REPORT OF THE STUDY GROUP ON LIFE HISTORIES AND ASSESSMENT OFPANDALUS STOCKS IN THE NORTH ATLANTIC

International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer

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1. TERMS OF REFERENCE

The Study Group on Life Histories and Assessment Methods of *Pandalus* Stocks in the North Atlantic, has by correspondence worked according to the ICES Council Resolution 1994 2:45 in order to report to the 1995 Annual Science Conference, to:
a) assess the status of stocks of *Pandalus* borealis in the North Sea, Skagerrak and Kattegat;
b) determine the predation mortality of *Pandalus* stocks;
c) report to ACFM for its meeting in October/November 1995.

2. MEMBERS OF THE STUDY GROUP

M. Aschan	Norway
N. Bailey	UK Scotland
B. Bergström	Sweden
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3. INTRODUCTION

In 1994 the North Sea *Pandalus* stocks were treated during the meeting of the joint Working group on *Nephrops* and *Pandalus* stocks in Lisbon , 1-9 March (Anon 1994). The WG recommended that in preparation for the next meeting a useful exercise would be to go through the ageing of shrimps in order to have a uniform method applied for the whole period. A subgroup (S. Munch-Petersen, B. Sjöstrand and S. Tveite) met for the purpose in January 1995 at Flødevigen Norway.
During the annual science conference in 1994 it was decided that *Pandalus* stocks should be treated by the Study Group by correspondence.
The Danish, Swedish and Norwegian input for stock assessment for IIIa/IVa E and landings and effort figures from UK. (England and Scotland) are the only information received.
The study group was not able to bring forward any information on predation mortality.

4. PANDALUS STOCKS IN SUB-AREA IV AND DIVISION IIIA

A detailed overview of the various stocks is given in Anon. (1990). The working Group grouped them into three assessments units:

1. Skagerrak and Norwegian Deeps combined
2. Fladen Ground
3. Farn Deeps

Nominal landings for Division IIIa and Sub-area IV are shown in Table 4.1

4.1 SKAGERRAK AND THE NORWEGIAN DEEPS

4.1.1 Natural mortality

The level of natural mortality for *Pandalus* have been discussed at several occasions. The value used in earlier assessments i.e. 0,75 for Div.IIIa, IVaE is not well founded.
Work is initiated to elucidate predation mortality, however, no changes were made in the values of natural mortality used in this years assessments.

4.1.2 Landings

Landings from the Skagerrak (Division IIIa) and Sub-area IV are shown separately in Table 4.1 Table 4.1.1 gives the landings since 1970 and discards since 1985 from the Skagerrak and Norwegian Deeps combined. For Denmark the splitting between Fladen and Norwegian Deeps are arrived at using the log book recordings. The landings have remained above 10 000 tonnes, since 1985. The total landings in 1994 amounted to 11650 tonnes, a small decrease since 1993. Norwegian landings are restricted by weekly quotas according to market situation.

4.1.3 Discards

The discards in the Norwegian and Swedish fisheries were estimated by the methods described in the 1993 report (Anon 1993) to 426 tonnes in 1994.

4.1.4 Effort

Annual figures for landings per unit of effort (LPUE) and effort are given in Table 4.1.2 Total effort values have been estimated from LPUE data based on log-book records. The proportion of landings included in logbook data varied from high (ca 95%) for Denmark and Sweden to low (ca 30%) for the Norwegian landings in 1994.
Both fishing effort and catch decreased in the Danish and Norwegian fisheries, whereas the Swedish catch increased by 18% in spite of 12% effort reduction.

4.1.5 Assessment

4.1.5.1 Age distributions

Numbers at age have been estimated by splitting length frequency distributions into normal distributions, using different method for collating the quarterly length frequencies and different software analysing the data.) It was felt that the assessment could be improved by reanalysing the data in an uniform way. The Pandalus working group in 1989 (Anon 1989) recomended that individual samples should be analysed before pooling. At the meeting in Flødevigen different solutions were discussed. It was decided to pool the length frequencies obtained from Danish, Norwegian and Swedish samples to one quarterly length frequency, because in many cases adding "impossible" length frequencies resulted in analysable ones.. The Bhattacharya method as implemented in ELEFAN (Pauly 1987) was believed to be the best program to determine number of components and MIX (MacDonald and Pitcher 1979) to calculate proportions. However, MIX would not accept some of the small proportions and the mean lengths at age given in Figure. 4.1.1. show more consistent growth curves than when the MIX results are plotted the same way. The ELEFAN results have therefore been used for all years.

The new analysis resulted in a decreasing trend for the proportion of 1-group and increasing trend for 2-4 group in relation to the distribution used in last years report. (Figure 4.1.2)

4.1.5.2 Mean weight and maturity at age

Weight at age have been obtained by applying quarterly length-weight relationships to the mean lengths at age. For the Danish and Swedish data it were formerly used summing of mean weight per length group for the length frequencies of each yearclass. This change in procedure led to some changes both positive and negative in SOP (Table 4.1.3). The mean weight at age in the stock were assumed to be equal to the mean weight in the catch.
The 0- and 1-group are assumed to be immature, and the 3-group and older groups fully mature. The mature part of the 2-group or potential spawners is taken as the sum of intersexes and females in the first quarter of the year. This proportions has been:

1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
0.62	0.09	0.20	0.30	0.68	0.73	0.73	0.68	0.70	0.64

4.1.5.3 Natural mortality

M has been set at 0.75 for all ages. The proportion of the annual M occurring before spawning is taken to be 0.25 on all ages in all years and proportion of F before spawning was set at 0.2.

4.1.5.4 VPA

Comparison new vs. old dataset:
Extended Survivor Analysis (XSA) was run for the new set of age distributions and weight at age, with exact same settings as in the 1994 report (Anon 1994). The tuning converged after 26 iterations, versus 90 for the old dataset. The majority of standard errors figures decreased and R-squares increased. In summary the fishing mortalities and spawning stock biomass levelled off. The F's became higher during the first years and lower during the last. (Fig. 4.1.3). The SSB showed the opposite development.

Standard error of the weighted Log(VPA populations):

	age	1	2	3	4	5
old	85-93	.25	.30	.36	.50	.80
new	85-93	.23	.26	.30	.44	.60
1985 - 1994		.24	.26	.28	.41	.69

1985-1994:
XSA was also used for the 1985-1994 dataset to estimate stock sizes and exploitation levels from data on catches, effort and catch per unit of effort data (three fleets) and the results from the yearly shrimp surveys. Table 4.1.4 gives the tuning input file with catch at age and efforts for the four "fleets" used.
In most instances default values were used for the various input variables in the XSA (Table 4.1.5). Age groups 0 and 1 were assumed to have catchabilities changing with stock size. Catchabilities were assumed independent of age for shrimps of age 2 and older.
The standard errors (logarithmic) surrounding the estimates of population abundance at 1 Jan. 1995 varied from .24 for the 1-group to .69 for the oldest shrimps (see table above).
Fishing mortalities, expressed as unweighted mean over age-groups 1-3, (see Table 4.1.6) seem to have decreased from 1992. This decrease is mainly due to a major drop in the value for the 3-group, which for the last 4 years has appeared as very high. Stock size in terms of number at age are given in Table 4.1.7. Both with and without sum of products corrections spawning stock increased from 1993 to 1994 due to the rich 1992 yearclass, whereas the total stock biomass decreased.

4.1.5.5 Recruitment

The abundance indices of young shrimps obtained by the Norwegian survey in October are given in Table 4.1.9. A description of the survey methods was given in Anon. (1991).
The 1992 index is a record high mainly because the catches in western Skagerrak were 6 times higher than obtained before, but also because the yearclass ranked very high in other areas. The 1993 year-class was estimated by the survey in 1993 and as 1-group in 1994 as about average size. The 1994 yearclass was below average in the 1994 survey.

4.1.5.6. Catch prediction

Comparison new vs. old dataset:
The new data for the 1985-1993 period gave 30% higher status quo prediction for landings in 1994 than the old dataset. The stock biomass predictions increased by 10-14% for 1994-1996.
1985-1994:
Input data for the prediction are shown in Table 4.1.10. The fishing pattern used is the 1992-1994 average scaled to the 1994 level (mean of ages 1-3). Mean weights are averages for the period 1985-94, and recruitment in 1995 and 1996 is the average for the period 1985-1993.
The average proportions of 0 - and 1-group catches that have been landed are 71 % and 85% respectively. These proportions were applied on the predicted catches in 1995 and 1996.
The status quo landings for 1995 was predicted to 14 630 tonnes. whereas the agreed TAC is 16 000 tonnes. Predicted status quo catches in 1996 and 1997 are 10 016 and 11 611 respectively (Table 4.1.11).

4.1.5.7 Management consideration

The landing figures for 1995 so far do not indicate that TAC will be reached. The 1993 and 1994 yearclasses are both below average, it would therefore be necessary to increase the effort in order to maintain the catch level for the next years. At least for Norway the market situation has been the effort governing factor and the capacity of fleet have not been utilised during the last years.

The high discard figures indicate that the selection properties of the trawl are not very good. The development of sorting grids and other means of facilitating the escape of small shrimps should be encouraged.

4.1.5.8 Assessment quality

The ageing of shrimps has been revised in this years assessment, resulting in slight improvements in performance of the XSA. The SOP factor could possibly be improved by utilising the Swedish and Danish measured weight per mm group, this year only length - weight relationships have been used.

4.2 FLADEN GROUND

Table 4.2.1 shows the landings from the Fladen Ground since 1972. In spite of relatively good CPUE (Table 4.2.2) the landings were low during 1994, only 16% of the maximum catch in 1983. No data for assessment purpose were available.

4.3 FARN DEEPS

In recent years *Pandalus* in the Farn Deeps have been fished by UK vessels only. Total landings fell from 500 tonnes in 1988 to none in 1993. In 1994 there was a small fishery of 4 tonnes.

5. REFERENCES

Anon (1989) Report on the Working group on the assessment of Pandalus Stocks ICES doc.C.M. 1989/Assess:9

Anon. (1990) Report on the Working group on the assessment of Pandalus Stocks ICES doc.C.M.1990/Assess:9

Anon. (1991) Report on the Working group on the assessment of Pandalus Stocks ICES doc.C.M.1991/Assess:8

Anon. (1993) Report on the Working group on the assessment of Nephrops and Pandalus Stocks ICES doc.C.M.1993/Assess:11

Anon. (1994) Report on the Working group on the assessment of Nephrops Pandalus Stocks ICES doc.C.M.1994/Assess:12

MacDonald,P.D.M. 1979. Age groups from size-frequency data: a versatile and efficient method of analysing distribution mixtures. J.Fish.Res. Board Can. 36:987-1001.

Pauly, D. 1987. A review of the ELEFAN system for analysis of length-frequency data in fish and aquatic invertebrates. ICLARM Conf. Proc. 13: 7-34.

Table 4.1 Nominal landings (tonnes) of *Pandalus borealis* in ICES Division IIIa and subarea IV as officially reported to ICES.

	Division IIIa				Sub-area IV					
Year	Denmark	Norway	Sweden †	Total	Denmark	Norway	Sweden	UK (Engl.)*	UK (Scotl.)*	Total
1970	757	982	2740	4479	3460	1107		14	100	4681
1971	834	1392	2906	5132	3572	1265			438	5275
1972	773	1123	2524	4420	2448	1216		692	187	4543
1973	716	1415	2130	4261	196	931		1021	163	2311
1974	475	1186	2003	3664	337	767		50	432	1586
1975	743	1463	1740	3946	1392	604	261		525	2782
1976	865	2541	2212	5618	1861	1051	136	186	2006	5240
1977	763	2167	1895	4825	782	960	124	265	1723	3854
1978	757	1841	1529	4127	1592	692	78	98	2044	4504
1979	973	2489	1752	5214	962	594	34	238	309	2137
1980	1679	3498	2121	7298	1273	1140	38	203	406	3060
1981	2593	3753	2210	8556	719	1435	31	1	341	2527
1982	2920	3877	1421	8218	1069	1545	92		354	3060
1983	1571	3722	988	6281	5752	1657	112	65	1836	9422
1984	1717	3509	933	6159	4638	1274	120	277	25	6334
1985	4105	4772	1474	10351	4582	1785	128	415	1347	8257
1986	4686	4811	1357	10854	3896	1681	157	458	358	6550
1987	4140	5198	1085	10423	9223	3145	252	526	774	13920
1988	2278	3047	1075	6400	2647	4614	220	489	109	8098
1989	2527	3156	1304	6987	3298	3418	122	353	590	7802
1990	2277	3006	1471	6754	2079	3146	137	304	365	6031
1991	3256	3441	1747	8444	750	2715	161	64	54	3744
1992	3296	4250	2057	9603	1881	2891	147	69	116	5104
1993	2490	4081	2133	8704	1985	3421	167	29	516	6118
1994	1987	4389	2526	8902	1337	2425	194	37	35	4028

* Includes small amounts of other Pandalid shrimp
† 1970 to 1974 includes subarea IV.
Total 1988 and 1989 includes 19 and 21 t. by the Netherlands
1994 figures are preliminary.

Table 4.1.1 *Pandalus borealis* landings from divisions IIIa (Skagerrak) and IVa . (eastern part, Norwegian Deeps) as estimated by the Working Group

Year	Denmark	Norway	Sweden	Total landings	Estimated discards
1970	1102	1729	2742	5573	
1971	1190	2486	2906	6582	
1972	1017	2477	2524	6018	
1973	755	2333	2130	5218	
1974	530	1809	2003	4342	
1975	817	2339	2003	5159	
1976	1204	3348	2529	7081	
1977	1120	3004	2019	6143	
1978	1459	2440	1609	5508	
1979	1062	3040	1787	5889	
1980	1678	4562	2159	8399	
1981	2593	5183	2241	10017	
1982	3766	5042	1450	10258	
1983	1567	5361	1136	8064	
1984	1747	4783	1022	7552	
1985	3827	6646	1571	12044	584
1986	4834	6490	1463	12787	477
1987	4599	8343	1321	14263	808
1988	3068	7661	1278	12007	830
1989	3150	6411	1433	10994	1548
1990	2479	6139	1540	10158	1723
1991	3583	6106	1908	11597	765
1992	3725	7136	2154	13015	713
1993	2915	7504	2300	12719	1188
1994	2118	6813	2719	11650	426

Table 4.1.2 National CPUE and effort as estimated by the Study Group , Pandalus borealis. Div. IIIa - IVa E

Year	Denmark CPUE kg/day	effort days	Norway CPUE kg/hr	effort Khrs	Sweden CPUE kg/hr	effort Khrs	combined effort index rel. to 1986
1984	452	3869	no data		25	40	0,00
1985	719	5326	no data		32	49	0,00
1986	556	8700	36	179	30	49	1,00
1987	499	9212	36	230	23	57	1,20
1988	432	7104	31	251	22	57	1,22
1989	421	7477	23	273	23	63	1,30
1990	585	4236	26	232	26	58	1,08
1991	653	5487	30	206	31	61	1,01
1992	634	5875	35	204	27	80	1,09
1993	571	5015	32	237	25	91	1,25
1994	677	3120	31	218	33	82	1,16

Table 4.1.3 Virtual Population Analysis. Catch number at age. Pandalus in Div. IIIa and IVa east

Run title : Pandalus IIIa + IVb Assessment
1995 WG
At 15/09/1995 18:39

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
AGE										
0	36461	14935	11110	55226	109572	46434	13460	108487	42707	15713
1	1027292	975704	1252658	613709	1557376	1333574	816547	436766	1227845	581274
2	1260871	1045879	1173137	971146	681884	1094654	1108258	1477651	872517	1242004
3	191514	508662	474785	429783	338637	158695	295515	579407	440173	288130
4	47929	22332	75088	164479	43328	38431	30660	19039	13896	17674
+gp	0	1444	712	4104	816	319	0	0	591	0
TOTALNUM	2564067	2568956	2987490	2238447	2731613	2672107	2264440	2621350	2597729	2144795
TONSLAND	12628	13234	15072	12857	12542	11852	12323	13728	13907	12076
SOPCOF %	92	100	100	105	91	90	102	92	99	106
SOP 1994	98	96	101	104	91	99	104	99	101	

Table 4.1.4 Virtual Population Analysis. Tuning input file. Pandalus in Div. IIIa and IVa east

Denmark	85	94			
1	1	0	1		
1	5				
5326	276485583	339351114	51544154	12899660	0
8700	326611687	350102566	170271875	7475389	483300
9212	340689967	319062162	129128971	20421873	193607
7105	142836988	226028144	100029250	38281428	955148
7477	410334845	179661620	89223659	11416082	214880
4236	271383830	222763369	32294578	7820680	65011
5487	195430088	265247147	70727586	7338002	0
5875	120202880	406666023	159459280	5239699	0
5015	263225692	187050350	94364469	2978960	126699
3120	97470046	208263515	48314692	2963602	0
Norway	86	94			
1	1	0	1		
1	5				
179	463152872	496464196	241454641	10600502	685345
230	670513635	627947843	254139376	40192390	381040
251	390658044	618185205	273579216	104699406	2612321
273	1003745988	439481640	218255629	27925599	525632
232	820255904	673300868	97610156	23637954	196496
206	356160180	483397786	128896988	13373090	0
204	244702376	827868200	324618385	10666689	0
237	745684975	529889898	267322564	8439016	358922
218	327720895	700238771	162447181	9964439	0
Sweden	85	94			
1	1	0	1		
1	5				
49	120833122	148307388	22526459	5637568	0
49.2	104423689	111934149	54439011	2390018	154520
57.1	105315499	98629822	39916884	6312894	59849
56.9	65074167	102974680	45571670	17440385	435149
62.8	219731053	96207372	47778561	6113221	115067
58.3	205786106	168917972	24488472	5930299	49297
61	120557947	163627064	43630807	4526706	0
80.3	78094762	264207367	103599303	3404187	0
90.8	229436995	163039822	82251471	2596569	110435
81.8	130529143	278900638	64701676	3968773	0
Norwegian Surveys		85	94		
1	1 0.833	0.917			
0	4				
100	2221	32650	13028	5785	1687
100	1476	10485	7047	2873	398
100	766	24061	11015	7525	912
100	2332	3878	4500	2584	0
100	9830	19714	5518	534	0
100	4594	17692	9639	1202	164
100	2015	23950	9222	2747	450
100	20517	17628	11123	4882	277
100	5030	30574	9492	1979	0
100	2425	16899	11260	4096	423

Table 4.1.6 Virtual Population Analysis. Fishing mortality at age. Pandalus in Div. IIIa and IVa east

Run title : Pandalus IIIa + IVb Assessment 1995 WG

At 16/09/1995 16:47

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	FBAR 92-94
AGE											
0	.0028	.0012	.0015	.0046	.0079	.0035	.0015	.0070	.0042	.0017	.0043
1	.1346	.1704	.2498	.1983	.3255	.2274	.1378	.1126	.1843	.1278	.1416
2	.5385	.3717	.6404	.6268	.7252	.8499	.5966	.8346	.7009	.5682	.7012
3	.9946	.9398	.5668	1.1905	1.0312	.7439	1.4504	2.3332	1.7277	1.2379	1.7662
4	.4829	.5456	.6681	.8193	.6703	.5683	.6008	.5893	.6400	.4999	.5764
+gp	.4829	.5456	.6681	.8193	.6703	.5683	.6008	.5893	.6400	.4999	
FBAR 1-3	.5559	.4940	.4857	.6718	.6940	.6071	.7283	1.0934	.8710	.6446	

Table 4.1.5 Virtual Population Analysis. XSA tuning output. Pandalus in Div. IIIa and IVa east.

Lowestoft VPA Version 3.1

16/09/1995 16:45

Extended Survivors Analysis

Pandalus IIIa + IVb Assessment 1995 WG

CPUE data from file C:\vpa\vpaiiia\nyiiiaef.dat

Catch data for 10 years. 1985 to 1994. Ages 0 to 5.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
Denmark	1985	1994	1	4	.000	1.000
Norway	1986	1994	1	4	.000	1.000
Sweden	1985	1994	1	4	.000	1.000
Norw. Surveys	1985	1994	0	4	.833	.917

Time series weights :

Tapered time weighting applied
Power = 3 over 20 years

Catchability analysis :
Catchability dependent on stock size for ages < 2
Regression type = C
Minimum of 5 points used for regression
Survivor estimates shrunk to the population mean for ages < 2
Catchability independent of age for ages >= 2

Terminal population estimation :
Survivor estimates shrunk towards the mean F
of the final 5 years or the 4 oldest ages.
S.E. of the mean to which the estimates are shrunk = .500
Minimum standard error for population
estimates derived from each fleet = .300
Prior weighting not applied

Tuning converged after 29 iterations

Regression weights

.751 .820 .877 .921 .954 .976 .990 .997 1.000 1.000

Fishing mortalities

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
0	0,00	0,00	0,00	0,01	0,01	0,00	0,00	0,01	0,00	0,00
1	0,14	0,17	0,25	0,20	0,33	0,23	0,14	0,11	0,18	0,13
2	0,54	0,37	0,64	0,63	0,73	0,85	0,60	0,84	0,70	0,57
3	1,00	0,94	0,57	1,19	1,03	0,74	1,45	2,33	1,73	1,24
4	0,48	0,55	0,67	0,82	0,67	0,57	0,60	0,59	0,64	0,50

XSA population numbers (Thousands)

YEAR \ AGE	0	1	2	3	4
1985	1.92E+07	1.19E+07	4.41E+06	4.42E+05	1.82E+05
1986	1.75E+07	9.06E+06	4.90E+06	1.21E+06	7.73E+04
1987	1.05E+07	8.25E+06	3.61E+06	1.60E+06	2.24E+05
1988	1.73E+07	4.97E+06	3.03E+06	8.99E+05	4.28E+05
1989	2.04E+07	8.15E+06	1.92E+06	7.66E+05	1.29E+05
1990	1.96E+07	9.54E+06	2.78E+06	4.40E+05	1.29E+05
1991	1.27E+07	9.23E+06	3.59E+06	5.62E+05	9.88E+04
1992	2.26E+07	5.97E+06	3.80E+06	9.34E+05	6.22E+04
1993	1.50E+07	1.06E+07	2.52E+06	7.79E+05	4.28E+04
1994	1.36E+07	7.05E+06	4.17E+06	5.90E+05	6.54E+04

Estimated population abundance at 1st Jan 1995

0.00E+00 6.43E+06 2.93E+06 1.12E+06 8.09E+04

Taper weighted geometric mean of the VPA populations:

1.64E+07 8.16E+06 3.32E+06 7.55E+05 1.12E+05

Standard error of the weighted Log(VPA populations) :

.2420 .2620 .2833 .4107 .6933

Table 4.1.5 Continued

Log catchability residuals.
Fleet : Denmark

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	-0,15	-0,11	0,00	0,03	0,33	0,25	-0,18	-0,17	-0,02	-0,01
2	0,03	-0,60	-0,34	-0,25	-0,04	0,42	-0,02	0,38	0,12	0,15
3	0,62	0,29	-0,46	0,35	0,29	0,29	0,82	1,33	0,96	0,89
4	-0,07	-0,23	-0,30	0,00	-0,12	0,03	-0,01	0,04	0,03	0,02

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	2	3	4
Mean Log q	-3.6930	-3.6930	-3.6930
S.E(Log q)	.3123	.7745	.1305

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1	.75	1.019	7.71	.69	10	.19	-4.95

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	1.40	-.723	-.83	.31	10	.45	-3.69
3	1.93	-1.163	-6.52	.18	10	.94	-3.13
4	1.06	-.904	3.29	.97	10	.13	-3.75

Fleet : Norway

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	-0,03	0,19	0,18	0,41	0,19	-0,38	-0,24	-0,03	-0,22
2	-0,48	-0,08	-0,01	0,05	0,32	-0,24	0,34	0,1	-0,09
3	0,42	-0,2	0,59	0,39	0,19	0,6	1,29	0,95	0,65
4	-0,1	-0,04	0,24	-0,02	-0,06	-0,24	0,01	0,02	-0,21

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	2	3	4
Mean Log q	.4168	.4168	.4168
S.E(Log q)	.2544	.7300	.1501

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1	.79	.505	3.95	.48	9	.28	-.83

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	1.78	-1.420	-12.44	.34	9	.43	.42
3	1.24	-.458	-4.42	.36	9	.56	.97
4	.90	1.607	.78	.98	9	.12	.37

Fleet : Sweden

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	-0,23	-0,06	-0,05	0,06	0,48	0,3	-0,15	-0,27	-0,08	-0,05
2	-0,08	-0,54	-0,4	-0,18	0,14	0,46	0,03	0,27	0,02	0,11
3	0,51	0,36	-0,52	0,43	0,48	0,33	0,87	1,22	0,87	0,85
4	-0,18	-0,16	-0,36	0,07	0,07	0,07	0,04	-0,06	-0,06	-0,01

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	2	3	4
Mean Log q	.2773	.2773	.2773
S.E(Log q)	.2949	.7559	.1487

Regression statistics :
Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1	.78	.651	4.24	.55	10	.25	-.98

Table 4.1.5 Continued

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	1.81	-1.290	-12.74	.26	10	.52	.28
3	1.95	-1.269	-14.48	.20	10	.88	.84
4	1.01	-.081	-.30	.96	10	.15	.22

Fleet : Norwegian Surveys

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
0	-0,30	-0,34	-0,05	-0,18	0,14	-0,08	0,09	0,27	0,22	0,07
1	-0,05	-0,39	0,20	-0,33	0,14	-0,12	0,03	0,29	0,05	0,10
2	0,02	-0,85	0,14	-0,60	0,15	0,45	-0,07	0,26	0,40	-0,05
3	1,90	0,14	0,51	0,56	-1,00	0,12	1,32	2,15	0,90	1,48
4	1,11	0,58	0,45			-0,80	0,50	0,47		0,76

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	2	3	4
Mean Log q	-9.3173	-9.3173	-9.3173
S.E(Log q)	.4100	1.2787	.7514

Regression statistics :
Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
0	.33	2.136	15.24	.58	10	.22	-12.43
1	.56	1.439	12.59	.59	10	.23	-9.94

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	3.17	-1.449	-3.05	.06	10	1.22	-9.32
3	1.80	-.529	4.48	.06	10	1.79	-8.51
4	1.15	-.228	8.51	.35	7	.76	-8.90

Terminal year survivor and F summaries :

Age 0 Catchability dependent on age and year class strength

Year class = 1994

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Denmark	1.	.000	.000	.00	0	.000	.000
Norway	1.	.000	.000	.00	0	.000	.000
Sweden	1.	.000	.000	.00	0	.000	.000
Norwegian Surveys	6926155.	.300	.000	.00	1	.374	.000
P shrinkage mean	8157589.	.26					.001
F shrinkage mean	2190113.	.50					.005

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
6426498.	.18	.31	3	1.688	.002

Age 1 Catchability dependent on age and year class strength

Year class = 1993

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Denmark	2893238.	.300	.000	.00	1	.151	.129
Norway	2342649.	.308	.000	.00	1	.143	.157
Sweden	2790752.	.300	.000	.00	1	.151	.134
Norwegian Surveys	3444916.	.212	.058	.27	2	.301	.110
P shrinkage mean	3317297.	.28					.114
F shrinkage mean	1765468.	.50					.204

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
2930165.	.12	.08	7	.648	.128

Table 4.1.5 continued

Age 2 Catchability constant w.r.t. time and dependent on age

Year class = 1992

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Denmark	1191082.	.223	.081	.36	2	.208	.540
Norway	1048380.	.214	.031	.14	2	.227	.596
Sweden	1138533.	.217	.094	.44	2	.220	.559
Norwegian Surveys	1249572.	.191	.092	.48	3	.267	.521
F shrinkage mean	725524.	.50					.778

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1115741.	.10	.06	10	.547	.568

Age 3 Catchability constant w.r.t. time and age (fixed at the value for age) 2

Year class = 1991

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Denmark	89046.	.222	.242	1.09	3	.182	1.171
Norway	85800.	.221	.207	.94	3	.186	1.196
Sweden	81919.	.217	.255	1.18	3	.190	1.229
Norwegian Surveys	107645.	.192	.161	.84	4	.214	1.044
F shrinkage mean	53940.	.50					1.541

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
80881.	.14	.11	14	.767	1.238

Age 4 Catchability constant w.r.t. time and age (fixed at the value for age) 2

Year class = 1990

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Denmark	19689.	.262	.095	.36	4	.263	.481
Norway	15957.	.258	.129	.50	4	.266	.566
Sweden	19001.	.260	.086	.33	4	.265	.494
Norwegian Surveys	27419.	.369	.189	.51	5	.072	.367
F shrinkage mean	18512.	.50					.505

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
18731.	.14	.06	18	.406	.500

Table 4.1.7 Virtual Population Analysis. Stock number at age. Pandalus in Div. IIIa and IVa east

Run title : Pandalus IIIa + IVb Assessment
At 16/09/1995 16:47
Terminal Fs derived using XSA (With F shrinkage)

Table 10 Stock number at age (start of year) Numbers*10**-4

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	GMST 85-92
AGE												
0	1923348	1747849	1052772	1734442	2035143	1960760	1265663	2262466	1498471	1362784	0	1701167
1	1187205	906019	824599	496531	815497	953803	923006	596932	1061257	704892	642650	811863
2	440607	490191	360914	303419	192365	278177	358889	379877	251952	416914	293017	338543
3	44222	121470	159668	89855	76579	44002	56167	93358	77884	59047	111574	77940
4	18207	7727	22418	42790	12906	12899	9878	6221	4277	6537	8088	13884
+gp	0	472	199	993	228	101	0	0	171	0	1873	
TOTAL	3613590	3273729	2420571	2668030	3132718	3249742	2613603	3338854	2894012	2550174	1E+06	

Table 4.1.8 Virtul Population Analysis. VPA summary tables with and without SOP corrections. Pandalus in Div. IIIa and Iva east.

Run title : Pandalus IIIa + IVb Assessment 1995 WG

At 16/09/1995 16:47

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS Age 0	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 1- 3
1985	19233480	93455	16763	12628	.7533	.5559
1986	17478494	92997	9208	13234	1.4372	.4940
1987	10527720	71974	14939	15072	1.0089	.4857
1988	17344416	65975	11676	12857	1.1011	.6718
1989	20351430	77666	11697	12542	1.0723	.6940
1990	19607602	83694	12475	11852	.9500	.6071
1991	12656627	75500	14383	12323	.8568	.7283
1992	22624662	83278	14495	13728	.9471	1.0934
1993	14984710	80424	12090	13907	1.1503	.8710
1994	13627836	64657	14525	12076	.8314	.6446
Arith. Mean	16843698	78962	13225	13022	1.0108	.6846
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 17 Summary (with SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS Age 0	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	SOPCOFAC	FBAR 1- 3
1985	19233480	86058	15436	12628	.8181	.9208	.5559
1986	17478494	92988	9207	13234	1.4373	.9999	.4940
1987	10527720	72239	14994	15072	1.0052	1.0037	.4857
1988	17344416	69005	12213	12857	1.0528	1.0459	.6718
1989	20351430	70657	10641	12542	1.1786	.9098	.6940
1990	19607602	74946	11171	11852	1.0609	.8955	.6071
1991	12656627	77218	14710	12323	.8377	1.0227	.7283
1992	22624662	76209	13264	13728	1.0350	.9151	1.0934
1993	14984710	79906	12012	13907	1.1577	.9936	.8710
1994	13627836	68256	15334	12076	.7875	1.0557	.6446
Arith. Mean	16843698	76748	12898	13022	1.0371	.6846	
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)			

Table 4.1.9 Indices of 0- and 1-group shrimp from Norwegian trawl surveys in October and VPA values. Pandalus in Div. IIIa and IVa east

	Survey		VPA(new 95)		
Year-dass	0-gr (IIIa)	1-gr(IIIa)	0-gr	1-gr	2-gr
1983		7023			4406
1984	3077	20902		11872	4902
1985	1813	6914	19233	9060	3609
1986	1432	5988	17478	8246	3034
1987	675	2541	10528	4965	1924
1988	2002	8714	17344	8155	2782
1989	9388	10743	20351	9538	3589
1990	4052	12116	19608	9230	3799
1991	1877	10739	12657	5969	2520
1992	19967	22294	22625	10613	4169
1993	4743	9911	14985	7049	
1994	2371		13628		

Table 4.1.10 Input value for prediction. Pandalus in Div. IIIa and IVa east

Most Recent Data year (enter)			1994	Age 0	Recruits	1995	17011
First Pred. Year			1995	Age 0	Recruits	1996	17011
Second "			1996	Age 0	Recruits	1997	17011
Third "			1997				(enter)
		maturity	Mean Wt	Mean Wt	Prop F before spawning:		0,2
Age	M	ogive	catch g	stock g	Prop M before spawning:		0,25
0	0,75	0,00	1,19	1,19			
1	0,75	0,00	3,57	3,57			
2	0,75	0,70	5,65	5,65			
3	0,75	1,00	8,54	8,54			
4	0,75	1,00	11,54	11,54			
5	0,75	1,00	14,68	14,68			

Age	Stock size Jan 1 1994 (enter)	F 1994 (enter)	Stock size Jan 1 1995 (from vpa)	Fishing pattern mean F 92-94 (enter)	Fishing pattern scaled to 1994 ref F
0	13627	0,0017		0,004	0,003
1	7048	0,1278	6427	0,142	0,143
2	4169	0,5682	2930	0,701	0,709
3	590	1,2379	1116	1,766	1,787
4	65	0,4999	81	0,576	0,583
5	0	0,4999	19	0,576	0,583

Table 4.1.11 Prediction results. Pandalus in Div. IIIa and IVa east

Stock size for prediction

Jan 1 1995 average recruit.	Stock Biomass 1995	SSB 1995	Landed prop 1995	Catch 1995	Landed 1995	
17011	20243	0	0,71	45	32	
6427	22944	0	0,85	2174	1848	
2930	16555	8336	1	6178	6178	
1116	9531	5527	1	6182	6182	
81	935	690	1	301	301	
19	279	206	1	90	90	
sum:	**70486**	**14758**		**14970**	**14630**	tonnes

Prediction with management option table

	1996					1997	
FACTOR	REFF	SSB	CATCH	LAND	TSB	SSB	CATCH
0	0,00	14611	0	0	70921	24939	0
0,2	0,13	14168	2506	2440	70921	22345	3675
0,4	0,26	13741	4714	4585	70921	20145	6464
0,6	0,39	13330	6676	6484	70921	18266	8609
0,8	0,52	12935	8433	8178	70921	16650	10284
1	0,64	12554	10016	9700	70921	15251	11611
1,2	0,77	12186	11452	11076	70921	14032	12678
1,4	0,90	11832	12763	12328	70921	12963	13550
1,6	1,03	11491	13966	13473	70921	12021	14273
1,8	1,16	11161	15075	14526	70921	11184	14880
2	1,29	10844	16103	15498	70921	10437	15398

Table 4.2.1 Landings in tonnes of Pandalus borealis from the Fladen Ground (Division IVa) as estimated by the Study Group

Year	Denmark	Sweden	Norway	UK (Scotland)	Total
1972	2 204			187	2 391
1973	157			163	320
1974	282			434	716
1975	1 308			525	1 833
1976	1 552			1 937	3 489
1977	425		112	1 692	2 229
1978	890		81	2 027	2 998
1979	565		44	268	877
1980	1 122		76	377	1 575
1981	685		1	347	1 033
1982	283			352	635
1983	5 729		8	1 827	7 564
1984	4 553		13	25	4 591
1985	3 649			1 341	4 990
1986	3 416			301	3 717
1987	7 326			686	8 012
1988	1 077		2	84	1 163
1989	2 438		25	547	3 010
1990	1 681	4	3	365	2 053
1991	422		31	53	506
1992	1 448			116	1 564
1993	1 521		29	509	2 059
1994*	1 207		0	35	1 242

* Provisional

Table 4.2.2 *Pandalus borealis*, Fladen Ground. Reported CPUE (shrimp trawlers), and estimated effort.

	Denmark			UK (Scotland)			
Year	CPUE (t per day)	Total effort (Days)	Index[1]	CPUE (kg per hour)	Total effort (hours)	Index[1]	Combined index[2]
1982	0,96	295	0,10	74	4757	0,31	0,21
1983	1,18	4855	1,61	89	20528	1,32	1,54
1984	0,97	4694	1,56	37	676	0,04	1,55
1985	1,21	3016	1,00	86	15593	1,00	1,00
1986	0,96	3558	1,18	71	4239	0,27	1,11
1987	1,24	5908	1,96	81	8469	0,54	1,84
1988	0,83	1298	0,43	44	1909	0,12	0,41
1989	0,99	2463	0,82	65	8415	0,54	0,77
1990	1,28	1313	0,44	106	3493	0,22	0,40
1991	1,50	281	0,09	124	429	0,03	0,09
1992	1,44	1006	0,33	69	1685	0,11	0,32
1993	1,83	831	0,28	90	5229	0,34	0,29
1994	1,93	621	0,21	91	330	0,02	0,20

Table 4.3 Landings (t) of Pandalus from division IVb the Farn Deeps as estimated by the Study Group

Year	UK (England)	UK (Scotland)	Denmark	Total
1977	227	No data		
1978	91	2	-	
1979	235	34	-	
1980	203	17	-	
1981	1		-	
1982			-	
1983	65		-	
1984	30		-	
1985	2	6	-	
1986	137	57	106	300
1987	212	86	92	390
1988	91	25	384	500
1989	168	8	72	248
1990	144	+	1	145
1991	3			3
1992	1			1
1993				0
1994	4			4

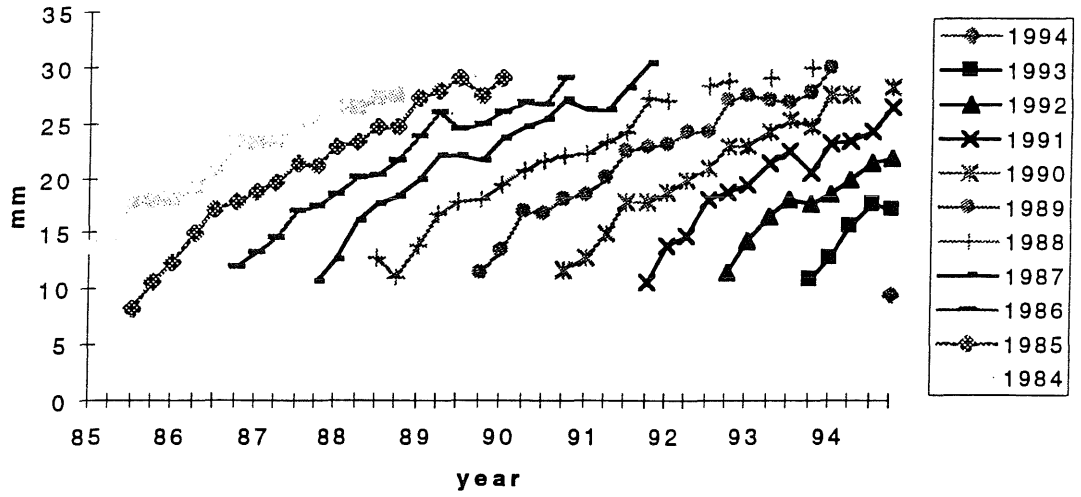

Figure 4.1.1 Mean carapace length (mm) at age (quarters) in area IIIa- IVa east for yearclasses 1984 to 1994

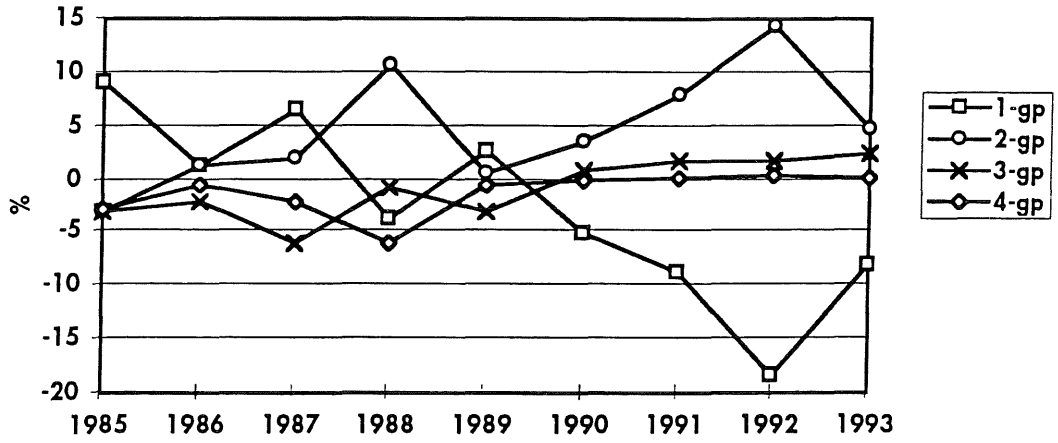

Figure 4.1.2 Percentage difference "new" minus "old" of age groups 1-4, for the two datasets.

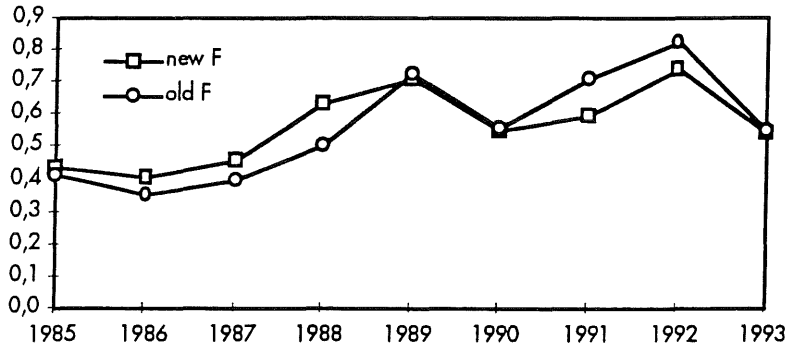

Figure 4.1.3 Average Fishing mortality for 1-3 group 1985-1993 according to XSA using "old" and "new" dataset