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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 2003

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Abstract

A stratified random bottom trawl survey for shrimp on Flemish Cap conducted in the period 1997-2003 estimated stock biomass to 16 000 tons, 22 000 tons, 16 500 tons, 20 000 tons, 19 000 tons, 28 000 tons and 27 000 tons, respectively.

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, 2001, 2002, 2003a).

Materials and Methods

Biomass estimate

In June 2003 a total of 61 stations were selected in a stratified random trawl survey as shown in Fig. 1. The number of stations was 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 1997-2002 the Faroese commercial shrimp trawler R/T *Høgifossur* (4400 HP) was used for the operation.

In 1997-2003 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 3 000 50 mm mesh equivalent (50 mm m.e.), which was 3 600 50 mm m.e. in 2000 and 3 200 50 mm m.e. in 2001- 2003. 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. 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.

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 2003 (Nicolajsen, 2003b).

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 27 246 tons with an unweighted average density of 0.948 g·m⁻² (Table 1).

Length distribution

The length distributions in stock by male, primiparous and multiparous female components as well as total stock are shown in Fig. 3. The stock weight at length in stock by male, primiparous and multiparous female components as well as total stock are shown in Fig. 4.

Growth

The preliminary interpretation of mean lengths at age/maturity groups are show in Table 2. These means were used as input to the Mix software. The average length for each age group from Table 3 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 3. Age distribution is shown in Table 4 and Fig. 6. Growth curve and relative size distribution of age/maturity groups is shown in Fig. 7. Stock in numbers in the period 1997-2003 are shown in Table 5 and plotted by year class in Fig. 8. A summary of stock parameters with C.V.% are shown in Table 6 and Fig. 9. Age structure in survey for 1997-2003 is shown in Fig. 10.

References

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Table 1. Area swept assessment of the Flemish Cap (NAFO Div. 3M) shrimp stock biomass for June 2003.

Strata No.	Average density t•km ⁻²	Strata area km ⁻²	Biomass tons	No. of Stations
13	0.785	2572	2020	5
14	1.391	2401	3341	5
15	0.141	1629	229	3
16	0.981	5574	5468	13
17	1.393	5402	7524	11
18	1.392	4116	5729	9
19	0.321	1715	550	4
20	0.185	1886	348	4
21	0.084	1629	137	2
22	0.805	943	759	2
23	0.886	1286	1140	3
Total		29154	27246	61
Average	0.935			

Table 2. Average OCL interpreted from size distributions.

Age	Males OCL, mm	Primiparous OCL, mm	Multiparous OCL, mm	Mean OCL, mm
1	9.50			9.50
2	15.60			15.60
3	18.75		18.75	18.75
4	20.75	20.75	20.75	20.75
5		23.00	22.75	22.88
6		25.25	25.25	25.25
7		26.25	26.50	26.38
8			27.75	27.75
9				

Table 3. 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	0.094	0.005					
2	0.282	0.007					
3	0.188	0.008			0.028	0.007	
4	0.435	0.009	0.072	0.014	0.122	0.019	
5			0.722	0.026	0.262	0.029	
6			0.194	0.032	0.471	0.032	
7			0.0121	0.019	0.114	0.023	
8					0.004	0.006	
	Mean	St.Dev	Mean	St.Dev	Mean	St.Dev	
1	9.6	0.024					
2	15.2	0.024					
3	17.9	0.049			18.1	0.197	
4	20.6	0.026	20.8	0.190	21.3	0.165	
5			23.0	0.058	23.1	0.142	
6			25.3	0.187	25.2	0.093	
7			26.1	1.545	27.1	0.194	
8					29.3	1.431	
	Sigma	St.Dev	Sigma	St.Dev	Sigma	St.Dev	
1	0.67	0.026					
2	1.02	0.030					
3	1.32	0.092			1.30	0.247	
4	1.15	0.026	0.94	0.136	1.02	0.176	
5			1.03	0.054	1.03	0.147	
6			1.16	0.157	1.11	0.092	
7			1.08	1.245	1.28	0.166	
					0.83	1.047	

Table 4. Stock in numbers (mill.) by age/maturity groups in Flemish Cap shrimp stock (NAFO DIV. 3M) in 2003.

Age	Male	Primiparous	Multiparous	Total
1	373			373
2	1119			1119
3	747		21	768
4	1727	54	93	1875
5		548	201	749
6		148	362	509
7		9	87	96
8			3	3
Total	3966	759	768	5493

Table 5. Stock in numbers (mill.) in Flemish Cap shrimp stock (NAFO DIV. 3M) in the period 1997-2003.

Age	1997	1998	1999	2000	2001	2002	2003	Average
1				9	15	24	373	106
2	855	210	214	108	1242	416	1119	595
3	1568	1269	1289	1392	359	3566	768	1459
4	446	934	835	1285	1098	340	1875	973
5	442	664	880	631	449	1115	749	704
6	89	570	200	517	677	214	509	397
7+		7	3			4	100	28
Total	3399	3654	3422	3942	3840	5680	5493	4204

Table 6. Summary of survey stock assessment parameters for shrimp on Flemish Cap (NAFO 3M) in the period 1997-2003.

Year	Biomass t	Density g.m ⁻²	Numbers (10 ⁻⁶)	Average weight, g	Abundance numbers.m ⁻²	Female biomass, t	C.V.%	Surveyed area, km ²
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
2002	27732	0.95	5681	4.88	0.195	11803	83	29154
2003	27246	0.93	5493	4.96	0.188	12402	78	29154
Average	21227	0.72	4204	5.06	0.142	9920	82	29828

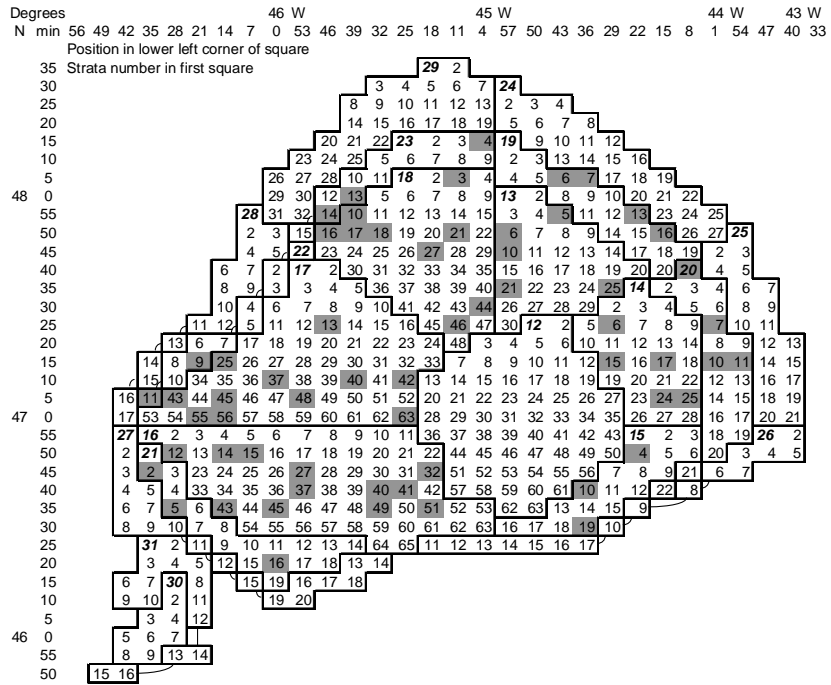


Fig. 1. Map of Flemish Cap (NAFO Div. 3M) showing strata with randomly selected stations (squares shaded) in the June 2003.

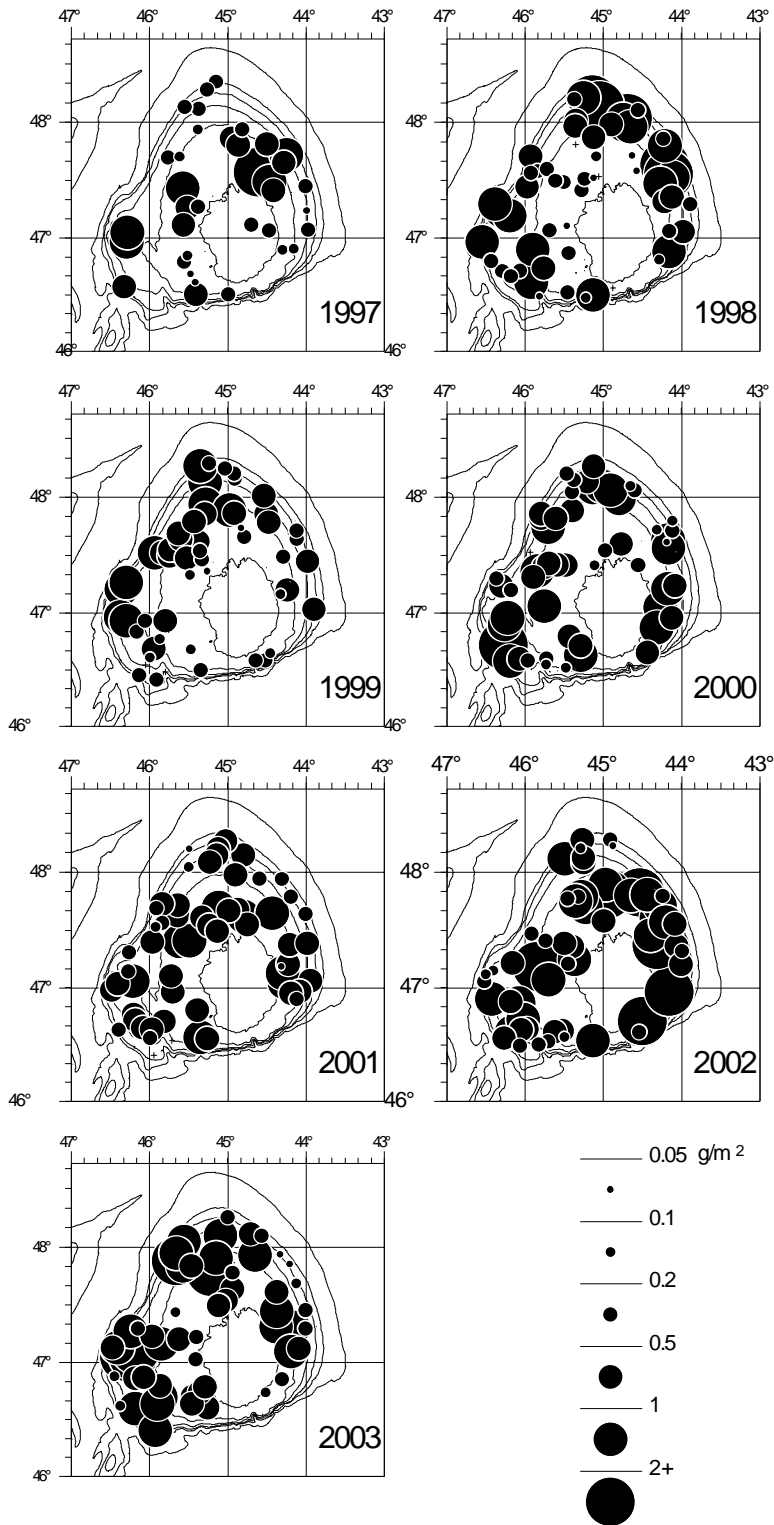


Fig. 2. Distribution of density of shrimp (g·m⁻²) from surveys on Flemish Cap (NAFO Div. 3M) in 1997-2003.

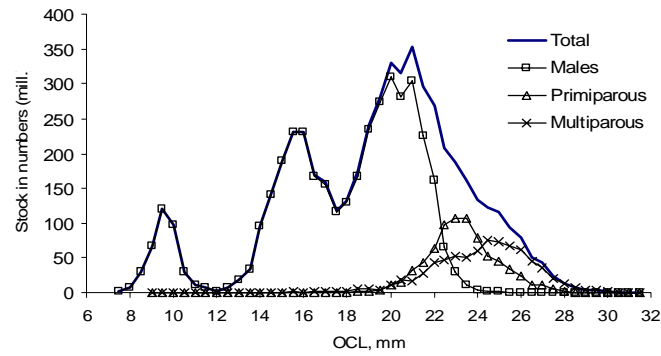


Fig. 3. Length distribution in shrimp stock on Flemish Cap (NAFO Div. 3M) of total, males, primiparous and multiparous females from the June 2003 survey.

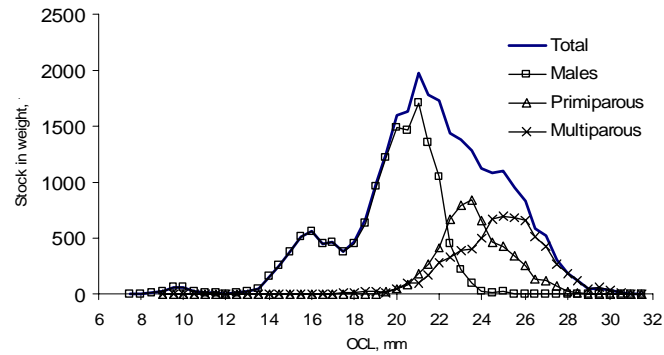


Fig. 4. Stock weight (t) at length in shrimp stock on Flemish Cap (NAFO Div. 3M) of total, males, primiparous and multiparous females from the June 2003 survey.

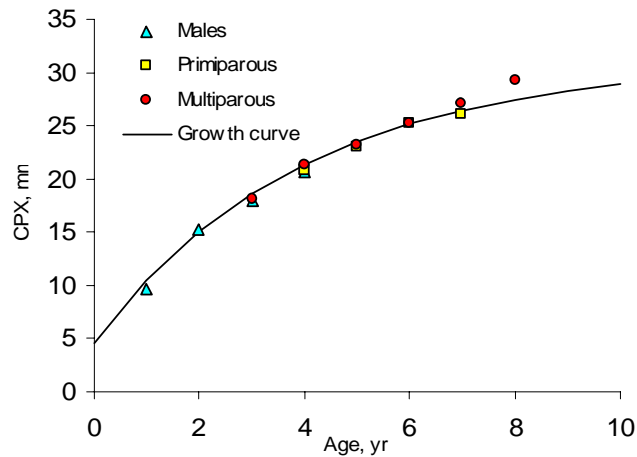


Fig. 5. von Bertalanffy growth curve for shrimp on Flemish Cap (NAFO Div. 3M). Data points from Table 3.

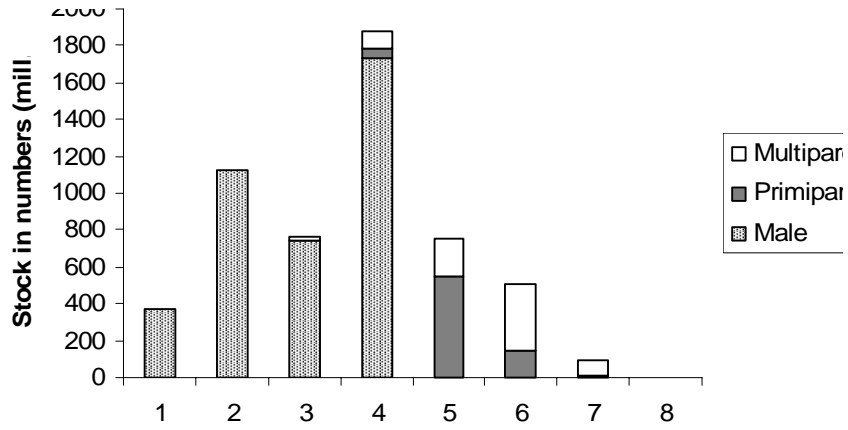


Fig. 6 Stock in numbers at age/maturity groups in Flemish Cap shrimp stock (NAFO DIV. 3M) in 2003. Data from Table 4.

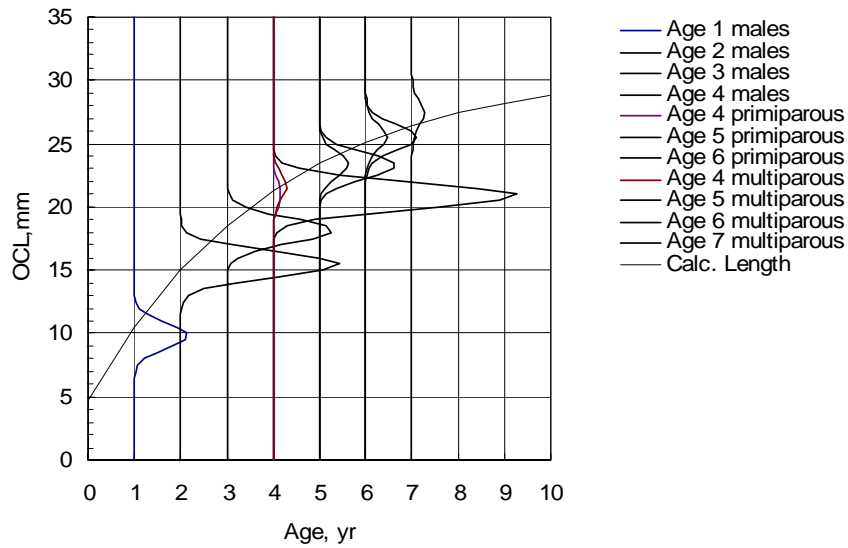


Fig. 7. Growth curve and relative size distribution of age/maturity groups of shrimp on Flemish Cap (NAFO Div. 3M) from survey in June 2003.

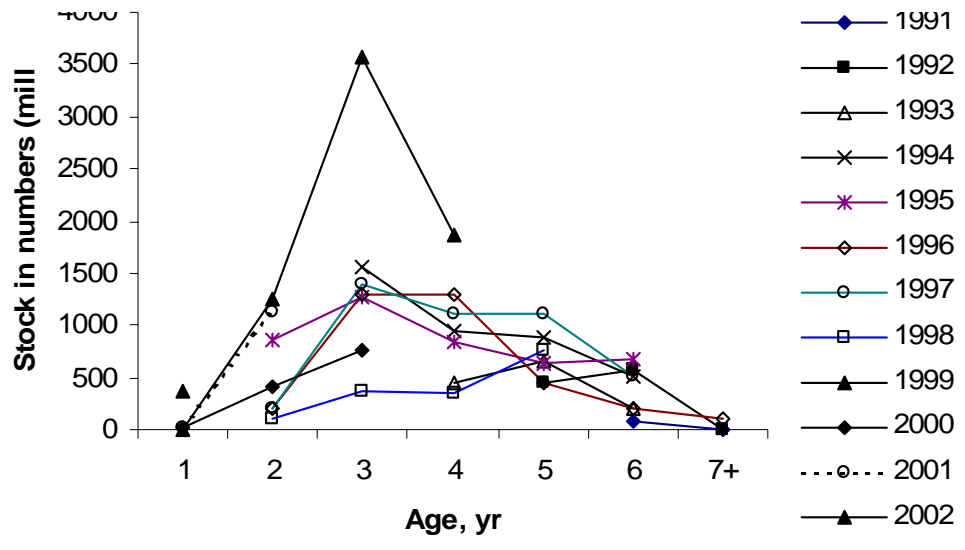


Fig. 8. Stock in numbers by year class in shrimp stock on Flemish Cap (NAFO Div. 3M) in the period 1997-2003.

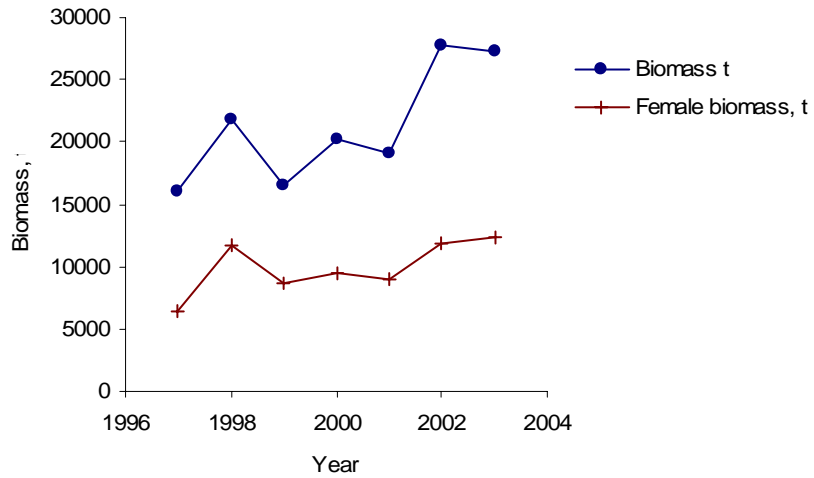


Fig. 9 Total shrimp stock biomass and female stock biomass on Flemish Cap (NAFO Div. 3M) in the period 1997-2003.

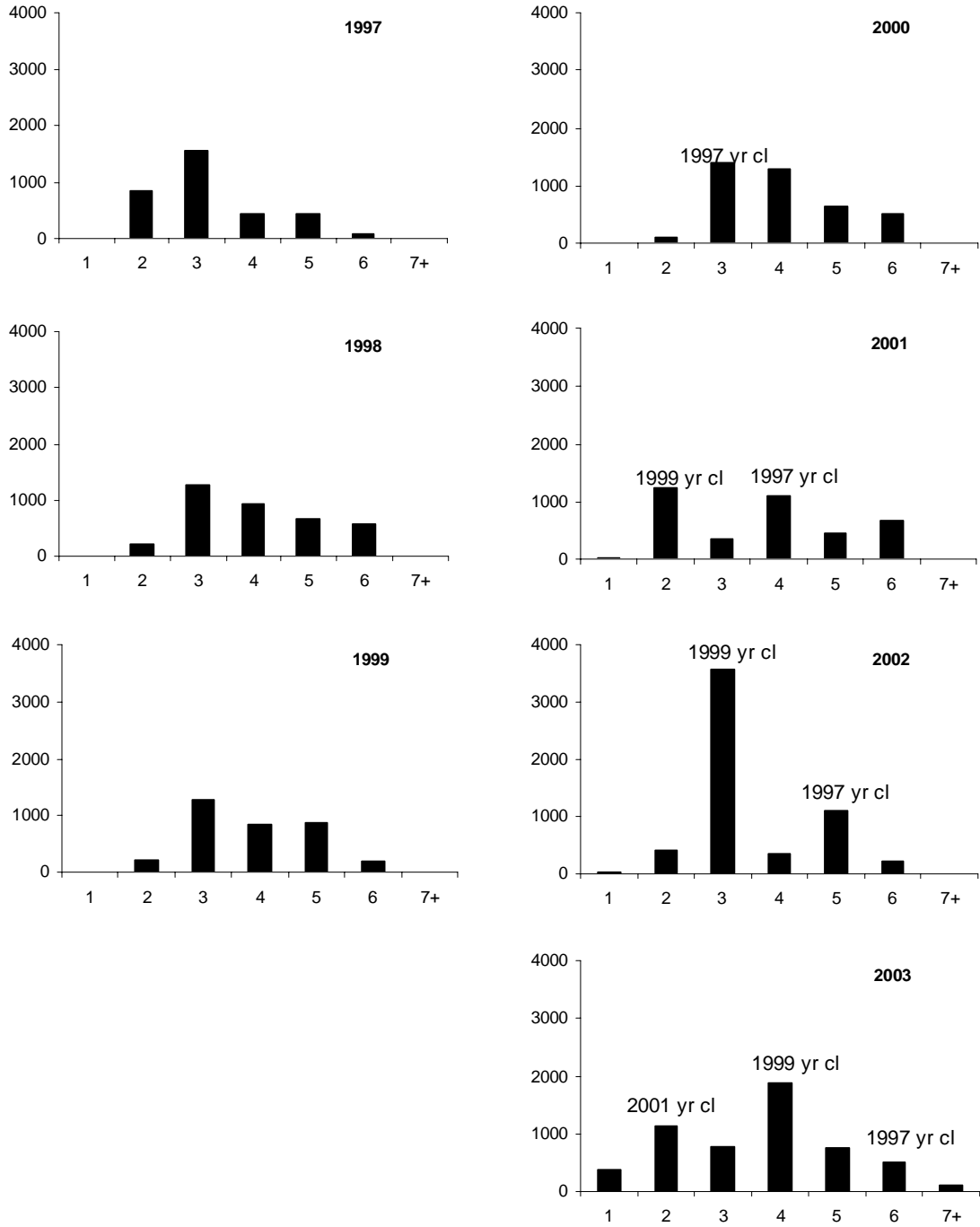


Fig. 10 Age structure in survey for 1997-2003 for northern shrimp on Flemish Cap (NAFO Div. 3M). Units for x is age and for y is number of shrimps in millions.