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Stratified-Random Trawl Survey for Shrimp (*Pandalus borealis*) in NAFO Subarea 0+1 1992.

by

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INTRODUCTION

In July-August 1992 a stratified-random trawl survey was carried out in NAFO Divisions 1A through 1E and a part of Subarea 0 with the scope of assessing the trawlable biomass of the offshore shrimp (*Pandalus borealis*) stock in Davis Strait, and to collect information on the composition of this stock.

The survey was carried out in almost the same area as similar surveys in 1988-91, however, data from a stratified-random survey in September 1992 covering the Divisions 1E and 1F have been included in the estimation of the total trawlable biomass in Subarea 1 offshore and adjacent parts of Subarea 0.

MATERIALS AND METHODS

The July-August survey was carried out in the offshore area between 61°52'5N and 72°30'N from the 3-mile limit off the Greenland coast in depths between 150 m and 600 m including that part of Subarea 0 which is adjacent to the shrimp areas in Subarea 1 (Fig. 1). The September survey ranged from 63°52'5N in the north to Cape Farewell, overlapping in stratum W6 with the former survey.

The surveys were conducted with a 722 GRT stern trawler as earlier used (Carlsson & Kanneworff, 1992). Also, the same trawling gear was used (Skjervoy 3000/20 with bobbin gear and a double-bag with 44 mm mesh size in the codend). Trawl doors were of the type 'PERFECT GREENLAND', size 370*250 cm, weight 2420 kg.

SCANMAR equipment was used to measure the distance between the trawl doors. Taking into account information on the rigging of the trawl the mean wingspread was estimated to 23.1 meters by The Danish Institute of Fishing Technology (U.J. Hansen, pers.comm.).

The duration of the hauls was held as close as possible to 60 minutes. In order to minimize the influence of vertical migration of shrimp all trawl operations were planned to be carried out only in the daytime (0900-1900 UTC).

In the area south of 69°30'N the stratification was made on basis of depth contours. This area was divided into subareas (Fig. 1), and each of these was further divided into four depth strata (150-200 m, 200-300 m, 300-400 m and 400-600 m). Due to scarce information on bottom topography the area between 69°30'N and 72°30'N was divided into separate shrimp grounds as defined by the distribution of the fishery. Depth stratification of the areas south of W7 (Julianehaab Bay) was made on basis of less precise depth information than for areas W1-W7. Two depth strata were identified, 100-200 m and 200-600 m.

A time frame of approximately five weeks for the first trawl survey and two weeks for the September-survey was set, and hence 134 hauls were taken within the shrimp stratification scheme (150-600 meters depth range) with trawling operations in the day-time only (Fig. 2). In Julianehaab Bay 16 trawling sites were occupied covering an area of 12,500 km². In the main survey area the coverage was about 750 km² per haul. In some of the strata in the northern area a lower coverage was accepted, being areas with very low shrimp densities. The average coverage in those strata was thus about 1400 km².

Hauls were allocated to the strata proportionally to area. However, a minimum of two hauls per stratum were always scheduled, so additional hauls were placed in some of the smaller strata. Within the strata trawling sites were chosen at random according to the NAFO 'Manual of Groundfish Surveys in the Northwest Atlantic' (Doubleday, 1981).

The mean biomass with standard deviation by stratum was calculated by the swept area method, assuming a catchability coefficient of 1. Sums of the calculated biomasses were made by region (north of 69°30'N, south of 69°30'N in the Greenland zone, and the Canadian zone, respectively).

Based on data from 1988-91 a new method was introduced for describing the distribution of shrimp biomass in the area south of 69°30'N by Carlsson & Kanneworff (1992). Shrimp densities in the depth range 150-600 meters were estimated on basis of the survey stations by the computer programme 'Spline Survey Designer Software System' (Stolyarenko, 1987), and maps with isolines for different levels of the estimated 1992-density were produced for the present paper.

Shrimp samples were taken from all catches, provided that the catch was not too small or damaged. Shrimps were sorted by sexual characteristics, and oblique carapace length was measured to the nearest 0.1 mm and afterwards pooled in 0.5 mm groups. Samples were weighted by catch and stratum area to obtain estimates of total number of shrimp by sex and length group for each stratum and for the total survey area.

Abundance estimates at length for male shrimp, derived from the research trawl survey samples from 1988 to 1992 (Fig. 5), were analyzed for age composition according to the methods used by Parsons and Veitch (1991). Tables were constructed for mean lengths, proportions and abundance at age, the last including a composite female age group. Estimates of total mortality (Z) also were derived for age 5+ and 6+.

RESULTS AND DISCUSSION

Shrimp catches from the trawl hauls (Table 1-2) were used to estimate the trawlable biomass for all strata. Table 3 gives the biomass estimates for all strata in the three regions based on data from the July-August survey, and Table 4 shows estimates from the September survey in strata W6-W7 and the Julianehaab Bay.

Calculation of the trawl swept area is heavily dependant on the trawl geometry in terms of wing spread and shape of the trawl opening. A trawl positioning system (SCANMAR) has been used during the trawl surveys in order to estimate the wing spread directly. However, only in 1989 the sensors were placed at the wings, while in 1988, 1991 and 1992, the sensors were mounted on the trawl doors. The system did not function in 1990. A retrospective study on the various riggings of the trawl during the five years has been undertaken, taking into account the door types, length of the sweep lines, trawling speed, and the available distance measurements (U.J. Hansen, Danish Institute of Fisheries Technology, pers. comm.). New estimates for the effective wing spread have been obtained and included into the biomass calculation programme. The following text table shows the revised figures for the wing spread at the bottom together with the estimated trawl opening area and the estimated height above the bottom of the headline.

Year	Wing spread m	Opening area m^2	Headline height m
1988	23.1	278	15.5
1989	17.9	247	17.9
1990	23.1	282	15.7
1991	24.8	286	14.9
1992	23.1	287	16.0

Some uncertainties about the 1989-estimates still remain due to fishing with a different type of trawl door (BMW, oval type) than in the other years, and lack of reliable information on the overall rigging of the trawl that year. This situation is unfortunate for the understanding of the sampling performance of the trawl, especially as the first appearance of the strong 1985 year class in survey catches was in 1989. Recalculation of the biomass estimates for the period 1988-91 caused only small changes in total values, the difference between 1989 and the other years becoming less pronounced.

When comparing the size of the estimated total biomass from the trawl surveys of the five years (Table 5, Fig. 3) a fairly stable situation is indicated, except for 1991 when a significantly lower total biomass was estimated.

The estimated biomasses for the strata W1-W3 and C1+C3 have been fairly stable through all five years. The observed increased value for C3 in 1992 was caused by one large catch of 1200 kg (Table 1). As was the case in 1989 and 1991 a larger part of the stock was found this year in the southern areas around Sukkertoppen Deep and Godthaab Deep. The steady decline in biomass in the northernmost areas (N1-N7) from 1988 to 1991 did not continue into 1992. During the present survey relatively good catches were taken, mainly in N4, being the most important area for the commercial fishery north of 71°N throughout the years.

Information on the significant changes in stock abundance between areas from year to year can be obtained by analyzing figures for the proportion of biomass in different strata relative to the annual totals (Table 6). In 1992, the stock was more concentrated than observed in earlier years in depths between 300 and 400 meters (60% of the stock, Table 7), however, one larger catch was taken in shallow water in the northern part of W6, dominated by small shrimp.

By means of the 'spline' computer programme (Stolyarenko, 1987) the shrimp densities have been calculated in order to visualize distribution of stock

concentrations (Fig. 4). Similar calculations were carried out by Carlsson & Kanneworff (1992) for the years 1988-91. The concentrations in the most important area for the commercial fishery between 68° and 69°N remained stable, and the earlier observed southern displacement of the stock from 1990 to 1991 has continued in 1992.

Overall length-frequency distributions of shrimp for the traditional survey area (strata N1-N7, C1, C3, W1-W6) in 1988-92 are given in Fig. 5. The text table below shows total numbers of males and females as calculated by year. Different from the table given by Carlsson and Kanneworff (1992) for 1988 to 1991 the female group is not separated in primiparous and multiparous females, as the surveys are conducted in the period when primiparous female shrimp begin to loose sternal spines prior to spawning, and the relative proportion of the two groups cannot be estimated with confidence.

No. of shrimp (billions)	1988	1989	1990	1991	1992
males	23.9	32.9	22.4	14.0	24.9
females	10.0	6.4	8.2	5.3	6.5
Total	33.8	39.3	30.6	19.2	31.3

The table shows an increase in numbers of both males and females from 1991 to 1992 and an increase in total number of shrimp to the level of 1988 and 1990. The overall 1992 distribution suggests that the increasing number of males is in part due to recruitment of the 1987 year class (19.5 mm CL), and - less important - the 1989 year class (15.5 mm CL).

Figures 6a-c show length frequencies by stratum in 1991 and 1992. The strata north of 69°30'N are combined (stratum NW = N1-N4, NS = N5-N7), as are strata on the Canadian side of the midline (stratum C = C1+C3). Overall frequencies for stratum NW, NS, and C show increasing numbers of both males and females in 1992, males peaking at 19.5, 21 and 22-23 mm CL in NW, at 23.5 mm CL in NS, and at 19.5 and 22.5 mm CL in C. In strata W1 to W6 shrimp abundance is increasing to the north (W1+W2) and to the south (W5+W6), but decreasing in W3 and W4. In W1 and W2 a prominent peak of males is found at 22 mm CL, smaller male groups being present but not numerous. In W5 and W6 the increase is occurring in the smaller male groups, in W6 especially a length group peaking at 17.5 mm CL, probably the 1988 year class.

Ageing of the overall length distributions produced estimates of mean length at age (Table 9) similar to those obtained from a previous ageing study by Savard et al. (1989). The estimates were also consistent with the results of Parsons and Veitch (this meeting) for the fishery in Div. 0A and the analysis by visual examination of the same distributions of 1988 to 1991 as described by Carlsson and Kanneworff (1992).

Proportions at age (Table 10) show the relative strength of the 1985 year class in 1989, 1990 and 1991. The year class was not well-represented as age 3 in the 1988 survey and was expected to change sex between 1991 and 1992.

Abundance at age estimates (Table 11) track the 1985 year class well up to 1991, but in 1992 suggest that the presumed 1986 year class is also strong and the 1985 year class not as abundant as expected. It can not be justified whether this is due to consistent differences in availability of different year classes to the survey gear, or whether the 1985 year class did not fulfil the expectations of growth and transition to primiparous females in 1992. A possible interpretation of the 1992 overall distribution is that only part of 1985 year class (the larger, fast-growing specimens) did change sex in 1992, while the smaller slow-growing specimens remained males. The length frequency distribution of the remaining male component might then superimpose the 1986 year class, which is assumed to be poor - as indicated by the analysis of 1988-91 overall distributions. This scenario (as described by Rasmussen, 1953), implies that a representative separation of the year classes is not possible by the method used.

Total mortality estimates (Z) calculated from this study indicate that shrimp are not fully recruited/available to the research gear and/or survey area at age 5. Estimates for age 6+ appear more realistic except for 1990.

CONCLUSIONS

The total biomass estimate from the stratified trawl surveys indicate a general stable situation from 1988 to 1992, apart from a lower level found in 1991 (about 65% of the overall level). The biomass in the areas north of 69°30'N exhibit a significant decrease in 1988-91, and an increase to the 1988-level in 1992, in accordance with higher catch rates and catches in 1992 (Carlsson and Kanneworff, 1993).

Some consistency has been found with regard to the progression of identifiable size groups of shrimp between years. In 1989 a significant recruitment of the 1985 year class (19.5 mm CL) to the survey was obvious. Recruitment of other year classes was low, especially in 1991. The 1985 year class was expected to contribute significantly to the group of primiparous females in 1992 with a mean carapace length at 24 to 25 mm. 1992 data do, however, suggest a strong component of males between 22 and 24 mm CL, and less then expected recruitment to the female group.

These anomalies suggest that either the 1985 year class was overestimated in past

surveys (1986 year class underestimated) or that the former did not change sex, as expected, resulting in the apparently high abundance at age 6 in 1992 (two year classes overlapped in length). Both cases might also apply.

The 1992 survey data show recruitment of the 1987 year class, although this year class does not appear to have the same strength as the 1985 year class. Some recruitment of the 1988 year class is indicated in Div. 1D (stratum W6), but in the overall picture the relative strength this year class diminishes. Also the 1989 year class mode is evident in the 1992 data. It is, however, too early to evaluate its strength.

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Table 1a. List of trawl stations in strata west of the midline, and north of 69°30'N in the Davis Strait survey, July-August 1992. Catches are given in kg.

STATION-IDENTIFICATION	AREA-CODE	DEPTH	TR-TIME	SHR	COD	GHL	RED	MIX	TOTAL
				STRATUM C1-3					
92PA0120058 056	KX437	326.0	60	46	0	3	2	6	56
92PA0120057 058	KZ435	372.5	60	488	0	26	169	31	714
				STRATUM C1-4					
92PA0120059 053	KX434	557.0	60	1	0	13	32	3	48
92PA0120056 063	LA435	556.0	60	3	0	10	12	3	26
				STRATUM C3-2					
92PA0120061 047	KT437	276.5	60	2	0	1	0	2	5
92PA0110039 050	KV439	289.0	62	53	0	1	3	2	59
				STRATUM C3-3					
92PA0120062 045	KT438	348.0	60	1198	0	9	19	13	1238
				STRATUM C3-4					
92PA0120063 040	KP437	519.0	60	0	0	10	4	3	17
92PA0120060 051	KT435	536.5	60	1	0	10	6	4	21
				STRATUM N1					
92PA0120032 115	MM005	268.5	34	3	0	5	0	15	23
92PA0120029 116	MN001	358.0	60	46	0	2	0	71	119
92PA0120030 118	MN003	314.0	60	38	0	2	0	29	69
92PA0120028 117	MN439	306.5	61	0	0	3	0	3	6
92PA0120031 119	MP005	399.5	60	128	0	86	1	31	245
				STRATUM N2					
92PA0120023 108	MB437	379.0	60	90	0	3	0	13	107
92PA0120043 109	MD003	308.0	56	13	0	0	0	5	19
92PA0120034 112	MH003	229.0	30	0	0	0	0	0	0
92PA0120035 113	MH008	164.0	60	0	0	0	0	2	2
92PA0120033 114	MK004	183.5	60	0	0	0	0	3	3
				STRATUM N3					
92PA0120037 110	MF007	283.5	60	46	0	0	0	3	50
92PA0120036 111	MG008	186.0	61	0	0	0	0	1	1
				STRATUM N4					
92PA0120041 105	MB007	379.5	60	581	0	7	0	112	700
92PA0120040 106	MB010	355.5	60	277	0	18	0	77	371
92PA0120042 107	MD005	317.5	60	280	0	1	0	30	311
				STRATUM N5					
92PA0120019 089	LN439	344.5	60	0	0	1	1	10	11
92PA0120020 090	LR437	309.5	60	1	0	0	1	3	5
92PA0120021 095	LS437	411.5	60	20	0	2	1	15	37
92PA0120022 094	LS439	361.5	60	134	0	4	4	39	181
92PA0120044 100	LX440	502.5	60	0	0	1	0	2	3
92PA0120026 102	LZ440	451.5	60	124	0	21	1	37	183
92PA0120024 103	MA437	366.5	58	0	0	0	0	0	0
92PA0120025 104	MA439	350.5	60	0	0	0	0	4	5
				STRATUM N6					
92PA0120051 092	LS003	365.5	60	50	0	9	5	38	101
92PA0120049 091	LS005	261.5	60	0	0	0	0	0	0
92PA0120048 093	LS008	167.5	52	0	0	0	0	0	0
92PA0120045 099	LV001	464.0	60	1	0	4	4	14	22
92PA0120050 097	LV005	411.5	60	37	0	3	1	19	59
92PA0120027 101	LZ002	473.0	61	60	0	24	1	17	102
				STRATUM N7					
92PA0120047 096	LS011	174.5	60	0	0	0	0	4	4
92PA0120046 098	LT011	191.0	60	0	0	0	0	10	10

Table 1b. List of trawl stations in strata between 67°00'N and 69°30'N, east of the midline in the Davis Strait survey, July-August 1992. Catches are given in kg.

STATION-IDENTIFICATION	AREA-CODE	DEPTH	TR-TIME	SHR	COD	GHL	RED	MIX	TOTAL
				STRATUM W1-1					
92PA0120065	080 LG012	167.0	60	0	0	0	0	1	1
92PA0120011	085 LH005	185.0	60	0	0	1	0	1	3
92PA0120016	082 LH007	167.0	60	0	0	0	0	0	0
				STRATUM W1-2					
92PA0110047	073 LD006	240.0	60	0	0	0	0	10	10
92PA0120064	071 LD007	204.0	26	0	0	0	0	0	0
92PA0120013	076 LF004	228.0	60	0	0	0	0	2	3
92PA0120012	085 LG004	216.5	60	0	0	0	0	0	0
92PA0120014	081 LG005	225.0	60	0	0	0	0	0	0
92PA0120017	087 LJ003	210.5	60	0	0	0	0	1	1
92PA0120015	084 LJ010	214.5	60	0	0	0	0	3	3
				STRATUM W1-3					
92PA0110041	052 KX002	384.5	60	160	2	17	20	6	205
92PA0120008	067 LA001	319.5	60	174	0	12	7	26	219
92PA0110044	064 LA002	343.0	62	256	0	25	36	31	347
92PA0110048	061 LA007	378.5	64	721	0	77	58	18	874
92PA0120007	062 LA439	348.5	60	159	0	31	165	24	379
92PA0110046	068 LB005	314.5	61	870	1	49	21	181	1121
92PA0120055	069 LB437	365.5	60	239	0	3	13	21	276
92PA0110045	072 LD004	322.0	60	341	0	50	39	65	495
92PA0120009	075 LE440	311.5	60	140	0	8	12	64	223
92PA0120010	077 LF440	305.0	61	6	0	2	0	7	15
92PA0120053	083 LG438	333.5	60	276	0	1	4	19	300
				STRATUM W1-4					
92PA0120054	074 LE436	559.0	60	0	0	5	62	3	70
92PA0120052	086 LH438	420.5	60	216	0	17	142	19	393
				STRATUM W2-1					
92PA0120067	070 LD014	166.0	61	0	0	0	0	1	2
92PA0120069	078 LF015	159.0	60	0	0	0	1	7	8
				STRATUM W2-2					
92PA0110050	066 LA011	272.0	60	833	0	1	5	15	853
92PA0110053	060 LA014	294.5	60	230	0	17	23	12	281
92PA0120066	079 LF013	215.0	60	0	0	0	0	1	1
				STRATUM W2-3					
92PA0110051	059 KZ014	305.0	60	887	0	28	40	2	956
92PA0110055	054 KZ015	340.0	60	212	0	8	3	6	230
				STRATUM W2-4					
92PA0110054	057 KZ015	503.0	60	331	0	52	13	10	407
92PA0110052	065 LA016	534.0	62	739	0	73	14	35	860
				STRATUM W3-1					
92PA0110032	033 KL007	160.5	60	0	0	0	0	2	2
92PA0110033	035 KM006	181.0	62	0	0	0	0	2	2
92PA0120003	043 KS006	158.0	50	0	0	0	0	0	0
				STRATUM W3-2					
92PA0120006	036 KL004	223.5	60	0	0	0	0	2	2
92PA0110031	034 KL005	219.0	62	0	0	0	0	10	10
92PA0120005	038 KM001	239.5	60	0	0	1	0	2	3
92PA0110035	037 KM002	229.5	60	0	0	0	0	1	1
92PA0110034	039 KN004	221.0	60	0	0	0	0	1	1
92PA0120004	041 KR005	229.0	60	0	0	0	0	3	3
				STRATUM W3-3					
92PA0120001	032 KJ006	363.0	60	888	0	4	866	2	1759
92PA0110036	042 KR440	315.0	60	958	0	2	38	9	1006
92PA0110037	044 KS439	373.5	60	474	0	31	35	5	544
92PA0110043	048 KV003	386.5	61	1052	0	45	156	7	1260
				STRATUM W3-4					
92PA0120002	031 KK004	517.5	60	6	0	10	50	6	71
92PA0110038	046 KT439	413.5	64	295	0	34	78	2	409
92PA0110040	049 KV001	425.0	63	47	0	7	4	0	57
92PA0110042	055 KX004	411.5	60	177	0	49	97	5	328

Table 1c. List of trawl stations in strata between 61°52′5N and 67°00′N in the Davis Strait survey, July-August 1992. Catches are given in kg.

STATION-IDENTIFICATION	AREA-CODE	DEPTH	TR-TIME	SHR	COD	GHL	RED	MIX	TOTAL
				STRATUM W4-1					
92PA0110020 021	JZ010	190.5	60	0	0	3	0	1	4
92PA0110021 022	KA009	178.5	60	0	0	0	0	1	1
92PA0110026 024	KB009	198.0	60	0	0	0	0	5	5
92PA0110029 029	KE008	166.5	63	0	0	0	0	1	1
92PA0110028 028	KE009	167.0	60	0	0	0	0	7	7
				STRATUM W4-2					
92PA0110025 023	KB007	278.5	64	0	0	1	1	6	8
92PA0110027 025	KD010	204.5	60	0	0	0	1	1	2
				STRATUM W4-3					
92PA0110023 027	KD007	358.0	63	1701	0	0	331	2	2034
92PA0110030 030	KH007	338.0	60	821	0	8	31	2	862
				STRATUM W4-4					
92PA0110022 020	JX007	573.0	60	0	0	0	8	4	11
92PA0110024 026	KD006	479.5	58	0	2	20	71	3	96
				STRATUM W5-1					
92PA0110013 017	JL020	154.5	60	0	0	0	0	1	1
92PA0110019 019	JS012	171.5	60	1	0	0	0	0	1
				STRATUM W5-2					
92PA0110009 009	JD020	263.0	60	96	0	0	13	3	112
92PA0110016 013	JH015	268.0	61	427	0	0	2	1	430
92PA0110017 015	JJ014	262.0	60	0	0	0	0	0	1
92PA0110014 014	JJ020	241.0	61	1730	0	0	19	4	1752
				STRATUM W5-3					
92PA0110010 010	JF021	359.0	60	294	0	1	66	8	369
92PA0110015 011	JG013	335.5	63	0	9	1	24	6	41
				STRATUM W5-4					
92PA0110011 012	JG021	469.5	60	1265	0	13	15	8	1301
92PA0110012 016	JK020	436.0	60	57	0	2	10	3	71
92PA0110018 018	JM013	543.0	60	0	0	5	6	4	15
				STRATUM W6-1					
92PA0110002 002	HL027	166.5	60	0	0	0	0	3	3
92PA0110008 008	JA023	194.0	60	809	0	0	3	6	817
				STRATUM W6-2					
92PA0110001 001	HJ031	223.5	60	163	0	3	3	11	178
92PA0110003 003	HL028	219.5	60	378	0	0	3	13	393
				STRATUM W6-3					
92PA0110006 006	HV022	324.0	60	225	0	0	17	12	254
92PA0110007 007	HX023	378.5	60	410	13	15	47	36	521
				STRATUM W6-4					
92PA0110004 004	HN025	530.5	60	0	0	0	23	12	35
92PA0110005 005	HT023	510.5	65	0	0	0	28	80	108

Table 2. List of trawl stations in the area Cape Farewell - 63°52'5N in the September 1992 survey.

STATION-IDENTIFICATION	AREA-CODE	DEPTH	TR-TIME	SHR	COD	GHL	RED	MIX	TOTAL
				STRATUM JULIANEHAAB BAY					
92PA0140043 999	GE051	399.0	60	0	0	0	12	3	15
92PA0140045 999	GE053	305.0	69	0	0	0	1	1	2
92PA0140042 999	GF050	363.5	54	0	0	0	1	1	2
92PA0140044 999	GF052	183.5	42	0	0	0	0	0	0
92PA0140048 999	GF054	249.0	45	1	0	0	1	0	2
92PA0140047 999	GF055	195.0	60	0	0	0	0	5	5
92PA0140041 999	GG050	161.0	60	0	0	0	1	2	3
92PA0140046 999	GG055	176.0	60	0	0	0	0	1	1
92PA0140040 999	GH048	295.0	48	3	0	0	16	0	19
92PA0140050 999	GK048	125.0	60	0	0	0	0	0	0
92PA0140049 999	GK050	125.0	60	0	0	0	0	0	0
92PA0140036 999	GM040	230.0	60	0	0	0	0	4	4
92PA0140038 999	GM042	110.5	60	0	0	0	0	0	0
92PA0140035 999	GN040	132.5	60	0	0	0	1	1	2
92PA0140037 999	GN042	112.0	60	0	0	0	0	0	1
92PA0140039 999	GN044	346.5	60	150	0	0	1	0	152
				STRATUM W6-2					
92PA0140028 999	HG031	297.5	34	238	0	1	9	8	256
92PA0140027 999	HJ031	223.0	60	29	0	5	0	4	37
92PA0140016 999	HX023	229.5	60	178	0	0	2	1	181
				STRATUM W6-3					
92PA0140029 999	HG031	346.0	65	1047	0	2	18	6	1074
92PA0140024 999	HM026	328.5	60	1	0	0	3	2	6
92PA0140022 999	HP025	362.5	60	426	10	2	76	12	525
92PA0140015 999	HX023	306.5	60	375	0	0	15	7	396
				STRATUM W6-4					
92PA0140026 999	HJ029	546.5	44	0	0	0	0	0	0
92PA0140019 999	HR026	402.5	60	474	2	2	8	3	488
92PA0140017 999	HX024	464.0	60	347	2	2	17	10	377
				STRATUM W7					
92PA0140034 999	GT035	115.0	60	1	0	0	0	5	6
92PA0140033 999	HA032	120.5	61	0	0	0	0	1	1
92PA0140032 999	HE031	104.0	60	0	0	0	0	2	2
				STRATUM W7-1					
92PA0140031 999	HE030	170.5	60	0	0	0	0	2	3

Table 3a. Estimated trawlable biomass in strata west of the midline in the Davis Strait survey July-August 1992.

STRATUM	SQKM	BIOMASS IN STRATA					
		TONS	HAULS	STD	STDERR	MIN	MAX
AREA C1 300-400 M	655	1820.6	2	2105.2	1488.6	332	3309
AREA C1 400-600 M	312	5.4	2	4.3	3.0	2	8
AREA C3 200-300 M	660	181.3	2	240.2	169.8	11	351
AREA C3 300-400 M	1192	14754.7	1	.	.	14755	14755
AREA C3 400-600 M	623	2.2	2	3.2	2.2	0	4

Table 3b. Estimated trawlable biomass in strata north of 69°30'N in the Davis Strait survey July-August 1992.

STRATUM	SQKM	BIOMASS IN STRATA					
		TONS	HAULS	STD	STDERR	MIN	MAX
AREA N1	3649	1871.7	5	2304.1	1030.4	3	5727
AREA N2	11789	2518.1	5	4624.6	2068.2	0	10654
AREA N3	367	88.9	2	125.7	88.9	0	178
AREA N4	2249	9717.3	3	3996.7	2307.5	7093	14317
AREA N5	5990	2470.3	8	4189.2	1481.1	0	10556
AREA N6	15926	4498.1	6	4905.5	2002.7	0	10112
AREA N7	1159	0.0	2	0.0	0.0	0	0

Estimated trawlable biomass in strata south of 69°30'N east of the line in the Davis Strait survey July-August 1992.

STRATUM	SQKM	BIOMASS IN STRATA					
		TONS	HAULS	STD	STDERR	MIN	MAX.
AREA W1 150-200 M	2363	3.5	3	6.1	3.5	0	11
AREA W1 200-300 M	5213	3.1	7	8.1	3.1	0	22
AREA W1 300-400 M	9239	30958.5	11	28648.6	8637.9	536	94813
AREA W1 400-600 M	752	790.3	2	1117.6	790.3	0	1581
AREA W2 150-200 M	1499	0.0	2	0.0	0.0	0	0
AREA W2 200-300 M	2477	9881.6	3	12317.4	7111.4	0	23681
AREA W2 300-400 M	1453	10685.5	2	8867.9	6270.6	4415	16956
AREA W2 400-600 M	559	3279.1	2	1536.9	1086.8	2192	4366
AREA W3 150-200 M	2215	0.0	3	0.0	0.0	0	0
AREA W3 200-300 M	4810	4.6	6	8.8	3.6	0	22
AREA W3 300-400 M	2714	23094.6	4	7291.9	3645.9	12335	28435
AREA W3 400-600 M	3361	4639.1	4	4578.1	2289.1	195	10317
AREA W4 150-200 M	4204	0.7	5	1.7	0.7	0	4
AREA W4 200-300 M	1736	0.0	2	0.0	0.0	0	0
AREA W4 300-400 M	745	10096.3	2	4650.2	3288.2	6808	13384
AREA W4 400-600 M	1915	1.1	2	1.6	1.1	0	2
AREA W5 150-200 M	1995	8.2	2	8.8	6.2	2	14
AREA W5 200-300 M	3454	21638.9	4	31875.3	15937.7	0	68567
AREA W5 300-400 M	1797	3132.3	2	4425.4	3129.2	3	6262
AREA W5 400-600 M	2806	11521.7	3	18881.6	10901.3	0	33312
AREA W6 150-200 M	1095	3826.9	2	5412.0	3826.9	0	7654
AREA W6 200-300 M	1491	3906.4	2	1921.0	1358.3	2548	5265
AREA W6 300-400 M	1300	3685.6	2	1397.4	988.1	2698	4674
AREA W6 400-600 M	884	0.0	2	0.0	0.0	0	0

Table 4. Estimated trawlable biomass in strata in the Davis Strait survey September 1992.

STRATUM	SQKM	BIOMASS IN STRATA					
		TONS	HAULS	STD	STDERR	MIN	MAX
AREA W6 200-300 M	1491	2899.6	3	3190.0	1841.7	328	6469
AREA W6 300-400 M	1300	4916.8	4	4140.6	2070.3	14	9916
AREA W6 400-600 M	884	2371.8	3	2073.1	1196.9	0	3838
AREA W7 150-200 M	2419	0.0	1	.	.	0	0
AREA JHB 100-200 M	6806	3.0	9	7.1	2.4	0	21
AREA JHB 200-600 M	5719	1230.9	7	3134.1	1184.6	0	8336

Table 5. Sums of estimated biomasses in main regions 1988-92.

AREA	BIOMASS IN YEAR 1988	1989	1990	1991	1992
WEST	140332	176525	151402	108406	141158
CANADA	9305	3836	11425	4668	16764
NORTH	21901	11342	11733	6032	21164
TOTAL	171538	191703	174560	119106	179089

Table 6a. Stratum areas per depth stratum in % of total survey area, and calculated biomass estimates per depth stratum in % of total yearly biomass from surveys 1988-92 in the area 61°52'5N - 69°30'N.

	D E P T H S T R A T U M 150-200 M	200-300 M	300-400 M	400-600 M	TOTAL
W1 AREA	2.3	5.0	8.8	0.7	16.8
1988-BIOM	0.0	0.8	19.5	0.0	20.3
1989-BIOM	0.1	5.2	6.7	0.0	12.0
1990-BIOM	0.1	1.5	17.2	0.0	18.8
1991-BIOM	0.1	0.1	18.6	0.0	18.9
1992-BIOM	0.0	0.0	17.3	0.4	17.7
W2 AREA	1.4	2.4	1.4	0.5	5.7
1988-BIOM	0.0	4.6	7.6	1.0	13.3
1989-BIOM	0.0	6.0	10.7	0.9	17.5
1990-BIOM	0.0	3.3	17.0	5.8	26.1
1991-BIOM	0.0	0.1	9.9	3.7	13.7
1992-BIOM	0.0	5.5	6.0	1.8	13.3
W3 AREA	2.1	4.6	2.6	3.2	12.5
1988-BIOM	0.0	12.3	8.0	4.5	24.9
1989-BIOM	0.1	17.2	5.9	3.8	27.0
1990-BIOM	0.0	6.0	10.0	4.5	20.4
1991-BIOM	0.0	2.9	9.7	9.8	22.4
1992-BIOM	0.0	0.0	12.9	2.6	15.5
W4 AREA	4.0	1.7	0.7	1.8	8.2
1988-BIOM	7.7	3.2	0.2	2.3	13.5
1989-BIOM	1.4	14.0	0.0	0.1	15.5
1990-BIOM	0.0	6.4	0.7	0.0	7.2
1991-BIOM	0.1	6.0	6.0	0.0	12.1
1992-BIOM	0.0	0.0	5.6	0.0	5.6
W5 AREA	1.9	3.4	1.9	2.7	9.6
1988-BIOM	0.0	3.4	2.7	3.7	9.8
1989-BIOM	3.4	9.9	5.2	1.5	20.0
1990-BIOM	0.0	2.3	5.1	2.4	9.8
1991-BIOM	0.0	6.4	3.6	3.0	13.0
1992-BIOM	0.0	12.1	1.7	6.4	20.3
W6 AREA	1.0	1.4	1.2	0.8	4.6
1988-BIOM	-	-	-	-	-
1989-BIOM	-	-	-	-	-
1990-BIOM	0.1	3.1	0.1	1.1	4.4
1991-BIOM	0.2	3.1	6.1	1.5	11.0
1992-BIOM	2.2	2.2	2.1	0.0	6.4
C1 AREA	-	-	0.6	0.3	0.9
1988-BIOM	-	-	1.1	0.0	1.1
1989-BIOM	-	-	0.5	0.0	0.6
1990-BIOM	-	-	2.4	0.0	2.4
1991-BIOM	-	-	1.5	0.0	1.5
1992-BIOM	-	-	2.1	0.0	1.0
C3 AREA	-	0.6	1.1	0.6	2.4
1988-BIOM	-	-	4.3	-	4.3
1989-BIOM	-	-	1.1	0.3	1.4
1990-BIOM	-	1.6	2.3	0.3	4.1
1991-BIOM	-	0.3	2.1	0.0	2.4
1992-BIOM	-	0.1	8.2	0.0	8.3

Table 6b. Stratum areas in % of total survey area, and calculated biomass estimates in % of total yearly biomass from surveys 1988-91 in the area 69°30'N - 72°30'N.

	TOTAL
N1 AREA	3.5
1988-BIOM	1.5
1989-BIOM	2.2
1990-BIOM	1.7
1991-BIOM	1.4
1992-BIOM	1.0
N2 AREA	11.3
1988-BIOM	3.2
1989-BIOM	0.6
1990-BIOM	1.2
1991-BIOM	0.0
1992-BIOM	1.4
N3 AREA	0.4
1988-BIOM	0.0
1989-BIOM	0.1
1990-BIOM	0.2
1991-BIOM	0.5
1992-BIOM	0.0
N4 AREA	2.1
1988-BIOM	2.7
1989-BIOM	1.4
1990-BIOM	2.0
1991-BIOM	1.5
1992-BIOM	5.4

	TOTAL
N5 AREA	5.7
1988-BIOM	1.5
1989-BIOM	1.7
1990-BIOM	0.7
1991-BIOM	0.1
1992-BIOM	1.4
N6 AREA	15.2
1988-BIOM	1.6
1989-BIOM	-
1990-BIOM	0.4
1991-BIOM	1.5
1992-BIOM	2.5
N7 AREA	1.1
1988-BIOM	2.2
1989-BIOM	0.0
1990-BIOM	0.6
1991-BIOM	0.0
1992-BIOM	0.0

Table 7. Relative distribution (%) of estimated biomasses 1988-92 in depth strata south of 69°30'N.

YEAR	DEPTH STRATUM 150-200	200-300	300-400	400-600
1988	8.9	28.0	49.9	13.2
1989	5.3	55.6	32.1	7.0
1990	0.3	25.8	58.8	15.1
1991	0.5	19.9	60.6	19.0
1992	2.4	22.6	62.2	12.8

Table 8. Summary of age and growth data for samples of northern shrimp from Davis Strait, 1983-87, combined (from Savard et al., 1989).

Age	Min - max lengths (mm)	Range	Mean length (mm)	Increment (mm)
1	7.4 - 9.8	2.4	8.4	> 3.9
2	10.9 - 13.1	2.2	12.3	> 3.4
3	14.5 - 16.6	2.1	15.7	> 2.8
4	17.6 - 19.4	1.8	18.5	> 2.1
5	19.1 - 22.1	3.0	20.6	> 2.1
6	21.3 - 23.8	2.5	22.7	> 2.2
7	23.0 - 26.6	3.6	24.9	> 1.4
8	24.4 - 28.0	3.6	26.3	

Table 9. Mean carapace length of shrimp at age estimated from Greenlandic research trawl samples, 1988 - 92.

Year	88	89	90	91	92
Age (yr)					
2	12.62	12.8	12.29	12.91	13.46
3	**14.97**	15.68	14.26	16.01	15.3
4	17.62	**17.55**	17.07	17.6	17.47
5	20.14	19.79	**19.41**	20.04	19.59
6	22.51	22.35	21.49	**21.76**	22.22

Table 10. Proportions of shrimp at age estimated from Greenlandic research trawl samples, 1988 - 92.

Year	88	89	90	91	92
Age (yr)					
2	0.023	0.014	0.038	0.013	0.034
3	**0.047**	0.145	0.048	0.052	0.118
4	0.19	**0.501**	0.144	0.141	0.151
5	0.392	0.219	**0.534**	0.181	0.271
6	0.348	0.121	0.236	**0.613**	0.427
Total	1	1	1	1	1

Table 11. Abundance of shrimp (x10-6) at age estimated from Greenlandic trawl surveys, 1988 - 92.

Year	88	89	90	91	92
Age (yr)					
2	549	461	852	182	846
3	**1122**	4775	1076	726	2932
4	4534	**16499**	3227	1970	3753
5	9354	7212	**11967**	2529	6736
6	8304	3985	5289	**8564**	10610
7+	9970	6398	8146	5257	**6459**
Total	33832	39331	30556	19228	31336
Z (5+)		**0.98**	**0.27**	**0.61**	**-0.04**
Z (6+)		**1.05**	**0.24**	**0.94**	**0.76**

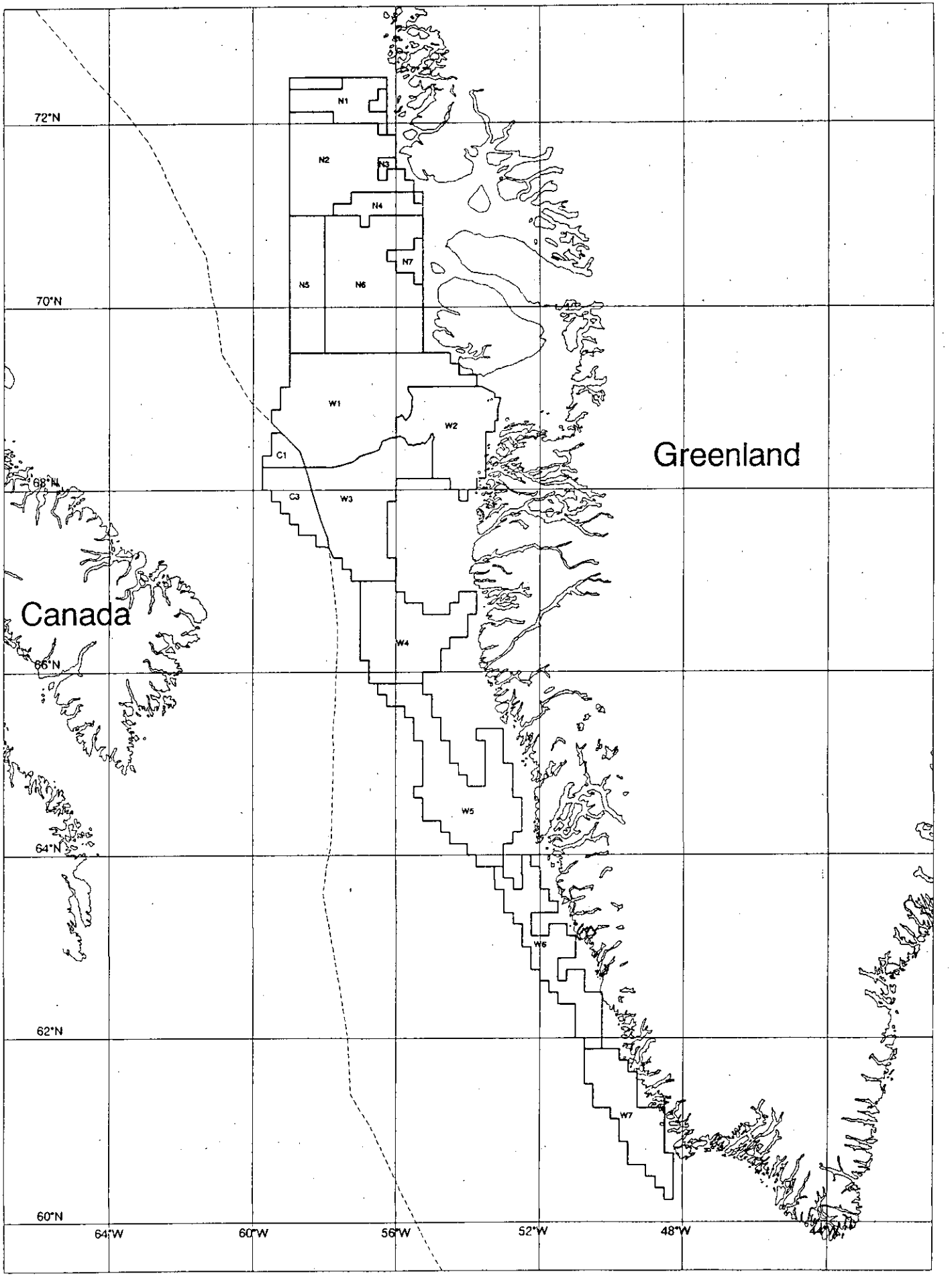


Fig. 1. Stratification scheme for West Greenland offshore shrimp surveys showing stratum numbering as used in the text.

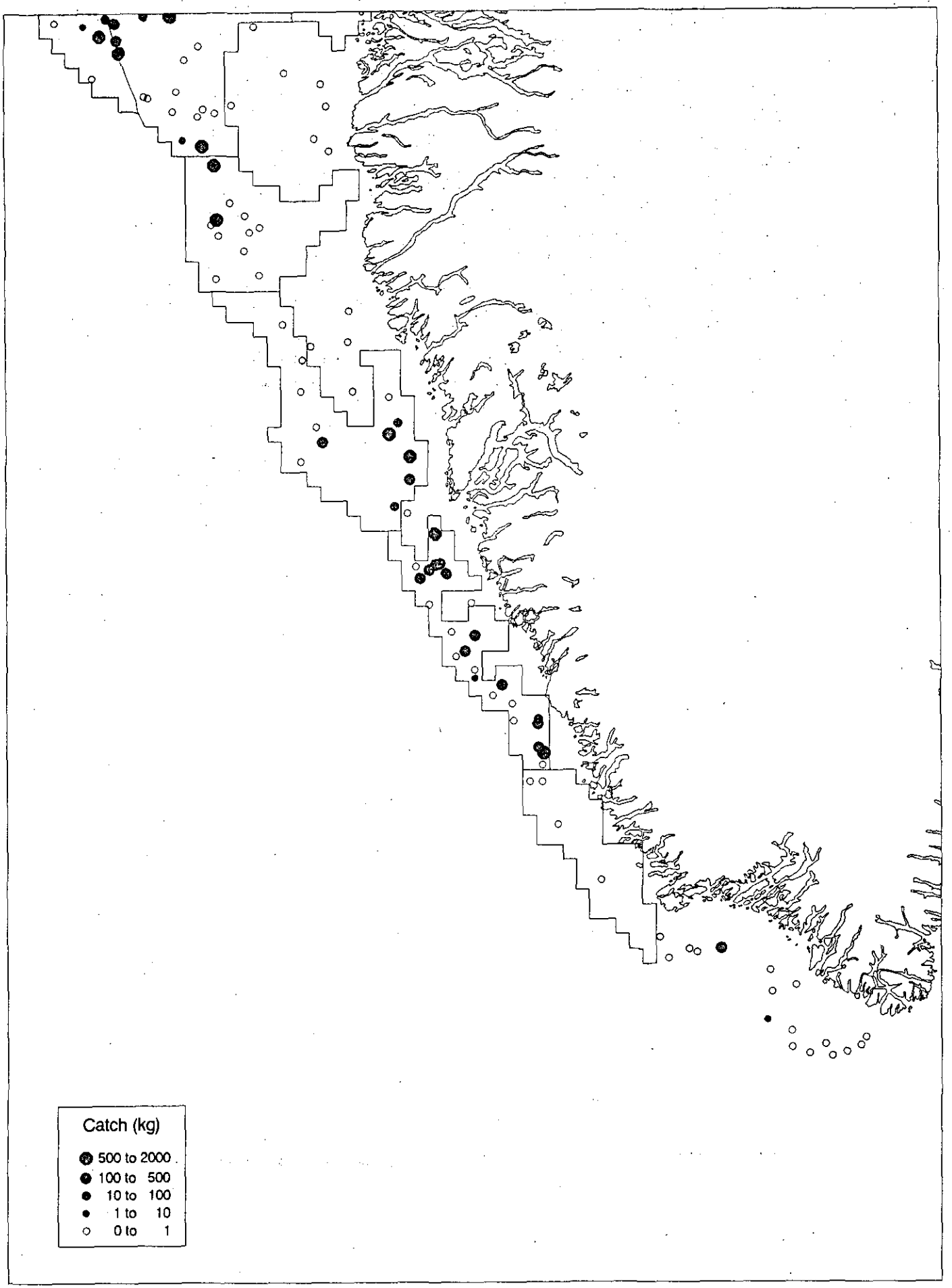


Fig. 2a. Sampling sites and trawl catches in the West Greenland offshore surveys in the period July-September, 1992, southern part.

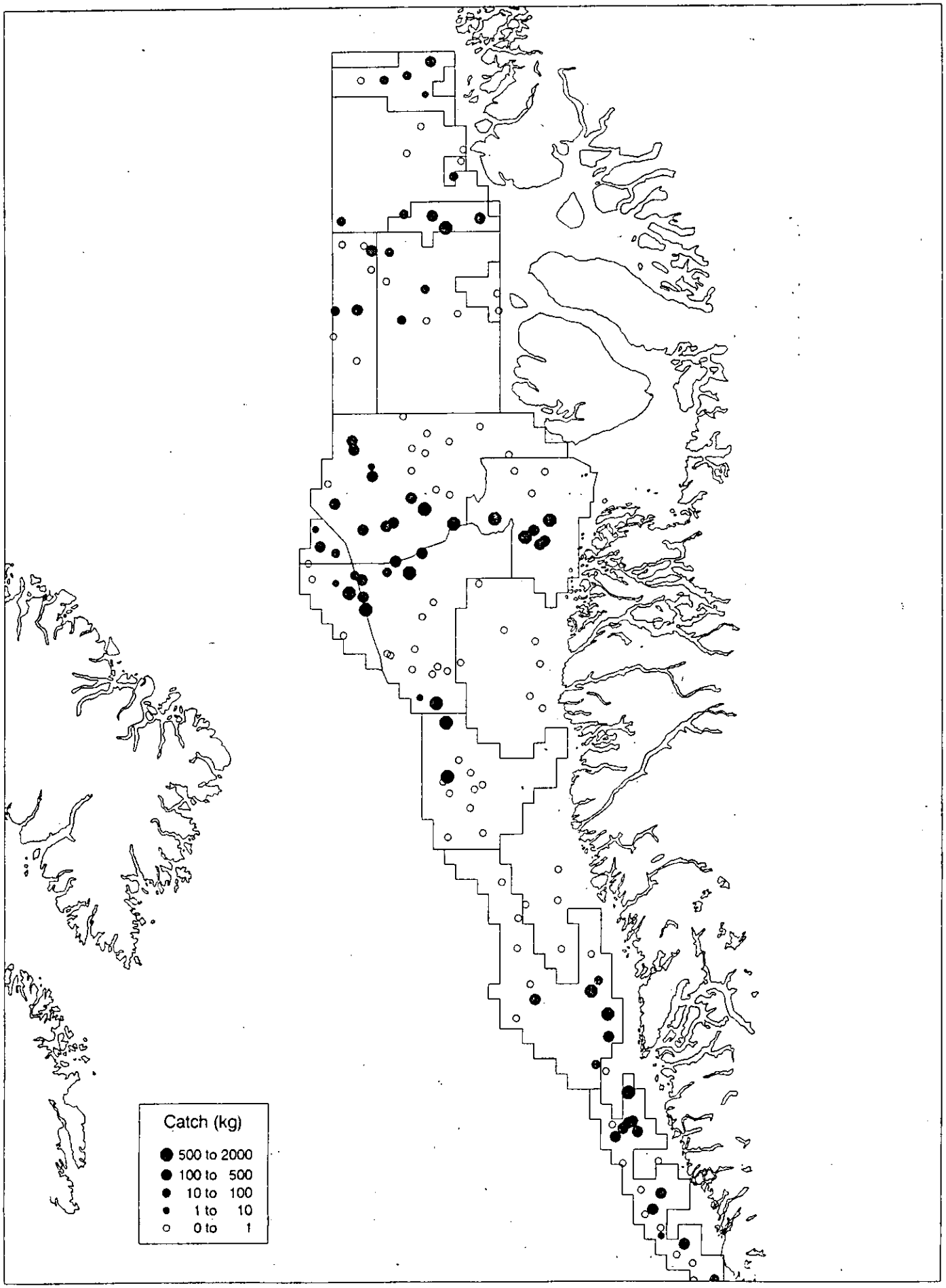


Fig. 2b. Sampling sites and trawl catches in the West Greenland offshore surveys in the period July-September, 1992, northern part.

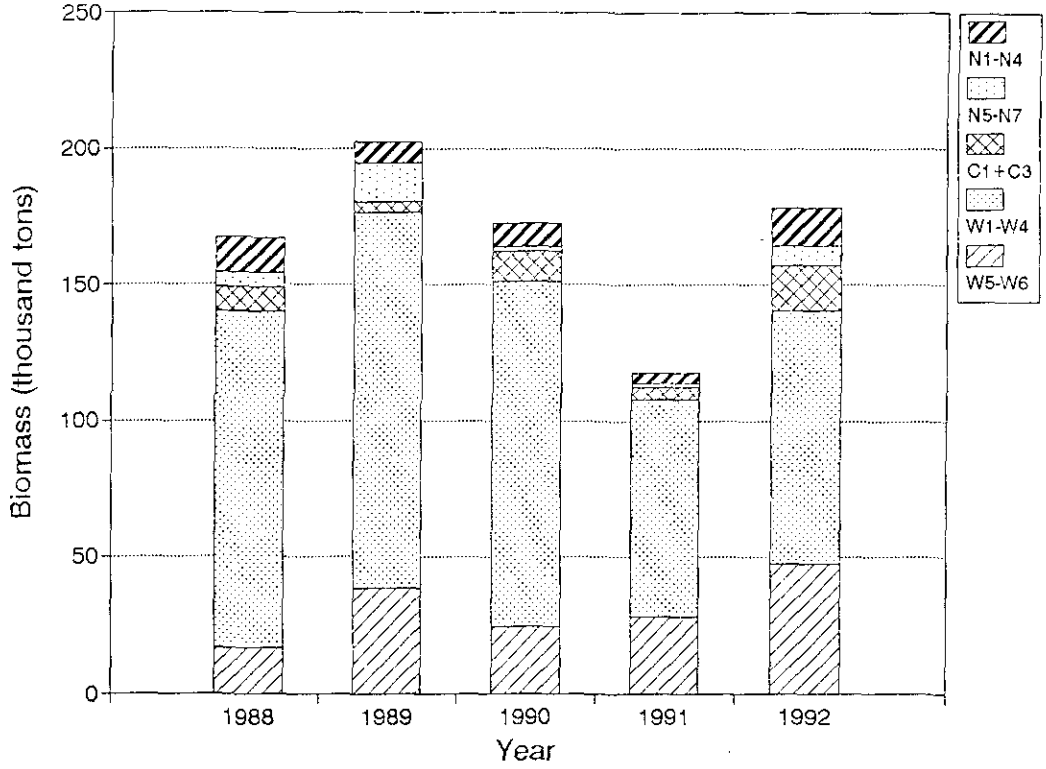


Fig. 3. Estimated total biomass 1988-92 for groups of strata in the Davis Strait.

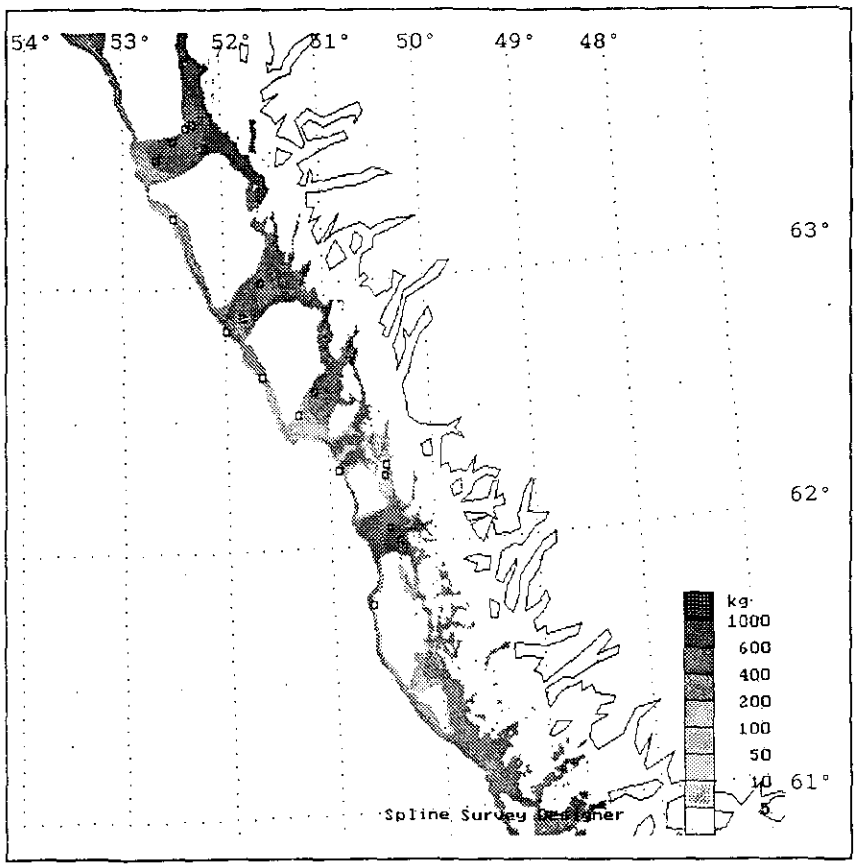


Figure 4a. Contour map with estimated shrimp densities 1992 for the area 61°N-64°N as calculated with the 'spline' method, based on survey data. Sampling sites are also given.

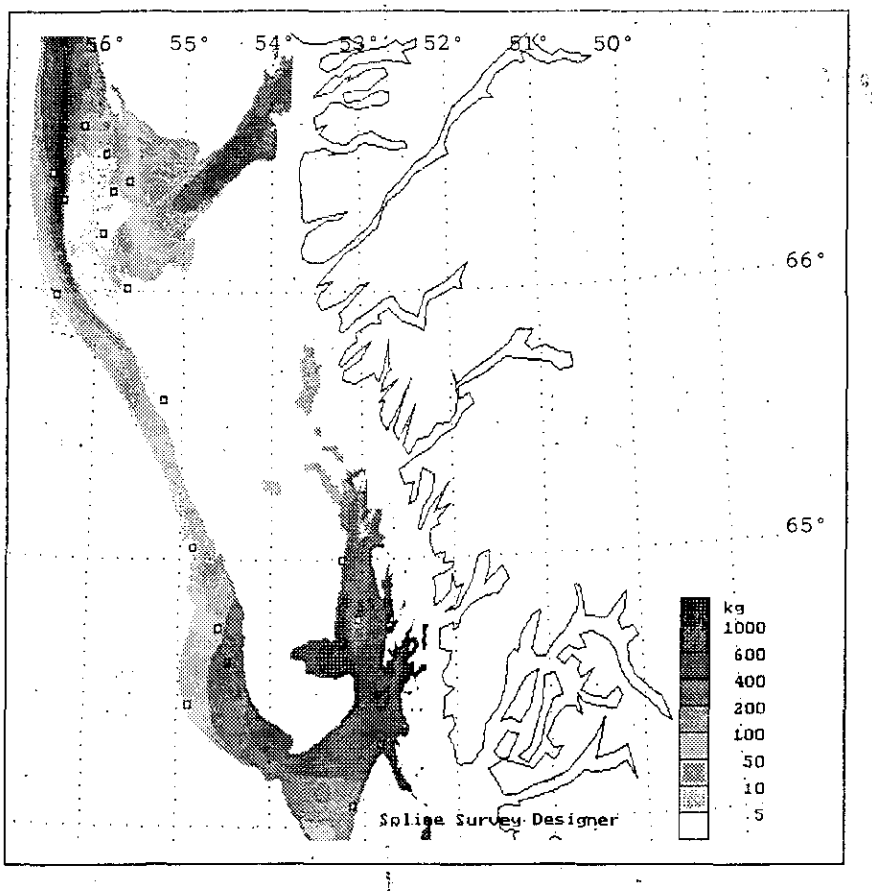


Figure 4b. Contour map with estimated shrimp densities 1992 for the area 64°N-67°N as calculated with the 'spline' method, based on survey data. Sampling sites are also given.

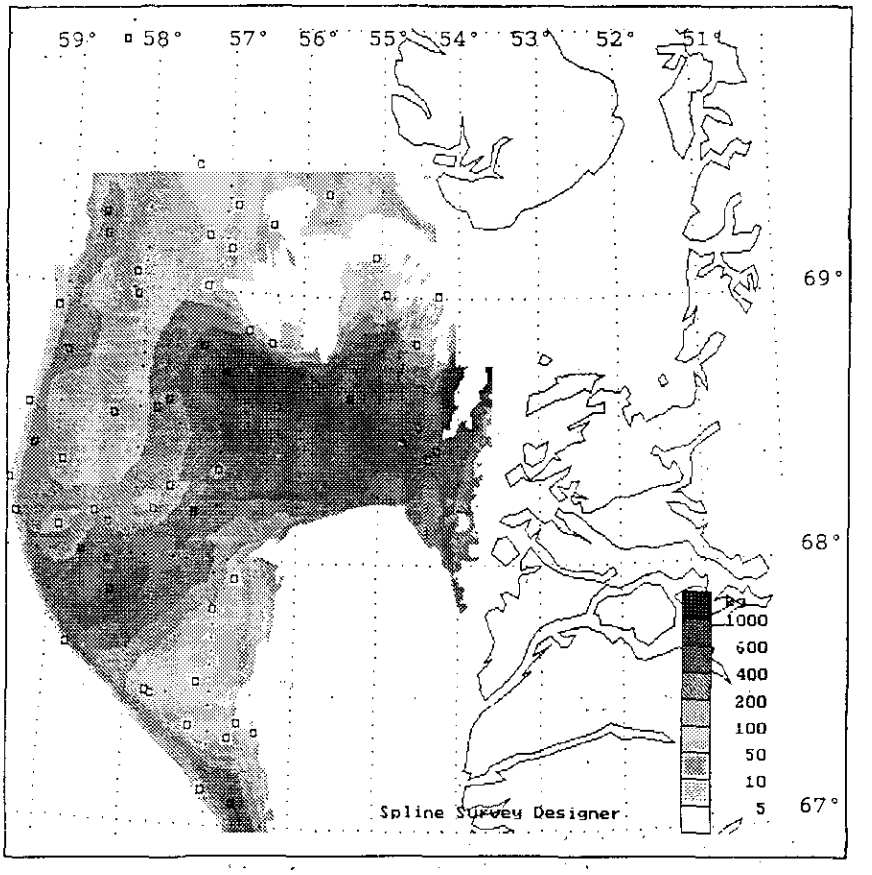
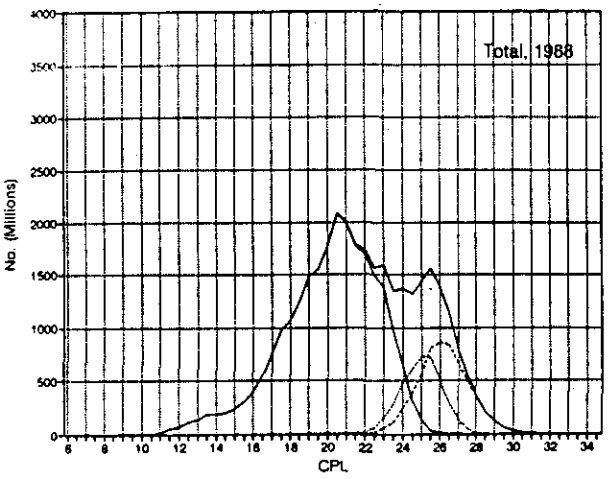
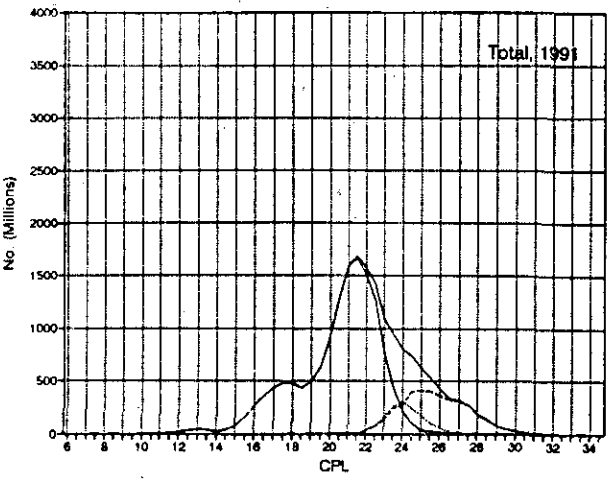
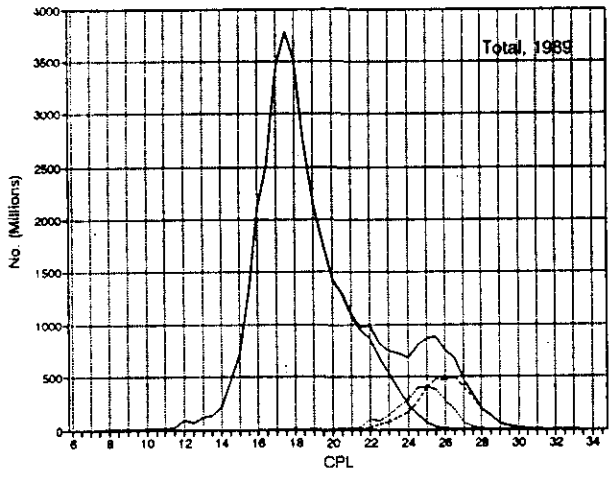
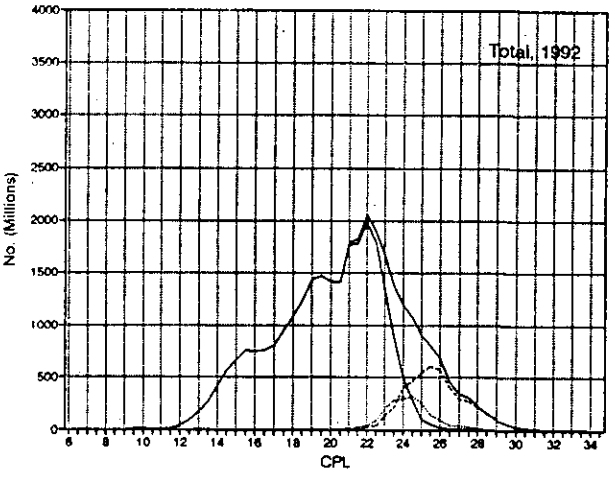


Figure 4c. Contour map with estimated shrimp densities 1992 for the area 67°N-70°N as calculated with the 'spline' method, based on survey data. Sampling sites are also given.









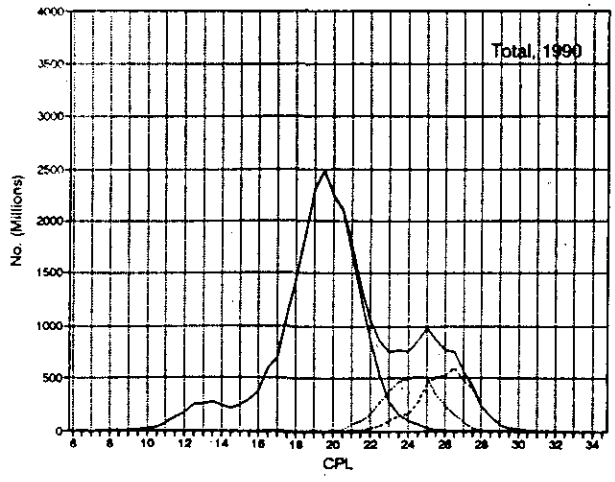


Fig. 5. Numbers of shrimp by length group (CL) in the total survey area in 1988-92, based on pooling of samples weighted by catch and stratum area.

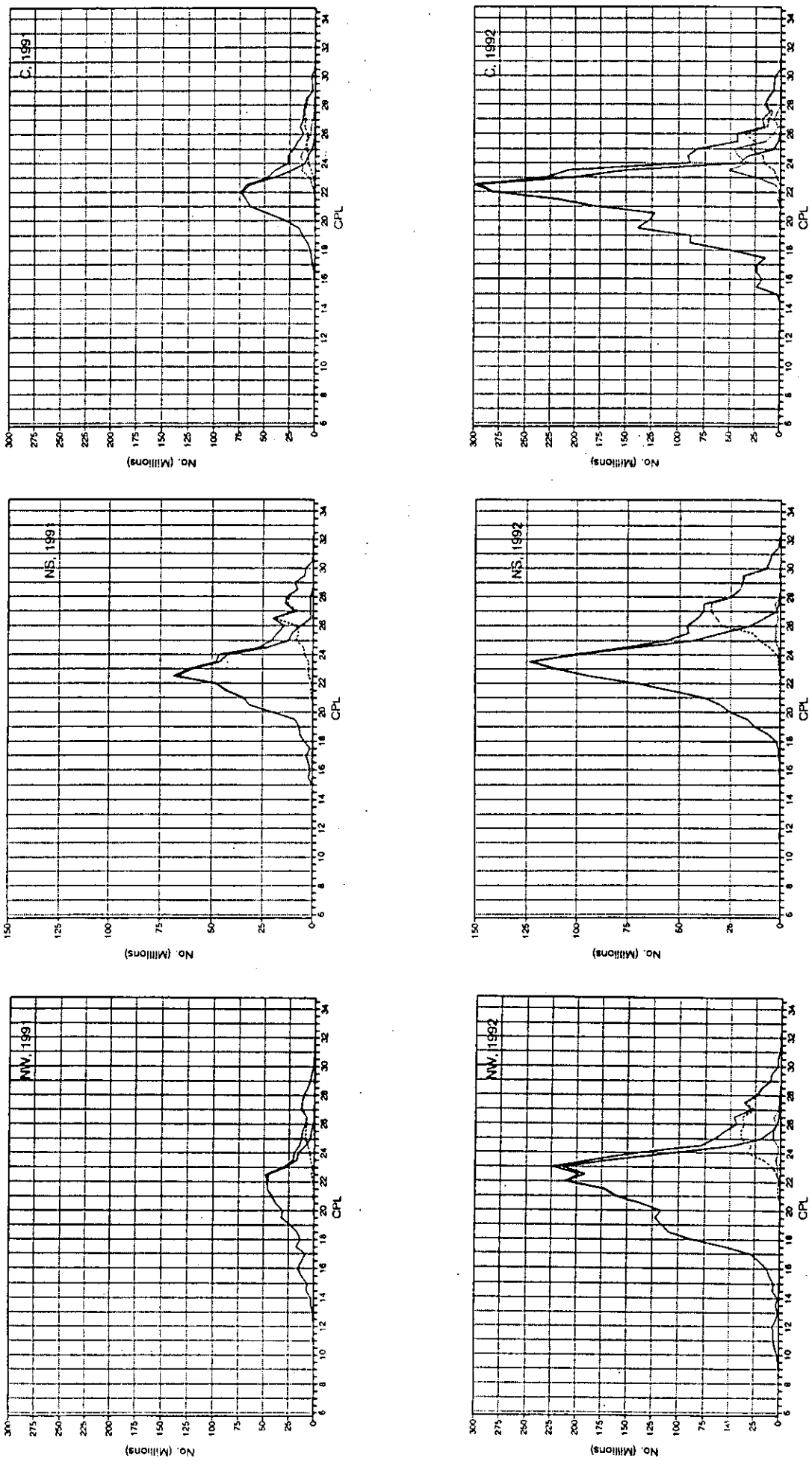


Fig. 6a. Numbers of shrimp by length group (CL) in strata NW, NS and C in 1991-92, based on pooling of samples weighted by catch and stratum area.

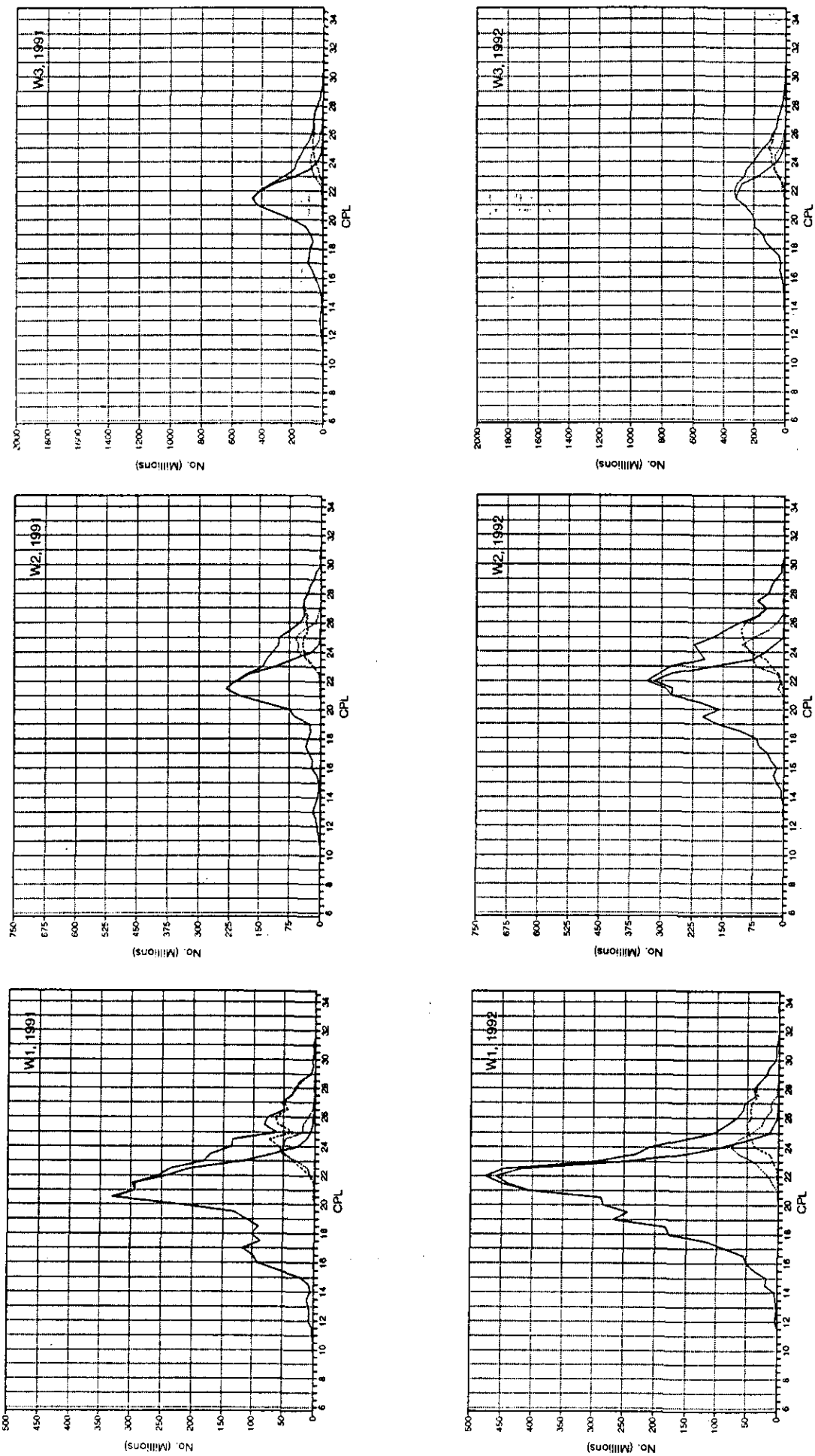


Fig. 6b. Numbers of shrimp by length group (CL) in strata W1-W3 in 1991-92, based on pooling of samples weighted by catch and stratum area.

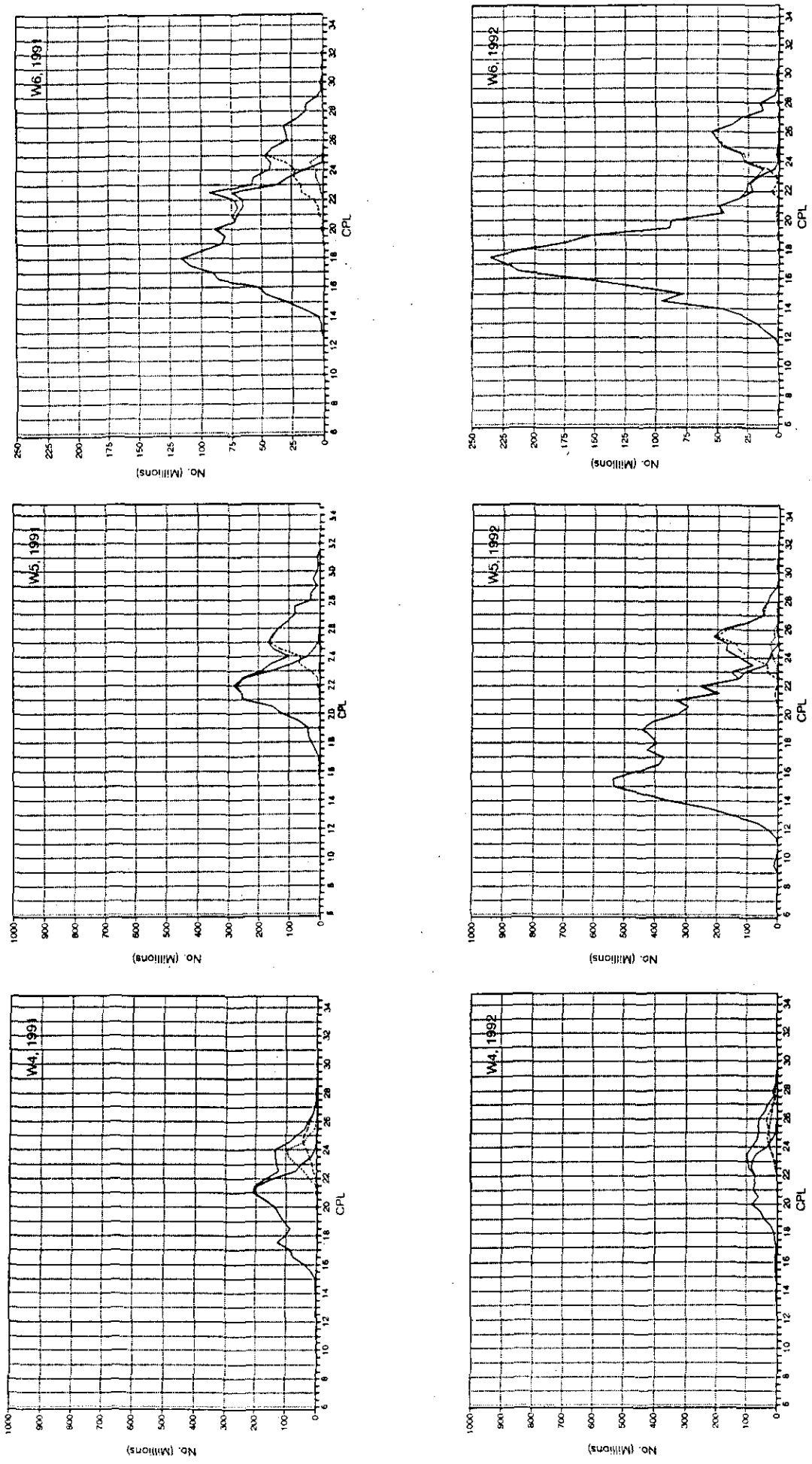


Fig. 6c. Numbers of shrimp by length group (CL) in strata W4-W6 in 1991-92, based on pooling of samples weighted by catch and stratum area.