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The Assessment of the International Fishery for Shrimp (*Pandalus borealis*) in Division 3M (Flemish Cap), 1993-2003

by

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Abstract

The development of the international shrimp (*Pandalus borealis*) fishery in NAFO Division 3M is described. A standard six nation data set is used to create a series of standardized catch per unit effort (CPUE) indices with the purpose of tracking the status of the Flemish Cap shrimp stock. Also an international observer database of length frequencies was created for the purpose of ageing. Observer samples were used on which ageing was carried out. Shrimp ages are presented as well as number/kg/age based on both nominal catch and standardized CPUE. Indices of recruitment and female stock are calculated from this using the standardized CPUE series. Recruitment indices were determined from the Faroese survey trawl and the juvenile net attached to the trawl. While Spawning Stock Biomass index (SSB) was obtained from the EU survey and the Faroese surveys.

Introduction

The fishery for northern shrimp on the Flemish Cap began during the spring of 1993 and has since continued with catches (estimated by STACFIS) of approximately 27 000 to 48 000 in the years 1993 through 1996. During 1997 catches decreased to 25 000 tons then increased to 50 000 tons in 2000 and finally 54 000 tons in 2001, the highest in the series. The catch of year 2002 was much lower or 49 000 tons. However removals to July 2003 of about 28 000 tons are higher than those reported for the same period in 2002 (22 000 tons) and projections to the end of year 2002 are expected to reach 52 000 tons. Vessels from as many as 19 nations have participated in this fishery since its beginning.

The following is an overview of the international fishery for shrimp on Flemish Cap. Trends in catch and effort from data provided by fleets from several nations are not included as the data were not ready as yet. As a provisional CPUE from the Icelandic fleet is presented were the CPUE is calculated per standard size of trawl of the circumference of 3 000 meshes. The effort of double trawl is multiplied wit 1.9 to get a realistic effort compared to that of a single trawl.

The spawning stock and recruitment indices are presented from the EU and Faroese surveys.

Background on the assessment and management of this resource since 1993 can be found in Skuladottir and Orr (2002) and NAFO Scientific Council Reports (2002).

Results

Catch and Effort

Preliminary catch per month as reported to NAFO for the years 2001 through 2003 is shown in Tables 1, 2 and 3. Much of the 2001 catch was taken during the period March to July. In 2002 the main catch was taken in the period April to September. The lowest amount of catch was taken in January during both 2001 and 2002. Catch (tons) by nations as estimated by STACFIS is presented in Table 4. The highest catch 54 000 tons was taken in 2001. Catches were somewhat lower in 2002 or 49 000 tons. In 2003 catch is expected to rise again to the 2001value when the catch of January to July is compared to that of the years 2001 and 2002. Projected total catch to the end of the year 2003 is 55 000 tons. Much of the nominal catch data were obtained from STATLANT 21A, however, some were obtained directly from assessment biologists working within nations that fish for Div. 3M shrimp. If a logbook catch differed from the STATLANT 21A catch, then the higher of the two was used in the analyses. Figure 1 shows the total catch of shrimp in Div. 3M as well as the reccommended catch.

CPUE

Figure 2 shows the CPUE of Icelandic fleet merely as preliminary results as standardized CPUE for many fleets is as yet not calculated for the year 2003. The CPUE is here standardized in a simple manner to the size of 3 000 meshes trawl of Icelandic fleet only. The CPUE is calculated both for the period January to July on one hand and January to September on the other (Table 5). There does seem to be a rise in CPUE in the last few years to become similar to that in 1993 (Table 5 and Fig. 2). Note how much the size of gear has changed with time. The Icelandic CPUE can be compared to the standardized CPUE done in November 2002 (Skuladottir and Orr) and is not very different in outcome (Fig. 3).

Recruitment

The Faroese survey provides two recruitment indices. Since 1997, a juvenile shrimp bag has been attached to the gear in the Faroese survey. The results are shown in Fig. 4 and the table below (Nicolajsen and Brynjolfsson, 2003). The abundance of two year olds obtained in the main trawl in the Faroese survey was observed for 5 years and is also shown in Figure 4 and the table below (Nicolajsen, 2002).

Survey/Year	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Faroese survey main trawl	855	210	214	108	1242	416	
Faroese survey juvenile bag		2532	5683	456	4377	913	1337

The two indices do not agree in all years. In 1999 the juvenile bag showed a greater abundance of two-year-olds, which was not apparent in the main survey gear. This 1997 year-class was above average in the 2001 commercial catch and is still strong at age 5 in 2002. Both indices showed that the 1998 year-class was weak in 2000 and although the 1998 year-class has improved with time it is still a little under average in 2002. During 2001, two year olds (1999 year-class) were abundant in both the main trawl and the juvenile bag. This indication has been confirmed by the presence of numerous shrimp at age 3 in the 2002 fishery. The 2000 year-class on the other hand appears average both in the juvenile bag and the main trawl (Nicolajsen, 2002; Nicolajsen and Brynjolfsson, 2002) as seen in year 2002 (Fig. 6).

Female Biomass

Similarly a spawning stock biomass (SSB) index was calculated as kg/hr of primiparous (including transitionals) plus multiparous females from the international observer database and the standardized CPUE model. This was compared to the results of the EU survey Table 6 (Del Rio *et al.*, 2002 and Del Rio, 2003 personal communication) and Faroese survey biomass indices (Nicolajsen, 2003). The raw data are provided in the table below. Once again, each index was standardized to the mean of the series and shown in Fig. 5.

Survey/Year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
EU survey biomass	1874	1340	1132	5362	11509	6839	2823	4286	4149	3807	8091	9051	6553	8977	11664	8585
Faroese survey biomass										6732	12559	8864	10155	9374	11761	12402
Standarized CPUE						207	99	105	88	44	116	140	152	117	162	

The spawning stock (female biomass) as determined from the EU survey biomass index gradually increased during the years prior to the fishery. This coincided with the decline in cod biomass in the area. But this was also a reflection of the very strong 1987 year-class, most of which were female during 1992. The index showed a decrease from 1994 through to 1997 followed by an increase during 1998. The SSB remained high during all years since 1998 except 2000 and is somewhat lower in 2003 than in 2002. The female biomass from the Faroese survey indices have shown much the same trend as the other two indices although showing the highest values during 1998 and 2003.

A standardized female SSB was calculated from the standardized CPUE as kg/hr of primiparous plus multiparous females. The standardized SSB declined from 1993 to 1997 increased in 1998 and stayed stable thereafter (Fig. 7). There are however no data for 2003 as yet.

Catch-at-age

There is no age analysis since November 2002 but results of years 1993-2002 are presented in the assessment paper of November 2002 (Skuladottir and Orr, 2002). Refering to that paper “1987 year-class appeared as a very strong age 6+ cohort (approximately 9 800 animals/hr). The 1993 year-class were two years old in 1995 namely some 17 900 the strongest ever seen in the series. It was strong in 1995 and 1996, but later the year-class appears to have decreased in strength resulting in fewer 4 and 5 year olds as might be expected also seen in the Spanish survey (Skuladottir and Diaz, 2001). The 1996 year-class was considered average during 1998, but appeared stronger during 1999-2001. The 1997 cohort was a strong year-class almost as numerous as the 1993 year-class at age 3. It continued to be strong in 2000-2002 being still exceptionally high in numbers at age 5. It is important to note that the 1998 year-class is by far the weakest in the series at age 3 and is still below average at age 4 in 2002. The 1999 year-class appears to be above average at age 3 in 2003 and is very promising for the future. First indications of the 2000 year-class are that it appears average”.

Summary

Catches of shrimp on the Flemish Cap have been maintained at a high level averaging about 44 000 tons for the last four years including year 2001 due to a possible increase in biomass. There was a general decline in CPUE between 1993 and 1994, varied without a trend to 1997, and increased to 2000, after which it remained stable. The spawning stock biomass also decreased between 1993 and 1994 increased between 1997 and 1998 and fluctuated without a trend thereafter in standardized CPUE and the Faroese survey. The EU female biomass index increased in 2002 to the highest level since the fishery started to fall to the 1999 and 2001 value.

The 1997 year-class was above average judging by its occurrence in the fishery in 2001 and 2002 as well as in the biomass estimates of the surveys. The 1998 year-class on the other hand is considered to be below average, confirming the results obtained during 2001. The 1999 year-class appears as promising as the 1997 year-class. The 2000 year-class appears to be average. There has been no analysing of biological samples in 2003.

At present the stock is in a stable conditions but recruitment appears below average as two year olds in 2002 and 2003.

Acknowledgement

Appreciation is expressed to those who provided data for inclusion in this paper in advance of the 2003 September Meeting.

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Table 1. Catch (tons) by nations and months as reported provisionally to NAFO in year 2001.

Nation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total by months	Year to date
Canada													294	294
Cuba										246	226	325	797	797
Estonia	217	311	1129	1385	1029	1041	1327		1133	774	891	241	9438	9438
EU/Denmark													0	0
EU/Spain			31		168			304		423			926	756
Faroe Is.		440	1443	1548	1548	2187		1239	508		624	570	10106	12780
France										157	126	125	408	408
Greenland													0	0
Honduras													0	0
Iceland		361	801	170		564	949	780	203	530	573	360	5291	5301
Japan									10	60	54	6	130	130
Latvia		102	418	327	346	545	284	314	169	172	80	213	2990	2984
Lithuania	4	116	212	221	213	399	473	284	241	236	215	89	2702	2702
Norway		565	566	986	1135	1972	2101		1336			568	9229	13255
Poland												196	196	196
Portugal													0	0
Russia	375	963	872	865	895	424	344	130	276	349	377	430	5900	5687
Ukraina												44	44	348
USA										186		225	411	411
Total	**596**	**2458**	**5472**	**5462**	**5334**	**7132**	**5478**	**3060**	**3896**	**3132**	**3166**	**3392**	**48862**	**55187**

Table 2. Catch (tons) by nations and months as reported provisionally to NAFO in year 2002.

Nation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Year to date
Canada						8			8				16	16
Cuba								106	47				153	153
Estonia	316	1027	1288	1699	1326	1356	1692	1418	1041	1246	787	514	13674	13674
EU/Denmark													0	0
EU/Spain				54			358	339		70	211	13	1045	751
Faroe Is.	523	554	485	725	1501	1043	1043	1346	727	360	438	365	9110	8509
France							29			99	33		161	161
Greenland						347							347	600
Honduras													0	0
Iceland			524	564	748	818	301	587		604	454	406	5006	5755
Japan													0	0
Latvia		100	142	365	175	403	206	95	344	55			1885	1885
Lithuania		336	378	404	246	345	370	284	336	299	218	105	3321	3321
Norway		83		451	1362	1484	1694		1739		1123	329	8265	11554
Poland													0	0
Portugal													0	0
Russia	178	189	206			142	114	83	175	59			1146	1145
Ukraina													0	0
USA									96				96	96
Total	**1017**	**2289**	**3021**	**4229**	**5357**	**5946**	**5807**	**4258**	**4513**	**2792**	**3264**	**1732**	**44225**	**47700**

Table 3. Catch (tons) by nations and months as reported provisionally to NAFO in year 2003.

Nation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Year to date
Canada													0	
Cuba													0	
Estonia	602	392	1279	1318		1217							4808	6244
EU/Denmark													0	
EU/Spain				6	15	6							27	27
Faroe Is.	125	294	1087	1022	1239	1705							5472	5471
France													0	
Greenland						15							15	
Honduras													0	
Iceland		382	240	440	721	591							2374	2374
Japan													0	
Latvia		254	530	480	425	319							2008	2043
Lithuania		67	289	453	362	365							1576	1576
Norway	165	306	1257	2305	2402	2695							9430	9500
Poland													0	
Portugal													0	
Russia				3									3	3
Ukraina													0	
USA													0	
Total	**892**	**1715**	**4682**	**6027**	**5184**	**7213**	**0**	**0**	**0**				25713	27238

Table 4. Catch (tons) by nations as estimated by STACFIS.

Nation	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003*
Canada	3724	1041	970	906	807	484	490	618	1 295	4 16	
Cuba							119	46	1 797	4 153	
Estonia		1081	2092	1900	3240	5694	10835	13256	3 9850	2 14215	4 6244
EU/Denmark	800	400	200			437	235		1 92		
EU/Spain	240	300	158	50	421	913	1019	1388	2 1095	4 1045	1 27
Faroe Is.	7333	6791	5993	8688	7410	9368	9199	7719	3 10228	2 8516	2 5472
Greenland	3788	2275	2400	1107	105	853	576	1636		2 684	2 247
Honduras	1265										
Iceland	2243	2300	7623	20681	6381	6572	9277	8912	2 5265	2 5741	2 3081
Japan									1 130		
Latvia		300	350	1940	997	1191	3080	3105	4 2990	4 1885	4 2043
Lithuania		1225	675	2900	1785	3106	3370	3595	1 2702	4 3321	4 1576
Norway	7183	8461	9533	5683	1831	1339	2975	2669	1 13291	4 11554	4 9500
Poland					288	148	894		1 209		
Portugal	300		150		170	203	227	289	1 420		
Russia		350	3327	4445	1090		1142	7078	1 5687	2 1148	2 3
St. Vincent's		75			150				1 408	4 161	
Ukraina									1 348		
USA									1 411	4 96	4 96
Total	**26876**	**24599**	**33471**	**48300**	**24675**	**30308**	**43438**	**50311**	**54218**	**48535**	**28289**

1 NAFO Statlant 21 A
2 From the fisheries biologist of respective countries
3 Assessed by Stacfis
4 Reported to NAFO provisionally

* Provisional to July

Table 5. Nominal catch for the whole year and some averages calculated from the Icelandic logbooks to show trends in CPUEs and size of trawl. In calculations of CPUE the effort of twin trawls is multiplied by 1.9.

Year	Nominal Catch Tons	Twin trawls % of catch	Mean trawl size No. of meshes January-July	Unstandardized CPUE January-July	CPUE at size 3000 trawl January-July	Mean trawl size No. of meshes January-Sept	Unstandardized CPUE January-Sept	CPUE at size 3000 trawl January-Sept.
1993	2 243	43.4	3063	373	363	3102	356	344
1994	2 300	54.4	2994	238	240	2951	216	219
1995	7623	38.2	2779	254	283	2733	228	251
1996	20681	42.9	2803	206	218	2813	198	211
1997	6483	53.4	2780	188	192	2921	198	203
1998	6572	74.8	3016	288	294	2974	264	266
1999	9217	70.6	3441	280	252	3402	276	243
2000	8978	81.4	3528	287	245	3528	282	240
2001	5301	63.0	3571	328	290	3518	325	289
2002	5741	73.6	3713	370	305	3713	363	294
2003	3081	85.0	4190	486	348			

Table 6. Results of EU surveys

Year	Biomass Index (tons)	Average catc per mile (kg)	Standard Error	Female Biomass Index (tons)
1988	2 164	1.5	0.28	1 874
1989	1 923	1.4	0.24	1 340
1990	2 139	1.5	0.21	1 132
1991	8 211	5.8	0.71	5 362
1992	16 531	11.8	1.86	11 509
1993	9 256	6.6	1.04	6 839
1994	3 337*	2.4	0.35	2 823
1995	5 413	3.9	0.44	4 286
1996	6 502	4.6	0.34	4 149
1997	5 096	3.6	0.25	3 807
1998	16 844*	11.8	0.80	8 091
1999	12 430	8.8	0.67	9 051
2000	9 720	6.9	0.52	6 553
2001	14 106	10.0	0.65	8 977
2002	18 109	12.9	1.12	11 664
2003	22 392			8 585 **

* not comparable to other years because of different codend mesh size
** provisional (only 25% of hauls analyzed)

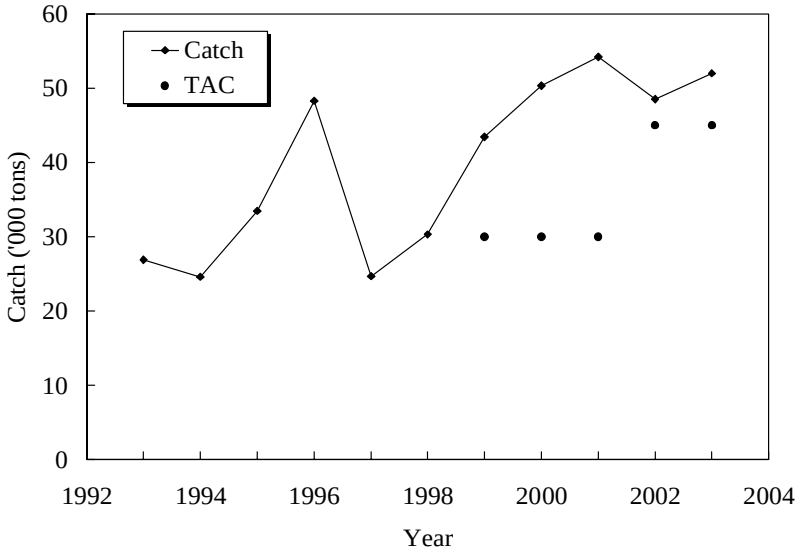

Fig. 1. Shrimp in Div. 3M: catches (2003 projected to end of the year).

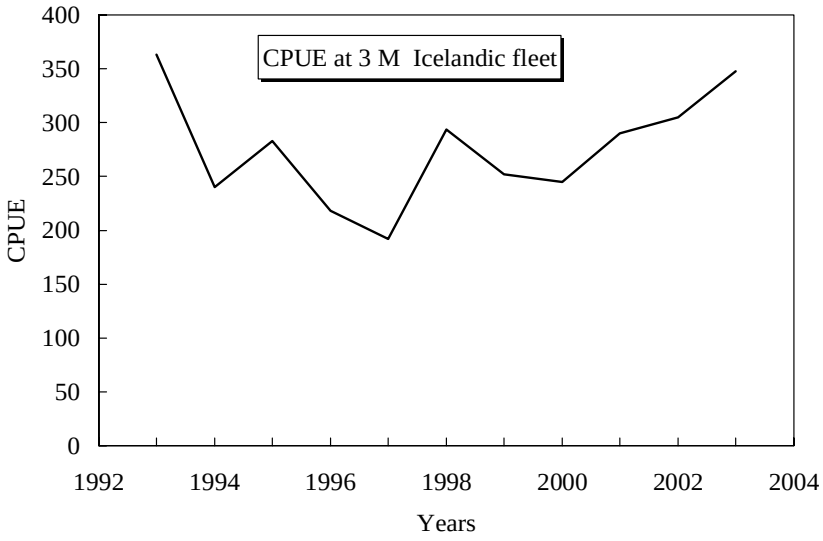

Fig. 2. Shrimp in Div. 3M: Shrimp in Div. 3 M: CPUE from the Icelandic fleet for the months January-July. CPUE is standardized to the size of trawl of 3000 meshes circumference. The effort for double trawl is multiplied with 1.9 in the calculations when combining CPUE for single and double trawls.

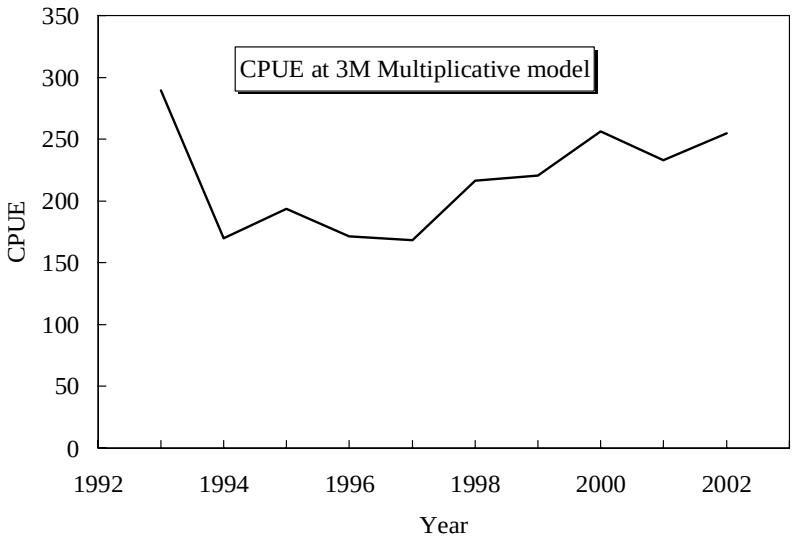

Fig. 3. Shrimp in Div. 3M: standardized CPUE indices (multiplicative model). From assessment in November 2002 (Skuladottir and Orr, 2002).

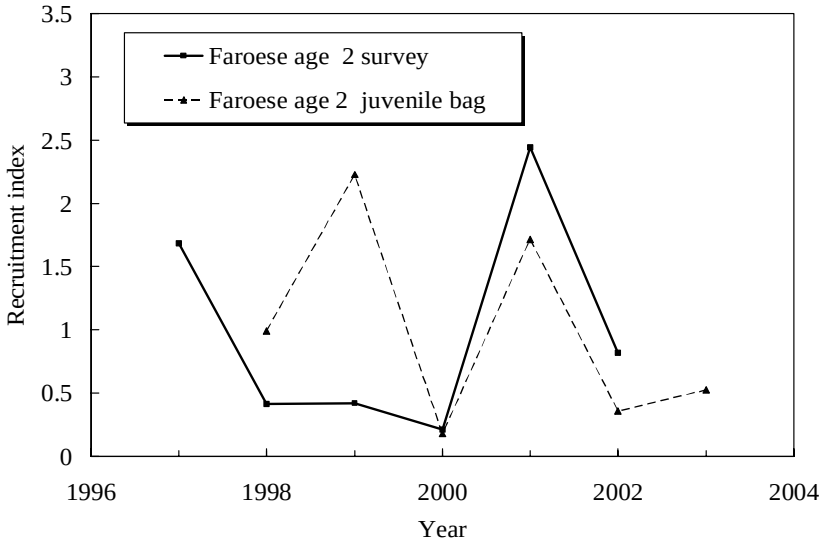

Fig.. 4. Shrimp in Div. 3M: abundance indices at age 2 from the Faroese survey and from the juvenile bag. Each series was standardized to its mean.

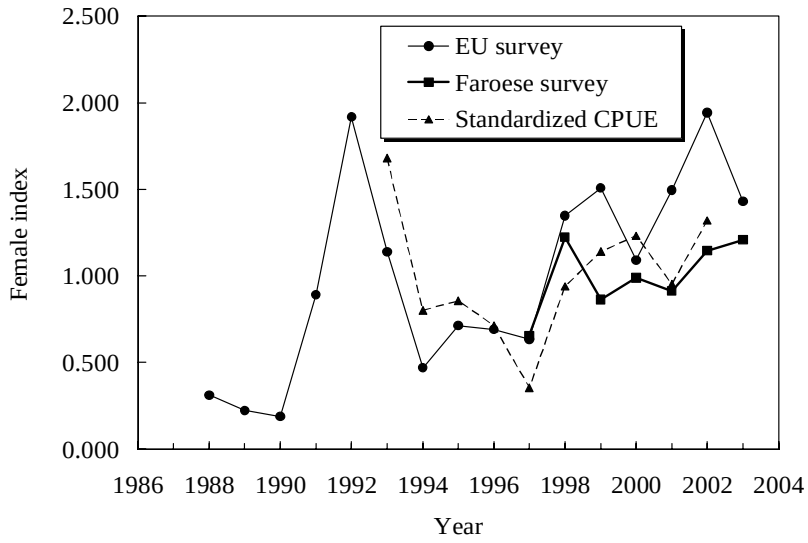

Fig.. 5. Shrimp in Div. 3M: female biomass index from EU trawl surveys (provisional), 1988-2003, Faroese survey 1997-2003 and standardized female CPUE 1993-2002. Each series was standardized to the mean of that series.