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Northern Shrimp (*Pandalus borealis*) on Flemish Cap in July 2001

by

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Abstract

Results on shrimp from the survey on Flemish Cap in 2001 are presented and compared to those from previous surveys of the same series. The female biomass remains at a high level, and it is dominated by age 4 shrimp.

A comparative trial between the Lofoten gear, the one used in the survey series, and a Campelen gear, indicates that the catch in weight of shrimp is around 7 times bigger in the second gear. The Campelen gear also catches large amounts of small shrimp due to its smaller cod-end mesh size.

Keywords: Shrimp, Flemish Cap, survey.

Material and methods

The survey was carried out from July 3rd to 20th following the same procedures as in previous years (Saborido-Rey and Vázquez, 2001). The Lofoten gear used was the same as in previous surveys, with a cod-end mesh size of 35 mm.

Samples of approximately one-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 immature (first time spawners) and matures (spawned previously) based on the condition of the external spines (McCrary, 1971). Ovigerous females were considered as a group and were not included with mature 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. Sampling length data were used to obtain an estimate of population length distribution in all the area and to compare it with the estimates of the other years.

7079 individuals were weighed to the nearest 0.1 g after a little draining time to calculate the length-weight relationship.

In order to compare the catchability of both Lofoten and Campelen gears, 20 additional bottom trawls were made with a Campelen gear with a cod-end mesh size of 20 mm, repeating previous Lofoten hauls. Main results on the shrimp stock status in the present paper came from the survey with the Lofoten gear as in previous years. Data

obtained with Campelen gear have been used to compare gear catchability and length distribution in both types of gears.

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.

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 73 kg).

Biomass

Total shrimp biomass, estimated by swept area method and average catch per mile from 1988 to 2001, are presented in Table 1. The biomass index obtained this year, 14,106 tons, is the third highest in the series.

The presence of shrimp in the shallowest strata, with depths less than 257 m (140 fathoms), increased from 1,709 tons in 1999 to 1,875 tons in 2000 and 3,458 tons in 2001 (Table 2). The presence of shrimp in shallowest water (stratum 1-6) 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 was considerably high, as a probably consequence of the abundance of the youngest age classes.

Biomass distribution observed during the survey is presented in Fig. 1. The results show that shrimp occurred mainly in intermediate depths (between 253 m and 547 m) (141-300 fathoms), where catches never exceeded 15 kg / tow. The three highest catches (73, 66 and 64 Kg) occurred at intermediate depth strata.

Adult stock, female biomass

Total biomass estimates by the series of bottom trawl surveys on Flemish Cap from 1988 to 2001 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 Río, 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.

The adult biomass estimates are compared in Fig. 2 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 1.7 % 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. Since then differences were greater than 20 % in all cases, the highest observed rates for a 35 mm cod-end mesh size. It was attributed to some increase in small shrimp abundance (Bruno, 2000).

The female biomass, as well as the adult biomass, appears more stable than the survey total biomass index and it is presumably free of mesh size effects. Female biomass and adult biomass reached a relative high level since 1988. Adult biomass in 2001 reached the second high in the series.

Length frequencies

Length frequencies and percentages by sex from the 2001 survey are shown in Table 3. These length frequencies are split into males, immature females, mature females and ovigerous females. The 2001 survey catches contained 50.9% males and 49.1% females (28.08% immature, 21.00% matures and 0.02% ovigerous). The percentage of ovigerous females is smaller than in the last two years, because the survey finished on July 20th, 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 10.0 and 25.5 mm. Females presented a CL between 16.5 and 35.5 mm comprising the groups: 16.5-31.0 mm immature, 17.0-35.5 mm mature and 19.0-27.5 mm ovigerous.

Length frequencies by strata are shown in Table 4. The older animals have generally a tendency to be more numerous at greater depths (Skúladóttir, 2000).

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	
3 to 11	183-360	101-200	10.0
12 to 15	361-547	201-300	14.5
16 to 19	548-725	301-400	20.0

Figure 3 shows shrimp length distribution on Flemish Cap from 1993 to 2001. Modal groups named with the same letter belong to the same year-class (Table 8b). 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.

Mean weights by length-class

Mean weight by length-class of shrimp for years 1989-2001 is shown in Table 5. It was observed that mean weights of this year are roughly equal or lightly higher than those observed in 2000, but well bellow the maximum weights observed in the 1992-1996 period.

Comparison of Lofoten and Campelen gears

To compare catchability of Campelen and Lofoten gears, 20 hauls were made with both gears. Haul positions were selected to cover the widest possible depth range. Each haul was repeated with the other gear in less than 24 hours. The test we use to compare catchability is a straightforward tow by tow comparison, without taking into account the stratified scheme of the random survey. However, catches were transformed for analysis to their values per mile, dividing the catch by the towed distance, taking into account the difference in towing speed of both gears: 3.5 knots for the Lofoten and 3.0 knots for the Campelen.

Campelen gear is more effective than Lofoten for all shrimp sizes but two factors must be taken into account: the difference in gear design and the difference in mesh size of the cod-end. The gear design might determine the catchability on the whole stock. The Campelen gear has a vertical opening of around 5 m and, consequently, it capture individuals that lives in the waters separated of the substratum more than 3 m. The vertical opening of the Lofoten gear is around 3 m, and it cannot capture the individuals more separated of the ground, consequently, it's possible that part of the population is underestimated, independently of the mesh size of each gear. The cod-end mesh size of both Lofoten and Campelen gears are 35 and 20 mm respectively and it may determine the retention of small size shrimp. It was observed in this trial, as well in previous surveys, that the Campelen gear retains much more smallest size shrimps than Lofoten gear (Garabana, 1999).

Table 6 shows length frequencies and percentages by sex in the 20 comparative hauls made with the Campelen and Lofoten (the one used in the survey) gears. Campelen catches contained 76% males and 24% females, compared with 54% and 46% respectively from the Lofoten gear.

The catch ratio between both gears was 7.95, but this ratio is influenced by the two factors already cited (gears design and cod-end selectivity). The 50% selectivity for the shrimp and a 35 mm mesh size used in the Lofoten gear would be around 18 mm CL. So, taking only into account the fully recruited portion of the catch of both gears, that is, those shrimps bigger than 20 mm CL (roughly the female stock), the biomass ratio is 5.98. This means that the Campelen gear is about six times more efficient to catch shrimp, and the difference from 5.98 to 7.95 is an effect of the different mesh size. Similar comparative trials were carried out in 1999 and 2000 surveys with the following results:

	Ratio for total catch	Ratio for 20 > mm CL catch
1999	5.00	2.60
2000	7.14	4.98
2001	7.95	5.98

For shrimp less than 20 mm CL, the Lofoten gear appears very inefficient due to its biggest cod-end mesh size. Even it was not calculated, the catch in number ratio between both gears must be much higher than the catch in weight ratio due to the contribution of the small size shrimp in the Campelen catch.

Table 6 and Fig. 4 show shrimp length distribution obtained with both Lofoten and Campelen gears. Length distribution of each gear was calculated adding the observed length frequency per mile of each haul. The distribution is based on the 20 hauls of the trial, which are considered an scarce and skew sample of the stock, so no quantitative conclusion can be derived for the whole bank from those frequencies. Both distributions show the same modal classes: 16.0, 19.0-19.5, 22.0 and 26.0-26.5 mm, but the occurrence of small sizes shrimp in the Campelen gear is much higher that in the Lofoten gear. Even more, an additional modal class of 9.5 mm CL is only observed in the Campelen catch.

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, and those 20 additional hauls made with a Campelen gear for the comparative trial cannot be used for a quantitative analysis. 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 year survey and in the current one. Total catch and length frequencies are presented in Table 7. Length distribution is presented in Fig. 5, joint to results from the 2000 survey. The catch in 2001 was roughly one half of the catch in 2000, both in weight and number.

In order to have a better length distribution than that provide for the survey, including some insight into the smallest size groups, information is available from the following sources:

i - survey: 120 hauls with the Lofoten gear. Total biomass estimates (Table 3).
ii - small mesh size bag attached to the Lofoten cod-end. 120 hauls, absolute values (Table 7)
iii - 20 hauls with the Lofoten gear, comparative trial. Absolute values (Table 6)
iv - 20 hauls with the Campelen gear, comparative trial. Absolute values (Table 6)

The Lofoten gear clearly catches one more modal group than the Lofoten gear. Accepting that length distribution obtained with the Campelen gear is wider and more representative that the one resulting from the Lofoten gear, an exercise was made to explore the conversion of Lofoten results in the equivalent Campelen distribution. In Fig. 6, sampling frequencies from the survey with the Lofoten gear (source i) were combined with sampling frequencies from the small mesh size bag (source ii) trying to get the best fit to length frequencies observed with the Campelen gear (source iv). The best fit corresponds to the relationship:

$$frec._{CAMPELEN\ (iv)} = frec._{SURVEY\ (i)} \times 4.5 \times 10^{-5} + frec._{BAG\ (ii)} \times 280$$

The same exercise made with data of the 2000 survey produced:

$$frec._{CAMPELEN\ (iv)} = frec._{SURVEY\ (i)} \times 8 \times 10^{-5} + frec._{BAG\ (ii)} \times 150$$

In both cases the fit was reasonably good, which indicate that all devices are consistently sampling the same population. The catch of the bag could be used as an index of recruitment and, also, it could be incorporated to the survey distribution if these previous relationships prove to be consistent. The combination of a Lofoten gear with a bag on the cod-end could be valuable to estimate length distribution for the widest range of modal groups (Bruno, 2000).

Age structure

Table 8a, b and Fig. 7 show modal groups and age interpretation of shrimp from length distribution of the two gears and one bag used. Age was deduced from previous interpretation and independently for each gear. Length distribution of Campelen catch shows modal groups at ages 1 to 7, although the youngest modal group (age 1) is scarcely represented. Age 1 is also absent in Lofoten gear, but it is well represented on the bag catch.

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Table 1. Average shrimp catch per towed mile in the years 1988-2001 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	16,844	10,476	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

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

Table 2. Total shrimp biomass estimated by strata (tons) by the Flemish Cap survey 1988-2001.

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

Table 3. Shrimp length frequencies and percentages by sex and stage maturation in the 2001 survey on Flemish Cap.

LENGTH		FEMALES		
(mm CL)	MALES	Immature	Mature	Ovigerus
10	3			
10.5				
11	2			
11.5	1			
12	7			
12.5	12			
13	34			
13.5	70			
14	159			
14.5	234			
15	396			
15.5	491			
16	739			
16.5	802	1		
17	749	3	1	
17.5	643	9		
18	584	13		
18.5	718	18	2	
19	794	44	18	2
19.5	816	65	46	
20	1005	105	67	
20.5	1099	208	163	
21	1115	352	239	
21.5	875	523	333	
22	567	794	439	
22.5	306	989	521	3
23	167	936	513	
23.5	53	793	552	
24	40	679	424	
24.5	17	444	336	
25	6	354	334	
25.5	2	212	216	
26		168	223	
26.5		100	188	
27		62	170	
27.5		17	132	1
28		10	91	
28.5		1	43	
29		1	42	
29.5			16	
30			28	
30.5			5	
31		1	10	
31.5			1	
32			5	
32.5				
33			1	
33.5				
34				
34.5				
35				
35.5			3	
Percentage	50,89	28,08	21,00	0,02

Frequencies x 10^5

Table 4. Shrimp length frequencies by strata in 2001 on Flemish Cap survey.

LENGTH	STRATA																
(mm CL)	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	19	Total
10.0		3															3
10.5																	
11.0									2								2
11.5				1													1
12.0		2		6													7
12.5	1			8	2					2							12
13.0	3			25	2				4								34
13.5	6	7		32	10		1		10	6							70
14.0	8	18	4	53	32	4		3	31	6							159
14.5	9	26	8	43	54	31	11		20	31				2			234
15.0	9	66	21	55	78	48	3	10	42	60				3			396
15.5	7	100	28	57	79	91	18		40	65	1			5			491
16.0	4	113	77	91	64	96	74	21	82	109	1			6			739
16.5	1	105	64	140	65	150	85	17	58	109	1			8			803
17.0	1	72	50	165	36	96	119	27	81	99	3		1	3			753
17.5		52	50	138	41	77	103	19	72	89	3		1	8			652
18.0	1	46	48	103	52	54	56	26	133	69	1		1	9			597
18.5		73	58	82	51	68	95	41	121	122	4	2	3	16			738
19.0		72	59	106	79	100	127	29	139	113	7	8	4	16			858
19.5		85	49	144	52	91	121	44	165	122	14	9	19	18			933
20.0		72	63	158	59	104	155	62	258	160	12	12	28	35	1		1178
20.5		77	38	207	122	147	189	79	221	275	13	15	42	42	2		1470
21.0		105	47	199	125	194	203	119	302	273	24	18	54	39	1	1	1706
21.5		125	60	181	163	194	222	108	242	286	31	39	32	38	6	3	1731
22.0		166	64	142	225	170	226	114	265	246	27	39	50	53	6	6	1800
22.5		181	83	120	162	218	216	155	220	283	36	43	32	51	16	6	1819
23.0		148	60	82	135	190	174	130	247	256	31	45	50	47	11	9	1616
23.5		114	38	50	76	182	170	103	227	270	29	33	37	48	14	9	1398
24.0		60	17	33	49	144	140	98	171	203	39	44	56	56	15	15	1143
24.5		42	11	24	28	96	85	49	104	128	56	41	64	42	15	15	797
25.0		15	5	16	32	87	35	47	62	122	93	58	49	41	15	17	694
25.5		5	1	5	9	34	22	12	30	41	87	39	51	41	30	22	430
26.0		3		4	6	27	8	22	25	49	68	32	53	41	32	22	391
26.5		2		3	2	9	4	9	14	41	60	31	34	22	35	20	288
27.0				2	6	12	1	4	12	30	43	20	24	27	35	17	232
27.5		3				4		4	6	13	25	10	28	13	26	17	150
28.0						3		3	4	14	17	6	19	13	17	7	101
28.5						2			2	4	6	4	6	4	11	4	44
29.0						1	1	3	5	4	3	1	5	3	12	3	43
29.5										3	1	1	2	1	5	2	16
30.0						4		1		5	1	1	4	2	7	2	28
30.5									1					1	2		5
31.0									3	6	1	1			1		11
31.5											1						1
32.0									2	2		1					5
32.5																	
33.0									1								1
33.5																	
34.0																	
34.5																	
35.0																	
35.5					3												3

Frequencies x 10^5

Table 5. Shrimp mean weights at length from Flemish Cap surveys 1989-2001.

CL (mm)	Mean weights (g)												
	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
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
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
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
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
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
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
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
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
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
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
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

Table 6. Shrimp length frequencies by sex and maturation stage in the 20 comparative hauls made with Lofoten and Campelen gears in the 2001 survey.

	Lofoten				**Campelen**			
LENGTH	Total	Male	Female		Total	Male	Female	
(mm CL)			Immature	Mature			Immature	Mature
8.5					1	1		
9					18	18		
9.5					122	122		
10	3	3			59	59		
10.5	1	1			53	53		
11					26	26		
11.5	3	3			26	26		
12					67	67		
12.5	3	3			369	369		
13	11	11			1331	1331		
13.5	48	48			2305	2305		
14	68	68			3049	3049		
14.5	95	95			4957	4957		
15	136	136			6152	6152		
15.5	213	213			9654	9654		
16	241	241			12100	12100		
16.5	379	379			11801	11783	18	
17	434	433	1		10854	10834	20	
17.5	396	396			5429	5409	21	
18	221	217	4		4087	4067	20	
18.5	295	288	5	1	5183	4878	87	218
19	527	505	16	6	6086	5951	136	
19.5	547	512	35		5917	5740	164	13
20	446	414	26	6	5003	4276	689	37
20.5	753	703	39	11	4915	4267	202	446
21	854	699	124	32	6880	5625	420	836
21.5	1097	875	128	93	8150	6420	993	737
22	1142	802	180	161	10774	7331	2391	1052
22.5	1134	478	419	238	8895	3890	3343	1662
23	1044	320	554	171	7093	1464	4679	950
23.5	953	94	587	272	5181	539	3671	971
24	669	72	470	127	3613	316	2555	742
24.5	456	30	349	77	2816	74	2193	549
25	413	17	325	71	1999	54	1456	490
25.5	458	3	358	97	1737	10	1302	425
26	386	2	277	107	1930	4	1502	424
26.5	466		279	187	1125	4	839	283
27	318		190	128	764		413	351
27.5	206		37	169	307		141	166
28	151		26	125	82		7	75
28.5	87	2		85	174		37	138
29	47			47	60			60
29.5	43			43	70			70
30	42		1	42	21			21
30.5	8			8	19			19
31	18		6	12	15			15
31.5	2			2	1			1
32	8			8	1			1
32.5								
33	1			1				
Percentage		54	30	16		76	17	7

Table 7. Shrimp length frequencies taken by the small mesh size bag attached to the cod-end in 2000 (Bruno 2000) and 2001 surveys.

	2000			2001	
LENGTH (mm CL)	MALES	FEMALES		MALES	FEMALES
		Immature	Mature		Immature
7				1	
7.5	6			1	
8	11			1	
8.5	32			3	
9	44			7	
9.5	55			8	
10	43			8	
10.5	24			9	
11	10			7	
11.5	1			4	
12	7			4	
12.5	13			3	
13	22			8	
13.5	37			9	
14	25			17	
14.5	30			23	
15	19			31	
15.5	10			34	
16	17			29	
16.5	33			16	
17	43			17	
17.5	52			14	
18	46			8	
18.5	28		1	5	
19	21	3		6	
19.5	8		1	1	
20	13	3	1	5	
20.5	4	2		2	
21		4		1	
21.5	1	3			
22		1			
22.5				1	1
23					1
23.5		1			
24					
24.5		2			
25					
25.5					
26					
26.5					
27					
27.5			1		
Total	655	19	4	283	2
Weight (g)		1376		676	

Table 8a. Shrimp modal groups and ages with Lofoten gear, Campelen gear and Bag on the cod-end in 2001 survey on Flemish Cap.

LOFOTEN			
Males		Females	
Age	Modal Group	Age	Modal Group
1	-	4	22.5
2	15	5	25
3	16.5	6	27
4	21	7	30
CAMPELEN			
Males		Females	
Age	Modal Group	Age	Modal Group
1	9.5	4	20
2	15	5	23
3	16.5	6	26
4	19.5	7	28.5
BAG ON THE CODEND			
Males		Females	
Age	Modal Group	Age	Modal Group
1	10.5	4	-
2	13.5	5	-
3	15.5	6	-
4	19	7	-

Table 8b. Shrimp modal groups and ages in 2001 survey on Flemish Cap.

Age	Cohort	Modal group
1	N	$10_{(B-C)}$
2	M	$14.5_{(B-C-L)}$
3	L	$16_{(B-C-l)}$
4	K	$20_{(B-C-L)}$
5	J	$24_{(C-L)}$
6	I	$26.5_{(C-L)}$
7	H	$29.5_{(C-L)}$

(B) Bag on the codend
(C) Campelen gear
(L) Lofoten gear

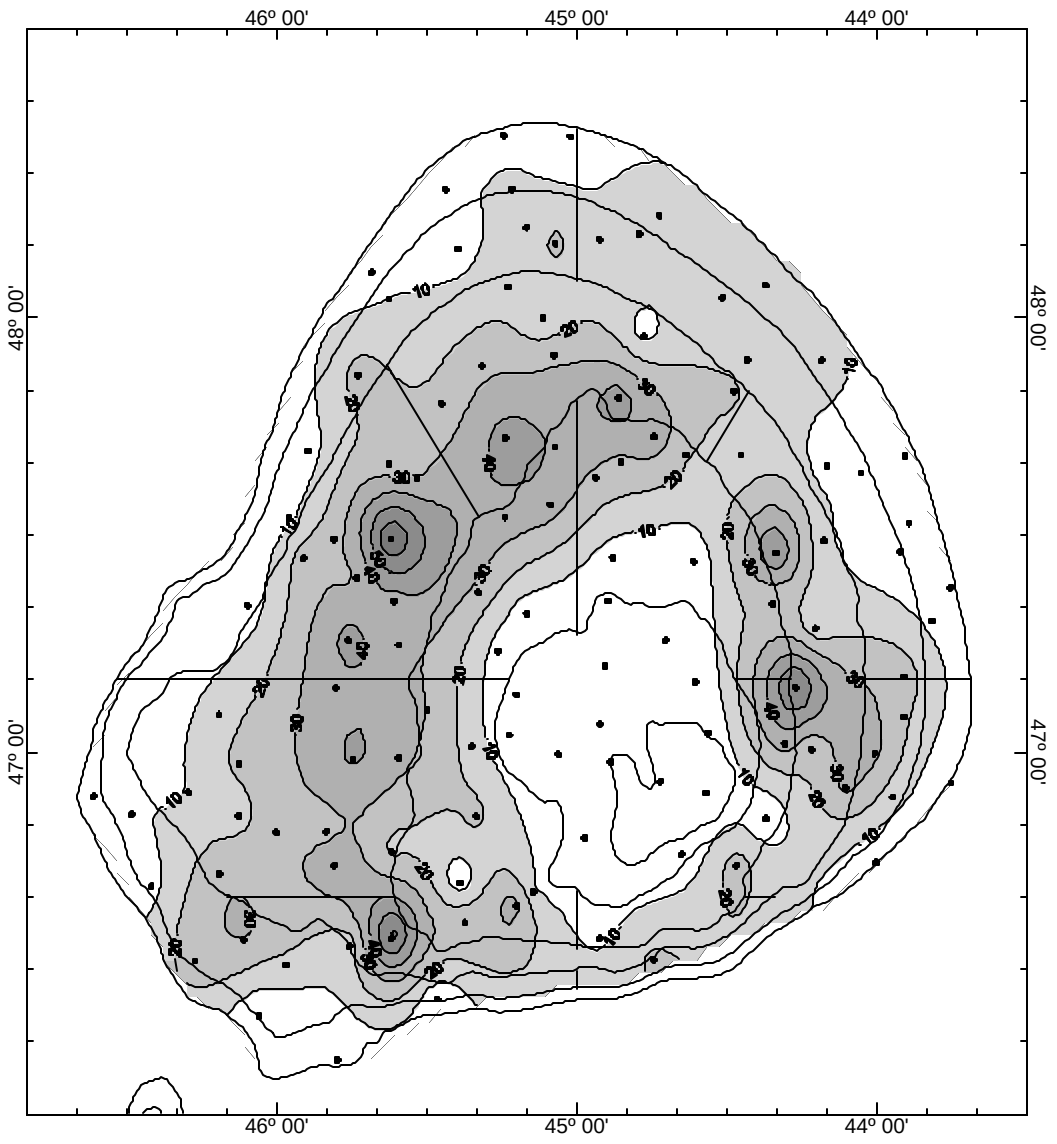


Fig. 1. Shrimp catches distribution (kg/tow) in July 2001 on Flemish Cap survey.

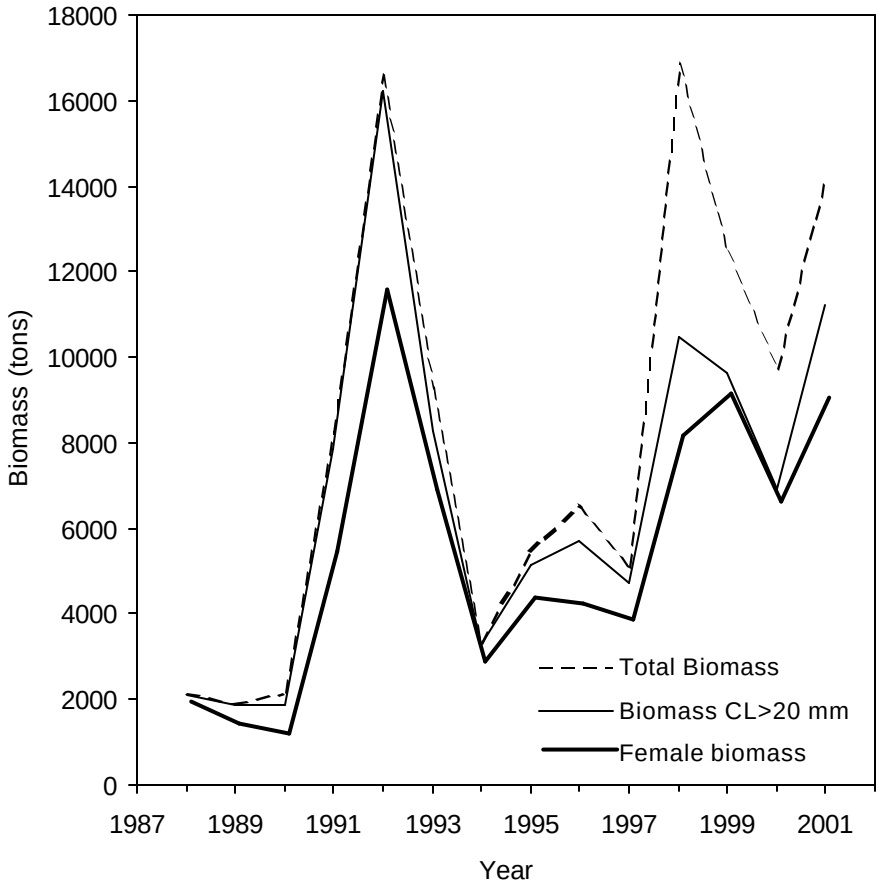


Fig. 2. Total biomass and biomass for shrimp bigger than 20 mm CL (adult stock) from Flemish Cap 1988-2001 surveys.

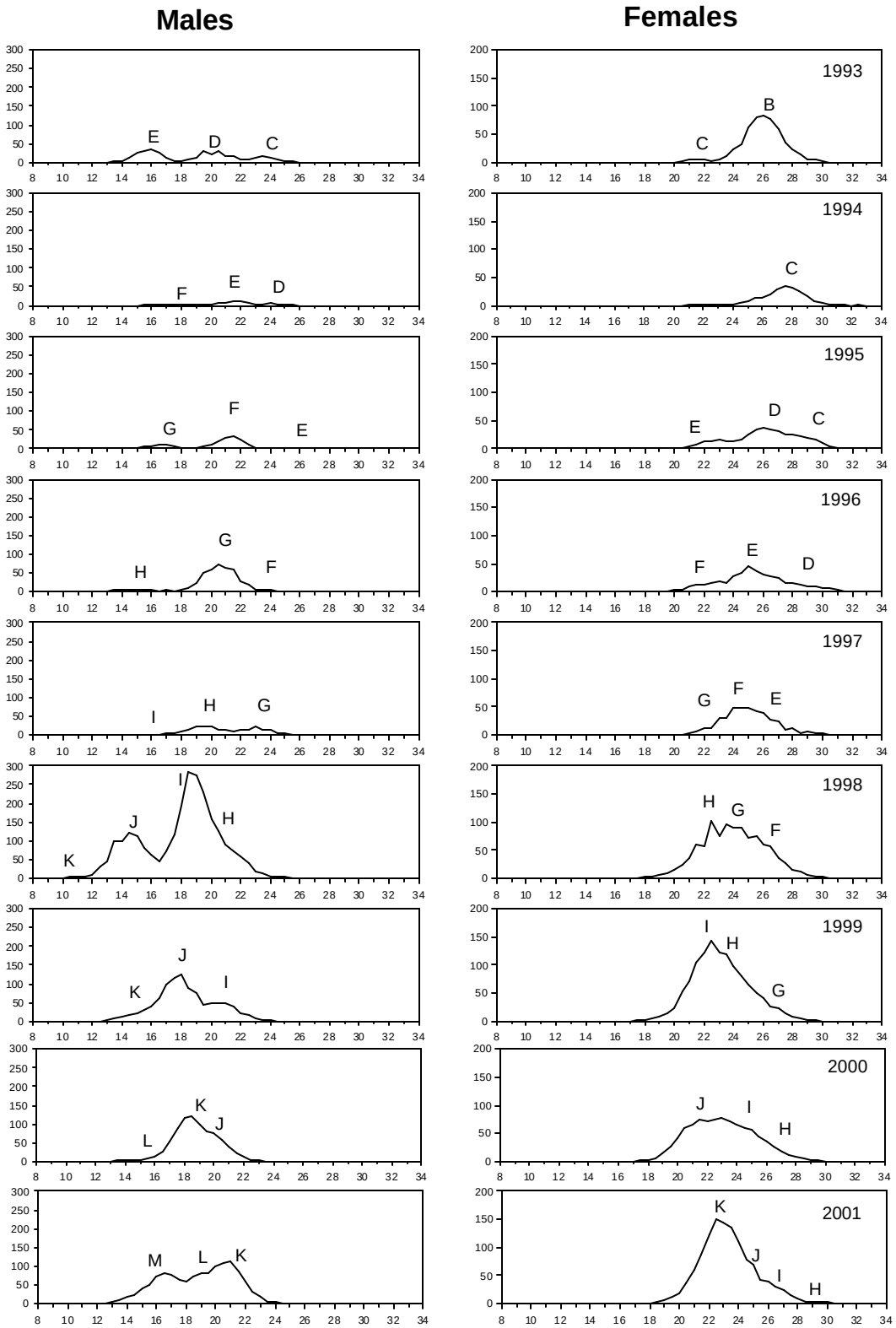


Fig. 3. Shrimp size distribution on Flemish Cap 1993-2001 surveys. Y-axis = Frequency (10^6) X-axis = Carapace Length (mm)

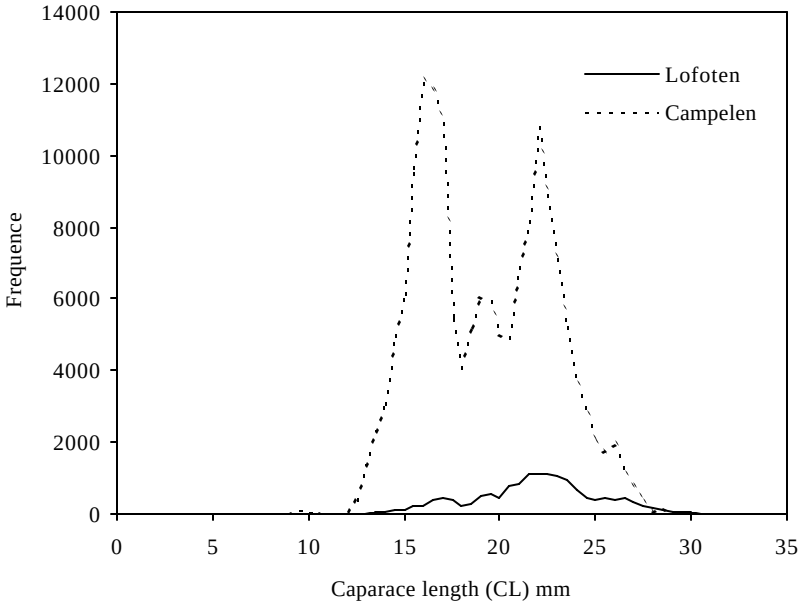


Fig. 4. Comparison of shrimp length distributions from 20 paired hauls with Lofoten and Campelen gears, in the 2001 survey on Flemish Cap.

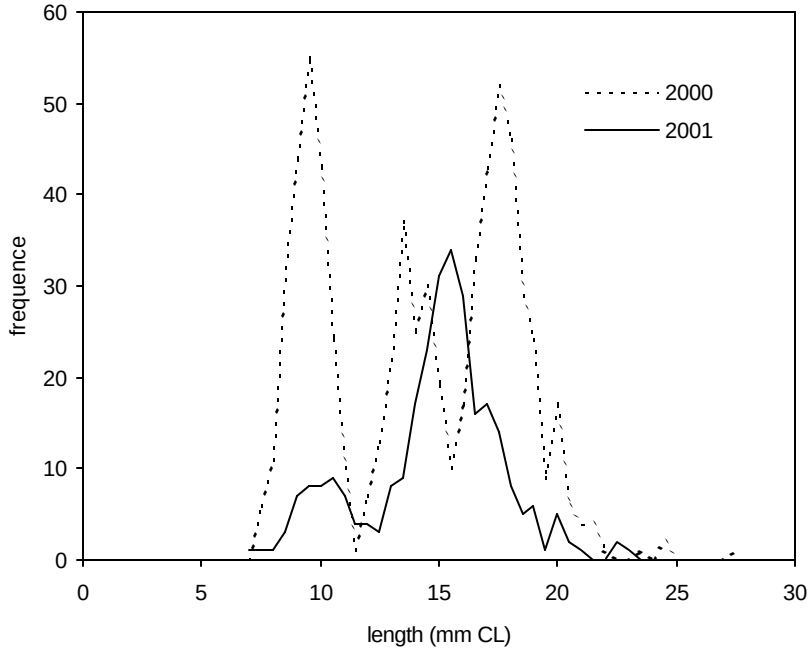


Fig. 5. Shrimp length distributions from the small mesh size bag on the cod-end, in the 2000 and 2001 surveys on Flemish Cap.

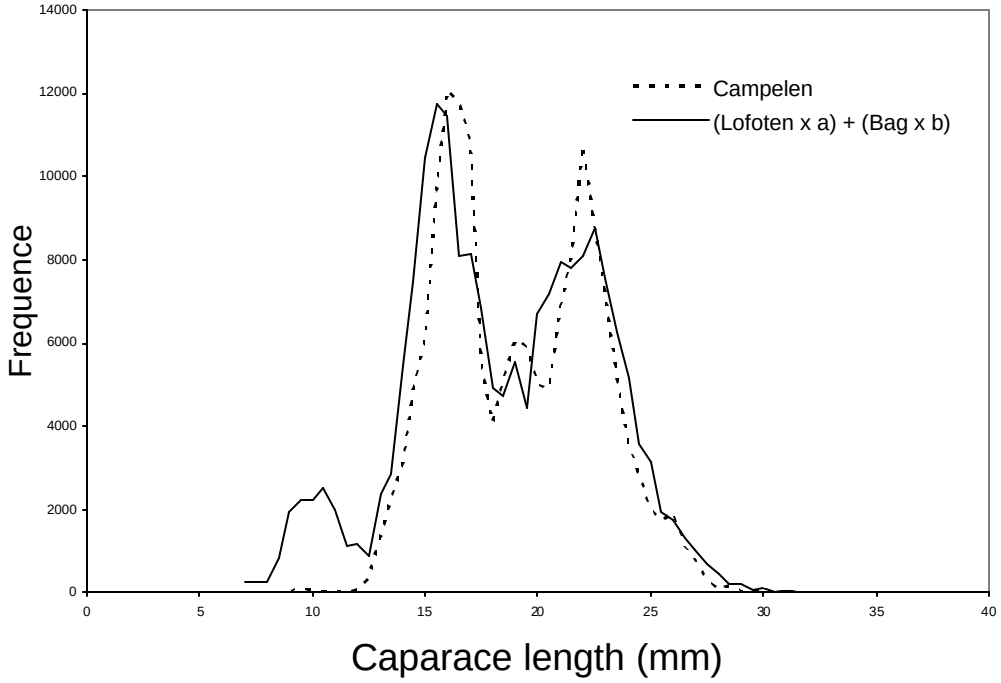
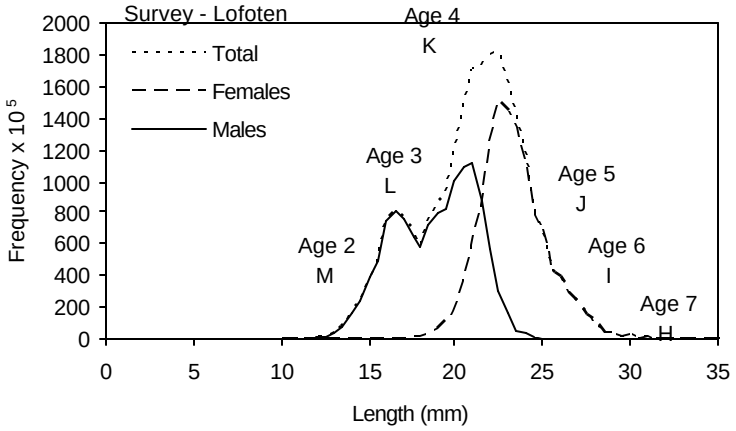
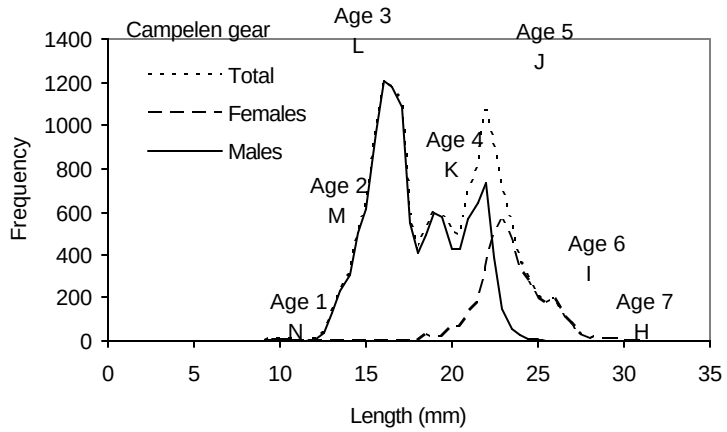


Fig. 6. Comparison of shrimp length distributions from Lofoten and Campelen gears, and Bag on the cod-end Lofoten, in the 2001 survey on Flemish Cap. Factor values: $a = 4.5 \times 10^{-5}$; $b = 280$





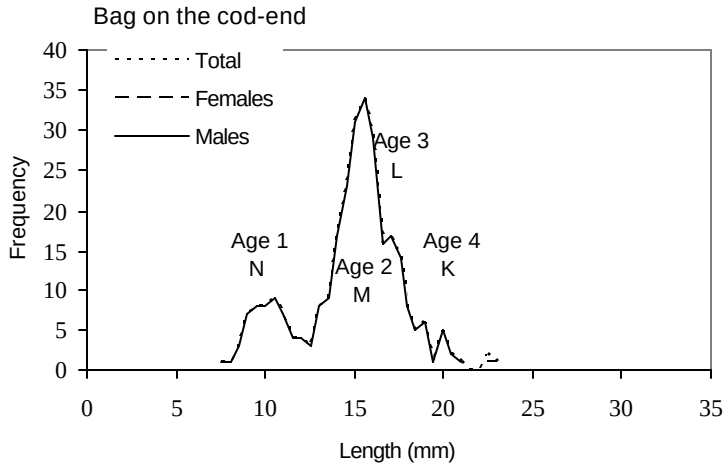


Fig. 7. Shrimp modal and age groups in the 2001 survey on Flemish Cap (letters from table 8b)