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Stratified Random Trawl Survey for Shrimp (Pandalus borealis) in Disko Bay and Vaigat, Inshore West Greenland 1996.

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 Greenland Institute of Natural Resources has conducted an annual stratified-random surveys in this area to evaluate the state of this stock component (Andersen et al., 1994, Carlsson et al. 1995). This paper presents results from the survey in 1996. 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°37'5N (Figure 1) in the depth interval 150-600 m, a total of 9364 km². 36 hauls were taken in the period from August 2 to August 15, 1996. One haul thus represents 260 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 measured 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 caliper to the nearest 0.1 mm.

Biomass estimate is calculated in accordance with the sweept area methode (Doubleday, 1981).

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. Five extra hauls were taken with one in D5 and two extra hauls in each of strata D4 and D7.

Length frequencies from individual hauls were weighted by catch and swept area and combined to mean abundance by length per stratum. Overall abundance by length was calculated by adding mean abundances by length from all strata.

The overall length distribution of shrimp in 1996 was separated in age groups by modal analysis (Macdonald and Pitcher, 1979).

Results and discussion

Table 1. lists the stations by stratum and shows positon, fishing depth in meters, trawl time in minutes and catch of *Pandalus borealis* in kg.

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 1996 survey is 54744 tons +/- 9877 tons (2x standard deviation).

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 for the Vaigat strata and for the Disko bay strata.

From 1995 to 1996 an increase in biomass index has taken place in the southern part of Vaigat (D7) and in the central part of Disko Bay (D4and D6), in all other strata a decrease of biomass index is observed.

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

The increase in estimated biomass from 1995 to 1996 is based on a significant increase in number of males and a slight increase in number of females.

Fig. 3 shows numbers of shrimp (males, females, and total) by stratum in 1996. Males are most abundant in south-western (stratum D1) and central (D4) Disko Bay and in southern Vaigat (D7). Females are most abundant in central Disko Bay (D4) and southern Vaigat (D7). Similar to earlier years female abundance is also relatively high in the Hareø area (D9).

The overall trend in abundance of males and females compared to 1995 is following the trend in biomass estimates. Abundance decreases in western (D3) and southeastern (D2) Disko Bay and in the Hareø area (D9) in the Vaigat, and increases in southwestern (D1), central (D4) and northeastern (D5 and D6) Disko Bay, and in southern and central

Vaigat (D7 and D8). The overall increase in number of males is mainly due to the significant increase in central and southwestern Disko Bay (D1 and D4), and in southern Vaigat (D7).

Overall length distributions of shrimp from 1991 to 1996 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.

In 1996 the 1990 year class i dominating the male group at 21-22 mm CL. Two peaks at 19 and 17 mm are representing the 1991 and the 1992 year class, respectively. A significant mode at 13 mm CL is supposed to represent mainly the 1993 year class, which was indicated in 1995 at 12.5 mm CL. Like in the offshore areas (Folmer *et al.*, 1996) this year class seems promising in terms of future recruitment to the fishery. In the Disko Bay, however, this mode may also include young males of the 1994 year class.

Fig. 5 (a-b) shows the overall length distributions by strata in 1996. The year classes - as described above - can be identified in most strata.

Conclussion

The total biomass estimate for the Disko and Vaigat area in the period 1991-1996 indicate a general stable situation apart from the low level in 1993.

Overall length frequencies for the Disko Bay area in 1996 show a significant size of the 1990 year class of males, which will recruit to the female stock in 1997. Recruitment of younger male groups is also indicated. The 1993 year class seems - like in the offshore areas - to be well above average size, and it may have the same significance to the future fishery as the 1985 year class had in the beginning of this decade.

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TABLE 1. List of trawl stations in the inshore shrimp survey 1996.

Stratum	Position (lat., long.)	Depth (m)	Trawl-time (min)	Shrimp catch (kg)
D1	68°57'36N 51°45'76W	264	30	407.60
	68°59'06N 52°15'71W	258	30	107.90
	68°56'51N 52°09'31W	265	30	64.60
D2	68°52'86N 51°23'16W	367	30	112.00
	68°56'46N 51°24'06W	373	30	123.30
D3	69°16'96N 53°10'96W	311	30	326.80
	69°11'71N 53°42'01W	270	30	105.00
	69°09'46N 52°47'41W	283	30	33.90
	69°10'26N 52°47'66W	315	30	41.50
D4	69°05'76N 51°51'36W	480	30	255.30
	69°10'51N 51°57'01W	382	30	707.10
	69°04'46N 52°12'66W	414	31	417.70
	69°13'51N 52°07'96W	452	30	540.80
	69°21'16N 52°10'06W	361	30	434.20
	69°17'71N 52°00'36W	379	30	341.50
	69°10'76N 51°58'41W	401	30	547.70
	69°10'31N 52°32'51W	471	30	278.80
D5	69°18'01N 51°12'51W	380	30	275.50
	69°17'91N 51°19'31W	390	30	169.80
	69°14'81N 51°31'31W	417	27	154.10
	69°07'21N 51°17'16W	274	30	404.50
D6	69°28'46N 51°42'16W	263	30	129.60
	69°26'71N 51°37'66W	277	30	169.80
D7	70°01'36N 52°22'41W	422	30	459.80
	69°57'81N 52°39'41W	394	30	628.30
	69°57'61N 51°45'66W	376	31	367.70
	69°52'81N 52°11'91W	469	30	682.50
	69°50'76N 52°06'26W	315	30	367.50
	69°58'21N 52°39'16W	392	28	350.90
	69°57'16N 51°38'96W	392	30	277.30
D8	70°15'46N 53°27'46W	292	30	139.00
	70°10'11N 52°54'81W	534	30	10.41
D9	70°33'56N 54°21'81W	346	30	81.10
	70°25'21N 54°35'16W	337	30	448.30
	70°19'61N 54°53'61W	250	30	23.30
	70°16'31N 54°57'86W	229	30	0.25

TABLE 2. The area in sq.km, number of hauls, mean density in kg per sq.km, and calculated biomass per stratum in 1996.

STRATUM	SQKM	BIOMASS IN STRATA					
		TONS	HAULS	STD	STDERR	MIN	MAX
D1	819	3691.9	3	3263.9	1884.4	1518	7445
D2	566	1469.0	2	127.2	89.9	1379	1559
D3	1124	2904.1	4	3187.8	1593.9	840	7618
D4	1834	18849.9	8	6823.2	2412.4	10460	30351
D5	612	3863.2	4	1857.4	928.7	2344	6368
D6	1014	3176.7	2	722.2	510.7	2666	3687
D7	1447	16194.9	7	4315.4	1631.1	9897	22419
D8	652	794.6	2	869.6	614.9	180	1409
D9	1296	3799.4	4	5765.1	2882.5	7	12358

TABLE 3. Estimated trawlable biomass per stratum and year in the Disko Bay - Vaigat area 1991-96.

Stratum	1991	1992	1993	1994	1995	1996
D1	9390	3211	2595	10457	5229	3692
D2	5632	1510	1765	654	2339	1469
D3	5667	5700	1719	7459	6575	2904
D4	9114	13676	7686	7318	10534	18850
D5	892	3401	2890	2558	4737	3863
D6	4039	5546	4717	2884	2011	3177
D7	5277	6046	3643	3995	7799	16195
D8	3219	1046	2084	2573	1389	795
D9	5385	4916	5072	3391	6467	3799
Total	48615	45052	32171	41289	47080	54744

Table 4. Numbers of shrimp (millions) per length group (CL) in total biomass estimate in 1996.

CL	Males	Prim.fem.	Mul.fem.	Total
5.0	0.0	0.0	0.0	0.0
5.5	0.0	0.0	0.0	0.0
6.0	0.0	0.0	0.0	0.0
6.5	0.0	0.0	0.0	0.0
7.0	0.0	0.0	0.0	0.0
7.5	0.3	0.0	0.0	0.3
8.0	1.2	0.0	0.0	1.2
8.5	2.8	0.0	0.0	2.8
9.0	0.7	0.0	0.0	0.7
9.5	3.8	0.0	0.0	3.8
10.0	10.6	0.0	0.0	10.6
10.5	15.1	0.0	0.0	15.1
11.0	56.4	0.0	0.0	56.4
11.5	118.2	0.0	0.0	118.2
12.0	189.5	0.0	0.0	189.5
12.5	273.9	0.0	0.0	273.9
13.0	317.0	0.0	0.0	317.0
13.5	251.0	0.0	0.0	251.0
14.0	175.0	0.0	0.0	175.0
14.5	112.8	0.0	0.0	112.8
15.0	83.5	0.0	0.0	83.5
15.5	107.6	0.0	0.0	107.6
16.0	158.5	0.0	0.0	158.5
16.5	226.4	0.0	0.0	226.4
17.0	241.4	0.0	0.0	241.4
17.5	207.3	0.0	0.0	207.3
18.0	179.5	0.0	0.0	179.5
18.5	201.0	0.0	0.0	201.0
19.0	221.9	0.0	0.3	222.1
19.5	208.7	0.0	0.2	208.9
20.0	190.8	0.0	1.6	192.3
20.5	246.4	0.0	1.0	247.4
21.0	329.5	0.0	1.3	330.7
21.5	335.8	0.0	1.3	337.0
22.0	342.1	0.0	3.0	345.1
22.5	323.6	0.5	6.5	330.6
23.0	230.3	0.0	9.4	239.8
23.5	201.0	0.8	20.7	222.6
24.0	152.8	0.8	40.1	193.7
24.5	111.8	1.1	99.6	212.5
25.0	68.2	1.4	152.2	221.8
25.5	38.8	1.4	200.0	240.3
26.0	15.4	1.4	255.9	272.7
26.5	12.3	0.0	286.1	298.4
27.0	1.2	0.9	263.2	265.3
27.5	2.1	1.7	248.2	252.0
28.0	0.9	0.0	210.6	211.5
28.5	0.6	0.2	150.9	151.7
29.0	0.0	0.0	97.8	97.8
29.5	0.0	0.0	64.0	64.0
30.0	0.4	0.0	39.5	39.9
30.5	0.0	0.0	18.2	18.2
31.0	0.4	0.0	13.2	13.6
31.5	0.0	0.0	7.1	7.1
32.0	0.4	0.0	3.3	3.7
32.5	1.0	0.0	1.0	2.0
33.0	0.0	0.0	1.2	1.2
33.5	0.4	0.0	0.0	0.4
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	5970.5	10.1	2197.2	8177.8

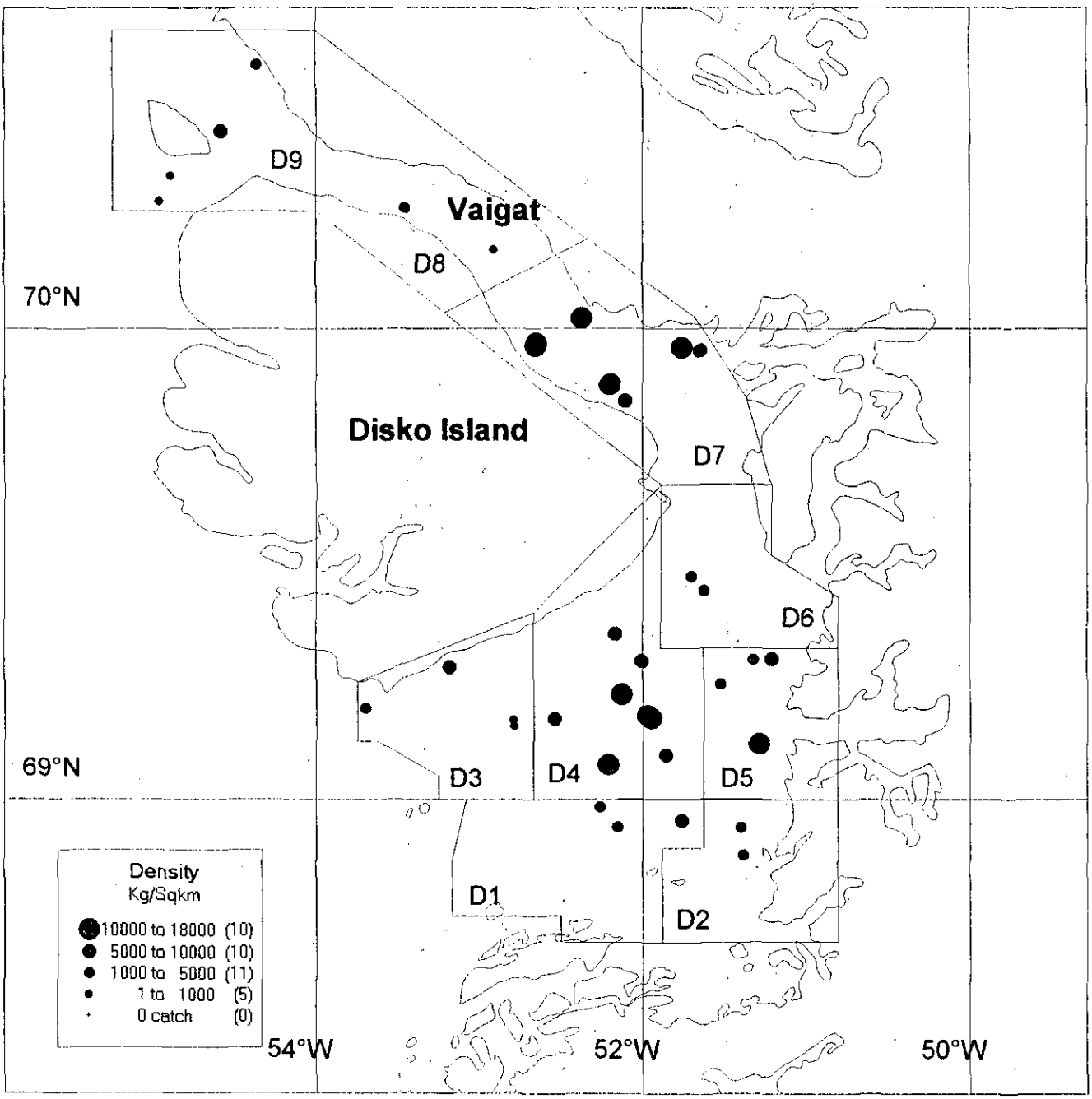

Figure 1. Strata and survey sampling sites in Disko Bay - Vaigat, 1996.
Shrimp catches are given in kg per SqKm.

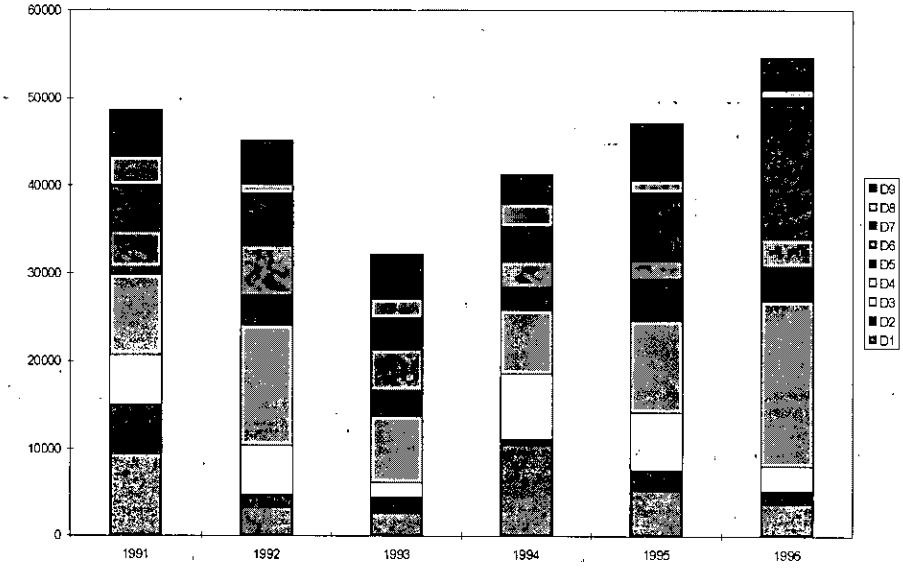

Figure 2. Shows the estimated biomass for strata in Disko Bay and the Vaigat area.

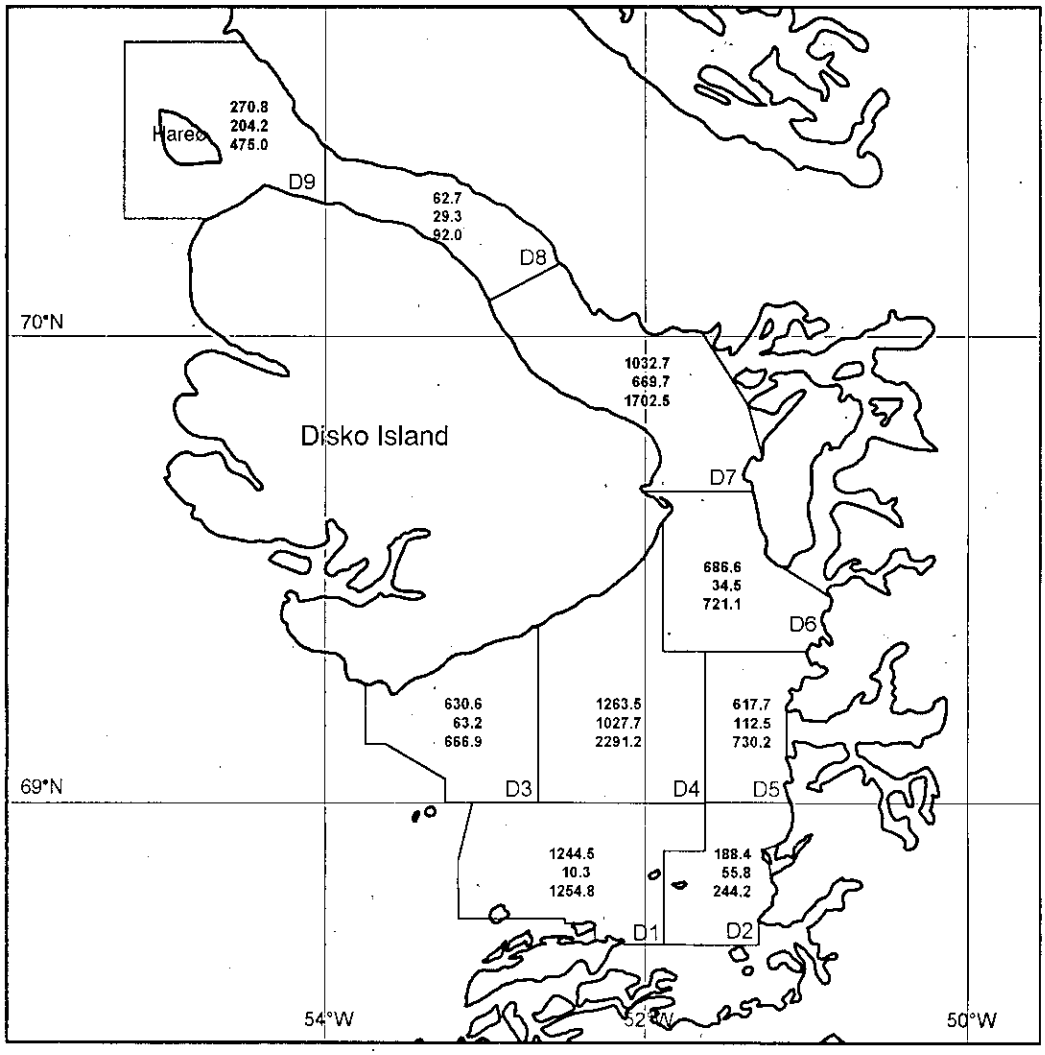

Figure 3. Calculated numbers of shrimp (males, females and total, in millions) per stratum in 1996.

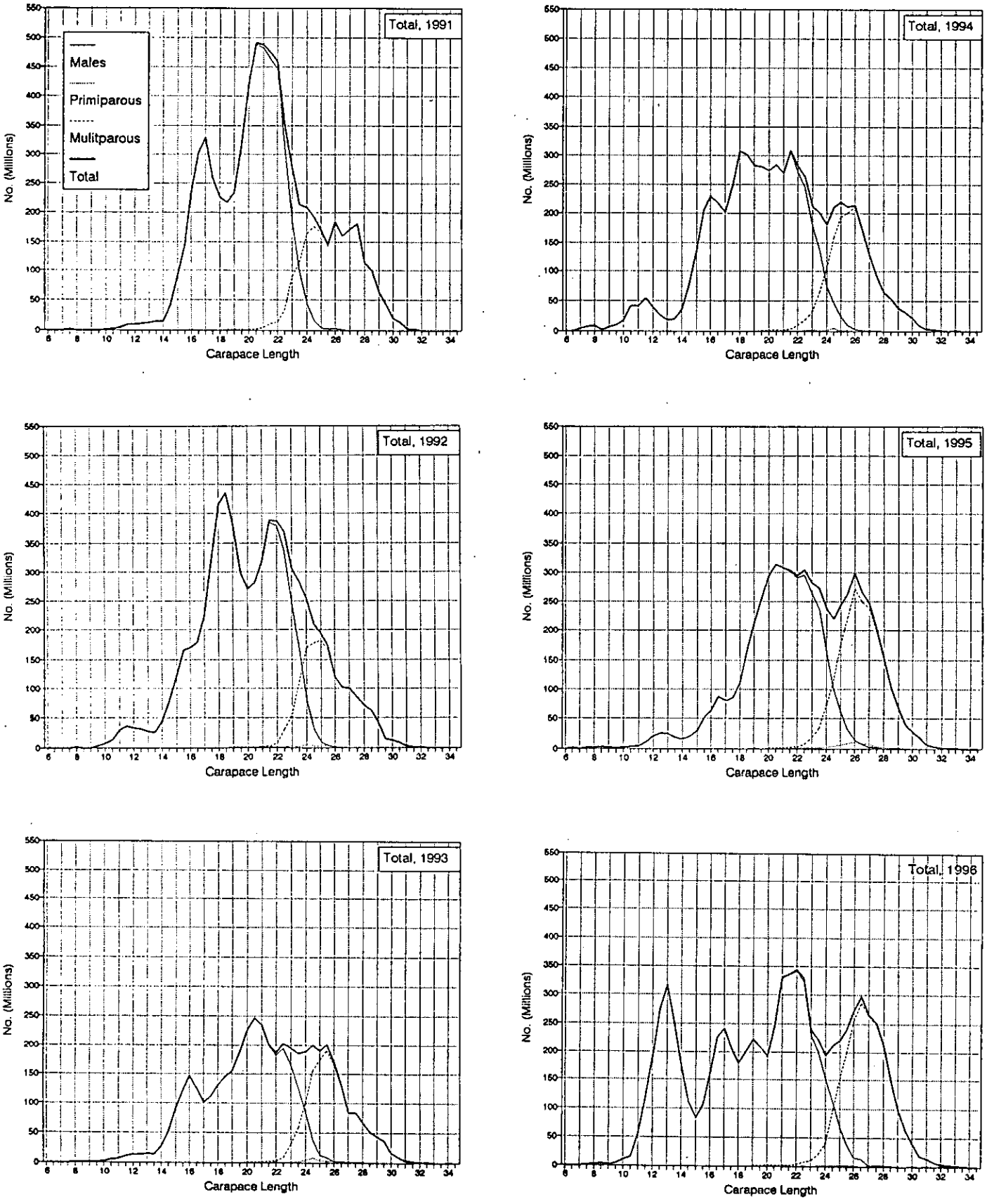

Figure 4. Numbers of shrimp by length group (CL) in the total survey area 1991-96.

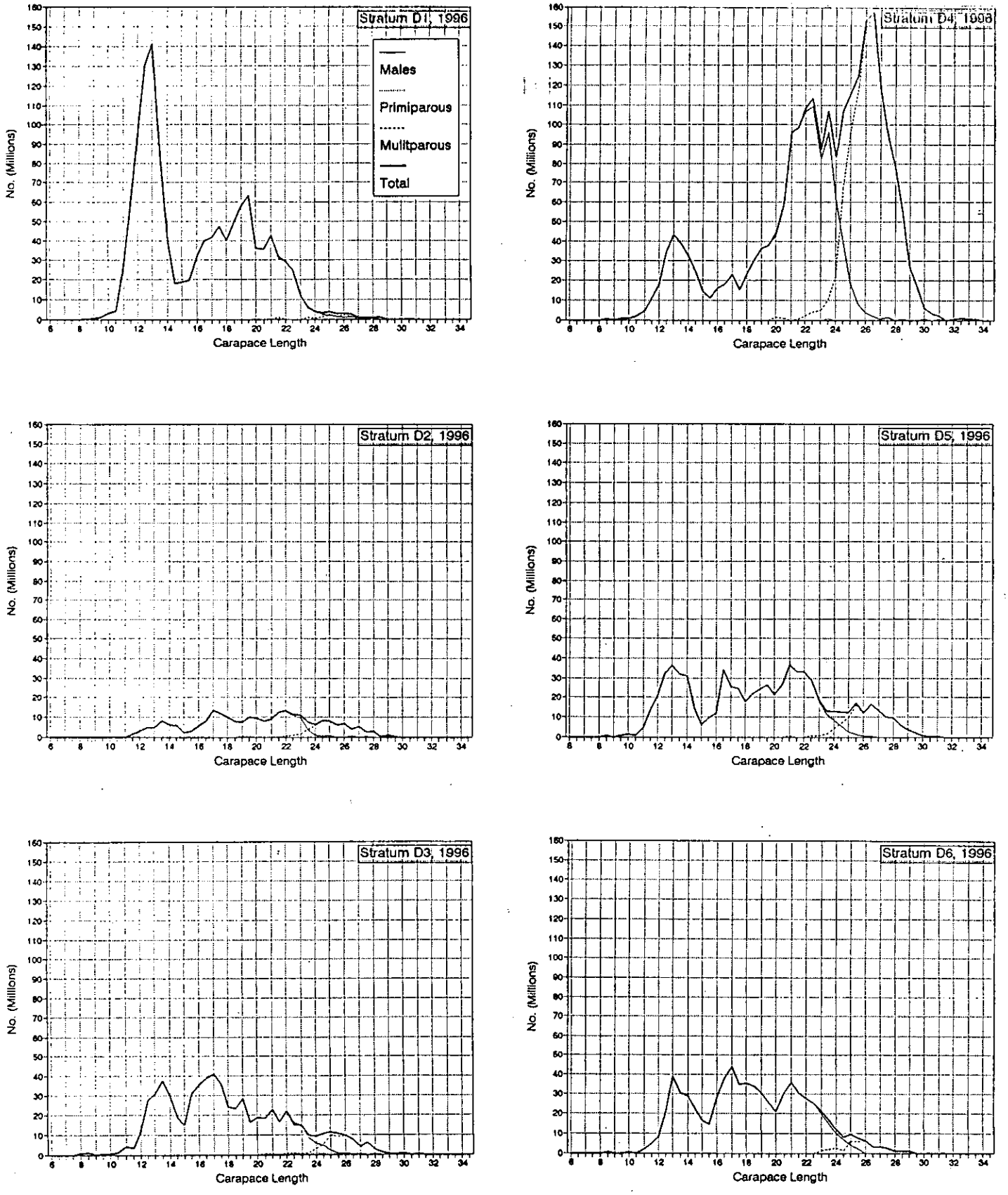

Figure 5a. Numbers of shrimp by length group (CL) in strata D1-D6 (see Fig. 1).

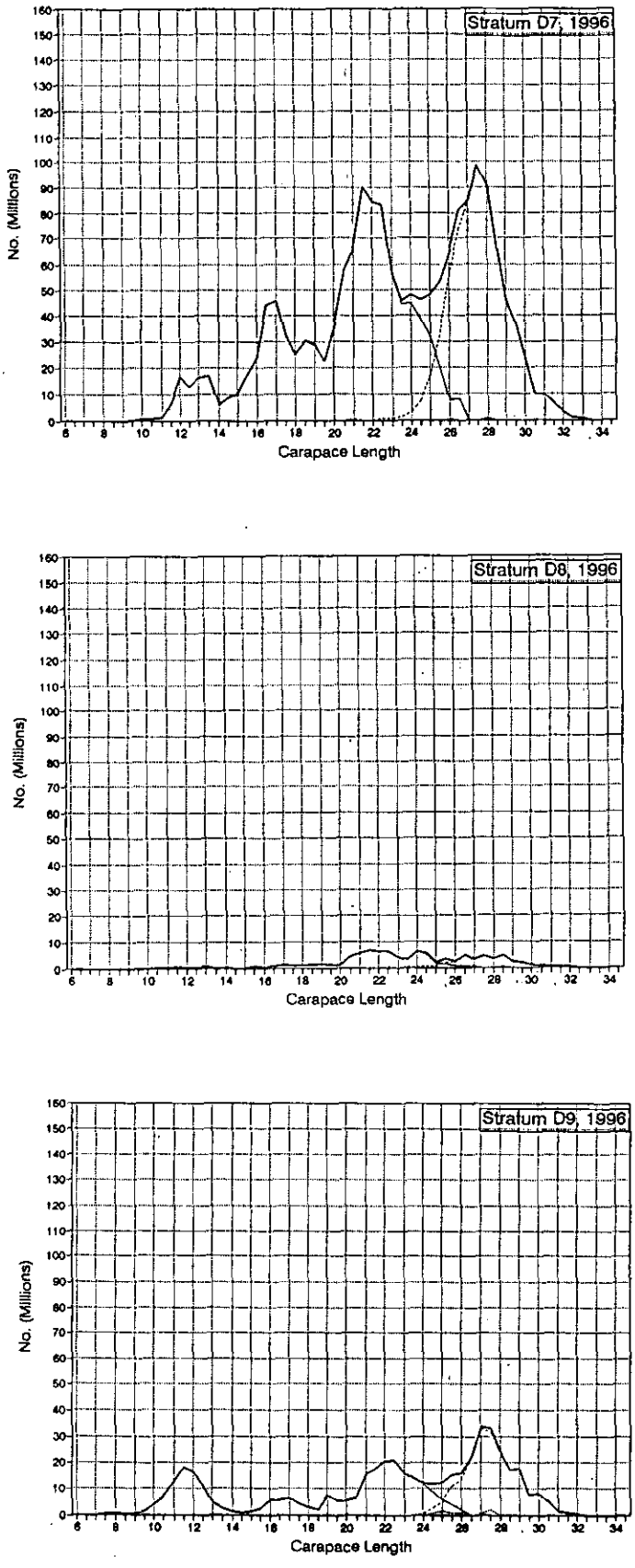

Figure 5b. Numbers of shrimp by length group (CL) in strata D7-D9 (see Fig. 1).