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Biomass Estimate, Growth, Length and Age Distribution of the Northern Shrimp (*Pandalus borealis*)  
Stock on Flemish Cap (NAFO Division 3M) in June 2001

by

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### Abstract

A stratified random bottom trawl survey for shrimp on Flemish Cap conducted in the period 1997-2001 estimated stock biomass to 16000 t, 22000 t, 16500 t, 20000 t and 19000 t, respectively. Average stock in numbers was about 3.65 billion, average density  $0.62 \text{ g}\cdot\text{m}^{-2}$  and average abundance  $0.122 \text{ numbers}\cdot\text{m}^{-2}$  for this period. Stock in numbers by length and age/maturity groups are calculated.

### Introduction

Previous results from the Faroese stratified random bottom trawl survey for northern shrimp on Flemish Cap are reported by Nicolajsen (1997, 1998, 1999, 2000).

### Materials and Methods

#### *Biomass estimate*

In June 2001 a total of 61 stations were selected in a stratified random trawl survey as shown in Fig. 1. 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 1997-2000 the Faroese commercial shrimp trawler R/T Høggifossur (4400 HP) was used for the operation.

In 1997-2001 an Angmassalik II shrimp trawl with 40 mm mesh size in the codend and 22 mm bar spacing in the sorting grade was used. A single trawl was almost exclusively used except for a few stations in 1997 where a double trawl was used. In 1997-1999 the trawl had a circumference of 3000 20 mm mesh equivalent (20mm m.e.), which was 3600 20mm m.e. in 2000 and 3200 20mm m.e. in 2001. Doorspread and towing speed was recorded for these trawl types and average values calculated for each type and arrangement.

For each station the density was calculated, Fig. 2. The catch data were standardized dividing the catches by area swept, i.e. length of tow times average 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 Scanmar acoustic distance measuring device (Nicolajsen, 2001). The average density values were calculated for each stratum and multiplied by the strata area and summed for all strata to total biomass, Table 1. This calculation was carried out for the previous surveys in this series and the stock in numbers adjusted accordingly, Tables 13 and 14, Fig. 2 and 8.

### *Length distribution*

At each station a sample of about 200 specimens of shrimp were taken from the unsorted catch and analyzed 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 for June 2001 (Nicolajsen, 2001).

### *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 19 036 t with an unweighted average density of 0.582 g·m<sup>-2</sup> (Table 1). The stock in weight calculated for all strata was 18 135 t (Table 6). The discrepancy between the two estimates is 5%.

### *Length distribution*

The length distributions in stock by strata and its male, primiparous and multiparous female components as well as total stock are shown in Tables 2-5, respectively, and in Fig. 3. The stock weight at length in stock by strata and its male, primiparous and multiparous female components as well as total stock are shown in Tables 6-9, respectively, and in Fig. 4.

### *Growth*

The preliminary interpretation of mean lengths at age/maturity groups are shown in Table 10. These means were used as input to the Mix software. The average length for each age group from Table 11 was used to estimate a von Bertalanffy growth curve, Fig. 5.

### *Age structure*

Proportion, average size and standard deviation of age/maturity groups from the Mix runs are shown in Table 11. Age distribution is shown in Table 12 and Fig. 6. Growth curve and relative size distribution of age/maturity groups is shown in Fig. 7. Stock in numbers in the period 1997-2001 are shown in Table 13 and plotted by year class in Fig. 8. A summary of stock parameters with C.V.% are shown in Table 14 and Fig. 9. Age structure in survey for 1997-2001 and age structure from juvenile bag for 1998-2001 (Nicolajsen, 2001) are shown in Fig. 10.

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**Table 1** Area swept assessment of the Flemish Cap (NAFO Div. 3M) shrimp stock biomass for June 2001.

Strata No.	Average density t•km <sup>-2</sup>	Strata area km <sup>-2</sup>	Biomass t	No. of Stations
13	0.899	2572	2311	5
14	0.784	2401	1882	5
15	0.728	1629	1186	3
16	0.728	5574	4057	12
17	0.747	5402	4036	11
18	0.668	4116	2750	9
19	0.483	1715	828	4
20	0.441	1886	832	4
21	0.156	1629	254	3
22	0.273	943	257	2
23	0.500	1286	643	3
Total		29154	19036	61
Average	0.582			

**Table 2.** Stock in numbers (mill.) at length by strata and total, Flemish Cap (NAFO Div. 3M) in June 2001.

STRATA OCL, mm	13	14	15	16	17	18	19	20	21	22	23	Total
9.0	1	0	0	0	0	0	0	0	0	0	0	1
9.5	0	0	0	0	0	1	0	0	0	0	0	2
10.0	1	0	0	0	2	3	0	0	0	0	0	5
10.5	1	0	0	0	2	3	0	0	0	0	0	6
11.0	0	0	0	0	0	1	0	0	0	0	0	1
11.5	0	0	0	0	0	2	0	0	0	0	0	2
12.0	1	1	0	0	0	0	0	0	0	0	0	2
12.5	5	0	0	1	0	0	0	0	0	0	0	6
13.0	17	1	0	2	2	6	0	0	0	0	0	28
13.5	34	1	0	3	6	13	0	0	0	0	0	57
14.0	53	7	0	9	8	17	0	0	0	0	0	95
14.5	58	15	0	11	18	45	0	0	0	0	0	148
15.0	77	30	0	13	32	59	0	0	0	0	0	210
15.5	63	46	0	12	34	60	0	0	0	0	0	217
16.0	65	47	4	14	26	43	0	0	0	0	0	198
16.5	35	36	3	16	14	33	0	0	0	0	0	137
17.0	32	34	9	26	17	16	0	0	0	0	0	133
17.5	20	18	7	29	13	16	0	0	0	0	0	103
18.0	15	20	6	35	20	11	0	0	0	0	0	107
18.5	13	24	6	27	16	19	1	0	0	0	1	107
19.0	15	22	8	46	26	18	0	0	0	0	2	137
19.5	13	22	12	36	20	13	1	1	0	0	2	120
20.0	20	26	12	59	47	28	3	0	1	0	4	199
20.5	14	21	15	62	54	27	3	1	1	0	6	204
21.0	24	25	22	61	51	30	8	5	2	0	9	237
21.5	27	17	18	51	46	28	8	7	1	0	7	211
22.0	15	13	19	49	32	31	9	8	2	0	5	185
22.5	17	10	9	45	41	34	7	6	1	0	5	176
23.0	15	8	11	43	44	23	7	7	1	1	4	163
23.5	13	12	13	39	31	20	6	7	2	1	5	150
24.0	8	8	11	29	35	16	11	7	2	2	7	136
24.5	3	1	8	21	28	8	10	11	3	3	8	102
25.0	5	1	5	14	28	7	10	10	2	3	7	93
25.5	2	0	2	9	15	6	7	10	3	4	5	62
26.0	1	0	1	4	11	3	6	8	2	3	3	42
26.5	0	0	0	2	6	2	2	4	2	3	1	24
27.0	1	0	0	2	2	1	1	2	1	2	2	14
27.5	0	0	0	0	3	1	1	2	1	1	1	9
28.0	0	0	0	0	1	1	1	0	0	1	0	4
28.5	0	0	0	0	1	0	0	1	1	1	0	4
29.0	0	0	0	0	0	0	0	0	0	0	0	1
29.5	0	0	0	0	0	0	0	0	0	0	0	1
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	683	467	201	771	731	644	105	98	30	26	84	3840

Table 3. Stock in numbers (mill.) at length of males by strata and total, Flemish Cap (NAFO Div. 3M) in June 2001.

STRATA OCL, mm	13	14	15	16	17	18	19	20	21	22	23	Total
9.0	1	0	0	0	0	0	0	0	0	0	0	1
9.5	0	0	0	0	0	1	0	0	0	0	0	2
10.0	1	0	0	0	2	3	0	0	0	0	0	5
10.5	1	0	0	0	2	3	0	0	0	0	0	6
11.0	0	0	0	0	0	1	0	0	0	0	0	1
11.5	0	0	0	0	0	2	0	0	0	0	0	2
12.0	1	1	0	0	0	0	0	0	0	0	0	2
12.5	5	0	0	1	0	0	0	0	0	0	0	6
13.0	17	1	0	2	2	6	0	0	0	0	0	28
13.5	34	1	0	3	6	13	0	0	0	0	0	57
14.0	53	7	0	9	8	17	0	0	0	0	0	95
14.5	58	15	0	11	18	45	0	0	0	0	0	148
15.0	77	30	0	13	32	59	0	0	0	0	0	210
15.5	63	46	0	12	34	60	0	0	0	0	0	217
16.0	64	47	4	14	26	43	0	0	0	0	0	198
16.5	35	36	3	16	14	32	0	0	0	0	0	136
17.0	32	33	9	26	17	16	0	0	0	0	0	132
17.5	20	18	7	29	13	16	0	0	0	0	0	102
18.0	14	20	6	35	18	10	0	0	0	0	0	103
18.5	13	23	6	27	16	19	1	0	0	0	1	107
19.0	13	22	7	45	26	18	0	0	0	0	2	133
19.5	12	22	12	33	20	12	1	1	0	0	2	115
20.0	18	25	12	49	47	25	3	0	1	0	4	183
20.5	13	21	15	41	51	23	3	1	1	0	6	175
21.0	18	24	21	32	43	22	8	5	2	0	9	184
21.5	16	14	17	21	29	13	8	7	1	0	7	133
22.0	5	7	17	11	16	6	7	8	2	0	5	83
22.5	5	2	5	8	7	4	5	6	1	0	4	45
23.0	1	0	1	2	4	1	3	4	1	0	1	18
23.5	0	0	1	1	1	0	1	1	0	0	2	7
24.0	0	0	0	0	0	0	1	1	0	0	0	3
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	591	416	144	439	449	471	43	35	9	1	42	2639

**Table 4.** Stock in numbers (mill.) at length of primiparous by strata and total, Flemish Cap (NAFO Div. 3M) in June 2001.

STRATA OCL, mm	13	14	15	16	17	18	19	20	21	22	23	Total
9.0	0	0	0	0	0	0	0	0	0	0	0	0
9.5	0	0	0	0	0	0	0	0	0	0	0	0
10.0	0	0	0	0	0	0	0	0	0	0	0	0
10.5	0	0	0	0	0	0	0	0	0	0	0	0
11.0	0	0	0	0	0	0	0	0	0	0	0	0
11.5	0	0	0	0	0	0	0	0	0	0	0	0
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	0	0	0	0	0	0	0	0	0	0	0	0
17.5	0	0	0	0	0	0	0	0	0	0	0	0
18.0	0	0	0	0	1	0	0	0	0	0	0	1
18.5	0	0	0	0	0	0	0	0	0	0	0	0
19.0	0	0	0	1	0	0	0	0	0	0	0	1
19.5	1	0	0	1	0	0	0	0	0	0	0	2
20.0	1	1	0	5	1	1	0	0	0	0	0	9
20.5	0	0	0	11	2	3	0	0	0	0	0	15
21.0	5	1	1	17	4	5	0	0	0	0	0	33
21.5	6	3	0	14	13	8	0	0	0	0	0	44
22.0	6	5	2	20	11	13	1	0	0	0	0	58
22.5	6	7	3	25	21	20	1	1	1	0	1	85
23.0	10	6	8	28	18	10	3	2	0	0	2	88
23.5	8	11	12	26	18	10	3	4	1	1	4	99
24.0	6	5	9	16	18	7	7	5	2	1	5	81
24.5	2	1	5	13	12	3	7	7	2	2	5	58
25.0	2	0	4	5	12	3	7	8	1	2	4	49
25.5	1	0	1	3	5	2	4	8	1	2	3	30
26.0	0	0	1	1	3	0	3	5	1	1	2	16
26.5	0	0	0	0	1	0	1	3	0	1	0	6
27.0	0	0	0	0	0	0	0	1	0	0	0	2
27.5	0	0	0	0	0	0	0	0	0	0	0	1
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
<b>Total</b>	<b>54</b>	<b>39</b>	<b>47</b>	<b>185</b>	<b>139</b>	<b>88</b>	<b>38</b>	<b>45</b>	<b>8</b>	<b>11</b>	<b>26</b>	<b>679</b>

**Table 5.** Stock in numbers (mill.) at length of multiparous by strata and total, Flemish Cap (NAFO Div. 3M) in June 2001.

STRATA OCL, mm	13	14	15	16	17	18	19	20	21	22	23	Total
9.0	0	0	0	0	0	0	0	0	0	0	0	0
9.5	0	0	0	0	0	0	0	0	0	0	0	0
10.0	0	0	0	0	0	0	0	0	0	0	0	0
10.5	0	0	0	0	0	0	0	0	0	0	0	0
11.0	0	0	0	0	0	0	0	0	0	0	0	0
11.5	0	0	0	0	0	0	0	0	0	0	0	0
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	1	0	0	0	0	0	0	0	0	0	0	1
16.5	0	0	0	0	0	1	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	1	1	0	0	0	0	0	3
18.5	0	0	0	0	0	0	0	0	0	0	0	0
19.0	1	0	0	0	0	0	0	0	0	0	0	3
19.5	0	0	0	1	0	1	0	0	0	0	0	2
20.0	1	0	0	5	0	2	0	0	0	0	0	7
20.5	1	0	0	10	1	1	0	0	0	0	0	14
21.0	1	0	0	12	3	3	0	0	0	0	0	19
21.5	5	1	0	16	5	6	0	0	0	0	0	33
22.0	5	2	0	19	6	12	1	0	0	0	0	44
22.5	6	1	1	12	13	10	1	0	0	0	1	45
23.0	4	2	2	13	22	12	2	1	0	0	1	57
23.5	5	1	0	12	12	9	2	1	1	0	0	45
24.0	2	3	2	12	17	8	3	1	0	0	2	52
24.5	2	0	2	8	15	4	3	4	1	1	3	43
25.0	4	0	1	9	16	4	3	2	1	2	3	44
25.5	1	0	1	6	10	4	3	2	2	2	2	32
26.0	1	0	0	4	8	3	3	3	1	2	2	26
26.5	0	0	0	2	5	2	1	2	2	2	1	18
27.0	1	0	0	2	2	1	1	1	1	2	2	12
27.5	0	0	0	0	3	1	1	1	1	1	1	8
28.0	0	0	0	0	1	1	0	0	0	1	0	4
28.5	0	0	0	0	1	0	0	1	1	1	0	3
29.0	0	0	0	0	0	0	0	0	0	0	0	1
29.5	0	0	0	0	0	0	0	0	0	0	0	1
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
<b>Total</b>	38	12	11	146	143	86	24	19	13	14	16	522

**Table 6.** Stock weight (t) at length by strata and total, Flemish Cap (NAFO Div. 3M) in June 2001.

STRATA OCL, mm	13	14	15	16	17	18	19	20	21	22	23	Total
9.0	0	0	0	0	0	0	0	0	0	0	0	0
9.5	0	0	0	0	0	1	0	0	0	0	0	1
10.0	1	0	0	0	1	2	0	0	0	0	0	3
10.5	0	0	0	0	1	2	0	0	0	0	0	4
11.0	0	0	0	0	0	1	0	0	0	0	0	1
11.5	0	0	0	0	0	2	0	0	0	0	0	2
12.0	2	1	0	0	0	0	0	0	0	0	0	2
12.5	6	0	0	1	0	0	0	0	0	0	0	8
13.0	22	1	0	3	3	8	0	0	0	0	0	37
13.5	50	2	0	4	9	18	0	0	0	0	0	83
14.0	86	12	0	15	13	28	0	0	0	0	0	153
14.5	103	28	0	21	32	81	0	0	0	0	0	265
15.0	152	59	0	25	63	117	0	0	0	0	0	416
15.5	137	101	1	26	75	131	1	0	0	0	0	473
16.0	155	113	10	32	61	102	1	0	0	0	0	474
16.5	92	93	8	42	38	87	0	0	0	0	0	360
17.0	91	97	27	73	47	45	1	0	0	0	0	381
17.5	61	57	22	91	40	50	0	0	0	0	0	322
18.0	50	69	21	117	66	38	1	0	0	0	0	362
18.5	49	87	24	100	57	70	3	0	1	0	3	394
19.0	58	87	31	183	102	72	2	1	1	0	6	542
19.5	56	92	50	153	87	57	4	4	1	0	8	513
20.0	94	119	54	270	219	129	13	2	4	0	17	921
20.5	71	107	75	306	266	133	15	7	4	1	28	1013
21.0	128	135	120	326	270	162	42	25	9	1	47	1265
21.5	155	99	104	291	263	157	48	40	7	1	39	1204
22.0	94	82	117	302	199	188	56	51	11	3	31	1133
22.5	111	64	61	295	265	222	46	41	8	2	33	1148
23.0	103	53	76	300	307	158	49	49	8	4	28	1135
23.5	98	88	96	287	231	149	43	49	18	11	40	1112
24.0	62	65	84	226	278	126	88	57	18	12	58	1073
24.5	27	10	64	176	234	63	83	91	25	23	63	859
25.0	48	5	45	129	246	60	89	88	19	31	64	824
25.5	16	2	16	83	143	56	67	96	28	34	44	585
26.0	5	0	7	44	111	30	60	76	17	33	33	416
26.5	0	2	0	25	65	17	25	46	26	34	15	255
27.0	6	0	0	25	23	7	16	27	13	21	19	157
27.5	0	0	0	4	41	7	9	18	7	13	8	107
28.0	0	0	0	0	13	11	8	6	2	7	6	53
28.5	0	0	0	5	12	3	2	9	8	7	1	47
29.0	0	0	0	0	5	0	3	3	6	3	0	20
29.5	0	0	0	0	4	0	3	2	1	0	0	10
30.0	0	0	0	0	0	0	0	0	0	1	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	0	0	0
Total	2189	1728	1110	3980	3891	2594	776	786	244	242	595	18135



**Table 7.** Stock weight (t) at length of males by strata and total, Flemish Cap (NAFO Div. 3M) in June 2001.

STRATA OCL, mm	13	14	15	16	17	18	19	20	21	22	23	Total
9.0	0	0	0	0	0	0	0	0	0	0	0	0
9.5	0	0	0	0	0	1	0	0	0	0	0	1
10.0	1	0	0	0	1	2	0	0	0	0	0	3
10.5	0	0	0	0	1	2	0	0	0	0	0	4
11.0	0	0	0	0	0	1	0	0	0	0	0	1
11.5	0	0	0	0	0	2	0	0	0	0	0	2
12.0	2	1	0	0	0	0	0	0	0	0	0	2
12.5	6	0	0	1	0	0	0	0	0	0	0	8
13.0	22	1	0	3	3	8	0	0	0	0	0	37
13.5	50	2	0	4	9	18	0	0	0	0	0	83
14.0	86	12	0	15	13	28	0	0	0	0	0	153
14.5	103	28	0	21	32	81	0	0	0	0	0	265
15.0	152	59	0	25	63	117	0	0	0	0	0	416
15.5	137	101	1	26	75	131	1	0	0	0	0	473
16.0	154	113	10	32	61	102	1	0	0	0	0	473
16.5	92	93	8	42	38	84	0	0	0	0	0	357
17.0	91	95	27	73	47	45	1	0	0	0	0	379
17.5	61	55	22	90	40	49	0	0	0	0	0	317
18.0	48	69	21	117	61	33	1	0	0	0	0	350
18.5	49	86	24	98	57	70	3	0	1	0	3	392
19.0	52	87	29	177	102	71	2	1	1	0	6	527
19.5	53	92	50	143	86	53	4	4	1	0	8	494
20.0	85	114	54	224	216	116	13	2	4	0	17	845
20.5	66	107	73	202	251	114	15	7	4	1	28	868
21.0	96	130	112	173	232	119	42	24	9	1	47	983
21.5	92	79	99	120	164	73	47	39	7	1	39	762
22.0	29	40	101	69	95	35	45	49	10	2	31	508
22.5	33	15	31	50	43	25	29	36	5	1	24	294
23.0	4	1	7	16	25	5	20	31	4	1	9	125
23.5	0	0	7	4	6	3	6	11	2	1	11	50
24.0	0	0	2	0	2	2	7	5	2	0	2	22
24.5	0	0	0	0	2	0	2	2	1	1	2	10
25.0	0	0	0	0	1	0	0	0	0	0	0	1
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	1565	1380	677	1726	1727	1391	240	210	52	9	228	9205

**Table 8.** Stock weight (t) at length of primiparous by strata and total, Flemish Cap (NAFO Div. 3M) in June 2001.

STRATA OCL, mm	13	14	15	16	17	18	19	20	21	22	23	Total
9.0	0	0	0	0	0	0	0	0	0	0	0	0
9.5	0	0	0	0	0	0	0	0	0	0	0	0
10.0	0	0	0	0	0	0	0	0	0	0	0	0
10.5	0	0	0	0	0	0	0	0	0	0	0	0
11.0	0	0	0	0	0	0	0	0	0	0	0	0
11.5	0	0	0	0	0	0	0	0	0	0	0	0
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	0	0	0	0	0	0	0	0	0	0	0	0
17.5	0	0	0	0	0	1	0	0	0	0	0	1
18.0	0	0	0	0	2	1	0	0	0	0	0	3
18.5	0	1	0	0	0	0	0	0	0	0	0	1
19.0	0	0	0	5	0	0	0	0	0	0	0	5
19.5	2	0	0	6	0	2	0	0	0	0	0	10
20.0	6	5	0	25	3	4	0	0	0	0	0	43
20.5	0	0	2	53	8	13	0	0	0	0	0	75
21.0	26	3	8	89	24	28	0	0	0	0	0	178
21.5	36	16	2	78	72	48	0	0	0	0	0	252
22.0	37	32	13	120	70	80	5	0	1	0	0	356
22.5	41	44	21	164	134	131	8	4	3	1	5	557
23.0	71	39	54	193	129	72	18	12	3	3	15	611
23.5	60	79	87	195	136	77	23	32	8	8	26	731
24.0	44	39	68	129	143	58	56	43	12	10	40	643
24.5	13	6	44	107	103	26	58	59	15	15	39	486
25.0	14	3	37	46	103	27	64	74	10	16	39	433
25.5	11	0	11	28	44	14	42	77	9	15	29	281
26.0	0	0	7	6	30	4	28	50	5	10	15	156
26.5	0	2	0	0	7	0	10	28	0	11	4	63
27.0	0	0	0	0	0	0	6	12	0	3	2	23
27.5	0	0	0	0	2	0	1	4	0	1	0	8
28.0	0	0	0	0	0	0	3	0	0	1	0	4
28.5	0	0	0	0	0	0	0	1	0	0	0	1
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	363	270	352	1243	1010	587	323	398	67	94	216	4921

**Table 9.** Stock weight (t) at length of multiparous by strata and total, Flemish Cap (NAFO Div. 3M) in June 2001.

STRATA OCL, mm	13	14	15	16	17	18	19	20	21	22	23	Total
9.0	0	0	0	0	0	0	0	0	0	0	0	0
9.5	0	0	0	0	0	0	0	0	0	0	0	0
10.0	0	0	0	0	0	0	0	0	0	0	0	0
10.5	0	0	0	0	0	0	0	0	0	0	0	0
11.0	0	0	0	0	0	0	0	0	0	0	0	0
11.5	0	0	0	0	0	0	0	0	0	0	0	0
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	1	0	0	0	0	0	0	1
15.5	0	0	0	0	0	0	0	0	0	0	0	0
16.0	1	0	0	0	0	0	0	0	0	0	0	1
16.5	0	0	0	0	0	2	0	0	0	0	0	2
17.0	0	2	0	0	0	0	0	0	0	0	0	2
17.5	0	2	0	1	0	0	0	0	0	0	0	4
18.0	2	0	0	0	3	4	0	0	0	0	0	9
18.5	0	0	0	2	0	0	0	0	0	0	0	2
19.0	6	0	2	1	0	1	0	0	0	0	0	10
19.5	0	0	0	5	1	3	0	0	0	0	0	9
20.0	3	0	0	21	0	9	0	0	0	0	0	33
20.5	4	0	0	52	7	7	0	0	0	0	0	69
21.0	6	2	0	65	15	15	0	1	0	0	0	104
21.5	28	3	2	92	26	36	1	1	0	0	0	190
22.0	28	10	3	113	34	73	6	2	0	0	0	269
22.5	36	5	9	81	87	65	8	0	0	0	5	297
23.0	28	12	14	90	153	80	11	6	1	0	4	399
23.5	38	10	2	89	89	69	14	6	9	2	3	330
24.0	18	26	15	96	133	66	25	9	4	1	17	409
24.5	13	3	20	70	128	37	23	30	9	7	22	363
25.0	33	2	9	82	142	33	25	15	9	16	25	390
25.5	5	2	5	55	99	42	25	19	19	18	15	303
26.0	5	0	0	38	81	26	31	26	12	23	18	260
26.5	0	0	0	25	57	17	15	19	26	23	11	193
27.0	6	0	0	25	23	7	11	15	13	18	17	134
27.5	0	0	0	4	40	7	8	14	7	13	8	99
28.0	0	0	0	0	13	11	4	6	2	7	6	49
28.5	0	0	0	5	12	3	2	8	8	7	1	46
29.0	0	0	0	0	5	0	3	3	6	3	0	20
29.5	0	0	0	0	4	0	3	2	1	0	0	10
30.0	0	0	0	0	0	0	0	0	0	1	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	0	0	0
<b>Total</b>	261	79	81	1012	1154	616	213	178	126	139	151	4009

**Table 10.** Average OCL interpreted from size distributions.

Age	Males OCL, mm	Primiparous OCL, mm	Multiparous OCL, mm	Mean OCL, mm
1	10.25			10.25
2	15.50			15.50
3	18.25		18.25	18.25
4	20.50	21.50		21.00
5		23.25	22.25	22.75
6		25.00	24.00	24.50
7				
8				

**Table 11.** Results from the age separation for each sex/maturity group calculated with the Mix software.

Sex and maturity group	Male		Primiparous		Multiparous		
	Age	Prop.	St.Dev	Prop.	St.Dev	Prop.	St.Dev
1		0.006	0.0015				
2		0.471	0.0322				
3		0.133	0.0653			0.014	0.013
4		0.390	0.0438	0.100	0.0822		
5				0.508	0.1197	0.200	0.425
6				0.393	0.1641	0.787	0.435
		Mean	St.Dev	Mean	St.Dev	Mean	St.Dev
1		10.2	0.153				
2		15.4	0.110				
3		18.2	0.259			17.7	1.1515
4		20.6	0.159	21.1	0.5241		
5				22.8	0.4339	22.1	0.5067
6				24.3	0.2688	24.1	1.0361
		Sigma	St.Dev	Sigma	St.Dev	Sigma	St.Dev
1		0.53	0.1248				
2		1.15	0.0622				
3		0.89	0.3166			1.02	0.6980
4		1.12	0.0769	0.95	FIXED		
5				1.03	FIXED	1.06	0.7411
6				1.09	FIXED	1.83	0.3483

**Table 12.** Stock in numbers (mill.) by age/maturity groups.

Age	Male	Primiparous	Multiparous	Total
1	15			15
2	1242			1242
3	352		7	359
4	1030	68		1098
5		345	104	449
6		266	410	677
Total	2639	679	522	3840

**Table 13.** Stock in numbers (mill.) in Flemish Cap shrimp stock (NAFO DIV. 3M) in the period 1997-2001.

Age	1997	1998	1999	2000	2001	Average
1				9	15	12
2	855	210	214	108	1242	526
3	1568	1269	1289	1392	359	1175
4	446	934	835	1285	1098	920
5	442	664	880	631	449	613
6	89	570	200	517	677	411
7+		7	3			5
Total	3399	3654	3422	3942	3840	3652

**Table 14.** Summary of survey stock assessment parameters for shrimp on Flemish Cap (NAFO 3M) in the period 1997-2001.

Year	Biomass t	Density g.m <sup>-2</sup>	Numbers (10 <sup>-6</sup> )	Average weight, g	Abundance numbers.m <sup>-2</sup>	Female biomass, t	C.V.%	Surveyed area, km <sup>2</sup>
1997	16102	0.50	3400	4.74	0.105	6417	111	32413
1998	21824	0.71	3654	5.97	0.119	11783	94	30612
1999	16486	0.57	3421	4.82	0.117	8621	75	29154
2000	20165	0.69	3941	5.12	0.135	9487	75	29154
2001	19036	0.65	3840	4.96	0.132	8930	58	29154
Average	18723	0.62	3651	5.12	0.122	9048	82	30097

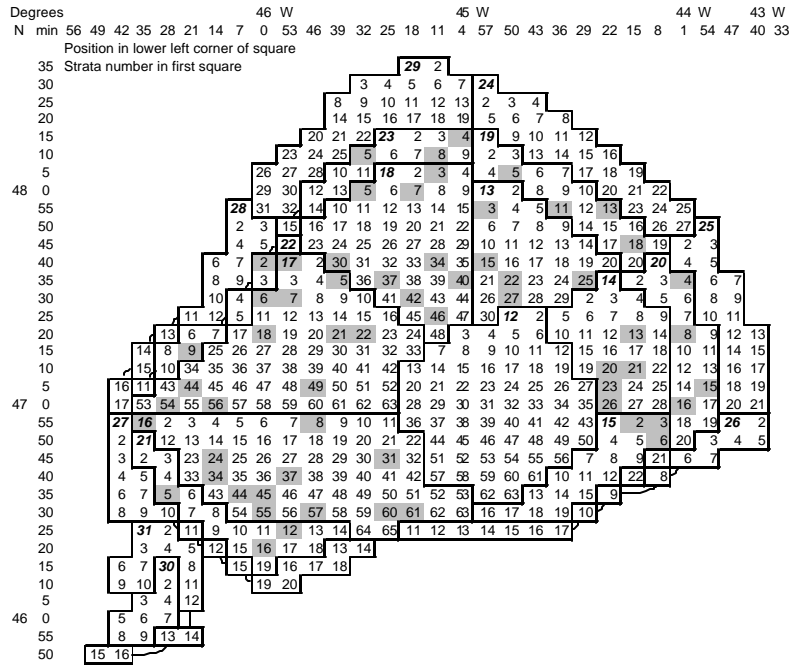
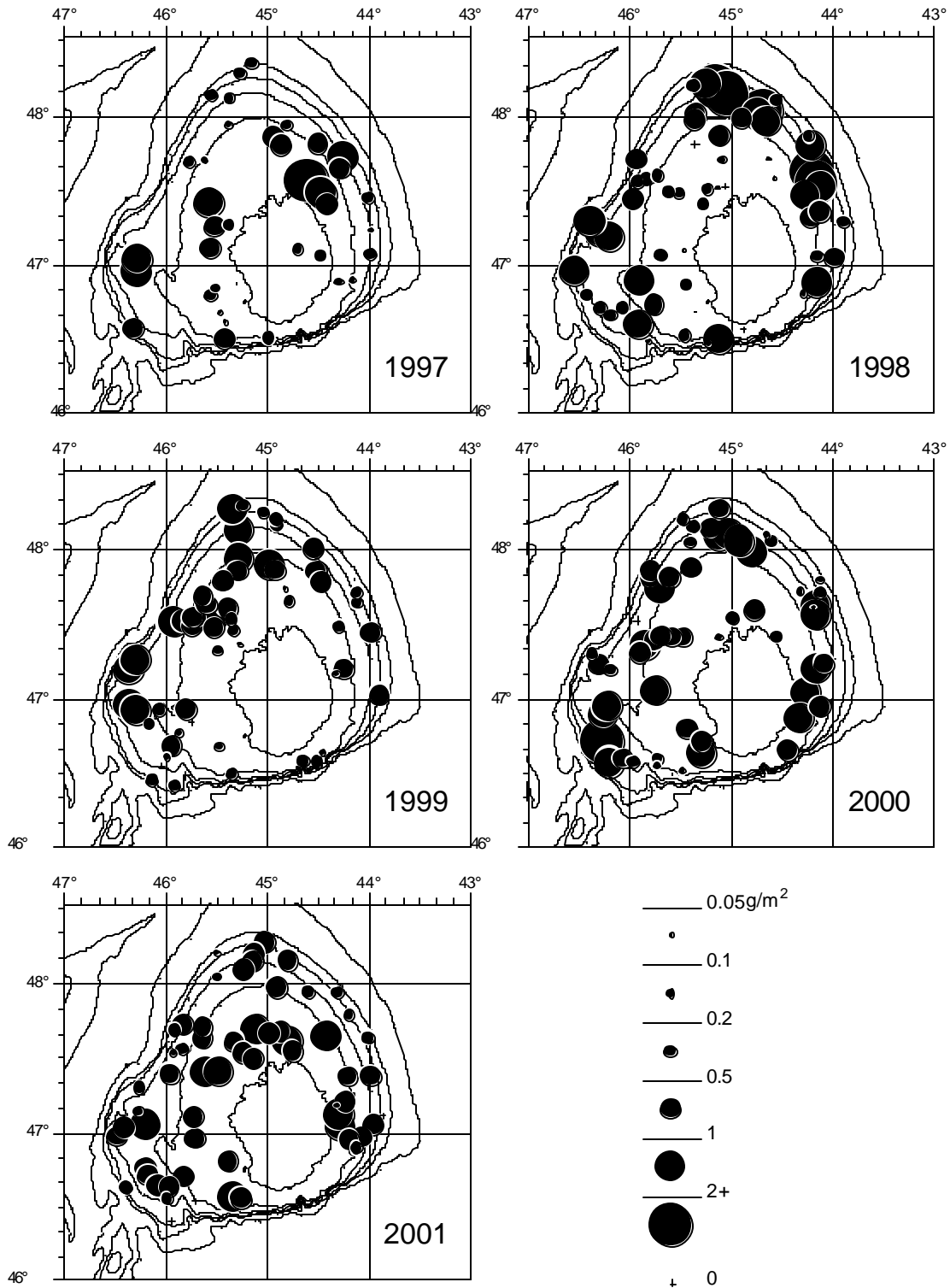
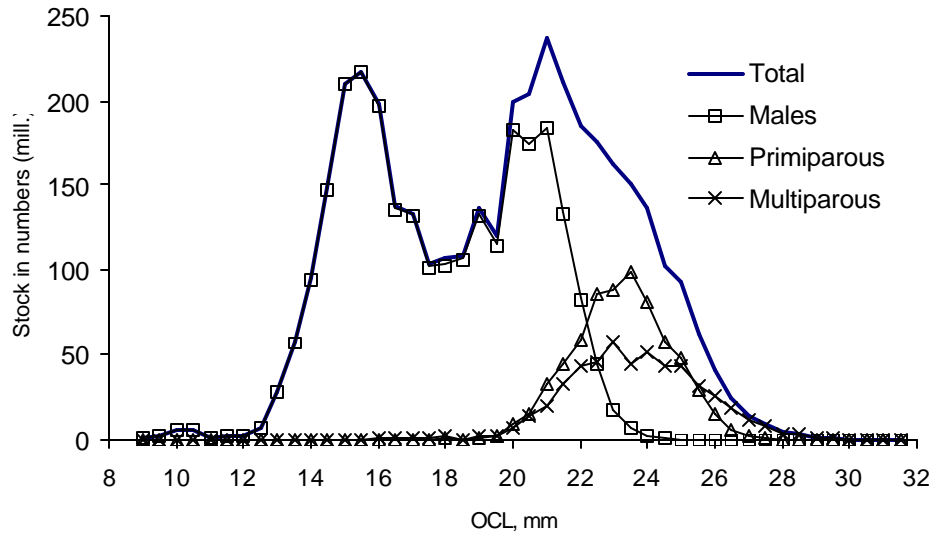


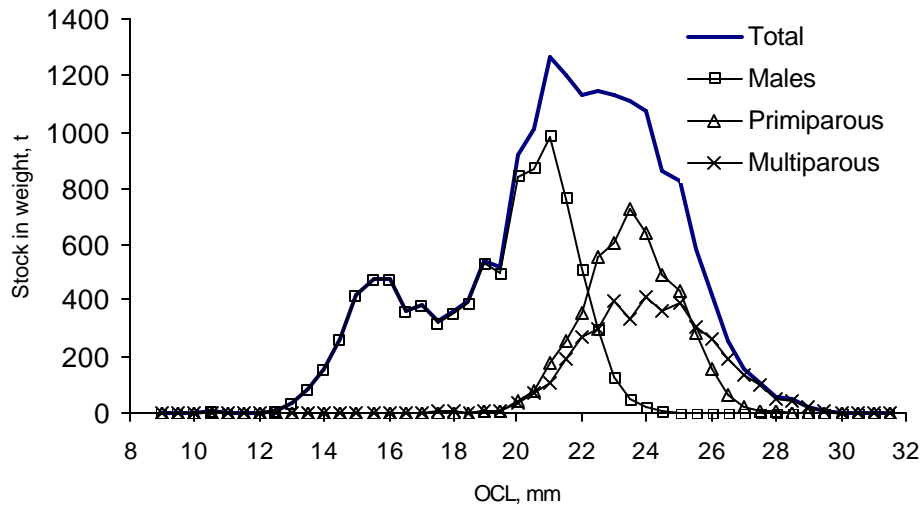
Figure. 1. Map of Flemish Cap (NAFO Div. 3M) showing strata with randomly selected stations (squares shaded) in the June 2001. survey. Each square area is 5 nm<sup>2</sup> by approx. 5 nm<sup>2</sup>.



**Fig. 2** Distribution of density of shrimp ( $\text{g}\cdot\text{m}^{-2}$ ) from surveys on Flemish Cap (NAFO Div. 3M) in 1997-2001.



**Figure 3** Length distribution in shrimp stock on Flemish Cap (NAFO Div. 3M) of total, males, primiparous and multiparous females from the June 2001 survey.



**Figure 4.** Stock weight (t) at length in shrimp stock on Flemish Cap (NAFO Div. 3M) of total, males, primiparous and multiparous females from the June 2001 survey.



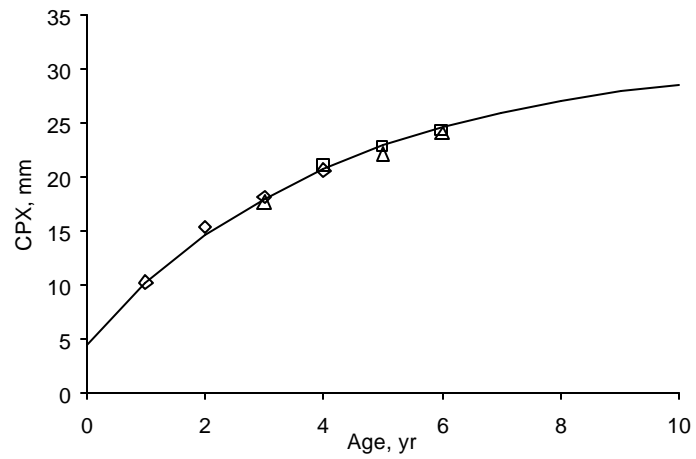


Figure 5. von Bertalanffy growth curve for shrimp on Flemish Cap (NAFO Div. 3M). Data points from calculation from Table 11.

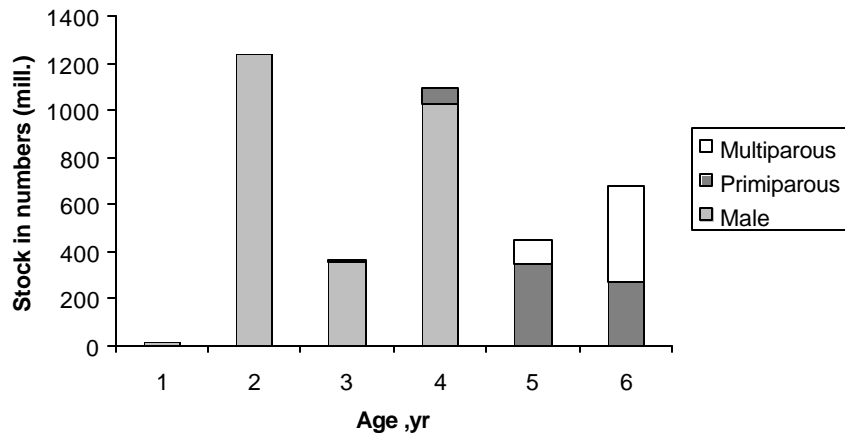


Figure 6. Stock in numbers at age/maturity. Data from Table 14.

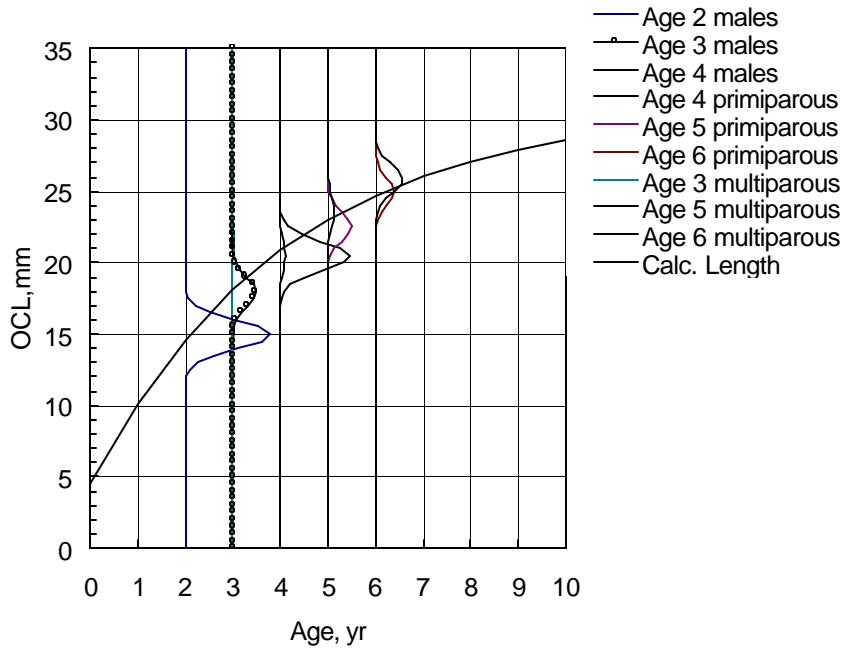


Figure 7. Growth curve and relative size distribution of age/maturity groups of shrimp on Flemish Cap (NAFO Div. 3M) from survey in June 2001.

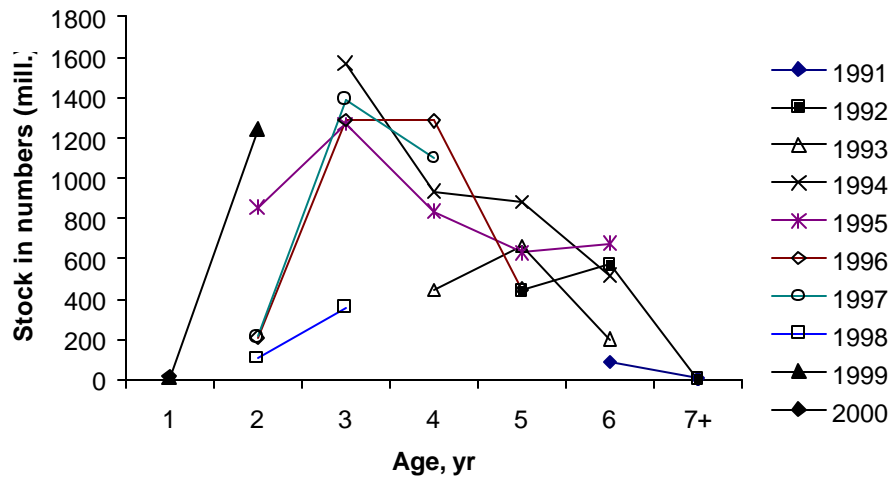


Figure 8. Stock in numbers by year class in shrimp stock on Flemish Cap (NAFO Div. 3M) in the period 1997-2001.

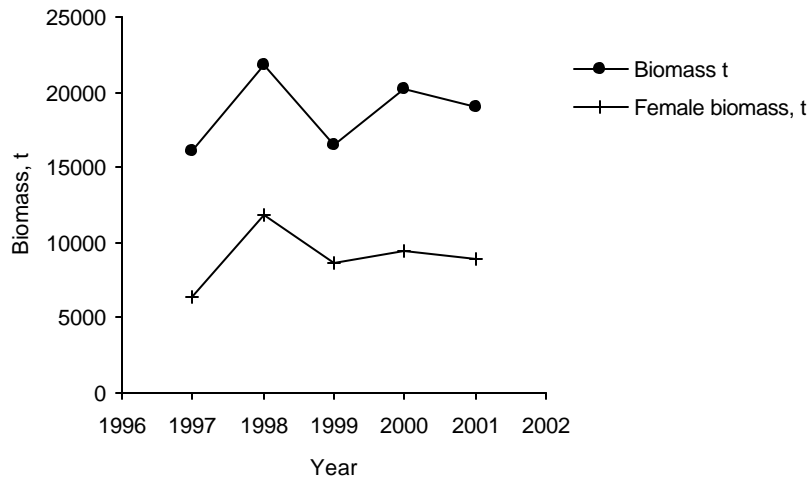


Figure 9. Total shrimp stock biomass and female stock biomass on Flemish Cap (NAFO Div. 3M) in the period 1997-2001.

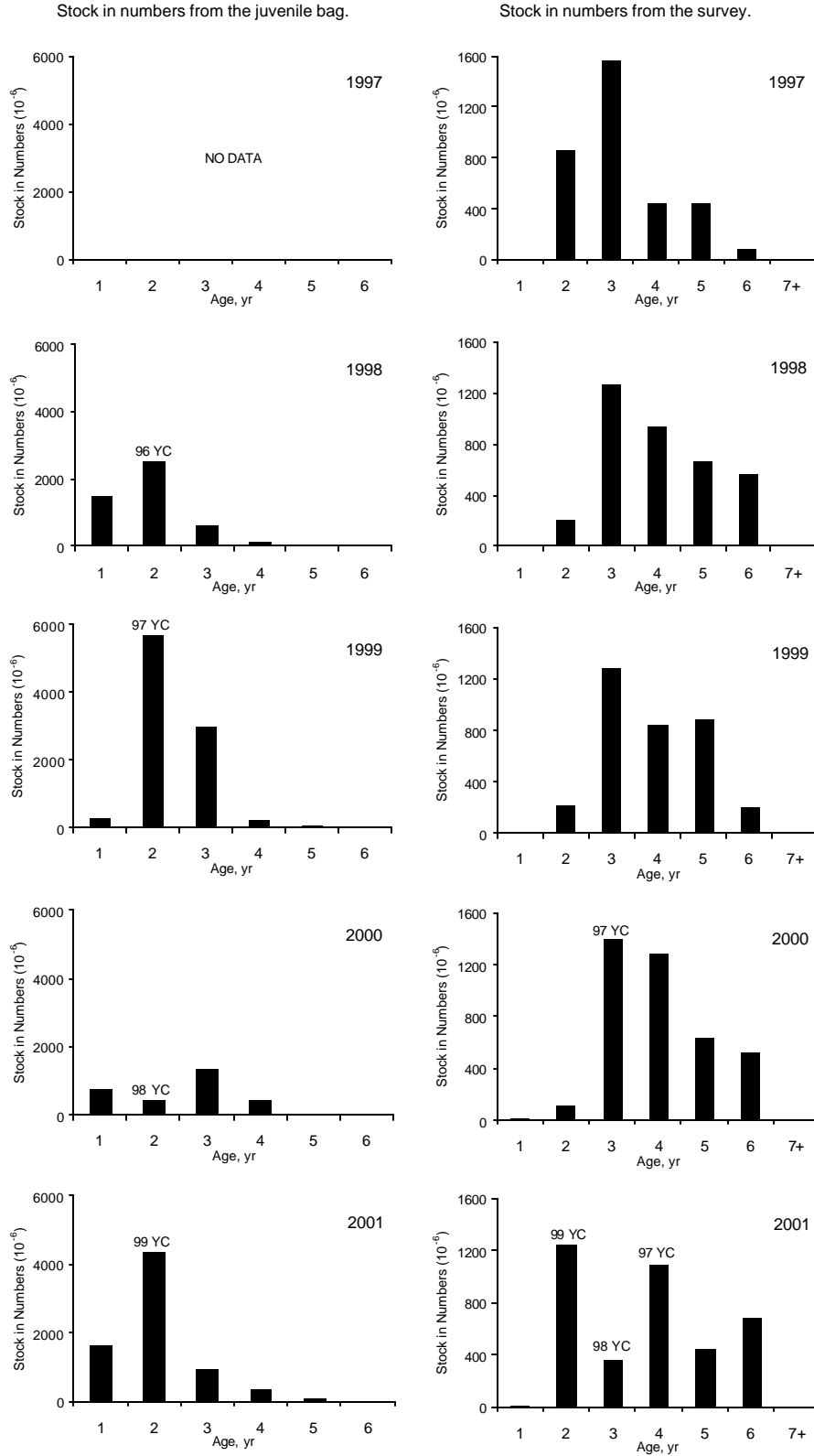


Figure 10. Age structure in survey for 1997-2001 and from juvenile bag for 1998-2001 for northern shrimp on Flemish Cap (NAFO Div. 3M).