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Assessment of Shrimp in Davis Strait Subareas 0+1

by

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1. INTRODUCTION

The shrimp fishery off West Greenland comprises three fishing areas: the offshore area north of 71° N; the inshore area (primarily the Disko Bay); and the offshore area south of 71° N (Fig. 1). STACFIS has provided advice on TAC (since 1977) for only the last area which includes the Greenland fishery in Subarea 1 (Divisions 1A to 1F) and the Canadian fishery in Division OA (Table 1). No TAC's have been advised for either the northern area or the inshore fishery but a cautious approach to exploitation has been advised in recent years for the former. Although treated separately for assessment purposes, it is likely that the shrimp resources in these areas are parts of a single stock or stock complex.

This paper provides the assessment of the status of the shrimp resource throughout the area, incorporating data from the various fisheries, research vessel surveys and results of other studies on various aspects of shrimp biology. Also, proposals are provided on the short-term management of the stock.

2. COMMERCIAL FISHERY (SCR Doc. 92/56, 58, 65)

2.1 History of the Fishery

The nominal catch in the offshore area south of 71° N increased from less than 1,000 tons before 1972 to almost 43,000 tons in 1976. Catches fluctuated in subsequent years but stabilized at a level about 44,000 tons from 1985 to 1988. Catches increased further in 1989 and 1990 to about 52,000 tons and preliminary statistics for 1991 indicate yet another increase to about 57,000 tons (Table 2, Fig. 2).

The Canadian fishery in Div. OA usually takes place from July to November whereas the Subarea 1 fishery occurs in all months. The location of fishing activity in the latter is affected in the early part of the year by the presence of ice, confining the fleet to the southern grounds of Div. 1C and 1D.

The offshore area north of 71° N, which is outside the area for which TAC's are advised, began in 1985 with a catch of about 4,300 tons. Catches increased to about 11,000 tons in both 1986 and 1987 but have declined sharply since then to about 1,100 tons in 1991. The fishery in this area usually occurs from June to November.

The West Greenland inshore fishery appeared relatively stable from 1972 to 1986 with estimated catches of 7,500 tons annually (except for 10,000 tons in 1974). Catches in recent years have increased from about 7,000 tons in 1987 to almost 18,000 tons in 1991 (preliminary).

2.2 Trends in Catch and Effort

Logbook data from 1987 to 1991 were available by NAFO Division and, although incomplete for catch and effort, especially in the earlier years, they were useful for examining the recent trends in the fishery. In the offshore fishery south of 71° N, overall catches have increased from about 45,000 tons in 1987 and 1988 to about 57,000 tons in 1991. Catches in Div. 1A, 1B and 0A have remained relatively stable since 1987 (except for a high catch in Div. 1B in 1988). Traditionally, the fishing grounds in Div. 1B have been the most important but, since 1987, catches have increased in Div. 1C and 1D, and in 1990 and 1991, the nominal catches exceeded those from Div. 1B (Fig. 3a). The contribution to the total catch from Div. 1E and 1F remains low (< 600 tons).

Effort values reflect the same trends as the catch data in relation to spatial pattern of the fishery (Fig. 3b).

2.3 Trends in Catch Rates

Several catch rate indices are available for the offshore area south of 71° N, covering various periods of the fishery: the performance of seven Greenland trawlers in Div. 1B from 1976 to 1989; the standardized catch rates of large (>8.5 g) and total shrimp for 22 Greenland trawlers from 1987 to 1991 in Div. 1B; and standardized catch rates for the Canadian fishery in Div. 0A from 1981 to 1991 (Fig. 4).

The old seven trawler index showed an increasing trend from 1979 to 1987 in Div. 1B, followed by a decline from 1987 to 1989. The large and total shrimp indices from the 22 Greenland trawlers in Div. 1B showed a decrease from 1987 to 1989 followed by stability from 1989 to 1991. The Canadian series showed two periods of decreasing catch rates: 1982 to 1985 and 1987 to 1991. The latter was similar to the Greenland index for large and total shrimp - a decrease between 1987 and 1989 and relative stability from 1989 to 1991.

2.4 Biological Data

Length frequency distributions obtained by observers were available from the commercial fishery in Div. 0A from 1981 to 1991 and in Subarea 1 in 1990 and 1991. The Canadian data in Div. 0A (Fig. 5) showed a decrease in the mean length of females between 1983 and 1985, followed by a period of similar size composition from 1987 to 1989. The relative importance of the 1985 year class was evident in 1990 as it recruited to the fishery and in 1991 when it clearly dominated in the catches. These data were separated into age classes by modal analysis and the results showed that the relative contribution of females (ages 7+) in the catches declined from over 80% in 1981 to 44% in 1991. The analysis also showed a general trend of declining catch rates for females since 1981 (especially during the 1987 to 1991 period) and an overall increase for males (ages 4, 5 and 6). The 1981 and 1985 year classes were estimated to be strong.

CPUE at age:

	YEAR										
	'81	'82	'83	'84	'85	'86	'87	'88	'89	'90	'91
Female 7+	1.0	1.0	0.8	0.6	0.7	0.6	0.9	0.8	0.7	0.6	0.5
Male 4-6	1.0	2.0	1.8	2.6	1.5	2.8	3.4	3.2	2.2	3.4	2.8

Length frequency distributions obtained from the commercial fishery in Subarea 1 in 1990 and 1991, pooled by division and month, also showed the importance of the 1985 year class (Fig 6). In 1990, third quarter samples from Div. 1A showed a dominant peak of female shrimp at 27 mm CL. A smaller, less distinct mode of males was evident at 21 mm. Second quarter samples from Div. 1B clearly showed the 1985 year class forming a dominant mode at 19 mm and a component of females at 24 mm. The 1991 samples from Div. 1A in September showed a peak of female shrimp about 27 mm CL and the dominant 1985 year class

of males at 22 mm. Samples from Div. 1B in September show dominant peaks at 22 mm (male) and 24.5 mm (female). The incidence of shrimp less than 20 mm was low.

2.5 Discards

In Div. 0A, discard rates were at the same level as in preceding years. Since 1981, the observed average discard rate has varied between 2 and 5.5%. It was noted that these figures are likely underestimates of the actual discard rate.

The observer program, initiated in 1990 to study shrimp discarding practices in Subarea 1, was continued in 1991. Levels of discards in Divisions 1A to 1D were estimated at approximately 11,000 tons in both years. Length frequency distributions obtained from the study (Fig. 7) showed that the 1985 year class was heavily discarded in both 1990 and 1991.

3. RESEARCH SURVEY DATA (SCR Doc. 92/55, 67)

3.1 Biomass Estimates

In July-August, 1991, a stratified random trawl survey was carried out in the main area of shrimp distribution in Divisions 1A-1E and a part of Subarea 0 (Fig. 1). The area surveyed was the same as in 1990 but both extended beyond the areas covered in 1988 and 1989. Because shrimp densities from the commercial fisheries in these southern areas appeared very low for the earlier years, the estimates from all four surveys are considered to be comparable between years.

The biomass estimate in 1991 was about 105,000 tons, compared to 163,000, 197,000 and 152,000 tons in 1988, 1989 and 1990, respectively. Biomass in the area north of 69° 30' N decreased from 24,500 tons in 1988 to 5400 tons in 1991 (Table 3). In the main fishery area between 67° and 69° 30' N, biomass was approximately stable around 110,000 tons from 1988 to 1990 but decreased in 1991 to 63,000 tons. Biomass estimates in the southern grounds were relatively stable between 25,000 and 35,000 tons except for 75,000 tons in 1989.

In September, 1991, a stratified-random trawl survey was conducted for the first time in the inshore areas around Disko Bay and Vaigat. Biomass was higher in the southern strata and the estimate for the survey area was 44,800 tons.

3.2 Demographic Structure

The abundance of male shrimp increased significantly in 1989 when the 1985 year class entered the fishable stock and then decreased in 1990 and 1991. The number of female shrimp decreased from 1988 to 1989, increased slightly in 1990 and then decreased to the lowest number observed in 1991. The numbers of multiparous females were relatively stable from 1989 to 1991.

No. of shrimp (billions)	1988	1989	1990	1991
males (age < 7)	19.8	34.0	19.4	12.5
prim.fem. (age 7)	3.5	2.6	3.3	1.3
mult.fem. (age 8+)	4.6	3.7	3.4	3.4
total fem. (age 7+)	8.1	6.3	6.7	4.7
Total	27.9	40.3	26.1	17.2

The research length frequency data show the predominance of the 1985 year class in 1989, 1990 and 1991 throughout the offshore area. In 1989, abundance was highest in shallower water, most animals being males of the 1985 year class. In subsequent years, abundance was higher to the north and in deeper water, reflecting the growth and behaviour of this strong year class (Fig. 8).

The overall size composition of shrimp from the inshore survey was similar to that for the offshore in relation to the occurrence of modes. In the inshore area, however, there was a higher proportion of younger male shrimp with a modal length of about 17 mm, likely representing the 1987 year class (Fig. 9).

4. SUMMARY OF ALL INDICES

an overall increase of catches in Davis Strait:

-overall increase from 1981 to 1991

short term variations in catches:

- catches North of 71° N decreased since 1987
- catches in the inshore area increased since 1987
- catches offshore increased since 1988 (TAC exceeded)
- catches in division OA have been stable since 1986

short term variations in effort:

- overall increase in effort from 1987
- effort fluctuated in divisions 1A, 1B
- effort increased in division OA
- effort increased in divisions 1C, 1D
- new fishing activity in the southern divisions, 1E, 1F

a shift in the fishery:

while catches fluctuated in the northern part of Davis Strait, the fishery (catches and effort) has increased in the southern divisions

long-term trend in catch rates:

variations in division OA:

-two periods of decreasing CPUE's: 1982 to 1985 and 1987 to 1991

variations in division 1B:

-increasing trend (1979 to 87) followed by a decline (1987 to 89)

short-term trend in catch rates:

variations in division OA:

-catch rates from 1989 to 91 substantially lower than 1987-88

variations in division 1B:

-decrease from 1987 to 89 followed by stability from 1989 to 91

composition of catches:

from division OA:

- in general, years of high catch rates are associated with a dominance of females in the catches
- the relative contribution of females (ages 7+) in the catches declined from over 80% in 1981 to 44% in 1991
- since 1981, catch rates for females showed an overall declining trend while those for males increased to 1987 and then stabilized

throughout West Greenland offshore area:

- the relative importance of the 1985 year class was evident in 1990 as it recruited to the fishery and in 1991 when it clearly dominated in the catches
- the occurrence of shrimp smaller than 20 mm (CL) was low in 1991

discarding:

- the discard data show that the 85 year class was heavily discarded in 1990 and to a lesser extent in 1991
- levels of discarding in divisions 1A to 1D were estimated at approximately 11,000 tons in both 1990 and 1991

biomass estimates from research surveys:

- biomass in the area north of 69° 30'N decreased from 1988 (24,500 tons) to 1991 (5,400 tons)
- between 67° N and 69° 30'N, biomass was stable at roughly 110,000 tons from 1988 to 1990 but decreased in 1991 to 63,000 tons
- south of 67° N, biomass was relatively stable between 25,000 and 35,000 tons except 1989 (75,000 tons)
- one estimate of biomass of 44,800 tons was obtained for 1991 in the inshore area

demographic structure:

- number of males was highest in 1989 and lowest in 1991
- number of primiparous females was at the lowest level in 1991 while number of multiparous females was stable from 1989 to 1991
- the 1985 year class dominated in 1989, 1990 and 1991 and the distribution reflects the migration into deeper water of the year class as it grows
- the size composition of shrimp from the inshore survey is similar in the occurrence of modes to the size composition of the offshore survey; it showed a predominance of males with modes at 17 mm (87 year class) and 21 mm (85 year class)

5. STATUS OF THE RESOURCE

Indices from the commercial fishery show that the abundance in 1989-91 is lower than the high 1987-88 level. The high level can be explained by the recruitment to the female component of at least two strong year classes around 1987. The decrease from the 87-88 level can be explained by mortality (fishing and natural) of these year classes while recruitment was lower.

The research survey index showed an increase from 1988 to 1989 followed by a decline to 1991. The increase in 1989 is due to the 1985 year class which resulted in an increase in biomass in the southern areas and maintained the biomass level in the central areas. The decrease in biomass in 1990 from the 1989 level appears to be due primarily to mortality of the male shrimp since female abundance remained fairly constant. The further decrease in 1991 appears again to be due to mortality of males, a lack of recruitment and the apparent weakness of the 1984 year class (primiparous females).

The strong 85 year class recruited to the fishery in 1990. It should have a positive effect on the catch rates as it becomes female in 1992 and thus maintain the spawning biomass. However, this year class has been subjected to high discarding in both 1990 and 1991 and might not contribute as much as previously expected to either the catch rates or the spawning stock. It is further noted that the advised TACs in both years (50,000 tons) were exceeded by 3,000 tons in 1990 and over 7,000 tons in 1991. Also, in contrast to the recruitment pattern prior to the 1987-88 situation, the success of the fishery and the level of the stock is dependant in the short term on only one year class (the 85 year class), since both the 86 and 84 year classes appear to be much weaker.

6. CONCLUSION

Given recent developments in the shrimp fishery in subareas 0+1, concern is warranted for the status of the stock. The success of the fishery in the short term will depend on the actual strength of the 85 year class and incoming recruitment but neither of these can be quantified. If the stock is declining to very low levels, it is possible that future recruitment will be adversely affected. Although a stock recruitment relationship is not apparent from the existing data, there is a concern that the spawning biomass will be reduced to the lowest level observed since 1981.

7. SOURCES OF REFERENCE

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Table 1. Advised and effective TAC (tons) in West Greenland.

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
SA 0+1 ¹ advised	29500	29500	29500	29500	36000	36000	36000	36000	44000	50000	50000
SA 0+1 ¹ effective	35000	34800	34625	34925	42120	42120	40120	40120	40120	44975	46225

Table 2. Shrimp in West Greenland: total nominal catches (tons).

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
North of 71	-	-	-	-	4349	11045	10700	6660	2522	2121	1077
Inshore	7500	7500	7500	7500	7500	7500	6921	10233	13224	15386	17891
SA 0+1 ¹ Offshore	37300	36827	39267	35883	42187	44584	46160	43649	49931	52773	57332
West Greenland	44800	44327	46767	43383	54036	63129	63781	60542	65677	70280	76300

¹ Includes the offshore fishery south of 71° N in Subarea 1 and the adjacent part of Division 0A.

	1988	1989	1990	1991
N1-N4	16825	8419	7712	3655
N5-N7	7706	3316	2516	1745
Inshore	-	-	-	44804
W1-W2	50830	51279	68348	34693
C1-C3	8111	3992	9959	4180
W3	51696	58285	31114	23865
W4	20232	30937	10946	12938
W5	15738	44543	14949	13848
W6	-	-	6620	10068
North	24531	11735	10228	5400
W1+W2+W3+C	103337	113556	109421	62738
W4+W5	35970	75480	25895	26786

Table 3. Shrimp biomass estimates (tons) obtained from stratified random surveys conducted in Davis Strait from 1988 to 1991. (Refer Fig. 1 for locations of strata.)

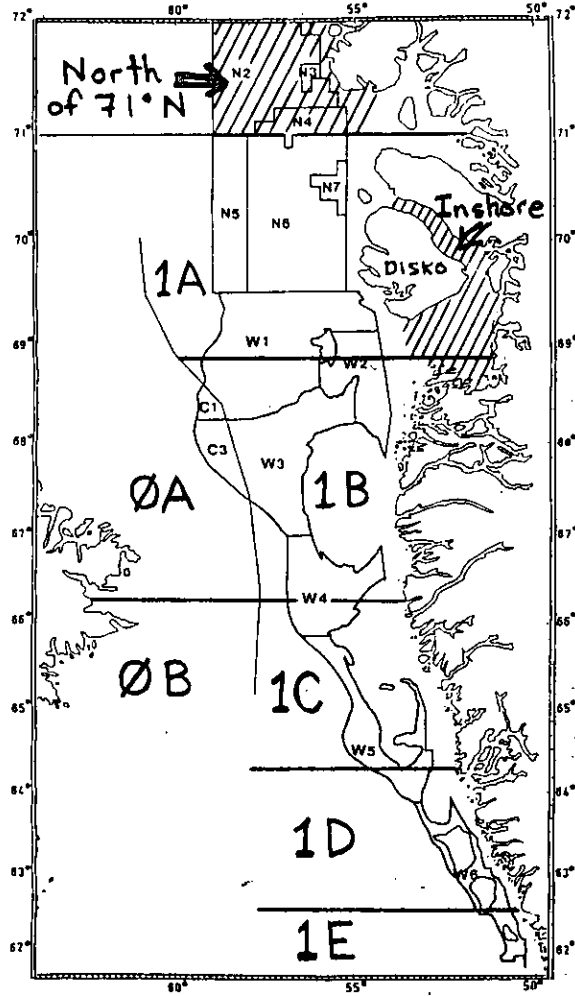


Figure 1. NAFO Divisions, shrimp fishing areas and the stratification scheme for shrimp surveys in Davis Strait.

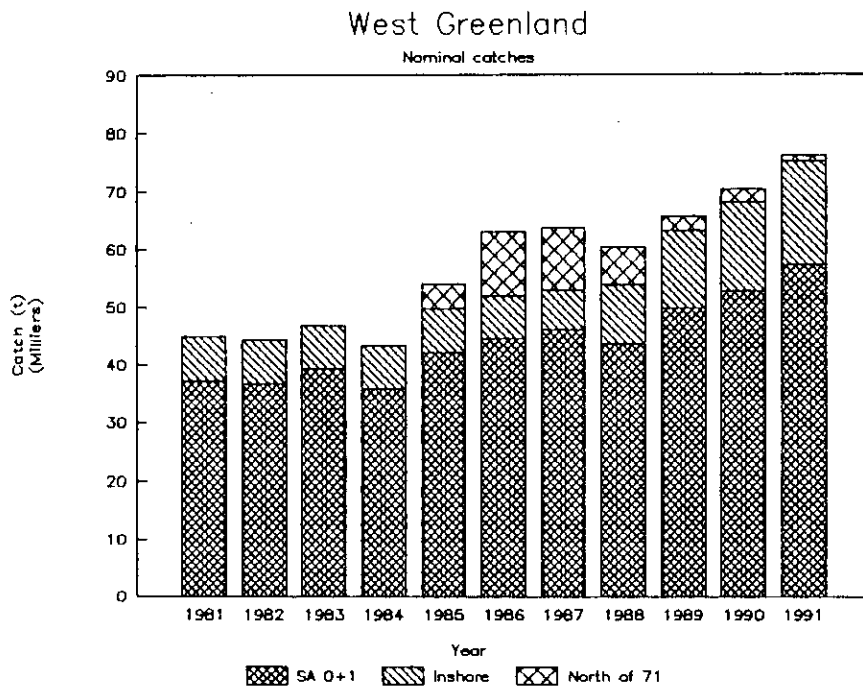


Figure 2. Nominal catches of shrimp in Davis Strait for the three fishing areas, 1981 - 1991.

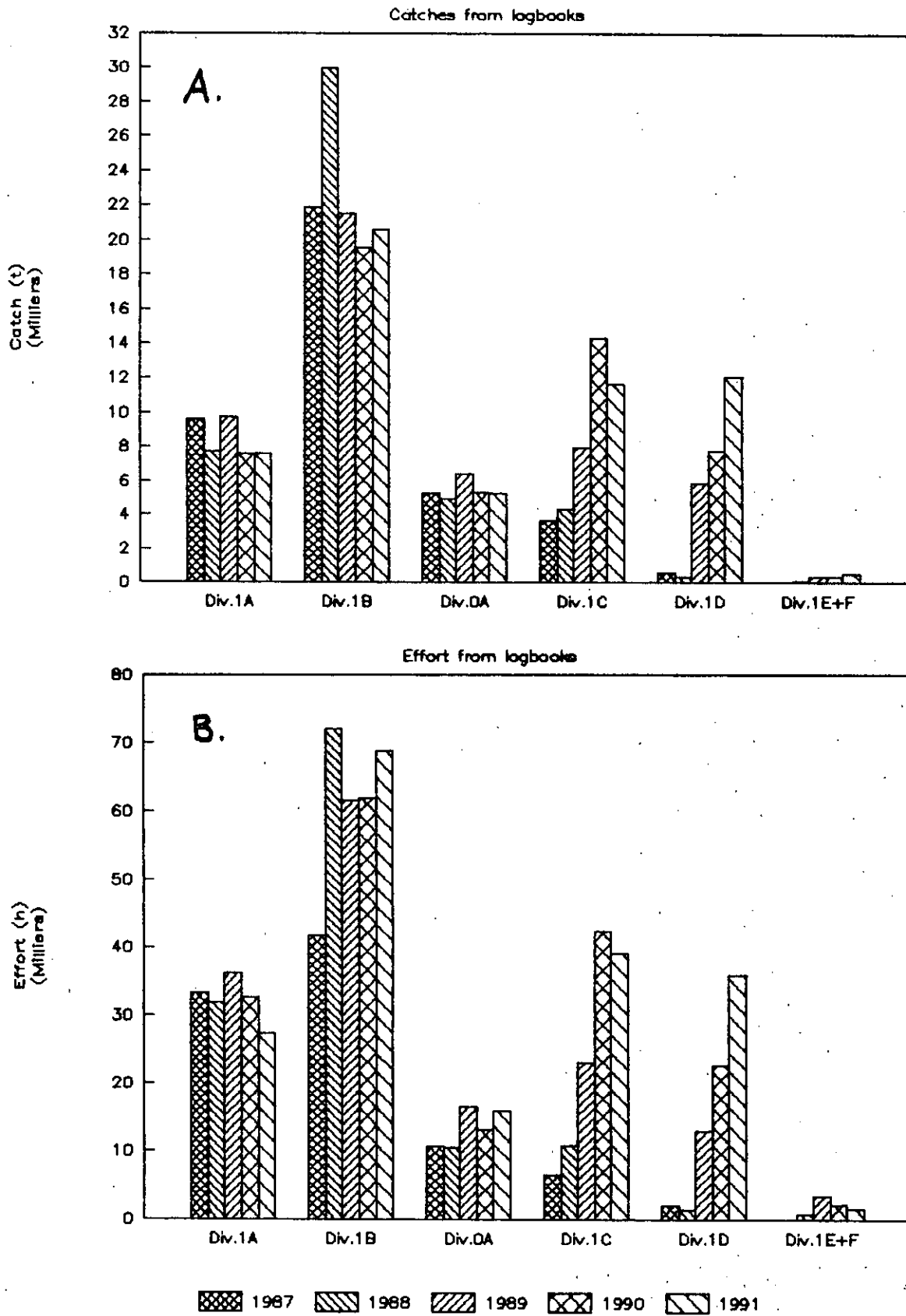


Figure 3. Trends in catch (A) and effort (B) determined from logbook data by NAFO Division, 1987 - 1991.

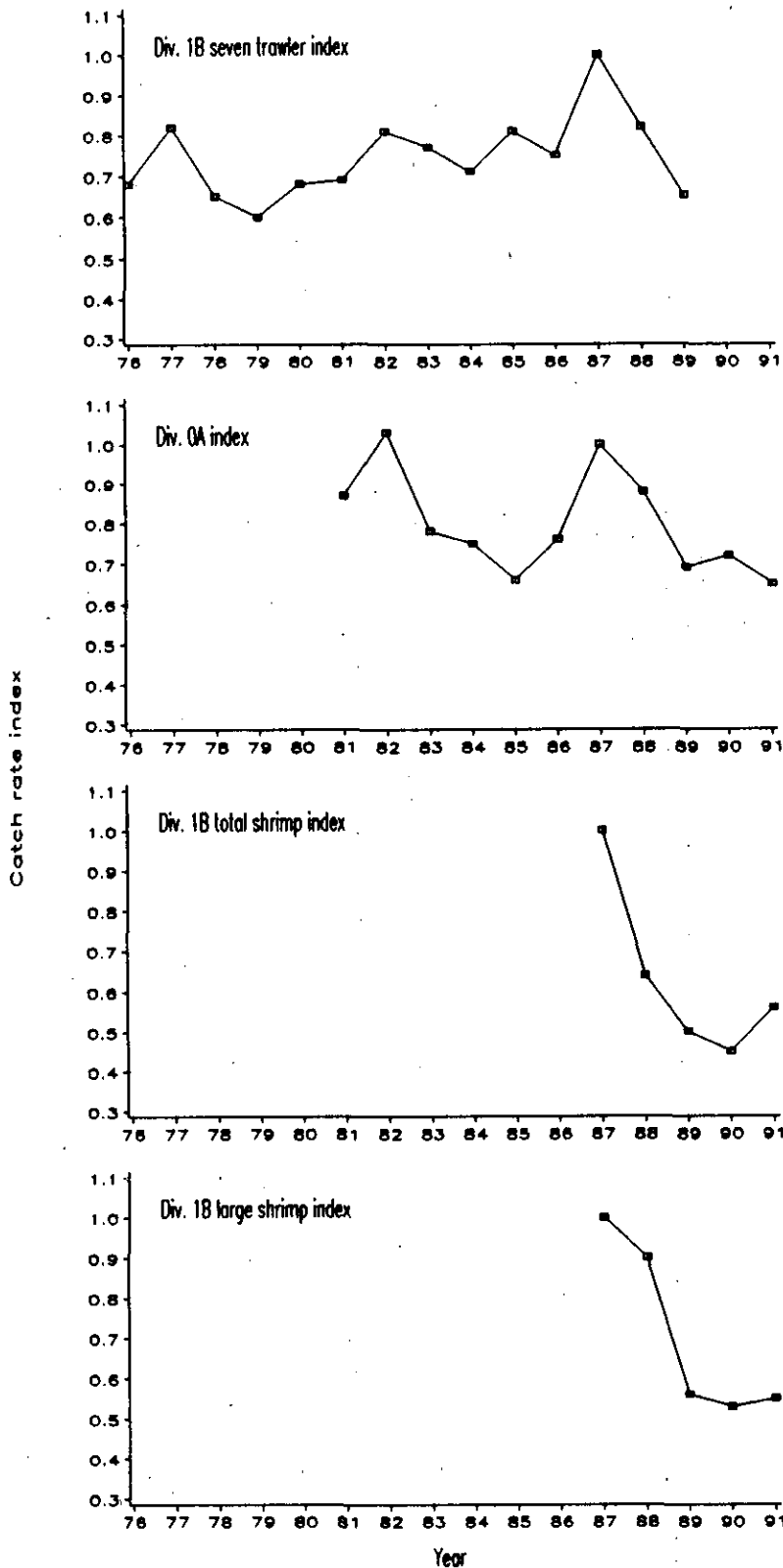


Figure 4. Catch rate indices for shrimp in Davis Strait.

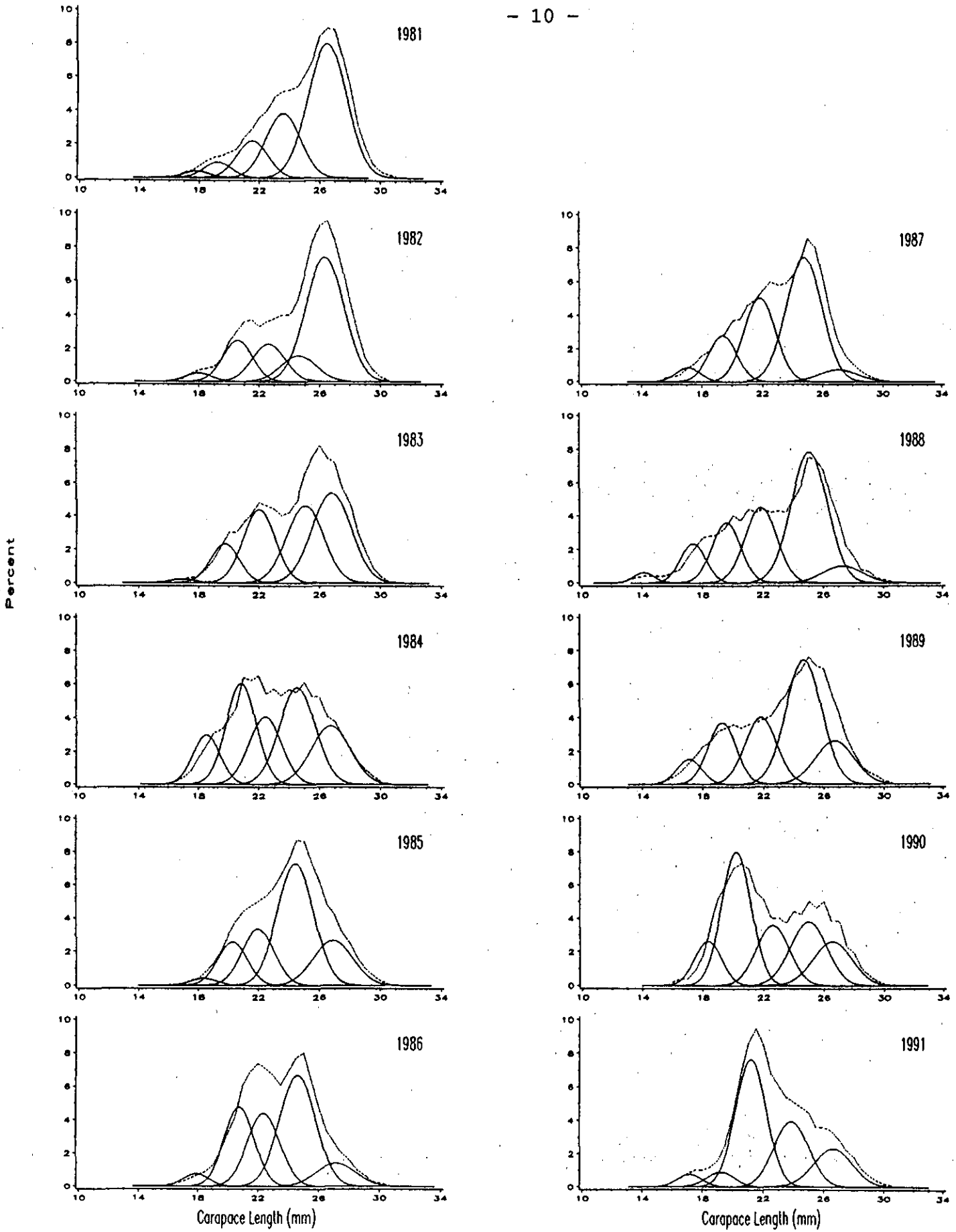


Figure 5. Length composition of shrimp catches in NAFO Div. OA, 1981 - 1991, and separation into age classes by modal analysis.

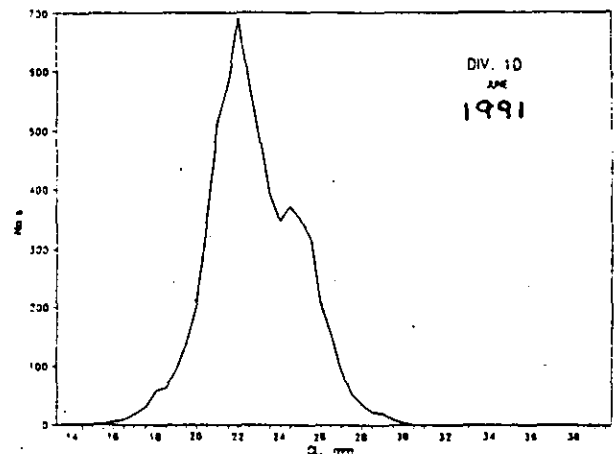
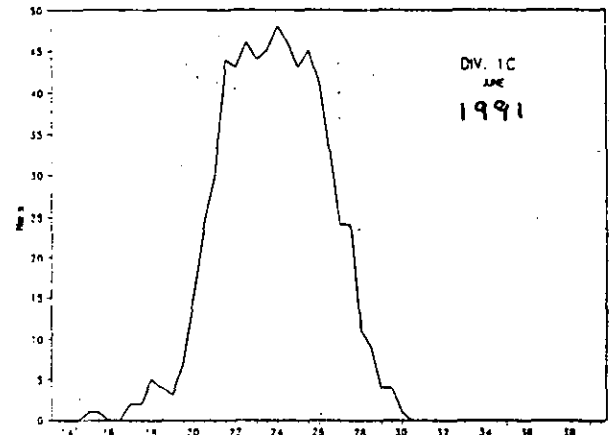
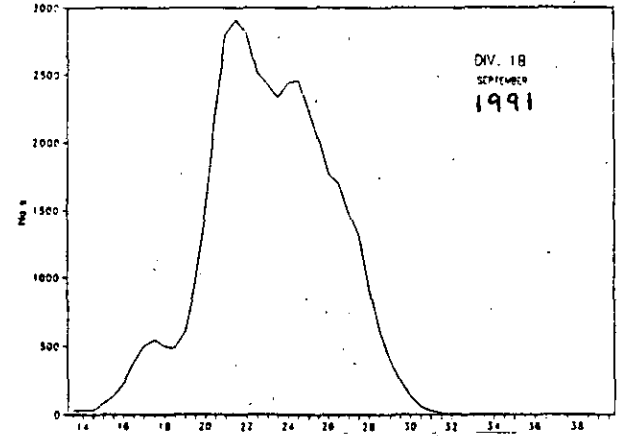
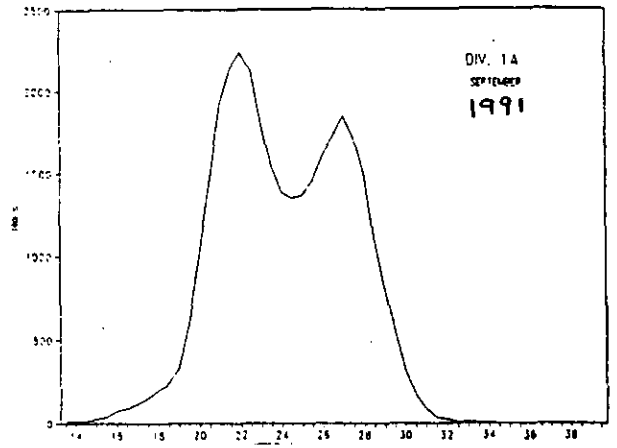
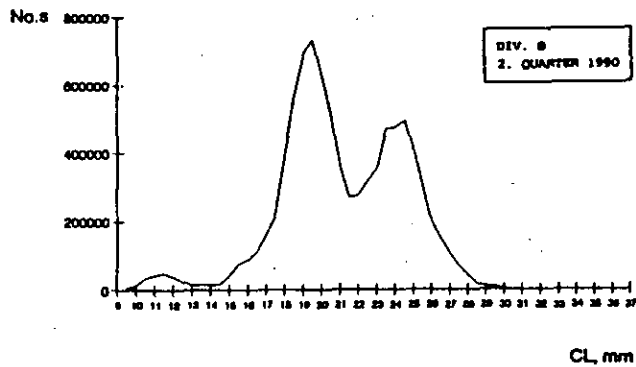
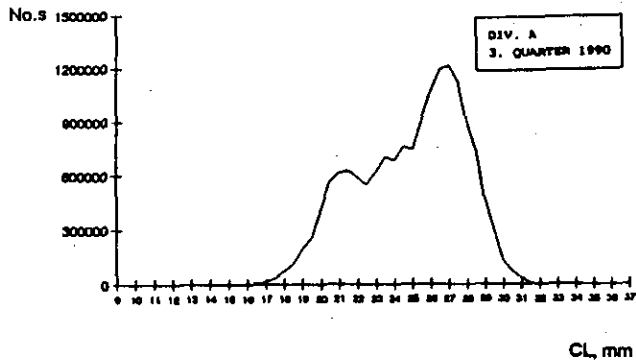


Figure 6. Length distributions of shrimp obtained from the commercial fishery in Subarea 1 in 1990 and 1991.

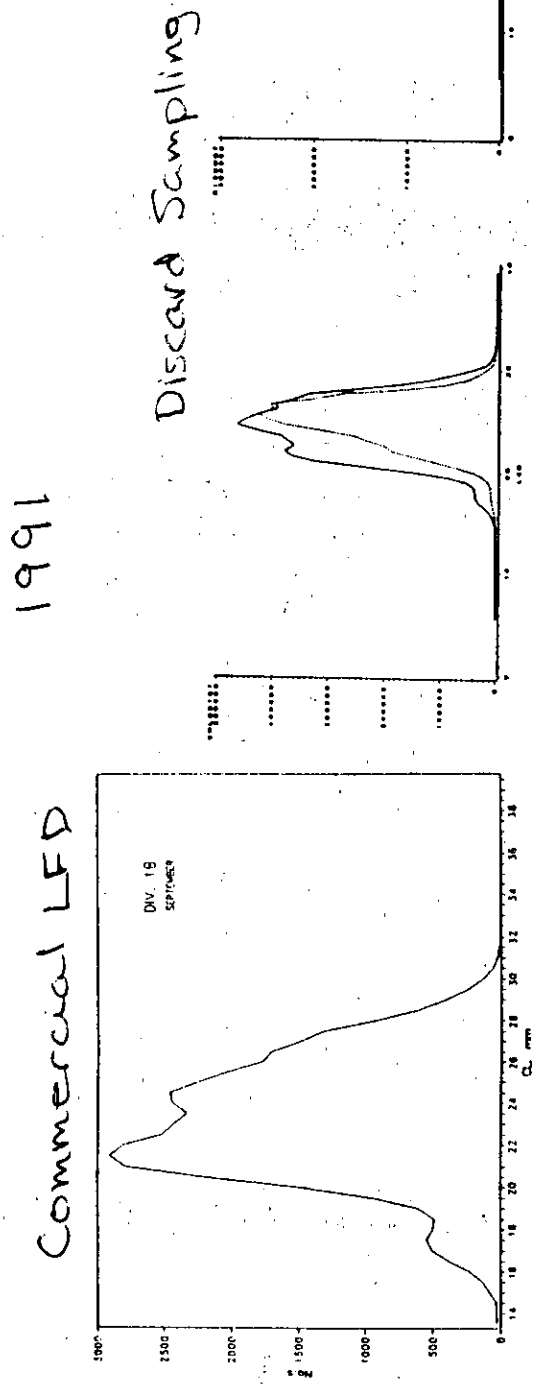
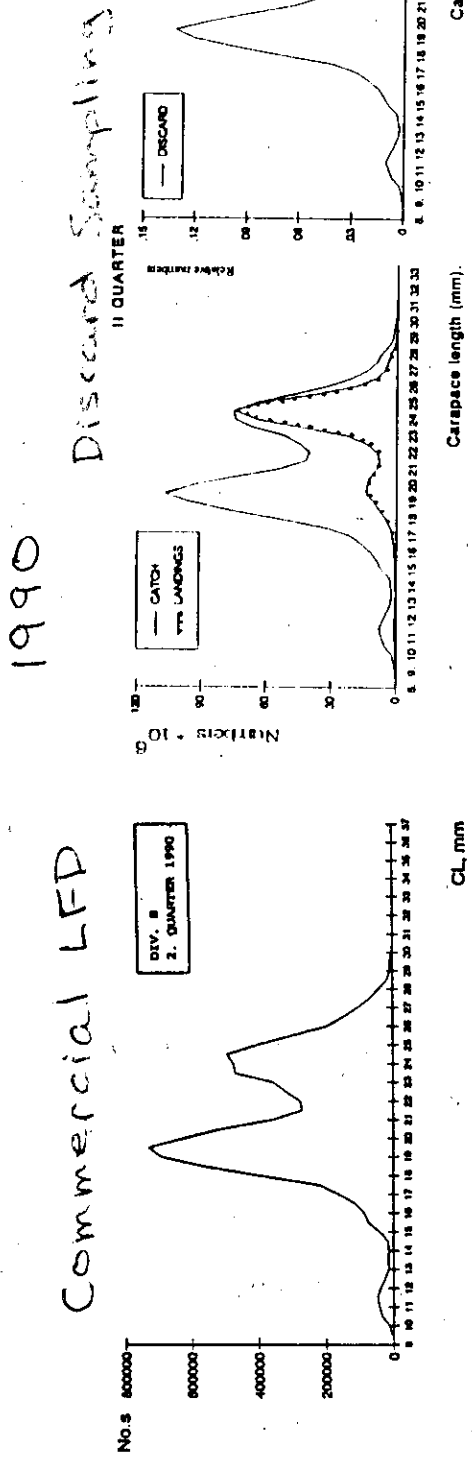


Figure 7. Length distributions of shrimp discards obtained from the Greenland observer program in 1990 and 1991.

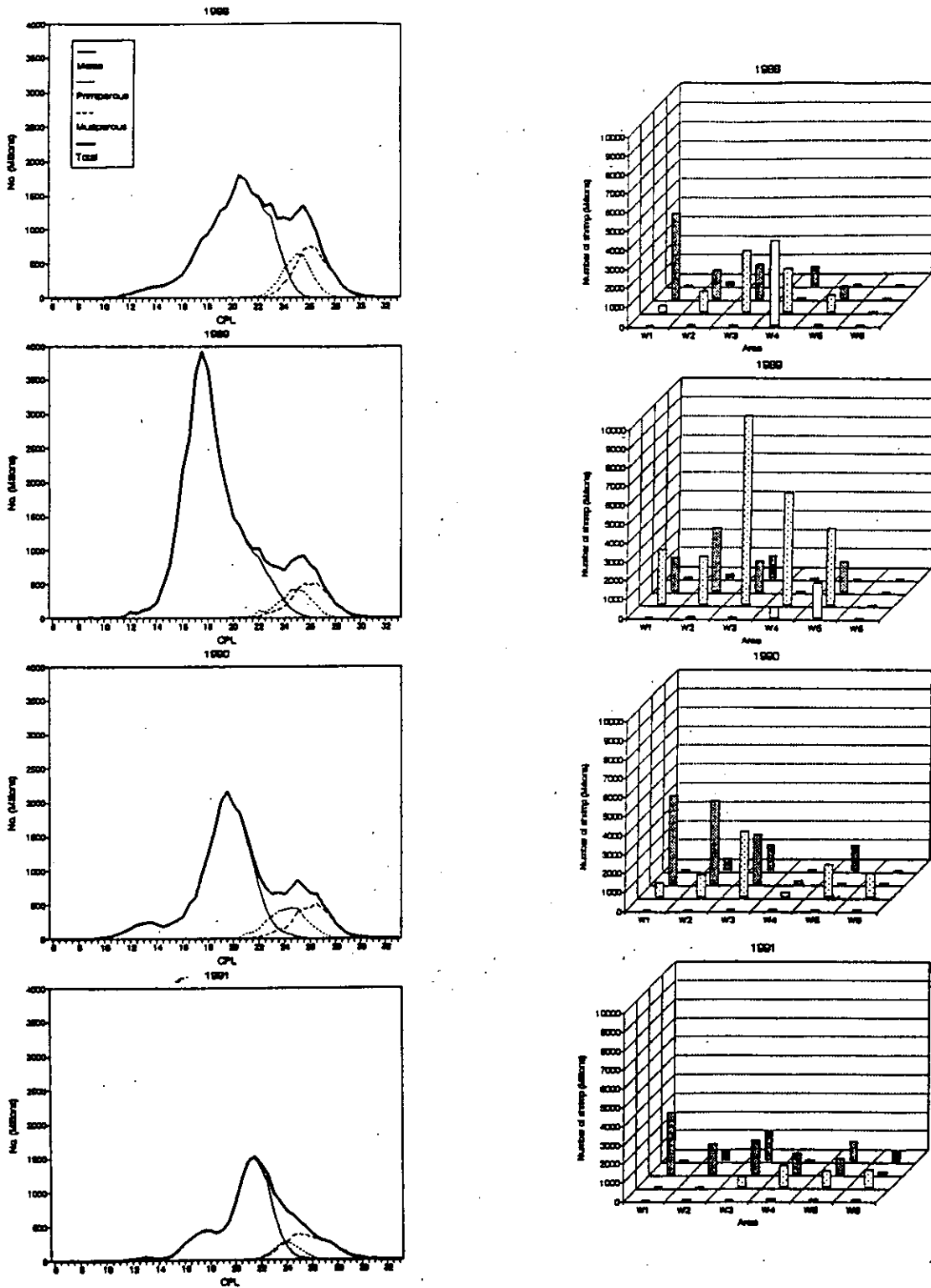


Figure 8. Research length frequency data and distribution patterns of shrimp in Davis Strait by area and depth, 1988 - 1991.

DISKO 1991

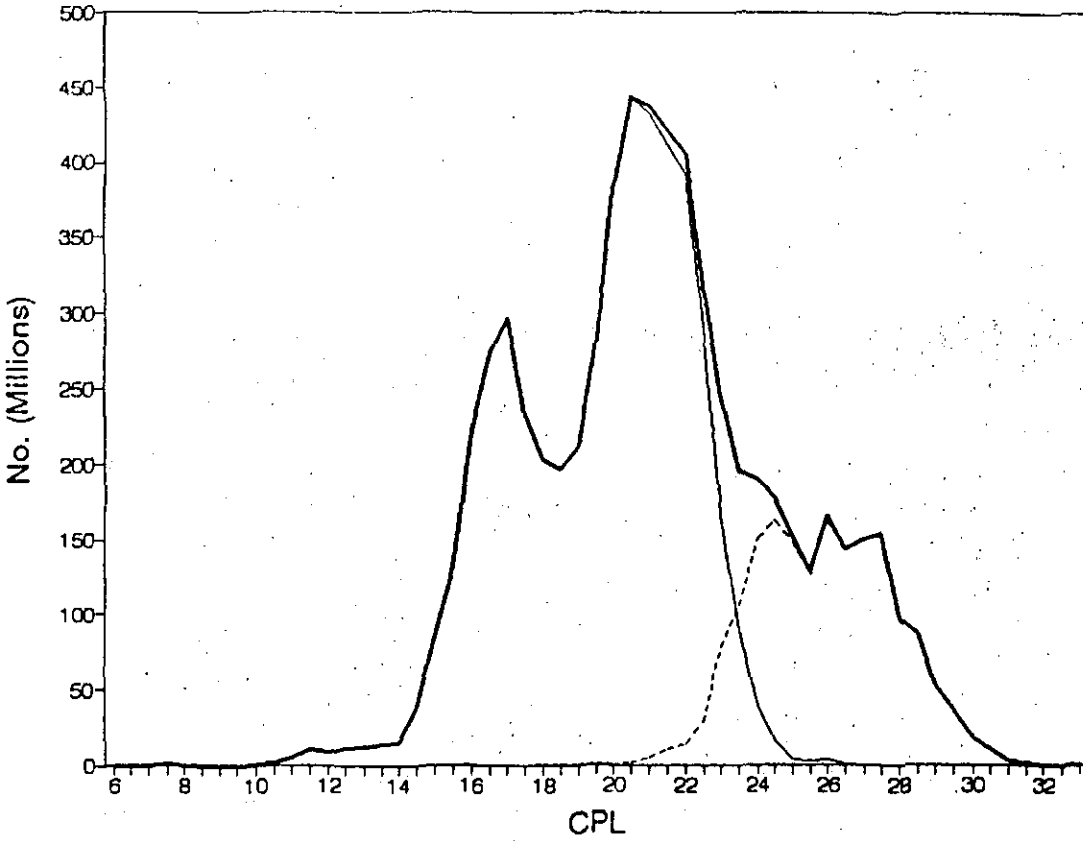


Figure 9 . Numbers of shrimp per length group (CL) in the total biomass estimate, based on pooling of individual samples weighted by catch and stratum area.