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Northern Shrimp (*Pandalus borealis*) on Flemish Cap in July 2000

by

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Abstract

Results on shrimp from the survey on Flemish Cap in 2000 are presented and compared to those from previous surveys of the same series. The adult stock biomass (shrimp bigger than 20 mm of carapace length) remains high but bellow the 1999 level. 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 this second gear than in the Lofoten one. The Campelen gear also catches large amounts of small shrimp due to its smaller cod-end mesh size.

Keywords: Shrimp, Flemish Cap, and survey.

Material and Methods

The survey was carried out from 2nd to 20th July following the same procedures as in previous years (Vázquez, 2000). 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. Samples were immediately frozen for further 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 immatures (first time spawners) and matures (spawned previously) based on the condition of the sternal 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.

3 114 individuals were weighed after a little draining time to the nearest 0.1 g 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 this 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 25 cm side.

Results

A total of 120 valid bottom trawls were completed with Lofoten trawl gear in Flemish Cap. Shrimp appeared in 101 sets and catches per tow were highly variable (from 2 g to 47 kg).

Biomass

Total shrimp biomass estimated by swept area method and average catch-per-mile from 1988 to 2000 are presented in Table 1. The biomass index obtained this year, 9720 tons, is the fourth highest in the series.

The presence of shrimp in the shallowest strata, with depths less than 257 m (140 fathoms), increased from 1 333 tons estimated in 1998 and 1 709 tons estimated in 1999 to 1 875 tons in 2000 (Table 2), even the cod-end mesh size used in 1999 and 2000 (35 mm) is bigger than the one used in 1998 (25 mm). During the first years (1988-1994), the presence of shrimp in shallowest water (stratum 1-6) was scarce. However, since 1995, a highest biomass of shrimp occurred in these strata. In the last three years the biomass in shallower waters was considerably high, probably reflecting the occurrence 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 447 m) (141-300 fathoms). Catches never exceeded 18 kg/tow in the highest depths of the slope, but in the shallowest area the two highest catches occurred, with 47 and 46 kg, respectively. The highest concentration (>20 kg) took place in the Western slope of the Cap.

Adult stock

Total biomass estimated in the series of bottom trawl surveys made on Flemish Cap from 1988 to 2000 is shown 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 25 mm liner was used.

The biomass index in 1994 is supposed to be underestimated because the mesh size of the cod-end was bigger (40 mm) than the one normally used. On the contrary, the biomass index in 1998 could have been overestimated by a factor of two (del Río, 1998) because the mesh size used that year was smaller (25 mm) than the one normally used. 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 biomass survey estimated of shrimp bigger than 20 mm CL, a proxy of the adult stock biomass, is compared in Fig. 2 with the total biomass along the series. The difference between these two quantities in each year corresponds to the shrimp smaller than 20 mm CL, those size classes that are more directly affected by differences in the cod-end mesh size. The biomass for shrimp bigger than 20 mm CL tries 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 differences between the total biomass and the biomass for shrimp larger than 20 mm CL were small in the analysed period 1988-1997. The differences ranged between 1.7% and 12.1% of the total (Table 3), that is, the main portion of shrimp catch was larger 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. However, the difference between both biomass estimates was 37.8% in 1998 when a 25 mm liner was used. Again we attribute this difference primarily to the mesh size effect and not to changes in small shrimp abundance. In 1999

and 2000 surveys the biomass differences was 22.6% and 29.0% and the nominal cod-end mesh size was 35 mm, but the effective mesh size was somewhat smaller in 1999. Once again we attribute this difference to a mesh size effect, not to variations in small shrimp abundance. In summary, our survey results did not quantified the abundance of small shrimp (Garabana, 1999).

The biomass index for shrimp bigger than 20 mm CL appears more stable than the survey total biomass index and it is presumably free of mesh size effects. However it corresponds to the adult stock instead the total biomass. The increase observed from 1997 to 1998 in the adult stock is smaller than previously assumed for the total stock but it is also a very important jump. Adult stock remains at roughly the same high level in 1999, but it decreased in 2000, as well as total biomass did.

Length frequencies

Length frequencies and percentages by sex from the 2000 survey are shown in Table 4. These length frequencies are split into males, immature females, mature females and ovigerous females. Catches of the 1999 survey contained 47.4 % males and 52.6% females (30.34% immature, 22.14% matures and 0.16% ovigerous). The current percentage of ovigerous females is smaller than in the last two years, because the survey finished on July 21st, 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 9.5 and 25.5 mm. Females presented a CL between 15.5 and 31.5 mm comprising the groups: 15.5-29.5 mm immature, 17.0-31.5 mm mature and 19.5-27.5 mm ovigerous.

Length frequencies by strata are shown in Table 5. Figure 3 shows shrimp length distribution on Flemish Cap from 1992 to 2000. Modal groups named with the same letter belong to the same year-class. In the 1998 survey, length frequencies by strata also 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 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	9.5
12 to 15	361-545	201-300	14.5
16 to 19	546-725	301-400	18.5

Minimum observed size was 9.5 mm CL in those strata between 183 and 360 m (101-140 fathoms). It was 14.5 mm CL in depths between 361 and 545 m (201-300 fathoms), and finally, the minimum size was 18.5 mm CL in strata between 546 and 725 m (301-400 fathoms).

Mean weights by length-class

Mean weight by length-class of shrimp for years 1989-2000 is shown in Table 6. It was observed that mean weights of this year are roughly equal or lightly smaller than those observed in 1998.

The lowest mean weights in the series were observed this year, except for the 10.0 mm size class, which was only lower in 1997.

Comparison of Lofoten and Campelen gears

Catchability. 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.

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, but the mesh size determines the retention of small size shrimp (Garabana, 1999).

Table 7 shows length frequencies by strata estimated in the 20 hauls made with the Campelen gear. Figure 4 shows shrimp length distribution obtained with both Lofoten and Campelen gears. Length distribution of each gear was calculated in absolute terms, adding the observed length distribution of each haul, so no quantitative conclusion can be derived for the whole back from those frequencies. Small size shrimp (8.0-9.0 mm CL) appears in strata 2 and 5, but it doesn't appear with the Lofoten gear because of the different cod-end mesh size.

Catches were transformed to catch per mile, dividing catch by the towed distance. The catch ratio between both gears was 7.00, being the highest the catch of the Campelen gear, but this ratio is influenced by the two factors already cited (gears design and cod-end selectivity). The cod-end mesh size is 35 mm in Lofoten gear and 20 mm in the Campelen one. The 50% selectivity for the 35 mm mesh size would be around 18 mm CL shrimp. 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 catch ratio is 4.5. This means that the Campelen gear is more than four times more efficient to catch shrimp. A similar comparative trial carried out during 1999 survey resulted in lower ratios: 5.00 for total catch, and 2.50 for bigger than 20 mm CL shrimps (Garabana, 1999).

For shrimp less than 20 mm CL, the Lofoten gear appears very inefficient due to its highest cod-end mesh size. The Campelen gear shows two modal groups in these lengths but the Lofoten only one. The abundance ratio between both gears is huge, but the contribution of these small size shrimp to the total catch ratio is low, due to the low weight at small sizes. The contribution of the small shrimp to the catch ratio is also dependent on the year-class abundance. Without small shrimp, the catch ratio would be around the 4.5 factor already cited.

Size distribution and age structure. Observed shrimp length distribution is very dependent on cod-end mesh size, particularly for small shrimp. 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 in the comparative trial cannot be used for a quantitative analysis.

In this survey, a small mesh size bag was attached to the cod-end of the Lofoten gear to collect the small size shrimp that gear cannot retain. Sampling frequencies from both the bag and from Lofoten gear were combined to compare with the sampling frequency in Campelen gear (Figure 5). The result is a length distribution similar to the one observed with the Campelen gear, since the bag on the cod-end retain the small size modal class that appears in the Campelen gear. Furthermore, the bag on the cod-end retains another smaller modal group (9.0-10.0 mm), which only appears in insignificant amount in the Campelen gear. Length distribution observed in the two gears and in the bag were related by:

$$frec._{CAMPELEN} \times 1.2 = frec._{LOFOTEN} + frec._{BAG} \times 35$$

These factors maximizes the agreement between sampling length distributions: catch with the Campelen gear (20 tows), total catch with the Lofoten gear (120 tows) and total catch in the bag (120 tows). The length distribution used for these two gears and one bag, are in absolute value, without any considerations on time trawled or strata area, so the factors used before are not relevant. This exercise only illustrates the fact that the catch of the Lofoten gear plus the catch of the bag, composed by shrimps escaped from the Lofoten cod-end, equal the catch of Campelen gear in an appropriate scale. Both gears seem to catch on the same component of the shrimp stock. The cod-end bag can be useful to improve length distribution estimates of the whole stock, but it's necessary a standardisation in size of the bag to compare the results of the surveys from different years.

Table 8a and figure 6 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 6, although the youngest modal group (age 1) is not clearly represented, and age 7 is absent. Age 7 shrimp appears clearly in Lofoten gear, and ages 1 and 2, which are absent or scarcely represented, dominated the bag catch.

In summary: the combination of a Lofoten gear with a bag on the cod-end is valuable to estimate length distribution for the widest range of modal groups. In fact the Lofoten gear with the bag catch clearly one more modal group than the Campelen gear (Table 8b).

Lofoten and Campelen gears, with 35 and 20 mm mesh size in the cod-end respectively, are different: Campelen gear retains a smaller length-class than Lofoten gear (Garabana, 1999). Campelen gear has a vertical opening of 4.0-4.5 m and, consequently, it captures individuals living in that distance range from the bottom. But the vertical opening of the Lofoten gear is only 3 m. So, even the bag on the cod-end capture all age classes that Lofoten gear don't retains, (because its mesh size) the bag works in a narrower stratum near of bottom than the Campelen gear does. But even the Lofoten gear tend to overestimate the stocks near the bottom, the differences observed in shrimp length distribution from both gears and the bag seems to be exclusively a consequence of differences in mesh size co-end.

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References

DEL RIO, J. L. 1998. Northern Shrimp (*Pandalus borealis*) on Flemish Cap in July-August 1998. *NAFO SCR Doc*., No. 81, 13 p.

GARABANA, D. 1999. Northern Shrimp (*Pandalus borealis*) on Flemish Cap in July 1998. *NAFO SCR Doc*., No. 106, 15 p.

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. 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 Tech. Rep. NMFS* 30, 57 p.

VÁZQUEZ, A. 2000. Results from Bottom Trawl Survey on Flemish Cap of July 1999. *NAFO SCR Doc*., No. 9, 50 p.

Table 1. Total shrimp biomass estimated by swept area method and average catch per towed mile in the years 1988-2000 on Flemish Cap surveys.

Year	Biomass (tons)	Average catch per mile (Kg)
1988	2167	1.54 ± 0.28
1986	1923	1.37 ± 0.24
1990	2139	1.53 ± 0.21
1991	8211	5.83 ± 0.71
1992	16531	11.75 ± 1.86
1993	9256	6.57 ± 1.04
1994[1]	3337	2.37 ± 0.35
1995	5413	3.85 ± 0.44
1996	6502	4.62 ± 0.34
1997	5096	3.62 ± 0.25
1998[2]	16844	11.81 ± 0.80
1999	12430	8.83 ± 0.67
2000	9720	6.91± 0.52

[1]codend mesh-size 40 mm

[2]codend mesh 40 mm and 25 mm liner

Table 2. Total shrimp biomass estimated by strata (tons) in the years 1989-2000 on Flemish Cap surveys.

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

Table 3. Total biomass shrimp (tons), biomass for shrimp bigger than 20 mm CL (adult stock) (tons) and percentage for shrimp bigger than 20 mm CL with respect the total biomass shrimp in the years 1988-2000 on Flemish Cap surveys.

Year	Total biomass shrimp (tons)	Biomass shrimp > 20 mm CL (tons)	Percentage shrimp >20mm (%)
1988	2164	2104	97.2
1989	1923	1856	96.5
1990	2139	1886	88.2
1991	8211	7856	95.7
1992	16535	16208	98.0
1993	9256	8292	89.6
1994	3337	3282	98.3
1995	5413	5153	95.2
1996	6502	5716	87.9
1997	5096	4699	92.2
1998	16844	10476	62.2
1999	12430	9626	77.4
2000	9720	6899	71.0

Table 4. Shrimp length frequencies and percentages by sex and stage maturation in 2000 on Flemish Cap survey.

LENGTH (mm CL)	MALES	FEMALES		
		Immature	Mature	Ovigerous
9.5	2			
10.0	2			
10.5	2			
11.0				
11.5	1			
12.0	1			
12.5	3			
13.0	6			
13.5	14			
14.0	35			
14.5	30			
15.0	41			
15.5	61	1		
16.0	108	1		
16.5	269	3		
17.0	515	4	4	
17.5	902	12		
18.0	1168	19	2	
18.5	1204	64	2	
19.0	980	136	7	
19.5	815	262	14	1
20.0	772	376	34	3
20.5	564	508	83	2
21.0	383	529	118	2
21.5	219	533	199	1
22.0	128	428	278	2
22.5	51	433	318	6
23.0	23	370	391	3
23.5	12	364	357	2
24.0	4	281	377	
24.5	7	295	301	3
25.0	1	249	303	2
25.5	1	195	252	
26.0		146	216	
26.5		76	180	
27.0		35	150	
27.5		8	112	1
28.0		3	82	
28.5		2	50	
29.0			30	
29.5		1	18	
30.0			7	
30.5			5	
31.0			1	
31.5			1	
Percentage	47.35	30.34	22.14	0.16

Frequence x 10^5.

Table 5. Shrimp length frequencies by strata in 2000 on Flemish Cap survey.

LENGTH	STRATA																
(mm CL)	3	4	5	6	7	8	9	10	11	12	13	14	15	16	18	19	Total
9.5							1										2
10.0			1		1												2
10.5				1	2												2
11.0																	
11.5								1									1
12.0								1									1
12.5			1	1				1									3
13.0		1	1					2	1								6
13.5	1		1	2	5	1	1	3									14
14.0	2	4	9	1	2		3	8	6								35
14.5	3	2	13	2	4			6				1					30
15.0	5	5	15	1	4		3	6	2								41
15.5	13	6	23	1	2	1		10	4			2					62
16.0	10	5	23	5	18	3	1	36	7								109
16.5	35	13	43	7	39	9	27	63	35	1		1					272
17.0	77	14	61	22	87	13	32	124	74	5		5	8				523
17.5	109	30	119	35	149	33	46	216	142	8		11	16				914
18.0	160	42	122	29	207	79	58	229	183	28		12	41				1189
18.5	167	49	112	19	215	97	57	234	203	18		23	73	2		1	1270
19.0	138	35	136	25	140	91	89	167	171	25		27	73	1		1	1123
19.5	78	28	192	50	115	62	92	170	149	35	1	30	84	3		2	1092
20.0	93	12	209	51	108	76	87	182	154	28	1	52	123	5		4	1185
20.5	105	18	238	47	96	89	80	128	139	39	1	50	114	9		4	1157
21.0	86	9	180	55	122	83	69	95	134	36	1	46	98	12		5	1032
21.5	96	8	162	50	126	84	44	99	127	40	1	29	66	15		5	952
22.0	69	2	101	57	104	75	40	97	152	43		27	52	8		4	836
22.5	54	1	94	44	114	76	24	110	164	40		21	53	10		3	808
23.0	30	2	50	30	122	45	37	113	191	65	1	37	47	13		1	787
23.5	35		51	27	83	56	30	86	166	78	1	36	70	15		1	735
24.0	12	1	23	17	57	32	25	93	174	82	1	38	89	16		2	662
24.5			8	8	62	24	69	87	97	79	3	30	107	30		3	606
25.0	1		7	13	30	20	42	61	91	82	2	35	130	36		4	555
25.5			8	6	26	8	18	37	79	75	2	22	116	41		8	448
26.0	19		3	4	10	6	15	30	46	66	3	20	83	44		10	362
26.5				2	10	3	15	20	39	40	3	12	64	36	1	10	256
27.0	1		2	1	5	3	8	19	21	23	2	15	41	32	1	8	185
27.5			1		1	1	11	8	17	14	5	13	16	25	1	10	121
28.0					1		6	9	9	10	2	14	12	18	1	4	85
28.5				1				6	2	7	2	6	9	14	1	5	52
29.0								2	3	4	2	4	4	6		5	30
29.5							1	5		2	1	3		4		1	19
30.0								2			1	2		1			7
30.5								1			1	1	2			1	5
31.0								1									1
31.5																	1

Frequence x 10^5.

Table 6. Shrimp mean weights by length-class in the years 1989-2000 on Flemish Cap surveys.

CL (mm)	Mean weights (g)											
	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
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
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
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
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
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
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
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
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
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
32.5	19.1	19.3	19.9	19.9	20.1	20.4	20.7	21.2	19.5	19.2	19.9	-
35.0	23.7	23.9	24.7	24.5	24.8	25.3	25.8	26.6	24.4	23.9	24.8	-

Table 7. Length frequencies by strata in the 20 additional hauls made with Campelen gear in 2000 on Flemish Cap survey. Sampling data.

LENGTH	STRATA					
(mm CL)	2	5	9	10	14	Total
8.0	3					3
8.5	5	12				18
9.0	15	25				40
9.5	42	10				52
10.0	65	48			13	126
10.5	55	25		11		91
11.0	27	31		13		71
11.5	29	45		13		88
12.0	108	98		13		219
12.5	238	216		53	4	511
13.0	258	424	13	233		928
13.5	246	600	13	225	4	1088
14.0	192	535	53	271	17	1067
14.5	92	469	26	296		884
15.0	65	541		361	26	994
15.5	32	399	44	306		781
16.0	23	590	48	707	4	1372
16.5	10	1267	154	1037	53	2521
17.0		1045	361	1989	74	3468
17.5	16	1455	520	2547	114	4652
18.0	18	1035	467	2066	200	3787
18.5	13	1003	519	1814	231	3579
19.0	8	970	387	1280	367	3013
19.5		977	299	1265	389	2930
20.0	2	933	308	1226	404	2872
20.5	2	665	274	937	311	2188
21.0	6	763	206	836	196	2006
21.5	1	605	147	866	146	1765
22.0		443	158	462	75	1137
22.5		406	124	735	106	1371
23.0		170	110	808	176	1264
23.5		170	82	466	136	855
24.0		135	154	480	191	960
24.5		77	65	204	175	521
25.0		68	105	162	201	537
25.5			41	74	151	265
26.0			18	145	129	292
26.5		10	13	70	83	177
27.0			13	49	31	93
27.5		19		45	41	105
28.0			13		42	55
28.5					19	19
29.0					20	20
29.5					6	6
30.0					2	2
30.5						
31.0					2	2
31.5					7	7

Table 8a. Shrimp modal groups and ages with Lofoten gear, Campelen gear and Bag on the codend in 2000 on Flemish Cap survey.

LOFOTEN			
Males		Females	
Age	Modal Group	Age	Modal Group
1	-	4	22.5
2	14.0	5	25.0
3	18.5	6	27.0
4	20.5	7	30.5
CAMPELEN			
Males		Females	
Age	Modal Group	Age	Modal Group
1	10.0	4	21.0
2	14.0	5	24.0
3	17.5	6	26.0
4	20.5	7	-
BAG ON THE CODEND			
Males		Females	
Age	Modal Group	Age	Modal Group
1	9.5	4	-
2	14.0	5	-
3	17.5	6	-
4	20.0	7	-

Table 8b. Shrimp modal groups and ages in 2000 on Flemish Cap survey.

Age	Modal group
1	$10.0_{(B-C)}$
2	$14.0_{(B-C)}$
3	$18.0_{(B-C-L)}$
4	$21.5_{(B-C-L)}$
5	$24.5_{(C-L)}$
6	$27.5_{(C-L)}$
7	$29.5_{(L)}$

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

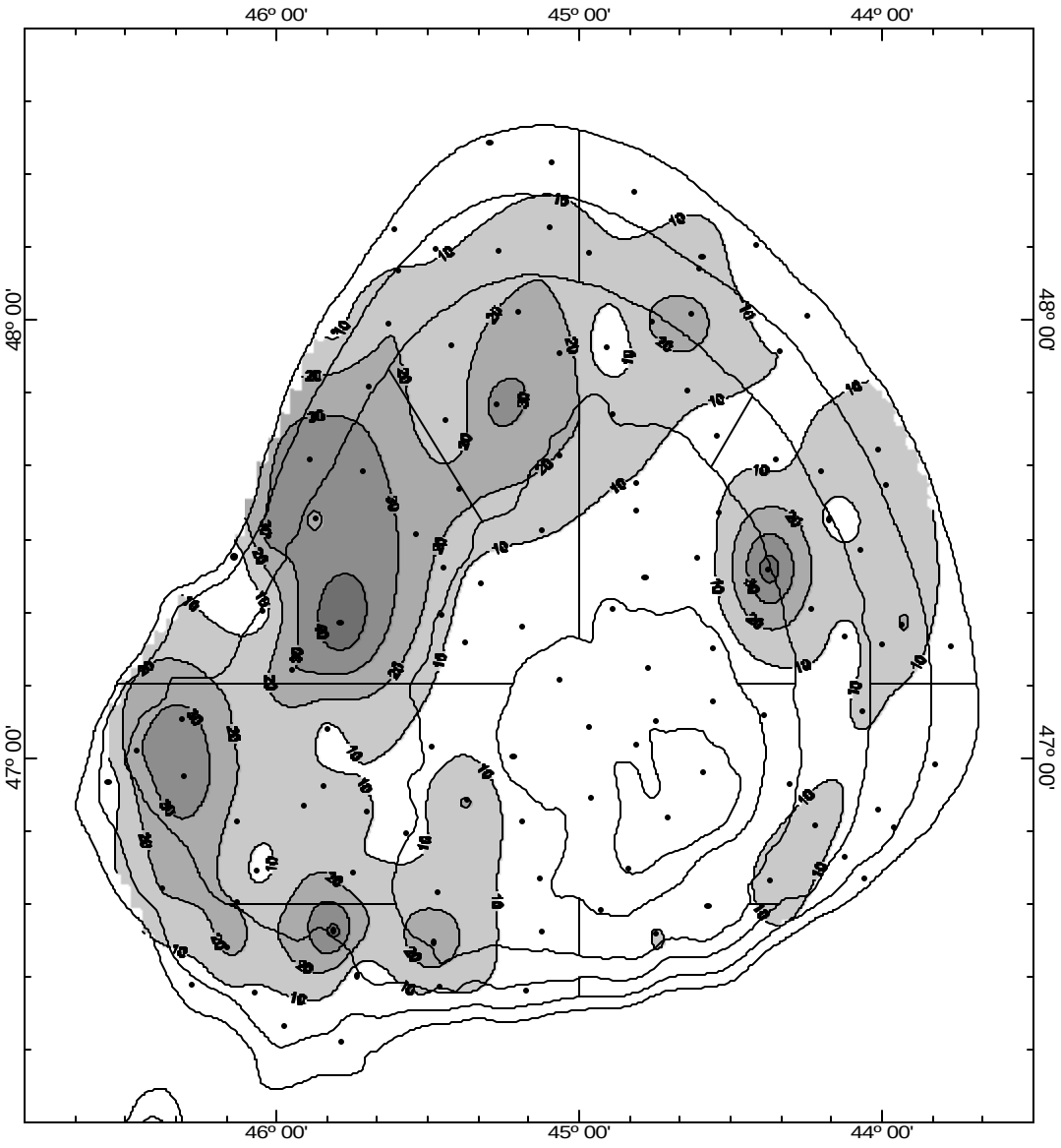

Fig. 1. Shrimp catches distribution (kg/tow) in July 2000 on Flemish Cap survey.

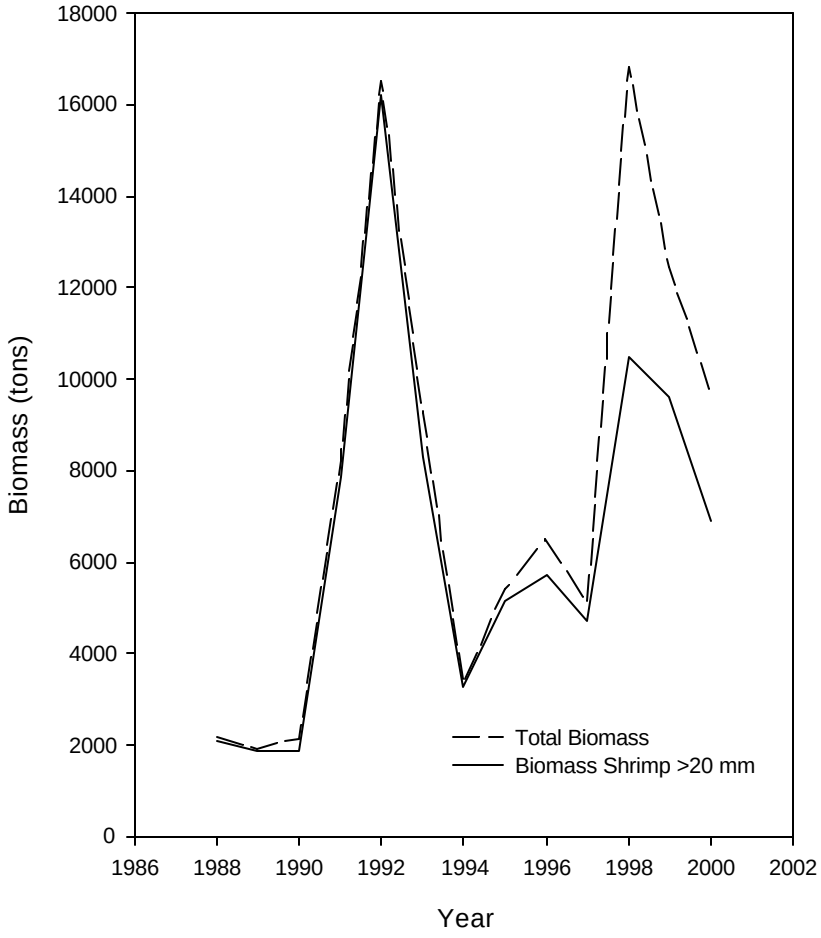

Fig.2. Total biomass and biomass for shrimp bigger than 20 mm CL (adult stock) in the period 1988-2000 on Flemish Cap surveys.

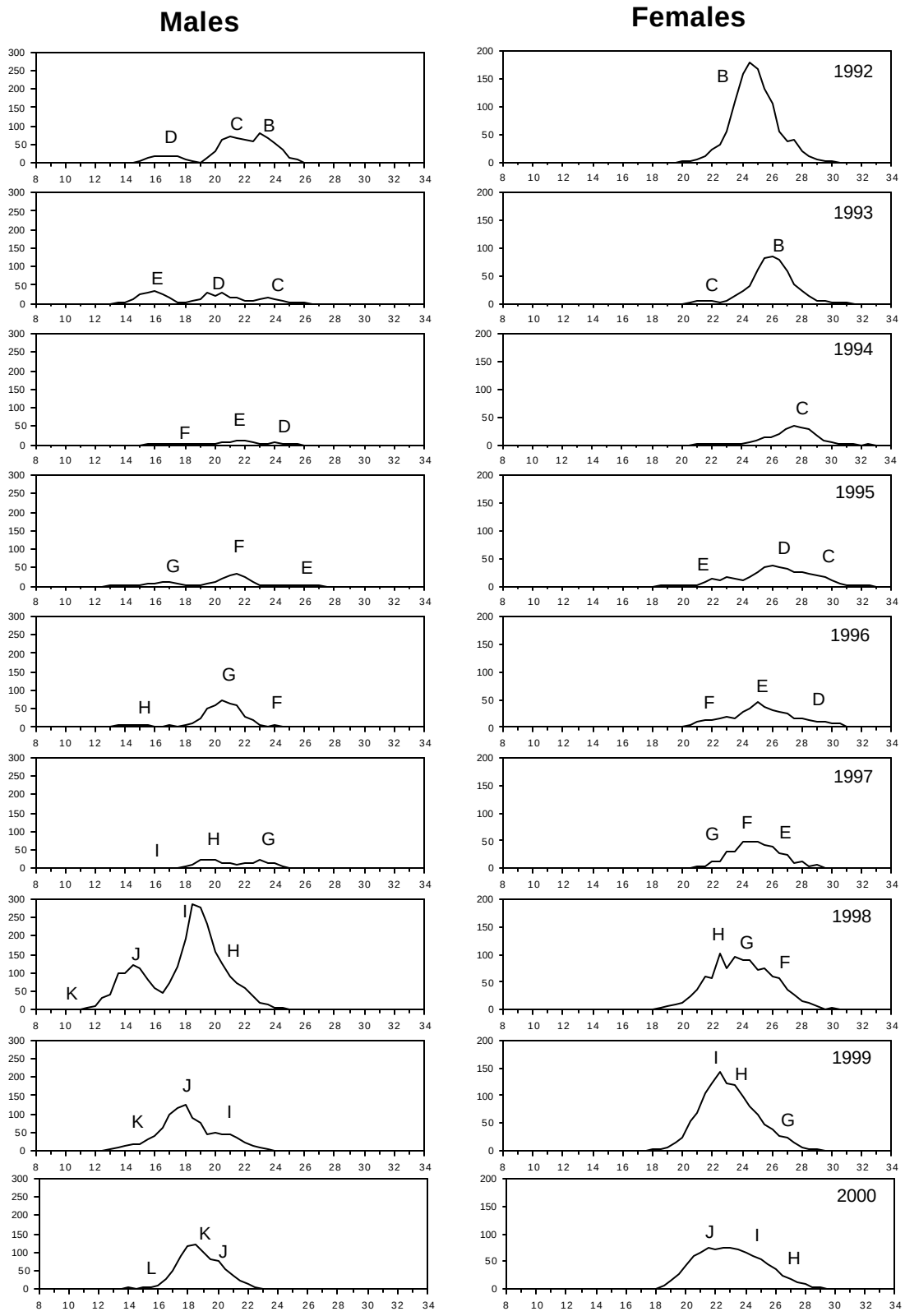

Fig.3. Shrimp size distribution on Flemish Cap 1992-2000 surveys. Y-axis = Frequence (10^6) X-axis = Caparace Length (mm).

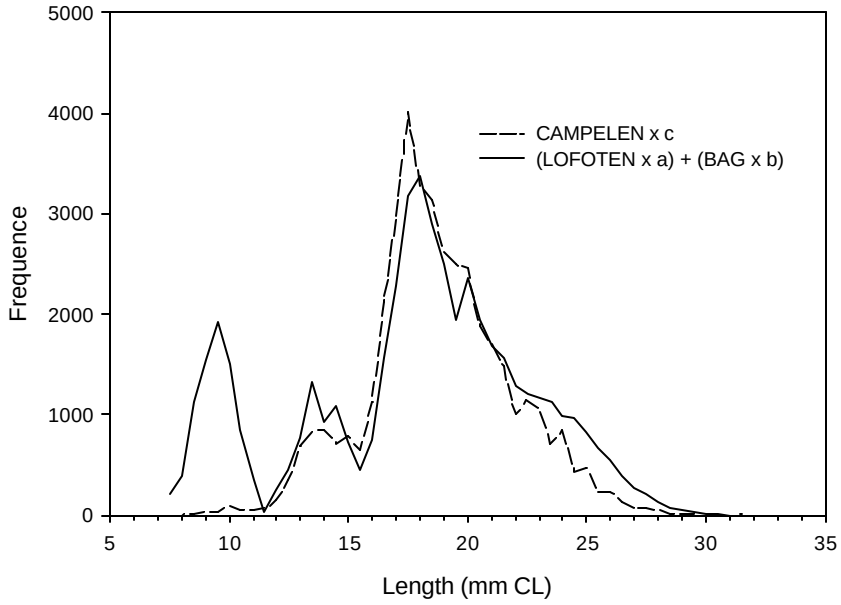

Fig. 4. Comparison of shrimp length distributions from 20 paired hauls with Lofoten and Campelen gears, in the 2000 survey on Flemish Cap.

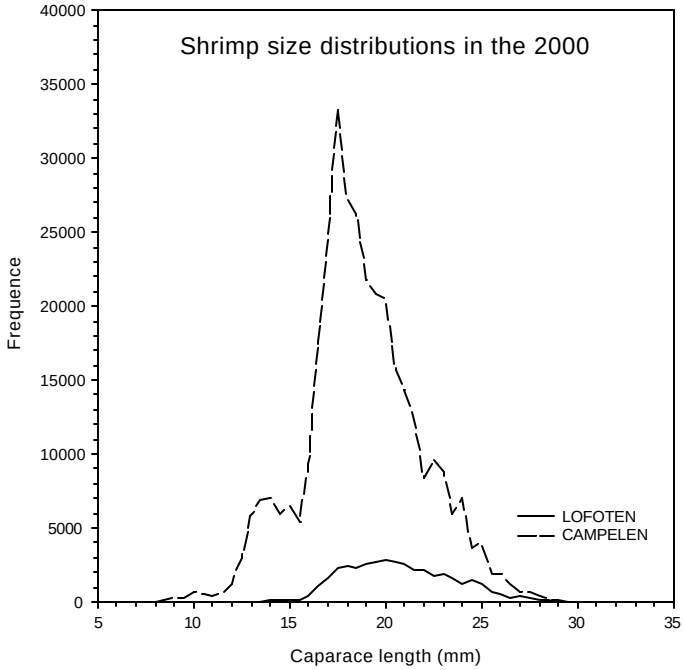

Fig. 5. Comparison of shrimp length distributions from Lofoten and Campelen gears, and Bag on the codend Lofoten, in the 2000 survey on Flemish Cap. Factor values: a = 1 ; b =35 ; c = 1.2

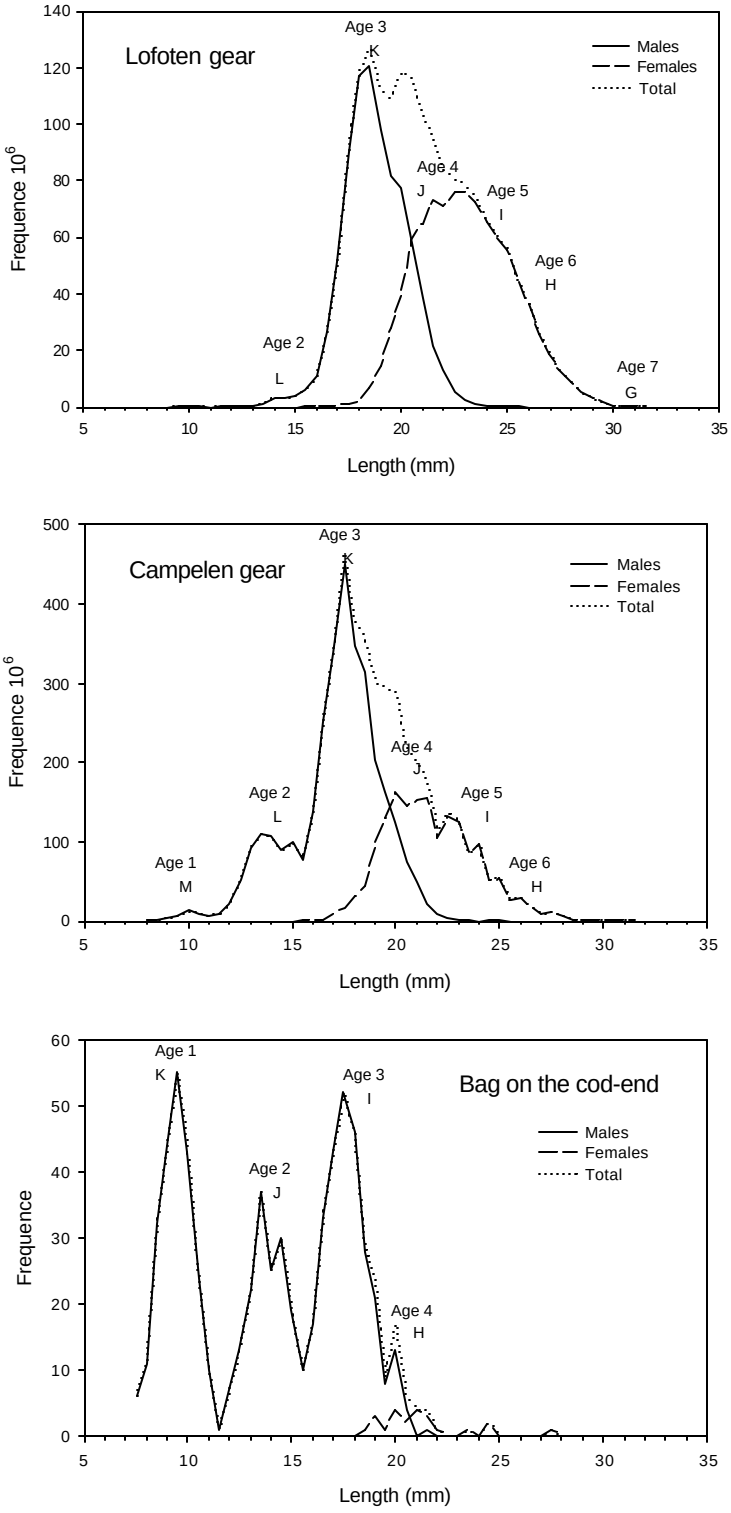

Fig. 6. Shrimp modal and age groups in the 2000 survey on Flemish Cap. (Same letters for each age group as in Fig. 3)