Northwest Atlantic Fisheries Organization

Serial No. N2814 NAFO SCR Doc. 96/117

SCIENTIFIC COUNCIL MEETING - NOVEMBER 1996

The Greenland Fishery for Northern Shrimp (*Pandalus borealis*) in Denmark Strait in 1995 and January-October 1996

by

C. Hvingel, H. Siegstad & O. Folmer

Greenland Institute of Natural Resources
Box 570, DK-3900 Nuuk, Greenland

Introduction

In November 1995 STACFIS advised that the TAC of shrimp in the Denmark Strait of 5,000 tons recommended for 1994 and 1995 remain for 1996 to allow for a continued improvement of stock size. Like in 1993 to 1995 the effective TAC for 1996 in the Greenland zone was set to 9,563 tons of which 4,088 tons was allocated to Greenland. No effective TAC is set for the Icelandic zone.

Besides Greenland, Denmark, the Faroe Islands and Norway participated in the fishery in the Greenland zone in 1995 and 1996. The total catches by these nations as reported to Greenland authorities amounted to 8,358 tons in 1995 and 5,963 tons in 1996 until October.

Catches by Greenland vessels alone accounted in 1995 for 48% of the total catches amounting to 4,048 tons. By the end of October 1996 Greenland vessels accounted for approximately 41% of this years catches equalling 2,440 tons.

Log book records provided preliminary information on fleet performance and geographical distribution of the fishery in 1995 and 1996 and samples from the commercial fleet on size composition of catches. These data of the Greenland fleet together with an update of data from previous years will be presented in this paper.

Materials and methods

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

Logbook data from the Danish, Faeroese and Greenland fleet 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 Greenland trawlers were used in a multiplicative model to calculate standardized annual catch rate indices for the years 1987-1996 covering the traditional fishing area north of 65°N (Siegstad and Carlsson, 1994). Indices were calculated for total catch and for shrimp larger than 8.5 g to avoid the influence of unreported discard of smaller shrimp (Carlsson & Lassen, 1991).

Catch and effort were aggregated by vessel, month and year. All cells in the matrix with less than 10 hours of effort or with more than 10% of the catch not being sorted by shrimp size were excluded to avoid the influence of cells with few hauls and non-sorted catch.

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, year). The final analysis was therefore run with main effects only.

Size composition of shrimp catches by year were generated from samples from the commercial Greenland 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.

Annual length frequency distributions of catches in the traditional fishing area north of 65°N from 1991 to 1995 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 Greenland Fishery

The fishing pattern in the Denmark Strait has changed since 1993 when new fishing areas were found south of 65°N. These and the traditional fishing area north of 65°N can be seen in figure 1 and 2 which show the geographical distribution of the Greenland catches in 1995 and 1996 respectively.

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 is about the same, but contrary to earlier years the area was only fished in January (fig. 3).

The new fishing areas south of 65°N got much attention in 1994 and 56% of the total Greenland fishing effort in the Denmark Strait were spent between 60°N and 65°N. Most catches were taken between 62°N and 62°30'N, but other concentrations were also located (Hvingel *et al.*, 1995). In 1995 the percentage of the total effort spent in the southern region dropped to about 40%.

The preliminary data for 1996 suggest a substantial decrease in trawling hours in the northern region and a corresponding increase in the south (fig. 4B).

Reported Catches 1994 - October 1995

The tables below show catches by month and nation in tons and the numbers of reporting vessels in the Denmark Strait in 1994 and 1995 as reported to Greenland authorities.

Total reported catch in 1995 was 8,358 tons, and at the same level as the year before. Preliminary figures indicate that the 1996 total catches will end up at the 1994-1995 level.

A total of 45 vessels participated in the fishery in 1995 and until October 1996 41 vessels have been registered.
The seasonal distribution of the fishery was similar to previous years with minimum activity in the summer period.

Catch (tons):

Year	Nation	Jan	Feb	Mar	April	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1995	Denmark	137	101	2	0	16	0	131	170	49	111	60	48	825
	Faroe Isl.	276	227	136	28	0	0	0	5	57	29	8	214	980
	Greenland	1363	648	214	0	193	0	5	197	14	121	399	894	4048
	Norway	392	87	274	115	80	0	0	140	410	580	280	147	2505
	Total	2168	1063	626	143	289	0	136	512	530	304	304	304	8358
1996	Denmark	100	36	126	159	103	116	155	0	0	0	-	-	795
	Faroe Isl.	305	175	155	7	0	0	0	0	0	0	-	-	642
	Greenland	770	454	218	172	0	9	327	411	65	14	-	-	2440
	Norway	267	225	484	529	198	0	43	142	155	43	-	-	2086
	Total	1442	890	983	867	301	125	525	553	220	57	-	-	5963

Number of vessels:

Year	Nation	Jan	Feb	Mar	April	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1995	Denmark	2	2	1	0	1	1	1	1	1	1	1	1	2
	Faroe Isl.	7	7	6	3	0	0	0	1	2	2	1	7	9
	Greenland	15	12	7	0	3	0	1	6	1	3	8	14	18
	Norway	9	6	12	8	4	0	0	6	14	16	12	11	16
	Total	33	27	26	11	8	0	2	14	18	22	22	33	45
1996	Denmark	1	1	1	1	1	1	1	0	0	0	-	-	1
	Faroe Isl.	8	7	2	1	0	0	0	0	0	0	-	-	8
	Greenland	10	5	3	3	0	1	5	5	2	2	-	-	15
	Norway	8	6	12	10	6	0	1	5	6	6	-	-	17
	Total	27	19	18	15	7	2	7	10	8	8	-	-	41

Catch, Effort and Unstandardized CPUE from Vessel Logs

Monthly, semiannual and annual catch, effort and mean catch rates based on logbooks from the Greenland, Danish and Faeroese fishery in the Denmark strait were compiled and are given in details in (Skuladottir, 1996). Only the data of the Greenland fleet will be presented in this paper.

The Greenland 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 in 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 very low catch rates (fig. 4C).

In the fishing areas south of 65°N no decisive seasonal pattern is yet obvious. In 1994 effort was distributed over all months except June. In 1995 the major part of the fishery took place in Jan, May and Nov-Dec., and in spite of catch rates being almost twice as high as north of 65°N (fig. 4C) only about 40% of the Greenland effort was spent in the southern area - probably due to less favourable bottom conditions for trawling in this area.

The fishery in 1996 until October followed the "seasonality" of 1994 with effort spent in all months except June.

Total Greenlandic fishing effort in the Denmark Strait has shown a declining trend from about 43,000 hr's in 1989 to about 15,000 hr's in 1994 (fig. 4D). In 1995 the effort stabilized around 15,000 hr's and the preliminary data for 1996 suggests a fishing effort at the same level.

The catches followed the same trend until 1993 when the new fishing grounds south of 65°N enhanced overall catch rates and made catches peak in 1994 and 1995 at almost 4,000 tons (fig 4,D).

In 1996 catches will probably reach the same level as in 1995.

Standardized CPUE from Greenland Vessel Logs

Results of the multiple regression analysis to standardize catch rates of both large shrimp (>8.5 g) and total catch (table 3-4) shows that all main effects are highly significant ($p<0.0001$) and their combined effects explain 69% and 64.0% of the variation in CPUE respectively. The model diagnostical outputs (fig. 5-6) indicate that the model and error structure are correct.

All first-order interactions between the effects of year, month and vessel are also highly significant, suggesting that the effect of year on CPUE differ from month to month and from vessel to vessel. The contribution of these interactions to the variability within the data set however are 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 as calculated from the regression analysis are presented in figure 4. The two curves are almost parallel showing a declining trend from 1987 to 1993, succeeded by an increase to a higher level in 1994 which was maintained in 1995. The 1996 value is the lowest on record.

In 1996 effort was only allocated to the area in January which makes the interpretation of the index difficult. Apparently catch rates were low in January, but when the area was not "surveyed" for a major part of the traditional fishing season, it is doubtful whether it is possible to deduce anything about catch rates of the year.

If we assume that the area was not approached later in 1996 due to reports of ongoing bad fishery from the Faeroese fleet, which have spent few hours of effort in the area in February and Marts, we might with some hesitation interpret the January CPUE as reflecting the shrimp abundance of the year.

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 these investigations the shrimp at East Greenland was treated as one stock and no areal stratification was used in pooling samples. The number of samples included are presented in table 2.

The length frequency distributions 1991-1996 are shown in fig. 7.

In the years 1991 to 1996 mean shrimp size caught have declined by 3.4mm from 27mm to 23.6mm (table 5).

Modal analysis was applied to the yearly length frequency distributions of the Greenland catches (table 5). 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 and the estimated mean lengths agree very well with her findings.

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), but added the prefix "x" to state that the actual age is a relative rather than an absolute one.

The estimated proportions were applied to the total numbers caught to produce a catch-at-age matrix which was subsequently divided by the unstandardized fishing effort to produce age-specific indices of abundance (table 5 and fig. 8).

The catch rates for all year classes indicate increasing abundance up to about age x7, suggesting only partial recruitment to the fishery, at least up to age x7.

As also noticed in Hvingel *et al.* (1995) the x1991 and x1992 year classes seem to be strong, but also the x1993 year class, which is indicated about seven times stronger than average at the age of x3 (table 5).

This apparent increase in incoming recruitment is also seen in the abundance of xmales (fig. 9) which have been increasing since 1994. xFemale abundance is after a peak in 1994 almost back to the level of 1991-1993.

It is possible, however, that the changes in fishing pattern, noticed above, might mimic good incoming recruitment, and this observation has to be verified in the survey data.

Conclusion

The overall geographical distribution of the Greenland fishery in the Denmark Strait in 1995 was maintained in 1996. However, the traditional area north of 65° was only approached in January.

Catches in 1996 will probably be at the same level as the 1995 catches of about 8,0000 tons. The effort spent in the area seems to stabilize at around 15,000 hours following a decline from more than 40,000 hours in 1989.

The unstandardized catch rates more than doubles from 1993 to 1994 partly due to the higher catch rates in the new fishing grounds south of 65°N, but also caused by an increased abundance in the area north of 65°N as indicated by the standardized CPUE.

In 1995 this enhanced level of abundance is maintained in both areas.

In 1996 abundance in the northern region drops to the lowest level ever and little effort is dedicated to this area.

However, in the southern region unstandardized catch rates are still high and the increased part of total effort spent in this area causes the overall unstandardized catch rates to increase.

The mean size of shrimp caught in the Denmark Strait has decreased in the resent six years. Both due to a reduction in the large female component but in the last three years also caused by an increased recruitment of males to the fishery.

The x1991 and x1992 year classes seem to be strong, but also the x1993 year class, which is indicated about seven times stronger than average at the age of x3.

If this interpretation is true, catch rates might improve in the following years as the individuals of these year classes become fully recruited to the fishery.

References

Carlsson, D. M. & H. Lassen (1991). A catch-rate index for large shrimp in the Greenland shrimp fishery in NAFO Division 1B. *NAFO SCR Doc. 91/57, Serial No. N1941.*

Hvingel, C., Siegstad, H. & Folmer, O. (1995). The commercial Shrimp Fishery in Denmark Strait in 1994 and January-October 1995. *NAFO SCR Doc. 95/112, Serial No. N2651.*

Macdonald, P. D. M. & T. J. Pitcher (1979). Age-groups from size-frequency data: A versatile and efficient method of analysing distribution mixtures. *J. Fish. Res. Board Can., 36: 987-1011.*

McCrary, J. A. (1971). Sternal spines as a characteristic for differentiating between females of some Pandalidae. *J. Fish. Res. Board Can., 28: 98-100.*

Siegstad, H. & D. M. Carlsson (1994). The commercial shrimp fishery in Denmark Strait in 1993 and January-October 1994. *NAFO SCR Doc. 94/91, Serial No. N2478.*

Skúldóttir, U. (1994). The Icelandic shrimp fishery (Pandalus borealis) in the Denmark Strait in 1992-1994, and a preliminary Estimation of age. *NAFO SCR Doc. 94/97, Serial No. N2486.*

Skúldóttir, U. (1996). The Catch Statistics of the Shrimp Fishery (Pandalus borealis) in the Denmark Strait in the years 1980-1996. *NAFO SCR Doc. 96/107, Serial No. N2804.*

Table 1. Total catch and effort of Greenland vessels in Denmark Strait 1987-1996 and by areas north and south of 65°N. (1996 incomplete).

	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	163	2277	2440	1871	5841	7712

Table 2. Number of biological samples (s) taken in the commercial Greenlandic shrimp fishery in the Demmark Strait and actual number of individuals measured (n) to examine size composition of catches.

Year/	1991		1992		1993		1994		1995		1996	
Month	n	s	n	s	n	s	n	s	n	s	n	s
1	14898	30	0	0	0	0	9957	30	3505	13	0	0
2	20127	28	4834	20	16258	56	9334	27	0	0	0	0
3	17872	42	0	0	6560	10	3916	14	6124	15	0	0
4	24286	75	0	0	27933	37	5115	11	0	0	5540	11
5	9861	38	0	0	0	0	0	0	0	0	2571	7
6	12181	24	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	4405	12
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	99225	237	4834	20	50751	103	28322	82	9629	28	12516	30

Table 3. Standardardization of CPUE for total shrimp catches in the Denmark Strait north of 65°N: ANOVA table and parameter estimates (output from the GLM procedure of the SAS-Application).

Dependent Variable: LNCPUE

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	51	176.42330821	3.45928055	23.42	0.0001
Error	683	100.88657936	0.14771095		
Corrected Total	734	277.30988757			

R-Square	C.V.	Root MSE	LNCPUE Mean
0.636196	7.987363	0.38433182	4.81174872

Source	DF	Type III SS	Mean Square	F Value	Pr > F
VESSEL	31	48.78872492	1.57382984	10.65	0.0001
YEAR	9	75.88493348	8.43165928	57.08	0.0001
MONTH	11	81.10422021	7.37311093	49.92	0.0001

Parameter		Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT		3.478470498 B	19.34	0.0001	0.17984189
VESSEL	OUIN	0.035231914 B	0.31	0.7592	0.11487178
	OUIQ	0.324885712 B	2.67	0.0077	0.12148745
	OUKV	0.438341709 B	2.14	0.0331	0.20525853
	OUOQ	0.037787617 B	0.40	0.6893	0.09446669
	OUPJ	0.168997852 B	1.93	0.0538	0.08748215
	OUTM	-0.284529485 B	-2.78	0.0055	0.10221140
	OUWH	0.167783526 B	1.87	0.0622	0.08981978
	OUYM	-0.482439741 B	-3.02	0.0026	0.15955670
	OWDV	-0.290766236 B	-1.92	0.0548	0.15117582
	OWGG	0.364933512 B	2.72	0.0068	0.13434903
	OWLQ	-0.347797491 B	-3.36	0.0008	0.10366441
	OWQU	0.515463650 B	5.34	0.0001	0.09658799
	OWSH	-0.141375213 B	-1.37	0.1726	0.10354754
	OWUD	-0.159230643 B	-0.57	0.5705	0.28057330
	OWUJ	-0.354128513 B	-1.74	0.0827	0.20375652
	OWVM	-0.222142560 B	-2.22	0.0270	0.10024714
	OWWP	0.281509278 B	3.05	0.0024	0.09235630
	OWZR	-0.459642640 B	-2.84	0.0046	0.16185925
	OXSY	-0.306180109 B	-1.90	0.0577	0.16104923
	OYAQ	-0.299705516 B	-1.75	0.0809	0.17144947
	OYBZ	0.281693007 B	3.12	0.0019	0.09039917
	OYCK	0.193836469 B	1.88	0.0604	0.10304919
	OYFF	0.165631874 B	1.29	0.1986	0.12870553
	OYHO	0.564065842 B	7.19	0.0001	0.07843484
	OYKK	-0.146854522 B	-1.72	0.0852	0.08519997
	OYNR	0.028944170 B	0.31	0.7561	0.09314661
	OYNS	-0.067808291 B	-0.74	0.4601	0.09173827
	OYRK	0.154242020 B	1.36	0.1727	0.11300912
	OYRT	0.153303985 B	1.70	0.0889	0.08998738
	OYXT	0.361236883 B	4.03	0.0001	0.08955153
	OZKQ	0.377070193 B	4.03	0.0001	0.09357107
	ZZZZ	0.000000000 B	.	.	.
YEAR	87	1.517004045 B	8.84	0.0001	0.17157555
	88	1.350895277 B	8.05	0.0001	0.16777527
	89	0.946430059 B	5.69	0.0001	0.16632533
	90	0.853497934 B	5.12	0.0001	0.16666029
	91	0.651933315 B	3.89	0.0001	0.16751916
	92	0.321935950 B	1.91	0.0571	0.16895848
	93	0.260039713 B	1.54	0.1245	0.16906034
	94	0.962094751 B	5.49	0.0001	0.17521057
	95	0.775807272 B	4.48	0.0001	0.17299634
	96	0.000000000 B	.	.	.
MONTH	1	0.687468335 B	12.78	0.0001	0.05378964
	2	0.639845400 B	12.01	0.0001	0.05326680
	3	0.428715064 B	7.82	0.0001	0.05481427
	4	0.354206328 B	5.13	0.0001	0.06900880
	5	0.080565105 B	1.05	0.2935	0.07663231
	6	-0.366638456 B	-2.21	0.0272	0.16559251
	7	-0.333481982 B	-1.44	0.1491	0.23088921
	8	-0.467237458 B	-3.72	0.0002	0.12559528
	9	-0.387780128 B	-3.68	0.0003	0.10551324
	10	-0.235067310 B	-2.75	0.0062	0.08560883
	11	-0.368805080 B	-5.20	0.0001	0.07097389
	12	0.000000000 B	.	.	.

Table 4. Standardardization of CPUE for catches of large shrimp (>8.5g) in the Denmark Strait north of 65°N: ANOVA table and parameter estimates (output from the GLM procedure of the SAS-Application).

Dependent Variable: LNCPUE

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	51	178.31339825	3.49634114	28.87	0.0001
Error	670	81.14950716	0.12111867		
Corrected Total	721	259.46290540			

R-Square	C.V.	Root MSE	LNCPUE Mean
0.687240	7.363923	0.34802107	4.72602807

Source	DF	Type III SS	Mean Square	F Value	Pr > F
VESSEL	31	41.20652395	1.32924271	10.97	0.0001
YEAR	9	88.88558783	9.87617643	81.54	0.0001
MONTH	11	84.06667339	7.64242485	63.10	0.0001

Parameter		Estimate		T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT		3.130751849	B	19.18	0.0001	0.16323332
VESSEL	OUIN	0.103726321	B	0.99	0.3212	0.10448548
	OUIQ	0.340104923	B	3.08	0.0021	0.11036467
	OUKV	0.563618665	B	3.03	0.0026	0.18609749
	OUOQ	0.159709368	B	1.80	0.0727	0.08885889
	OUPJ	0.194654349	B	2.44	0.0149	0.07970837
	OUTM	-0.228086553	B	-2.45	0.0144	0.09299381
	OUWH	0.248288013	B	3.01	0.0027	0.08254556
	OUYM	-0.437880818	B	-3.02	0.0026	0.14477998
	OWDV	-0.248258369	B	-1.81	0.0708	0.13716870
	OWGG	0.388015693	B	3.18	0.0015	0.12195657
	OWLQ	-0.263904073	B	-2.80	0.0053	0.09434870
	OWQU	0.571514590	B	6.50	0.0001	0.08790754
	OWSH	-0.097287336	B	-1.03	0.3021	0.09420802
	OWUD	-0.243074033	B	-0.96	0.3395	0.25428220
	OWUJ	-0.374369260	B	-2.03	0.0431	0.18474883
	OWVM	-0.200476176	B	-2.17	0.0305	0.09244874
	OWWP	0.344037450	B	4.09	0.0001	0.08411681
	OWZR	-0.399385000	B	-2.72	0.0068	0.14701713
	OXSY	-0.242510627	B	-1.66	0.0975	0.14613040
	OYAQ	-0.272475302	B	-1.75	0.0802	0.15551672
	OYBZ	0.315983626	B	3.81	0.0002	0.08304010
	OYCK	0.176320073	B	1.88	0.0605	0.09377968
	OYFF	0.162897540	B	1.39	0.1639	0.11688366
	OYHO	0.480273846	B	6.69	0.0001	0.07178668
	OYKK	-0.025983647	B	-0.33	0.7443	0.07964412
	OYNR	0.063620815	B	0.75	0.4533	0.08478696
	OYNS	-0.026779183	B	-0.32	0.7486	0.08351265
	OYRK	0.195700558	B	1.91	0.0571	0.10269388
	OYRT	0.248093038	B	3.00	0.0028	0.08258575
	OYXT	0.402072578	B	4.93	0.0001	0.08158755
	OZKQ	0.417677904	B	4.90	0.0001	0.08518514
	ZZZZ	0.000000000	B	.	.	.
YEAR	87	1.698563131	B	10.91	0.0001	0.15575415
	88	1.665768178	B	10.95	0.0001	0.15207792
	89	1.253040222	B	8.32	0.0001	0.15065990
	90	1.098507566	B	7.27	0.0001	0.15107873
	91	0.846597408	B	5.58	0.0001	0.15176166
	92	0.515714158	B	3.37	0.0008	0.15319307
	93	0.402508458	B	2.63	0.0088	0.15321033
	94	0.976372099	B	6.15	0.0001	0.15868025
	95	0.873874848	B	5.58	0.0001	0.15666699
	96	0.000000000	B	.	.	.
MONTH	1	0.703348324	B	14.37	0.0001	0.04894000
	2	0.649492507	B	13.38	0.0001	0.04852833
	3	0.404695003	B	8.11	0.0001	0.04989847
	4	0.332489736	B	5.20	0.0001	0.06392540
	5	0.027334734	B	0.38	0.7032	0.07171172
	6	-0.444876056	B	-2.96	0.0031	0.15005176
	7	-0.314911143	B	-1.51	0.1326	0.20915073
	8	-0.463571715	B	-4.07	0.0001	0.11393618
	9	-0.426490628	B	-4.46	0.0001	0.09571482
	10	-0.291095228	B	-3.74	0.0002	0.07779284
	11	-0.355592640	B	-5.35	0.0001	0.06651366
	12	0.000000000	B	.	.	.

Table 5. Output from the modal analysis of annual length frequency distributions in the commercial Greenland catches in the Denmark Strait. Numbers caught as derived from the calculated proportions and age specific catch rates are also shown. (The prefix "x" is used to illustrate that the ageing is a relative rather than an absolute one).

Mean Cpl. length (mm)

Year/Year class	1991	1992	1993	1994	1995	1996
x3	19.4	19.0	19.3	19.1	19.2	19.2
x4	21.5	21.5	21.3	21.0	21.2	21.1
x5	23.8	24.1	23.2	23.0	23.0	23.2
x6	26.2	26.3	25.7	25.1	25.2	26.0
x7	29.7	29.7	28.5	27.6	28.3	28.0
x8+	31.6	31.2	30.9	30.3	30.9	30.7

Mean Length of total catch (mm)

Year	1991	1992	1993	1994	1995	1996
Mean	27.0	26.5	26.3	26.4	25.4	23.6

Proportion of total catch

Year/Year class	1991	1992	1993	1994	1995	1996
x3	0.03	0.04	0.02	0.03	0.05	0.13
x4	0.12	0.16	0.10	0.07	0.13	0.27
x5	0.20	0.22	0.21	0.16	0.20	0.24
x6	0.16	0.17	0.29	0.22	0.27	0.17
x7	0.36	0.29	0.21	0.31	0.27	0.18
x8+	0.13	0.12	0.17	0.22	0.08	0.01

Number caught (millions)

Year/Year class	1991	1992	1993	1994	1995	1996
x3	11	7	5	9	18	31
x4	42	26	18	19	44	64
x5	70	35	40	48	72	57
x6	55	27	54	65	97	41
x7	123	46	40	93	96	43
x8+	43	19	32	66	27	2
Total	345	161	188	299	353	238

Number caught per hour (unstandardized)

Year/Year class	1991	1992	1993	1994	1995	1996
x3	314	350	233	621	1174	3984
x4	1151	1320	931	1391	2878	8308
x5	1941	1784	2045	3467	4697	7382
x6	1513	1377	2763	4623	6285	5343
x7	3397	2330	2055	6635	6239	5559
x8+	1199	978	1667	4687	1773	309
Total	9514	8147	9694	21402	23024	30886

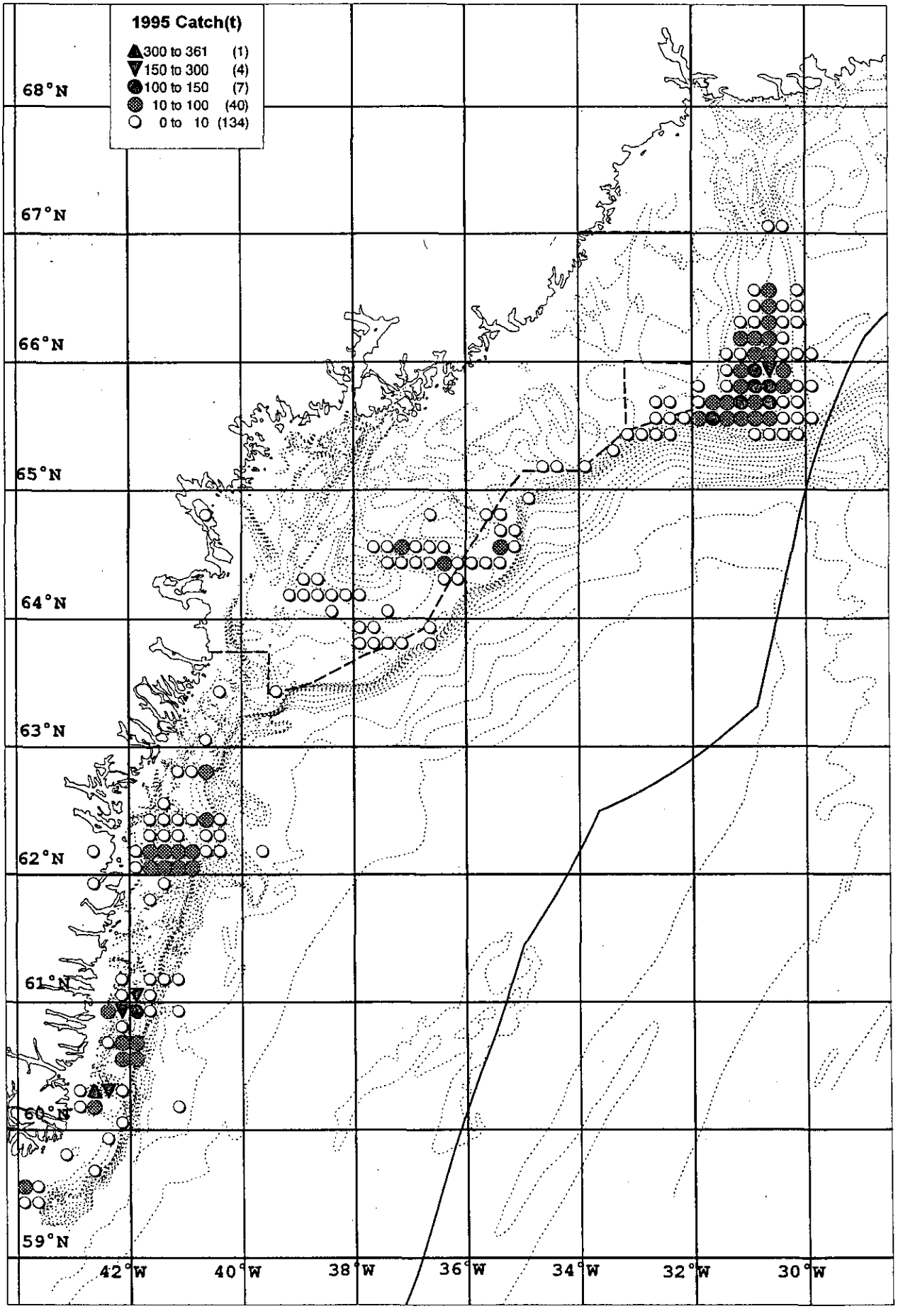


Fig 1. The geographical distribution of the Greenland catches in *1995* as recorded in vessel logs.

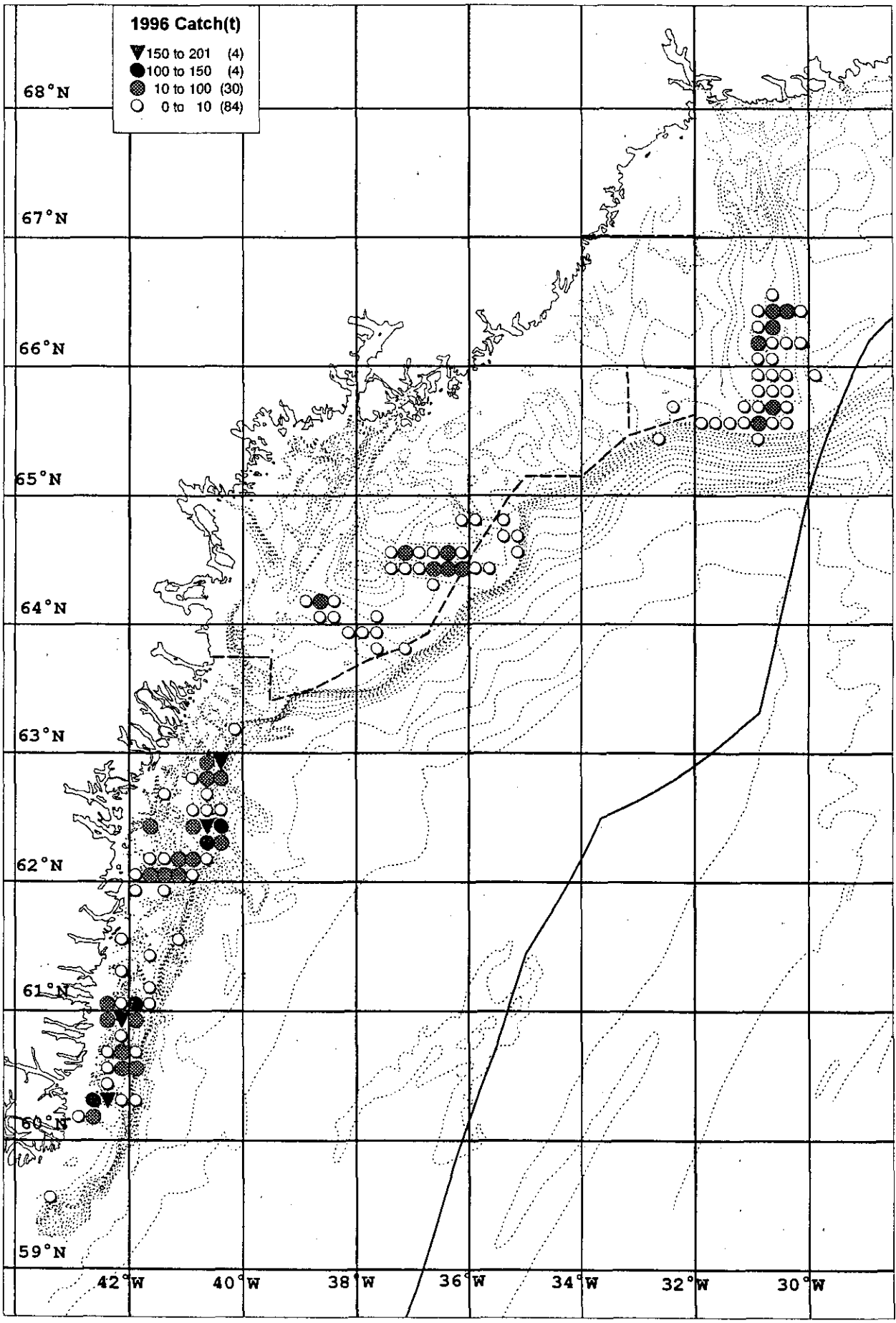
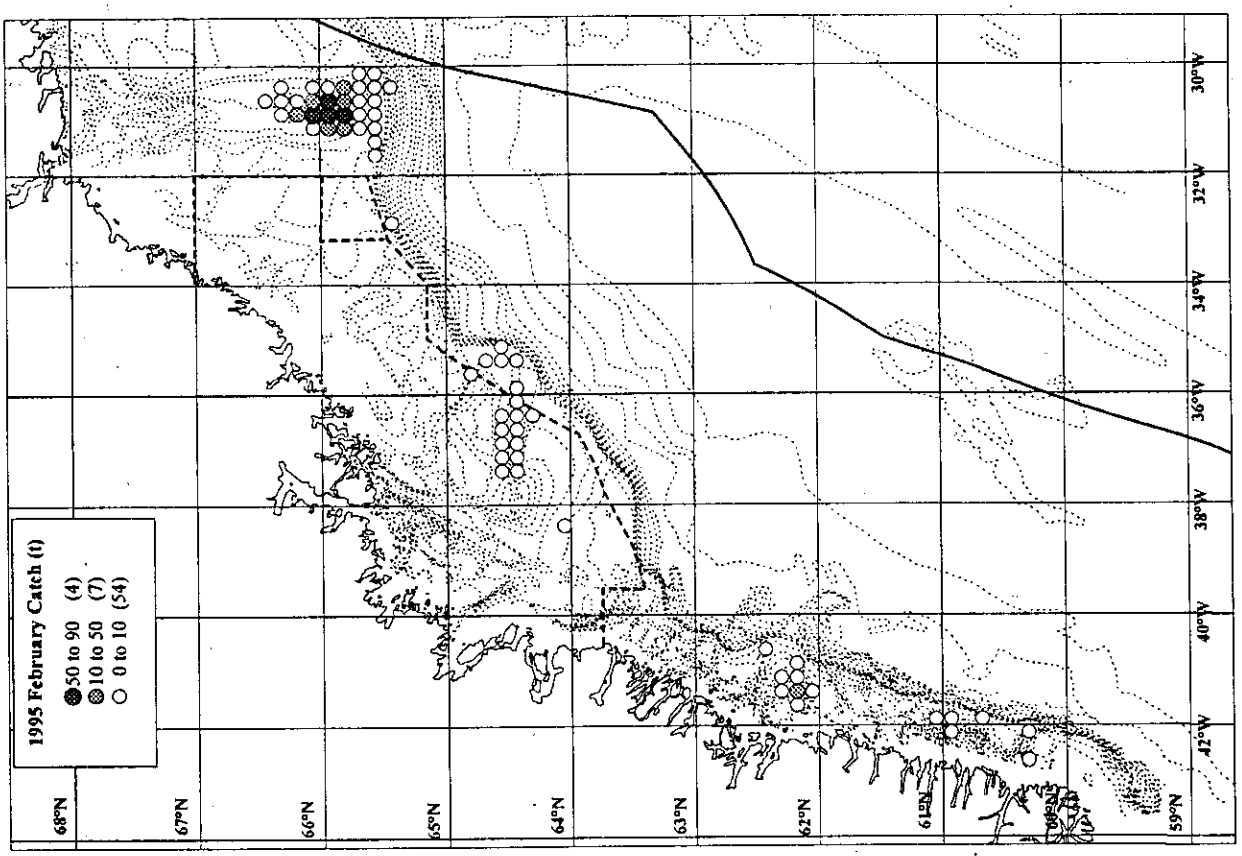


Fig 2. The geographical distribution of the Greenland catches in 1996 as recorded in vessel logs.



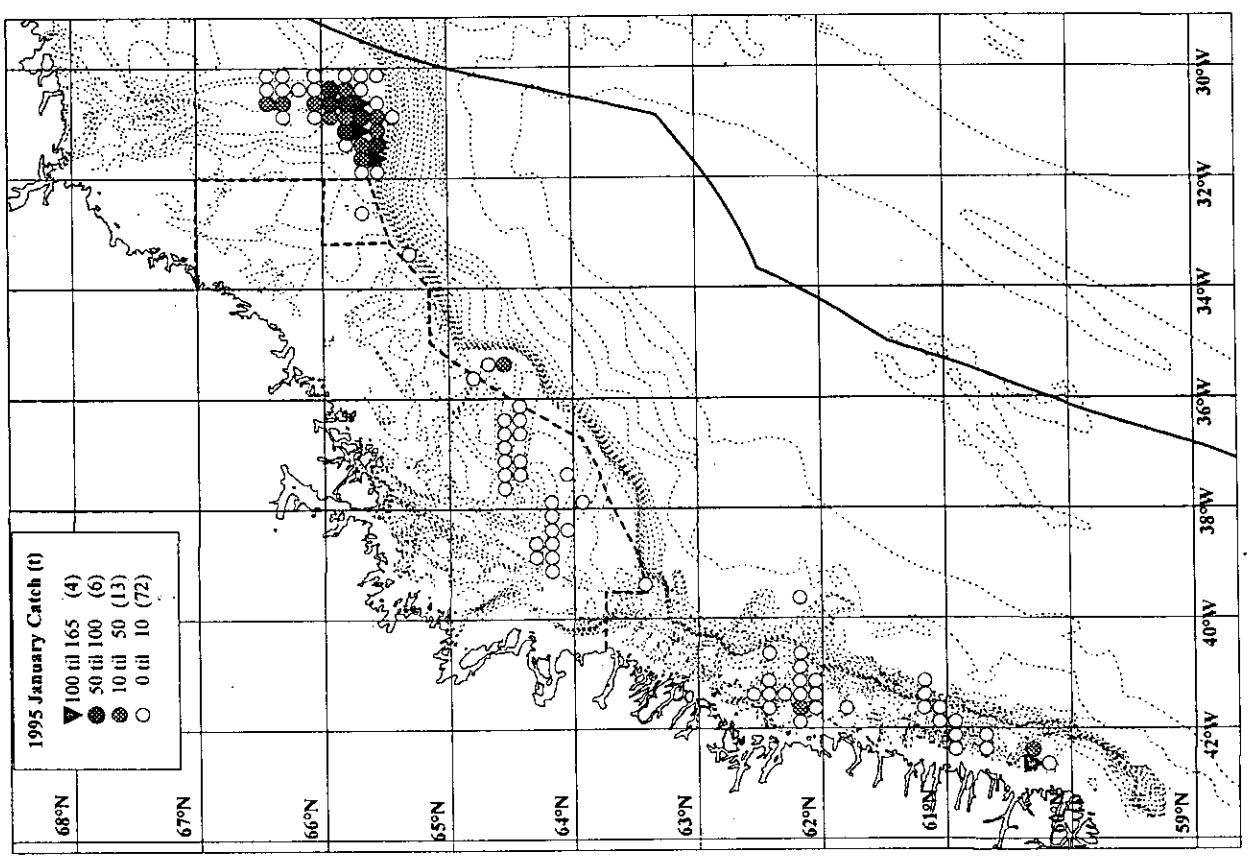
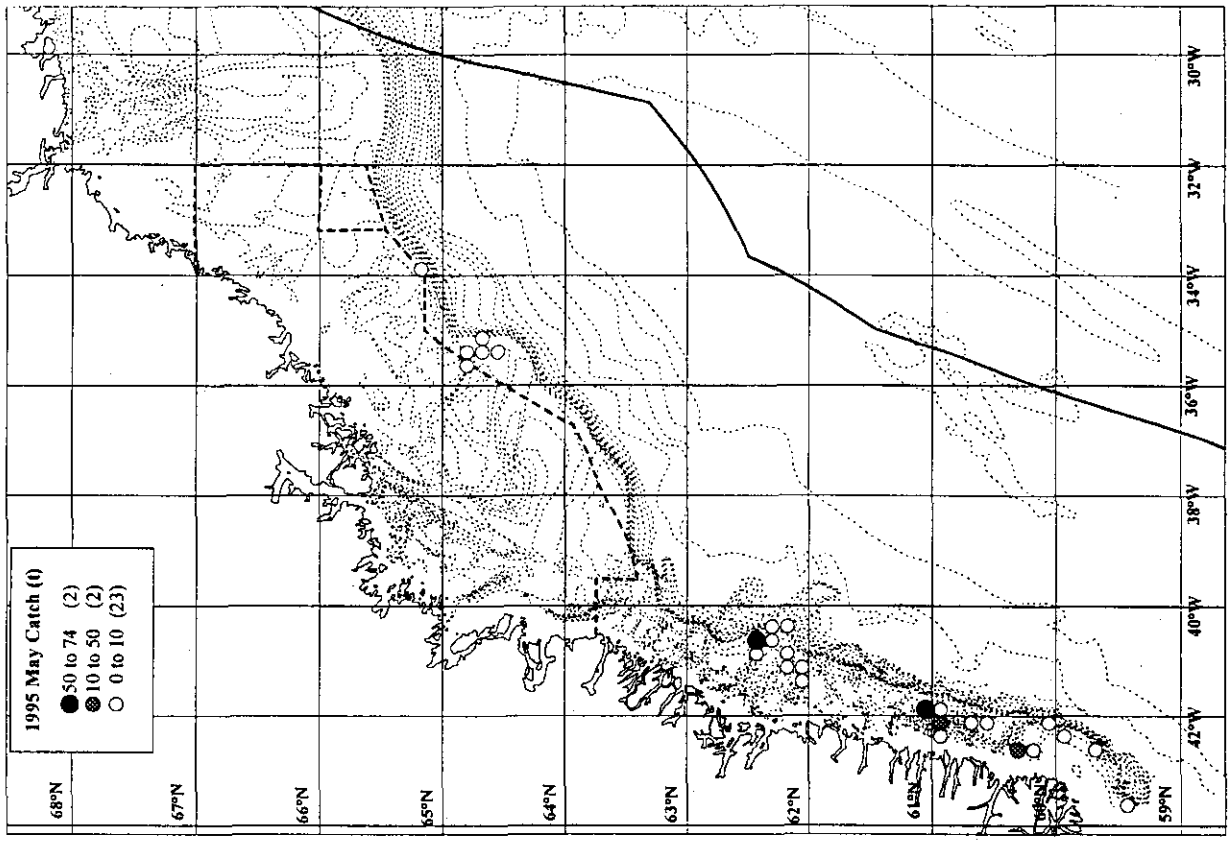


Fig 3. The geographical distribution of catches by Greenland vessels (logbook data) by month from January 1995 to August 1996. Note the figure continues on the following pages.



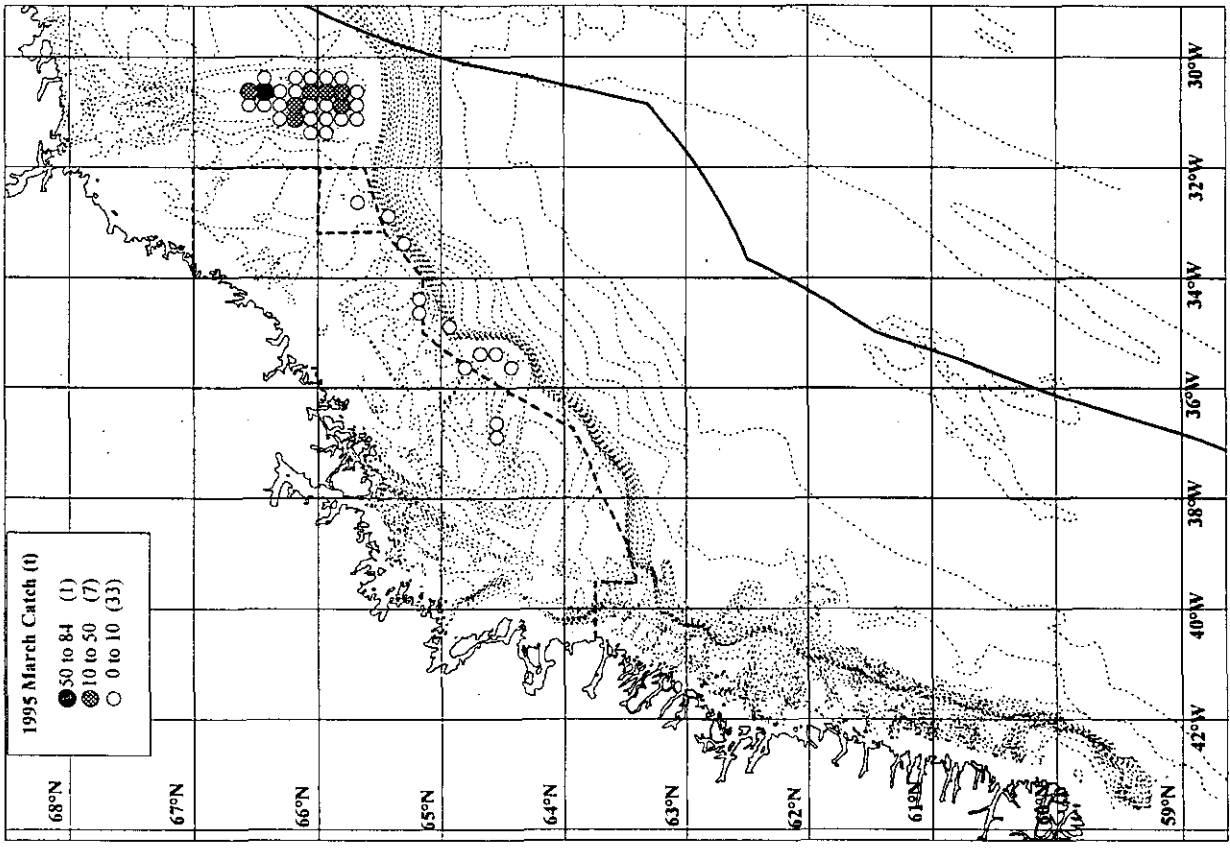
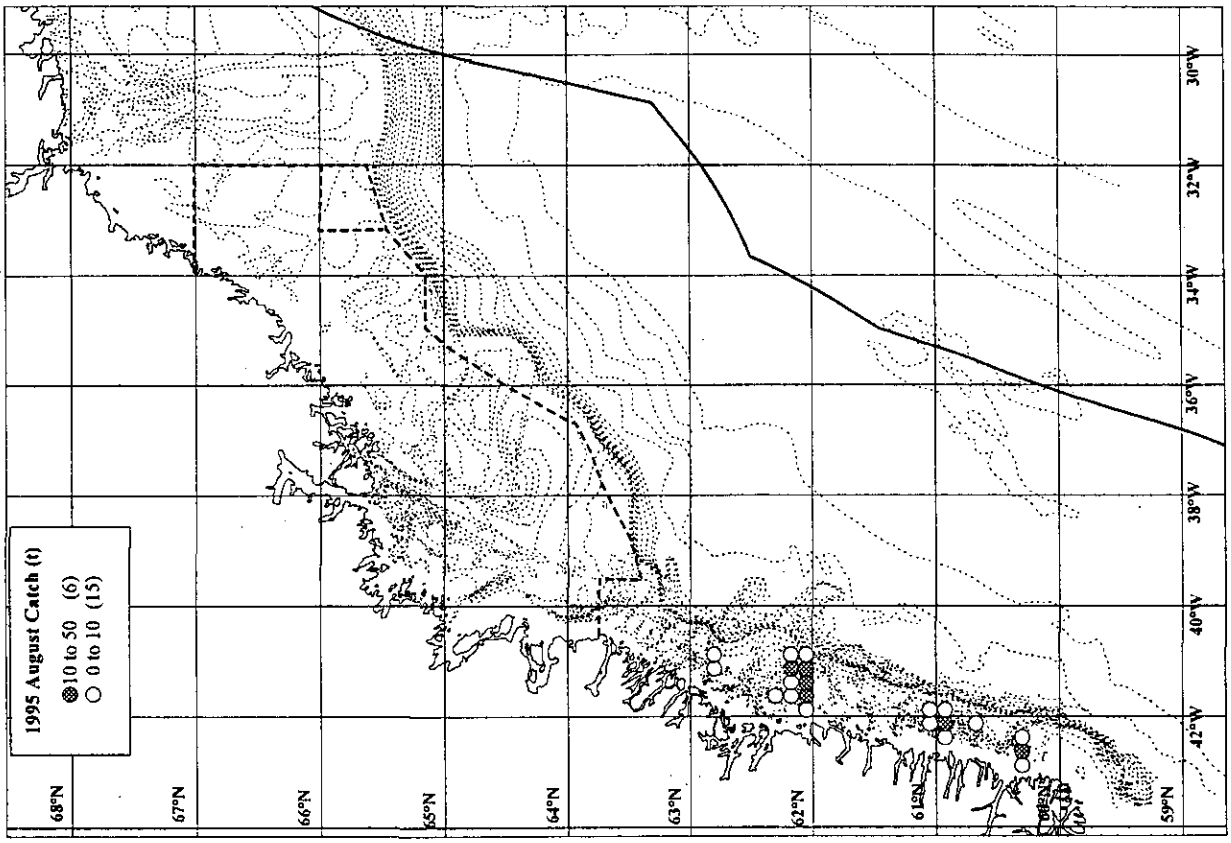


Fig 3. continued..



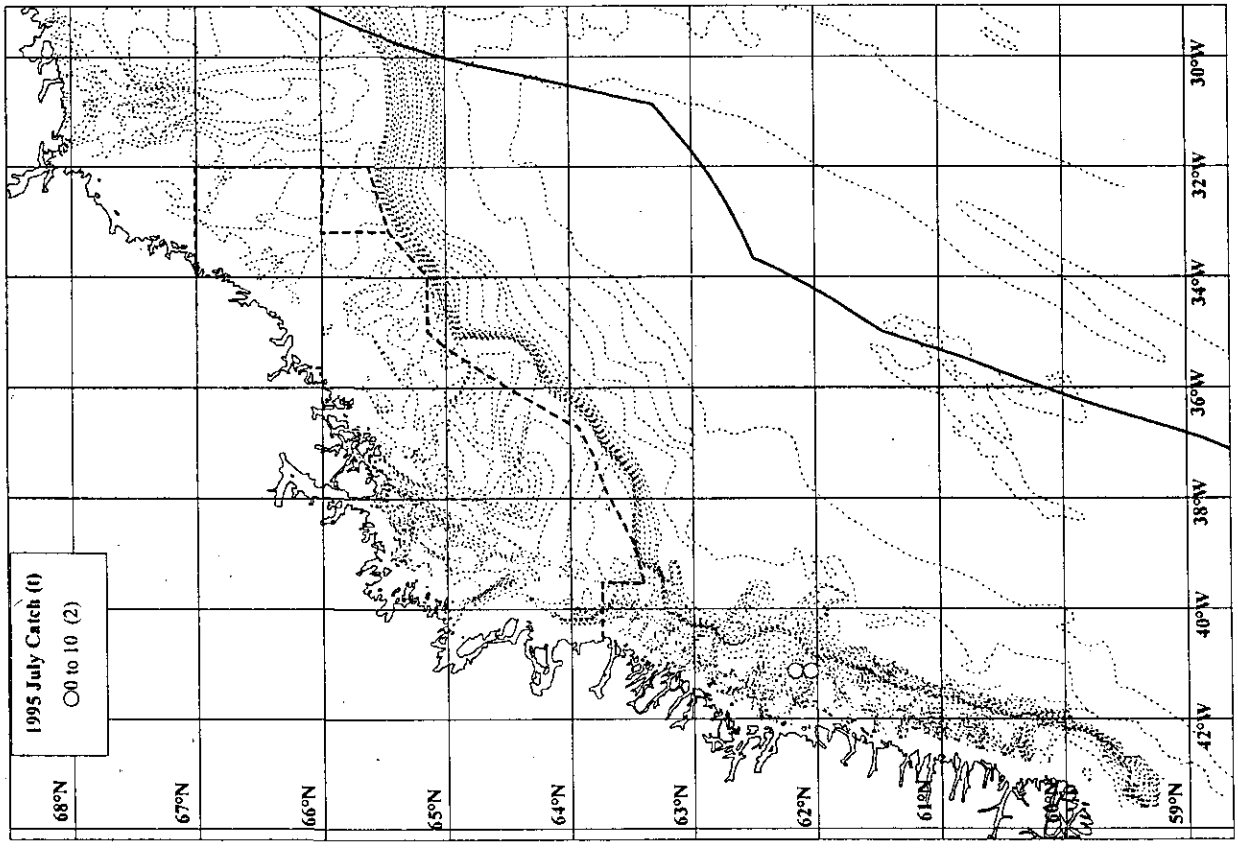
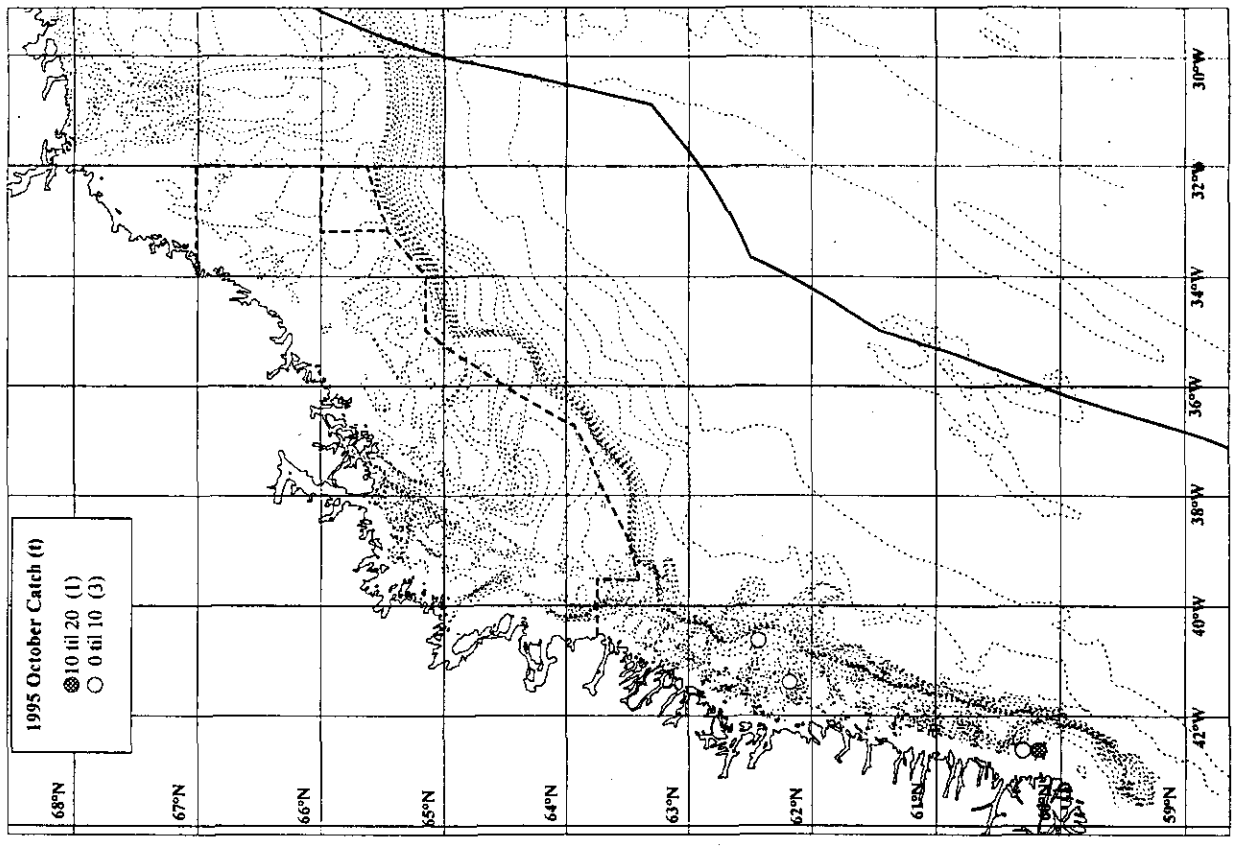


Fig 3. continued..



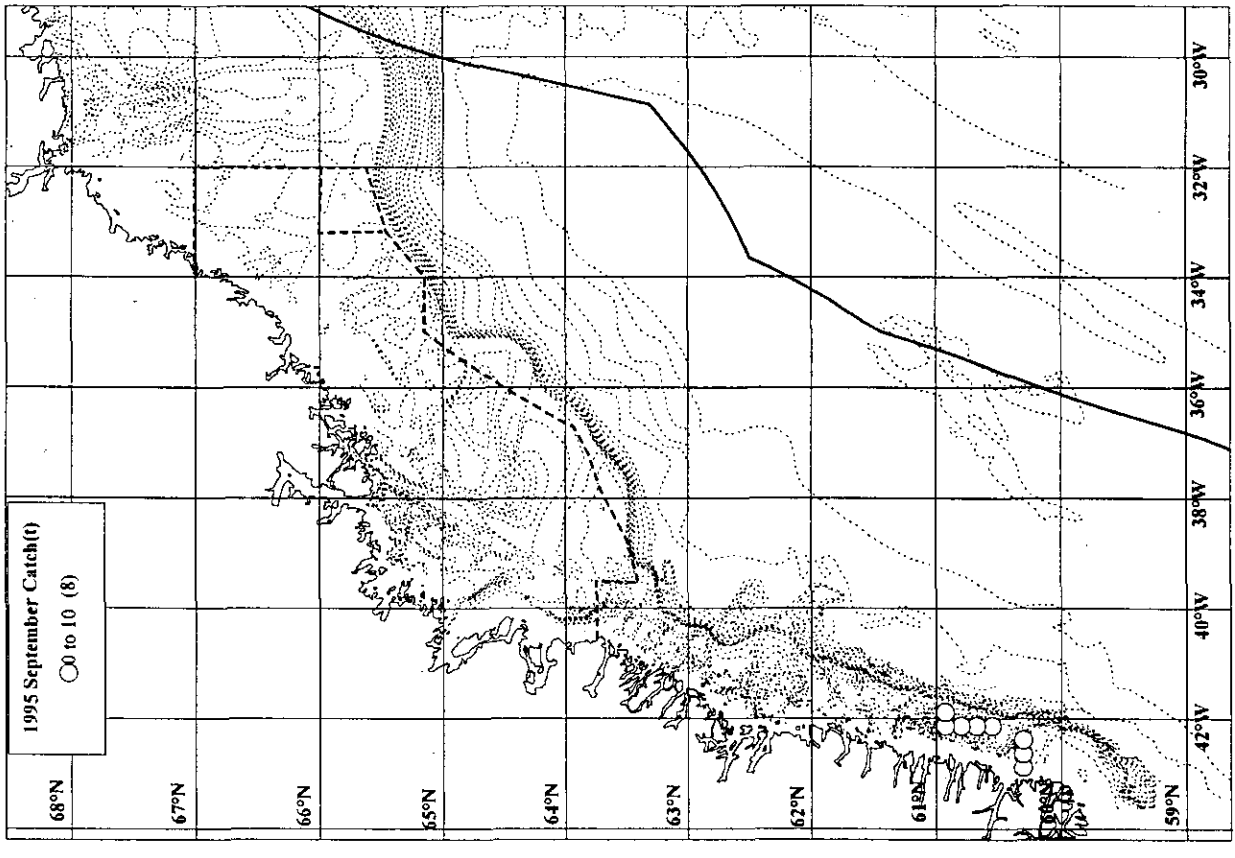
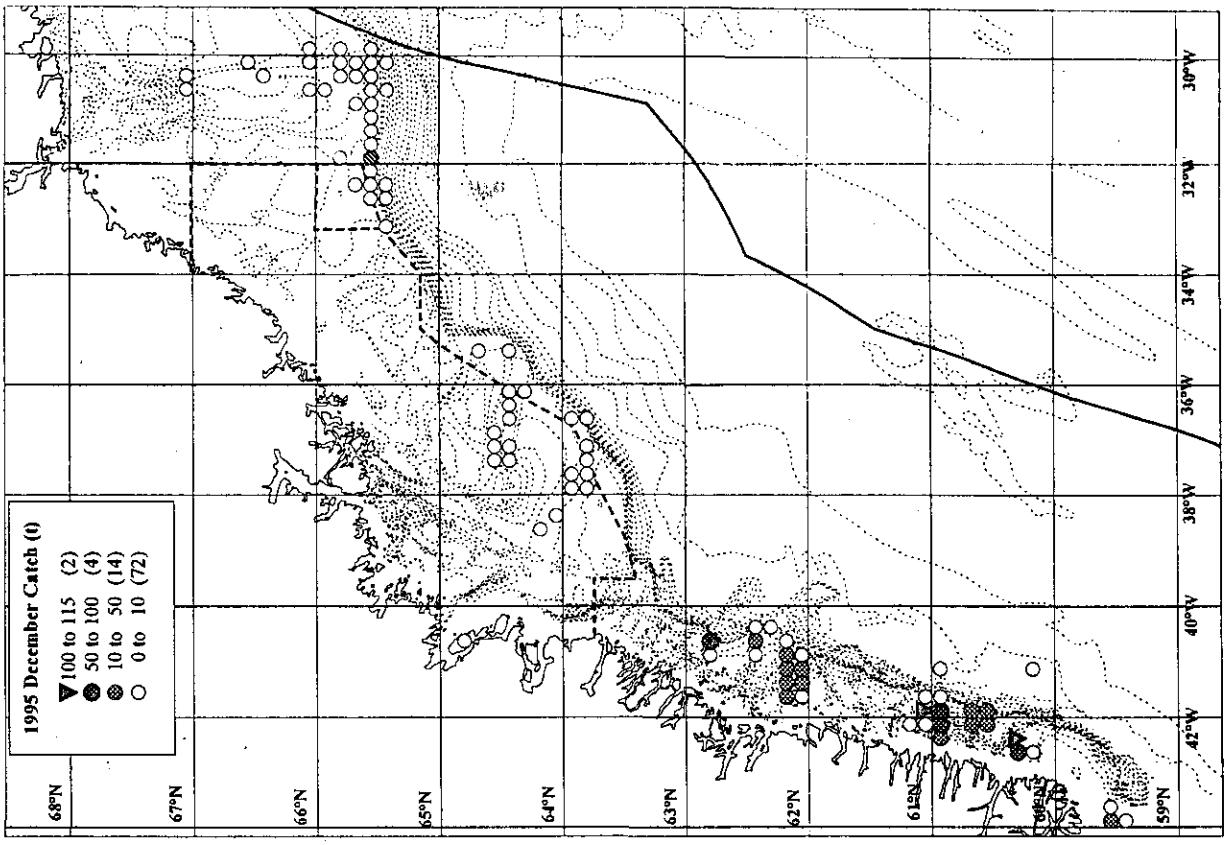


Fig 3. continued..



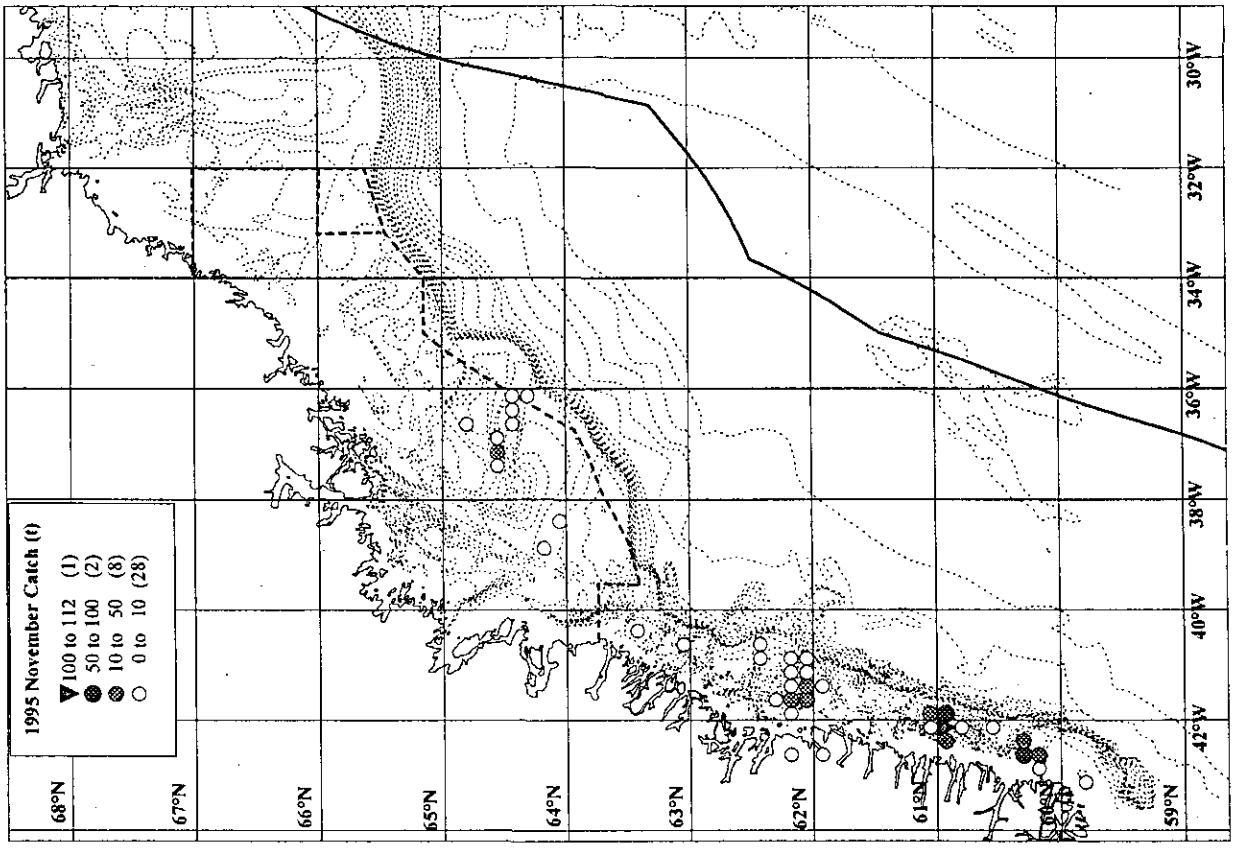
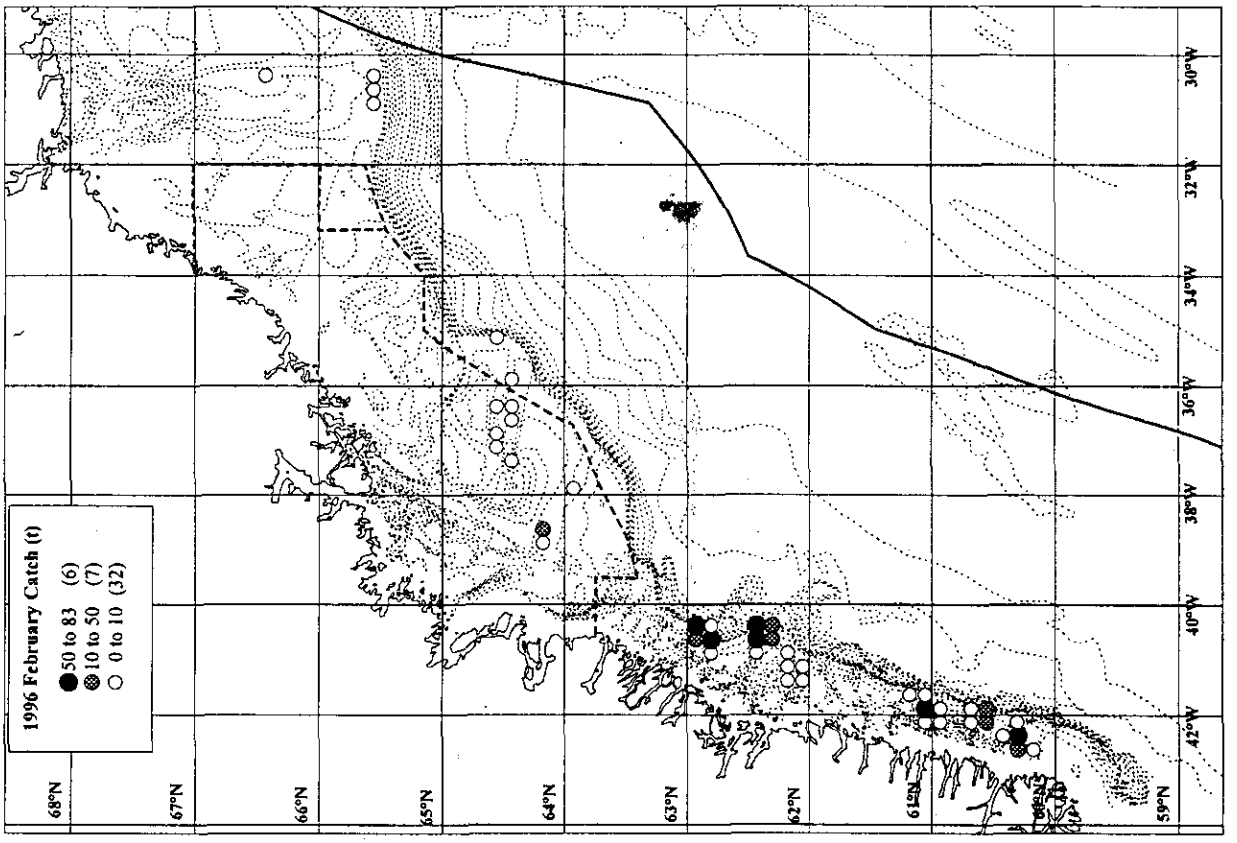


Fig 3. continued..



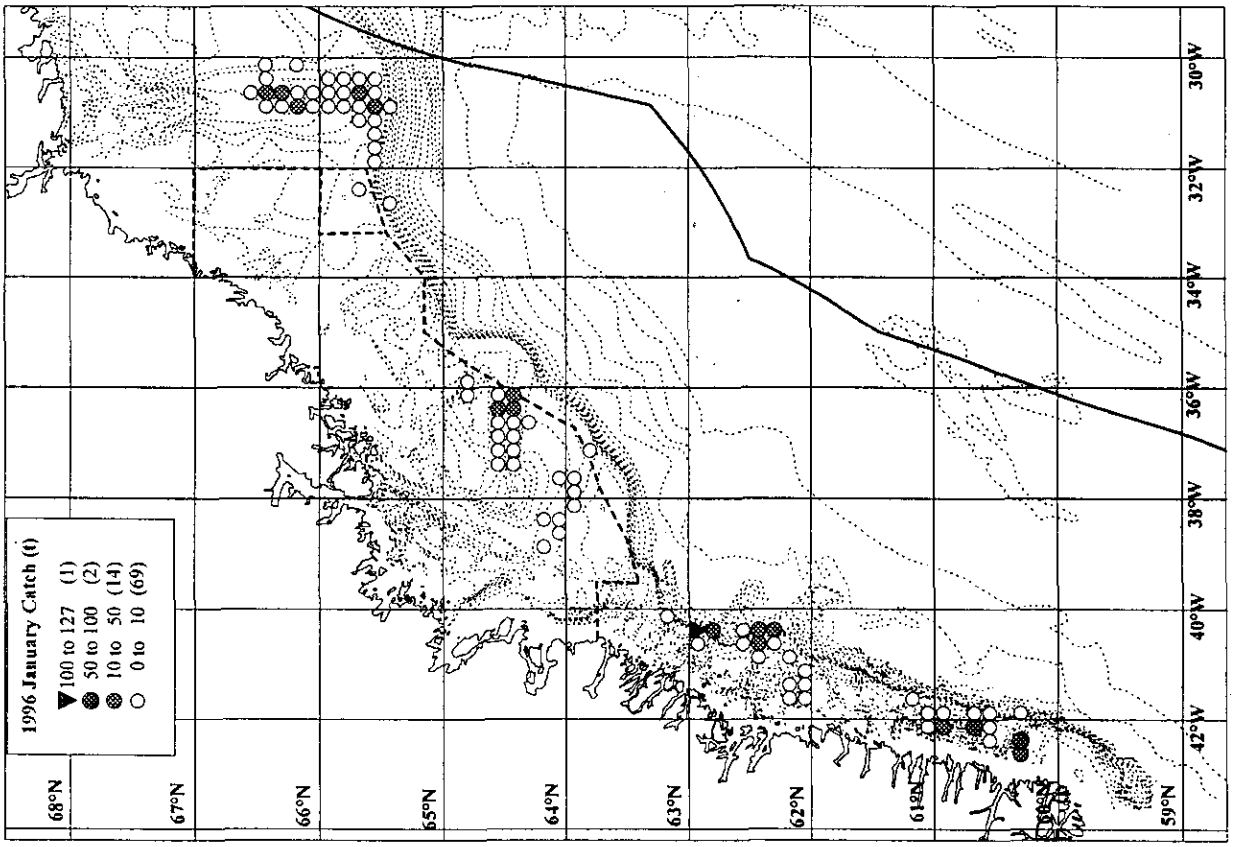
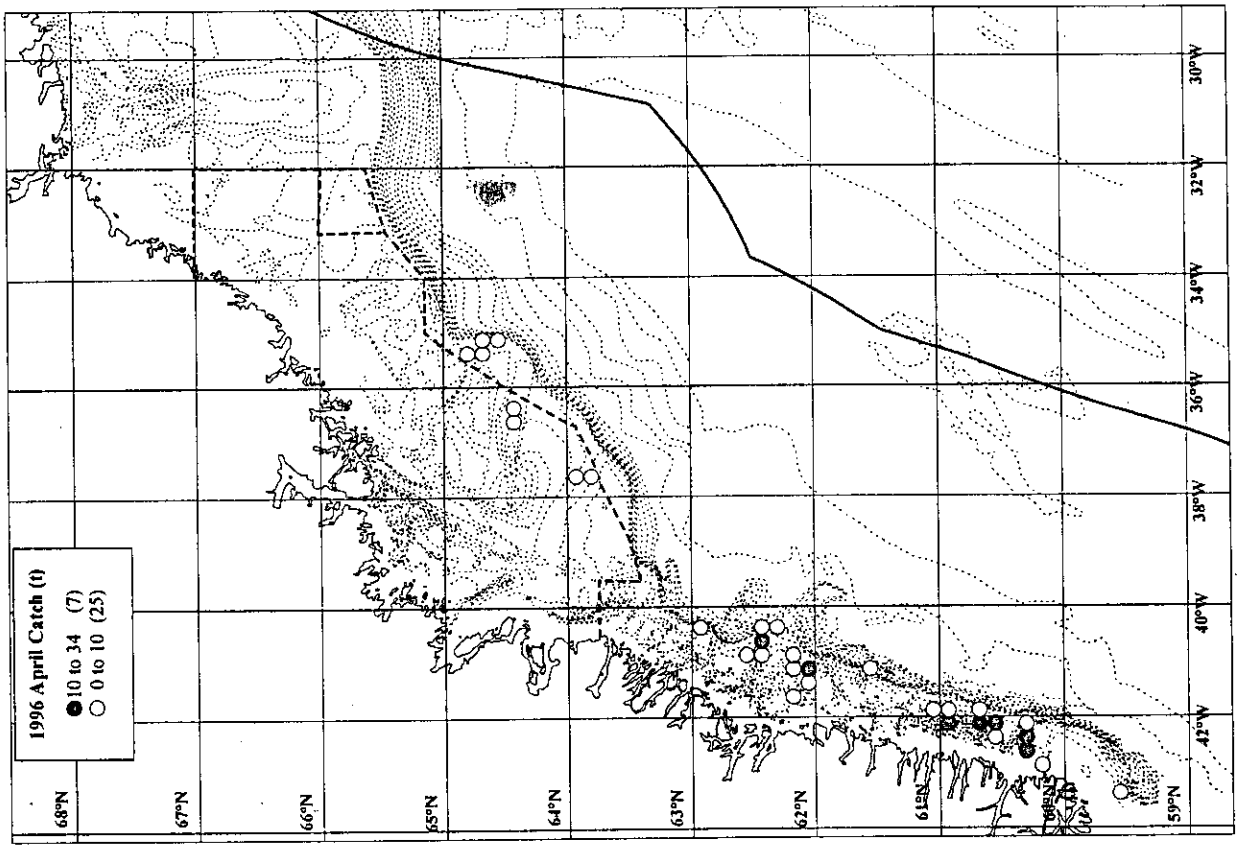


Fig 3. continued..



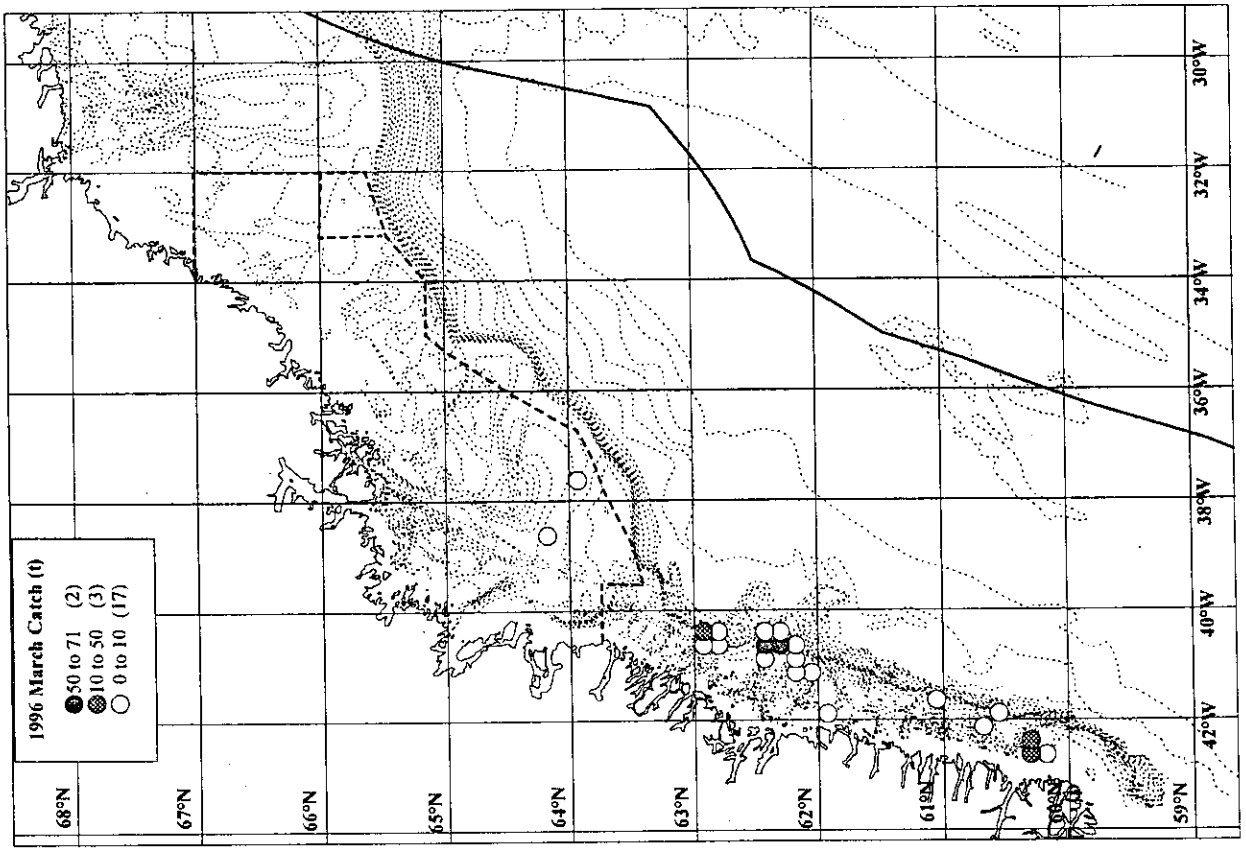
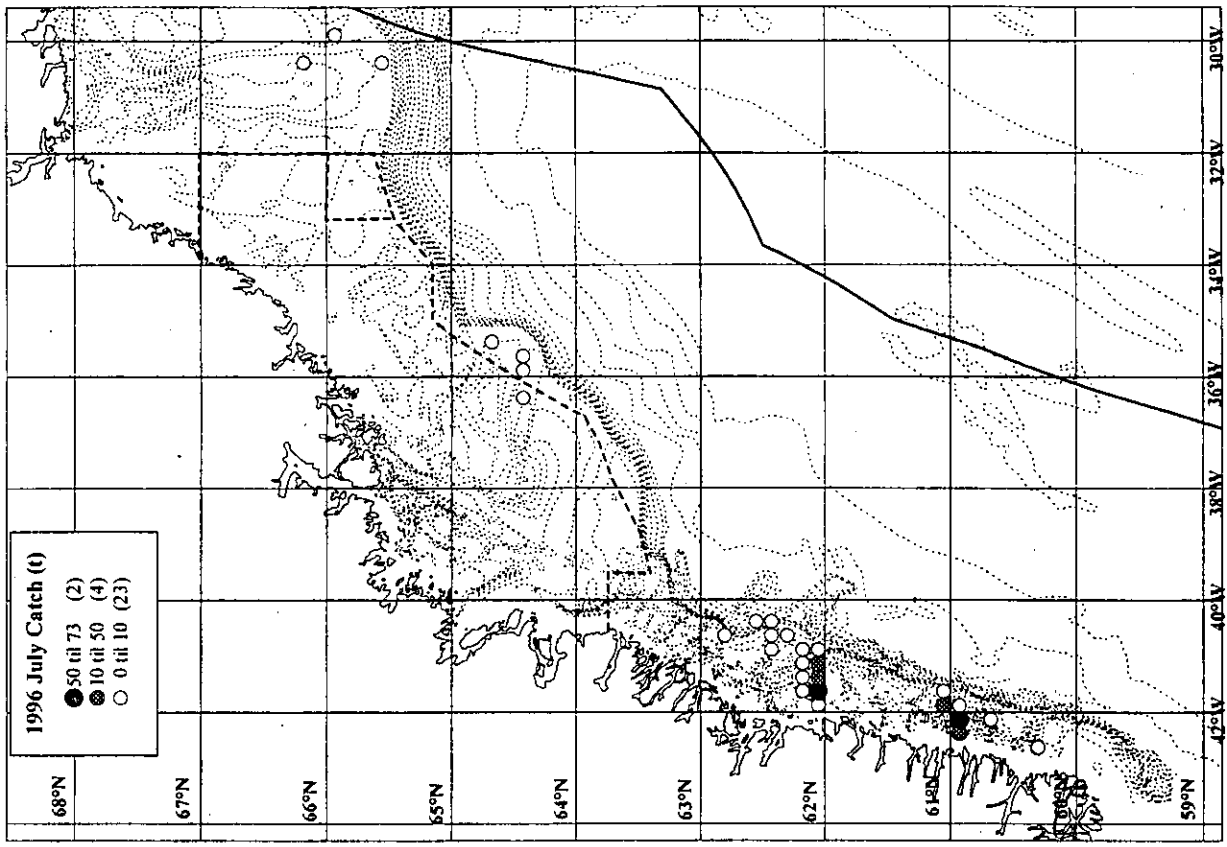


Fig 3. continued..



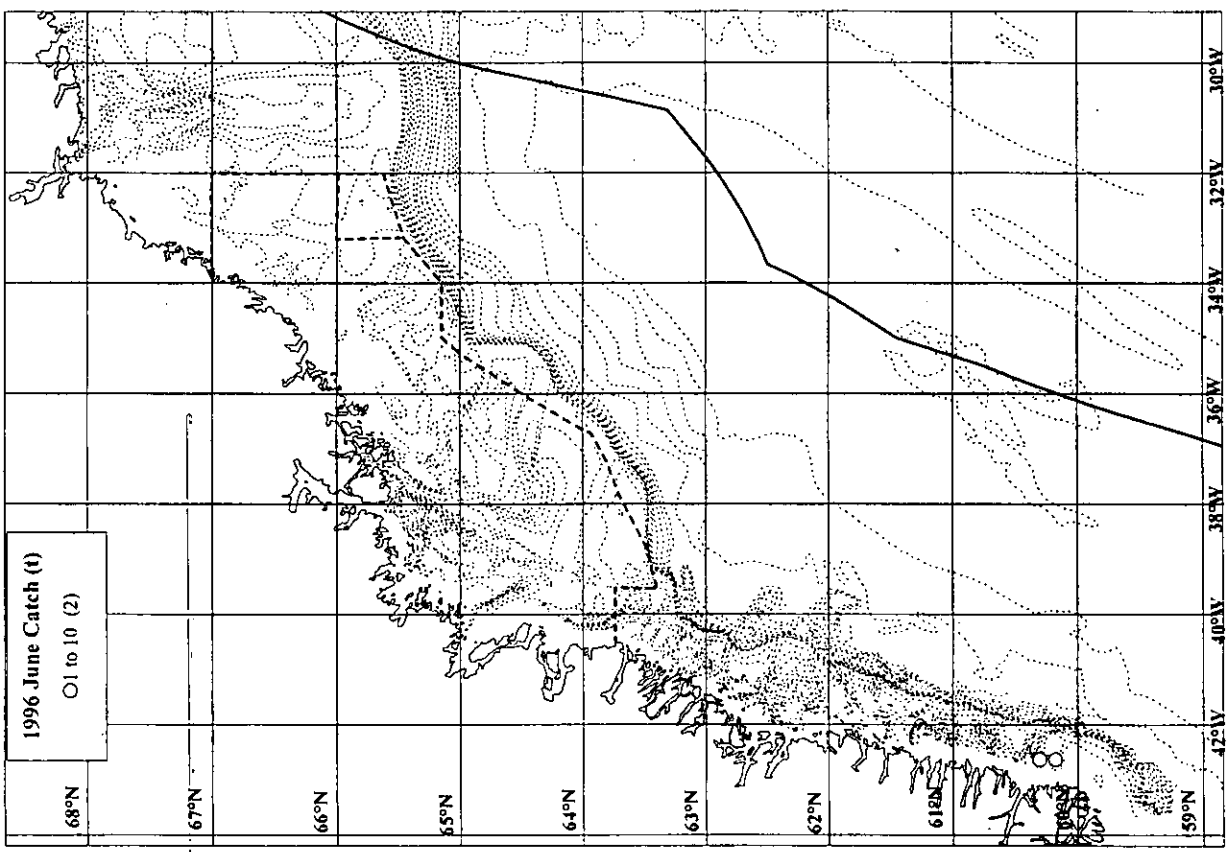


Fig 3. continued..

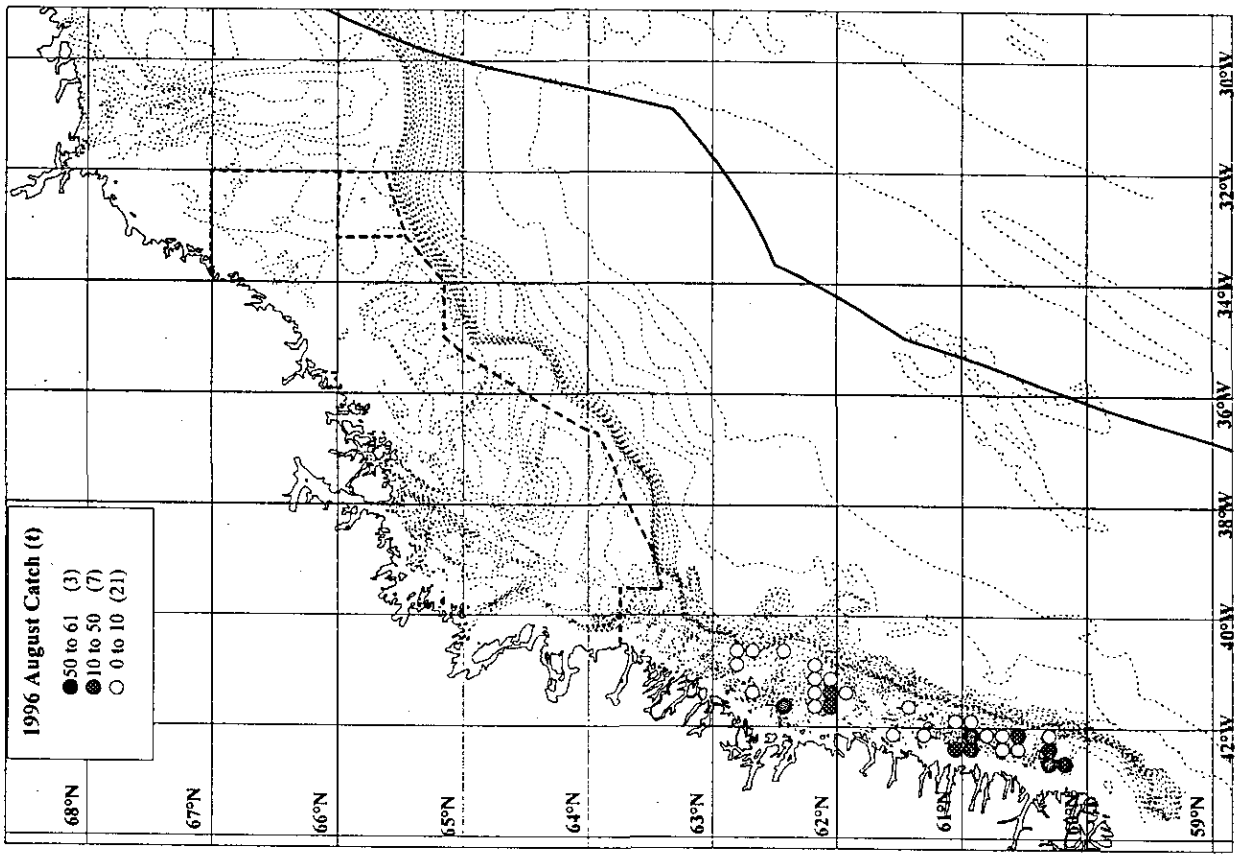


Fig 3. continued..

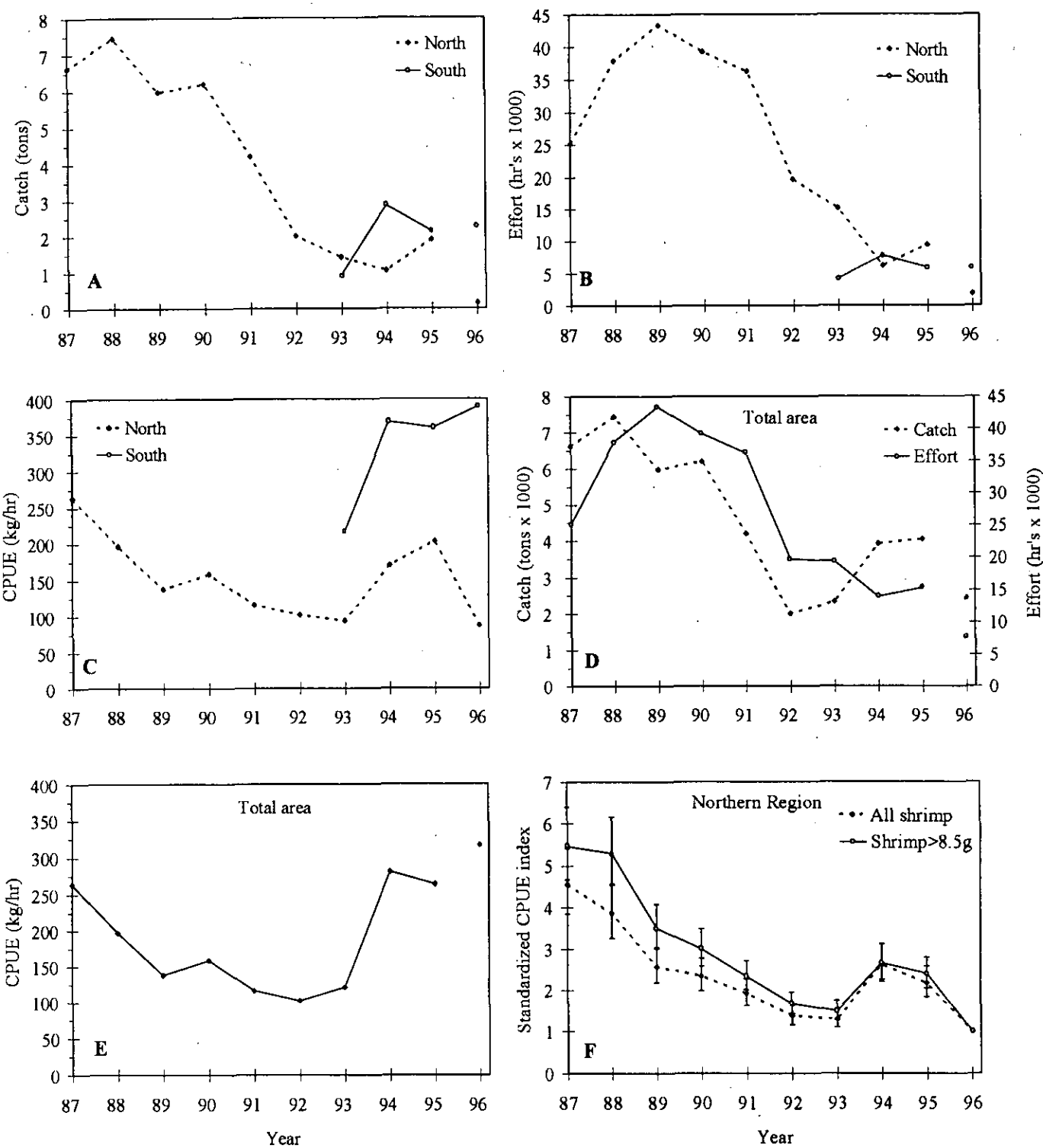


Figure 4. Catch, effort and CPUE by Greenland vessels in the Denmark Strait. Graph A, B, C: north and south of 65°N. Graph D,E: Total area. Graph F: standardized CPUE for shrimp>8.5g and total catch north of 65°N. (Note that data for 1996 are incomplete).

Figure 5. Model diagnostical output from the estimation of the CPUE index of total catches.

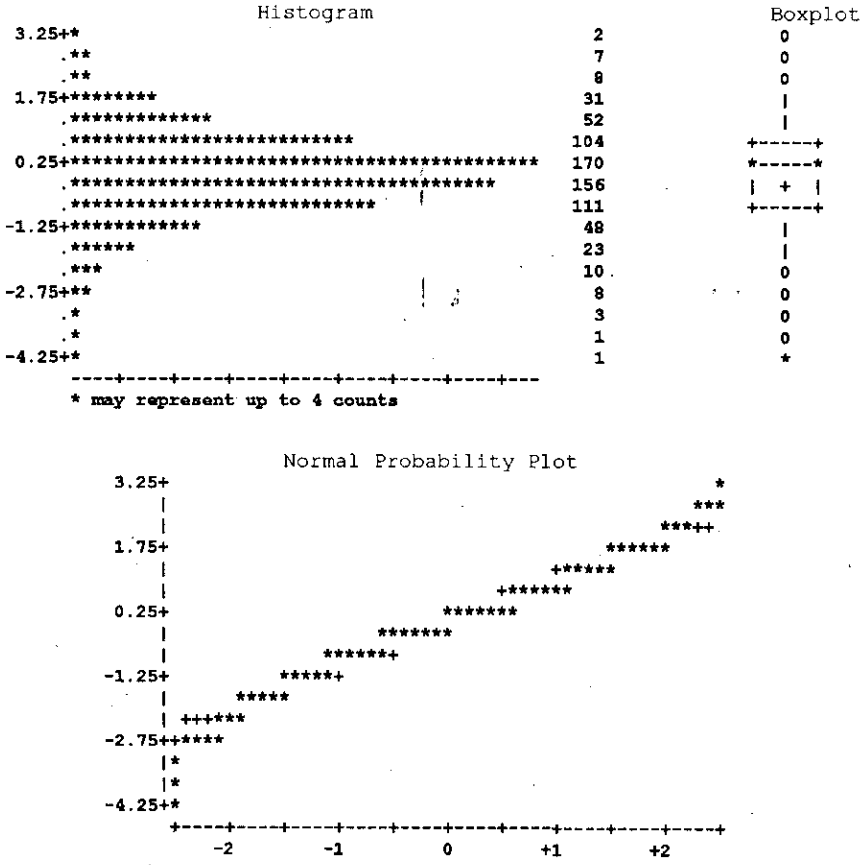
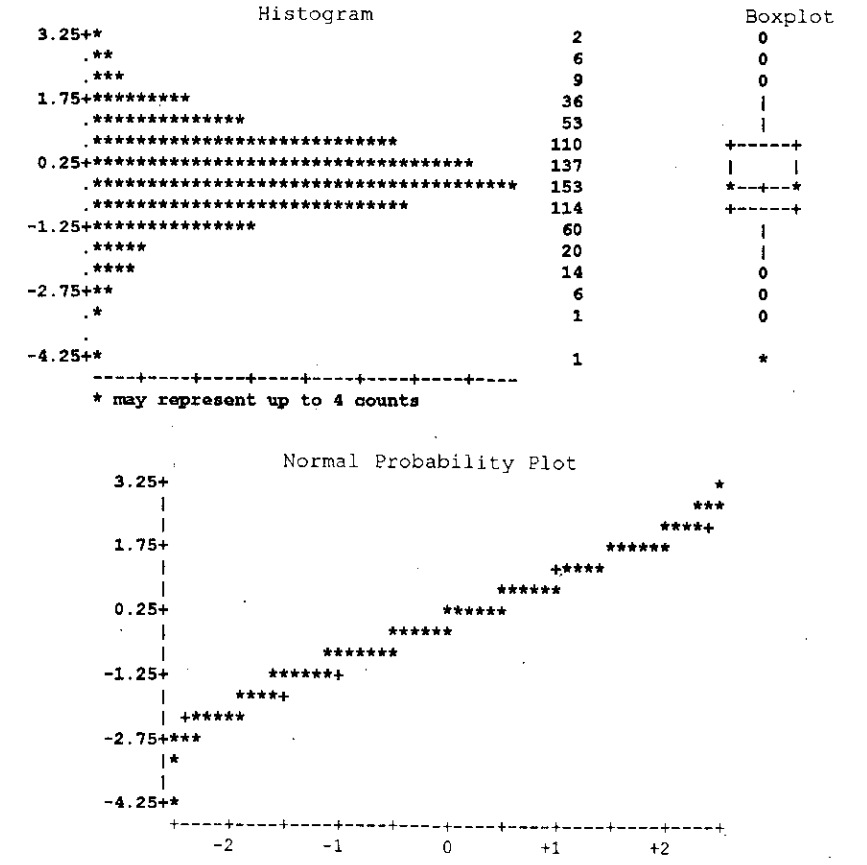


Figure 6. Model diagnostical output from the estimation of the CPUE index of shrimp > 8.5g.



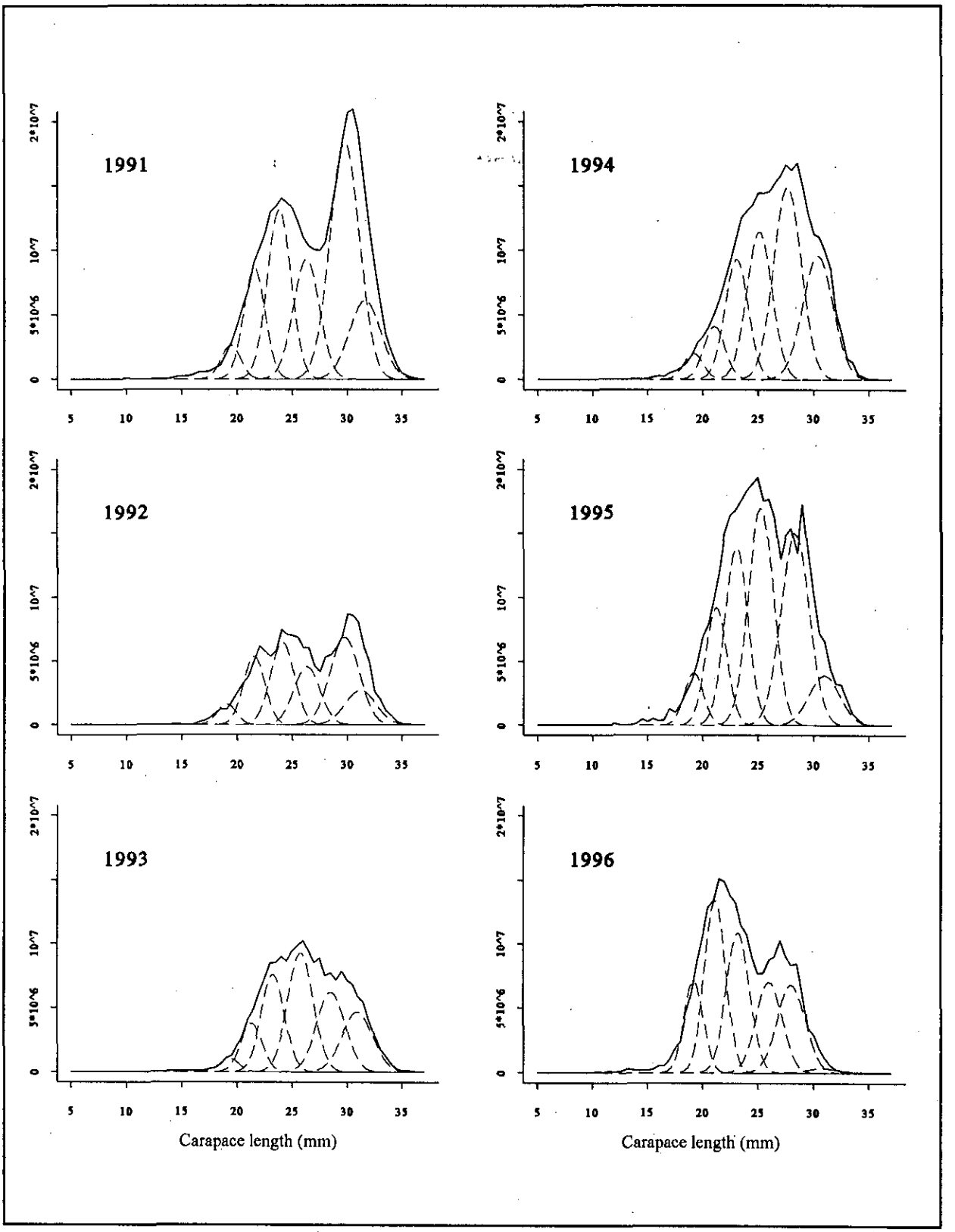


Figure 7. Length frequency distributions of shrimp caught in the commercial fishery in Denmark Strait by Greenland (solid line). The dotted lines indicate the distributions of 6 year classes, as calculated by modal analysis (Macdonnal and Pitcher, 1979). The year class of the largest shrimp probably contain more older year classes.

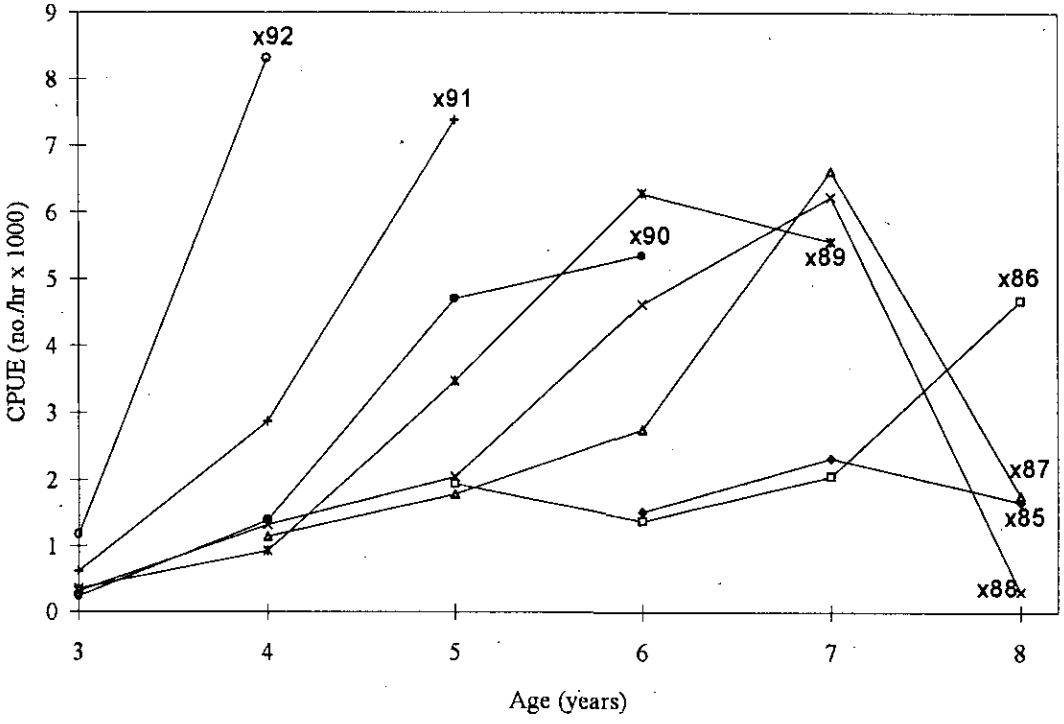


Figure 8. Unstandardized CPUE (numbers/hr. x 1000) of the year classes x1985 - x1992 of the Greenland fishery in Denmark Strait 1991-1996. The figures were estimated from samples of catch and logbook data.

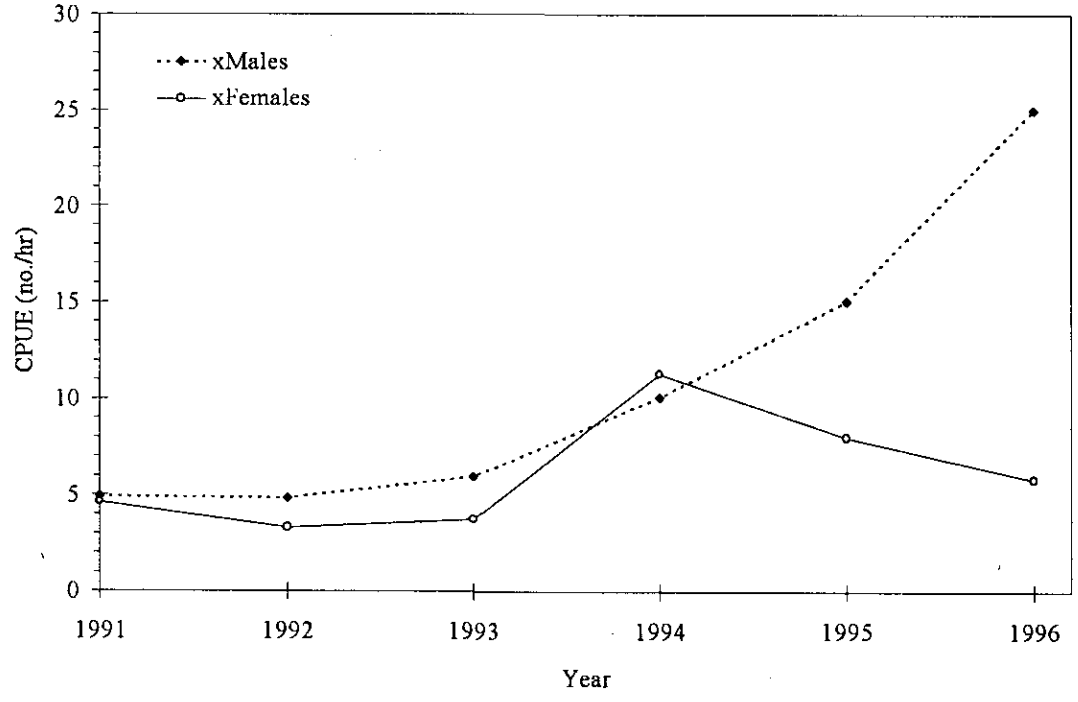


Figure 9. Unstandardized catch rates (numbers/hr.) of age x3-x6 and age x7-x8+ of the Greenland fishery in Denmark Strait 1991-1996. The figures were estimated from samples of catch and logbook data.