

**Catch statistics and life history of shrimp,
Pandalus borealis, in the Jan Mayen area**

M. Aschan¹, E.M. Nilssen², L.H. Ofstad² & S. Torheim³

¹Norwegian Institute of Fisheries and Aquaculture Ltd., PO Box 2511, N-9002 Tromsø, Norway [tel: + 47 77 62 90 00, fax: + 47 77 62 91 00, e-mail: michaelaa@fiskforsk.norut.no].

²Norwegian College of Fishery Science, University of Tromsø, Breivika, N-9037 Tromsø, Norway [tel: + 47 77 64 60 00, fax: + 47 77 64 60 20, email einarn@nfh.uit.no].

³Institute of Marine Research, PO Box 1870 Nordnes, N-5024 Bergen, Norway.

Authors in alphabetic order

ABSTRACT

The Norwegian shrimp (*Pandalus borealis*) fisheries in the Jan Mayen area in the North East Atlantic started in 1974. The catches reached 2000 tons in 1985. Since 1986 the catches decreased, but lately they have increased again to 500 tons in 1994 and 1400 tons in 1995. Larger vessels (> 2000 HP) were introduced in 1984. They caught more than 50% of the landings in the period from 1993 to 1995. The annual catch depends on stock biomass, availability according to ice coverage and circumstances in the shrimp fisheries off Greenland.

The results of Norwegian shrimp surveys conducted in 1980, 1981, 1994 and 1995 are presented and discussed in relation to earlier studies, especially data from 1976 and 1979. The squared study area is defined by the coordinates 70°20' N, 7°30' W and 71°15' N, 9°40' W. It covers the Jan Mayen Bank, south of the Jan Mayen island, and the Marøy Bank in the Northwest corner. Shrimp biomass is calculated for each 100 m depth interval for the six years, and show without exception the highest densities at the depth 200-299 m. The biomass index for the six years varies between 3000 and 6600 tons.

The size of the shrimp increase with depth, thereby females dominate at depths greater than 300 m. The Jan Mayen shrimp is large compared to Barents Sea shrimp and can reach a carapace length of 38 mm. The large size at sex transformation (> 23 mm) and analysis of length frequency distributions indicate that the shrimp may be five to eight years when changing sex.

The fish community composition is described and discussed for the years studied. Fish community composition is described for the years studied. Polar cod and capelin are the most abundant fish species in the study area. A high number of blue whiting was registered in 1979 but the number declined in 1980 and 1981. During the surveys in 1994 and 1995 no blue whiting was registered. The number of Greenland halibut has declined from the beginning of the 80-ties to the mid 90-ties.

INTRODUCTION

During the first years of this century a few hydrography and biology cruises took place in the Jan Mayen area (Hjort 1901, Collet 1909). Information on the hydrographic conditions around Jan Mayen has been given by Iversen (1936) and a review is given by Gulliksen (1974).

Until recently very little was known about the shrimp (*Pandalus borealis*) biology in the Jan Mayen area. The first shrimp sample taken in August 1950 consisted of 639 individuals measured during a cruise with R/V "G.O. Sars" (Devold 1950, Rasmussen 1956). This haul was made at a depth of 150-210 meters and Rasmussen concluded that the shrimps were very large. Later the Directorate of Fishery initiated shrimp cruises to Jan Mayen with commercial vessels (Godtlibsen 1974, Torrisen 1974, Strøm 1976, Olsen 1977). In October 1979 R/V "Michael Sars" mapped the shrimp and fish biomass and distribution in the area (Torheim 1980). The 1979 cruise was followed by cruises in 1980 and 1981 (Torheim unpubl.). The same kind of mapping of shrimp resources Southwest and Northwest of Jan Mayen has been conducted by the Soviet Union fisheries authorities in 1974, 1975, 1978, 1979, 1986 and 1990 (Anon. 1976, 1991).

In August 1994 a cruise was conducted with R/V "Jan Mayen". The main goal was to study size and biomass distribution of *P. borealis*. In August 1995 the vessel F/T "Remøy" was used when mapping the shrimp resources in the Jan Mayen area (Aschan 1995).

In this paper the results of Norwegian shrimp surveys conducted in 1980, 1981, 1994 and 1995 are presented and discussed in relation to earlier studies, especially the data from 1976 and 1979.

MATERIAL AND METHODS

The study area is defined as a rectangle with the north-west corner at 70°20' N and 7°30' W and the south-east corner at 71°15' N and 9°40' W (Figures 1 and 2). The Jan Mayen Island, a volcanic island on the Mid-Atlantic Ridge, is situated in the northern part of the area with the Jan Mayen Bank on the southern side and the Marøy Bank on the north-eastern side of the island. The water masses occurring in the area are cold water brought from the north by the East Greenland Current and warmer water coming with the North Atlantic Current, and a mixture of these two (Iversen 1936). The ice conditions are variable from year to year. The mean ice limit in April for the period 1946-1963 reached Jan Mayen (Steffensen 1969).

Four cruises were conducted to the Jan Mayen area in the period 12.-15.08. 1980, 14-16.07. 1981, 26.08.-1.09. 1994 and 18.08.-20.08 1995. The sampling trawl used during the four surveys was a standard sampling trawl, the Campelen 1800 super. The sampling trawl is a modified shrimp trawl with "rockhopper" ground gear. In the 80-ties the innernet of the trawl had a mesh size of 18 mm while it was 20 mm in the 90-ties. The "sweep width" is set to 11.7 m for shrimp surveys resulting in a swept area of a 3 nm. haul of 0.01895 sq.nm. The trawling was conducted by a speed of three knots for 20 minutes to one hour, that equals a trawling length of one to three nm. The trawl hauls were taken along the continental edge at 100 m to 500 m depth.

A temperature sensor (Scanmar) was used during trawling in 1994 and 1995. CTD runs were conducted occasionally in 1981, 1994 and 1995. Unfortunately a mistake in calibrating the sensor for salinity and water density allows us to use only the temperature data from 1995.

The number of individuals and weight for each species was recorded. In this paper the species of economical importance are included for further discussion. The biomass index for shrimp is the sum of biomass in each depth zone, that is calculated on the basis of swept area.

The area for the depth zones 100-199 m, 200-299m, 300-399m and 400-500 m were calculated from the Norwegian Hydrographic Service (NSKV) chart nr 512. The mean catch for each depth range is multiplied in relation to total area and then summed up to an estimated biomass for the above defined Jan Mayen study area.

A sample of 300 shrimps at each station was allocated within seven sex groups (Aschan et al. 1993). Length measurements were then conducted on the shrimp. In the 80-ties a manual calliper was used and in the 90-ties an electronic calliper (Mitutoyo CD-150 mm, Mitutoyo, Japan) was used to measure the carapace length on 0.1 mm accuracy. The data were then compressed into 0.5 mm length groups before cohort analysis were run. The MIX 2.3 (MacDonald and Green 1988) and MULTIFAN (Fournier et al. 1990) were used for cohort analysis.

RESULTS AND DISCUSSION

Hydrography

Temperature registrations are given in Appendix I - IV and a profile for temperature, salinity and density registrations in 1994 is given in Figure 3. The profile to the right in Figure 4a represents Atlantic water East of Bear Island and is therefore different from the profiles taken in the Jan Mayen area where no pure Atlantic water is present. The temperature profiles for 1994 and 1995 are alike. The Jan Mayen area is dominated by cold polar water from the East Greenland current and therefore we find temperatures below zero at 120-320 m depth. The surface temperature in August varies between 4.5°C and 7°C. Between the summer heated water and the cold deep polar water there is a transition layer between 60 and 110 m in 1995. The transition layer seems some deeper in 1994. In 1981 (Figure 4b) the surface water was below 4.0 °C, that is explained by the one month earlier sampling. The salinity profiles for 1994 show a more diverse composition than the temperature profiles, and illustrate that different water masses occur around the Jan Mayen island (Figure 3).

Catch statistics

As in the Barents Sea, the Svalbard area and East Greenland area, the Norwegian shrimp fisheries started off Jan Mayen in the early 70-ties. In the period of 1974-1976 more than 1000 tonnes of shrimp was caught in the Jan Mayen area (Øynes 1979). The shrimp fisheries off Jan Mayen has been dominated by Norwegian vessels. However, limited Soviet Union shrimp fishery has been conducted in the area in 1974 with a catch of 178 tons. In 1975 total catch taken by the Soviet Union in the area was 582 tons. Since only an experimental fishery has taken place in 1986 and 1990 and the Soviet Union catches have not approached the quota of 750 tons that is set by the Joint Norwegian- Russian Fisheries Commission (Anon. 1991).

The data on Norwegian shrimp catches is based on logbooks recorded by the Norwegian Fisheries Directorate. In the mid 80-ties the annual catch in the Jan Mayen area (Norwegian statistical area 35, 36 and 38) was large reaching more than 2000 tons in 1987 (Figure 5). In the 90-ties the catches have been lower. However, the catch in 1995 was good and preliminary data for 1996 suggest catches to be substantial.

Medium size vessels (1000 - 2000 HP) stands for the greatest catch in the 80-ties, while the largest vessels (> 2000 HP) catches the most in the 90-ties. Preliminary annual catch per annual effort data suggest that the medium size vessels are most sufficient (Figure 6).

Fish community

The available data for 1995, 1994, 1981, 1980, 1979 and 1976 are shown in Appendix I - VI. The appendix includes station number, date, position, time, depth, haul length, bottom temperature, shrimp catch, shrimp catch/nm., fish weight (kg/3nm) for Greenland halibut (*Reinhardtius hippoglossoides*), long rough dab (*Hippoglossoides platessoides*), blue whiting (*Micromesistius poutassou*), capelin (*Mallotus villosus*), polar cod (*Boreogadus saida*) including arctic cod (*Arctogadus glacialis*) in 1995. Between 16 and 39 stations has been sampled in the years that have been studied.

Polar cod and capelin are the most abundant fish species in the study area. The arctic cod (*Arctogadus glacialis*) is not recorded in the area before (Aschan in prep.). A high number of blue whiting was registered in 1979 but the number declined in 1980 and 1981. Cod was also registered each year in the period 1979-1981. During the surveys in 1994 and 1995 the fish fauna was dominated by species characteristic for the arctic, and no blue whiting nor cod was registered in the area. During a survey in the Norwegian Sea including the Jan Mayen area, the blue whiting avoided water colder than +2 °C and is probably spread by the Norwegian Atlantic Current (Blindheim & Jákupsstovu 1976). There has been a general reduction in the blue whiting stock and the cod stock of the Norwegian Sea since 1979 (Anon. 1985, 1996). Changes in species composition in the Jan Mayen area may be explained by hydrographic and current conditions in the study area and the size of the fish stocks in the neighbouring waters.

The number of Greenland halibut has declined from the beginning of the 80-ties to the mid 90-ties. Only very few individuals of the ray species *Raja hyperborea* and *Beviraja spinicauda* were observed in 1994 and 1995. Cod and blue whiting are absent and one can thereby conclude that there is hardly any predation on the shrimp in the study area.

Shrimp distribution

Shrimp catch (kg/nm) in each 100 m depth zone from available surveys are given in Table 1. Shrimp biomass is calculated for each 100 m depth interval for the six years, and shows without exception the highest biomass at the 200-299 m depth.

The biomass index for the six years varies between 3000 and 6600 tonnes. The total biomass estimate is rather small and corresponds to less than 10 % of the estimate in the Hopen area in the Northern Barents Sea (Aschan et al. 1996). The total estimate for 1995 is higher than in 1994 and the preliminary catch statistics show also a grate increase in catch in 1995 (Figure 5). The catch statistics probably illustrates the development in stock size in the same way as it does in the Barents Sea (Anon. 1996). Still one has to take into account that low catches in the Jan Mayen area may not only be caused by a small stock size but also may be explained by low fishing activity due to ice cover or good fishing conditions off Greenland, in the Barents Sea or off Spitsbergen.

Shrimp size, growth and sex change

Number of shrimp per kilo varied between 65 and 259 in 1995 and 71 and 243 in 1994 (Appendix I, II). The length frequency distribution for shrimp measured in 1994 is shown in Figure 7. The shrimp gets rather large and male individuals dominate. The shrimp size varies with depth and there are more small shrimp and thereby more male individuals in the areas shallower than 200 m. The number of shrimp per kg and the number of male decrease with depth and there by female shrimp dominate at depths grater than 300 m (Figure 8).

It is not easy to identify cohorts in the total material and also when dividing the length frequency data into depth groups it is difficult to run a reliable cohort analysis (Table 2). Therefore cohort analyses using MIX 2.3 (MacDonald and Green 1988) were run only on male shrimp for each station sampled in 1995. The length at age relationship received describes a growth curve (Figure 9). MULTIFAN (Fournier et al. 1990) was used to analyse size at age for all male individuals sampled in 1995. The von Bertalanffy equation ($K=0.191$, $L_{\infty}=33.2$) achieved from the MULTIFAN fits well to the observations on male growth and

thereby illustrates a slow growing species. The von Bertalanffy run on results from MULTIFAN and MIX 2.3 gave almost the same result.

The size at age received when running the cohort analysis on all sex groups in each depth zone also fits in to the growth curve especially for the first five year classes (Table 2 and Figure 9). The mean size for the age groups decrease with depth. This may be explained by the by depth increasing amount of female individuals that use energy on egg production and thereby grow slower.

The sex change from male to female takes place when the shrimp has reached a carapace length between 23 mm and 29 mm which equals 5 to 9 years (Figure 8 and 9). Late sex change is characteristic for slow growing shrimp in cold water and is also observed in the northern parts of the Barents Sea, North of Spitsbergen (Nilssen and Hopkins 1991), Bering Sea and Western Gulf of Alaska (Anon 1994). Several NAFO areas like Davis Strait, Div. OB, Div. 2G, Hopedale Channel, Cartwright Channel, Hawke Channel, St Anthony and Funk Island have shrimp populations with slow growth and high age (6-7 years) at first time spawning (Anon 1994). The shrimp at Jan Mayen has a life-history, with slow growth, late sex change, high age and big size. This strategy can be explained by low water temperatures, low predation mortality and low fishing mortality (Nilssen and Hopkins 1991).

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TABLES

Table 1. Results from surveys in the Jan Mayen area in -95, -94, -81,-80 and -79 (Torheim 1980) and -76 (Strøm 1976).						
depth (m)	100-199	200-299	300-399	400-499	Estimate (tonn)	
					total in area 100-500m	percent in 200-400m
area (nm ²)	276.14	292.48	200.98	180.87		
aug.95						
sum	267.39	561.32	256.59	4.57		
n	7.00	13.00	6.00	4.00		
mean (kg/nm)	38.20	43.18	42.77	1.14		
std (s)	42.09	39.67	39.66	0.89		
	30 %	34 %	34 %	1 %	5062.01	66 %
aug.94						
sum	47.80	271.60	93.20	5.20		
n	4.00	7.00	5.00	1.00		
mean (kg/nm)	11.95	38.80	18.64	5.20		
std (s)	9.54	16.38	22.05			
	16 %	52 %	25 %	7 %	3060.57	78 %
jul.81						
sum	227.40	338.40	70.00	25.00		
n	6.00	6.00	4.00	1.00		
mean (kg/nm)	37.90	56.40	17.50	25.00		
std (s)	21.21	23.55	2.83			
	28 %	41 %	13 %	18 %	5540.31	57 %
aug.80						
sum	555.30	802.70	190.90	133.60		
n	12.00	11.00	9.00	7.00		
mean (kg/nm)	46.28	72.97	21.21	19.09		
std (s)	33.02	9.19	14.14	12.52		
	29 %	46 %	13 %	12 %	6622.40	61 %
okt.79						
sum	126.33	332.43	92.07	48.40		
n	7.00	8.00	4.00	2.00		
mean (kg/nm)	18.05	41.55	23.02	24.20		
std (s)	5.42	8.34	9.66	3.11		
	17 %	39 %	22 %	23 %	4137.82	64 %
aug.76						
sum		719.50	95.69		total estimate of -76 is estimated from depth distribution in the other years	
n		13.00	3.00			
mean (kg/nm)		55.35	31.90			
std (s)		27.50	7.95			
		46 %	26 %		5589.31	64 %

Table 2. Year class (YC) distribution for all shrimp in different depth zones and in total analysed by MIX 2.3 (MacDonald and Green 1988) and year class distribution for male shrimp in total analysed by MULTIFAN (Fournier et al. 1990). Length frequency data from 1995 is used as input for the analyses.

Depth: 100-199m	MIX		MALE AND FEMALE					
	YC: 93	92	91	90	89	88	87+	
mean m:	10.6	14.2	17.3	19.8	23.5	26.5	29.3	chi-sq: 24.4
pro:	0.04	0.16	0.34	0.16	0.07	0.17	0.07	P: 0.7
sigma-sd:	1.15	1.15	1.15	1.15	1.15	1.15	1.15	N: 2014

Depth: 200-299m	MIX		MALE AND FEMALE						
	YC: 93	92	91	90	89	88	87	86	
mean m:		12.5	16.5	19.6	23.0	25.7	27.4	29.9	chi-sq: 49.3
pro:		0.02	0.14	0.1	0.19	0.24	0.13	0.16	P: 0.05
sigma-sd:		1.37	1.37	1.37	1.37	1.37	1.37	1.37	N: 3741

Depth: 300-399m	MIX		MALE AND FEMALE						
	YC: 93	92	91	90	89	88	87	86	
mean m:			15.6	18.8	22.4	25.2	27.0	29.7	chi-sq: 37.5
pro:			0.04	0.1	0.15	0.21	0.26	0.24	P: 0.22
sigma-sd:			1.38	1.38	1.38	1.38	1.38	1.38	N: 1280

Depth: 400-499m	MIX		MALE AND FEMALE						
	YC: 93	92	91	90	89	88	87	86	
mean m:	no good analysis								chi-sq:
pro:									P:
sigma-sd:									N: 562

TOTAL:	MIX		MALE AND FEMALE						
	YC: 93	92	91	90	89	88	87	86	
mean m:	10.8	14.1	17.1	19.8	23.0	25.5	27.7	30.1	chi-sq: 39.2
pro:	0.01	0.06	0.16	0.11	0.14	0.21	0.18	0.11	P: 0.37
sigma-sd:	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	N: 7597

TOTAL:	MULTIFAN			MALE				
	YC: 93	92	91	90	89	88	87+	
mean m:	10.8	14.7	18	20.6	22.8	24.6	26.1	L_{∞} : 33.2
average sd	0.99							K: 0.19
sd-ratio	0.55							

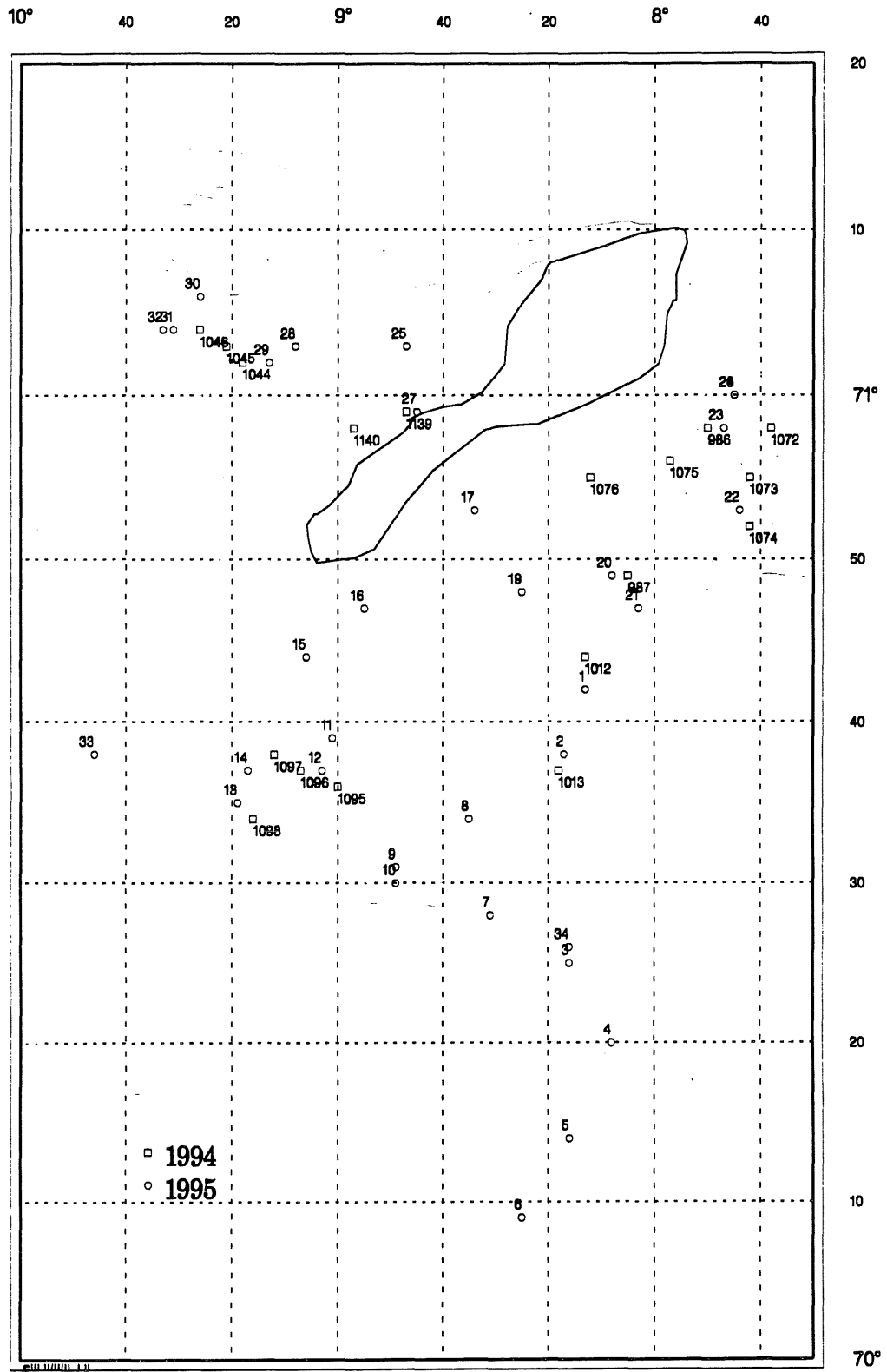


Figure 1. Trawl stations taken off Jan Mayen in 1994 and 1995. Station numbers as in Appendix I and II

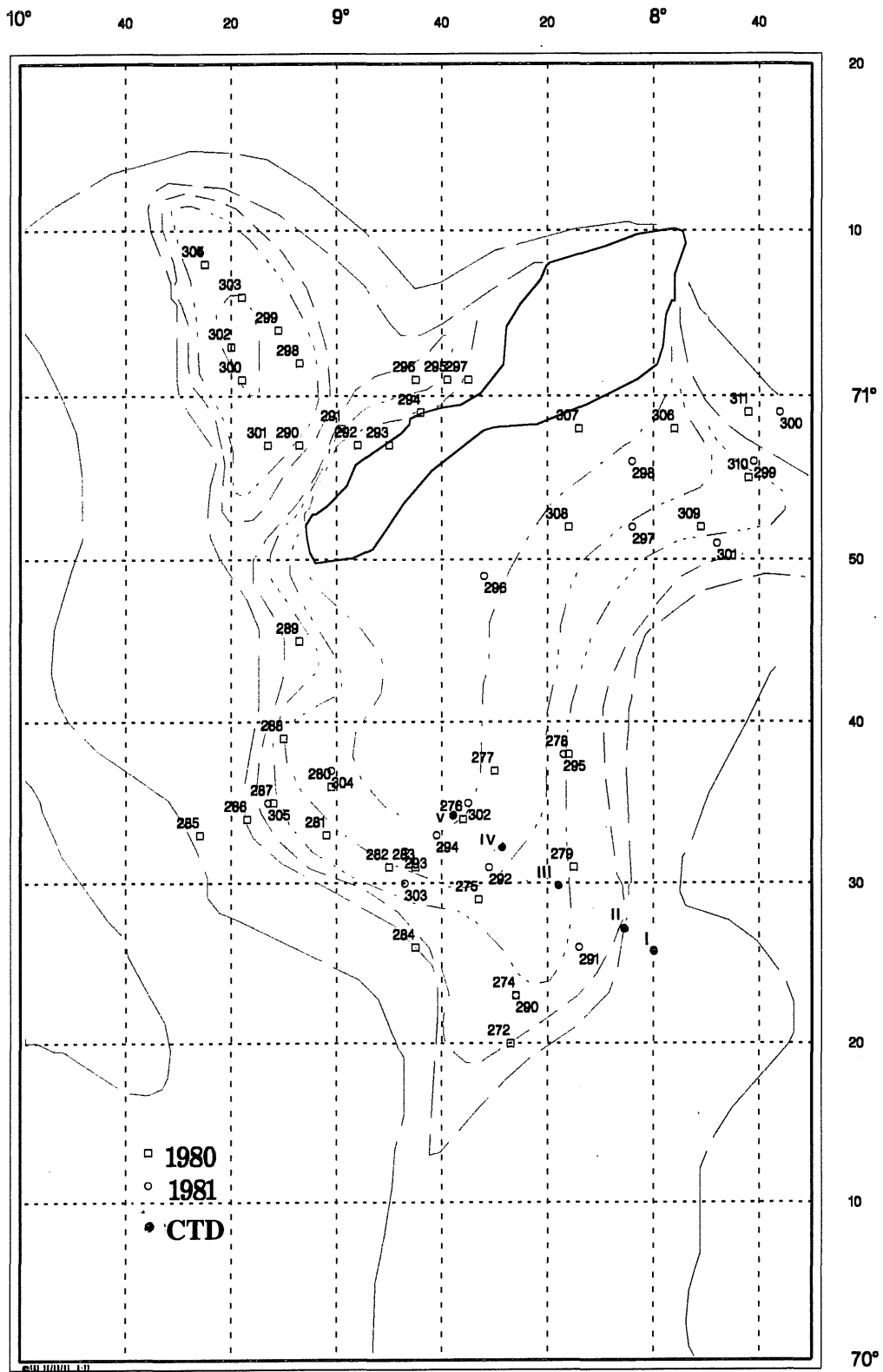


Figure 2. Trawl stations taken off Jan Mayen in 1980 and 1981 and CTD-stations taken in a section Jan Mayen Bank - SE in July 1981. Station numbers as in Figure 4b, Appendix III and IV.

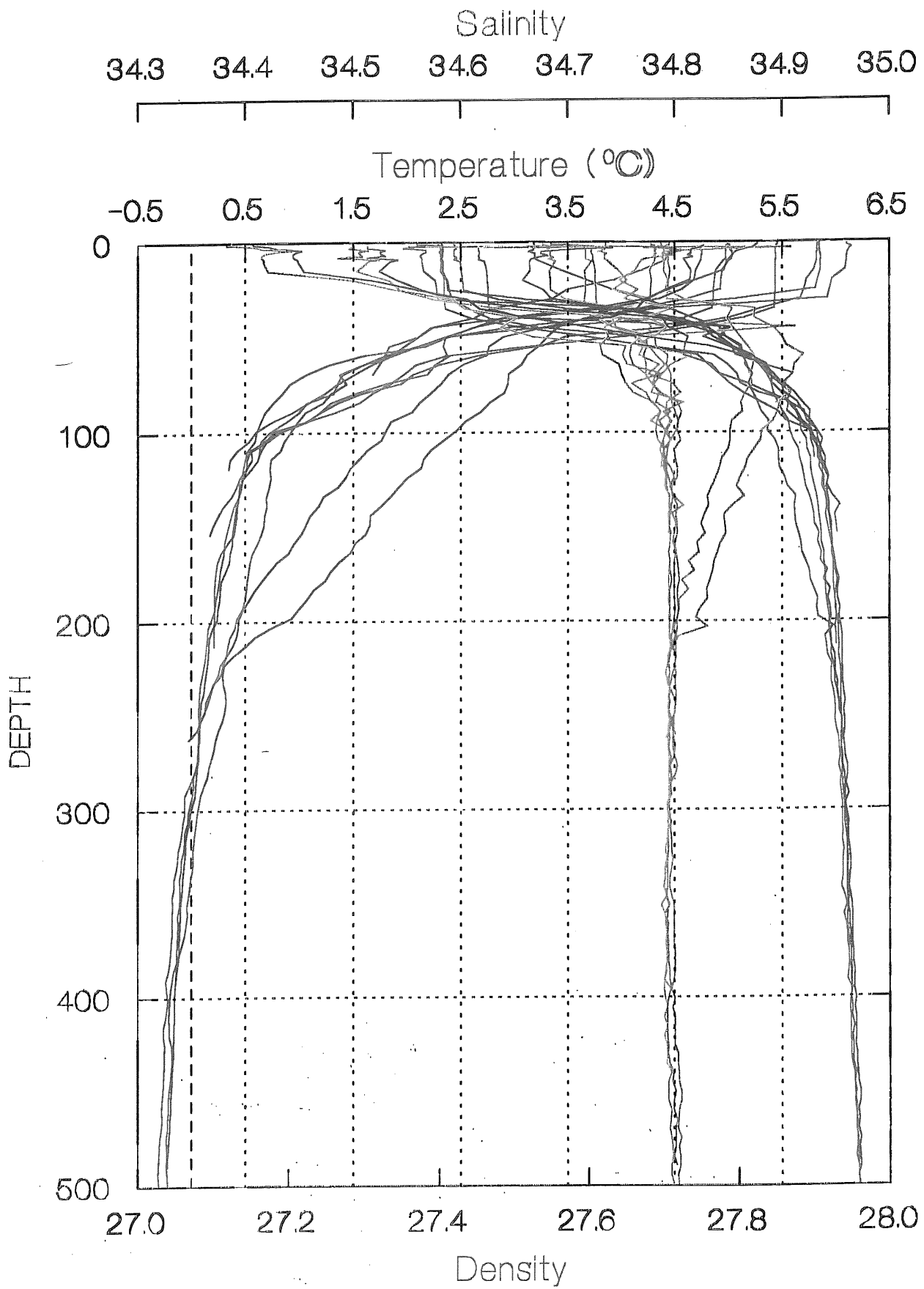


Figure 3. Temperature, salinity and density profiles for 10-CTD-stations in the Jan Mayen area in August 1994.

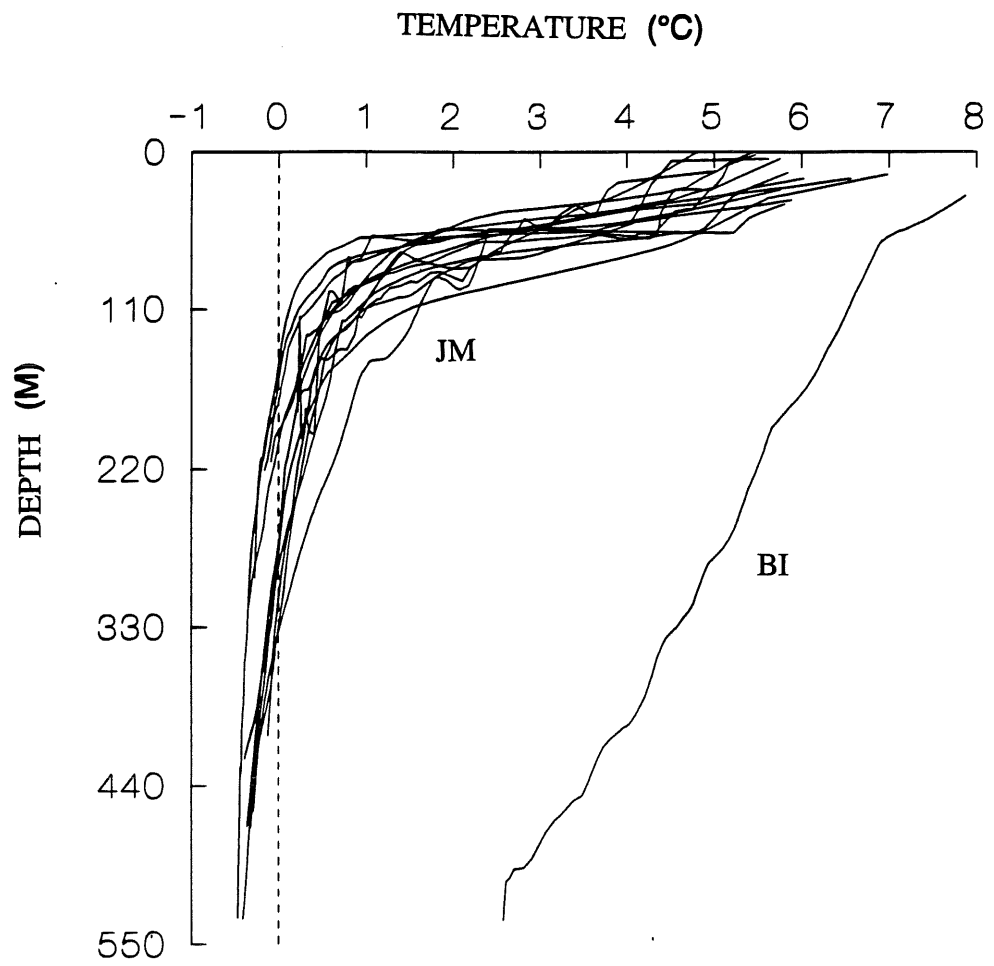


Figure 4a. Temperature profiles for 14 stations off Jan Mayen (JM) and 1 station off Bear Island (BI) in August 1995.

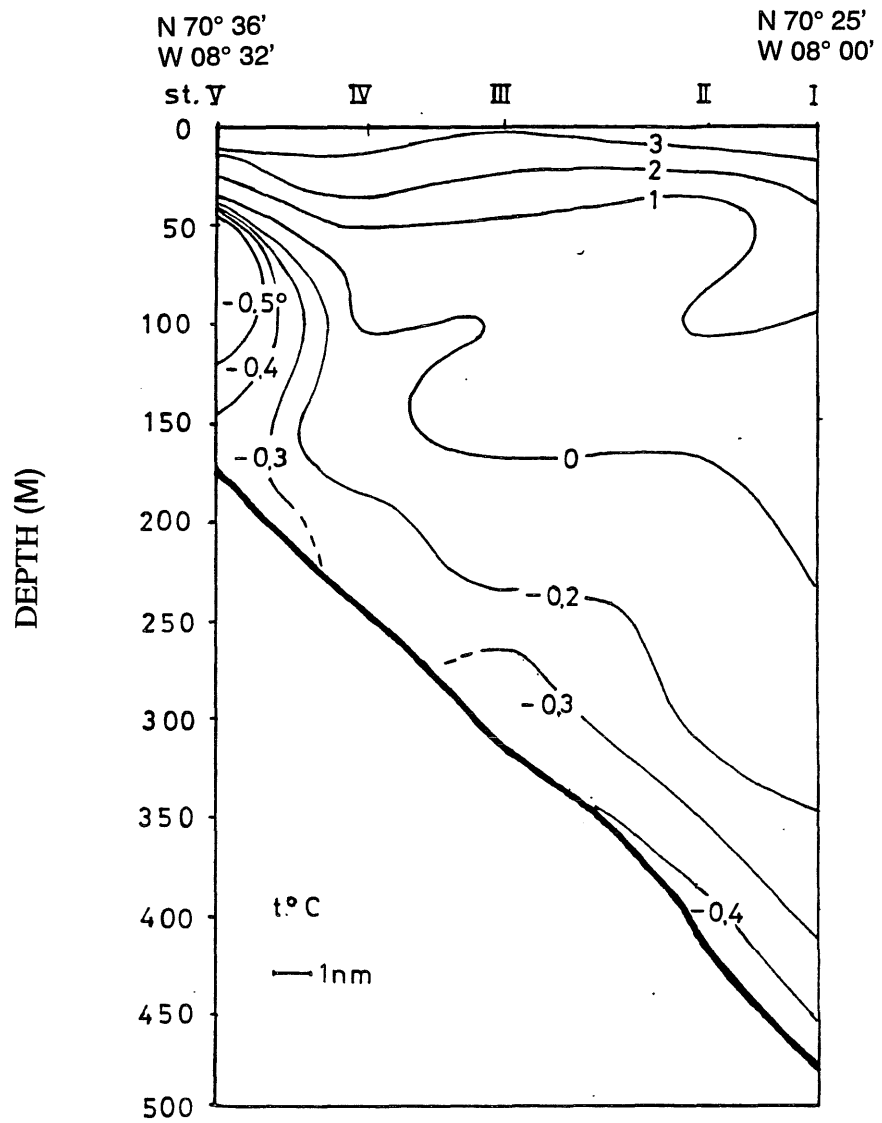


Figure 4b. Temperature in a section, Jan Mayen Bank - South East in July 1981. Station I - V are shown in figure 2.

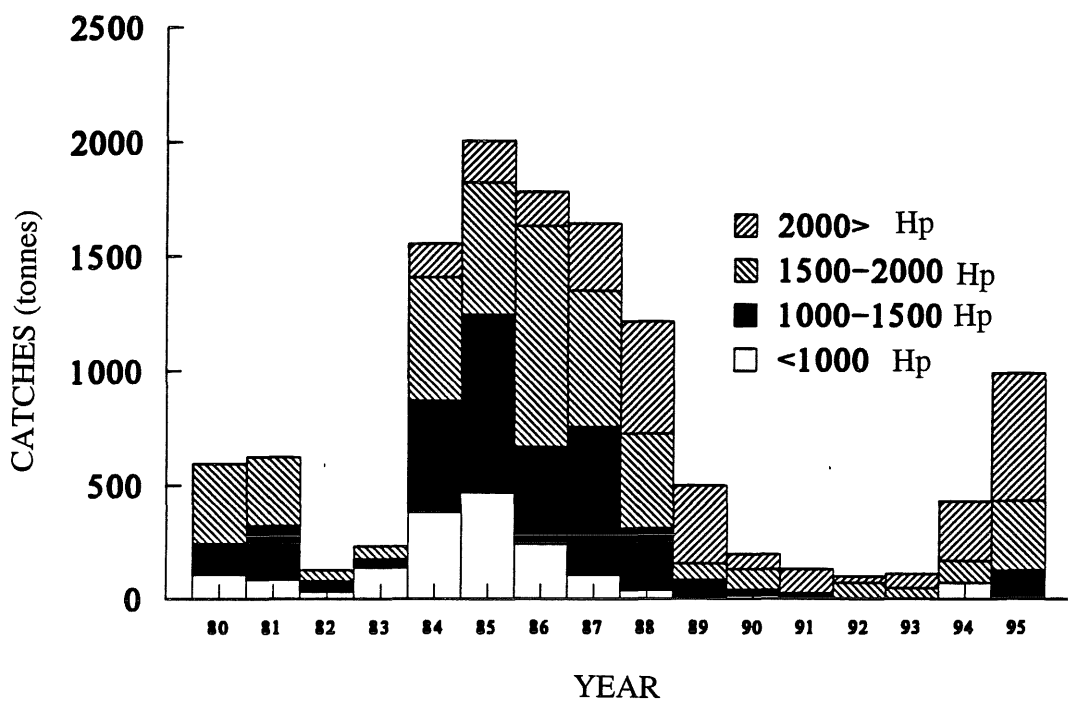


Figure 5. Norwegian catches of shrimp (*Pandalus borealis*) in the Jan Mayen area for four vessel sizes in 1980 - 1995 (Norwegian Fisheries Directorate. Preliminary data for 1995).

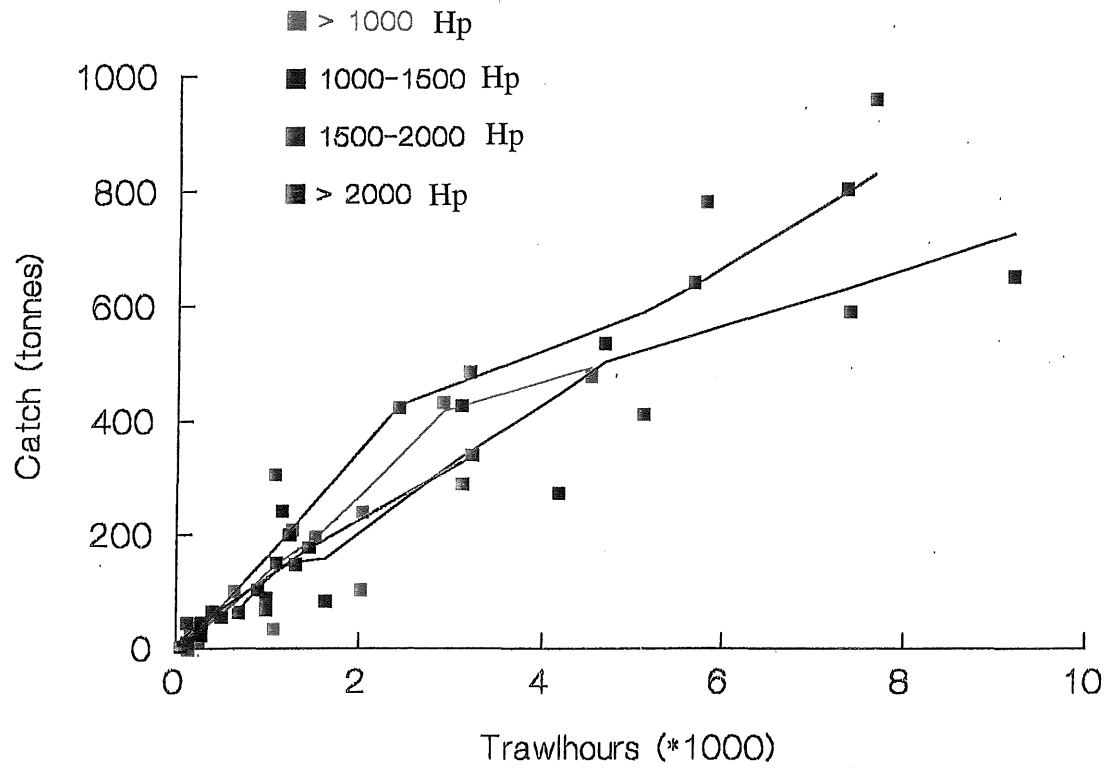


Figure 6. Annual catch per annual trawl hours for four vessel size groups in the Jan Mayen area (Norwegian Fisheries Directorate).

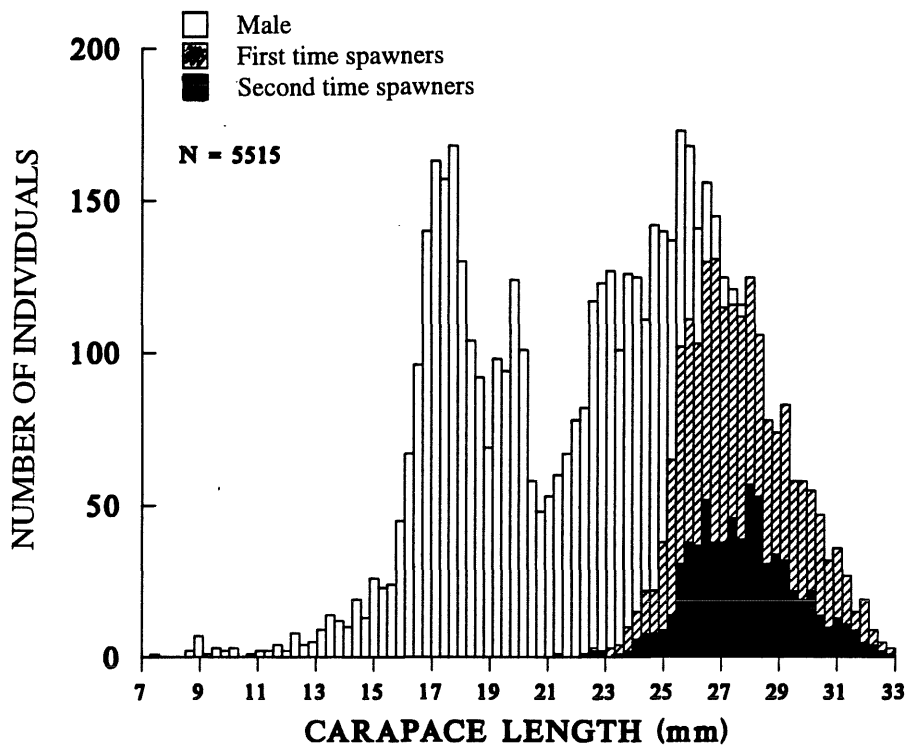


Figure 7. Carapace length (mm) and sex composition of shrimp in the Jan Mayan area in August 1994.

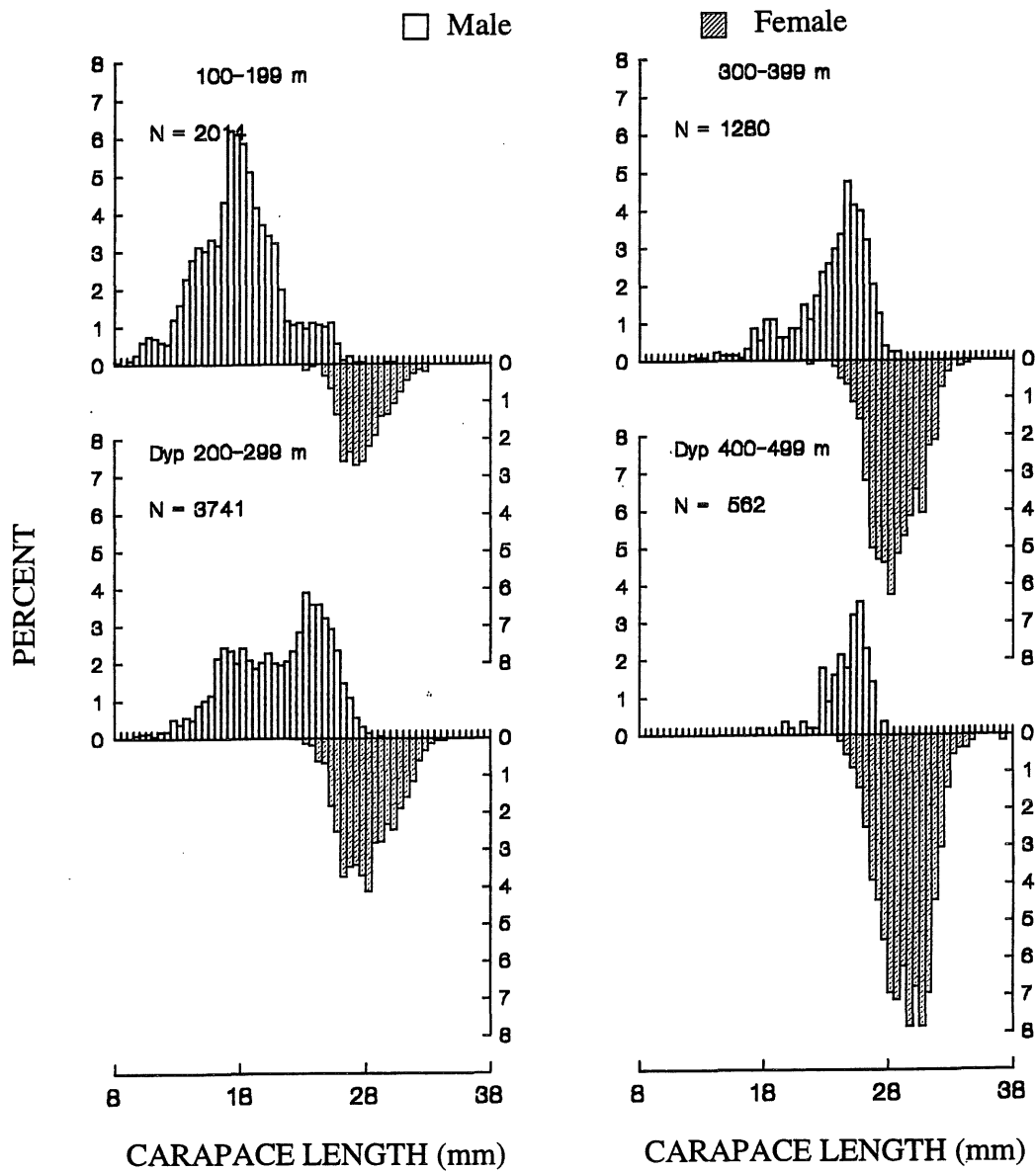


Figure 8. Carapace length and sex composition of shrimp in four depth zones in the Jan Mayan area in 1995.

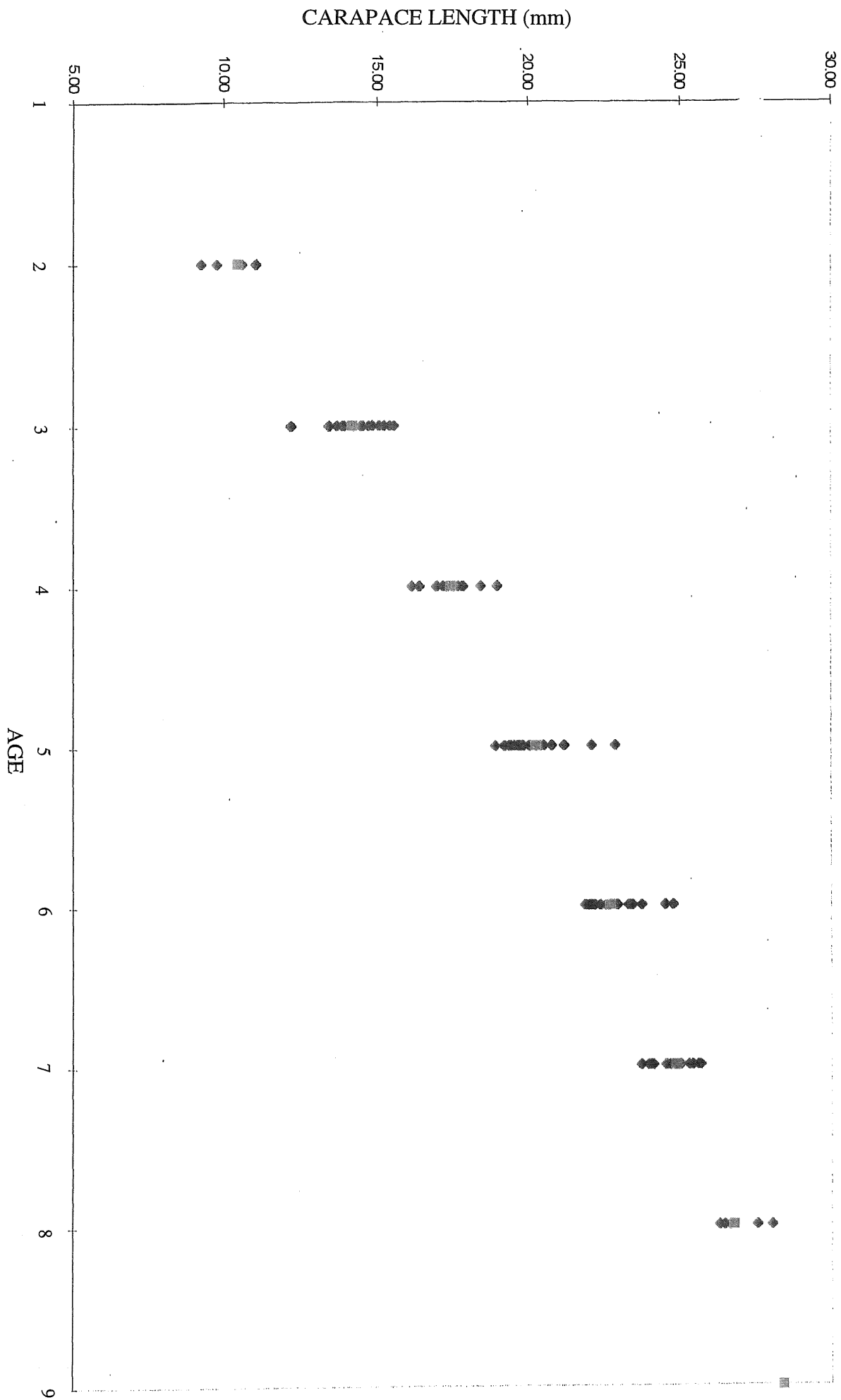


Figure 9. Size at age for male individuals at single stations in the Jan Mayan area in 1995 achieved by MIX 2.3 analyses (MacDonald and Green 1988).

Appendix I. Shrimp catch (kg/nm) and bycatch (number/3 nm) in Campelen 1800 trawl off Jan Mayen in August 1995.

ST. NR.	DATE	POSITION		TIME KL.	DEPTH M	HAUL LENGTH (NM)	BOTTOM TEMP t °C	LIGHT LUX	SHRIMP TOTAL KG	SHRIMP KG/NM	SHRIMP NR./KG	FISH (NUMBER/3NM)				
		LAT. °N	LON. °W									Greenl. halibut	LRD	Arctic cod	Capelin	Polar-cod
1	18.08	70°42'	08°13'	1.20	250	1.0	-0.6	8	21.2	21.2	85	0	15	0	0	24
2	18.08	70°38'	08°17'	2.55	256	1.5	-0.5	4	5.6	3.7	69	0	10	0	0	6
3	18.08	70°25'	08°16'	5.50	341	1.5	-0.7	450	148.6	99.1	77	0	4	0	4098	16
4	18.08	70°20'	08°08'	8.00	490	1.0	-0.9	7600	2.4	2.4	85	0	0	0	375	0
5	18.08	70°14'	08°16'	9.55	650	1.0	-0.9	7000	0.0	0.0		0	0	0	0	0
6	18.08	70°09'	08°25'	11.30	677	1.0	-0.9	13000	0.0	0.0		0	0	0	0	0
7	18.08	70°28'	08°31'	15.05	235	1.3	-0.5	16000	87.1	69.7	131	0	58	0	15918	0
8	18.08	70°34'	08°35'	16.30	175	1.3	0.0	18000	142.8	114.2	142	0	16	0	24831	72
9	18.08	70°31'	08°49'	18.10	215	1.3	0.1	16000	24.0	19.2	93	0	5	0	6588	0
10	18.08	70°30'	08°49'	19.15	254	1.0		9000	30.9	24.7	85	0	12	0	0	108
11	18.08	70°39'	09°01'	21.30	120	1.0		1700	65.8	65.8	150	0	30	0	2085	0
12	18.08	70°37'	09°03'	22.55	163	1.0		700	51.2	51.2	179	0	9	0	546	63
13	19.08	70°35'	09°19'	0.30	355	1.0		40	1.7	1.7	98	0	3	0	0	36
14	19.08	70°37'	09°17'	3.50	270	1.0		5	39.5	39.5	83	0	54	0	0	48
15	19.08	70°44'	09°06'	5.20	245	1.0		130	98.5	98.5	160	0	51	0	0	150
16	19.08	70°47'	08°55'	6.25	170	1.0		1300	26.0	26.0	123	0	15	0	135	171
17	19.08	70°53'	08°34'	8.20	137	1.0		8000	2.8	2.8	397	0	0	0	135	60
19	19.08	70°48'	08°25'	12.15	176	1.0	-0.2	24000	5.0	5.0	249	0	6	0	135	6
20	19.08	70°49'	08°08'	13.35	235	1.0	-0.4	32000	28.9	28.9	259	0	27	59	0	87
21	19.08	70°47'	08°03'	14.50	340	1.0	-0.6	28000	25.7	25.7	109	0	6	0	9	54
22	19.08	70°53'	07°44'	16.50	280	1.0	0.1	27000	68.1	68.1	105	0	0	0	429	0
23	19.08	70°58'	07°47'	18.50	340	1.0		13000	60.1	60.1	84	0	0	0	150	66
24	19.08	71°00'	07°45'	20.15	430	1.0		5000	1.1	1.1	106	3	0	9	0	42
25	19.08	71°03'	08°47'	0.50	444	1.0		15	0.6	0.6	65	0	0	6	0	0
26	20.08	71°00'	07°45'	2.15	245	1.0		0	25.8	25.8	112	0	0	0	0	234
27	20.08	70°59'	08°45'	3.10	245	1.0		0	2.3	2.3	126	0	9	0	0	225
28	20.08	71°03'	09°08'	5.10	410	1.0		170	0.4	0.4	126	0	0	0	0	42
29	20.08	71°02'	09°13'	6.25	385	1.0		1200	1.2	1.2	75	0	0	0	0	90
30	20.08	71°06'	09°26'	8.10	155	1.0		3000	1.9	1.9	70	0	3	66	3	54
31	20.08	71°04'	09°31'	9.15	270	1.5		14000	127.0	84.7	84	0	0	0	0	70
32	20.08	71°04'	09°33'	10.35	270	1.0		19000	2.5	2.5	73	0	0	33	9	24
33	20.08	70°38'	09°46'	14.15	970			28000		problems		with		trawl		
34	20.08	70°26'	08°16'	18.15	340	1.0		17000	68.9	68.9	77	0	9	0	2466	0

Appendix II. Shrimp catch (kg/nm) and bycatch (number/3 nm) in Campelen 1800 trawl off Jan Mayen in August 1994. LRD = long rough dab.

ST. NR.	DATE	POSITION		TIME KL.	DEPTH M	HAUL LENGTH (NM)	BOTTOM TEMP t °C	LIGHT LUX	SHRIMP TOTAL KG	SHRIMP KG/NM	SHRIMP NR./KG	FISH (NUMBER/ 3NM)			
		LAT. °N	LON. °W									Greenl. halibut	LRD	Capelin	Polar-cod
986	26.08	70°58'	7°50'	21.15	308	1.5	0.1	3000	86.3	57.5	98	0	0	0	36
987	26.08	70°49'	8°05'	22.45	250	1.5	0.1	800	50.0	33.3	204	0	0	10	15
1012	27.08	70°44'	8°13'	16.35	244	1.5		44000	38.6	25.7	118	0	8	15	10
1013	27.08	70°37'	8°18'	18.15	231	1.5			68.9	45.9	91	0	10	0	10
1044	28.08	71°02'	9°18'	11.03	300	1.5	0.3	10000	9.9	6.6	80	0	0	0	100
1045	28.08	71°03'	9°21'	12.13	240	1.5	0.3		109.4	72.9	102	0	0	16	160
1046	28.08	71°04'	9°26'	13.06	200	1.5	0.3	80000	52.8	35.2	84	0	0	12	30
1072	29.08	70°58'	7°38'	12.30	400	1.5	-0.1	120000	7.8	5.2	71	3	0	8	13
1073	29.08	70°55'	7°42'	13.45	330	1.5	-0.2		21.6	14.4	86	0	0	6	24
1074	29.08	70°52'	7°42'	14.50	277	1.5	0.3	38000	44.7	29.8	89	0	1	28	8
1075	29.08	70°56'	7°57'	18.40	532	1.5	0.0		68.0	45.3		0	2	0	48
1076	29.08	70°55'	8°12'	19.45	179	1.5	0.1		3.0	2.0	243	0	0	200	0
1095	30.08	70°36'	9°00'	12.50	160	1.5	0.2		22.5	15.0	108	0	0	1000	0
1096	30.08	70°37'	9°07'	13.45	190	1.5	0.0		10.5	7.0		0	51	100	10
1097	30.08	70°38'	9°12'	14.45	250	1.5	-0.1		43.2	28.8	94	0	31	0	4
1098	30.08	70°34'	9°16'	15.50	326	1.5	-0.2		6.8	4.5	79	0	0	10	7
1139	1.09	70°59'	8°47'	11.31	190	1.0	0.3		23.8	23.8		0	7	0	78
1140	1.09	70°58'	8°57'	12.20	335	1.0	-0.1		10.2	10.2		0	0	0	10

Appendix III. Shrimp catch (kg/nm) and bycatch (kg / 3 nm) in Campelen 1800 trawl off Jan Mayen in July 1981. LRD = long rough dab.

ST. NR.	DATE	POSITION		TIME KL.	DEPTH M	HAUL LENGTH (NM)	BOTTOM TEMP t °C	SHRIMP TOTAL KG	SHRIMP KG/NM	FISH (KG/3NM)					
		LAT. °N	LON. °W							Greenl. halibut	LRD	Blue whiting	Capelin	Polar-cod	Cod
290	14.07	70°23'	08°26'	08.00	330	3.0		60	20.0	0.0	0.0	0.0	0.0	0.0	0.0
291	14.07	70°26'	08°14'	09.50	349	3.0	-0.25	72	24.0	12.0	0.0	0.6	0.0	0.5	0.0
292	14.07	70°31'	08°31'	12.12	216	3.0	-0.22	264	88.0	0.0	0.0	0.0	0.2	0.0	0.0
293	14.07	70°32'	08°47'	14.10	186	3.0	-0.21	156	52.0	0.0	0.0	0.0	1.4	0.0	0.0
294	14.07	70°33'	08°41'	16.07	180	3.0	-0.22	180	60.0	0.0	0.0	0.0	0.0	0.0	0.0
295	14.07	70°38'	08°17'	18.10	250	3.0	-0.22	156	52.0	0.0	10.0	0.0	0.0	0.0	0.0
296	15.07	70°49'	08°32'	6.45	142	3.0		0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
297	15.07	70°52'	08°04'	08.40	178	3.0	-0.26	110	36.7	0.0	33.0	0.0	0.0	0.0	0.0
298	15.07	70°56'	08°04'	10.48	236	3.0	-0.12	236	78.7	0.0	48.0	0.0	0.0	3.0	0.0
299	15.07	70°56'	07°41'	13.00	345	3.0		30	10.0	0.0	0.0	0.0	0.0	0.0	0.0
300	15.07	70°59'	07°36'	15.00	470	3.0	-0.18	75	25.0	120.0	0.0	0.0	0.0	0.0	0.0
301	15.07	70°51'	07°48'	19.00	287	3.0	0.00	125	41.7	0.0	9.0	0.0	0.0	1.0	3.0
302	16.07	70°35'	08°35'	06.35	170	3.0	-0.37	170	56.7	0.0	12.0	0.0	0.0	3.0	0.0
303	16.07	70°30'	08°47'	08.38	264	3.0		70	23.3	0.0	0.0	0.0	0.1	1.0	0.0
304	16.07	70°37'	09°01'	10.34	186	3.0	-0.23	66	22.0	0.0	2.0	0.0	0.0	1.0	0.0
305	16.07	70°35'	09°13'	12.31	247	3.0	-0.22	164	54.7	0.0	0.0	0.0	0.0	1.5	0.0
306	16.07	70°33'	09°12'	14.23	393	3.0	-0.23	48	16.0	problems		with		trawl	

Appendix IV. Shrimp catch (kg/nm) and bycatch (kg / 3 nm) in Campelen 1800 trawl off Jan Mayen in August 1980. LRD = long rough dab.

ST. NR.	DATE	POSITION		TIME KL.	DEPTH M	HAUL LENGTH (NM)	BOTTOM TEMP t °C	SHRIMP TOTAL KG	SHRIMP KG/NM	FISH (KG/3NM)					
		LAT. °N	LON. °W							Greenl. halibut	LRD	Blue whiting	Capelin	Polar-cod	Cod
272	12.08	70°20'	08°27'	04.00	402	3.0	-0.16	16	5.3	0.0	0.0	0.0	0.0	0.1	0.0
274	12.08	70°23'	08°26'	11.20	336	3.0	-0.02	28	9.3	0.0	0.0	0.0	0.0	0.1	0.0
275	12.08	70°29'	08°33'	13.30	224	3.0	0.09	155	51.7	0.0	11.0	0.0	0.0	0.5	0.0
276	12.08	70°34'	08°36'	15.20	180	3.0	0.33	300	100.0	0.0	6.4	0.0	0.0	4.0	26.0
277	12.08	70°37'	08°30'	17.25	165	3.0	0.39	180	60.0	0.0	5.0	0.0	0.0	0.7	0.0
278	12.08	70°38'	08°16'	19.45	253	3.0	0.11	66	22.0	0.0	21.0	0.0	0.0	0.3	0.0
279	13.08	70°31'	08°15'	06.25	315	3.0	0.10	88	29.3	0.0	8.0	0.0	0.0	0.5	0.0
280	13.08	70°36'	09°01'	09.35	186	3.0	0.40	180	60.0	0.0	20.3	0.0	0.0	6.8	0.0
281	13.08	70°33'	09°02'	12.05	168	3.0	0.05	171	57.0	0.0	0.0	5.4	0.0	5.4	0.0
282	13.08	70°31'	08°50'	14.00	226	3.0	0.05	193	64.3	0.0	0.0	10.0	0.0	10.0	0.0
283	13.08	70°31'	08°45'	15.45	190	3.0		163	54.3	0.0	0.0	7.0	0.0	2.5	3.0
284	13.08	70°26'	08°45'	18.10	365	3.0	0.02	15	5.0	0.0	0.0	0.0	0.0	0.0	0.0
285	14.08	70°33'	09°26'	06.00	443	3.0	-0.24	18	6.0	0.0	0.0	0.0	0.0	0.0	0.0
286	14.08	70°34'	09°17'	08.15	345	3.0		50	16.7	0.0	0.0	0.0	0.1	0.3	0.0
287	14.08	70°35'	09°12'	11.55	250	3.0	0.03	252	84.0	0.0	0.0	0.0	0.0	3.6	0.0
288	14.08	70°39'	09°10'	14.00	179	3.0	0.61	204	68.0	0.0	2.4	0.0	0.0	2.4	0.0
289	14.08	70°45'	09°07'	16.00	264	3.0	0.09	226	75.3	0.0	22.0	0.0	0.0	11.0	0.0
290	14.08	70°57'	09°07'	20.40	435	3.0	-0.27	66	22.0	24.0	0.0	3.0	0.0	0.5	0.0
291	15.08	70°58'	08°59'	06.00	380	3.0	-0.07	92	30.7	11.5	0.0	0.0	0.0	2.0	0.0
292	15.08	70°57'	08°56'	08.30	240	3.0		233	77.7	0.0	36.0	0.0	0.4	2.4	0.0
293	15.08	70°57'	08°50'	10.40	160	3.0	0.46	70	23.3	0.0	40.1	8.0	0.0	1.5	0.0
294	15.08	70°59'	08°44'	12.35	160	3.0	0.26	65	21.7	0.0	60.0	15.0	0.0	4.2	0.0
295	15.08	71°01'	08°39'	14.30	234	3.0	0.11	180	60.0	0.0	30.0	5.0	0.0	4.0	0.0

ST. NR.	DATE	POSITION		TIME KL.	DEPTH M	HAUL LENGTH (NM)	BOTTOM TEMP t °C	SHRIMP TOTAL KG	SHRIMP KG/NM	FISH (KG/3NM)					
		LAT. °N	LON. °W							Greenl. halibut	LRD	Blue whiting	Capelin	Polar-cod	Cod
296	15.08	71°01'	08°45'	16.30	350	3.0	-0.04	123	41.0	15.0	3.0	0.0	0.2	3.0	0.0
297	15.08	71°01'	08°35'	18.40	430	3.0	-0.36	117	39.0	27.3	0.0	1.2	0.0	0.6	0.0
298	16.08	71°02'	09°07'	05.55	450	3.0	-0.24	25	8.3	8.0	0.0	0.0	0.2	0.2	0.0
299	16.08	71°04'	09°11'	08.05	340	3.0		58	19.3	0.0	0.0	0.0	0.2	6.0	0.0
300	16.08	71°01'	09°18'	17.15	380	3.0		31	10.3	0.0	0.0	0.0	0.2	0.0	0.0
301	16.08	70°57'	09°13'	13.25	440	3.0		64	21.3	54.4	0.0	0.0	0.1	0.8	0.0
302	16.08	71°03'	09°20'	16.30	255	3.0	0.11	315	105.0	0.0	60.0	0.0	0.0	15.0	0.0
303	16.08	71°06'	09°18'	17.15	230	3.0	0.30	387	129.0	0.0	27.0	0.0	1.0	0.0	0.0
304	16.08	71°08'	09°25'	19.10	155	3.0		80	26.7	0.0	0.0	0.0	0.0	0.0	0.0
305	16.08	71°08'	09°25'	20.50	160	3.0	0.34	33	11.0	0.0	0.0	0.0	0.0	4.2	0.0
306	17.08	70°58'	07°56'	05.45	225	3.0	0.39	285	95.0	0.0	30.0	0.0	0.0	4.5	3.5
307	17.08	70°58'	08°14'	07.30	170	3.0	0.52	60	20.0	0.0	12.0	0.0	0.0	0.0	0.0
308	17.08	70°52'	08°16'	09.00	190	3.0		160	53.3	0.0	20.0	0.0	0.0	10.0	0.0
309	17.08	70°52'	07°51'	11.15	275	3.0	0.27	116	38.7	0.0	0.0	0.0	0.1	2.1	0.0
310	17.08	70°55'	07°42'	13.10	335	3.0	0.01	88	29.3	2.8	13.8	0.0	0.0	1.0	0.0
311	17.08	70°59'	07°42'	15.20	425	3.0	-0.27	95	31.7	6.5	0.0	0.0	10.0	0.0	0.0

Appendix V. Shrimp catch (kg/nm) and bycatch (number / 3 nm) in Campelen 1800 trawl off Jan Mayen in October 1979 (Torheim 1980). LRD = long rough dab.

ST. NR.	DATE	POSITION		TIME KL.	DEPTH M	HAUL LENGTH (NM)	BOTTOM TEMP t °C	SHRIMP TOTAL KG	SHRIMP KG/NM	FISH (NUMBER/3NM)					
		LAT. °N	LON. °W							Greenl. halibut	LRD	Blue whiting	Capelin	Polar-cod	Cod
174	6.10	71°03'	09°20'	06.50	280	5.0	0.6	275	55.0	0	98	12	50	562	0
175	6.10	71°06'	09°24'	09.35	180	4.0	0.7	40	10.0	0	40	20	5	160	1
176	6.10	71°02'	09°07'	12.50	410	5.0	-0.2	110	22.0	2	0	9	45	110	0
177	6.10	71°02'	09°15'	17.00	370	3.0	0.2	80	26.7	0	16	0	52	200	0
178	7.10	71°01'	09°11'	07.45	390	5.0	0.0	110	22.0	5	21	0	63	833	0
179	7.10	71°01'	08°39'	12.45	235	5.0	0.7	204	40.8	0	61	90	24	144	0
180	7.10	71°04'	08°45'	16.00	440	5.0	-0.2	132	26.4	0	0	0	54	306	0
181	8.10	71°00'	08°42'	20.30	150	3.0	1.3	96	32.0	4	8	0	16	48	0
182	8.10	70°40'	09°16'	07.45	265	5.2	0.7	185	35.6	0	84	910	0	425	1
184	8.10	70°34'	09°16'	13.40	365	5.0	0.3	152	30.4	0	0	9	0	207	0
185	8.10	70°32'	08°47'	17.20	215	3.0	1.1	180	60.0	0	30	40	0	70	1
186	8.10	70°31'	08°50'	19.30	250	3.0	1.0	200	66.7	0	22	290	0	210	0
187	8.10	70°37'	09°01'	22.00	160	3.0	1.2	105	35.0	0	84	35	0	14	0
188	9.10	70°56'	08°11'	07.06	194	3.0	0.8	4	1.3	0	3	108	42	27	0
189	9.10	70°50'	08°15'	08.55	230	5.2	0.3	40	7.7	0	48	248	0	480	1
190	9.10	70°49'	08°25'	12.33	170	5.0	0.6	59	11.8	0	36	168	0	108	0
191	9.10	70°49'	08°32'	15.06	125	5.0	1.1	96	19.2	0	56	56	656	120	0
192	9.10	70°34'	08°34'	18.20	175	3.0	0.7	52	17.3	0	24	54	0	9	0
193	10.10	70°34'	09°01'	06.10	250	2.6	0.6	66	25.4	0	24	138	0	198	0
194	10.10	70°38'	08°16'	09.35	240	5.0	0.6	216	43.2	0	70	1080	0	60	0
195	10.10	70°26'	08°15'	15.10	350	5.0	0.2	65	13.0	0	0	5	15	130	0
196	10.10	70°21'	08°06'	18.40	510	1.0	0.3	2	2.0	1	0	0	0	0	0

Appendix VI. Shrimp catch (kg/nm) in Selstad 1300 shrimptrawl (38 mm) off
Jan Mayen in August 1976 (Strøm 1976).

ST. NR.	DATE	POSITION		TIME	DEPTH M	HAUL LENGTH (NM)	SHRIMP TOTAL KG	SHRIMP KG/NM
		LAT. °N	LON. °W					
1	9.08	70°51'	8°03'	9.10	245	3.0	50	16.7
2	9.08	70°50'	8°14'	11.40	247	9.0	250	27.8
3	9.08	70°51'	7°51'	19.00	250	6.0	200	33.3
4	10.1	70°58'	8°56'	10.05	340	8.0	250	31.3
5	10.1	70°58'	8°53'	14.40	305	9.0	400	44.4
6	10.1	71°01'	9°16'	20.00	360	6.0	120	20.0
7	11.1	70°37'	9°17'	9.00	235	6.0	200	33.3
8	11.1	70°32'	8°57'	13.40	218	10.5	1100	104.8
9	11.1	70°29'	8°46'	20.00	230	5.5	800	145.5
10	12.1	70°29'	8°31'	7.40	245	6.0	400	66.7
11	12.1	70°40'	8°17'	12.00	225	2.5	50	20.0
12	12.1	70°38'	8°18'	13.35	235	9.0	560	62.2
13	14.1	71°06'	9°16'	13.00	240	3.0	240	80.0
14	15.1	70°44'	8°12'	15.00	235	9.0	240	26.7
15	17.1	71°05'	9°25'	8.30	250	8.5	400	47.1
16	17.1	71°10'	9°25'	12.30	260	9.0	500	55.6