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Offshore Trawl Survey for Shrimp (Pandalus borealis) in NAFO Subareas 0 and 1, in 1995

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Introduction

Since 1988, Greenland Fisheries Research Institute (now Greenland Institute of Natural Resources) has conducted annual stratified-random surveys on and around the shrimp fishing grounds off West Greenland during the months July - September, to assess the trawlable biomass of the offshore shrimp stock, and to collect information on the size composition of this stock (Carlsson and Kanneworff 1989, 1990, 1991, 1992, Carlsson *et al.* 1993, Andersen *et al.*, 1993, 1994). The survey was performed as a two-phase stratified random survey allocating extra hauls to strata with high densities, thus reducing the variance of the biomass estimate.

The survey covers offshore areas NAFO Div. 1A-F and 0A in the depth interval from 150 to 600 meters, and is thus assumed to cover the total offshore distribution of the stock.

Materials and methods

The survey was performed with a 722 GRT trawler, *Paamiut*, using 3000/20 meshes *Skjervøy* bottom trawl with a twin cod-end. Mesh size in the cod-end was 20 mm stretched mesh. Cod-end mesh size was change in 1993 from 44 mm stretched mesh used in previous years. Trawl,doors were *Greenland Perfect*, measuring 370*250 cm and weighing 2420 kg. Trawl geometry was measured every 10 min. with *Scanmar* acoustic sensors, mounted on the trawl doors. Trawl performance was observed with a *Furuno* trawleye mounted on the headrope.

In order to minimize the influence of vertical migrations of shrimp, the trawl operations were carried out only in the day-time (0900-1900 UTC). The position (GPS) of the vessel at the beginning and end of each tow was used to determine the length of the track. Standard towing time was 60 minutes.

The mean wingspread was calculated for each haul, based on information on warp length, towing speed and the measured distance between doors. Swept area was calculated as the distance between starting and ending position, multiplied by the mean wingspread.

Stratification of the survey area is based primarily on information on bottom topography and on the distribution of the commercial fishery. In areas with reliable depth information four depth zones are applied: 150-200 m, 200-300 m, 300-400 m, and 400-600 m. Four main regions are established (Fig. 1):

N: The region extends from 69°30'N to 72°'30N, and from an approximated three mile limit from land or from the shallow continental shelf (wherever depth information is available) towards west to 59°W, except from a small area south of 70°N where it extends a few miles further to the west. In this region bottom topography is not known well enough to apply a depth stratification. The region is divided into nine strata, based on the distribution of the commercial fishery.

W: This region includes the West Greenland area south of 69°30'N, west of 48°15'W. The region is divided into seven areas, based on distribution of commercial catches and bottom topography. Each of these are further divided into depth strata: 150-200 m, 200-300 m, 300-400 m, and 400-600 m.

C: The stock area in Canadian territorial waters. The region is divided into two areas with similar depth stratification as in region W.

S: The region includes part of NAFO Div. 1F east of 48°15'W with depths between 150 and 600 m. As in region N depth stratification is not possible. Based on the distribution of the commercial fishery the region is divided into two strata.

All shrimp in the survey area are believed to belong to the same stock (NAFO, 1994), and the separation of regions merely reflects different methods of stratification and national territories.

The survey was performed as a two-phase stratified-random survey as described by Francis (1984). In phase one, hauls were allocated at random to strata proportionally to the area of these (Doubleday, 1981) with a coverage of one haul per 800 km^2. However, strata with minor commercial importance in regions N (N2, N5, and N8) and S (S2) were only given one third of this coverage. At least two hauls were planned in each stratum.

In phase two extra hauls were allocated to strata with the highest value of G' (Francis, loc. cit.) in:

$$G' = Ai^2 * Mi^2/(ni * (ni+1))$$

where G' is a relative figure for the gain in variance by allocating one extra haul to depth stratum i.
Ai is the area of depth stratum i.
Mi is the average catch per haul in depth stratum i.
ni is the number of hauls in depth stratum i in phase one.

Stations in phase two were distributed randomly as in phase one.

From each haul a sample of approx. 5 kg of shrimp was taken from the codend of the trawl. The shrimp were sorted by sex and the oblique carapax length was measured by slide caliper to the nearest 0.1 mm. The total catch was sorted and weighed by species.

The overall length distribution of shrimp in 1995 was separated in age groups by modal analysis (Macdonald and Pitcher, 1979), and compared to results from modal analysis of overall distributions from earlier years (D. G. Parsons, pers. comm., and NAFO, 1995).

Results and Discussion

157 hauls were taken in the survey area in the period between July 4 and August 30 as shown in Fig. 2. Table 1a-1c lists the stations by stratum and shows fishing depth in meters, trawl time in minutes, the catch in kg of shrimp, cod, Greenland halibut, redfish, and other species combined. The number of hauls and estimated biomass of shrimp per stratum are shown in Table 2a-2d.

The total biomass estimate in tons in each of the four regions is shown in the following text table.

Region	Biomass estimate	Standard deviation	Standard Error
North	9788	6144	1141
Canadian	5138	3189	1127
West	143181	45775	4467
South	1793	-	-

In Table 3 the biomass is shown by region for each year since 1988. Figure 3 shows the biomass by year in groups of strata, not including the two strata in region S, formerly area W8. The total biomass estimate from the 1995 survey is lower than in 1994, and is the second lowest in the series. The 1991 estimate was the lowest on record.

In region N there is no significant overall change from 1994 to 1995. Figure 3 shows that in both years more than 50 % of the biomass is concentrated in the southern part of the region. In all previous years most of the biomass in this region was found in the northern part i.e. north of 71°N, but in 1994 and 1995 the biomass in this area is reduced to a very low level. Most of the biomass in the southern part of the region is, both in 1994 and 1995, found in the presumed low density stratum N5, while the other strata had a much lower biomass.

In region C the estimated biomass has fluctuated between 3,000 and 17,000 tons over the eight years of surveys. The estimate from 1995 is relatively low but within the range of the estimates from other years.

In region W there has been a general decrease in total estimated biomass from 1993 to 1995. The decrease is mainly due to a reduction in density in the northernmost part of the region (W1 and W2). The estimated biomass in the southern part of the region (W6 and W7) has fluctuated around 55,000 tons in the period 1988-94, and is relatively high in 1995.

The biomass estimate for region S has decreased drastically since 1993, however, the figures for 1993 and 1994 are most likely overestimated.

Table 4 shows that the biomass in 1994 was more concentrated within a narrow depth interval than earlier. The relative increase in the depth interval 3-400 meters to 68 % of the total biomass was caused by a reduced abundance in deeper as well as in more shallow strata. From 1994 to 1995, a considerable displacement from depths between 200 and 400 meters to deeper water is indicated, especially in the areas W3-W6. Further, a biomass larger than normal was observed in shallow water (150-200 m) in the area W7.

As it is generally believed that shrimp migrate towards north and to greater depth as they grow (Carlsson et al. 1993), the results indicate lower abundance of medium sized shrimp, and a possible recruitment of small shrimp to the southernmost area.

For the purpose of making the survey results visible, shrimp distribution was calculated with the spline method (Stolyarenko, 1987) and plotted on maps. Figure 4 a-c shows contour maps of the shrimp distribution and shows the same trends for this years distribution as perviously described in terms of area-stratification.

Stock Composition

Number of shrimp in overall length distributions for the survey area from 1989 to 1995 were:

No. of shrimp (billions)	1989	1990	1991	1992	1993	1994	1995
males	31.9	21.9	12.2	20.9	31.8	25.0	18.0
females	6.0	8.0	4.4	5.5	7.9	6.4	5.1
Total	37.8	29.8	16.6	26.5	39.7	31.4	23.1

In accordance with the decreasing biomass estimates since 1993, numbers of shrimp have also decreased. The decrease from 1994 to 1995 is about 26% (28% for males and about 20% for females).

The number of males may be biased upwards when compared to earlier years due to the introduction in 1993 of a 20 mm mesh size in the cod-end of the survey gear (compared to 44 mm used before).

Overall length distributions for the total survey area in 1990-95 are shown in Fig. 5, and abundance at lenght in 1995 in Table 5. In 1995 a mode of males at 20 mm carapace length (CL) dominates, probably the 1990 year class, which appeared in the 1994 distribution at 17.5 mm CL. Recruitment of several younger year classes is indicated. Female modes are found at 25 mm (primiparous) and 26 mm CL (multiparous). The primiparous distribution is assumed to consist primarily of transitioned shrimp from the 1988 year class, which dominated the male distribution at 21 mm CL

in 1994.

Figures 6a and 6b show total length frequencies by stratum in 1995. Strata north of 69°30'N are combined into two strata NW (includes N1-N4) and NS (includes N5-N9), while strata on the Canadian side of the midline are combined into stratum C (includes C1 and C3).

The male group around 20 mm CL (probably the 1990 year class) is evident in most strata and dominates in the northern part of the main survey area (strata W1-W4 and C). Another group around 17.5 mm CL is obvious in strata W1, W4 and W6, indicating recruitment of the 1991 year class. In stratum W5 this group merges with the 20 mm mode. Modes of smaller males are present in most strata, but small shrimp are most abundant in the southermost strata W5 and W6. Females are most abundant in stratum W3, concurrent with the high biomass estimate in this area. In most strata female modes are found at 25 mm (primiparous) and 26 mm CL (multiparous).

Results of modal analysis of the overall length frequency distributions are shown in Table 6. Results from 1988-1994 were taken from D. G. Parsons (pers. comm.) and NAFO (1995). Analysis of the 1995 distribution was made with a fixed C.V. of 0.05, but without any other constraints. While there are some problems with the identification of the modes of 2 and 3 years old males, none of them being inside the range of earlier years, the modes of 4, 5, and 6 years old males do fit well in the general pattern. Abundance at age indicates a relatively strong 1990 year class in 1995, close to the size of the 1985 year class in 1990. In 1994, however, the 1990 year class was far from the size of the 1985 year class at age 4.

The biomass estimate from the survey in 1991 is the lowest on record. The abundance of six years old shrimp in 1991 indicates that the biomass was heavily underestimated, if the concept of a very strong 1985 year class is correct and results from the modal analysis are reliable.

Conclusions

The total biomass estimates from the surveys in the period 1988-95 indicate a generally stable situation apart from a low level in 1991. A decline from a high level in 1993 through 1995 is, however, indicated, the area between 68° and 69°30'N exhibiting a marked reduction in biomass estimate. The biomass estimate for the northernmost part of the survey area (north of 71°N) is reduced to a very low level in 1995.

Overall length distributions and results from modal analysis indicate a relatively strong 1990 year class and recruitment of several year classes of smaller shrimp. Females and larger older males were most abundant in the northern strata in the main area, while smaller males dominated in the southern strata W5 and W6.

Abundance at age of the strong 1985 year class indicates that the biomass was heavily underestimated in 1991.

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Tabel 1a. List of trawl stations in strata west of the midline, and north of 69°30'N in Davis Strait survey, July to August 1995. Catches are given in kg.

STATION-IDENTIFICATION	AREA-CODE	DEPTH	TR-TIME	SHR	COD	GHL	RED	MIX	TOTAL
STRATUM C1-3									
95PA0060008 103	KX438	337.5	59	93	0	3	24	20	140
95PA0060007 107	KZ436	322.5	60	18	0	1	19	9	47
STRATUM C1-4									
95PA0060006 110	KZ435	446.0	60	31	0	10	24	13	78
95PA0060005 111	LA435	522.5	60	5	0	13	74	10	103
STRATUM C3-2									
95PA0060018 088	KP439	279.0	60	6	0	0	1	5	13
95PA0060011 098	KT437	277.0	60	0	0	1	0	1	3
STRATUM C3-3									
95PA0060012 090	KR437	349.5	60	70	0	16	80	9	175
95PA0060013 094	KS438	379.5	60	368	0	23	265	8	663
STRATUM C3-4									
95PA0060010 097	KT435	517.5	60	16	0	21	22	6	65
95PA0060014 096	KT439	402.0	60	417	0	31	210	10	669
STRATUM N1									
95PA0050027 165	ML004	313.5	60	0	0	1	0	25	26
95PA0050028 166	ML007	233.5	55	0	0	0	0	5	5
95PA0050026 167	MM002	304.0	60	0	0	1	0	22	23
95PA0050025 169	MN001	217.5	60	0	0	0	0	5	5
95PA0050024 168	MN440	304.5	60	1	0	1	0	40	42
STRATUM N2									
95PA0050035 158	ME440	281.5	60	0	0	0	0	28	28
95PA0050034 160	MF001	266.0	60	0	0	0	0	14	14
95PA0050033 159	MF004	198.0	60	0	0	0	0	1	1
95PA0050031 162	MF008	176.0	60	0	0	0	0	9	9
95PA0050029 164	MH007	167.0	60	0	0	0	0	8	8
STRATUM N3									
95PA0050032 161	MF007	281.0	60	0	0	1	0	3	4
95PA0050030 163	MG008	171.0	60	0	0	0	0	1	1
STRATUM N4									
95PA0050037 155	MB004	327.0	60	1	0	6	0	88	95
95PA0050038 156	MB005	295.0	60	31	0	1	0	30	61
95PA0050039 157	MD006	294.0	60	325	0	1	0	105	430
STRATUM N5									
95PA0050036 154	MA001	343.5	60	38	0	1	0	54	93
95PA0050040 153	MA011	539.0	60	124	0	42	0	24	190
STRATUM N6									
95PA0050022 147	LS438	343.5	60	11	0	2	7	19	38
95PA0050021 148	LT001	428.0	60	56	0	2	16	11	86
95PA0050020 150	LT004	404.0	60	49	0	4	3	44	99
95PA0050023 151	LV439	520.5	60	1	0	11	11	9	31
STRATUM N7									
95PA0050042 149	LT011	194.5	60	0	0	0	0	0	0
95PA0050041 152	LV011	365.5	37	24	0	4	7	54	89
STRATUM N8									
95PA0050017 141	LL002	226.0	60	0	0	0	0	9	9
95PA0050018 144	LM001	271.0	60	0	0	0	0	1	1
95PA0050019 146	LP003	273.5	60	0	0	1	0	54	54
STRATUM N9									
95PA0050016 142	LL440	307.5	60	0	0	2	1	41	44
95PA0050015 145	LM434	486.5	60	6	0	12	46	32	96
95PA0050014 143	LM437	401.5	60	1	0	5	4	93	103

Table 1b. List of trawl stations in strata between 67°00'N and 69°30'N, east of the midline in Davis Strait survey, July to August 1995. Catches are given in kg.

STATION-IDENTIFICATION	AREA-CODE	DEPTH	TR-TIME	SHR	COD	GHL	RED	MIX	TOTAL
STRATUM W1-1									
95PA0060042 132	LF007	170.5	33	0	0	0	0	0	0
95PA0050009 133	LG010	177.5	60	0	0	0	0	16	16
95PA0050006 139	LH014	167.0	60	0	0	0	0	36	36
STRATUM W1-2									
95PA0060041 129	LE005	218.0	60	0	0	0	0	0	0
95PA0060040 131	LF003	229.0	60	0	0	0	0	0	0
95PA0050012 135	LH003	239.0	60	0	0	0	0	12	12
95PA0050011 140	LJ005	205.0	54	0	0	0	0	11	11
95PA0050010 136	LJ007	213.0	60	0	0	0	0	20	20
95PA0050008 134	LJ011	240.0	60	0	0	9	0	23	32
95PA0050007 138	LJ012	263.0	60	1	0	3	0	37	41
STRATUM W1-3									
95PA0060030 101	KX003	318.5	60	66	0	6	15	24	111
95PA0060031 104	KX440	331.0	60	231	0	8	12	27	278
95PA0060009 108	KZ438	341.0	60	11	0	1	4	21	37
95PA0060035 112	LA006	383.0	60	471	0	25	54	38	588
95PA0060032 116	LA439	346.0	60	590	0	7	15	62	673
95PA0060033 114	LA440	312.0	60	18	0	5	1	10	34
95PA0060034 121	LB002	312.0	60	156	0	5	2	27	190
95PA0060036 118	LB007	346.0	60	291	0	10	2	69	372
95PA0060039 122	LD003	307.5	60	270	0	3	1	22	295
95PA0060002 126	LE438	337.0	60	71	0	2	11	22	106
95PA0050013 137	LJ439	319.0	60	1	0	0	3	55	60
STRATUM W1-4									
95PA0060003 124	LD436	558.0	60	0	0	11	4	2	17
95PA0060001 130	LF437	507.0	60	0	0	5	32	6	43
STRATUM W2-1									
95PA0040062 128	LE011	185.5	60	0	0	0	0	0	0
95PA0040061 127	LE014	187.5	50	0	0	0	1	2	3
STRATUM W2-2									
95PA0040069 100	KV016	268.0	60	174	0	3	5	57	238
95PA0040065 117	LA014	298.0	60	197	0	1	2	28	229
95PA0040060 120	LB011	257.0	60	0	0	0	0	0	0
95PA0040064 123	LD012	247.0	60	0	0	0	0	1	1
95PA0040063 125	LE012	226.0	45	0	0	0	0	0	0
STRATUM W2-3									
95PA0060044 350	KZ013	361.5	60	821	0	22	91	86	1019
95PA0060037 349	LA009	372.0	60	837	0	13	2	190	1042
95PA0040059 113	LA011	348.0	60	1311	0	9	3	37	1359
95PA0050004 347	LA011	371.0	60	986	0	23	7	32	1049
95PA0050005 348	LA014	336.0	60	22	0	5	7	41	75
95PA0040066 119	LA015	329.5	60	66	0	6	3	40	114
95PA0060043 351	LB009	356.0	60	444	0	13	2	219	678
STRATUM W2-4									
95PA0040068 106	KX016	424.5	48	291	0	45	44	13	392
95PA0040067 105	KZ015	502.5	60	75	0	15	71	46	208
STRATUM W3-1									
95PA0040053 083	KM006	172.0	55	0	0	0	1	6	7
95PA0040052 079	KM007	156.0	60	0	0	0	0	6	6
95PA0040055 089	KP006	188.5	60	0	0	0	0	2	2
STRATUM W3-2									
95PA0040050 072	KJ006	235.5	60	0	0	0	1	0	1
95PA0060022 078	KL004	221.0	61	1	0	0	2	5	8
95PA0060024 084	KM001	249.5	60	0	0	0	1	5	6
95PA0060023 081	KM004	221.5	60	0	0	0	0	5	5
95PA0040054 087	KN005	214.5	60	0	0	0	0	6	6
95PA0060015 092	KR001	288.0	60	2	0	0	1	2	5
STRATUM W3-3									
95PA0060021 076	KK004	344.5	30	472	0	1	36	22	531
95PA0060025 380	KM001	362.5	60	502	0	1	48	15	566
95PA0060017 091	KR440	316.5	60	741	0	2	29	29	800
95PA0060027 379	KS003	321.0	60	14	0	1	0	7	22
95PA0060016 093	KS440	320.0	60	801	0	2	38	44	885
95PA0060028 381	KT002	369.0	60	850	0	16	89	55	1010
95PA0060029 378	KV439	311.0	61	10	0	0	1	2	12
95PA0060026 377	KX006	364.5	60	384	0	10	25	43	462
STRATUM W3-4									
95PA0060020 073	KK004	576.5	60	1	0	4	2	13	19
95PA0060038 386	KX006	433.5	50	420	0	50	85	50	605
95PA0040057 102	KX012	440.5	60	621	0	66	39	17	744
95PA0040058 109	KZ012	457.5	53	343	0	25	26	19	413

Table 1c. List of trawl stations in strata between 59°30'N and 67°00'N in the Davis Strait survey, July to August 1995. Catches are given in kg.

STRATUM W4-1										
95PA0040035	055	JX009	195.0	60	0	0	0	0	0	0
95PA0040034	054	JX011	151.0	60	0	0	0	0	0	0
95PA0040041	060	KB009	171.5	60	0	0	0	5	6	10
95PA0040040	062	KD008	177.5	60	0	0	0	3	6	9
95PA0040046	065	KE011	170.5	60	0	0	0	0	3	3
95PA0040045	064	KE014	186.5	60	4	0	1	0	20	25
STRATUM W4-2										
95PA0060049	402	KA011	231.5	60	5	0	3	1	11	20
95PA0040042	061	KB013	251.0	60	1009	0	10	24	24	1068
95PA0040044	066	KE015	256.5	60	235	0	38	6	96	374
95PA0040049	401	KH007	245.0	60	8	0	0	4	3	15
STRATUM W4-3										
95PA0040036	057	JZ007	372.5	54	46	1	1	30	15	93
95PA0060048	405	KE015	385.5	60	178	0	10	6	7	201
95PA0040043	067	KF015	319.0	60	1374	0	88	17	70	1649
STRATUM W4-4										
95PA0060050	409	JX007	569.0	60	1	0	1	38	2	41
95PA0040037	059	KA006	570.0	60	0	0	15	23	4	42
95PA0040038	063	KD006	563.0	60	0	0	12	44	6	61
95PA0040039	068	KF006	545.5	39	0	0	20	27	3	51
STRATUM W5-1										
95PA0040020	042	JJ015	176.0	60	0	0	0	0	0	0
95PA0040022	043	JJ019	164.0	55	1	0	0	0	2	2
95PA0040019	045	JK015	196.0	60	1	0	0	2	1	3
STRATUM W5-2										
95PA0040010	032	JB020	225.5	60	0	0	0	3	14	18
95PA0040015	037	JF016	223.5	60	1	0	1	16	2	20
95PA0040016	039	JH013	276.5	60	852	0	0	65	2	919
95PA0040026	048	JN020	260.0	30	1	0	0	0	0	2
STRATUM W5-3										
95PA0040013	035	JE019	351.0	60	435	1	5	123	12	576
95PA0060055	490	JE020	360.5	60	465	0	0	36	3	504
95PA0060054	428	JF021	352.5	50	208	0	0	21	7	236
95PA0060053	000	JJ012	347.5	60	0	0	0	8	6	14
95PA0060052	426	JK012	373.0	60	0	0	1	16	1	17
95PA0060051	429	JK021	345.5	60	495	0	12	22	9	538
95PA0040025	046	JM020	331.5	60	2033	0	23	56	26	2138
STRATUM W5-4										
95PA0040014	036	JE016	482.5	60	0	0	40	0	0	40
95PA0040017	038	JH012	469.5	60	0	2	1	25	3	29
95PA0040018	040	JJ012	477.0	60	0	1	3	47	3	54
95PA0040023	041	JJ020	442.5	60	992	14	86	104	8	1202
STRATUM W6-1										
95PA0070002	022	HJ029	153.5	60	1	0	0	0	17	18
95PA0070001	023	HJ031	196.5	60	422	0	0	2	2451	2876
95PA0040003	025	HL028	181.0	60	31	0	0	0	87	87
STRATUM W6-2										
95PA0040004	026	HL026	228.5	60	4	0	0	5	96	106
95PA0040006	028	HS023	271.0	60	2	0	1	43	9	54
STRATUM W6-3										
95PA0040002	024	HK027	375.0	50	0	0	0	0	37	37
95PA0040005	027	HR026	337.0	60	535	0	18	35	69	657
STRATUM W6-4										
95PA0070004	451	HF030	501.5	60	0	0	1	0	0	1
95PA0040007	029	HX023	437.0	60	712	2	17	23	19	772
95PA0040008	030	HX023	460.0	60	1187	2	67	16	36	1307
95PA0060056	450	HX025	484.5	60	221	0	2	29	12	264
STRATUM W7-1										
95PA0070015	011	GP038	168.5	60	1	0	0	0	103	104
95PA0070008	018	HA033	176.0	60	313	0	0	1	111	426
95PA0070007	019	HD032	170.5	60	1026	0	0	1	320	1348
STRATUM W7-2										
95PA0070013	012	GT034	248.0	60	37	0	0	1	304	342
95PA0070012	014	GV035	221.5	23	29	0	0	0	1	31
STRATUM W7-3										
95PA0070011	013	GX034	332.5	60	8	0	0	1	1	11
95PA0070006	017	HA031	331.0	60	0	0	0	0	0	1
STRATUM W7-4										
95PA0070017	006	GN038	452.0	27	1	0	0	1	0	2
95PA0070014	008	GP037	460.5	47	0	0	0	0	0	0
STRATUM S1										
95PA0070020	007	GN048	424.5	60	96	0	11	6	8	120
STRATUM S2										
95PA0070024	001	GG048	192.0	60	0	0	0	1	85	87
95PA0070018	005	GM040	196.0	60	1	0	0	0	12	13

Table 2a. Estimated trawlable biomasse in strata west of the midline in the Davis Strait survey July-August 1995

STRATUM	SQKM	BIOMASS IN STRATA					
		TONS	HAULS	STD	STDERR	MIN	MAX
AREA C1 300-400 M	655	453.0	2	325.9	230.4	223	683
AREA C1 400-600 M	312	60.8	2	64.4	45.5	15	106
AREA C3 200-300 M	660	29.6	2	36.3	25.6	4	55
AREA C3 300-400 M	1192	3104.6	2	2558.7	1809.2	1295	4914
AREA C3 400-600 M	623	1489.4	2	1874.5	1325.5	164	2815

Table 2b. Estmated trawlable biomass in starta north of 69°30'N in the Davis Strait survey July-August 1995.

STRATUM	SQKM	BIOMASS IN STRATA					
		TONS	HAULS	STD	STDERR	MIN	MAX
AREA N1	3664	11.0	5	17.8	8.0	0	41
AREA N2	11740	0.0	5	0.0	0.0	0	0
AREA N3	368	0.0	2	0.0	0.0	0	0
AREA N4	2257	3120.4	3	4614.1	2663.9	28	8424
AREA N5	5766	5199.5	2	3892.0	2752.0	2447	7952
AREA N6	3237	1154.4	4	1093.5	546.7	26	2230
AREA N7	1029	245.3	2	346.9	245.3	0	491
AREA N8	8063	0.0	3	0.0	0.0	0	0
AREA N9	2407	58.9	3	79.6	46.0	0	149

Table 2c. Estimated trawlable biomass in strata south of 69°30'N east of the midline (area W1-W7) in the Davis Strait survey July- August 1995.

STRATUM	SQKM	BIOMASS IN STRATA					
		TONS	HAULS	STD	STDERR	MIN	MAX
AREA W1 150-200 M	2416	0.0	3	0.0	0.0	0	0
AREA W1 200-300 M	5295	13.3	7	25.8	9.8	0	68
AREA W1 300-400 M	9239	22263.2	11	19917.8	6005.5	82	60115
AREA W1 400-600 M	752	0.4	2	0.1	0.1	0	0
AREA W2 150-200 M	1857	0.0	2	0.0	0.0	0	0
AREA W2 200-300 M	3026	3034.3	5	4158.1	1859.6	0	7826
AREA W2 300-400 M	2158	15872.8	7	11698.4	4421.6	672	30420
AREA W2 400-600 M	1723	3865.8	2	3423.3	2420.6	1445	6286
AREA W3 150-200 M	2215	0.1	3	0.2	0.1	0	0
AREA W3 200-300 M	4810	31.9	6	51.7	21.1	2	132
AREA W3 300-400 M	2714	17164.2	8	12540.4	4433.7	357	35691
AREA W3 400-600 M	3361	13289.5	4	9822.9	4911.5	34	21749
AREA W4 150-200 M	4252	53.2	6	125.5	51.2	0	309
AREA W4 200-300 M	1791	7322.3	4	10743.6	5371.8	122	22875
AREA W4 300-400 M	812	5980.8	3	8556.2	4939.9	344	15826
AREA W4 400-600 M	1967	7.4	4	5.7	2.8	0	12
AREA W5 150-200 M	1995	14.9	3	13.5	7.8	0	27
AREA W5 200-300 M	3454	8072.0	4	16044.3	8022.1	21	32138
AREA W5 300-400 M	1797	10784.0	7	14373.7	5432.8	0	41971
AREA W5 400-600 M	2806	7413.1	4	14826.2	7413.1	0	29652

(CONTINUED)

STRATUM	SQKM	BIOMASS IN STRATA					
		TONS	HAULS	STD	STDERR	MIN	MAX
AREA W6 150-200 M	1095	1853.6	3	3198.0	1846.4	0	5546
AREA W6 200-300 M	1491	63.4	2	27.2	19.2	44	83
AREA W6 300-400 M	1300	5026.8	2	7109.0	5026.8	0	10054
AREA W6 400-600 M	884	5090.4	4	5091.6	2545.8	0	11302
AREA W7 150-200 M	2419	15288.8	3	18182.8	10497.9	26	35406
AREA W7 200-300 M	985	885.8	2	461.0	326.0	560	1212
AREA W7 300-400 M	239	16.1	2	20.9	14.8	1	31
AREA W7 400-600 M	273	1.5	2	2.2	1.5	0	3

Table 2d. Estimated trawlable biomass in strata in South Greenland (Julianehaab Bay) in the Davis Strait survey July-August 1995.

STRATUM	SQKM	BIOMASS IN STRATA					
		TONS	HAULS	STD	STDERR	MIN	MAX
AREA S1	1993	1765.4	1	.	.	1765	1765
AREA S2	4526	27.5	2	8.8	6.3	21	34

Table 3. Sums of estimated biomass in the main regions 1988-1995 (region 'South' excluded).

	Biomass in Year							
Area	1988	1989	1990	1991	1992	1993	1994	1995
West	140332	176525	151402	108406	141158	211966	162495	143181
Canada	9305	3836	11425	4668	16764	3609	7036	4510
North	21901	11342	11733	6032	21164	9057	8473	9788
Total	171538	191703	174560	119106	179089	224632	178004	157479

Table 4. Relative distribution (%) of estimated biomass 1988-1995 in depth strata south of 69° 30'N (region C and W).

	Depth Stratum			
Year	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
1993	0,0	23,5	58,4	18,1
1994	0,3	18,2	68,0	13,5
1995	11,7	13,1	54,1	21,0

Table 5. Numbers of shrimps (millions) per length group (CL) in total biomass estimate in 1995, based on pooling of individual samples weighted by catch and stratum area.

CL	Males	Prim.fem.	Mul.fem.	Total
5.0	0.6	0.0	0.0	0.6
5.5	0.6	0.0	0.0	0.6
6.0	5.1	0.0	0.0	5.1
6.5	3.5	0.0	0.0	3.5
7.0	9.2	0.0	0.0	9.2
7.5	50.6	0.0	0.0	50.6
8.0	61.8	0.0	0.0	61.8
8.5	121.0	0.0	0.0	121.0
9.0	126.7	0.0	0.0	126.7
9.5	131.7	0.0	0.0	131.7
10.0	107.2	0.0	0.0	107.2
10.5	95.1	0.0	0.0	95.1
11.0	67.5	0.0	0.0	67.5
11.5	88.8	0.0	0.0	88.8
12.0	129.0	0.0	0.0	129.0
12.5	151.5	0.0	0.0	151.5
13.0	154.2	0.0	0.0	154.2
13.5	195.2	0.0	0.0	195.2
14.0	219.9	0.0	0.0	219.9
14.5	195.2	0.0	0.0	195.2
15.0	217.6	0.0	0.0	217.6
15.5	193.5	0.0	0.0	193.5
16.0	296.1	0.0	0.0	296.1
16.5	443.6	0.0	0.0	443.6
17.0	655.3	0.0	0.0	655.3
17.5	834.5	0.0	0.0	834.5
18.0	927.4	1.0	0.0	928.4
18.5	1055.5	0.0	0.0	1055.5
19.0	1187.9	0.6	0.0	1188.5
19.5	1330.7	0.3	0.0	1331.0
20.0	1459.8	0.3	0.6	1460.7
20.5	1389.9	0.4	0.0	1390.3
21.0	1266.8	0.4	0.3	1267.5
21.5	1094.6	4.4	0.8	1099.7
22.0	942.8	9.2	3.7	955.8
22.5	858.4	29.5	7.6	895.5
23.0	726.7	61.7	24.6	813.0
23.5	513.8	161.3	49.2	724.3
24.0	331.4	250.2	114.6	696.2
24.5	206.7	372.7	188.9	768.3
25.0	76.0	398.4	277.6	752.1
25.5	51.4	360.8	362.9	775.0
26.0	20.8	266.5	411.4	698.7
26.5	11.1	154.3	390.8	556.2
27.0	3.5	88.7	342.9	435.2
27.5	0.3	30.0	245.7	276.0
28.0	0.2	18.8	201.2	220.2
28.5	0.0	7.9	120.9	128.8
29.0	0.0	0.7	82.1	82.8
29.5	0.0	0.0	36.9	36.9
30.0	0.0	0.9	24.4	25.3
30.5	0.0	0.1	13.6	13.6
31.0	0.0	0.0	3.5	3.5
31.5	0.0	0.0	6.7	6.7
32.0	0.0	0.0	1.9	2.0
32.5	0.0	0.0	0.2	0.2
33.0	0.0	0.0	0.0	0.0
33.5	0.0	0.0	0.0	0.0
34.0	0.0	0.0	0.0	0.0
34.5	0.0	0.0	0.0	0.0
35.0	0.0	0.0	0.0	0.0
35.5	0.0	0.0	0.0	0.0
36.0	0.0	0.0	0.0	0.0
36.5	0.0	0.0	0.0	0.0
Total	18010.7	2219.3	2913.0	23143.0

Table 6. Length- and percents-at-age of males, and abundance-at-age of all shrimp based on modal analysis of total length frequency distributions from the survey area 1988-1995.

Males, lengths-at-age

Age	1988	1989	1990	1991	1992	1993	1994	1995
1						9.3	8.5	8.5
2	12.3	12.6	12.0	12.7	13.2	11.9	11.9	10.9
3	14.7	15.4	14.0	15.8	15.1	14.1	14.3	13.7
4	17.4	17.3	16.8	17.3	17.2	16.9	16.8	17.1
5	19.9	19.5	19.2	19.8	19.3	19.3	19.5	19.7
6	22.3	22.1	21.2	21.5	22.0	21.8	22.0	22.3

Males, percents-at-age

Age	1988	1989	1990	1991	1992	1993	1994	1995
1						1.6	1.0	2.9
2	2.3	1.4	3.8	1.3	3.4	6.8	5.3	2.7
3	4.7	14.5	4.8	5.2	11.8	10.7	9.6	6.3
4	19.0	50.1	14.4	14.1	15.1	22.5	26.4	20.0
5	39.2	21.9	53.4	18.1	27.1	32.1	27.9	42.1
6	34.8	12.1	23.6	61.3	42.7	26.3	29.8	26.0
Total	100.0	100.0	100.0	100.0	100.1	100.0	100.0	100.0

Abundance-at-age, all shrimp (billions)

Age	1988	1989	1990	1991	1992	1993	1994	1995
1						0.5	0.3	0.5
2	0.4	0.4	0.8	0.2	0.7	2.2	1.3	0.5
3	0.9	4.6	1.1	0.6	2.5	3.4	2.4	1.1
4	3.4	16.0	3.2	1.7	3.2	7.2	6.6	3.6
5	7.1	7.0	11.7	2.2	5.7	10.2	7.0	7.6
6	6.3	3.9	5.2	7.5	8.9	8.4	7.5	4.7
7+	7.7	6.0	8.0	4.4	5.5	7.9	6.4	5.1
Total	25.8	37.9	29.9	16.6	26.4	39.7	31.4	23.1

Figure 1. Stratification scheme for West Greenland offshore shrimp survey showing stratum numbering as used in tekst.

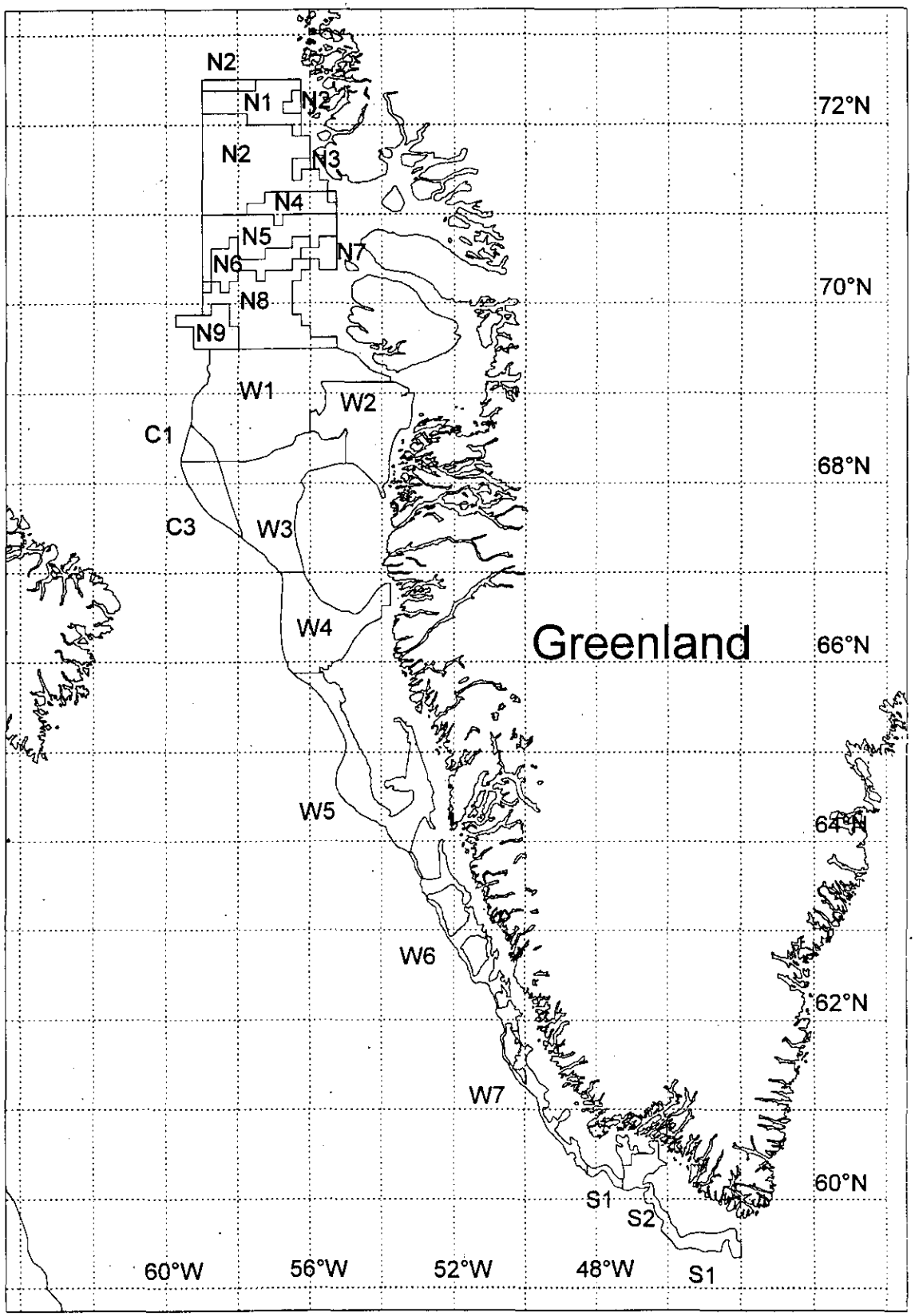
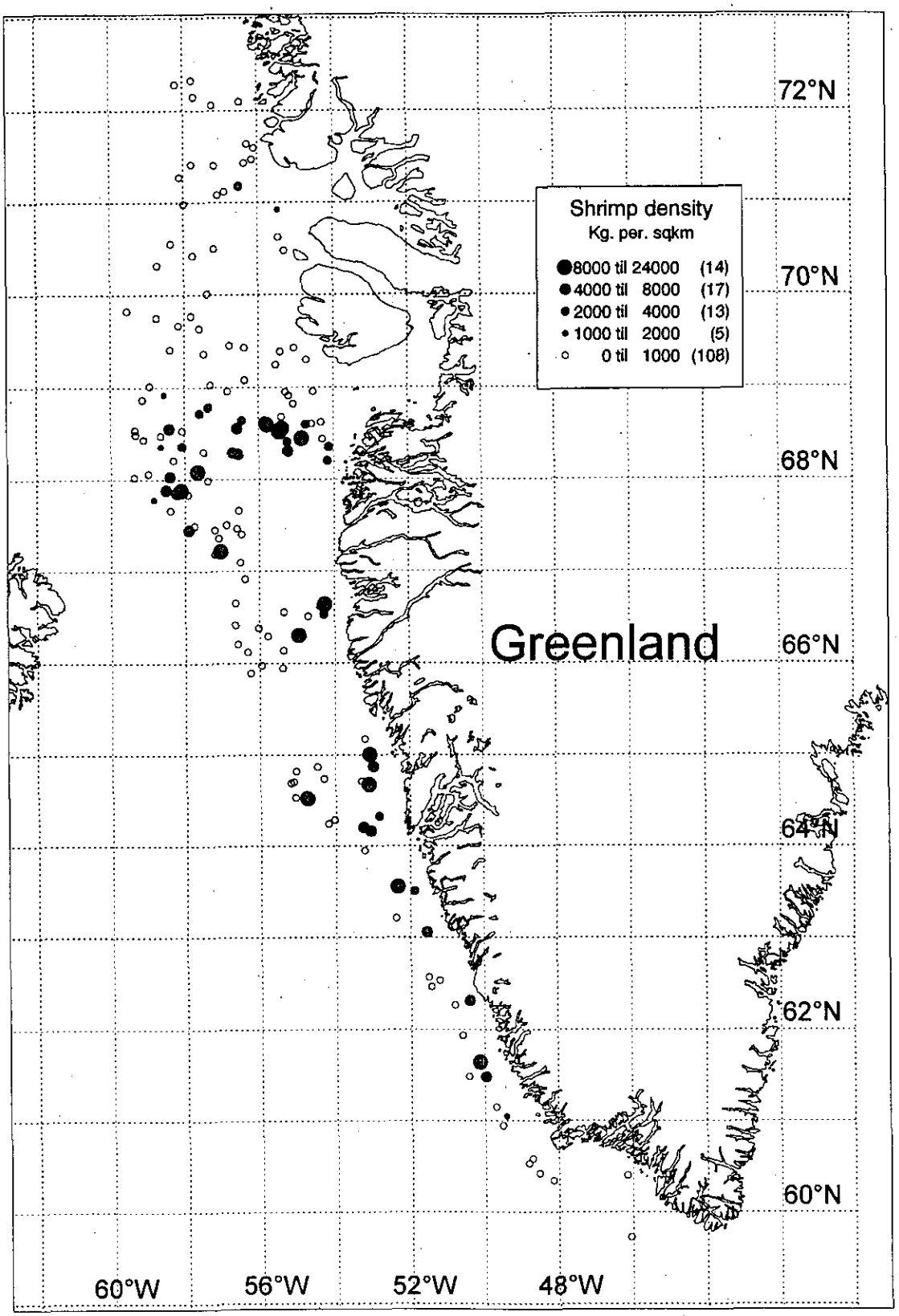
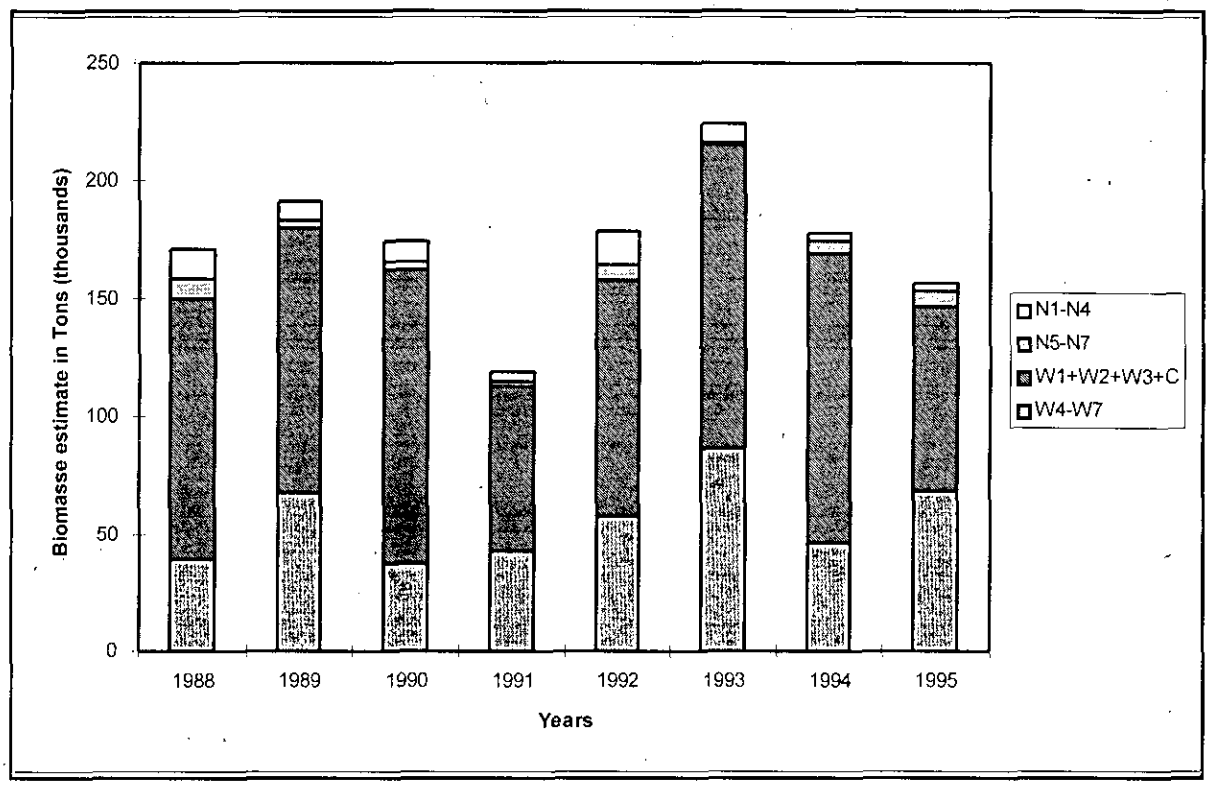


Figure 2 . Sampling sites and catch of shrimps (per km2) in the West Greenland offshore shrimp survey.



Figur 3. Estimated total biomass 1988-1995 for groups of strata in the Davis Strait.



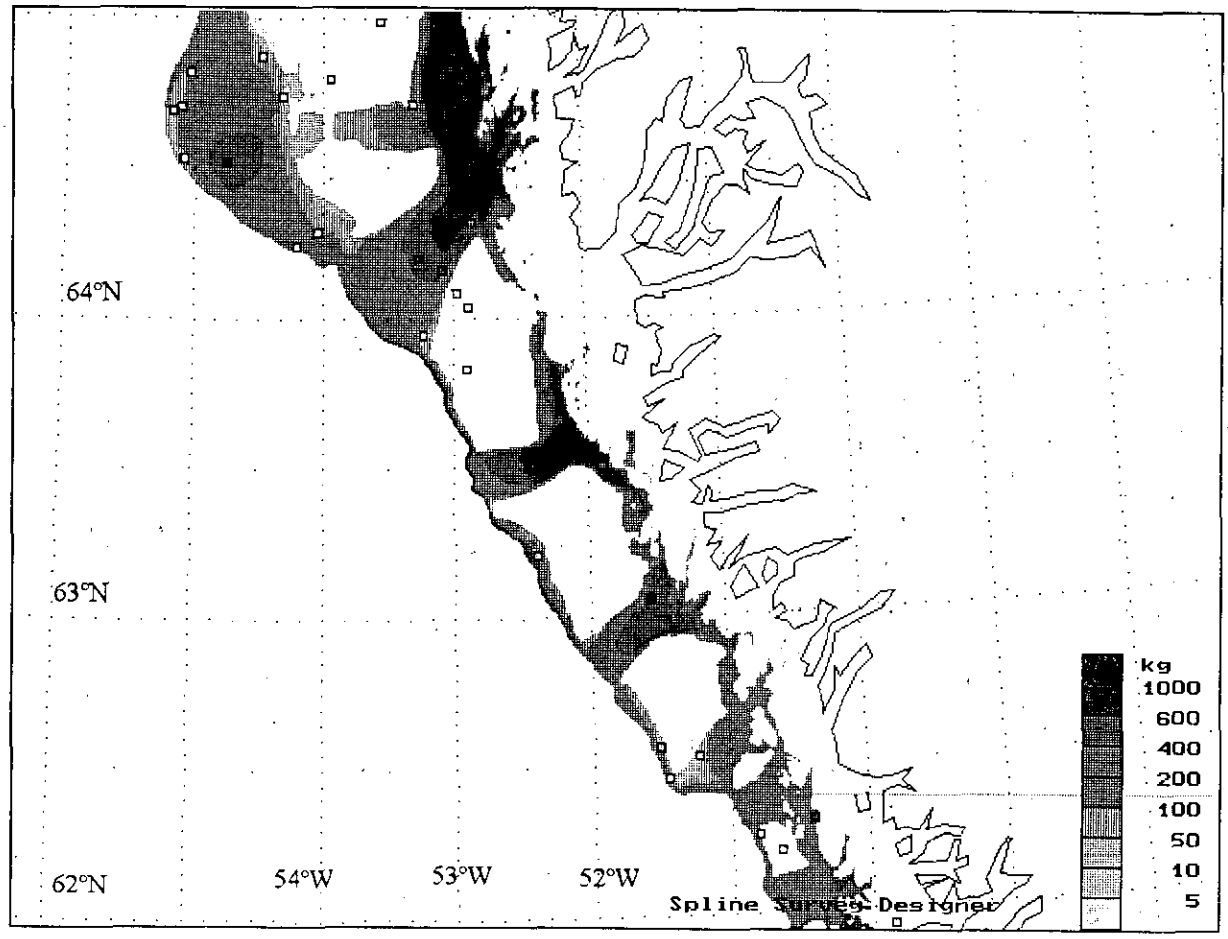


Figure 4a. Contour map with estimated shrimp densities in 1995 for the area 61° N - 64° N as calculated with the 'Spline' method, based on survey data. Sampling sites are also given.

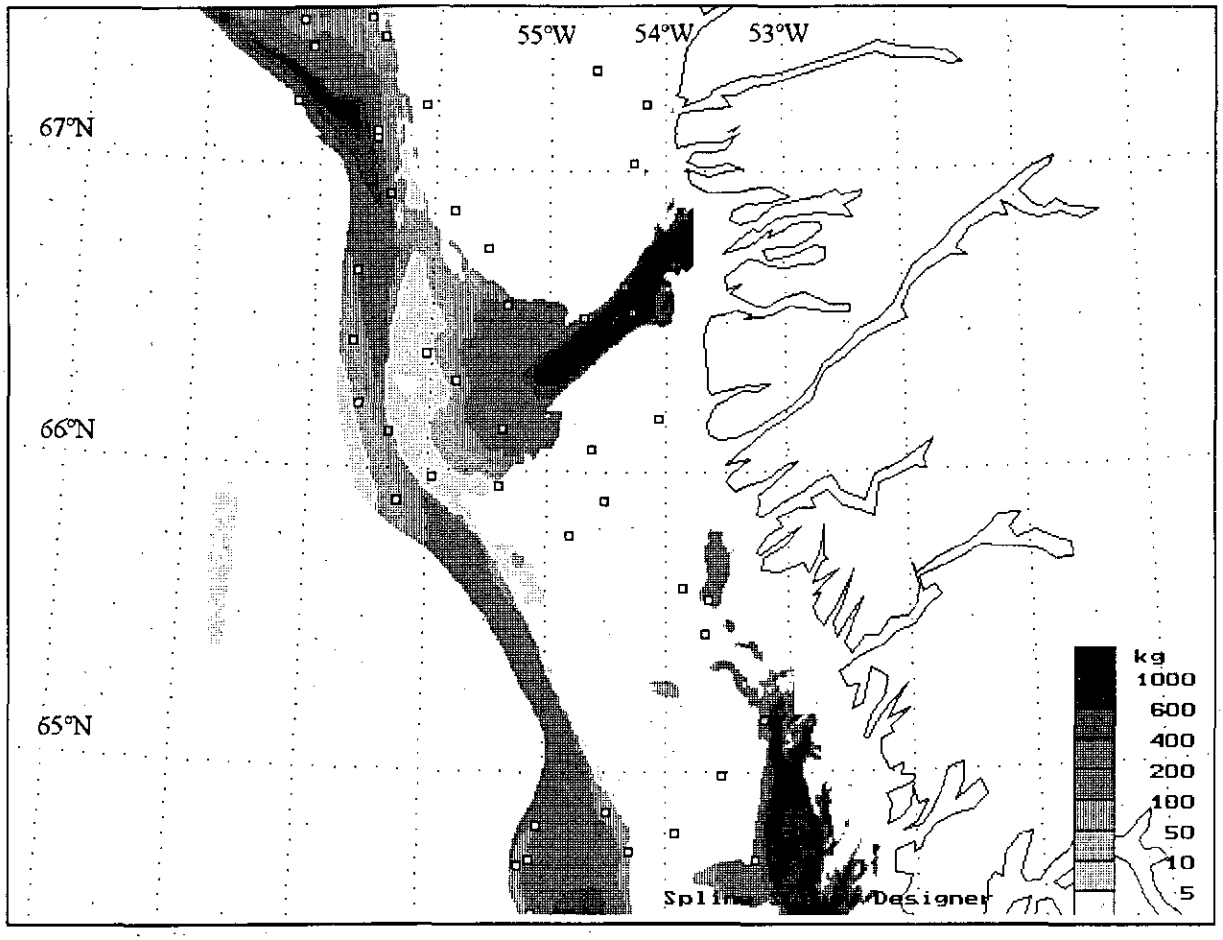


Figure 4b. Contour map with estimated shrimp densities in 1995 for the area 64° N - 67° N as calculated with the 'Spline' method, based on survey data. Sampling sites are also given.

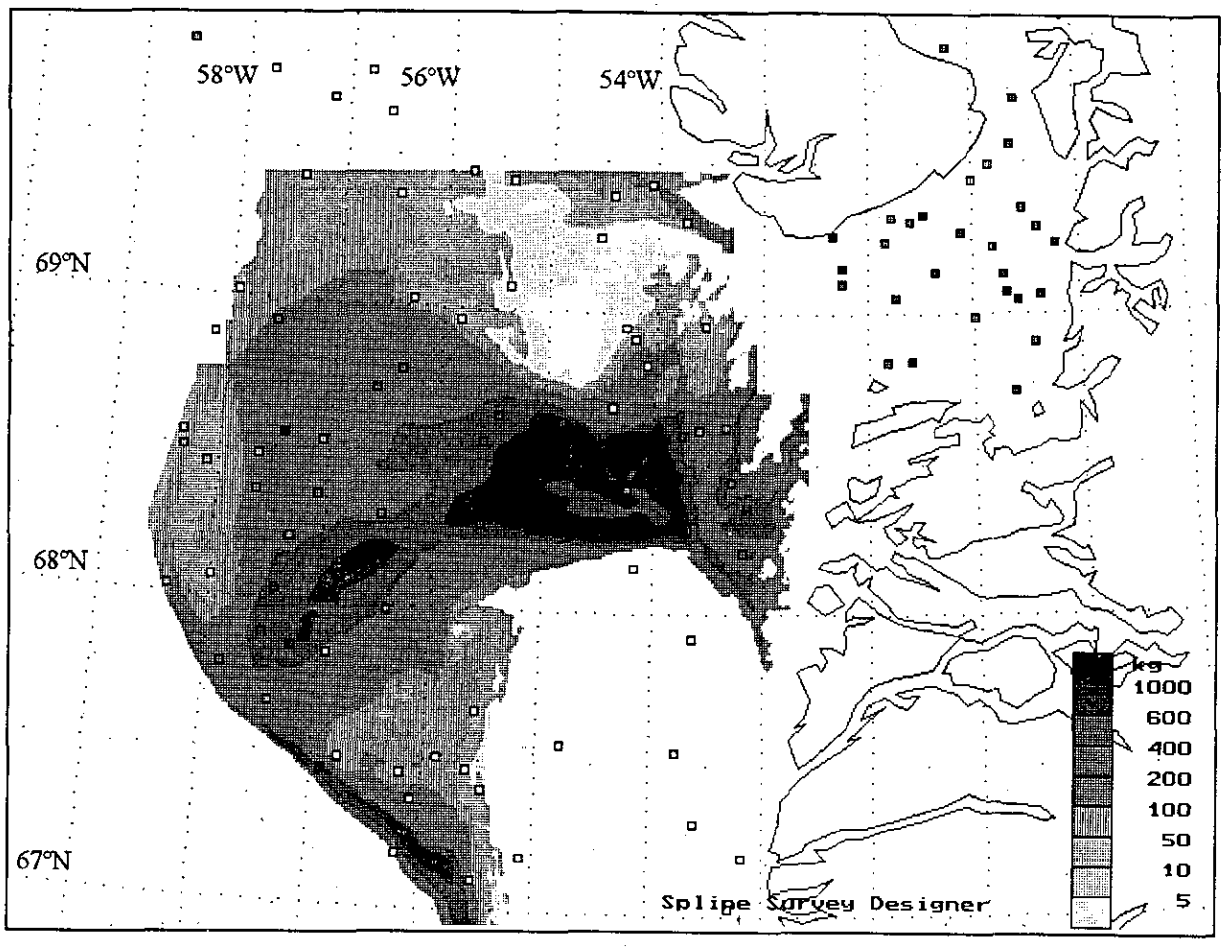


Figure 4c. Contour map with estimated shrimp densities in 1995 for the area 67° N - 69°30'N as calculated with the 'Spline' method, based on survey data. Sampling sites are also given.

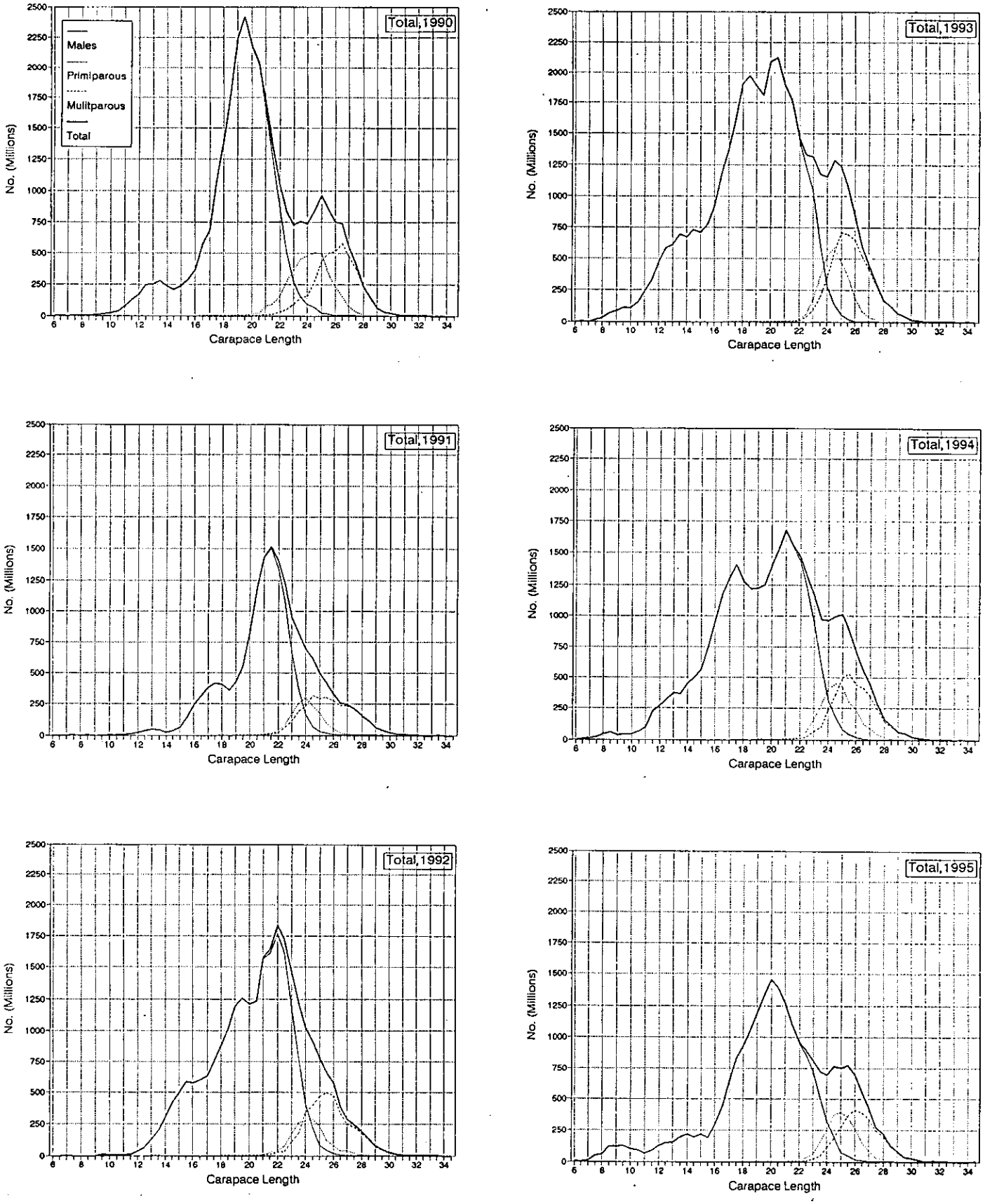


Figure 5. Numbers of shrimp by length group (CL) in total survey area (excluding region S) in 1990–1995, based on pooling of samples weighted by catch and stratum area.

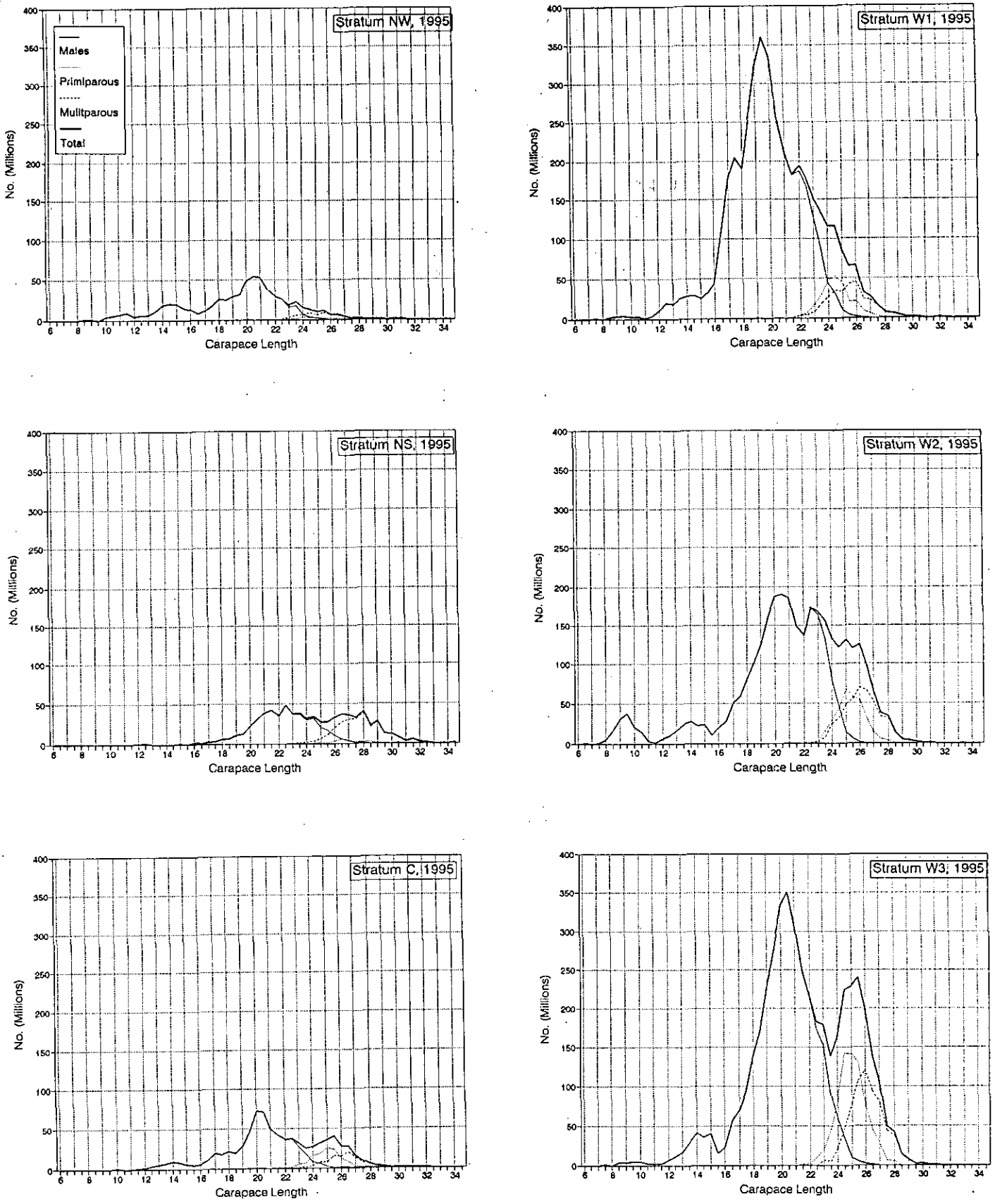
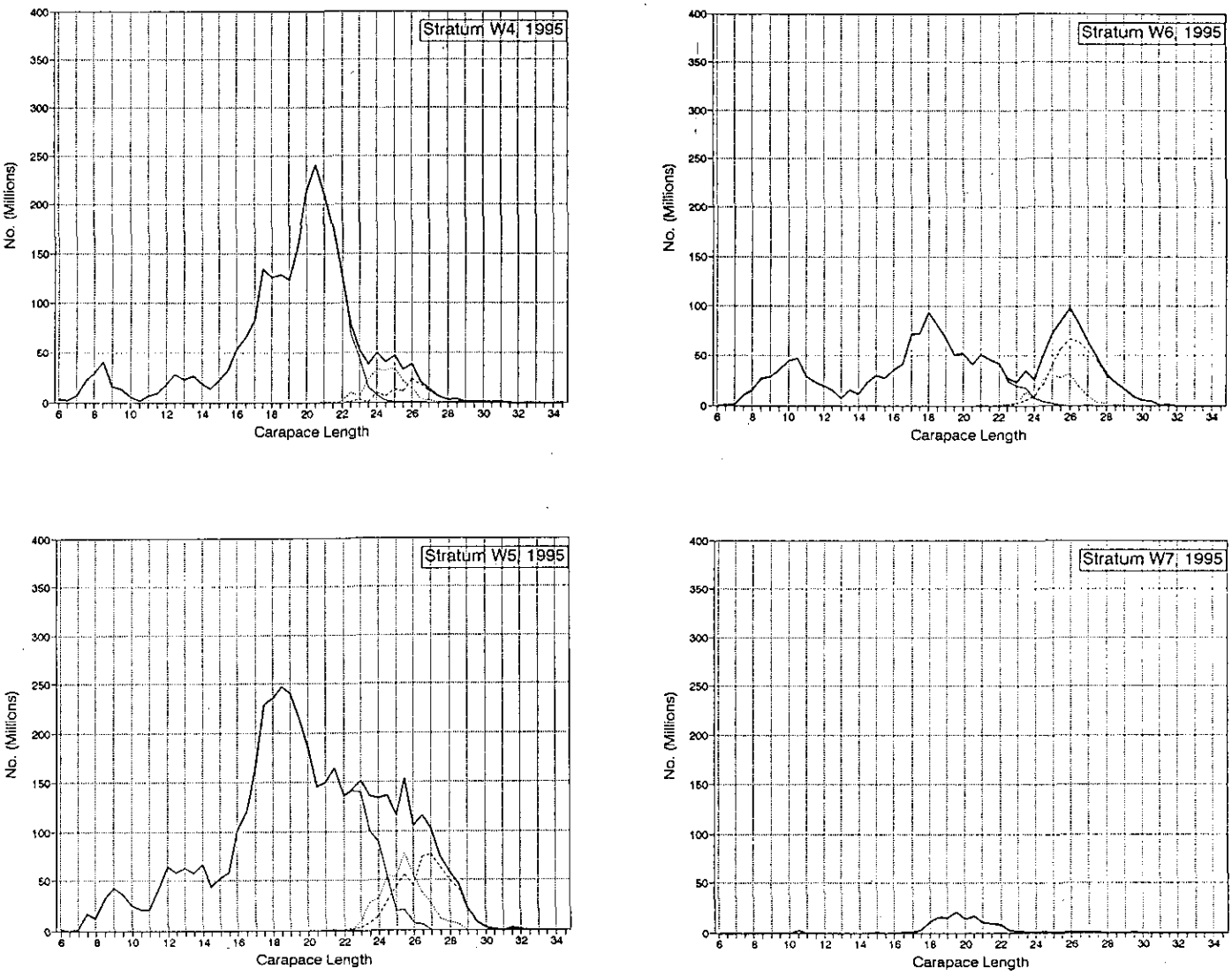


Figure 6a. Numbers of shrimp by length group (CL) in strata NW, NS, C and W1–W3 in 1995, based on pooling of samples weighted by catch and stratum area.



Figur 6b. Numbers of shrimp by length group (CL) in strata W4–W7 in 1995, based on pooling of samples weighted by catch and stratum area.