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Assessment of the International Fishery for Shrimp (*Pandalus borealis*) in Division 3M (Flemish Cap), 1993-2004

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. The standardized CPUE was at a high level in 2003. A provisional CPUE of Iceland alone shows a CPUE below average in 2004. In 2003 a peak catch of shrimp was caught at the Flemish Cap of some 62 000 tons. An international observer database of length frequencies was used for ageing the shrimp. Indices of female stock are calculated from this using the standardized CPUE series. Spawning Stock Biomass index (SSB) was obtained from the EU survey and the Faroese surveys to year 2003. Recruitment indices were determined from the Faroese surveys both the main trawl and the juvenile net attached to the trawl. to 2003 showing that the 2001 year-class was about average. A good recruitment of one year olds was detected in the EU survey of 2003 and preliminary information from the Icelandic observer samples in late 2003 and early 2004 also show the presence of a prominent 2002 year-class.

1. 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. Then in 2003 the catch increased to the high 62,000 tons. The increase was largely due to Norway doubling their catch between years 2002 and 2003 using triple trawls. Removals to July 2004 of about 18,100 tons are much lower than those reported for the same period in 2003 (28,000 tons) and projections to the end of year 2004 are expected to reach 40,000 tons.

The development of the international shrimp (*Pandalus borealis*) fishery in NAFO Div. 3M is described. Various indices are listed with the purpose of tracking the status of the Flemish Cap shrimp stock. Among these the standardized CPUE an international database of observer samples is used on which ageing was carried out. The results from the ageing are presented as well as numbers/kgs per age based on either nominal catch or standardised CPUE. The indices of female stock are calculated from this using the standardized CPUE series. Moreover there are recruitment indices from the Faroese survey both from the main trawl and the juvenile bag. Last and not least the for female indices these are also obtained from the EU survey and the Faroese survey.

Trends in standardized CPUE provided by fleets from several nations are presented only to year 2003 as the data for 2004 have not been processed as yet. A CPUE series from the Icelandic fleet is presented as there is information on CPUE from one vessel in 2004. Vessels from as many as 19 nations have participated in this fishery since its beginning.

Background on the assessment and management of this resource since 1993 can be found in Skuladottir and Orr (2002) Skuladottir (2003b) and NAFO Scientific Council Reports (2003).

2. MATERIAL AND METHODS

CPUE for Icelandic logbook data alone is calculated per standard size of trawl of the circumference of 3000 meshes. The effort of double trawl is multiplied with 1.9 to get a realistic effort compared to that of a single trawl.

Shrimp were separated into 3 categories namely, males, primiparous females (including transitionals) and multiparous females according to the sternal spine criterion (McCrary, 1971), oblique carapace lengths were measured using sliding callipers and grouped into 0.5 mm length-classes. These data form the International shrimp aging database as recommended, Appendix II of the 1999 NAFO Scientific Council meeting on shrimp (NAFO, 1999).

3. CPUE

The CPUE of the Icelandic fleet is shown here as there is some preliminary information for year 2004. As seen in Fig. 2 and Table 5 the CPUE (3000 meshes) has dropped considerably after the large catch of 62,000 tons in 2003. The reduction in January-July 2004 is about 22% from the 2003 value. The catch of 243 kg/hour in 2004 is below the average of 272 kg/hour for the years 1993-2003. Standardized CPUE (see Fig. 3) was the highest in 2003 of the series 1993-2003.

4. 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 6 (Nicolajsen and Brynjolfsson, 2003). The abundance of two year olds obtained in the main trawl in the Faroese survey was observed for 7 years and is also shown in Fig. 4 and Table 6.

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. The 1997 year-class is average or above average in the commercial catch. Both indices showed that the 1998 year-class was weak in 2000 and that the 1998 year-class had been weak in all years. During 2001, two-year-olds were abundant in both the main trawl and the juvenile bag. This is the 1999 year-class which has turned out to be quite strong. The 2000 year-class appears to be small in both the main trawl and the juvenile bag. That year-class never got big. The 2001 year-class however could be big as it is prominent in the main trawl in 2003 although not well presented in the juvenile bag (Nicolajsen and Brynjólfsson, 2003). In Icelandic observer samples in late 2003 and early 2004 the 2001 year-class appears to be above average (Skuladottir, 2004). The appearance of a new year-class 2002 that appears in the EU survey. This is the first time a one year old shrimp are detected in the EU survey. This year-class is also very prominent in the catch of Iceland both in late 2003 and in the months January through March in 2004 as two year olds.

5. FEMALE BIOMASS

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 (Diaz, 2003) and Faroese survey biomass indices (Nicolajsen, 2003). The raw data are provided in Table 7. Once again, each index was standardized to the mean of the series and shown in Fig. 5.

The spawning stock (female biomass) as determined from the EU survey biomass index gradually increased during the years prior to the fishery. This may have been due to a gradual increase in stock size after the cod biomass declined in the area. But this was also a reflection of the very strong 1987 year class, most of that were female during 1992. The index showed a decrease from 1994 through to 1997 then an increase during 1998. The SSB of EU survey has fluctuated and increased to a high peak in 2002 to decrease again in 2003. The female biomass from the Faroese survey indices have shown much the same trend as the EU although not flutuating as much and appears to be rather stable since 1998. The female CPUE decreased from 1993 to 1997 then rose in 1998 and 1999, remaining stable to 2002 to rise considerably in 2003. The biomass indices should have been corrected for the years

1988-2002 by a factor of 1.74 adjusting for the more efficient research vessel taken into use in 2003 according to del Rio *et al*. (2003).

6. AGE ASSESSMENTS

Age analysis was carried out on biological samples obtained from Canadian, Icelandic and Greenlandic vessels. This analysis allows the calculation of the number per hour caught and number caught per year (based on nominal catch and the CPUE model) by age group.

The female part of the standardized CPUE is that of primiparous + multiparous females which is presented in Fig. 5.

In 1993, the 1987 year class appeared as a very strong age 6+ cohort (approximately 12,000 animals / hr). The 1993 year class were two years old in 1995. It was strong in 1995 and 1996, but later the class appears to have decreased in strength resulting in fewer 4 and 5 year olds as might be. The 1996 year class was considered mediocre during 1998, but appeared stronger during 1999 - 2001. The EU survey is not in agreement with the commercial data as the 1995 year class appears to be a very strong year class. It is important to note that the 1998 year class is by far the weakest in the series, but appears to be numerous as 5 year old in 2003. This is probably due to incorrect ageing as it is difficult to assess the age of older shrimp. The 1999 year-class appears to be very strong and is the most abundant four year olds in the whole series in 2003. The 2000 year-class appears to be weak as 3 year olds in 2003 and the 2001 year-class appears to be above or about average.

7. SUMMARY

Catches of shrimp on the Flemish Cap have been maintained at a high level averaging about 45,000 tons for the last five years. The CPUE model indicated that there was a general decline between 1993 and 1996. Then beginning in 1997, catch rates began to increase and increased to 2003 similar to that in 1993. The spawning stock biomass also decreased between 1993 and 1994. The survey SSB of the Faroese survey remained low during 1997 but showed an increasing trend to 2003. The SSB of the EU survey also increased from 1997 to 2002. As the 74% increase in the estimate of biomass index of EU is considered unconvincingly high the status of the 2003 SSB will be unclear for the time being.

The 1999 year-class appears to be very strong, the 2000 year-classes is considered to be weak judging by its occurrence in the fishery in 2003. The 2001 year-class is considered to be about average. The 2002 is considered a promishing year-class

8. ACKNOWLEDGEMENT

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Table 1. 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**	**8**
Cuba								106	47				**153**	**153**
Estonia	316	1027	1286	1666	1325	1356	1692	1418	1041	1246	787	514	**13674**	**13674**
EU/Denmark													**0**	**0**
EU/Spain				54			358	339		70	211	13	**1045**	**1045**
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**	**680**
Honduras													**0**	**0**
Iceland			524	564	748	818	301	587		604	454	406	**5006**	**5351**
Japan													**0**	**100**
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**	**11225**
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**	**47353**

Table 2. 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**	**81**
Estonia	602	392	1279	1318		1217	1506	1371	1169	883			**9737**	**12732**
EU/Denmark													**0**	
EU/Portugal													**0**	
EU/Spain				6	15	6	21		19	33	26	11	**137**	**161**
Faroe Is.	125	294	1087	1022	1239	1705	1380	1453	1253	952	851	501	**11862**	**12622**
France													**0**	
Greenland						15	760						**775**	**873**
Honduras													**0**	
Iceland		382	240	440	721	591	595	431	194	376	312	306	**4588**	**4588**
Japan										73	29	15	**117**	**116**
Latvia		254	530	480	425	319	363	247	245	159	192		**3214**	**3453**
Lithuania		87	289	453	382	365	450	338	292	402	333	353	**3744**	**3744**
Norway	165	306	1257	2305	2402	2995	2435		3074		1234	680	**16853**	**22874**
Poland													**0**	
Portugal													**0**	
Russia				3									**3**	**3**
Ukraina							73	141	24				**238**	**238**
USA								162	215	245		6	**628**	**628**
Total	**892**	**1715**	**4682**	**6027**	**5184**	**7213**	**7583**	**4143**	**6485**	**3123**	**2977**	**1872**	**51896**	**62113**

Table 3. Catch (tons) by nations and months as reported provisionally to NAFO in year 2004.

Nation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	**Total**	**Year to date**
Canada													**0**	
Cuba	95	2	178	218	241								**734**	**734**
Estonia	50	829	510	971									**2360**	**2880**
EU/Denmark													**0**	
EU/Portugal													**0**	
EU/Spain				22	528	570							**1120**	**1328**
Faroe Is.	26		60	227	434	564							**1311**	**1596**
France													**0**	
Greenland													**0**	
Honduras													**0**	
Iceland		272	290	360		356							**1278**	**1278**
Japan													**0**	
Latvia			305	240	267	154							**966**	**1417**
Lithuania	203	529	410	443	576	790							**2748**	**2951**
Norway		579			369	447							**1395**	**2472**
Poland		93	242	62									**397**	**397**
Portugal													**0**	
Russia													**0**	
Ukraina						147							**147**	**147**
USA			153	180									**333**	**333**
Total	**374**	**2304**	**2148**	**2723**	**2415**	**3028**	**0**	**0**	**0**				**12789**	**15533**

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

Nation	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003***	**2004***
Canada	3724	1041	970	906	807	484	490	618	1 295	4 16		
Cuba							119	46	1 797	4 153	81	734
Estonia		1081	2092	1900	3240	5694	10835	13256	3 9850	2 14215	4 12732	4 2880
EU/Denmark	800	400	200			437	235		4 92	4 359		
EU/Portugal	300		150		170	203	227	289	4 420	4 15		
EU/Spain	240	300	158	50	421	913	1019	1388	4 799	671	4 161	4 1328
Faroe Is.	7333	6791	5993	8688	7410	9368	9199	7719	3 10228	2 8516	2 12676	4 1596
Greenland	3788	2275	2400	1107	105	853	576	1636		2 684	4 873	4
Honduras	1265											
Iceland	2243	2300	7623	20681	6381	6572	9277	8912	2 5265	2 5741	2 4695	2 2196
Japan									1 130		116	
Latvia		300	350	1940	997	1191	3080	3105	4 2990	4 1885	4 3453	4 1417
Lithuania		1225	675	2900	1785	3106	3370	3595	1 2702	4 3321	4 3744	4 2951
Norway	7183	8461	9533	5683	1831	1339	2975	2669	1 13291	4 11624	4 22765	2 4161
Poland					288	148	894		1 209			4 397
Russia		350	3327	4445	1090		1142	7078	1 5687	2 1148	2 3	2
France		75			150				1 408	4 161		
Ukraina									1 348		4 238	4 147
USA									1 411	4 96	4 628	4 333
Total	**26876**	**24599**	**33471**	**48300**	**24675**	**30308**	**43438**	**50311**	**53922**	**48605**	**62165**	**18140**

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

* Provisional to 1 October

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	4695	87.6	4189	376	**311**	4001	365	**296**
2004	2196	91.8	4460	309	**243**			
Mean 93-2003	**8366**	**62**	**3261**	**290**	**272**	**3241**	**279**	**260**

Table 6. Shrimp in Div. 3M. Recruitment indices of 2 year olds (numbers). in the Faroese survey.

Year	Main trawl	juvenile bag
1997	855	
1998	210	2532
1999	214	5683
2000	108	456
2001	1242	4377
2002	416	913
2003	1119	1337

Table 7. Shrimp in Div. 3M. Indices of female biomass converted by coefficient 1.74 in 1988 to 2002, EU survey, Faroese survey and standardized CPUE.

Year	EU survey biomass	Faroese Survey biomass	andardized CPUE Kg/hour
1988	3270		
1989	2338		
1990	1975		
1991	9357		
1992	20084		
1993	11935		275.9
1994	4926		130.0
1995	7480		141.0
1996	7240		122.4
1997	6644	6731	122.5
1998	14120	12559	166.0
1999	15795	8863	204.4
2000	11436	10154	211.3
2001	15666	9374	176.3
2002	20355	11761	196.9
2003	10697	12402	252.7

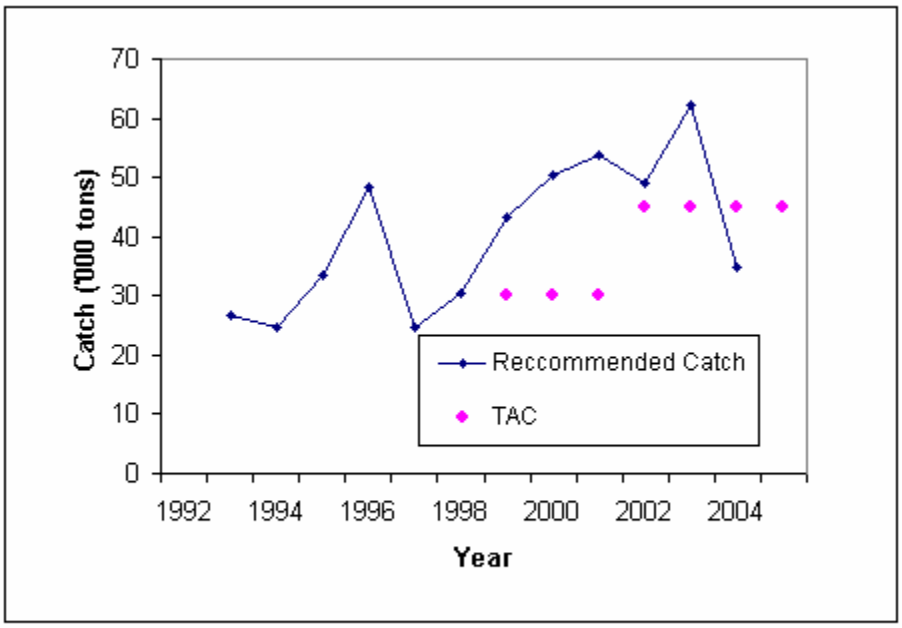

Figure 1. Shrimp in Div. 3M: catches (2004 projected to end of the year).

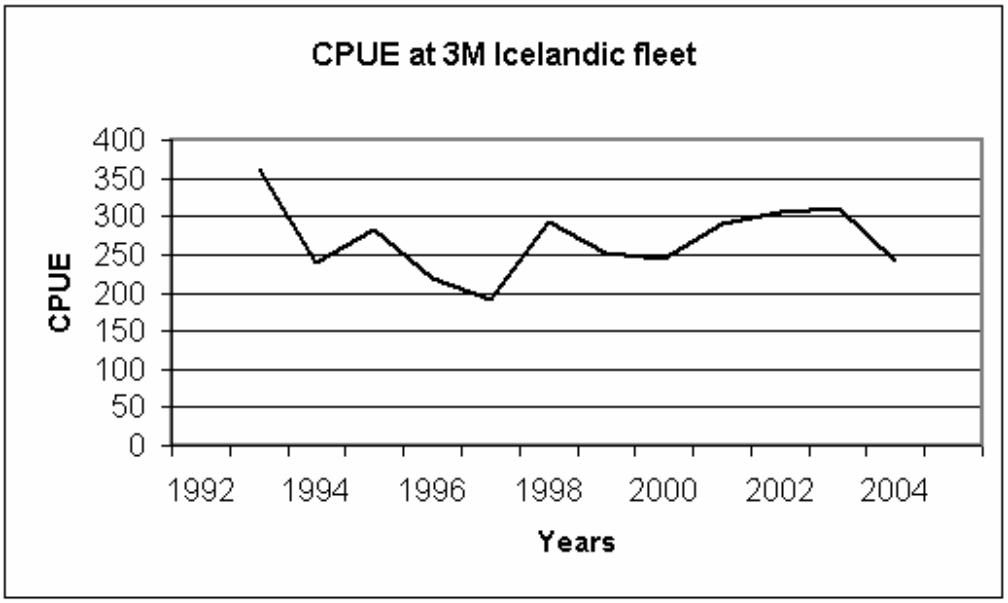

Figure 2. Shrimp in Div. 3M: CPUE from the Icelandic fleet for the months January-July. CPUE is standardized to the trawl of 3000 meshes circumference. The effort for double trawl is multiplied by1.9 when combining CPUE for single and double trawls.

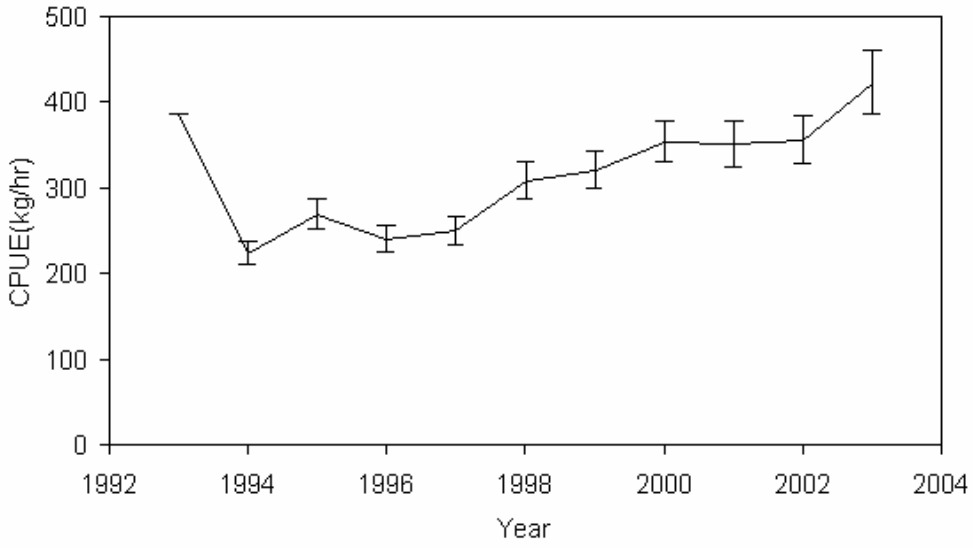

Fig. 3 Shrimp Div. 3M: The standardized CPUE of shrimp on Flemish Cap between 1993-2003. The model was standardized to 1993, June, single trawl and Icelandic catch-per-unit data.

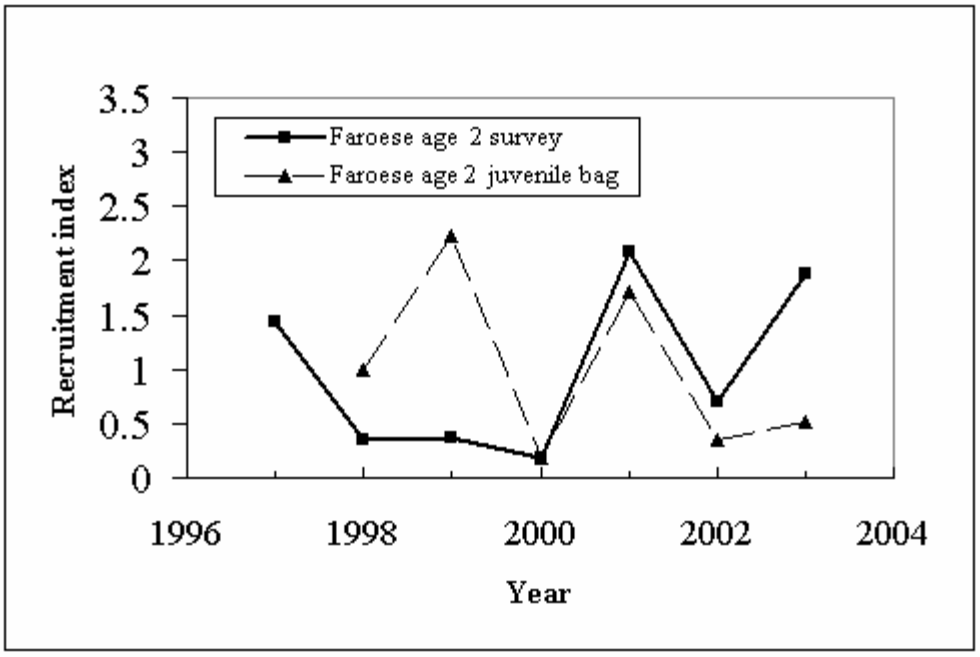

Figure. 4. Shrimp in Div. 3M: abundance indices at age 2 from the Faroese survey and from the juvenile bag. Each series was standardized to its mean.

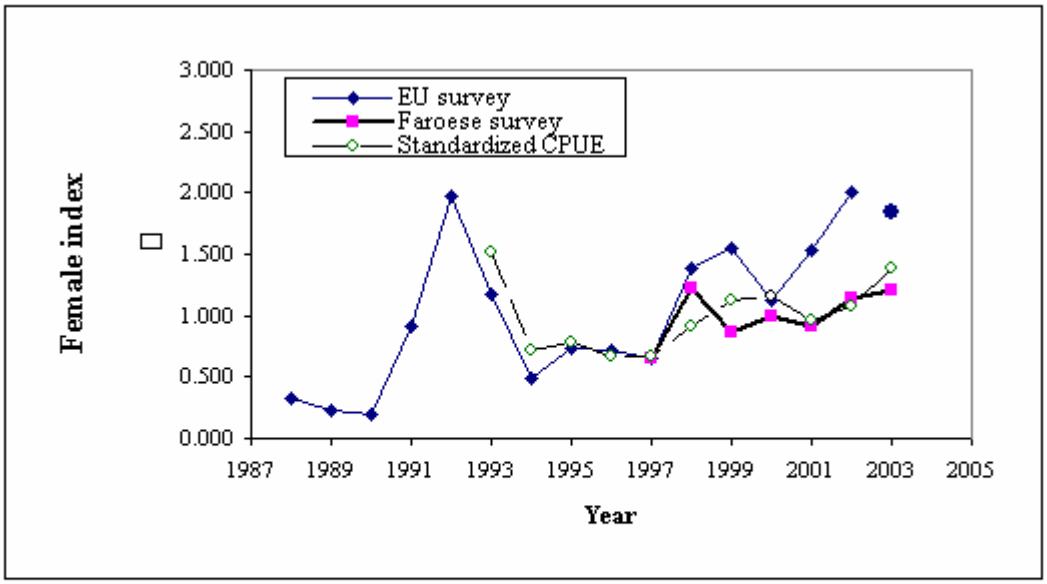

Figure. 5. Shrimp in Div. 3M: female biomass index from EU trawl surveys, 1988-2003, Faroese survey, 1997-2003 and standardized female CPUE, 1993-2003. Each series was standardized to the mean of that series.