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The Assessment of the International Fishery for Shrimp (*Pandalus borealis*) in Division 3M (Flemish Cap), 1993 - 2001

by

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Abstract

The development of the international fishery shrimp (*Pandalus borealis*) in NAFO Division 3M is described. A standard five-nation data set was used to create a series of standardized catch per unit effort (CPUE) indices with the purpose of tracking the status of the Div. 3M shrimp stock. Aging was carried out on length frequencies collected within observer databases. Number and kg per hour of each age class were then calculated. Recruitment indices from the Faroese survey and female indices from both the EU survey and the Faroese surveys are also used in the present evaluation of the shrimp stock on the Flemish Cap.

INTRODUCTION

The fishery for northern shrimp at Flemish Cap began in the spring of 1993 and has since continued with estimated annual catches (as estimated by STACFIS) of approximately 27 000, 25 000, 33 000, 48 000, 25 000, 30 000 and 43 000 tons from 1993 to 1999, respectively. The 2000 catch was about 50 000 tons, the highest in the series. Removals to October 2001 of about 41 000 tons are similar to those reported for the same period in 2000 (40 000 tons). Projections to the end of year 2001 are expected to reach 50 000 tons. Vessels from as many as 16 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 the fleets of several nations are described. Standardized catch per unit effort (CPUE) series, addressing differences in catch rate due to nation, fishing power of individual vessels, seasonality of the fishery, and gear type are used as possible indicators of change in the stock over time.

The spawning stock and recruitment indices are presented from two surveys. Virtual population analysis (Skuladottir *et al* 2001) was conducted on the catch-at-age data.

Background on the assessment and management of this resource since 1993 can be found in Parsons (1998), Skuladottir and Orr (2000) and NAFO Scientific Council Reports (2000).

MATERIAL AND METHODS

Commercial samples and aging

Shrimp were separated into 3 categories namely, males, primiparous females (including transitionals) and multiparous females according to the sternal spine criterion (McCrary. 1971), and oblique carapace lengths were

measured using sliding calipers 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). Modal analysis (MacDonald and Pitcher, 1979) was conducted on an individual month-by-month basis using each nation's catch, for weighting. This analysis provided the mean lengths and proportions at age and sex per month. The mean lengths were converted to mean weights using length weight relationships for the appropriate months to calculate the number caught (Skuladottir, 1997). An average length at age was calculated for the whole period, weighted by number caught each month and by nation. The mean lengths were then converted to weights using the length weight relationship for April-June. This was said to be the average weight for that particular year at age and sex.

Since the Canadian data (Parsons and Veitch 1996) were only available as annual results for the years 1993-1995, the following two equations were used for this period:

For males and primiparous females for April and all year around: $\ln y = 3.037 * \ln x - 7.549$

For multiparous females in April-June: $\ln y = 2.778 * \ln x - 6.689$

Analyses for 1996 - 2001 also made use of the following:

For multiparous females July: $\ln y = 2.921 * \ln x - 7.144$

For multiparous females August: $\ln y = 3.111 * \ln x - 7.689$

For multiparous females Sept-March: $\ln y = 2.929 * \ln x - 7.085$

Catch Per Unit Effort (CPUE) model

The General Linear Modeling Procedure (Proc GLM), within the SAS program, was used to model the natural log of CPUE against year, month, and vessel. Prior to 2001, the standard data set included data from Canada, Greenland, Iceland and Norway. Faroese data from 1995 to present was available and is now included as part of the standard dataset. Data were deleted if CATCH <= 0 kg and/or EFFORT <10 hours. Also, the number of tows associated with each catch-effort record was used as a weighting factor. No attempt was made to determine interaction effects. The model was standardized to 1993, June, single trawl and Icelandic data. Results were then scaled to the average CPUE during 1993.

RESULTS

COMMERCIAL FISHERY

Trends in Catch

Catch by nation and year

Preliminary estimates by the Scientific Council's Standing Committee on Fisheries Science (STACFIS) of catch (tons) by nation and year are shown in Table 1.

In 1993, Faroe Islands and Norway took 54% of the estimated total catch in tons. Canada and Greenland each caught approximately 3 700 tons, while Iceland caught about 2 200 tons. Lesser amounts were reported for other nations.

Faroese and Norwegian vessels accounted for over 60% of the estimated catch in 1994. Estonia, Latvia and Lithuania joined the fishery that year and, in combination, caught about 2 600 tons. Canadian vessels caught 1 040 tons, substantially less than in 1993. Greenlandic and Danish catches were also less than those of the previous year, whereas Icelandic catches remained about the same.

Data for 1995 showed some changes in the distribution of the catches by nation. Most noteworthy are the substantial increases in catches by Iceland and Russia, although catches by Faroe Islands and Norway were still very high.

The 1996 data showed substantial increases in catch for several nations. Icelandic catches increased from about 7 600 tons in 1995 to 20 700 tons in 1996. Catches by Faroe Islands increased from 6 000 tons to 8 700 tons and Russian catches from 3 300 to 4 400 tons. Latvia and Lithuania also increased their catches from 1995 to 1996, while catches by Canada, Greenland and Norway decreased.

Catches in 1997 of about 25 000 tons were much lower than in 1996. The reduction was, in part, due to the Icelandic quota of 6 800 tons (in effect, decreasing the catch by 14 000 tons), low CPUE and possibly a depressed market for northern shrimp, which affected all nations.

Catches in 1998 of about 30 000 tons were higher than in 1997. Most noteworthy was the increase in catches by Estonia from 3 200 tons in 1997 to about 5 700 tons in 1998. Faroe Islands took most of the catch both in 1997 and 1998.

Total catches increased in 1999 by 30% over 1998. The Estonian catch almost doubled to 10 800 tons. Iceland increased its quota and caught 9 300 tons.

Catches in 2000 increased to 50 200 tons; the highest annual catches recorded in the series. Most notable was the large increase of catch by Russia from 1 142 tons in 1999 to 7 000 tons in 2000. Iceland and the Faroe Islands were among the four nations with biggest catches. Estonia took 13 200 tons.

Catches to October 2001 were approximately 41 000 tons. The Faroese recorded 10 584 tons, the highest catches in 2001, followed by 8 425 tons taken by Estonia.

Double Trawl *versus* Single Trawl

During 1993 most vessels employed single trawls but gradually more vessels made use of double trawls until 2000 when very few vessels used single trawls. The increased usage of double trawls over time represented changes in catches from approximately 8% of the total catch in 1993 and 1994 to 82% in 1997, about 89% in 1998 and 1999 and to over 98% in year 2001. It is therefore not appropriate to model CPUE for any one gear.

Trends in Effort

The standard five-country data set was used to describe trends in fishing effort, with the assumption that data are representative of total fleet activities. The model tracks the unstandardized effort in all years with an apparent divergence as time goes on. Aside from a peak in 1996, the effort appears stable over time (Fig. 1). However, this stability is confounded by the fact that technology changed from single to double trawl over the time series.

Trends in Catch Rates

The main purpose for constructing the five-country catch and effort data set was for the calculation of catch per unit of effort (CPUE).

Standardized CPUE

Standardized catch rate series were developed in an attempt to account for effects such as seasonality, fishing power of vessels and/or nations and trawl type.

The model indicates that there was a general decline between 1993 and 1996 (Fig. 2). Then beginning in 1997, catch rates began to increase and stabilized at high levels similar to that in 1993.

Twelve outliers were deleted from the final run (IF -1.5<RESID.<1.5). The final model explained 48% of the variation and all class variables were significant at $P < 0.05$ (Table 2) using type III sum of squares. Results

indicated that the estimate for all years except 2000 and 2001 were significantly different ($P < 0.05$) from zero, the 1993 standard. A plot of residuals is given in 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 text table below (Nicolajsen and Brynjolfsson, 2001). 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 Fig. 4 and the text table below (Nicolajsen, 2001).

Survey/Year	1997	1998	1999	2000	2001
Faroese survey main trawl	855	210	214	108	1242
Faroese survey juvenile bag		2532	5683	456	4377

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 2001 commercial catch. Both indices showed that the 1998 year-class was weak in 2000 and that the 1998 year-class is still weak as three-year-olds in the 2001 fishery. During 2001, two-year-olds were abundance in both the main trawl and the juvenile bag.

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 (Diaz, 2001) and Faroese survey biomass indices (Nicolajsen, 2001). The raw data are provided in the text 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
EU survey biomass	1874	1340	1132	5362	11509	6839	2823	4286	4149	3807	8091	9051	6553	8977
Faroese survey biomass										6417	11783	8621	9487	8930
Standardized CPUE						249	138	141	114	65	171	200	205	189

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 which were females during 1992. The index showed a decrease from 1994 through to 1997 then an increase during 1998. The SSB remained high during all years except 2000. The female CPUE decreased from 1993 to 1997 then rose in 1998. The female biomass from the Faroese survey indices have shown much the same trend as the other two indices although showing the highest value in 1999.

AGE ASSESSMENTS

Age analyses were carried out on biological samples obtained from Canadian, Icelandic and Greenlandic vessels. Table 3 provides results of the age analyses (length- and weight-at-age and sex are listed). 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. It should be noted that there are difficulties in aging shrimp once they reach carapace lengths of 26 mm or more. For this reason, it is likely that 6- and 7-year-olds are badly defined.

Table 4 provides the maturity ogive based on the proportions given in Table 3. Shrimp usually change sex at ages over two years, thus for example 79% of the 1997 year-class changed sex in 2001 as 4-year-old shrimp. The rest of the 1997 year-class should change sex in year 2002. Most shrimp in Div. 3M were thought to have changed sex at the age of 5 during 1993 and 1994. During 1996, 21% of the shrimp changed sex as three year olds. Since then, the average age at sex change appears to have increased to four years of age.

Table 5 lists the number per hour harvested in the commercial fishery. In 1993, the 1987 year-class appeared as a very strong age 6+ cohort (approximately 12 000 animals/hr). The 1993 year-class was 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 expected (Skuladottir and Diaz, 2001). The 1996 year-class was considered mediocre during 1998, but appeared stronger during 1999-2001. The EU survey data are not in agreement with the commercial data as the 1995 year-class appears to be a very strong year-class. The 1997 cohort was the last strong year-class; with the highest abundance of 3 year olds since the time series began. The 1997 year-class continued to be strong in 2000. It is important to note that the 1998 year-class is by far the weakest in the series as a three year old.

The harvest given as kg/hour at age is presented in Table 6. This table indicates that the 4 and 5 year-old shrimp are the most important commercial size shrimp, in terms of total weight.

The catch in numbers at age from this paper were used in Virtual Population Analysis using XSA and ADAPT, Skuladottir *et al*. (2001) as was done the year before (Ratz and Skuladottir, 2000). The program did not converge this time, but the results are promising and provided some catch–age information. The 1993 and 1996 year-classes were the largest in the series followed by the 1997 year-class.

SUMMARY

Catches of shrimp on the Flemish Cap have been maintained at a high level averaging about 43 000 tons for the last four years including year 2001 due to a possible increase in biomass. The CPUE model indicated that there was a general decline between 1993 and 1996. Then beginning in 1997, catch rates began to increase and stabilized at high levels similar to that in 1993. The spawning stock biomass also decreased between 1993 and 1994. The survey SSB remained low during 1997 but increased in 1998 at which point there appeared to be stability.

The 1997 year-class was at least average or above average, judging by its occurrence in the fishery in 2001 as well as in the biomass estimates of the surveys. The 1998 year-class on the other hand is considered to be weak, confirming the results obtained during 2000. Recruitment of the 1999 year-class appears as promising as the 1997 year-class.

Although the standardization of CPUE has been improved by including double trawl effort, results are still difficult to interpret as an index of stock size due to the major changes in fishing pattern between years.

The age assessments in this paper were used in Virtual Population Analysis using XSA and ADAPT, Skuladottir *et al*. (2001) as was done the year before (Ratz and Skuladottir, 2000). The program did not converge this time but the results are promising.

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Table 1. Catch (tons) by nations as estimated by STACFIS.

Nation	1993	1994	1995	1996	1997	1998	1999	2000	2001*
Canada	3724	1041	970	906	807	484	490	540	296
Cuba							119	46	
EU/Denmark	800	400	200			437	235		
Estonia		1081	2092	1900	3240	5694	10835	13247	8425
Faroe Is.	7333	6791	5993	8688	7410	9368	9199	7719	10854
Greenland	3788	2275	2400	1107	105	853	576	1636	
Honduras	1265								
Iceland	2243	2300	7623	20681	6381	6572	9277	8912	4368
Latvia		300	350	1940	997	1191	3080	3105	2525
Lithuania		1225	675	2900	1785	3106	3370	3595	2163
Norway	7183	8461	9533	5683	1831	1339	2975	2669	7133
Poland					288	148	894		
Portugal	300		150		170	203	227	289	
Russia		350	3327	4445	1090		1142	7078	4880
EU/Spain	240	300	158	50	421	913	1019	1388	677
St. Vincent's		75			150				
Total	26876	24599	33471	48300	24675	30308	43438	50224	41321

* Provisional to October

Table 2 Multiplicative year, month, nation, vessel and gear CPUE model in Division 3M, 1993 - 2001, weighted by effort.

MULTIPLICATIVE MODEL, 1993 - 2001
The GLM Procedure
Class Level Information

Class	Levels	Values
YEAR	9	1994 1995 1996 1997 1998 1999 2000 2001 3000
MONTH	12	1 2 3 4 5 7 8 9 10 11 12 99
NATION	5	CAN FRO GRL NOR ZICE
GEAR	2	2 9

Number of observations 3059

Dependent Variable: LNCPUE

Weight: WFACTOR

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	24	9158.03387	381.58474	118.87	<.0001
Error	3034	9739.21198	3.21002		
Corrected Total	3058	18897.24585			

R-Square	Coeff Var	Root MSE	LNCPUE Mean
0.484623	31.62917	1.791654	5.664562

Source	DF	Type I SS	Mean Square	F Value	Pr > F
YEAR	8	5300.844495	662.605562	206.42	<.0001
MONTH	11	1488.416657	135.310605	42.15	<.0001
NATION	4	358.445075	89.611269	27.92	<.0001
GEAR	1	2010.327644	2010.327644	626.27	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YEAR	8	3031.035926	378.879491	118.03	<.0001
MONTH	11	1465.390462	133.217315	41.50	<.0001
NATION	4	375.832763	93.958191	29.27	<.0001
GEAR	1	2010.327644	2010.327644	626.27	<.0001

Parameter		Estimate		Standard Error	t Value	Pr > |t|
Intercept		5.890147432	B	0.02556578	230.39	<.0001
YEAR	1994	-0.382713417	B	0.02405653	-15.91	<.0001
YEAR	1995	-0.286584834	B	0.02307029	-12.42	<.0001
YEAR	1996	-0.489414365	B	0.02342468	-20.89	<.0001
YEAR	1997	-0.402284618	B	0.02864672	-14.04	<.0001
YEAR	1998	-0.073620440	B	0.02996442	-2.46	0.0141
YEAR	1999	-0.094724718	B	0.02926719	-3.24	0.0012
YEAR	2000	0.007442649	B	0.03277377	0.23	0.8204
YEAR	2001	-0.068291528	B	0.06581214	-1.04	0.2995
YEAR	3000	0.000000000	B	.	.	.

Table 3. Proportion of nominal catch by sex and age in the years 1993 to 2001. Also provided are carapace lengths and weight at age and sex. Standardized CPUE for the whole year of double and single trawl is used to calculate kg/hour at age. Numbers at age are calculated from nominal catch and proportion by weight for the months January to September.

					1993				
Sex	Age	Carapace length mm	Prop. by no.	Weight g	Prop. by weight	Nominal catch 26876 tons	kg/hr 344.4	No./hour	Number (´000´000)
Males	1	10.4	0.0041	0.646	0.0026	9	0.1	169	13.186
Males	2	16.8	0.1148	2.772	0.3182	1023	13.1	4731	369.204
Males	3	20.7	0.2146	5.225	1.1213	3606	46.2	8844	690.166
Males	4	24.0	0.1156	8.188	0.9465	3044	39.0	4764	371.777
Primip.	5	26.0	0.2619	10.441	2.7345	8794	112.7	10793	842.286
Multip.	6+	26.5	0.2890	11.189	3.2336	10400	133.3	11910	929.441
Total			1.0000		8.3568	26876	344.4	41212	3216.060
					1994				
Sex	Age	Carapace length mm	Prop. by no.	Weight g	Prop. by weight	Nominal catch 24599 tons	kg/hr 234.0	No./hour	Number (´000´000)
Males	2	16.4	0.1817	2.576	0.4681	1670	15.9	6166	648.149
Males	3	20.4	0.3629	4.998	1.8138	6470	61.5	12314	1294.515
Males	4	22.9	0.0854	7.101	0.6064	2163	20.6	2898	304.634
Primip.	5	25.7	0.1944	10.08	1.9596	6990	66.5	6597	693.452
Multip.	6+	26.9	0.1756	11.664	2.0482	7306	69.5	5959	626.390
Total			1.0000		6.8960	24599	234.0	33933	3567.140
					1995				
Sex	Age	Carapace length mm	Prop. by no.	Weight g	Prop. by weight	Nominal catch 33471 tons	kg/hr 259.0	No./hour	Number (´000´000)
Males	2	15.0	0.4516	1.965	0.8874	5989	47.0	23937	3047.819
Males	3	20.3	0.2714	4.924	1.3364	9019	70.8	14386	1831.661
Primip.	4	22.2	0.0507	6.462	0.3276	2211	17.4	2687	342.171
Primip.	5	25.3	0.0962	9.611	0.9246	6240	49.0	5099	649.247
Multip.	6+	26.2	0.1301	10.84	1.4103	9518	74.8	6896	878.036
Total			1.0000		4.8863	32977	259.0	53006	6748.934
					1996				
Sex	Age	Carapace length mm	Prop. by no.	Weight g	Prop. by weight	Nominal catch 48300 tons	kg/hr 211.0	No./hour	Number (´000´000)
Males	2	15.3	0.0622	2.066	0.1286	1011	4.4	2138	489.359
Males	3	20.0	0.6076	4.728	2.8728	22585	98.7	20868	4776.919
Primip.	3	21.4	0.0379	5.788	0.2192	1723	7.5	1301	297.749
Primip.	4	24.8	0.1511	9.034	1.3651	10732	46.9	5190	1187.950
Multip.	3	22.2	0.0063	6.799	0.0427	336	1.5	216	49.423
Multip.	4	24.8	0.0474	9.296	0.4411	3468	15.1	1630	373.028
Multip.	5	26.6	0.0574	11.306	0.6493	5105	22.3	1972	451.492
Multip.	6	28.8	0.0300	14.167	0.4249	3340	14.6	1030	235.767
Total			1.0000		6.1437	48300	211.0	34344	7861.686
					1997				
Sex	Age	Carapace length mm	Prop. by no.	Weight g	Prop. by weight	Nominal catch 24675	kg/hr 230.0	No./hour	Number (´000´000)
Males	1	10.4	0.0001	0.91	0.0002	1			0.855
Males	2	15.7	0.0522	3.201	0.1671	650	6.1	1893	203.060
Males	3	19.0	0.4092	4.117	1.6846	6552	61.1	14833	1591.329
Males	4	22.3	0.2089	6.633	1.3857	5389	50.2	7573	812.434
Primip.	3	20.6	0.0029	5.237	0.0150	58	0.5	104	11.127
Primip.	4	24.3	0.1724	8.39	1.4463	5625	52.4	6249	670.401
Multip.	3	19.1	0.0025	5.018	0.0124	48	0.4	90	9.608
Multip.	4	24.2	0.0488	9.57	0.4674	1818	16.9	1770	189.929
Multip.	5	25.6	0.0845	10.631	0.8982	3493	32.6	3063	328.586
Multip.	6	28.3	0.0171	14.35	0.2456	955	8.9	620	66.555
Multip.	7	29.3	0.0015	15.07	0.0223	87	0.8	54	5.761
Total			1.0000		6.3448	24675	230.0	36248	3889.644

Table 3. Continued

1998									
Sex	Age	Carapace length mm	Prop. by no.	Weight g	Prop. by weight	Nominal catch 30308	kg/hr 320.0	No./hour	Number (´000´000)
Males	2	14.9	0.0598	1.925	0.1150	587	6.2	3217	304.723
Males	3	18.7	0.3471	3.869	1.3430	6849	72.3	18690	1770.177
Males	4	21.2	0.2327	5.642	1.3128	6695	70.7	12529	1186.618
Primip.	4	23.2	0.1403	7.358	1.0323	5264	55.6	7554	715.461
Primip.	5	25.9	0.0219	10.284	0.2249	1147	12.1	1178	111.539
Multip.	3	18.6	0.0025	4.16	0.0102	52	0.6	132	12.541
Multip.	4	23.9	0.0644	8.359	0.5384	2746	29.0	3468	328.477
Multip.	5	25.7	0.1103	10.076	1.1115	5668	59.8	5940	562.547
Multip.	6	27.2	0.0204	11.968	0.2444	1246	13.2	1099	104.129
Multip.	7	30.0	0.0007	15.821	0.0106	54	0.6	36	3.406
Total			1.0000		5.9432	30308	320.0	53843	5099.618

1999									
Sex	Age	Carapace length mm	Prop. by no.	Weight g	Prop. by weight	Nominal catch 43438	kg/hr 313.0	No./hour	Number (´000´000)
Males	1	6.0	0.0001	0.122	0.0000	0	0.0	5	0.714
Males	2	14.5	0.0467	1.769	0.0827	591	4.3	2405	333.814
Males	3	17.6	0.2773	3.176	0.8807	6291	45.3	14272	1980.715
Males	4	21.0	0.2253	5.49	1.2368	8834	63.7	11595	1609.113
Males	5	22.3	0.0003	6.56	0.0019	13	0.1	15	2.035
Primip.	4	22.1	0.0758	6.348	0.4812	3437	24.8	3901	541.412
Primip.	5	24.2	0.1327	8.418	1.1168	7977	57.5	6828	947.601
Multip.	3	18.2	0.0009	3.97	0.0036	26	0.2	47	6.499
Multip.	4	22.0	0.0207	6.672	0.1382	987	7.1	1066	147.950
Multip.	5	24.2	0.1259	8.674	1.0924	7802	56.2	6482	899.527
Multip.	6	26.4	0.0932	11.06	1.0309	7363	53.1	4797	665.738
Multip.	7	29.6	0.0011	15.171	0.0164	117	0.8	56	7.714
Total			1.0000		6.0815	43438	313.0	51469	7142.833

2000									
Sex	Age	Carapace length mm	Prop. by no.	Weight g	Prop. by weight	Nominal catch 50224	kg/hr 347.0	No./hour	Number (´000´000)
Males	2	13.0	0.0217	1.257	0.0273	257	1.8	1413	204.442
Males	3	17.2	0.3461	3.003	1.0394	9776	67.5	22492	3255.409
Males	4	20.0	0.2314	4.707	1.0892	10244	70.8	15036	2176.259
Males	5	21.9	0.0039	6.2	0.0241	227	1.6	253	36.559
Primip.	4	21.0	0.0906	5.458	0.4946	4652	32.1	5888	852.281
Primip.	5	24.5	0.0985	8.728	0.8595	8083	55.8	6399	926.143
Primip.	6	25.8	0.0017	10.235	0.0174	164	1.1	111	16.024
Multip.	3	18.3	0.0023	4	0.0093	87	0.6	151	21.872
Multip.	4	22.0	0.0491	6.638	0.3262	3068	21.2	3193	462.119
Multip.	5	24.3	0.1124	8.815	0.9906	9317	64.4	7303	1056.957
Multip.	6	26.2	0.0404	10.875	0.4391	4129	28.5	2623	379.711
Multip.	7	27.7	0.0018	12.691	0.0234	220	1.5	120	17.346
Total			1.0000		5.3401	50224	347.0	64980	9405.120

2001									
Sex	Age	Carapace length mm	Prop. by no.	Weight g	Prop. by weight	Nominal catch 41300	kg/hr 321.0	No./hour	Number (´000´000)
Males	2	15.5	0.0429	2.166	0.0929	626	4.9	2247	289.126
Males	3	17.0	0.1084	2.889	0.3132	2110	16.4	5677	730.419
Males	4	20.6	0.4084	5.164	2.1090	14212	110.5	21390	2752.052
Primip.	4	21.6	0.0194	5.929	0.1153	777	6.0	1019	131.057
Primip.	5	23.9	0.2261	8.095	1.8304	12334	95.9	11843	1523.683
Multip.	4	21.1	0.0240	5.925	0.1424	959	7.5	1259	161.933
Multip.	5	23.8	0.1174	8.311	0.9755	6573	51.1	6147	790.903
Multip.	6	25.7	0.0522	10.275	0.5367	3617	28.1	2736	351.983
Multip.	7	27.7	0.0011	12.606	0.0136	91	0.7	56	7.256
Total			1.0000		6.1290	41300	321.0	52374	6738.413

Table 4. Shrimp. Maturity of females (transititionals, primiparous and multiparous) at age based on the period, January to September.

Age gr.	1993	1994	1995	1996	1997	1998	1999	2000	2001	Mean
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0.207	0.021	0	0	0	0	0.025
4	0	0	0.345	1	1	0.865	0.364	0.475	0.792	0.538
5	1	1	1	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1	1	1	1

Table 5. Number per hour at age based on nominal catch and weight at age for the period January to September extracted from Table 3.

Age gr.	1993	1994	1995	Age gr.	1996	1997	1998	1999	2000	2001
1	169			1				5		
2	4731	6166	23937	2	2138	1893	3217	2405	1413	2247
3	8844	12314	14386	3	22385	15026	18822	14319	22643	5677
4	4764	2898	2687	4	6819	15592	23551	16562	24117	23667
5	10793	6597	5099	5	1972	3063	7117	13324	13954	17990
6+	11910	5959	6896	6	1030	620	1099	4797	2623	2736
				7		54	36	56	120	56
Total	41212	33933	53006		34344	36248	53843	51469	64870	52374

Table 6. Shrimp. Standardized kg per hour (international data base) at age extracted from Table 3.

Age gr.	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	0.1						0.0	0.0	
2	13.1	15.9	47.0	4.4	6.1	6.2	4.3	1.8	4.9
3	46.2	61.5	70.8	107.7	62.1	72.9	45.5	68.1	16.4
4	39.0	20.6	17.4	62.0	119.6	155.3	95.5	124.1	124.0
5	112.7	66.5	49.0	22.3	32.6	72.0	113.8	121.8	147.0
6	133.3	69.5	74.8	14.6	8.9	13.2	53.1	28.5	28.1
7					0.8	0.6	0.8	1.5	0.7
Total	344.4	234.0	259.0	211.0	230.0	320.0	313.0	345.9	321.0

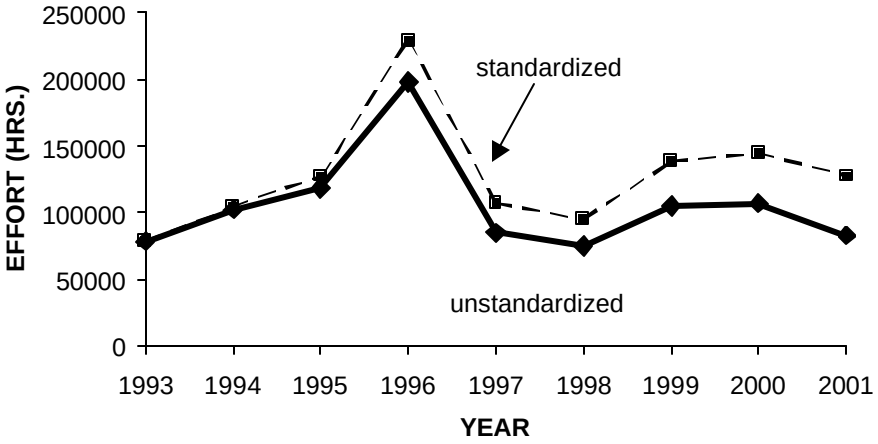

Fig. 1. Standardized and unstandardized effort during 1993-2001 using the five-country data set.

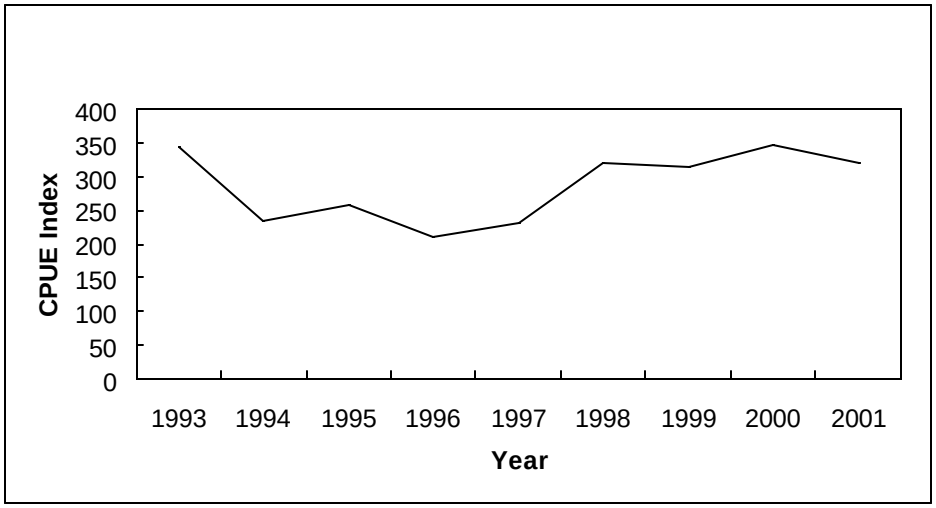

Fig. 2. Standardized catch rate series.

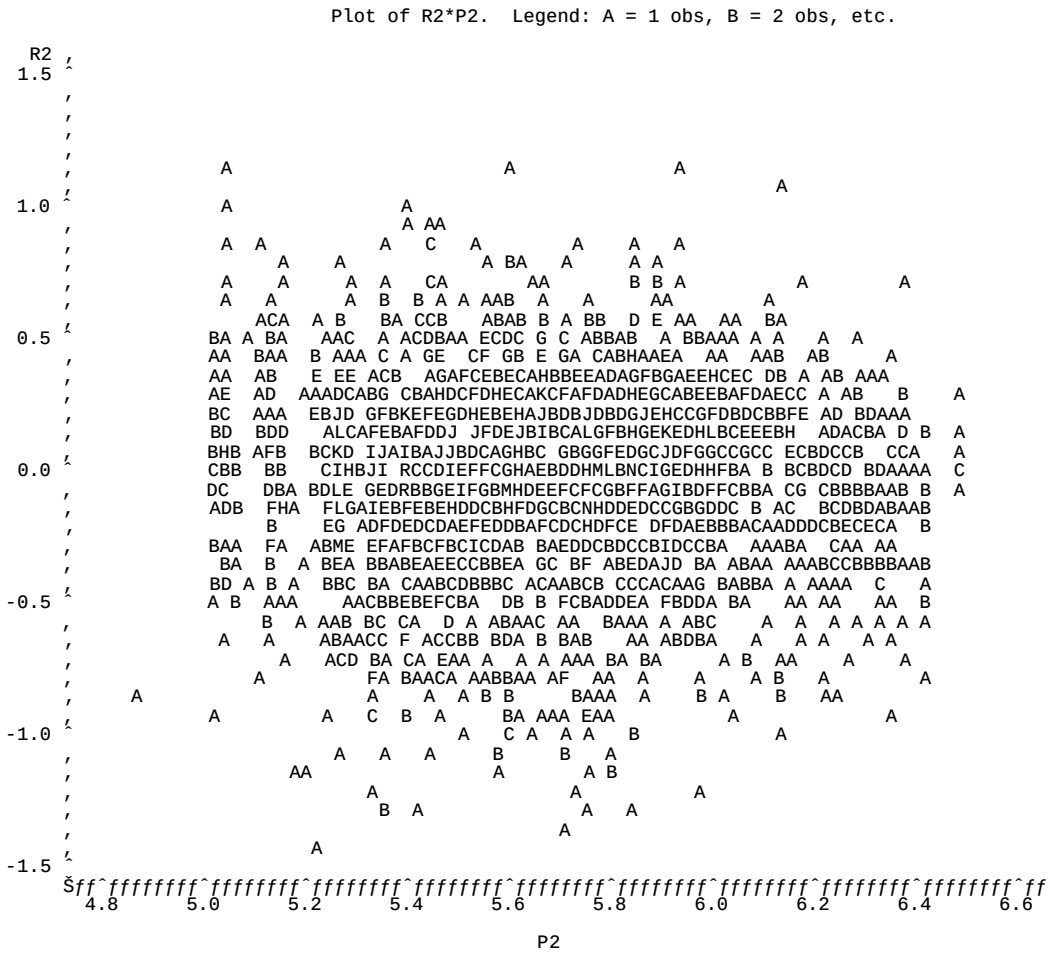

Fig. 3. A plot of residuals for the year, month, nation, vessel and gear CPUE model in Div. 3M, 1993-2001, weighted by effort.

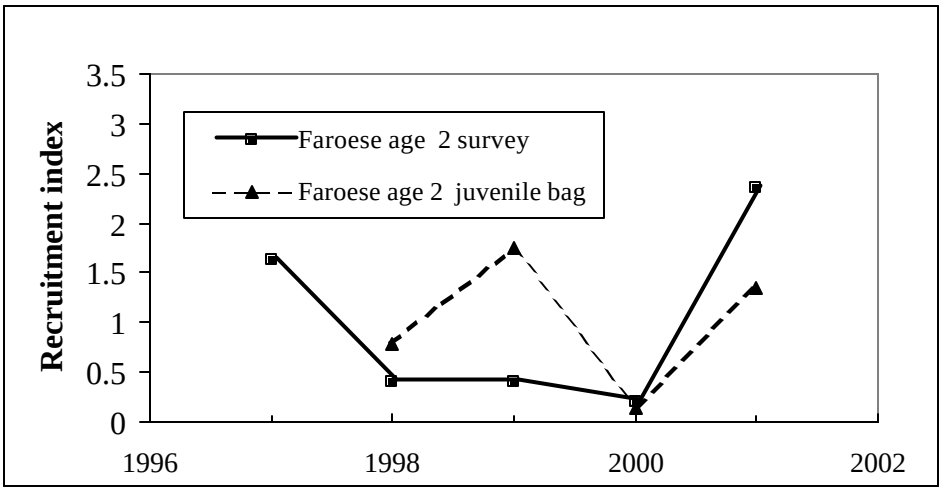

Fig. 4. Abundance of 2 years olds from the Faroese survey and number of 2 year olds from the juvenile bag. Each series was standardized to the mean of that series.

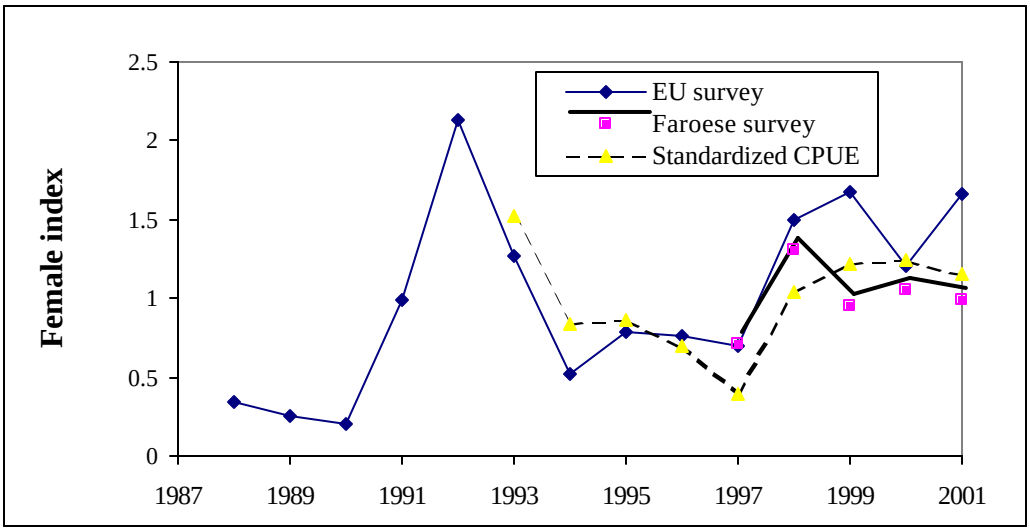

Fig. 5. Female biomass index from EU trawl surveys, 1988-2001, Faroese survey 1997-2001 and female CPUE from commercial samples and standardized CPUE 1993-2001. Each series was standardized to the mean of that series.