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Revision of the Northern Shrimp (*Pandalus borealis*) on Flemish Cap in June 2003

by

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Abstract

Since 1988, a stratified random summer bottom trawl survey in Flemish Cap (NAFO Regulatory Area of Division 3M) was conducted by UE. In June 2003, the survey was carried out by the new research vessel R/V *Vizconde de Eza*, which will continue for this survey in the future. In order to calibrate the new ship, the comparative fishing trial (calibration) initiated in 2003 between the old research vessel R/V *Cornide de Saavedra* and the new R/V *Vizconde de Eza*, will continue during the survey in 2004. Because of this, the indexes in the series from 1988 to 2002 were not changed to the new scale by now. Still, the 2003 current indices from R/V *Vizconde de Eza* were transformed to the R/V *Cornide de Saavedra* scale, to make them comparable to the results obtained in previous years. The 2003 indexes were transformed by a length conversion method. The entire series of abundance, biomass, mean catch per tow and length distribution for northern shrimp (*Pandalus borealis*) are presented for the period 1988-2002, and the transformed data for the year 2003. In this year, a decreasing of shrimp biomass was observed. It was mainly due to declining of 3 and 5 age-classes. Also the youngest model groups (age 1 and 2) appeared well represented, predicting a good recruitment in next years.

However, all these results must be taken carefully because the scarce number of hauls carried out during the calibration in 2003.

Keywords: Survey, Flemish Cap, calibration, shrimp.

Introduction

The aim of this paper is to reply the research recommendations endorsed by the scientific council meeting carried out from 5 to 11 of November 2003 and to correct the preliminary results about the biomass and abundance of Northern shrimp presented here the last year (del Río *et al*., 2003). The correction of some errors in the data base caused important changes in the posterior analysis. Also, due to the continuation of the calibration during the survey in 2004, we considerer in this year to maintain the historic indexes prior to 2003 and transform the biomass and abundance indexes corresponding to the lat year 2003. Also, due to the importance of the length distribution of the catches, in the present paper the Warren transformation method has been used. More details about conversion method, geometry and behaviour of the trawls and transformation of the whole historical series will be presented when the calibration exercise has finished and the whole information analysed.

Material and Methods

Change of vessel and calibration

The survey was carried out from May 31st to July 27th. Even the survey was carried out following the same procedures as in previous years, the same bottom trawl net Lofoten, with a cod-end mesh size of 35 mm, as well as all other details of its use (Saborido-Rey and Vázquez, 2003), the R/V *Vizconde de Eza* replaced the traditional research vessel used up to now.

In order to establish a link between the two sets of survey data, during the present survey comparative fishing trials were conducted to develop factors between the two vessels.

Direct comparison of catches from vessel fishing side by side is based on the assumption that the number of fish in the trawl paths is more or less the same. The vessels conducted fishing operations at the same time, along parallel courses at a speed of 3.0 knots and a tow length of 30 minutes.

A series of 59 valid paired hauls were carried out. For shrimp, for the 46 trawl pairs in which the species was present in both vessels, only 36 hauls could be used for the calibration due to the great differences in the catches in ten hauls, that made to think in aggregations missed at one of the two vessels.

To convert the length distribution and abundance, a multiplicative model, proposed by Warren (1997)

$$y = ax^b e^{cx}$$

was adjusted as: log (y)= log (a)+ b log (b) +cx

Where y is the ratio:

$$Ratio = \frac{R/V\ Cornide\ de\ Saavedra\ (catch\ number)}{R/V\ Vizconde\ de\ Eza\ (catch\ number)}\ by\ length$$

x is the length and a, b y c are the estimated parameters.

The estimate of the parameters was carried out fitting the observed ratio by weighted least squares.

Sampling

Samples of approximately 1.5 kilogram shrimp were taken in each tow where this species was present for length frequency determination. Some samples were frozen for length-weight analysis at the laboratory.

Shrimps were separated into males and females according to the endopod of the first pleopod (Rasmussen, 1953). Individuals changing sex phase, according to this criterion, were included with males. Females were further separated as primiparous (first time spawners) and multiparous (spawned previously) based on the condition of the external spines (McCrary, 1971). Ovigerous females were considered as a group and were not included with multiparous females.

Oblique carapace length (CL), the distance from the base of the eye to the posterior dorsal edge of the carapace (Shumway *et al.*, 1985), was measured to the lower 0.5 mm length-classes. Sampling length data were used to obtain an estimate of population length distributions in the whole area and to compare it with the estimates of the other years.

The length-weight relationship was calculated from 2 192 individuals, which were weighed to the nearest 0.1 g after a little draining time.

Skúladóttir and Diaz (2001) present the first age assessment by Modal analysis using the Mix software (MacDonald and Pitcher, 1979) of the shrimp caught in the EU survey in the years 1988-2001. In 2003 a modal analysis of the length distribution to estimate age structure was carried out using the same method and compared with previous results in 2002 (del Río *et al.*, 2002).

Results

From the 36 paired hauls used to calibrate the shrimp catches and lengths, the parameters calculated by Warren method were:

	A	b	c	Hauls number
Pandalus borealis	1.41E+06	-7.8528	0.4348	36

A total of 114 valid bottom trawls were completed with Lofoten trawl gear in Flemish Cap. Shrimp appeared in 109 sets and all indexes of 2003 year are transformed by means of multiplicative model proposed by Warren.

Biomass

Shrimp biomass indexes estimated by swept area method (mean catch per tow, total, CL>20 mm, female) from 1988 to 2003 are presented in Table 1. The biomass index obtained this year decreased from 18 109 tons in 2002 to 13 847 tons in this survey.

Biomass distributions estimated by strata from 1988 to 2003 are shown in Table 2. The presence of shrimp in shallowest strata, with depths less than 140 fathoms (257 m), was scarce in the first years (1988-1994). However, since 1995, a noticeable amount of shrimp occurred in these strata and the estimated biomass increased from 1995 to 2003 according the following table:

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003
Estimated biomass (tons) **(< 140 fathoms)**	181	192	189	1333	1709	1875	3458	5332	5089
% Total biomass **(< 140 fathoms)**	3.3	3.0	3.7	7.9	13.7	19.3	24.5	29.4	36.7

This increase in shallowest strata is a consequence of the greater abundance of the youngest age classes. In this survey the 36.7% of total estimated biomass was obtained in depths less than 140 fathoms (257 m).

Biomass distribution observed during the survey is presented in Fig. 1. As previous years shrimp population have a distribution around the central area of the bank. In depths less than 80 fathoms (strata 1 and 2) and bigger than 300 fathoms (strata 16 and 19), the catches never exceeded 10 kg/tow. The three highest catch (175, 102 and 95 kg) occurred in the West of the Flemish Cap at intermediate depth strata.

Adult stock, female biomass

Total biomass estimates by the series of bottom trawl surveys on Flemish Cap from 1988 to 2003 are shown in Table 1. These estimations are quite variable due to predominant sizes of the shrimp are in the selection range of the cod-end mesh size used, so the biomass estimations are clearly affected by small changes in cod-end mesh size. To solve this problem it was proposed to use only the shrimp bigger than 20 mm CL (Table 1). The biomass for shrimp bigger than 20 mm CL tried to be an index of the adult biomass not affected by differences in the cod-end mesh size used. The 20 mm CL was chosen because it is approximately the limit between 3 and 4 years old shrimp in this season (Garabana, 1999).

The use of female biomass estimate is also an index not affected by small changes in mesh size, and it is the one used by the NAFO Scientific Council, so it was also included in Table 1.

The standard gear used in the surveys was a Lofoten with a cod-end mesh size of 35 mm with the exception of the 1994 and 1998 surveys when a 40 mm and 25 mm cod-end mesh size were used respectively. Consequently, the biomass index in 1994 is supposed to be underestimated and that of 1998 could have been overestimated by a factor of two (del Río, 1998).

In Fig. 2 the adult biomass estimates are compared with the total biomass and female biomass along the series. Differences between these quantities in each year correspond to the different catches of small shrimp, those size classes that are more directly affected by small changes in the cod-end mesh size. The differences between the total biomass and the adult biomass were small in the 1988-1997 period, ranged between 1.6 % and 12.1 % of the total. That is, the greater portion of shrimp catch was bigger than 20 mm CL. The small variations in these percentages over the period could be mainly due to the intrinsic variability of trawl catches and not to differences in small shrimp abundance. The difference between both biomass estimates was 37.8 % in 1998 when a 25 mm liner was used, and not comparable conclusions can be thrown. From 1999 to 2003 the differences increased and always were greater than 22 % and the highest observed rates were 29.0 % in 2000, 33.7 % in 2002 and 24.8 % in this year. It was attributed to increase in small shrimp abundance.

Length frequencies

Length frequencies and percentages by sex from the 2003 survey are shown in Table 3. These length frequencies are split into males, primiparous females and multiparous females. The percentage of males increased from 53.33% in 2002 to 56.18% in 2003 (del Río *et al*., 2002). The percentage of females decreased from 46.66% in 2002 to 43.82% in 2003 (17.53 % primiparous and 26.29 % multiparous). The ovigerous females are not present in the catches because the spawning period in Flemish Cap begins between the end of July and the beginning of August (Mena, 1991) and this year the survey finished on June 27th. Males presented a CL between 7.5 and 26.5 mm. Females presented a CL between 15.0 and 31.0 mm comprising the groups: 15.0-28.5 mm primiparous and 16.5-31.0 mm multiparous.

Length frequencies by strata in 2003 are shown in Table 4. In this survey as in previous years, the results indicate that the minimum shrimp size increases with depth. The small size individuals (males shrimp) dominated shallowest strata and the large size individuals (females shrimp) are present in deepest strata:

Strata	Depth range		Minimum observed size (mm CL)
	Meters	Fathoms	
2 to 6	147-256	81-140	7.5
7 to 11	257-360	141-200	8.5
12 to 15	361-547	201-300	19
16 to 19	548-725	301-400	21.5

The shrimp length distributions are illustrated from 1995 to 2003 in Fig. 3. Modal groups named with the same letter belong to the same year-class (Table 5) according to the previous results of age analysis (del Río *et al.*, 2002) and the modal analysis of this year. In the 2003 the youngest modal group (age 2) appears well represented with a modal length of 14.8 mm CL. However, the prominent peak of about 18 mm CL (age 3) in 2002 survey doesn't appear as it was expected in the length distribution obtained this year.

Length-weight relationship

Length-weight relationship for males and females in year 2003 are illustrated in Fig. 4. Length-weight equations by sex were for this period:

For males: $W = 0.0006*CL^{2.9899}$ (N= 1214, r^2=0.98)
For primiparous females: $W = 0.0005*CL^{3.0245}$ (N= 365, r^2=0.95)
For multiparous females: $W = 0.0006*CL^{2.9810}$ (N= 613, r^2=0.92)
For sexes combined: $W = 0.0006*CL^{2.9653}$ (N= 2192, r^2=0.98)

where W is weight in g and CL is the oblique carapace length in mm.

Weight by length-class of shrimp for years 1989-2003 is shown in Fig. 5. The decrease tendencies observed in the 2002 is continued in this year, mainly at length bigger than 20 mm CL.

Age structure

Table 5 shows the preliminary and visual interpretation of shrimp modal groups and ages from length distribution.

The age assessment of the shrimp caught from 1988 to 2002 in the surveys presented by Skúladóttir and Diaz (2001) and del Río, *et al.*, 2002, always indicated the presence of four age groups, (from 3 to 6 year olds). Since 1995 the youngest age groups were present: the age group two since 1995 and age group one since 2002.

In 2003 a similar modal analysis of the length distribution to estimate age structure was realized and the proportion, average size and standard deviation of age/maturity groups are shown in Table 6. The results of the modal analysis indicated the presence of seven age groups shrimp in this year and age at sex change is at age 4. Contrary to the last year, in 2003 didn't appear any age groups dominant. Females were split into primiparous (age 3 and 6) and multiparous (age from 3 to 7). Figure 6 shows modal groups and age distribution of shrimp from modal analysis of length distribution obtained in the 2003 survey on Flemish Cap. Mean carapace length at age from 1988 to 2003 surveys are presented in Table 7.

After getting the proportions and mean lengths for every age/sex in this survey, the results were used to calculate the total number of individuals in every age/sex according the biomass estimated for males, primiparous females and multiparous females. This was done by transforming the CL to weight applying length weight relationship obtained in this year. Abundance and biomass estimated index by age groups in all surveys are shown in Tables 8 and 9, respectively. The total biomass estimated decreased the 23.4% with regard to the year 2002, this declined was mainly due to reduction of 85.5% in the biomass of age 3. In this survey the highest biomass estimated was obtained for age 5 annual class (4 751 t), but the total catch in numbers is dominated by age 4 shrimp. The biomass estimated for age groups 1 and 2 was the biggest in the all series predicting a good recruitment in next years.

The strong year-classes may be followed according the abundance by age groups from 1988 to 2003 (Table 8). The 1987 year-class stand out in the beginning of historical series with 3, 4 and 5 years olds in the years 1990, 1991 and 1992. These age were also specially abundant in the years 1998-2003 indicated three strong year-classes: 1995, 1997 and 1999. In 1998 the number of three year olds (1995 year-class) could have been overestimated because the mesh size used that year was smaller (25 mm) than the one normally used. The 1997 year-class was quite numerous as 4 years olds in 2001 and 5 years olds in 2002. The 1999 year-class stand out especially judging by the high number of 3 and year olds in 2002 and 2003 respectively. Finally, in 2003 the number of 1 and 2 years olds (2001 and 2002 year-class) were the biggest in the series and possibly indicate a good recruitment in next surveys.

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Table 1 – Different biomass indexes of shrimp estimated by swept area method in the years 1988-2003 on Flemish Cap surveys.

Year	Mean catch per tow (kg)	Standard error	Total Biomass (tons)	Biomass CL>20mm (tons)	Female Biomass (tons)
1988	4.70	0.73	2,164	2,104	1,874
1989	2.39	0.42	1,923	1,856	1,340
1990	2.66	0.36	2,139	1,886	1,132
1991	10.21	1.25	8,211	7,856	5,362
1992	20.56	3.25	16,531	16,208	11,509
1993	11.51	1.58	9,256	8,292	6,839
1994[1]	4.15	0.62	3,337	3,282	2,823
1995	6.73	0.77	5,413	5,153	4,286
1996	8.09	0.59	6,502	5,716	4,149
1997	6.34	0.43	5,096	4,699	3,807
1998[2]	20.95	1.39	16,620	10,337	8,091
1999	15.46	1.17	12,430	9,626	9,051
2000	12.09	0.92	9,720	6,899	6,553
2001	17.54	1.15	14,106	11,225	8,977
2002	22.52	1.96	18,109	12,009	11,664
2003[3]	17.22	1.25	13,847	10,416	8,958

[1] codend mesh-size 40 mm
[2] codend mesh 40 mm and 25 mm liner
[3] indexes transformed by Warren method.

Table 2.- Total shrimp biomass estimated by strata (tons) in the years 1988-2003 on Flemish Cap surveys.

Stratum	Depth (Fathoms)	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003[1]
1	70-80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
2	81-100	0	0	0	0	0	0	0	162	0	0	16	0	0	10	8	393
3	101-140	0	0	0	5	0	1	0	2	86	21	184	161	582	969	2344	1044
4	101-140	0	0	0	0	0	0	0	0	0	0	29	155	96	472	646	360
5	101-140	0	0	0	4	8	0	0	6	12	57	299	851	878	1081	961	2294
6	101-140	0	0	2	19	3	3	0	11	94	111	805	542	319	926	1373	997
7	141-200	18	20	212	713	2134	1404	93	299	684	637	1304	1438	1038	1528	2007	973
8	141-200	9	51	46	158	1130	545	3	183	412	269	827	1158	559	1458	1925	632
9	141-200	57	47	24	150	88	109	0	506	324	287	1898	653	570	828	967	566
10	141-200	115	44	188	1499	2278	972	658	873	707	706	2910	1883	1287	1915	1983	2896
11	141-200	89	0	105	733	2714	794	358	452	699	669	2463	1477	1588	2146	1799	1911
12	201-300	786	582	313	1733	3329	1786	599	778	910	871	1033	1192	730	641	1090	424
13	201-300	64	58	42	63	28	120	0	28	416	394	984	929	38	441	187	35
14	201-300	255	218	407	814	1640	1161	556	632	706	286	1778	995	428	607	1314	416
15	201-300	404	328	558	1485	2522	2029	916	1021	922	332	1320	764	1123	558	788	662
16	301-400	308	234	239	171	303	133	44	47	148	121	340	136	369	333	429	148
17	301-400	2	10	0	0	0	0	0	0	0	1	0	0	0	0	3	0
18	301-400	0	0	0	0	0	0	0	1	30	8	0	2	9	0	27	0
19	301-400	56	331	4	663	354	163	111	412	351	327	656	91	103	193	258	97
Total		2164	1923	2139	8211	16531	9256	3337	5413	6502	5096	16844	12430	9720	14106	18109	13847

[1]transformed by Warren method

Table 3. Shrimp length frequencies and percentages by sex and stage maturation in the 2003 survey on Flemish Cap.

LENGTH (mm CL)	MALES	FEMALES	
		Primiparous	Multiparous
7.5	37		
8	37		
8.5	79		
9	47		
9.5	52		
10	32		
10.5	42		
11	22		
11.5	7		
12	27		
12.5	122		
13	236		
13.5	519		
14	693		
14.5	1027		
15	1185	14	
15.5	1070		
16	937	39	
16.5	717	2	14
17	620	49	
17.5	628	39	2
18	922	74	3
18.5	900	73	44
19	1199	90	14
19.5	1092	161	80
20	1038	269	101
20.5	1003	430	232
21	691	435	315
21.5	366	456	343
22	203	527	358
22.5	68	506	422
23	23	477	605
23.5	9	280	605
24	5	234	594
24.5	4	166	507
25	2	58	491
25.5		93	411
26		148	580
26.5	2	114	404
27		87	641
27.5		42	210
28		16	182
28.5		7	63
29			56
29.5			26
30			19
30.5			3
31			5
Total	15663	4886	7330
Percentage	56.18 %	17.53 %	26.29 %

Frequence x 10^5

Table 4. Shrimp length frequencies by strata in 2003 on Flemish Cap survey.

LENGTH	STRATA																	
mm (CL)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	19	TOTAL
7.5		37																37
8		37																37
8.5		49									30							79
9		42		5														47
9.5		27		5		17												49
10		15	17															32
10.5		12									30							42
11		17		5														22
11.5		2		5														7
12		27																27
12.5		50	3		70													123
13		71	15	5	102	15				21	9							238
13.5		161	54	15	221	21				29	19							520
14		231	115	18	195	61		3		46	25							694
14.5		180	193	31	246	91	38	4	8	148	86							1025
15		198	240	26	171	120	40	9	2	222	172							1200
15.5		113	241	23	132	112	39	6	4	226	174							1070
16		53	169	23	117	105	45	21	6	141	296							976
16.5	5	12	104	17	125	99	51	11	4	69	236							733
17		10	62	19	172	61	65	15	1	143	120							668
17.5		31	55	16	276	43	10	17	4	136	81							669
18		21	93	38	311	72	56	41	18	227	123							1000
18.5		30	96	62	203	83	61	67	19	276	121							1018
19		21	68	43	301	107	101	89	32	356	181	1			1			1301
19.5		33	122	58	206	97	69	104	46	347	245	2		2	2			1333
20		41	97	28	286	114	125	146	45	381	140	2			2			1407
20.5		75	130	51	292	103	125	107	57	410	308	2		1	3			1664
21		42	94	57	334	92	172	129	49	340	118	8		3	3			1441
21.5		31	113	49	301	63	97	77	46	219	156	6		2	5		1	1166
22		32	128	47	262	65	100	59	70	160	150	6		2	7			1088
22.5		20	126	42	173	107	52	83	68	169	140	7		2	6			995
23		9	109	41	123	123	53	85	68	280	182	18		9	6	1		1107
23.5		9	41	32	108	124	97	40	43	234	120	24		11	9	1	1	894
24			54	22	60	72	103	39	51	275	106	27		7	14	1		831
24.5			35	7	59	81	52	25	51	200	100	30		10	19	2	1	672
25		8	40	12	39	36	32	9	29	157	102	26	2	28	26	2	2	550
25.5			12		44	27	36	12	38	141	69	41	2	22	53	3	3	503
26			23	5		30	65	5	65	140	136	61	5	51	112	21	9	728
26.5			26	5		19	33	5	26	96	77	56	7	45	96	14	12	517
27					309	7	38	7	5	56	16	52	9	68	117	24	21	729
27.5						7	9		17	16	9	35	5	37	75	26	14	250
28							5	5			52	26	3	35	47	14	12	199
28.5											2	10		19	21	10	7	69
29							3	2				5		23	14	5	3	55
29.5												2		7	12	5		26
30											5	3		7		2	2	19
30.5														3				3
31														3		2		5
TOTAL	5	1747	2675	812	5238	2174	1772	1222	872	5661	3936	450	33	397	650	133	88	27865

Frequencies x 10^5

Table 5. Shrimp modal groups and ages in the 2003 on Flemish Cap survey interpreted from size distributions.

Age	Modal groups		Cohort
	Males	Females	
1	9	-	R
2	15	-	P
3	18	-	O
4	19	20.5	N
5	-	23	M
6	-	26	L
7	-	28	K

Table 6. Results from the modal analysis (Mix) for each sex/maturity group.

Sex and maturity group	Male		Primiparous Female		Multiparous Female	
Age	Prop.	St.Dev.	Prop.	St.Dev.	Prop.	St.Dev.
1	0.022					
2	0.445	0.009				
3	0.113	0.052	0.055	0.005	0.014	0.005
4	0.421	0.047	0.363	0.017	0.100	0.030
5			0.470	0.018	0.598	0.057
6			0.112	0.006	0.255	0.046
7					0.032	0.021
	Mean CL	St.Dev.	Mean CL	St.Dev.	Mean CL	St.Dev.
1	9.09					
2	14.87	0.037				
3	17.77	0.169	17.82	0.081	18.78	0.284
4	19.54	0.143	20.54	0.059	20.67	0.097
5			22.53	0.052	23.43	0.067
6			26.03	0.059	26.38	0.068
7					28.26	0.726
	Sigma	St.Dev.	Sigma	St.Dev.	Sigma	St.Dev.
1						
2	1.179	0.023				
3	0.824	0.147	0.802	Fixed CV	0.613	0.139
4	1.192	0.053	0.925	Fixed CV	0.667	0.116
5			1.014	Fixed CV	1.405	0.158
6			0.832	Fixed CV	0.777	0.078
7					1.019	0.270

Table 7. Mean carapace length (mm) at age by years on Flemish Cap surveys.

Year Age group	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Mean CL
1															10.4	9.1	9.7
2					16.8	16.0		15.5	14.9	15.9	14.6	15.2	14.8	15.8	15.6	14.9	15.5
3	18.0	18.3	18.4	17.5	21.3	20.4	17.5	17.0	20.9	19.9	18.9	18.0	18.3	18.1	18.5	17.8	18.7
4	23.6	21.6	21.5	21.6	23.4	23.5	21.9	22.0	24.7	23.6	21.8	21.4	21.1	21.6	21.2	19.8	22.1
5	26.6	25.6	23.6	23.5	24.2	26.2	25.9	25.7	25.7	25.8	24.7	23.6	24.4	24.1	23.7	23.1	24.8
6	28.7	28.2	26.8	26.8	27.0	28.7	28.1	26.5	27.2	29.2	26.7	26.1	27.1	26.4	25.7	26.3	27.2
7					29.0			30.0	29.4		29.1	28.4		29.3	28.1	28.3	28.9

Table 8. Abundance (10^5) at age by years on Flemish Cap surveys.

Year Age group	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1															118	370
2					1202	2234		95	420	97	6243	998	174	2598	2344	7657
3	380	579	2289	1576	3178	2008	119	473	4478	1189	12855	5374	4832	3457	13418	2331
4	1234	740	486	3943	4145	1310	547	2179	1456	2369	7348	6194	6681	11081	5337	9911
5	923	1093	961	4529	8662	5799	754	1064	1124	2282	4474	5862	3698	4893	9331	7137
6	18	121	225	1633	2717	269	1625	1282	509	192	1616	1811	798	1149	1738	2583
7					204			823	587		159	120		136	224	251
Total	2555	2533	3960	11682	20107	11620	3044	5917	8575	6129	32694	20359	16182	23313	32510	30240

Table 9. Biomass estimated (tons) at age by years on Flemish Cap surveys.

Year Age group	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1															8	15
2					334	537		21	81	23	1127	205	33	598	516	1376
3	129	207	829	494	1819	998	37	137	2415	552	5088	1837	1745	1210	4976	717
4	966	441	288	2355	3158	1013	337	1381	1313	1866	4483	3596	3733	6665	2996	4181
5	1043	1110	760	3493	7661	6326	779	1076	1167	2366	4037	4672	3245	4133	7514	4751
6	26	165	262	1869	3258	383	2184	1455	624	289	1873	1954	964	1293	1798	2517
7					301			1343	902		236	166		207	303	303
Total	2164	1923	2139	8211	16531	9257	3337	5413	6502	5096	16844	12430	9720	14106	18109	13860

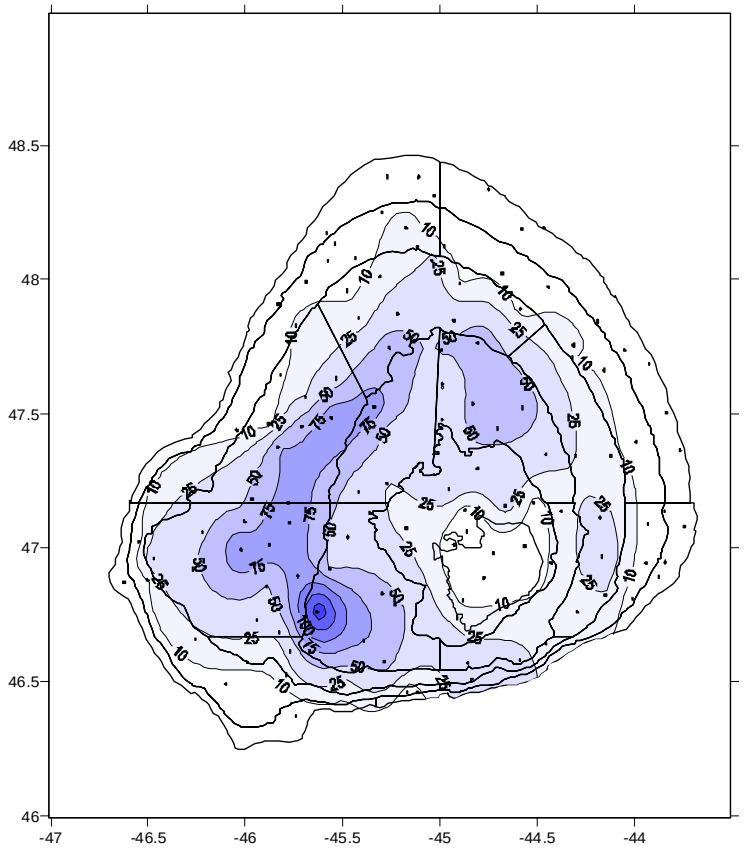

Fig. 1. Shrimp catches distribution (kg/tow) in June 2003 on Flemish Cap survey.

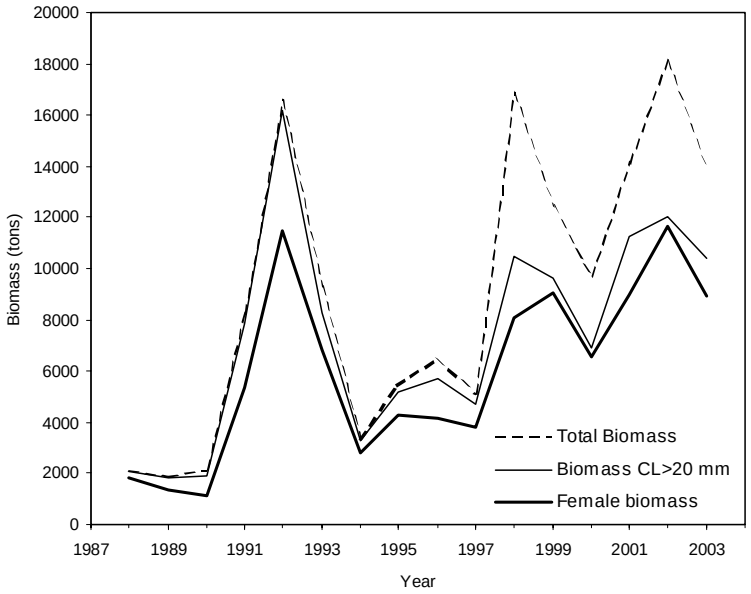

Fig. 2. Total biomass, biomass for shrimp bigger than 20 mm CL and female biomass from Flemish Cap surveys 1988-2003.

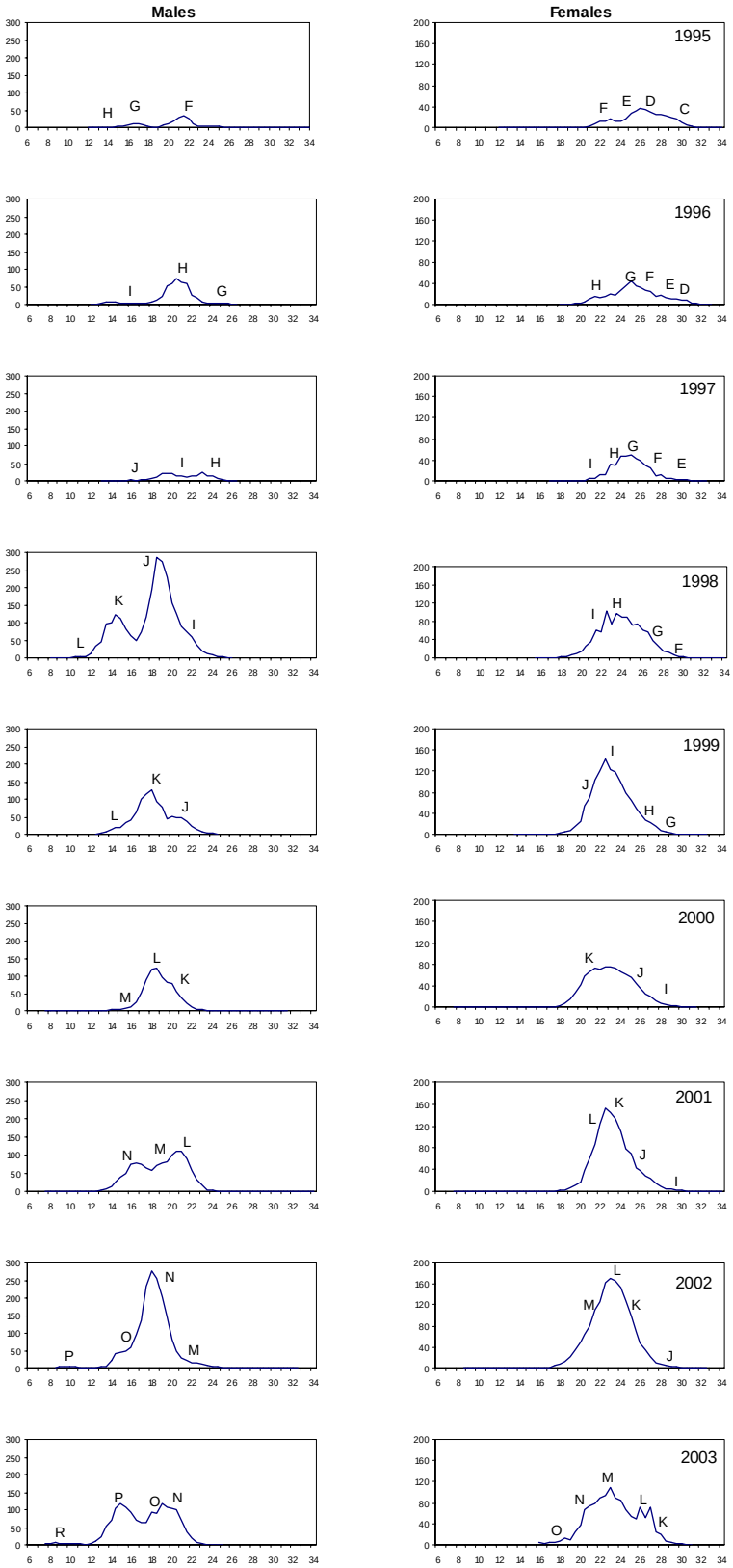

Fig. 3. Shrimp size distribution on Flemish Cap 1995-2003 surveys. Y-Axis=Frequency (10^6), X-Axis=Carapace Length (mm).

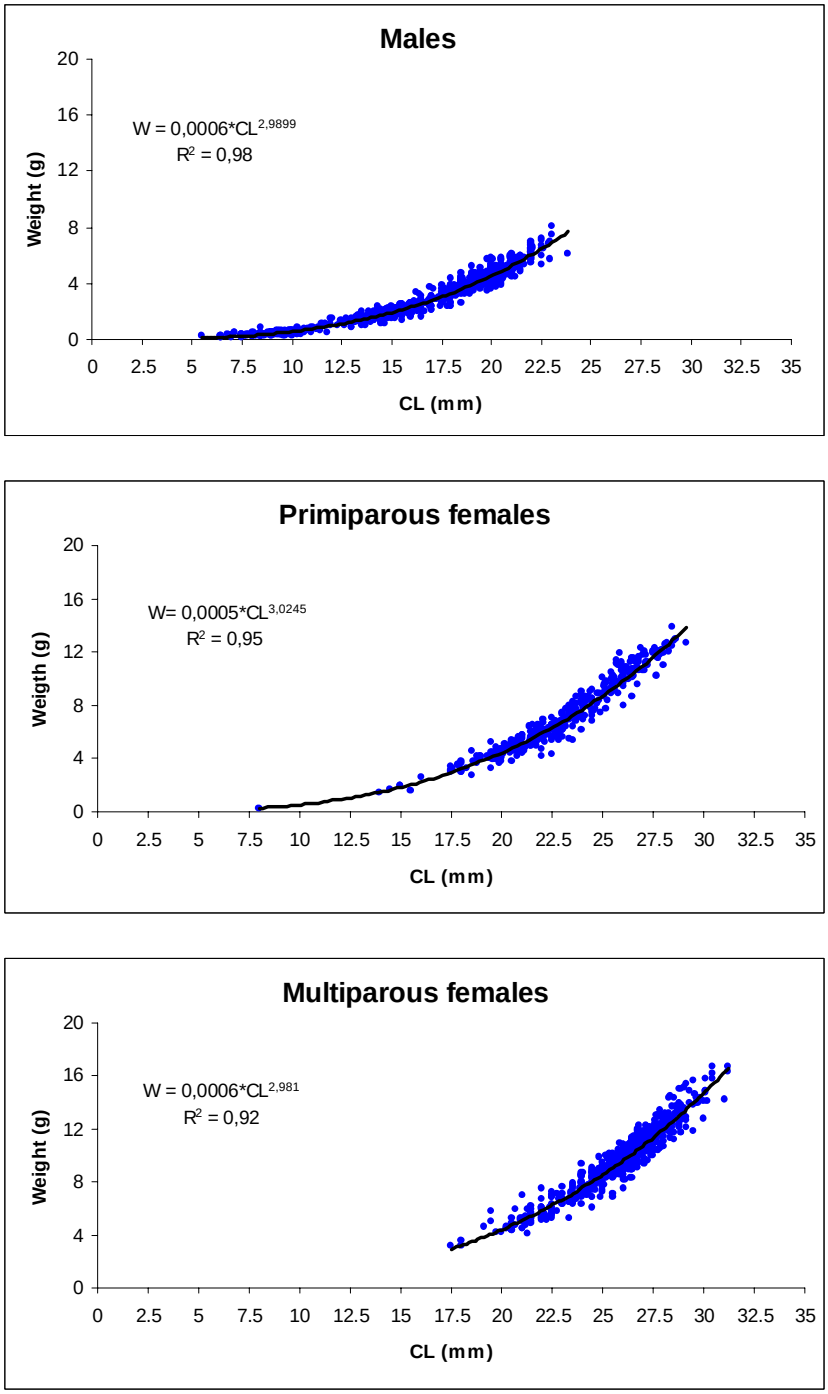

Fig. 4. Shrimp length-weight relationship by sex in 2003 on Flemish Cap survey.

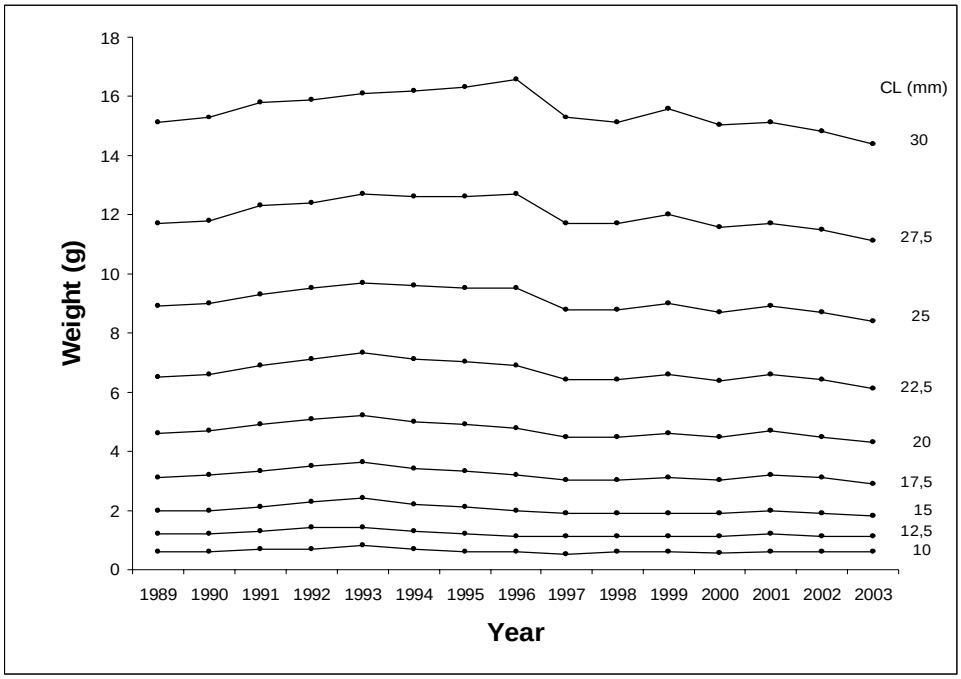

Fig. 5. Shrimp weights at length from Flemish Cap surveys 1989-2003.

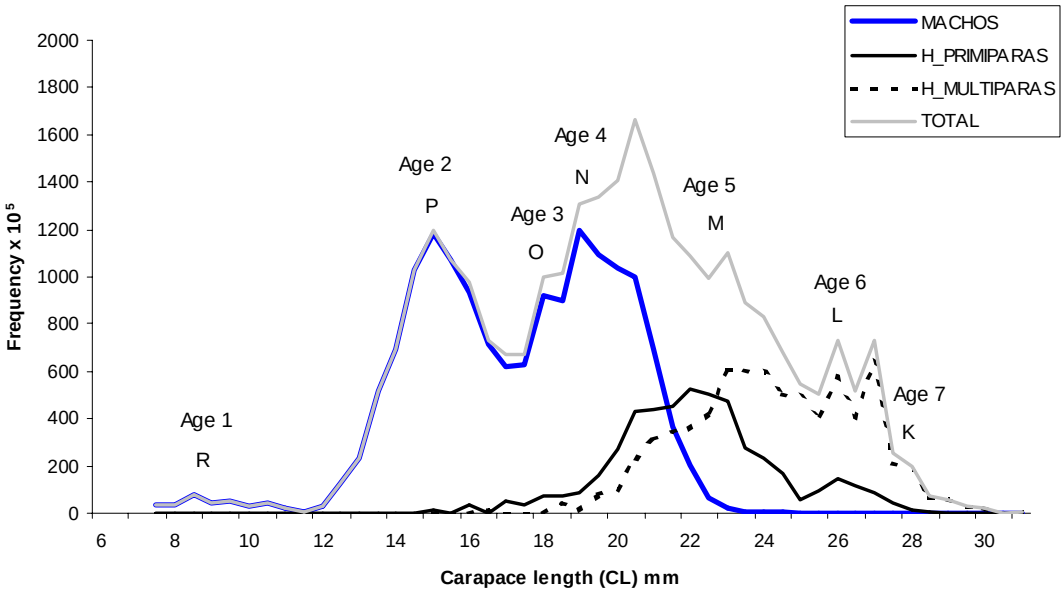

Fig. 6. Shrimp modal and age groups in the 2003 survey on Flemish Cap (letters from table 6 and 7).