

Fol. 41 K

21/10/84

This paper not to be cited without prior reference to the author.

International Council for
the Exploration of the Sea

C.M. 1984/K:21
Shellfish Committee

*Fiskeridirektoratets
Bibliotek*

NORWEGIAN INVESTIGATIONS ON THE DEEP SEA SHRIMP (PANDALUS BOREALIS) IN THE BARENTS SEA IN APRIL - MAY 1984 AND IN THE SPITSBERGEN AREA IN JULY - AUGUST 1984

by

Arvid Hysten, Bjarte Tveranger and Per Øynes
Institute of Marine Research
Bergen - Norway

ABSTRACT

This report describes the results from a stratified bottom trawl survey with R/V "Michael Sars" in April - May 1984 in the Barents Sea between 71°30'N - 76°00'N and between 16°30'E - 35°30'E. The report also describes the results from a survey with the same vessel in the Svalbard region between 74°00'N - 80°30'N and between 08°00'E - 18°00'E in July - August 1984. On the basis of the data from 116 trawl stations, the biomass of the shrimp, Pandalus borealis in the Barents Sea survey was estimated to be about 420 000 tonnes. In the Spitsbergen area the biomass of the shrimp was estimated to be about 54 000 tonnes, based on data from 77 trawl station, by-catch data for fish are also given.

Introduction

A stratified random bottom trawl survey was carried out in the Barents Sea from 29 April to 21 May 1984 and from 21 July to 17 August in the Bear Island - Spitsbergen area. The aim of the surveys was to investigate the structure of the shrimp stocks,

measure the by-catches of fish and estimate the abundance of shrimps in these areas.

Materials and Methods

The Barents Sea

The 1984 survey covered the area indicated in Fig. 1. A total of 116 stations were taken (Table 1). During the Barents Sea survey the strata 1 to 18 were worked according to the same method as used by Teigsmark and Øynes (1983). The strata south of Bear Island (no 19 and 21) were not covered due to lack of time. For the same reason only 4 stations were taken in strata 20 and 22. These four strata were covered during the Svalbard survey in July-August, and the data from the two surveys were used in estimating the biomass.

Due to cooperation with the USSR R/V "Menselinsk" altogether 4 stations had to be taken during the night, i.e. stations no 164, 165, 172 and 173. Caused by vertical migration of shrimp during night, these hauls give an underestimate of the shrimp abundance.

As in years before each stratum was divided into rectangles of 5x5 nautical miles. Within each stratum, rectangles were given consecutive numbers and the trawl stations were randomly allocated to rectangles. The same number of hauls have been allocated to each stratum as in 1982 and 1983. In the most important strata up to 9% of the rectangles were trawled. The trawling distance was 3.0 nautical miles. However, stations 133 and 197 had to be stopped after 2.6 and 0.9 nautical miles respectively due to rough bottom.

Due to great numbers of 1- and 2-group cod and haddock in the shrimp trawl catches most of the Barents Sea was closed for shrimp trawling in the winter and spring 1984. The main fishing areas were opened for Norwegian commercial fishing in the first part of May. Before the survey time, only Norwegian

in spection vessels and a few foreign shrimp trawlers had been working in the survey area.

The Spitsbergen area

The survey in 1984 covered 77 stations in the area from "Kveithola" (stratum 1) and northwards along the western slope off Spitsbergen up to $80^{\circ}30'N$ (Table 4). The sampling strata are given in Fig. 2. They are the same as in 1983 (Teigsmark and Øynes, 1983). Stratum 23 was included in the survey. The number of hauls were increased for some strata in the 1984 survey compared with the 1983 survey. The sampling intensity, measured as relative number of rectangles sampled in each stratum was 5-33% for the strata in the depth intervall 200-300 m, between 11-50% for the intervall 300-400 m and between 16-50% for the 400-600 m intervall. The trawling distance was 3.0 nautical miles. Trawling on some stations had to be stopped before 3,0 nautical miles, due to rough bottom (Table 4).

All fish species taken as by-catch were counted and Commercial important species as cod, haddock. Greendand halibut, redfish etc. were measured by length (Tables 1 and 4). Fishing gear and techniques were the same as described by Tavares and Øynes (1980).

The statistical treatment of the data follows Teigsmark and Øynes (1981). The horizontal opening of the trawl was calculated to be 11,7 m. The size of the stock available to the commercial fleet using cod ends with a mesh size of 35 mm was calculated from the total length compositions of the shrimp in each stratum, applying a selection ogive given by Teigsmark and Øynes (1981).

Results and discussion

Shrimp stock biomass in the Barents Sea

Total biomass of shrimp in the Barents Sea survey is estimated to $420\ 000 \pm 52\ 000$ tonnes (Table 2). For the strata investigated both in 1983 and 1984 this indicates an increase of the

biomass of about 11%. The biomass of the commercial stock is estimated to be about 371 000 ± 47 000 tonnes, giving an increase of 10% from 1983 (Table 3).

A decline was observed in the biomass from 1983 to 1984 in the western strata (1, 3, 5, 6, 8) while it increased in the eastern strata (2,4,7). Further north, an increase in the biomass was observed in all strata except 10, 14 and 18, where a decrease occurred (Table 7 and 8).

In 1983 the main fishery took place in the eastern part of the survey area, in strata 2, 3, 4, 7, 11 and 12 and south of stratum 7 (outside the survey area). The shift in the geographical distribution of the shrimp stock and the fishery towards east and north might be a result of a change in the climate, from a cooler waters regime in 1977 - 1981 to a warmer regime in 1982 - 1984 (Loeng and Midttun 1984). The effect of the warmer regime might have been a transport of shrimp east- and northwards.

Shrimp stock biomass in the Spitsbergen area

The total biomass of the shrimp stock is estimated to 53 000 ± 14 000 tonnes in 1984 (Table), which gives a decrease in the biomass of about 6% from 1983 for the strata surveyed both years. The decline in the total shrimp biomass from 1983 to 1984 might be the effect of some poor year classes following the rich 1977 year class which is on the way out.

A drastic decline in biomass was observed from 1983 to 1984 in the strata (2,4,7,9,13,15) between 200-300 m. For strata (1,3,5,8,11) between 300-400 m a corresponding increase was observed. The biomass in the strata deeper than 400 m investigated both year declined by 15%. The most drastic change in stock biomass was observed in strata 4 (depth intervall 200 - 300 m) and 3 (depth intervall 300 - 400 m) where the stock biomass declined by 94% and increased by 106% respectively (Table 9).

By-catches

The Barents Sea

In winter 1984 a high number of 1 and 2 group cod and haddock were observed at the areas where the shrimp fishing usually takes place (Dalen et. al 1984). On some localities as many as 2 - 4 thousand specimens were caught per hour trawling. In order to limit the by catches of the 1982 and 1983 year classes of cod and haddock almost all areas worked by the shrimp fleet were closed for shrimp trawling during the winter 1983/84 and spring 1984.

During the survey in May - June high abundance of small cod and haddock were observed in the strata near the Finnmark coast, in the sentral Barents Sea and south of bear Island. Lower abundance indexis were estimated for the more northern strata in the Barents Sea and in the deeper part of the area south of Bear Island. The cod and haddock in these areas were mostly of commercial sized (Table 10).

For the coastal and sentral strata there have been a tremendous increase from 1983 to 1984 in the abundance of small cod and haddock (Teigsmark and Øynes 1983) of the good 1982 and 1983 year classes. The highest abundance is observed at 260 m or less. However, cod and haddock were abundant down to more than 300 m in stratum 5 and 8. As a general observation were that the haddock was more abundant in shallow waters than cod.

The highest abundance of redfish was observed near Thor Iversen Bank (Strata 11 and 12 and south of Bear Island (Stratum 19). The overall abundance was at the same level in 1984 as in 1983.

Only a few Greenland halibut were taken as by-catch in 1984, and the level was close to the 1981 - 1983 level. However, its abundance is less than in 1980.

Long rough dab was observed in relatively high numbers all over the survey area. The abundance index is for some strata higher in 1984 than in 1983.

The Spitsbergen region

The by-catches of cod and haddock off Spitsbergen were higher in 1984 than in previous years, and the by-catches of these species were dominated by the 1982 and 1983 year classes. These year classes of cod and haddock were more abundant in shallow waters than deeper. However, north of Kongsfjord (strata 12 - 15, 21 - 23), very few cod and haddock were caught (Table 11).

High abundance of redfish (Sebastes mentella) was observed in several strata. However, strata 4 and 13 have the highest abundance.

The highest number of Greenland halibut, 1773 specimens per hour trawling, was observed in stratum 4.

Capelin and polar cod was less abundant in 1984 than in the years before.

The abundance of long rough dab is about the same level as in the years 1982 - 1983. Long rough dab is observed in small numbers on depth more than 400 m (strata 16 to 22).

References

Dalen, J., Høyen, A., Jakobsen, T., Nakken, O. and Randa, K., 1984. Preliminary report of the Norwegian investigations on young cod and haddock in the Barents Sea during the winter 1984. Coun. Meet. int. Coun. Explor. Sea 1984 (G:44): 1-9, 11 tabs, 20 figs.

Loeng, H. and Midttun, L. 1984. Climatic variations in the Barents Sea during the 1970's. Coun. Meet. Int. Coun. Explor. Sea, 1984. (C 2): 1-10. (Mimeo.)

Tavares, A.M. and Øynes, P., 1980. Results of a stratified trawl survey for shrimps (Pandalus borealis) in the Barents Sea and the Spitsbergen area in May-June 1980. Coun. Meet. int. Coun. Explor. Sea, 1980 (K:22): 1-6, 3 tabs, 1 fig. (Mimeo).

Teigsmark, G. and Øynes, P., 1981. Results of a stratified trawl survey for shrimp (Pandalus borealis) in the Barents Sea in May - June 1981. Coun. Meet. int. Coun. Explor. Sea, 1981 (K:21): 1-9, 5 tabs, 4 figs. (Mimeo).

Teigsmark, G. and Øynes, P., 1982. Norwegian investigations on the deep sea shrimp (Pandalus borealis) in the Barents Sea in 1982. Coun. Meet. int. Coun. Explor. Sea, 1982 (K:12): 1-8, 6 tabs, 6 figs. (Mimeo.)

Teigsmark, G. and Øynes, P., 1983. Results of a stratified bottom trawl survey for shrimps (Pandalus borealis) in the Spitsbergen area in July 1982. Coun. Meet. int. Coun. Explor. Sea, 1983 (K:17): 1-5, 7 tabs, 2 figs. (Mimeo.)

Table 1

Trawl station data from cruise with R/V "Michael Sars" in the Barents sea in april-may 1984

1

St. no.	Date	Str	Squ	ti	dist.	Position		depth	Shrimp catch (Kg)	Cod	By - catches (number)				Long Rough Dab	Others		
						N	E				Haddock	Redfish	G. hal.	Capelin			Polarcod	
240	19-	5	01	039	1540	3.0	7120	03001	315	45	393	193	1712	1	40		68	416
239	19-	5	01	036	1320	3.0	7130	02940	322	94	94	36	2165		450		36	148
115	29-	4	01	003	945	3.0	7124	02710	280	112	49	18	200				24	93
243	20-	5	02	025	625	3.0	7127	03138	269	50	347	158	1181	2	11		97	99
244	20-	5	02	028	900	3.0	7114	03136	234	25	309	111	303				135	256
246	20-	5	02	063	1440	3.0	7116	03312	260	40	1051	174	386				43	37
245	20-	5	02	045	1145	3.0	7113	03223	240	51	403	110	87	1	30		188	315
117	29-	4	03	018	1545	3.1	7134	02634	335	130	129	40	429		16		77	384
143	2-	5	03	072	2030	3.0	7158	02850	293	139	255	36	640				196	236
116	29-	4	03	041	1245	3.0	7136	02734	378	110	59	5	256		3		32	77
142	2-	5	03	051	1620	3.0	7149	02656	310	183	66	27	236	2			118	207
238	19-	5	03	067	1025	3.0	7131	02844	348	217	95	10	566	2			39	93
118	29-	4	03	004	1810	3.0	7140	02601	300	50	30	5	300					3
119	29-	4	03	010	2015	3.0	7147	02606	324	116	55	16	108		5		114	107
151	3-	5	04	009	1345	3.0	7144	02928	325	155	102	42	1190	10			182	108
155	4-	5	04	046	510	3.0	7148	03109	330	230	240	3	301	7	5		376	175
156	4-	5	04	058	745	3.0	7148	03154	323	270	653	1	107	10			307	141
157	4-	5	04	060	1030	3.0	7157	03140	319	220	602	88	803	11			627	170
150	3-	5	04	003	1155	3.0	7148	02915	300	121	94	14	1122				289	164
152	3-	5	04	042	1710	3.0	7135	03050	308	105	134	22	256	3			94	36
139	2-	5	05	072	710	3.0	7228	02842	300	6	391	297	1153	1			247	1
122	30-	4	05	021	520	3.0	7214	02635	237	3	321	736	400				200	300
141	2-	5	05	044	1325	3.0	7209	02754	230	3	1287	1616						0
170	6-	5	06	095	1600	3.0	7251	03215	258	155	96	8	1376		24	8	964	345
149	3-	5	06	012	815	3.0	7204	03015	330	15	301	30	465	6	2		492	142
158	4-	5	06	087	1305	3.0	7210	03200	260	63	212	35	2739		13	4	1006	83
164	5-	5	06	046	2325	3.0	7248	03054	280	43	80	320	1465	5			1145	143
165	6-	5	06	050	205	3.0	7252	03113	270	136	54	186	1470		12		1294	240
166	6-	5	06	069	420	3.0	7244	03135	270	143	24	6	1410		75	6	861	241
167	6-	5	06	053	610	3.0	7239	03124	286	139	34	2	1271	3	2	7	807	204
160	4-	5	06	079	1850	3.0	7226	03155	273	80	70	5	2672	7	30		420	187
162	5-	5	06	021	1725	3.0	7243	03018	292	96	46	25	625		1035		600	200
148	3-	5	06	016	515	3.0	7217	03020	299	124	448	9	158	3			249	73
193	9-	5	07	063	1415	3.0	7219	03516	238	245	103	4	2162		495	25	550	976
169	6-	5	07	001	1325	3.0	7240	03251	290	172	48		1098		24	24	1132	229
248	21-	5	23	022	510	3.0	7036	03218	304	120	270	9	57				24	32
249	21-	5	23	015	840	3.0	7024	03146	305	305	130	32	275	2	4		17	203
250	21-	5	23	6	1140	3.0	7035	03122	425	30								0
251	21-	5	23	007	1555	3.0	7050	03030	357	218	157	180	1604	2	22		32	131

Table 1 Cont.

Trawl station data from cruise with R/V "Michael Sars" in the Barents sea in april-may 1984

2

St. no.	Date	Stratum	Squid	ti	dist.	Position		depth	Shrimp catch (kg)	Cod	By - catches (number)							
						N	E				Haddock	Redfish	G. hal.	Capelin	Polarcod	Long Rough Dab	Others	
192	9-	5	07	059	1145	3.0	7231	03445	280	330	11	11	329		250	4	135	108
168	6-	5	07	014	1100	3.0	7233	03308	298	309	38	28	1525	1	50	28	847	566
191	9-	5	07	048	700	3.0	7228	03423	280	861	60	40	129	6	267		1362	588
159	4-	5	07	007	1550	3.0	7213	03242	275	113	75	91	891	11	349		651	212
190	9-	5	07	034	420	3.0	7239	03346	289	291	38	11	1265	1	53		733	442
163	5-	5	08	094	2020	3.0	7248	03016	289	53	51	9	354		21		315	127
133	1-	5	08	084	1505	2.6	7259	02923	275	6	138	435	417				408	32
126	30-	4	08	011	1800	3.0	7255	02604	365	191	46	23	586	11	28		84	125
140	2-	5	08	078	910	3.0	7231	02859	310	36	90	317	1064				228	21
123	30-	4	08	017	900	3.0	7236	02615	286	10	386	240						0
124	30-	4	08	033	1130	2.9	7242	02703	310	101	107	412	2580		16		75	49
134	1-	5	09	042	1700	3.0	7303	02904	330	149	218	477	602	1			349	137
131	1-	5	09	039	845	3.0	7317	02855	350	253	102	275	1370	11	12		414	85
130	1-	5	09	003	510	3.0	7316	02716	360	388	44	9	539	17	26		304	264
178	7-	5	10	028	1400	3.0	7344	03052	390	296	13		510	23	21	6	434	461
174	7-	5	10	042	425	3.0	7327	03100	360	170	19	1	576	27	7		429	125
132	1-	5	10	012	1145	3.1	7305	03000	260	4	942	576	1630				919	70
179	7-	5	10	002	1630	3.0	7351	03011	345	361	11	1	1838	66	350	63	683	369
172	6-	5	11	011	2200	3.0	7311	03215	278	151	29	11	17500	1	20	20	800	140
175	7-	5	11	007	630	3.0	7330	03209	293	206	27	5	4920	12		79	1060	95
185	8-	5	11	040	910	3.0	7334	03427	260	759	189	26	4149	1	21		956	459
183	8-	5	12	038	420	3.0	7351	03322	319	273			754	1	96	436	861	312
184	8-	5	12	52	700	3.0	7344	03419	306	400								0
173	7-	5	12	008	35	3.0	7320	03139	295	64	155	200	4646	16	115	5	548	202
176	7-	5	12	014	840	3.0	7336	03200	303	444	168	106	10256	8	5	33	214	188
177	7-	5	12	016	1110	3.0	7348	03203	347	402	15		426	28		36	183	955
201	12-	5	13	073	525	3.0	7358	02817	389	158	11		1964	30	4	4	244	161
196	11-	5	13	030	1205	3.0	7345	02630	440	139	9	1	592	36	4		172	106
195	11-	5	13	056	905	3.0	7336	02732	400	188	41	7		23	25		187	2591

Table 1 Cont.

Trawl station data from cruise with R/V "Michael Sars" in the Barents sea in april-may 1984

3

St. no.	Date	Stratum	Squid	ti	dist.	Position		depth	Shrimp catch (Kg)	Cod	By - catches (number)				Long Rough Dab	Others		
						N	E				Haddock	Redfish	G. hal.	Capelin			Polarcod	
197	11-	5	13	019	1430	.9	7348	02609	440	56	6		189	10	11		24	17
200	12-	5	13	061	315	3.0	7400	02748	405	160	12	1	1148	59	1	1	222	119
202	12-	5	13	097	830	3.0	7358	02927	359	390	53		1534	50	1	1	525	242
230	16-	5	14	049	2025	3.0	7431	02700	391	357			2983	18	13	7	200	519
227	16-	5	14	094	915	3.0	7443	02822	380	197	9		1102	35	48	6	90	245
198	11-	5	14	023	1640	3.0	7401	02610	450	225	11		958	49	8	10	204	78
229	16-	5	14	058	1805	3.0	7420	02722	404	263	5	1	608	60	38	1	212	177
226	16-	5	14	073	705	3.0	7449	02748	357	350	8		1332	44	16	16	144	401
199	11-	5	14	036	1955	3.0	7403	02724	410	149	7	2	1938	55	6	1	100	36
204	12-	5	15	046	1305	3.0	7420	02952	350	452	28		5229	38	180	12	275	262
205	12-	5	15	067	1510	3.0	7420	03022	330	532	64	6	4030	28	8	18	782	155
180	7-	5	15	051	1845	3.0	7402	03003	344	363	21		2079	15	36	18	444	333
209	13-	5	15	039	1610	3.0	7441	02947	377	395			3152	19	47	25	75	233
208	13-	5	15	080	350	3.0	7445	03101	350	300	5		1035	12	22	22	344	197
203	12-	5	15	033	1105	3.0	7412	02940	368	381	32	1	1836	89	10	2	319	291
228	16-	5	15	005	1210	3.0	7430	02838	400	259	11	1	935	56			78	224
221	15-	5	16	025	1640	3.0	7514	02816	320	585		1	6032	24	48	80	288	619
220	15-	5	16	039	1350	3.0	7523	02838	329	539	6	1	2261	8		147	294	372
225	16-	5	16	028	425	3.0	7459	02800	340	202		1	1116	16	136	60	292	268
210	14-	5	17	005	415	3.0	7505	02944	375	240	1		1744	43	27	139	153	248
213	14-	5	17	087	1240	3.0	7521	03155	330	137	4		982		50	115	819	258
211	14-	5	17	027	710	3.0	7510	03035	375	350	1		3690	40	35	620	180	124
212	14-	5	17	051	1000	3.0	7506	03132	341	309			826	4	13	66	637	157
214	14-	5	18	090	1525	3.0	7536	03216	320	90	8		140		52	152	486	245
215	14-	5	18	083	1750	3.0	7545	03205	322	62			124		200	296	236	322
217	15-	5	18	039	345	3.0	7551	02950	310	1			2925	9	186		171	198
219	15-	5	18	008	1050	3.0	7540	02744	250	71	26	1	4661				1088	354
253	21-	5	19	007	2300	3.0	7057	02852	200		387	214	2516					213
233	17-	5	20	059	630	3.0	7359	02454	455	154	4		242	41	4	4	153	75
232	17-	5	20	044	400	3.0	7404	02418	400	288	5	1	273	23	5		311	277
235	17-	5	22	120	1420	3.0	7314	02508	410	211	6	1	830	22				117

Table 1 Cont-

Trawl station data from cruise with R/V "Michael Sars" in the Bjørnøya area in July-August 1984

St. no.	Date	Stratum	Squid	Time	Dist.	Position		Depth	Shrimp catch (Kg)	Cod	By - catches (number)				Long Dab	Others	
						N	E				Haddock	Redfish	G. hal.	Capelin			
0272	22-07	19	008	0750	3.0	7336	1719	400	27	42	1	7840	50	40	93	125	
0289	24-07	19	045	1110	3.0	7350	01943	253	10	233	112	1718			1211	67	
0290	24-07	19	041	1355	03.0	7339	01918	365	182	164	32	11144	15	52	172	308	
0303	26-07	20	030	1215	03.0	7403	02347	450	146	3		328	66	46	8	138	232
0301	26-07	20	059	0405	03.0	7355	02504	454	50			32	33	6	64	3	
0302	26-07	20	044	0955	03.0	7401	02419	454	84	1		141	101	11	4	104	158
0304	26-07	20	015	1500	3.0	7355	02256	455	175	2		144	66	42		232	142
0271	22-07	21	005	0320	03.0	7324	01613	485	5			495	6		72	11	
0291	24-07	21	091	1625	03.0	7329	01941	483	145	16	1	7140	27	84	135	71	
0292	24-07	21	094	1915	03.0	7314	01951	455	195	19	2	4140	7	20	205	26	
0295	25-07	22	004	0635	3.0	7328	02120	475	110	8		485	24	36	130	59	
0294	25-07	22	002	0405	03.0	7339	02123	500	100	3		112	39	58	6	360	36
0297	25-07	22	095	1435	3.0	7321	02410	400	160	4	10	3409	25	138		238	125
0299	25-07	22	120	1950	3.0	7313	02514	410	77			189	3	153		93	62
0296	25-07	22	062	1105	3.0	7309	02310	405	108	8	9	1188	18	15	6	153	106
0298	25-07	22	122	1725	03.0	7322	02508	426	88	5	2	180	24	180		180	51

Table 2. Estimated density (\bar{C}_k) and biomass in each stratum in the Barents Sea and estimated biomass in all strata summarized with the precision of the estimates.

Stratum	Area nm ²	Number of hauls	\bar{C}_k tons/nm ²	S_k^2	$V(\bar{C}_k)$	Coeff. of var. (S.E./ \bar{C}_k)	Biomass tons	S.E. of biomass
1	1200.	3.	4.432	3.377	1.126	0.239	5319.	1273.166
2	1650.	4.	2.203	0.424	0.106	0.148	3635.	537.114
3	1950.	7.	7.122	8.086	1.155	0.151	13887.	2095.857
4	1800.	6.	9.708	11.982	1.997	0.146	17475.	2543.706
5	2400.	3.	0.809	1.270	0.423	0.804.	1942.	1561.801
6	2700.	10.	6.965	10.021	1.002	0.144	18805.	2702.851
7	1850.	7.	17.533	168.758	24.108	0.280	32435.	9083.530
8	2400.	6.	3.540	14.051	2.342	0.432	8495.	3672.745
9	1500.	4.	13.498	27.128	6.782	0.193	20247.	3906.320
10	1500.	4.	10.973	69.083	17.271	0.379	16460.	6233.693
11	1325.	3.	17.517	404.046	134.682	0.662	23211.	15376.968
12	1375.	5.	17.391	46.825	9.365	0.176	23912.	4207.804
13	2700.	6.	10.781	24.051	4.009	0.186	29110.	5405.743
14	2550.	6.	13.551	19.473	3.245	0.133	34556.	4593.871
15	2025.	7.	20.133	23.141	3.306	0.090	40769.	3681.884
16	1575.	3.	23.339	122.012	40.671	0.273	36759.	10044.339
17	1525.	4.	13.758	23.737	5.934	0.177	20981.	3714.948
18	2500.	4.	2.994	4.060	1.015	0.336	7486.	2518.604
19	1325.	3.	3.852	25.009	8.336	0.750	5104.	3825.602
20	1525.	4.	10.091	12.007	3.002	0.172	15389.	2642.161
21	3300.	7.	5.080	13.328	1.904	0.272	16765.	4553.458
22	3125.	6.	7.044	5.396	0.899	0.135	22012.	2963.594
23	550.	4.	8.877	39.548	9.887	0.354	4883.	1729.403
All strata:							419636.	25803.693

Table 3. Estimated commercial density (\bar{C}_k) and biomass in each stratum in the Barents Sea and estimated commercial biomass in all strata summarized with the precision of the estimates.

Stratum	Area nm ²	Number of hauls	\bar{C}_k tons/nm ²	S_k^2	$V(\bar{C}_k)$	Coeff. of var. (S.E./ \bar{C}_k)	Biomass tons	S.E. of biomass
1	1200.	3.	4.018	2.856	0.952	0.243	4821.	1170.948
2	1650	4.	1.552	0.210	0.053	0.148	2561.	378.498
3	1950.	7.	6.224	6.830	0.976	0.159	12137.	1925.232
4	1800.	6.	8.452	9.026	1.504	0.145	15214.	2207.760
5	2400.	3.	0.698	0.912	0.304	0.791	1674.	1323.596
6	2700.	10.	6.110	8.607	0.861	0.152	16498.	2504.872
7	1850.	7.	15.324	134.721	19.246	0.286	28349.	8115.961
8	2400.	6.	3.068	11.279	1.880	0.447	7364.	3290.539
9	1500.	4.	12.047	22.614	5.653	0.197	18070.	3566.544
10	1500.	4.	9.927	59.620	14.905	0.389	14891.	5791.042
11	1325.	3.	16.308	362.251	120.750	0.674	21608.	14559.947
12	1375.	5.	15.486	38.004	7.601	0.178	21294.	3790.823
13	2700.	6.	9.341	17.410	2.902	0.182	25222.	4599.252
14	2550.	6.	12.187	16.491	2.749	0.136	31077.	4227.587
15	2025.	7.	18.483	19.810	2.830	0.091	37429.	3406.597
16	1575.	3.	20.895	89.465	29.822	0.261	32909.	8600.972
17	1525.	4.	11.225	27.975	6.994	0.236	17118.	4032.950
18	2500.	4.	1.848	1.550	0.388	0.337	4621.	1556.331
19	1325.	3.	3.564	21.298	7.099	0.748	4722.	3530.402
20	1525.	4.	9.020	10.415	2.604	0.179	13756.	2460.788
21	3300.	7.	4.666	11.133	1.590	0.270	15396.	4161.704
22	3125.	6.	6.264	4.218	0.703	0.134	19575.	2620.296
23	550.	4.	8.181	33.764	8.441	0.355	4499.	1597.934
All strata:							370806.	23579.503

Table 4

Trawl station data from cruise with R/V "Michael Sars" in the Svalbard area in July-August 1984

1

St. no.	Date	Stratum	Squid	ti	dist.	Position		depth	Shrimp catch (kg)	Cod	By - catches (number)						
						N	E				Haddock	Redfish	G. hal.	Capelin	Long Dab	Polarcod	Rough
281	23-07	01	009	1250	3.0	7449	1754	322	662	80		607	93	373		607	898
279	23-07	01	004	0635	3.0	7448	1605	344	52	2	3	244		12		64	464
282	23-07	02	009	1500	3.0	7445	1732	265		257	259	6578				1960	299
0274	22-07	02	018	1530	03.0	7414	01654	238	1	220	184	546				726	60
278	23-07	02	011	0415	3.0	7440	1622	250		7	2344	173		45		933	338
0404	16-08	03	013	1949	03.0	7553	01452	374	85	4	1	294	18	18	198	360	183
0401	16-08	03	028	1232	03.0	7540	01628	345	155	14	1	2344	348	159	24	603	1086
0398	15-08	03	020	1933	03.0	7554	01636	350	310	127		2033	1491	100		1750	1307
0406	17-08	03	030	0900	03.0	7534	01431	390	230	14		1086	13	1		161	157
0402	16-08	03	024	1512	03.0	7541	01530	384	143	1		585	238	123	97	449	156
0403	16-08	03	016	1727	03.0	7552	01535	380	88	14		301	42	172	77	269	435
0408	17-08	04	16	1440	03.0	7514	01523	270	11	3	4	203				43	117
0409	17-08	04	012	1735	03.0	7518	01522	291	10	27	55	985				218	259
0400	16-08	04	002	0850	03.0	7557	01746	275	70	157	105	63200	5320		210	1050	4620
0397	15-08	05	026	1703	03.0	7603	01630	350	213	101	3	2720	333		15		120
0394	15-08	05	007	0928	03.0	7619	01456	325	69	24		699	16	78	184	285	115
0395	15-08	05	015	1127	03.0	7611	01580	354	34	21		562	17	65	15	345	262
0332	30-07	06	002	1345	03.0	7644	01319	275	15	57	546	1735			6	114	106
0396	15-08	06	011	1445	3.0	7613	01615	270	25		1	27	16	27	2070	508	335
0325	29-07	07	007	1400	03.0	7629	01806	255	2					4	493	76	264
0320	28-07	07	049	2100	3.0	7614	01946	228	5				3		200	5	0
0319	28-07	07	017	1720	3.0	7629	02132	254							350		0
0331	30-07	08	008	0930	03.0	7700	01220	340	656	19		3078	53	4	43	75	328
0339	01-08	08	006	0655	03.0	7721	01125	367	450			2815	400	1	1	285	238
0391	14-08	09	009	1420	03.0	7729	01133	260	8	26	67	5008	3	1	168	312	309
0340	01-08	09	008	0920	03.0	7731	01142	250	10	150	150	2275		60	130	235	781
0342	01-08	09	005	1420	03.0	7740	01046	293	120	1	1	7200		1	240	840	601
0338	01-08	09	011	0415	03.0	7707	01152	292	20	2	9	303	1	5	46	100	153
0358	06-08	10	011	1105	03.0	7815	01052	360	159	11	2		200	1	258	162	2979
0357	06-08	10	007	0905	03.0	7815	01018	300	101	60	67	1495	722	67	269	2402	1997

Table 4 Cont.

Trawl station data from cruise with R/V "Michael Sars" in the Svalbard area in july-august 1984

2

St. no.	Date	Stratum	Squid	ti	dist.	Position		depth	Shrimp catch (Kg)	Cod	By - catches (number)				Long		
						N	E				Haddock	Redfish	G. hal.	Capelin	Polarcod	Rough Dab	Others
0349	04-08	10	013	1835	03.0	7902	01055	330	49			9	405		1530	18	113
0361	06-08	11	042	1815	3.0	7803	01205	248	318	315	971	165	975	30	165	6600	2873
0359	06-08	11	038	1345	3.0	7802	01105	214	65	53	19	3384		9576	18	852	1658
0345	03-08	11	021	1313	03.0	7813	01229	277	538		1	182	50	165	2640	8069	6868
0336	31-07	11	034	1800	03.0	7807	01256	270	165	159	204	1320	1	330	726	2607	4291
0389	14-08	11	024	0615	03.0	7812	01016	265	70	16	10	549	76	9	225	1890	1548
0360	06-08	11	031	1605	03.0	7806	01144	260	266	67	206	363	113		363	820	3086
0365	07-08	11	013	1930	03.0	7852	00917	198	5	25	7	4350			1	156	79
0354	05-08	12	010	1655	3.0	7904	00834	370	24			331	21				58
0384	11-08	12	001	1700	3.0	8000	01042	380	37			1075	29	48	54	174	405
0387	12-08	12	002	1200	03.0	7945	00953	360	58			289	50	30	12	129	378
0367	08-08	12	007	1033	03.0	7926	00809	345	1			347		3	8	2	3
0368	08-08	12	006	1330	03.0	7934	00907	340	238	2		3429	35	45	37	285	1237
0353	05-08	13	008	1335	03.0	7907	00840	235		41		9903	1		1	93	157
0352	05-08	13	007	1051	03.0	7914	00824	280	56	8		4700	53	1	118	231	742
0351	05-08	13	006	0623	03.0	7927	00820	266		39		8340		24	24		36
0383	11-08	14	004	1500	03.0	8005	01056	340	202			3604	114	42	90	809	375
0378	10-08	14	002	0934	03.0	8016	01055	340	50			90	25	25	35	100	145
0377	10-08	15	003	0619	03.0	8011	01057	275	170	2		5590		480	110	610	450
0380	10-08	15	002	1357	03.0	8019	01119	250	37			165		2273	45	65	56
0273	22-07	16	008	1220	3.0	7401	1608	475	190	7	8	3771	9	8			44
0275	22-07	16	004	1855	03.0	7430	01615	419	205	17		1569	1	8		44	77
0405	17-08	17	004	0618	03.0	7544	01404	585	20			73	48	5	1	2	35
0407	17-08	17	008	1155	03.0	7519	01435	500	180	2		758	223	8			51
0330	30-07	18	001	0720	03.0	7655	01232	598	80		1	20	418	14	139		129
0393	15-08	18	006	0624	02.4	7628	01428	425	4			3	2	1	2		1

Table 4 Cont.

Trawl station data from cruise with R/V "Michael Sars" in the Svalbard area in july-august 1984

3

St. no.	Date	Stratum	Squid	ti	dist.	Position		depth	Shrimp catch (Kg)	Cod	By - catches (number)					
						N	E				Haddock	Redfish	G. hal.	Capelin	Polarcod	Long Rough Dab
0341	01-08	19	004	1135	03.0	7732	01103	465	700		2401	768	7		9	168
0343	01-08	19	002	1640	03.0	7747	01007	475	30		1025	25		38		1
0392	14-08	19	008	1742	03.0	7708	01143	550	155		71	209	29	30		102
0390	14-08	19	003	1057	03.0	7743	01026	470	280		1380	62	20	6	18	250
0363	07-08	20	005	1450	03.0	7838	00916	440	246		1386	376	1	366	5	402
0362	07-08	20	007	1225	03.0	7834	00910	550	34		37	84	5	226		54
0355	05-08	20	001	2125	3.0	7854	00830	500	57		842	151		367		397
0372	09-08	21	020	0908	1.5	7949	00827	530	60		30	69	5	5		318
0371	09-08	21	023	0622	3.0	7949	00917	450	55		438	77	6	24	42	223
0373	09-08	21	006	1056	03.0	7956	00805	520	91		275	105	2	7	2	218
0370	08-08	21	027	1938	03.0	7943	00816	584	2		10	49	4	2		106
0385	12-08	21	015	0625	3.0	7958	01026	436	108		194	91	5	104	104	740
0386	12-08	21	026	0920	03.0	7951	00954	446	25		160	100	10	35	60	246
0369	08-08	21	037	1647	03.0	7935	00830	487	2	1	61	23	2	7		98
0375	09-08	22	005	1617	03.0	8011	00917	550	38		1	159	6	276	1	102
0374	09-08	22	007	1327	03.0	8009	00808	555	89		70	156	7	206	2	168
0376	09-08	22	004	1916	03.0	8011	01041	430	307		481	320	139	108	95	364
0379	10-08	22	002	1144	03.0	8017	01043	475	137		31	526		307		130
0381	10-08	23	003	2029	03.0	8018	01615	355	6		24	130	96	2928	234	632
0382	11-08	23	001	0650	01.5	8002	01706	317	183		142	43	10	1995		90

Table 5. Estimated density (\bar{C}_k) and biomass in each stratum at Vest-Spitsbergen and estimated biomass in all strata summarized with the precision of the estimates.

Stratum	Area nm ²	Number of hauls	\bar{C}_k tons/nm ²	S_k^2	$V(\bar{C}_k)$	Coeff. of var. (S.E./ \bar{C}_k)	Biomass tons	S.E. of biomass
1	284.	2.	18.837	517.961	258.981	0.854	5346.	4567.159
2	842.	3.	0.053	0.000	0.000	0.000	44.	0.001
3	1189.	6.	8.908	21.188	3.531	0.211	10591.	2234.149
4	486.	3.	1.600	3.286	1.095	0.654	778.	508.432
5	611.	3.	5.575	24.859	8.286	0.516	3405.	1758.255
6	353.	2.	1.055	0.139	0.070	0.250	373.	93.180
7	1530.	3.	0.141	0.012	0.004	0.451	215.	96.992
8	109.	2.	29.178	59.071	29.535	0.186	3175.	591.289
9	539.	4.	2.084	8.095	2.024	0.683	1124.	767.481
10	201.	3.	5.470	8.275	2.758	0.304	1098.	333.326
11	815.	8.	9.478	95.323	11.915	0.364	7726.	2813.961
12	155.	5.	3.778	25.279	5.056	0.595	585.	348.073
13	89.	3.	1.038	2.910	0.970	0.949	93.	88.052
14	56.	2.	6.648	32.161	16.080	0.603	376.	226.567
15	95.	2.	6.461	24.623	12.312	0.643	520.	334.386
16	200.	2.	11.212	2.819	1.409	0.106	2242.	237.436
17	357.	2.	5.276	35.635	17.818	0.800	1884.	1506.926
18	246.	2.	2.242	7.830	3.915	0.882	552.	486.744
19	249.	4.	15.367	235.729	58.932	0.500	3826.	1911.505
20	269.	3.	5.945	37.521	12.507	0.595	1599.	951.322
21	570.	7.	3.038	6.868	0.981	0.326	1731.	564.599
22	734.	4.	7.532	37.930	9.482	0.409	5528.	2260.249
23	125.	2.	9.814	180.403	90.201	0.968	1227.	1187.179
						All strata	54039.	7241.441

Table 6. Estimated commercial density (\bar{C}_k) and biomass in each stratum and estimated commercial biomass in all strata summarized with the precision of the estimates.

Stratum	Area nm ²	Number of hauls	\bar{C}_k tons/nm ²	S_k^2	$V(\bar{C}_k)$	Coeff. of var. (S.E./ \bar{C}_k)	Biomass tons	S.E. of biomass
1	284.	2.	15.733	355.495	177.748	0.847	4465.	3783.678
2	842.	3.	0.047	0.000	0.000	0.000	39.	0.000
3	1189.	6.	7.937	15.776	2.629	0.204	9437.	1927.808
4	486.	3.	1.388	2.355	0.785	0.638	674.	430.395
5	611.	3.	5.136	19.230	6.410	0.493	3137.	1546.429
6	353.	2.	1.004	0.099	0.050	0.222	355.	78.628
7	1530.	3.	0.119	0.010	0.003	0.482	182.	87.607
8	109.	2.	26.979	53.560	26.780	0.192	2935.	563.035
9	539.	4.	2.028	7.787	1.947	0.688	1094.	752.766
10	201.	3.	4.725	6.689	2.230	0.316	948.	299.676
11	815.	8.	8.303	68.975	8.622	0.354	6769.	2393.681
12	155.	5.	3.533	22.244	4.449	0.597	547.	326.509
13	89.	3.	0.840	1.907	0.636	0.949	75.	71.272
14	56.	2.	6.383	28.846	14.423	0.595	361.	214.574
15	95.	2.	5.206	21.916	10.958	0.636	496.	315.472
16	200.	2.	10.220	2.016	1.008	0.098	2044.	200.777
17	357.	2.	4.817	29.429	14.714	0.796	1720.	1369.431
18	246.	2.	2.058	6.503	3.252	0.876	506.	443.592
19	249.	4.	13.716	183.072	45.768	0.493	3415.	1684.537
20	269.	3.	5.319	27.226	9.075	0.566	1431.	810.369
21	570.	7.	2.900	6.351	0.907	0.328	1653.	542.931
22	734.	4.	7.081	31.027	7.757	0.393	5098.	2044.275
23	125.	2.	9.238	161.183	80.591	0.972	1155.	1122.158
All strata:							48635.	6238.871

Table 7. Estimated biomass of shrimps in each stratum in the Barents Sea in the years 1981 to 1984 in tons.

Stratum \ Year	1981	1982	1983	1984
1	6584	8337	6036	5319
2	5262	5180	4788	3635
3	9377	7437	14698	13949
4	11395	13914	14769	17475
5	2634	5150	8062	1942
6	13352	26042	38920	18805
7	9255	7572	18009	32435
8	8889	19206	10570	8421
9	9660	15691	12980	20247
10	11372	14939	21385	16460
11	10178	11768	16187	23211
12	13580	16788	22868	23912
13	15556	13273	20942	29110
14	7171	21146	39355	34556
15	16421	22377	31428	40769
16	-	7202	16039	36759
17	-	9294	16898	20981
18	-	5903	8046	7486
19	2908	1561	-	5104
20	11453	12975	15972	15389
21	6499	14502	8034	16765
22	14146	24391	22205	22012
23				4883
	185700	284646	368191	419636

Table 8. Estimated commercial biomass of shrimps in each stratum in the Barents Sea in the years 1980 to 1984 in tons.

Stratum \ Year	1980	1981	1982	1983	1984
1		5701	7202	5587	4821
2		4055	4161	4123	2561
3	3728	7652	6112	12950	12137
4	11297	9322	11505	12669	15214
5		2157	4167	6489	1674
6	12751	11342	21968	33743	16498
7	2464	7333	6031	15818	28349
8		7656	15490	8833	7364
9		8022	13056	11774	18070
10		9355	12579	19399	14891
11		7940	9287	13972	21608
12		10962	13721	20744	21294
13		13097	11166	19203	25222
14		6001	18788	36039	31077
15		14139	19922	30266	37429
16			5767	14498	32909
17			7061	14546	17118
18			4409	7098	4621
19		2482	1367		4722
20		9808	10911	14051	13756
21		5774	12494	7226	15396
22		12183	20208	19512	19575
23					4499
		154981	237351	328541	370806

Table 9. Estimated biomass of shrimps in each stratum at Vest-Spitsbergen in the years 1982 to 1984 in tons.

Stratum \ Year	1982	1983	1984
1	75	3222	5346
2	1422	889	44
3	8193	5131	10591
4	4088	13296	770
5	4351	204	3405
6	466	298	378
7		646	215
8	1111	2444	3175
9	3359	4797	1124
10	4162	1294	1098
11	6354	3789	7726
12	2164	2462	585
13	833	1955	93
14	2270	508	376
15	1506	1722	520
16		565	2242
17		330	1884
18		163	552
19		6040	3826
20		1355	1599
21		5489	1731
22		871	5528
23			1227
		57370	54039

Table 10. Catch of shrimps and by-catch composition in the different strata in the Barents Sea in April and May 1984.

Stratum number	Number of hauls	Shrimps pr 3 n.m. (kg)	Cod	<u>By-catch of fish in numbers pr 3 n.m. trawled</u>						
				Haddock	Redfish	Gr.hal	Capelin	Polarcod	Long rough dab	Others
1	3	84	179	82	1359	0	163	0	43	219
2	4	42	553	172	466	1	3	0	116	176
3	7	136	98	20	362	1	3	0	82	158
4	6	184	304	28	630	7	0	0	308	139
5	3	15	652	883	551	0	0	0	219	120
6	10	114	137	63	1360	2	119	2	784	191
7	7	332	53	26	1057	3	198	66	773	331
8	6	67	136	239	929	2	13	0	222	71
9	4	258	116	188	1408	7	11	0	421	153
10	4	208	246	145	1139	29	95	17	616	257
11	3	327	82	14	8856	5	14	33	939	237
12	5	317	85	77	4022	13	54	128	452	423
13	6	182	22	2	1316	35	7	1	229	146
14	6	257	7	1	1487	44	22	7	158	425
15	7	384	23	1	2614	37	43	14	331	246
16	3	442	2	1	3136	16	61	96	291	420
17	4	261	1	0	1811	22	31	235	569	75
18	4	57	9	0	1963	2	110	112	495	280
19	3	73	728	48	6900	22	31	0	492	166
20	4	191	2	0	161	67	26	3	135	133
21	7	96	8	0	2210	11	36	0	153	31
22	6	134	4	4	729	22	97	2	192	58
23	4	168	186	74	645	1	9	0	24	122

Tabel 11. Catch of shrimps and by-catch composition in the different strata in the Spitsbergen area in July and August 1984.

Stratum number	Number of hauls	Shrimps pr 3 n.m. (kg)	Cod	<u>By-catch of fish in numbers pr 3 n.m. trawled</u>						Long rough dab	Others
				Haddock	Redfish	Gr.hal	Capelin	Polarcod			
1	2	357	41	1	426	47	193	0	336	682	
2	3	1	161	129	2432	0	15	0	1206	233	
3	6	169	29	0	1107	358	89	66	599	567	
4	3	30	1812	55	21463	1773	0	70	437	1666	
5	3	106	50	1	1327	122	48	71	243	409	
6	2	20	29	274	881	8	14	1038	311	221	
7	3	3	0	0	0	1	1	348	28	88	
8	2	553	10	0	2964	227	6	25	180	292	
9	4	40	45	57	3697	1	18	146	496	337	
10	3	105	24	23	501	302	23	686	861	2030	
11	8	180	80	182	1298	152	1267	522	2327	3684	
12	5	70	0	0	1094	27	25	22	118	412	
13	3	20	29	0	7648	18	8	8	108	352	
14	2	126	0	0	1847	70	39	53	455	260	
15	2	104	1	0	2878	0	1377	78	338	253	
16	2	198	12	4	2670	5	8	0	22	61	
17	2	100	1	0	416	131	7	1	1	43	
18	2	42	0	1	12	210	8	71	0	65	
19	4	291	0	0	1201	261	14	19	7	130	
20	3	113	0	0	755	204	2	320	2	284	
21	7	58	0	0	171	83	5	26	30	324	
22	4	143	0	0	146	293	38	224	25	195	
23	2	186	0	0	154	108	58	3460	117	528	

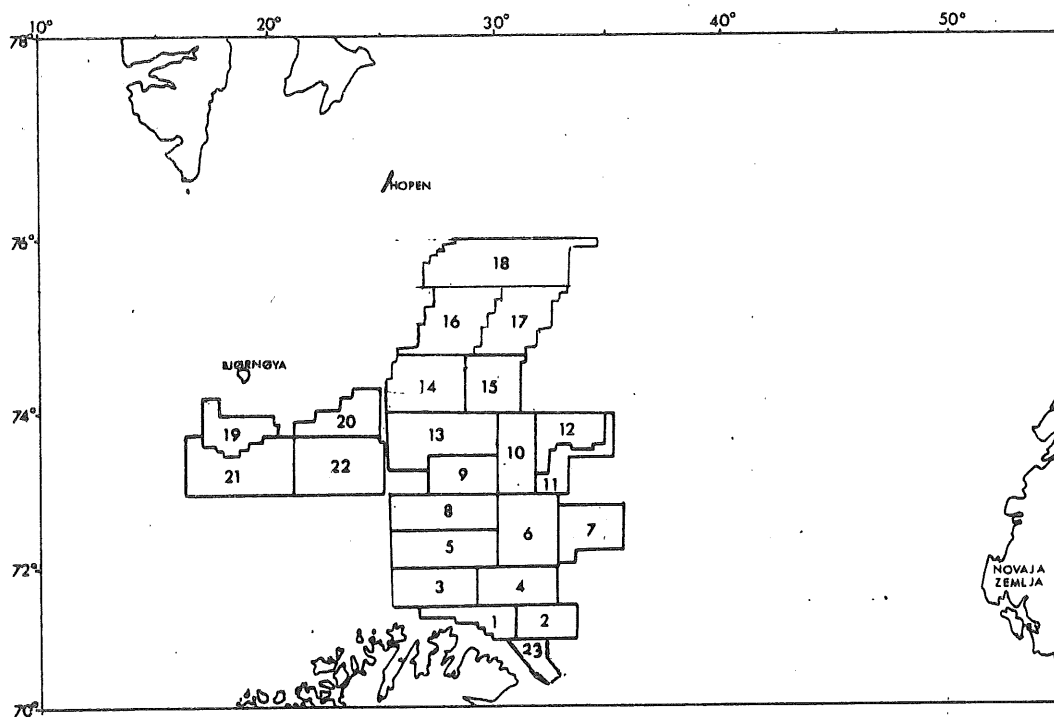


Fig. 1. Sampling strata used in April-May 1984 in the Barents Sea for the shrimp survey with R/V "Michael Sars".

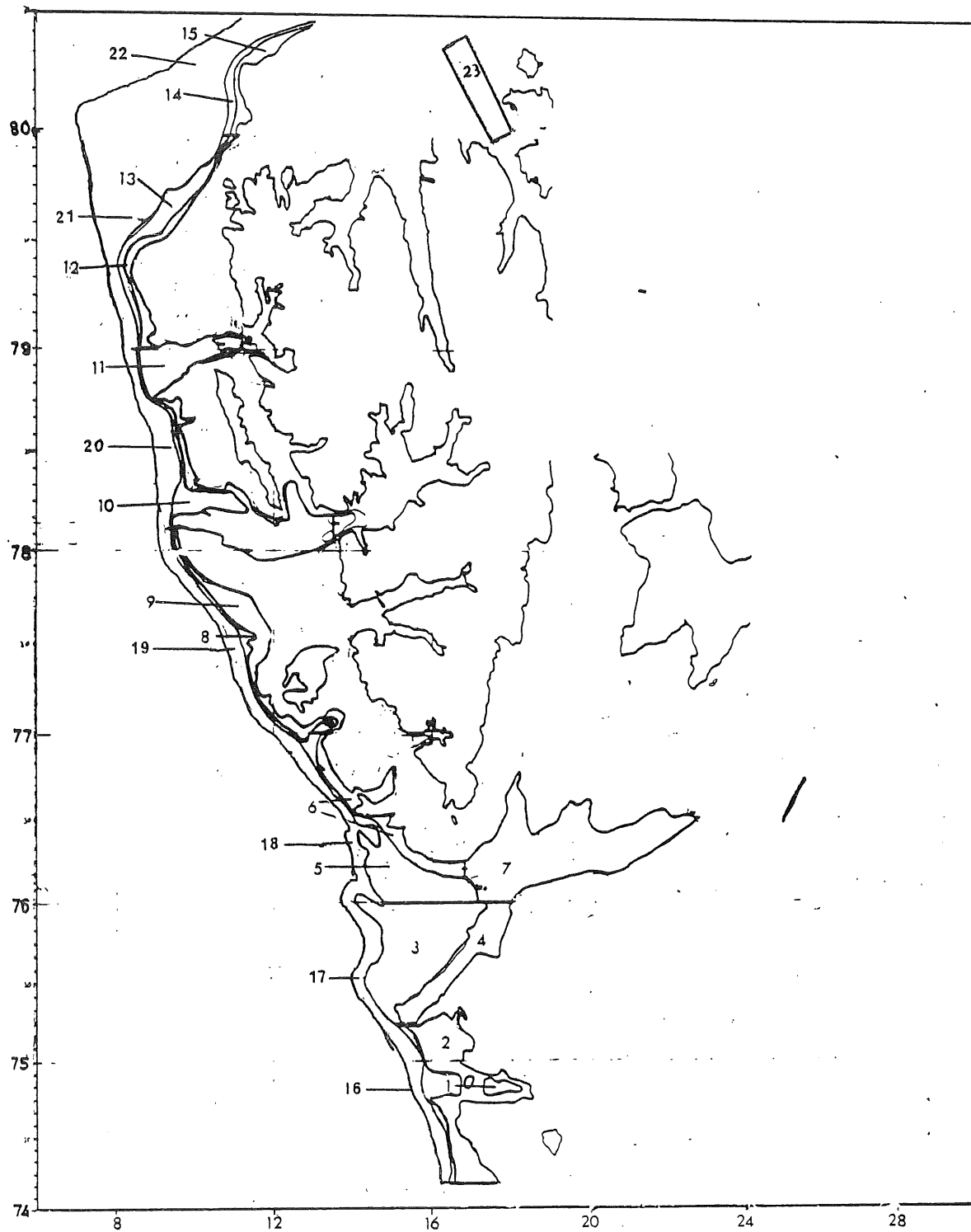


Fig. 2. Sampling strata used in July - August 1984 in the Spitsbergen area for the shrimp survey with R/V "Michael Sars"

