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Age Assessment of Northern Shrimp (*Pandalus borealis*) in EU surveys on Flemish Cap in 1988-2001

by

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Abstract

Modal analysis of carapace length was carried out on the overall length frequency distributions of northern shrimp measured during surveys of EU for demersal fish and shrimp ever since they were started in 1988. There were always four age groups present, the 3 to 6 year olds, and sometimes also 2- and 7 year olds. Thus making shrimp becoming 7 years old at most. Age at sex change is usually at age 4 and/or 5. Growth has been variable throughout the series, but appeared to be much slower in the last four years. Mean lengths at age, abundance and biomass by age and years are also presented.

Introduction

The EU surveys have been carried out in July since 1988 using bottom trawl of the Lofoten type. The codend had usually a 35-mm mesh size. Although the main purpose in the beginning was to measure stock size of demersal fish, it became evident in the beginning of the nineties that measuring stock size of shrimp was also very important. As the mesh size elsewhere in the gear used in the EU surveys was large NAFO considered that the EU survey did not give a true picture of the very young shrimp. Older males and especially females on the other hand could be reasonably assessed. In 2000 and 2001 a small meshed juvenile bag was attached to the gear so as to catch very young shrimp. In 2001 there were trials using a different gear as well as Lofoten gear or Campelen trawl with a cod end of 20-mm mesh size. The overall length frequency distribution for year 2001 was however that of 35-mm mesh size

It has become increasingly urgent to assess the age of shrimp measured in these surveys. From the age analysis it is possible to assess total mortality and year-class strength. In this paper is the first attempt of age assessment by Modal analysis (MacDonald and Pitcher, 1979) of the shrimp caught in the EU survey in the years 1988-2001.

Material and Methods

The carapace of shrimp was measured obliquely from the eye socket to the end of the carapace middorsally to the lower 0.5 mm length-class, using sliding callipers. Shrimp were then separated into 4 categories namely, males (including transitionals), primiparous females and multiparous females according to the sternal spine criterion (McCrary, 1971), with and without eggs. The last two categories were in this paper combined into one category, females without sternal spines.

These three length frequency distributions were run through Modal analysis (MacDonald and Pitcher, 1979) with as many components as possible. The program is called Mix. The output like proportions, mean lengths and standard deviations of the mean length (sigma) are calculated for each age component and here also sex group as mentioned above. Then there are standard deviations (St. Dev.) calculated by Mix. When St. Dev. are sensible for

proportions and mean lengths sigma is often about 1 mm +/- 0.2 mm. As it is often difficult to get sensible results with regards St. Dev. of either proportions or mean lengths, we have constrained sigma very often to have a fixed coefficient of variation (CV). The coefficient was in that case always put to the value of 0.045. As the overall error Chi-Square estimate was sometimes quite low but at the same time St. Dev. of proportions and mean lengths were far too high the St. Dev. of these were considered to be more reliable.

After getting the proportions and mean lengths for every age/sex group the results were used to calculate the total number of individuals in every age/sex group according to the biomass estimate. This was done by transforming the Cl to weight by using two types of weight length relationships taken from Skuladottir (1997), namely the following:

For multiparous females in July:	$\ln y = 2.921 * \ln x - 7.144$
For males and primiparous females based on samples of the whole year	$\ln y = 3.037 * \ln x - 7.549$

The weight length relationships were calculated from samples taken by Icelandic observers onboard shrimp vessels, then frozen and rethawed in the laboratory measured sorted into the many sexual stages and weighed to the nearest 0.1 g. The mean lengths were converted to mean weights using the appropriate length weight relationship listed above to calculate the number of males, primiparous females and multiparous females. Biomass has been calculated for males and females (primiparous + multiparous) separately for the whole series except for year 1991. So these biomass indices were used to calculate total number/total weight at age of each sex group separately each year.

Results and Discussion

The biomass indices as measured in the EU surveys are listed in Table 1. The data have been published every year in NAFO papers in form of length frequency distributions, split into 4 sex groups, male, primiparous females, multiparous females without eggs and multiparous females with eggs. In 1997, Del Rio and Sainza published length frequency distributions for all surveys in the years 1988-1996. The shrimp was measured laterally instead of obliquely until 1992 but in the afore-mentioned paper the measurements of surveys 1988-1992 were turned into that of oblique measurements by calculation by Sainza (1993). After that data have been gathered from the annual papers from various authors (Del Rio and Sainza, 1997; Del Rio, 1997; Del Rio, 1998; Garabana, 1999; Bruno, 2000; Diaz, 2001). There is some variation in mesh size throughout the series. Most of the time a Lofoten trawl was used which had a cod-end of 35-mm mesh size. The exception to this was in 1994 when a mesh size of 40 mm was used possibly underestimating biomass especially that of males. Also in 1998, cod-end had a liner of 25 mm. This could explain the very high biomass of males of almost 9 000 tons in that year, by far the highest in the series. There is another explanation of this as seen below, namely the appearance of a strong year-class here assumed to be the 1995 year-class, which was very numerous in 1998 as three year olds.

The results of the modal analysis of all samples combined for each survey are shown in Table 2. The proportions within each sex group are listed as well as mean lengths and standard deviation (sigma) of the age class in mm. Sigma is often about 1 mm +/- 0.2 mm. Then there are Standard deviations (St. Dev.) listed for each value as calculated by Mix. The results of Table 2 were then used for calculation of numbers at age and sex group as described before. From those results there are various tables produced. First of all there is table 3 containing the mean Carapace length at age per year. The length is here calculated by weighting the length with total no. in that age class be it male, primiparous female or multiparous female. Four and five year olds are often found in two or three sex groups. In the first three years the youngest shrimp found are considered here to be three year olds at sizes 18 to 18.4 mm long. These could also be very fast growing two year olds as Parsons and Veitch (1993) considered. In the years 1992 and 1993 the two year olds are of the size 16.8 and 16 mm, respectively. Although these are called two year old here, they could also be 3 year olds. But then they would be the smallest in the whole series, the average being 18.8 mm for the three year olds for the whole period 1988-2001. The four year olds would then be similar in size to the four year olds in the years 1998 through 2001. There are several uncertainties in these analyses and the assigning of age to the youngest ages may have to be revisited.

Growth appears moderate at Flemish Cap in the first years as compared to later years if the detection of age classes is right. Thus a 4 year old is calculated to be 21.5 mm Cl in 1989-1991 where as it is appears to be 22.4 mm on the average for the whole period but again very similar in the years 1998-2001 (Table 3). If judging from the size of four year olds growth is faster approximately in the period 1992-1997 than in other years, the four year olds being from 21.9-23.5 mm Cl. The 5 year olds are not such a good indicator as there is a possible mixing of 6 year olds with the 5 group. In the period 1998-2001, 5 year olds are 23.6-24.7 as compared to the mean of 25 mm for the whole period, namely slightly slower growth than in the years 1993-1997.

In Table 4 there are numbers at age as calculated from Table 2 and biomass index from Table 1 for each year. By applying length weight relationships as described earlier. Numbers were gradually increasing since 1988 to 1992 or from 26 to 2 000 millions shrimp. There was no fishery in those years and cod was gradually disappearing from the grounds. After shrimp fishery started in 1993 numbers of shrimp started to go down at first or to 304 in 1994 to increase gradually again to 860 millions. After the very heavy fishing in year 1996 when some 48 000 tons were caught there was a decrease in numbers of shrimp as biomass index to 610 millions in 1997. The stock seemed to recover remarkably soon and has been between 1 620 and 3 270 millions in the last four years. During the period there have been a few strong year-classes. In 1990 the first one is detected as the 1987 year-class at the size of 18.4 mm CL. This year-class could be followed till 1992 as 5 year olds. Following closely was the 1988 year-class, which was quite numerous as three year olds in 1991 and could be followed until year 1995. It is possible that the two year-classes mixed together in 1993 at the same time as growth slows down in 1987 year-class, as it became multiparous female. The 1988 year-class would then catch up in size with the 1987 year-class and in 1994 and 1995 it seemed difficult to separate these two year-classes using Mix. The great numbers of the so-called 6 year olds in 1994 are thus possibly a mixture of the 1987 and 1988 year-classes. The difficulty of detecting the two year olds in the length frequency distribution is less after samples in commercial fishery have been collected the whole year around as it has been since 1996 Skuladottir and Orr (2001). The results from the international commercial sample data have been compared to the EU survey data and found to agree.

In the years 1997 through 2001 there seems to be a succession of five strong year-classes going through the population, namely the 1993-, 1994-, 1995-, 1996- and 1997- year-classes as judged by the number of 4 and 5 year olds calculated from the biomass indices in the years 1997-2001. The 1995 appeared especially big if judged by the number of three year olds in 1998. But that could be caused by the use of unusually small mesh of 25 mm in the cod-end (as a liner) in that survey instead of the usual 35 mm.

The biomass indices split up by age are shown in Table 5. These are also calculated from Tables 1 and 2 by applying the appropriate length weight relationships. These show much the same results as the numbers at age.

Conclusions

Further analysis is needed to confirm the validity of the findings in this paper, as it is at times very difficult to get clear results from the modal analysis especially in the older shrimp. It is also difficult in some cases to see how old is the youngest shrimp seen in the length frequency distribution as one has to decide at which age it was when it first appeared as an age group. In the last 2-4 years the juvenile bag, which is in use in the Faroese and the EU surveys can be of help in detecting the youngest age groups.

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Table 1. Biomass (tons) in EU surveys by sex groups.

Years	Biomass		
	males	females	Total
1988	290	1874	2164
1989	583	1340	1923
1990	1007	1132	2139
1991	2849	5362	8211
1992	5022	11509	16531
1993	2417	6839	9256
1994	514	2823	3337
1995	1127	4286	5413
1996	2353	4149	6502
1997	1289	3807	5096
1998	8753	8091	16844
1999	3379	9051	12430
2000	3167	6553	9720
2001	5129	8977	14106

Table 2. Results from the modal analysis (Mix) for each sex/maturity group.

1988

Sex and maturity group	Male		Primiparous Female		Multiparous Female	
Age	Prop.	St.Dev.	Prop.	St.Dev.	Prop.	St.Dev.
1						
2						
3	0.605	0.005			0.004	0.001
4	0.395	0.005	0.522	0.005	0.464	0.015
5			0.478	0.005	0.480	0.013
6					0.052	0.010
7						
	Mean CL	St.Dev.	Mean CL	St.Dev.	Mean CL	St.Dev.
1						
2						
3	17.95	0.005			19.46	0.279
4	22.29	0.005	23.93	0.014	23.85	0.040
5			26.72	0.015	26.29	0.067
6					28.68	0.199
7						
	Sigma	St.Dev.	Sigma	St.Dev.	Sigma	St.Dev.
1						
2						
3	0.800	Fixed CV			0.876	Fixed CV
4	1.000	Fixed CV	1.080	Fixed CV	1.073	Fixed CV
5			1.200	Fixed CV	1.183	Fixed CV
6					1.291	Fixed CV
7						

1989

Sex and maturity group	Male		Primiparous Female		Multiparous Female	
Age	Prop.	St.Dev.	Prop.	St.Dev.	Prop.	St.Dev.
1						
2						
3	0.480	0.008				
4	0.467	0.010	0.160	0.009	0.124	0.005
5	0.053	0.004	0.840	0.009	0.753	0.009
6					0.124	0.009
7						
	Mean CL	St.Dev.	Mean CL	St.Dev.	Mean CL	St.Dev.
1						
2						
3	18.3	0.029				
4	21.4	0.020	22.43	0.069	22.100	0.049
5	24.1	0.087	26.04	0.028	25.550	0.026
6					28.180	0.084
7						
	Sigma	St.Dev.	Sigma	St.Dev.	Sigma	St.Dev.
1						
2						
3	1.047	0.021				
4	0.763	0.021	1.010	Fixed CV	0.995	Fixed CV
5	0.796	0.057	1.172	Fixed CV	1.150	Fixed CV
6					1.268	Fixed CV
7						

1990

Sex and maturity group	Male		Primiparous Female		Multiparous Female	
Age	Prop.	St.Dev.	Prop.	St.Dev.	Prop.	St.Dev.
1						
2						
3	0.898	0.002				
4	0.102	0.002	0.216	0.006	0.0762	0.005
5			0.784	0.006	0.528	0.012
6					0.396	0.012
7						
	Mean CL	St.Dev.	Mean CL	St.Dev.	Mean CL	St.Dev.
1						
2						
3	18.35	0.006				
4	22.61	0.037	20.04	0.032	20.76	0.077
5			23.45	0.017	24.03	0.041
6					26.75	0.045
7						
	Sigma	St.Dev.	Sigma	St.Dev.	Sigma	St.Dev.
1						
2						
3	0.802	0.005				
4	1.240	0.029	0.902	Fixed CV	0.934	Fixed CV
5			1.055	Fixed CV	1.081	Fixed CV
6					1.204	Fixed CV
7						

1991

Sex and maturity group	Male		Female	
Age	Prop.	St.Dev.	Prop.	St.Dev.
1				
2				
3	0.286	0.002		
4	0.714	0.002		
5			0.735	0.003
6			0.265	0.003
7				
	Mean CL	St.Dev.	Mean CL	St.Dev.
1				
2				
3	17.50	0.009		
4	21.63	0.005		
5			23.53	0.007
6			26.80	0.014
7				
	Sigma	St.Dev.	Sigma	St.Dev.
1				
2				
3	0.891	0.007		
4	0.887	0.004		
5			1.059	Fixed CV
6			1.206	Fixed CV
7				

Table 2 continued

1992

Sex and maturity group	Male		Primiparous Female		Multiparous Female	
Age	Prop.	St.Dev.	Prop.	St.Dev.	Prop.	St.Dev.
1						
2	0.149	0.001				
3	0.393	0.003				
4	0.459	0.003	0.106	0.005	0.010	0.0004
5			0.894	0.005	0.655	0.003
6					0.311	0.004
7					0.023	0.004
	Mean CL	St.Dev.	Mean CL	St.Dev.	Mean CL	St.Dev.
1						
2	16.82	0.008				
3	21.33	0.010				
4	23.55	0.009	22.85	1.028	20.01	0.049
5			25.21	1.134	24.01	0.007
6					27.01	0.026
7					29.01	0.133
	Sigma	St.Dev.	Sigma	St.Dev.	Sigma	St.Dev.
1						
2	0.757	Fixed CV				
3	0.960	Fixed CV				
4	1.060	Fixed CV	1.028	Fixed CV	0.901	Fixed CV
5			1.134	Fixed CV	1.081	Fixed CV
6					1.216	Fixed CV
7					1.306	Fixed CV

1993

Sex and maturity group	Male		Primiparous Female		Multiparous Female	
Age	Prop.	St.Dev.	Prop.	St.Dev.	Prop.	St.Dev.
1						
2	0.418	0.003				
3	0.376	0.003				
4	0.205	0.003	0.099	0.003	0.007	0.001
5			0.901	0.003		
6					0.933	0.005
7					0.060	0.005
	Mean CL	St.Dev.	Mean CL	St.Dev.	Mean CL	St.Dev.
1						
2	16.03	0.008				
3	20.36	0.012				
4	23.86	0.022	21.80	0.034	21.55	0.087
5			25.82	0.012		
6					26.37	0.010
7					28.65	0.077
	Sigma	St.Dev.	Sigma	St.Dev.	Sigma	St.Dev.
1						
2	0.863	0.006				
3	0.953	0.011				
4	1.094	0.016	0.811	0.024	0.970	Fixed CV
5			1.240	0.010		
6					1.187	Fixed CV
7					1.289	Fixed CV

1994

Sex and maturity group	Male		Primiparous Female		Multiparous Female	
Age	Prop.	St.Dev.	Prop.	St.Dev.	Prop.	St.Dev.
1						
2						
3	0.143	0.004				
4	0.607	0.009	0.076	0.005		
5	0.250	0.009	0.924	0.005	0.012	0.002
6					0.988	0.002
7						
	Mean CL	St.Dev.	Mean CL	St.Dev.	Mean CL	St.Dev.
1						
2						
3	17.53	0.026				
4	21.74	0.022	23.12	0.083		
5	24.09	0.042	26.62	0.019	24.22	0.157
6					28.08	0.011
7						
	Sigma	St.Dev.	Sigma	St.Dev.	Sigma	St.Dev.
1						
2						
3	0.789	Fixed CV				
4	0.979	Fixed CV	1.040	Fixed CV		
5	1.084	Fixed CV	1.198	Fixed CV	1.090	Fixed CV
6					1.264	Fixed CV
7						

1995

Sex and maturity group	Male		Primiparous Female		Multiparous Female	
Age	Prop.	St.Dev.	Prop.	St.Dev.	Prop.	St.Dev.
1						
2	0.044	0.004				
3	0.219	0.004				
4	0.737	0.003	0.403	0.005	0.02	0.003
5			0.597	0.005	0.109	0.012
6					0.531	0.012
7					0.341	0.005
	Mean CL	St.Dev.	Mean CL	St.Dev.	Mean CL	St.Dev.
1						
2	15.51	0.056				
3	17.04	0.019				
4	21.78	0.008	22.81	0.019	22.01	0.121
5			26.02	0.017	24.51	0.141
6					26.51	0.038
7					30.01	0.023
	Sigma	St.Dev.	Sigma	St.Dev.	Sigma	St.Dev.
1						
2	0.698	Fixed CV				
3	0.767	Fixed CV				
4	0.980	Fixed CV	1.027	Fixed CV	0.991	Fixed CV
5			1.171	Fixed CV	1.103	Fixed CV
6					1.193	Fixed CV
7					1.351	Fixed CV

Table 2 continued

1996

Sex and maturity group	Male		Primiparous Female		Multiparous Female	
Age	Prop.	St.Dev.	Prop.	St.Dev.	Prop.	St.Dev.
1						
2	0.091	0.001				
3	0.852	0.002	0.369	0.005		
4	0.057	0.001	0.631	0.005	0.095	0.009
5					0.458	0.063
6					0.208	0.057
7					0.239	0.017
	Mean CL	St.Dev.	Mean CL	St.Dev.	Mean CL	St.Dev.
1						
2	14.91	0.011				
3	20.74	0.005	22.06	0.018		
4	23.97	0.030	25.22	0.014	23.41	0.078
5					25.71	0.136
6					27.21	0.370
7					29.41	0.062
	Sigma	St.Dev.	Sigma	St.Dev.	Sigma	St.Dev.
1						
2	0.671	Fixed CV				
3	0.934	Fixed CV	0.993	Fixed CV		
4	1.079	Fixed CV	1.135	Fixed CV	1.053	Fixed CV
5					1.157	Fixed CV
6					1.225	Fixed CV
7					1.323	Fixed CV

1997

Sex and maturity group	Male		Primiparous Female		Multiparous Female	
Age	Prop.	St.Dev.	Prop.	St.Dev.	Prop.	St.Dev.
1						
2	0.044	0.001				
3	0.493	0.004	0.041	0.006		
4	0.463	0.004	0.395	0.310		
5			0.564	0.035	0.279	0.008
6					0.612	0.007
7					0.108	0.005
	Mean CL	St.Dev.	Mean CL	St.Dev.	Mean CL	St.Dev.
1						
2	15.86	0.026				
3	19.75	0.010	21.78	0.114		
4	23.22	0.012	23.98	0.085		
5			25.35	0.040	23.87	0.031
6					26.34	0.028
7					29.21	0.059
	Sigma	St.Dev.	Sigma	St.Dev.	Sigma	St.Dev.
1						
2	0.714	Fixed CV				
3	0.889	Fixed CV	0.980	Fixed CV		
4	1.045	Fixed CV	1.079	Fixed CV		
5			1.141	Fixed CV	1.074	Fixed CV
6					1.185	Fixed CV
7					1.315	Fixed CV

1998

Sex and maturity group	Male		Primiparous Female		Multiparous Female	
Age	Prop.	St.Dev.	Prop.	St.Dev.	Prop.	St.Dev.
1						
2	0.267	0.003				
3	0.550	0.004				
4	0.183	0.003	0.476	0.010	0.135	0.013
5			0.524	0.010	0.422	0.034
6					0.403	0.032
7					0.040	0.014
	Mean CL	St.Dev.	Mean CL	St.Dev.	Mean CL	St.Dev.
1						
2	14.59	0.009				
3	18.89	0.009				
4	21.58	0.020	21.96	0.028	22.2	0.095
5			24.68	0.028	24.67	0.131
6					26.70	0.148
7					29.08	0.321
	Sigma	St.Dev.	Sigma	St.Dev.	Sigma	St.Dev.
1						
2	0.657	Fixed CV				
3	0.850	Fixed CV				
4	0.971	Fixed CV	0.988	Fixed CV	0.999	Fixed CV
5			1.111	Fixed CV	1.110	Fixed CV
6					1.202	Fixed CV
7					1.309	Fixed CV

1999

Sex and maturity group	Male		Primiparous Female		Multiparous Female	
Age	Prop.	St.Dev.	Prop.	St.Dev.	Prop.	St.Dev.
1						
2	0.114	0.004				
3	0.612	0.006				
4	0.274	0.005	0.545	0.012	0.054	0.012
5			0.455	0.012	0.570	0.014
6					0.352	0.013
7					0.023	0.010
	Mean CL	St.Dev.	Mean CL	St.Dev.	Mean CL	St.Dev.
1						
2	15.22	0.027				
3	18.00	0.013				
4	21.12	0.022	21.62	0.028	21.34	0.180
5			23.85	0.033	23.42	0.057
6					26.05	0.086
7					28.36	0.363
	Sigma	St.Dev.	Sigma	St.Dev.	Sigma	St.Dev.
1						
2	0.685	Fixed CV				
3	0.810	Fixed CV				
4	0.950	Fixed CV	0.973	Fixed CV	0.96	Fixed CV
5			1.073	Fixed CV	1.054	Fixed CV
6					1.172	Fixed CV
7					1.276	Fixed CV

Table 2 continued

2000

Sex and maturity group	Male		Primiparous Female		Multiparous Female	
Age	Prop.	St.Dev.	Prop.	St.Dev.	Prop.	St.Dev.
1						
2	0.022	0.002				
3	0.624	0.008			0.002	0.001
4	0.354	0.008	0.586	0.008	0.306	0.021
5			0.414	0.008	0.469	0.018
6					0.223	0.014
7						
	Mean CL	St.Dev.	Mean CL	St.Dev.	Mean CL	St.Dev.
1						
2	14.80	0.060				
3	18.33	0.017			17.98	0.385
4	20.53	0.026	21.14	0.021	22.31	0.070
5			24.44	0.029	24.41	0.086
6					27.07	0.077
7						
	Sigma	St.Dev.	Sigma	St.Dev.	Sigma	St.Dev.
1						
2	0.666	Fixed CV				
3	0.825	Fixed CV				
4	0.924	Fixed CV	0.951	Fixed CV	0.809	Fixed CV
5			1.100	Fixed CV	1.004	Fixed CV
6					1.100	Fixed CV
7					1.219	Fixed CV

2001

Sex and maturity group	Male		Primiparous Female		Multiparous Female	
Age	Prop.	St.Dev.	Prop.	St.Dev.	Prop.	St.Dev.
1						
2	0.215	0.004				
3	0.286	0.005				
4	0.498	0.005	0.633	0.013	0.206	0.019
5			0.367	0.013	0.527	0.017
6					0.239	0.010
7					0.028	0.005
	Mean CL	St.Dev.	Mean CL	St.Dev.	Mean CL	St.Dev.
1						
2	15.80	0.019				
3	18.14	0.024				
4	21.08	0.014	22.48	0.026	21.62	0.081
5			24.66	0.040	23.55	0.065
6					26.43	0.090
7					29.32	0.233
	Sigma	St.Dev.	Sigma	St.Dev.	Sigma	St.Dev.
1						
2	0.711	Fixed CV				
3	0.816	Fixed CV				
4	0.949	Fixed CV	1.010	Fixed CV	0.973	Fixed CV
5			1.110	Fixed CV	1.060	Fixed CV
6					1.189	Fixed CV
7					1.319	Fixed CV

Table 3. Mean carapace length (mm) at age by years.

Year / Age group	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	Mean CL
2					16.8	16.0		15.5	14.9	15.9	14.6	15.2	14.8	15.8	15.5
3	18.0	18.3	18.4	17.5	21.3	20.4	17.5	17.0	20.9	19.9	18.9	18.0	18.3	18.1	18.8
4	23.6	21.6	21.5	21.6	23.4	23.5	21.9	22.0	24.7	23.6	21.8	21.4	21.1	21.6	22.4
5	26.6	25.6	23.6	23.5	24.2	26.2	25.9	25.7	25.7	25.8	24.7	23.6	24.4	24.1	25.0
6	28.7	28.2	26.8	26.8	27.0	28.7	28.1	26.5	27.2	29.2	26.7	26.1	27.1	26.4	27.4
7					29.0			30.0	29.4		29.1	28.4		29.3	29.2

Table 4. Abundance ('000) by age groups and years.

Year / Age group	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
2					120191	223393		**9517**	**42039**	**9746**	**624269**	**99843**	17375	259808
3	37994	57911	**228863**	**157572**	317788	200783	11862	47348	**447846**	**118876**	**1285454**	**537439**	**483170**	345666
4	123364	73965	48575	**394344**	**414493**	130964	54669	217861	145623	**236916**	**734802**	**619352**	**668109**	**1108126**
5	92314	109296	96067	452944	**866157**	**579941**	75363	106432	112381	228234	**447392**	**586200**	**369789**	**489255**
6	1848	12136	22454	163298	271669	**26881**	**162525**	128189	50934	19155	161567	**181078**	**79786**	**114888**
7					20395			**82333**	58689		15885	12031		**13573**
Total	255520	253308	395959	1168158	2010693	1161962	304419	591680	857510	612927	3269369	2035943.5	1618229	2331316

Table 5. Biomass index (tons) by age groups and years.

Year / Age group	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
2					334	537		21	81	23	1127	205	33	598
3	129	207	829	494	1819	998	37	137	2415	552	5088	1837	1745	1210
4	966	441	288	2355	3158	1013	337	1381	1313	1866	4483	3596	3733	6665
5	1043	1110	760	3493	7661	6326	779	1076	1167	2366	4037	4672	3245	4133
6	26	165	262	1869	3258	383	2184	1455	624	289	1873	1954	964	1293
7					301			1343	902		236	166		207
Total	2164	1923	2139	8211	16531	9257	3337	5413	6502	5096	16844	12430	9720	14106