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An Update of the Icelandic Shrimp Fishery (*Pandalus borealis* Kr.) at Flemish Cap in 1993-2003

by

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Abstract

Some 3 Icelandic vessels have been fishing for shrimp in the waters at Flemish Cap in 2003 as was the case in 2002. In this paper there is logbook information on the Icelandic fishery for the years 1993 through 2003. The standardized catch rate has recently increased considerably or from 203 kg/hour in January-September 1997 to 294 in 2002 and further to 335 kg/hour in 2003 the second highest since 1993 when it was 344 kg/hour.

The biological samples show that the 1999 year-class, four year olds in 2003 is very strong.

Introduction

The Spanish investigators (EU) have been measuring the biomass index of northern shrimp at the Flemish Cap since 1988 in their annual bottom trawl survey at Flemish cap. In 1993 the fishery was initiated by Canada, followed closely by Faroe Islands and Iceland.

The fishery was some 24-33 thousand tons in the years 1993-1995 to increase in 1996 to 48 thousand tons. Since then the fishery decreased to some 25 thousand tons in 1997. The total catch of all countries has since increased to about 54 thousand in 2001. Iceland has been catching a fair deal of the catch in some previous years. in later years the catch has decreased substantially due to low prizes in shrimp.

In this paper all the information from the Icelandic side is gathered. From the logbooks come effort, catch and size of trawl. From this CPUE is calculated. From the biological samples taken by Icelandic observers comes various information on length and sex distribution of shrimp.

Materials and Methods

The logbook data include catch and effort. Sometimes information on landings as obtained from the Fisheries Directorate in Iceland exceeds the logbook information. The effort is then raised by dividing the nominal catch of each month/half year with the calculated CPUE from the logbooks. The overall CPUE of the January-July was then obtained by summing nominal catch of all months and corresponding effort. Nominal catch for the whole period was then divided by "nominal effort" to get the CPUE for the period January-July. When twin trawls were used the effort was always multiplied by 1.9 for those but the catch was kept the same. The same method was applied to the period January –September.

For calculation of standardized CPUE to the standard size of trawl of 3000 meshes, the catch and effort of a period like January to July was calculated in the manner described above. At the same time the average size of trawl (no. of standard meshes (40 mm) in circumference of the belly) be it single or double was calculated. The CPUE for trawl size 3000 meshes was then considered to be proportional to the mean size of trawl in the same period.

Icelandic observers have sampled shrimp onboard Icelandic vessels since 1996 at Flemish Cap. The shrimp was measured fresh to the nearest 0.5 mm using Vernier callipers. Observers then sorted each length class into

males and females using the method of Rasmussen (1953) and the females further into primiparous and multiparous using the sternal spine criterion of McCrary (1971).

The deviations from an overall mean length frequency distribution (lfd) are calculated using data from Canada, Faroe Islands and Iceland for the years 1993-1995. From 1996-2003 there are only Icelandic data. The basic unit is a promille length frequency distribution for each month where all the samples of that month are compiled. Then a mean overall promille lfd for say April months for all the years 1993-2003 is calculated. From this the overall mean lfd of April is subtracted from the lfd of April in 1993 and so on every year (Fig. 6). What is unusual about each year appears as a deviation high or low. The positive modes are representive of stronger than usual year-classes. As each year-class is supposed to grow from one year to another, the positive bump one year moves to the right t in the next year and so on.

Catch and Effort Data

In 2003 the fishery was carried out since January. The catch in 2003 so far is 3 742 tons (Table 1). Iceland increased the total allowable catch (TAC) for Icelandic vessels from 6 800 tons in 1999, to about 10 000 tons for years 2000 to 2002 and to 13 500 for year 2003. In spite of this high TAC the total catch was only 5 300 tons in year 2001, 5 700 tons in 2002.

The distribution of effort is shown by years in Figure 1 for the years 1999 through 2003. There appears to be a lack of tows in the south east of Flemish Cap area but in other years the distribution of tows is traditional.

The mean CPUE for the year 1997 was the lowest ever for Iceland or 203 kg per trawling hour for the period January through September (Table 2). In 1998 the mean CPUE for the same period was much higher or 266 kg and decreased slightly in 1999 and 2000 to increase in 2001 and 2002 to 294 kg/hour. In 2003 the CPUE was 335 kg/hour,

The average size of gear used was about 3000 meshes in most years, but increased to about 3500 meshes in the years 1999 to 2001 and 4 066 meshes in 2003. The trawl size in year 2003 is by far the largest so the unstandardized CPUE of 2003 gives an impression of unrealistic stock increase. Therefore it makes more sense to look at CPUE at a standard trawl size. At the same time the use of twin trawls has increased in 1998 from a little less than 60% in 1995-1997 to about 67%- 85% in the years 2000 - 2003.

Length Frequencies and Age Groups

The length frequency distributions of Icelandic samples from 2002 through 2003 are shown by months in Figures 2-3. Two year olds are seen in May year 2001about 15-16 mm CL and get more prominent in the latter part of the year, namely September to December (Skuladottir, 2002). This 1999 year-class is also very prominent in years 2002 and 2003 (figures 2 and 3).

The deviation method (Sund, 1939, Skuladottir, 1981) is very useful in detecting year-classes and can be of great aid in assessing age when it comes to applying the modal analysis. The major drawback of the modal analysis is the fact that it does not tell you how many components there should be in a lfd and sometimes there is e.g. no difference in fitting 4 components when there should indeed be only be 3. From the Figures 4 to 14 it is possible to study the deviations as positive peaks and occasionally as a peak that is at the mean line like in Fig. 14, the 3 year olds of December 1998.

The aforementioned 1999 year-class is first seen as a positive peak in August 2001 (Fig. 10). It can be seen in September as well and then again in November and December. In year 2002 the most prominent peak is that of the 1999 year-class as three year olds in all months from March and onwards (no samples in February). In 2003 this same year-class can be seen all year although sometimes like in April and June 2003 it appears to be mixed with the 1997 and 1998 year-classes. A drawback to the method is when growth slows down there is a fusion with adjacent year-classes which then for a single peak may broader than it should be.

From the deviations in Figures 4-14 it has been attempted to follow the various year-classes and the mean length of each is assessed by eye from the deviations. The results are listed in Table 3 where the 7 year-classes, namely 1993, 1994, 1995, 1996, 1997, 1999 and 2001 are followed. In Table 3, the year stated is the one where the appropriate deviation is assessed. So e.g. the 1993 year-class which was quite strong can be seen first as 2 year old in March 1995 at the CL 14 mm. The 2001 year-class is unusual in being detected already as one year old in September 2002.

By-catch

The by-catch was about 0.3 % in the years 2002 and 2003, 0.9% in 2000 and 0.8% in 2001 as compared to 0.8% of the shrimp catch in 1999 and 1998, 1.8% in 1997 and 3 % in 1996 (Skúladóttir, 1998). Most of this was redfish or 0.7-0.8 % in the years 1999 to 2002. Other species were wolffish, Greenland halibut and American plaice. Cod was seen for the first time in April 1999, but has not been seen since.

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Table 1. Catch (tons) effort (trawling hours *1.9 when double trawl) and unstandardized CPUE (kg/hr) of Icelandic vessels at Flemish Cap.

	January - July				August - December			
Year	Month	CPUE	Effort	Catch	Month	CPUE	Effort	Catch
1993					Aug	320.4	1334	427.4
					Sep	349.8	1034	361.7
					Oct	231.7	334	77.4
	Jun	380.2	1767	671.8	Nov	306.8	588	180.4
	Jul	342.4	1097	375.6	Dec	236.5	537	127.0
	Subtotal	365.7	2864	1047.4	Subtotal	306.7	3827	1173.9
	Total	365.7	2918	1067.0	Total	306.7	3834	1176.0
1994	Jan	228.5	144	32.9	Aug	175.3	1657	290.4
	Feb	371.8	510	189.6	Sep	126.9	476	60.4
	Mar	295.5	531	156.9	Oct	125.4	492	61.7
	Jun	256.4	1297	332.5	Nov	115.5	181	20.9
	Jul	212.9	2653	564.8	Dec	75.0	8	0.6
	Subtotal	248.6	5135	1276.7	Subtotal	154.2	2814	434
	Total	248.6	6693	1664.0	Total	154.2	4123.7	636
1995	Feb	280.0	65	18.2	Aug	178.0	4869	866.9
	Mar	246.8	711	175.5	Sep	134.1	2928	392.5
	Apr	149.9	1487	222.9	Oct	166.3	2088	347.2
	May	260.1	2617	680.7	Nov	144.4	1074	155.1
	June	248.9	3733	929.2	Dec	174.5	740	129.1
	Jul	249.5	6625	1653.0				
	Subtotal	241.5	15238	3679.5	Subtotal	161.6	11699	1890.8
	Total	241.5	16932	4088.5	Total	161.6	21868	3534.4
1996	Jan	207.2	1755	363.7	Aug	165.4	8156	1349.4
	Feb	251.7	1326	333.7	Sep	167.1	8089	1351.7
	Mar	261.8	4604	1205.1	Oct	129.7	5482	711.2
	Apr	211.2	10754	2271.2	Nov	137.9	1456	200.8
	May	189.1	12749	2410.2	Dec	158.1	253	40.0
	Jun	202.5	13933	2821.5				
	Jul	235.9	11963	2821.5				
	Subtotal	214.2	57084	12226.9	Subtotal	155.9	23436	3653.1
	Total	214.2	64760	13871.0	Total	155.9	43689	6810.0
1997	Jan	175.8	413	72.6	Aug	206.7	4252	879.0
	Feb	214.7	621	133.3	Sep	202.4	3476	703.6
	Apr	135.0	514	69.4	Oct	222.0	2519	559.1
	May	141.4	3736	528.2	Nov	192.5	1039	200.0
	Jun	167.7	5386	903.2	Dec	176.9	429	75.9
	Jul	209.2	5802	1213.7				
	Subtotal	177.3	16472	2920.4	Subtotal	206.4	11715	2417.6
	Total	177.3	19478	3453.3	Total	206.4	14681	3029.6
1998 *	Feb	217.2	297	64.5	Aug	256.4	3184	816.3
	Mar	206.8	812	167.9	Sep	184.5	5028	927.5
	Apr	229.5	880	202.0	Oct	196.3	3612	708.9
	May	261.4	2820	737.2	Nov	204.6	1761	360.3
	Jun	330.7	3537	1169.7	Dec	222.5	644	143.3
	Jul	285.3	4117	1174.7				
	Subtotal	282.1	12463	3516.0	Subtotal	207.8	14229	2956.3
	Total	282.1	12657	3570.8	Total	207.8	14447	3001.5
1999 *	Feb	350.5	382	133.9	Aug	250.8	3642	913.4
	Mar	289.4	1851	535.7	Sep	235.5	1371	322.9
	Apr	253.0	3483	881.2	Oct	255.6	2150	549.6
	May	249.5	5941	1482.3	Nov	256.2	2173	556.8
	Jun	285.8	5993	1712.7	Dec	230.6	989	228.1
	Jul	280.4	5224	1464.6				
	Subtotal	271.5	22874	6210.4	Subtotal	249.0	10325	2570.8
	Total	271.5	24009	6518.6	Total	249.0	10837	2698.4
2000 *	Jan	263.8	1050	277.0	Aug	244.9	2357	577.1
	Feb	280.5	2206	618.8	Sep	239.0	2134	510.2
	Mar	306.3	3297	1009.8	Oct	274.8	1787	491.1
	Apr	280.7	4378	1229.0	Nov	256.1	2984	764.3
	May	231.9	4943	1146.6	Dec	267.5	798	213.5
	Jun	304.3	3679	1119.6				
	Jul	250.1	3064	766.4				
	Subtotal	272.7	22618	6167.2	Subtotal	254.1	10060	2556.2
	Total	272.7	22618	6167.2	Total	254.1	11051	2807.8
2001 *	Jan	285.9	538	153.7	Aug	292.6	2094	612.9
	Feb	299.9	1593	477.6	Sep	277.3	1160	321.6
	Mar	303.6	2174	660.0	Oct	267.5	1563	418.1
	Apr	239.6	45	10.8	Nov	253.4	1210	306.6
	May	271.1	917	248.7	Dec	500.8	404	202.5
	Jun	282.9	2777	785.6				
	Jul	296.5	2992	887.2				
	Subtotal	292.1	11036	3223.6	Subtotal	289.5	6431	1861.7
	Total	292.1	11036	3223.6	Total	289.5	7178	2077.8
2002 *	Jan	292.6	372	108.9	Aug	311.7	1739	542.0
	Feb	343.4	705	242.0	Sep	313.2	1054	330.0
	Mar	264.6	1786	472.4	Oct	234.7	923	216.7
	Apr	305.7	2056	628.4	Nov	312.9	559	174.9
	May	330.8	2439	806.6	Dec	359.9	437	157.1
	Jun	346.0	2113	731.1				
	Jul	444.6	1241	551.7				
	Subtotal	330.6	10710	3541.1	Subtotal	301.6	4711	1420.7
	Total	330.6	10711	3541.1	Total	301.6	7296	2200.3
2003 *	Jan	384.3	162	62.1	Aug			
	Feb	422.0	715	301.8	Sep	242.1	718	173.8
	Mar	565.1	1303	736.3				
	Apr	430.9	967	416.5				
	May							
	Jun	329.7	925	305.1				
	Jul	287.6	85	24.5				
	Subtotal	444.2	4157	1846.3	Subtotal			
	Total	444.2	6937	3081.0	Total			

Table 2. Nominal catch for the whole year and some averages calculated from the Icelandic logbooks to show trends in CPUEs and size of trawl. In calculations of CPUE the effort of twin trawls is multiplied by 1.9.

Year	Nominal Catch Tons	Twin trawls % of catch	Mean trawl size No. of meshes January-July	Unstandardized CPUE January-July	**CPUE at size 3000 trawl January-July**	Mean trawl size No. of meshes January-Sept	Unstandardized CPUE January-Sept	CPUE at size 3000 trawl January-Sept.
1993	2 243	43.4	3063	373	**363**	3102	356	344
1994	2 300	54.4	2994	238	**240**	2951	216	219
1995	7623	38.2	2779	254	**283**	2733	228	251
1996	20681	42.9	2803	206	**218**	2813	198	211
1997	6483	53.4	2780	188	**192**	2921	198	203
1998	6572	74.8	3016	288	**294**	2974	264	266
1999	9217	70.6	3441	280	**252**	3402	276	243
2000	8978	81.4	3528	287	**245**	3528	282	240
2001	5301	63.0	3571	328	**290**	3518	325	289
2002	5741	73.6	3713	370	**305**	3713	363	294
2003	3081	85.0	4190	486	**348**	4066	455	335

Table 3. Length at age as assessed by eye from the deviations in length frequency distributions each month in figures 5 to 14.

Months	1995	1996	1997	1998	1999	2000	2001	2002	2003	Average
	1 years									
Sept.								12.5		
Nov.								13.8		
	2 years									
Jan.										
Feb.									13.5	13.5
Mar.	14.0						14.0			14.0
Apr.	14.5			13.0	12.7				14.6	13.7
May	15.5									15.5
Jun.	15.7									15.7
Jul.	16.2			14.8					17.2	16.1
Aug.		15.5	15.5				16.5			15.8
Sept.	16.5						16.5	16.0		16.3
Oct.	17.5	16.0	16.0	17.5	15.5					16.5
Nov.	18.3		16.5	16.0	15.5			17.2		16.7
Dec.	18.2			16.0			16.2			16.8
	3 years									
Feb.			18.5	17.5		15.7				17.2
Mar.		19.0		17.8	16.0	16.7		16.7		17.2
Apr.		20.0	18.5	18.3	16.2	16.8		17.5		17.9
May		20.0	18.7	18.5	17.2	17.6		18.5		18.4
Jun.		20.5	19.4	19.0	18.0	18.5		18.3		19.0
Jul.		20.7	19.0	19.2	18.3	18.7				19.2
Aug.		21.0	19.2	19.7	18.0	18.5		18.5		19.2
Sept.		20.8	19.5	19.5	18.5					19.6
Oct.		21.2	19.7	19.8	18.6			19.7		19.8
Nov.		22.0	20.3	20.5				20.3		20.8
Dec.		22.2	20.7	20.7	19.2	19.5		19.8		20.4
	4 years									
Feb.			23.0	21.2	20.7		20.5			21.4
Mar.				22.0	22.0		21.5		20.7	21.6
Apr.			23.0	22.3	22.0					22.4
May			22.7	22.6	22.6		21.8		20.7	22.1
Jun.			23.3	22.7	23.0		21.8			22.7
Jul.			23.3	23.0	23.2	20.8	22.0			22.5
Aug.			23.5	22.7	23.5	20.8	21.7			22.4
Sept.			23.5	22.8	23.2		22.0			22.9
Oct.			23.8	22.7	23.0					23.2
Nov.				23.5		22.0				22.8
Dec.				23.7			21.8			22.8
	5 years									
Feb.				25.2	23.7					24.5
Mar.				25.7	23.7					24.7
Apr.										
May					24.5		24.0	23.7		24.1
Jun.			25.2		25.0	24.5	24.2	24.0		24.6
Jul.							24.8	24.3		24.6
Aug.				26.7			24.0	24.5		25.1
Sept.						24.5	24.2	24.0		24.2
Oct.				26.3			25.2	24.0		25.2
Nov.				27.0			25.5	25.0		25.8
Dec.				26.8	24.7			24.5		25.3
	6 years									
Feb.					26.2					26.2
Mar.										
Apr.										
May										
Jun.										
Jul.								26.0		26.0
Aug.										
Sept.										
Oct.								25.8		25.8
Nov.										
Dec.										

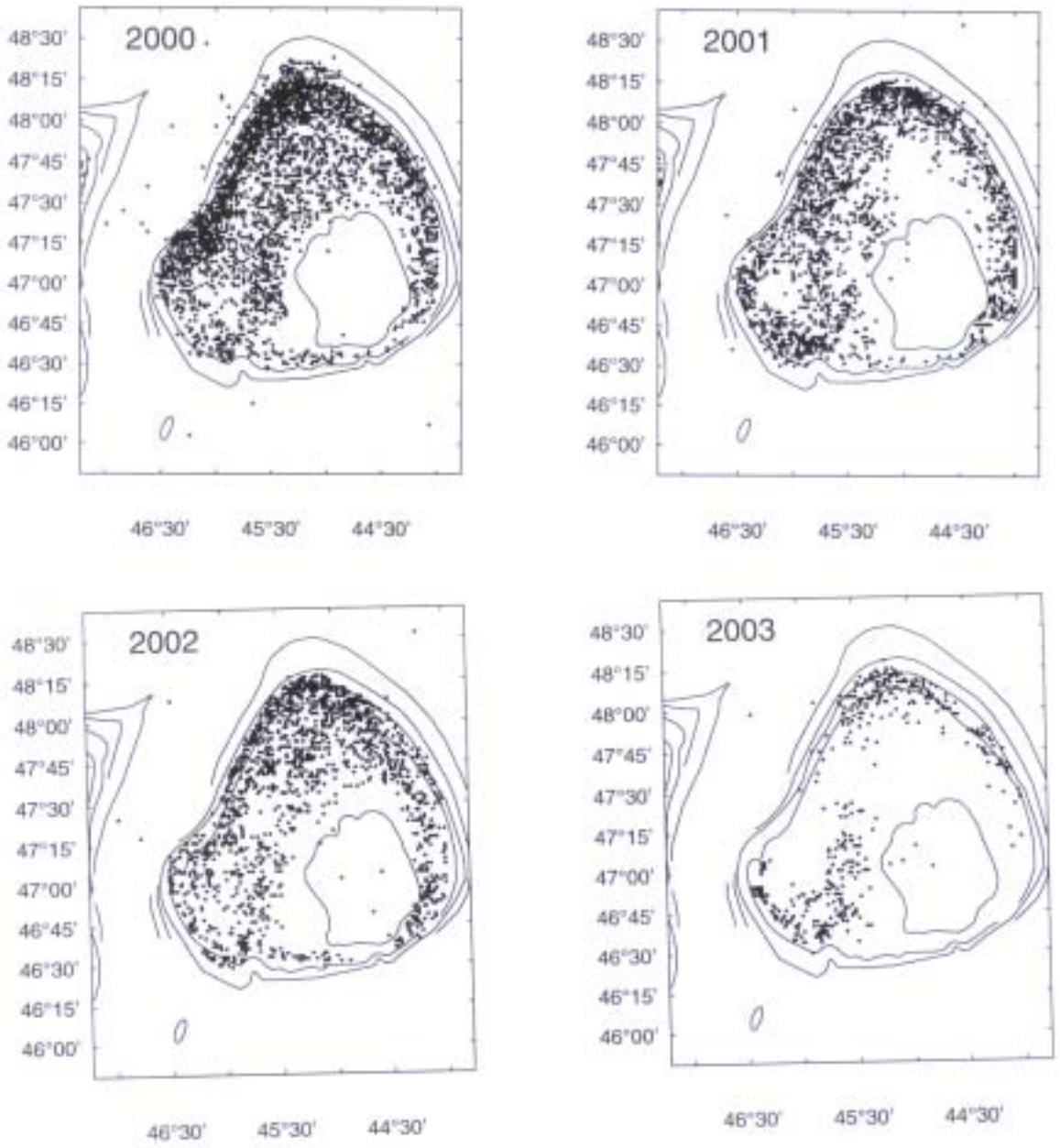

Fig. 1. Shrimp in Div. 3 M: Towing positions in the Icelandic fleet on Flemish Cap in years 2000-2003.

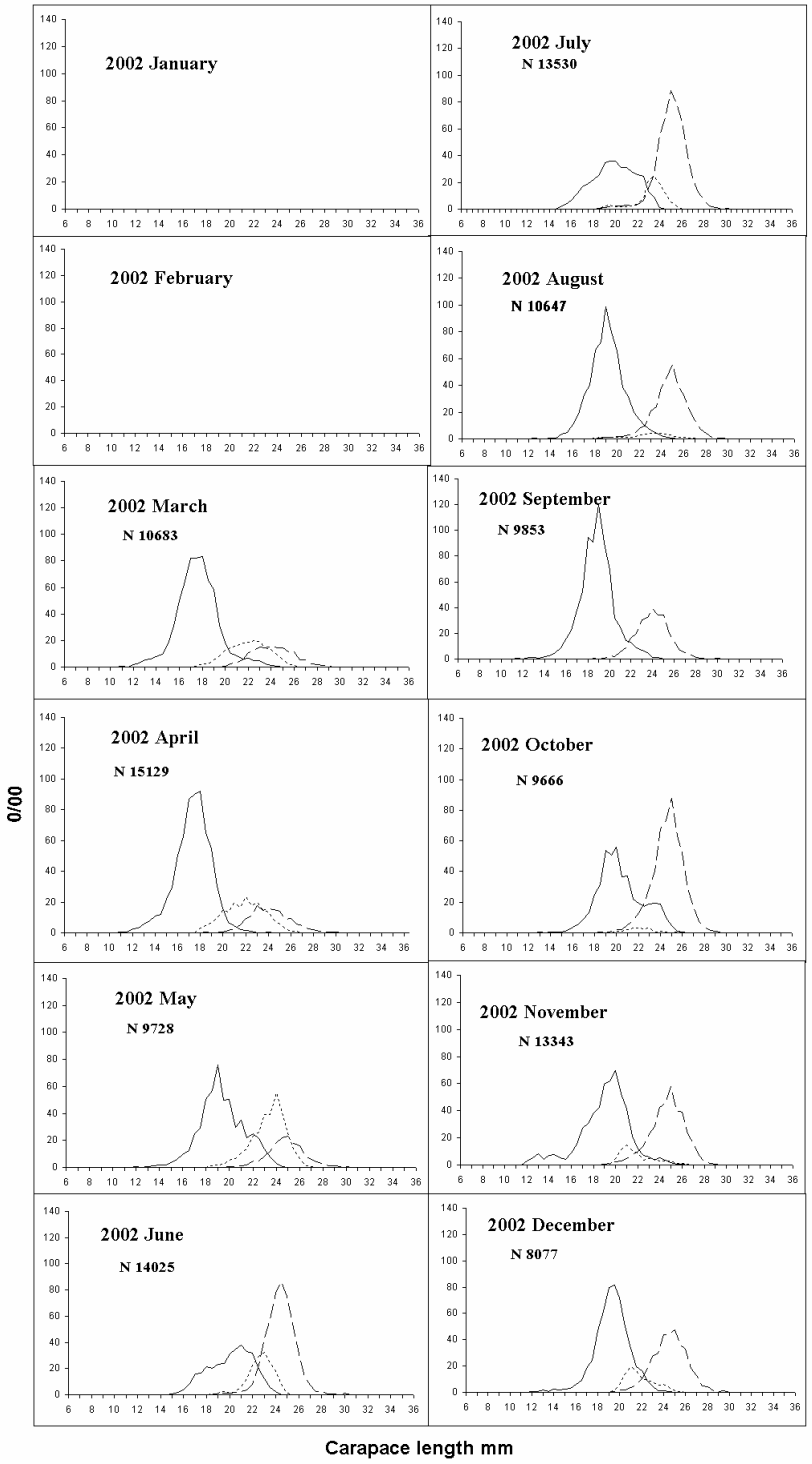

Fig.2. Shrimp in Div. 3M: The length frequency distribution of northern shrimp at Flemish Cap by months in 2002.

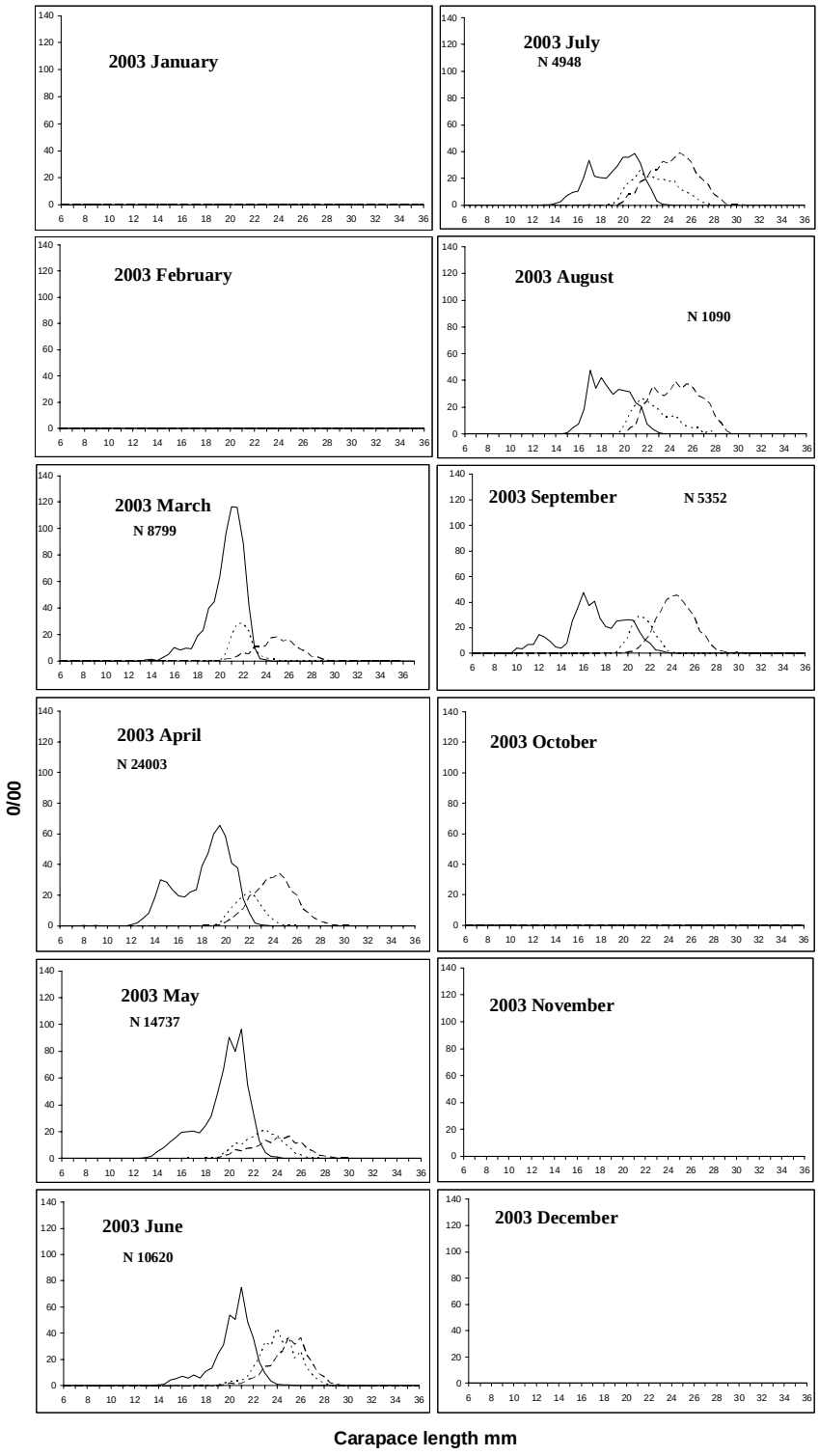

Fig. 3. Shrimp in Div. 3M: The length frequency distribution of northern shrimp at Flemish Cap by months in 2003.

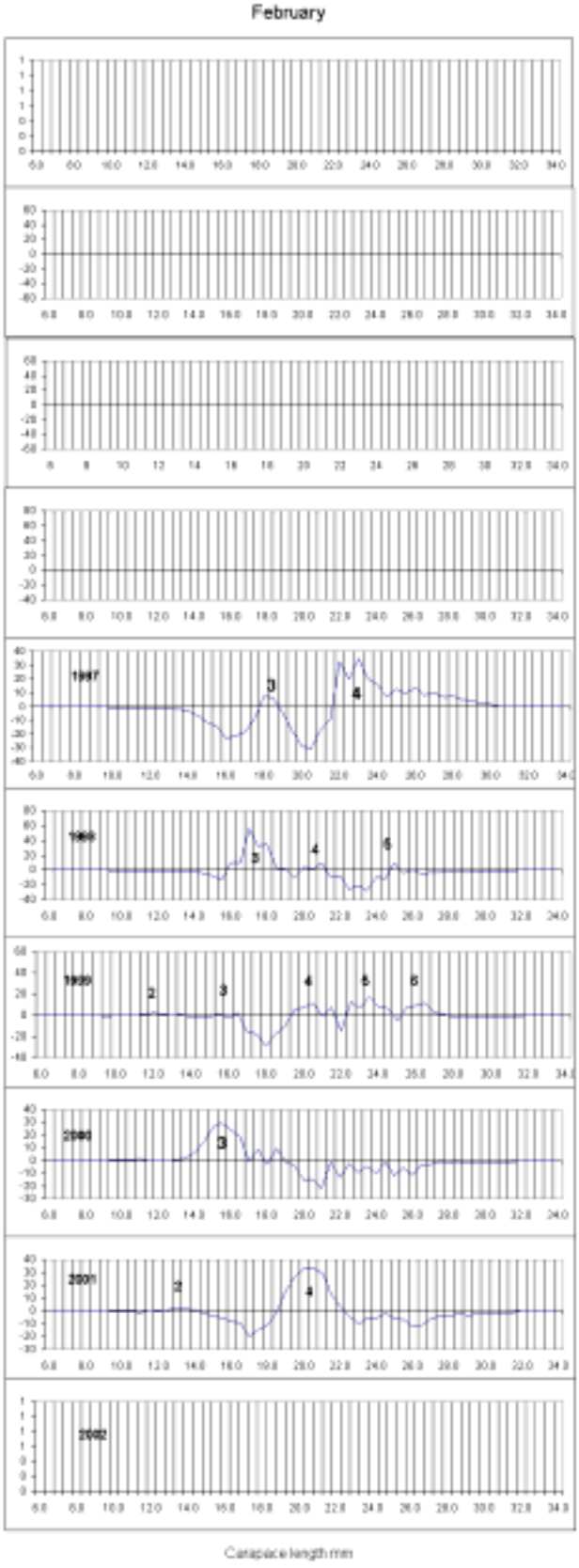

Fig. 4. Shrimp in Div. 3 M: The deviations of length frequencies of northern shrimp by years in February from the mean lfd. of the years 1997-2003 in the same month.

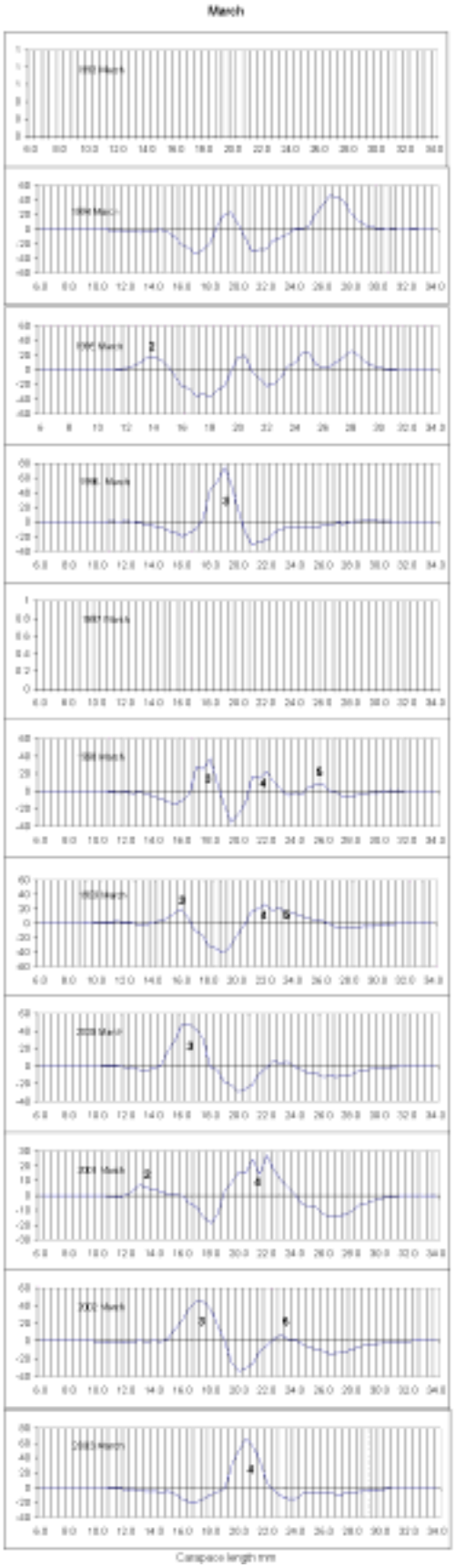

Fig. 5. Shrimp in Div. 3 M: The deviations of length frequencies of northern shrimp by years in March from the mean lfd. of the years 1994-2003 in the same month.

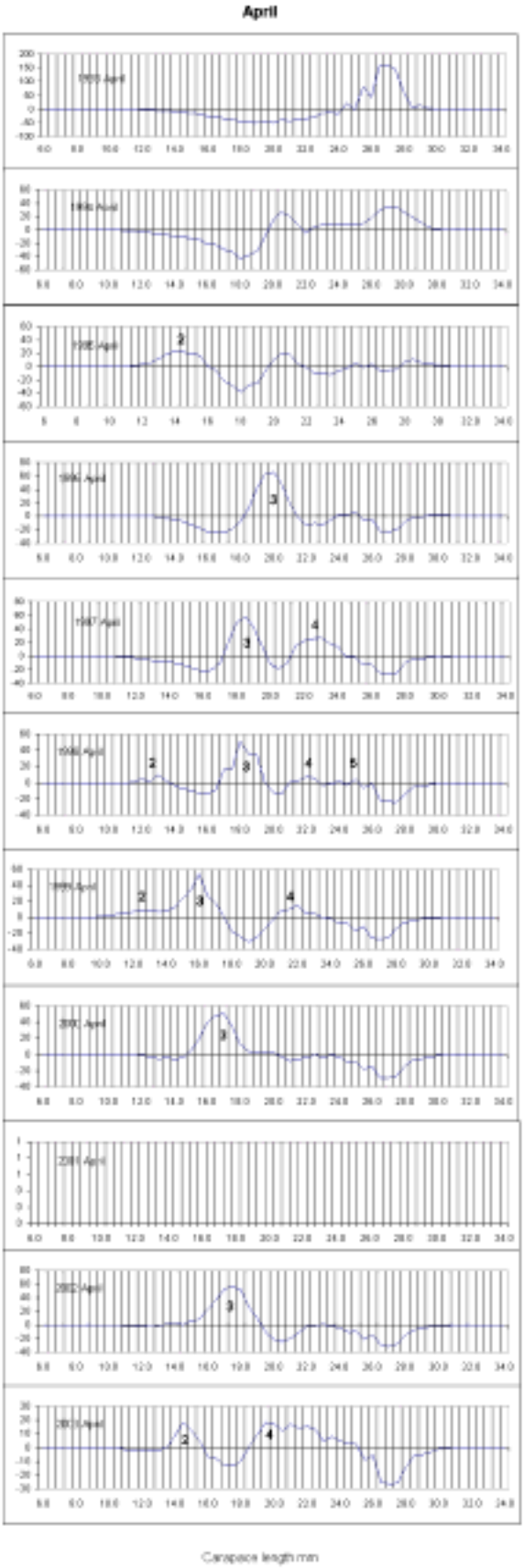

Fig. 6. Shrimp in Div. 3 M: The deviations of length frequencies of northern shrimp by years in April from the mean lfd. of the years 1994-2003 in the same month.

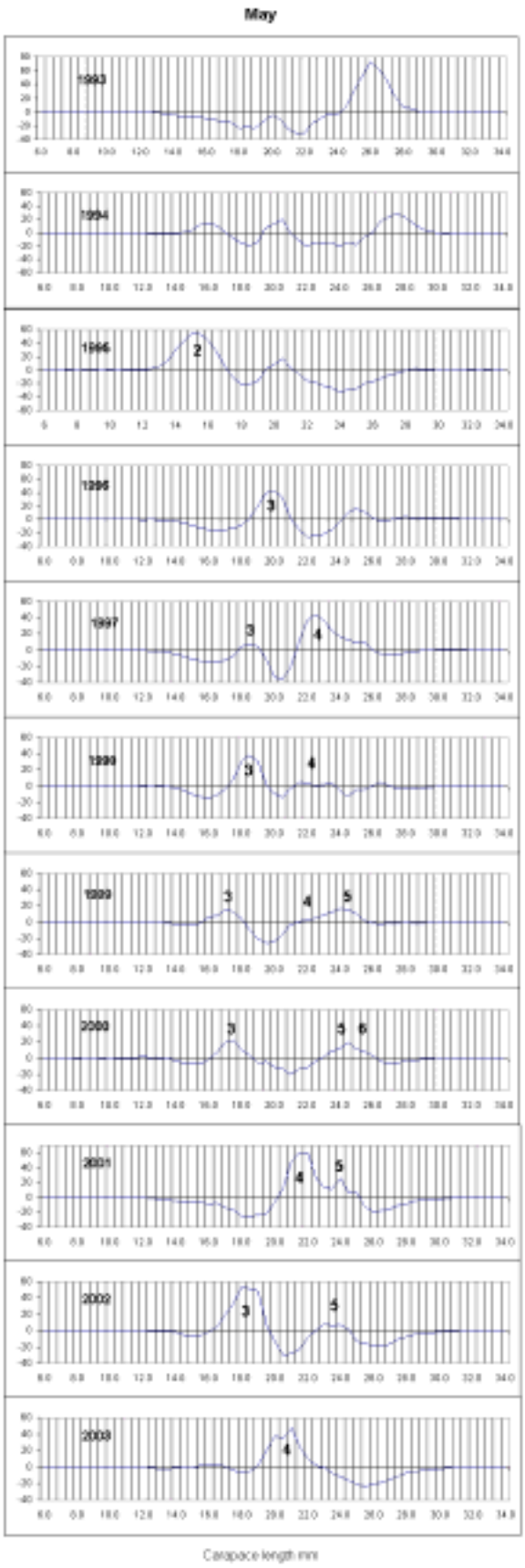

Fig. 7. Shrimp in Div. 3 M: The deviations of length frequencies of northern shrimp by years in May from the mean lfd. of the years 1993-2003 in the same month.

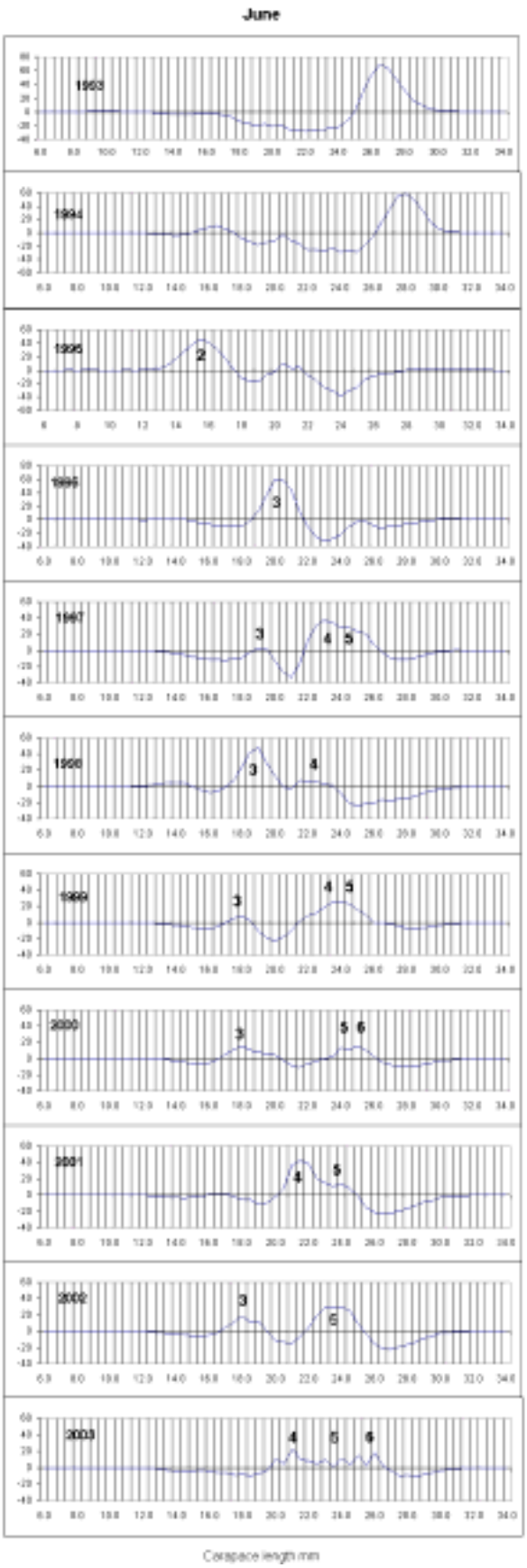

Fig. 8. Shrimp in Div. 3 M: The deviations of length frequencies of northern shrimp by years in June from the mean lfd. of the years 1993-2003 in the same month.

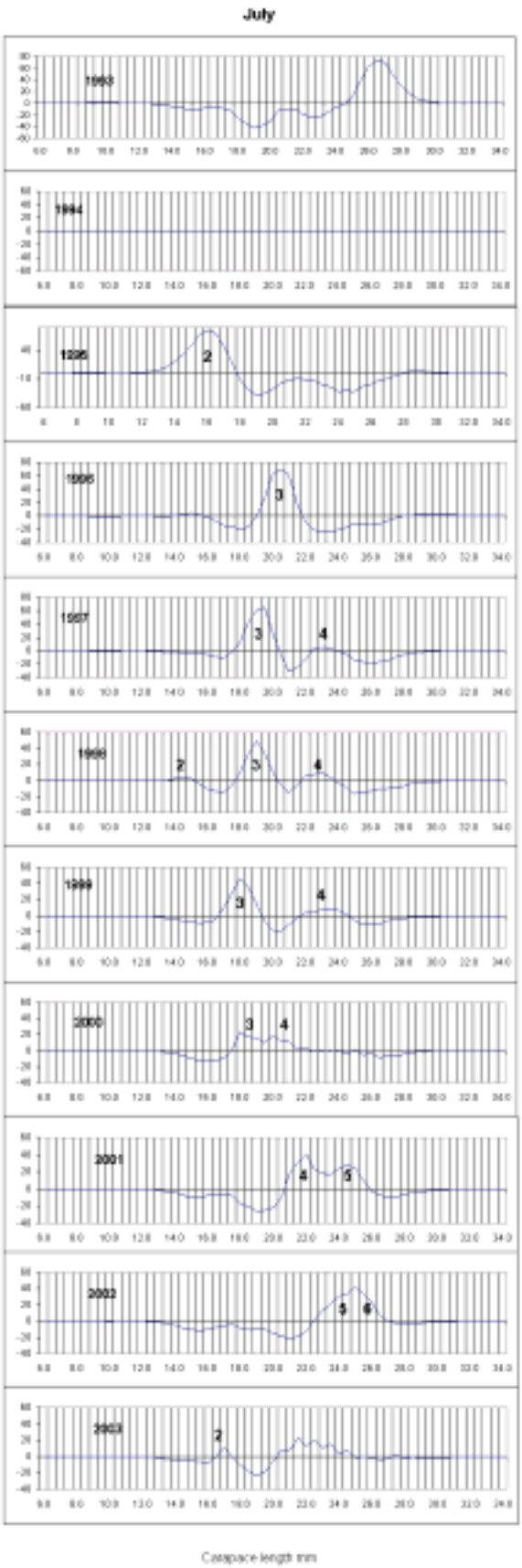

Fig. 9. Shrimp in Div. 3 M: The deviations of length frequencies of northern shrimp by years in July from the mean lfd. of the years 1993-2003 in the same month.

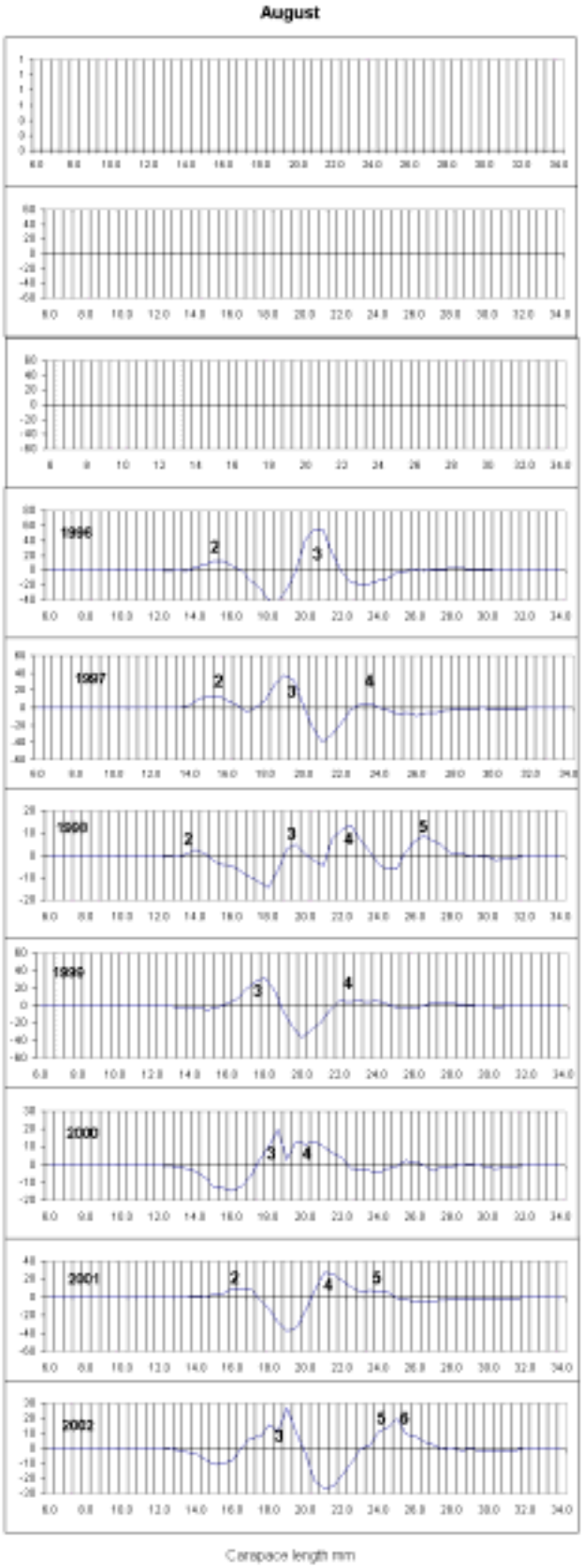

Fig. 10. Shrimp in Div. 3 M: The deviations of length frequencies of northern shrimp by years in August from the mean lfd. of the years 1996-2003 in the same month.

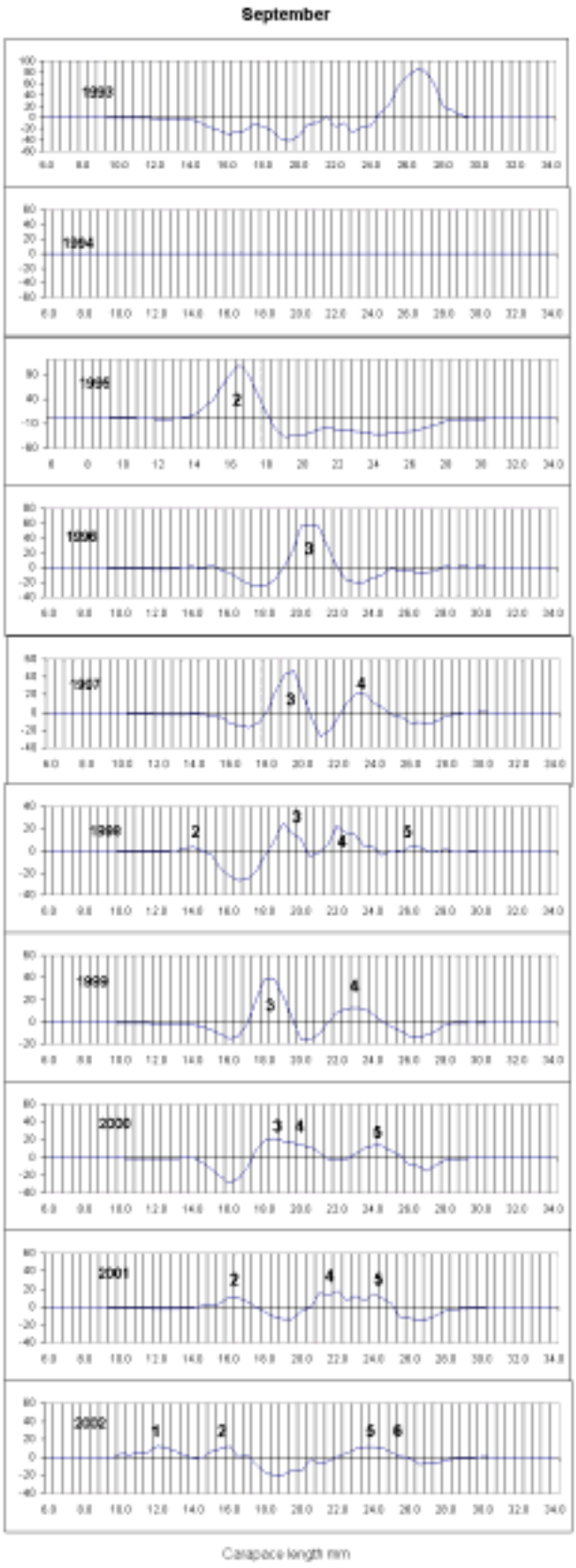

Fig. 11. Shrimp in Div. 3 M: The deviations of length frequencies of northern shrimp by years in September from the mean lfd. of the years 1996-2002 in the same month.

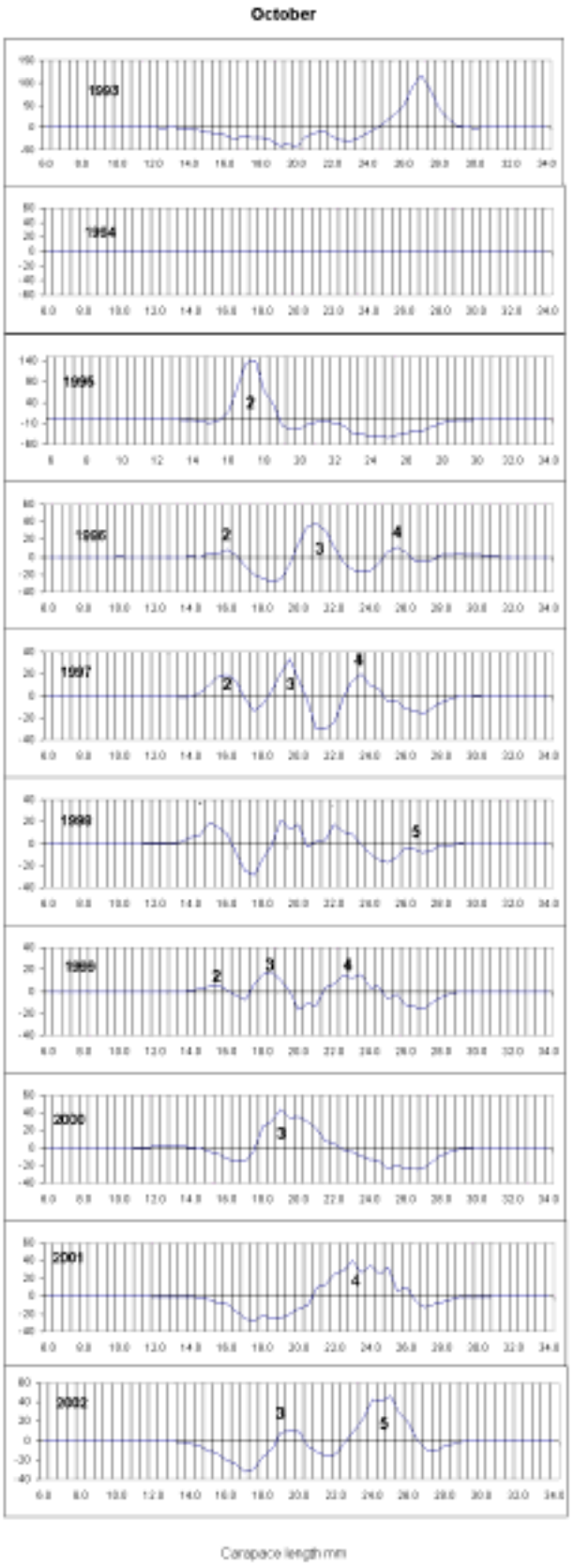

Fig. 12. Shrimp in Div. 3 M: The deviations of length frequencies of northern shrimp by years in October from the mean lfd. of the years 1995-2002 in the same month.

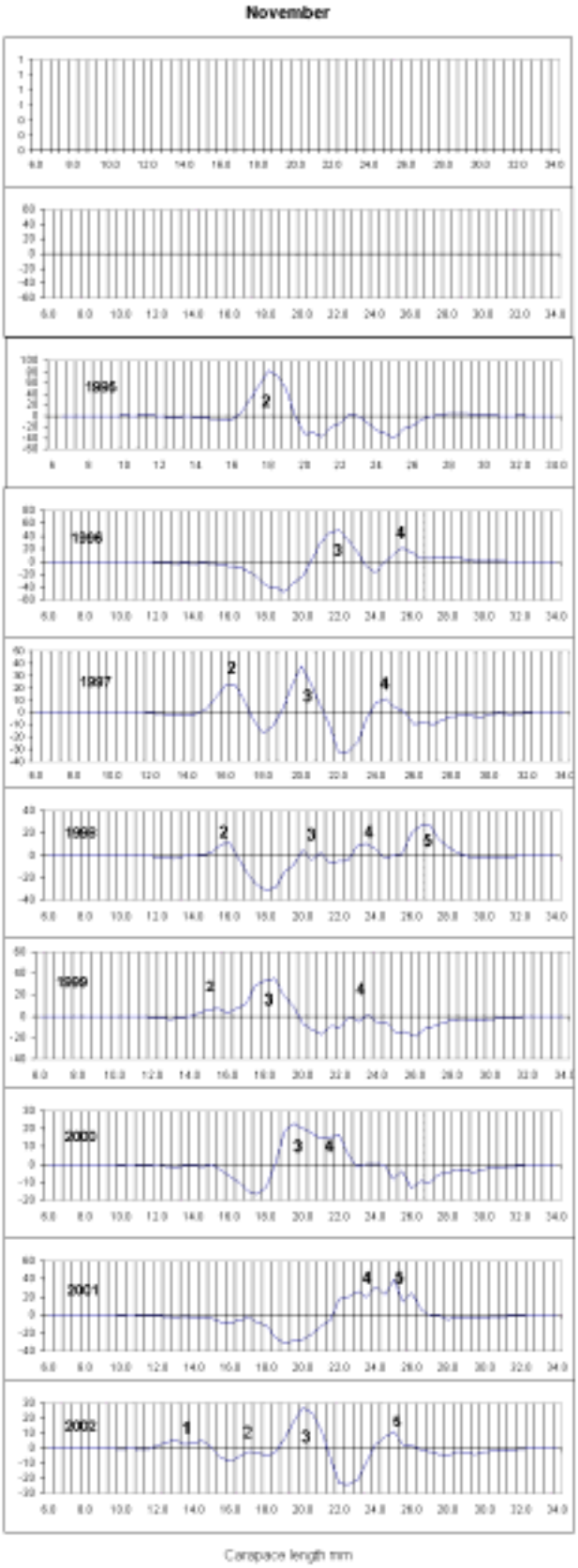

Fig. 13. Shrimp in Div. 3 M: The deviations of length frequencies of northern shrimp by years in November from the mean lfd. of the years 1995-2002 in the same month.

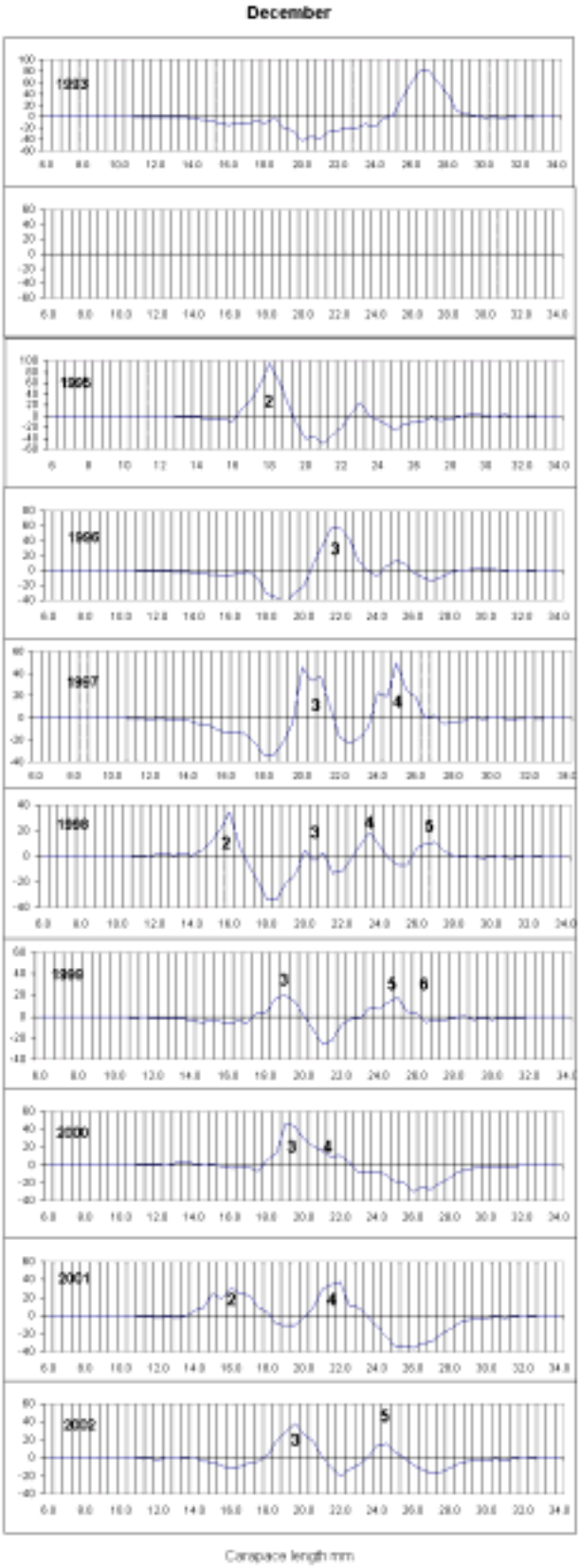

Fig. 14. Shrimp in Div. 3 M: The deviations of length frequencies of northern shrimp by years in December from the mean lfd. of the years 1995-2002 in the same month.