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Preliminary Assessment of Shrimp (P*andalus borealis*) in Davis Strait, 2000 (Subareas 0+1)

by

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Abstract

The shrimp stock off West Greenland is distributed to NAFO Div. 0A and Subarea 1 inshore and offshore and the entire shrimp stock is assessed as a single population. Two offshore fleet components, one from Canada and one from Greenland participated in the fishery.

This paper presents the preliminary assessment of the shrimp resource in Davis Strait by summarising and interpreting data from the Greenland and the Canadian fishery and the Greenland research vessel surveys. No analytical assessment is available and fishing mortality is unknown. Evaluation of the status of the stock is based on interpretation of commercial fishery data (catch, effort and standardized catch rates), research survey indices and biological data. The indices of stock sizes shows that both the recruitment and SSB estimates in 2000 are the highest observed. In addition the stock appears to be well represented by a broad range of size groups.

1. INTRODUCTION

The shrimp stock off West Greenland is distributed to NAFO Div.0A and Subarea 1 and the entire shrimp stock is assessed as a single population. The Greenland fishery exploits the stock in Subarea 1 (Div. 1A to 1F) in offshore and inshore areas (primarily Disko Bay). The Canadian fishery has been restricted to Div. 0A since 1981 (Fig. 1). The Scientific Council recommended at its 1999 November meeting that catches in Subareas 0 and 1 in 2000 should not exceed 65 000 tons, based on the observed stability in the stock at recent catches of approximately 65 000 tons.

Two offshore fleet components, one from Canada and one from Greenland participated in the fishery. The offshore fleet has been restricted by areas and quotas since 1977. An inshore small-vessel Greenland fleet was unrestricted by areas and quotas until January 1997, where quota regulation was imposed. The Canadian fishery in Div. 0A is regulated by a quota based on 17% of the advised TAC of the offshore area. Canada set the effective TAC for 2000 to 7.650 tons in Div. 0A and Greenland set the effective TAC to a total of 71.000 tons (40.109 tons to the offshore fleet and 30.891 tons to the small-vessel fleet).

2. COMMERCIAL FISHERY (SCR Doc. 00/81)

2.1. History of the Fishery

The nominal catch of shrimp in the **offshore areas** of Subarea 1 and the adjacent part of Subarea 0 (Div. 0A) increased from less than 1 000 tons before 1972 to almost 43 000 tons in 1976. Catches fluctuated thereafter and stabilized around a level of 54 000 tons during 1985-88, then increased to about 66 000 tons in 1992 and decreased thereafter to about 56 000 tons in 1998. Total catch in the offshore areas for 1999 increased again to 59 500 tons and catches in 2000 is projected to be at the same level. The Canadian fishery in Div. 0A amounted to about 2 500 tons in 1995 and 1996, declined to under 1 000 tons in 1997 and 1998. 2 500 tons has been reported in 1999 and 2500 is reported up to October 2000 (Table 1).

Until 1988, the fishing grounds in Div. 1B have been the most important. Since then, a southward shift in the offshore fishery has taken place, and from 1990 catches in Div. 1C and 1D have exceeded those from Div. 1B. At the end of the 1980s, exploitation began in Div. 1E and 1F, and catches from these areas now account for about 20% of the total catch. The distribution of the fishery has not changed since 1996 (Fig. 3).

The West Greenland **inshore** shrimp fishery was relatively stable from 1972 to 1987 with estimated catches of 7 000-8 000 tons annually (except for 10 000 tons in 1974). Inshore catches in recent years have increased to over 20 500 tons in 1992, but decreased to 9 515 tons in 1998. Inshore catches in 1999 increased again to 17 000 tons and preliminary data for 2000 (January-October) suggest catches at the same level as in 1999. During the 1990s inshore catches have accounted for about 25% of the total catch in Subarea 1.

In Subarea 1 fishery takes place in all months. In general the monthly amount of shrimp caught tracks a dome shaped curve over the year with a maximum in June-July of about 8000 tons. In some years (1991-1994) a second maximum occur in October. In Div. 0A the fishery usually begins in late June - early July and continues into late November. However, most of the catch and effort occurs in August-October.

2.2. **Trends in fishing effort and CPUE**

Catch and effort data from the shrimp fishery were available from fishing records from Canadian vessels in Div. 0A and from Greenland logbooks for Subarea 1. Twin trawls introduced in 1995 on several Greenland trawlers have been accounted for in analyses of effort data using a factor 2 as a multiplier for recorded effort by vessels using twin trawl. CPUE data from Greenland fishing vessels fishing in Subarea 1 and Canadian vessels fishing in Div. 0A were used in multiplicative models to calculate standardised annual catch rate indices. One unified time series covering 1976-2000 was calculated by the methods described in Hvingel *et al.* (in press).

A standardized catch rate (CPUE) index (Table 2, Fig. 2.C) was presented. CPUE data from Greenland vessels fishing in Subarea 1 and Canadian vessels fishing in Div. 0A were used in multiplicative models to calculate annual catch rate indices. One unified time series covering 1976-2000 was calculated. All fleets included in the analysis mainly exploit shrimp greater than 16 mm carapace length. The CPUE indices are therefore indicative of the older male and the female stock combined.

The standardized CPUE series showed a slightly increasing trend in the 1990s. The projected 2000 value marks the highest value of continuously increasing trend since the early-1990s.

From 1975 until 1984 annual unstandardised effort showed a slightly increasing trend from about 75.000 hrs to about 93.000 hrs (Fig. 2B). In the subsequent years a considerable enlargement of the offshore fleet took place and effort went up by almost a factor three reaching 250.000 hrs in 1991-1992. Hereafter unstandardised effort has decreased as a result of management measures, reduced activity in Div. 0A and a general increased fishing efficiency of the participating vessels. The increase in unstandardised effort from 1996 to 1997 is caused by the addition of logbooks from vessels below 50 tons to the database (new logbook system). In 1999 about 170.000 trawling hrs were registered and preliminary data suggest that the year 2000 Figure will of the same magnitude size.

The standardised effort (Fig. 2B) may be considered a proxy for harvest rate. The course of the weight based standardised effort time series is in good agreement with the unstandardised (Fig. 2B). Since 1992, when it reached its highest value as yet, standardised effort has decreased by about 40%. A corresponding effort index based on number of individuals (Fig. 2B) showed a similar decreasing trend of the 1990s however the reduction was less i.e. about 25%.

2.3. **By-catch and discard**

Logbook from the Greenland fleet reports on landed by-catch of *Pandalus montagui*, discards of shrimp and fish during the years 1987-2000 (Table 3). The reported discard of shrimp has remained less than 1 % of total catch throughout the period. The recorded discard of fish has shown increasing trend from about 1 to 3% of total catch in the years 1987-1998. A negligible quantity of fish discarded is registered for 1999 and 2000.

2.4. **Spatial distribution of the fishery**

A substantial change in the relative importance of the different areas is indicated in Subarea 1. Since the mid-1970s until the early-1980s Div. 1A+1B have been the far most important areas of this shrimp fishery. Div. 1C and 0A received some attention but almost no effort was allocated to Div. 1D, 1E and 1F. Since then the fishery has gradually expanded southward to include also these three southern most Divisions in Subarea 1. The southward expansion/displacement of the offshore fishery since the late-1980s is also indicated by the mean latitude of effort allocation shown in Fig. 3. The preliminary data for 2000 do not suggest any significant changes in the distribution of the fishery in Subarea 1 and Div. 0A from 1999 to 2000.

2.5. **Catch composition**

Length frequency distributions obtained by observers were available from the commercial fishery in Subarea 1 and Div. 0A during the 1991-2000 period (Fig. 6, Table 4).

The male proportion of the catch in numbers has increased during the 1990s. (Table 4). This development was also reflected by the calculated mean shrimp size caught, which in Subarea 1 has declined by 3.1 mm cpl. since 1991 corresponding to a mean individual weight reduction of about 25% (Fig. 5). Mean shrimp size caught in the Canadian fishery in Div. 0A showed a corresponding declining trend since 1981. Part of this development may be due to better market prices for small shrimp along with a thorough restructuring of the Greenland offshore fleet during this time period leaving most vessels with enough quota to make high-grading less profitable.

The standardised catch rates indicate increasing abundance of males (Fig. 4) while abundance indices of females have stayed more or less at the same level throughout the 1990s. However, these results may be bias by the change in targeting strategy.

Like the previous years catches the LFD of 2000 shows good representation of all sizes.

3. **RESEARCH SURVEY DATA** (SCR Doc 00/77)

3.1 **Biomass Estimate**

Stratified-random trawl surveys have been conducted from 1988 in offshore areas (Subarea 1 + Div. 0A) and from 1991 in inshore Subarea 1 (Fig. 7). Since 1992, the survey extended further to the south in Div. 1F compared to the survey coverage in 1988 to 1991. In 1994-97, the survey was carried out as a two-phase survey allocating extra hauls to strata with high shrimp densities to reduce the variance of the biomass estimates.

The design of the survey and the analysis of the resulting data were reviewed in 1998 and 1999 and some changes were suggested. Among those that could modify the design and executions of the survey were a) shorten the tows; b) use buffered random sampling to choose trawl stations; c) fix the location of some stations from year to year; d) review the allocation of stations. Most of these suggestions were simultaneously implemented in the 1999 and 2000 survey. To study the stability of the stock distribution and assess the performance of a fixed-station design relative to that of resampling about 50 % of the stations from the surveys in 1998 and 1999, randomly chosen, were repeated as fixed stations in the surveys in 1999 and 2000, respectively. The remainder of the stations was re-selected, using the above-mentioned buffer zone method, and using the fixed stations as already chosen stations. The survey design has been evaluated and adjusted in the later years in order to reduce the sampling variation and to study and optimize the performance of the sampling.

During the period of stratified random surveys in the offshore areas of shrimp distribution the biomass estimates have indicated a good stability until 1998 around a level of 250 thousand tons, apart from somewhat lower values in 1991, 1995 and 1997 (Fig. 8). From 1998 a significant increase is observed with record high biomass in 2000 of 350 thousand tons. Large variations from year to year both geographically and over depth zones are observed and may suggest that the stock is highly migratory. Some areas account for a large proportion of the variances of the estimated biomasses.

The biomass in 2000 had a fairly normal distribution with traditional high densities in the deeps south of the shallow

banks along the coast, especially in Sukkertoppen and Holsteinsborg Deeps (around 64°30'N and 66°30'N, respectively) and in Disko Bay. The Disko Bay area has the longest history of commercial fishery for shrimp in Greenland, as it developed in the early-1950s. When the trawl survey first included this area a biomass of around 50 thousand tons was estimated, corresponding to 29 % of the biomass for the total survey area at that time. The estimates through the following years (1991-97) were fairly stable, followed by an increase to the record high estimate of about 84 thousand tons in 2000 (24% of the total).

3.2. **Demographic structure**

Estimated total numbers and total biomass of shrimp in the survey area (including both inshore and offshore areas, but excluding region S) from 1988 to 2000 are given in Table 6 and Table 7, respectively. Total number of shrimp in 2000 was higher than all other years, and numbers of both male and female are the highest on record.

Overall length distributions for the offshore survey area from 1988-2000 are shown in Fig. 11a and 11b, and for the inshore survey area from 1991-2000 in Fig. 12a and 12b. The overall length-frequency distributions for the offshore area in 2000 show a number of distinct male modes (at 9, 15, 19-20 and 22 mm CL), a mode of primiparous females at 24.5 mm CL and one of multiparous females at 26.5 mm CL. As in 1999 the presence of several male groups is promising in terms of recruitment to the female group in coming years.

The overall length-frequency distribution for the inshore area in 2000 show similar male and female modes as in the offshore areas, however as in earlier years with higher proportion of smaller males. Different from all other years in the survey series primiparous females in 2000 form a distinct mode (or two modes) in the inshore distribution, indicating that at least some spawning is taking place at a later time than usual (primiparous females are here defined as pre-first-spawning females and have been almost absent in the inshore area, because the survey here traditionally and also in 2000 is undertaken at a time when most spawning normally has taken place).

Inspection of overall length-frequencies by the deviation method and a preliminary modal analysis of offshore and inshore length distributions indicate a change between 1997 and 1998 to faster growth. At the same time age at sex reversal appears to have changed from six years to five years.

Total number of shrimp in 2000 is at the highest level found in the survey series, accounting for both male and female shrimp. Recruitment to the female group appears therefore to be secured for the coming years.

A recruitment index (shrimp less than 17 mm CL, mainly age 2) show an increasing trend since 1997 with the 2000 value the highest since 1993, the beginning of the time series (Fig. 13).

The index of exploitation rate for 1988-2000 derived from the catch/biomass ratio is presented in Fig. 14.

4. **OTHER INFORMATION**

Spatial structure of the resource of P. borealis: result from an experimental trawl survey in the Sukkertoppen Deep (SCR Doc 00/79). *Pandalus borealis* was experimentally fished in the Sukkertoppen Deep off West Greenland in July 2000. Trawl stations were fished along transects at 300, 350 and 400 m as pairs of contiguous 15-minute tows, pairs being separated by a distance equivalent to a 30-minute tow. Each of the 50–60-km-long transects comprised 19 or 20 tows. The design, of tows disposed in spaced pairs, proved an effective method of investigating both short-range and longer-range variation in density of the resource. This study indicated strongly that short-range variation in the density of *P. borealis* was much smaller than long-range variation and long tows would probably be unnecessary for getting adequate information about local densities. It indicated large long-range variation, with density changing by a factor of about 6, on average, in 20 km. The only limitation of the study was the restricted size of its study area; however, its conclusions do not contradict those of studies based on analyses of the data from the entire West Greenland survey area.

Occurrence of *Pandalus montagui* in trawl survey samples from NAFO Subarea 0+1(SCR Doc 00/77). Since 1988, Greenland Institute of Natural Resources has conducted annual stratified-random survey in the distribution area of *Pandalus borealis* off West Greenland. *Pandalus montagui* has occurred frequently as by-catch in a large part of the surveyed area. Large variations in biomass are indicated, but no clear trend can be seen. However, as the survey design

has been made with reference to the distribution of *Pandalus borealis*, too few stations in the distribution area of Pandalus montagui have been applied to give reliable estimates of the biomass. Compared to the stock of *Pandalus borealis Pandalus montagui* occur in shallower water, mainly in depths between 150 and 200 meters. Compared to the biomass estimates of *P. borealis* the biomass estimates of *Pandalus montagui* has normally been 1-2 % of the former, apart from two years with higher values (9 and 5 %, respectively).

5. SUMMARY OF ALL INDICES

overall variations in catches:

- overall increase from 1981 to 1992, thereafter decreased from 1992 to 1998. In 1999 catches increased again.
- catches in 2000 are expected to be at the 1999 level.

a shift in the fishery:

- from 1987 to 1996 a southward movement of the Greenland fishery has occurred, hereafter it stabilized

variation in catch-rates indices and in effort indices:

- a standardized CPUE series showed an increasing trend in the 1990s
- the projected CPUE-value for 2000 is the highest value of continuously increasing trend since the early-1990s.
- standardised effort showed a decreased since 1992 by about 40%
- standardized effort when based on numbers of individuals showed a similar decreasing trend of the 1990s, however the reduction was less than 25 %
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trends in recent catch-rates on the males and females component:

- standardized CPUE series for female shrimp showed stability in the 1990s
- standardized CPUE series for male showed an increasing trend in the 1990s
- standardized CPUE in 2000 indicate a decrease in the abundance of males compared to 1999, while abundance indices of female increased

composition of catches:

- overall sample data indicate good recruitment, but until 1999 a gradual decline in the mean carapace length of shrimp taken in this fishery
- males comprise about 2/3 of the catches in 1998 and 1999 compared to about 1/2 in the early-1990s in 2000 males increased again and represent 45% of the catches

biomass estimates from research surveys:

- the biomass estimates have indicated a good stability until 1998 around a level of 250 thousand tons
- From 1998 a significant increase is observed with record high biomass in 2000 of 350 thousand tons
- large variations from year to year both geographically and over depth zones are observed and may suggest that the stock is highly migratory

demographic structure:

- total number of shrimp in 2000 is the highest level found in the survey series accounting for both male and female shrimp
- the number of female shrimp was below average
- recruitment to the female group appears to be assured for the coming years
- there are indications of a change between 1997 and 1998 to faster growth
- at the same time age at sex reversal appears to have changed from six years to five years

6. STATUS OF THE RESOURCE

The standardized catch-rate index for 1976-99 remained stable during the early-1990s, but has shown a slight increase since 1994. The projected 2000 value was the highest on record during the 1990s.

Indices show that the abundance of female shrimp declined from 1990 to 1998, but have increased again thereafter. Indices of total (male and female) abundance of shrimp showed a slightly increasing trend in the 1990s. The 1999 value for total shrimp abundance is among the highest value in the 1990s and the projected value for 2000 is at the same level as 1999. Catch rates of female shrimp show a slightly increasing trend since 1995. Overall commercial sample data indicate good recruitment.

The observed southward movement of the Greenland fishery from 1987 to 1996 has stabilized. The southward displacement of the fishery may be due to the fleet tracking the southward shift in the distribution of the stock.

During the period of stratified random surveys in the offshore areas of shrimp distribution the biomass estimates have indicated a good stability until 1998 around a level of 250 thousand tons, apart from somewhat lower values in 1991, 1995 and 1997. From 1998 a significant increase is observed with record high biomass in 2000 of 350 thousand tons. Large variations from year to year both geographically and over depth zones are observed and may suggest that the stock is highly migratory.

Total number of shrimp in 2000 is at the highest level found in the survey series, accounting for both male and female shrimp. Recruitment to the female group appears therefore to be secured for the coming years.

The combined inputs to the assessment indicate that the stock has increased under the present level of exploitation.

7. REFERENCES

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Table 1. Total Allowable Catch (TAC), catch, effort and Catch per Unit of Effort (CPUE) of the shrimp fishery in NAFO SA 1 and Div. 0A 1970-2000. Catch are in tons, effort in '000 hr's (unstandardized) or as an index (standardized). CPUE is given in kg/hr (unstandardized) or as an index (standardized).

Year	TAC (t)					Catch (t)					Effort				CPUE			
	Subarea 1			Div. 0A	Total	Subarea 1			Div. 0A	Total	SA 1	Div. 0A	Total	Total	SA 1	Div. 0A	Total	Total
	Offshore	Inshore*	Total	Offshore		Offshore	Inshore	Total	Offshore		Unstd. ('000 hr's)			Std. (index)	Unstd. (kg/hr)			Std. (index)
1970	no	no	no	no	no	130	8429	8559	0	8559	-	-	-	-	-	-	-	-
1971	no	no	no	no	no	696	8741	9437	0	9437	-	-	-	-	-	-	-	-
1972	no	no	no	no	no	2314	7342	9656	0	9656	-	-	-	-	-	-	-	-
1973	no	no	no	no	no	4692	7950	12642	0	12642	-	-	-	-	-	-	-	-
1974	no	no	no	no	no	11945	10064	22009	0	22009	-	-	-	-	-	-	-	-
1975	no	no	no	no	no	29190	8700	37890	0	37890	74,2	-	74	-	511	-	511	-
1976	no	no	no	no	no	42374	7300	49674	392	50066	80,1	-	80	0,69	620	-	625	0,95
1977	-	no	-	-	36000	33843	7800	41643	457	42100	73,0	-	73	0,62	571	-	577	0,89
1978	-	no	-	-	41000	26747	7600	34347	122	34469	84,1	-	84	0,64	408	-	410	0,70
1979	-	no	-	-	31500	25958	7500	33458	1732	35190	72,4	7,3	80	0,72	462	236	441	0,64
1980	-	no	-	-	32000	35778	7500	43278	2726	46004	80,0	7,6	88	0,79	541	358	525	0,77
1981	35000	no	35000	5000	40000	32016	7500	39516	5284	44800	88,2	17,7	106	0,79	448	299	423	0,74
1982	34800	no	34800	5000	39800	35015	7500	42515	2064	44579	81,1	6,2	87	0,62	524	335	511	0,93
1983	34625	no	34625	5000	39625	33854	7500	41354	5413	46767	89,0	19,1	108	0,75	464	284	433	0,81
1984	34925	no	34925	5000	39925	33741	7500	41241	2142	43383	85,0	7,7	93	0,75	485	280	468	0,76
1985	42120	no	42120	6120	48240	43896	7500	51396	3069	54465	109,4	9,9	119	0,90	470	309	457	0,79
1986	42120	no	42120	6120	48240	52634	7500	60134	2995	63129	129,2	6,7	136	1,00	466	445	464	0,83
1987	40120	no	40120	6120	46240	50720	6921	57641	6095	63736	136,6	12,4	149	0,79	422	491	428	1,06
1988	40120	no	40120	6120	46240	44159	10233	54392	5881	60273	150,1	12,6	163	1,00	362	468	371	0,79
1989	45245	no	45245	7520	52765	45198	13224	58422	7235	65657	176,4	18,5	195	1,36	331	391	337	0,63
1990	45245	no	45245	7520	52765	49554	13630	63184	6177	69361	206,3	15,3	222	1,50	306	405	313	0,61
1991	46225	no	46225	8500	54725	52834	16258	69092	6788	75880	228,7	20,6	249	1,68	302	330	304	0,59
1992	44200	no	44200	8500	52700	58664	20594	79258	7493	86751	232,9	17,6	250	1,75	340	425	346	0,65
1993	40600	no	40600	8500	49100	52280	17843	70123	5491	75614	206,1	13,6	220	1,53	340	404	344	0,65
1994	42300	no	42300	8500	50800	53693	18118	71811	4766	76577	209,6	16,3	226	1,64	343	292	339	0,61
1995	39500	no	39500	8500	48000	51900	16429	68329	2361	70690	186,9	7,2	194	1,39	366	329	364	0,66
1996	37890	26032	63922	8500	72422	49251	17359	66610	2623	69233	168,6	8,6	177	1,31	395	303	391	0,69
1997**	38292	26308	64600	8500	73100	50483	13517	64000	517	64517	191,2	1,2	192	1,27	335	443	335	0,66
1998**	36000	24729	60729	7650	68379	55655	9515	65170	954	66124	159,2	3,2	162	1,16	409	300	407	0,74
1999**	40109	30891	71000	7650	78650	56968	17017	73985	2500	76485	170,1	7,1	177	1,27	435	354	432	0,79
2000***	40109	30891	71000	7650	78650	54000	20000	74000	2500	76500	139,7	2,1	142	1,00	530	800	540	1,00

Table 2. Time series of the four standardized CPUE indices included in the combined CPUE index for NAFO Subarea 1 + Div. 0A.

Year	1BCD	KGH	Small ves.	0A	Combined
1976	-	1,66	-	-	0,95
1977	-	1,56	-	-	0,89
1978	-	1,23	-	-	0,70
1979	-	1,11	-	-	0,64
1980	-	1,34	-	-	0,77
1981	-	1,27	-	1,13	0,74
1982	-	1,61	-	1,33	0,93
1983	-	1,42	-	1,06	0,81
1984	-	1,34	-	0,97	0,76
1985	-	1,43	-	0,85	0,79
1986	-	1,49	-	0,89	0,83
1987	1,85	1,79	-	1,38	1,06
1988	1,19	1,47	1,29	1,22	0,79
1989	1,04	1,09	1,03	0,90	0,63
1990	1,00	1,00	1,00	1,00	0,61
1991	0,98	-	0,88	0,88	0,59
1992	1,08	-	0,92	1,02	0,65
1993	1,05	-	1,02	0,96	0,65
1994	1,05	-	0,87	0,74	0,61
1995	1,17	-	0,87	0,81	0,66
1996	1,25	-	0,84	0,76	0,69
1997	1,21	-	0,85	0,59	0,66
1998	1,33	-	1,01	0,70	0,74
1999	1,42	-	0,99	0,89	0,79
2000*	1,55	-	1,49	-	1,00

*Projected.

Table 3. Annual discard of shrimp and fish in tons and % of total shrimp catch and catch of *P. montagui* as reported in vessel logs from Subarea 1 1987-2000.

Year	P. borealis		Fish		P. montagui
	discard (tons)	discard (%)	discard (tons)	discard (%)	landed (tons)
1987	150	0,3	693	1,2	0
1988	169	0,3	864	1,6	0
1989	166	0,3	1070	1,8	0
1990	218	0,3	1028	1,6	0
1991	332	0,5	1680	2,4	0
1992	264	0,3	1765	2,2	0
1993	204	0,3	1562	2,2	0
1994	270	0,4	2175	3,0	4
1995	389	0,6	2162	3,2	470
1996	267	0,4	2207	3,3	632
1997	254	0,4	1918	3,0	336
1998*	257	0,4	1787	2,7	1026
1999*	161	0,2	1172	1,6	530
2000**	168	0,2	1306	1,8	756

*Preliminary

Table 4. Composition of shrimp catches in NAFO SA 1 as derived from sub samples weighted up to the total catch and analyzed by modal analysis to produce catch at age table. Numbers caught were divided by standardized effort to produce abundance at age indices.

Mean size

Year	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Cpl (mm)	23.5	23.5	22.9	22.3	21.8	21.9	21.2	21.2	21.1	22.3
Weight (g)	8.4	8.5	8.4	7.8	7.6	7.2	6.5	6.6	6.3	7.5
Count (no/kg)	119	118	119	128	132	140	154	151	160	133

Proportion of total catch

Year	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Males	46%	33%	51%	56%	64%	64%	64%	66%	64%	45%
Primi	9%	3%	1%	11%	15%	9%	12%	8%	12%	2%
Multi	45%	63%	48%	33%	21%	27%	24%	26%	24%	53%
Females total	54%	67%	49%	44%	36%	36%	36%	34%	36%	55%

Number caught (millions)

Year	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Males	4188	3388	4560	5502	5971	6243	6368	6583	7584	4232
Primi	825	350	96	1067	1384	824	1197	835	1391	188
Multi	4031	6493	4370	3217	1962	2614	2363	2583	2840	4989
Females Total	4856	6843	4466	4284	3347	3438	3560	3418	4230	5177
Total	9044	10231	9026	9786	9317	9681	9928	10001	11814	9409

Abundance index

Year	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Males	2.5	1.9	3.0	3.3	4.3	4.8	5.0	5.7	6.0	4.2
Primi	0.5	0.2	0.1	0.6	1.0	0.6	0.9	0.7	1.1	0.2
Multi	2.4	3.7	2.9	2.0	1.4	2.0	1.9	2.2	2.2	5.0
Females total	2.9	3.9	2.9	2.6	2.4	2.6	2.8	2.9	3.3	5.2

Table 5. Biomass estimates 1988-2000 (thousand tons) in combined areas from north to south. Standard errors and error percentages are also given.

Year	N1-N9	D1-D9[1]	W1-W2	W3-W4	C1+C3	W5-W7[2]	S1-S2	Total	SE	%
1988	21.7	46.5	58.6	74.4	9.6	19.0	-	229.8	24.7	13.5
1989	11.3	46.5	48.2	79.6	3.9	38.6	-	228.0	32.3	17.8
1990	11.1	46.5	82.1	54.2	11.1	23.3	-	228.3	32.6	17.9
1991	5.8	50.6	30.9	52.4	4.8	28.1	-	172.6	22.8	13.2
1992	20.6	47.4	52.0	35.0	24.1	46.1	-	225.1	30.4	13.5
1993	8.0	33.6	103.1	41.3	3.4	67.5	-	256.8	30.1	11.7
1994	8.0	40.0	107.7	49.7	6.8	37.7	20.7	270.6	53.0	19.6
1995	8.2	47.3	43.7	58.6	4.4	53.0	1.7	217.1	29.2	13.5
1996	10.0	54.3	53.8	34.9	1.7	90.5	3.7	248.9	40.1	16.1
1997	7.2	52.3	40.1	15.1	0.2	66.5	24.9	206.2	30.6	14.8
1998	8.3	61.9	42.2	107.1	0.4	50.9	22.3	293.3	55.6	18.9
1999	14.4	61.2	54.2	26.1	11.9	55.9	63.7	287.4	40.6	14.1
2000	9.6	83.5	68.0	72.7	11.7	79.6	24.5	349.5	37.8	10.8

[1]) D1-D9 1988-90 not sampled, but set to mean of 1991-97.

[2]) Areas W6 and W7 were sampled from 1990 and 1993, respectively

Table 6. Numbers (billions) of male and female Northern shrimp in over-all length distributions from the total survey area (mean values for inshore areas 1991-1997 used in 1988-1990).

Year	males	females	total	males, %	females, %
1988	24.3	9.9	34.2	71.0	29.0
1989	35.0	7.6	42.5	82.2	17.8
1990	28.5	10.0	38.5	74.1	25.9
1991	17.4	6.2	23.6	73.8	26.2
1992	29.7	7.3	36.9	80.3	19.7
1993	35.5	9.7	45.2	78.5	21.5
1994	33.9	10.9	44.8	75.7	24.3
1995	29.2	7.9	37.1	78.7	21.3
1996	41.4	8.1	49.5	83.7	16.3
1997	29.5	7.6	37.0	79.6	20.4
1998	42.9	11.5	54.5	78.8	21.2
1999	44.8	11.3	56.2	79.9	20.1
2000	66.7	12.7	79.4	84.0	16.0
Average [1]	32.7	9.0	41.7	78.0	22.0

Table 7. Biomass estimates of male and female shrimp (thousand tons) in total survey area, based on weight-at-length key applied to overall length-frequency distributions (mean values for Disko Bay 1991-1997 used in 1988-1990).

Year	males	females	total	males, %	females, %
1988	125.9	107.4	233.3	54.0	46.0
1989	150.2	81.3	231.5	64.9	35.1
1990	129.8	102.0	231.8	56.0	44.0
1991	102.6	70.0	172.6	59.4	40.6
1992	149.3	75.8	225.1	66.3	33.7
1993	156.5	100.3	256.8	60.9	39.1
1994	157.9	112.7	270.6	58.3	41.7
1995	133.3	83.8	217.1	61.4	38.6
1996	161.9	87.0	248.9	65.0	35.0
1997	126.6	79.6	206.2	61.4	38.6
1998	181.9	111.4	293.3	62.0	38.0
1999	175.4	112.0	287.4	61.0	39.0
2000	228.7	120.8	349.5	65.4	34.6
Average	152.3	95.7	248.0	61.2	38.8

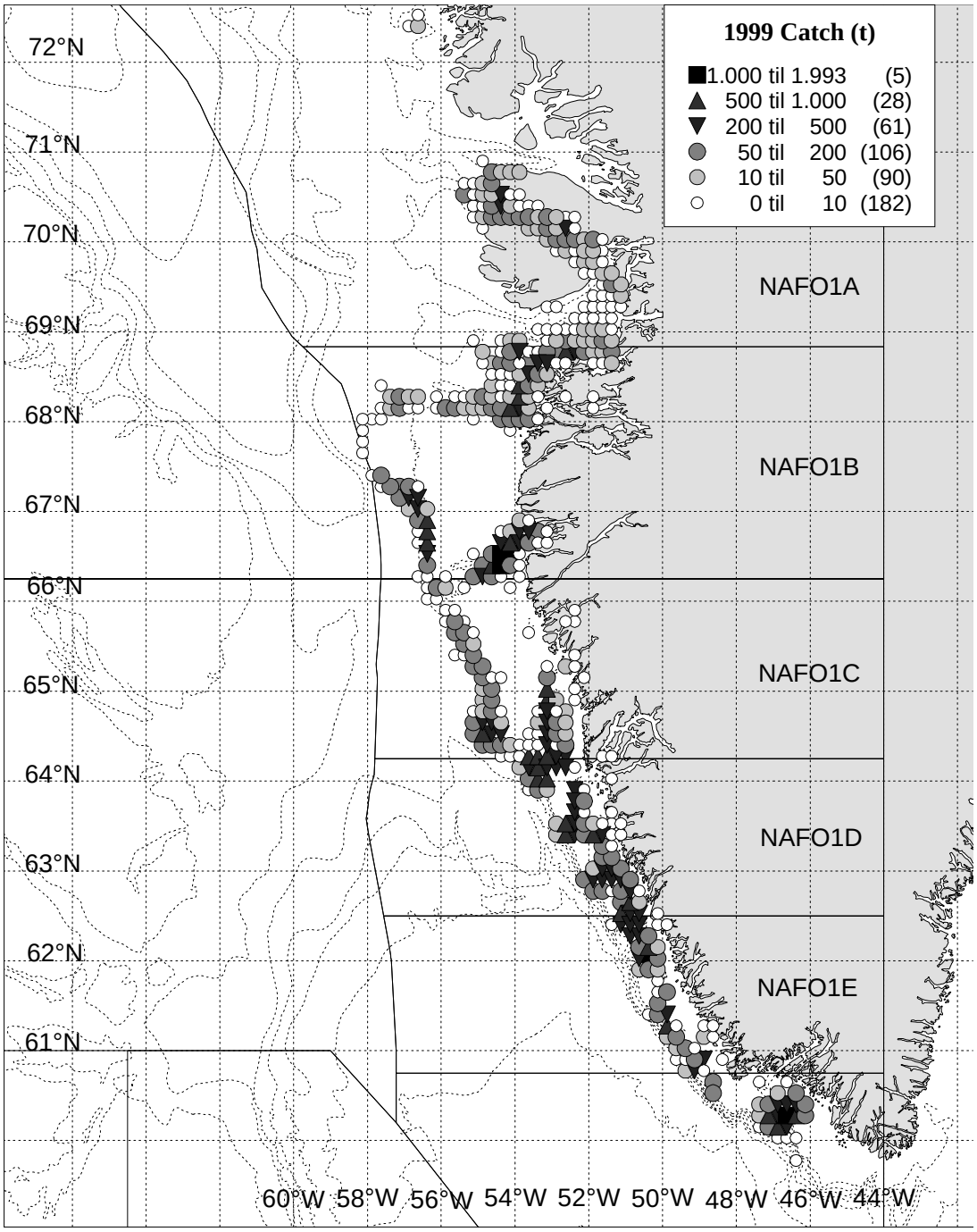

Figure 1. The geographical distribution of the catches in Subarea 1 in 1999.

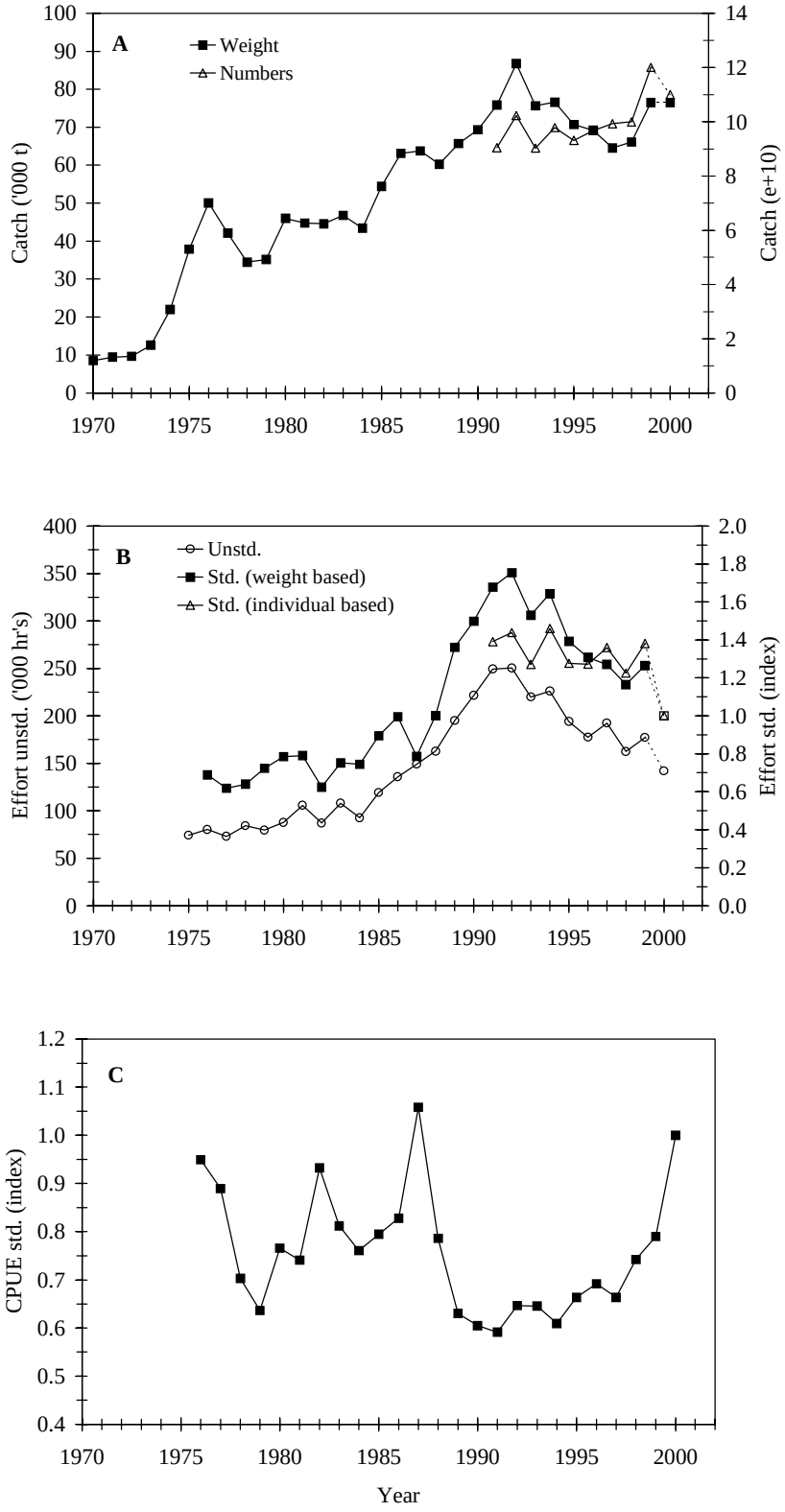

Figure 2. Total catch (panel A), effort standardized and unstandardized (Panel B) and standardized CPUE indices (panel C) of the shrimp fishery in NAFO SA 1 + Div. 0A. Data for 2000 are projected values.

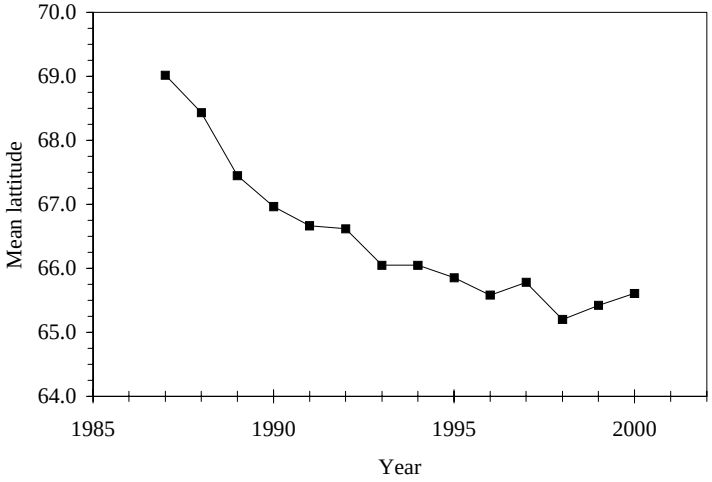

Figure 3. Mean latitude (^{o}N) of allocated effort by the Greenlandic offshore fleet 1987-2000.

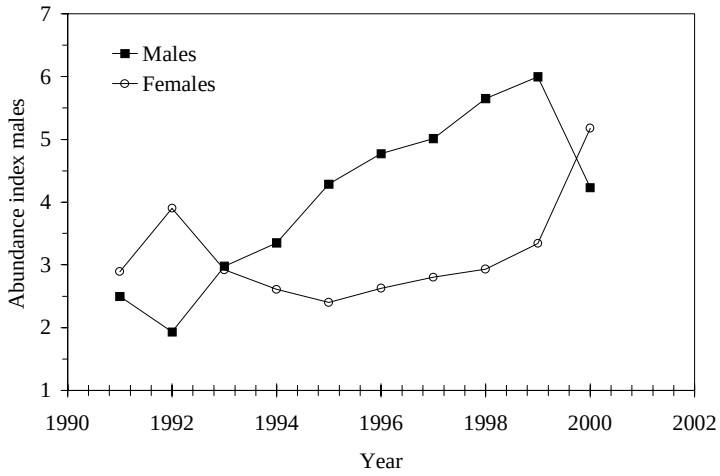

Figure 4. Standardized CPUE indices of the male and female component of the West Greenland shrimp stock 1991-2000.

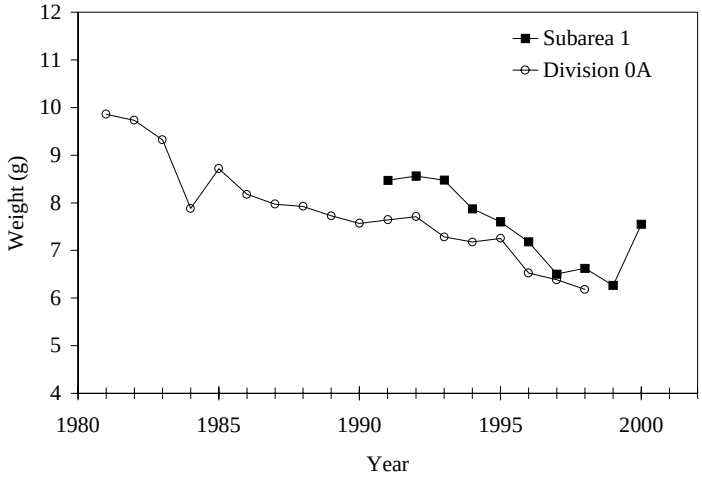

Figure 5. Mean shrimp size (g) in catches in Subarea 1 and Division 0A, 1998-2000.

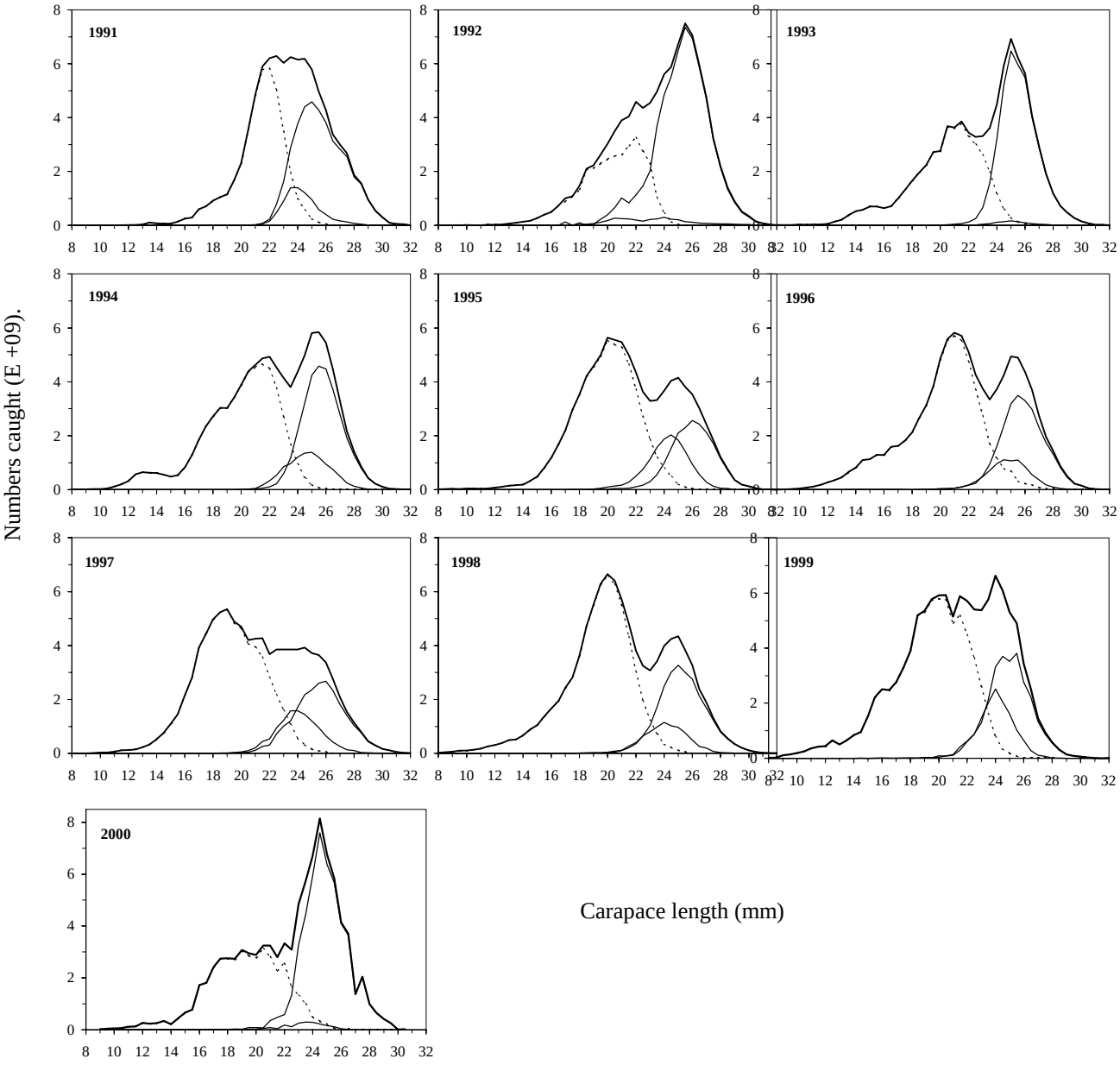

Figure 6. Length frequency distributions of commercial shrimp catches in Subarea 1 + Div. 0A, 1991-2000 (1999 and 2000 values were based on data from Subarea 1 only). The distribution of male shrimp is shown by the dotted line, primiparous and multiparous as the thin line (Primi. is recognized as the smallest component of the two) and total distribution as the bold line.

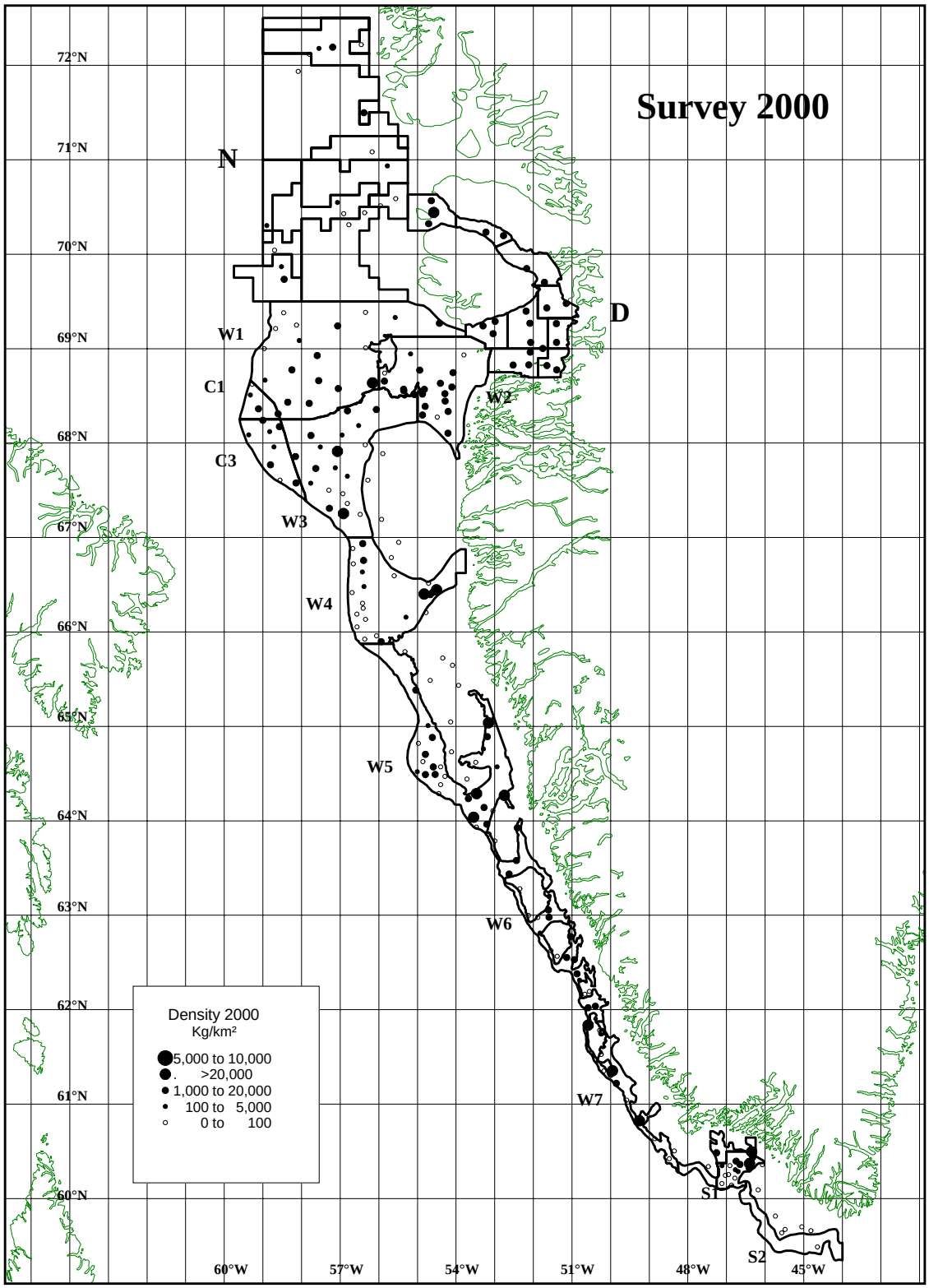

Figure 7. Sampling sites and shrimp densities (kg per km2 swept area) in the trawl survey in 2000.

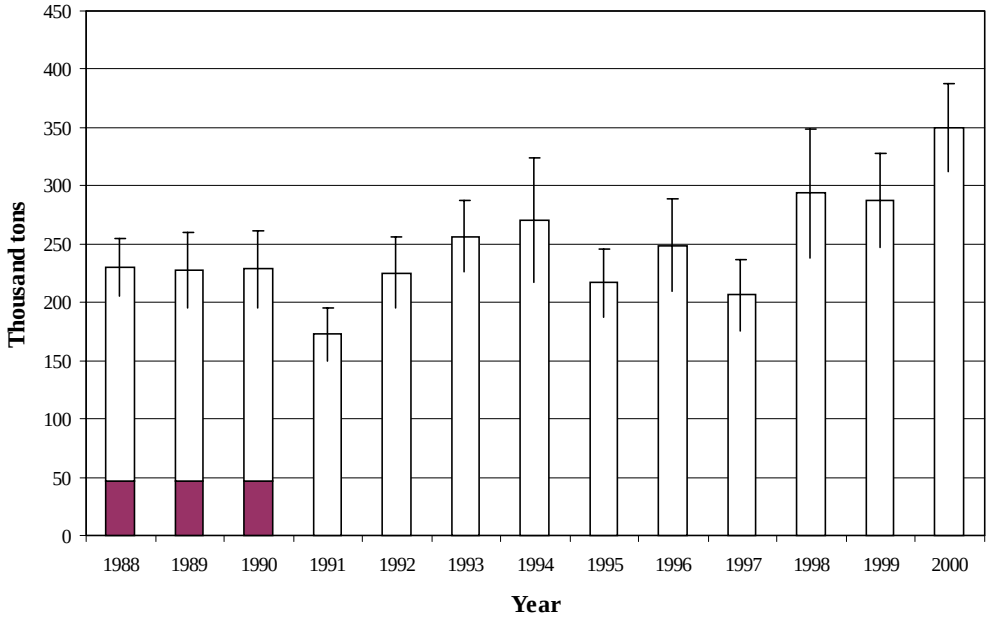

Figure 8. Estimated yearly biomass 1988-2000 with standard errors. Estimates for 1988-1990 do not include inshore areas (Disko-Vaigat), but estimated average biomass for those areas 1991-2000 is inserted to facilitate between-year comparisons.

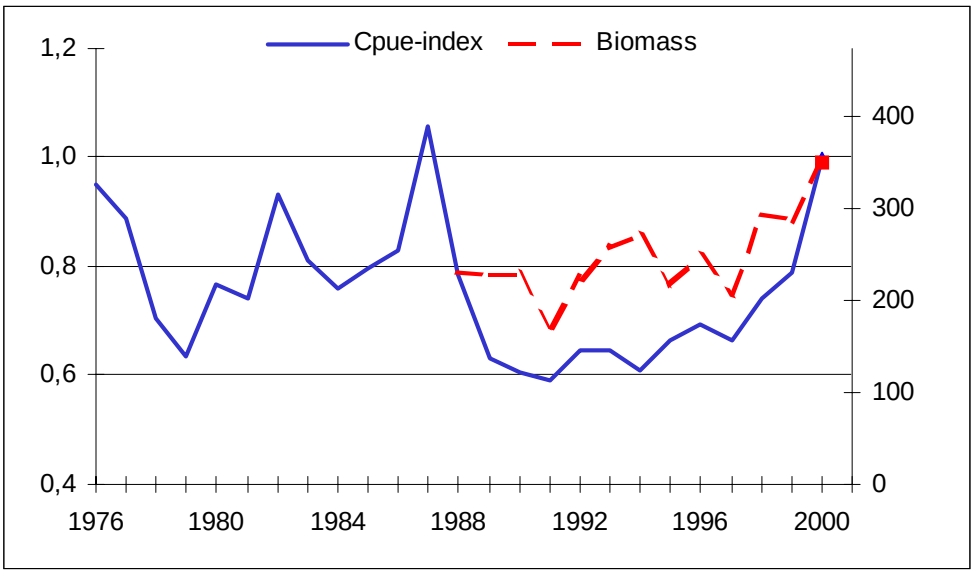

Figure 9. Indices of biomass from survey (1988-2000) and CPUE (1976-2000).

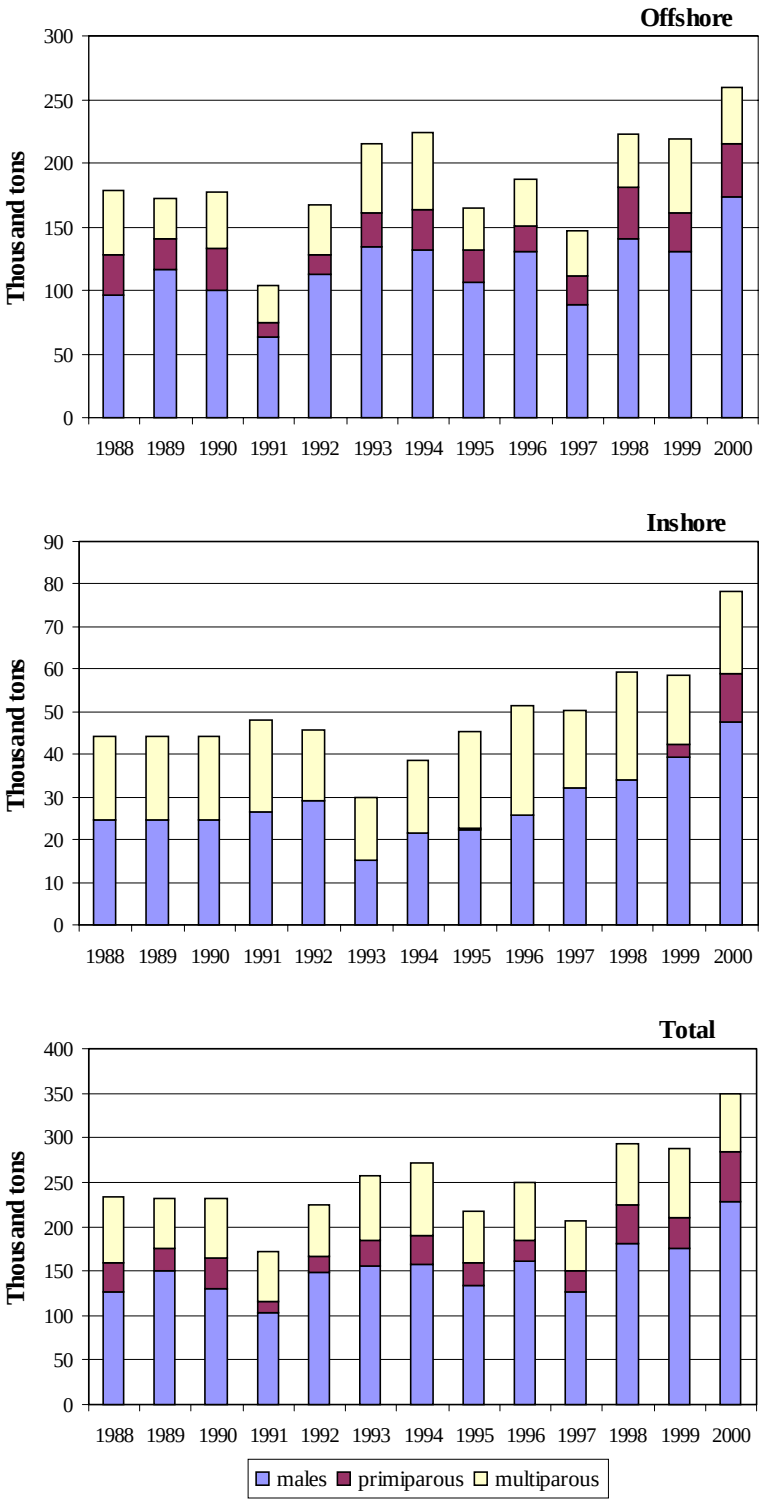

Figure 10. Biomass estimates of male and female shrimp (thousand tons) in total survey area, based on a weight-at-length key applied to overall length-frequency distributions (mean values for Disko Bay 1991-1997 used in 1988-1990).

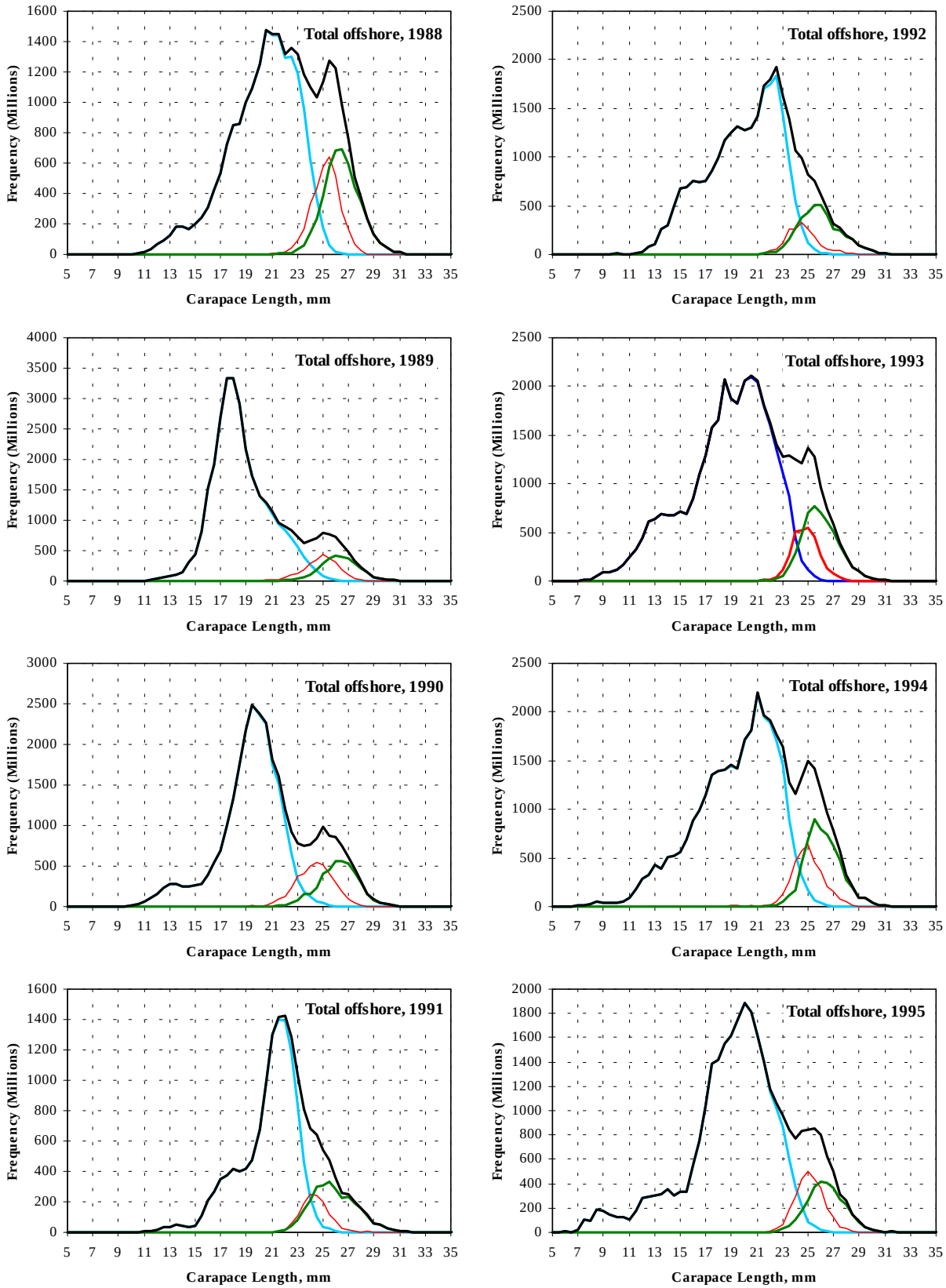

Figure 11a. Numbers of shrimp by length group (CL) in total offshore survey area in 1988-95.

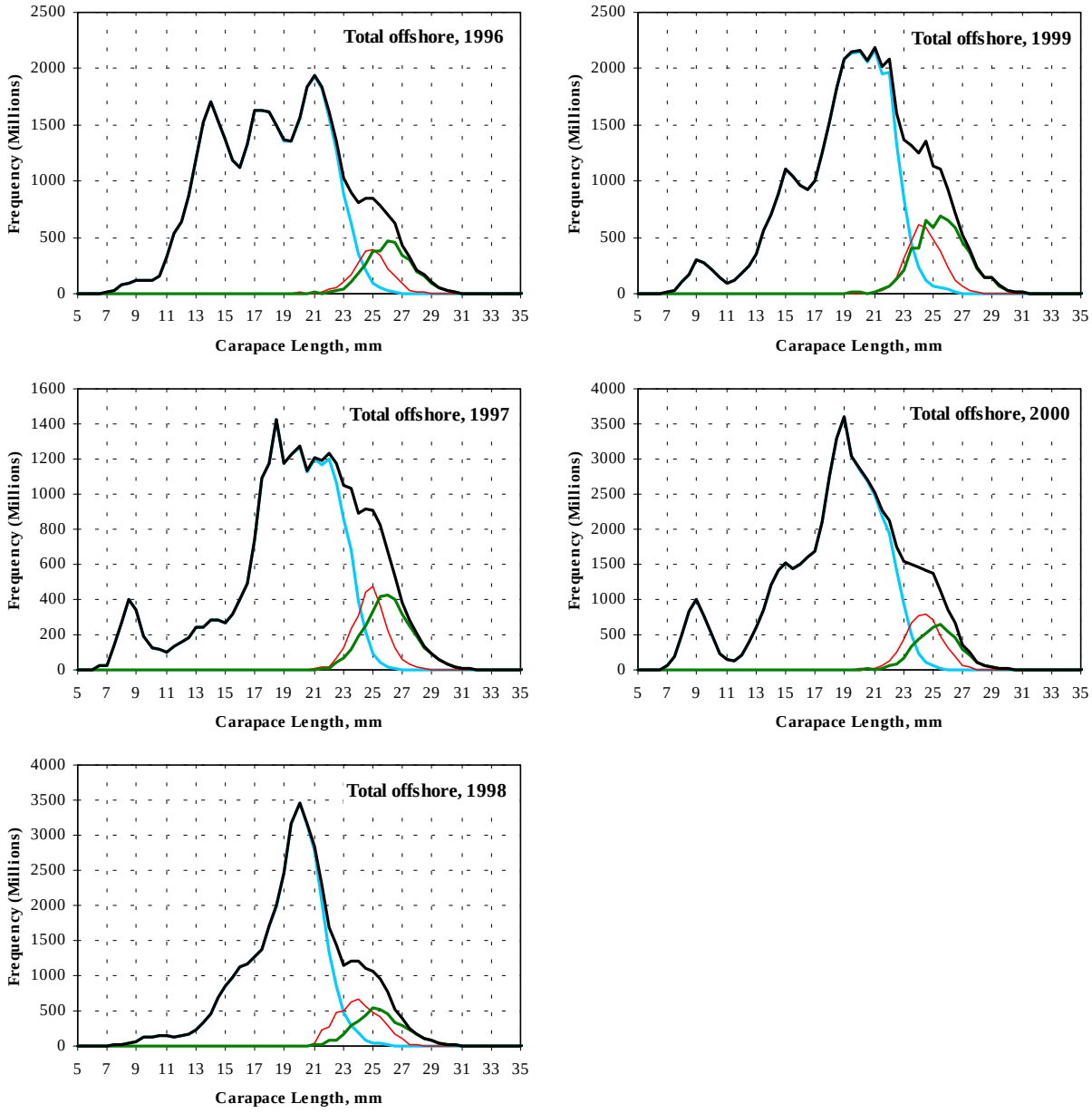

Figure 11b. Numbers of shrimp by length group (CL) in total offshore survey area in 1996-2000

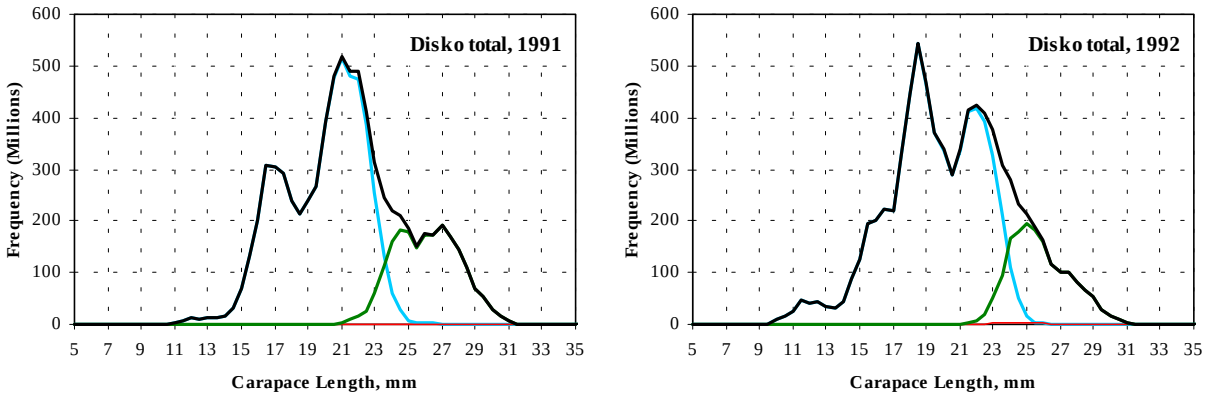

Figure 12a. Numbers of shrimp by length group (CL) in total inshore survey area in 1991-92.

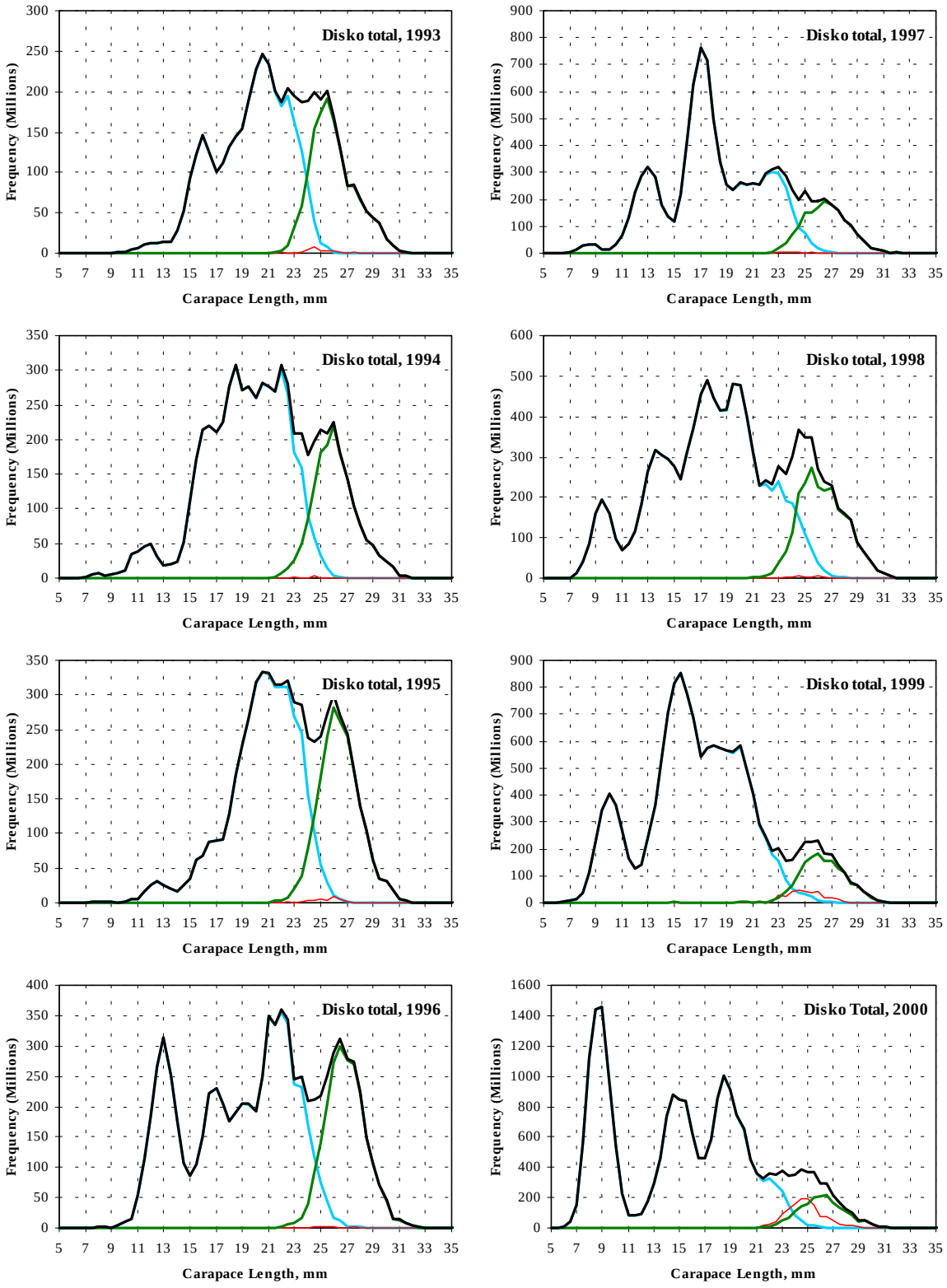

Figure 12b. Numbers of shrimp by length group (CL) in total inshore survey area in 1993-2000.

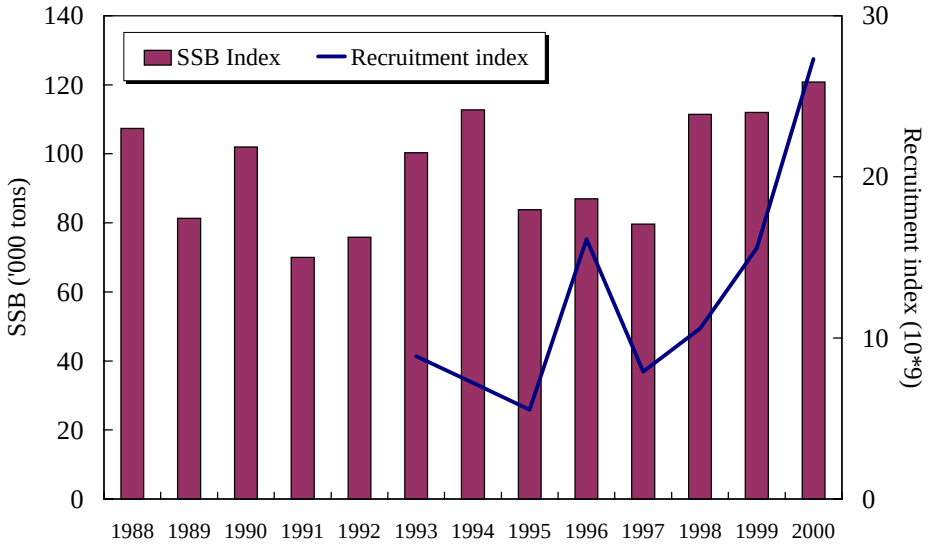

Figure 13. Total female biomass index (inshore and offshore) and index for recruit for 1993-2000 (shrimp CL less than 17 mm, mainly age 2).

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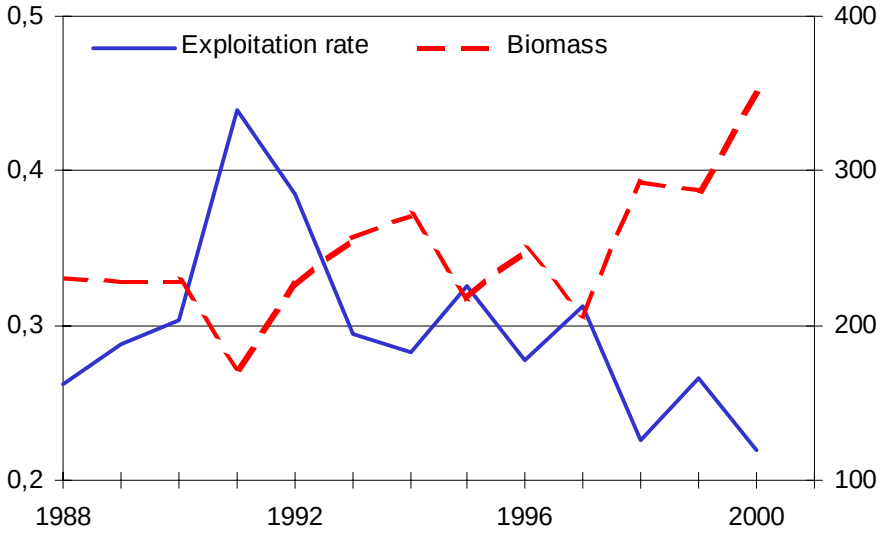

Figure 14. Total biomass and exploitations rate 1988-2000 (a biomass in 2001 on 300.000 tons and exploitations rates of 0,31 gives a catch on 93.000 tons in 2001).