months and nation as reported to Greenlandic authorities 1996 and 1997.

Catches (tons)

Year	Nation	Jan	Feb	Mar	April	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1996	Denmark	100	36	126	159	103	116	155	0	0	23	78	63	959
	Faroe Isl.	305	175	155	7	0	0	0	0	0	0	65	436	1143
	Greenland	770	454	218	172	0	9	333	411	65	974	770	370	4546
	Norway	267	225	484	529	198	0	43	142	155	228	246	0	2517
	Total	1442	890	983	867	301	125	531	553	220	1225	1159	869	9165
1997	Denmark	0	4	0	236	173	262	232	165	61	66	-	-	1199
	Faroe Isl.	261	268	87	28	0	0	0	0	5	7	-	-	656
	Greenland	1035	220	6	22	0	0	112	0	0	34	-	-	1429
	Norway	342	423	296	485	140	0	82	40	129	113	-	-	2050
	Total	1638	915	389	771	313	262	426	205	195	220	-	-	5334

No. of vessels

Year	Nation	Jan	Feb	Mar	April	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1996	Denmark	1	1	1	1	1	1	1	0	0	1	1	1	1
	Faroe Isl.	8	7	2	1	0	0	0	0	0	0	2	7	8
	Greenland	10	5	3	3	0	1	5	5	2	11	11	6	16
	Norway	8	6	12	10	6	0	1	5	6	11	9	0	17
	Total	27	19	18	15	7	2	7	10	8	23	23	14	42
1997	Denmark	0	1	0	1	1	1	1	1	1	1	-	-	1
	Faroe Isl.	6	3	3	1	0	0	0	0	1	1	-	-	7
	Greenland	12	4	1	1	0	0	3	0	0	2	-	-	13
	Norway	7	9	9	9	6	0	2	2	5	6	-	-	15
	Total	25	17	13	12	7	1	6	3	7	10	-	-	36

Table 2. Catch (tons) and effort (hr's) by Greenlandic shrimp trawlers fishing in Denmark Strait 1987-1997. Data is given by areas north and south of 65°N and as total area.

	Catch (tons)			Effort (hr's)		
Year	North	South	Total	North	South	Total
1987	6627	0	6627	25168	0	25168
1988	7450	0	7450	37931	0	37931
1989	5981	0	5981	43382	0	43382
1990	6210	0	6210	39254	0	39254
1991	4205	0	4205	36256	0	36256
1992	2012	0	2012	19712	0	19712
1993	1425	918	2343	15174	4245	19419
1994	1056	2869	3925	6200	7780	13980
1995	1913	2135	4048	9430	5923	15353
1996	289	4256	4545	3387	12303	15690
1997	40	1389	1429	294	3452	3746

Table 3. ANOVA-table and parameter estimates. Output from the GLM procedure of the SAS application calculating standardised CPUE indices for total shrimp catches in the Denmark Strait north of 65°N.

Dependent Variable: LNCPUE
Weight: HAULS

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	52	12548.31621782	241.31377342	31.43	0.0001
Error	709	5442.86687340	7.67682211		
Corrected Total	761	17991.18309123			

R-Square	C.V.	Root MSE	LNCPUE Mean
0.697470	56.47202	2.7707078	4.90633748

Source	DF	Type III SS	Mean Square	F Value	Pr > F
VESSEL	31	3704.91043593	119.51323987	15.57	0.0001
YEAR	10	5390.82191622	539.08219162	70.22	0.0001
MONTH	11	5307.55506827	482.50500621	62.85	0.0001

Parameter		Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT		4.218136945 B	11.53	0.0001	0.36580796
VESSEL	OUIN	0.027941532 B	0.30	0.7622	0.09230127
	OUIQ	0.350255079 B	3.51	0.0005	0.09976981
	OUKV	0.462146827 B	2.26	0.0239	0.20417438
	OUOQ	0.113804258 B	1.36	0.1745	0.08372699
	OUPJ	0.249679976 B	3.45	0.0006	0.07242272
	OUTM	-0.191554891 B	-2.02	0.0434	0.09466335
	OUWH	0.179686590 B	2.38	0.0174	0.07539410
	OUYM	-0.465194714 B	-3.21	0.0014	0.14486918
	OWDV	-0.245375495 B	-1.75	0.0808	0.14035004
	OWGG	0.427644638 B	3.58	0.0004	0.11943615
	OWLQ	-0.287171863 B	-3.23	0.0013	0.08891797
	OWQU	0.517530914 B	6.74	0.0001	0.07680741
	OWSH	-0.124427328 B	-1.40	0.1617	0.08882880
	OWUD	-0.215180208 B	-0.63	0.5280	0.34077606
	OWUJ	-0.091286344 B	-0.34	0.7320	0.26643633
	OWVM	-0.184664788 B	-2.21	0.0277	0.08372780
	OWWP	0.407375266 B	5.34	0.0001	0.07630973
	OWZR	-0.571956774 B	-4.17	0.0001	0.13710977
	OXSY	-0.309884377 B	-2.18	0.0292	0.14182413
	OYAQ	-0.234914638 B	-1.34	0.1814	0.17558536
	OYBZ	0.335406827 B	4.53	0.0001	0.07396766
	OYCK	0.249379990 B	2.70	0.0071	0.09231681
	OYFF	0.242331115 B	2.14	0.0327	0.11323050
	OYHO	0.590783622 B	9.65	0.0001	0.06120234
	OYKK	-0.011160278 B	-0.16	0.8767	0.07192751
	OYNR	0.118691731 B	1.52	0.1282	0.07792761
	OYNS	0.019312298 B	0.26	0.7963	0.07478918
	OYRK	0.228267027 B	2.46	0.0143	0.09295149
	OYRT	0.146657883 B	1.88	0.0600	0.07785292
	OYXT	0.397614214 B	5.45	0.0001	0.07295744
	OZKQ	0.439647274 B	5.79	0.0001	0.07592067
	ZZZZ	0.000000000 B	.	.	.
YEAR	87	0.740990547 B	2.04	0.0414	0.36271086
	88	0.591317945 B	1.64	0.1023	0.36142157
	89	0.201547356 B	0.56	0.5770	0.36118921
	90	0.080446154 B	0.22	0.8239	0.36126915
	91	-0.107566515 B	-0.30	0.7660	0.36130812
	92	-0.374044916 B	-1.03	0.3027	0.36262183
	93	-0.566698191 B	-1.56	0.1188	0.36291047
	94	0.204458137 B	0.56	0.5779	0.36725752
	95	0.193013884 B	0.53	0.5967	0.36464409
	96	-0.102442003 B	-0.27	0.7884	0.38157804
	97	0.000000000 B	.	.	.
MONTH	1	0.647207153 B	14.36	0.0001	0.04508400
	2	0.624284915 B	13.79	0.0001	0.04527860
	3	0.427842902 B	9.01	0.0001	0.04750866
	4	0.411809107 B	7.14	0.0001	0.05765473
	5	0.055723741 B	0.82	0.4102	0.06762043
	6	-0.354315943 B	-1.60	0.1094	0.22105211
	7	-0.254671528 B	-0.50	0.6168	0.50873934
	8	-0.372871124 B	-2.99	0.0029	0.12466939
	9	-0.346735099 B	-4.01	0.0001	0.08650895
	10	-0.302697583 B	-4.06	0.0001	0.07464328
	11	-0.323182848 B	-5.52	0.0001	0.05851613
	12	0.000000000 B	.	.	.

Table 4. ANOVA-table and parameter estimates. Output from the GLM procedure of the SAS application calculating standardised CPUE indices of shrimp>8.5 g in the Denmark Strait north of 65°N.

Dependent Variable: LNCPUE
Weight: HAULS

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	52	12930.80163281	248.66926217	35.72	0.0001
Error	695	4838.28970934	6.96156793		
Corrected Total	747	17769.09134215			

R-Square	C.V.	Root MSE	LNCPUE Mean
0.727713	54.79460	2.6384783	4.81521604

Source	DF	Type III SS	Mean Square	F Value	Pr > F
VESSEL	31	3202.43274893	103.30428222	14.84	0.0001
YEAR	10	6288.97318849	628.89731885	90.34	0.0001
MONTH	11	5633.80156652	512.16377877	73.57	0.0001

Parameter		Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT		4.057964488 B	11.65	0.0001	0.34844053
VESSEL	OUIN	0.082047335 B	0.93	0.3519	0.08807068
	OUIQ	0.347222377 B	3.65	0.0003	0.09512792
	OUKV	0.550281905 B	2.83	0.0048	0.19448834
	OUOQ	0.166818987 B	2.08	0.0382	0.08031919
	OUPJ	0.253460622 B	3.67	0.0003	0.06913043
	OUTM	-0.152006704 B	-1.68	0.0927	0.09028004
	OUWH	0.206160345 B	2.86	0.0043	0.07198978
	OUYM	-0.441723933 B	-3.20	0.0014	0.13804702
	OWDV	-0.227208072 B	-1.70	0.0898	0.13373173
	OWGG	0.420335986 B	3.69	0.0002	0.11382324
	OWLQ	-0.225025181 B	-2.65	0.0082	0.08481263
	OWQU	0.575460771 B	7.84	0.0001	0.07337766
	OWSH	-0.102462046 B	-1.21	0.2269	0.08472260
	OWUD	-0.291717821 B	-0.90	0.3691	0.32456508
	OWUJ	-0.126716280 B	-0.50	0.6177	0.25377173
	OWVM	-0.179735946 B	-2.21	0.0272	0.08120183
	OWWP	0.453038044 B	6.22	0.0001	0.07281487
	OWZR	-0.543487663 B	-4.16	0.0001	0.13066543
	OXSY	-0.274530167 B	-2.03	0.0426	0.13514025
	OYAQ	-0.226716619 B	-1.36	0.1757	0.16727158
	OYBZ	0.357593279 B	5.04	0.0001	0.07095409
	OYCK	0.191116810 B	2.17	0.0303	0.08805875
	OYFF	0.197564853 B	1.83	0.0676	0.10792960
	OYHO	0.504821733 B	8.61	0.0001	0.05861712
	OYKK	0.038868110 B	0.56	0.5754	0.06935360
	OYNR	0.127633986 B	1.72	0.0866	0.07436837
	OYNS	0.027760457 B	0.39	0.6974	0.07136573
	OYRK	0.241815893 B	2.73	0.0065	0.08864009
	OYRT	0.215505779 B	2.89	0.0040	0.07462446
	OYXT	0.416716447 B	5.98	0.0001	0.06963153
	OZKQ	0.471826790 B	6.51	0.0001	0.07244367
	ZZZZ	0.000000000 B	.	.	.
YEAR	87	0.751792325 B	2.18	0.0299	0.34548754
	88	0.722750353 B	2.10	0.0361	0.34422498
	89	0.335617005 B	0.98	0.3296	0.34398009
	90	0.152100427 B	0.44	0.6586	0.34408670
	91	-0.080661638 B	-0.23	0.8147	0.34409665
	92	-0.375876862 B	-1.09	0.2768	0.34538097
	93	-0.575577558 B	-1.67	0.0963	0.34562697
	94	0.059924170 B	0.17	0.8640	0.34975286
	95	0.100683946 B	0.29	0.7720	0.34727940
	96	-0.240259359 B	-0.66	0.5087	0.36337102
	97	0.000000000 B	.	.	.
MONTH	1	0.673773151 B	15.66	0.0001	0.04301646
	2	0.638961806 B	14.78	0.0001	0.04322374
	3	0.425183590 B	9.38	0.0001	0.04533049
	4	0.352884226 B	6.36	0.0001	0.05548479
	5	0.016657117 B	0.25	0.7995	0.06556192
	6	-0.502488105 B	-2.39	0.0173	0.21053192
	7	-0.229325709 B	-0.47	0.6361	0.48447052
	8	-0.377978510 B	-3.18	0.0015	0.11879591
	9	-0.373283219 B	-4.53	0.0001	0.08244095
	10	-0.340294851 B	-4.78	0.0001	0.07113954
	11	-0.319593145 B	-5.63	0.0001	0.05675296
	12	0.000000000 B	.	.	.

Table 5. Number of catch sub samples (S) by area taken from Greenlandic trawlers and number of individual shrimp measured (N).

Area north

Year/	1991		1992		1993		1994		1995	
Month	S	N	S	N	S	N	S	N	S	N
1	30	14898	0	0	0	0	0	0	13	3505
2	28	20127	20	4834	56	16258	19	6682	0	0
3	42	17872	0	0	0	0	0	0	15	6124
4	75	24286	0	0	0	0	0	0	0	0
5	32	9861	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0
Total	207	87044	20	4834	56	16258	19	6682	28	9629

Area south

Year/	1993		1994		1995		1996		1997	
Month	S	N	S	N	S	N	S	N	S	N
1	0	0	30	9957	0	0	0	0	0	0
2	0	0	8	2712	0	0	0	0	0	0
3	10	6560	14	3916	0	0	0	0	0	0
4	37	27933	11	5115	0	0	10	4973	0	0
5	0	0	0	0	0	0	7	2571	0	0
6	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	9	3064
8	0	0	0	0	0	0	12	4405	2	833
9	0	0	0	0	0	0	0	0	-	-
10	0	0	0	0	0	0	0	0	-	-
11	0	0	0	0	0	0	24	6444	-	-
12	0	0	0	0	0	0	0	0	-	-
Total	47	34493	63	21700	0	0	53	18393	11	3897

Table 6. Output from modal analyses of annual length frequency distributions of the Greenlandic shrimp catches in Denmark Strait and derived age specific catch rates. Note that the assignment of age to the modes is a matter of convenience rather than actual knowledge of shrimp growth at East Greenland.

Area north

Mean Cpl. length (mm)

Year class	1991	1992	1993	1994	1995
3	18.9	18.7	18.7	19.1	19.2
4	21.2	21.3	21.4	20.7	21.2
5	23.5	23.8	23.3	22.9	23.0
6	26.0	25.9	25.9	25.0	25.2
7	29.4	29.2	28.8	27.9	28.9
8+	31.2	30.7	31.5	31.1	30.9

Proportion of total catch

Year class	1991	1992	1993	1994	1995
3	0.02	0.04	0.01	0.01	0.05
4	0.12	0.16	0.06	0.05	0.12
5	0.22	0.20	0.18	0.22	0.20
6	0.18	0.18	0.38	0.32	0.27
7	0.27	0.19	0.25	0.30	0.27
8+	0.18	0.23	0.12	0.10	0.08

Number caught (millions)

Year class	1991	1992	1993	1994	1995
3	9	10	1	1	8
4	52	39	6	4	20
5	96	49	19	19	33
6	78	44	41	28	45
7	118	46	27	26	45
8+	78	56	13	9	13
Total	436	243	108	88	166

Abundance index

Year class	1991	1992	1993	1994	1995
3	15	27	4	8	43
4	92	110	21	42	104
5	169	137	64	185	173
6	138	123	135	269	234
7	207	130	89	252	234
8+	138	158	43	84	69
Total	767	685	354	841	866

Area south

Mean Cpl. length (mm)

Year class	1993	1994	1995	1996	1997
3	18.0	16.8	-	16.3	16.0
4	20.4	19.5	-	19.1	18.6
5	22.7	21.9	-	21.4	21.1
6	25.0	24.3	-	23.5	23.3
7	27.7	27.2	-	26.9	26.5
8+	30.5	30.1	-	29.1	28.6

Proportion of total catch

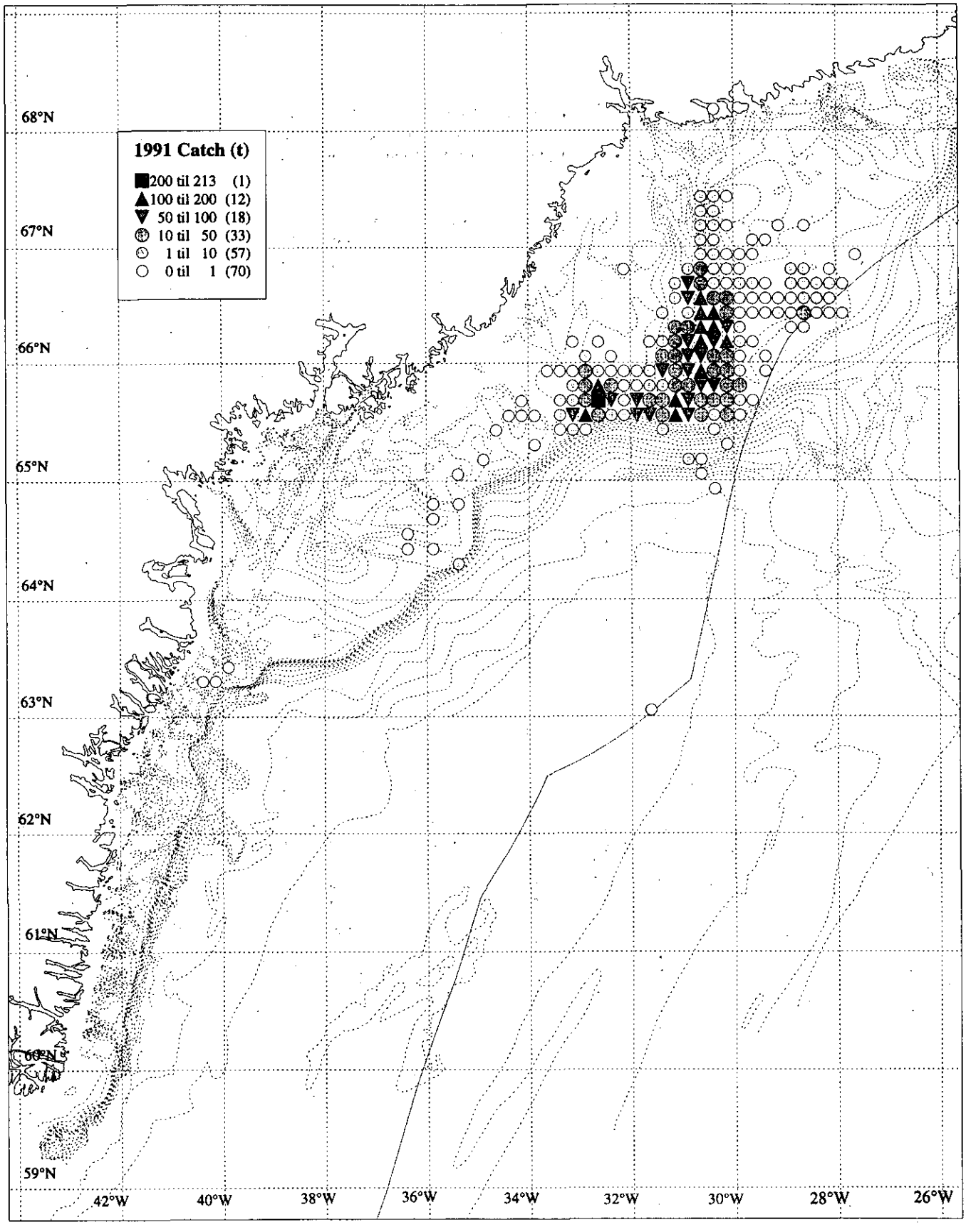
Year class	1993	1994	1995	1996	1997
3	0.01	0.01	-	0.01	0.00
4	0.11	0.05	-	0.05	0.03
5	0.23	0.11	-	0.24	0.27
6	0.22	0.21	-	0.28	0.19
7	0.18	0.34	-	0.25	0.32
8+	0.25	0.28	-	0.17	0.19

Number caught (millions)

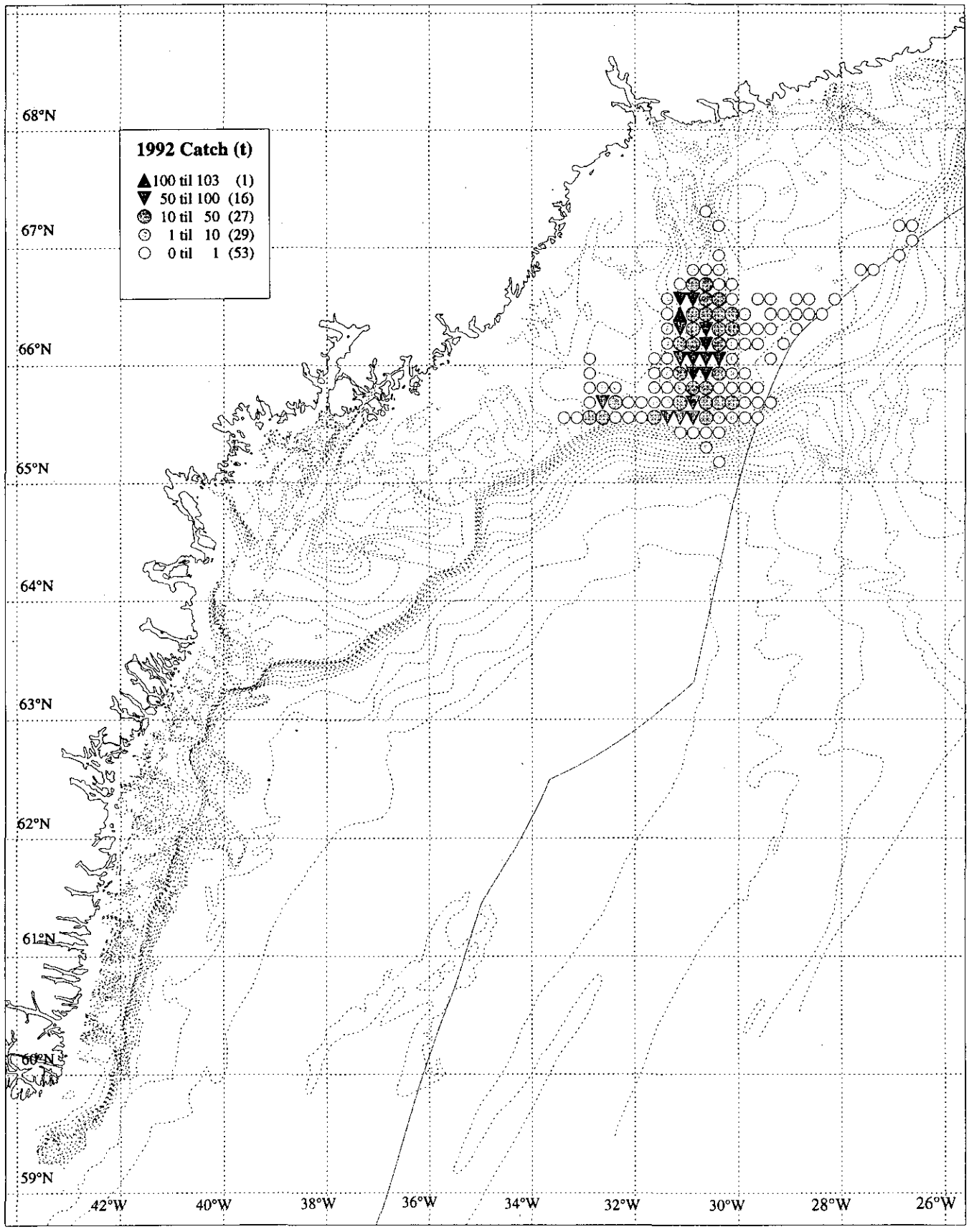
Year class	1993	1994	1995	1996	1997
3	1	2	-	3	0
4	9	11	-	24	4
5	19	24	-	109	36
6	18	44	-	126	25
7	14	72	-	115	42
8+	20	60	-	78	25
Total	80	211	-	455	133

Number caught per hour (unstandardized)

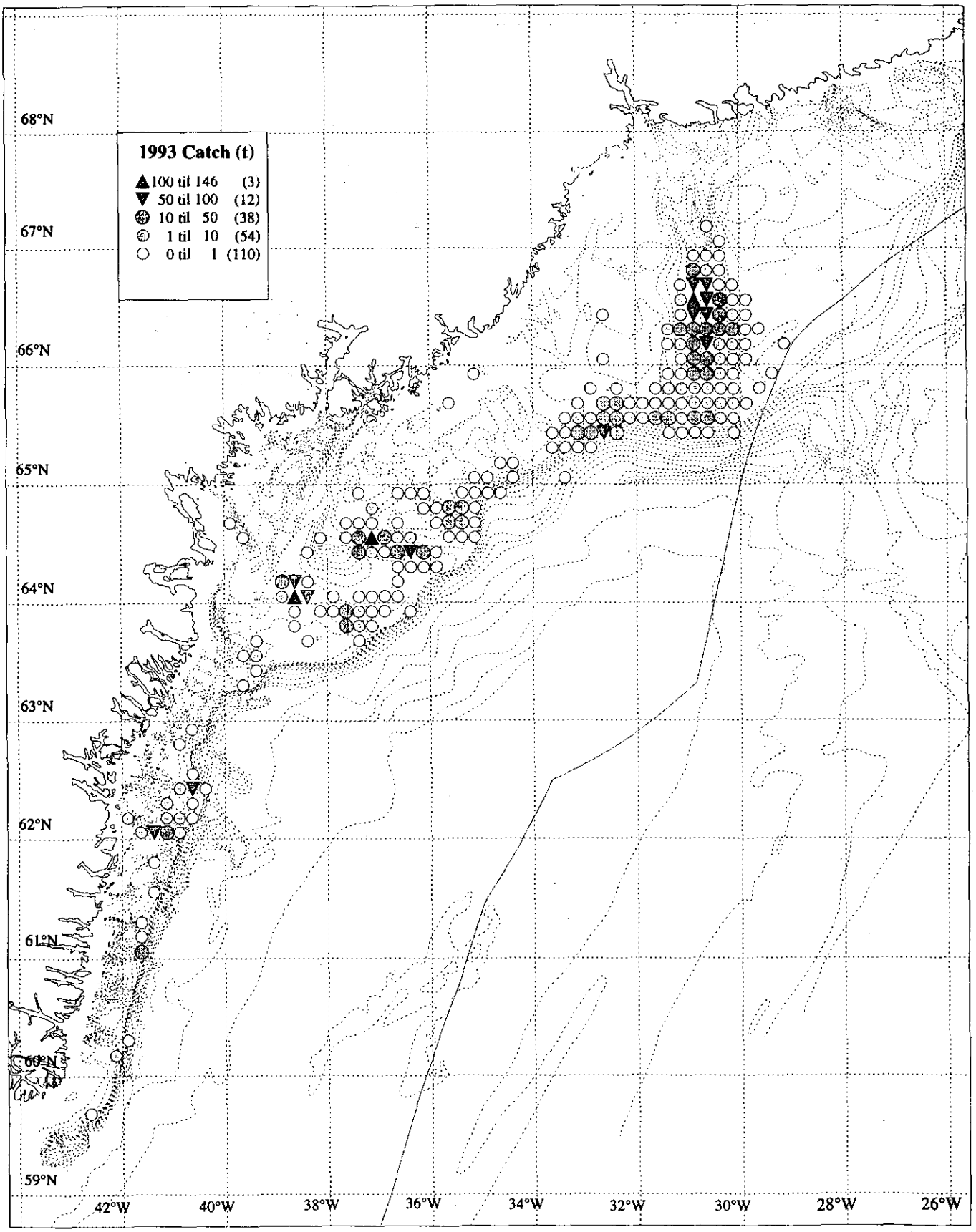
Year class	1993	1994	1995	1996	1997
3	221	244	-	233	49
4	2028	1352	-	1945	1430
5	4404	3074	-	8835	11708
6	4180	5605	-	10258	8227
7	3366	9203	-	9348	13573
8+	4759	7663	-	6326	7966
Total	18847	27140	-	36946	42951



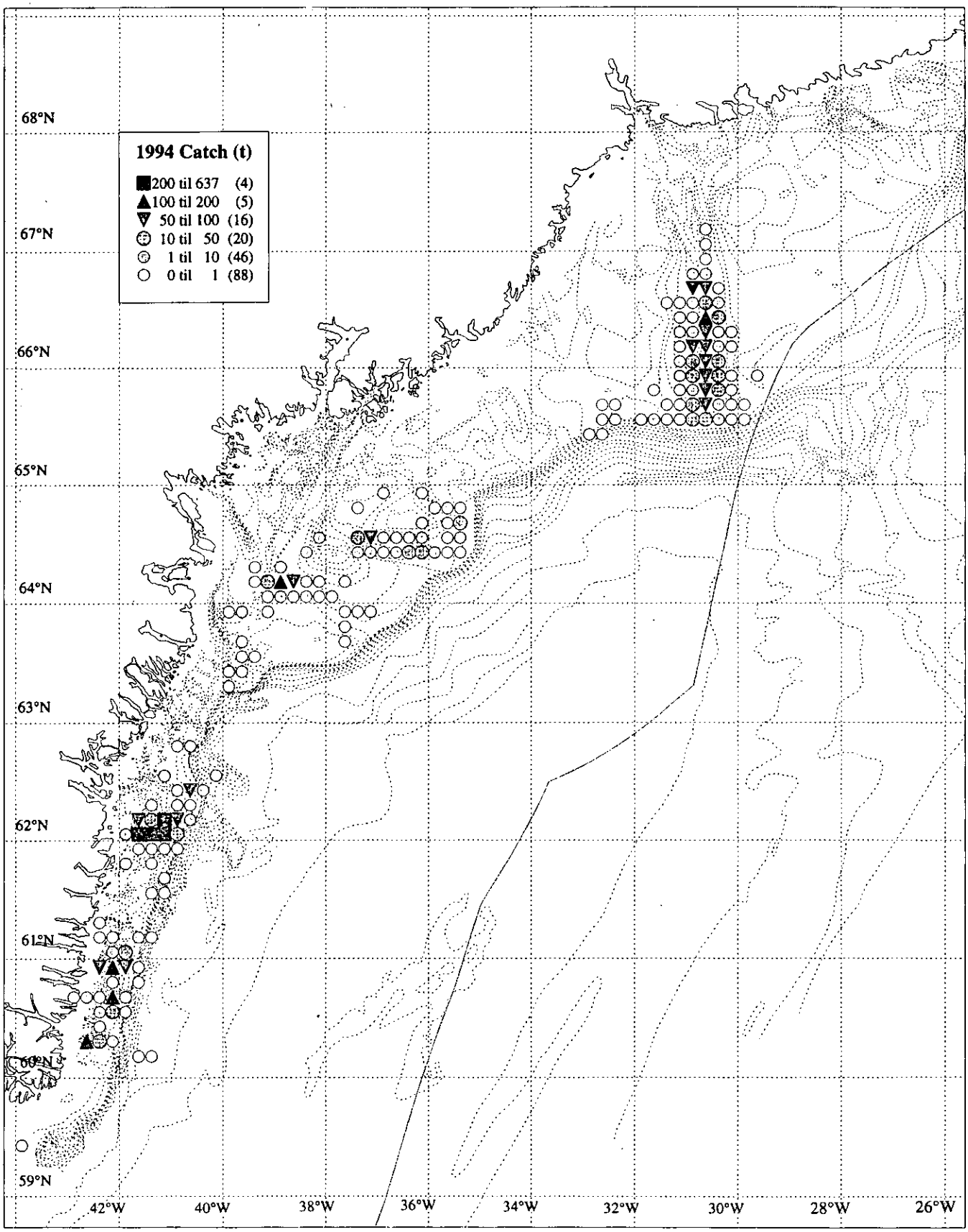
Figur 1A. The spatial distribution of the Greenlandic shrimp catches in Denmark Strait 1991.



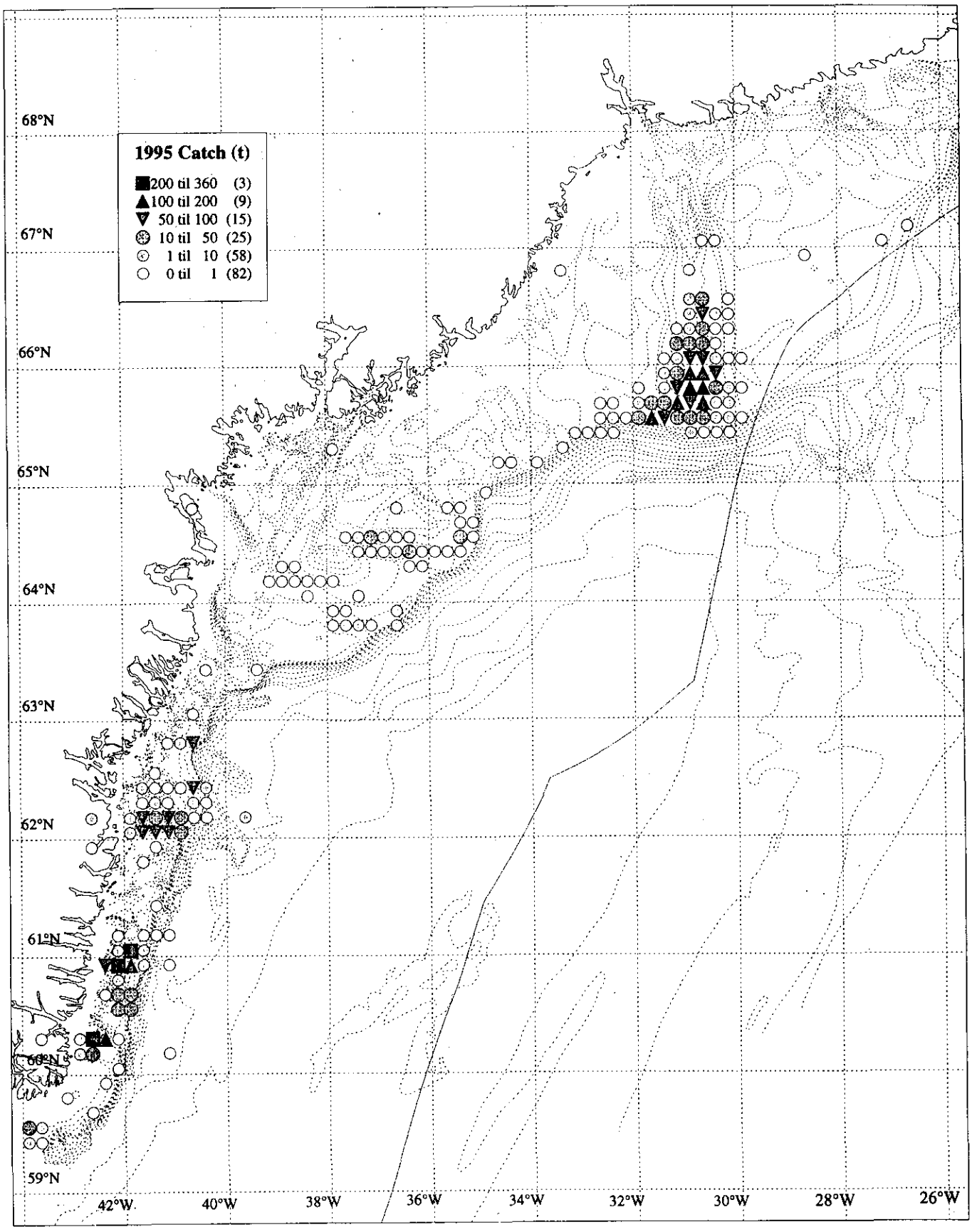
Figur 1B. The spatial distribution of the Greenlandic shrimp catches in Denmark Strait 1992.



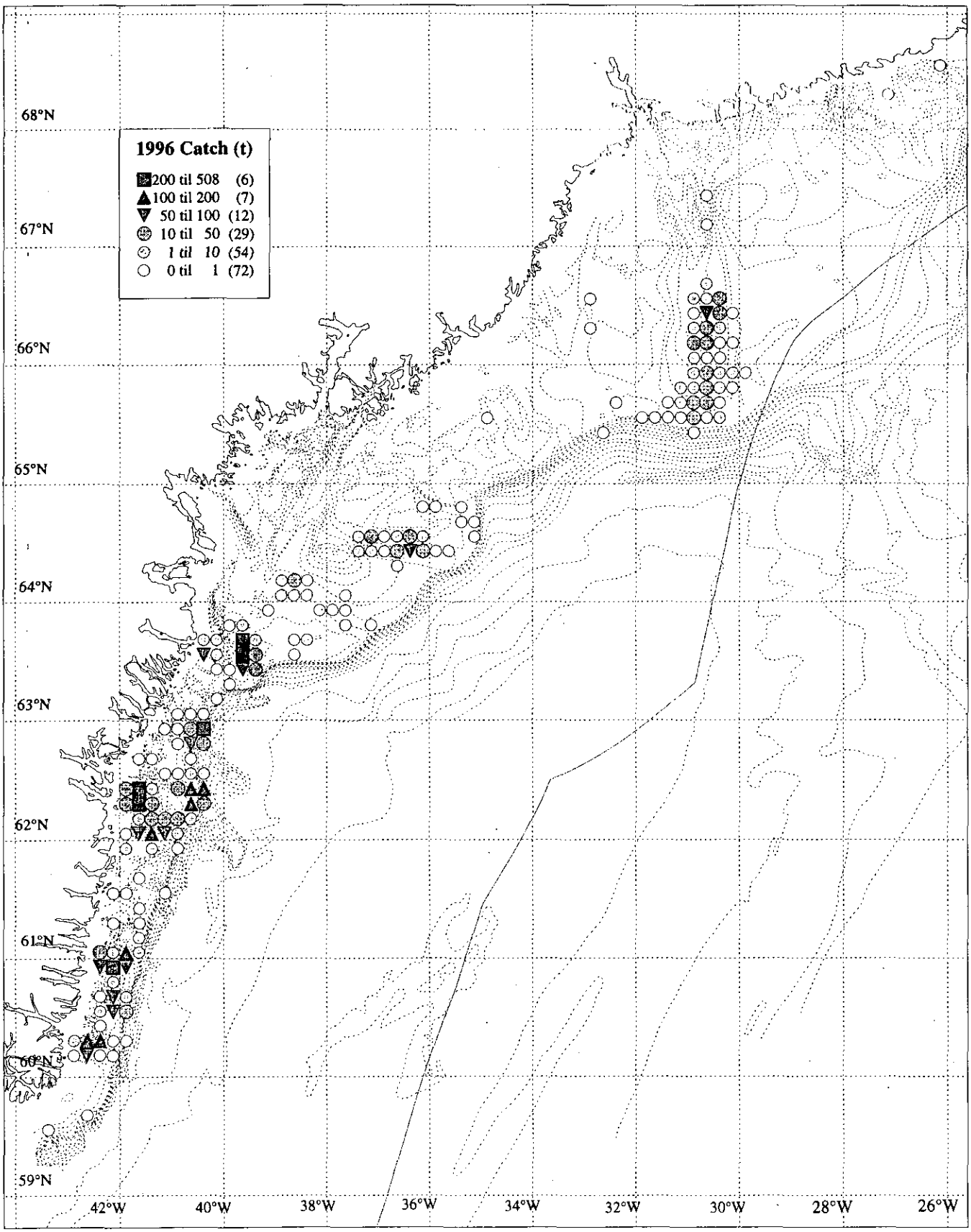
Figur 1C. The spatial distribution of the Greenlandic shrimp catches in Denmark Strait 1993.



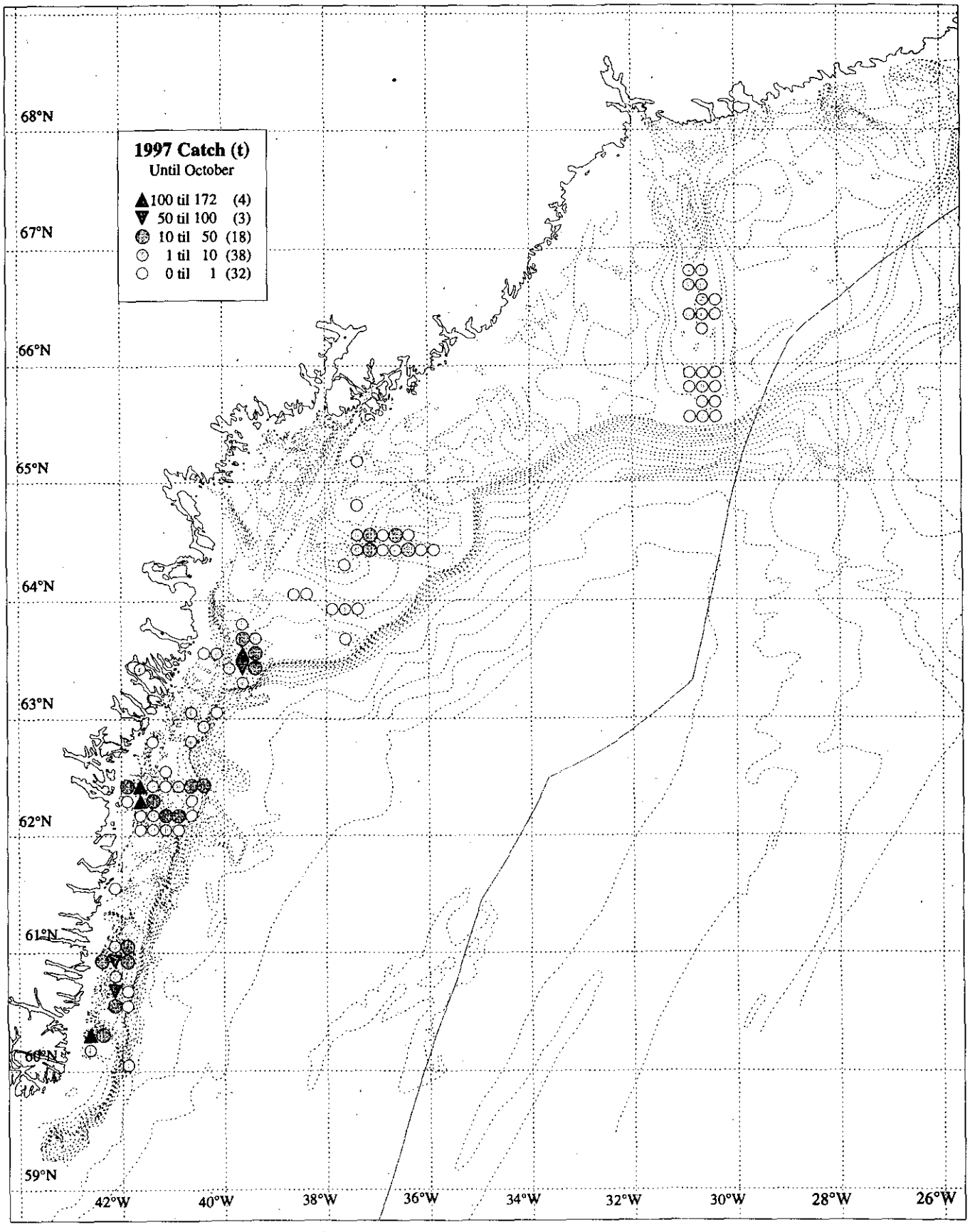
Figur 1D. The spatial distribution of the Greenlandic shrimp catches in Denmark Strait 1994.



Figur 1E. The spatial distribution of the Greenlandic shrimp catches in Denmark Strait 1995.



Figur 1F. The spatial distribution of the Greenlandic shrimp catches in Denmark Strait 1996.



Figur 1G. The spatial distribution of the Greenlandic shrimp catches in Denmark Strait until October 1997.

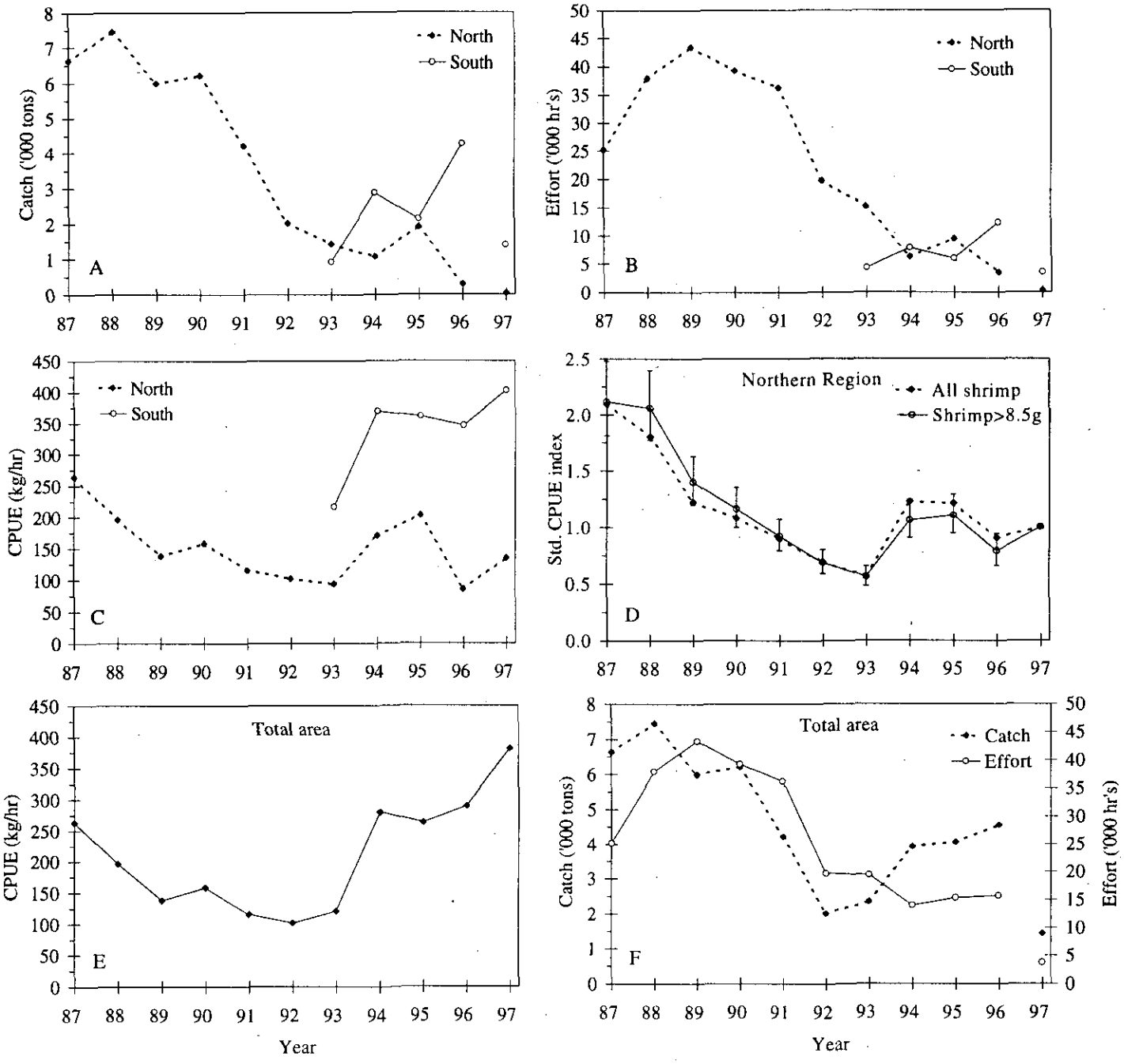


Figure 2. Catch, effort and CPUE by Greenland vessels fishing in Denmark Strait north and south of 65° N (panel A, B, C and D) and total area (panel E and F). Data for 1997 are incomplete.

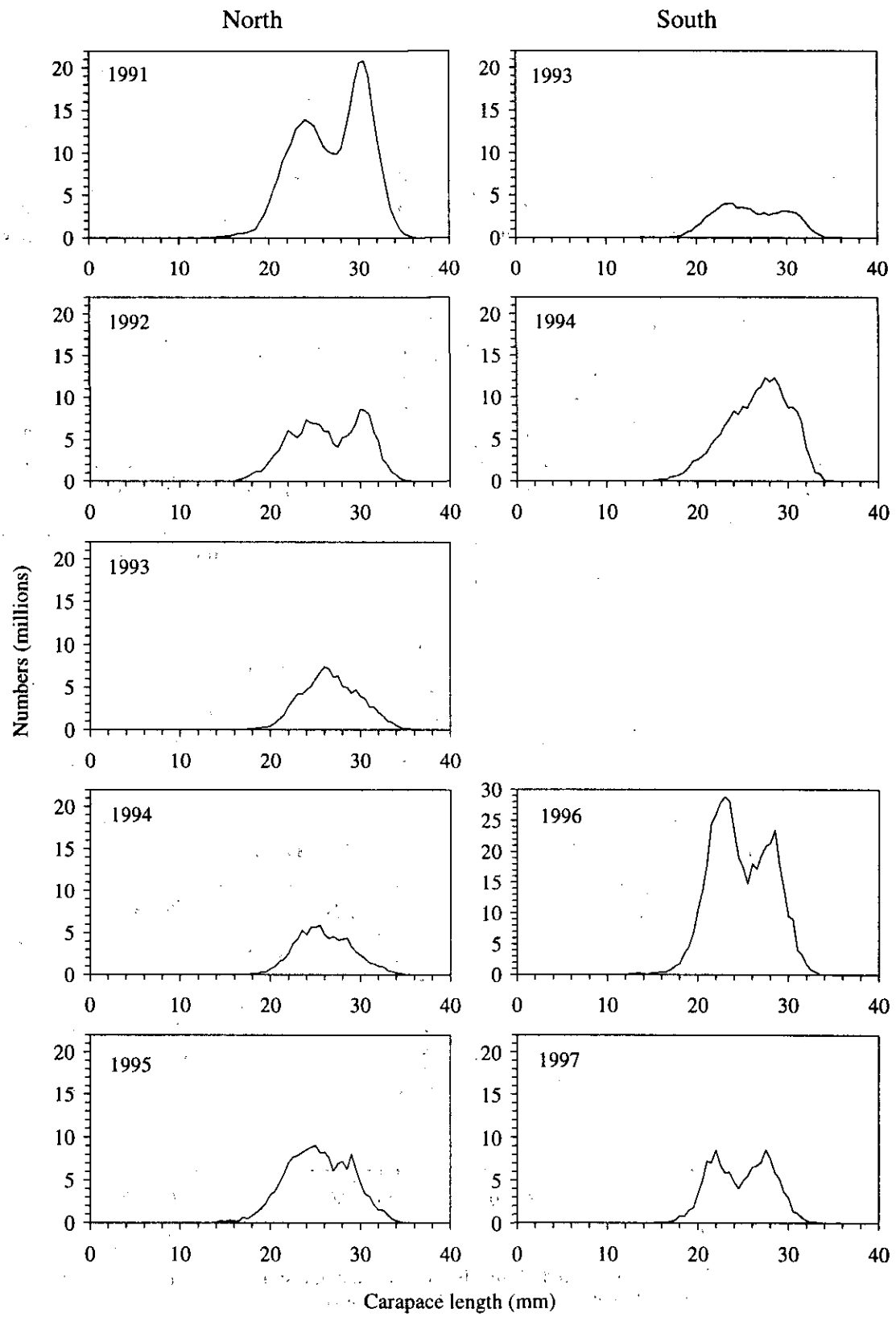
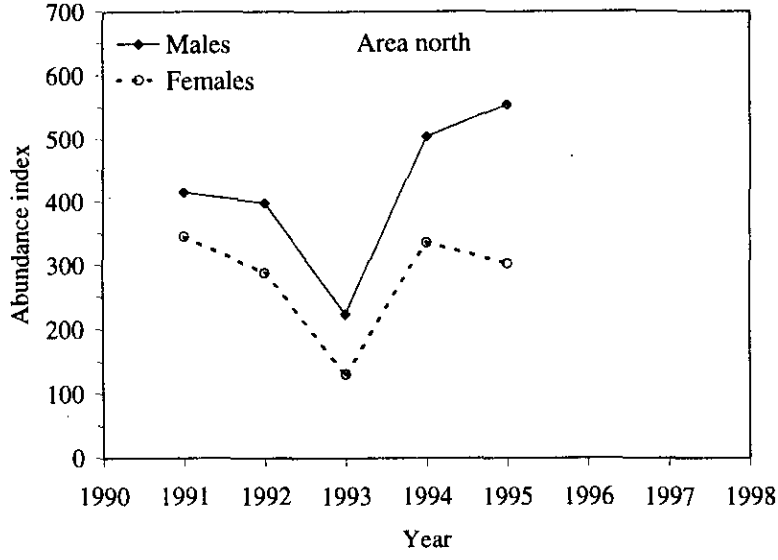


Figure 3. Length frequency distributions of shrimp catches north and south of 65°N in Denmark Strait by Greenlandic vessels.



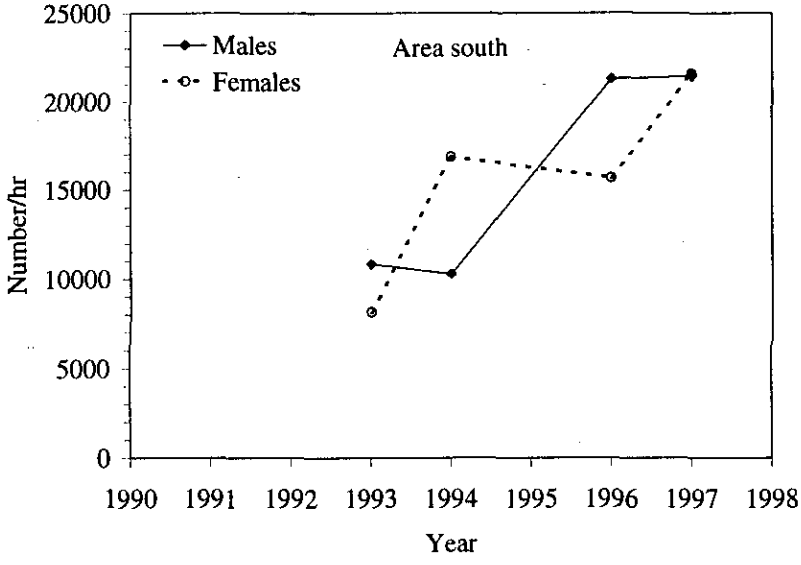


Figure 4. Catch rates of male (age 3-6) and female (age 7-8+) shrimp in numbers pr. hr. Data from the Northern area are standardised using the standardised CPUE-index for total shrimp catches (se table 3). No data for 1996-1997 were available from the northern area. Data for the southern area are unstandardised. There were no data for 1995 in area south.