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Northwest Atlantic Fisheries Organization

Serial No. N4195 **NAFO SCR Doc. 99/114**

SCIENTIFIC COUNCIL MEETING – NOVEMBER 1999

Biomass Estimate, Growth, Length and Age Distribution of the Northern Shrimp (*Pandalus borealis*) Stock on Flemish Cap (NAFO Div. 3M) in July 1999 and Faroese Shrimp Catches 1996-1999

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This paper looks at the status of the shrimp stock on Flemish Cap by presenting Faroese catch and effort statistics and results from the survey.

Catch and Effort

In 1998 five double trawl and two single trawl and in 1999 six double trawl Faroese shrimp vessels were engaged in the shrimp fishery on Flemish Cap (NAFO Div. 3M). Catch and effort by month for 1996 and 1999 (until week no. 39) are presented in Tab. 1. The data were originally recorded by week and subsequently transformed to months. A month that shared a week was allotted a value proportional to the number of days of the shared week. Variation in CPUE ($t \cdot d^{-1}$) by month in the period 1996-1999 is shown in Fig. 1.

The catches were between 7387 t and 9179 t in the period 1996-1998 and 7456 t in 1999 (until week no. 39). The effort dropped from 1831 d in 1996 to 1250 d in 1997 and that level continued in 1998 at 1292 d. In 1999 (until week no. 39) the effort was 822 d. The level of CPUE increase in the period 1996-1998 from 4.70 $t \cdot d^{-1}$ to 6.80 $t \cdot d^{-1}$ and reached 8.97 $t \cdot d^{-1}$ in 1999 (until week no. 39).

Table 1. Shrimp catches (t), effort (d) and CPUE (t·d-1) by Faroese shrimp vessels on Flemish Cap (NAFO Div. 3M) in 1998 and 1999 (until week no. 39).

	Catch, t				*Effort, d*				*CPUE, $t \cdot d^{-1}$*			
Month	1996	1997	1998	1999	1996	1997	1998	1999	1996	1997	1998	1999
Jan												
Feb	154	37			30	7			5.13	5.19		
Mar	901	756	625	311	129	110	98	32	6.98	6.87	6.38	9.75
Apr	1021	1015	1030	853	197	138	130	96	5.19	7.37	7.92	8.92
May	1453	845	1528	949	231	159	177	110	6.28	5.31	8.63	8.66
Jun	1334	924	1493	1397	224	165	153	111	5.96	5.59	9.76	12.55
Jul	1249	998	1216	1233	262	159	168	146	4.76	6.27	7.25	8.46
Aug	736	836	1247	1397	191	135	180	168	3.86	6.18	6.92	8.31
Sep	772	817	782	1221	214	127	140	146	3.60	6.43	5.58	8.37
Oct	656	563	448	95	227	94	88	14	2.89	5.99	5.10	6.74
Nov	396	385	512		125	102	104		3.18	3.77	4.91	
Dec	5	210	298		1	53	54		3.89	3.97	5.54	
Total/Avg.	8677	7387	9179	7456	1831	1250	1292	822	4.70	5.72	6.80	8.97

Total catches from March to August fluctuated without a trend between 1 % and 17 % compared to the 1996 level in the period 1996-1999, Tab. 2. Total effort for the same season and period declined to about 30 % in 1997 and 1998 and further to 44 % in 1999 compared to the 1996 level. Catch rates increased from 21 % to 77 % in the period 1997-1999 compared to the 1996 level. This partly reflects the change in the fleet structure as the single trawlers were phased out in this period.

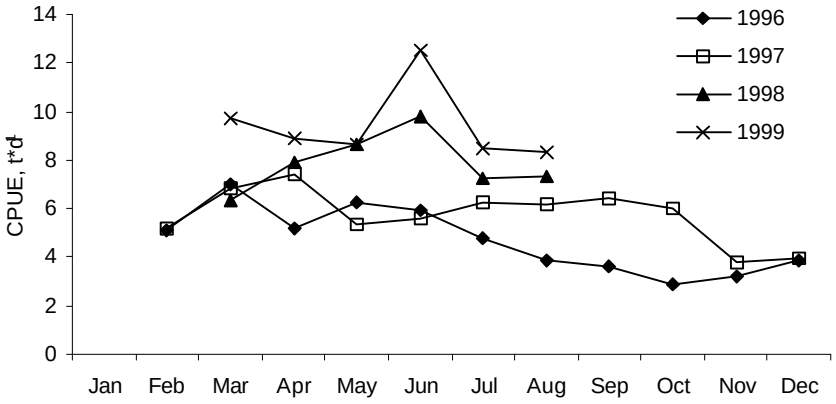

Figure 1 Monthly variation in CPUE (t·d-1) vessels on Flemish Cap (NAFO Div. 3M) for Faroese shrimp vessels in Div. 3M in the period 1996-1999.

Table 2. Faroese catch, effort and CPUE in the period 1996-1999 (March-August) and their changes compared to the 1996 level.

	Catch, t				*Effort, d*				*CPUE, t·d^{-1}*			
Month	1996	1997	1998	1999	1996	1997	1998	1999	1996	1997	1998	1999
Mar-Aug	7466	6192	7921	7360	1448	994	1046	808	5.16	6.23	7.57	9.11
Change		-0.17	0.06	-0.01		-0.31	-0.28	-0.44		0.21	0.47	0.77

Survey

In 1996 the Faroese Government decided to conduct a survey to assess the shrimp stock on Flemish Cap. The investigations started in 1997 and continued in 1998 and 1999. The results of the 1997 and 1998 surveys were reported by Nicolajsen (1997, 1998).

Materials and Methods

Biomass estimate

In July 1999 a total of 61 stations were selected in a stratified random trawl survey as shown in Fig. 2. The number of stations were allotted to the strata proportional to strata area. Stations were in the depth range 100-300 fathoms. Tow duration was 60 minutes and towing went on both in day and night time. As in the surveys in 1997 and 1998 the Faroese commercial shrimp trawler R/T Høgifossur (4400 HP) was used for the operation. A single Angmassalik 3000 shrimp trawl with 40 mm meshsize in the codend and 22 mm bar spacing in the sorting grade was used.

For each station the density was calculated, Fig. 3. The catch data were standardised dividing the catches by area swept, i.e. length of tow times width of the trawl. The length of tow was calculated by multiplying towing time with the average towing speed. The width of the trawl was calculated as the average distance between the doors as measured by accustic distance measuring device (Scanmar). The average density values were calculated for each strata and multiplied with the strata area and summed for all strata to total biomass, Tab. 3.

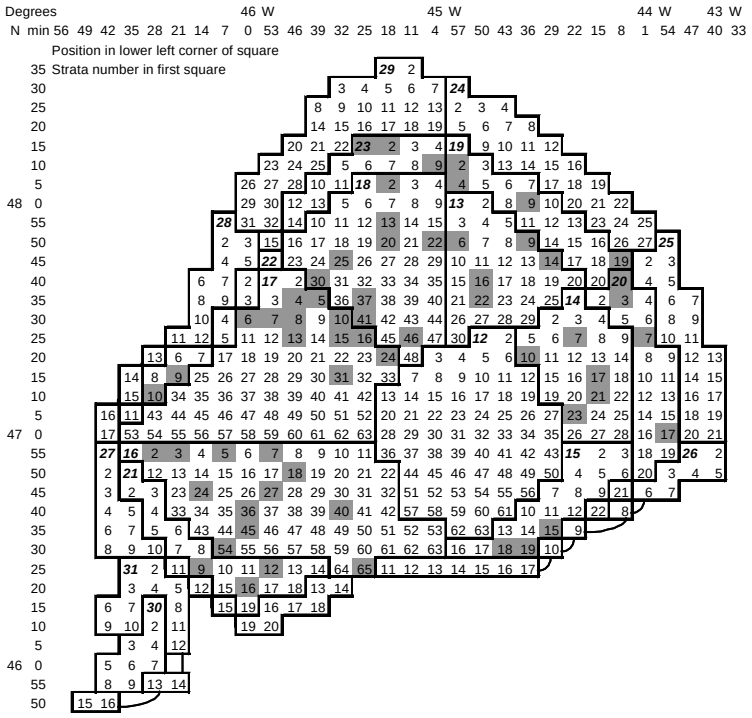

Figure 2 Map of Flemish Cap (NAFO Div. 3M) showing strata with randomly selected stations (squares shaded) in the July 1999

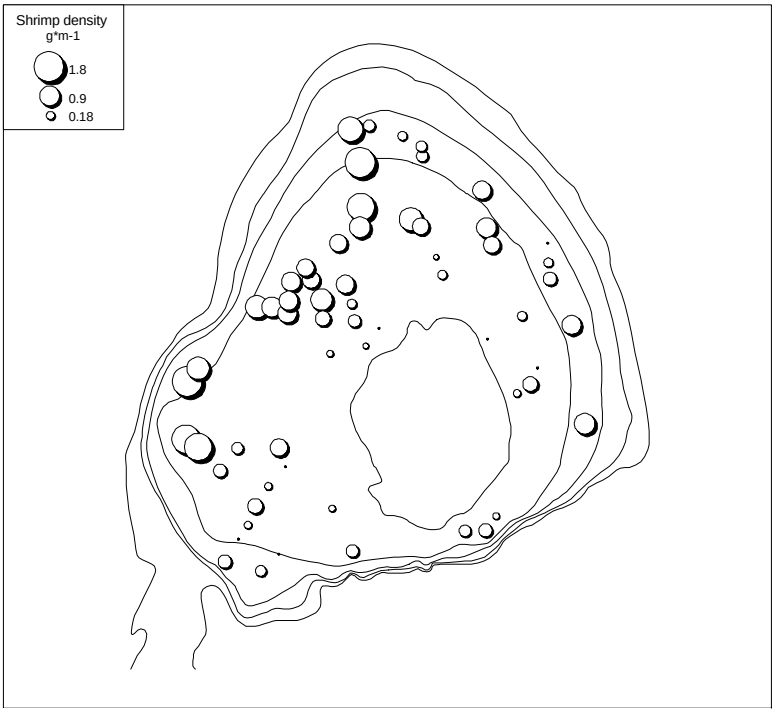

Figure 3 Density of shrimp (g·m-2) from survey on Flemish Cap (NAFO Div. 3M) in July 1999. Depth curves 200 m, 400 m, etc.

Length distribution

At each station a sample of about 200 specimens of shrimp were taken from the unsorted catch and analysed onboard. The shrimps were measured to the nearest 0.5 mm using Vernier calipers and within length groups sorted by males and females (Rasmussen, 1953) and the females were further grouped into primiparous and multiparous (McCrary, 1971). The length distribution from each sample was raised to the total shrimp catch and divided by area swept for each station to get abundance per unit area (density) at length. Mean density at length was calculated for each strata and multiplied by strata area to get stock in numbers by strata before summing all strata by length and sex/maturity groups. Stock in weight was calculated using a weight-length curve for shrimp in Div. 3M in the period 1993-95 (Nicolajsen, 1996).

Growth

The mean length at age/maturity was estimated by visually identifying the modes of each age group in the length distribution of males, primiparous and multiparous females in the stock.

Age structure

The length distributions of males, primiparous and multiparous females were separated into age groups using the MIX software by MacDonnald and Pitcher (1979). The mean length at age input was taken from the estimated growth curve. A so-called Solver function in the Excel spreadsheet software was used to make preliminary estimates of proportion of each age/maturity group while certain constraints were set on the value range of sigmas. The calculated proportions were used as input to the Mix software.

Results

Biomass estimate

The result of the total stock biomass calculations by the area swept method was 16 477 t with a weighted average density of 0.565 $g \cdot m^{-2}$ (Tab. 3). The stock in weight calculated for all strata was 16 017 t (Tab. 5). The discrepancy between the two estimates is less then 3%.

Table 3. Area swept assessment of the Flemish Cap (NAFO Div. 3M) shrimp stock biomass for July 1999.

Strata No.	Average density $t \cdot km^{-2}$	Strata area km^{-2}	Biomass t	No. of stations
13	0.503	2572	1293	5
14	0.194	2401	466	5
15	0.308	1629	501	3
16	0.504	5574	2809	12
17	0.658	5402	3557	11
18	0.865	4116	3561	9
19	0.347	1715	595	4
20	0.605	1886	1142	4
21	0.253	1629	413	3
22	1.410	943	1330	2
23	0.629	1286	809	3
Total		*29154*	*16477*	*61*
Average	*0.565*			

Length distribution

The length distributions in stock by strata and its males, primiparous and multiparous female components as well as total stock are shown in Tabs. 4-7, respectively, and in Fig. 4. The stock weight at length in stock by strata and its males, primiparous and multiparous female components as well as total stock are shown in Tabs. 8-11, respectively, and in Fig. 5.

Growth

The preliminary interpretation of mean lengths at age/maturity groups are show in Tab. 12. These means were used as input to the Mix software. The average length for each age group was used to calculate a von Bertalanffy growth curve, Fig. 6. The growth parameters were L_∞ = 33 mm, k= 0.249 and t_0= -0.25 yr.

Age structure

Proportion, average size and standard deviation of age/maturity groups from the Mix runs are shown in Tab. 13. Age distribution is shown in Tab. 14 and Fig. 7. Growth curve and relative size distribution of age/maturity groups is shown in Fig. 8. Stock in numbers in the period 1997-1999 are shown in Tab. 15 and plotted by year class in Fig. 9. A summary of stock parameters are shown in Tab. 16.

Discussion

Biomass estimate

The stock biomass went up 38% from 16 978 t in 1997 to 23 495 t in 1998 and dropped to 16 477 t in 1999 back to the 1997 level, Tab. 16. The abundance was stable at 0.111-0.129 numbers$\cdot m^{-2}$ in the period but mean weight in the stock were higher in 1998 at 0.77 $g\cdot m^{-2}$ compared to 0.52 $g\cdot m^{-2}$ and 0.57 $g\cdot m^{-2}$ in 1997 and 1999, respectively.

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Table 4. Stock in numbers (mill.) at length by strata and total, Flemish Cap (NAFO Div. 3M) in June 1999.

STRATA OCL, mm	13	14	15	16	17	18	19	20	21	22	23	Total
12.0	0	0	0	0	1	1	0	0	0	0	0	3
12.5	0	0	0	0	5	2	0	0	0	0	0	7
13.0	3	1	0	4	12	8	0	0	0	0	0	29
13.5	7	3	0	5	20	17	0	0	0	1	0	52
14.0	18	7	0	12	41	35	0	0	0	2	0	115
14.5	22	10	0	31	54	50	0	0	0	2	0	169
15.0	26	16	2	33	52	52	0	0	0	3	0	185
15.5	27	16	4	39	43	36	0	0	0	5	0	170
16.0	18	13	4	31	39	31	0	0	0	10	0	147
16.5	20	7	3	46	34	29	2	0	0	10	0	153
17.0	22	9	4	52	52	38	2	2	1	19	0	201
17.5	24	8	4	55	50	51	5	3	0	24	0	224
18.0	28	6	7	53	34	53	8	8	1	33	1	232
18.5	19	4	6	40	31	44	7	6	2	26	1	185
19.0	14	5	5	25	19	27	6	9	1	16	1	127
19.5	9	4	2	14	15	21	5	5	2	10	2	89
20.0	5	4	4	11	16	15	3	6	2	10	1	77
20.5	3	2	4	15	22	15	3	4	1	6	1	77
21.0	7	2	2	18	21	29	2	4	2	6	1	94
21.5	8	4	2	20	27	34	3	6	2	13	3	123
22.0	10	4	3	17	28	32	3	5	3	11	4	120
22.5	12	4	3	45	24	45	3	5	2	9	3	156
23.0	6	3	4	19	19	37	4	8	1	6	3	110
23.5	7	2	5	21	22	34	5	7	1	8	5	117
24.0	6	1	4	19	13	29	6	7	1	5	6	96
24.5	5	1	4	10	13	19	6	13	3	11	8	93
25.0	4	0	3	10	9	7	5	9	2	5	10	66
25.5	3	0	1	8	8	3	4	9	3	3	10	52
26.0	1	0	2	7	9	3	3	8	3	3	8	46
26.5	0	0	1	5	3	4	2	6	3	1	4	31
27.0	0	0	1	3	1	1	2	6	3	5	4	27
27.5	0	0	1	2	2	0	1	5	3	2	7	23
28.0	0	0	0	1	0	1	1	2	2	0	3	10
28.5	0	0	0	1	0	0	0	1	2	1	1	6
29.0	0	0	0	0	0	0	0	2	0	0	0	2
29.5	0	0	0	0	0	0	0	0	1	0	0	1
30.0	0	0	0	0	0	0	0	0	0	0	0	1
30.5	0	0	0	0	0	0	0	0	0	0	0	0
31.0	0	0	0	0	0	0	0	0	0	0	0	0
31.5	0	0	0	0	0	0	0	0	0	1	0	1
Total	335	137	86	675	744	805	91	144	48	268	87	3419

Table 5. Stock in numbers (mill.) at length of males by strata and total, Flemish Cap (NAFO Div. 3M) in June 1999.

STRATA OCL, mm	13	14	15	16	17	18	19	20	21	23	26	Total
12.0	0	0	0	0	1	1	0	0	0	0	0	3
12.5	0	0	0	0	5	2	0	0	0	0	0	7
13.0	3	1	0	4	12	8	0	0	0	0	0	29
13.5	7	3	0	5	20	17	0	0	0	1	0	52
14.0	18	7	0	12	41	35	0	0	0	2	0	115
14.5	22	10	0	31	54	50	0	0	0	2	0	169
15.0	26	16	2	33	52	52	0	0	0	3	0	185
15.5	27	16	4	39	43	36	0	0	0	5	0	170
16.0	18	13	4	31	39	31	0	0	0	10	0	147
16.5	20	7	2	46	34	29	2	0	0	10	0	152
17.0	21	8	4	52	51	38	2	2	1	19	0	198
17.5	23	7	4	55	50	50	5	3	0	24	0	221
18.0	27	6	6	52	33	52	8	8	1	33	1	229
18.5	18	4	6	40	31	43	7	6	2	26	1	183
19.0	13	3	4	24	19	25	6	9	1	16	1	120
19.5	8	3	1	13	13	19	5	5	2	10	2	81
20.0	3	1	1	9	12	12	3	6	2	10	1	59
20.5	1	0	1	10	11	8	3	4	1	6	1	44
21.0	2	0	1	9	8	9	2	4	2	5	1	42
21.5	1	0	0	6	5	9	2	5	2	12	2	46
22.0	1	0	0	3	4	4	2	3	3	9	3	32
22.5	0	0	0	1	2	4	1	2	2	7	2	22
23.0	0	0	0	2	1	1	1	5	1	2	1	14
23.5	0	0	0	0	0	0	0	2	1	2	0	5
24.0	0	0	0	0	0	0	0	1	0	0	0	1
24.5	0	0	0	0	0	0	0	0	0	0	0	1
25.0	0	0	0	0	0	0	0	0	0	0	0	0
25.5	0	0	0	0	0	0	0	0	0	0	0	0
26.0	0	0	0	0	0	0	0	0	0	0	0	0
26.5	0	0	0	0	0	0	0	0	0	0	0	0
27.0	0	0	0	0	0	0	0	0	0	0	0	0
27.5	0	0	0	0	0	0	0	0	0	0	0	0
28.0	0	0	0	0	0	0	0	0	0	0	0	0
28.5	0	0	0	0	0	0	0	0	0	0	0	0
29.0	0	0	0	0	0	0	0	0	0	0	0	0
29.5	0	0	0	0	0	0	0	0	0	0	0	0
30.0	0	0	0	0	0	0	0	0	0	0	0	0
30.5	0	0	0	0	0	0	0	0	0	0	0	0
31.0	0	0	0	0	0	0	0	0	0	0	0	0
31.5	0	0	0	0	0	0	0	0	0	0	0	0
Total	262	105	41	478	543	536	49	64	20	215	16	2329

Table 6. Stock in numbers (mill.) at length of primiparous by strata and total, Flemish Cap (NAFO Div. 3M) in June 1999.

STRATA OCL, mm	13	14	15	16	17	18	19	20	21	22	23	Total
12.0	0	0	0	0	0	0	0	0	0	0	0	0
12.5	0	0	0	0	0	0	0	0	0	0	0	0
13.0	0	0	0	0	0	0	0	0	0	0	0	0
13.5	0	0	0	0	0	0	0	0	0	0	0	0
14.0	0	0	0	0	0	0	0	0	0	0	0	0
14.5	0	0	0	0	0	0	0	0	0	0	0	0
15.0	0	0	0	0	0	0	0	0	0	0	0	0
15.5	0	0	0	0	0	0	0	0	0	0	0	0
16.0	0	0	0	0	0	0	0	0	0	0	0	0
16.5	0	0	0	0	0	0	0	0	0	0	0	0
17.0	1	0	0	0	0	0	0	0	0	0	0	1
17.5	1	0	0	0	0	1	0	0	0	0	0	2
18.0	0	0	0	0	1	1	0	0	0	0	0	2
18.5	0	0	0	0	0	0	0	0	0	0	0	1
19.0	1	2	1	0	1	2	0	0	0	0	0	6
19.5	1	2	1	0	1	2	0	0	0	0	0	7
20.0	2	3	3	2	5	3	0	0	0	0	0	17
20.5	2	2	3	5	10	6	0	0	0	1	0	30
21.0	4	2	1	7	12	17	0	0	0	2	0	46
21.5	6	4	2	10	18	20	1	1	0	1	0	62
22.0	6	4	2	11	18	22	1	1	0	2	1	67
22.5	9	4	2	36	16	32	2	3	0	2	2	107
23.0	5	3	4	9	10	23	3	3	0	2	2	62
23.5	3	1	4	8	12	23	4	4	1	5	4	69
24.0	3	0	4	7	4	18	5	5	0	2	4	53
24.5	1	1	4	5	6	10	4	10	2	4	6	52
25.0	0	0	3	2	3	2	4	6	1	3	7	32
25.5	1	0	1	2	2	1	2	5	2	1	5	22
26.0	0	0	1	0	2	0	1	3	1	1	5	15
26.5	0	0	1	0	0	1	1	2	0	1	1	8
27.0	0	0	1	0	0	0	1	1	0	1	2	5
27.5	0	0	0	0	0	0	0	1	0	0	2	4
28.0	0	0	0	0	0	0	0	0	0	0	1	1
28.5	0	0	0	0	0	0	0	0	0	0	0	0
29.0	0	0	0	0	0	0	0	0	0	0	0	0
29.5	0	0	0	0	0	0	0	0	0	0	0	0
30.0	0	0	0	0	0	0	0	0	0	0	0	0
30.5	0	0	0	0	0	0	0	0	0	0	0	0
31.0	0	0	0	0	0	0	0	0	0	0	0	0
31.5	0	0	0	0	0	0	0	0	0	0	0	0
Total	46	27	38	106	120	182	29	46	8	26	42	671

Table 7. Stock in numbers (mill.) at length of multiparous by strata and total, Flemish Cap (NAFO Div. 3M) in June 1999.

STRATA OCL, mm	13	14	15	16	17	18	19	20	21	22	23	Total
12.0	0	0	0	0	0	0	0	0	0	0	0	0
12.5	0	0	0	0	0	0	0	0	0	0	0	0
13.0	0	0	0	0	0	0	0	0	0	0	0	0
13.5	0	0	0	0	0	0	0	0	0	0	0	0
14.0	0	0	0	0	0	0	0	0	0	0	0	0
14.5	0	0	0	0	0	0	0	0	0	0	0	0
15.0	0	0	0	0	0	0	0	0	0	0	0	0
15.5	0	0	0	0	0	0	0	0	0	0	0	0
16.0	0	0	0	0	0	0	0	0	0	0	0	0
16.5	0	0	0	0	0	0	0	0	0	0	0	1
17.0	0	1	0	0	0	0	0	0	0	0	0	1
17.5	0	1	0	0	0	0	0	0	0	0	0	1
18.0	1	0	0	0	0	0	0	0	0	0	0	1
18.5	1	0	0	0	0	1	0	0	0	0	0	2
19.0	0	0	0	1	0	0	0	0	0	0	0	1
19.5	0	0	0	0	1	0	0	0	0	0	0	2
20.0	0	0	0	0	0	0	0	0	0	0	0	0
20.5	0	0	0	1	1	1	0	0	0	0	0	3
21.0	1	0	0	2	1	3	0	0	0	0	0	7
21.5	0	0	0	4	4	5	0	0	0	0	0	14
22.0	3	1	1	3	6	7	0	1	0	1	0	21
22.5	3	0	1	8	6	8	0	0	0	0	0	27
23.0	1	0	0	8	8	12	0	0	0	2	0	34
23.5	4	0	0	13	10	11	1	1	0	1	1	42
24.0	2	1	0	12	8	11	1	1	1	2	2	41
24.5	4	0	1	5	8	9	1	3	0	7	2	40
25.0	4	0	1	8	6	5	1	3	1	2	3	34
25.5	2	0	0	7	6	3	2	3	1	2	5	30
26.0	1	0	1	6	7	3	1	4	2	2	3	31
26.5	0	0	0	5	3	3	1	4	3	0	3	23
27.0	0	0	1	3	1	1	1	5	3	4	2	22
27.5	0	0	0	2	2	0	1	4	3	2	4	20
28.0	0	0	0	1	0	1	1	2	2	0	3	9
28.5	0	0	0	1	0	0	0	1	2	1	1	6
29.0	0	0	0	0	0	0	0	1	0	0	0	2
29.5	0	0	0	0	0	0	0	0	1	0	0	1
30.0	0	0	0	0	0	0	0	0	0	0	0	1
30.5	0	0	0	0	0	0	0	0	0	0	0	0
31.0	0	0	0	0	0	0	0	0	0	0	0	0
31.5	0	0	0	0	0	0	0	0	0	1	0	1
Total	28	5	7	91	80	86	13	35	20	26	29	420

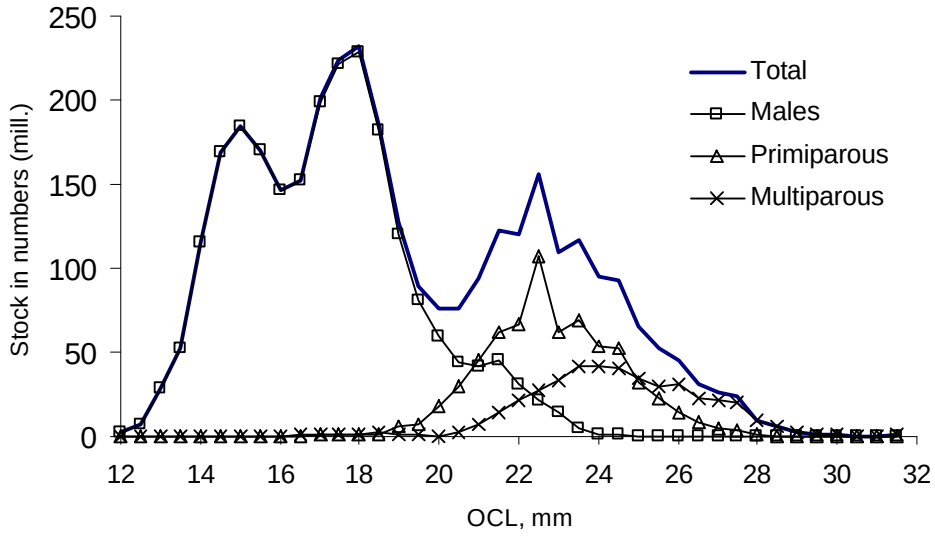

Figure 4 Length distribution in shrimp stock on Flemish Cap (NAFO Div. 3M) of total, males, primiparous and multiparous females from the July 1999 survey.

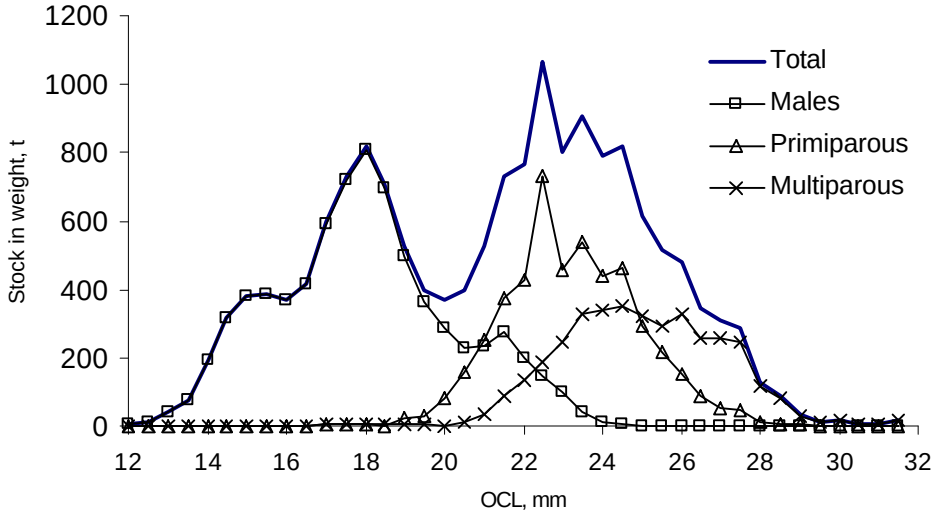

Figure 5 Stock weight (t) at length in shrimp stock on Flemish Cap (NAFO Div. 3M) of total, males, primiparous and multiparous females from the July 1999 survey.

Table 8. Stock weight (t) at length by strata and total, Flemish Cap (NAFO Div. 3M) in June 1999.

STRATA OCL, mm	13	14	15	16	17	18	19	20	21	22	23	Total
12.0	0	0	0	0	2	1	0	0	0	0	0	3
12.5	0	0	0	0	6	3	0	0	0	0	0	9
13.0	5	1	0	6	16	11	0	0	0	0	0	39
13.5	10	4	0	8	29	26	0	0	0	1	0	79
14.0	31	12	0	20	70	58	0	0	0	3	0	194
14.5	40	18	1	58	102	93	0	0	0	5	0	316
15.0	53	33	5	69	107	107	1	0	0	7	0	382
15.5	60	36	9	88	97	83	1	0	0	12	0	386
16.0	46	32	11	77	98	77	1	0	0	25	0	367
16.5	55	20	7	126	94	80	5	0	0	28	0	417
17.0	66	26	12	156	154	115	6	6	2	57	0	599
17.5	78	27	12	178	163	165	15	9	1	79	1	729
18.0	98	23	24	187	119	187	28	27	5	118	3	819
18.5	71	15	23	153	119	168	26	24	7	99	4	710
19.0	57	19	20	103	81	111	25	35	5	67	4	526
19.5	41	18	11	63	69	93	22	22	8	43	8	400
20.0	23	20	19	53	79	70	14	27	9	50	5	370
20.5	18	11	21	79	115	76	16	21	4	33	5	398
21.0	39	11	12	98	116	164	11	22	12	35	5	526
21.5	46	25	13	120	161	206	20	35	12	77	16	732
22.0	64	28	16	109	176	206	21	31	20	73	23	767
22.5	85	29	19	310	166	306	19	31	15	62	21	1065
23.0	46	25	27	138	139	267	26	58	8	43	22	800
23.5	52	13	36	166	169	268	38	57	11	59	37	905
24.0	47	8	36	156	104	238	47	57	8	39	49	790
24.5	46	8	38	87	118	166	51	113	23	94	73	818
25.0	42	2	32	90	87	68	49	86	23	46	91	616
25.5	26	1	14	83	80	34	36	86	25	32	98	514
26.0	10	1	19	68	97	33	27	79	34	28	83	479
26.5	0	0	16	59	33	45	26	69	34	15	48	345
27.0	1	0	14	41	15	17	19	69	35	53	47	311
27.5	5	0	6	26	29	2	16	57	43	23	81	289
28.0	0	0	6	12	1	9	7	31	22	0	43	131
28.5	0	0	0	16	0	5	3	18	25	11	12	89
29.0	0	0	0	3	0	0	2	23	5	0	1	34
29.5	0	0	0	0	0	0	0	1	9	0	1	11
30.0	0	0	0	0	0	0	0	7	5	0	6	19
30.5	0	0	0	0	0	0	0	1	7	0	0	8
31.0	0	0	0	3	0	0	0	5	0	0	0	8
31.5	0	0	0	0	0	0	0	0	2	14	0	16
Total	1263	467	481	3012	3014	3557	581	1107	416	1330	789	16017

Table 9. Stock weight (t) at length of males by strata and total, Flemish Cap (NAFO Div. 3M) in June 1999.

STRATA OCL, mm	13	14	15	16	17	18	19	20	21	22	23	Total
12.0	0	0	0	0	2	1	0	0	0	0	0	3
12.5	0	0	0	0	6	3	0	0	0	0	0	9
13.0	5	1	0	6	16	11	0	0	0	0	0	39
13.5	10	4	0	8	29	26	0	0	0	1	0	79
14.0	31	12	0	20	70	58	0	0	0	3	0	194
14.5	40	18	1	58	102	93	0	0	0	5	0	316
15.0	53	33	5	69	107	107	1	0	0	7	0	382
15.5	60	36	9	88	97	83	1	0	0	12	0	386
16.0	46	32	11	77	98	77	1	0	0	25	0	367
16.5	55	20	7	126	93	80	5	0	0	28	0	415
17.0	63	24	12	155	153	114	6	6	2	57	0	592
17.5	76	24	12	178	162	161	15	9	1	79	1	720
18.0	97	21	23	185	117	185	28	27	5	118	3	809
18.5	69	15	23	152	118	163	26	24	7	99	4	699
19.0	52	11	16	99	78	104	25	35	5	67	4	496
19.5	35	12	6	60	60	83	22	22	8	43	8	360
20.0	16	5	5	44	57	57	13	27	9	50	5	286
20.5	5	1	4	50	57	41	16	19	4	29	5	229
21.0	12	1	3	51	42	52	8	22	12	26	5	235
21.5	9	1	1	38	30	54	13	28	12	73	15	274
22.0	6	0	0	19	25	24	10	22	18	59	18	201
22.5	3	0	0	4	16	31	7	12	15	50	11	148
23.0	0	0	0	16	9	11	5	34	4	17	4	100
23.5	0	0	1	1	0	0	1	18	4	15	2	42
24.0	0	0	0	0	0	0	0	9	0	0	0	9
24.5	0	0	1	0	0	0	3	2	0	0	0	6
25.0	0	0	0	0	0	0	0	0	0	0	0	0
25.5	0	0	0	0	0	0	0	3	0	0	0	3
26.0	0	0	0	0	0	0	0	0	0	0	0	0
26.5	0	0	0	0	0	0	0	0	0	0	0	0
27.0	0	0	0	0	0	0	0	0	0	0	0	0
27.5	0	0	0	0	0	0	0	0	0	0	0	0
28.0	0	0	0	0	0	0	0	0	0	0	0	0
28.5	0	0	0	0	0	0	0	0	0	0	0	0
29.0	0	0	0	0	0	0	0	0	0	0	0	0
29.5	0	0	0	0	0	0	0	0	0	0	0	0
30.0	0	0	0	0	0	0	0	0	0	0	0	0
30.5	0	0	0	0	0	0	0	0	0	0	0	0
31.0	0	0	0	0	0	0	0	0	0	0	0	0
31.5	0	0	0	0	0	0	0	0	0	0	0	0
Total	744	271	138	1504	1546	1619	207	320	105	860	85	7400

Table 10. Stock weight (t) at length of primiparous by strata and total, Flemish Cap (NAFO Div. 3M) in June 1999.

STRATA OCL, mm	13	14	15	16	17	18	19	20	21	22	23	Total
12.0	0	0	0	0	0	0	0	0	0	0	0	0
12.5	0	0	0	0	0	0	0	0	0	0	0	0
13.0	0	0	0	0	0	0	0	0	0	0	0	0
13.5	0	0	0	0	0	0	0	0	0	0	0	0
14.0	0	0	0	0	0	0	0	0	0	0	0	0
14.5	0	0	0	0	0	0	0	0	0	0	0	0
15.0	0	0	0	0	0	0	0	0	0	0	0	0
15.5	0	0	0	0	0	0	0	0	0	0	0	0
16.0	0	0	0	0	0	0	0	0	0	0	0	0
16.5	0	0	0	1	0	0	0	0	0	0	0	1
17.0	3	0	0	0	0	1	0	0	0	0	0	4
17.5	2	0	0	0	1	2	0	0	0	0	0	6
18.0	0	0	0	2	2	2	0	0	0	0	0	6
18.5	1	0	0	1	0	0	0	0	0	0	0	3
19.0	5	8	4	0	3	7	0	0	0	0	0	26
19.5	6	7	4	2	6	8	0	0	0	0	0	32
20.0	8	16	13	10	22	14	1	0	0	0	0	83
20.5	12	10	17	26	52	33	0	2	0	4	0	155
21.0	23	10	7	39	67	97	2	0	0	9	0	254
21.5	34	22	12	60	107	119	7	7	0	5	1	373
22.0	39	24	12	69	115	139	9	5	2	10	5	429
22.5	63	26	14	248	106	220	10	18	0	13	11	731
23.0	35	23	26	64	70	166	19	21	2	11	16	454
23.5	20	10	32	64	90	181	31	34	6	38	30	537
24.0	27	3	34	59	35	145	41	38	2	20	36	439
24.5	13	4	32	42	51	88	37	87	19	35	52	460
25.0	0	2	27	16	32	18	38	58	13	29	62	295
25.5	9	1	13	18	24	6	21	52	15	8	52	218
26.0	0	0	13	2	20	0	11	34	11	8	53	153
26.5	0	0	11	3	0	8	10	22	4	15	16	89
27.0	0	0	6	0	0	0	7	12	0	7	22	54
27.5	0	0	2	0	0	0	4	7	5	0	27	44
28.0	0	0	0	0	0	0	0	3	0	0	8	12
28.5	0	0	0	0	0	0	0	1	0	0	4	6
29.0	0	0	0	0	0	0	0	4	0	0	0	4
29.5	0	0	0	0	0	0	0	0	0	0	0	0
30.0	0	0	0	0	0	0	0	0	0	0	0	0
30.5	0	0	0	0	0	0	0	0	0	0	0	0
31.0	0	0	0	0	0	0	0	0	0	0	0	0
31.5	0	0	0	0	0	0	0	0	0	0	0	0
Total	299	166	280	727	803	1255	247	405	79	210	395	4864

Table 11. Stock weight (t) at length of multiparous by strata and total, Flemish Cap (NAFO Div. 3M) in June 1999.

STRATA OCL, mm	13	14	15	16	17	18	19	20	21	22	23	Total
12.0	0	0	0	0	0	0	0	0	0	0	0	0
12.5	0	0	0	0	0	0	0	0	0	0	0	0
13.0	0	0	0	0	0	0	0	0	0	0	0	0
13.5	0	0	0	0	0	0	0	0	0	0	0	0
14.0	0	0	0	0	0	0	0	0	0	0	0	0
14.5	0	0	0	0	0	0	0	0	0	0	0	0
15.0	0	0	0	0	0	0	0	0	0	0	0	0
15.5	0	0	0	0	0	0	0	0	0	0	0	0
16.0	0	0	0	0	0	0	0	0	0	0	0	0
16.5	0	0	1	0	1	0	0	0	0	0	0	2
17.0	0	2	0	1	0	0	0	0	0	0	0	3
17.5	0	2	0	0	0	1	0	0	0	0	0	4
18.0	2	1	1	0	0	0	0	0	0	0	0	4
18.5	2	0	0	0	1	5	0	0	0	0	0	8
19.0	0	0	0	4	0	0	0	0	0	0	0	4
19.5	0	0	1	1	4	2	0	0	0	0	0	8
20.0	0	0	0	0	0	0	0	0	0	0	0	1
20.5	1	0	0	3	6	3	0	0	0	0	0	14
21.0	5	0	1	9	7	15	0	0	0	0	0	37
21.5	3	3	0	22	25	33	0	0	0	0	0	85
22.0	19	4	3	21	36	43	2	4	0	5	0	137
22.5	19	3	6	58	44	56	2	0	0	0	0	187
23.0	11	2	1	58	60	89	2	3	2	15	1	246
23.5	32	2	3	101	79	86	7	5	0	6	5	327
24.0	20	5	3	97	69	93	7	9	6	19	13	341
24.5	33	4	5	46	67	78	12	24	4	59	21	352
25.0	42	0	6	74	55	50	12	27	10	18	29	321
25.5	17	0	2	65	56	27	15	32	10	24	46	293
26.0	10	1	6	66	77	33	16	45	23	20	30	326
26.5	0	0	5	56	33	37	16	47	31	0	32	257
27.0	1	0	8	41	15	17	12	57	35	46	26	257
27.5	5	0	4	26	29	2	12	50	38	23	54	245
28.0	0	0	6	12	1	9	7	28	22	0	35	119
28.5	0	0	0	16	0	5	3	16	25	11	8	83
29.0	0	0	0	3	0	0	2	19	5	0	1	30
29.5	0	0	0	0	0	0	0	1	9	0	1	11
30.0	0	0	0	0	0	0	0	7	5	0	6	19
30.5	0	0	0	0	0	0	0	1	7	0	0	8
31.0	0	0	0	3	0	0	0	5	0	0	0	8
31.5	0	0	0	0	0	0	0	0	2	14	0	16
Total	221	30	63	781	666	684	127	381	232	260	308	3752

Table 12. Average OCL interpreted from size distribution.

Age	Males OCL, mm	Primiparous OCL, mm	Multiparous OCL, mm	Mean OCL, mm
0				
1				
2	15.00			15.00
3	18.00			18.00
4	21.50			21.50
5		22.50	24.00	23.25
6		25.00	26.00	25.50
7			27.50	27.50
8			29.00	29.00
9			30.00	30.00
10			31.00	31.00

Table 13. Results from the age separation for each sex/maturity group calculated with the Mix software.

Sex and maturity group	Males		Primiparous females		Multiparous females	
Age	Prop.	St.Dev.	Prop.	St.Dev.	Prop.	St.Dev.
1						
2	0.380	0.0301				
3	0.504	0.0419			0.019	0.0079
4	0.116	0.0187				
5			0.876	0.0253	0.696	0.1347
6			0.124	0.0253	0.278	0.1344
9					0.006	0.0055
	Means	St.Dev.	Means	St.Dev.	Means	St.Dev.
1						
2	14.9	0.1032				
3	17.8	0.0758			18.1	0.4855
4	21.0	0.2577				
5			22.5	FIXED	23.7	0.3498
6			25.0	FIXED	26.7	0.5188
9					30.7	0.7787
	Sigmas	St.Dev.	Sigmas	St.Dev.	Sigmas	St.Dev.
1						
2	0.99	0.0567				
3	1.02	0.0913			0.95	0.3948
4	1.20	0.1376				
5			1.52	0.0584	1.39	0.2011
6			1.34	0.1607	1.11	0.2711
9					0.69	0.5769

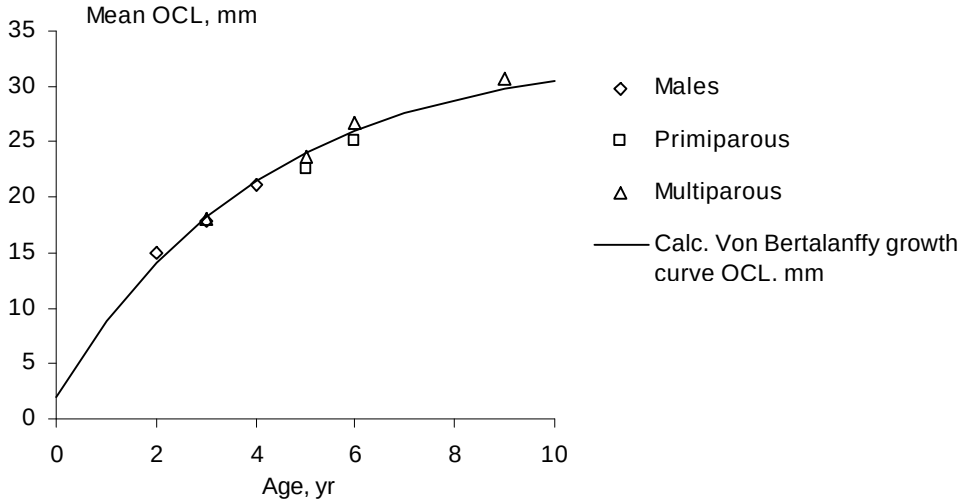

Figure 6 von Bertalanffy growth curve for shrimp on Flemish Cap (NAFO Div. 3M). Data points from calculation from Tab. 13.

Table 14. Stock in numbers (mill.) by age/maturity groups.

Age	Males	Primiparous	Multiparous	Total
1				
2	214			214
3	1280		8	1288
4	835			835
5		588	292	880
6		83	117	200
7+			3	3
Total	2329	671	420	3420

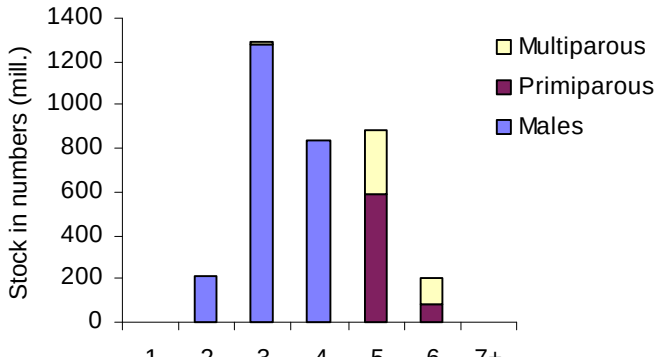

Figure 7. Stock in numbers at age/maturity. Data from Tab. 14.

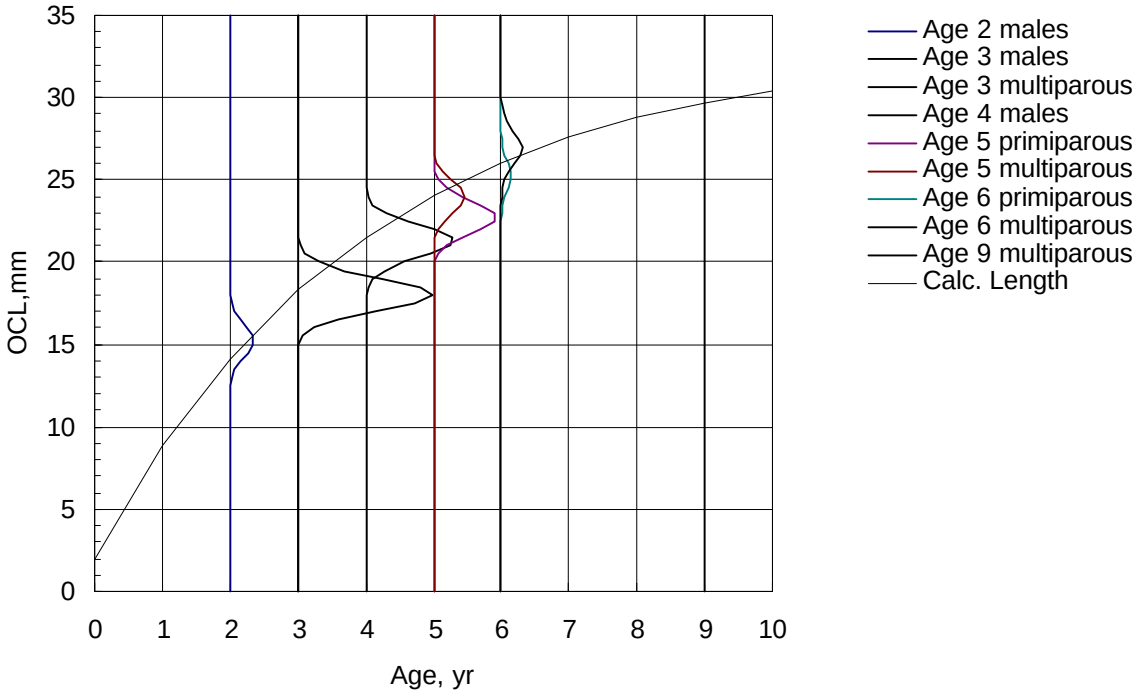

Figure 8 Growth curve and relative size distribution of age/maturity groups of shrimp on Flemish Cap (NAFO Div. 3M) from survey in July 1999. (Age/sex groups 3 and 9 multiparous are so small that they do not show up on the graph).

Table 15 Stock in numbers (mill.) in Flemish Cap shrimp stock (NAFO DIV. 3M) in the period 1997-1999.

Age	1997	1998	1999	Average
1				
2	901	226	214	447
3	1653	1366	1288	1436
4	470	1006	835	770
5	466	715	880	687
6	94	614	200	303
7+		7	3	3
Total	3585	3934	3420	3646

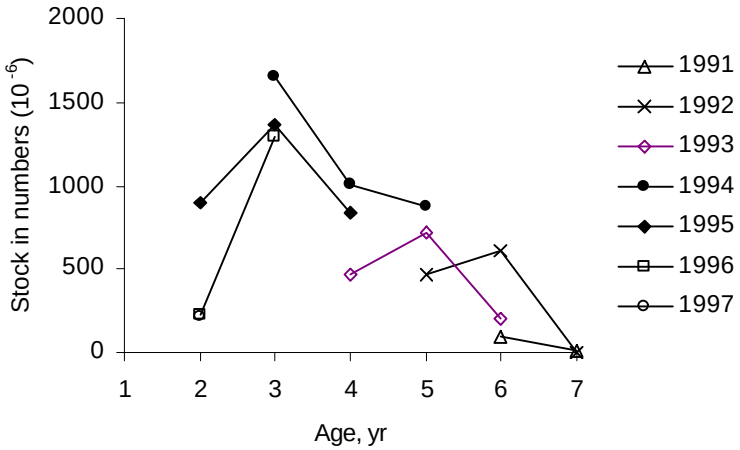

Figure 8 Stock in numbers by year class in shrimp stock on Flemish Cap (NAFO Div. 3M) in the period 1997-1999.

Table 16 Summary of survey stock assessment parameters for shrimp on Flemish Cap (NAFO 3M) in the period 1997-1999.

Year	Biomass t	Density $g \cdot m^{-2}$	Numbers (10^{-6})	Average weight, g	Abundance numbers$\cdot m^{-2}$	Surveyed area, km^2
1997	16978	0.52	3585	4.74	0.111	32413
1998	23495	0.77	3934	5.97	0.129	30612
1999	16477	0.57	3419	4.82	0.117	29154
Average	18983	0.62	3646	5.18	0.119	30726