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Report on a Stratified-random trawl survey for Shrimp (*Pandalus borealis*) in NAFO Subareas 0+1 in July-August 1989

by

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1. INTRODUCTION.

In July-August 1989 a stratified-random trawl survey was carried out in the main part of the area of shrimp (*Pandalus borealis*) distribution in NAFO Divisions 1A-1D and a part of SA0.

The survey was carried out in almost the same area as a similar survey in 1988 with the scope of assessing the trawlable biomass of the offshore Subarea 0+1 shrimp stock, and to collect biological samples to estimate the size composition of this stock.

A commercial trawler owned by the Greenland Home Rule Trawler Company was made available to the Institute for the purpose.

Surveying conditions were favorable without ice problems and bad weather. Thus all planned sampling sites were visited.

2. MATERIAL AND METHODS.

The survey was carried out in the offshore area between 64°52'5N and 72°30'N at the west coast of Greenland, from the 3-mile limit in depths between 150 meters and 600 meters.

The survey was conducted with a 722 GRT vessel (*M/T SISIMIUT*), which was of the same size as the trawler used during the survey in the year before. Also, a similar trawling gear (*Skjervoy 3300/20* with bobbin gear and a double-bag with 44 mm mesh-size in the codend) was used. The trawl doors, however, were of the type BMV no. 8 (in 1988: 'PERFECT'). During the trawl operations in 1989 the wing spread was measured by means of SCANMAR equipment to 17.2 m at average. In the 1988-survey the wing spread was estimated to 26.5 m, lacking suitable equipment to measure the actual wing spread. Uncertainties about this estimate, however, excludes a direct comparison of results from the two surveys.

The duration of hauls was held as close as possible to 60 minutes throughout the survey. In order to minimize the influence of vertical shrimp migration the trawl operations were carried out only in the daytime during the first half of the survey (hours: 0900-1900 UTC). Due to a change in the programme, however, which included a new area with extra 16 stations it became necessary to work on a 24-hour schedule in the last part of the survey.

In the area between 63°52'N and 69°30'N the stratification was made on basis of depth contours. As in the stratification scheme for the survey in 1988 this area was divided into five subareas (Fig. 1a-b). Each of these subareas was further divided into four depth strata: 150-200 m, 200-300 m, 300-400 m and 400-600 m. The sizes in squarekilometers of these strata are given in Table 1. The area A is reduced with about 6000 km² compared to the survey plan for 1988 (Carlsson & Kanneworff, 1989), being an area of very low shrimp density. A minor change in area E has also been made (a small area around area code JT018 has been removed).

Due to scarce information on the topography the area between 69°30'N and 71°00'N was in both survey years divided into separate shrimp grounds as defined by the distribution of the fishery. However, some changes have been made in the 1989-strata (see Fig. 1c): the former area VI was removed from the scheme, and a new area west of 58°W to the midline between Greenland and Canada (9547 km²) was introduced (K0). This area was included in accordance with new commercial fishing interests, and was also treated by the Home Rule administration as a special management area in 1989. The sizes in squarekilometers of the different strata are given in Table 2.

It was estimated that about 140 hauls could be taken during the time available for the survey and with trawling operations in the day-time only. In most of the survey area the degree of coverage would then be close to 600 km² per haul, and only in the stratum V in the northern area a lower degree of coverage (around 1600 km² per haul) was accepted - as in the 1988 survey - being an area with very low shrimp densities.

The hauls were allocated to the strata proportionally to the sizes of their areas. However, a minimum of two hauls per stratum was always scheduled, so additional hauls were placed in some of the smaller strata (Tables 1-2). Within the strata the trawling sites were chosen at random according to the NAFO 'Manual of Groundfish Surveys in the Northwest Atlantic' (Doubleday, 1981). Fig. 2a-b show the fishing locations and the survey route.

A total of 135 trawl stations were occupied during the survey. For each station a shrimp biomass estimate for the actual stratum was calculated by means of the swept area method. On the basis of these a mean estimate for each stratum together with standard deviations of the means were calculated. Further, a pooled standard deviation for each region was derived to indicate the level of confidence for the final biomass estimate.

Biological samples from all trawl hauls were taken, and the distribution of sex groups have been used for estimating the development in the different strata from 1988 to 1989.

3. RESULTS AND DISCUSSION.

Catches in all trawl hauls are tabulated in the station list, Tables 3a-f. Best catches of shrimp were taken in Sukkertoppen Deep, outer part of Holsteinsborg Deep and the deep between Store Hellefiske-banke and Disko Banke. On a few locations high densities were met, offering catches of around two tons shrimp per hour; at one site a catch of 4.8 tons per hour's trawling was taken. Fair densities of shimp (catches between 100 and 500 kg per hour) were met at the western slopes of Lille Hellefiskebanke and Store Hellefiskebanke, the westernmost part of the area between 68 and 69°N and at the shrimp ground off Umanak. In all strata within depths of 150 to 200 meters very low shrimp densities were observed.

The data indicate that the biomass in 1989 has been more concentrated in depths between 200 and 300 meters than before. Also, a more southern distribution of the stock is evident.

Total trawlable biomass estimates for all strata covered by the trawl survey were calculated by means of the density figures obtained from each trawl haul multiplied by the stratum areas (Tables 4a-b). The total biomass estimate for all strata south of 69°30'N amounts to **185,045 tons** +/- 39% (= 2 * standard deviation), and to **11,725 tons** +/- 58% for strata north of 69°30'N (Tables 5a-b). Biomass estimates from the corresponding survey in the year before (Carlsson & Kanneworff, 1989) were 138,497 tons and 24,530 tons respectively. Even when disregarding the difference in the survey areas, which in this respect is of minor importance, is it not possible to compare the absolute values of the biomass estimates from the two years, because of the uncertainty regarding the wing spread of the trawl used in the 1988-survey. Unfortunately, it is no longer possible for the vessel (*ELIAS KLEIST*) to carry out any measurements of the trawl, being brought out of duty in December 1989, but during the forthcoming trawl survey in July-August 1990 with a vessel of similar type, measurements on the trawl used in the 1988-survey will be made, in order to reestimate the biomass figures for 1988.

In the 1988-survey no attempt was made to avoid the influence of diel variation in the catchability of the stock, as the fishery was carried out 24 hours a day. The trawling in 1989, however, was limited to the day-time only to reduce this influence as much as possible. A correction factor for the diel migration pattern is still not available. However, when comparing biomass estimates based on the 1988 day-time hauls only with the 1989-estimates from corresponding strata an increase in the biomass of the same size as mentioned above (about 30%) is indicated for strata south of 69°30'N. This apparent increase in the biomass is not reflected in the commercial catch rates from logbook information (Carlsson & Kanneworff, 1990) and may be due to differences in the trawling gear used in the two surveys.

Shrimp samples from the surveys in 1988 and 1989 have been used to estimate numbers of shrimps of three sexual groups (males & juveniles, females without roe, females with either head-roe or berried) in the different strata calculated as mean number per stratum. Table 6 gives the 1989/1988 ratio between the numbers in strata south of 69°30'N. Bearing in mind the difficulties in comparing the absolute values from the two successive surveys the table indicates, however, that the incidence of all sex groups has decreased in areas A and D and increased significantly in the area E. A significant displacement towards strata in 200-300 meters depths and partly also in 300-400 meters is further indicated. This displacement is most pronounced for the males & juveniles group. The large ratios for the stratum E1 is mainly due to an extremely low biomass in 1988 in that area. Table 7 compares the ratios for all sex groups combined with ratios of calculated biomass indices from the survey trawl catches. An overall reduction in shrimp size in most strata is indicated except for the shallow areas (150-200 meters), for stratum A3 (western slope of area A) and for the 200-300 meter stratum in Holsteinsborg Deep (D3).

In all trawl hauls the by-catch was sorted out into species, and the weight of each group was recorded (Tables 3a-f). As a rule, by-catches were small when shrimp catches were large and vice versa. In all strata south of 69°30'N redfish was the most important by-catch species, while in the north greenland halibut were more frequent in the catches. In some hauls also polar cod occurred here. The overall mean rate of all by-catch species was 13% of the total catches with lowest values in areas B and C, and highest in areas north of 69°30'N. In all strata with depths between 200 and 300 meters the by-catches were very small, especially south of 68°30'N.

4. CONCLUSION.

The stratified trawl survey is assumed to cover the most important offshore areas for the shrimp distribution. However, as a southward displacement from 1988 to 1989 of the stock is indicated, both in the survey data and in data from the commercial fishery (loc. cit.), it is conceivable that some part of the shrimp stock was outside the survey area in 1989.

A concentration of the stock in the strata with depths between 200 and 300 meters is seen, especially in the southern districts. A reduction of mean shrimp size is also indicated for most areas.

The comparison of the biomass estimates with those from the year before is somewhat troublesome because of the lack of suitable information about the wingspread of the trawl in the first year.

5. REFERENCES.

Carlsson, D.M. & P. Kanneworff, 1989. Report on a Stratified-random Trawl survey for Shrimp (*Pandalus borealis*) in NAFO Subarea 0+1 in July 1988. NAFO SCR Doc. 89/40. Serial No. N1617.

Carlsson, D.M. & P. Kanneworff, 1990. The shrimp fishery in NAFO Subarea 1 in 1989. NAFO SCR Doc. 90/[redacted].

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Table 1. Stratum areas (in km²), their relative size in % and number of trawlhauls in the area 63°52'N - 69°30'N. Number of planned hauls are given in brackets.

	DEPTH STRATUM				
	150-200 M	200-300 M	300-400 M	400-600 M	TOTAL
AREA A	1522	2307	7831	477	12137
%	2.86	4.34	14.73	0.90	22.84
HAULS	2 (3)	4 (4)	14 (14)	2 (2)	22 (23)
AREA B	1497	2477	1450	554	5978
%	2.82	4.66	2.73	1.04	11.25
HAULS	3 (3)	5 (5)	3 (3)	2 (2)	13 (13)
AREA C	2234	5470	3909	3989	15602
%	4.20	10.30	7.36	7.51	29.37
HAULS	4 (4)	10 (10)	6 (7)	7 (7)	27 (28)
AREA D	4204	1736	745	1915	8600
%	7.91	3.27	1.40	3.60	16.19
HAULS	8 (8)	3 (3)	2 (2)	3 (3)	16 (16)
AREA E	2151	3944	1957	2762	10814
%	4.05	7.42	3.68	5.20	20.35
HAULS	4 (4)	7 (7)	4 (4)	5 (5)	20 (20)

Table 2. Stratum areas (i km²) and number of trawlhauls from 69°30'N to 72°30'N. Number of planned hauls are given in brackets.

STRATUM	AREA	NUMBER OF HAULS
I	3648.6	6 (6)
II	367.0	3 (2)
III	2247.7	4 (4)
IV	1159.7	2 (2)
V	11210.2	6 (7)
KO	9547.0	16 (16)

Table 3a. List of trawl hauls in the four depth strata in area A. For area codes, see Fig. 2a. Catches are given in kg.

STATION-IDENTIFICATION	AREA CODE	DEPTH	TR-TIME	SHR	COD	GHL	RED	MIX	TOTAL
STRATUM A1									
89SI0230091 096	LH011	182.5	60	4	0	1	1	1	8
89SI0230092 098	LH011	175.0	60	6	0	0	0	2	8
STRATUM A2									
89SI0230088 089	LD006	242.5	60	72	0	2	3	5	81
89SI0230093 097	LH011	220.5	60	80	0	0	0	15	96
89SI0230094 099	LJ010	242.0	60	199	0	13	0	22	234
89SI0230095 100	LJ012	254.0	60	355	0	4	0	13	372
STRATUM A3									
89SI0220055 065	KX003	366.5	60	286	0	7	10	3	306
89SI0230074 062	KX436	329.0	60	279	3	.	142	19	442
89SI0230071 063	KX437	326.5	60	89	0	5	12	4	110
89SI0230077 064	KX439	337.0	60	31	0	13	13	2	58
89SI0230086 072	KZ002	379.5	60	26	0	11	92	3	132
89SI0230075 070	KZ436	341.5	60	89	1	.	137	27	254
89SI0230078 071	KZ439	354.5	60	33	1	18	6	2	60
89SI0230085 078	LA001	327.0	60	51	0	9	19	5	83
89SI0230079 077	LA439	349.5	60	30	0	12	17	4	62
89SI0230087 083	LB003	321.5	61	203	0	17	6	8	234
89SI0230080 082	LB437	338.5	60	455	0	3	7	7	471
89SI0230081 081	LB437	354.0	60	105	0	2	17	3	128
89SI0230084 088	LB439	327.5	60	142	0	2	25	18	187
89SI0230082 087	LD437	373.5	60	14	0	3	38	4	58
STRATUM A4									
89SI0230076 069	KZ435	431.0	60	11	.	.	38	6	55
89SI0230083 091	LE436	485.5	60	1	0	2	40	2	44

Table 3b. List of trawl hauls in the four depth strata in area B. For area codes, see Fig. 2a. Catches are given in kg.

STATION-IDENTIFICATION	AREA CODE	DEPTH	TR-TIME	SHR	COD	GHL	RED	MIX	TOTAL
STRATUM B1									
89SI0230098 090	LD015	170.0	60	5	0	0	2	8	14
89SI0230097 093	LE015	192.0	60	3	0	0	1	2	6
89SI0230096 094	LF014	175.0	60	4	0	0	0	4	9
STRATUM B2									
89SI0230103 061	KX013	275.0	60	1838	0	16	7	32	1892
89SI0230101 075	KX015	258.0	60	31	0	1	1	2	35
89SI0220057 084	LB009	239.0	60	4	0	0	0	8	12
89SI0220058 085	LB011	257.0	60	85	0	3	1	8	97
89SI0230089 092	LE011	225.0	60	1	0	0	0	2	3
STRATUM B3									
89SI0230100 076	KZ015	368.0	60	273	0	5	5	8	290
89SI0220060 079	LA010	349.0	60	2130	.	.	.	69	2198
89SI0220059 080	LA011	332.0	60	1448	.	.	.	43	1491
STRATUM B4									
89SI0230102 068	KX016	463.5	36	23	2	10	16	22	72
89SI0230099 086	LB016	449.5	60	484	0	20	25	12	540

Table 3c. List of trawl hauls in the four depth strata in area C. For area codes, see Fig. 2a. Catches are given in kg.

STATION-IDENTIFICATION		AREA CODE	DEPTH	TR-TIME	SHR	COD	GHL	RED	MIX	TOTAL
STRATUM C1										
89SI0220037	038	KL006	191.5	60	3	0	0	1	2	6
89SI0220041	041	KM006	186.0	60	0	0	0	0	2	2
89SI0220039	047	KN006	195.5	60	5	0	0	0	4	9
89SI0220052	057	KT006	189.5	60	14	0	0	1	9	24
STRATUM C2										
89SI0220046	037	KL003	253.0	61	551	0	1	15	5	571
89SI0220042	039	KL005	212.5	60	4826	.	.	.	8	4834
89SI0220043	042	KN001	254.0	60	331	0	0	1	5	337
89SI0220044	043	KN002	248.0	60	346	0	0	2	4	351
89SI0220038	044	KN004	221.5	60	32	0	0	0	6	38
89SI0220040	045	KN005	210.5	60	52	0	0	1	6	59
89SI0220048	046	KP003	258.0	60	91	0	0	2	6	98
89SI0220049	050	KR002	293.0	60	162	0	2	7	3	174
89SI0220047	051	KR004	218.5	60	81	0	0	0	3	84
89SI0220053	060	KV006	232.5	60	41	0	0	3	11	54
STRATUM C3										
89SI0220050	049	KR440	308.0	60	445	1	22	23	7	496
89SI0230067	048	KS437	341.0	60	41	0	4	107	3	154
89SI0230068	052	KS438	375.0	60	48	1	16	120	4	188
89SI0220051	056	KS440	346.0	60	265	0	10	33	2	310
89SI0230073	058	KV435	347.5	60	397	.	.	91	10	498
89SI0220054	066	KX006	360.5	60	306	1	8	10	5	330
STRATUM C4										
89SI0220045	040	KM002	403.5	60	1	0	11	18	5	36
89SI0230069	053	KS439	402.0	60	162	1	31	11	5	210
89SI0230070	055	KT439	410.0	60	90	4	26	106	4	229
89SI0230072	054	KV435	410.0	60	1	0	8	38	2	49
89SI0220063	067	KZ008	512.5	60	152	.	.	.	74	226
89SI0220062	074	KZ009	517.5	60	126	.	.	.	83	209
89SI0220061	073	LA009	460.0	60	327	.	.	.	72	399

Table 3d. List of trawl hauls in the four depth strata in area D. For area codes, see Fig. 2a. Catches are given in kg.

STATION-IDENTIFICATION		AREA CODE	DEPTH	TR-TIME	SHR	COD	GHL	RED	MIX	TOTAL
STRATUM D1										
89SI0220021	022	JX009	171.5	60	1	0	1	3	1	5
89SI0220025	025	KB008	163.0	60	0	0	0	2	3	5
89SI0220026	029	KB009	187.0	60	40	0	0	1	2	44
89SI0220027	026	KB011	197.5	60	25	.	.	.	6	31
89SI0220028	027	KB011	196.0	60	9	.	.	.	3	12
89SI0220033	031	KE010	163.5	60	3	0	0	1	5	10
89SI0220031	032	KE013	172.0	60	0	0	0	1	20	21
89SI0220036	036	KH007	189.0	60	353	0	0	10	8	371
STRATUM D2										
89SI0220029	028	KB012	260.0	60	2326	.	.	.	45	2370
89SI0220032	030	KD012	214.0	60	1937	.	.	.	33	1970
89SI0220030	033	KE015	239.5	60	71	1	2	24	24	122
STRATUM D3										
89SI0220024	024	KB007	342.5	60	2	1	3	14	1	20
89SI0220034	034	KF007	342.5	60	2	0	8	432	7	449
STRATUM D4										
89SI0220022	021	JX008	439.5	60	10	0	0	58	9	77
89SI0220023	023	JZ007	511.5	60	1	0	2	9	3	15
89SI0220035	035	KH006	477.5	60	13	2	3	40	22	79

Table 3e. List of trawl hauls in the four depth strata in area E. For area codes, see Fig. 2a. Catches are given in kg.

STATION-IDENTIFICATION		AREA CODE	DEPTH	TR-TIME	SHR	COD	GHL	RED	MIX	TOTAL
STRATUM E1										
89SI0220006	006	JH015	171.5	60	14	0	0	0	0	14
89SI0220010	009	JJ018	169.0	60	0	0	0	1	6	7
89SI0220011	012	JJ019	179.5	60	119	0	0	1	3	122
89SI0220018	018	JR012	179.0	60	1071	0	0	1	2	1074
STRATUM E2										
89SI0220004	001	JB019	257.0	60	3	0	0	40	9	51
89SI0220005	003	JF016	251.0	60	63	0	0	5	1	69
89SI0220001	004	JF019	225.0	60	1458	0	0	0	4	1463
89SI0220007	007	JH014	284.5	60	65	1	1	13	2	80
89SI0220008	008	JK013	298.0	60	1	0	0	18	3	21
89SI0220009	011	JK014	249.0	60	247	0	0	13	1	260
89SI0220014	017	JM020	268.0	60	1279	3	2	83	34	1401
STRATUM E3										
89SI0220003	002	JE019	331.5	60	331	3	0	68	18	419
89SI0220002	005	JF019	366.5	60	411	77	13	69	23	593
89SI0220013	013	JK020	352.5	60	954	44	0	15	11	1023
89SI0220015	015	JL014	359.5	60	24	1	0	3	0	29
STRATUM E4										
89SI0220012	010	JJ020	496.5	53	245	2	13	5	7	271
89SI0220016	014	JM013	514.0	60	0	0	0	3	1	4
89SI0220017	016	JM013	480.5	60	0	1	0	4	17	22
89SI0220019	019	JS010	564.0	60	52	0	4	24	27	106
89SI0220020	020	JT010	442.5	60	50	1	10	177	12	251

Table 3f. List of trawl hauls in depth strata in the area north of 69°30'N. For area codes, see Fig. 2b. Catches are given in kg.

STATION-IDENTIFICATION		AREA CODE	DEPTH	TR-TIME	SHR	COD	GHL	RED	MIX	TOTAL
STRATUM N1										
89SI0230128	117	MM001	323.5	60	52	0	2	0	29	83
89SI0230129	118	MM001	351.5	60	321	0	19	0	107	448
89SI0230130	119	MM003	324.0	60	98	0	6	2	63	168
89SI0230126	116	MM438	341.0	61	28	.	.	.	45	73
89SI0230127	120	MN439	307.5	60	39	1	0	0	25	65
89SI0230131	121	MP005	252.0	60	25	0	0	0	14	38
STRATUM N2										
89SI0230135	108	MF007	234.0	60	0	0	0	0	1	1
89SI0230133	112	MG007	273.5	60	120	0	4	0	27	150
89SI0230132	113	MG008	237.5	60	6	0	0	0	7	13
STRATUM N3										
89SI0230120	103	MB002	314.5	60	59	0	4	0	14	78
89SI0230137	104	MB006	343.5	60	131	0	6	0	11	148
89SI0230138	105	MB007	380.5	60	222	1	18	1	36	277
89SI0230136	107	MD006	309.5	60	41	0	0	0	3	44
STRATUM N4										
89SI0230140	101	LT011	155.0	60	2	0	0	0	36	38
89SI0230139	102	LV008	174.5	60	2	0	0	0	4	6
STRATUM N5										
89SI0230121	106	MD002	293.0	60	33	0	2	0	10	44
89SI0230122	109	ME002	224.5	60	0	0	1	0	6	7
89SI0230134	110	MF006	226.5	60	2	0	1	0	1	4
89SI0230123	111	MG437	366.5	60	1	0	4	0	11	16
89SI0230124	114	MJ437	399.0	60	10	0	5	0	22	37
89SI0230125	115	ML438	268.0	60	0	0	1	0	0	1
STRATUM K0										
89SI0230105	122	LL437	437.0	65	109	0	2	6	7	125
89SI0230104	123	LL440	316.0	60	70	0	2	1	12	84
89SI0230106	124	LM437	412.0	60	25	0	7	5	12	48
89SI0230107	125	LM438	340.0	60	85	0	4	6	12	107
89SI0230109	126	LP433	461.0	60	0	0	0	9	3	12
89SI0230110	127	LP434	407.0	60	3	0	1	7	2	13
89SI0230111	129	LP435	383.5	60	7	0	0	2	4	13
89SI0230108	128	LP439	344.5	60	12	0	2	1	16	31
89SI0230112	130	LR436	335.0	60	28	0	1	2	5	36
89SI0230113	131	LR438	318.0	60	24	0	2	3	17	46
89SI0230114	132	LS438	315.0	63	33	0	1	1	7	41
89SI0230115	134	LV439	547.5	61	1	0	2	1	0	3
89SI0230116	133	LX437	594.0	60	0	0	2	0	0	2
89SI0230117	135	LX437	565.0	60	0	0	1	1	2	4
89SI0230118	136	LZ435	412.5	60	1	0	2	0	32	35
89SI0230119	137	MA434	402.5	60	64	1	6	1	24	97

Table 4a. Trawlable biomass of shrimp in strata south of 69°30'N.

		STRBIOMASS					
		TONS	HAULS	STD	STDERR	MIN	MAX
STRATUM	KM²						
AREA A, 150-200 M	1522	85.14	2	20.95	14.82	70	100
AREA A, 200-300 M	2307	4598.23	4	3160.78	1580.39	1912	8575
AREA A, 300-400 M	7831	11650.39	14	10870.45	2905.25	1268	38276
AREA A, 400-600 M	477	37.45	2	44.34	31.35	6	69
AREA B, 150-200 M	1497	61.18	3	12.53	7.23	47	69
AREA B, 200-300 M	2477	11908.09	5	24516.99	10964.33	15	55721
AREA B, 300-400 M	1450	21226.77	3	16479.21	9514.28	3875	36667
AREA B, 400-600 M	554	1713.32	2	2118.62	1498.09	215	3211
AREA C, 150-200 M	2234	150.46	4	138.74	69.37	8	327
AREA C, 200-300 M	5470	39110.00	10	81809.31	25870.38	2805	268977
AREA C, 300-400 M	3909	12264.68	6	8348.04	3408.07	1968	21029
AREA C, 400-600 M	3989	6760.43	7	6542.32	2472.76	49	18788
AREA D, 150-200 M	4204	2828.58	8	6311.92	2231.60	11	18294
AREA D, 200-300 M	1736	27924.56	3	22632.96	13067.15	1808	41818
AREA D, 300-400 M	745	15.66	2	4.59	3.24	12	19
AREA D, 400-600 M	1915	167.03	3	134.22	77.49	22	286
AREA E, 150-200 M	2151	7359.01	4	12397.53	6198.77	0	25817
AREA E, 200-300 M	3944	22455.72	7	33919.08	12820.21	23	84679
AREA E, 300-400 M	1957	11723.22	4	11322.89	5661.44	544	27401
AREA E, 400-600 M	2762	3004.61	5	4772.16	2134.18	0	11367

Table 4b. Trawlable biomass of shrimp in strata north of 69°30'N.

		STRBIOMASS					
		TONS	HAULS	STD	STDERR	MIN	MAX
STRATUM	KM²						
I	3649	4311.90	6	5194.01	2120.45	1160	14459
II	367	214.91	3	347.67	200.73	1	616
III	2248	2789.37	4	2011.16	1005.58	981	5379
IV	1160	26.68	2	1.86	1.32	25	28
V	11210	1093.30	6	1858.25	758.63	0	4751
KO	9547	3289.20	16	3731.27	932.82	0	11371

Table 5a. Calculated trawlable biomass (in tons) of shrimp for the areas between 63°52'5N and 69°30'N.

AREA	DEPTH STRATUM 150-200	200-300	300-400	400-600	TOTAL
A	85	4598	11650	37	16370
B	61	11908	21227	1713	34909
C	150	39110	12265	6760	58285
D	2829	27925	16	167	30937
E	7359	22456	11723	3005	44543
TOTAL	10484	105997	56881	11682	185045

Table 5b. Calculated trawlable biomass (in tons) of shrimp for the areas between 69°30'N and 72°30'N. The areas 'north' and 'south' are bordered by 71°N.

AREA	STRATUM I	II	III	IV	V	KO	TOTAL
North	4312	215	2789	.	1093	.	8419
South	.	.	.	27	.	3289	3316
TOTAL	4312	215	2789	27	1093	3289	12725

Table 6. Ratios of numbers in 1989 to numbers in 1988 of shrimp in three sex groups (males & juveniles, NR = females without roe, HR,BR = females with head-roe or berried) by areas and depth zones calculated from survey shrimp samples.

	A	B	C	D	E	ALL
MALES+JUVENILES						
150-200 M	-	2.29	6.93	0.14	2273.12	0.57
200-300 M	8.99	2.94	3.68	3.42	4.75	4.48
300-400 M	0.37	3.13	0.47	0.09	7.23	1.06
400-600 M	3.74	1.24	1.10	0.05	0.36	0.67
ALL DEPTHS	0.97	2.94	2.29	1.17	3.89	2.08
FEMALES: NR						
150-200 M	-	0.84	3.61	0.60	130.51	1.32
200-300 M	0.81	1.23	0.61	0.41	1.52	1.02
300-400 M	0.45	0.11	0.55	0.01	0.26	0.34
400-600 M	74.69	0.36	0.64	0.01	0.20	0.43
ALL DEPTHS	0.55	0.53	0.60	0.41	0.67	0.61
FEMALES: HR,BR						
150-200 M	-	0.75	0.76	0.09	941.47	0.35
200-300 M	2.07	1.74	0.87	0.94	3.34	1.52
300-400 M	0.61	1.21	0.89	0.30	0.75	0.86
400-600 M	16.12	1.18	0.65	0.03	0.54	0.48
ALL DEPTHS	0.77	1.41	0.82	0.33	1.22	0.89
ALL SEX GROUPS						
150-200 M	-	2.07	1.34	0.14	1894.45	0.43
200-300 M	8.10	2.41	3.25	2.83	4.53	3.80
300-400 M	0.44	2.20	0.56	0.05	2.66	0.98
400-600 M	10.29	1.16	0.90	0.04	0.42	0.59
ALL DEPTHS	0.90	2.21	1.93	0.98	2.94	1.72

Table 7. Ratio of 1989/1988 shrimp biomass-indices from shrimp catches and numbers 1989/1988 of shrimp from biological samples in the same hauls in all strata.

AREA		150-200	200-300	300-400	400-600	ALL
A	catch	-	7.85	0.49	26.33	0.79
	samples	-	8.10	0.44	10.29	0.90
B	catch	20.50	1.70	1.87	1.10	1.78
	samples	2.07	2.41	2.20	1.16	2.21
C	catch	2.39	1.65	0.62	0.84	1.13
	samples	1.34	3.25	0.56	0.90	1.93
D	catch	0.24	5.77	0.04	0.05	1.53
	samples	0.14	2.83	0.05	0.04	0.98
E	catch	3421.00	3.83	2.68	0.56	2.88
	samples	1894.00	4.53	2.66	0.42	2.94
ALL	catch	0.98	2.94	0.97	0.67	1.50
	samples	0.43	3.80	0.98	0.59	1.72

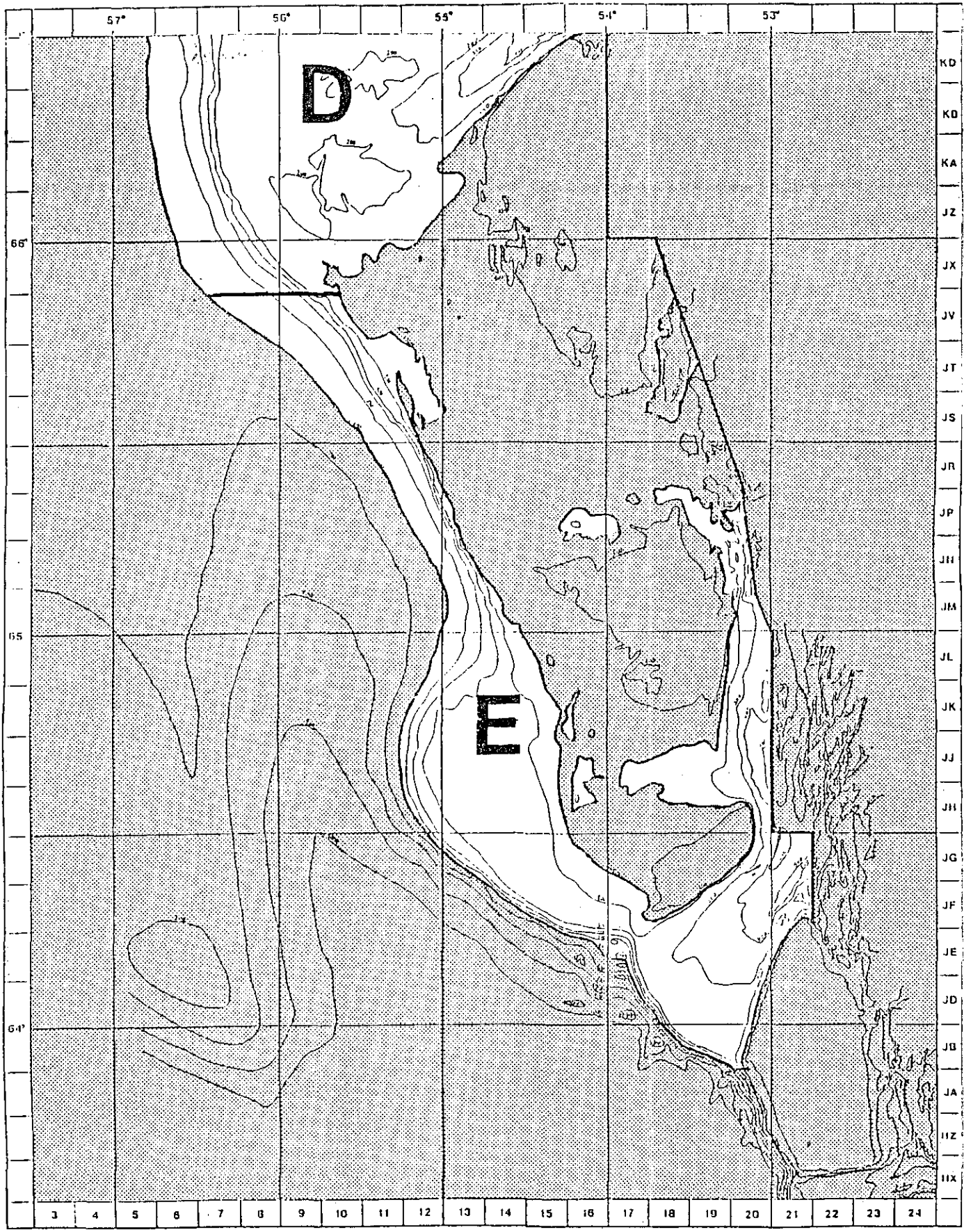

Fig. 1a. Strata in the area 63°30'N - 66°30'N. Note that the areas D-E do *not* correspond to the NAFO divisions with the same lettering.

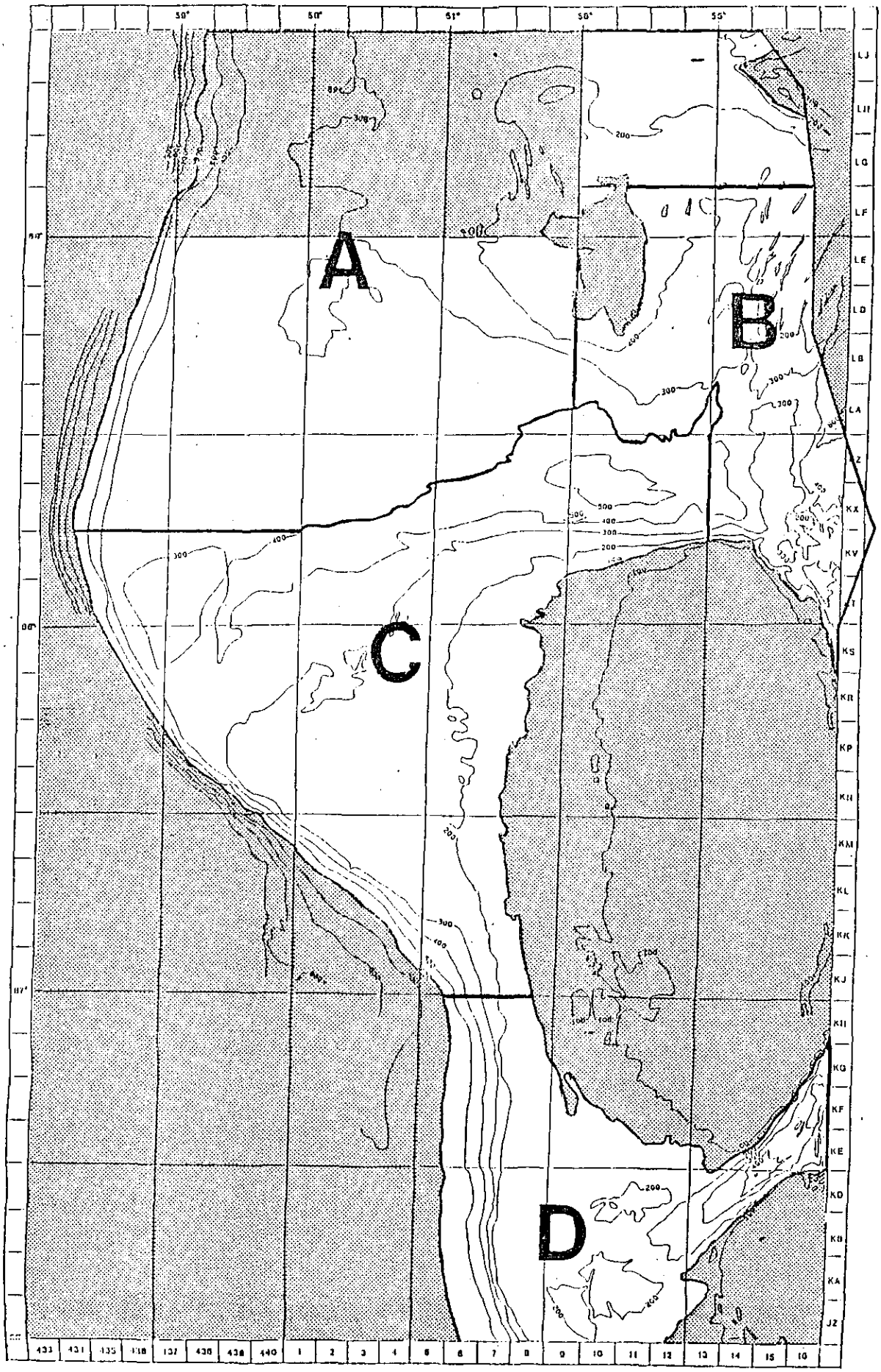

Fig. 1b. Strata in the area 66°00'N - 69°30'N. Note that the areas A-D do *not* correspond to the NAFO divisions with the same lettering.

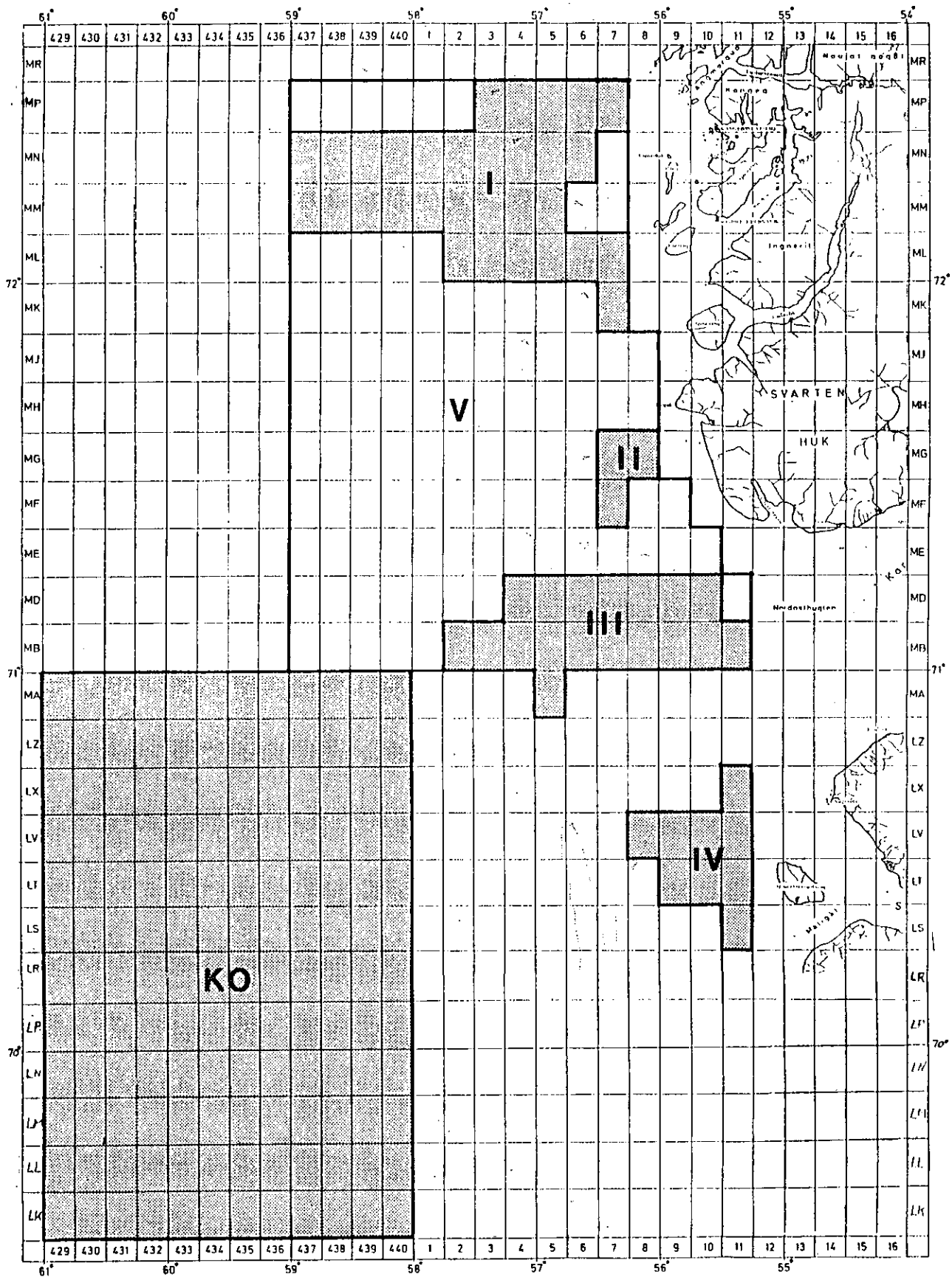

Fig. 1c. Strata in the area north of 69°30'N. The strata I-IV and stratum K0 are the areas of commercial interest (see text).

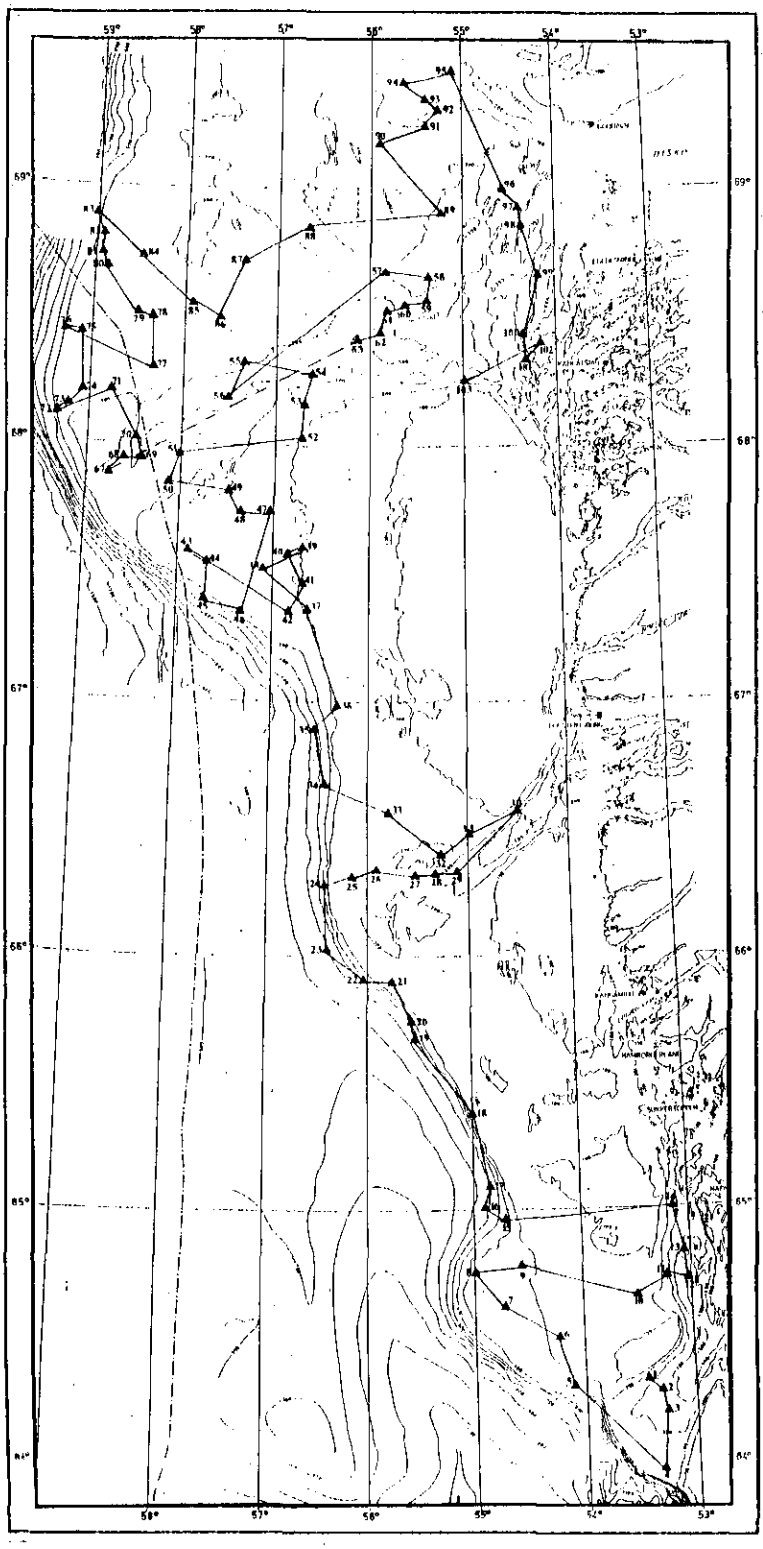

Fig. 2a. Selected stations and the survey route in the area 63°50'N - 69°30'N.

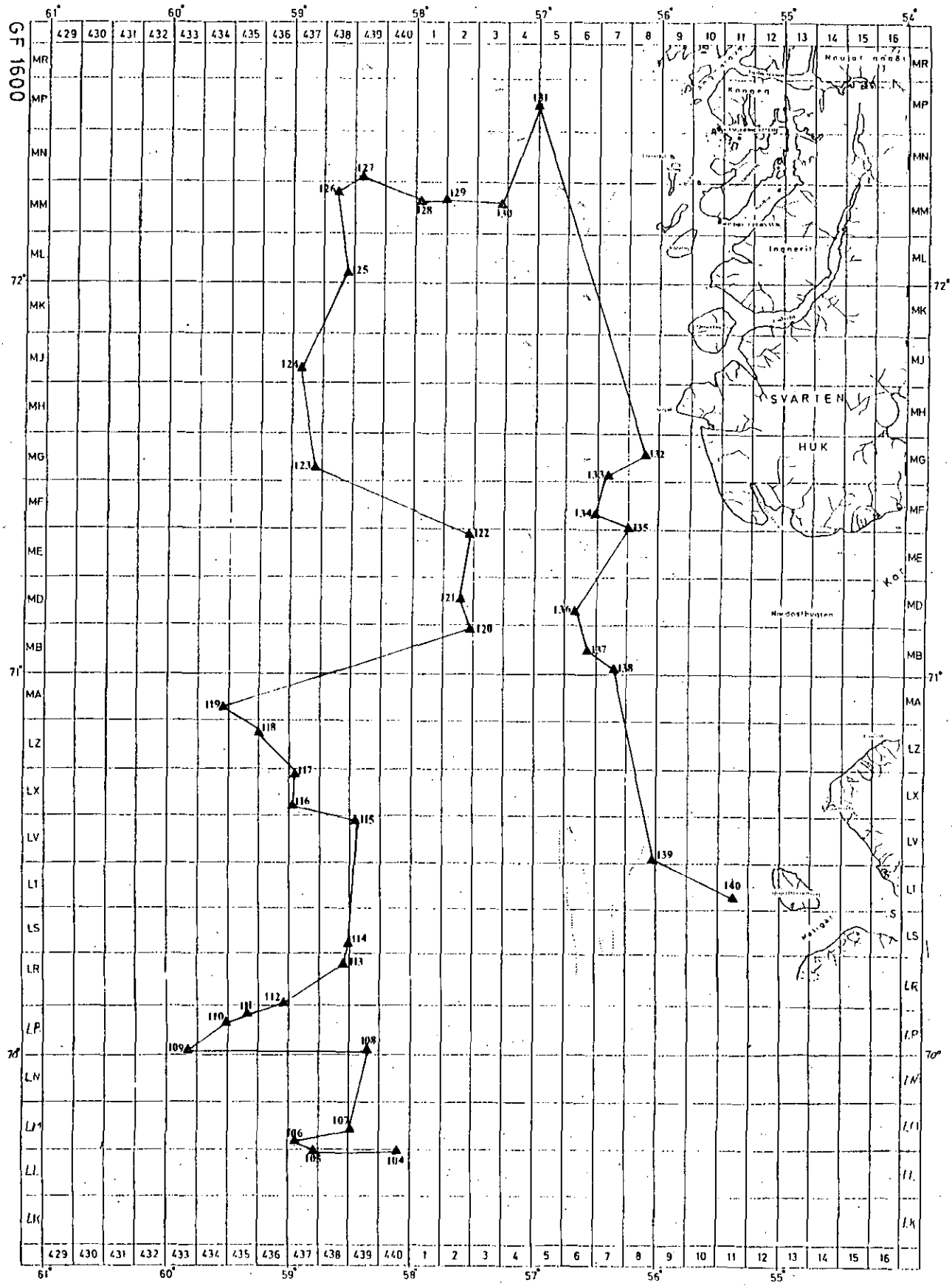

Fig. 2b. Selected stations and the survey route in the area north of 69°30'N.

APPENDIX

The Proportion between Male and Female Shrimp in Subarea 0+1 in 1988 and 1989 as Judged from Trawl Surveys

by

Svend Aa. Horsted

Data

NAFO SCR Doc. 90/46 (Corrigendum) Tables 6 and 7.

Calculations and Assumptions

1. Females (NR) and females (HR, BR) are combined to a single gorup of females assuming proportion between them being 1 to 9.

   1 x 0.61 (from 90/46 Table 6)

   9 x 0.89

   i.e. weighted mean of female group 0.862

2. $N_{m,88}$ denotes number of males in 1988 survey stock

   $N_{f,88}$ denotes number of females in 1988 survey stock

   $N_{f,88} = 1 - N_{m,88}$

   $N_{m,88} \times 2.08 + (1 - N_{m,88}) \times 0.862 = 1.72$

   $N_{m,88} = 0.70 = 70\%$ of survey stock by numbers

   $N_{f,88} = 0.30 = 30\%$ " "

3. Calculate proportion of males and females in 1989

   $N_{m,89} = 2.08 \times N_{m,88} = 1.456 = 85\%$

   $N_{f,89} = 0.862 \times N_{f,88} = 0.259 = 15\%$

4. The above given proportions are independent of survey biomass estimates. However, to get change in numbers of each sex group from 88 to 89 it is necessary to know mean weight of each age group. These figures not being readily available it is assumed that mean weights for both years are:

   5 g for males, and
   10 g for females

5. Overall mean weight

   for 1988 = 0.70 x 5 + 0.30 x 10 = 6.50 g
   for 1989 = 0.85 x 5 + 0.15 x 10 = 5.75 g

6. For each sex group the relative change in numbers from 1988 to 1989 can now be calculated for various values of survey biomass values in the two years from the following equation:

$$(N_{m,89} + N_{f,89}) \times 5.75 = \frac{\text{Biomass 89}}{\text{Biomass 88}} \quad (N_{m,88} + N_{f,88}) \times 6.50$$

   i) Taking biomass as presently calculated by swept area method (SCR Doc. 90/46)

   Biomass 89 = 1.5 x Biomass 88

   $N_{m,89} + N_{f,89} = 1.70 \times (N_{m,88} + N_{f,88})$

i.e.	1988	1989
N_m	70	145
N_f	30	26

   ii) Assuming biomass in 1989 equal to biomass 88

   $N_{m,89} + N_{f,89} = 1.13 \times (N_{m,88} + N_{f,88})$

i.e.	1988	1989
N_m	70	96
N_f	30	17

7. Eventually, comparing ratio between sex groups in the survey stock with those in that part of the commercial catches which are produced on board or landed could lead to estimates of numbers discarded. Such analysis should, however, be carried out for each stratum (or smaller units) to avoid too wide assumptions on distribution of fishing effort over the survey area.