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Northern Shrimp (*Pandalus borealis*) on Flemish Cap Surveys 2005

by

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Abstract

Since 1988, a stratified random summer bottom trawl survey are being carried out in Flemish Cap (NAFO Regulatory Area of Division 3M) by UE. From 2003 the traditional research vessel *Cornide Saavedra* was replaced by the R/V *Vizconde de Eza*. The new vessel was calibrated and the indexes transformed. In 2004 year, the lack of time has not permitted to transform the biomass and abundance shrimp indexes of the whole series and only the 2003 and 2004 indexes from the R/V *Vizconde de Eza* were transformed to the R/V *Cornide de Saavedra* scale. In this paper, the series from 1988 to 2002 obtained with the R/V *Cornide de Saavedra* were transformed to make them comparable to the results obtained with the new vessel R/V *Vizconde de Eza*.

The results of shrimp from the last survey on Flemish Cap in 2005 are presented and compared to those from previous years of the same series. Both biomass and abundance have increased significantly due to increasing of 3 age-class. The female biomass decreased, mainly due to declining of 5 and 6 year-classes. Also, in recent years (2004 and 2005) the youngest specimens (age 1) didn't appear in the catches, and they were only presents in the small mesh size bag on the codend.

Introduction

The change of R/V *Cornide de Saavedra* by the R/V *Vizconde de Eza* carried out in 2003 was due, among others reasons, to the spreading of the prospected area up to depths about 1 400 m. In order to maintain the temporal continuity of series, conversion coefficients between the two vessels were estimated through an intercalibration experiment carried out during the bottom trawl surveys in 2003 and 2004.

The aim of this paper is to show the results obtained in the summer bottom trawl surveys in Flemish Cap (NAFO Regulatory Area of Div. 3M) in 2005. The indexes for this year and the past two years 2003 and 2004 obtained by R/V *Vizconde de Eza*, are compared with the transformed series previous to 2003 obtained by R/V *Cornide de Saavedra*. Also the Modal analysis of carapace length was carried out on the new length frequencies of northern shrimp resultants of the transformation and the new abundance and biomass by age estimated.

Material and Methods

Survey Design and Gear Used

The surveys on Flemish Cap (NAFO Regulatory Area of Div. 3M) was initiated by UE in 1988 and carried out in summer (June-July), on board the Spanish Research vessel R/V *Cornide de Saavedra* until 2002 year. Since 2003, the R/V *Cornide de Saavedra* was replaced by the R/V *Vizconde de Eza*. The gear used was a bottom trawl net type Lofoten during the whole of period.

In 2005 the survey was carried out from 2nd of July to 21th of August. As the last year, the area prospected in Flemish Cap was spread up to 1 400 meters. The new area was sampled by means of 59 additional hauls proportionally distributed in the new 15 strata. The haul number carried out in the 19 strata with depths minor than 740 m. was of 117.

The bottom trawl surveys followed the same procedures as in previous years. The specifications about the main technical data of the survey are described in Table 1.

Series Conversion

From the results of the calibration accepted last year in the November meeting (Fig. 1) (Casas *et al*., 2004), the shrimp indexes collected by the R/V *Cornide de Saavedra* from 1988 to 2002 were transformed in order to make them comparable to the new indexes obtained from 2003 by the R/V *Vizconde de Eza* (Fig. 2).

With the length distribution by sex resultants of the Warren's transformation and the length-weight relationship parameters the total and female biomass were estimated from 1998 to 2002. In the same way the female biomass since 2003 onward was estimated from their respective and original length frequencies.

The age assessment of the shrimp caught from 1988 to 2002 in the surveys (Skúladotir and Díaz, 2001 and Del Río *et. al*., 2002), were rebuilt in according to the transformed length composition by running again the Modal analysis carried out with the MIX software (MacDonald and Pitcher, 1979).

With the results of the modal analysis the total number of individuals by age and sex group were calculated according to the biomass estimated. This was done by transforming the CL to weight by using the weight length relationship obtained from samples taken every year in the survey. The followed process was he same that one used in previous years.

Sampling

Samples of approximately 1.5 kilogram shrimp were taken in each tow where this species was present for length frequency determination. Also, some samples were frozen for length-weight analysis in 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 as 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.

As previous years the length frequency distribution by sex group were analysed by MIX program and the proportion, mean lengths and standard deviations of the mean length (sigma) are calculated for each age component and sex group. When the modal components overlap and obscure one another, was necessary to reduce the number of parameters estimated in order to get the best and reasonable adjust. We have constrained sigma very often fixing the coefficient of variation (CV) at 0.045.

After getting the proportions and mean lengths for every age/sex group the results were used to calculate the total number of individuals in every age/sex group according to the biomass estimate. This was done by transforming the CL to weight using the weight length relationship estimated each year during the survey. So, the mean lengths were converted to mean weights to calculate the number of males, primaparous females and multiparous females (Skúladóttir and Diaz, 2001).

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 years to the cod-end of the Lofoten gear, just in a position where escapement is believed to be maxinum. 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.

The length-weight relationship were calculated from individuals caught by the Lofoten gear and the juvenile bag attached to the Lofoten gear. 2 872 individuals were weighed to the nearest 0.1 g after a little draining time.

Results

Biomass

A total of 176 valid bottom trawls were completed with Lofoten trawl gear in Flemish Cap surveys 2005. 117 of them were carried out in the traditional strata prospected from 1988 with depths up to 740 m. (Fig. 3).

Total shrimp biomass, estimated by swept area method and mean catch per tow from 1988 to 2005 are presented in Table 2. The values presented from 1988 to 2002 year are those resultants of the Warren's transformation of the lengths distribution obtained by the R/V *Cornide Saavedra* and the length-weight relationship estimated every year.

The increasing of biomass since 1988 to 1992 coincided with a period of time where there was not a directed fishery to shrimp and the cod stock began to decline. With the beginning of the shrimp fishery in 1993 the biomass declined up to 1997. After that the stock recovered reasonably well staying without trends in the last years. The biomass index obtained in 2005 (24 599 tons), is among the highest of the series, increasing an 18% in respect of 2004.

Biomass estimated by strata from 1988 to 2005 are shown in Table 3. The presence of shrimp in shallowest strata, with depths less than 140 fathoms (257 m), was scarce in the first years (1988-1995). However, since 1996, a noticeable amount of shrimp occurred in these strata and the estimated biomass increased up to 2002 year where 12 978 tons (36%) were estimated in depths lesser than 140 fathoms (Table 4). After 2002 the biomass estimated in these depths decreased to 2000 and 2001 levels.

Catch distributions observed during the 2005 surveys are presented in Fig. 4. As previous years, shrimp catches had a distribution around the central area of the bank between 250 and 350 m.

Adult Stock, Female Biomass

Total biomass estimates by the series of bottom trawl surveys on Flemish Cap from 1988 to 2005 were shown in Table 2. These estimations are quite variable due to the predominant sizes of the shrimp are in the selection range of the cod-end mesh size used (35 mm), 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 2). 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 2. This year the female biomass decreased about 3.5 % respect to 2004 index (Fig. 5).

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. 5 the adult biomass estimates are compared with the total biomass and female biomass along the series. Differences between these quantities in every year correspond to the greater or smaller catch of young shrimp. Contrary to previous years in 2004 and 2005 the female biomass was bigger than the adult biomass (>20 mm.).

Although the smaller size-classes are more directly affected by small changes in the cod-end mesh size the differences between the total biomass and the adult biomass (>20 mm.) showed an increasing trend in the total period 1988-2005, from 6% in the beginning of the series to 57% in 2005 (Fig. 6). The greatest difference founded in 1998 (60%) was due to the lesser mesh size of the liner codend used (25 mm.), and not comparable conclusions can be thrown.

Length Frequencies

The length frequencies and percentages by sex for 2005 are shown in the Table 5. These length frequencies are split into males, primiparous females, multiparous females and ovigerous. In a similar way to the happened with the smaller sizes along the years, the percentage of males increased in general way, getting in 2005 the biggest value in the historical series (74%) with the exception of 1998 (which can not be compared as it was before said).

Length frequencies by strata in 2005 were shown in Table 6. In 2005 survey, as in previous years, the results indicate that the mean shrimp size increases with depth (Table 7). The small size individuals (males) dominated shallowest strata and the large size individuals (females) were present in deepest strata.

Figure 7 shows the length distribution by sex on Flemish cap 1997-2005 surveys. From 1997 to 2002 the length distribution by sex were transformed following the Warren's method. In 2002 year the youngest modal group (age 1) appears for first time well represented with a modal length about 9-10 mm. Up to this year, with the exception of 1998, where a lesser mesh size was used in the survey (25 mm.), the most important modal size in the historical series (850×10^{6} individuals) occurred in 2002 around 18 mm. CL. In 2005 the importance of the youngest individuals increased and a new maximum (1000×10^{6}) in the frequency of the modal size corresponding at lengths of 16.5 mm was reached.

Length-weight Relationship

Length-weight relationships by sex group in year 2005 are illustrated in Fig. 8. Length-weight equations by sex group for this period were:

For males:	$W = 0.0004*CL^{3.1108}$	(N= 1560, r^2=0.94)
For primiparous females:	$W = 0.0003*CL^{3.1804}$	(N= 742, r^2=0.93)
For multiparous females:	$W = 0.0004*CL^{3.1058}$	(N= 571, r^2=0.87)
For sexes combined:	$W = 0.0004*CL^{3.0967}$	(N= 2872, r^2=0.98)

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

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. Total catch and length frequencies as absolute values obtained with the small mesh size bag in 2005 survey are presented in Table 8. The total catch estimated was 7 801 g. The length distribution of the shrimp caught in the bag shows two modes at 8.5 mm and 16 mm. CL, corresponding to age-classes 1 and 3. The age-class 2 was weakly represented (Fig. 9).

Age Structure

Table 9 and Fig. 9 show the preliminary and visual interpretation of shrimp modal groups and ages from the length distribution of the gear Lofoten and juvenile bag used in 2005.

Age assessment was carried out using the MIX software from the shrimp length distributions (transformed by Warren's method since 1988 to 2002), estimated every year in the survey series. The results of the modal analysis for annual surveys are shown in Table 10. The proportions within each sex group are listed as well as mean lengths and standard deviation (sigma) by age-classes.

The results of Table 10 were then used to calculate the mean length, abundance and biomass at age Tables 11, 12 and 13. In general way, an increased of the abundance can be observed along the historical series. This increase was mainly due to bigger presence of the youngest shrimps with three year olds in the whole of series and with two and one year olds since 1996 and 1998, respectively.

At the beginning of the series (1988-1995) the youngest shrimp were considered to be three year olds with lengths between 15.4 and 18.2 mm. Since 1996 shrimps with two years old have been present and the lengths ranged between 12.8 to 15.7 mm. The shrimps with one year old appeared at first time in 1998 and were present up to 2003 with lengths around of 10 mm. Seven years old (exceptionally eight years old in 1991) was the greatest age estimated in the whole of the series with lengths between 27.4 and 32.2 mm. In spite of the variability of the length by age along the years, it can be observed a decreasing trend in the mean length of the older age groups (5-7) (Fig. 10).

One of the most important uncertainties in the assessment of age was the location of the first modal group smaller than 18 mm in the first years of the series (1988-1995). The lack of shrimp with one and two year olds didn't permit to assign the first age group for certain and only the presence of the following mode at lengths next to 20 mm. considered to be four year olds permitted us to group them in the modal group of three year olds.

Some strong year-classes may be followed according the abundance by age groups from 1988 to 2005 (Table 12) if the assignation of the age is right. The 1986 year-class stand out in the beginning of historical series with 4, 5 and 6 years olds in the years 1990, 1991 and 1992. These ages were also specially abundant in the years 1999-2002 indicated three strong year-classes: 1995, 1996 and 1997. 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 year old in 2002.

In this year the results of the modal analysis indicated the presence of seven age groups and the age at sex change was 4, as previous years. In 2005 the shrimp modal group with sizes around 16 mm (considered to be three years old) was the highest in the series confirming the good recruitment of 2002 year-class predicted last year where the number of individuals with 2 years olds was the maximum for that age.

The biomass indices by age (Table 13), were calculated in the same way that the abundance by age and show similar results to the numbers at age.

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Table 1. Technical data of bottom trawl research surveys on Flemish Cap 2005.

Procedure	**Specification**
Vessel	*R/V Vizconde de Eza*
GT	1 400 t
Power	1 800 HP
Maximun trawling depth	1 400 m
Trawl winch	Automatic control on warp tension
Mean trawling speed	3.5 knots
Trawling time	30 minutes effective time
Fishing gear	type *Lofoten*
footrope / handrope	31.20 / 17.70 m
footgear	27 steel bobbins of 35 cm
mesh size in cod-end	35 mm
bridle	100 meters, 45 mm, 200 Kg/100m
trawl doors	polyvalent, 850 Kg
vertical opening	3.5 m
warp length	1.6 × depth + 430 m.
warp diameter	20
dan leno bobbin	not used
Type of survey	Stratified sampling
Station selection procedure	Random
Criterion to change position of a selected tow	- unsuitable bottom for trawling according to ecosonder register. Information on gear damage from previous surveys.
Criterion to reject data from tow	- tears in cod-end - severe tears in the gear - less than 20 minutes tow - bad behaviour of the gear
Daily period for fishing	6.00 to 22.00 hours
Species for sampling	All fish, squid and shrimp

Table 2. Different indexes of shrimp estimated by swept area method in the years 1988-2005 on Flemish Cap surveys. From 1988-2002 the data were transformed by Warren method.

Year	Mean catch per tow (kg)	Total Biomass (tons)	Biomass CL>20mm (tons)	Female Biomass (tons)	Female Mean catch per tow (kg)
1988	6.98	5615	5255	4525	5.63
1989	2.80	2252	2082	1359	1.69
1990	4.23	3405	2756	1363	1.69
1991	14.12	11352	10306	6365	7.91
1992	30.48	24508	23214	15472	19.24
1993	14.52	11673	8596	6923	8.61
1994[1]	4.82	3879	3702	2945	3.66
1995	9.05	7276	6379	4857	6.04
1996	13.01	10461	8083	5132	6.38
1997	9.26	7449	6344	4885	6.07
1998[2]	48.95	39367	15562	11444	14.23
1999	30.70	24692	15073	13669	17.00
2000	23.63	19003	10649	10172	12.65
2001	33.83	27204	17462	13336	16.58
2002	45.40	36510	17319	17091	21.25
2003	26.22	21087	13070	11589	14.41
2004	25.10	20182	12027	12081	15.02
2005	30.59	24599	10457	11642	14.48

[1] codend mesh-size 40 mm
[2] codend mesh-size 25 mm liner

Table 3. Total shrimp biomass estimated by strata (tons) in the years 1988-2005 on Flemish Cap surveys. Between 1988 and 2002 data were transformed by Warren's method.

Stratum	Depth (Fathoms)	1988	1989	1990	1991	1992	1993	1994[1]	1995	1996	1997	1998[2]	1999	2000	2001	2002	2003	2004	2005
1	70-80																3	0	
2	81-100											175			69	112	690	217	164
3	101-140				10					148	39	639	450	1486	2169	5527	1817	2107	1023
4	101-140											239	596	306	1099	1942	637	785	2395
5	101-140					8				26	110	1107	1948	2135	2782	2445	3780	867	695
6	101-140				32	2	5		20	422	161	2915	1142	657	2112	2951	1667	1250	883
7	141-200		30	400	1265	3763	2704	117	506	1336	988	4056	3072	2213	3006	4632	1521	3108	2607
8	141-200			88	248	1662	826	4	248	676	393	2402	2507	1140	2900	4257	1110	2043	4585
9	141-200	133	69	35			135		613	459	412	3981	1139	1110	1483	1754	819	673	583
10	141-200	275	75	321	2103	3235	1778	752	1315	1148	1099	7186	4052	2771	3760	3748	4685	2489	2447
11	141-200	263		148	1144	4096	1335	447	650	1235	1018	6049	3017	3005	4091	3460	3003	2350	2284
12	201-300	2170	505	512	2361	4654	2115	636	1201	1295	1195	2042	2127	1082	845	1468	378	1222	1510
13	201-300		66	64	89	38	136		28	687	554	1580	1465	43	620	217	23	230	689
14	201-300	618	375	623	995	2543		679	792	1076	426	3034	1717	689	843	2014	303	726	2155
15	201-300	963	451	855	2004	3605	2292	1078	1370	1278	478	2575	1156	1753	837	1108	483	993	1039
16	301-400	777	253	355	179	420	139	49	57	237	168	515	172	464	375	506	92	696	1099
17	301-400						35									3			5
18	301-400						175			43	9			6		44		42	42
19	301-400	134	359		792	388		118	467	397	404	887	109	121	229	311	61	366	402
20	401-500																	6	250
28	401-500																	52	130
33	401-500																		5
21	501-600																		0
34	501-600																		13

[1] codend mesh-size 40 mm
[2] codend mesh-size 25 mm liner

Table 4. Biomass of shrimp and percentage of total biomass in depths lesser than 140 fathoms (257 meters) from 1995 to 2005 surveys.

Year	1995	1996	1997	1998[1]	1999	2000	2001	2002	2003	2004	2005
Biomass (tons) **(< 140 fathoms)**	20	596	309	5075	4136	4584	8231	12978	8594	5226	5160
% of Total biomass **(< 140 fathoms)**	0%	6%	4%	13%	17%	24%	30%	36%	41%	26%	21%

[1] codend mesh-size 25 mm liner

Table 5. Shrimp length frequencies (x 10^5) and percentages by sex and maturity stage on Flemish Cap 2005.

LENGTH (mm CL)	MALES	FEMALES		
		Primiparous	Multiparous	Ovigerous
7.5	8			
8	17			
8.5	8			
9	18			
9.5	26			
10	8			
10.5	17			
11	70			
11.5	67			
12	192			
12.5	335			
13	537			
13.5	874			
14	1479			
14.5	2502	3		
15	4589	17		
15.5	7066	13		
16	9939	59		
16.5	9152	44		
17	8049	105		
17.5	5104	232	1	
18	2998	261	4	
18.5	1366	445		
19	774	528	37	
19.5	247	816	73	
20	217	929	144	
20.5	183	993	243	
21	151	1269	377	1
21.5	111	1276	511	
22	43	1255	722	1
22.5	14	953	669	2
23	7	770	893	1
23.5	3	394	856	5
24		275	956	5
24.5		181	826	3
25		116	600	3
25.5		43	507	1
26		34	320	3
26.5		7	203	1
27		2	128	
27.5		1	100	
28			50	
28.5			29	
29			6	
29.5			6	
30			4	
30.5			5	
31			2	
Total	56170	11021	8272	27
Percentage %	74.41%	14.60%	10.96%	0.04%

Table 6. Shrimp length frequencies (x 10^5) by strata in 2005 on Flemish Cap survey.

Length	STRATA																							Total
mm (CL)	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	28	33	34	
7.5		8																						8
8		8	8																					16
8.5		8																						8
9			17																					17
9.5		8					18																	26
10		8																						8
10.5	6	8			2																			16
11	9	3	25		5		22		3															67
11.5	15	21	8		10		5		4															63
12	38	46	17	9	13		31		15	2			11											182
12.5	48	68	17	25	21		90		27	5	12		7											320
13	147	72	62	7	51	23	59	6	34	26	6		21											514
13.5	187	105	140	47	72	26	74		72	48	21		41											833
14	218	146	151	78	104	60	311	16	158	55	22		90											1409
14.5	128	260	434	217	143	92	468	14	268	110	72	8	174		1									2389
15	99	500	823	235	239	263	1032	54	474	201	152	19	284	13	3			1						4392
15.5	37	497	1484	389	295	444	1742	47	657	444	352	52	281	16	10			1				1		6749
16	42	634	2130	235	327	857	2800	111	836	609	351	67	434	88	8			2				1		9532
16.5	18	549	1701	176	250	919	2413	80	722	705	492	168	383	151	27			11				2		8767
17	22	305	1286	72	206	1190	2180	74	513	694	312	243	359	275	28		1	15	1			2		7778
17.5	18	116	747	46	104	848	1285	80	317	514	340	163	193	255	26			36	1			2		5091
18	5	66	169	30	61	502	870	69	183	294	282	123	156	231	28			42	3			2		3116
18.5	2	40	174	11	23	300	287	61	136	169	126	81	90	157	34		1	33	4			3		1732
19	1	15	116	28	30	197	246	30	101	98	73	63	95	117	36		1	28	2			1		1278
19.5	1	23	38	66	27	142	234	44	133	78	85	58	53	62	21			18	5		1			1089
20	3	53	20	67	41	129	193	94	156	96	75	48	124	75	32		1	23	8		2	1		1241
20.5		58	36	54	60	142	200	70	164	104	157	54	102	64	56		1	30	10	1	3		1	1367
21		73	43	52	55	140	239	120	281	157	93	111	147	88	80		1	33	12		4		1	1730
21.5		48	72	69	58	195	314	82	184	177	148	89	171	98	70		1	33	12		6			1827
22		40	42	65	47	180	263	129	267	191	135	78	212	146	100		2	29	10		7		1	1944
22.5		46	6	48	60	180	117	42	197	193	141	83	188	136	105		1	17	9		5		4	1578
23		25	48	68	48	152	196	40	181	199	113	46	200	116	119		2	41	11		3		4	1612
23.5		18		41	78	103	86	16	180	168	93	40	205	66	68		2	36	13		6		1	1220
24		32		33	67	115	72	37	164	176	74	36	190	43	94		3	42	11		6		3	1198
24.5		27		12	43	104	69	12	101	127	76	17	193	61	76		3	43	17		8		1	990
25		11		2	20	46	40	18	72	90	52	8	154	38	90		3	42	23		10		1	720
25.5				7	22	66	17	6	40	56	39		107	9	117		4	32	30		12			564
26		8		12	19	5	8	6	20	40	17	11	73	5	83		4	28	27		12		1	379
26.5		8		5	8	11			26	28	8	1	17	4	72	1	4	10	19		11			233
27					13	4			18	9	4	4	6	1	55	1	4	5	16		8			148
27.5					5	14				4	5		16	8	35	1	3	5	14		9			119
28					2	2			2		2	2	7	3	21		2	4	11		7			65
28.5									3				4		19	1	1	1	8		5			42
29															4		1		6		5			16
29.5										2							1	3	3		3			12
30														3					2		2			7
30.5													4								1			5
31													2								1			3
Total	1044	3961	9814	2206	2629	7451	15981	1358	6709	5869	3930	1673	4794	2329	1518	4	47	644	288	1	137	15	18	72420

Table 7. Mean lengths by depth range on Flemish Cap surveys 2005

Strata	Depth range		Mean lengths (mm CL)
	Meters	Fathoms	
2	147-182	81-100	14.1
3 to 6	183-256	101-140	16.5
7 to 11	257-360	141-200	17.7
12 to 15	361-547	201-300	19.1
16 to 19	548-733	301-400	22.7
20 to 34	734-1464	401-800	24.5
Total	147-1464	80-800	17.8

Table 8. Shrimp length frequencies taken by the small mesh size bag attached to the cod-end in 2005 survey.

Length (CL) mm	Frequency
6.5	7
7	35
7.5	129
8	157
8.5	181
9	152
9.5	104
10	55
10.5	31
11	26
11.5	50
12	68
12.5	87
13	115
13.5	103
14	152
14.5	199
15	238
15.5	262
16	301
16.5	258
17	174
17.5	109
18	56
18.5	26
19	16
19.5	7
20	6
20.5	6
21	5
21.5	1
22	
22.5	3
23	
23.5	
24	
Total general	3119
Catch weight (gr)	7801
Sampled weigth (gr)	5200

Table 9. Shrimp modal groups and ages with Lofoten gear and bag in the codend in the 2004 on Flemish Cap survey interpreted from size distributions.

LOFOTEN

Age	Modal groups		Cohort
	Males	Females	
1	-	-	
2	12	-	R
3	16	-	P
4	19	19.5	O
5	-	22	N
6	-	24	M
7	-	-	

BAG ON THE CODEND

Age	Modal groups		Cohort
	Males	Females	
1	8	-	S
2	12.5	-	R
3	16	-	P

Table 10. Results from the modal analysis (MIX) for each sex/maturity group on EU Flemish Cap surveys 1988-2005.

1988

Sex and maturity group	Males		Females	
Age	*Prop.*	*St. Dev.*	*Prop.*	*St. Dev.*
1				
2				
3	0.069	0.004		
4	0.646	0.005		
5	0.285	0.003	0.501	0.007
6			0.456	0.005
7			0.043	0.004
Age	*Mean CL*	*St. Dev.*	*Mean CL*	*St. Dev.*
1				
2				
3	18.16	0.051		
4	20.30	0.012		
5	24.96	0.016	26.72	0.017
6			29.49	0.032
7			32.18	0.106
Age	*Sigma*	*St. Dev.*	*Sigma*	*St. Dev.*
1				
2				
3	0.817	Fixed CV		
4	0.913	Fixed CV		
5	1.123	Fixed CV	1.202	Fixed CV
6			1.327	Fixed CV
7			1.448	Fixed CV

1989

Sex and maturity group	Males		Females	
Age	*Prop.*	*St. Dev.*	*Prop.*	*St. Dev.*
1				
2				
3	0.008	0.001		
4	0.538	0.005	0.013	0.002
5	0.424	0.005	0.158	0.005
6	0.030	0.002	0.729	0.008
7			0.099	0.007
Age	*Mean CL*	*St. Dev.*	*Mean CL*	*St. Dev.*
1				
2				
3	15.40	0.071		
4	20.40	0.012	22.05	0.155
5	23.92	0.020	25.20	0.056
6	27.04	0.101	28.76	0.028
7			31.70	0.095
Age	*Sigma*	*St. Dev.*	*Sigma*	*St. Dev.*
1				
2				
3	0.693	Fixed CV		
4	0.918	Fixed CV	0.992	Fixed CV
5	1.076	Fixed CV	1.134	Fixed CV
6	1.217	Fixed CV	1.294	Fixed CV
7			1.427	Fixed CV

1990

Sex and maturity group	Males		Females	
Age	*Prop.*	*St. Dev.*	*Prop.*	*St. Dev.*
1				
2				
3				
4	0.936	0.001	0.187	0.004
5	0.031	0.004	0.592	0.007
6	0.033	0.004	0.210	0.006
7			0.011	0.003
8				
Age	*Mean CL*	*St. Dev.*	*Mean CL*	*St. Dev.*
1				
2				
3				
4	20.68	0.005	22.53	0.029
5	24.59	0.140	26.11	0.024
6	26.18	0.095	29.16	0.066
7			32.09	0.316
8				
Age	*Sigma*	*St. Dev.*	*Sigma*	*St. Dev.*
1				
2				
3				
4	0.886	Const. CV	1.013	Fixed CV
5	1.054	Const. CV	1.175	Fixed CV
6	1.122	Const. CV	1.312	Fixed CV
7			1.444	Fixed CV
8				

1991

Sex and maturity group	Males		Females	
Age	*Prop.*	*St. Dev.*	*Prop.*	*St. Dev.*
1				
2				
3	0.0635	0.004		
4	0.349	0.004		
5	0.587	0.002	0.051	0.003
6			0.703	0.004
7			0.185	0.005
8			0.060	0.006
Age	*Mean CL*	*St. Dev.*	*Mean CL*	*St. Dev.*
1				
2				
3	18.05	0.051		
4	19.96	0.012		
5	24.35	0.005	24.39	0.043
6			26.52	0.009
7			29.60	0.46
8			32.22	0.068
Age	*Sigma*	*St. Dev.*	*Sigma*	*St. Dev.*
1				
2				
3	0.729	0.024		
4	0.732	0.008		
5	0.947	0.004	0.861	Const. CV
6			0.936	Const. CV
7			1.045	Const. CV
8			1.102	Const. CV

Table 10 continued

1992

Sex and maturity group	Males		Primimarous females		Multiparous females	
Age	*Prop.*	*St. Dev.*	*Prop.*	*St. Dev.*	*Prop.*	*St. Dev.*
1						
2						
3	0.145	0.005				
4	0.133	0.005				
5	0.385	0.006			0.022	0.003
6	0.336	0.006	0.174	0.017	0.827	0.009
7			0.826	0.017	0.151	0.009
Age	*Mean CL*	*St. Dev.*	*Mean CL*	*St. Dev.*	*Mean CL*	*St. Dev.*
1						
2						
3	18.20	0.030				
4	19.74	0.035				
5	24.00	0.019			24.04	0.149
6	26.62	0.022	25.76	0.096	27.81	0.024
7			28.49	0.040	30.70	0.077
Age	*Sigma*	*St. Dev.*	*Sigma*	*St. Dev.*	*Sigma*	*St. Dev.*
1						
2						
3	0.663	Cons. CV				
4	0.719	Cons. CV				
5	0.875	Cons. CV			1.081	Fixed CV
6	0.970	Cons. CV	0.790	0.054	1.252	Fixed CV
7			1.062	0.027	1.381	Fixed CV

1993

Sex and maturity group	Males		Primimarous females		Multiparous females	
Age	*Prop.*	*St. Dev.*	*Prop.*	*St. Dev.*	*Prop.*	*St. Dev.*
1						
2						
3	0.651	0.001				
4	0.258	0.002	0.161	0.003	0.008	0.001
5	0.090	0.001	0.839	0.003	0.037	0.004
6					0.839	0.006
7					0.116	0.005
Age	*Mean CL*	*St. Dev.*	*Mean CL*	*St. Dev.*	*Mean CL*	*St. Dev.*
1						
2						
3	15.83	0.004				
4	20.25	0.007	21.89	0.023	21.00	0.063
5	23.77	0.018	25.74	0.010	23.86	0.087
6					26.21	0.011
7					28.32	0.035
Age	*Sigma*	*St. Dev.*	*Sigma*	*St. Dev.*	*Sigma*	*St. Dev.*
1						
2						
3	0.923	0.003				
4	0.951	0.007	0.985	Fixed CV	0.790	Cons. CV
5	1.059	0.013	1.158	Fixed CV	0.897	Cons. CV
6					0.986	Cons. CV
7					1.065	Cons. CV

1994

Sex and maturity group	Males		Primimarous females		Multiparous females	
Age	*Prop.*	*St. Dev.*	*Prop.*	*St. Dev.*	*Prop.*	*St. Dev.*
1						
2						
3	0.272	0.004				
4	0.524	0.009	0.078	0.004		
5	0.204	0.008	0.521	0.011	0.037	0.002
6			0.401	0.012	0.919	0.007
7					0.044	0.006
Age	*Mean CL*	*St. Dev.*	*Mean CL*	*St. Dev.*	*Mean CL*	*St. Dev.*
1						
2						
3	17.45	0.017				
4	21.59	0.016	22.53	0.045		
5	23.96	0.054	25.56	0.028	24.70	0.067
6			27.56	0.033	27.94	0.013
7					30.29	0.113
Age	*Sigma*	*St. Dev.*	*Sigma*	*St. Dev.*	*Sigma*	*St. Dev.*
1						
2						
3	1.004	0.014				
4	0.739	0.012	0.762	Cons. CV		
5	0.970	0.031	0.864	Cons. CV	0.927	Cons. CV
6			0.932	Cons. CV	1.049	Cons. CV
7					1.137	Cons. CV

1995

Sex and maturity group	Males		Primimarous females		Multiparous females	
Age	*Prop.*	*St. Dev.*	*Prop.*	*St. Dev.*	*Prop.*	*St. Dev.*
1						
2						
3	0.454	0.002				
4	0.516	0.002				
5	0.031	0.001	0.484	0.005	0.088	0.003
6			0.516	0.005	0.453	0.007
7					0.459	0.008
Age	*Mean CL*	*St. Dev.*	*Mean CL*	*St. Dev.*	*Mean CL*	*St. Dev.*
1						
2						
3	16.58	0.007				
4	21.39	0.006				
5	24.71	0.027	22.71	0.015	23.35	0.045
6			25.92	1.167	26.19	0.033
7					28.62	0.023
Age	*Sigma*	*St. Dev.*	*Sigma*	*St. Dev.*	*Sigma*	*St. Dev.*
1						
2						
3	1.043	0.006				
4	0.905	0.006				
5	0.666	0.020	1.022	Fixed CV	1.051	Fixed CV
6			1.167	Fixed CV	1.179	Fixed CV
7					1.288	Fixed CV

Table 10 continued

1996

Sex and maturity group	Males		Primimarous females		Multiparous females	
Age	*Prop.*	*St. Dev.*	*Prop.*	*St. Dev.*	*Prop.*	*St. Dev.*
1						
2	0.281	0.001				
3	0.704	0.001				
4	0.015	0.000	0.420	0.004	0.129	0.008
5			0.547	0.005	0.512	0.047
6			0.033	0.004	0.204	0.027
7					0.156	0.056
Age	*Mean CL*	*St. Dev.*	*Mean CL*	*St. Dev.*	*Mean CL*	*St. Dev.*
1						
2	14.44	0.007				
3	20.63	0.004				
4	24.73	0.042	21.84	0.014	23.30	0.057
5			24.85	0.020	25.65	0.105
6			27.27	0.116	27.49	0.559
7					29.57	0.369
Age	*Sigma*	*St. Dev.*	*Sigma*	*St. Dev.*	*Sigma*	*St. Dev.*
1						
2	1.200	0.006				
3	1.143	0.004				
4	0.862	0.028	0.983	Fixed CV	1.049	Fixed CV
5			1.118	Fixed CV	1.154	Fixed CV
6			1.227	Fixed CV	1.237	Fixed CV
7					1.250	Fixed CV

1997

Sex and maturity group	Males		Primimarous females		Multiparous females	
Age	*Prop.*	*St. Dev.*	*Prop.*	*St. Dev.*	*Prop.*	*St. Dev.*
1						
2	0.123	0.002				
3	0.564	0.004				
4	0.313	0.003	0.214	0.006	0.068	0.015
5			0.786	0.006	0.360	0.012
6					0.503	0.015
7					0.069	0.004
Age	*Mean CL*	*St. Dev.*	*Mean CL*	*St. Dev.*	*Mean CL*	*St. Dev.*
1						
2	15.72	0.037				
3	19.69	0.009				
4	23.17	0.015	22.72	0.029	22.67	0.139
5			24.94	0.011	24.34	0.092
6					26.48	0.048
7					29.32	0.076
Age	*Sigma*	*St. Dev.*	*Sigma*	*St. Dev.*	*Sigma*	*St. Dev.*
1						
2	1.351	0.026				
3	1.014	0.010				
4	1.039	0.011	1.022	Fixed CV	1.020	Fixed CV
5			1.122	Fixed CV	1.095	Fixed CV
6					1.191	Fixed CV
7					1.319	Fixed CV

1998

Sex and maturity group	Males		Primimarous females		Multiparous females	
Age	*Prop.*	*St. Dev.*	*Prop.*	*St. Dev.*	*Prop.*	*St. Dev.*
1	0.009	0.000				
2	0.536	0.002				
3	0.410	0.002	0.345	0.004		
4	0.045	0.001	0.155	0.011	0.183	0.012
5			0.581	0.011	0.439	0.026
6			0.229	0.010	0.350	0.026
7					0.028	0.103
Age	*Mean CL*	*St. Dev.*	*Mean CL*	*St. Dev.*	*Mean CL*	*St. Dev.*
1	10.32	0.060				
2	14.24	0.006				
3	18.92	0.008	18.58	0.106		
4	21.98	0.030	20.77	0.104	22.08	0.068
5			22.90	0.046	24.56	0.106
6			25.96	0.051	26.61	0.133
7					29.03	0.331
Age	*Sigma*	*St. Dev.*	*Sigma*	*St. Dev.*	*Sigma*	*St. Dev.*
1	0.840	0.039				
2	1.077	0.005				
3	1.141	0.009	0.836	Fixed CV		
4	1.000	fixed	0.934	Fixed CV	0.994	Fixed CV
5			1.031	Fixed CV	1.105	Fixed CV
6			1.137	Fixed CV	1.197	Fixed CV
7					1.306	Fixed CV

1999

Sex and maturity group	Males		Primimarous females		Multiparous females	
Age	*Prop.*	*St. Dev.*	*Prop.*	*St. Dev.*	*Prop.*	*St. Dev.*
1						
2	0.142	0.004	0.005	0.001		
3	0.711	0.009	0.042	0.023	0.010	0.004
4	0.146	0.007	0.771	0.100	0.185	0.054
5			0.181	0.082	0.523	0.047
6					0.271	0.014
7					0.011	0.005
Age	*Mean CL*	*St. Dev.*	*Mean CL*	*St. Dev.*	*Mean CL*	*St. Dev.*
1						
2	14.42	0.026	14.53	0.106		
3	17.68	0.016	19.18	0.495	19.77	0.327
4	21.00	0.067	22.03	0.108	22.12	0.233
5			24.30	0.387	23.57	0.127
6					26.09	0.092
7					28.66	0.436
Age	*Sigma*	*St. Dev.*	*Sigma*	*St. Dev.*	*Sigma*	*St. Dev.*
1						
2	0.755	0.016	0.711	0.103		
3	1.182	0.020	0.989	0.184	0.890	Fixed CV
4	1.158	0.033	1.180	0.109	0.995	Fixed CV
5			1.088	0.111	1.061	Fixed CV
6					1.174	Fixed CV
7					1.290	Fixed CV

Table 10 continued

2000

Sex and maturity group	Males		Primimarous females		Multiparous females	
Age	*Prop.*	*St. Dev.*	*Prop.*	*St. Dev.*	*Prop.*	*St. Dev.*
1	0.004	0.000				
2	0.045	0.001				
3	0.708	0.009	0.011	0.002	0.004	0.001
4	0.244	0.009	0.454	0.016	0.125	0.026
5			0.335	0.013	0.469	0.024
6			0.201	0.009	0.293	0.248
7					0.109	0.017
Age	*Mean CL*	*St. Dev.*	*Mean CL*	*St. Dev.*	*Mean CL*	*St. Dev.*
1	10.34	0.070				
2	14.43	0.035				
3	18.27	0.019	17.69	0.152	17.12	0.272
4	20.24	0.035	20.56	0.037	21.33	0.148
5			22.44	0.076	23.10	0.131
6			24.86	0.050	25.18	0.187
7					27.36	0.146
Age	*Sigma*	*St. Dev.*	*Sigma*	*St. Dev.*	*Sigma*	*St. Dev.*
1	0.593	Cons. CV				
2	0.828	Cons. CV				
3	1.049	Cons. CV	0.796	Fixed CV	0.771	Fixed CV
4	1.162	Cons. CV	0.925	Fixed CV	0.960	Fixed CV
5			1.010	Fixed CV	1.039	Fixed CV
6			1.119	Fixed CV	1.133	Fixed CV
7					1.231	Fixed CV

2001

Sex and maturity group	Males		Primimarous females		Multiparous females	
Age	*Prop.*	*St. Dev.*	*Prop.*	*St. Dev.*	*Prop.*	*St. Dev.*
1						
2	0.085	0.005				
3	0.475	0.004	0.018	0.003		
4	0.439	0.003	0.109	0.013	0.237	0.015
5			0.711	0.013	0.548	0.014
6			0.162	0.011	0.195	0.008
7					0.020	0.004
Age	*Mean CL*	*St. Dev.*	*Mean CL*	*St. Dev.*	*Mean CL*	*St. Dev.*
1						
2	14.19	0.047				
3	16.49	0.023	18.71	0.149		
4	20.30	0.017	20.92	0.148	21.39	0.058
5			22.89	0.040	23.35	0.049
6			25.12	0.064	26.23	0.081
7					29.11	0.225
Age	*Sigma*	*St. Dev.*	*Sigma*	*St. Dev.*	*Sigma*	*St. Dev.*
1						
2	1.003	Cons. CV				
3	1.166	Cons. CV	0.842	Fixed CV		
4	1.436	Cons. CV	0.941	Fixed CV	0.963	Fixed CV
5			1.030	Fixed CV	1.051	Fixed CV
6			1.130	Fixed CV	1.180	Fixed CV
7					1.310	Fixed CV

2002

Sex and maturity group	Males		Primimarous females		Multiparous females	
Age	*Prop.*	*St. Dev.*	*Prop.*	*St. Dev.*	*Prop.*	*St. Dev.*
1	0.030	0.001				
2	0.181	0.003				
3	0.736	0.010	0.207	0.006		
4	0.053	0.008	0.475	0.008	0.054	0.008
5			0.318	0.008	0.571	0.024
6					0.319	0.023
7					0.056	0.009
Age	*Mean CL*	*St. Dev.*	*Mean CL*	*St. Dev.*	*Mean CL*	*St. Dev.*
1	10.21	0.023				
2	15.10	0.022				
3	18.22	0.010	19.67	0.029		
4	20.95	0.287	22.05	0.032	20.89	0.122
5			24.31	0.029	23.13	0.063
6					24.99	0.117
7					27.37	0.147
Age	*Sigma*	*St. Dev.*	*Sigma*	*St. Dev.*	*Sigma*	*St. Dev.*
1	0.925	0.020				
2	0.870	0.014				
3	1.085	0.012	0.885	Fixed CV		
4	1.663	0.011	0.992	Fixed CV	0.940	Fixed CV
5			1.094	Fixed CV	1.041	Fixed CV
6					1.125	Fixed CV
7					1.231	Fixed CV

2003

Sex and maturity group	Males		Primimarous females		Multiparous females	
Age	*Prop.*	*St. Dev.*	*Prop.*	*St. Dev.*	*Prop.*	*St. Dev.*
1	0.005	0.000				
2	0.421	0.005				
3	0.574	0.005	0.060	0.003	0.012	0.002
4			0.364	0.014	0.264	0.009
5			0.509	0.014	0.517	0.009
6			0.066	0.044	0.198	0.005
7					0.009	
Age	*Mean CL*	*St. Dev.*	*Mean CL*	*St. Dev.*	*Mean CL*	*St. Dev.*
1	9.27	0.104				
2	15.47	0.018				
3	19.57	0.018	17.60	0.050	18.27	0.130
4			20.76	0.044	21.38	0.043
5			22.74	0.040	23.81	0.047
6			25.78	0.084	26.32	0.097
7					28.72	0.490
Age	*Sigma*	*St. Dev.*	*Sigma*	*St. Dev.*	*Sigma*	*St. Dev.*
1	1.063	0.092				
2	1.146	0.013				
3	1.358	0.013	0.792	Fixed CV	0.822	Fixed CV
4			0.934	Fixed CV	0.962	Fixed CV
5			1.023	Fixed CV	1.071	Fixed CV
6			1.160	Fixed CV	1.185	Fixed CV
7					1.292	Fixed CV

Table 10 continued

2004

Sex and maturity group	Males		Primimarous females		Multiparous females	
Age	*Prop.*	*St. Dev.*	*Prop.*	*St. Dev.*	*Prop.*	*St. Dev.*
1						
2	0.760	0.004				
3	0.229	0.005	0.148	0.005	0.012	0.002
4	0.012	0.002	0.498	0.014	0.218	0.022
5			0.354	0.015	0.585	0.018
6					0.160	0.048
7					0.025	0.065
Age	*Mean CL*	*St. Dev.*	*Mean CL*	*St. Dev.*	*Mean CL*	*St. Dev.*
1						
2	14.38	0.014				
3	18.92	0.023	19.28	0.038	19.36	0.194
4	22.27	0.261	22.17	0.041	22.14	0.104
5			24.11	0.043	24.09	0.091
6					26.69	0.565
7					27.96	0.550
Age	*Sigma*	*St. Dev.*	*Sigma*	*St. Dev.*	*Sigma*	*St. Dev.*
1						
2	1.497	0.010				
3	1.121	0.027	0.868	Fixed CV	0.871	Fixed CV
4	1.144	0.126	0.998	Fixed CV	0.996	Fixed CV
5			1.085	Fixed CV	1.084	Fixed CV
6					1.201	Fixed CV
7					1.258	Fixed CV

2005

Sex and maturity group	Males		Primimarous females		Multiparous females	
Age	*Prop.*	*St. Dev.*	*Prop.*	*St. Dev.*	*Prop.*	*St. Dev.*
1						
2	0.022	0.001				
3	0.955	0.001	0.055	0.004		
4	0.023	0.001	0.287	0.009	0.089	0.022
5			0.581	0.009	0.380	0.023
6			0.077	0.006	0.492	0.030
7					0.038	0.005
Age	*Mean CL*	*St. Dev.*	*Mean CL*	*St. Dev.*	*Mean CL*	*St. Dev.*
1						
2	12.75	0.045				
3	16.52	0.006	17.51	0.061		
4	20.18	0.071	19.84	0.044	21.13	0.156
5			22.09	0.031	22.82	0.139
6			24.48	0.082	24.68	0.074
7					27.56	0.157
Age	*Sigma*	*St. Dev.*	*Sigma*	*St. Dev.*	*Sigma*	*St. Dev.*
1						
2	0.886	Cons. CV				
3	1.148	Cons. CV	0.788	Fixed CV		
4	1.402	Cons. CV	0.893	Fixed CV	0.951	Fixed CV
5			0.994	Fixed CV	1.027	Fixed CV
6			1.101	Fixed CV	1.111	Fixed CV
7					1.240	Fixed CV

Table 10 continued

Year Age-class	1988	1989	1990	1991	1992	1993	1994[1]	1995	1996	1997	1998[2]	1999	2000	2001	2002	2003	2004	2005	Mean CL
1											10.3	8.5	10.3	10.5	10.2	9.3			10.2
2									14.4	15.7	14.2	14.4	14.4	14.2	15.1	15.5	14.4	12.8	14.5
3	18.2	15.4		18.0	18.2	15.8	17.4	16.8	20.6	19.7	18.9	17.7	18.3	16.5	18.3	19.5	19.0	16.5	18.0
4	20.3	20.4	20.8	20.0	19.7	20.4	21.6	21.5	22.6	23.0	21.8	21.7	20.4	20.4	21.7	21.1	22.2	20.1	21.1
5	26.3	24.2	25.9	24.4	24.0	24.2	24.8	23.0	25.3	24.8	23.5	23.8	22.7	23.1	23.7	23.3	24.1	22.3	23.6
6	29.5	28.7	28.8	26.5	27.3	26.3	27.9	26.0	27.5	26.5	25.9	26.1	25.0	25.6	25.0	26.2	26.7	24.6	26.4
7	32.2	31.7	32.1	29.6	29.2	28.3	30.3	28.4	29.6	29.3	29.0	28.7	27.4	29.1	27.4	28.7	28.0	27.6	28.9
8				31.2															31.2
Total (mm)	26.4	25.2	22.5	24.9	26.2	21.4	25.3	23.0	21.5	23.1	18.1	20.1	20.5	20.1	19.6	20.2	18.9	18.5	20.0

[1]Codend mesh-size 40 mm.
[2]Codend mesh-size 25 mm.

Table 12. Abundance (10^5) at age by years on EU Flemish Cap surveys.

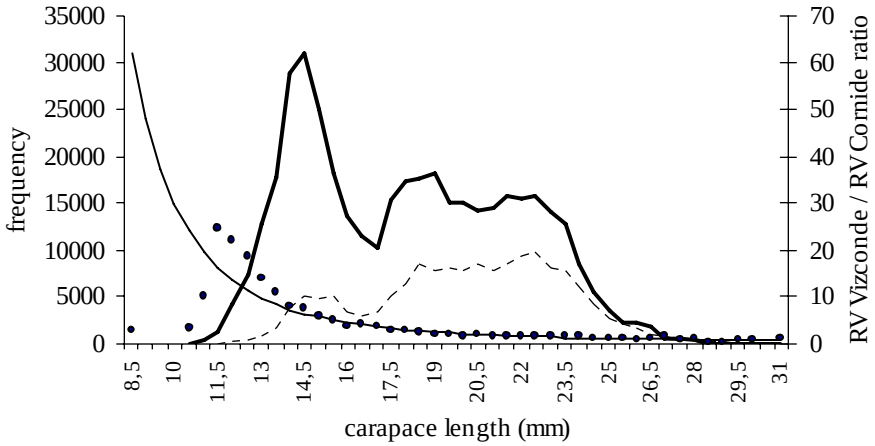
Year Age-class	1988	1989	1990	1991	1992	1993	1994[1]	1995	1996	1997	1998[2]	1999	2000	2001	2002	2003	2004	2005
1											944	13	89	28	1806	142		
2									3424	629	54968	4735	1069	3321	11004	12572	27415	1271
3	133	11		472	1586	7878	427	2431	8571	2894	42349	23924	17044	18773	47872	17744	9603	54623
4	1232	821	4039	2596	1459	3760	875	2764	1530	2410	7073	14962	10740	20148	11276	5484	6425	5211
5	2334	809	919	4654	4396	2052	726	1203	2730	3218	7891	6008	5721	11844	10467	9073	7831	9618
6	1631	828	331	3885	11289	4458	1806	2146	648	1152	4136	2043	3488	3232	3112	2426	1330	4996
7	153	108	15	1025	3975	492	75	1217	437	158	152	81	605	156	545	85	206	317
8				332														
total ('00000)	5482	2578	5304	12964	22705	18641	3909	9760	17339	10461	117514	51766	38757	57501	86082	47526	52810	76035

[1]Codend mesh-size 40 mm.
[2]Codend mesh-size 25 mm.

Table 13. Biomass estimated (tons) at age by years on EU Flemish Cap surveys.

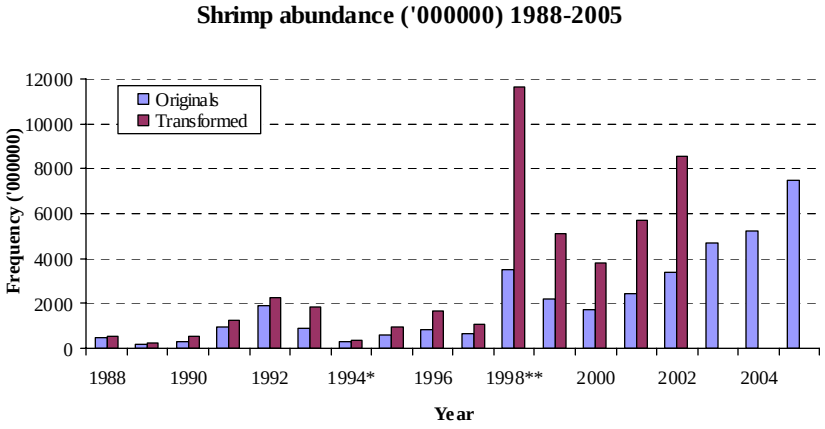
Year Age-class	1988	1989	1990	1991	1992	1993	1994[1]	1995	1996	1997	1998[2]	1999	2000	2001	2002	2003	2004	2005
1											60	0.5	6	2	114	6		
2									609	139	9039	832	183	572	2178	2541	4660	130
3	44	2		166	610	2144	145	685	4552	1270	16203	7811	5924	5018	16710	7134	3730	12450
4	575	387	2053	1214	705	2083	554	1658	1071	1705	4099	9016	5233	9992	6436	2762	3969	2180
5	2377	626	888	3843	3683	1823	681	892	2703	2853	5719	4784	3838	8321	7758	6197	6206	5566
6	2334	1053	436	4094	13637	4948	2374	2313	827	1249	4038	2138	3112	3087	2696	2339	1430	3920
7	285	183	28	1478	5801	675	124	1728	700	234	207	112	706	215	616	108	254	351
8				557														
total (ton.)	5615	2252	3405	11352	24436	11673	3879	7276	10461	7449	39365	24695	19002	27206	36508	21087	20248	24598

[1]Codend mesh-size 40 mm.
[2]Codend mesh-size 25 mm.



Warren's Model parameters	α	β	δ
	15.4762	-5.8907	0.1481

Fig. 1. Results of the calibration R/V *Vizconde de Eza* - R/V *Cornide de Saavedra*. Length frequencies taken with the R/V *Cornide de Saavedra* (break line) and R/V *Vizconde de Eza* (bold line). Ratio plot (dotted line) and fitted curve by Warren's model ($Ratio = \alpha\, l^{\beta}\, e^{\delta l}$).



*Abundance underestimated (codend mesh size 40 mm.)
** Abundance overestimated (codens mesh size 25 mm)

Fig. 2. Shrimp abundance (millions of individuals) in the EU series of bottom trawl research surveys carried out on Flemish Cap 1988-2005. In blue colour are shown the original frequencies obtained by the *R/V Cornide de Saavedra* (1988-2002) and the *R/V Vizconde de Eza* (2003-2005). In red colour are shown the transformed frequencies by Warren's method from *R/V Cornide Saavedra* period.

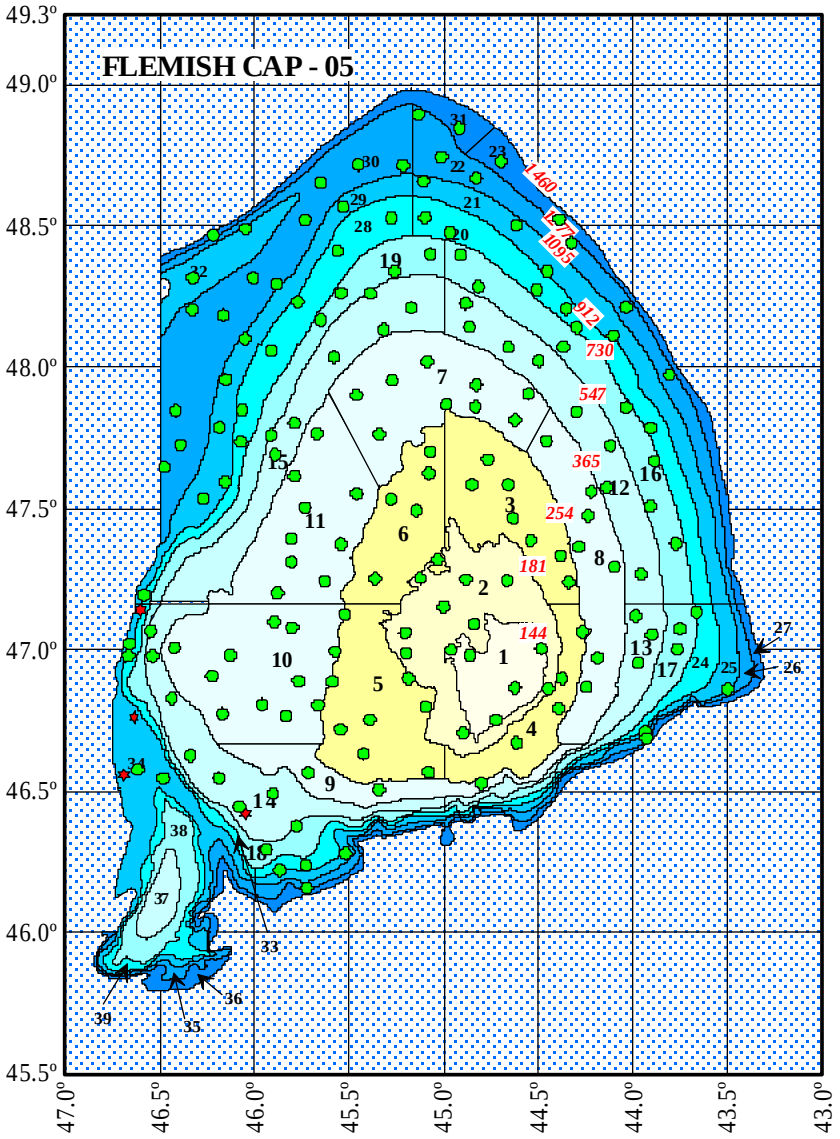


Fig. 3. Chart with the positions of the hauls carried out in Flemish Cap survey of 2005.

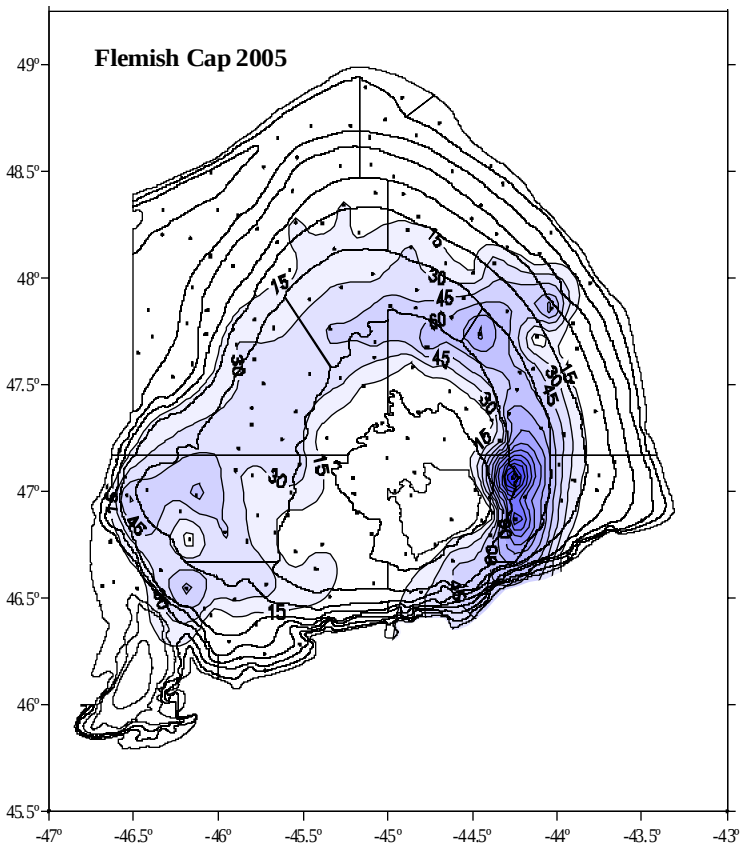


Fig. 4. Shrimp catches distribution (kg/tow) on Flemish Cap survey in summer 2005

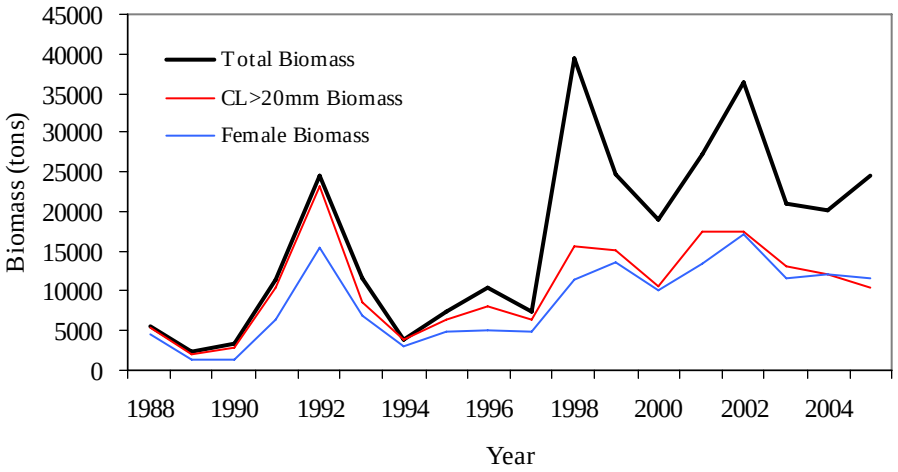


Fig. 5. Total biomass, female biomass and biomass for shrimp bigger than 20 mm CL (adult stock) from Flemish Cap 1988-2005 surveys.

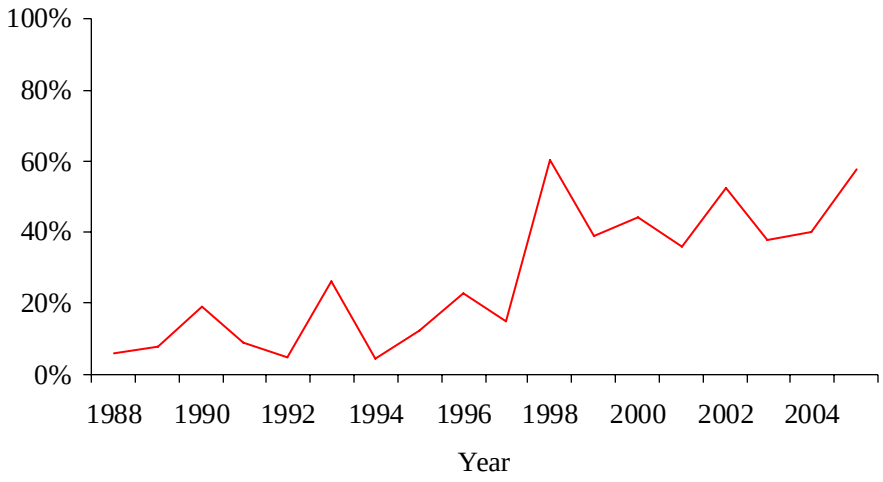


Fig. 6. Difference between total biomass and adult stock (>20 mm.) biomass as percentage of total biomass.

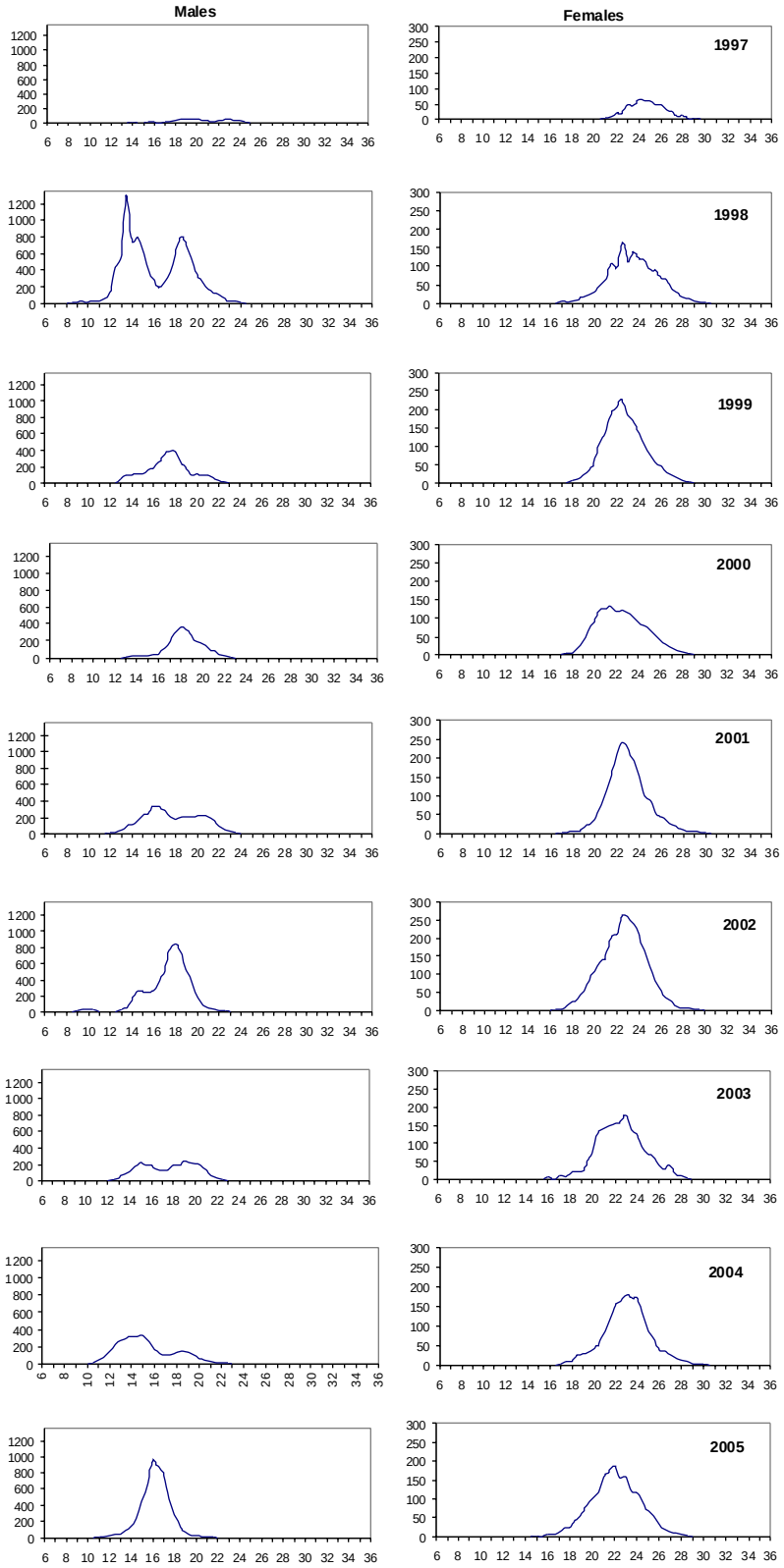


Fig. 7. Shrimp size distribution on Flemish Cap 1997-2005 surveys. Y-Axis=Frequency (10^6), X-Axis=Carapace Length (mm).

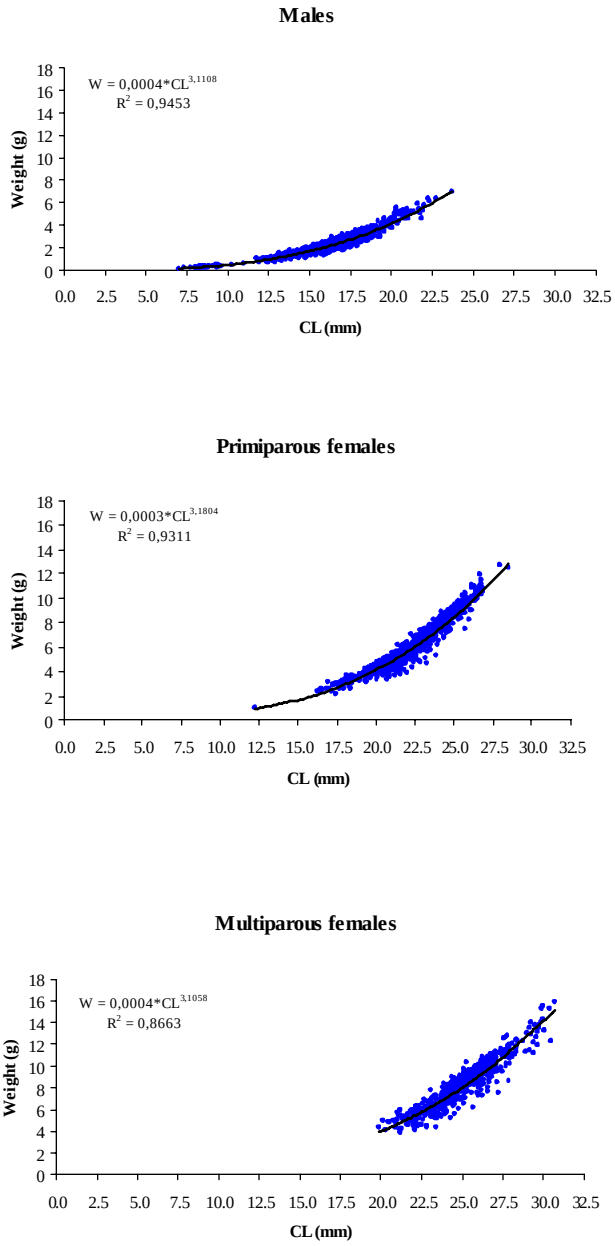


Fig. 8. Shrimp length-weight relationships by sex and maturity states in 2005 on Flemish Cap survey.

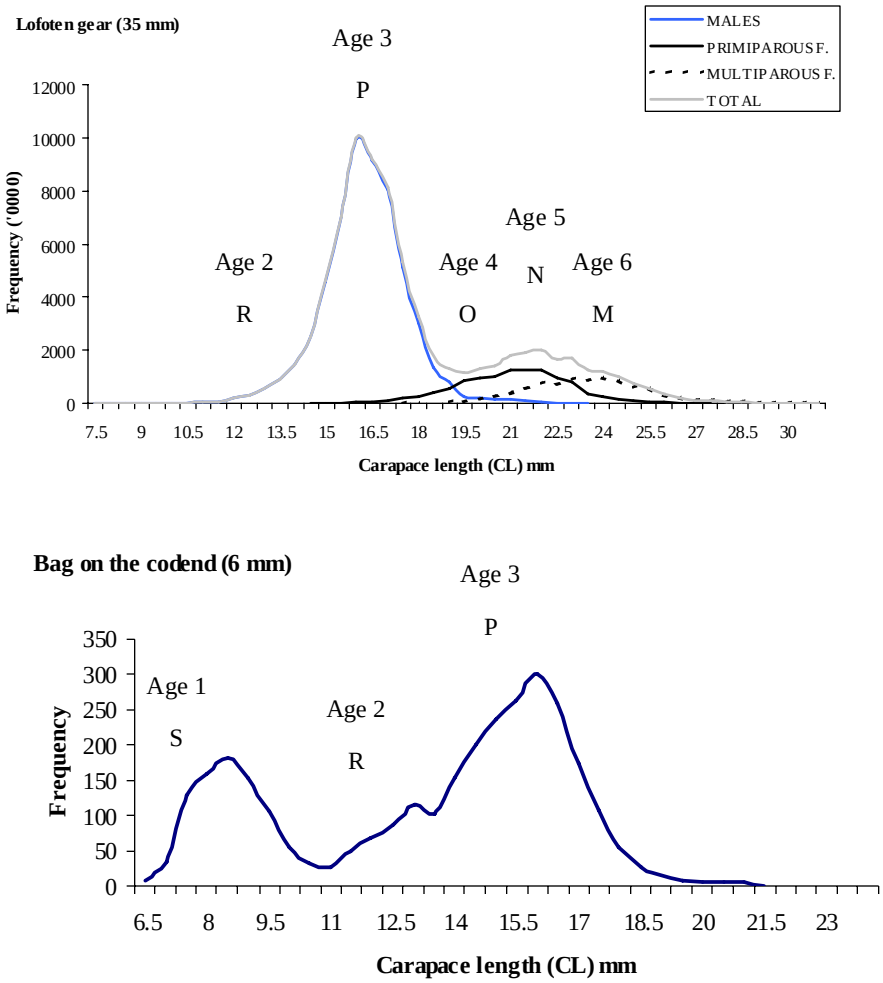


Fig. 9. Shrimp modal and age groups in the 2005 survey on Flemish Cap (letters from table 9).

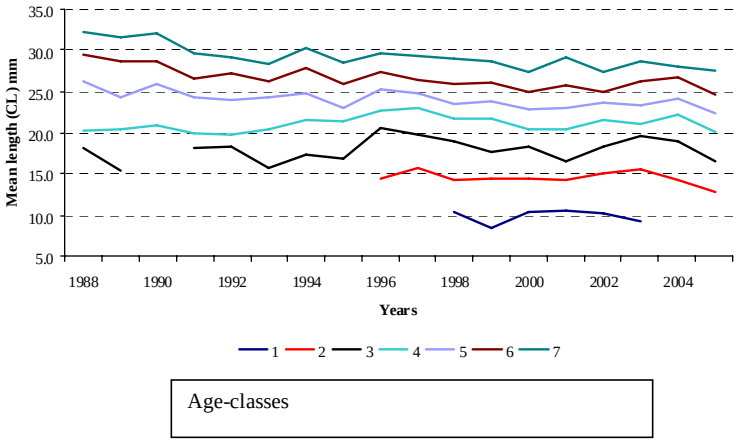


Fig. 10. Shrimp mean lengths at age in the series of EU surveys on Flemish Cap.