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Stratified-random Trawl Survey for Shrimp (*Pandalus borealis*) in Disko Bay and Vaigat, Inshore West Greenland, 1997

by

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Introduction

Since 1991, Greenland Institute for Natural Resources has annually conducted stratified-random trawl surveys in part of the inshore areas of West Greenland (Disko Bay and Vaigat) to assess the trawlable biomass and to obtain information on the biology of this component of the *Pandalus borealis* stock (Folmer et al., 1996). The present paper reports on a survey carried out in August 1997 in connection with a corresponding survey in the offshore areas (Carlsson and Kanneworff, 1997).

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.

Material and Methods

The survey area covers the inshore West Greenland area between 68°42'N and 70°37'5N (Fig. 1) in the depth interval 150-600 m, a total of 9,364 km². 37 hauls were taken in the period August 7.-26., 1997. One haul thus represents 253 km² on average. Depth contours are not mapped in detail, so a stratification based on depth is not possible, but done by separating the region into nine geographical areas, based on information from the commercial fishery.

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 biomass estimates as recommended by Francis (1984) to reduce the variance of the estimate. Six extra hauls were taken in the strata D1 (2), D2, D5, D6 and D8.

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 distance between doors.

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

From each haul a sample of approx. 4 kg of shrimp was taken from the cod-end of the trawl before the catch was sorted and weighed by species. Shrimps were sorted by sexual stage, and oblique carapax length was measured by slide calliper to the nearest 0.1 mm. The 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 area.

In a special study age-at-length was reanalysed for the survey area in Disko Bay and Vaigat (Carlsson, 1997). Using the new interpretatation, the overall length distribution of shrimp in 1997 was separated in age groups by modal analysis (Macdonald and Pitcher, 1979) after identification of modes by visual inspection of combined length frequencies from survey strata. Results were compared to results from modal analysis of total distributions from 1995 and 1996.

Results and Discussion

Biomass estimates

For the nine strata in the area the trawlable biomass has been estimated based on the average catch per swept area. Table 1 shows the details from this calculation. In total, 48,8 Kt is estimated for this region with approximate 95% confidence limits of ±11,174 tons.

The estimated biomass for 1997 is at the same level as the years before (Table 2, Fig. 2), however, an increase is indicated since the low value in 1993. Some minor changes from year to year are observed for the various parts of the area, but on average a high degree of stability is seen despite the large commercial catches taken in this area in recent years (Hvingel et al., 1997). The apparent stability in the biomass is also seen in the commercial catch rates.

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
1996	5.97	2.21	8.18
1997	8.23	1.44	9.67

While the estimated biomass was relatively stable from 1995 to 1997, the estimated number of shrimp increased in the same years, due to an increase in number of males. Number of females increased slightly from 1995 to 1996, but decreased by about 30% from 1996 to 1997.

Table 3 shows the number of shrimp (males, females and total) by stratum and year in 1995-97. Compared to 1996 number of males increased in 1997 in all strata except in western and central Disko Bay (D3 and D4) and in southern Vaigat (D7). Number of females increased in southern, western, and northeastern Disko Bay (D1, D2, D3, and D6) and decreased in central Disko Bay (D4) and in southern Vaigat (D7). As in earlier years female abundance is still relative high in the Hareø area (D9).

Overall length distributions of shrimp from 1992 to 1997 are shown in Fig. 3. Age-at-length analysis has hitherto been based on the theoretical size at age as interpreted in shrimp samples from the Davis Strait (Savard et al. 1994), but based on the progression of a strong year-class from 1996 to 1997 a reanalysis has been undertaken (Carlsson, 1997), and the new interpretation is used here.

Under the new interpretation male modes of age 1 to 5 can be identified at 8.5, 12.5, 16.5, 19.5, and 22.4 mm CL in most years, and the progression of modes can be followed through the years. In 1996 the group of two years old males is significant at 12.5 mm CL, and this 1994 year-class dominates the male group in 1997 at 17 mm CL.

Figures 4a and 4b show the overall length-frequency distributions by stratum in 1997. The 1994 year class dominates in most strata at 17 mm CL. A mode at 12-13 mm CL show recruitment of the 1995 year class in eastern Disko Bay (strata D5 and D6) and in northern Vaigat (D9). Some recruitment of the 1996 year class is found at 8 mm CL in northern Vaigat.

Table 4 shows mean carapace length and percents-at-age for males, and abundance-at-age for alle shrimp in the survey area from 1995 to 1997. In 1997, the numbers of older males (age 4 and 5) and females (age 6+) are below averages for the three years, while the number of males at age 2 and - especially - age 3 are above. This indicates that the fishery in 1998 will experience smaller mean size of shrimp in the catches, and significant recruitment to the female group will not take place before year 2000, depending heavily on the size of the 1994 year class at that time.

Conclusions

The estimated biomass for the Disko Bay and Vaigat area is at the same level as in earlier years, and on average the stock seems stable in biomass terms despite large commercial catches in recent years. However, stock composition data indicate smaller mean size of shrimp in the stock, with fewer larger males and females than average. Recruitment prospects for the female group are poor in 1998 and 1999, and significant recruitment to the females can not be expected until year 2000, depending on the fate of the 1994 year-class.

References

Carlsson, D.M., 1997. A new interpretation of the age-at-length key for shrimp (*Pandalus borealis*) in the Disko area (Disko Bay and Vaigat) in West Greenland (NAFO Subarea 1). NAFO SCR Doc. 97/104, Serial No. N2961.

Carlsson, D.M. and P. Kanneworff, 1997. Offshore stratified-random trawl survey for shrimp (*Pandalus borealis*) in NAFO Subarea 0+1, in 1997. NAFO SCR Doc. 97/101, Serial No. N2958.

Folmer, O., D.M. Carlsson, C. Hvingel and P. Kanneworff, 1996. Stratified trawl survey for shrimp (*Pandalus borealis*) in Disko Bay and Vaigat, inshore west Greenland 1996. NAFO SCR Doc. 96/112, Serial No. N2809.

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.

Hvingel, C., H. Siegstad and O. Folmer, 1997. The Greenland fishery for northern shrimp (*Pandalus borealis*) off West Greenland 1970 - 1997. NAFO SCR Doc. 97/98, Serial No. N2955.

Macdonald, P.D.M., and T.J. Pitcher, 1979. Age-groups from size-frequency data: a versatile and efficient method of analysing distribution mixtures. J. Fish. Res. Board Can., 36: 987-1001.

Savard, L., D.G. Parsons, and D.M. Carlsson, 1994. Estimation of age and growth of northern shrimp (*Pandalus borealis*) in Davis Strait (NAFO Subareas 0+1) using cluster analysis and modal analysis. J. Northw. Atl. Fish. Sci., Vol. 16:64-74.

Table 1. Estimated trawlable biomass and sampling statistics in strata in Disko Bay – Vaigat area, 1997.

STRATUM	SQKM	TONS	HAULS	STD	STDERR	MIN	MAX
D1	819	9409.5	5	9104.6	4071.7	672	23576
D2	566	3792.8	3	1214.2	701.0	2486	4886
D3	1124	3162.0	4	4451.9	2225.9	53	9770
D4	1834	9130.9	6	2236.2	912.9	6908	12609
D5	612	4232.8	3	470.1	271.4	3727	4656
D6	1014	5910.4	4	1501.6	750.8	3811	7353
D7	1447	6165.1	5	2934.1	1312.2	3565	10771
D8	652	2921.8	3	2709.6	1564.4	531	5865
D9	1296	4154.4	4	3769.2	1884.6	0	7952

Table 2. Biomass estimates (tons) 1991-97 in strata in Disko Bay – Vaigat.

Stratum	Sqkm	Biomass						
		1991	1992	1993	1994	1995	1996	1997
D1	819	9390	3238	2595	10474	5229	3688	9410
D2	566	5869	1510	1765	654	2339	1470	3793
D3	1124	5667	5700	1719	7459	6572	2824	3162
D4	1834	7928	13676	7686	7318	10534	18853	9131
D5	612	892	3416	2890	2558	4722	3862	4233
D6	1014	4006	5552	4717	2884	2008	3177	5910
D7	1447	5298	6077	3643	3995	7799	16095	6165
D8	652	3264	1046	2084	2573	1389	794	2922
D9	1296	5264	4953	5072	3391	6467	3802	4154
Total	9364	47578	45167	32169	41306	47058	54565	48880

Table 3. Estimated no. of shrimp (males, females and total) by stratum in 1995-97.

No. of males, *millions*

Year/stratum	D1	D2	D3	D4	D5	D6	D7	D8	D9	Total
1995	428.8	370.0	854.7	795.3	441.3	194.1	414.2	49.5	437.5	3985.4
1996	1244.5	188.4	603.6	1263.5	617.7	686.6	1032.7	62.7	270.8	5970.5
1997	1896.5	829.2	256.6	1149.7	950.9	1757.3	777.4	131.7	485.4	8234.7
Mean	1189.9	462.5	571.6	1069.5	670.0	879.3	741.4	81.3	397.9	6063.5

No. of females, millions

Year/stratum	D1	D2	D3	D4	D5	D6	D7	D8	D9	Total
1995	263.5	67.6	216.8	505.9	216.7	96.1	402.5	19.3	287.8	2076.2
1996	10.3	55.8	63.2	1027.7	112.5	34.5	669.7	29.3	204.2	2207.2
1997	208.1	95.6	144.9	367.9	104.4	69.3	152.6	140.1	155.3	1438.2
Mean	160.6	73.0	141.6	633.8	144.5	66.6	408.3	62.9	215.8	1907.2

Total No. of shrimp, millions

Year/stratum	D1	D2	D3	D4	D5	D6	D7	D8	D9	Total
1995	692.3	437.6	1071.5	1301.2	658.0	290.2	816.7	68.8	725.3	6061.6
1996	1254.8	244.2	666.9	2291.2	730.2	721.1	1702.5	92.0	475.0	8177.9
1997	2104.6	924.8	401.4	1517.6	1055.3	1826.5	930.1	271.8	640.8	9672.9
Mean	1350.6	535.5	713.3	1703.3	814.5	945.9	1149.8	144.2	613.7	7970.8

Table 4. Carapace length and percents-at-age for males, and abundance at age for all shrimp in Disko Bay in 1995-1997, based on modal analysis of total length-freqencies for the survey area.

CL, mm	AGE				
Year	1	2	3	4	5
1995		12.6	16.2	19.5	22.4
1996		12.6	16.4	19.3	22.2
1997	8.3	12.5	16.7	19.7	22.5

Proportion	AGE					TOTAL
Year	1	2	3	4	5	MALES
1995		0.03	0.10	0.39	0.48	3985.5
1996		0.25	0.19	0.20	0.36	5970.5
1997	0.02	0.21	0.44	0.13	0.20	8234.7

Abundance	AGE						
Year	1	2	3	4	5	6+	TOTAL
1995	0.0	119.6	398.6	1554.3	1913.0	2076.1	6061.6
1996	0.0	1492.6	1134.4	1194.1	2149.4	2207.3	8177.8
1997	164.7	1729.3	3623.3	1070.5	1646.9	1438.2	9672.9

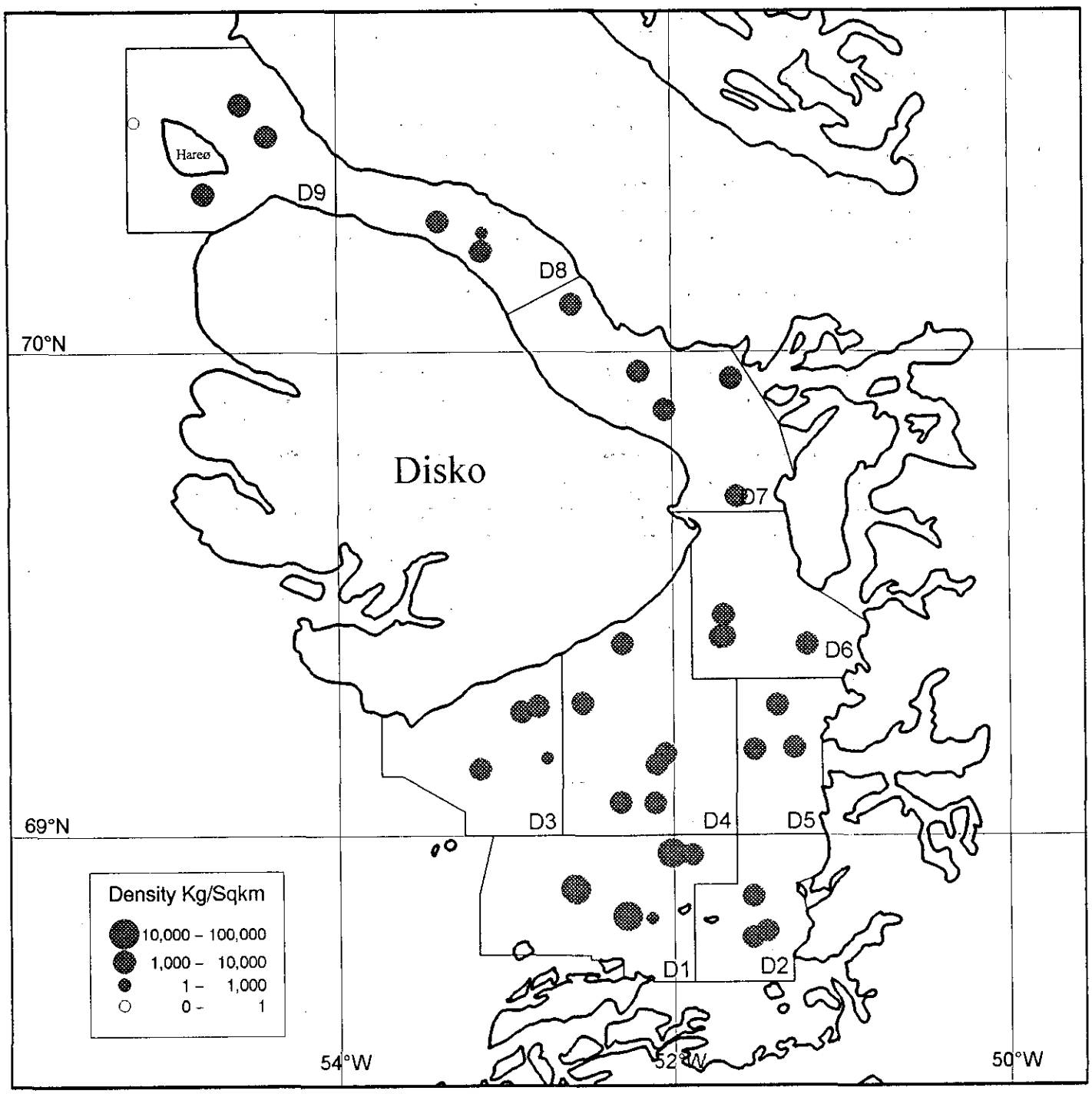

Figure 1. Sampling sites and shrimp densities (kg per km² swept area) in the 1997 trawl survey in Disko Bay - Vaigat area.

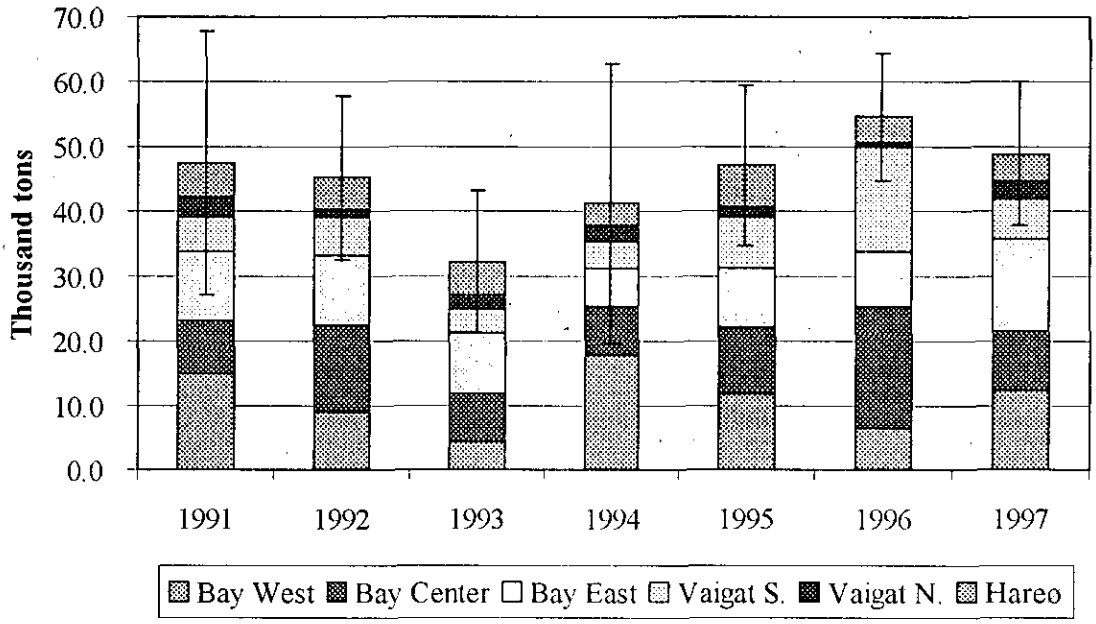

Figure 2. Estimated biomass 1991-97 in different parts of the Disko Bay – Vaigat area. Approximate confidence limits (95%) for the total biomass estimates are also indicated.

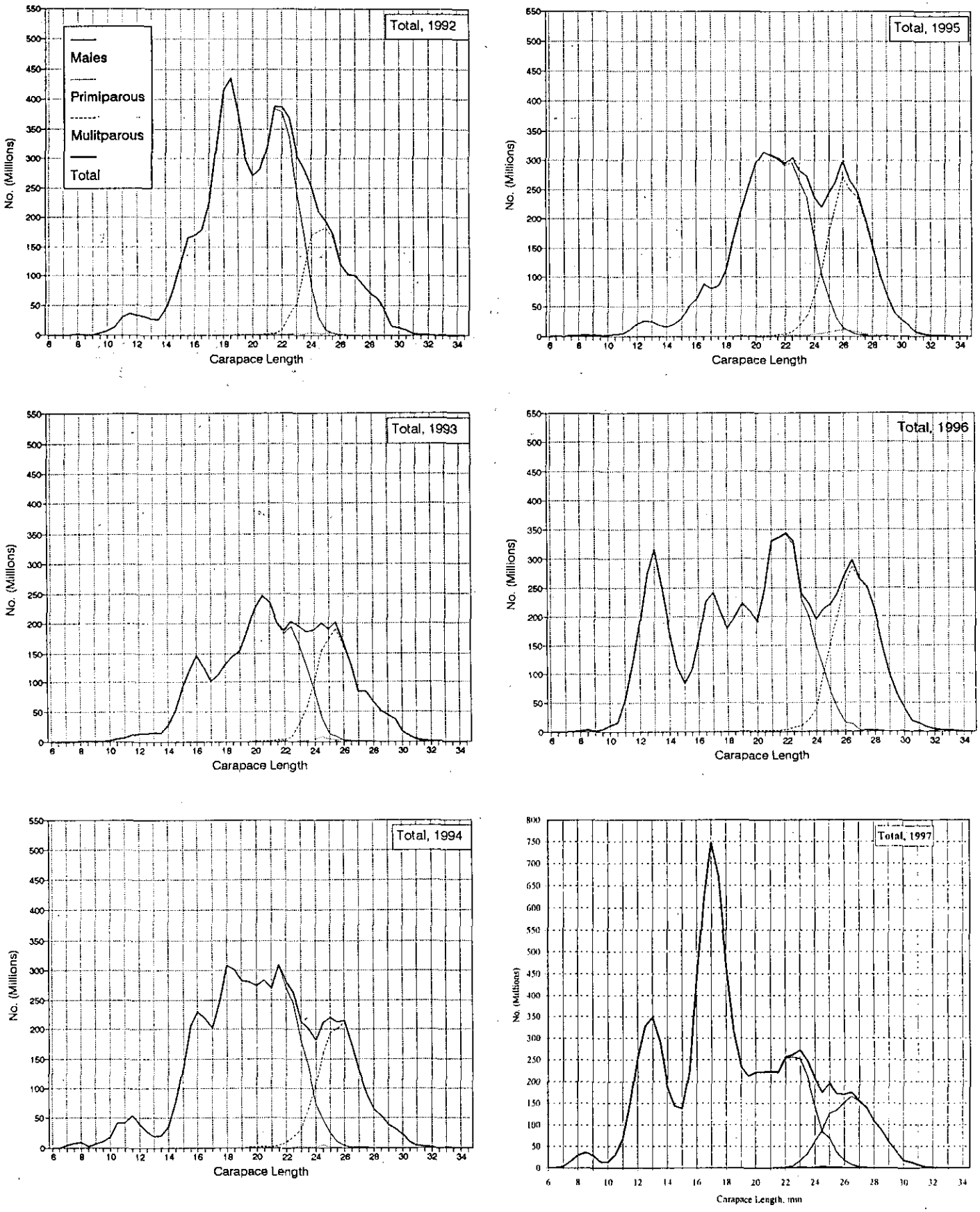

Figure 3. Numbers of shrimp by length group (CL) in total survey area 1992-97 (NB: scale changed for 1997).

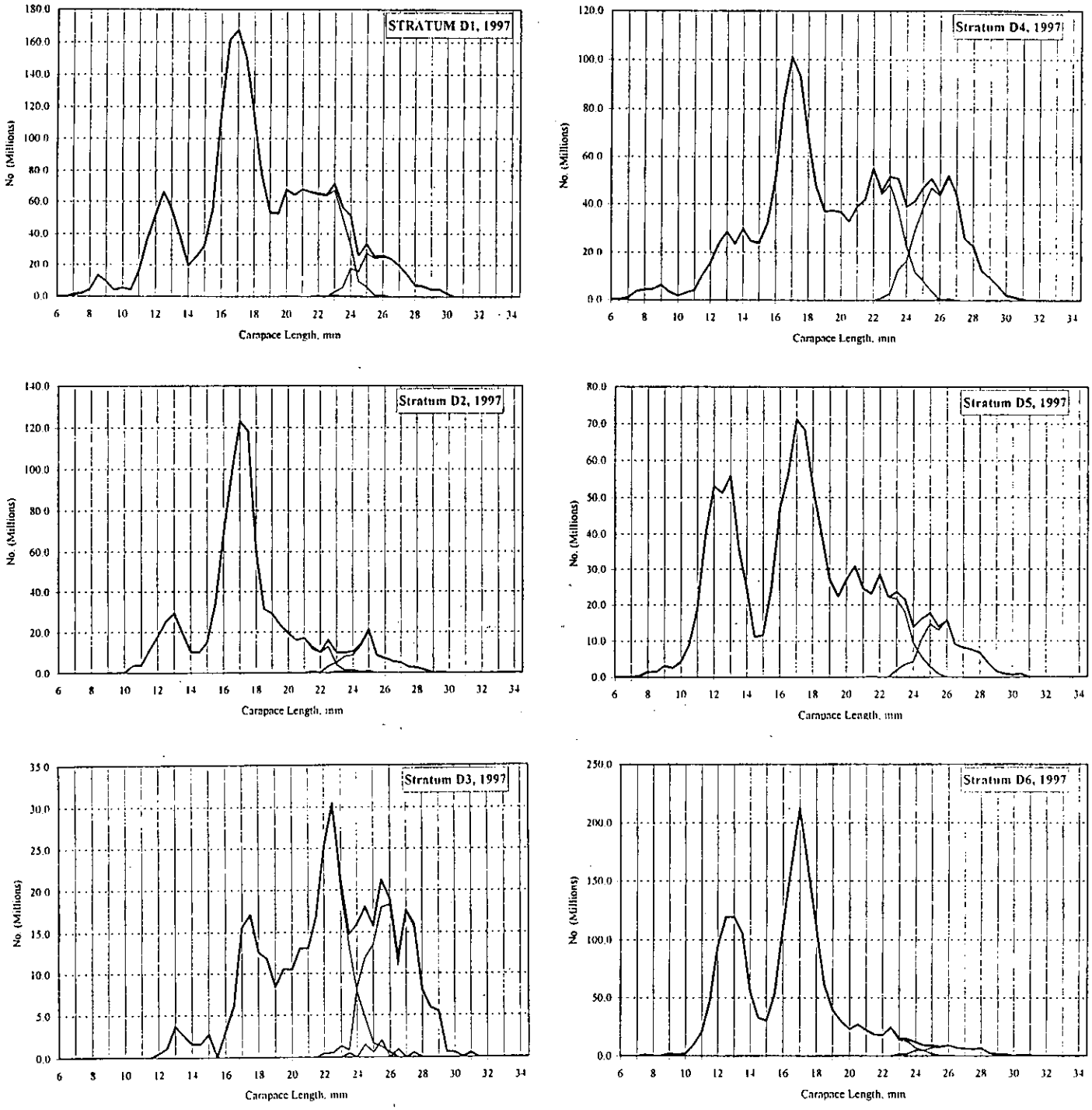

Figure 4a. Numbers of shrimp by length group (CL) in strata D1-D6 (see Fig. 1).

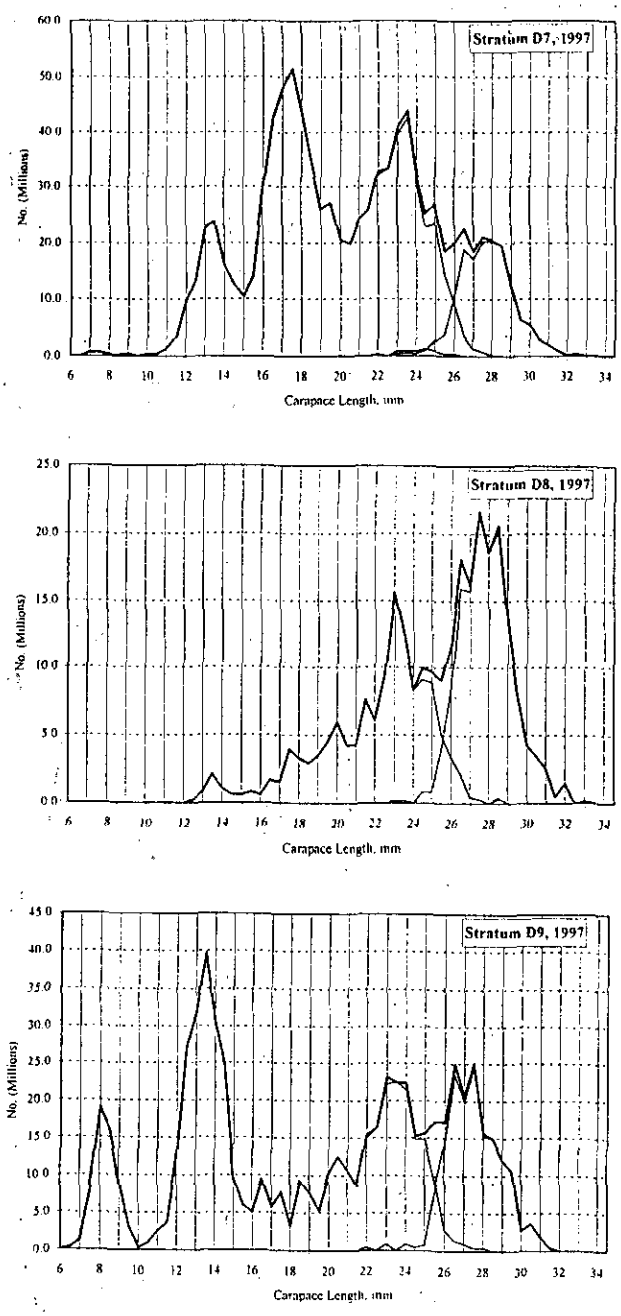

Figure 4b. Numbers of shrimp by length group (CL) in strata D7-D9 (see Fig. 1).