

Northwest Atlantic



Fisheries Organization

Serial No. N4779

NAFO SCR Doc. 02/150

SCIENTIFIC COUNCIL MEETING – NOVEMBER 2002

Northern Shrimp (*Pandalus borealis*) on Flemish Cap in July 2002

by

J. L. del Rio, J.M. Casas and T. Patrocinio

Instituto Español de Oceanografía, Apdo. 1552, 36200 Vigo, Spain
e-mail:joseluis.delrio@vi.ieo.es

Abstract

A stratified random bottom trawl survey on Flemish Cap was carried out on July 2002. Results on shrimp from the survey are presented and compared to those from previous surveys of the same series. The total biomass index obtained this year, 18 109 tons, is the highest in the series. The female biomass remains at a high level, and it is dominated by age 5 shrimp. Mean lengths at age, abundance and biomass by age are presented.

Keywords: Shrimp, Flemish Cap, survey.

Material and Methods

The survey was carried out from June 30th to July 17th following the same procedures as in previous years (Vázquez, 2002). The Lofoten gear used was the same as in previous surveys, with a cod-end mesh size of 35 mm.

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 all the area and to compare it with the estimates of the other years.

The length-weight relationship were calculated from individuals caught by the Lofoten gear and the juvenile bag attached to the Lofoten gear. 1968 individuals were weighed to the nearest 0.1 g after a little draining time.

Knowing that mean size of shrimp coincides with the selection range of the 35 mm mesh currently used, a bag with 6 mm mesh size was attached as last year to the cod-end of the Lofoten gear, just in a position where escapement is believed to be maximum. The base of the bag was a square of 36 cm in each side. The whole shrimp caught in the juvenile bag was weighed and measured.

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 2002 a modal analysis of the length distribution to estimate age structure was carried out using the same method and compared with previous results reported by Skúladóttir and Diaz (2001).

Results

A total of 120 valid bottom trawls were completed with Lofoten trawl gear in Flemish Cap. Shrimp appeared in 111 sets and catches per tow were highly variable (from 5 g to 110 kg).

Biomass

Total shrimp biomass estimated by swept area method and average catch per mile from 1988 to 2002 are presented in Table 1. The biomass index obtained this year, 18 109 tons, is the highest in the series.

Biomass distributions estimated by strata from 1988 to 2002 are shown in Table 2. The presence of shrimp in shallowest strata, with depths less than 257 m (140 fathoms), was scarce in the first years (1988-1994). However, since 1995, a noticeable amount of shrimp occurred in these strata. In the last three years the biomass in shallowest strata increased from 1 875 tons in 2000 to 3 458 tons in 2001 and 5 332 tons in 2002 (Table 2), as a probably consequence of the abundance of the youngest age classes. The highest biomass estimated from 1988 to 1997 was obtained in strata 12 and 14 (201-300 fathoms), from 1998 to 2001 in strata 10 and 11 (141-200 fathoms) and in 2002 for first time the highest biomass estimated was obtained in stratum 3 (101-140 fathoms).

Biomass distribution observed during the survey is presented in Figure 1. The results show that shrimp occurred mainly between 253 m and 547 m (141-300 fathoms). Catches never exceeded 10 kg/tow in the shallowest area in the centre of the bank. The three highest catch (110.2, 110.3 and 100.4 kg) occurred in the East of the 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 2002 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 those surveys was a Lofoten with a cod-end mesh size of 35 mm with the exception of the 1994 survey when a 40 mm cod-end mesh size was used, and the 1998 survey, when a liner of 25 mm was used. 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 R o, 1998). In order to make comparable the biomass indices of all surveys, the variations due to the different cod-end mesh size must be removed.

In Figure 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 catch or not 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. The differences 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 2002 the differences increased and always were greater than 20 % in all years, the highest observed rates for a 35 mm cod-end mesh size and in this survey the difference between the total biomass and the adult biomass reached the 33,7 %. It was attributed to some increase in small shrimp abundance.

Length frequencies

Length frequencies and percentages by sex from the 2002 survey are shown in Table 3. These length frequencies are split into males, primiparous females, multiparous females and ovigerous females. The 2002 survey catches contained 53.33 % males and 46.67 % females (26.65 % primiparous, 20.01 % multiparous and 0.01 % ovigerous). The percentage of ovigerous females is smaller than in the last three years, because the survey finished on July 17th, that is, early for the spawning period in Flemish Cap, which begins between the end of July and the beginning of August (Mena, 1991). Males presented a CL between 8.5 and 26.0 mm. Females presented a CL between 15.5 and 32.5 mm comprising the groups: 15.5-28.5 mm primiparous, 18.0-32.5 mm multiparous and 22.0-24.5 mm ovigerous.

Length frequencies by strata are shown in Table 4. The older individuals have generally a tendency to be more numerous at greater depths (Skúladóttir, 2001).

In this survey as in previous years, the results indicate that the minimum shrimp size increases with depth:

Strata	Depth range		Minimum observed size (mm CL)
	Meters	Fathoms	
2	147-182	81-100	8.5
3 to 6	183-256	101-140	9.5
7 to 11	257-360	141-200	10.0
12 to 15	361-547	201-300	16.0
16 to 19	548-725	301-400	17.0

Figure 3 shows shrimp length distribution on Flemish Cap from 1994 to 2002. Modal groups named with the same letter belong to the same year-class (Table 7b and 10) according to the previous results of age analysis carried out by Skúladóttir and Diaz (2001) and the modal analysis of this year. In the 1998 survey, length frequencies by strata show an increase of small shrimp in shallower water, but it could be explained by the small size of the cod-end mesh used that year (25 mm instead of 35 mm), as it was already commented. In the 2002 survey appears a prominent peak of about 18 mm CL in males, due to increase in small shrimp abundance (age 3).

Length-weight relationship

Length-weight relationship for males and females in year 2002 are illustrated in Figure 4. Length-weight equations by sex were for this period:

$$\text{For males: } W = 0.0007 * CL^{2.9333} \quad (N= 964, r^2=0.99)$$

$$\text{For primiparous females: } W = 0.0010 * CL^{2.8384} \quad (N= 539, r^2=0.92)$$

$$\text{For multiparous females: } W = 0.0011 * CL^{2.8069} \quad (N= 465, r^2=0.92)$$

$$\text{For sexes combined: } W = 0.0007 * CL^{2.9278} \quad (N=1968, r^2=0.99)$$

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

Weight by length-class of shrimp for years 1989-2002 is shown in Table 5 and it was observed that weights of this year are lightly lower than those observed in 2001 and roughly equal to those obtained from 1997 to 2000.

Small mesh size bag on the cod-end

The length distribution of shrimp obtained in the survey with the Lofoten gear did not record adequately the small size groups. The use of a small mesh size bag attached to the cod-end to collect a portion of the small size shrimp escaping through the meshes is a common alternative, and it was used in the last two surveys (2000 and 2001) and in the current one. Total catch and length frequencies in absolute values are presented in Table 6. The total catch was around 6 times bigger in this survey than in 2001, both in weight and number. The length distribution is presented in Figure 5, joint to results from the 2000 and 2001 surveys (Diaz, 2001).

Age structure

Table 7a, b shows the preliminary interpretation of shrimp modal groups and ages from length distribution of the gear Lofoten and juvenile bag used.

Skúladóttir and Diaz (2001) present the age assessment of the shrimp caught from 1988 to 2001 in the surveys and the results indicated the presence always of four age groups, the 3 to 6 year olds, and sometimes also 2 and 7 year olds. In 2002 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 in Lofoten gear are shown in Table 8, according to Unnur Skúladóttir (personal communication). 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. The youngest modal group (age 1) is scarcely represented and the component at 18,49 mm CL (age 3), accounting for 41,3% of the total catch in numbers. Females were split into primiparous (age 4 and 5) and multiparous (age from 4 to 7). The same modal analysis of the shrimp length distribution obtained with juvenile bag was realized from 2000 to 2002 and the results, according to Unnur Skúladóttir (personal communication) are presented in Table 9. Always appear three age groups, the 1 to 3 year olds, and sometimes also 4 year olds, although in very low proportions. Figure 6 shows modal groups and age distribution of shrimp from modal analysis of length distribution obtained with the Lofoten gear and juvenile bag in 2002. Mean carapace length at age from 1988 to 2002 surveys are presented in Table 10.

After getting the proportions and mean lengths for every age/sex the results were used to calculate the total number of individuals in every age/sex according the biomass estimated with Lofoten gear, this was done by transforming the CL to weight applying length weight relationship described by Skúladóttir and Diaz (2001). Abundance and biomass index by age groups in all surveys are shown in Tables 11 and 12, respectively. The female biomass increased from 8 977 t in 2001 to 11 664 t in 2002, and it is dominated by age 5 shrimp (7 514 t), but the total catch in numbers is dominated by age 3 shrimp (1 341 mill.).

Age structure from shrimp length distribution of the Lofoten gear in surveys from 1988 to 2002 are shown in Fig. 7. In general, strong year-classes may be followed in these years. The 1987 year-classes could be following until 1992 (5 years olds). The number of 3, 4 and 5 years olds calculated from the biomass estimated in the years 1998-2002 indicated three especially strong year-classes: 1995, 1997 and 1999. In 1998 the number of three year olds (1995 year-classes) could have been overestimated because the mesh size used that year was smaller (25 mm) than the one normally used. The 1997 year-classes was quite numerous as 4 years olds in 2001 and 5 years olds in 2002. The 1999 year-classes appeared especially big if judged by the number of three year olds in 2002.

Age structure (%) from shrimp length distribution of the juvenile bag from 2000 to 2002 are presented in Fig. 8.

Acknowledgements.

To Unnur Skúladóttir of the Marine Research Institute, Iceland, for her contribution with the modal analysis of the shrimp length distribution obtained with the Lofoten gear and juvenile bag.

References

- Del Rio, J.L. 1998. Northern Shrimp (*Pandalus borealis*) on Flemish Cap in July-August 1998. *NAFO SCR Doc.*, No. 81. Serial No. 3082, 13 p.
- Díaz, P. 2001. Northern Shrimp (*Pandalus borealis*) on Flemish Cap in July 2001. *NAFO SCR Doc.*, No. 172. Serial No. 4517, 18 p.
- Garabana, D. 1999. Northern Shrimp (*Pandalus borealis*) on Flemish Cap in July 1999. *NAFO SCR Doc.*, No. 106. Serial No. 4186, 15 p.
- MacDonald, P. D. M. and T. J. Pitcher. 1979. Age groups from size-frequency data: a versatile and efficient method of analysing distribution mixtures. *J. Fish. Res. Board Can.*, 36: 987-1011.

McCrary, J.A. 1971. Sternal spines as a characteristic for differentiating between females of some pandalidae. *J. Fish. Res. Board Can.* 28: 98-100.

Mena, I. 1991. Northern prawn (*Pandalus borealis*) length distribution and fecundity in Flemish Cap. *NAFO SCR Doc.*, No. 91/29, 7 p.

Rasmussen, B. 1953. On the geographical variation on growth and sexual development of the deep sea prawn (*Pandalus borealis*, Kroyer). *Fish. Dir. Skr. Ser Hav Unders.* 10 (3): 1-160.

Shumway, S.E., H.C. Perkins, D.F. Schick and A.P. Stikney. 1985. Synopsis of biological data on the Pink Shrimp (*Pandalus borealis*, Kroyer, 1838). *NOAA Techn. Rep. NMFS* 30, 57 p.

Skúladóttir, U. 2001. The Icelandic Shrimp Fishery (*Pandalus borealis* Kr.) at Flemish Cap in 1993-2001. *NAFO SCR Doc.*, No. 183. Serial No. 4573, 26 p.

Skúladóttir, U. and P. Diaz. 2001. Age assessment of Northern Shrimp (*Pandalus borealis*) in EU surveys on Flemish Cap in 1988-2001. *NAFO SCR Doc.*, No. 189. Serial No. 4579, 8 p.

Vázquez, A. 2002. Results from Bottom Trawl Survey on Flemish Cap of July 2001. *NAFO SCR Doc.*, No. 12. Serial No. 4613, 43 p.

Table 1. Average shrimp catch per towed mile in the years 1988-2002 on Flemish Cap surveys. Total biomass and Female biomass indices estimated by swept area method.

Year	Average catch per mile (Kg)	Standard error	Total Biomass (tons)	Biomass CL>20mm (tons)	Female Biomass (tons)
1988	1.54	0.28	2,164	2,104	1,874
1989	1.37	0.24	1,923	1,856	1,340
1990	1.53	0.21	2,139	1,886	1,132
1991	5.83	0.71	8,211	7,856	5,362
1992	11.75	1.86	16,531	16,208	11,509
1993	6.57	1.04	9,256	8,292	6,839
1994 ¹	2.37	0.35	3,337	3,282	2,823
1995	3.85	0.44	5,413	5,153	4,286
1996	4.62	0.34	6,502	5,716	4,149
1997	3.62	0.25	5,096	4,699	3,807
1998 ²	11.81	0.80	16,620	10,337	8,091
1999	8.83	0.67	12,430	9,626	9,051
2000	6.91	0.52	9,720	6,899	6,553
2001	10.02	0.65	14,106	11,225	8,977
2002	12.87	1.12	18,109	12,009	11,664

¹codend mesh-size 40 mm

²codend mesh 40 mm and 25 mm liner

Table 2. Total shrimp biomass estimated by strata (tons) in the years 1988-2002 on Flemish Cap surveys.

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

Table 3. Shrimp length frequencies and percentages by sex and stage maturation in the 2002 survey on Flemish Cap.

LENGTH (mm CL)	MALES	FEMALES		
		Primiparous	Multiparous	Ovigerous
8.5	11			
9	19			
9.5	27			
10	29			
10.5	24			
11	9			
11.5	12			
12	3			
12.5	8			
13	26			
13.5	43			
14	205			
14.5	413			
15	439			
15.5	477	2		
16	596			
16.5	978	5		
17	1363	8		
17.5	2346	40		
18	2787	75	3	
18.5	2563	111	6	
19	2041	211	4	
19.5	1442	334	24	
20	820	432	51	
20.5	471	547	93	
21	292	630	152	
21.5	212	773	348	
22	145	817	431	1
22.5	140	955	678	
23	108	912	794	
23.5	60	868	797	
24	54	708	823	
24.5	26	595	676	1
25	10	453	537	
25.5		288	412	
26	1	170	299	
26.5		95	249	
27		49	184	
27.5		14	89	
28		3	75	
28.5		1	44	
29			22	
29.5			17	
30			11	
30.5			5	
31			2	
31.5				
32				
32.5			1	
Percentage	53.33	26.65	20.01	0.01

Frequence x 10⁵

Table 4. Shrimp length frequencies by strata in 2002 on Flemish Cap survey.

LENGTH (mm CL)	STRATA																		Total
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
8.5	11																		11
9	19																		19
9.5	22	1		4															27
10	26	1		2						1									29
10.5	18	2		3						1									24
11	5	3		2															9
11.5	2			7							3								12
12				1						2									3
12.5		2		1	4														8
13		5	9	7	4						2								26
13.5		17		9	9	6				2									43
14	2	117	18	11	33	6	12			6									205
14.5	1	185	51	24	71	35	35			4	7								413
15	2	212	35	32	62	13	58	3	11	10									439
15.5	2	157	69	53	41	78	44	7	9	17									479
16	3	160	120	103	56	55	19	11	44	23			1						596
16.5	2	288	86	136	122	128	90	21	46	59			2	1					983
17	4	356	178	115	145	128	224	24	100	69	3		21	3				1	1371
17.5	3	639	187	115	237	409	456	41	157	104	2		29	6					2386
18	3	642	197	78	196	643	564	47	206	209	30		37	11	3			1	2865
18.5	2	390	247	97	190	617	474	51	194	292	54		47	24				1	2680
19	1	241	120	80	143	559	418	53	167	270	90		85	22	5	1		3	2256
19.5	1	215	129	125	101	398	211	46	156	211	82		77	39	7	1		2	1800
20	1	146	68	122	66	227	132	56	140	161	62		84	32	4			2	1303
20.5		120	43	164	89	123	125	47	133	103	40	1	78	29	11			3	1111
21		113	26	164	87	135	106	52	172	101	20		60	21	9			4	1074
21.5		124	17	217	144	81	114	136	200	150	25	1	86	26	7			3	1333
22		108	59	188	149	86	115	112	275	183	21		53	36	4			5	1394
22.5		189	51	155	195	90	195	225	254	210	56	5	77	50	5			3	1773
23		189	16	106	196	88	178	200	323	241	90	4	105	55	8	1		4	1814
23.5		218	42	75	138	151	118	127	242	251	113	8	133	80	12			2	1725
24		146	17	34	125	97	125	195	215	220	130	12	118	104	20			3	1585
24.5		82	16	23	64	110	87	90	165	139	147	23	175	101	39			1	1298
25		25		9	44	50	78	59	125	83	133	20	190	94	47				1000
25.5		12		2	19	37	18	28	71	61	111	34	127	94	54				700
26		6	8	11	8	11	9	11	45	19	58	31	111	60	47				470
26.5				7	8	10	13	3	21	18	47	23	63	47	52				344
27		6		8		4	2	4	12	19	21	15	51	31	42				233
27.5				2	3	1			9	7	8	6	18	12	25			1	103
28						1		3	6	3	4	3	13	19	19				78
28.5							1		8	2	3	4	8	7	10				45
29										3	3	2	5	3	4			1	22
29.5									4	3	1	1	1	3	3				17
30										1	3			1	4			1	11
30.5										1			2		1				5
31													1		1				2
31.5																			
32																			
32.5										1									1

Frequencies x 10⁵

Table 5. Shrimp weights at length from Flemish Cap surveys 1989-2002.

CL (mm)	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
10.0	0.6	0.6	0.7	0.7	0.8	0.7	0.6	0.6	0.5	0.6	0.6	0.6	0.6	0.6
12.5	1.2	1.2	1.3	1.4	1.4	1.3	1.2	1.1	1.1	1.1	1.1	1.1	1.2	1.1
15.0	2.0	2.0	2.1	2.3	2.4	2.2	2.1	2.0	1.9	1.9	1.9	1.9	2.0	1.9
17.5	3.1	3.2	3.3	3.5	3.6	3.4	3.3	3.2	3.0	3.0	3.1	3.0	3.2	3.1
20.0	4.6	4.7	4.9	5.1	5.2	5.0	4.9	4.8	4.5	4.5	4.6	4.5	4.7	4.5
22.5	6.5	6.6	6.9	7.1	7.3	7.1	7.0	6.9	6.4	6.4	6.6	6.4	6.6	6.4
25.0	8.9	9.0	9.3	9.5	9.7	9.6	9.5	9.5	8.8	8.8	9.0	8.7	8.9	8.7
27.5	11.7	11.8	12.3	12.4	12.7	12.6	12.6	12.7	11.7	11.7	12.0	11.6	11.7	11.5
30.0	15.1	15.3	15.8	15.9	16.1	16.2	16.3	16.6	15.3	15.1	15.6	15.0	15.1	14.8
32.5	19.1	19.3	19.9	19.9	20.1	20.4	20.7	21.2	19.5	19.2	19.9	-	19.0	18.7
35.0	23.7	23.9	24.7	24.5	24.8	25.3	25.8	26.6	24.4	23.9	24.8	-	23.6	23.2

Table 6. Shrimp length frequencies taken by the small mesh size bag attached to the cod-end from 2000 to 2002 surveys.

LENGTH (mm CL)	2000			2001		2002		
	MALES	FEMALES		MALES	FEMALES Primiparous	MALES	FEMALES	
		Primiparous	Multiparous				Primiparous	Multiparous
6						1		
6.5								
7				1				
7.5	6			1		2		
8	11			1		11		
8.5	32			3		49		
9	44			7		109		
9.5	55			8		209		
10	43			8		186		
10.5	24			9		146		
11	10			7		107		
11.5	1			4		56		
12	7			4		26		
12.5	13			3		11		
13	22			8		25		
13.5	37			9		25		
14	25			17		34		
14.5	30			23		50		
15	19			31		46		
15.5	10			34		74		
16	17			29		97		
16.5	33			16		98	1	
17	43			17		101	2	
17.5	52			14		108	1	
18	46			8		80	2	
18.5	28		1	5		85	2	
19	21	3		6		58	0	
19.5	8		1	1		25	2	
20	13	3	1	5		13	6	
20.5	4	2		2		13	7	2
21		4		1		6	5	2
21.5	1	3					1	
22		1				1	2	
22.5				1	1		1	3
23					1		2	1
23.5		1						
24							1	1
24.5		2						1
25								
25.5								
26								
26.5								
27								
27.5			1					
Total	655	19	4	283	2	1852	35	10
Weight (g)		1376			676		3682	

Table 7a. Shrimp modal groups and ages with Lofoten gear and Bag on the codend in the 2002 on Flemish Cap survey interpreted from size distributions.

LOFOTEN					
Males			Females		
Age	Modal Group		Age	Modal Group	
1	10		4	21.5	
2	14.5		5	23	
3	18		6	25.5	
4	21.5		7	No defined	

BAG ON THE CODEND					
Males			Females		
Age	Modal Group		Age	Modal Group	
1	9.5		4	-	
2	14.5		5	-	
3	17.5		6	-	
4	20.5		7	-	

Table 7b. Shrimp modal groups and ages in the 2002 on Flemish Cap survey interpreted from size distributions.

Age	Cohort	Modal group
1	P	10 _(B)
2	O	14.5 _(B-L)
3	N	18 _(B-L)
4	M	21.5 _(B-L)
5	L	23 _(L)
6	K	25.5 _(L)
7	J	-

(B) Bag on the codend(L) Lofoten gear**Table 8.** Results from the modal analysis (Mix) for each sex/maturity group from the Lofoten gear .

Sex and maturity group	2002					
	Male		Primiparous Female		Multiparous Female	
Age	Prop.	St.Dev.	Prop.	St.Dev.	Prop.	St.Dev.
1	0,0068	0,0006				
2	0,134	0,003				
3	0,769	0,004				
4	0,091	0,003	0,3784	0,008	0,072	0,013
5			0,6216	0,008	0,618	0,019
6					0,275	0,020
7					0,035	0,008
	Mean CL	St.Dev.	Mean CL	St.Dev.	Mean CL	St.Dev.
1	10,36	0,044				
2	15,57	0,019				
3	18,49	0,008				
4	21,66	0,031	20,87	0,022	21,48	0,144
5			23,88	0,018	23,55	0,066
6					25,68	0,128
7					28,12	0,229
	Sigma	St.Dev.	Sigma	St.Dev.	Sigma	St.Dev.
1	0,466	Fixed CV				
2	0,701	Fixed CV				
3	0,832	Fixed CV				
4	0,975	Fixed CV	0,939	Fixed CV	0,967	Fixed CV
5			1,075	Fixed CV	1,060	Fixed CV
6					1,156	Fixed CV
7					1,265	Fixed CV

Table 9. Results from the modal analysis (Mix) for each sex/maturity group from the juvenile bag.

2000							2001							
Sex and maturity group	Male		Primiparous Female		Multiparous Female		Sex and maturity group	Male		Primiparous Female		Multiparous Female		
	Age	Prop.	St.Dev.	Prop.	St.Dev.	Prop.		St.Dev.	Age	Prop.	St.Dev.	Prop.	St.Dev.	Prop.
1	0,345	0,018					1	0,018	0,023					
2	0,244	0,020					2	0,579	0,031					
3	0,370	0,037					3	0,239	0,027					
4	0,041	0,028	1	Fixed	4 specim.		4			2 specim				
5							5							
	Mean CL	St.Dev.	Mean CL	St.Dev.	Mean CL	St.Dev.		Mean CL	St.Dev.	Mean CL	St.Dev.	Mean CL	St.Dev.	
1	9,66	0,058					1	10,32	0,068					
2	14,07	0,102					2	15,22	0,060					
3	17,73	0,113					3	18,21	0,114					
4	20,02	0,476	21,22	0,458	20	Approxim.	4			22,5	Approxim.			
5							5							
	Sigma	St.Dev.	Sigma	St.Dev.	Sigma	St.Dev.		Sigma	St.Dev.	Sigma	St.Dev.	Sigma	St.Dev.	
1	0,817	0,045					1							
2	0,925	0,095					2	0,464	Fixed CV					
3	0,916	0,125					3	0,685	Fixed CV					
4	0,644	0,240	1,927	0,386			4	0,820	Fixed CV					
5							5							

2002						
Sex and maturity group	Male		Primiparous Female		Multiparous Female	
	Age	Prop.	St.Dev.	Prop.	St.Dev.	Prop.
1	0,484	0,012				
2	0,178	0,009				
3	0,338	0,011				
4			1	Fixed	0,702	0,261
5					0,298	0,261
6						
	Mean CL	St.Dev.	Mean CL	St.Dev.	Mean CL	St.Dev.
1	10,28	0,016				
2	15,02	0,044				
3	18,02	0,035				
4			20,42	0,307	21,46	0,144
5					24,00	0,066
6						
	Sigma	St.Dev.	Sigma	St.Dev.	Sigma	St.Dev.
1						
2	0,711	Fixed CV				
3	0,816	Fixed CV				
4	0,949	Fixed CV	1,803	0,226	0,966	Fixed CV
5					1,080	Fixed CV
6						

Table 10. Mean carapace length (mm) at age by years on Flemish Cap survey.

Year Age group	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	Mean CL
1															10.4	10.4
2					16.8	16.0		15.5	14.9	15.9	14.6	15.2	14.8	15.8	15.6	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	18.8
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	22.4
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	25.0
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	27.4
7					29.0			30.0	29.4		29.1	28.4		29.3	28.1	29.2

Table 11. Abundance (10^5) at age by years on Flemish Cap survey.

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

Table 12. Biomass estimated (tons) at age by years on Flemish Cap survey.

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

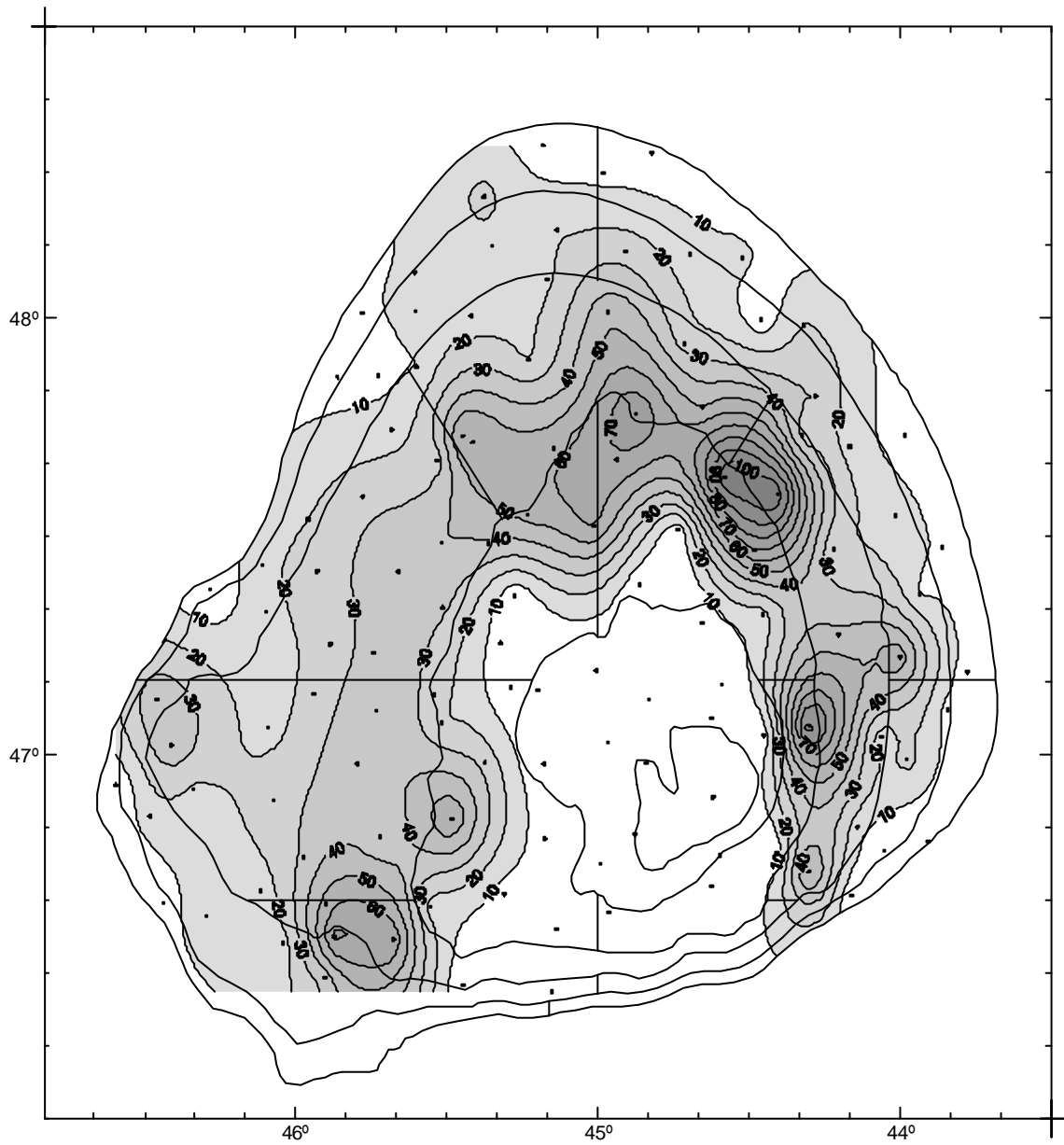


Figure 1. Shrimp catches distribution (kg/tow) in July 2022 on Flemish Cap survey.

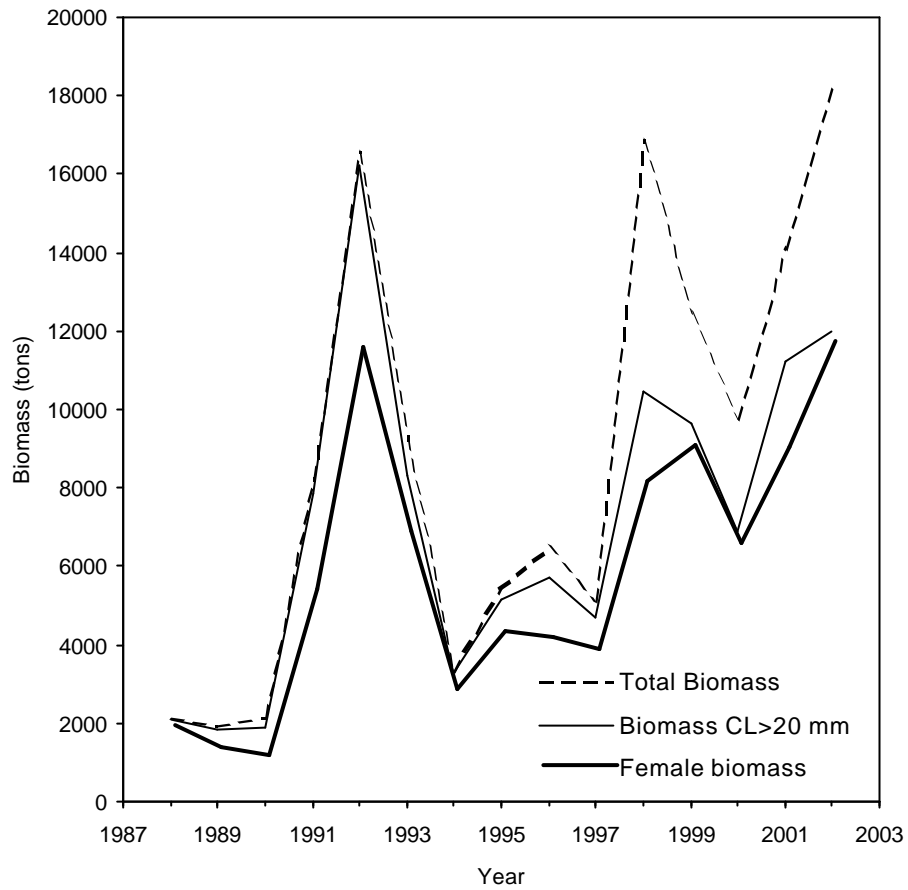


Figure 2. Total biomass and biomass for shrimp bigger than 20 mm CL (adult stock) from Flemish Cap 1988-2002 surveys.

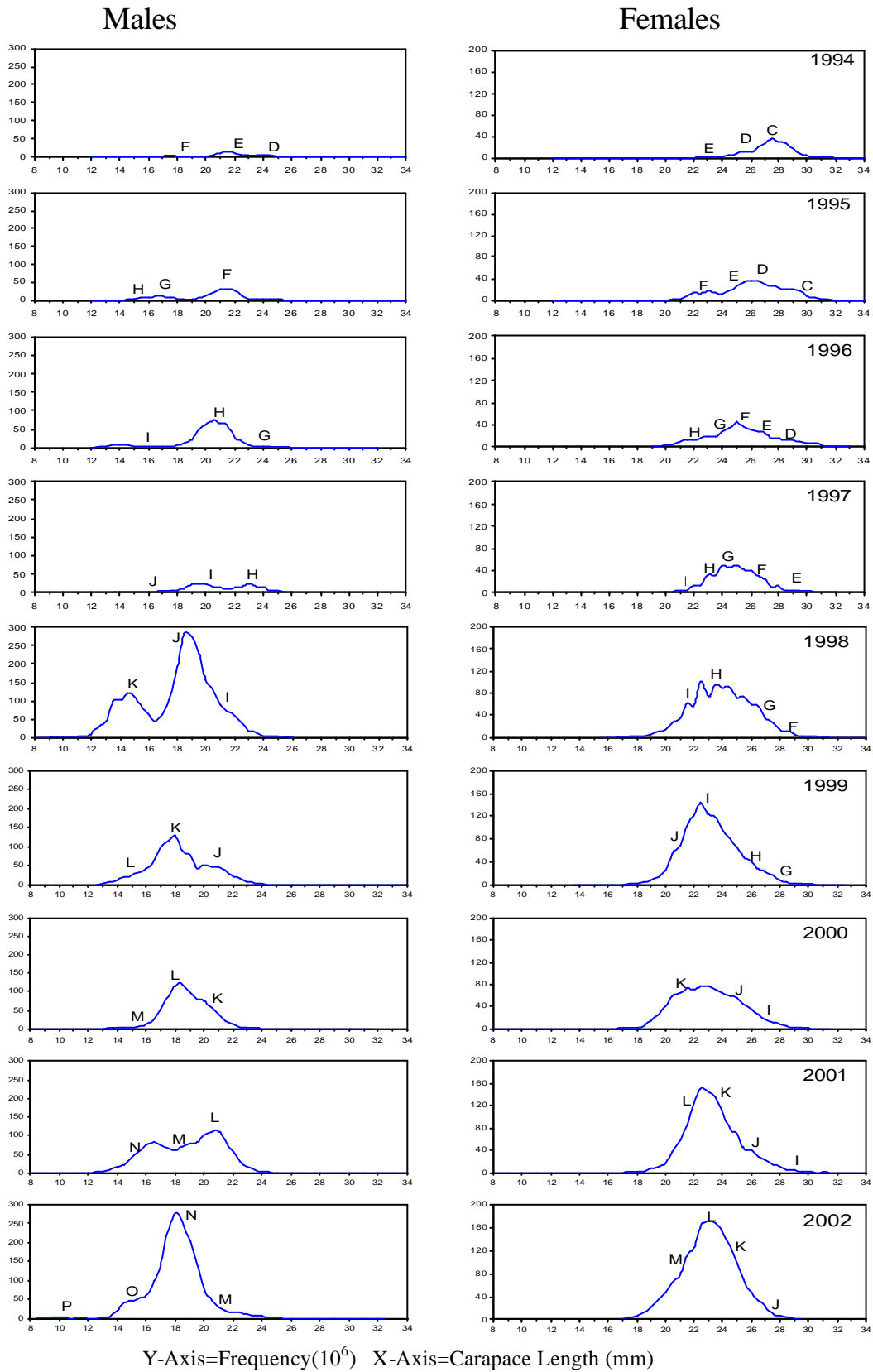


Figure 3. Shrimp size distribution on Flemish Cap 1993-2002 surveys.

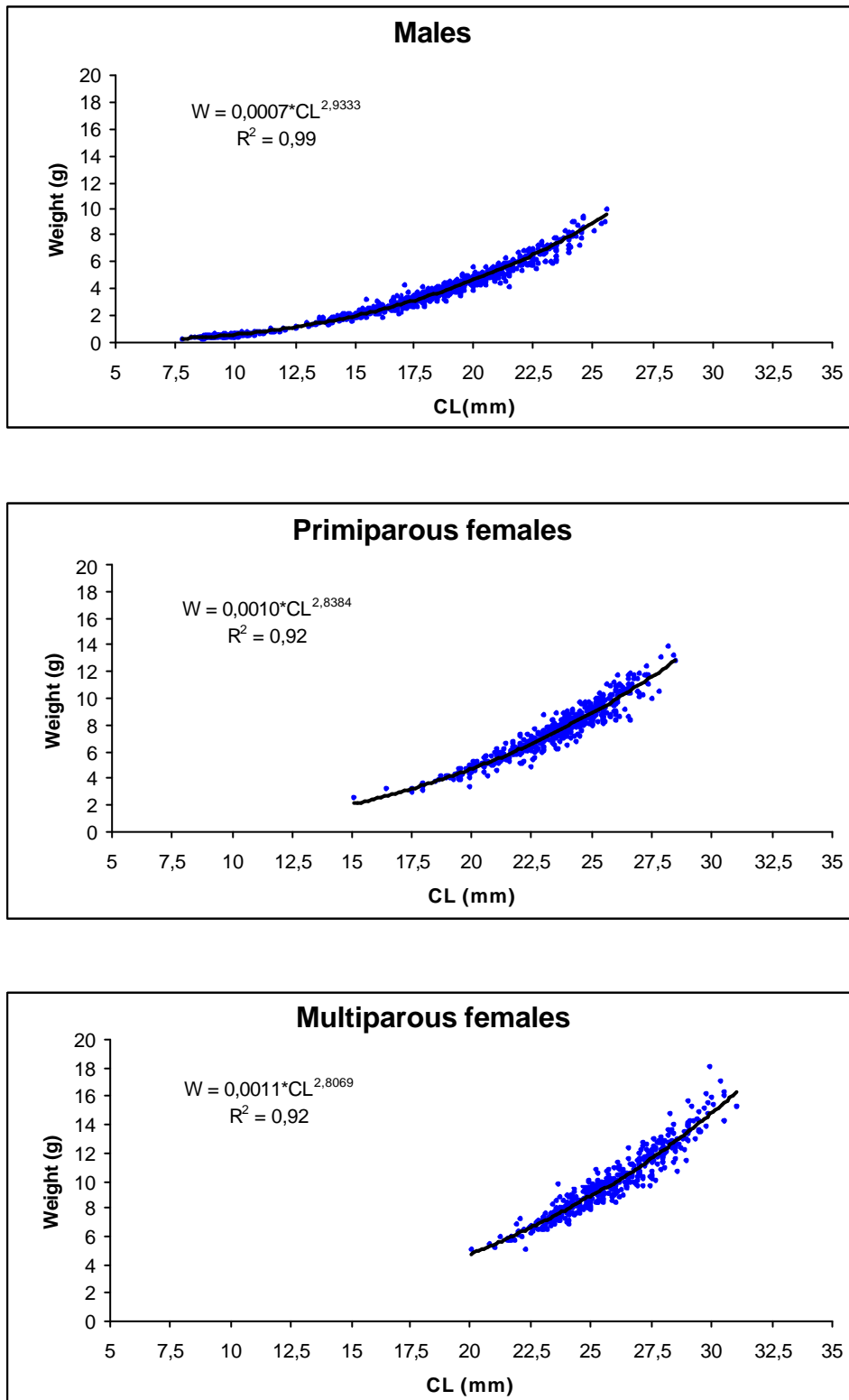


Figure 4. Shrimp length-weight relationship by sex in 2002 on Flemish Cap survey.

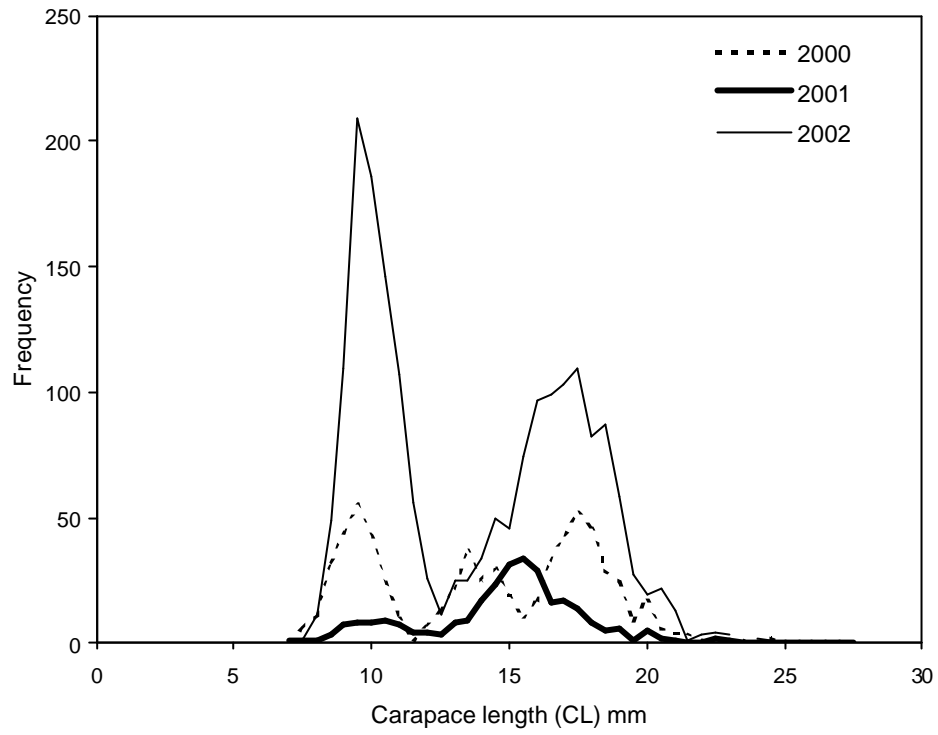
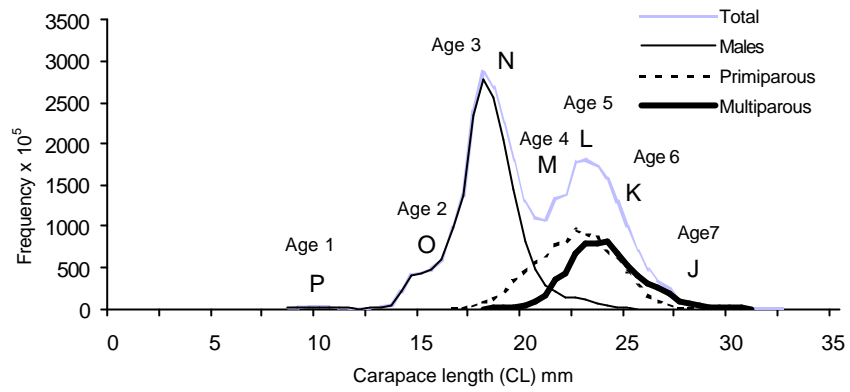


Figure 5. Shrimp length distributions from the small mesh size bag on the cod-end, in the 2000, 2001 and 2002 surveys on Flemish Cap.

Lofoten gear (35 mm)



Bag on the cod-end (6 mm)

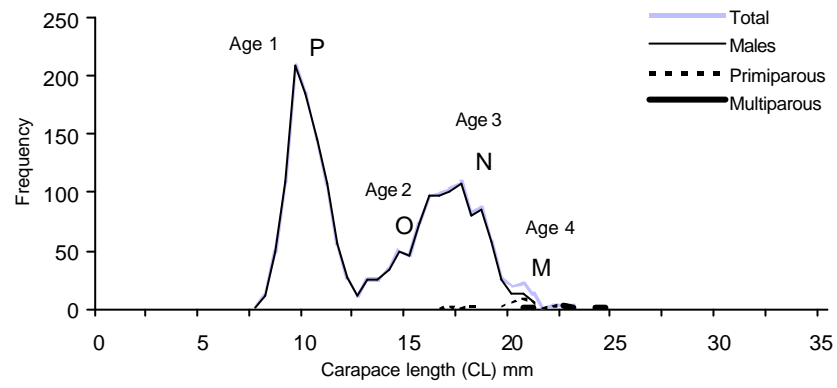


Figure 6. Shrimp modal and age groups in the 2002 survey on Flemish Cap (letters from table 7b, 8 and 9).

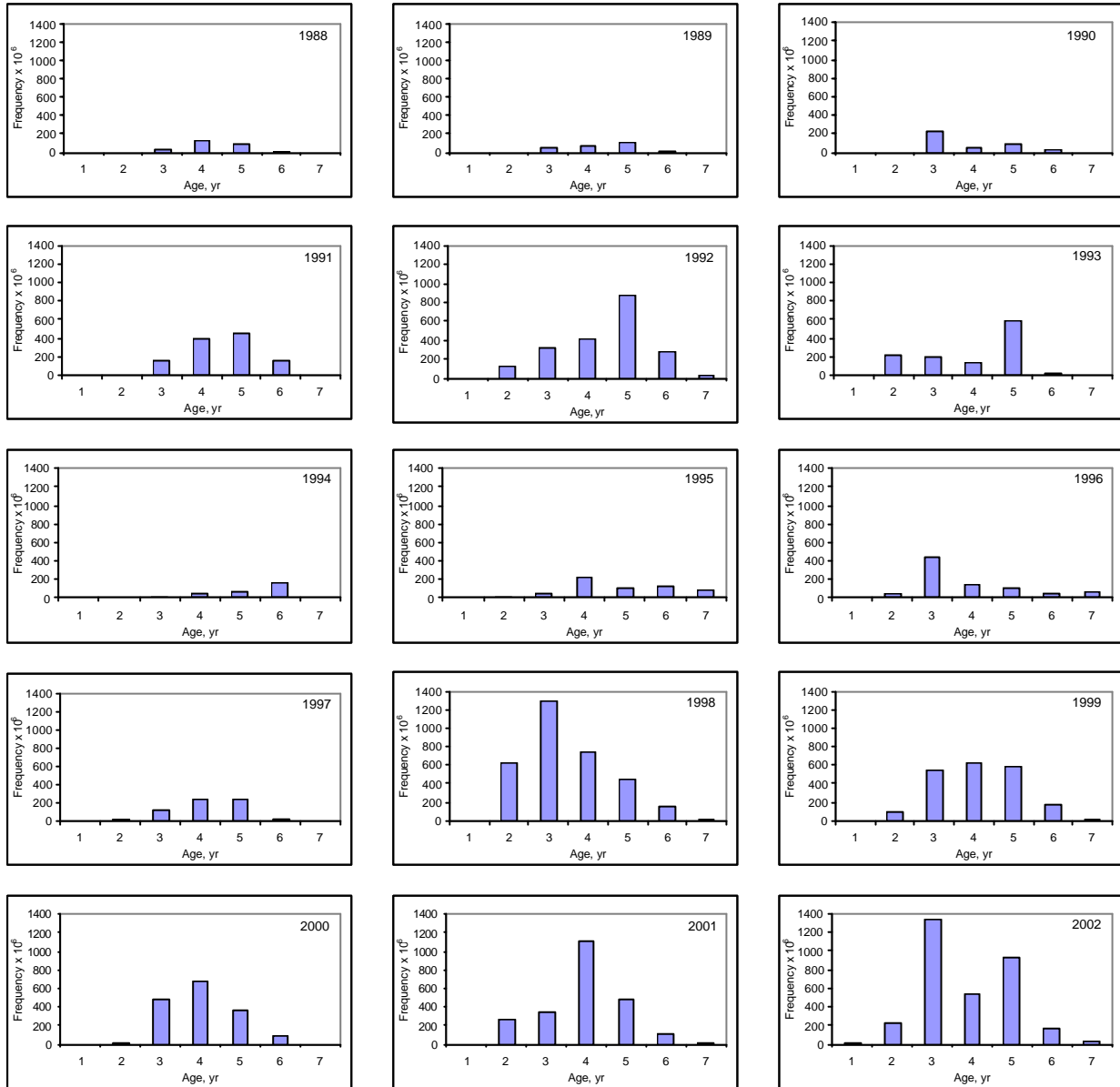


Figure 7. Age structure for shrimp in the years 1988-2002 on Flemish Cap surveys (Lofoten gear).

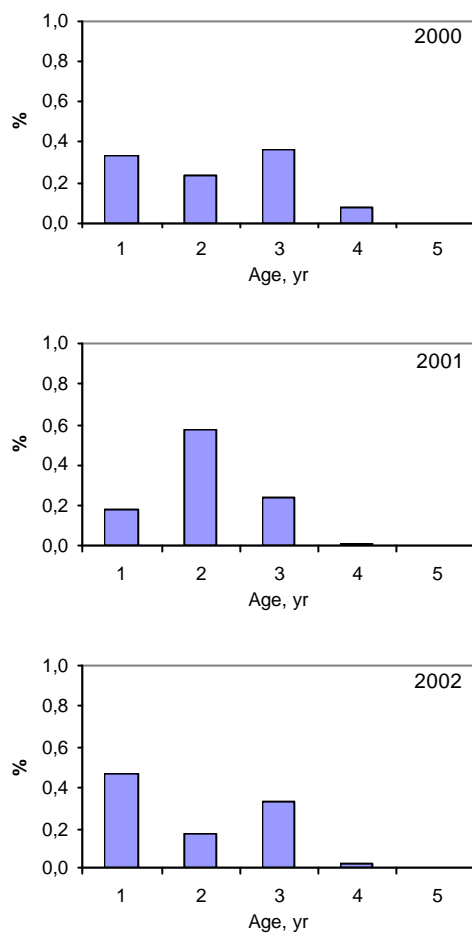


Figure 8. Age structure (%) for shrimp in the years 2000-2002 on Flemish Cap surveys (juvenile bag).