Northwest Atlantic Fisheries Organization

Serial No. N2955 NAFO SCR Doc. 97/98

SCIENTIFIC COUNCIL MEETING - NOVEMBER 1997

The Greenlandic Fishery for Northern Shrimp (*Pandalus borealis*) off West Greenland, 1970-1997

by

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Introduction

The shrimp stock at West Greenland is confined to NAFO Subarea 1 and Div. 0A. In accordance with the recommendations by STACFIS in November 1993 (Anon., 1993), this stock is assessed as a single population.

Two Greenlandic fleet components exploit the stock in Subarea 1: the offshore fleet, which at present consists of 17 large factory trawlers and the small vessel fleet composed of about 100 vessels below 80 GRT. The offshore fleet component is restricted to offshore areas and by quotas. With few exceptions vessels below 80 GRT were unrestricted by areas and quotas until 1997 when a TAC was set also for the small vessel fleet.

Since 1986 logbooks have been mandatory for all vessels above 50 GRT fishing in Greenlandic waters and from 1997 for all vessels. Until 1997 catch from vessels below 50 GRT can only be estimated from sales slips.

In 1996 Greenlandic shrimp trawlers reported a total catch in SA 1 of 66,610 tons including 17,359 tons taken in the inshore areas. This represents a decline of about 2,000 tons compared to the previous year.

From Jan-Oct 1997 reported catches amounted to 56,060 tons of which 9,849 tons were taken inshore. The total 1997 catch is projected to be at the 1996 level.

The present paper updates time series of total catch, catch composition, effort, CPUE-indices and spatial distribution of the Greenlandic shrimp fishery off West Greenland.

Materials and methods

Total catches were estimated from vessel logs and weekly reporting to Greenlandic authorities by vessels above 75 GRT. Total landings from vessels below 75 GRT were estimated and allocated to inshore/offshore areas, based on information from logbooks and sales slips.

Logbook data were analysed to show the spatial distribution of the fishery and the overall distribution of catch, effort and catch rates by year.

Unstandardised CPUE was calculated using a factor 2 as a multiplier for recorded effort by vessels using twin-trawl.

CPUE data from Greenlandic vessels above 50 GRT were used in multiplicative models to calculate standardised annual catch rate indices. Four time series of standardised CPUE indices exist including both the offshore and small vessel components. The derivation of the models along with the resulting time series up to and including 1995 are described in Hvingel, Lassen and Parsons (1996). The indices of the last two years were estimated by the models presented by Hvingel *et al.* (1996a) using their estimated mean effects in a back calculation procedure. Thus, the index values were fixed at the 1995 level. The index of Div. 0A is given in Parsons *et al.* (1996, 1997).

The calculated 1996 and 1997 indices were then combined and added to an integrated SA 0+1 index series as also described in Hvingel *et al.* (1996a). The 1997 data for Div. 0A were considered unreliable due to low effort allocated to the area. Therefore the Greenlandic Div 1B index covering the adjacent area were used as representative also for Div. 0A.

Standardised and unstandardised effort were calculated by dividing total nominal catches with the combined CPUE-index for SA 0+1 and mean CPUE as calculated from logbooks respectively.

Annual size compositions of shrimp catches were obtained from samples taken before processing by fisheries observers onboard offshore vessels. In the laboratory samples 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 the weight of the catch to the number caught in the set. Numbers from all sets for the month were totalled and adjusted by weight to the monthly catch by NAFO Division. The numbers from all months and areas were totalled and adjusted by weight to the total catch of the year.

The annual length frequency distributions of the total catch in SA 1 were converted to catch at age by modal analysis including use of the MIX application (McDonald & Pitcher, 1979). Due to persistent inconsistency in the results of the calculation methods used previously (Hvingel *et al.* 1996b) the data were reanalysed using fixed mean modal lengths. Four modes with mean lengths at 14, 18.5, 21 and 25 mm respectively were included in the analysis. The iterations were run with all coefficients of variations held a fixed value of 0.065.

A catch-at-age table was produced by multiplying proportions of the four modes by total number caught. Age specific indices of abundance were then calculated by dividing the numbers caught at age by the standardised effort.

Results and Discussion

Catch, effort and CPUE

Table 1 and Figure 1 show total catch, effort and CPUE by shrimp vessels in SA 1. Since 1973 most catches are taken offshore. Along with the development of the offshore shrimp fishery total annual catch has increased from less than 10,000 tons in the early 1970's to a peak of almost 80,000 tons in 1992. Since then, government restrictions have somewhat reduced the landings to an annual level of about 67,000 tons. The projected catch of 1997 is at this level.

Since the beginning of the 1970's catches in the inshore areas have been fluctuating between 10,000-20,000 tons. Limited access for vessels >78 GRT has been the only catch limitations until 1997 when a TAC was enforced also for the small vessel fleet. In the nineties inshore catches accounted for about 25% of the total catch in SA 1.

From 1975, when the offshore fishery was well established, until 1984 annual unstandardised effort showed a slightly increasing trend from about 75,000 hr's to about 85,000 hr's (Fig. 1B). In the subsequent seven years a considerable enlargement and rationalisation of the offshore fleet took place and effort went up by almost a factor three reaching 230,000 hr's in 1991-1992. Hereafter unstandardised effort has decreased primarily due to enforced government policy to reduce catches.

In 1996 nominal effort was about 170,000 hr's and preliminary data for suggest that this will also be the level for 1997. The long time trend of the standardised effort is in well agreement with the unstandardised except for the last year when the projected standardised effort show a substantial increase (Fig. 1B).

A general declining trend is seen in overall unstandardised catch rates in SA 1 since the mid 1970's to the beginning of the 1990's (Fig. 1C). Until 1987 most of this decline was caused by a decrease in catch rates in Div. 1A (Table 2). From 1987 the decline in Div. 1A levels out, but now catch rates in Div. 1B and 1C declines significantly until the beginning of the 1990's.

In the nineties overall unstandardised catch rates showed an up going trend. This increase is mainly accomplished by the expansion of the fishery to the shrimp grounds in Div. 1E and 1F with high catch rates (Table 2), but presumably also due to technological improvements of vessel fishing power. During the 1990's a substantial restructuring of the offshore fleet component has taken place. The number of vessels >80 GRT participating in the fishery has been reduced from about 42 in 1990 to 17 in 1997.

Spatial distribution of the fishery

The allocation of catch and effort to NAFO Divisions and the resulting mean CPUE based on logbook information is given in Table 2. Incomplete logbook coverage of in particular the small vessel component, causes underestimation of the fishery in Div. 1A (Disko Bay). Alternating quota restrictions in offshore areas of Div. 1A may also have biased data for this area.

However, a substantial change in the relative importance of the different areas is indicated. Since the mid 1970's until the early 1980's Div. 1A+1B have been the far most important areas of the shrimp fishery. Div. 1C received minor attention and almost no effort was allocated to Div. 1D+E+F. Since then the fishery has gradually expanded southward to include also the three southern most Divisions in SA 1. The southward movement of the fishery during the last 10 years as shown in Hvingel (1996) is not continued in 1997 (Fig. 3).

Evidence of biomass distribution from the German groundfish survey (Rätz, 1997) and the Greenlandic trawl survey (Carlsson *et al.*, 1997) suggest that the fishery is tracking a southward shift in shrimp biomass.

The increase in total catches from 1985-1992 (Fig. 1A) was initiated by increasing catches in Div. 1A+B followed by a corresponding increase in Div. C+D three years later (Fig. 2). After the peak of total catches in 1992 catches have declined in Div. 1A+1B. Catch level was maintained in Div 1C and increased catches were taken in Div. 1D+1E+1F.

A precise quantification of habitat size within NAFO Divisions is not possible at present. However, taken as sea bottom area between 150-600 m, which makes up the prime depth distribution of shrimp at west Greenland, Div. 1A south of 73°N-Div. 1F contain about 53, 26, 9, 5, 3 and 4% of "suitable shrimp grounds", respectively. The southward movement of the fishery may therefore mean local increases in exploitation rate.
The spatial distribution of catches by statistical units of 7.5' latitude and 15' longitude from 1987 to 1997 is shown in Figure 1, which further confirms the interpretation of the geographical changes in fishing pattern noted above. The preliminary catch figures for 1997 do not suggest any significant changes in the distribution of the fishery from 1996 to 1997. The change from 1995-1996 concerning less effort allocated to the north-western corner of Div. 1B, north of 68° and west of 56° prevailed in 1997.

Standardised CPUE indices

The time series of the four Greenlandic, the Canadian and the combined Subarea 0+1 CPUE indices are given in Table 3. Table 4 shows the results of the 1996 and 1997 calculations.

Although the preliminary data of 1996 (Hvingel *et al.*, 1996b) gave a too optimistic picture of the development from 1995-1996, all three indices (1B, 1CD and Small vessel) still showed an either stable or increasing trend from 1995-1996 when the data set was complete. The preliminary data for 1997, however, came out with a 30% decrease for both the 1B and 1CD index. The Small vessel index is a little above the 1996 value. This translates to the lowest value of the combined index on record.

Part of the explanation for the low index values of the latest years may be the southward movement of shrimp biomass out of the areas covered by the index. This does not necessarily compensate for the reduction in the combined index, as the area suitable for shrimp is much smaller in the south (see section on spatial distribution).

At the assessment in 1996 the combined index series was interpreted as showing two levels of stock biomass: One higher level from 1976 to 1989 and a new lower level of the nineties (Fig. 1C). The addition of one extra

data point to the time series (the 1997 index value) should not be able to change that point of view. However, it must be kept in mind that no correction for individual vessel increase in fishing power was applied in deriving the index and therefore the curve may be biased upwards. This effect may be most influential in the last years of a time series as technological improvement events tend to be somewhat averaged out in the models as years go by.

Catch composition.

Modal analyses were applied to the annual length frequency distributions of the total catch in SA 1 from 1991 to 1997 (Fig. 5). Table 5 updates the underlying number of samples and the number of individuals measured as given in Hvingel *et al.* (1996).

Compared to a similar analysis done in 1996 (b) by Hvingel *et al.* the number of parameters has been reduced. In the 1996 analysis eight age groups as identified by Savard *et al.* (1994) were fitted to the length frequency data and the analysis was unconstrained except for a fixed coefficient of variation. However, the assigned year classes were hard to track cross the catch at age tables.

In the present analysis the number of parameters has been reduced to a minimum by using only four modes with fixed mean length and a fixed coefficient of variation. The mean modal lengths were set at 14, 18.5, 21 and 25 mm respectively partly based on the findings of Savard *et al.* (1994) and by looking at length frequency distributions. Data from the Greenlandic offshore survey 1996 and 1997 which included the relative strong 1993 year class showed identifiable peaks at about 14 mm and 18-18.5 mm respectively (Folmer *et al.*, 1996; Carlsson *et al.*, 1997). In the analysis by Parsons *et al.* (1992) the strong 1985 year class showed peaks at 14.6, 17.5, 20.7 and 21.7. Inspections of samples from both commercial fishery and survey data revealed reiterating peaks at around 14, 18.5, 21 and 25 mm.

The modes may be interpreted as age group 3-6+. The assignment of absolute age to the modes still needs further research. However for assessment purposes this analysis approach proved better consistency in measuring modal strength from one year to another.

The proportion of the 6+ group in the catches has shown a declining trend along with an increase in the proportion of small shrimp at age 3 and 4 during the 1990's (Table 6). This tendency is reflected in the development of the mean size of shrimp caught which has declined by about 2 mm cpl. since 1991 corresponding to a mean individual weight reduction of about 20%.

The standardised catch rates of most year classes indicate increasing abundance up to age 6+, as they pass through the fishery (Fig. 6). This suggest that the shrimp are only partly recruited to the fishery until at least their first year as females as also noted by Savard *et al.* (1991). The increase in abundance of the 1991 and 1992 year class however levels off at age 4 indicating increased mortality for these particular year classes compared to the others in the time series.

Recruitment to the fishery is not only determined by mesh size but may also be strongly influenced by the targeting strategy of the trawlers and/or the degree of spatial segregation of shrimp sizes at the fishing grounds. The shrimp sizes targeted by the fishery depends on what is available in the sea. Thus low abundance or availability of older shrimp may have caused the increased mortality of the 1991-1992 year classes at young age. This could be the case in both 1995 and 1996 when the 6+ group is relative weak. Increased spatial mixing of shrimp sizes may also hinder skippers from deliberately "picking out" the large shrimp.

Anyway the expectations made from last years data that the 1991 and 1992 year classes would make good contributions to the fishery as large males and young females in 1997 did not fulfil (Table 6).

The 1992 year class enters the female group in 1998. As this year class appears as one of the weaker in the 1997 data and the strength of current 6+ group seems low female abundance may be reduced in 1998.

The 1993 year class however seems good and may be abundant in 1998 with a mean carapace length at 21 mm. It is however possible that the current weakness of the 6+ component will increase exploitation rate of the younger year classes. Thus the strength of the 1993 year class may have weakened considerably when it reaches the female stage in 1999-2000.

Conclusion

The projected catch of 1997 is at the 1996 level of 67,000 tons.

In broad outline the geographical distribution of the fishery in SA 1 in 1996 was maintained in 1997. As in 1996 the north-western corner of Div. 1B, about north of 68°N and west of 56°N, received much less attention than in the previous years, which further adds to the general trend of a more southerly distribution of the fishery in recent years.

There are indications that the southward displacement of fishing effort is due to the fishery tracking changes in shrimp distribution. The changes in distribution may mean local increases in exploitation rate, due to areal concentration of shrimp on the narrow continental shelf in the southern Davis Strait.

Overall unstandardised catch rates showed an up going trend in the nineties. The expansion of the fishery to the "virgin" shrimp grounds in Div. 1E and 1F and technological improvements of vessel fishing power is probably the main cause. The 1997 CPUE is projected to 378 kg/hr - a little lower than the 1996 value.

The Greenlandic standardised CPUE indices of NAFO Div. 1B and 1CD both show about 30% decrease from 1996-1997, while the small vessel CPUE index showed a minor increase. Integrated in the combined index, 1997 turns out the lowest value on record. The southward displacement of shrimp distribution out of the area covered by the index may be part of the explanation. The interpreted new level of std. CPUE index values of the 1990' put forward at the 1996 assessment meeting is in serious danger of becoming a downward trend.

Fewer large and more small shrimp in the catches has made the mean size of shrimp caught decline by about 2 mm cpl. since 1991 corresponding to a mean individual weight reduction of about 20%.

Increased mortality has reduced the strength of the 1991 and 1992 year classes and the abundance of the female component in 1998 may therefore be reduced. The 1993 year class still looks strong and may be abundant in 1998 at 21 mm cpl. The current and expected weakness of the 6+ component in 1998 will probably increase exploitation rate of the younger year classes. Thus the strength of the 1993 year class may have weakened considerably when it reaches the female stage in 1999-2000.

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Table 1. Total catch, unstandardised effort and unstandardised CPUE of the shrimp fishery in NAFO SA 1, 1970-1997 and the standardised effort and CPUE of the fishery in SA 1+Div. 0A.

Year	Catch (t)			Effort (hr's)		CPUE (kg/hr)	
	Total	Inshore	Offshore	Unstd.	Std.(index)	Unstd.	Std.(index)
1970	8559	8429	130	-	-	-	-
1971	9437	8741	696	-	-	-	-
1972	9656	7342	2314	-	-	-	-
1973	12642	7950	4692	-	-	-	-
1974	22009	10064	11945	-	-	-	-
1975	37890	8700	29190	74149	-	511	-
1976	49674	7300	42374	80119	2.92	620	1.72
1977	41643	7800	33843	72930	2.62	571	1.60
1978	34347	7600	26747	84184	2.81	408	1.23
1979	33458	7500	25958	72420	3.33	462	1.06
1980	43278	7500	35778	79996	3.67	541	1.25
1981	39516	7500	32016	88205	3.53	448	1.27
1982	42515	7500	35015	81135	2.84	524	1.57
1983	41354	7500	33854	89125	3.48	464	1.34
1984	41241	7500	33741	85033	3.39	485	1.28
1985	51396	7500	43896	109353	4.06	470	1.34
1986	60134	7500	52634	129043	4.51	466	1.40
1987	57641	6921	50720	136590	3.34	422	1.91
1988	54392	10233	44159	150254	4.16	362	1.45
1989	58422	13224	45198	176502	6.14	331	1.07
1990	63184	13630	49554	206484	6.70	306	1.03
1991	69092	16258	52834	228781	8.51	302	0.89
1992	79258	20594	58664	233112	9.33	340	0.93
1993	70123	17843	52280	206244	7.57	340	1.00
1994	71811	18118	53693	209362	9.21	343	0.83
1995	68329	16429	51900	186691	7.95	366	0.88
1996	66610	17359	49251	168633	7.49	395	0.92
1997	56060	9849	46211	148307	7.75	378	0.72

Table 2. Catch, effort and CPUE as allocated to NAFO Divisions in SA 1. Data was derived from vessel logs and weighted up to total catch of the year.

Year	Catch (tons)						Effort (hr's)						CPUE (kg/hr)					
	1A	1B	1C	1D	1E	1F	1A	1B	1C	1D	1E	1F	1A	1B	1C	1D	1E	1F
1975	0	36264	1626	0	0	0	0	70523	3626	0	0	0	-	514	448	-	-	-
1976	0	44497	5141	0	0	35	71	70051	8047	71	780	1099	0	635	639	0	0	32
1977	132	38832	2510	169	0	0	455	67590	4423	462	0	0	290	574	567	365	-	-
1978	433	33320	433	160	0	0	1394	80748	1281	760	0	0	311	413	339	211	-	-
1979	3927	29094	432	5	0	0	6714	64127	1527	52	0	0	585	454	283	91	-	-
1980	11900	28447	2697	234	0	0	21204	53356	4935	482	19	0	562	533	547	485	0	-
1981	4658	30489	4329	40	0	0	11205	66456	10424	121	0	0	416	459	415	333	-	-
1982	659	35176	6646	33	0	0	1719	65785	13526	105	0	0	384	535	492	316	-	-
1983	391	32940	7638	379	0	6	860	69581	17788	878	6	12	455	474	430	432	0	500
1984	940	24753	13834	1709	0	4	2683	51158	28400	2675	16	102	351	484	487	639	0	38
1985	5025	29947	12582	3841	0	0	15822	62204	24263	7064	0	0	318	481	519	544	-	-
1986	21962	25741	7485	4927	19	0	55507	50543	13729	9041	84	138	395	509	545	544	-	-
1987	16201	34964	5774	701	0	0	56469	67128	10183	2803	7	0	287	521	567	250	0	-
1988	9996	38222	5655	402	0	118	41288	92191	14042	1777	3	953	242	415	403	226	0	124
1989	13216	27060	10193	7571	0	383	48141	77744	29723	16581	3	4310	275	348	343	457	0	89
1990	9914	24607	18427	9856	0	380	42353	77950	54447	28902	1	2831	234	316	339	341	0	134
1991	10269	26871	15324	15932	497	198	37174	90127	51848	47637	742	1254	276	298	296	335	671	158
1992	13192	26662	16126	18778	3989	512	49461	76286	47860	50792	7424	1289	267	350	337	370	538	398
1993	6240	29710	12945	14888	3695	2646	22940	82026	41256	44333	8104	7584	272	363	314	336	456	349
1994	5945	27384	12972	16211	5907	3391	23332	83689	40675	42541	9953	9170	254	327	318	381	593	369
1995	5593	21805	12459	17669	6865	3938	21048	69755	34104	41515	12421	7849	265	312	365	425	552	501
1996	4436	18253	13911	19009	6662	4339	18684	52026	35933	40837	12012	9141	237	351	387	465	555	475
1997	3732	13481	10316	17504	5775	5252	23353	41054	26454	39059	9668	8720	160	328	390	448	597	602

Table 3. Time series of the five standardised CPUE indices used in the assessment of the West Greenland shrimp stock including the Greenlandic 1B, KGH, 1CD and Small vessel index and the Canadian 0A index (Hvingel *et al.*, 1996a and Parsons *et al.* 1996, 1997). Note that the individual index values are not standardised to a common level.

Year	1B		KGH		1CD		Small Vessel		0A		Combined
	Index	Weight	Index	Weight	Index	Weight	Index	Weight	Index	Weight	index
1976	-	-	1.72	1.00	-	-	-	-	-	-	1.72
1977	-	-	1.60	1.00	-	-	-	-	-	-	1.60
1978	-	-	1.23	1.00	-	-	-	-	-	-	1.23
1979	-	-	1.06	1.00	-	-	-	-	-	-	1.06
1980	-	-	1.25	1.00	-	-	-	-	-	-	1.25
1981	-	-	1.24	0.87	-	-	-	-	1.48	0.13	1.27
1982	-	-	1.55	0.87	-	-	-	-	1.74	0.13	1.57
1983	-	-	1.35	0.87	-	-	-	-	1.36	0.13	1.34
1984	-	-	1.28	0.87	-	-	-	-	1.27	0.13	1.28
1985	-	-	1.38	0.87	-	-	-	-	1.09	0.13	1.34
1986	-	-	1.44	0.87	-	-	-	-	1.12	0.13	1.40
1987	2.25	0.37	1.85	0.49	-	-	-	-	1.71	0.13	1.91
1988	1.64	0.21	1.47	0.28	1.76	0.30	1.53	0.14	1.53	0.09	1.45
1989	1.07	0.21	1.09	0.28	1.36	0.30	1.22	0.14	1.12	0.09	1.07
1990	1.04	0.21	1.00	0.28	1.32	0.30	1.17	0.14	1.27	0.09	1.03
1991	0.94	0.41	-	-	1.07	0.30	1.03	0.21	1.10	0.09	0.89
1992	0.93	0.41	-	-	1.17	0.30	1.06	0.21	1.26	0.09	0.93
1993	1.07	0.41	-	-	1.14	0.30	1.22	0.21	1.19	0.09	1.00
1994	0.91	0.41	-	-	0.93	0.30	1.02	0.21	0.93	0.09	0.83
1995	1.00	0.41	-	-	1.00	0.30	1.00	0.21	1.00	0.09	0.88
1996	1.00	0.41			1.10	0.30	1.08	0.21	0.92	0.09	0.92
1997	0.72	0.50	-	-	0.78	0.30	1.12	0.21	-	-	0.72

Table 4. The 1996 and 1997 standardised CPUE index values of the Greenlandic 1B, 1CD and Small vessel indices (Hvingel *et al.*, 1996a). N is the number of cells included in the calculations i.e. number of YEAR*MONTH*AREA*VESSEL combinations available in the data set. Mean is the index value. SE is standard error of the estimate.

	1996 index			1997 index		
	1B	1CD	Small	1B	1CD	Small
N	140	323	87	40	205	83
Mean	1.00	1.10	1.08	0.72	0.78	1.12
SE	0.11	0.06	0.12	0.24	0.08	0.12

Table 5. Data on catch samples taken in NAFO SA 1 in 1996-1997. (This table updates Table 8 in Hvingel *et al.*, 1996).

Year	Month	Division	Number of samples	Number measured	Sample weight (kg)	Catch total (kg)
96	1	1D	8	3502	23.37	17803
96	1	1F	4	1107	10.88	5119
96	2	1C	9	4366	27.13	20062
96	2	1D	1	381	3.04	1000
96	3	1C	3	783	7.41	3201
96	4	1C	14	8170	71.23	24526
96	4	1D	8	3390	25.39	14987
96	5	1B	8	4546	48.71	16282
96	5	1C	13	7500	66.25	28083
96	5	1D	10	5463	31.4	23589
96	6	1C	7	6005	37.18	15113
96	6	1D	17	9966	69.72	38933
96	7	1D	13	7533	56.62	42595
96	7	1E	2	782	5.33	3709
96	8	1B	3	1344	11.86	5500
96	8	1C	20	11032	80.6	36621
96	8	1D	38	25613	163.72	95840
96	8	1E	10	4540	34.16	15293
96	8	1F	6	2655	20.05	7652
96	9	1D	5	3250	20.13	7215
96	10	1B	13	8228	56.19	25400
96	10	1D	5	2707	17.49	6658
96	10	1E	22	11464	102.84	30959
97	1	1B	3	1935	9.92	3864
97	1	1D	3	1320	9.45	4398
97	1	1E	14	6884	47.06	27686
97	2	1D	2	917	5.45	5403
97	2	1E	7	3934	25.66	16508
97	3	1B	3	1220	14.95	14167
97	3	1C	7	3341	25.63	25161
97	3	1D	3	1300	6.29	3587
97	3	1E	9	2655	22.73	11105
97	4	1C	10	3960	31.9	19327
97	4	1D	24	11577	75.38	55630
97	4	1E	1	409	2.82	4100
97	5	1C	11	2489	25.34	8161
97	5	1E	13	5904	46.78	27312
97	6	1D	12	5830	35.85	47622
97	6	1E	6	2511	16.97	13148
97	7	1F	10	4251	33.96	45554
97	8	1C	1	370	2	4156
97	8	1D	17	8959	61.66	51592
97	8	1E	10	5854	40.91	21221
97	9	1D	23	13097	81.33	38195
97	9	1E	9	4403	26.12	19892

Table 6. Composition of shrimp catches in NAFO SA 1 as derived from sub samples weighted up to the total catch and analysed by modal analysis to produce catch at age tables. Numbers caught were divided by standardised effort to produce abundance at age indices.

Mean size

Year	1991	1992	1993	1994	1995	1996	1997
Cpl (mm)	23.4	23.4	23.0	22.3	21.7	22.0	21.5
Weight (g)	7.6	7.5	7.2	6.6	6.1	6.3	6.0
Count (no/kg)	132	132	138	152	163	159	168

Proportion of total catch

Year/Year class	1991	1992	1993	1994	1995	1996	1997
3	0.01	0.01	0.04	0.06	0.03	0.07	0.04
4	0.04	0.10	0.14	0.19	0.30	0.18	0.34
5	0.39	0.28	0.22	0.27	0.31	0.34	0.24
6+	0.56	0.60	0.60	0.48	0.36	0.41	0.38

Number caught (millions)

Year/Year class	1991	1992	1993	1994	1995	1996	1997
3	54	119	343	502	236	676	372
4	351	968	1120	1729	2710	1643	2826
5	3212	2573	1811	2480	2796	3126	1979
6+	4551	5599	4998	4408	3258	3794	3179
Total	8174	9260	8272	9121	9001	9239	8356

Numbers caugth (millions)

Year	1991	1992	1993	1994	1995	1996	1997
Unidentified	8178	8170	2144	15	44	33	30
Males	0	0	2897	5089	5767	5907	4988
Females	0	1091	3231	4018	3190	3299	3339

Abundance index

Year	1991	1992	1993	1994	1995	1996	1997
Unidentified	961	876	283	2	6	4	4
Males	0	0	383	553	725	789	644
Females	0	117	427	436	401	440	431

Abundance index

Year/Year class	1991	1992	1993	1994	1995	1996	1997
3	6	13	45	54	30	90	48
4	41	104	148	188	341	219	365
5	377	276	239	269	352	417	255
6+	535	600	660	479	410	506	410
Total	960	992	1093	990	1132	1233	1078

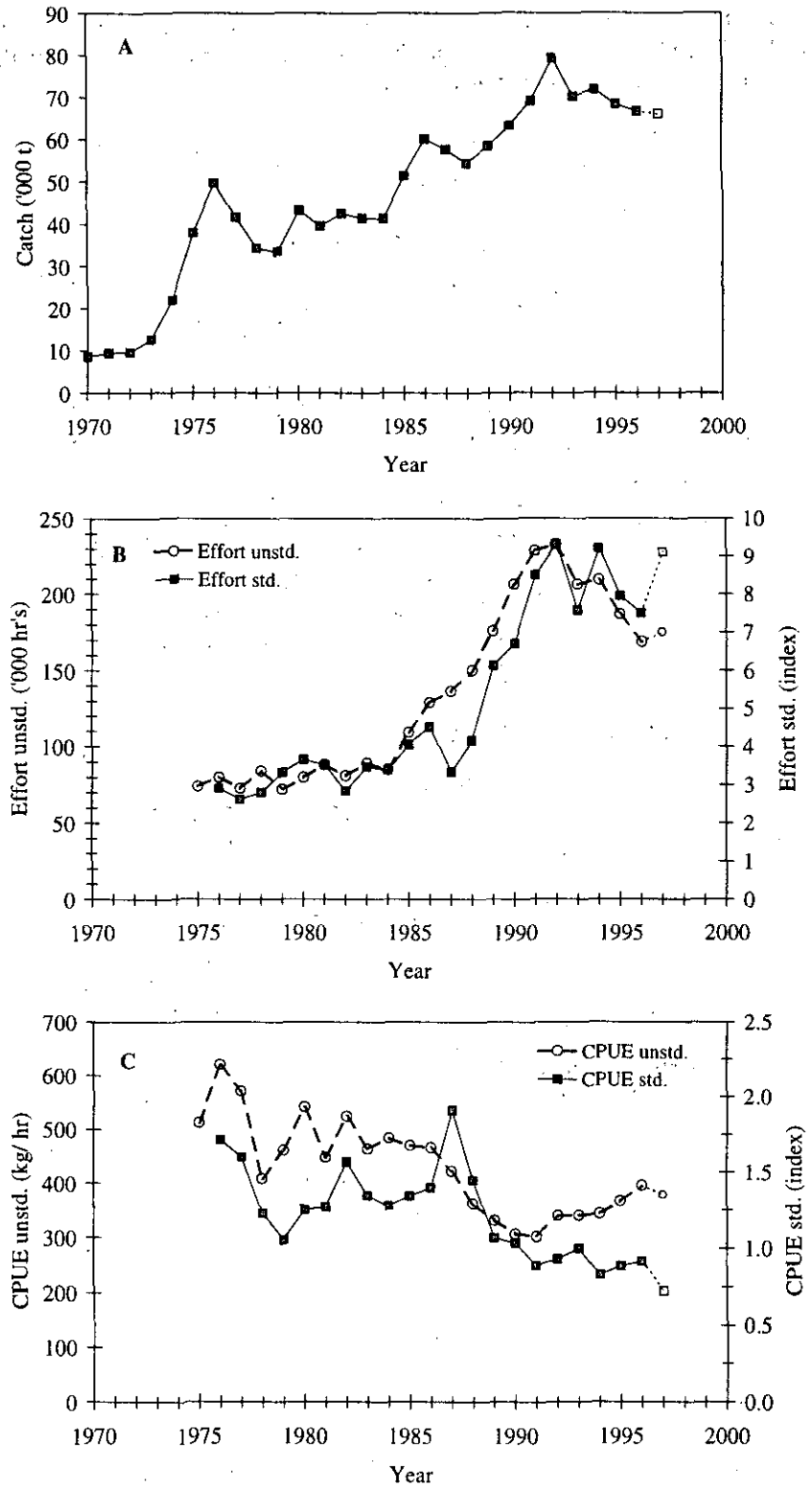


Figure 1. Total catch, effort and CPUE of the Greenland shrimp fishery in NAFO SA 1 (panel A, B and C left Y-axis) and standardised effort and CPUE of the shrimp fishery in NAFO SA 1 and Div. 0A by Canada and Greenland (panel B and C right Y-axis). Effort is calculated from total catch/CPUE. CPUE is calculated from vessel logs. Data for 1997 are projected values.

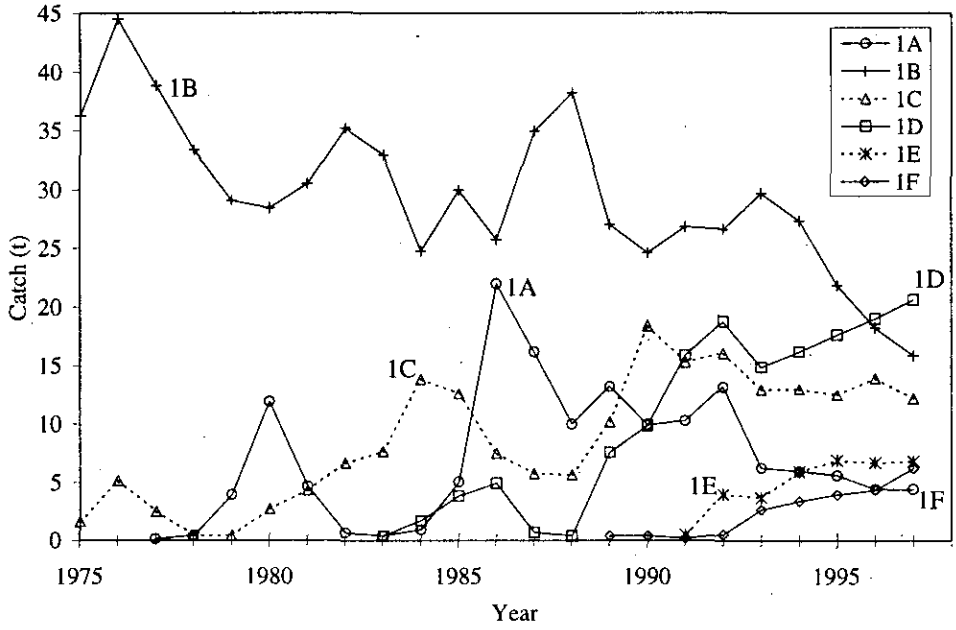


Figure 2. Shrimp catch by NAFO Divisions in SA 1. Data was based on vessel logs and weighted up to total catch. No correction for incomplete logbook coverage of the fleet has been done. Data for1997 is projected catches.

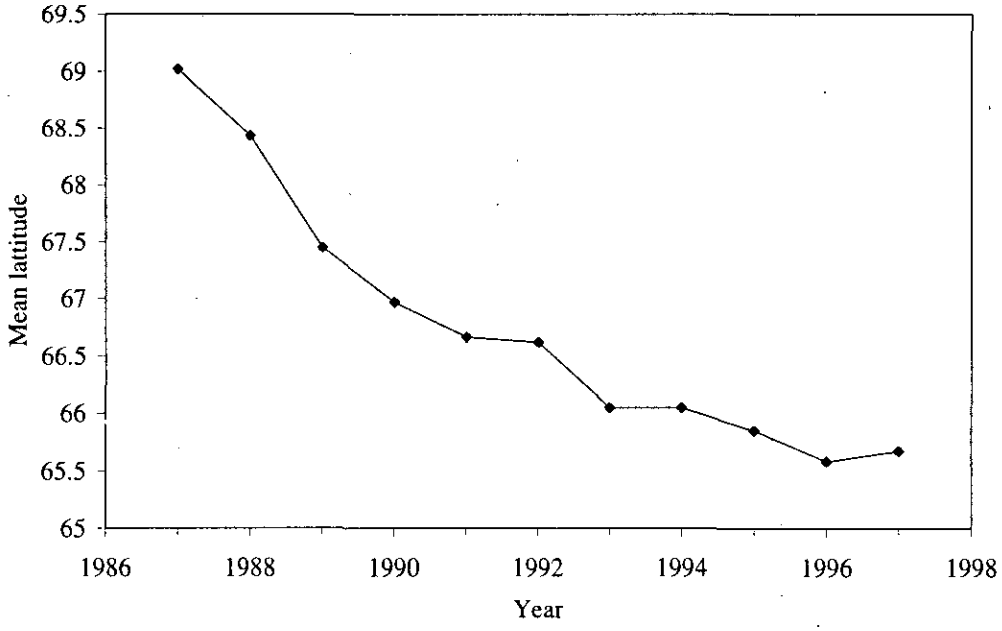
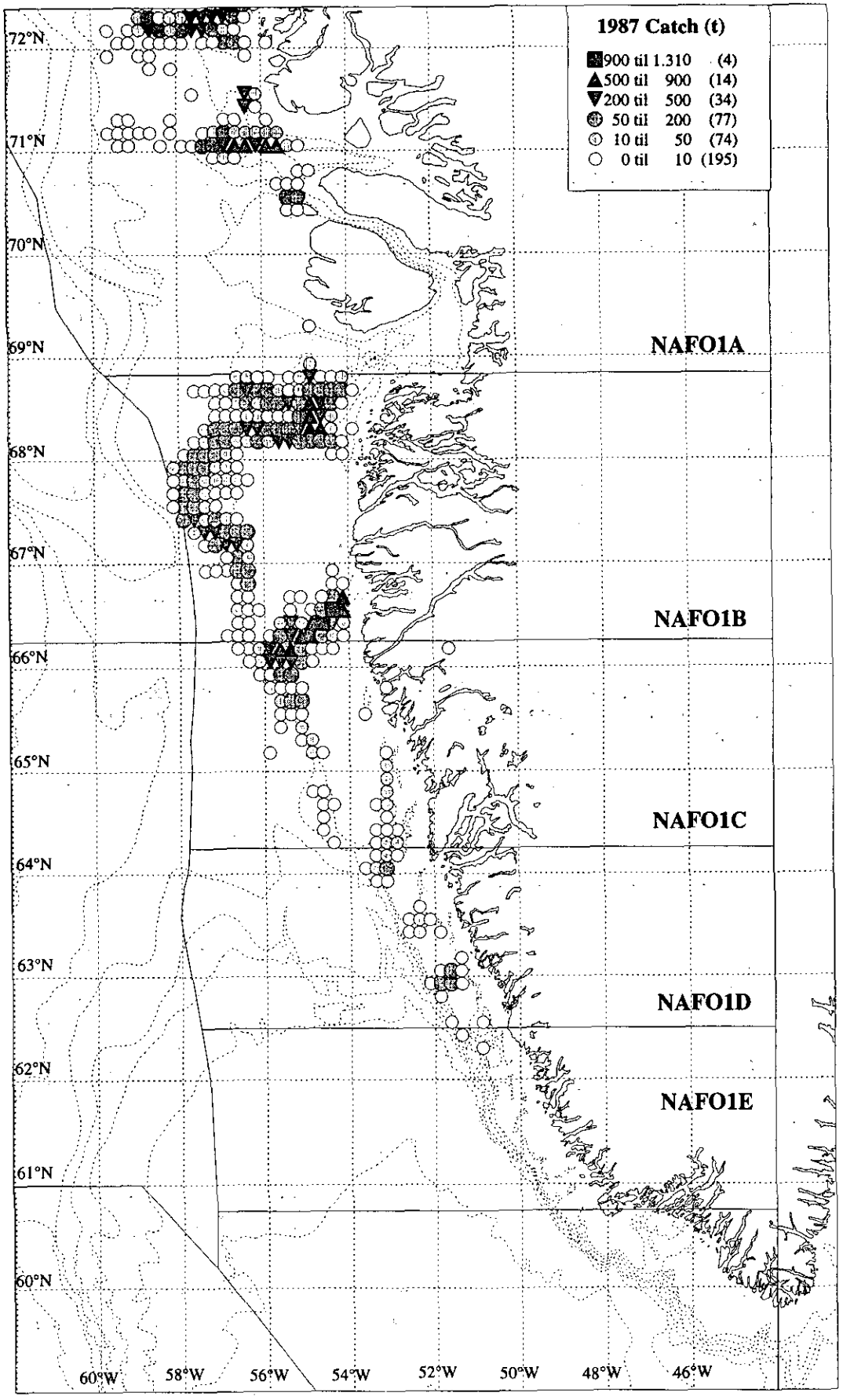
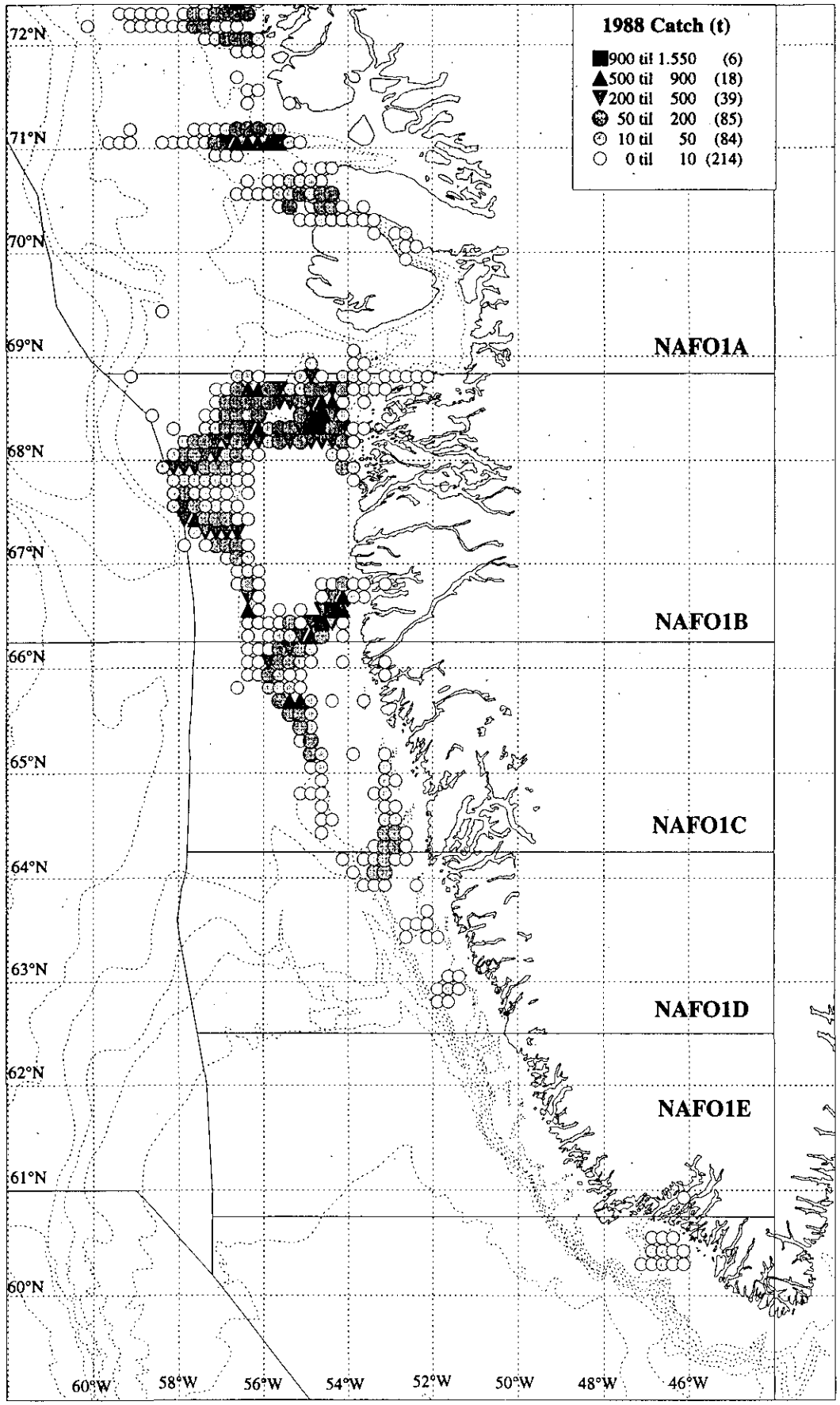


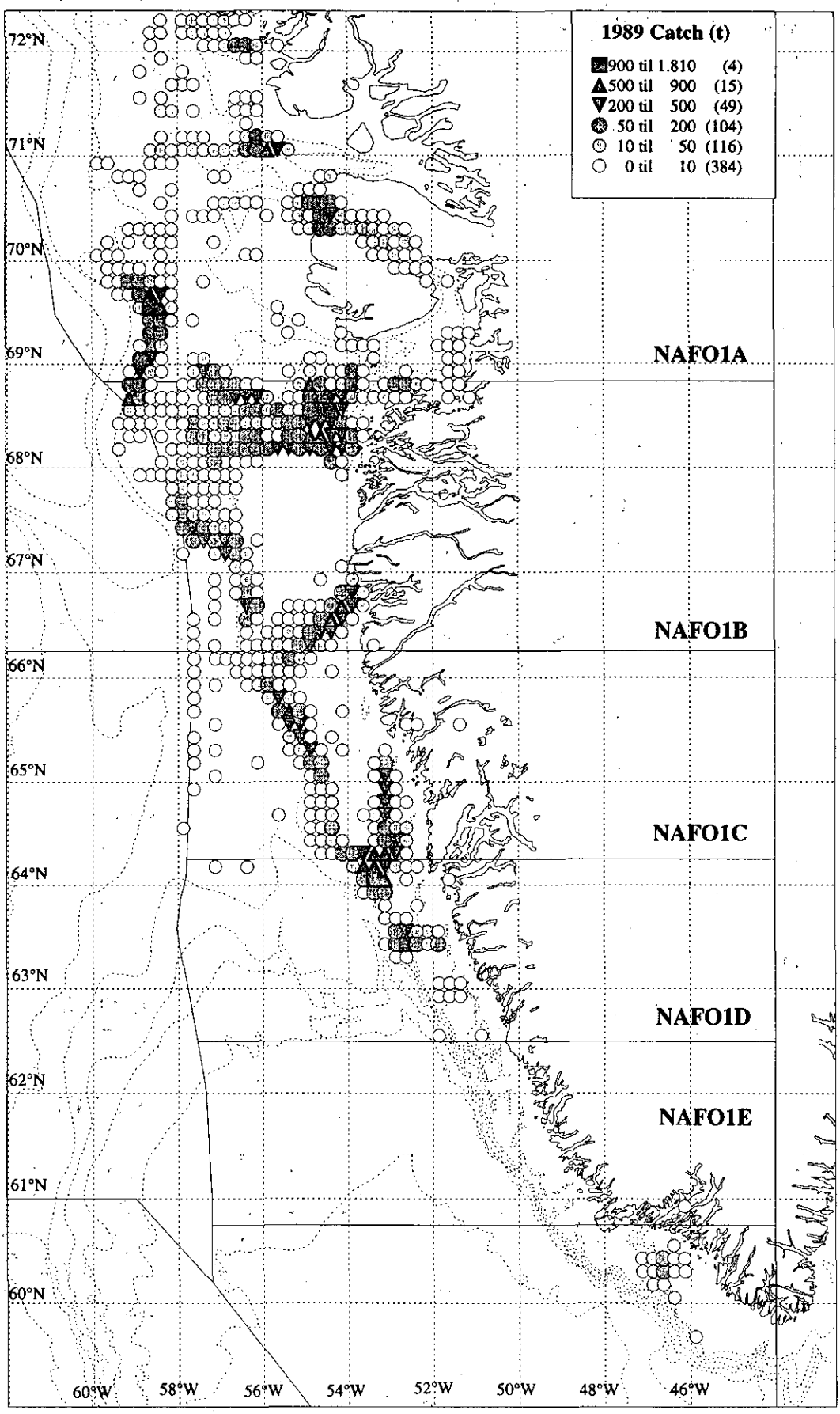
Figure 3. Weighted mean latitude (°N) using effort as the weighting factor of 410,000 hauls as reported in Greenlandic vessel logs 1987-1997.



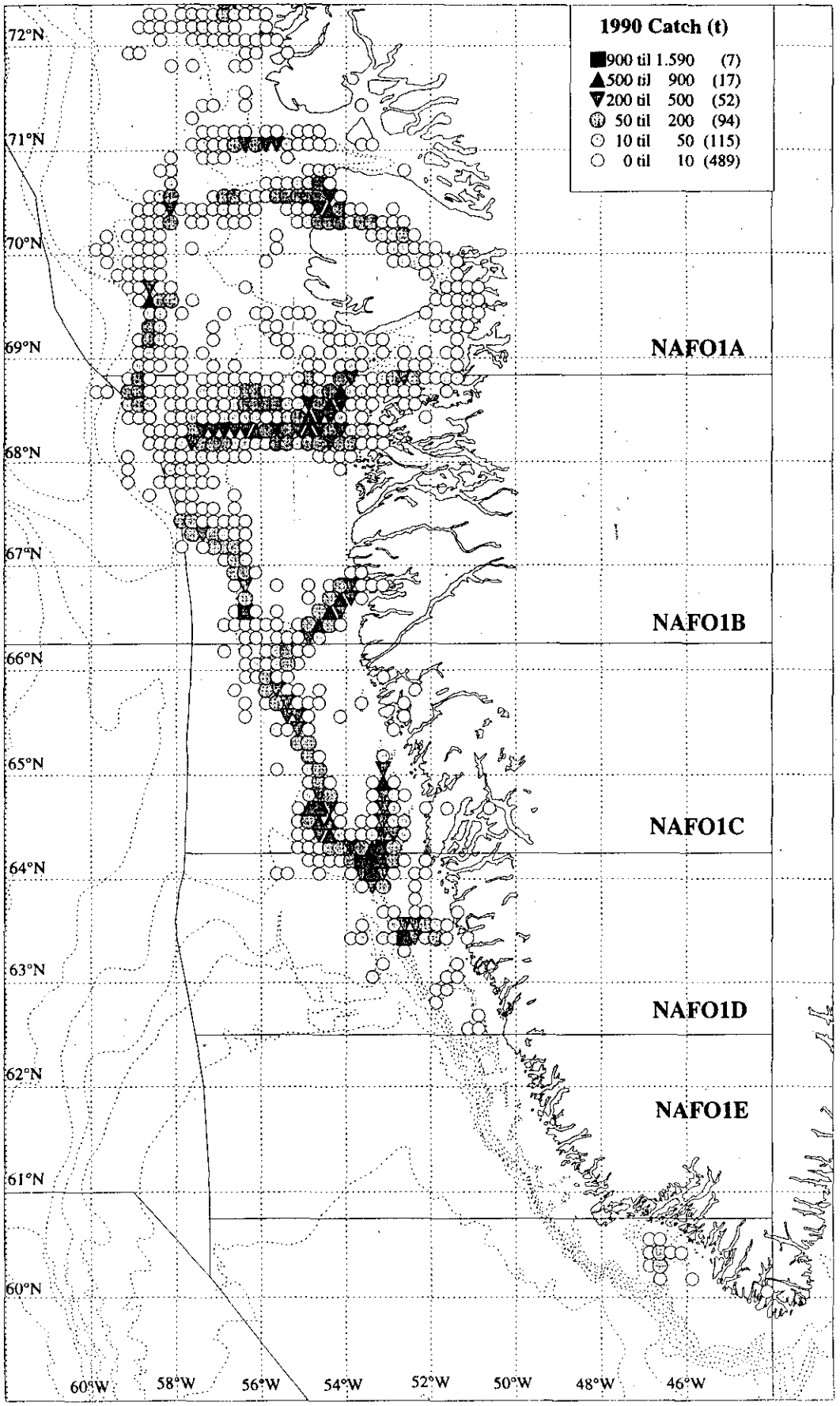
Figur 4A. The spatial distribution of the Greenlandic shrimp catches in SA 1, 1987.



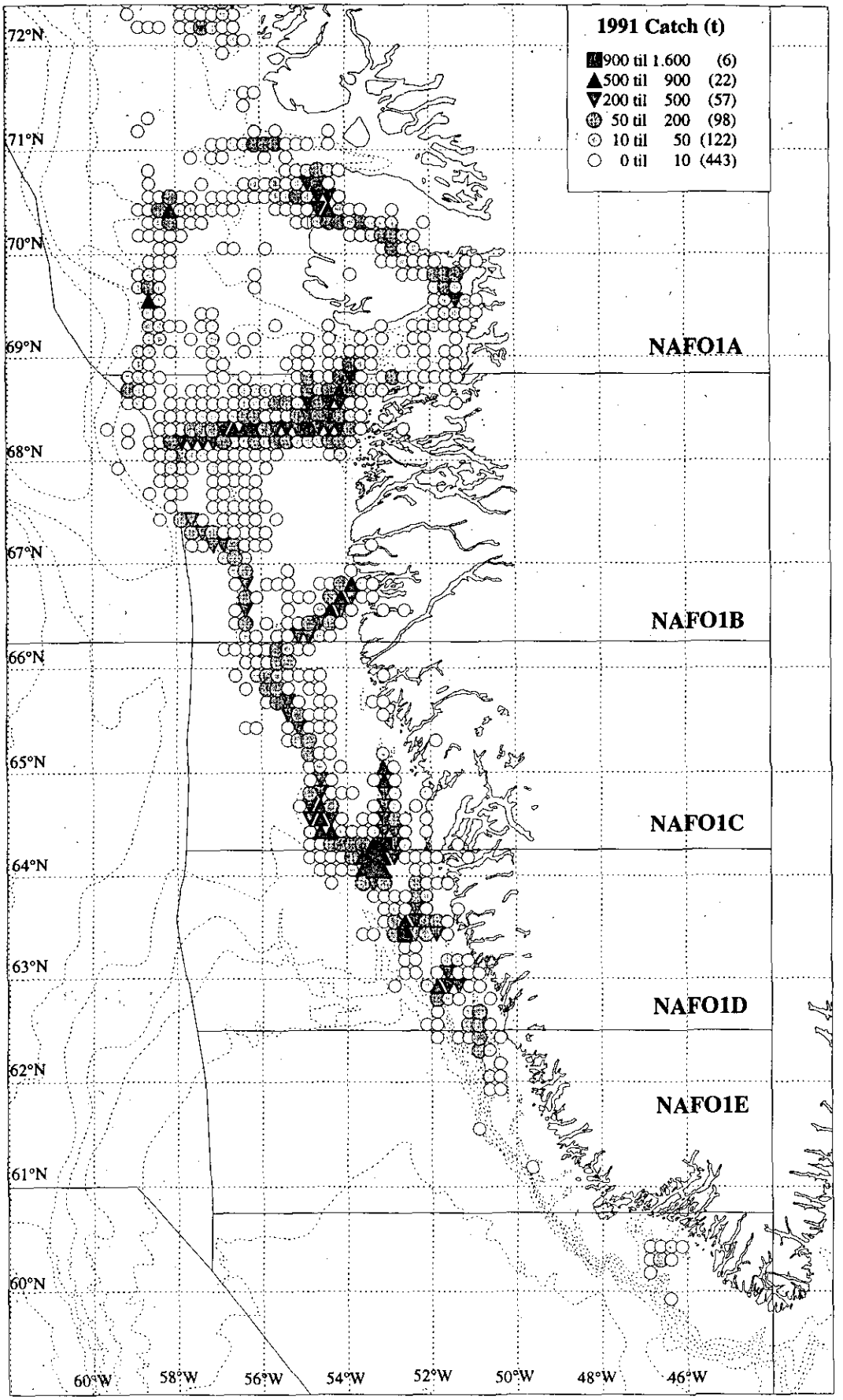
Figur 4B. The spatial distribution of the Greenlandic shrimp catches in SA 1, 1988.



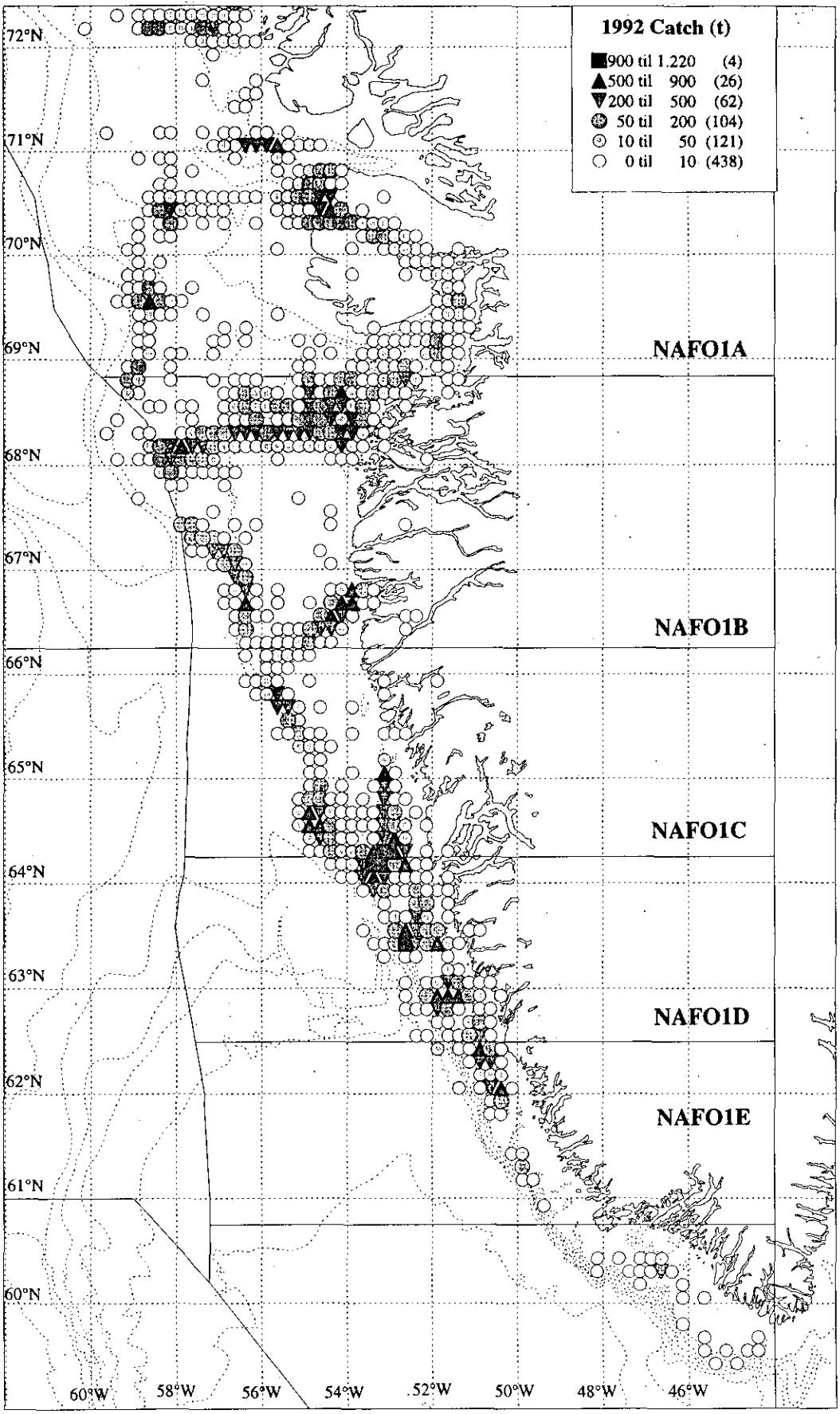
Figur 4C. The spatial distribution of the Greenlandic shrimp catches in SA 1, 1989.



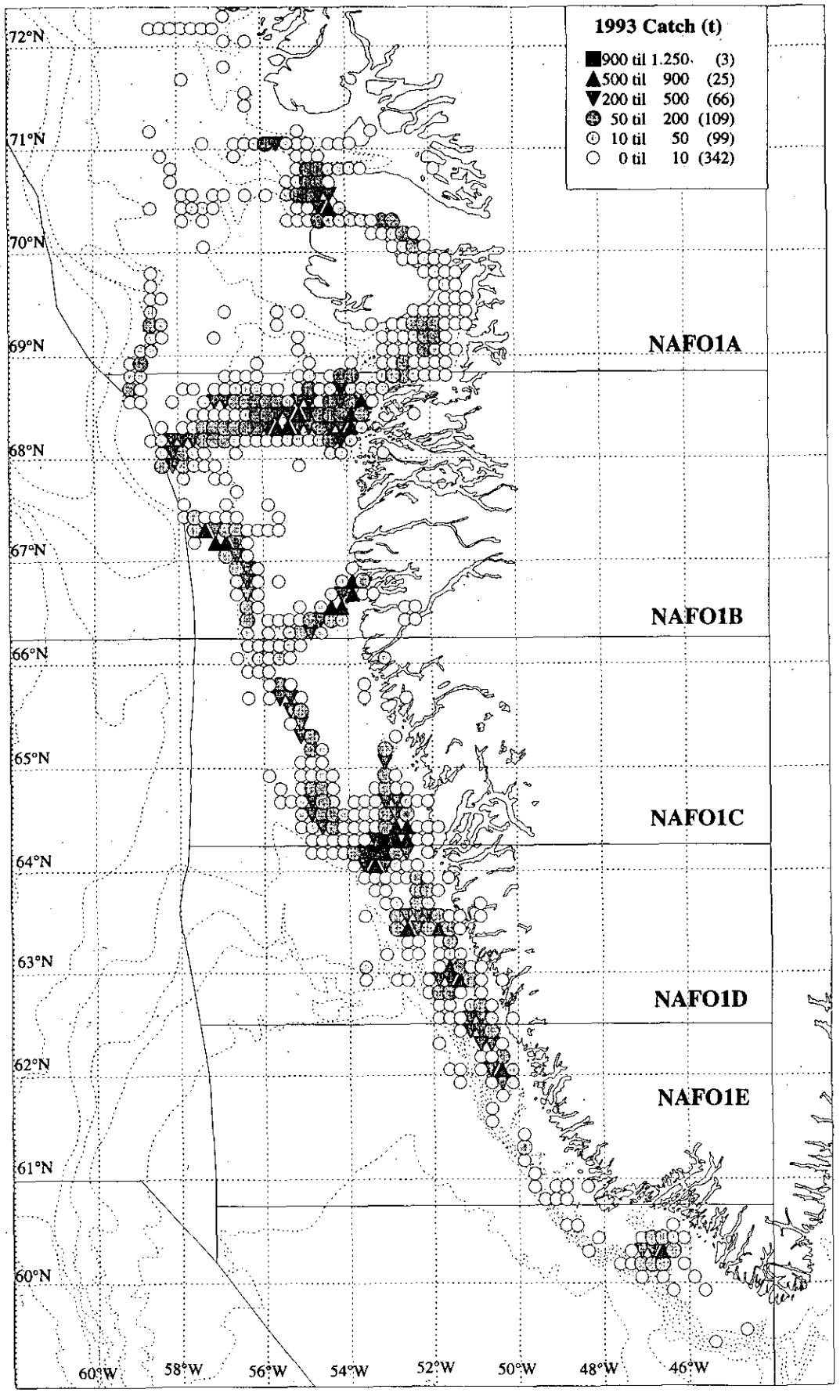
Figur 4D. The spatial distribution of the Greenlandic shrimp catches in SA 1, 1990.



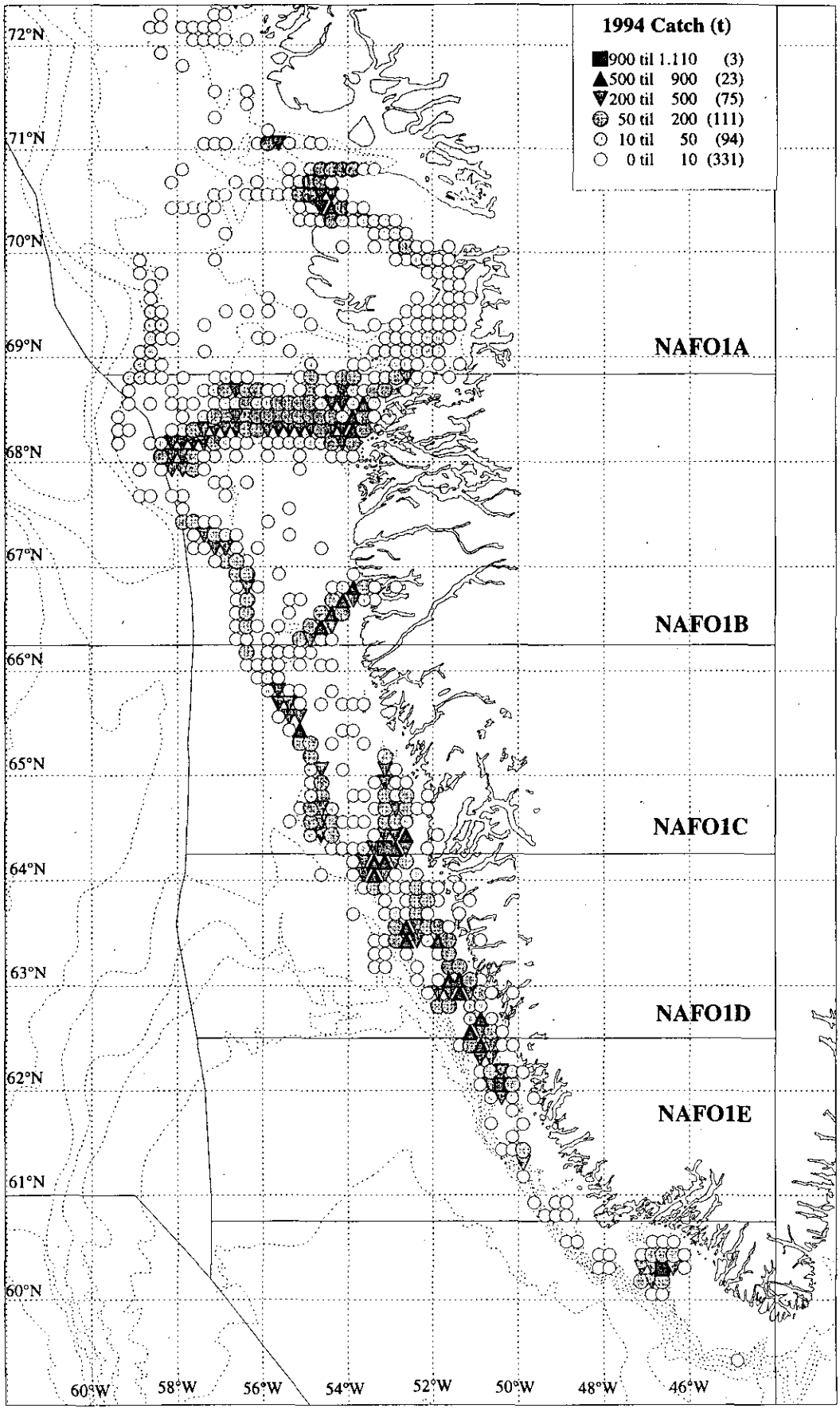
Figur 4E. The spatial distribution of the Greenlandic shrimp catches in SA 1, 1991.



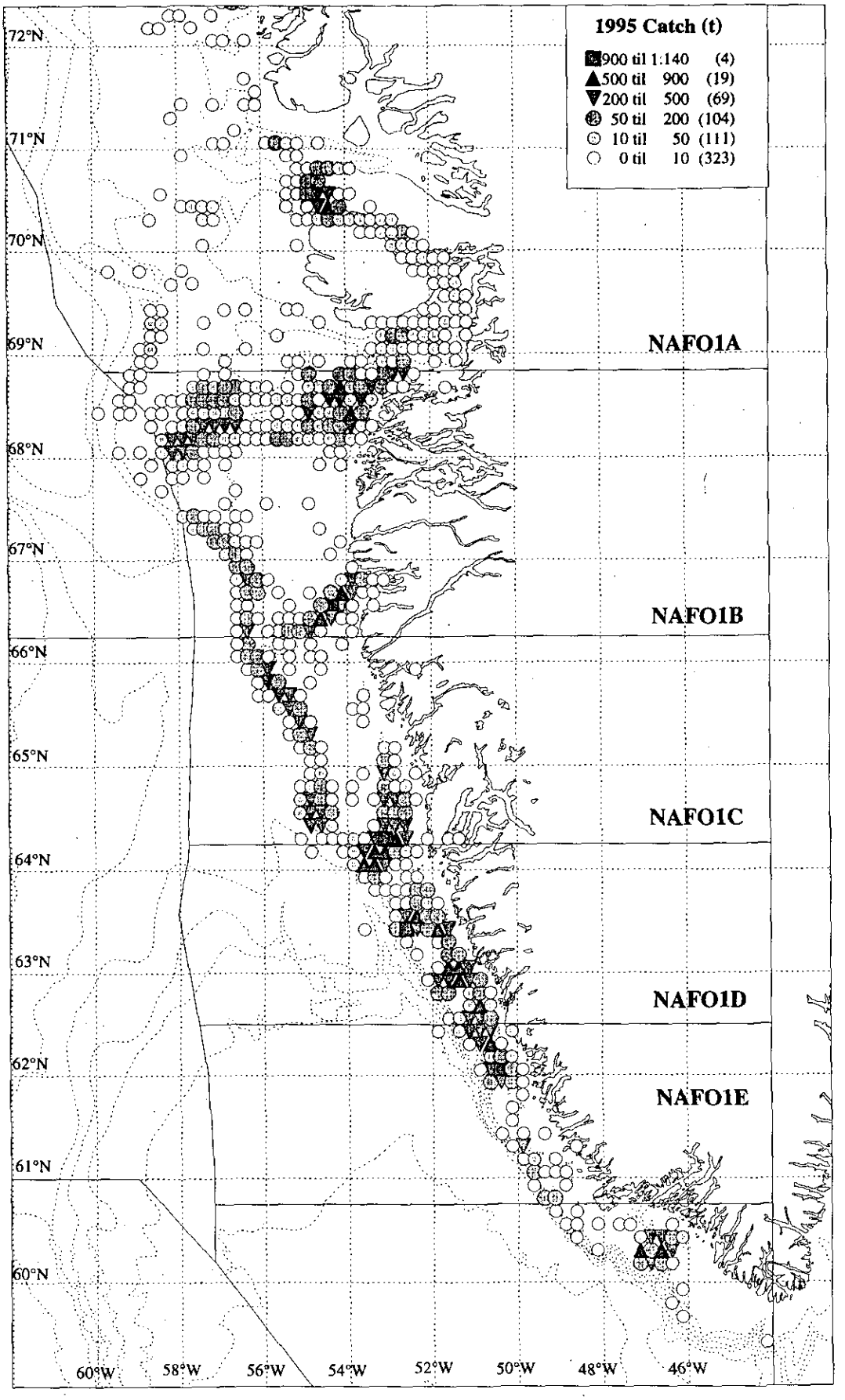
Figur 4F. The spatial distribution of the Greenlandic shrimp catches in SA 1, 1992.



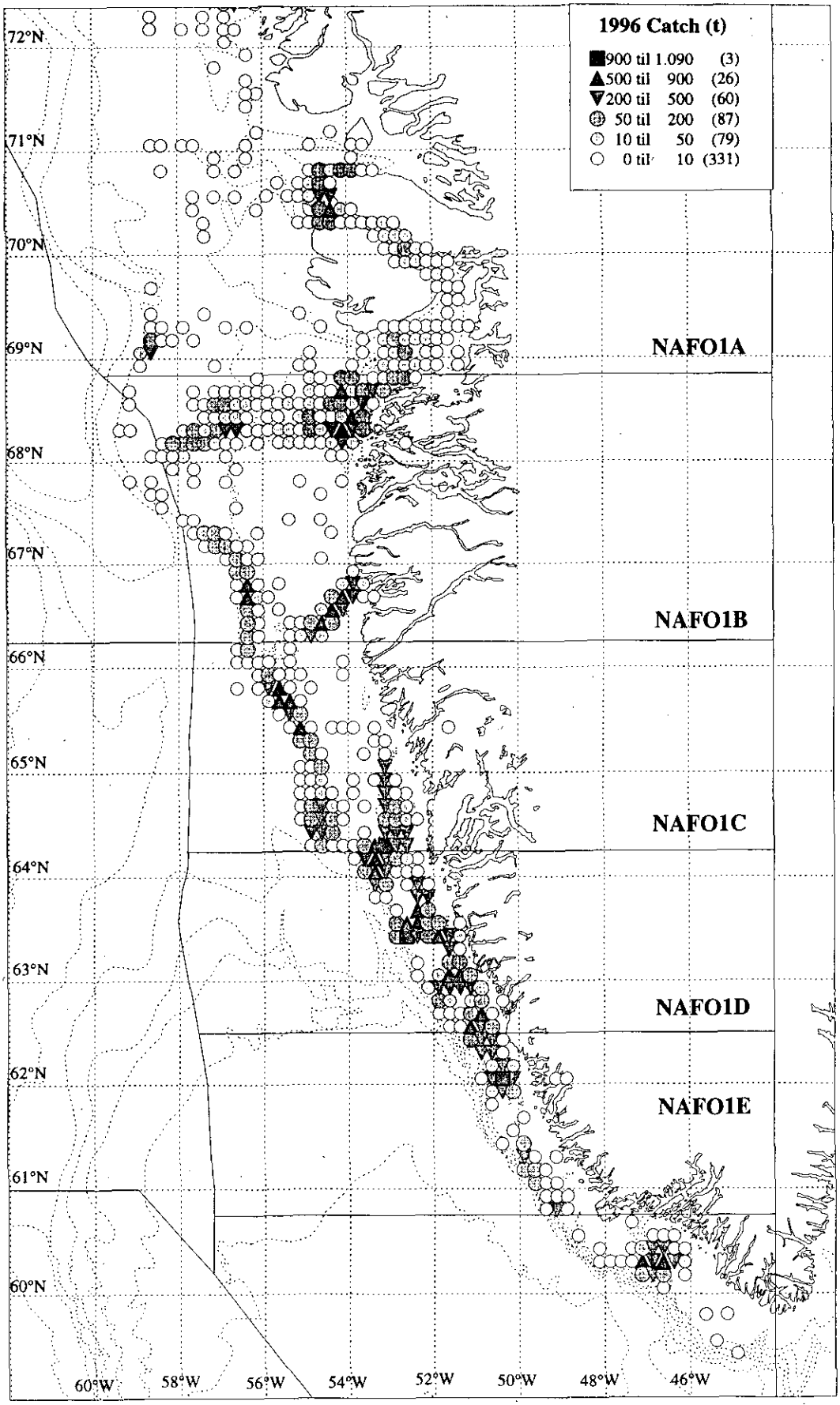
Figur 4G. The spatial distribution of the Greenlandic shrimp catches in SA 1, 1993.



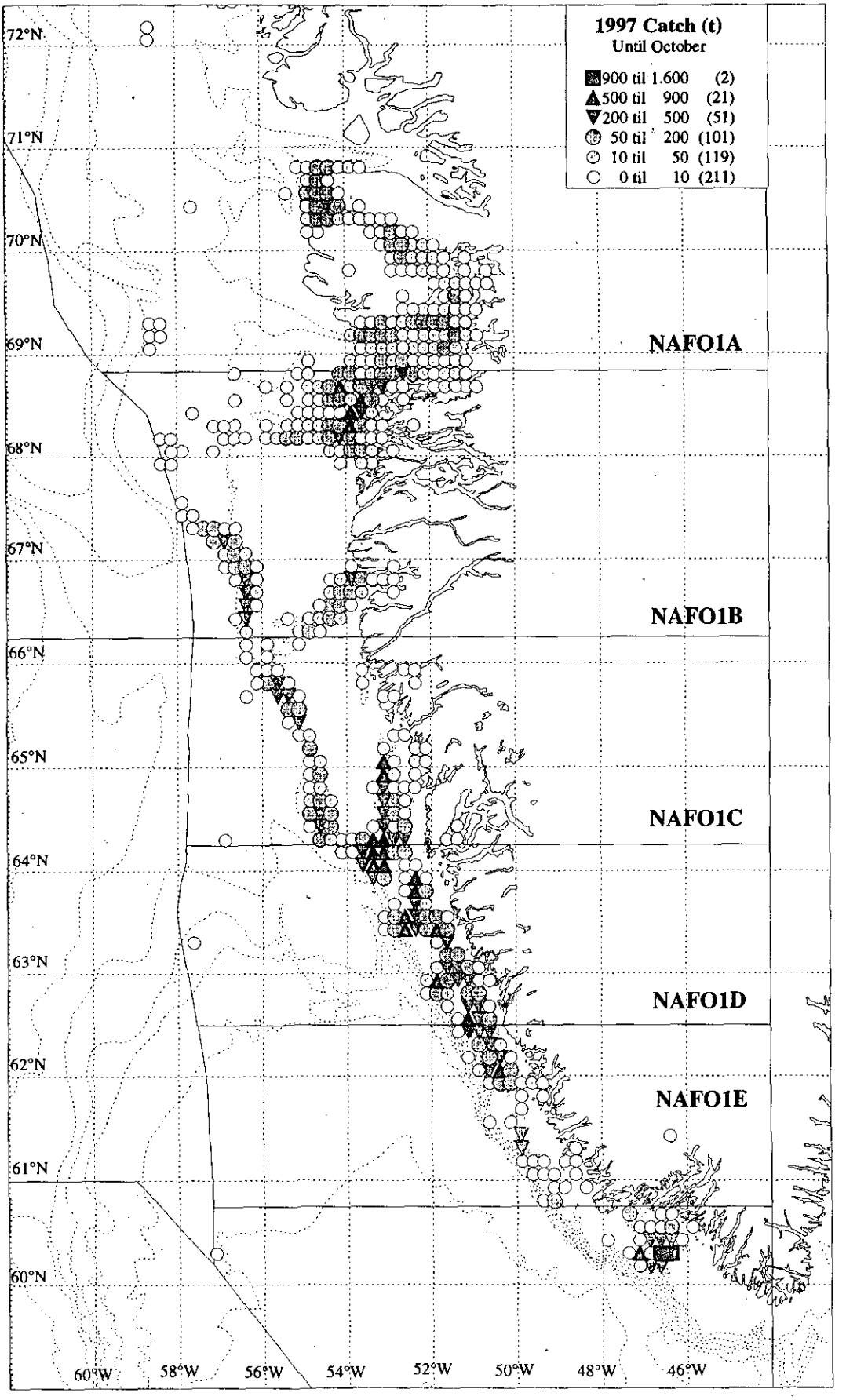
Figur 4H. The spatial distribution of the Greenlandic shrimp catches in SA 1, 1994.



Figur 4I. The spatial distribution of the Greenlandic shrimp catches in SA 1, 1995.



Figur 4J. The spatial distribution of the Greenlandic shrimp catches in SA 1, 1996.



Figur 4K. The spatial distribution of the Greenlandic shrimp catches in SA 1 until October 1997.

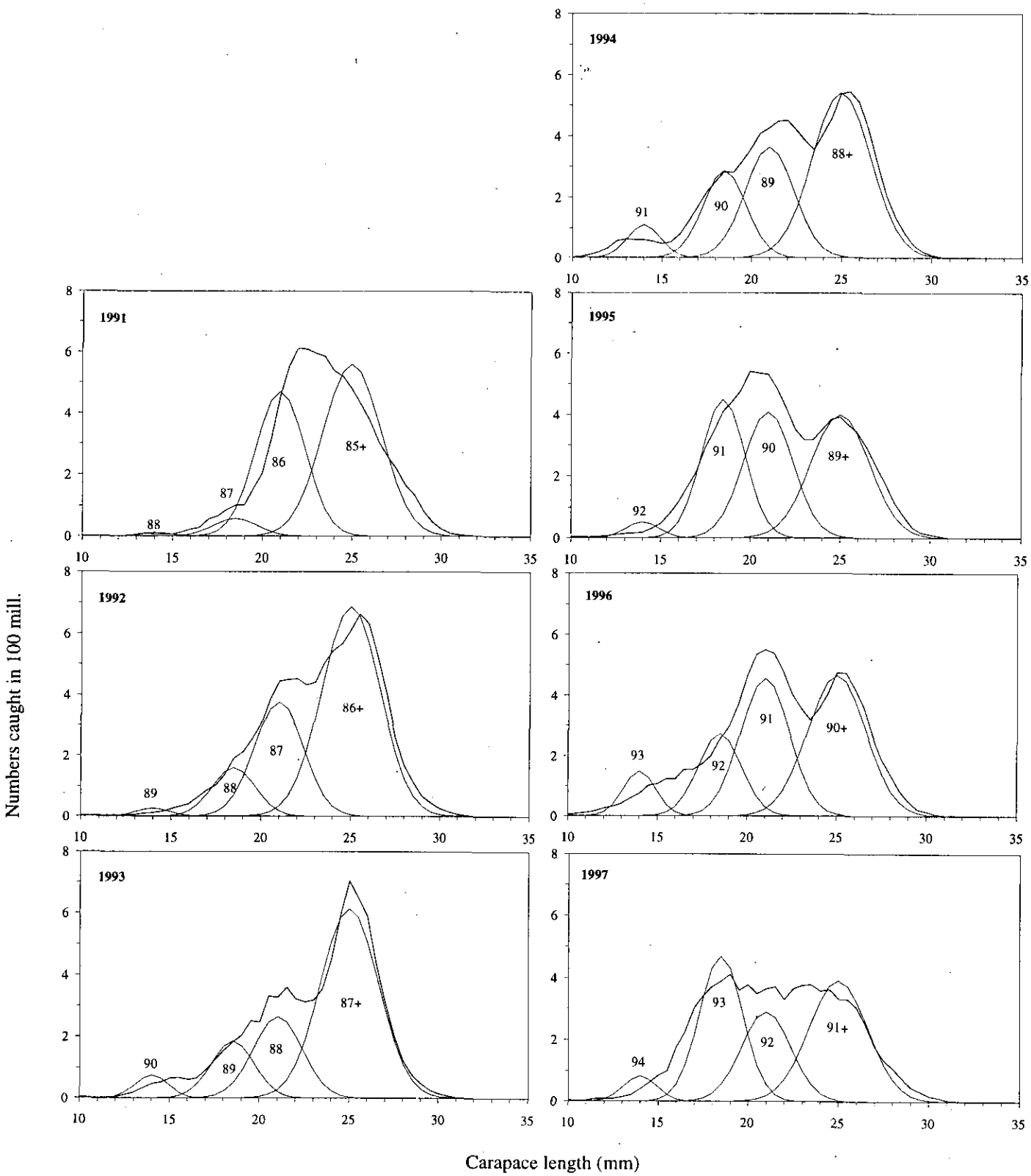


Figure 5. Length frequency distributions of shrimp caught in the commercial fishery off West Greenland 1991–1997. The age separation as calculated by modal analysis is given as normal distributions with a year class label. The modes represent age 3 to 5 and 6+.

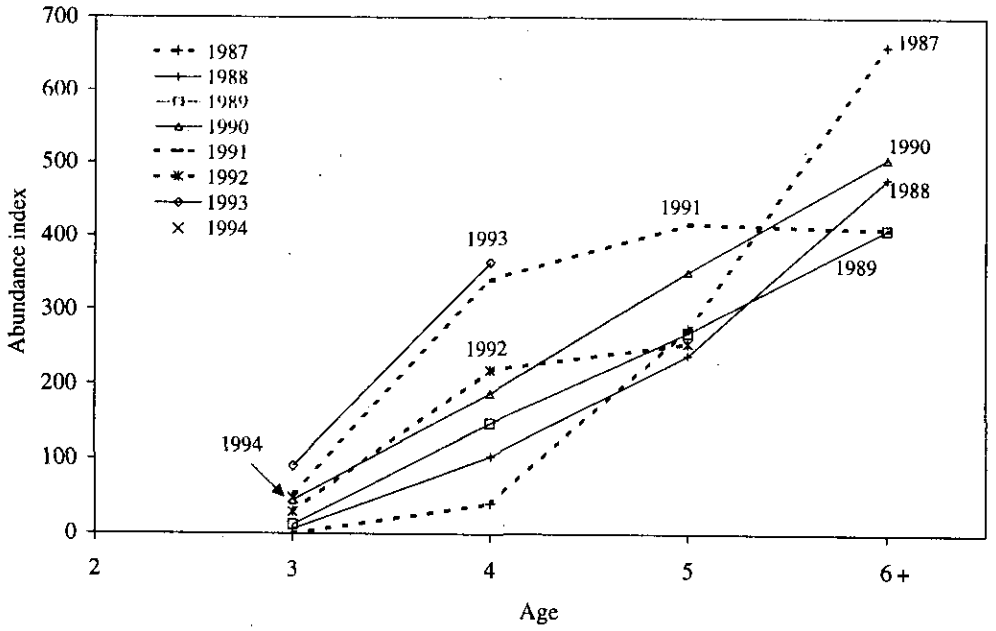


Figure 6. Standardised CPUE indices based on number of individuals caught of the year classes 1987-1994 as calculated by modal analysis (table 6).