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Stratified random trawl survey for shrimp (*Pandalus borealis*) in Disko Bay and Vaigat, inshore West Greenland 1995.

by

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Introduction

A major part of the inshore fishery for shrimp in West Greenland takes place in Disko Bay - Vaigat area, NAFO Div. 1A. Since 1991 Greenland Fisheries Research Institute (now Greenland Institute of Natural Resources) has conducted stratified-random surveys annually in this area to evaluate the state of this stock component (Andersen et al., 1994). This paper presents results from the survey in 1995. The survey was carried out as a two-phase stratified random survey allocating extra hauls to strata with high densities, thus reducing the variance of the biomass estimate.

Materials and methods

The survey area covers the inshore West Greenland area between 68°42'N and 70°375'N (Figure 1) in the depth interval 150-600 m, a total of 9364 km². 37 hauls were taken in the period from July 31. to August 7., 1995. One haul thus represents 253 km² on average. Depth contours are not mapped in detail, so a stratification based on depth is not possible. Stratification is therefore done by separating the area into nine strata, based on information from the commercial fishery.

The survey was performed with the 722 GRT trawler *Paamiut*, using a 3000/20 meshes *Skjervøy* bottom trawl with a twin cod-end. Mesh size in the cod-end was 20 mm (stretched mesh). Trawl doors were *Greenland Perfect*, measuring 370*250 cm and weighing 2420 kg. Trawl geometry was measured with *Scanmar* acoustic sensors mounted on the trawl doors and *Furuno* trawleye on the headrope.

Standard towing time was 30 minutes. Trawling was carried out only in the day-time (0900-1900 UTC), to minimize the influence of vertical migrations. The mean wingspread was calculated for each haul, based on information on warp length, towing speed and distance between doors.

Swept area was calculated as the distance between starting and ending positions (GPS) multiplied by the mean wingspread.

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

The survey was conducted as a two phase survey. In the first phase one haul per 300 km² or 31 stations were taken in the total area. Additional hauls were allocated to strata with highest density estimates as recommended by Francis (1984) to reduce the variance of the biomass estimate. Six extra hauls were taken with two hauls in each of the strata D3, D4 and D5.

Results and discussion

Table 1 lists the stations by stratum and shows the catch in kg of shrimp, cod, Greenland halibut, redfish, and other species combined.

The area in km², the number of hauls, the mean density of shrimp in kg per km², and the calculated biomass in tons for each stratum are shown in Table 2.

The total biomass estimate from the 1995 survey is 47,060 tons with a standard deviation of 13,175 tons and a standard error of mean at 2,166. The biomass estimate calculated from the first 31 hauls (phase one of the survey) is 47,949 tons with a standard deviation of 12,971 tons and a standard error of mean at 2,330.

In Table 3 the calculated biomass by year and stratum is shown. Apart from a low value in 1993 the estimated overall biomass has been fairly stable around 45,000 tons. In Figure 2 the estimated biomass per year is shown in groups of strata for the period 1991 to 1995. Disko bay west corresponds to D1 and D3, central area to D4 and eastern bay to D2, D5 and D6. Some shift in the distribution of biomass is indicated among strata, and in 1995 the biomass is apparently more evenly spread over the strata that in earlier years.

Stock composition

The estimated total numbers of shrimp (billions) in the survey area over the years are as follows:

Year	males	females	total
1991	5.46	1.97	7.43
1992	5.55	1.55	7.10
1993	3.20	1.45	4.65
1994	4.94	1.63	6.57
1995	3.99	2.08	6.06

The increase in estimated biomass from 1994 to 1995 is based on an increase in number of females, while the number of males decreased. Fig. 3 shows numbers of shrimp (males, females, and total) by stratum in 1995. Males are most abundant in northwestern (stratum D3) and central (D4) Disko Bay. Females are most abundant in central Disko Bay (D4) and southern Vaigat (D7). As in earlier years female abundance is also relatively high in the Hareø area (D9). The overall trend in abundance of males and females compared to 1994 is following the trend in biomass estimates. Abundance decreases in western (D1 and D3) and northern (D6) Disko Bay and in the northern stratum (D8) in the Vaigat, and increases in central (D4) and eastern (D2 and D5) Disko Bay, in southern Vaigat (D7) and in the Hareø area (D9). The overall decrease in number of males is mainly due to the significant decrease in western Disko Bay (D1 and D3).

Overall length distributions of shrimp from 1991 to 1995 are shown in Fig. 4. Based on the theoretical size at age as interpreted in shrimp samples from the Davis Strait (Savard et al., 1994), the recruitment and growth of year classes can be followed over the years:

In 1991 the overall distribution was dominated by two components of males at 17 and 21 mm CL - assumed to represent the 1987 and 1985 year class. The female group was composed of several size groups.

In 1992 dominant male peaks were found at 18.5 and 22 mm CL (1987 and 1985 year classes), and two recruiting year classes (1989 and 1990) were indicated around 15 mm CL and 11.5 mm CL, respectively. A dominating female peak at 25 mm CL supposedly includes a transitioning component of the 1985 year class.

In 1993 the male group was dominated by a peak at 20.5 mm CL representing the 1987 year class, but peaks at 16, 18, and 22.5 mm CL were also evident (1990, 1989, and 1986 year classes). Several female modes were present with a dominant peak at 25.5 mm CL, probably mainly representing the 1985 year class.

In 1994 a number of male peaks are present, among which the 1990 year class is found at 18 mm CL and the 1991 year class at 16 mm. A small peak at 11.5 mm CL indicates the occurrence of the 1992 year class. The female group is dominated by one peak at 26 mm CL, which may represent a transitioning part of the 1987 year class.

In 1995 the 1990 year class is dominating the male group at 20.5 mm CL. The 1992 year class is found at 16.5 mm and the 1993 year class at 12.5 mm CL.

Fig. 5 (a-b) shows the overall length distributions by strata in 1994. The year classes - as described above - can be identified in most strata.

Conclusion

The total biomass estimate for the Disko and Vaigat area in the period 1991-1995 indicate a general stable situation apart from the low level in 1993.

References

Andersen, M., D.M. Carlsson, and P. Kanneworff, 1994. Stratified-Random Trawl Survey for Shrimp (*Pandalus borealis*) in Disko Bay, West Greenland, 1994. NAFO SCR. Doc. 94. Serial No. N2481 10 p.

Francis, R.I.C.C., 1984. An adaptive strategy for stratified random trawl surveys. New Zealand Journal of Marine and Freshwater Research. 1984, (18): pp. 59-71.

Table 1. List of trawl stations in the inshore shrimp survey 1995. Catches are given in kg.

STATION-IDENTIFICATION	AREA-CODE	DEPTH	TR-TIME	SHR	COD	GHL	RED	MIX	TOTAL
STRATUM D1									
95PA0050072 203	LD021	606.0	30	35	0	4	2	4	45
95PA0050062 202	LD022	349.0	30	558	0	21	35	43	657
95PA0050063 501	LE025	307.0	30	78	0	2	1	15	96
STRATUM D2									
95PA0050061 201	LB026	303.0	30	253	0	11	0	34	298
95PA0050060 204	LE027	373.0	30	143	0	26	5	93	267
STRATUM D3									
95PA0050071 509	LF019	300.5	31	425	0	6	0	14	446
95PA0050073 206	LF022	374.5	30	561	0	6	2	21	590
95PA0050070 209	LG020	432.0	30	324	0	49	1	17	391
95PA0050075 512	LG021	571.0	31	29	0	24	2	41	96
95PA0050069 212	LH019	255.0	30	324	0	10	0	46	380
95PA0050074 511	LH021	409.5	31	129	0	7	1	15	152
STRATUM D4									
95PA0050064 207	LF026	422.0	30	383	0	42	16	130	571
95PA0050076 208	LG023	453.0	31	204	0	35	6	60	306
95PA0050066 210	LG025	427.0	31	285	0	95	0	70	450
95PA0050077 515	LG026	369.0	30	485	0	23	2	34	544
95PA0050068 214	LH022	399.5	30	147	0	17	3	13	180
95PA0050078 516	LH023	367.5	30	233	0	8	1	13	255
95PA0050067 211	LH024	409.0	30	167	0	41	8	37	252
95PA0050056 514	LJ024	260.5	30	22	0	0	0	2	24
STRATUM D5									
95PA0050059 205	LF026	396.0	30	585	0	16	3	34	637
95PA0050065 519	LF027	339.0	30	239	0	46	3	34	321
95PA0050079 520	LG028	323.5	45	389	0	92	3	28	511
95PA0050058 213	LH027	399.5	30	127	0	72	4	40	241
STRATUM D6									
95PA0050057 215	LH026	354.5	30	138	0	28	0	8	174
95PA0050055 216	LJ025	252.0	30	34	0	0	0	4	38
95PA0050054 217	LK026	249.0	31	118	0	2	0	31	150
STRATUM D7									
95PA0050053 218	LL026	337.5	36	216	0	7	0	51	275
95PA0050052 219	LN024	456.5	30	75	0	19	0	8	103
95PA0050049 221	LP022	396.5	30	183	0	24	0	13	220
95PA0050050 529	LP022	414.0	30	422	0	32	0	59	513
95PA0050051 220	LP022	510.5	31	211	0	20	2	35	266
STRATUM D8									
95PA0050047 222	LS018	513.0	30	39	0	59	0	28	127
95PA0050048 223	LS019	377.5	20	71	0	9	1	11	92
STRATUM D9									
95PA0050046 538	LS015	343.0	30	374	0	7	0	32	413
95PA0050045 224	LT014	356.0	30	340	0	16	0	42	398
95PA0050043 226	LV012	174.0	30	0	0	0	0	0	0
95PA0050044 225	LV014	483.5	30	169	0	7	0	12	188

Tabel 2. The area in sq.km, number of hauls, mean density in kg per sq.km, and calculated biomass per stratum in 1995.

Stratum	Area	# Hauls	Density	Biomass	Std	Std Error
D1	819	3	6384	5229	7022	4054
D2	566	2	4132	2339	869	614
D3	1124	6	5847	6571	4756	1941
D4	1834	8	5744	10534	6572	2323
D5	612	4	7719	4724	3497	1749
D6	1014	3	1981	2008	1077	622
D7	1447	5	5390	7799	4088	1829
D8	652	2	2130	1389	1082	765
D9	1296	4	4990	6467	5141	2570
Total	9364	37	-	47060	13175	2166

Tabel 3. Estimated trawlable biomass per stratum and year in the Disko Bay - Vaigat area 1991-95.

Stratum	1991	1992	1993	1994	1995
D1	9390	3238	2595	10474	5229
D2	5869	1510	1765	654	2339
D3	5667	5700	1719	7459	6571
D4	7928	13676	7686	7318	10534
D5	892	3416	2890	2558	4724
D6	4006	5552	4717	2884	2008
D7	5298	6077	3643	3995	7799
D8	3264	1046	2084	2573	1389
D9	5264	4953	5156	3391	6467
Total	47578	45168	32255	41306	47060

Table 4. 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
6.5	0.2	0.0	0.0	0.2
7.0	0.0	0.0	0.0	0.0
7.5	1.2	0.0	0.0	1.2
8.0	1.1	0.0	0.0	1.1
8.5	1.9	0.0	0.0	1.9
9.0	1.6	0.0	0.0	1.6
9.5	0.2	0.0	0.0	0.2
10.0	1.4	0.0	0.0	1.4
10.5	2.8	0.0	0.0	2.8
11.0	3.9	0.0	0.0	3.9
11.5	11.5	0.0	0.0	11.5
12.0	21.2	0.0	0.0	21.2
12.5	25.7	0.0	0.0	25.7
13.0	24.6	0.0	0.0	24.6
13.5	18.5	0.0	0.0	18.5
14.0	16.0	0.0	0.0	16.0
14.5	20.0	0.0	0.0	20.0
15.0	30.1	0.0	0.0	30.1
15.5	51.7	0.0	0.0	51.7
16.0	63.6	0.0	0.0	63.6
16.5	87.1	0.0	0.0	87.1
17.0	80.4	0.0	0.0	80.4
17.5	85.7	0.0	0.0	85.7
18.0	111.5	0.0	0.0	111.5
18.5	165.7	0.0	0.0	165.7
19.0	212.2	0.0	0.1	212.3
19.5	256.2	0.0	0.0	256.2
20.0	293.8	0.0	0.4	294.2
20.5	313.3	0.0	0.4	313.7
21.0	307.7	0.1	0.6	308.3
21.5	301.2	0.0	2.5	303.7
22.0	291.4	0.3	3.1	294.8
22.5	296.5	1.8	6.5	304.7
23.0	263.6	0.1	18.1	281.8
23.5	237.0	1.7	34.3	273.1
24.0	163.8	2.2	71.2	237.3
24.5	100.6	4.2	115.2	220.1
25.0	62.1	5.5	177.4	245.0
25.5	32.6	8.1	221.6	262.3
26.0	14.5	11.5	272.6	298.6
26.5	6.8	8.6	249.5	264.8
27.0	2.6	6.8	237.4	246.8
27.5	1.7	3.2	195.2	200.1
28.0	0.0	2.1	150.0	152.1
28.5	0.0	0.2	102.2	102.4
29.0	0.3	0.5	66.0	66.8
29.5	0.0	0.0	39.1	39.1
30.0	0.0	0.0	27.6	27.6
30.5	0.0	0.0	18.2	18.2
31.0	0.0	0.0	5.8	5.8
31.5	0.0	0.0	3.0	3.0
32.0	0.0	0.0	0.6	0.6
32.5	0.0	0.0	0.7	0.7
33.0	0.0	0.0	0.1	0.1
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	3985.5	56.9	2019.2	6061.6

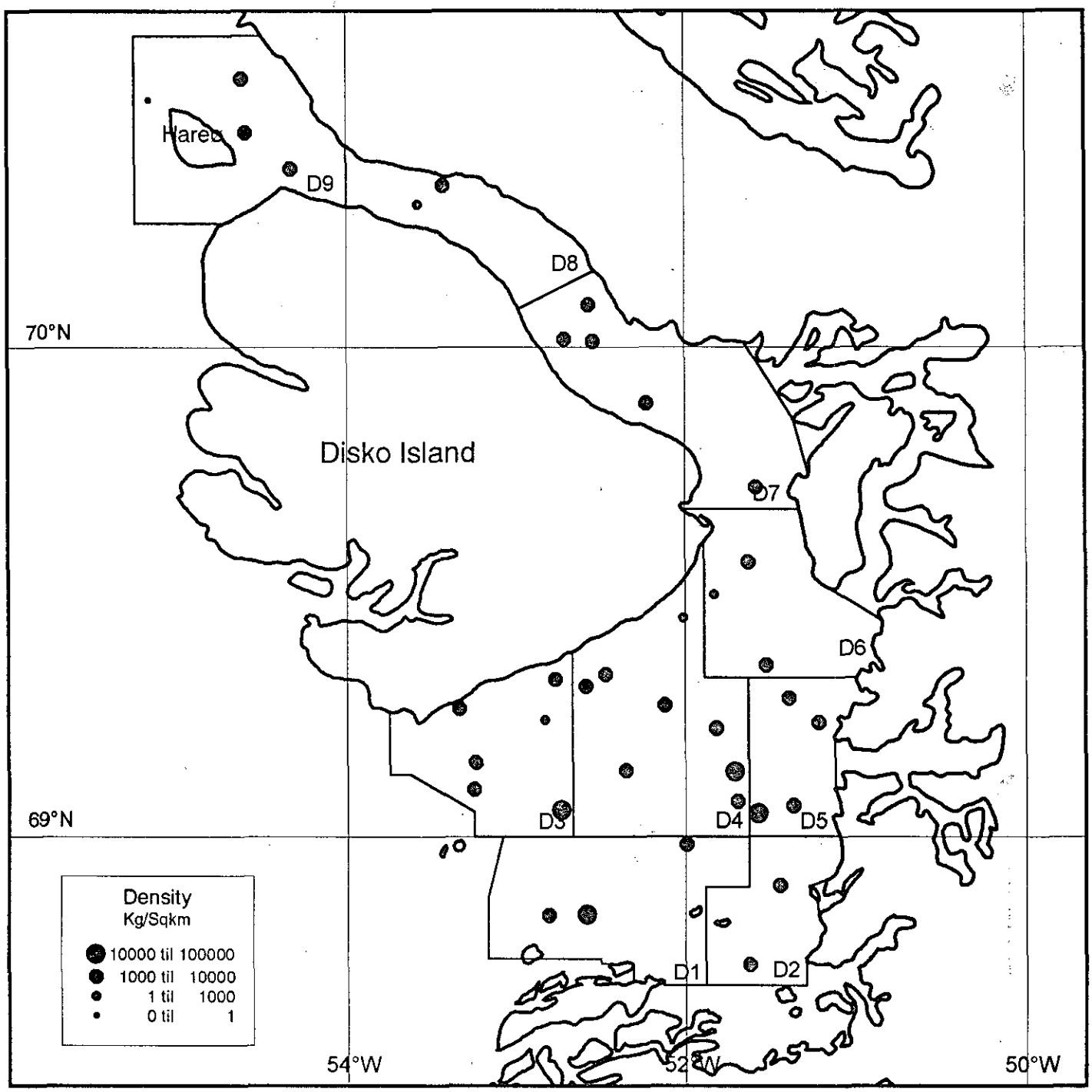


Figure 1. Strata and survey sampling sites in Disko Bay – Vaigat, 1995. Shrimp catches are given in kg per km².

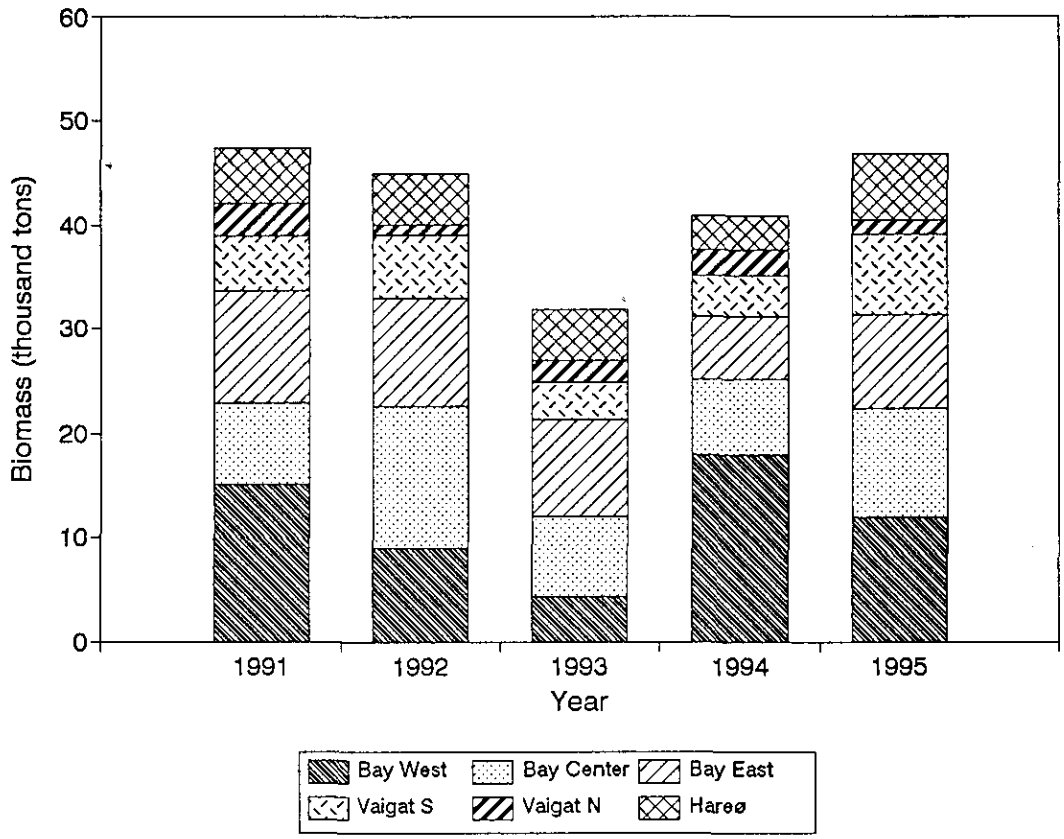


Figure 2. Estimated total biomass 1991–1995 for groups of strata in the Disko Bay – Vaigat area.

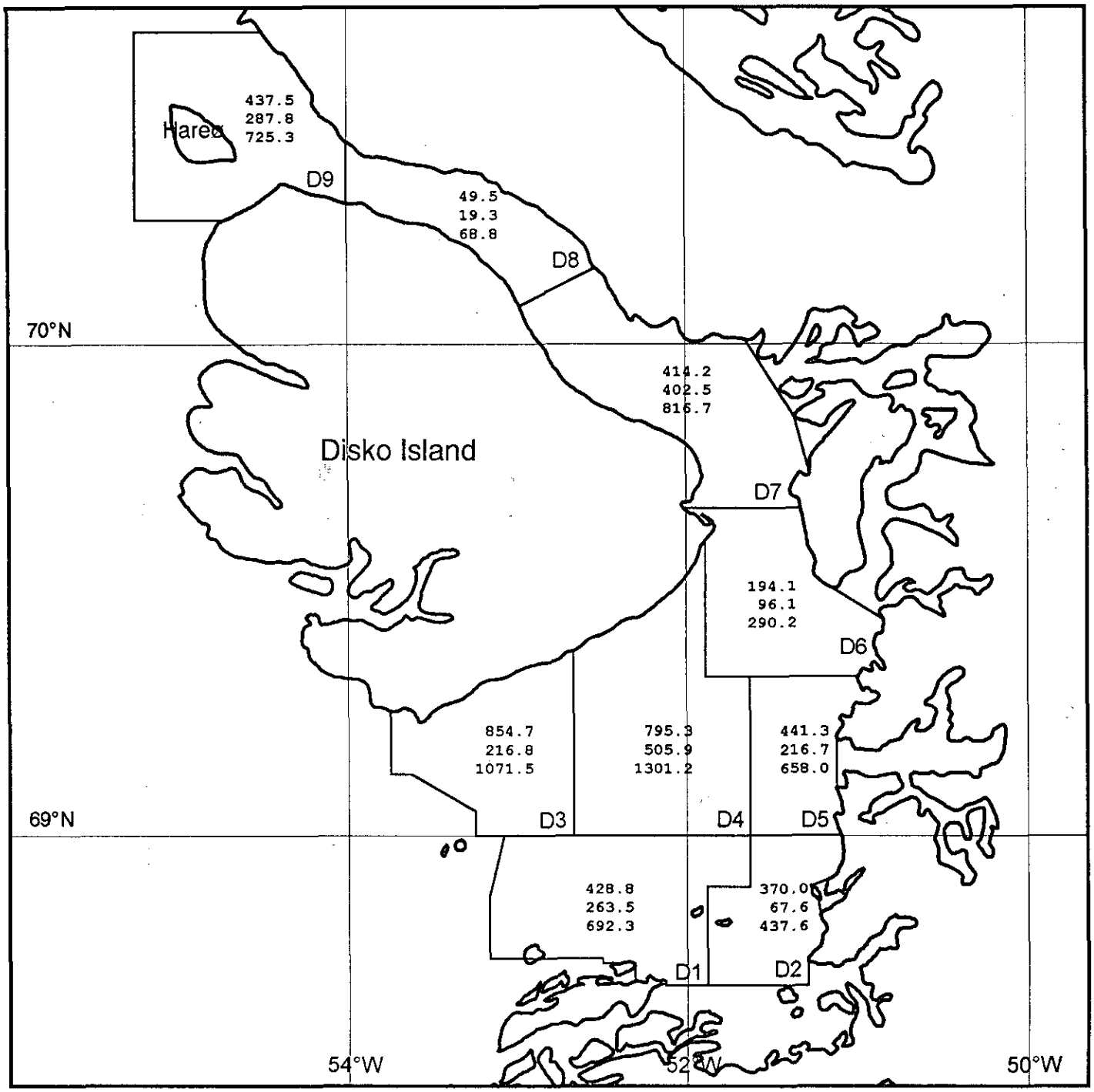


Figure 3. Calculated numbers of shrimp (males, females and total, in millions) per stratum in 1995.

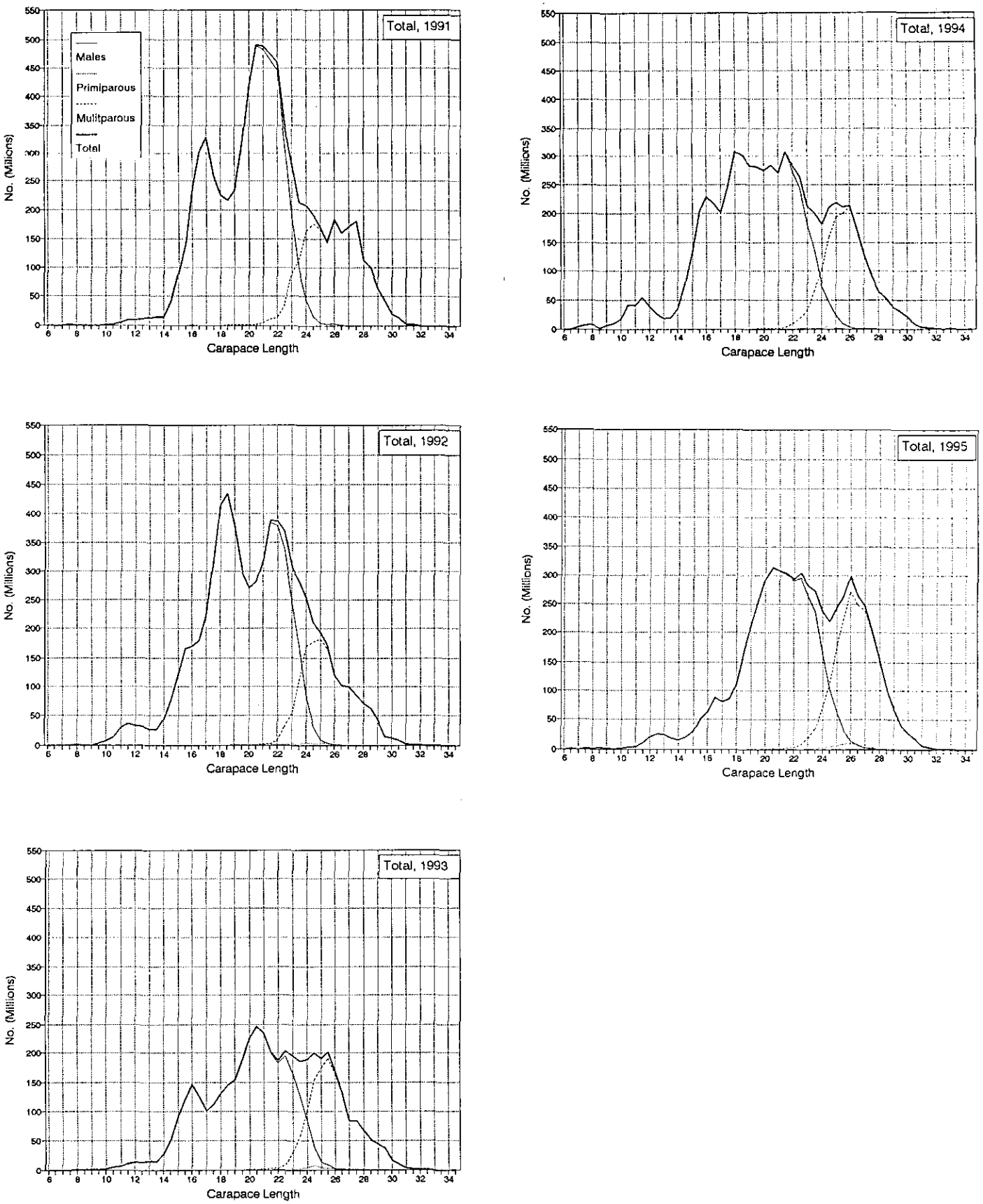


Figure 4. Numbers of shrimp by length group (CL) in the total survey area 1991–95, based on pooling of samples weighted by catch and stratum area.

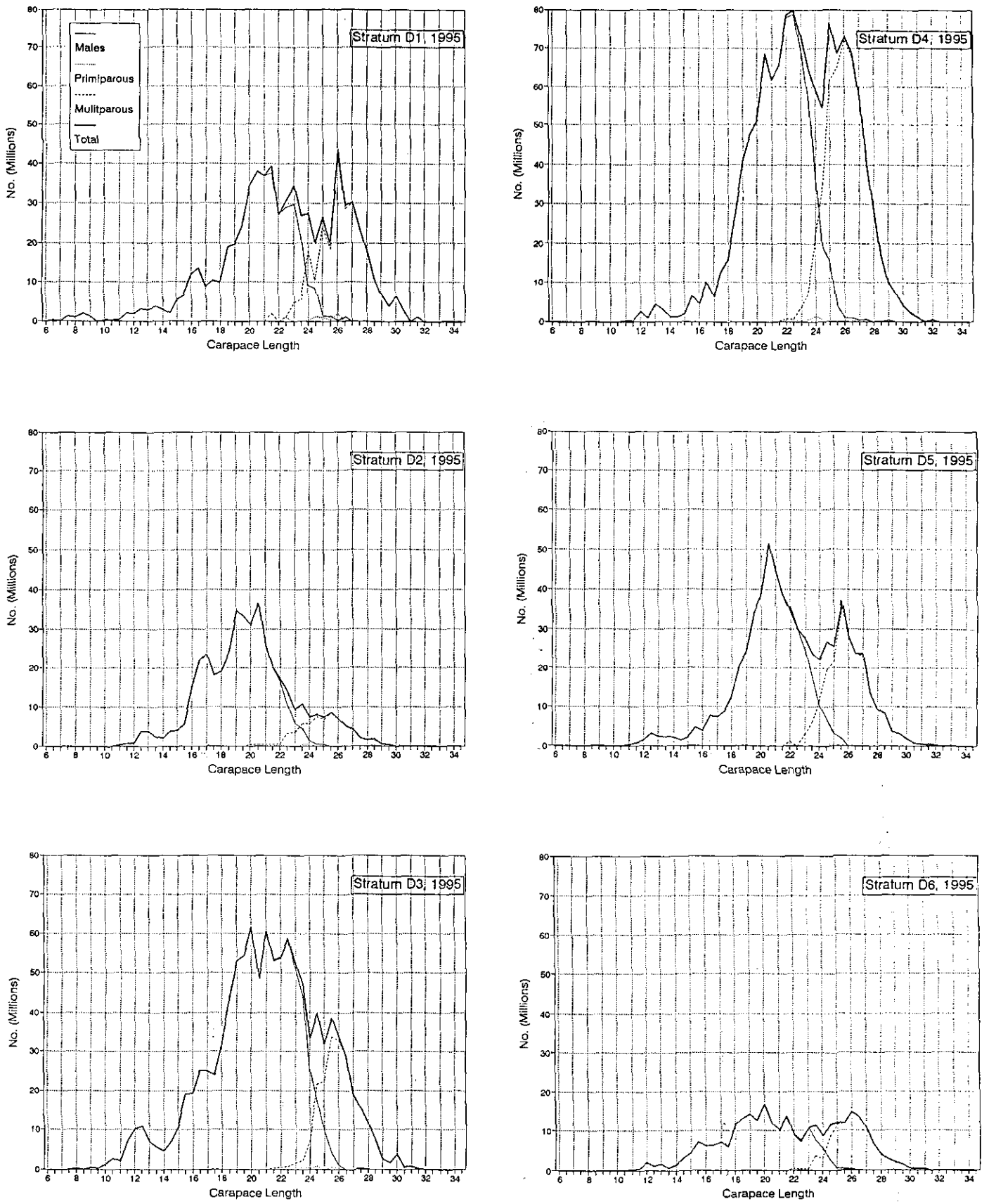
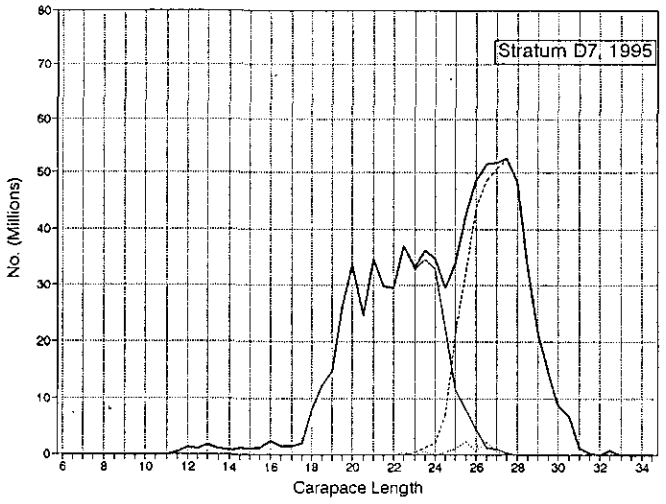
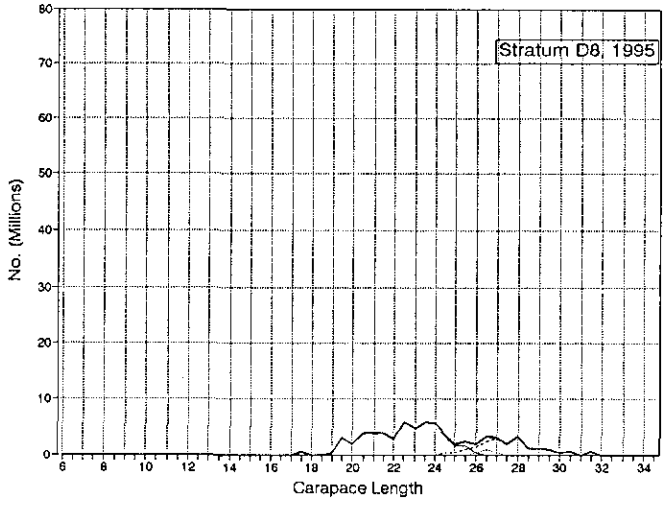


Figure 5a. Numbers of shrimp by length group (CL) in strata 1-6 (see Fig. 1), based on pooling of samples weighted by catch and stratum area.





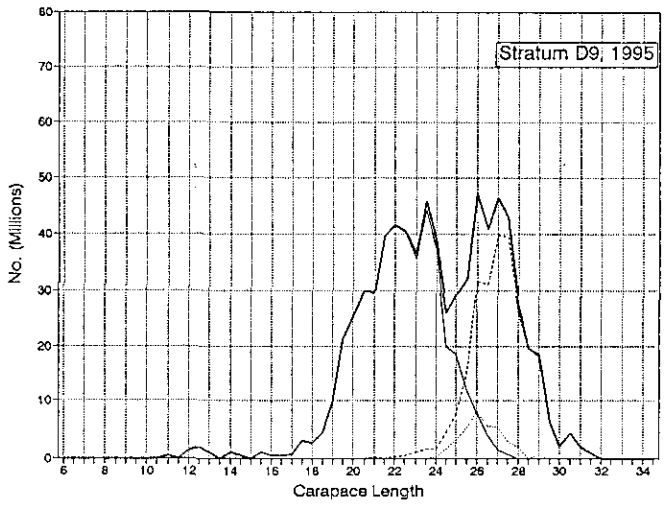


Figure 5b. Numbers of shrimp by length group (CL) in strata 7–9 (see Fig. 1), based on pooling of samples weighted by catch and stratum area.