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The Shrimp Fishery in NAFO Subarea 1 in 1985 and 1986

by

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INTRODUCTION

The scientific advice for the offshore catch of shrimp in NAFO Subareas 0 and 1 (not including Subarea 1 north of 70°52'N) was 36,000 tons for 1985 and 1986. The effective TAC for offshore Subarea 1 in the area considered by STACFIS was for 1986 set by the Greenland Home Rule Authorities to 34,300 tons, including a Greenland allocation of 32,225 tons. Trawlers above 80 GRT reported a total catch in the Subarea of about 47,500 tons, including 11,071 tons taken north of the area considered by STACFIS. Catches of smaller vessels including inshore catches were about 12,800 tons.

Logbooks from the fishery of nine trawlers owned by the Greenland Home Rule Administration have been available to the Greenland Fisheries and Environmental Research Institute since 1975. In 1986 available logbooks cover 21,709 hours of shrimp trawling and a total catch of 12,760 tons of shrimp in Subarea 1, i.e. about 27% of the total offshore catch by vessels above 80 GRT.

The present paper updates earlier information on the geographical distribution, catch rates and by-catches in the offshore Subarea 1 shrimp fishery, compiled from the logbook data base. Also information based on the analysis of commercial and research shrimp samples is presented.

MATERIAL AND METHODS

Total catches and numbers of vessels in the shrimp fishery in NAFO Subarea 1 in 1985 and 1986 were compiled by nation and month based on the obligatory weekly reportings to Greenland authorities by all vessels above 80 GRT. Logbook data from nine trawlers were analysed to show the yearly and monthly distribution of fishing effort.

Monthly mean catch rates in Division 1B from 1975 to December 1986 and the corresponding numbers of hours trawled were calculated from the logbook data base. Indices of mean catch rates for the July-September period used to evaluate the status of the shrimp stock in Division 1B in recent years were derived from the same data base, as were the levels of by-catches in the shrimp fishery in Subarea 1. Shrimp samples from commercial and research fisheries were sorted by stages of sexual development and shrimps were measured to nearest 0.1 mm carapace length. Length-frequency diagrams were established to evaluate the occurrence of sexual stages in the shrimp stock.

RESULTS AND DISCUSSION

Reported catches in 1985.

Table 1 shows catches in Subarea 1 in 1985 and 1986 as reported by vessels above 80 GRT, and Table 2 shows the corresponding numbers of reporting vessels. The figures for Greenland include catches in the offshore trial fishery north of 70°52´N. The importance of this area for the Greenland shrimp fishery in 1986 is obvious, especially in October when catches were more than three times the size of catches in the traditionally exploited parts of Subarea 1.

The shrimp landings (in tons) from Subarea 1 in 1986 by smaller Greenland vessels (below 80 GRT - preliminary figures) were:

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
495	757	417	1268	1819	1444	1918	1167	1257	1246	670	264	12722

These figures include inshore catches, which are estimated to total about 7,500 tons.

The total nominal shrimp catch in Subarea 1 was thus more than 60,000 tons in 1986.

Geographical distribution of the offshore fishery.

Figures 1 and 2 show the distribution of fishing effort (in numbers of hours trawled) in 1985 and 1986 as recorded in the logbook data base (the map does not include the northern fishing grounds in the trial area - see Lund, 1987). In 1986 the trawlers of the Greenland Home Rule Authorities participated in the trial fishery north of 70°52´N, while - similar to the years from 1982 to 1985 - very little effort was expended around 70°30´N, which was an important area in 1980 and 1981 (Carlsson, 1981). In 1986 the fishery concentrated on the northern and western slopes of the Store Hellefiske Bank, in the Holsteinsborg Deep and in the Sukkertoppen Deep. Similar to 1984 and 1985 an extensive fishery again took place in Division 1C and 1D (Carlsson, 1986).

Figure 4 shows the monthly distribution of effort (in numbers of hours trawled) from January 1985 through December 1986. While severe ice conditions hampered the shrimp fishery in the main fishing area in the first months of 1982, 1983 and 1984 (Carlsson, 1985), ice was a minor problem in 1985 and 1986. In 1986 the important fishing grounds north of Store Hellefiske Bank and in the Holsteinsborg Deep were open to the fishery throughout the year.

Trends in catch rates.

Figure 5 shows the variation in mean catch rates by month from October 1975 through December 1986 in NAFO Division 1B based on logbook information and landings of seven trawlers (630-722 GRT) - Table 3 shows the corresponding numbers of hours trawled. A spring peak in catch rate is found in April 1986, but it is not followed by the typical decline throughout the year as has been the case in most years since the fishery started. Rather, it is followed by a decrease in May and an increase in July to almost the same level as in April. Catch rates decline again from July to October, and increase in November and December. The development in 1986 catch rates may reflect that favourable ice conditions in both 1985 and 1986 influenced the distribution of the fishery on the different components of the stock.

Table 4 shows the mean catch rates by division and month in a south to north 7.5´ latitude grid in 1985 and 1986, and Table 5 shows the corresponding numbers of hours trawled. Different from previous years there is no northward shift in the fishery throughout the year in 1986 excepting the trial fishery

in the autumn. In general the fishery is almost evenly distributed over the exploited area in a south to north scale except late in the year, when there is a southward shift probably due to quota regulations by areas.

Comparison of catch rates between years in the Davis Strait fishery has been based on mean catch rate indices (using the 1976 mean catch rate as reference point) for the period July-September in Division 1B. CPUE indices for seven Greenland trawlers (630-722 GRT) from 1976 to 1986 are shown in Figure 6, based on the following figures:

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Hours trawled	1,005	2,966	3,446	3,588	1,872	5,285	3,543	3,967	2,784	3,817	2,967
kg/hour	743	549	501	379	468	438	550	490	495	563	620
Index	1.00	0.74	0.67	0.51	0.63	0.59	0.74	0.66	0.67	0.76	0.84

CPUE indices since 1980 may not be directly comparable to those from earlier years due to the introduction of more efficient gears around 1980 (Carlsson, 1983). In 1985 and 1986 even more efficient gears with vertical openings ranging up to 20 meters have been taken into use, with reported higher catches indicating that a larger part of the shrimp biomass than hitherto expected is found above the bottom. In the same years also electronic trawl positioning systems (e.g. SCANMAR) allowing better control with the performance of the trawl have been introduced. Finally the use of new netting material (KEVLAR) reducing the weight and water resistance of the trawl has allowed the use of much larger trawls with the same engine power. It is not possible to quantify the influence of these innovations on mean catch rates, but upward bias would be expected. Neither is it possible to judge the influence on the abundance of shrimp of difference in ice coverage and hence the availability of the different components of the shrimp stock from year to year.

Figure 7 shows the variation from 1976 to 1986 in CPUE in the July-September period in 30´ latitude strips (see Figure 3). From 1982 to 1984, catch rates seem to have stabilized at 400-500 kg/hour in all strips. In 1985 all catch rates increased, while in 1986 they remained at the 1985-level with the exception of a drastic increase in strip no. 5 and a decrease in strip no. 6. The increase in strip no. 5 is responsible for the increase in catch rate index in Division 1B for the July-September period in 1986.

By-catches in the shrimp fishery

Table 6 shows by-catches as reported in the logbook data in 1986 compared to earlier years. The by-catch level in relation to total shrimp catch is slightly higher in 1986 compared to 1984 and 1985, but is still low compared to 1978 and 1979 figures.

Biological samples

Table 7 shows the composition by stages of sexual development of commercial shrimp samples collected on a diel basis in Division 1B in August 1986. The mesh size (stretched) used was about 44 mm. Figure 8 shows the length frequency distributions of some of the samples. From Table 7 a significant diurnal variation in sample composition is seen, juveniles and males dominating the catch at mid-day, while relative frequencies of females (both females with head roe and berried females) are highest during night time. Further analysis is necessary to explain the diel variation in terms of diel vertical migrations of components of the stock. However, an upward migration of shrimp in the dark hours has been found based on diel variation in catch

rates in logbook data (Smidt, 1978), and the actual samples stress the need for comparing samples from the same time of the day - preferably from around mid-day.

Length frequencies of the commercial samples (Fig. 9) show dominance of males and females, transitionals being relatively scarce. In most samples males show a significant peak around 21-22 mm carapace length.

Since 1977 the Greenlands Fisheries and Environmental Research Institute has conducted a research survey in Divisions 1A, 1B and 1C each year in July-August. The aim has been to combine shrimp abundance data from bottom photography with catch data and shrimp samples from trawling (e.g. Kanneworff, 1986). In 1986 the photographic method was abandoned due to problems with the interpretation of data obtained from the method (Carlsson and Kanneworff, 1987), and instead an intensified trawl survey was performed. The same stations as in earlier years were covered, but the survey was also extended further south in Division 1C. Also some new shallow water stations were selected in Division 1B in an attempt to identify possible nursery areas for juvenile shrimp in this area. Table 8 shows composition of shrimp samples from the 1986 survey by stages of sexual development, and Figure 9 shows length-frequency distributions of selected samples. In 1985 shrimp samples from the commercially important area west of Store Hellefiske Bank showed a decrease in the relative proportion of males compared to samples from 1984 (Carlsson, 1986). In 1986 the proportion of males in samples from the same area increased to a level similar to that found in 1984, indicating a better recruitment to the fishery in these two years compared to 1985. Samples from the Holsteinsborg Deep area and the southwestern slopes of Store Hellefiske Bank showed a similar proportion of males in 1985 and 1986.

In general the same age groups as in 1984 and 1985 were found in samples from 1986. Modal size-groups of males were present at 12, 15, 18-19 and 21-22 mm carapace length. In one sample from 190 meters depth in statistical unit KR006 the group of 12 mm juveniles was dominating, indicating that this might be a specific nursery area.

CONCLUSIONS

The nominal offshore catch of shrimp by vessels above 80 GRT in NAFO Subarea 1 is estimated to be about 47,500 tons in 1986, including about 11,000 tons from the trial fishery north of 70°52´N.

Different from earlier years the important shrimp fishing grounds on the slopes of Store Hellefiske Bank were open to the fishery throughout 1986. The northward shift in the fishery as seen in earlier years was not found in 1986.

Mean catch rates of Greenland trawlers in Division 1B in the July-September period increased again in 1986 compared to preceeding years, reaching the highest level since the reference year of 1976. Introduction of new trawl technology is supposed to bias the index upwards.

Reported by-catches in the shrimp fishery in 1985 were still low compared to 1978 and 1979 figures, redfish still being the dominant species.

Commercial shrimp samples from Division 1B in August 1986 showed a significant diel variation in the relative proportion of sexual stages, males being most abundant in mid-day samples when catch rates are known to be at the highest.

Research shrimp samples from July-August 1986 from Divisions 1A, 1B and 1C

showed the same length groups to be present as in samples from 1984 and 1985. Compared to 1985 samples relative numbers of males and juveniles increased in 1986 in the area west of Store Hellefiske Bank, to the same level as found in 1984. A shallow water sample from 1986 might point to the existance of a specific nursery area on Store Hellefiske Bank, the sample being dominated by males and juveniles around 12 mm carapace length.

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Table 1. Offshore catches of shrimp (tons) by nation and month in NAFO Subarea 1 by trawlers above 80 GRT as reported to Greenland authorities in 1985 (a) and 1986 (b). Figures for Greenland include catches in a trial fishery in the northern part of the Davis Strait.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
						a. 1985							
Greenland	2298	2067	3276	3440	4978	2970	3086	3070	3010	4567	3259	2653	38674
Denmark	-	-	-	-	-	-	78	72	-	39	237	-	426
Faroe Islands	-	85	-	-	-	-	-	-	-	211	86	199	581
Norway	-	-	-	-	136	229	88	-	-	-	-	-	453
France	-	-	-	-	-	-	114	196	121	-	-	-	431
Total	2298	2152	3276	3440	5114	3199	3366	3338	3131	4817	3582	2852	40565
(Greenl. trial)	-	-	-	-	-	20	248	163	460	2096	1226	136	4349
						b. 1986							
Greenland	2623	2090	2451	4974	4096	4765	4881	3253	3988	7475	2787	2053	45436
Denmark	-	-	-	19	279	52	85	54	-	83	-	-	572
Faroe Islands	170	-	-	-	-	-	-	-	9	171	131	-	481
Norway	-	-	-	-	119	197	148	-	-	-	-	-	464
France	-	-	-	-	-	-	201	334	-	-	-	-	535
Total	2793	2090	2451	4993	4494	5014	5315	3641	3997	7729	2918	2053	47488
(Greenl. trial)	-	-	-	-	30	838	845	1239	1981	5706	432	0	11071

Table 2. No. of vessels above 80 GRT by nation and month in the shrimp fishery in NAFO Subarea 1 as reported to Greenland authorities in 1985 (a) and 1986 (b).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
						a. 1985							
Greenland	17	23	26	25	31	25	22	29	29	32	33	27	37
Denmark	-	-	-	-	-	-	1	1	-	2	2	-	2
Faroe Islands	-	1	-	-	-	-	-	-	-	4	3	1	5
Norway	-	-	-	-	3	4	2	-	-	-	-	-	4
France	-	-	-	-	-	-	1	2	1	-	-	-	2
Total	17	24	26	25	34	29	26	32	30	38	38	28	50
(Greenl. trial)	-	-	-	-	-	2	4	5	7	17	19	4	21
						b. 1986							
Greenland	20	20	21	26	34	28	28	21	23	21	26	25	39
Denmark	-	-	-	1	1	2	1	1	0	1	0	0	2
Faroe Islands	1	-	-	-	-	-	-	-	1	4	4	0	5
Norway	-	-	-	-	2	4	2	-	-	-	-		4
France	-	-	-	-	-	-	2	2	-	-	-	-	2
Total	20	20	21	26	34	28	28	21	23	21	26	25	52
(Greenl. trial)	-	-	-	-	2	6	14	13	22	27	14	2	27

Table 3. No. of hours trawled per month and year from October 1975 through December 1986 in NAFO Divisions 1A and 1B in the shrimp fishery of seven trawlers (630-722 GRT) of the Royal Greenland Trade Department (1986 incomplete).

Div.	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1A	1975	-	-	-	-	-	-	-	-	-	-	-	-	0
	1976	-	-	-	-	-	-	2	-	-	-	-	-	2
	1977	-	-	-	-	-	-	-	4	58	-	-	-	62
	1978	-	-	-	-	-	-	-	10	-	-	-	100	110
	1979	77	-	-	91	65	143	-	-	-	-	-	-	376
	1980	39	118	93	46	70	979	171	199	255	319	-	-	2289
	1981	187	-	13	71	369	178	66	209	82	72	-	19	1266
	1982	6	-	-	-	6	-	35	14	-	20	25	-	106
	1983	-	-	-	-	5	-	13	20	5	24	9	-	76
	1984	-	-	-	34	45	-	3	-	-	20	20	49	171
	1985	-	-	-	-	-	-	-	17	22	43	4	-	86
	1986	-	-	-	-	-	40	-	-	-	178	53	0	271

Div.	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1B	1975	-	-	-	-	-	-	-	-	-	50	331	183	564
	1976	12	-	-	-	7	252	326	309	370	329	-	-	1605
	1977	104	84	245	391	643	839	874	1053	1039	1297	1293	957	8819
	1978	233	-	-	13	948	1209	1226	1326	894	1282	1199	626	8956
	1979	27	18	823	752	991	972	1191	1521	876	911	922	891	9895
	1980	771	627	685	670	1330	131	469	822	581	254	-	-	6340
	1981	857	172	366	729	1059	1167	1915	1816	1554	1436	1254	692	13017
	1982	169	-	-	220	711	1001	1301	1302	940	1258	684	13	7599
	1983	-	-	-	15	1032	1184	1244	1307	1416	1452	819	50	8519
	1984	-	-	3	543	1936	1800	1851	602	331	1512	1136	180	9894
	1985	19	146	606	728	1281	785	1244	1071	1502	1418	1608	961	11369
	1986	1706	1645	474	1013	1707	1170	1126	1162	679	586	396	199	11863

Table 4. Mean catch of shrimp (kg/hour) by month in 1985 and 1986 in NAFO Subarea 0+1 in the shrimp fishery of eight trawlers (473-722 GRT) of the Royal Greenland Trade Department in a south to north grid (7.5 minutes latitude scale, see Fig. 2).

DIV.		8501	8502	8503	8504	8505	8506	8507	8508	8509	8510	8511	8512	8601	8602	8603	8604	8605	8606	8607	8608	8609	8610	8611	8612
0A	KP	-	-	-	-	-	-	615	-	-	-	-	-	-	-	-	-	-	-	-	-	275	-	-	-
	KM	-	-	-	-	-	-	536	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	KX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1375	-	-	-	-	-	-
1A	MN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	189	133	-	-	-
	NM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	199	-	0	139	-
	NL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	26	-	-
	NG	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	286	-	-
	NF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	221	-	-
	ND	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	257	226	-	-
	NB	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	735	302	-
	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	497	289	-
	LV	-	-	-	-	-	-	-	-	-	505	-	-	-	-	-	-	-	846	-	-	-	-	-	-
	LE	-	-	-	-	-	-	-	379	426	-	371	-	-	-	-	-	-	-	-	-	-	-	-	-
1B	LD	-	-	-	-	-	-	-	399	400	331	523	294	167	-	-	976	-	-	-	559	-	-	0	-
	LB	-	-	-	-	464	314	776	413	418	422	300	234	186	-	-	479	-	-	-	531	-	-	-	-
	LA	-	-	-	-	470	-	782	630	213	256	523	539	-	-	-	-	-	-	-	-	-	-	-	-
	KZ	-	-	-	-	804	465	606	569	459	391	509	290	354	350	519	684	403	400	222	280	-	-	-	-
	KX	-	-	-	960	608	328	762	650	462	377	428	363	626	559	665	789	604	376	500	274	-	-	649	-
	KV	-	-	-	1083	692	363	639	587	424	549	308	392	481	496	555	822	592	511	563	409	323	-	621	-
	KT	-	-	-	806	-	687	512	646	333	492	55	270	542	410	527	804	496	456	556	591	179	-	-	-
	KS	-	-	-	-	-	619	592	459	414	-	171	-	274	-	831	-	407	481	365	464	535	-	-	-
	KR	-	-	-	-	100	571	532	441	187	-	162	-	179	25	-	-	409	804	552	285	395	-	-	-
	KP	-	-	-	-	-	453	601	-	422	-	365	-	-	317	-	-	198	469	296	537	295	455	-	0
	KN	-	-	-	-	-	504	554	-	235	-	347	507	-	-	-	-	433	-	529	515	585	175	-	-
	KM	-	-	-	-	356	605	566	294	343	444	399	614	107	-	-	-	514	594	975	304	229	409	111	-
	KL	100	-	-	-	-	552	692	364	423	439	436	264	-	1350	-	-	414	782	878	406	-	227	837	150
	KK	-	-	-	-	-	679	629	440	440	679	284	420	-	312	-	-	187	1124	758	355	94	106	668	860
	KJ	-	-	-	-	388	498	500	352	382	392	316	243	-	-	-	-	108	756	209	-	-	-	478	1564
	KH	-	-	-	-	-	310	907	583	245	47	207	73	-	-	-	-	-	-	147	-	-	-	889	1346
	KG	74	-	583	250	-	0	758	692	463	476	418	214	557	-	-	-	-	-	-	-	-	575	19	1091
	KF	-	-	459	314	203	-	213	-	437	237	-	300	569	487	523	1087	497	846	-	-	0	357	-	-
	KE	-	-	785	906	-	-	0	171	427	628	281	450	449	460	408	788	453	857	-	476	379	596	0	576
	KD	94	1488	807	596	391	694	949	251	349	482	333	358	546	444	601	955	304	609	709	359	383	493	436	391
	KB	-	1033	869	576	305	966	709	414	421	430	452	299	313	219	815	803	367	805	971	660	488	353	463	1157
1C	KA	453	400	997	419	227	825	858	630	405	375	322	321	104	-	826	936	409	454	1026	569	576	415	454	60
	JZ	436	705	-	259	211	829	912	805	505	292	229	325	341	0	546	1149	669	504	963	578	396	229	482	-
	JX	344	511	-	0	309	79	580	982	-	276	127	-	-	-	83	-	-	-	500	457	-	-	-	-
	JV	225	415	-	682	565	1032	723	215	-	100	119	230	-	-	114	1011	-	-	-	0	-	-	-	-
	JT	595	387	-	811	565	999	779	200	-	520	441	180	440	1286	1479	1233	-	-	292	-	-	0	-	-
	JS	1147	680	-	1508	877	278	-	0	-	645	350	318	-	-	3010	712	-	-	494	219	.0	-	-	-
	JR	875	564	-	-	-	167	528	-	-	415	393	-	-	-	-	-	-	-	-	-	-	-	-	-
	JP	602	235	-	0	-	633	-	-	-	-	467	-	-	-	-	-	-	0	-	-	-	0	-	-
	JN	399	471	0	400	-	760	-	-	-	-	331	0	-	-	0	-	-	-	0	-	-	502	1125	-
	JM	550	358	285	503	-	632	-	-	-	120	281	139	-	354	630	-	-	150	-	639	-	713	321	-
	JL	118	261	273	451	508	738	470	-	120	480	247	265	-	0	504	-	624	327	-	475	344	614	1168	-
	JK	141	274	468	369	151	796	365	-	468	293	183	120	-	255	477	-	505	397	-	515	-	720	-	-
	JJ	75	482	433	527	140	889	471	-	-	303	241	344	-	-	470	745	575	470	0	247	-	383	-	-
	JH	370	533	447	545	48	718	290	-	-	288	195	294	-	748	689	-	150	310	-	-	-	225	-	689
	JG	443	501	503	373	-	395	319	-	-	222	75	354	-	467	334	-	-	697	-	160	-	656	-	0
	JF	286	540	545	379	-	390	-	-	-	-	171	155	-	25	623	-	379	942	154	432	-	122	-	-
1D	JE	283	546	729	667	117	386	-	-	345	-	253	280	-	-	641	415	-	453	1364	430	327	178	-	300
	JD	505	564	533	-	-	-	-	-	-	425	287	40	-	-	1189	-	-	944	1015	532	304	419	-	338
	JB	612	209	376	-	-	-	-	-	-	-	186	-	-	-	-	-	-	1288	1579	-	200	160	-	-
	JA	64	168	-	-	-	-	-	-	-	-	-	109	-	-	-	-	-	1825	-	-	-	-	-	-
	HZ	-	350	-	32	-	-	-	-	-	-	-	320	-	-	-	-	-	-	-	-	-	400	-	-
	HX	-	418	647	584	-	-	-	-	-	-	-	206	-	-	-	-	-	-	-	-	-	83	-	270
	HV	-	246	771	495	-	-	-	-	-	-	-	186	-	-	-	-	-	-	-	-	-	-	-	256
	HT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	343
	HP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	104

Table 5. No. of hours trawled by month in 1985 and 1986 in NAFO Subarea 0+1 in the shrimp fishery of eight trawlers (473-722 GRT) of the Royal Greenland Trade Department in a south to north grid (7.5 minutes latitude scale, see Fig. 1).

Div.		8501	8502	8503	8504	8505	8506	8507	8508	8509	8510	8511	8512	8601	8602	8603	8604	8605	8606	8607	8608	8609	8610	8611	8612
0A	KP	-	-	-	-	-	-	13	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-
	KM	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	KK	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-
1A	MN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13	4	-	-	-
	MM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	19	-	2	27	-
	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-
	MG	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	-	-
	MF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11	-	-
	MD	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	122	108	-	-
	MB	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	357	109	-
	MA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	19	34	-
	LV	-	-	-	-	-	-	-	-	-	43	-	-	-	-	-	-	-	40	-	-	-	-	-	-
	LS	-	-	-	-	-	-	-	17	22	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-
1B	LD	-	-	-	-	-	-	-	66	43	47	184	9	3	-	-	10	-	-	-	36	-	-	4	-
	LB	-	-	-	-	45	9	24	31	60	144	46	20	22	-	-	19	-	-	-	56	-	-	-	-
	LA	-	-	-	-	12	-	9	20	18	9	5	9	-	-	-	-	-	-	-	-	-	-	-	-
	KZ	-	-	-	-	30	8	36	121	240	179	73	60	16	10	59	22	20	11	2	9	-	-	-	-
	KX	-	-	-	10	444	23	4	273	473	331	210	75	616	414	56	53	58	14	8	16	-	-	256	-
	KV	-	-	-	25	675	79	72	163	219	293	93	56	513	1021	150	45	890	161	59	135	131	-	24	-
	KT	-	-	-	22	-	22	40	195	169	97	9	3	80	72	8	16	187	91	48	273	7	-	-	-
	KS	-	-	-	-	-	180	123	133	142	-	4	-	16	-	2	-	99	47	45	79	102	-	-	-
	KR	-	-	-	-	1	97	108	7	9	-	4	-	10	4	-	-	50	17	19	46	26	-	-	-
	KP	-	-	-	-	-	68	42	-	5	-	21	-	-	4	-	-	32	25	19	98	22	15	-	11
	KN	-	-	-	-	-	127	58	-	18	-	46	3	-	-	-	-	39	-	69	55	27	4	-	-
	KM	-	-	-	-	5	63	75	12	63	52	175	14	4	-	-	-	50	60	211	23	14	43	6	-
	KL	5	-	-	-	-	283	142	17	100	47	196	80	-	2	-	-	55	167	448	18	-	49	12	13
	KK	-	-	-	-	-	56	159	94	29	16	104	45	-	15	-	-	8	17	356	34	7	7	8	68
	KJ	-	-	-	-	83	8	43	37	34	4	20	7	-	-	-	-	7	165	7	-	-	-	12	5
	KH	-	-	-	-	-	10	192	83	31	4	14	12	-	-	-	-	-	-	5	-	-	-	12	18
	KG	5	-	9	2	-	4	98	36	16	44	9	3	12	-	-	-	-	-	-	-	-	4	11	17
	KF	-	-	63	19	19	-	4	-	23	39	-	11	70	15	16	73	49	31	-	-	4	3	-	-
	KE	-	-	141	24	-	-	4	4	4	18	23	83	199	35	8	195	93	292	-	14	10	63	4	2
	KD	9	15	154	200	129	46	99	38	55	106	126	229	113	33	45	322	92	290	46	35	141	212	6	57
	KB	-	131	239	427	60	17	145	108	138	114	246	237	32	20	130	259	53	190	100	280	317	187	42	9
1C	KA	4	14	79	37	48	141	129	50	57	217	117	59	13	-	84	58	65	47	158	254	502	108	59	10
	JZ	30	21	-	25	130	200	96	315	61	177	33	44	9	3	21	16	20	32	297	311	96	16	70	-
	JX	16	43	-	8	20	10	5	4	-	21	15	-	-	-	5	-	-	-	10	11	-	-	-	-
	JV	8	58	-	9	20	55	43	3	-	6	15	4	-	-	2	21	-	-	-	3	-	-	-	-
	JT	33	105	-	76	77	44	13	1	-	48	81	30	13	1	82	194	-	-	15	-	-	9	-	-
	JS	32	141	-	16	24	12	-	1	-	25	61	28	-	-	15	19	-	-	3	8	2	-	-	-
	JR	40	46	-	-	-	3	2	-	-	2	20	-	-	-	-	-	-	-	-	-	-	-	-	-
	JP	28	45	-	7	-	50	-	-	-	-	11	-	-	-	-	-	-	2	-	-	-	3	-	-
	JN	68	99	5	3	-	50	-	-	-	-	8	2	-	-	3	-	-	-	2	-	-	32	8	-
	JM	87	48	28	8	-	86	-	-	-	3	19	21	-	12	39	-	-	4	-	21	-	29	9	-
	JL	9	14	28	15	24	93	10	-	7	4	17	22	-	2	58	-	23	9	5	4	9	35	6	-
	JK	9	46	74	17	22	99	13	-	6	117	6	23	-	16	36	-	24	10	-	16	-	9	-	-
	JJ	24	60	46	69	4	81	4	-	-	9	20	30	-	-	43	6	4	26	2	9	-	8	-	-
	JH	28	45	59	67	6	111	17	-	-	29	7	63	-	6	41	-	4	23	-	-	-	4	-	4
	JG	52	29	118	37	-	7	12	-	-	5	8	24	-	3	30	-	-	79	-	4	-	5	-	5
	JF	53	133	227	19	-	11	-	-	-	-	17	15	-	4	90	-	3	45	9	116	-	12	-	-
1D	JE	47	257	274	24	6	14	-	-	7	-	47	11	-	-	315	17	-	37	47	22	27	19	-	27
	JD	200	113	250	-	-	-	-	-	-	28	16	5	-	-	164	-	-	128	116	8	17	14	-	79
	JB	199	6	26	-	-	-	-	-	-	-	5	-	-	-	-	-	-	90	88	-	4	6	-	-
	JA	9	8	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	12	-	-	-	-	-	-
	HZ	-	4	-	3	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	1	-	-
	HX	-	11	58	164	-	-	-	-	-	-	-	14	-	-	-	-	-	-	-	-	-	6	-	30
	HV	-	7	81	31	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-	-	-	-	-	10
	HT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33
	HP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13

Table 6. Reported by-catches (tons) in the shrimp fishery from 1977 to 1986 in NAFO Subarea 0 and 1 by eight trawlers (473-722 GRT) of the Royal Greenland Trade Department and a comparison with the corresponding total shrimp catches.

		Species	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Div	0A	Redfishes	4.2	9.2	132.7	106.9	0.1	0.3	-	-	-	-
		Others	-	-	-	-	-	-	-	-	-	-
-	1A	Redfishes	0.1	4.1	5.8	18.3	0.6	-	-	1.6	0.2	2.3
		Others	-	-	-	-	-	-	-	-	1.2	2.2
-	1B	Redfishes	102.3	1035.5	903.8	360.1	63.4	27.6	39.8	154.4	86.1	201.2
		Others	1.2	19.9	8.4	1.6	-	21.0	-	0.2	61.8	29.1
-	1C	Redfishes	2.8	15.6	39.3	40.4	6.9	5.6	29.1	49.2	31.3	50.2
		Others	4.2	-	1.4	20.5	-	-	-	-	18.3	2.2
-	1D	Redfishes	-	-	-	-	-	-	-	1.2	8.5	15.3
		Others	-	-	-	-	-	-	-	-	5.2	1.1
SA	0+1	Redfishes	109.4	1064.4	1081.6	525.7	71.0	33.5	68.9	206.4	126.1	269.0
		Others	5.4	19.9	9.8	22.1	-	21.0	-	0.2	86.5	34.6
-		Total bycatch	114.8	1084.3	1091.4	547.8	71.0	54.5	68.9	206.6	212.6	303.6
-		Total shrimp catch	5503	4703	6605	8484	9239	6946	6228	9907	10356	10757
-		Bycatch in % of total shrimp catch	2.1	23.1	16.5	6.5	0.8	0.8	1.1	2.1	2.1	2.8

Table 7. Composition by stages of sexual development (% by number) of samples of P. borealis from the commercial shrimp fishery in Division 1B in August 1986.

Station no.	Area code	Number of specimens in groups, %								Totals, %			Nos.
		1	2	3	4	5	6	7	8	Mal	Tran	Fem	
820TR01	KX007	25.7	0.5	13.9	2.7	38.8	0.0	15.0	3.3	25.7	14.5	59.8	366
820TR02	KV005	67.5	0.0	8.3	1.2	13.9	0.0	5.6	3.5	67.5	8.3	24.2	483
820TR03	KT004	70.8	0.2	7.0	1.8	11.2	0.0	7.0	2.0	70.8	7.2	22.0	500
820TR04	KS004	67.2	0.0	4.6	0.9	22.0	0.0	2.4	2.9	67.2	4.6	28.2	546
820TR05	KT004	47.8	0.0	12.1	2.5	31.2	0.0	4.1	2.3	47.8	12.1	40.1	439
821TR01	KT004	33.1	0.2	8.0	4.0	41.5	0.0	10.4	2.7	33.1	8.2	58.7	402
821TR02	KS005	61.1	0.0	5.6	2.5	23.2	0.0	6.2	1.4	61.1	5.6	33.3	483
821TR03	KT004	71.0	0.0	1.5	1.2	21.2	0.0	4.4	0.8	71.0	1.5	27.6	482
821TR04	KT005	69.5	0.0	7.0	1.0	17.6	0.0	3.7	1.2	69.5	7.0	23.6	488
821TR05	KR005	47.5	0.0	13.1	1.0	30.0	0.0	6.9	1.5	47.5	13.1	39.4	406
822TR01	KT004	40.8	0.3	18.8	2.1	31.4	0.0	4.6	2.1	40.8	19.0	40.2	373
822TR02	KT004	59.1	0.0	12.2	0.5	19.7	0.0	6.5	2.0	59.1	12.2	28.7	401
822TR03	KT003	75.1	0.0	8.2	0.2	10.9	0.0	3.6	2.1	75.1	8.2	16.7	478
822TR04	KS003	74.4	0.2	10.2	0.7	8.0	0.0	4.7	1.8	74.4	10.4	15.1	450
822TR05	KT003	32.2	0.0	20.8	0.3	33.8	0.0	8.2	4.7	32.2	20.8	47.0	379
823TR01	KS003	21.0	0.0	26.0	0.0	42.3	0.0	5.6	5.0	21.0	26.0	53.0	338
823TR02	KS001	62.3	0.3	10.3	0.5	19.4	0.0	4.0	3.2	62.3	10.6	27.1	377
823TR03	KS001	68.2	0.0	11.4	0.2	14.7	0.0	3.2	2.2	68.2	11.4	20.4	402
823TR04	KT002	63.1	0.3	16.6	0.8	13.5	0.0	3.9	1.7	63.1	16.9	20.0	355
824TR01	KS004	32.3	0.0	8.4	2.2	38.7	0.0	13.3	5.2	32.3	8.4	59.4	406
824TR02	KS004	58.9	0.0	5.9	1.2	23.8	0.0	8.3	1.9	58.9	5.9	35.2	421
824TR03	KT004	73.2	0.0	6.0	0.2	10.2	0.0	7.9	2.5	73.2	6.0	20.8	481
824TR04	KT005	45.3	0.0	2.0	3.2	39.7	0.0	8.4	1.5	45.3	2.0	52.7	406
824TR05	KT005	8.2	0.3	6.1	2.0	73.0	0.0	5.1	5.1	8.2	6.5	85.3	293

Group 1. Juveniles and males.
- 2. Transitionals without roe.
- 3. Transitionals with head roe.
- 4. Females without roe.
- 5. Females with head roe.
- 6. Females, berried, with head roe.
- 7. Females, berried.
- 8. Females with egg hairs.

Table 8. Composition by stages of sexual development (% by number) of samples of *P. borealis* from a research trawl survey in Division 1A, 1B and 1C in July-August 1986 (for explanation of groups see Table 7).

Station	Area	Number of specimens in groups, %								Totals, %			Nos.
no.	code	1	2	3	4	5	6	7	8	Mal	Tran	Fem	
001TR01	JF020	47.7	0.0	2.3	0.0	50.0	0.0	0.0	0.0	47.7	2.3	50.0	44
003TR01	JH015	28.8	0.0	1.9	0.0	69.2	0.0	0.0	0.0	28.8	1.9	69.2	52
004TR01	JL015	66.7	0.2	16.1	0.5	16.6	0.0	0.0	0.0	66.7	16.2	17.1	579
006TR01	JN012	20.6	0.0	17.5	0.0	61.9	0.0	0.0	0.0	20.6	17.5	61.9	63
007TR01	JT011	83.3	0.0	0.0	0.0	16.7	0.0	0.0	0.0	83.3	0.0	16.7	6
008TR01	KA010	69.7	0.0	11.7	0.0	18.4	0.0	0.0	0.2	69.7	11.7	18.6	554
009TR01	KD013	54.8	0.0	24.4	0.6	20.2	0.0	0.0	0.0	54.8	24.4	20.8	471
011TR01	KB007	66.7	0.0	4.2	0.0	29.2	0.0	0.0	0.0	66.7	4.2	29.2	216
012TR01	KB007	92.9	0.0	0.0	0.0	7.1	0.0	0.0	0.0	92.9	0.0	7.1	14
013TR01	KB008	18.8	0.0	7.5	0.0	73.7	0.0	0.0	0.0	18.8	7.5	73.7	361
014TR01	KF007	95.0	0.0	2.5	0.0	2.5	0.0	0.0	0.0	95.0	2.5	2.5	121
015TR01	KF008	81.2	0.5	13.9	0.0	4.5	0.0	0.0	0.0	81.2	14.4	4.5	202
016TR01	KJ005	44.7	0.0	28.5	0.0	26.8	0.0	0.0	0.0	44.7	28.5	26.8	291
017TR01	KL006	91.4	0.2	2.8	0.2	5.3	0.0	0.1	0.0	91.4	3.0	5.6	1002
018TR01	KN003	81.5	0.0	6.0	0.0	12.5	0.0	0.0	0.0	81.5	6.0	12.5	616
019TR01	KP440	75.3	0.0	9.0	0.6	15.1	0.0	0.0	0.0	75.3	9.0	15.7	522
020TR01	KR438	51.2	0.0	30.1	1.4	16.8	0.0	0.2	0.2	51.2	30.1	18.7	428
021TR01	KT436	51.2	0.2	14.6	2.8	31.2	0.0	0.0	0.0	51.2	14.7	34.0	529
022TR01	KX438	65.1	0.0	8.3	3.7	22.0	0.0	0.0	0.9	65.1	8.3	26.6	109
023TR01	LA436	72.8	0.0	12.4	0.4	14.4	0.0	0.0	0.0	72.8	12.4	14.8	500
024TR01	LD438	48.2	0.4	19.3	1.8	28.5	0.0	0.9	0.9	48.2	19.7	32.0	456
025TR01	LB005	61.0	1.7	11.0	1.7	22.9	0.0	0.0	1.7	61.0	12.7	26.3	118
025TR02	LB005	52.5	0.0	19.9	2.3	17.3	0.0	5.1	3.0	52.5	19.9	27.6	568
026TR01	KZ014	60.4	0.4	8.4	3.3	16.6	0.0	7.8	3.1	60.4	8.8	30.8	548
028TR01	KR006	99.4	0.1	0.1	0.1	0.3	0.0	0.0	0.0	99.4	0.2	0.4	1382
029TR01	KR004	73.4	0.0	14.0	1.0	11.5	0.0	0.1	0.0	73.4	14.0	12.6	793
030TR01	KF016	57.7	0.0	16.2	0.8	12.1	0.0	6.9	6.3	57.7	16.2	26.1	605
031TR01	KT006	60.1	1.7	9.4	1.7	23.8	0.0	2.1	1.0	60.1	11.2	28.7	286
032TR01	KT001	80.4	0.0	10.3	0.1	6.5	0.0	1.3	1.3	80.4	10.3	9.4	672
033TR01	KV002	70.6	0.4	12.7	0.7	13.0	0.0	1.3	1.3	70.6	13.1	16.3	687
034TR01	KZ002	83.3	0.4	7.8	0.6	4.1	0.0	0.7	3.1	83.3	8.1	8.5	810
035TR01	LD439	72.3	0.2	12.5	0.9	11.0	0.0	0.8	2.3	72.3	12.7	15.0	639
036TR02	LE005	62.0	0.0	2.6	1.7	23.7	0.0	8.9	1.0	62.0	2.6	35.4	582
037TR01	LK010	91.7	0.1	0.1	0.0	0.9	0.0	7.1	0.1	91.7	0.2	8.1	991
039TR01	LS014	61.4	0.3	1.4	6.9	10.3	0.0	16.5	3.3	61.4	1.7	36.9	642
040TR01	LV012	54.4	0.2	7.5	12.2	5.7	0.0	19.1	0.8	54.4	7.7	37.9	491
041TR01	LX008	0.0	0.0	6.3	37.5	37.5	0.0	18.8	0.0	0.0	6.3	93.8	16
043TR01	LS004	46.9	2.8	0.5	31.5	6.6	0.0	9.4	2.3	46.9	3.3	49.8	213
045TR02	LH013	65.8	0.4	0.2	1.8	1.3	0.0	30.2	0.4	65.8	0.5	33.6	556
047TR01	LD012	89.2	0.0	0.1	4.0	2.8	0.0	4.0	0.0	89.2	0.1	10.7	759
048TR01	KZ012	46.8	0.0	6.6	0.9	25.3	0.0	15.6	4.8	46.8	6.6	46.6	558
049TR01	KV009	68.3	0.0	1.5	0.5	15.2	0.0	9.0	5.5	68.3	1.5	30.2	587

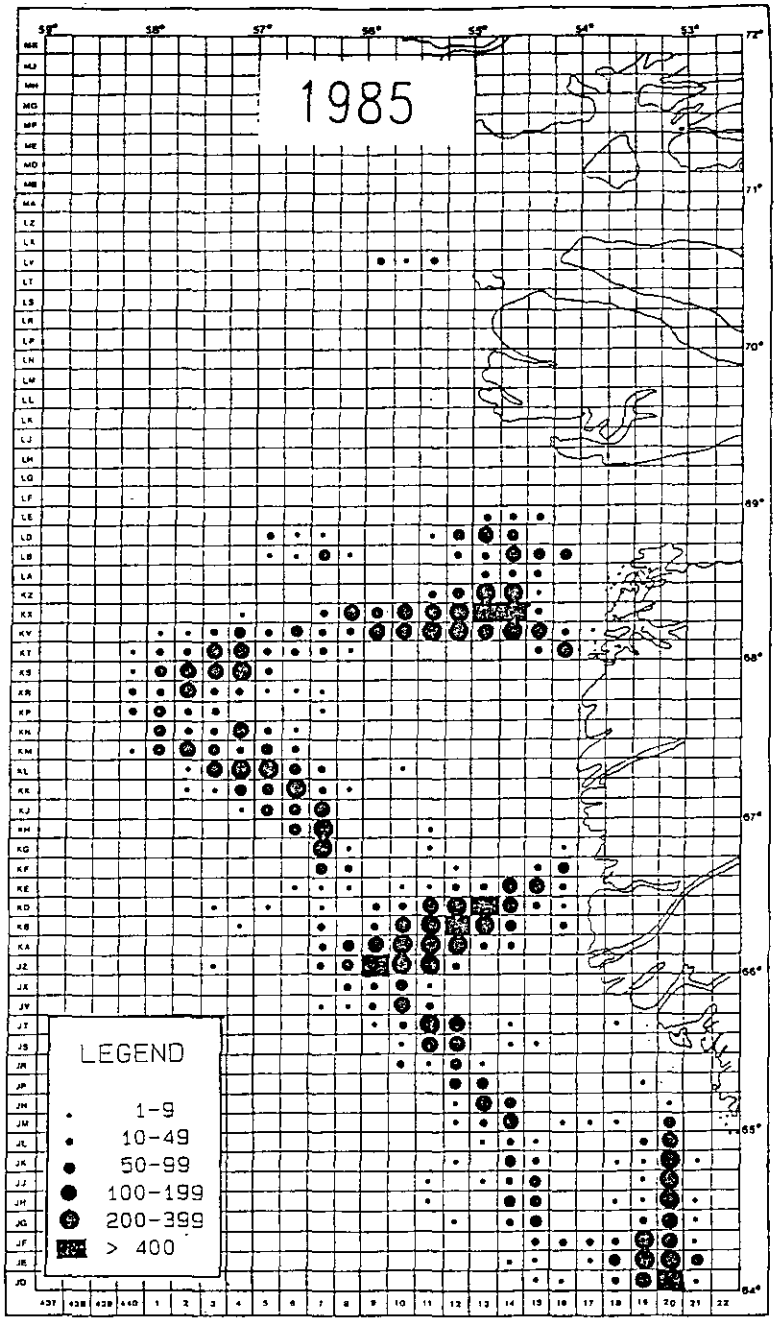

Figure 1. Distribution of hauls in 1985 in the shrimp fishery of seven trawlers (473-722 GRT) of the Royal Greenland Trade Department in NAFO Subarea 0 and 1 between 64°N and 72°N.

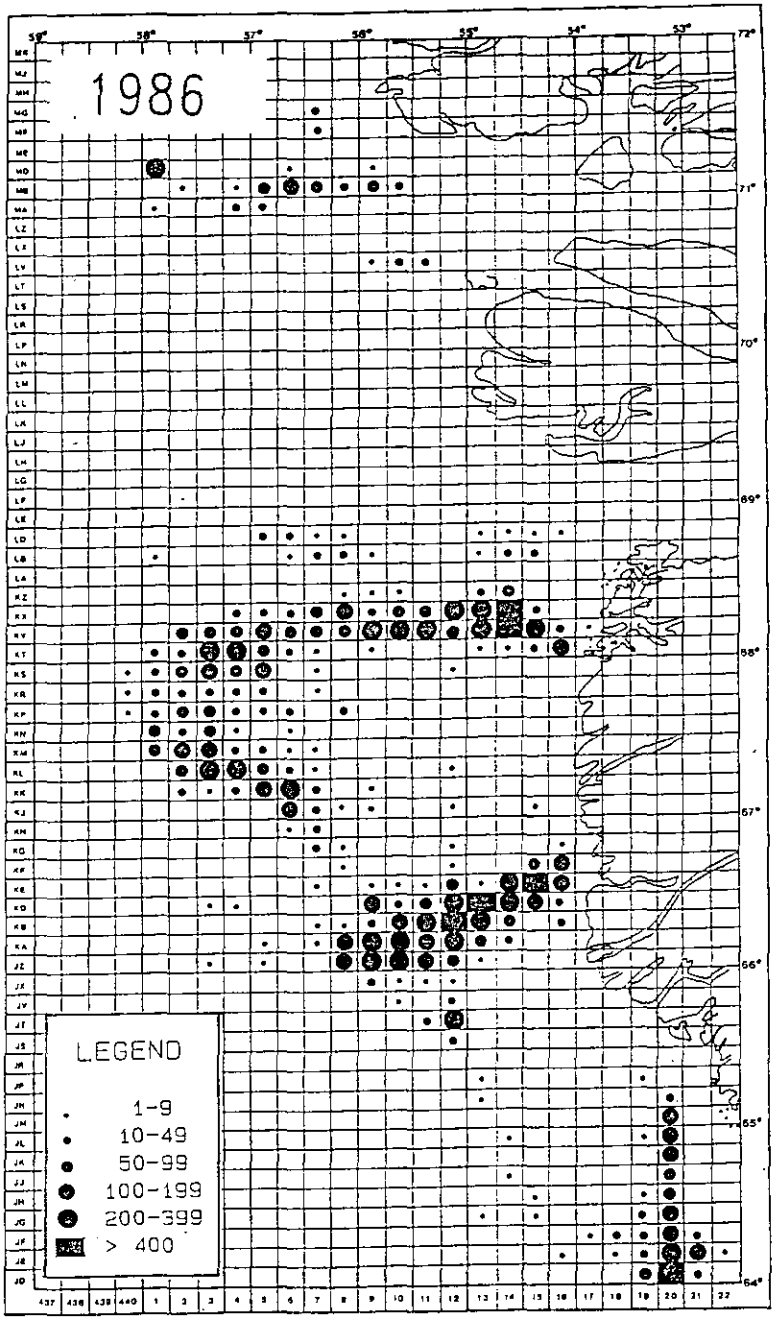

Figure 2. Distribution of hauls in 1986 in the shrimp fishery of eight trawlers (473-722 GRT) of the Royal Greenland Trade Department in NAFO Subarea 0 and 1 between 64°N and 72°N.

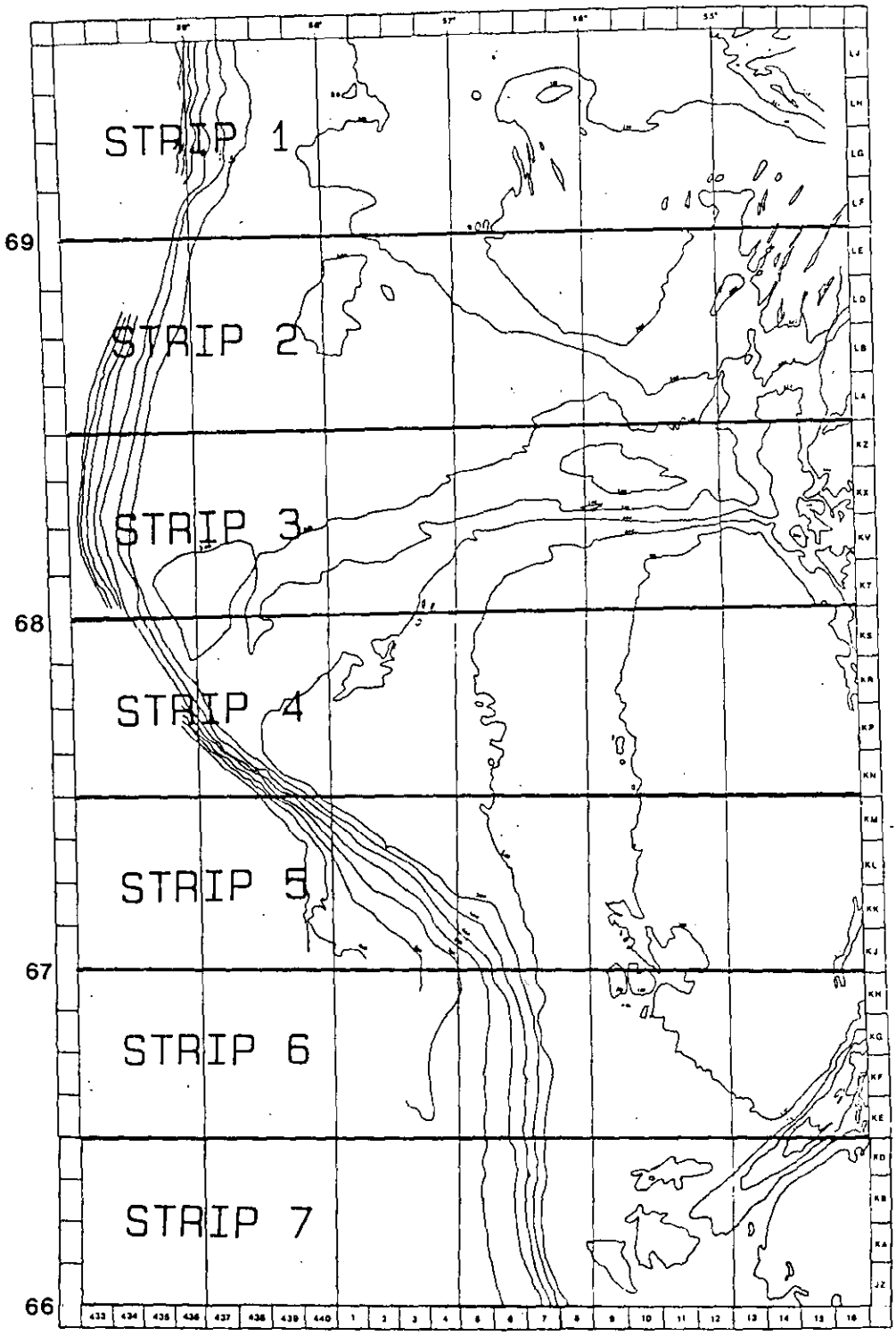

Figure 3. Map showing block-strips used in Figure 7.

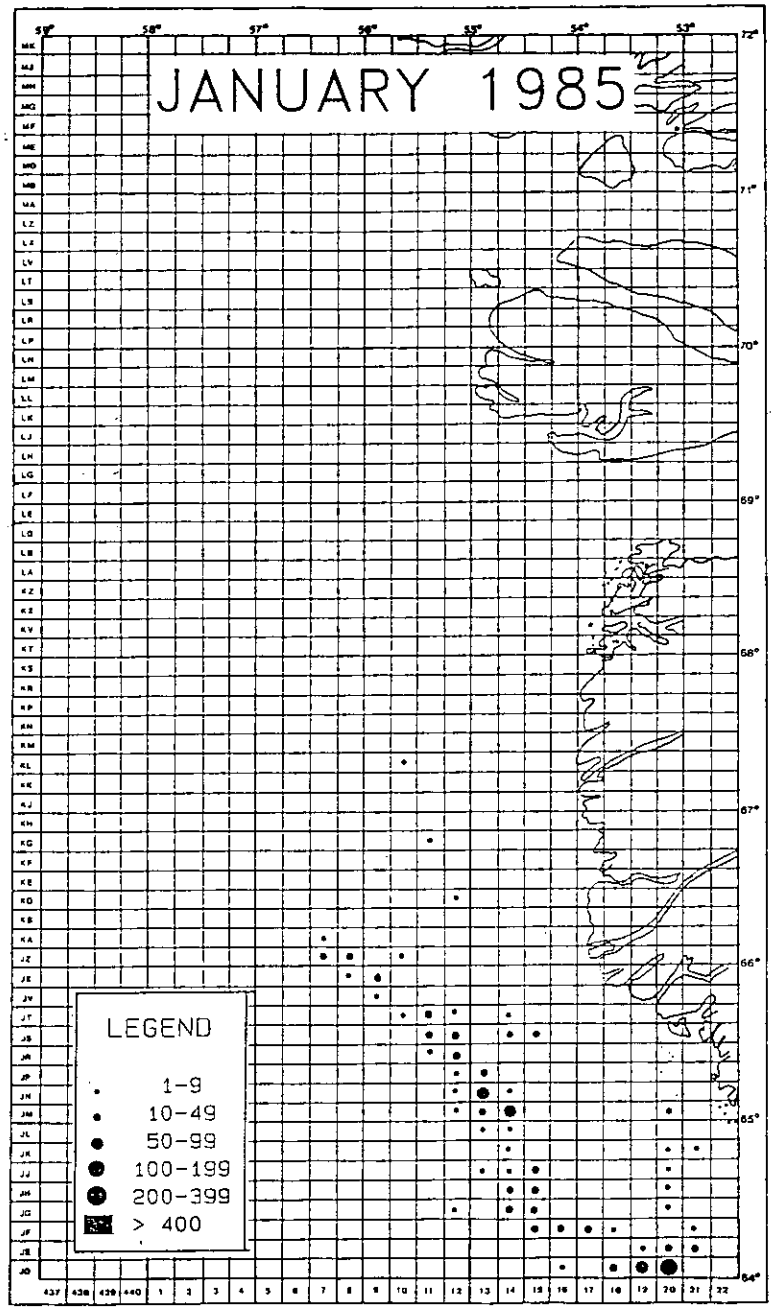

Figure 4. Distribution of effort and mean catch of shrimp per hour in January 1985 in NAFO Subarea 1 in the shrimp fishery of seven trawlers (473-722 GRT) of the Royal Greenland Trade Department. Upper figure in each statistical is no. of hours trawled, lower figure the mean catch rate (kg/hour). A minor fishery (9 hours trawled) was carried out south of map.

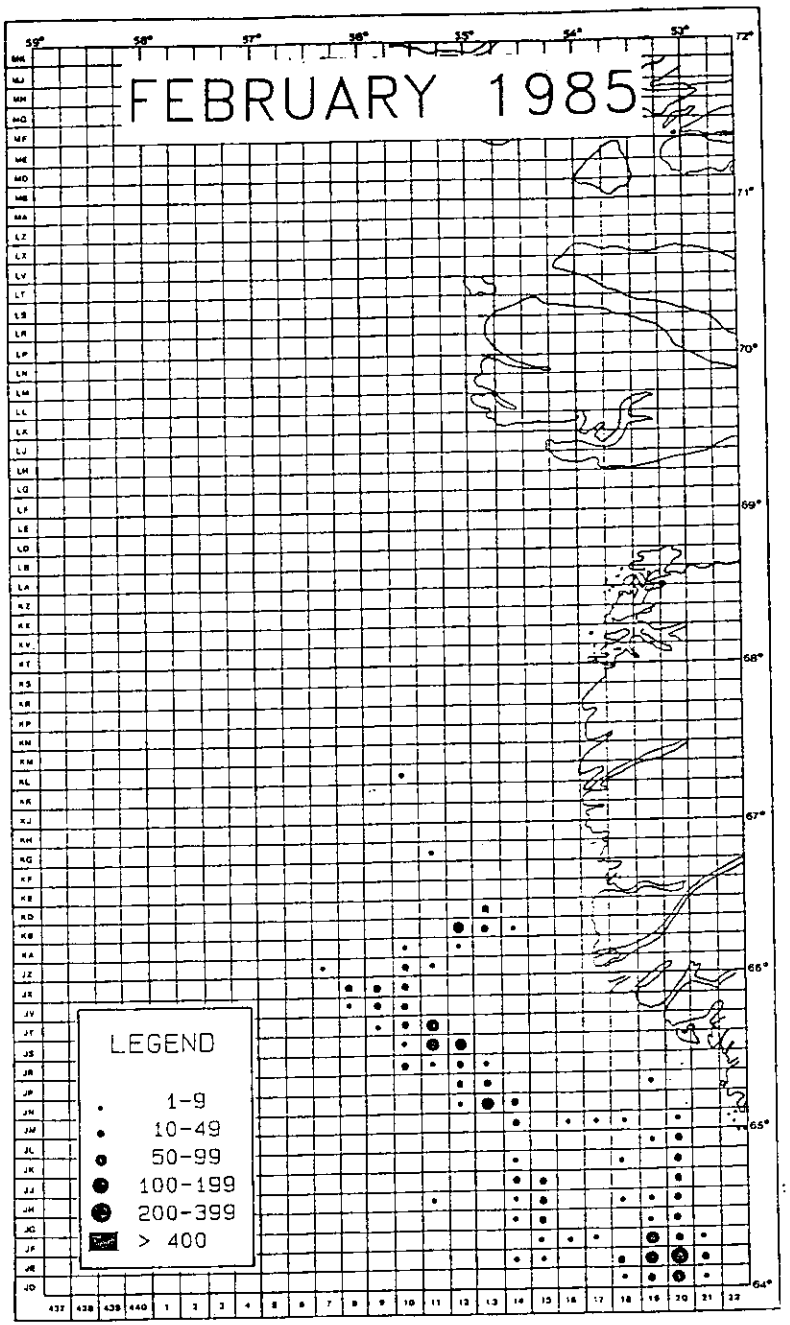

Figure 4. Continued. February 1985. A minor fishery (9 hours trawled) was carried out south of map.

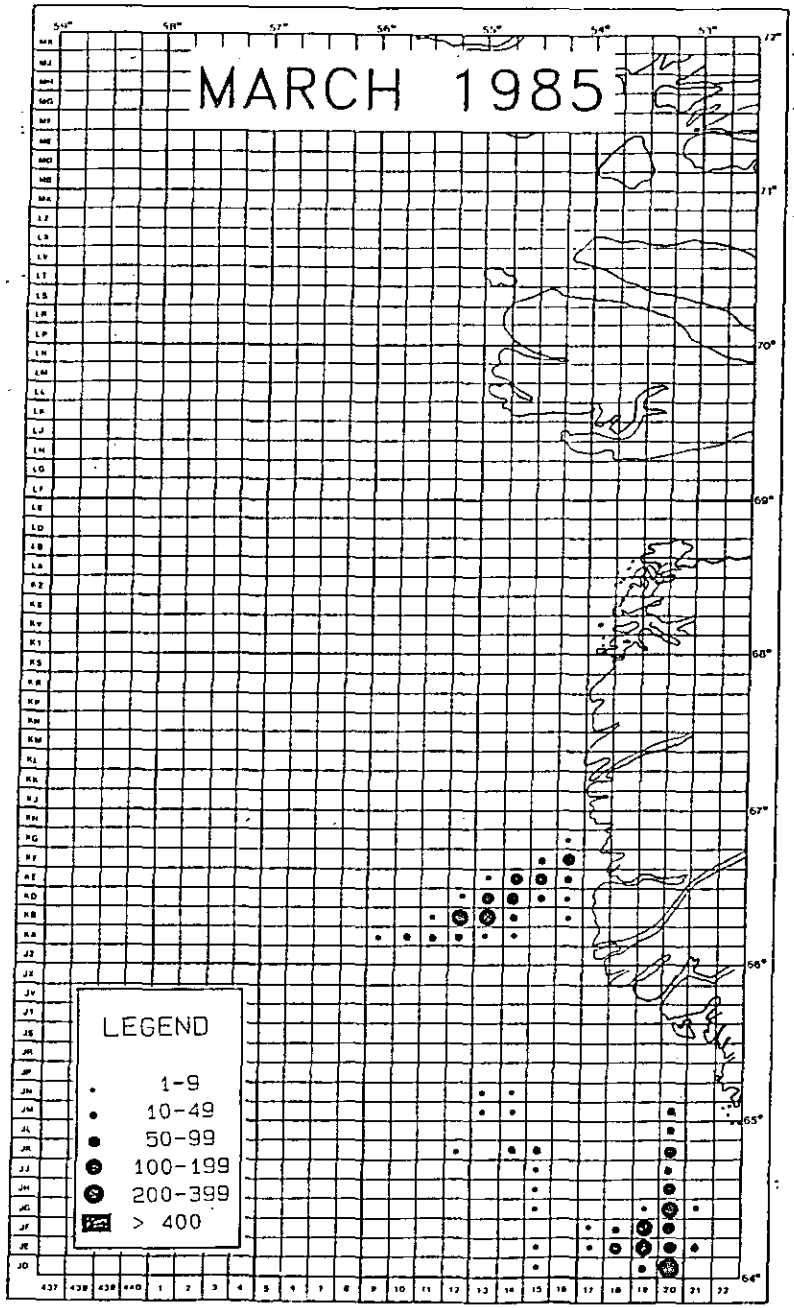

Figure 4. Continued. March 1985. A minor fishery (14 hours trawled) was carried out south of map.

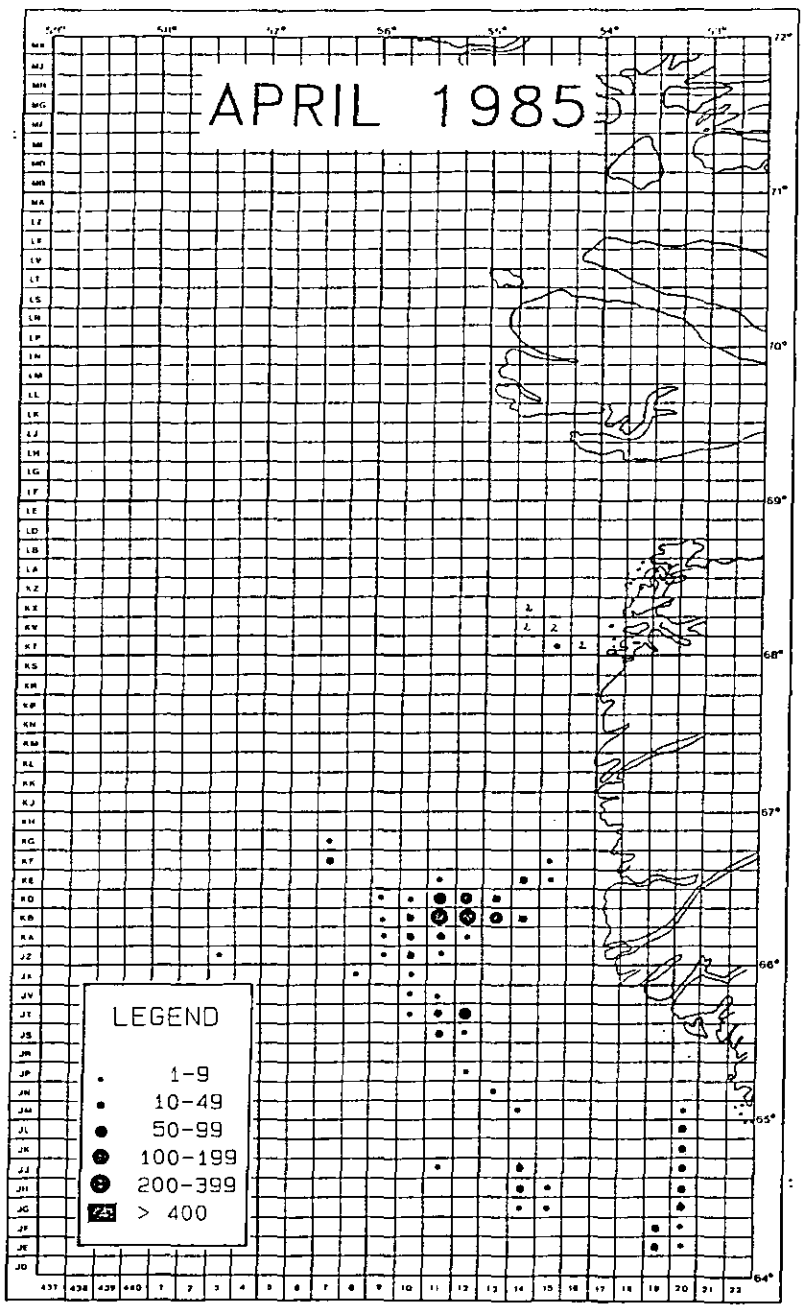

Figure 4. Continued. April 1985. A minor fishery (8 hours trawled) was carried out south of map.

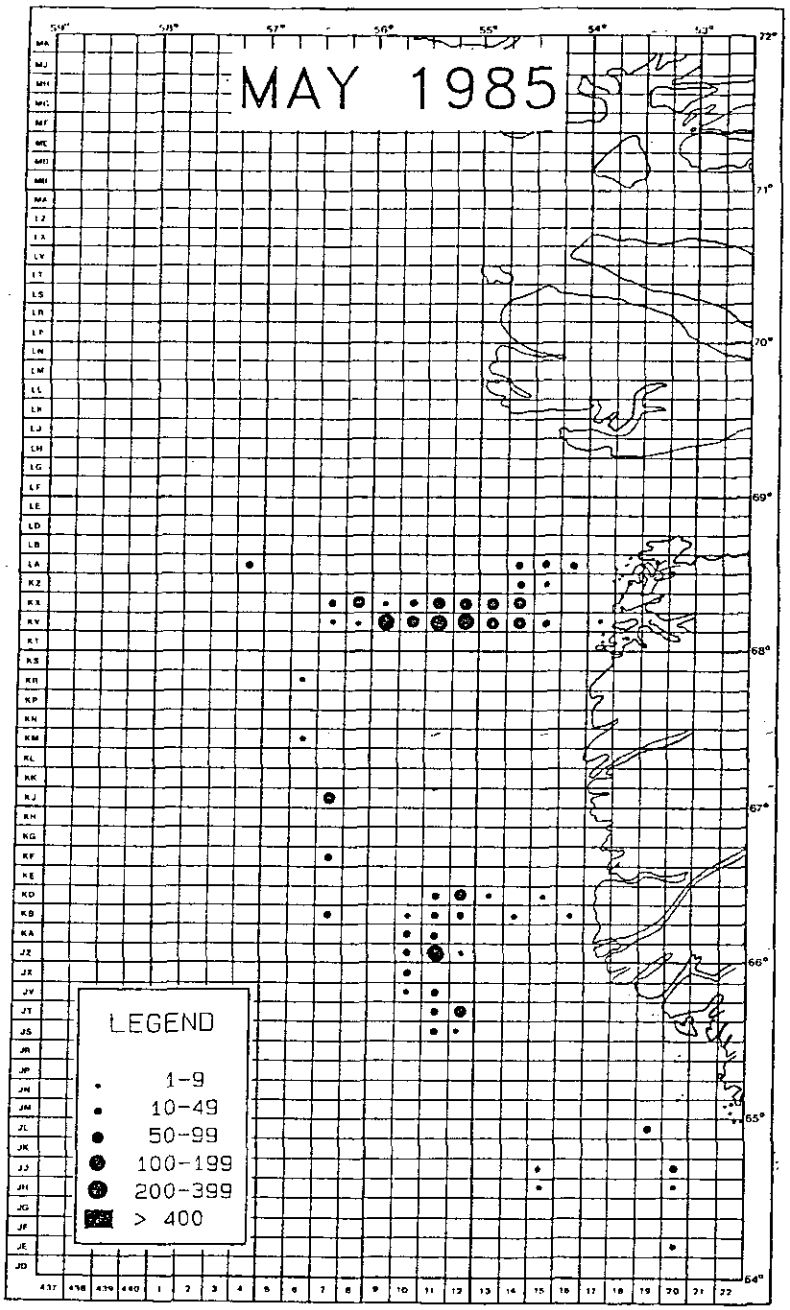

Figure 4. Continued. May 1985.

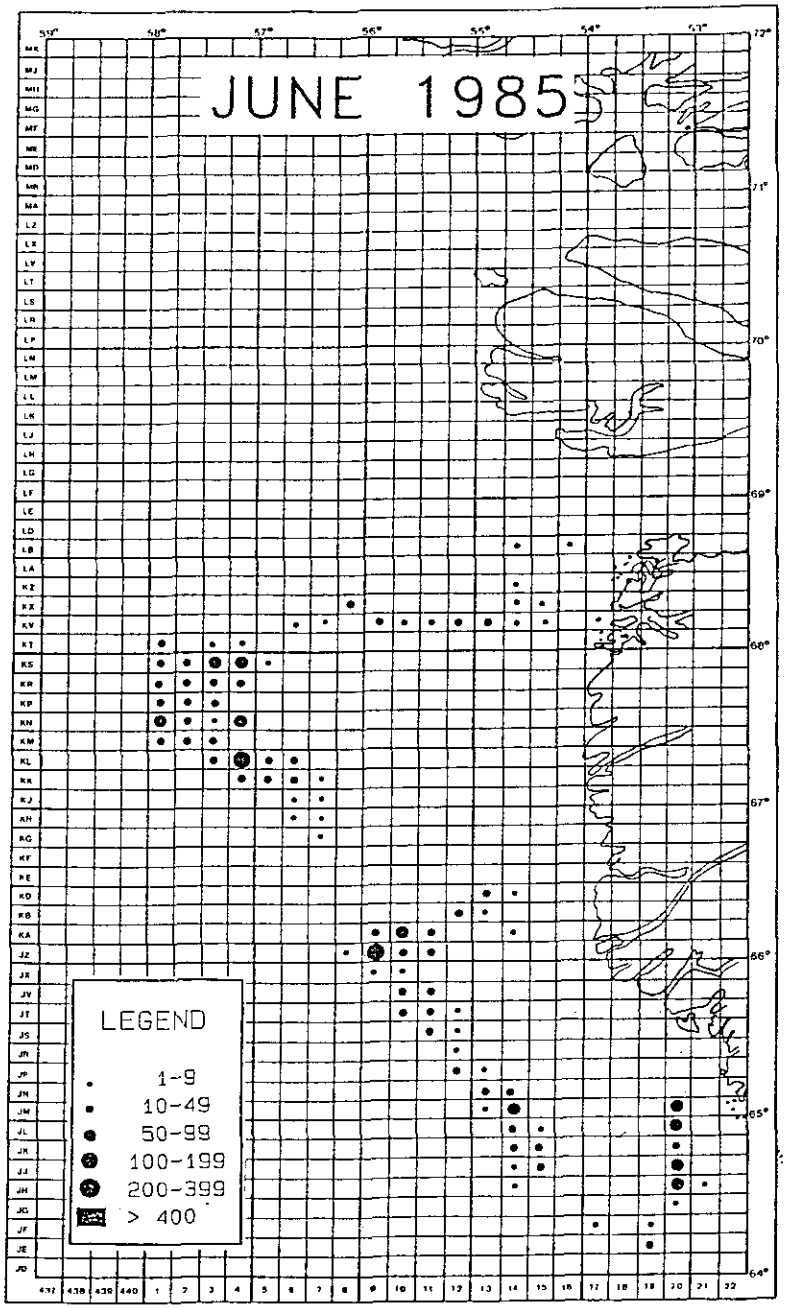

Figure 4. Continued. June 1985.

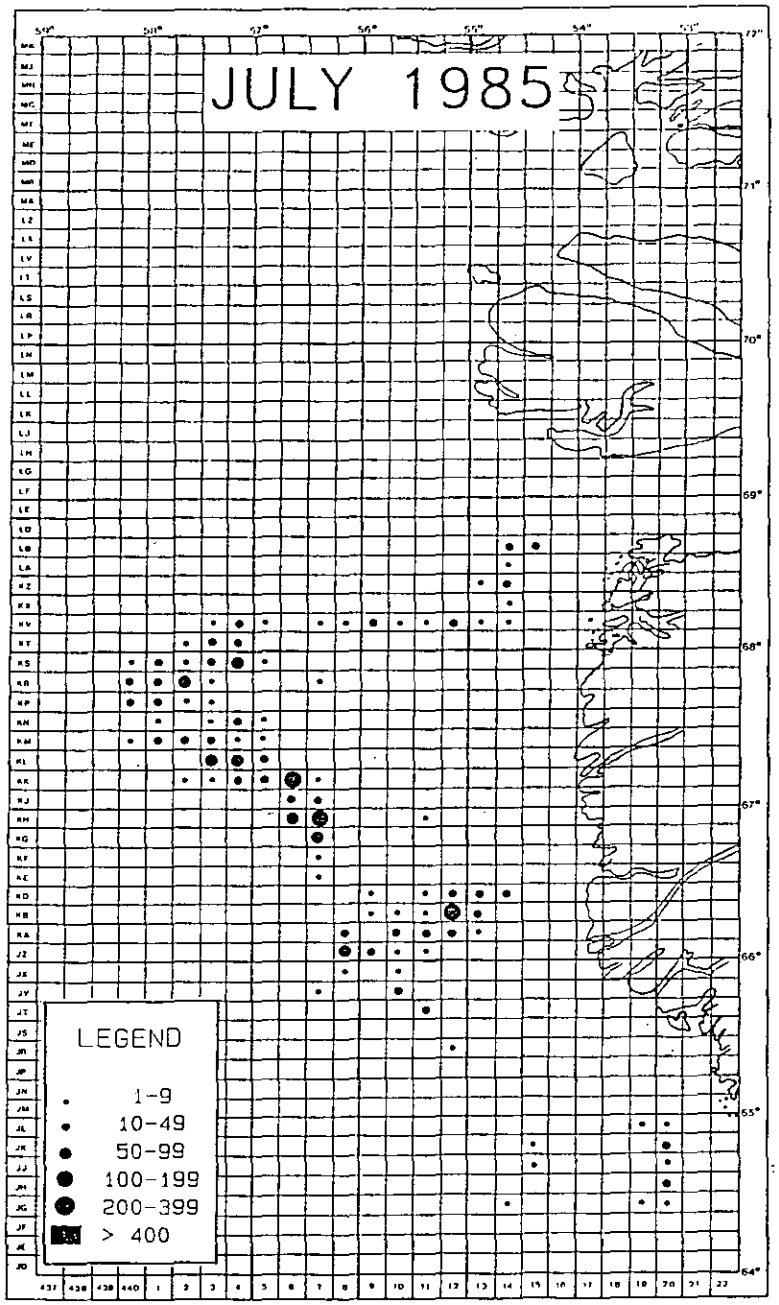

Figure 4. Continued. July 1985.

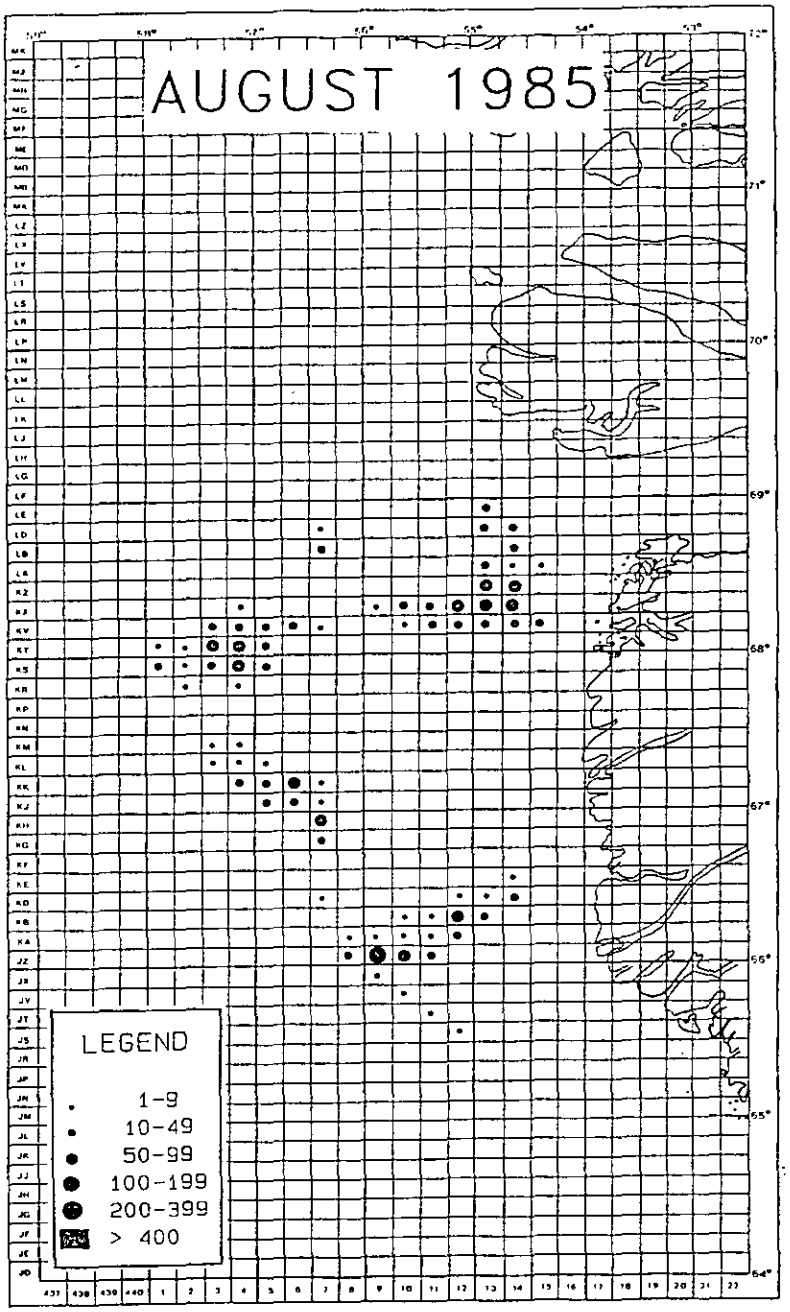

Figure 4. Continued. August 1985.

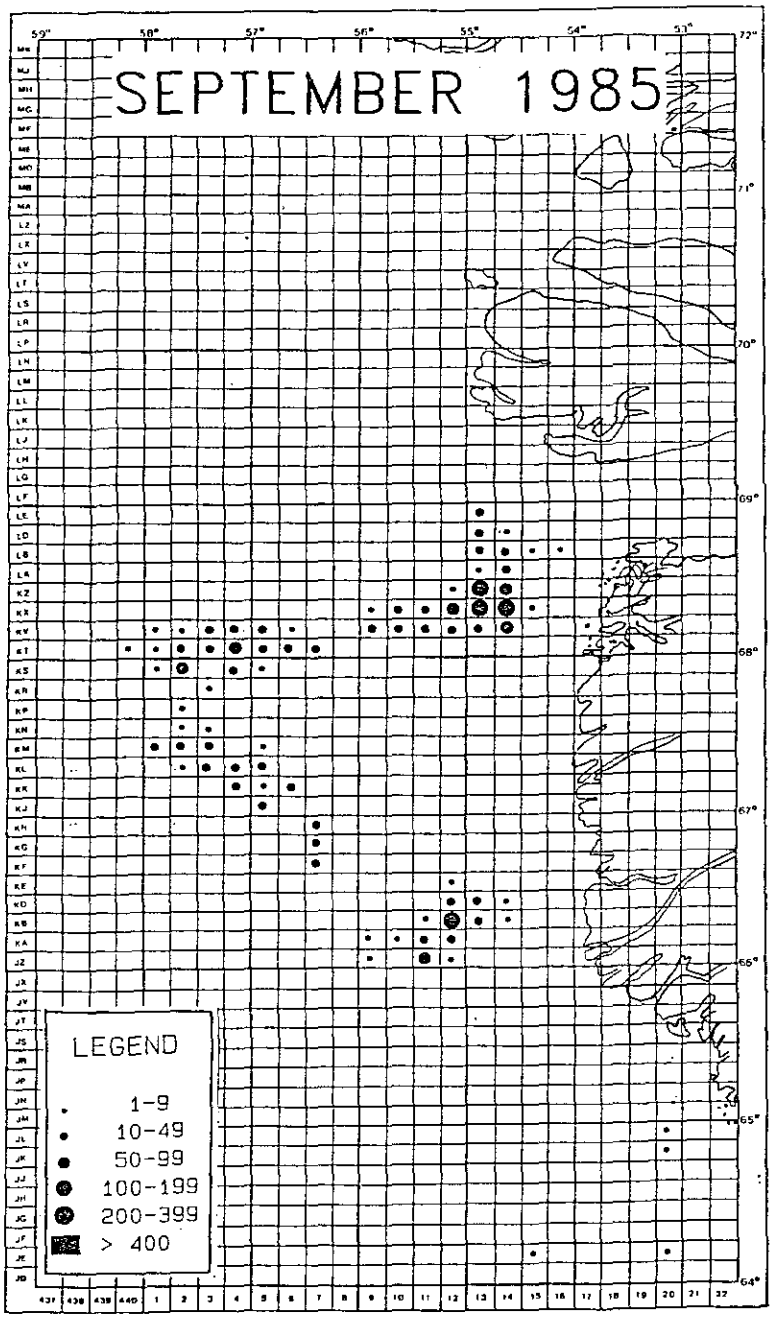

Figure 4. Continued. September 1985.

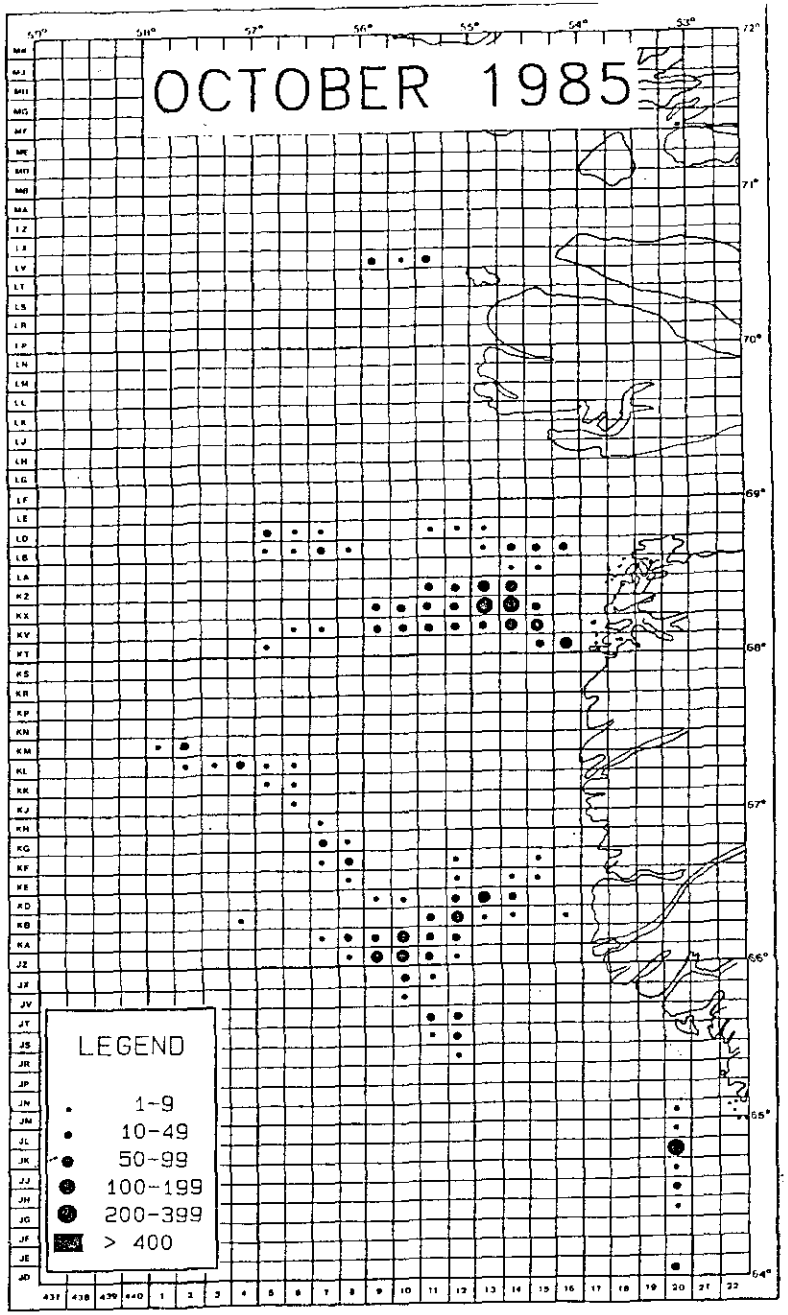

Figure 4. Continued. October 1985.

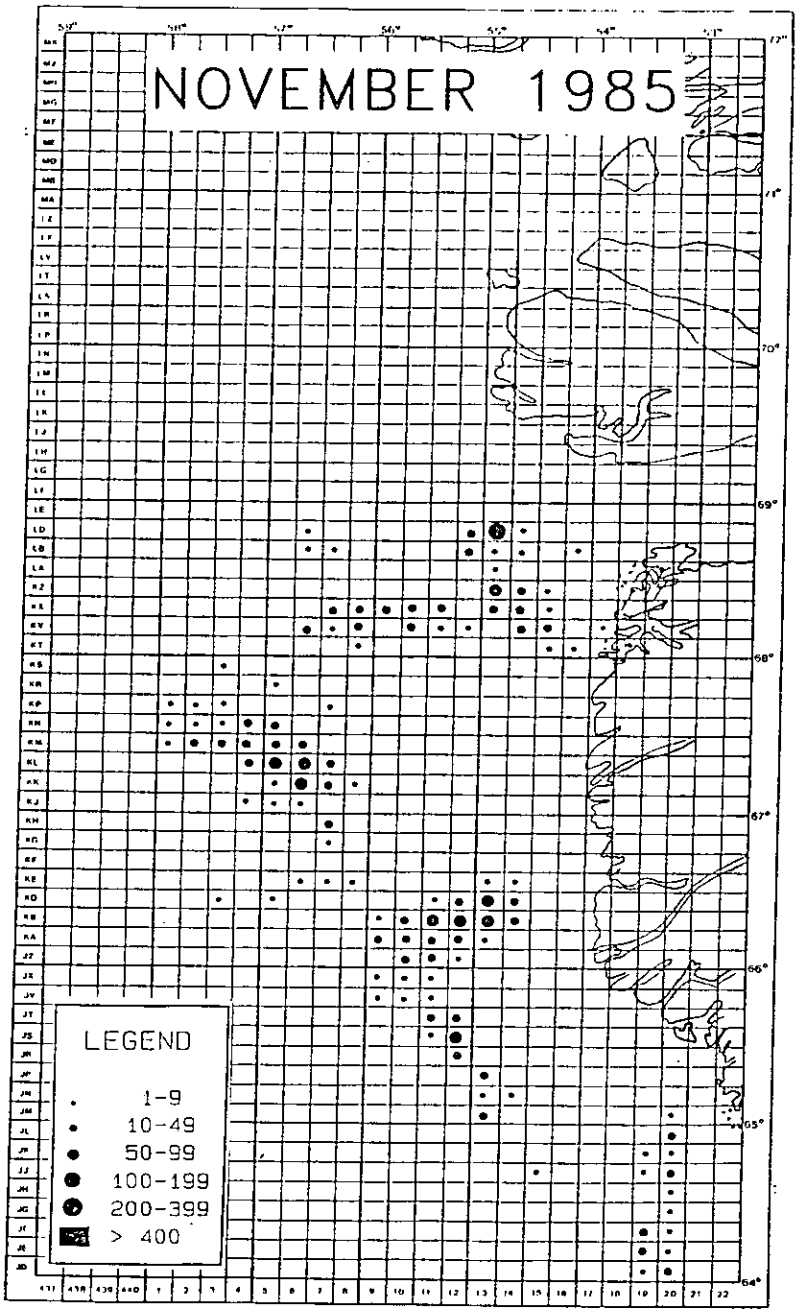

Figure 4. Continued. November 1985.

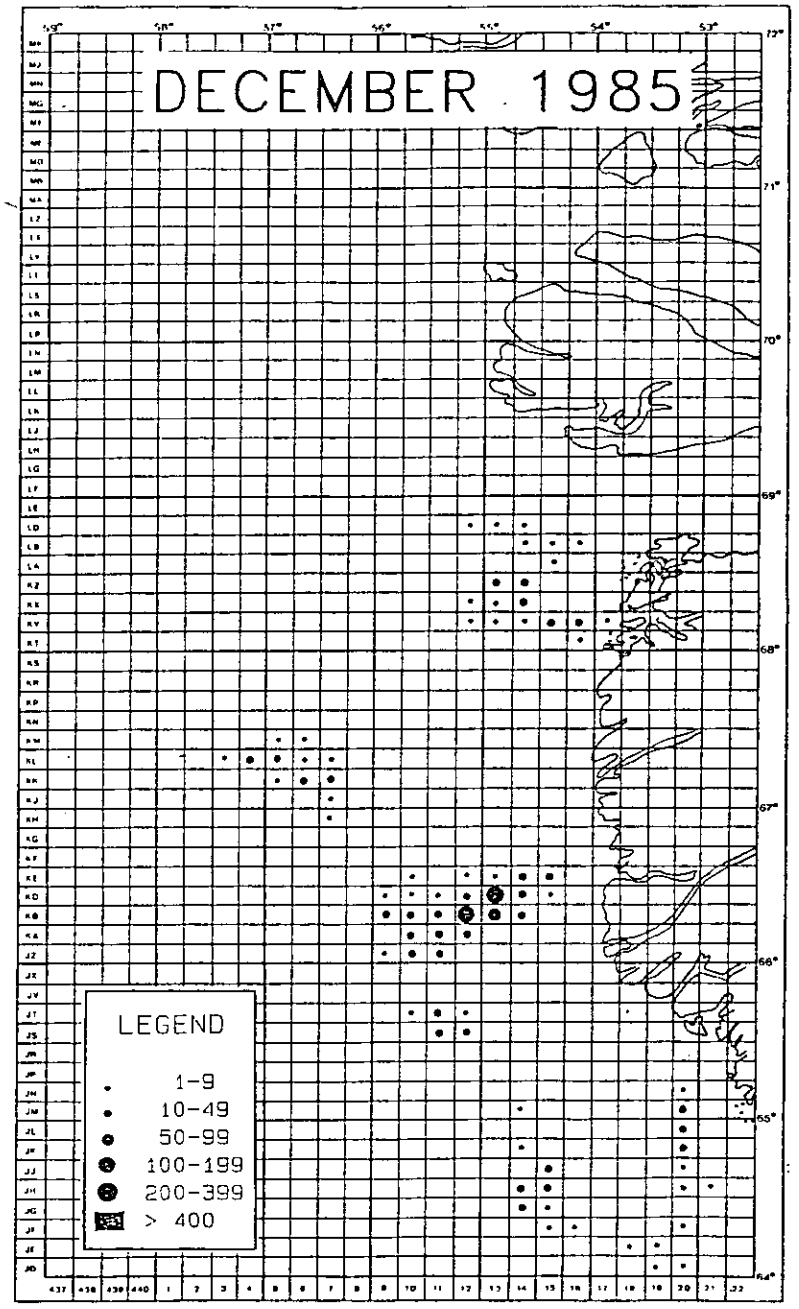

Figure 4. Continued. December 1985. A minor fishery (6 hours trawled) was carried out south of map.

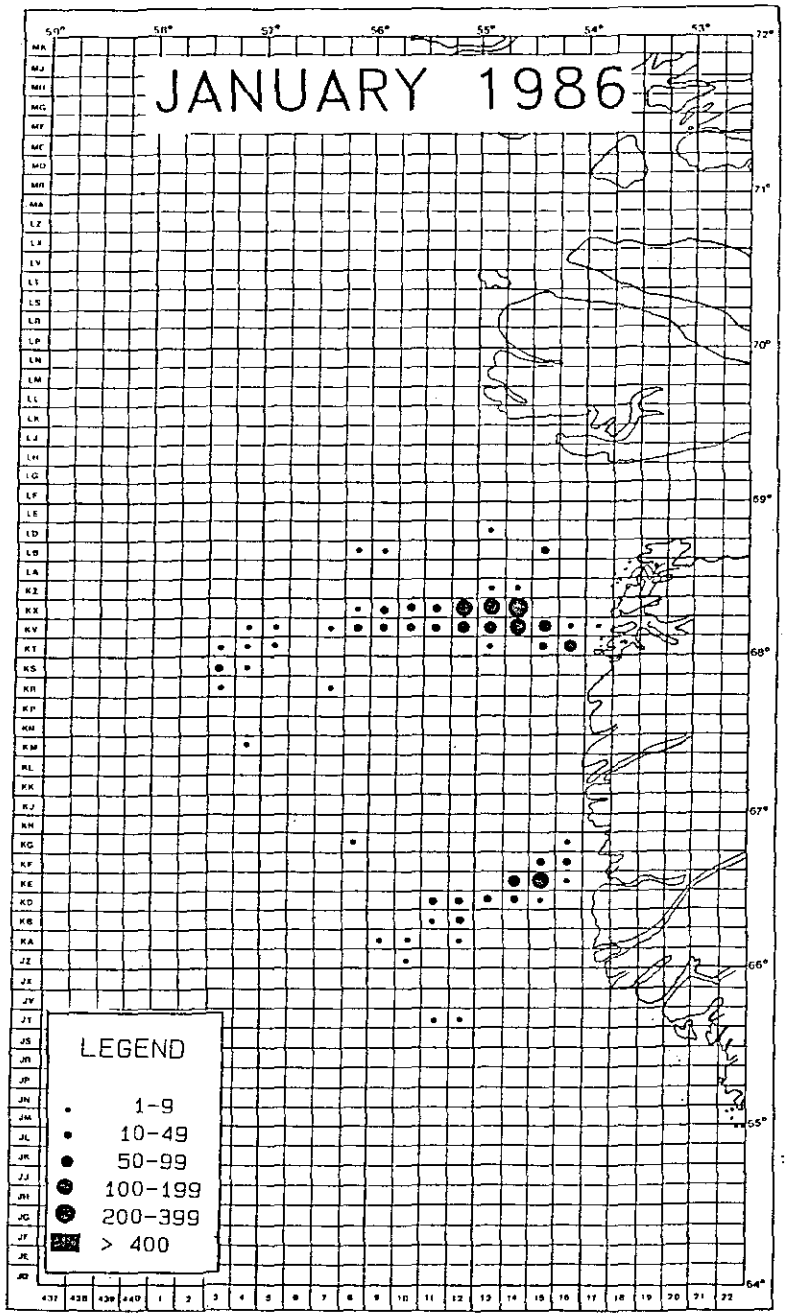

Figure 4. Continued. January 1986.

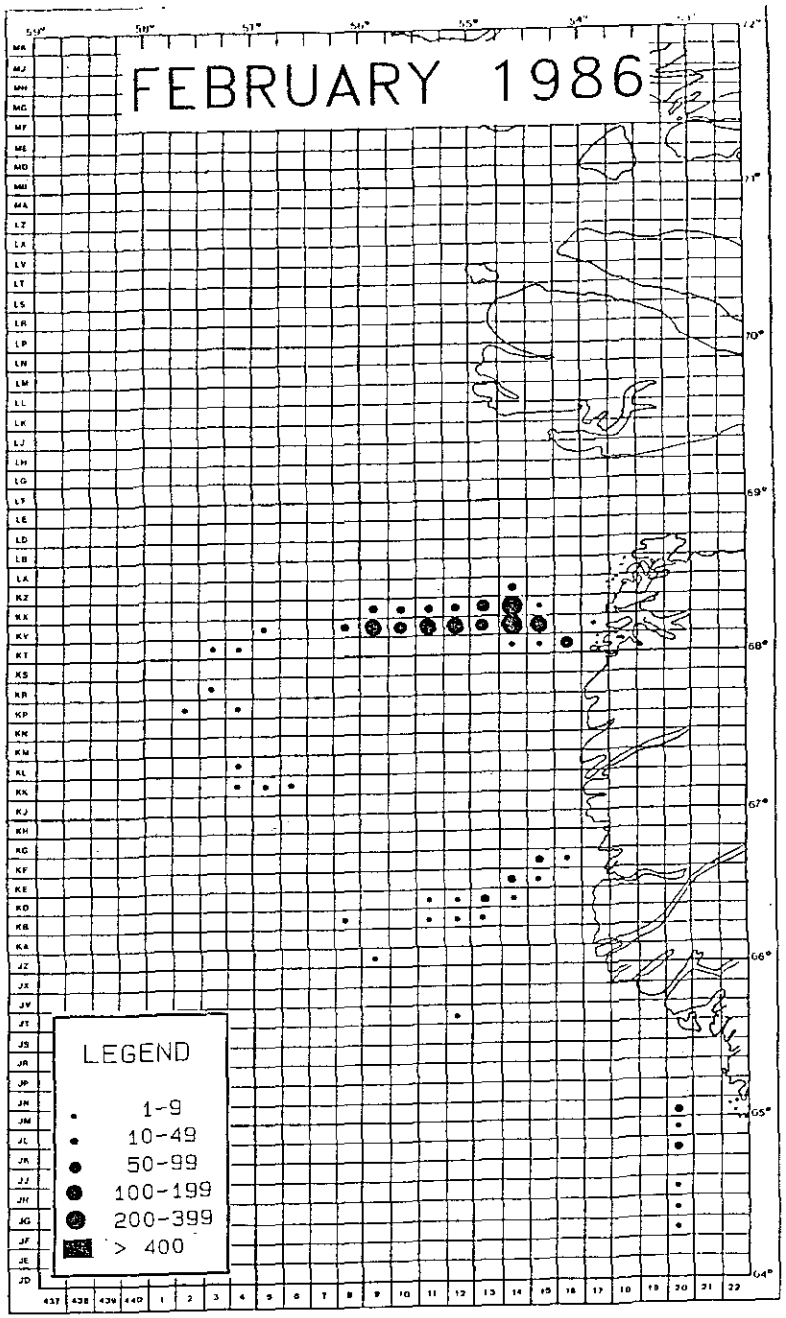

Figure 4. Continued. February 1986.

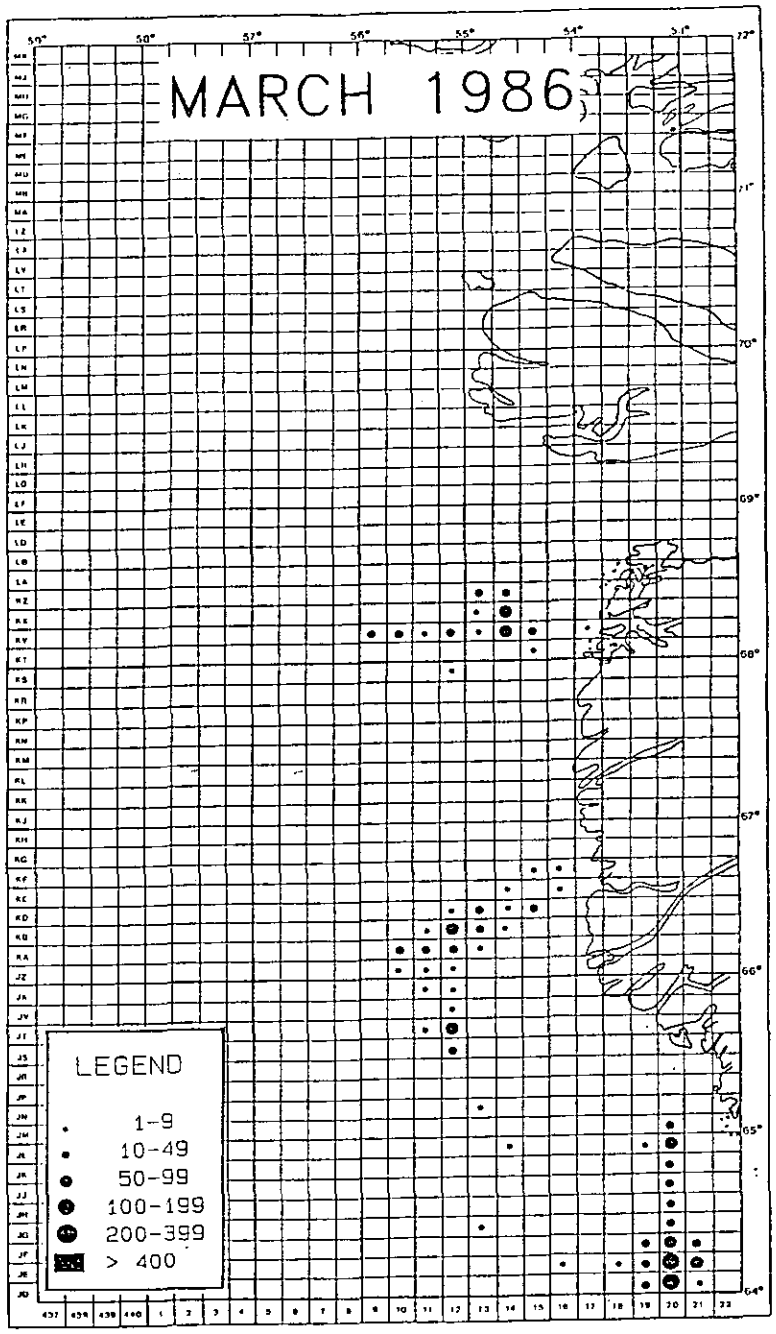

Figure 4. Continued. March 1986.

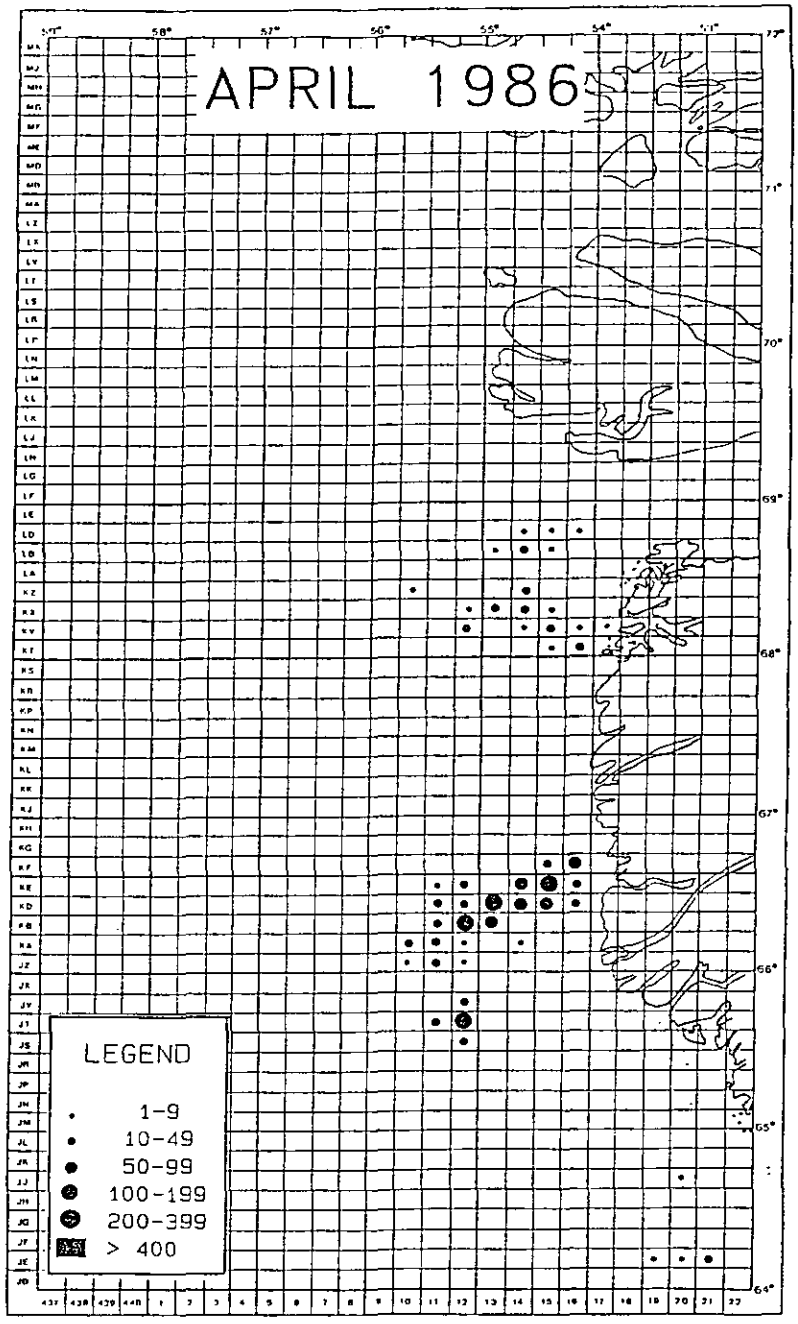

Figure 4. Continued. April 1986.

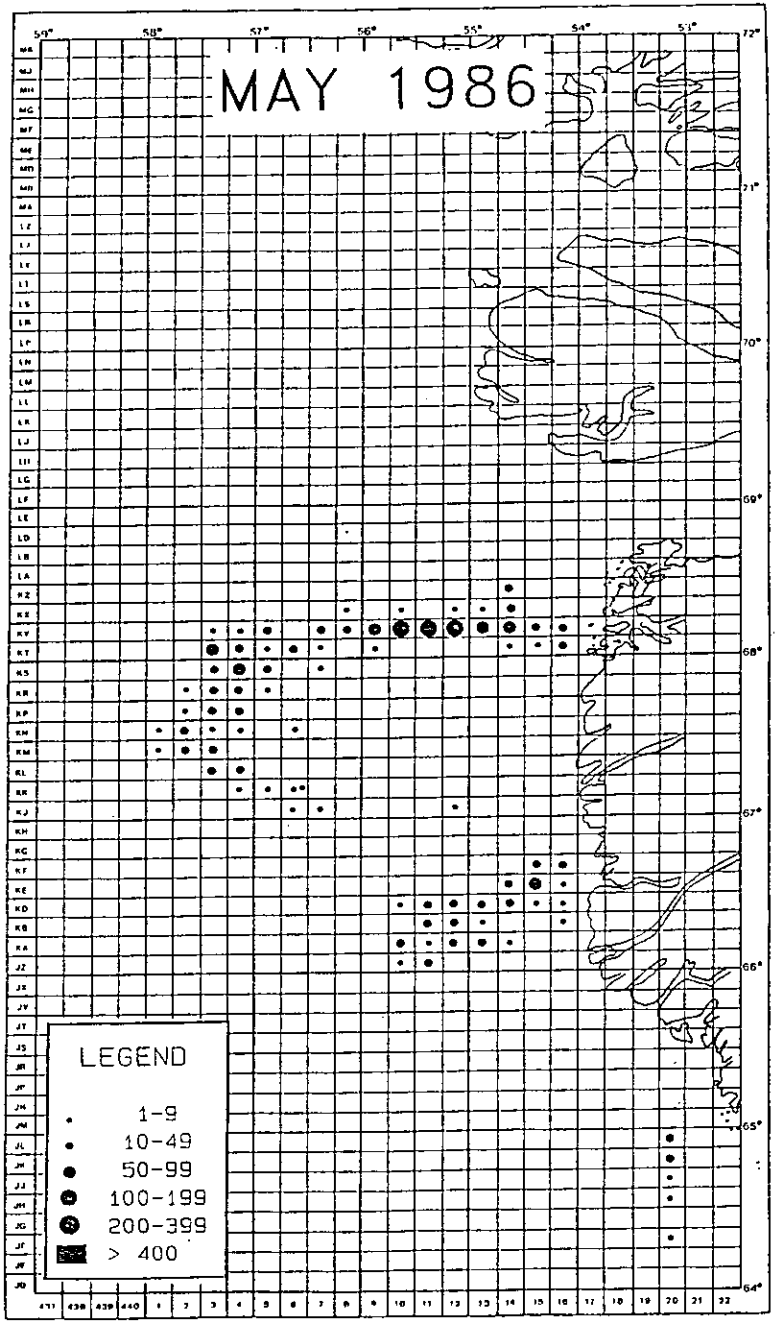

Figure 4. Continued. May 1986.

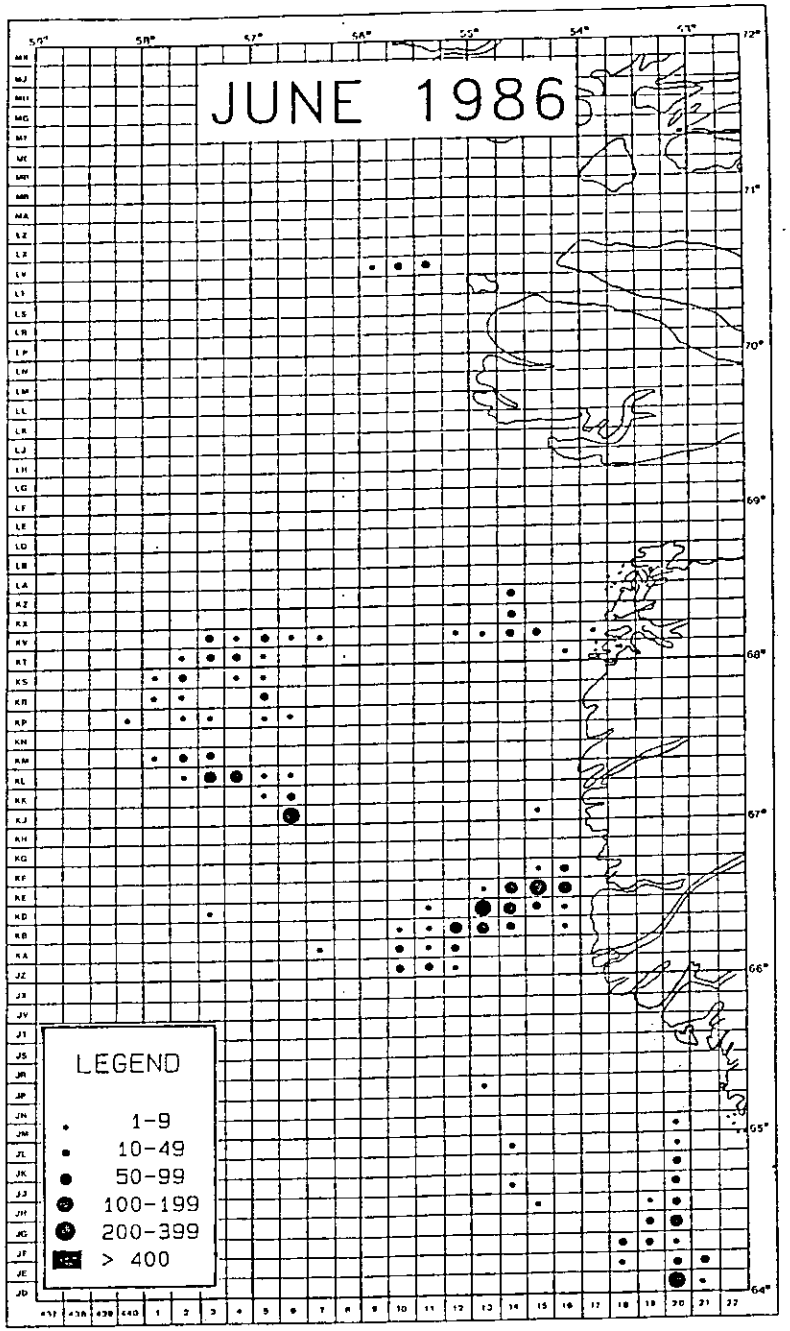

Figure 4. Continued. June 1986. A minor fishery (7 hours trawled) was carried out south of map.

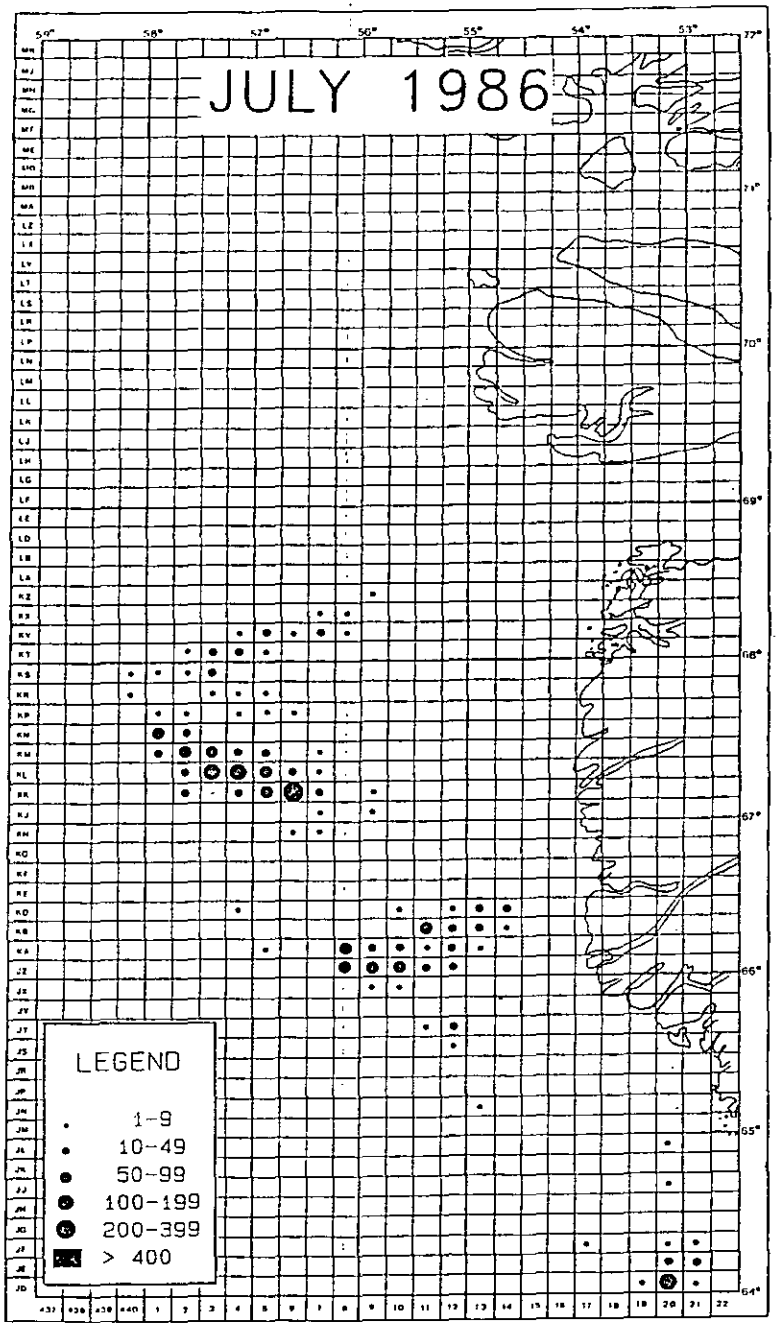

Figure 4. Continued. July 1986. A minor fishery (5 hours trawled) was carried out south of map.

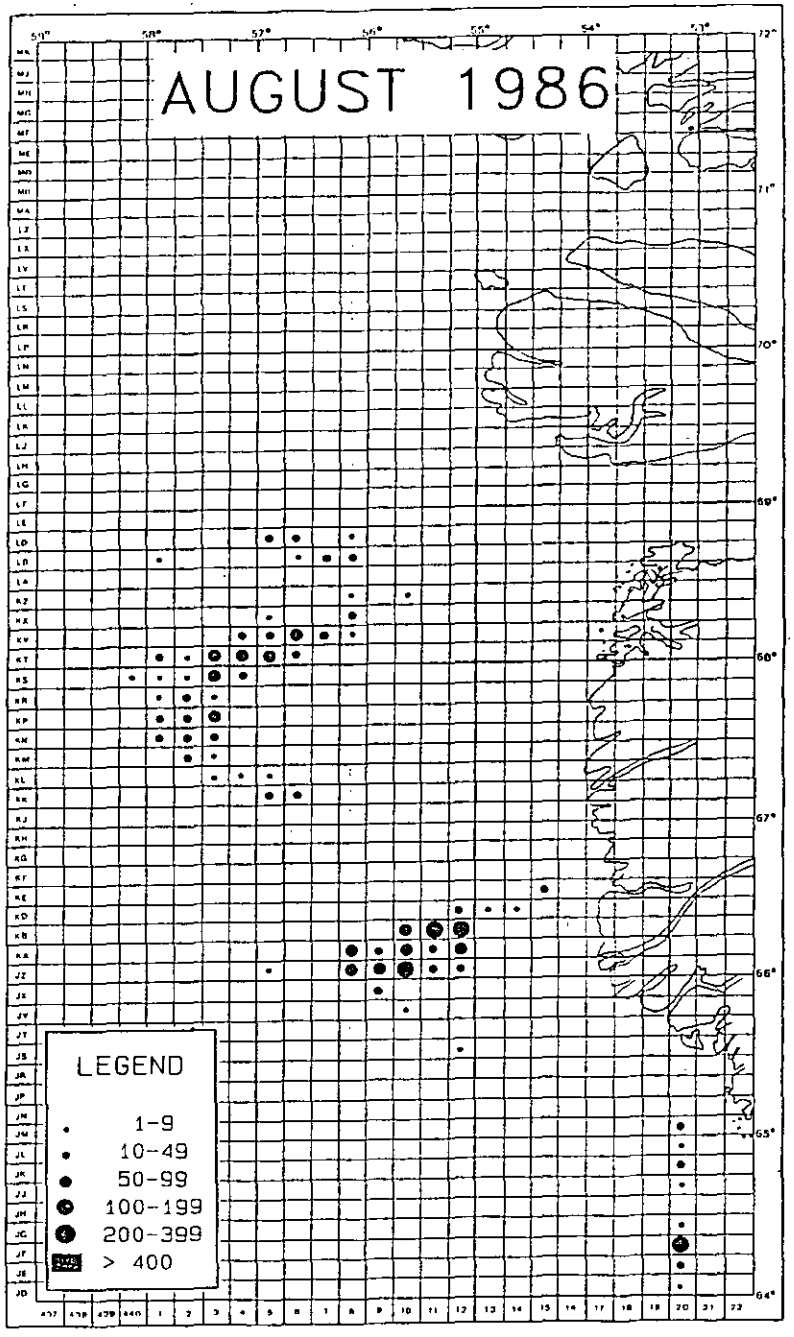

Figure 4. Continued. August 1986. A minor fishery (7 hours trawled) was carried out north of map.

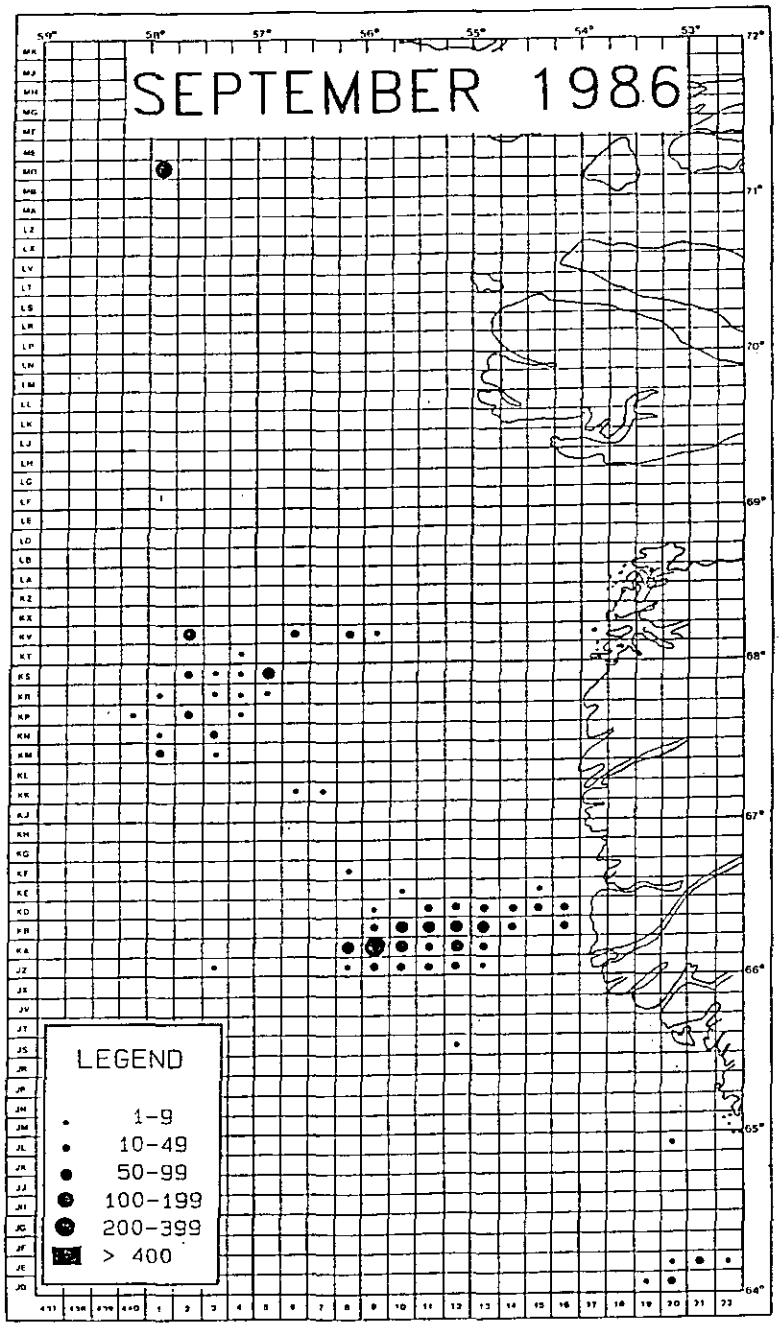

Figure 4. Continued. September 1986. A minor fishery was carried out outside the map (1 hour trawled north of map and 1 hour south).

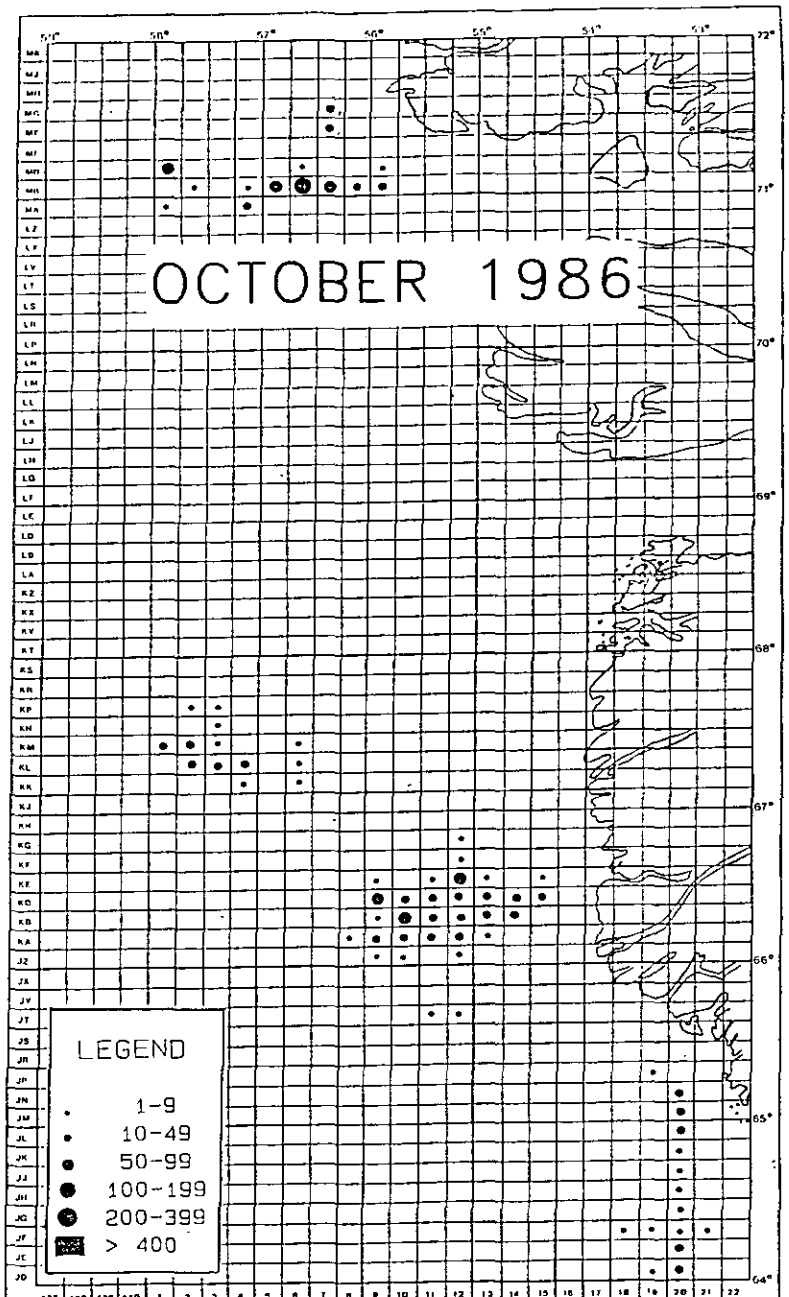

Figure 4. Continued. October 1986. A minor fishery was carried out outside the map (2 hours trawled north of map and 4 hours south).

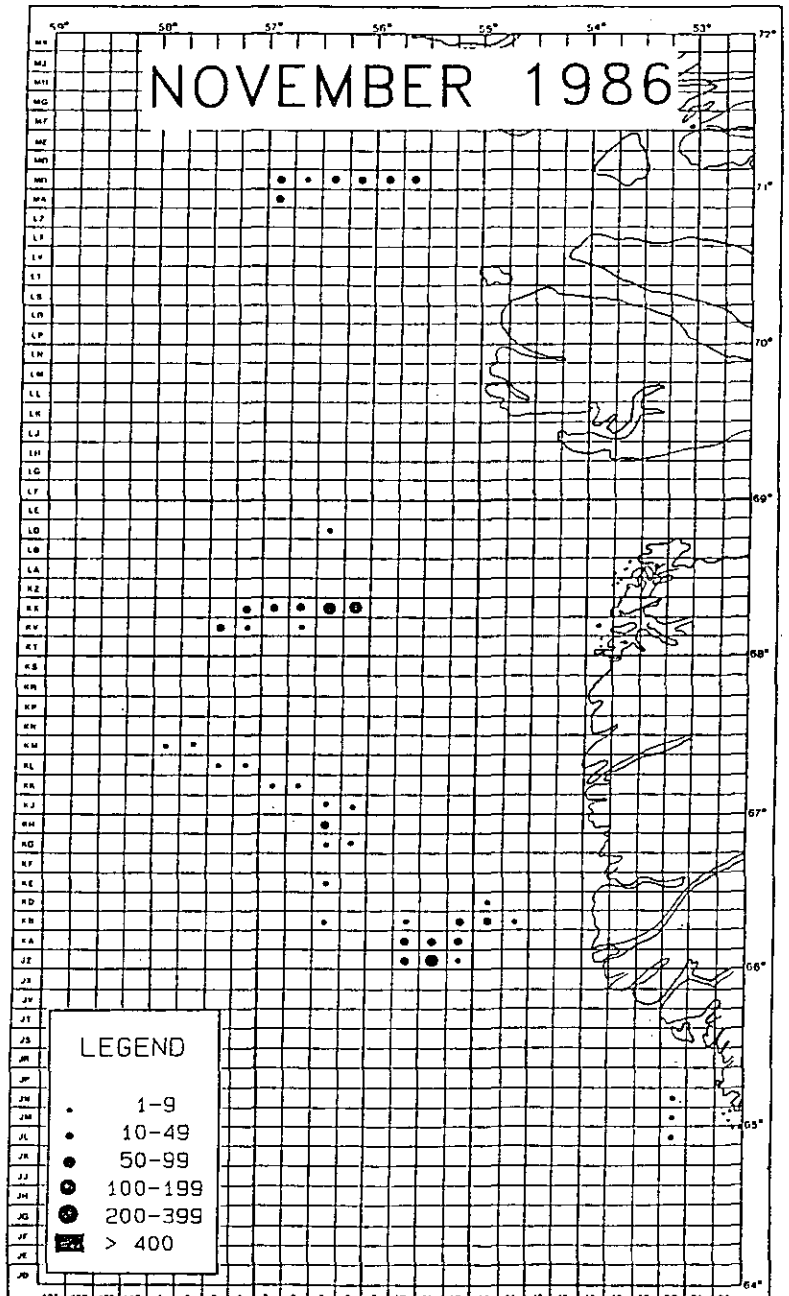

Figure 4. Continued. November 1986. A minor fishery (5 hours trawled) was carried out north of map.

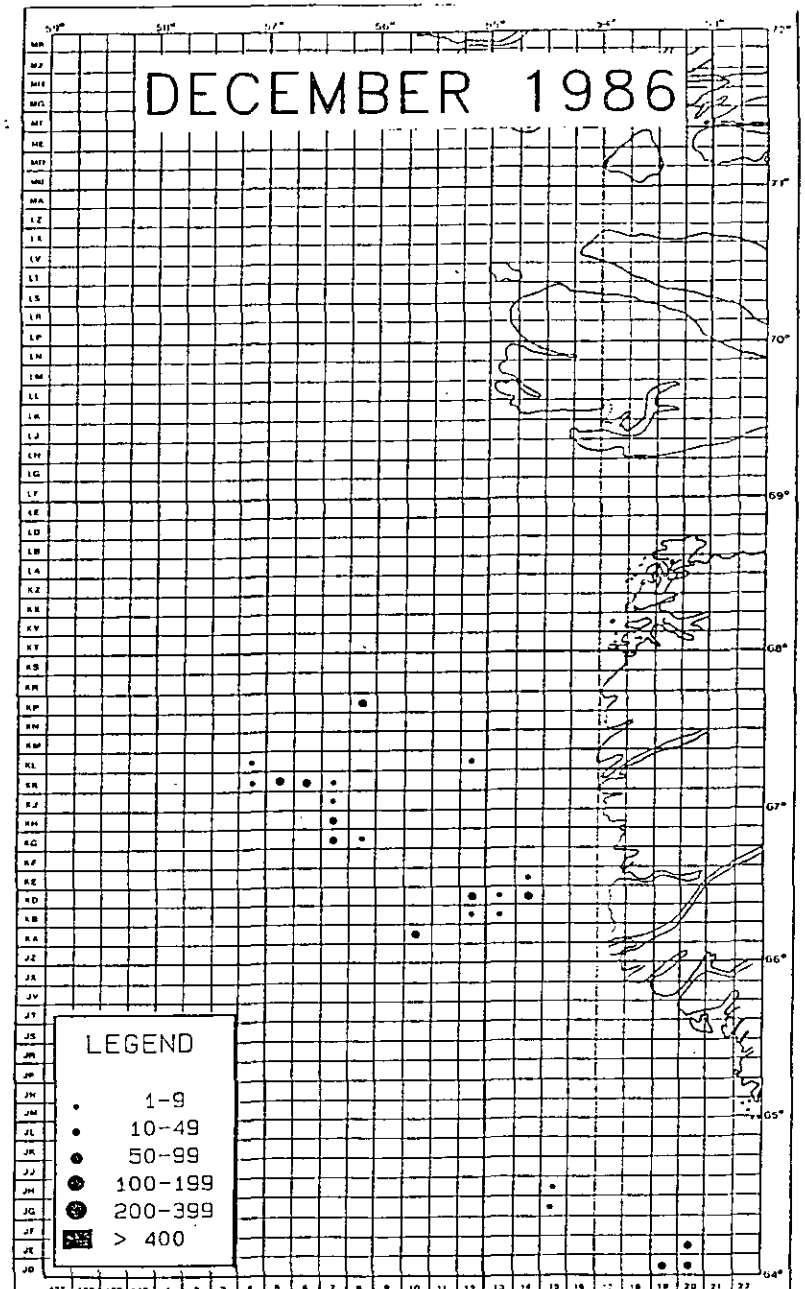

Figure 4. Continued. December 1986. A minor fishery (10 hours trawled) was carried out south of map.

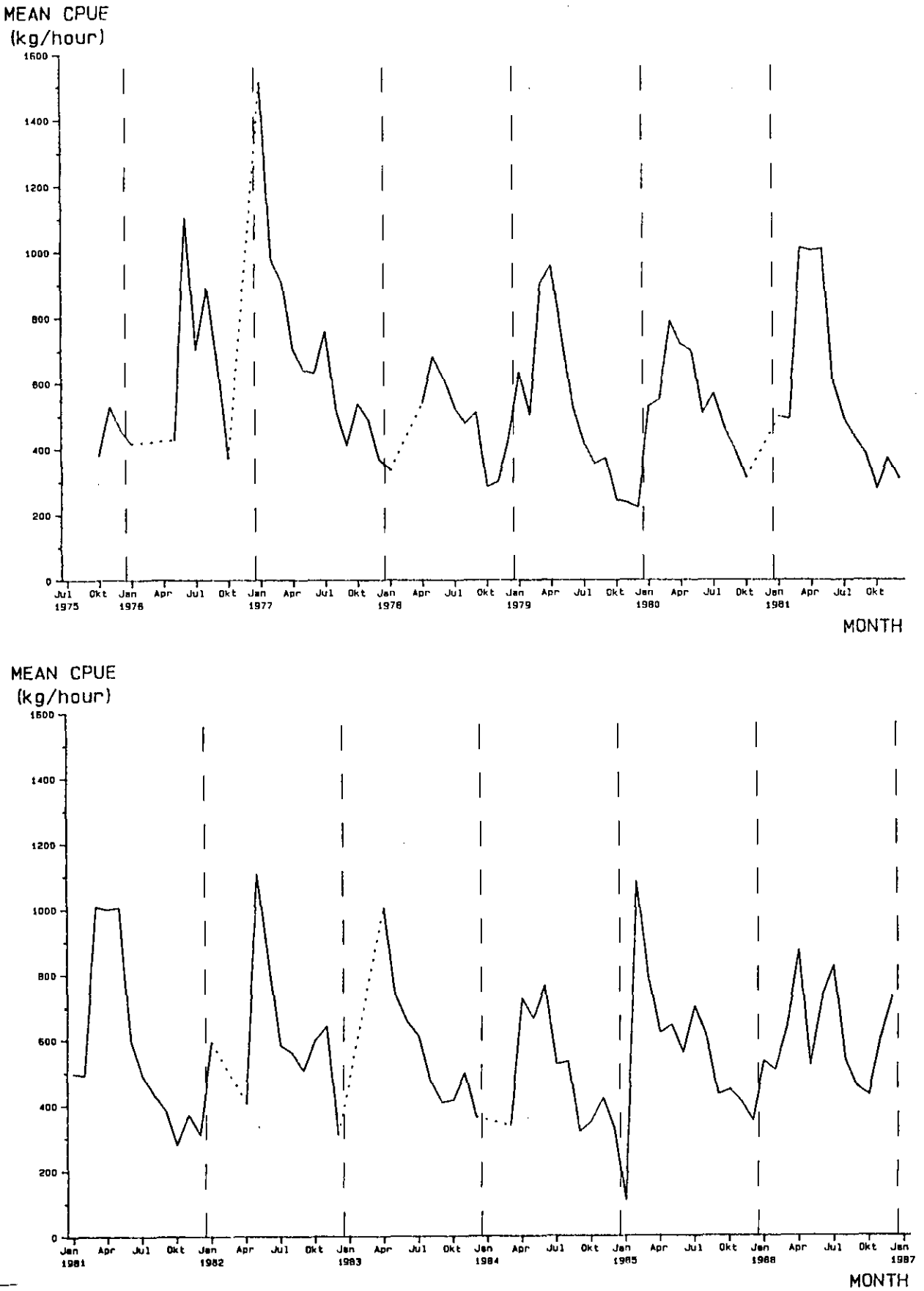

Figure 5. Monthly mean catch rate of shrimp (kg/hour) in NAFO Division 1B from October 1975 to December 1986 based on logbook information and landings from seven trawlers (630-722 GRT) of the Royal Greenland Trade Department (corresponding no. of hours trawled are given in Table 3).

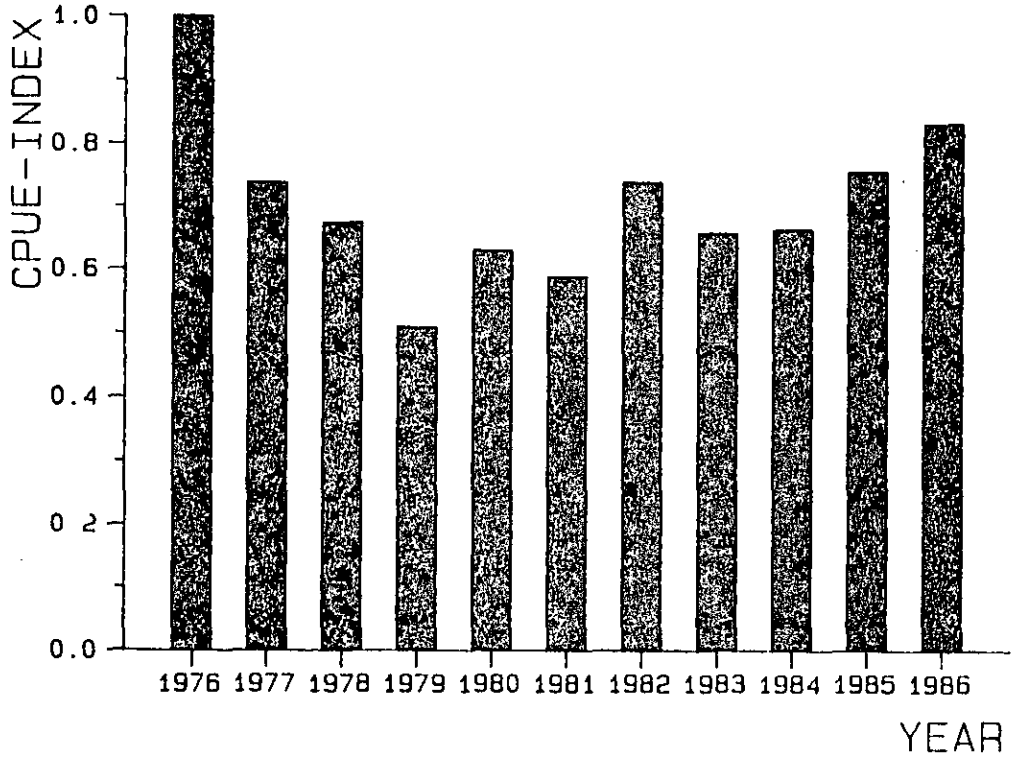

Figure 6. Indices of mean catch rates for the period July-September by year in NAFO Divison 1B from 1976 to 1986, based on logbook information and landings of seven trawlers (630-722 GRT) of the Royal Greenland Trade Department. Indices are calculated relative to the mean catch rate for the period in 1976.

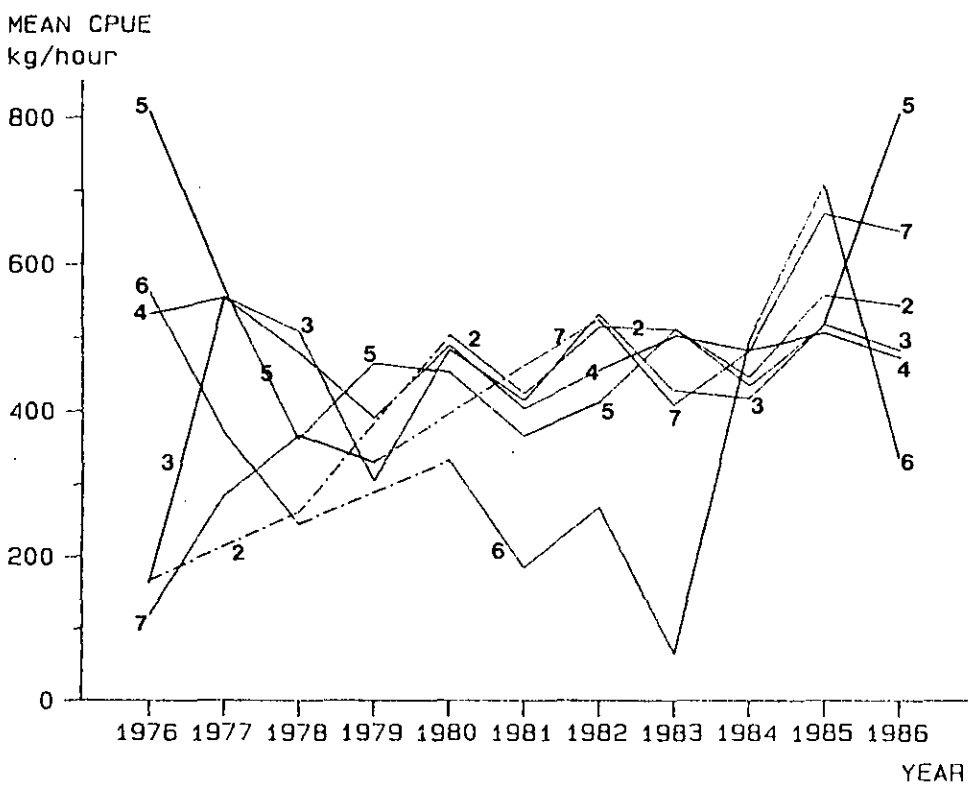

Figure 7. Mean catch rates (kg/hour) of shrimp for the period July-September in block-strips in NAFO Division 1 from 1976 to 1986, based on logbook information from eight trawlers (473-722 GRT) of the Royal Greenland Trade Department. Curve no.s refer to blockstrips shown in Fig. 8.

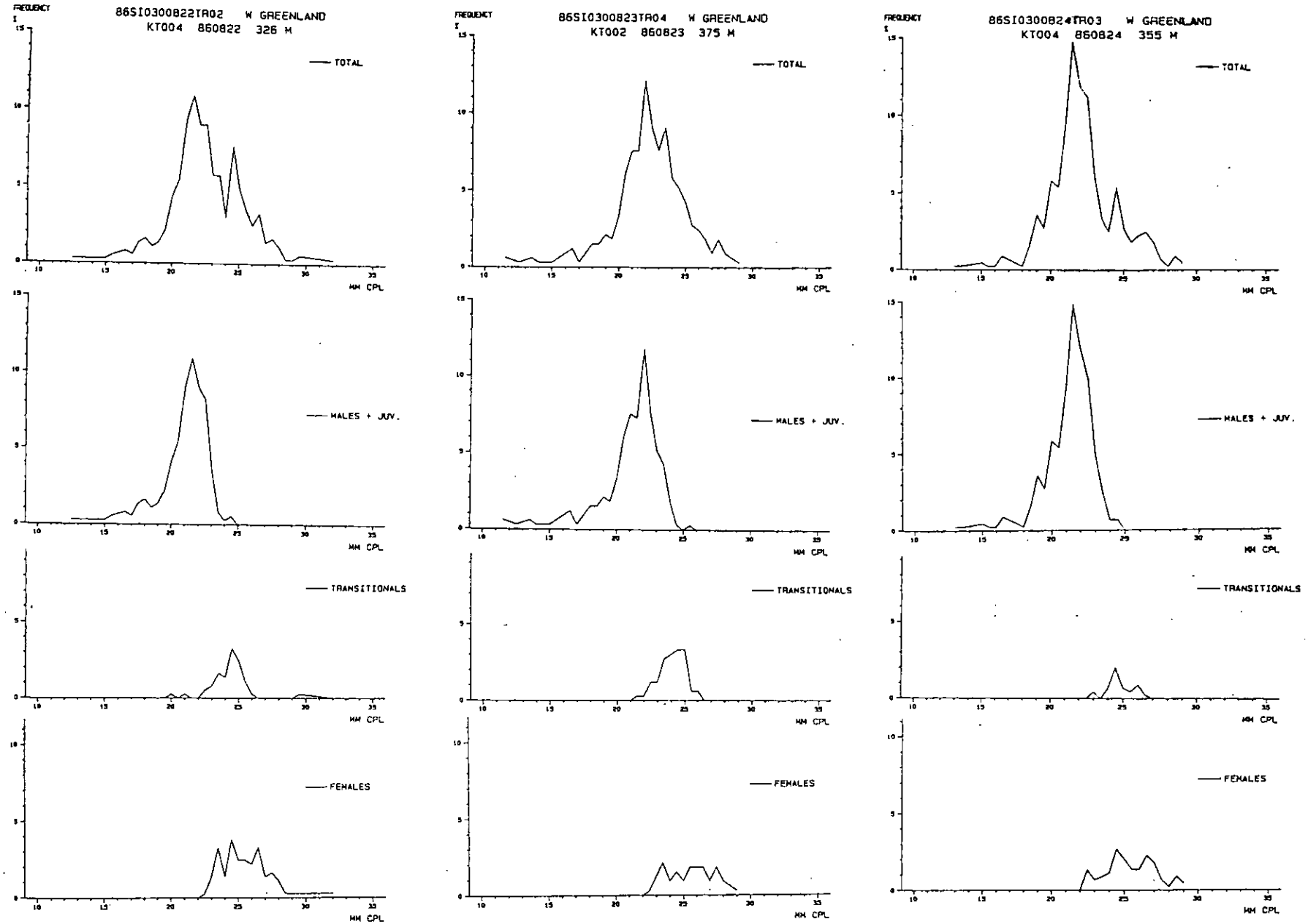

Figure 8. Length-frequency distributions of Pandalus borealis in commercial shrimp samples from Division 1B in August 1986 (see Table 7).

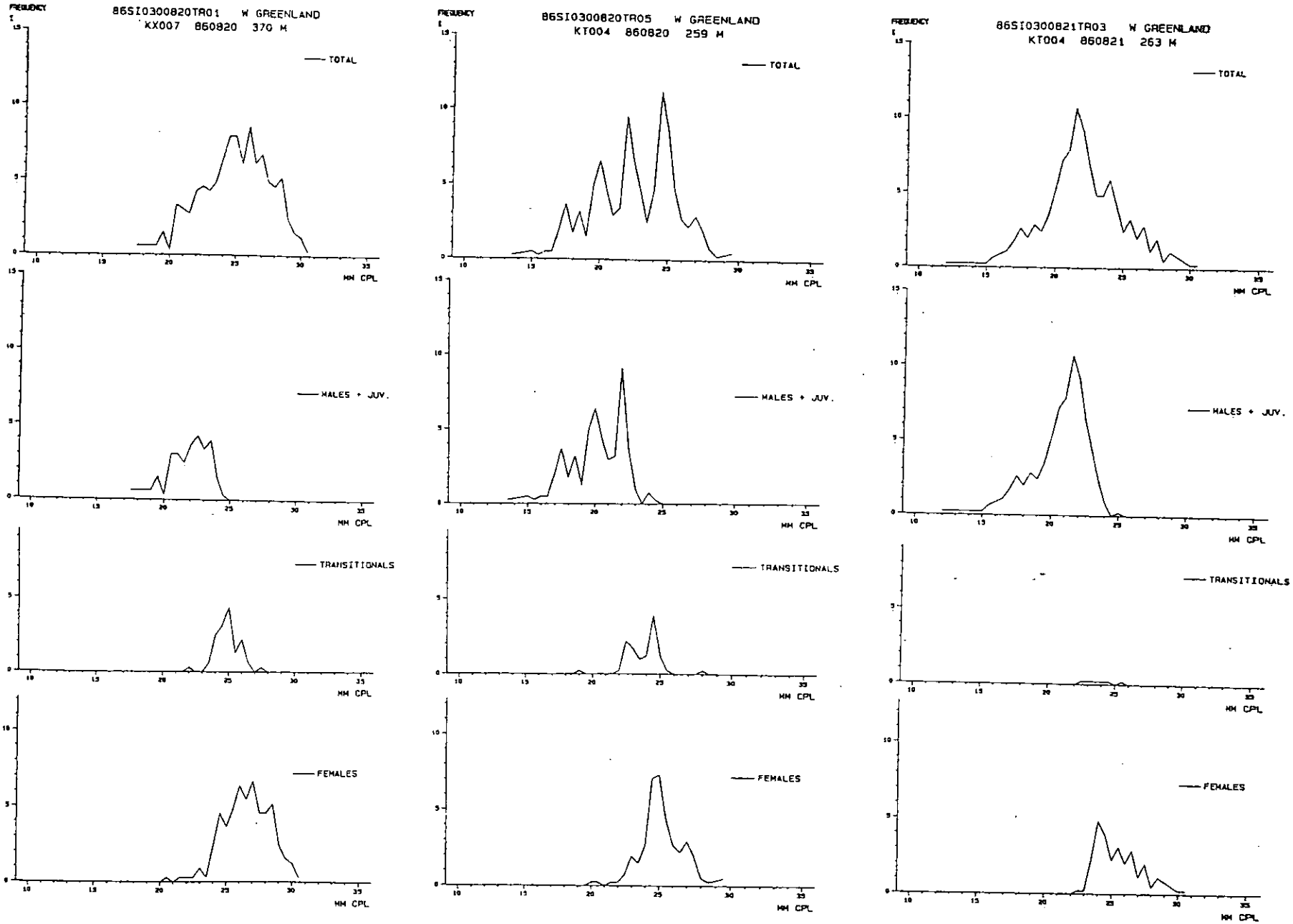

Figure 8 continued.

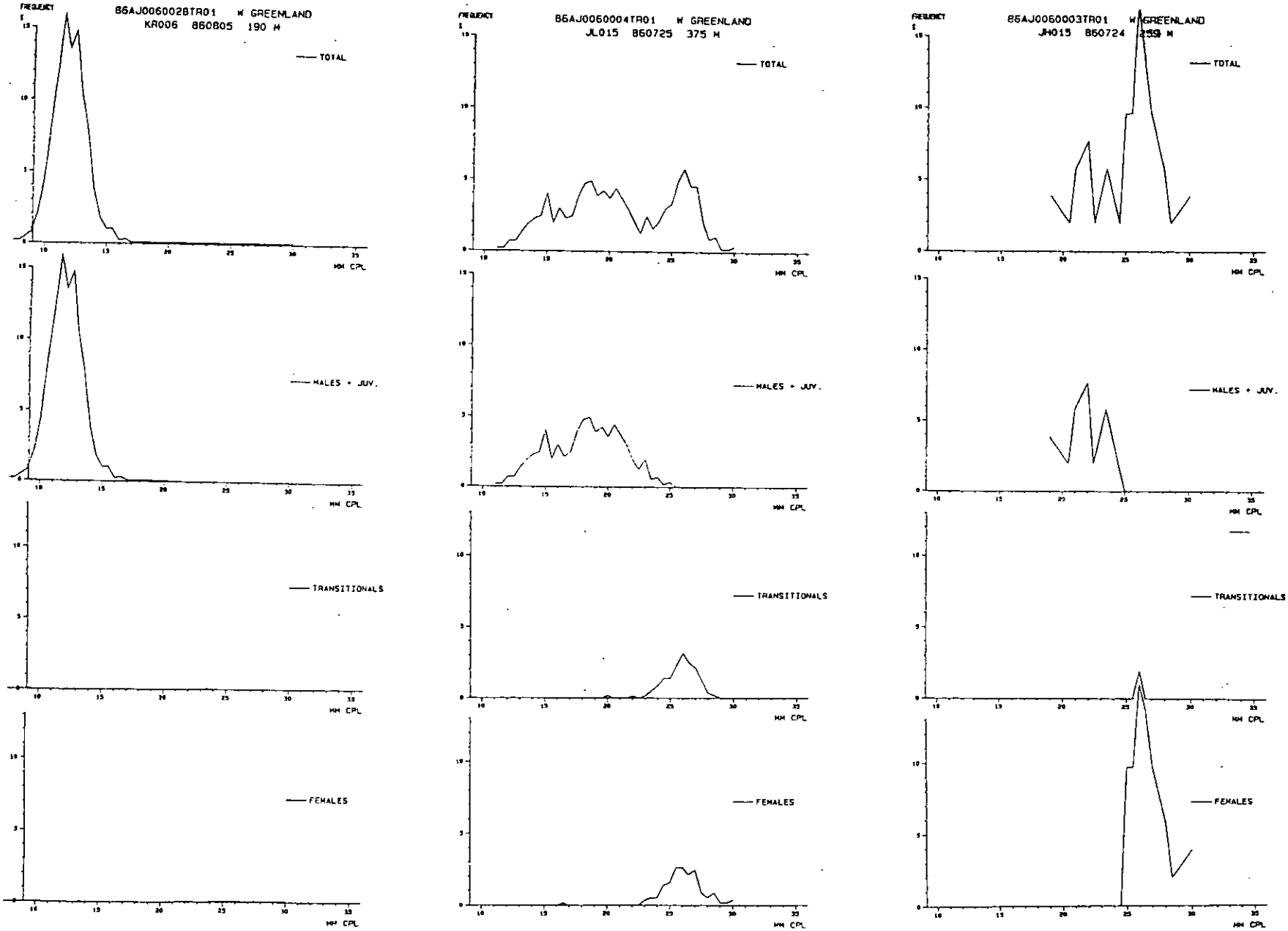

Figure 9. Length-frequency distributions of Pandalus borealis in research shrimp samples from Division 1A, 1B and 1C in July-August 1986 (see Table 8).

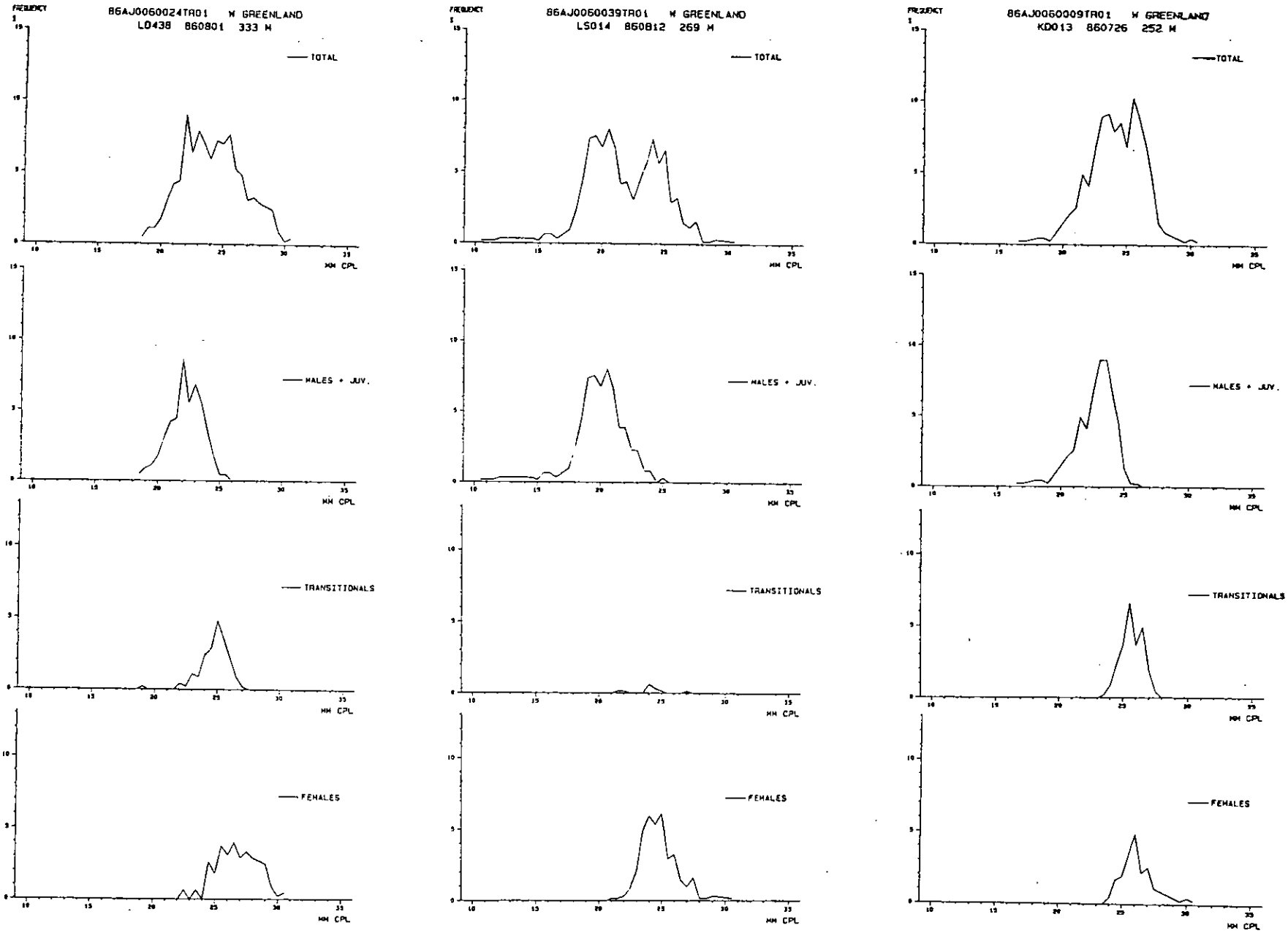

Figure 9 continued.

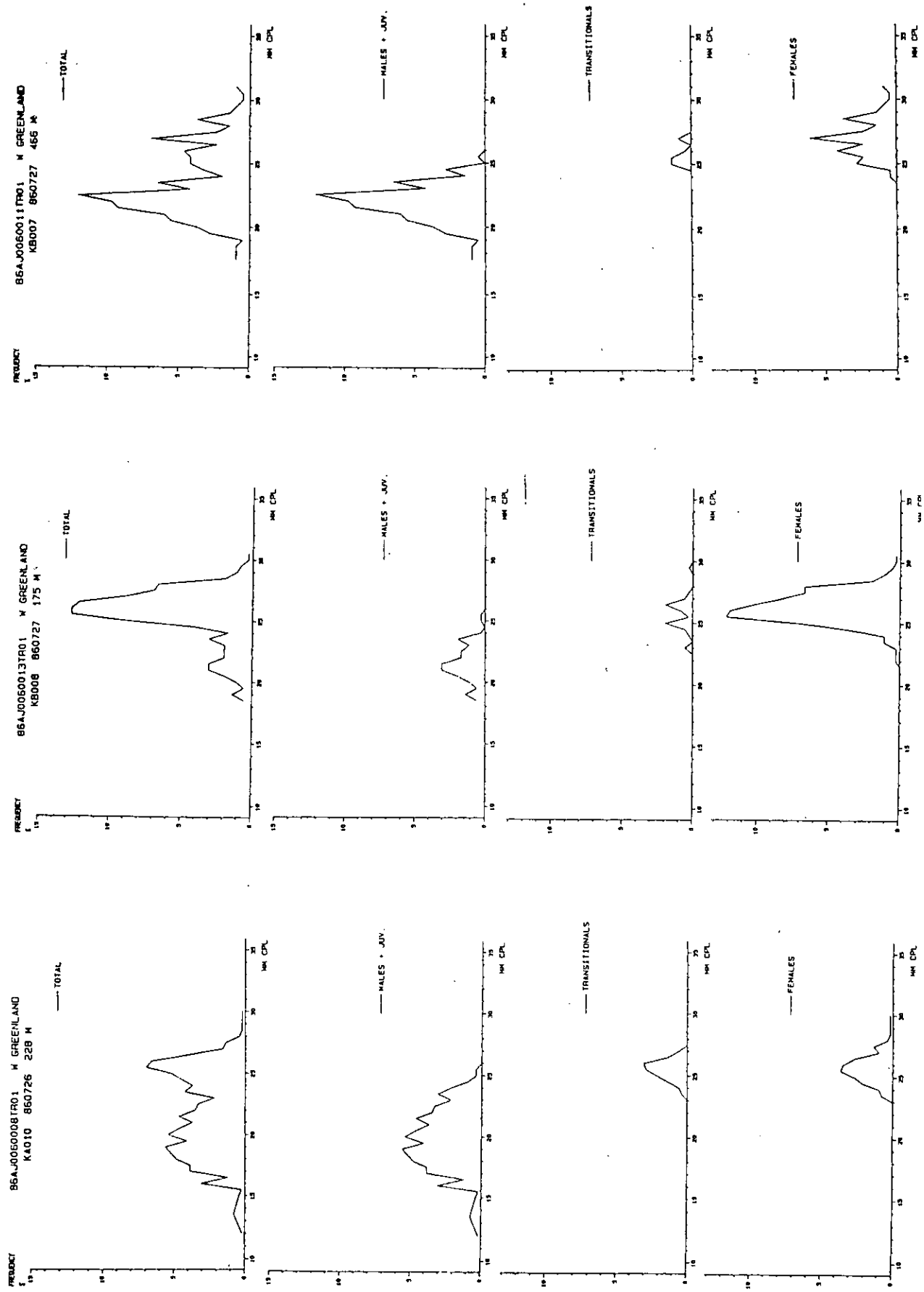

Figure 9 continued.

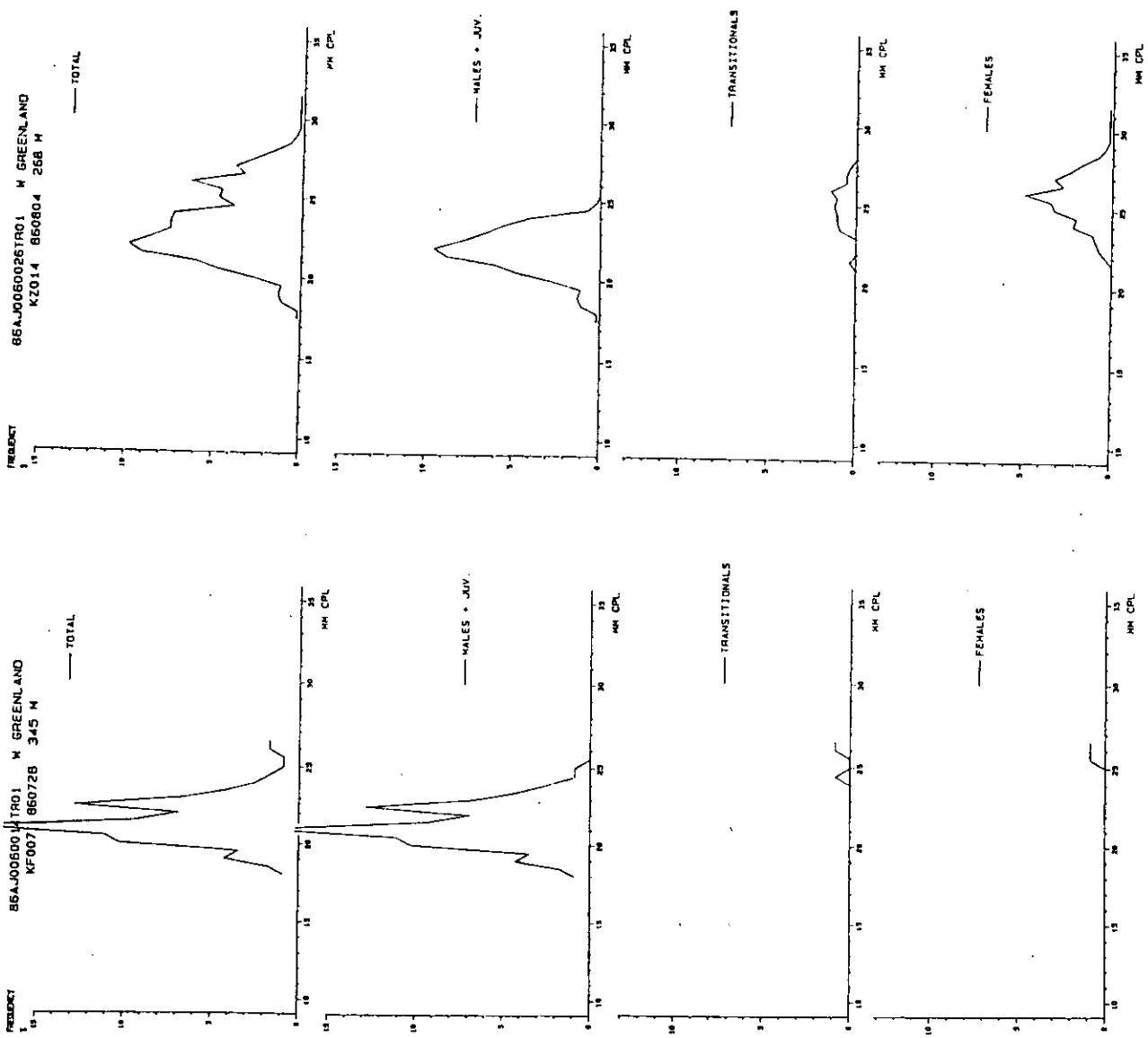

Figure 9 continued.