



**SCIENTIFIC COUNCIL MEETING - NOVEMBER 1998**

Preliminary Assessment of Shrimp in the Denmark Strait in 1998

by

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1. INTRODUCTION

The fishery was initiated in 1978 with a catch of about 360 tons and subsequently increased rapidly to about 12 500 tons in 1988. In 1989 and 1990 the nominal catch decreased to less than 11,000 tons and in 1991 and 1992 declined further to 8 600 and 7 500 tons respectively. The annual catches have continued to fall in the traditional (northern area), to 5 000 in 1994 and finally to 3 400 tons in 1996. In 1997 the provisional figure is about 3 700 tons. A new fishery started in 1993 in two areas found further south where some 1 200 to 6 200 tons were taken in the southern area in the years 1993 to 1996. In 1996 the catch is already about 2 400 tons in the southern area.

The fishery takes place primarily in the area of Stred Bank and Dohrn Bank as well as on the slopes of Storfjord Deep. Two new areas were discovered in 1989 by Greenland (Lehmann, 1990), but not found profitable at the time have now been fished for 6 years. The new areas lie south of 65°N. The traditional northern fishing area extends from approximately 65°20'N to 67°30'N and between 26°W and 34°W. The southern area is between 60°30'N and 65°N and west of 35°W. For the sake of comparison and because of the uncertainty of whether the shrimp of the southern area belong to the same stock, the catch and effort data of this area are kept separate from those of the northern area.

2. Input Data

2.1 Commercial fishery data

2.1.1. Trends in catch and effort.

Catch and effort data from logbooks were available from Greenland, Norway, Iceland, Faroe Islands and Denmark since 1980 and from France for the years 1980 to 1991 (Skúladóttir, 1997a). Catches and corresponding effort were compiled by month and by fleet. CPUE was calculated by month and the mean weighted CPUE of two periods of the year (January to June and July to December) was then applied to the total catch of the period to estimate the total effort.

Total catches increased rapidly from 1978 to 1980, decreased in 1981 and remained stable to 1983. Catches increased steadily from 1983 to 1988 to 12 500 tons and then decreased to 2 900 tons in 1996 in the northern area. The catch in the northern area has increased again in 1997 to 4 200 tons and 3 900 tons in 1998 (provisional). The overall catch in north and south has been about 10 000 tons in the years 1994 through 1996 to rise to 11 600 tons in 1997 (Fig. 1, Table 1).

Total effort values in the northern area showed the same pattern as catch. Between 1980 and 1989, effort increased from about 35 000 hours to more than 100 000 hours in 1989, declining thereafter gradually to about 24 000 in 1997. The fishery from July-December became more important at the end of the eighties, accounting for approximately 50% of the total annual effort. In the early nineties the effort is again exerted

mainly in the first half of the year. In the southern area the effort was between 12 100 and 26 600 hours in 1993-97.

### 2.1.2 Trends in catch rates

Abundance indices were calculated from the unstandardized catch rate series of the years 1980 to 1998 using all countries. In the paper on catch statistics the catch and effort for all countries are combined (Skúladóttir, 1998 a). The calculations leading up to the annual CPUE can be followed in tables 2-4 of the present paper in the northern and the whole area respectively. The unstandardized CPUE in the north area has been set against removals as catch from the stock in every 3 previous years (Fig. 3). From this figure it appears that recovery has taken place as the annual removals of shrimp decreased to less than 5 000 tons on the average in the fishery north of 65°N. The CPUE of 1996 appears lower than expected, but the 1997 and 1998 values are as expected. The unstandardized catch rates for the northern area are presented in Fig. 4. and for both northern and southern in Fig. 5). In the northern area there is a declining trend from 1980 to 1989. Catch rates were similar in the period from 1989 to 1993, where the 1989-93 level was about 50% of the level seen during the period of relative stability from the early 1980's. In year 1994 there was a considerable rise in this catch rate, which subsequently declined in 1995-96 but increased in 1997 and further in 1998 reaching the same value as in 1982. The unstandardized catch rate for the whole area rose from the 1993 value to a higher value in 1994 and increased slightly after that (Fig. 5).

### 2.1.3 Standardization of the catch rates

The catch and effort data from Greenland for the north area from 1987 to 1998 were analyzed using SAS multiple regression procedures to account for the vessel size and seasonality (months) of the fishery both the total catch and the proportion of shrimp >8.5 g of weight ( Fig. 6). The results for both showed a continuous decline till 1993 and a considerable increase in 1994 and remained relatively constant thereafter to increase in 1998. The standardized cpues for the southern area were calculated in the same manner. In 1993 both catch rates were low to increase in 1994. The catch- rates increased after that (Fig. 7) (SCR Doc. 98/112).

### 2.1.4 Surplus production analysis

The surplus production model (ASPIC) was run on landings, effort and unstandardized and standardized catch rates respectively of the northern area (Cadrin and Skuladottir, 1998). The stock biomass in the northern area was calculated to be 22 000 tons at a maximum sustainable yield (MSY) of 8 500 tons. A long term target catch of 8 000 tons is considered to have 90% chance of being less than MSY.

## 2.2 Commercial Biological data

### 2.2.1 Icelandic fishery data

The Icelandic samples (Fig. 8) taken in the spring of 1991, 1992 and 1993 showed that male shrimp dominated in all three years. After that males were dominant in 1996 but 1994, 1995 and 1997 show about 50% occurrence of females again and 40 % in 1998. The occurrence of a component of female shrimp with a mode at 25-26 mm in the Icelandic samples in 1990 suggested that sex change occurred earlier than normal. The samples in the 1991 through 1997 show a tiny proportion of small females but there was no noticeable component as seen in the 1990 data (Skúladóttir et al, 1994). Samples taken in 1994 on the eastern area and analysed electrophoretically show more affinity with samples taken in the offshore Icelandic waters than to samples taken west of the midline (Jónsdóttir, 1998). This could indicate occasional influxes from the Icelandic continental shelf. rather than a change in age/length at sex change.

### 2.2.2 Greenlandic fishery data

The samples from the Greenlandic fishery in 1991-1998 are shown on Fig. 9a and b. There were no samples in 1996 and 1997 from the northern area. In 1996 males and females seemed to be in equal numbers in the southern area whereas in 1997 and 1998 males were dominant in the southern area. In 1998 the females on the other hand were quite numerous in the northern area (Hvingel et al. 1998).

### 2.2.3. Size at female sexual maturity, L50

A study of the length at which 50% of animals have become mature females (without sternal spines) termed L50 was carried out on both Icelandic and Greenlandic sample data (Table 6, Fig. 10). Skuladottir (1995) has pointed out differences in L50 in the Denmark Strait as compared to Icelandic waters. The L50 for the northern area is here presented as monthly means. In the case of the Icelandic samples L50 was first calculated per sample (using the sternal spine criterium) and then averaged over a month, whereas the Greenlandic samples were first compiled per month (Folmer, personal communication) from where L50 was calculated (not sternal spines but the division females/all). The average L50 for the northern area was 27.2 mm for the Icelandic samples on the eastern side of the midline. The average L50 of the Greenlandic samples in the northern area was a bit lower or 26.5 mm, probably due to this difference in classification. The value of February 1994 in the northern area was surprisingly low. Although the L50 of the southern area is generally lower than that of the northern area, namely 25.7 mm it does not appear significantly lower than that of other Greenlandic samples in the northern area, only a difference of some 0.8 mm. The higher L50 of the Icelandic samples especially in 1994 could result from a difference in the measuring technic

## 2.3 RESEARCH SURVEY DATA

### 2.3.1 Abundance estimates

A two phase stratified random trawl survey (Spline method) was conducted by Greenland in the Denmark Strait in September-October, 1995 as was also done in 1994. The biomass estimate of 4 558 and 3 800 tons respectively, being much higher than that of either 1990 or 1992, which were only 1 860 and 1 044 tons respectively. Due to bad weather the second phase was never carried out, so only the abundance indices can be compared. The higher abundance estimate found in 1995 1996 as compared to 1990, 1992 and 1994 is the result of an increasing number of both male and female shrimp (Carlsson, 1996).

	Males	Females	Total
1989	231.0	135.4	366.3
1990	142.6	86.7	228.3
1992	163.6	45.3	209.0
1994	264.4	90.4	354.8
1995	315.7	109.9	425.6
1996	527.3	124.0	651.3

### 2.3.2. Demographic structure

showed an increase in the proportion of males over the period which is consistent with a trend from the 1985 to 1989 in Norwegian surveys. However overall abundance declined, especially for females. In 1996 the total number of females has increased (text table).

	Percent males									
	1985	1986	1987	1988	1989	1990	1992	1994	1995	1996
Norway	43.8	41.4	53.5	58.5	58.0					
Greenland					63.1	62.5	78.3	74.5	74.2	81.0

## 3. SUMMARY OF ADVICE FROM PREVIOUS YEARS

The interpretation of the effects of fishing on the stock in the Denmark Strait north of 65°N has changed since the first assessment was conducted in 1980. In 1981, it was thought that the decrease observed in the spring catch rates were due to heavy exploitation. Also it was considered that the stock was at the northern limit of the species distribution range, and as such, could be more sensitive to exploitation. Therefore, a

cautious approach for the exploitation was recommended, and a TAC of 5 000 tons (average catch of 1981-1984) was advised.

No TAC advice was provided for 1986, 1987 or 1988 because the catch rates could not be interpreted as an index of stock abundance. In 1988, it was observed that increased catches over the previous several years had no apparent effect on the resource and catch levels at about 10 000 tonnes were recommended as an exploratory level for several years.

Catch rates declined in 1987 and 1988, however catch composition and biomass estimates from 1985 to 1989 suggested that the stock was stable and in 1990 it was recommended that the TAC remain at 10 000 tons. The 1989 Norwegian survey showed that the stock was dispersed and the sexes well mixed. In 1991, the catch rate series for the Greenlandic fleet was standardized to account for changes in seasonality and fleet composition and it was interpreted that the stock in 1989-90 was substantially lower than in the period of stabilized catch rates. Also more males appeared in the catches and there were indications of earlier sex change. These concerns resulted in an arbitrary reduction of the TAC from 10 000 to 8 000 tons. The depressed conditions were still evident in the 1991 data and in 1992 a further reduction to 5 000 tonnes was advised for 1993 and several years thereafter in an attempt to protect the spawning biomass and rebuild the stock.

#### 4. STATUS OF THE RESOURCE

Unstandardized catch rates in the northern area for all nations combined, showed a declining trend from 1987 to 1989, but a stabilization between 1989 and 1993 a rise in 1994 and fluctuations after that and an increase in 1998. Taking the whole area into account the catch rates are stable. The standardized catch rates of Greenland north of 65°N show also a decline from 1987 to 1992 and a stabilization between 1992 and 1993 followed by about the same increase in catch rate in 1994 and 1995 as for that of all fleets combined for the area north of 65°N. Moreover there was an increase in abundance index from the Greenlandic surveys, in 1994 and 1995 from the low abundance of the years 1990 and 1992. The abundance of the 1996 survey was the highest of all the Greenlandic surveys but can not be used as an indicator as the coverage was incomplete.

#### 5. PROGNOSIS

The changes in fishing pattern (changes in proportion of effort allocated to northern and southern areas), low levels of commercial sampling make assessment difficult. It is uncertain whether or not there are two stocks although the recovery of the northern area points to the existence of a separate population there.

In the northern area the standardized CPUE indices are now higher than the minimum values reached in 1989-93 approaching the level observed Standardized CPUE data from both the northern and the southern areas indicate a general increasing trend in fishable biomass since 1993. Catch rates have increased in the southern area since 1993.

#### 6. REFERENCES

- Cadrin, S. X., and U. Skúladóttir 1998. Surplus production analysis of shrimp in the Denmark Strait, 1977-1998. NAFO SCR Doc. 98/125, Ser. No. N4034.
- Carlsson, D. M. 1996. Trawl survey for shrimp (*Pandalus borealis*) in Denmark Strait, 1996. NAFO SCR Doc. 96/116, Ser. No. N2813. 6 p.
- Hvingel, C., and O. Folmer 1998. The Greenlandic fishery for northern shrimp fishery (*Pandalus borealis*) in Denmark Strait 1997 -September 1998. NAFO SCR Doc. 98/112, Ser. No. N4021. 21 p.
- Jónsdóttir, Ó. D., A. K. Imsland, and G. Nævdal 1998. Population genetic studies of northern shrimp, *Pandalus borealis*, in Icelandic waters and the Denmark Strait. Can. J. Fish. Aquat. Sci. **55**. 770-780.

- Lehmann, K. 1990. Report on a commercial trial fishery for shrimp (*Pandalus borealis*) off southwest, southeast and east Greenland. NAFO SCR Doc. 90/62, Ser. No. N1784. 6 p.
- McCrary, J. A. 1971. Sternal spines as a characteristic for differentiating between females of some Pandalidae. J. Fish. Res. Board Can. 28. 98-100.
- Skúladóttir, U. 1995. The female sexual maturity of northern shrimp (*Pandalus borealis* Kr.) in Denmark Strait in the years 1985-1993 and a comparison to the nearest Icelandic shrimp populations. NAFO SCR Doc. 95/14, Ser. No N2521 15 p.
- Skúladóttir, U. 1998 a. The catch statistics of the shrimp fishery (*Pandalus borealis*) in the Denmark Strait, in the years 1980-1998. NAFO SCR Doc. 98/122, Ser. No N4031 21p.
- 1998 b. The Icelandic shrimp fishery (*Pandalus borealis* Kr.) in the Denmark Strait in 1997-1998 and some reflection on age groups in the years 1991-1997. NAFO SCR Doc. 98/120, Ser. No N4029. 11p.
- Skúladóttir, U., M. Andersen, D. M. Carlsson, P. Kannevorf, and H. Siegstad 1994. Preliminary assessment of shrimp in the Denmark Strait. NAFO SCR Doc. 94/96, Ser. No N2483 12 p.

Table 1. Nominal catch (tons) of shrimp in the Denmark Strait.

Nation	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	
Northern area																						
Denmark	-	-	702	581	740	204	443	353	500	555	444	366	390	358	160	111	199	242	21	69	344	
Faroe Islands	-	-	4233	713	737	443	668	674	727	595	679	595	843	1007	1092	554	368	745	800	509	1006	
France	-	-	50	353	414	291	500	642	780	1030	494	381	51	118	-	-	-	-	-	-	-	
Greenland	-	-	200	1004	1115	1467	2250	2596	5781	6627	7456	5976	6210	4205	2012	1425	1056	1913	289	84	341	
Iceland	363	485	759	125	0	43	742	1794	1150	1930	1431	1926	281	465	1750	2553	1514	1151	566	2856	1403	
Norway	-	800	2461	2016	1896	1727	2128	2051	2026	2041	2052	2098	2500	2504	2500	1473	1736	1923	1241	639	809	
Subtotal	363	1285	8405	4792	4902	4175	6731	8110	10964	12178	12556	10742	10275	8657	7514	6116	4873	5974	2917	4157	3903	
Southern area																						
Denmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	48	488	585	938	1337	777	
Faroe Islands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	225	776	236	323	526	-	
Greenland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	918	2870	2135	4257	3767	1791	
Norway	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	341	805	576	1278	1812	154	
Total	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1532	4939	3532	6796	7442	2722	
Σ Iceland EEZ	363	485	759	125	0	43	742	1794	1150	1330	1431	1326	281	465	1750	2553	1514	1151	566	2856	1403	
Σ northern area Greenland EEZ	0	800	7646	4667	4902	4132	5989	6316	9814	10848	11125	9416	9994	8192	5764	3563	3359	4823	2351	1301	2500	
Σ Southern area Greenland EEZ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1532	4939	3532	6796	7442	2722	
Σ Greenland EEZ	0	800	7646	4667	4902	4132	5989	6316	9814	10848	11125	9416	9994	8192	5764	5095	8298	8355	9147	8743	5222	
ΣΣ all areas	363	1285	8405	4792	4902	4175	6731	8110	10964	12178	12556	10742	10275	8657	7514	7648	9812	9506	9713	11599	6625	
Advised TAC	-	-	-	-	4200	4200	4200	5000	-	-	-	-	10000*	10000*	8000	5000	5000	5000	5000	5000	5000	5000
Effective TAC Greenland EEZ	-	-	-	8000	4500	5725	5245	6090	7525**	7725**	8725**	9025**	14100	14500	13000	9563	9563	9563	9563	9563	9563	9563

\* Advised for a few years as a precautionary measure.

\*\* not including Greenland fishery north of 66°30'N.

\*\*\* Provisional

Table 2. North area. Catch rates (kg per hour trawling) and corresponding effort (hours trawling) and catch (tons) from the shrimp fishery in Denmark Strait north of 65° N, by years.

Year	Periods	CPUE	Effort	Catch	Year	Periods	CPUE	Effort	Catch
1980	Jan-Jun	393	15775	6198.3	1990	Jan-Jun	150	52697	7880.9
	Jul-Dec	117	18815	2206.4		Jul-Dec	57	42003	2394.1
	Mean/Total	243	34590	8404.7		Mean/Total	109	94700	10275.0
1981	Jan-Jun	260	18072	4698.0	1991	Jan-Jun	99	72144	7153.6
	Jul-Dec	62	1516	93.9		Jul-Dec	63	23960	1502.7
	Mean/Total	245	19588	4791.9		Mean/Total	90	96104	8656.3
1982	Jan-Jun	212	23072	4900.0	1992	Jan-Jun	95	60241	5697.3
	Jul-Dec	-	-	-		Jul-Dec	78	23412	1817.1
	Mean/Total	212	23072	4900.0		Mean/Total	90	83653	7514.4
1983	Jan-Jun	203	17332	3524.1	1993	Jan-Jun	98	58331	5730
	Jul-Dec	103	6338	651.3		Jul-Dec	42	9115	385.2
	Mean/Total	176	23670	4175.4		Mean/Total	91	67446	6115.2
1984	Jan-Jun	247	23900	5899.2	1994	Jan-Jun	185	21354	3943.2
	Jul-Dec	103	8074	831.6		Jul-Dec	98	9506	930.0
	Mean/Total	211	31974	6730.8		Mean/Total	158	30860	4873.2
1985	Jan-Jun	181	28959	5249.0	1995	Jan-Jun	168	26997	4548.9
	Jul-Dec	126	22779	2861.0		Jul-Dec	69	20655	1424.8
	Mean/Total	157	51738	8110.0		Mean/Total	125	47652	5973.7
1986	Jan-Jun	189	41140	7755.0	1996*	Jan-Jun	111	15638	1741.7
	Jul-Dec	205	15668	3209.0		Jul-Dec	101	11639	1174.4
	Mean/Total	193	56808	10964.0		Mean/Total	107	27277	2916.1
1987	Jan-Jun	235	36251	8512.0	1997*	Jan-Jun	225	14261	3206.2
	Jul-Dec	99	37004	3666.0		Jul-Dec	101	9434	950.5
	Mean/Total	166	73255	12178.0		Mean/Total	175	23695	4156.7
1988	Jan-Jun	158	51842	8190.5	1998*	Jan-Jun	212	18451	3902.5
	Jul-Dec	91	47717	4352.5		Jul-Dec	45	11	0.5
	Mean/Total	126	99559	12543.0		Mean/Total	211	18462	3903.0
1989	Jan-Jun	155	45428	7034.6					
	Jul-Dec	59	62475	3712.5					
	Mean/Total	100	107903	10747.1					

Table 3. Middle and south area. Catch rates (kg per hour trawling) and corresponding effort (hours trawling) and catch (tons) from the shrimp fishery in the area south of 65° N in the Denmark Strait.

Year	Periods	CPUE	Effort	Catch
1993	Jan-Jun	115	11935	1368.6
	Jul-Dec	1076	152	163.5
	Mean/Total	127	12087	1532.1
1994	Jan-Jun	254	10445	2655.6
	Jul-Dec	289	7896	2283.4
	Mean/Total	269	18341	4939.0
1995	Jan-Jun	194	4297	834.8
	Jul-Dec	299	9005	2696.9
	Mean/Total	266	13302	3531.7
1996*	Jan-Jun	246	13893	3415.9
	Jul-Dec	293	11554	3380.1
	Mean/Total	267	25447	6796.0
1997*	Jan-Jun	237	16207	3842.6
	Jul-Dec	345	10428	3598.9
	Mean/Total	279	26635	7441.5
1998*	Jan-Jun	422	6444	2722.0
	Jul-Dec			
	Mean/Total	422	6444	2722.0



Table 4. North and south area. Catch rates (kg per hour trawling) and corresponding effort (hours trawling) and catch (tons) from the shrimp fishery by all nations combined in two periods of the year.

Year	Country	January-June			July - December		
		CPUE	Effort	Catch	CPUE	Effort	Catch
1993	North	98	58331	5730.0	42	9115	385.2
	South	115	11935	1368.6	1076	152	163.5
	Total	101	70266	7098.6	59	9267	548.7
1994	North	185	21354	3943.2	98	9506	930.0
	South	254	10445	2655.6	289	7896	2283.4
	Total	208	31799	6598.8	185	17402	3213.4
1995*	North	168	26997	4548.9	69	20655	1424.8
	South	194	4297	834.8	299	9005	2696.0
	Total	172	31294	5383.7	139	29660	4120.8
1996*	North	111	15638	1741.7	101	11639	1174.4
	South	246	13893	3415.9	293	11554	3380.1
	Total	175	29531	5157.6	196	23193	4554.5
1997*	North	225	14261	3206.2	101	9434	950.5
	South	237	16207	3842.6	345	10428	3598.9
	Total	231	30468	7048.8	229	19862	4549.4
1998*	North	212	18451	3902.5	45	11	0.5
	South	422	6444	2722.0			
	Total	266	24895	6624.5	45	11	0.5

Table 5. North and south area combined to the whole year as regards effort, catch and CPUE.

Year	Country	CPUE	Effort	Catch
1993	Jan-Jun	101	70266	7098.6
	Jul- Dec	59	9267	548.7
	Total	96	79533	7647.3
1994	North	208	31799	6598.8
	South	185	17402	3213.4
	Total	199	49201	9812.2
1995*	North	172	31294	5383.7
	South	139	29660	4120.8
	Total	156	60954	9504.5
1996*	North	175	29531	5157.6
	South	196	23193	4554.5
	Total	184	52724	9712.1
1997*	North	231	30468	7048.8
	South	229	19862	4549.4
	Total	230	50330	11598.2
1998*	North	266	24895	6624.5
	South	45	11	0.5
	Total	266	24906	6625.0

Table 6. Size of shrimp where 50% are mature females (L50) in the Denmark Strait from Icelandic and Greenlandic samples in two areas, namely north of 65° N and south of 65°N respectively.

Northern area Iceland			Northern area Greenland		Southern area Greenland	
1994	L50 mm	No. of samples	1994	L50 mm	1994	L50 mm
March	27.02	2	Feb	24.25	Jan	24.92
Feb	26.59	2			Feb	26.07
					March	25.68
					Apr	25.40
1995			1995		1995	
Feb	26.67	8	Jan	26.59		
			Feb	25.73		
			March	27.45		
1996			1996		1996	
Feb	26.79	1			April	24.55
March	27.84	4			May	26.96
April	26.95	9			Aug	25.99
					Nov	25.28
1997			1997		1997	
March	26.91	17			Jul	24.51
April	27.37	6			Nov	25.85
May	27.95	2			Dec	26.55
Dec.	27.32	2				
1998			1998		1998	
Jan	26.80	2	Jan	27.52	Feb	27.17
Feb	27.20	4	Feb	27.54	March	25.72
April	27.73	8				
May	27.80	6				
Average	27.21			26.51		25.74

To the calculated L50 values of Greenland have been added 0.25 mm for the comparison with the Icelandic data due to differences in classification of the measurements. Iceland uses the midpoint of a length-class and Greenland uses the lower limit.

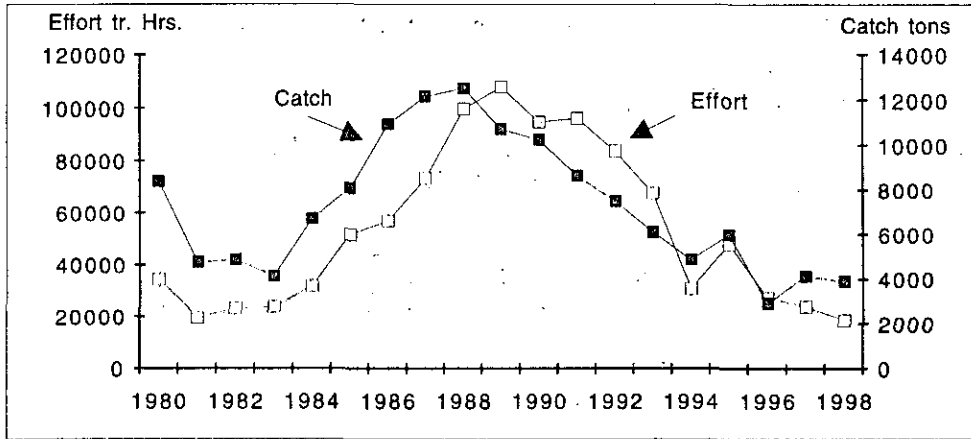


Fig. 1. Catch and effort from the logbooks weighted by nominal catches from the area north of 65°N.

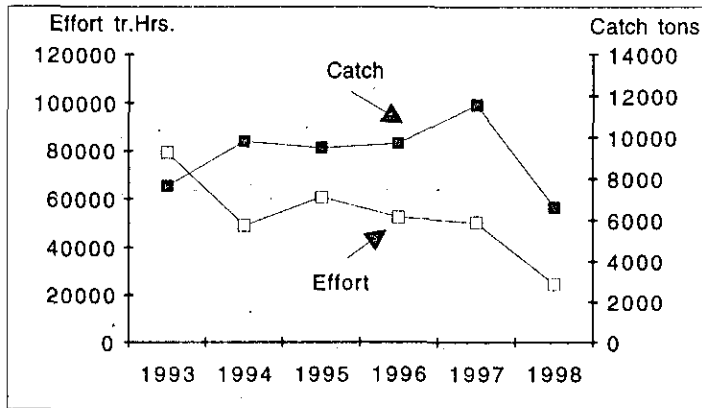


Fig. 2. Catch and effort in north and south combined.

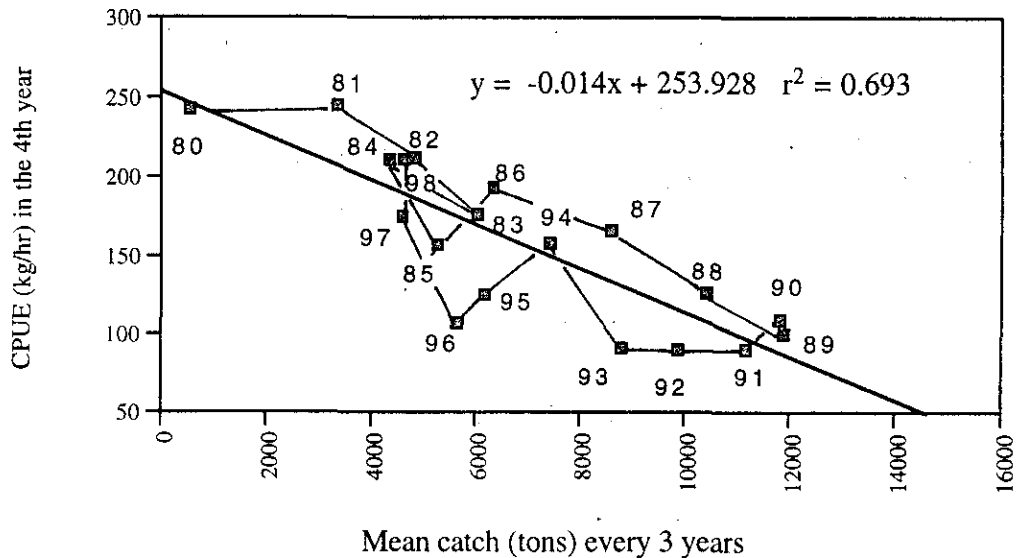


Fig. 3. North area. The mean catch of every 3 years against unstandardized CPUE in the 4th year, denoted by that year.

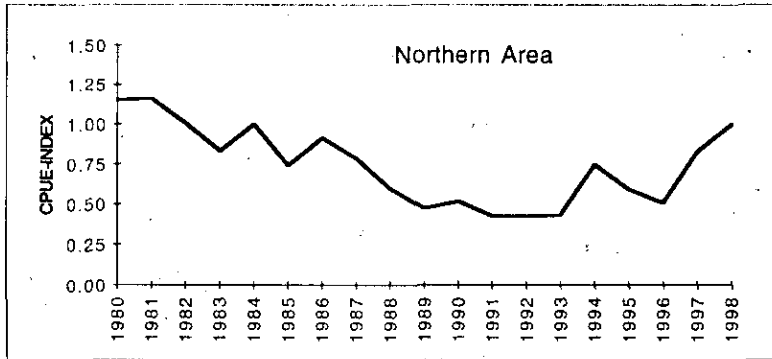


Fig. 4. The unstandardized catch rate indices, north of 65°N, of all countries combined.

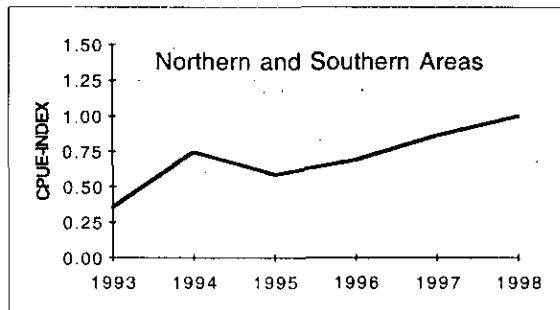


Fig. 5. The unstandardized catch rate indices for both north and south areas combined.

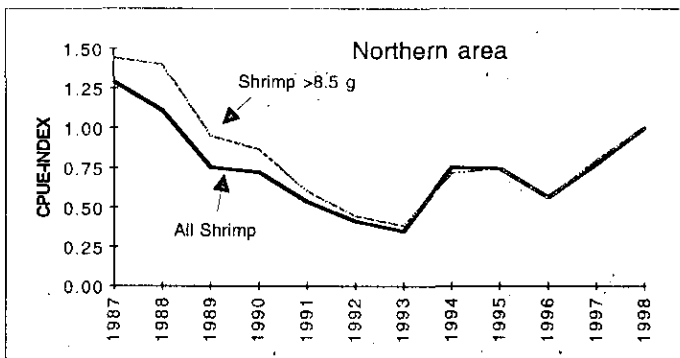


Fig. 6. Annual standardized CPUE-indices calculated for shrimp > 8.5 g and for total catch of Greenlandic vessels in the area north of 65°N.

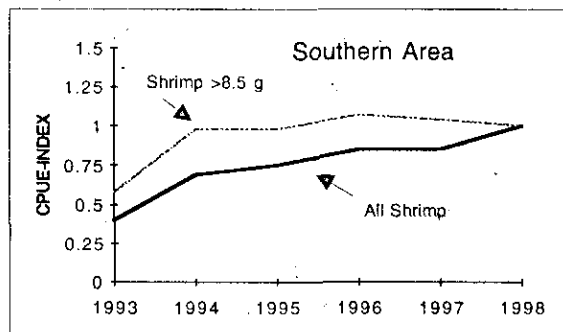


Fig. 7. Annual standardized CPUE-indices calculated for shrimp > 8.5 g and for total catch of Greenlandic vessels in the area south of 65°N.

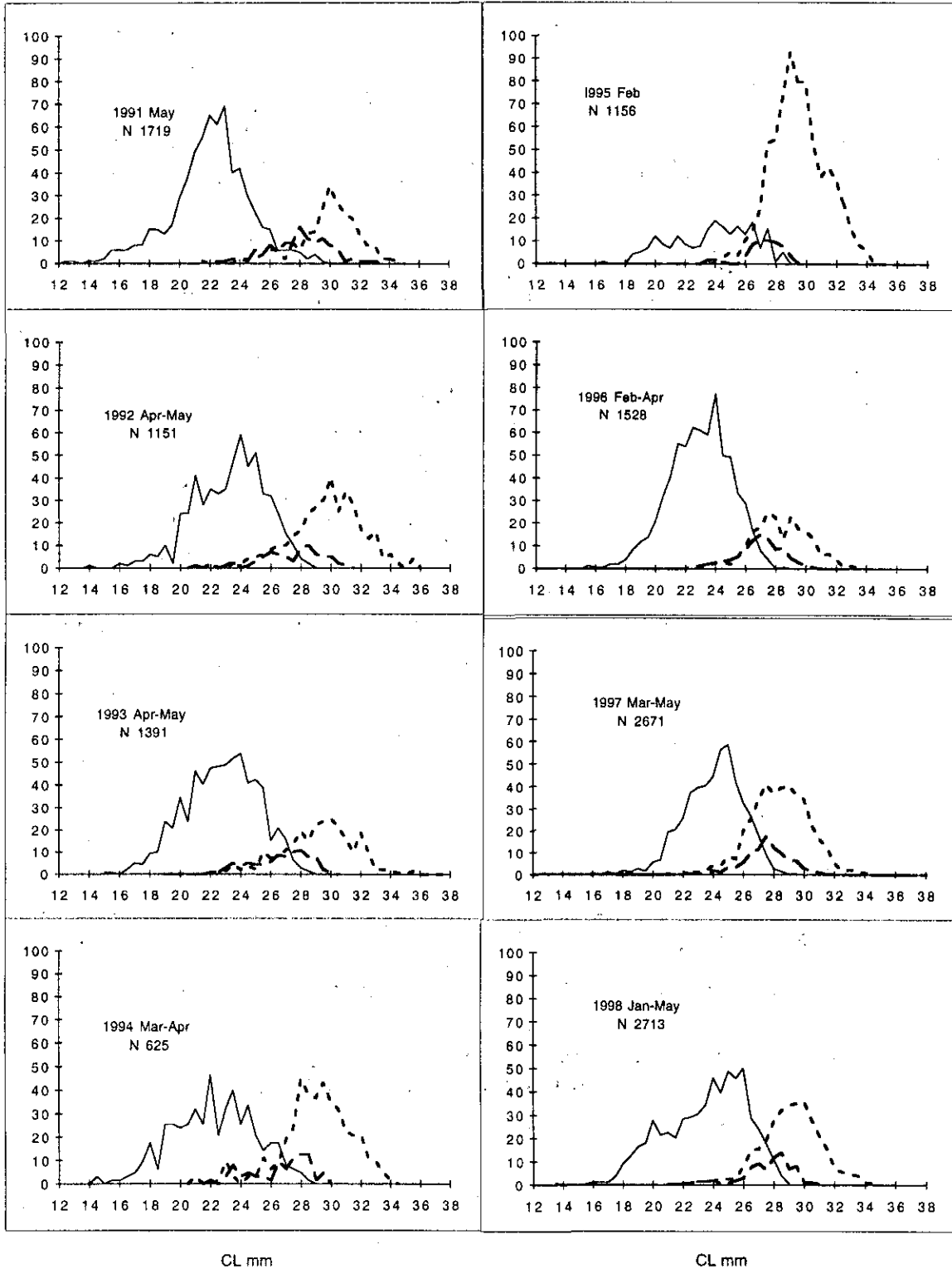


Fig. 8. The Icelandic commercial samples in the years 1991 to 1998 in the eastern part of the Denmark Strait area north of 65°N.

Northern area

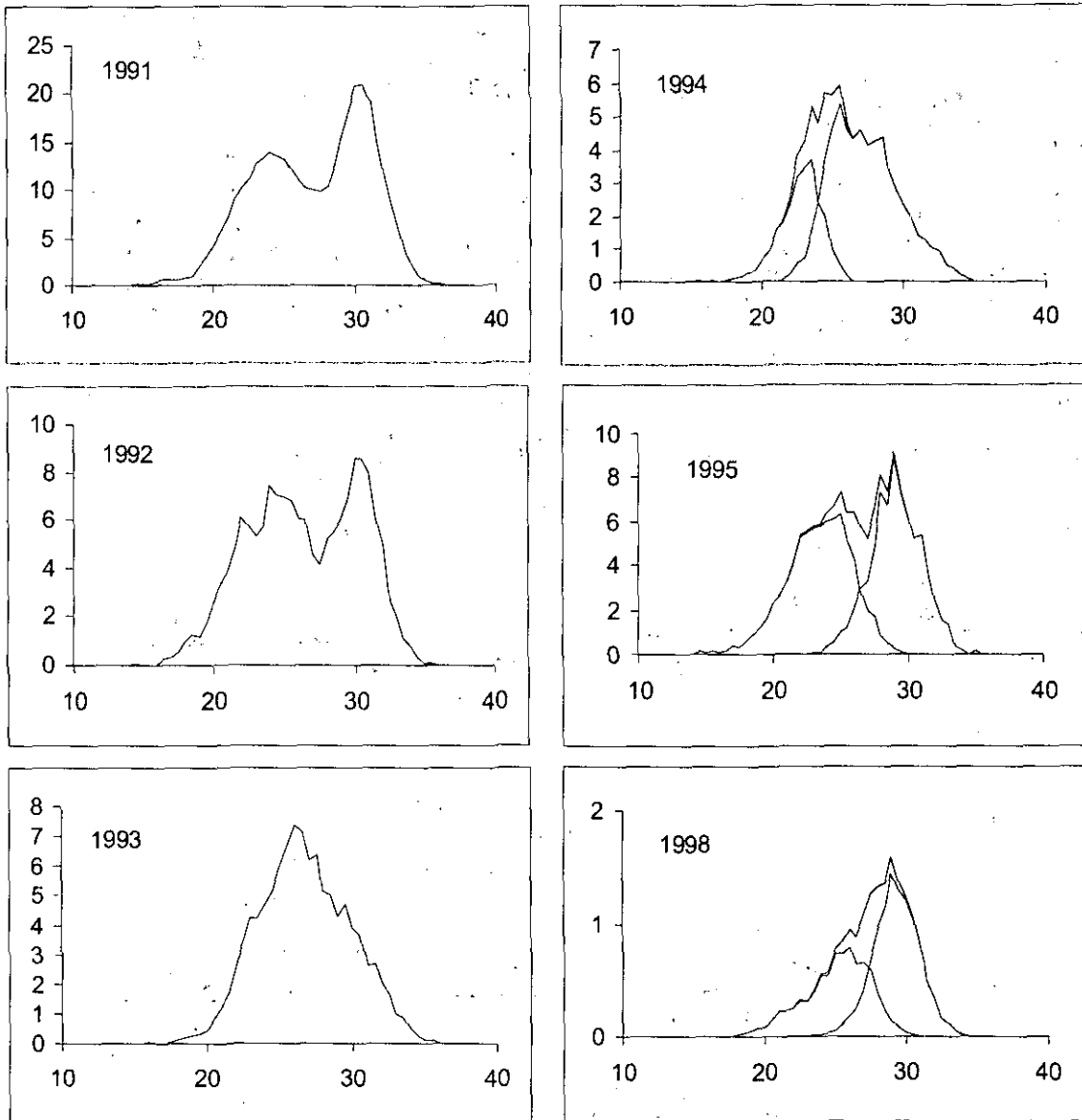


Figure 9a. Length frequency distribution of shrimp catches North of 65°N in Denmark Strait by Greenlandic vessels. Male and female components are indicated under the total distributions where data are available.

Southern area

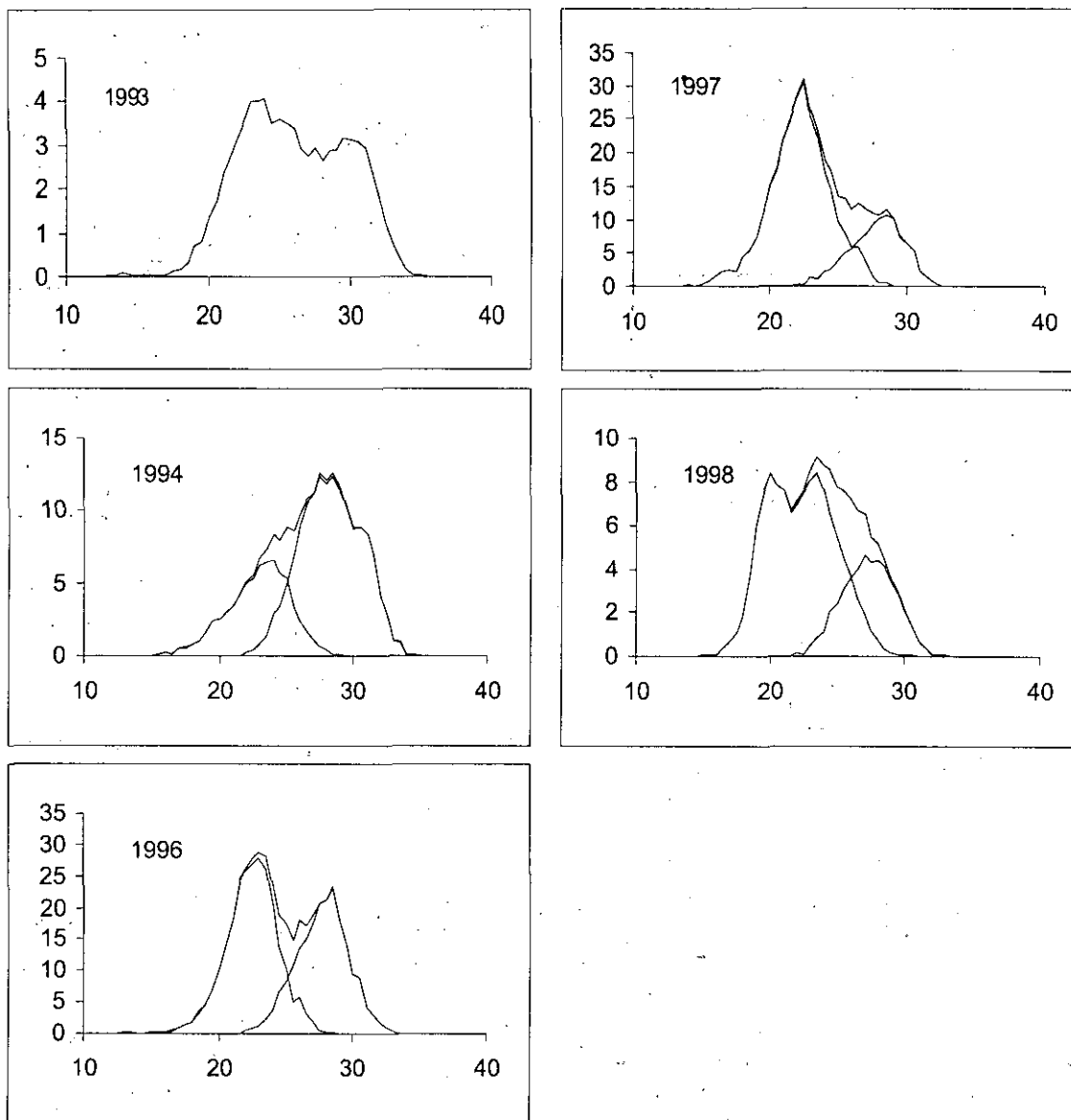


Figure 9b. Length frequency distribution of shrimp catches South of 65°N in Denmark Strait by Greenlandic vessels. Male and female components are indicated under the total distributions where data are available.

Southern area

Southern area

Northern area

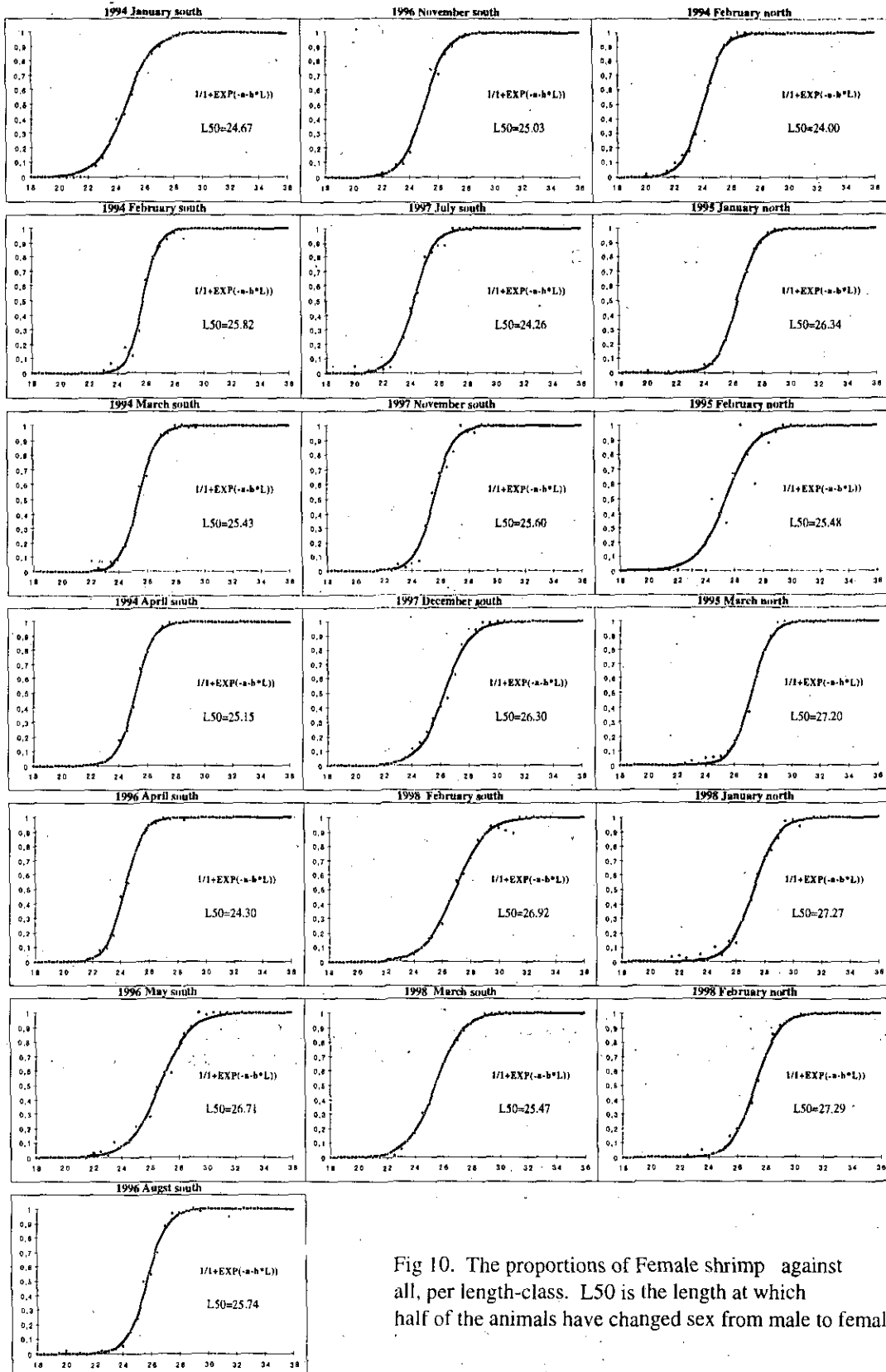


Fig 10. The proportions of Female shrimp against all, per length-class. L50 is the length at which half of the animals have changed sex from male to female.