https://doi.org/10.17895/ices.pub.19263677

Advisory Committee on Fishery Management

ICES CM 2000/ACFM:2 Ref:G

REPORT OF THE

PANDALUS ASSESSMENT WORKING GROUP

Flødevigen Norway 23-26 August 1999



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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 terms of reference for our 1998 meeting are according to 1997

Council resolution 2:11:15:

The *Pandalus* Assessment Working Group [WGPAND] (Chair: Mr S. Tveite, Norway) will meet in Flödevigen, Norway from 23-26 August 1999 to:

- a) assess the status of the stocks of *Pandalus borealis* in the North Sea, Skagerrak and Kattegat and provide catch options for 2000;
- b) determine the predation mortality of *Pandalus* stocks;
- c) continue the work on determining the criteria for ageing.

The above Terms of Reference are set up to provide ACFM with the information required to respond to the requests for advice from NEAFC and the EC.

WGPAND will report to ACFM before its October 1999 meeting and to the Living Resources Committee at the 2000 Annual Science Conference.

2 PARTICIPANTS

S. Munch-Petersen	Denmark
B. Sjöstrand	Sweden
S. Tveite (Chair)	Norway

J. Kinnear and Jon Elson supplied data from the Scottish and English shrimp fishery in the North Sea.

3 PANDALUS STOCK IN SUB-AREA IVA EAST AND DIVISION IIIA

3.1 Landings

Landings are given in Table 3.1 by area (Division IIIa and Sub-area IV) as officially reported to ICES. The landings in Skagerrak in 1998 were the highest recorded. In the sub area IV landings increased by 1000 tonnes above the 1997 level.

Table 3.2 presents the landings and estimated discards for the assessment unit, i.e., Division IIIa and eastern part of Sub-area IVa. These landings have increased compared to the 1997 level and are on a record high level viz. around 15 400 t.

Landings from Norway and Sweden (and to a small extent from Denmark) consist of a fraction of larger shrimps that are boiled on board and a remaining portion of smaller shrimps landed fresh. The boiling causes the shrimps to loose weight. The conversion factor to obtain live weight is 1.15. Official reported figures from Norway are given as landed weight. Sweden has adopted the same procedure for the last few years. In the amounts used by Working Group, the Swedish landings of large shrimps have, however, been converted to live weight. The amount added for 1997 was 194 tonnes. The Working Group has applied no conversion on the Norwegian landings. The underestimate of total landings by this omission is for 1997 was roughly estimated to about 500 t. The Working Group felt that this estimate was too inaccurate to include in the assessment figures. When more reliable methods for estimations become available, the landings for all years should be updated.

3.2 Discards

Discarded shrimps are of two categories:

The smallest size fractions from the sieving procedure are not accepted by the canning industry and are discarded. This practice is traditional in the Norwegian and Swedish fisheries. The Working Group estimated the amounts of discards by using the Norwegian length measurements from samples taken onboard before discarding. The proportions below 15-mm carapace length are considered discarded.

More recently, the substantial price difference between large, boiled shrimps and medium sized fresh ones has resulted in high grading by discarding the latter. The amounts of discards in this category were in last year's report estimated for 1996 and 1997 only. The estimation was based on separate quarterly length distributions for the categories large and medium sized and the selection ogive for the sieved ones. In this years report these estimates were considered too inaccurate to be included in assessments. The working group is, however, aware of the activity and is looking for more reliable methods for estimations.

3.3 Effort

Annual figures for landings per unit of effort (LPUE) and effort are given in Table 3.3 Total effort values have been estimated from LPUE data based on logbook records. Danish and Swedish effort were reduced compared to the 1997 level, while Danish and Norwegian LPUE were record high. Also the Swedish CPUE would have been record high if high grading had been accounted for.

3.4 Assessment

At this year's WG meeting several of the main input components to the assessment were subject to critical discussion and revisions in order to improve the assessment. The major topics were:

Estimation of discards in the Swedish and Norwegian fisheries (see Sect. 3.2).

A change in the procedures for estimating age composition in the catches (see Sect. 3.4.2).

Options for variable natural mortality, (see Sect.3.4.6)

As described below, a main reason for reverting to conversion of the length data to age data on a national basis has been that the different spatial distribution of the fisheries among the 3 countries apparently also resulted in different stock components in the catches. It was also hoped that 3 different sets of C(a) and effort figures would improve the tuning of the XSA. However, this has not been the case.

3.4.1 Procedures for estimating age compositions in the catches

This year the standard procedures for splitting the observed length composition in the catches (as recorded by sampling) into age compositions for further cohort analyses were subject for special consideration.

3.4.2 Pooling of the length data from the samples

From 1988 to 1995 the length data from the individual samples for each stock were pooled by quarter. These quarterly data were then <u>for each country</u> split up into separate age compositions by the methods mentioned below. At the meeting in 1995 it was, however, decided to pool the data from Denmark, Norway and Sweden (by quarter) before the age composition analyses. Ideally, if the fisheries were exploiting exactly the same stock components, this pooling should improve the length data, both by the spatial coverage of the stock and by increasing the amount of length data for the analyses.

However, the experience has been that this change in the procedures for pooling of the length compositions of the 3 national catches has not in general improved the results. It appears that there are consistent differences in the length compositions especially between the Norwegian catches on the one side and the Danish and Swedish on the other side, even if the catches are taken from the (presumably) same stock.

Another consequence of the pooling of the national data before applying the ageing routines has been that the amount of information contained in the national catch-effort data used for tuning the VPA has been reduced.

At the 1999 WG meeting it was decided to revert to the previous way of analysing the catches on a national basis. Thus all the available data (from 1987-1998) were re-analysed).

3.4.3 Methods for splitting length compositions into age compositions

The *Pandalus* stocks in the North Sea and Skagerrak are composed of few age groups, which for the youngest ones normally are recognised as modes in the composite length compositions. Hitherto the standard method used by the WG has been the one of Bhattacharya (1967). This has in some cases been supplemented by maximum-likelihood based

Norm-Sep programmes. Both methods assume that the sizes of the individuals belonging to the separate age groups are normally distributed.

The Bhattacharya method has the advantage that the visible modes influence the choice of means of the separate normal distributions and thus give the method some degree of objectivity. However, the method is applicable only when distinct modes are visible. Composite size distributions of for instance the old age groups do not show distinct modes and can therefore not be properly separated by this method. In the maximum-likelihood methods one may adjust the input values for means and s.d. until the calculated distribution fits the observed distribution to a very high degree even if such input do not represent biological realistic cohort values.

At this year's WG Sweden presented an alternative method by which a calculated composite length distribution was obtained from normal distributed length-at-ages. The mean lengths were estimated following von Bertalanffy growth parameters for *Pandalus*. The s.d. for each distribution was generated by assuming a C.V. of 6.5% for each age group. The calculated composite distributions are then fitted to the observed length distributions by varying the proportions of age groups in a spread sheet routine. The method is similar to 'slicing' routines used for instance in some Nephrops assessments.

All the Swedish age composition data presented to this WG have been calculated by this routine. Since the Danish and Norwegian age compositions were estimated using the Bhattacharya method a comparison of the results from the two methods was carried out using Swedish data for 1997 and 1998.

Table 3.4 compares the mean CL of the age groups in the Swedish catches for these two years as estimated by Bhattacharya's method and the Swedish spreadsheet 'slicing' routine. In general the agreement between the two methods is good. Table 3.5 compares the proportions of each age group in total catches estimated by the two methods. This is the input to the cohort analyses. In most cases the agreement between the two methods here is also good, but in a few cases the differences seem to be significant, e.g. estimates for quarter 3 in 1998.

The Bhattacharya method will only recognise normal distributions that are visible in the composite distribution whereas a constant number of age groups are an input to this slicing routine. One may vary the number of age groups according to the relevant information on the particular stock.

3.4.4 Age distributions

As said above, all the length data have been re-analysed on a national basis. The length data are pooled by quarter, and these quarterly length compositions have then been split into age compositions by the methods mentioned above. The Danish and Norwegian age compositions have been estimated by the Bhattacharya method (software: FISAT). The Swedish age compositions are estimated by the above mentioned spreadsheet routine. As in previous years, the mean lengths of the estimated age groups are used as a check of the consistency of the estimates, see Figure 3.1.

Table 3.8 (tuning input file) gives the national catch-at-age data and Table 3.6 the combined data, i.e., the input to the XSA. Note that the differences in C(a) compared to last year are due both to the change in discard estimation and the change in the procedures for converting length distributions into age distributions.

3.4.5 Mean weights and maturity at age

Weights-at-age for the Danish catches were derived from the length samples of the catches, where the weights of the measured shrimps in each sample are recorded by length group. The corresponding Norwegian and Swedish weights-at-age figures are based on quarterly length-weight relationships obtained from the Swedish length samples from which all shrimps are weighted individually. The mean weights-at-age in the catch is given in Table 3.7. These figures are also used as weight-at-age in the stock.

The 0- and 1-group were assumed to be immature, and the 3+ groups fully mature. The mature part of the 2-group or potential spawners was taken as the sum of intersexes and females in the first quarter of the year

These proportions have been revised since last year's report and are:

1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 0.62 0.09 0.20 0.26 0.82 0.96 0.73 0.59 0.45 0.70 0.51 0.58 0.51 0.60

In this assessment spawning stock size has been calculated as per 1 Jan, i.e. FPROP = MPROP = 0 for all years.

3.4.6 Natural mortality

In the standard assessment was M=0.75 for all ages and years used, as in previous years. The WG had no new information available to get an estimate of the level of M, but did explore the effects of M varying with time. *Pandalus* is eaten by many fish species and predation is thus likely to be the main cause of natural death. Two series of indices of predator biomass was constructed in order to track the variability in predation. SSB for demersal species (cod, haddock, whiting and saithe) in the North Sea (and Skagerrak) was summed. The index was expressed relative to the average for 1985 to 1997. The other series consisted of total weight of likely predator species (about 30 species) caught per nautical mile in the yearly Norwegian trawl surveys in Skagerrak and NE North sea. These data were also expressed relative to their 1985-98 average. Both series were scaled to give average values of 0.75.

The general trend in both data series is an increase of the predator biomass from about 1990 to 1998. The North Sea series was used as M values in an alternative XSA. In comparison with the standard XSA (see section 3.4.7), the introduction of variable M gave differences in the stock estimates for *Pandalus* in the order of 20 000 ton; i.e. the part of the stock consumed by predators (Figure 3.2).

3.4.7 XSA

An XSA was performed on the 1985-1998 dataset to estimate stock sizes and exploitation levels. The national effort and catch numbers at age were first used for tuning together with the annual Norwegian shrimp survey (Table 3.8). The residuals were unacceptable high for all fleets except for the survey. It was therefore decided that only the survey should be used for tuning.

Default values were accepted, in most instances, as input variables in the XSA (Table 3.9). Catchabilities were, however, assumed independent of stock size for all ages, and independent of age for ages 2 and older. Survivor estimates were shrunk towards the mean F of final 5 years or the 2 oldest ages.

Fishing mortalities, expressed as unweighted mean over age groups 1-3, (see Table 3.10) decreased from 1992 to a minimum in 1994. This decrease is mainly due to a major drop in the high values for the 3-group.

Stock size in terms of number at age is given in Table 3.11. Spawning stock increased in 1998 due to the strong 1996 year class.

Summary results without SOP corrections are given in Table 3.12 both for the run with constant M and variable M.

Log catchability residuals are quite high, especially for the III and IV group, but show no trend over time. (Figure 3.3.)

A retrospective XSA covering the period 1990-98 is presented in Figures 3.4.

3.4.8 Recruitment

The abundance indices of young shrimps obtained by the Norwegian survey in October 1998 are given in Table 3.13. The 1997 0-group index was below average and was estimated by the XSA to be very small. Both the new XSA and 1998 survey show that this year class is far below average. The 1998 year class is also estimated at the 0-group stage to be below average. A new and more reliable estimate of this year class as I-group will be made during the 1999 surveys. The results will be made available to the October meeting of the ACFM.

3.4.9 Catch prediction

Input data and results for the short-term prediction are shown in Table 3.14. The fishing pattern used for 1999 is the 1996-1998 average (not scaled to the 1998 level). Mean weights are averages for the period 1985-1998. Recruitment in 1999 - 2001 is the geometric average for the period 1985-1998.

The spawning stock estimates are very dependent on the maturity ogive, which has varied considerably during the period of investigation. In this year's prediction the maturity for age group 2 is based on the percentage intersexes and females in the 2-group observed in Norwegian samples during quarter one 1998.

The *status quo* landings for 1999 is predicted to 13 817 tonnes, whereas the agreed TAC is 18,800 tonnes. Predicted *status quo* catches in 2000 is 11 665 tonnes assuming mean abundance for 1998 and 1999 year classes (Table 3.14).

The status quo landings for 1999 is predicted to 13 362 tonnes, whereas the agreed TAC is 18,800 tonnes. Predicted status quo catches in 2000 is 11 967 assuming mean recruitment (Table 3.14). In the first 6 months of 1999 the Swedish and Norwegian landings were 4200 tonnes. The Danish landings in the first 7 months were around 1000 t, a considerable drop compared to 1998 and 1997. In years with comparable recruitment indices the catches in the rest of the year will be approximately the same as in the first half of the year. Following this rough extrapolation the expected total catches for 1999 will be around 10 000 t. Last year's estimate for 1999 was above 17 000 tonnes assuming average 1997 recruitment. The 1997 yearclass at the I-group stage was, however, approximately 50% of an average year class.

3.4.10 Management consideration

3.4.10.1 Medium-term evaluation

Predictions of yield and spawning stock size for the period 1999-2008 were performed based on a model originally developed at the Danish Institute for Fisheries Research. It is implemented in Excel. The model includes uncertainties in the estimated population size in 1999, in mean weights at age and in the proportion mature of age group 2. The uncertainty in population size in 1998 is the one estimated in the XSA. Uncertainties in mean weights and maturity are estimated from the historic data. Recruitment (at age 1) is based on the historic relationship between SSB and recruitment assuming a double linear function: above B_{loss} is it assumed to vary around the mean and below B_{loss} to follow a straight line to the origin. Recruitment is assumed to be lognormally distributed around the linear function using the variance observed in the historic data. (Table 3.15)

The percentiles of the probability distributions after 200 runs are presented in Figure 3.5 for yield and SSB under constant fishing mortality at the F_{med} (98) level and with an estimated catch of 11 000 t in 1999. The results indicates a drop in yield and SSB to 2001 and thereafter a likely catch of about 9 000 t and about 10% risk that SSB will be less than B_{loss} .

3.4.10.2 Long term evaluation

Additional calculations of yield and SSB per recruit (average number of recruits) were performed in order to illustrate the dependence of natural mortality on long-term yield and SSB.

Input values (given in Table 3.16) are based on averages over 1985-98 for WEST, WECA, 1985-97 for stock size and 1996-98 for F at age. The values of both F and M were varied in the calculations. In Table 3.17 is given the output of long-term yield for fixed M levels and the maximum values for F (factor) that gives a SSB > B_{loss} . In Table 3.18 the F (factor) levels are fixed and the maximum M for which the condition SSB > B_{loss} holds, are presented. Exploitation rate are in both cases expressed as F/Z, reference F is the average over ages 1-3. The results illustrate that - under given assumptions - if M approaches 1.4 the fishery has to stop, whereas an M of about 0.5 could give room for around 20 000 ton yield. In other words an increasing M have to be accompanied by a decresed F if the SSB should remain above B_{loss} .

3.4.10.3 Biological Reference Points

The large uncertainties of the assessment and the large influence of the natural mortality value, made ACFM in 1998 to point out that it would not be appropriate to define the usual biological reference points for this stock. The objective on which to base advice would be to keep the spawning stock above the lowest observed spawning stock biomass (B_{loss}) (Table 3.19).

This objective has a high probability to be achieved if fishing mortality is kept at or below F_{med} .

The historical development of F and SSB in relation to the precautionary approach reference points is illustrated in Figure 3.6.

3.4.10.4 Trawl selection

The high discard figures indicate that the selection properties of commercial shrimp trawls are poor. Sorting grids or other means facilitating the escape of small shrimps should be included in the management of the stock.

3.4.10.5 Assessment quality

Most of the samples used for length frequencies for the stock assessment are from the Skagerrak area. Survey data in the fourth quarter demonstrate a much higher proportion of large shrimps in the Norwegian Deeps than in the Skagerrak indicating a considerable bias in sampling of commercial catches.

4 FLADEN GROUND

Table 4.1 shows the landings from the Fladen Ground since 1972. During the last 10 years total landings fluctuated between a low of around 500 tonnes to a high of more than 5000 tonnes. Mainly the Danish and Scottish fleets exploit the Fladen stock of *Pandalus*. Denmark accounts for the majority of landings. In general, the main part of these fisheries take part in the first half of the year.

4.1 Effort data

Total effort for the Danish and Scottish Fladen fisheries is estimated from logbook data from these fisheries. Table 4.2 gives the effort data. Both Danish and Scottish CPUE (LPUE) have been at rather high levels in recent years. In order to combine Danish and Scottish effort data relative effort indices have been calculated for each country. The combined effort indices have been weighted by landings, see Table 4.2. It appears that total effort has been at a relatively low level in 1997 and 1998.

4.2 Assessment

Analytical assessments of this stock have not been presented since the one in the 1992 Working Group Report (ICES, 1992). Data for analytical assessments for all later years have been compiled at the national laboratories (Denmark and Scotland) and are available to the Working Group. However, due to the frequent large fluctuations in the Fladen fishery samples for length composition of the catches do not always cover the entire year.

A main characteristic of the Fladen stock of *Pandalus* is that the catches consist of mainly 2 age groups. During the first two quarters of the year age groups 2 and 3 normally dominate the catches. During quarter 4 age group 3 usually disappears from the catches, while age group 1 adds to the catches. Because of the few age groups constituting this stock predictions for the Fladen fishery are possible only if very reliable information on recruitment is available.

5 FARN DEEPS

In recent years *Pandalus* in the Farn Deeps have been fished by UK vessels only. Total landings fell from 500 t in 1988 to none in 1993. In 1994 there was a small fishery of 4 tonnes, 171 t in 1995 and 60 t in 1996. In 1997 and 1998 the landing fell to 5 tonnes annually, and this fishery can be considered insignificant at present (Table 5.1).

6 BY-CATCH

By-catch data for the Danish *Pandalus* fisheries from logbooks are available for 1998 as a continuation of the data series presented in previous working group reports. In this connection it should be mentioned that currently various EU funded projects aim at elucidating the by-catches and discarding in the main fisheries in the North Sea and Skagerrak including the *Pandalus* fisheries.

7 **REFERENCES**

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	Division II	Ia			Sub-area P	V				
Year	Denmark	Norway S	weden †	Total	Denmark	Norway	Sweden	UK	UK	Total
		-				•		(Engl.)*	(Scotl.)*	
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	364	579	7802
1990	2277	3006	1471	6754	2079	3146	137	305	365	6083
1991	3256	3441	1747	8444	750	2715	161	130	54	3810
1992	3296	4257	2057	9610	1881	2945	147	69	116	5158
1993	2490	4089	2133	8712	1985	3449	167	29	516	6146
1994	1973	4388	2553	8914	1352	2426	176	41	35	4030
1995	2494	5181	2512	10187	4698	2879	166	217	1324	9284
1996	3664	5143	1985	10792	4063	2772	82	97	1899	8913
1997	3617	5460	2281	11358	3117	3112	316	52	365	6962
1998	2941	6519	2086	11546	3273	3092	187	55	1364	7971
*	Includes sr	nall amount	s of other l	Pandalid	shrimp					

Table 3.1 Nominal landings (tonnes) of Pandalus borealis in ICES Division IIIa and subarea IV as officially reported to ICES.

1970 to 1974 includes subarea IV.

†

Total 1988 - 1990 includes 19, 21 AND 51 t. by the Netherlands

1998 figures are preliminary.

				E	stimated		
Year	Denmark	Norway	Sweden	Total	discards	TAC	Catch
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	558		12602
1986	4834	6490	1463	12787	414		13201
1987	4488	8343	1322	14153	723		14876
1988	3240	7661	1278	12179	750		12929
1989	3150	6411	1433	10994	1107		12101
1990	2479	6108	1608	10195	1226		11421
1991	3583	6119	1908	11610	497		12107
1992	3725	7136	2154	13015	541	15000	13556
1993	2915	7371	2300	12586	889	15000	13475
1994	3134	6813	2601	11532	214	18000	11745
1995	2465	8900	2882	14247	275	16000	14523
1996	3868	7878	2371	14229	318	15000	14548
1997	3909	8565	2597	15070	1039	18000	16109
1998	3330	9606	2469	15406	348	18800	15753

 Table 3.2 Pandalus borealis landings from divisions IIIa (Skagerrak) and IVa (eastern part).

 (Norwegian Deeps) as estimated by the Working Group

	i anuaius ui	vision ma	anu i va cast				
	Denmark		Norway		Sweden		combined
Year	LPUE	effort	LPUE	effort	LPUE	effort	effort index
	kg/day	days	kg/hr	Khrs	kg/hr	Khrs	rel. to1986
1984	452	3869	no data		25	40	
1985	719	5326	no data		32	49	
1986	556	8700	36	179	30	49	1.00
1987	499	9212	36	230	23	57	1.16
1988	432	7104	31	251	22	57	1.18
1989	441	7143	23	273	23	63	1.23
1990	591	4195	26	232	26	58	1.03
1991	645	5555	30	206	31	61	0.97
1992	641	5811	35	204	27	80	0.97
1993	571	5105	31	243	25	91	1.09
1994	677	3152	31	218	33	82	1.03
1995	801	3071	35	255	39	76	1.21
1996	860	4519	37	214	32	74	0.99
1997	1034	3780	42	212	33	78	0.98
1998	1090	3249	44	219	34.	73	1.02

Table 3.3 National LPUE and effort as estimated by the Study Group , Pandalus division IIIa and IVa east

Table 3.4	Comparison of mean C	CL (in mm) as estimated by the	two methods (Swedish data).
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			1997				1998		
Age group	Quarter:	1	2	3	4	1	2	3	4
0	'Slicing' routine	-	-	-	-	-	-	-	-
	(Bhattacharya)	-	-	-	11.0	-	-	-	-
1	'Slicing' routine	13.4	15.0	16.7	17.2	13.4	14.6	16.2	17.3
	(Bhattacharya)	13.7	16.7	17.4	17.5	13.8	15.5	18.7	18.3
2	'Slicing' routine	17.8	19.2	20.7	20.8	17.8	18.7	20.0	21.0
	(Bhattacharya)	18.6	20.3	21.8	21.9	18.3	18.9	21.9	22.0
3	'Slicing' routine	21.2	22.3	23.7	23.6	21.2	21.9	23.0	23.9
	(Bhattacharya)	22.2	23.7	25.5	-	21.9	22.0	-	-
4	'Slicing' routine	23.7	24.7	-	-	23.7	24.3	-	26.0
	(Bhattacharya)	25.5	-	-	-	26.0	26.6	-	-
5	'Slicing' routine	25.7	26.4	27.7	27.2	25.7	26.1	-	27.7
	(Bhattacharya)	-	-	-	-	-	-	-	-

		19	997			19	98		
Age group	Quarter:	1	2	3	4	1	2	3	4
0	'Slicing' routine	_	_	_		_	_	_	_
Ŭ	(Bhattacharya)	-	-	-	0.2	-	-	-	-
1	'Slicing' routine	0.9	13.5	25.7	54.9	0.3	1.4	13.6	41.5
	(Bhattacharya)	0.9	24.6	31.8	53.8	0.4	1.3	34.6	48.8
2	'Slicing' routine	57.2	60.1	64.8	37.7	51.1	41.6	59.2	56.9
	(Bhattacharya)	59.9	60.3	63.9	46.0	54.1	43.4	65.4	51.2
3	'Slicing' routine	31.7	25.6	9.6	7.1	43.0	55.7	27.2	1.6
	(Bhattacharya)	35.7	15.1	4.3	-	42.1	52.4	-	0.0
4	'Slicing' routine	8.9	0.5	-	-	4.7	0.0	-	-
	(Bhattacharya)	3.5	-	-	-	3.5	2.8	-	-
5	'Slicing' routine	1.3	0.3	0.0	0.2	0.9	1.3	-	-
	(Bhattacharya)	-	-	-	-	-	-	-	-

Table 3.5 Comparison of proportions of age groups in catches (%) estimated by the two methods.

Table 3.6 Catch in numbers at age. Pandalus division IIIa and IVa east

Table 1 Catch numbers at age		Numbers*10	**-3				
YEAR	1985	1986	1987	1988	1989	1990	1991
AGE							
0	17677	7397	2666	14136	31328	0	3947
1	1200771	1146414	1260489	1086554	2083644	2250093	1231759
2	1305436	1029705	1205579	923865	385493	910845	1035782
3	187940	482651	390172	300195	173819	121106	326666
4	52222	24060	198379	146037	13475	28150	22398
+gp	34	1062	4848	679	171	3138	3251
TOTALNUM	2764080	2691289	3062133	2471466	2687930	3313332	2623803
TONSLAND	12602	13201	14876	12929	12101	11420	12106
SOPCOF %	85	98	105	102	106	88	97
YEAR	1992	1993	1994	1995	1996	1997	1998
AGE							
0	25481	27172	666	2678	61140	19701	12695
1	1071420	1889578	671932	645975	1211633	2175622	903366
2	1289159	803781	1380397	970480	991351	1181917	1597910
3	569130	262698	142951	851452	454614	295595	468092
4	56541	14856	30450	32119	69501	27780	45725
+gp	925	619	0	9796	0	1999	2454
TOTALNUM	3012656	2998704	2226396	2512500	2788239	3702614	3030242
TONSLAND	13556	13475	11745	14605	14547	16109	15753
SOPCOF %	88	93	95	93	89	94	96

Table 3.7 Mean weight at age. Pandalus division IIIa and IVa east

Table 2	Catch	n weigh	its at ag	ge (kg)											
YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	average gram
AGE															Brann
0	0.000	0.001	0.000	0.000	0.001	0.000	0.002	0.001	0.000	0.000	0.000	0.001	0.000	0.001	0.4
1	0.003	0.003	0.002	0.003	0.003	0.003	0.003	0.004	0.004	0.003	0.003	0.004	0.003	0.003	3.2
2	0.006	0.005	0.005	0.005	0.007	0.005	0.005	0.005	0.007	0.006	0.006	0.007	0.006	0.006	5.8
3	0.010	0.008	0.008	0.009	0.010	0.008	0.008	0.008	0.009	0.009	0.009	0.009	0.009	0.009	8.8
4	0.013	0.014	0.011	0.012	0.013	0.011	0.012	0.009	0.011	0.012	0.011	0.014	0.012	0.013	12.0
+gp	0.000	0.017	0.015	0.017	0.018	0.011	0.013	0.013	0.014	0.012	0.014	0.000	0.014	0.013	12.2
SOPCOFAC	0.852	0.976	1.054	1.021	1.055	0.882	0.973	0.877	0.927	0.955	0.926	0.891	0.944	0.958	

Table 3.8 Extended Survivor analysis. Tuning input file. *Pandalus* division IIIa and IVa east

PANDALUS IIIA+IVa east tuning file 1999 WG

104 Norway

86	98					
1	1	0	1			
1	5					
179	271	656338	532593	234288	12673	617
230	0	651309	772141	317842	160672	4019
250	0	836632	542891	179015	84568	589
273	1922	1558608	228712	144857	11154	137
231	0	1526490	544329	96122	14201	0
206	0	760044	426984	189939	19696	337
204	2613	764156	625318	347453	13959	677
243	0	1398357	433176	86630	370	0
218	0	471527	788805	64624	10902	0
254	0	351925	589116	625142	12882	0
214	0	653465	497797	258184	54750	0
203	0	1534435	572591	142658	15744	0
219	0	545817	1091375	254386	35684	0
Sweden						
85	98					
1	1	0	1			
1	5					
48	1641	155615	170900	25241	8362	11
49	5089	138477	116740	56145	2642	104
57	2666	83797	122795	52701	28607	828
56	14136	130040	84757	26083	12698	90
62	26880	324579	50454	28962	2321	33
58	0	231377	171535	14348	13949	3138
61	3947	154018	189644	69814	0	2913
80	20400	67277	195110	128334	42582	247
90	27172	269373	146387	76646	10596	619
81	666	89566	328737	51961	11316	0
76	2678	82083	209974	144905	14858	9796
73	11741	153814	138198	118761	13451	0
78	19701	230105	239138	81592	9600	1999
72	9931	89731	214616	137202	5004	2454

Table 3.8 Extended Survivor analysis. Tuning input file. Pandalus division IIIa and IVa east(cont.)

Denmark						
85	98					
1	1	0	1			
1	5					
5325	16036	273993	405201	54007	16265	22
8700	2036	351598	380371	192217	8745	339
9211	0	525383	310643	19629	9099	0
7103	0	119881	296216	95097	48771	0
7477	2525	200457	106326	0	0	0
4235	0	492225	194981	10636	0	0
5487	0	317697	419153	66912	2702	0
5875	2467	239987	468731	93342	0	0
5015	0	221848	224217	99421	3889	0
3120	0	110838	262854	26366	8231	0
3076	0	211967	171390	81404	4379	0
4626	49399	404354	355355	77669	1300	0
3624	0	411082	370188	71345	2436	0
3054	2764	267818	291918	76504	5036	0
Norsur						
85	98					
1	1	0.833	0.917			
0	4					
100	2694	35741	16347	3228	1443	
100	1304	10456	6853	2823	201	
100	909	26002	11055	7289	933	
100	2196	3368	4150	2935	533	
100	10247	20024	5791	466	10	
100	4546	18504	9186	980	66	
100	2240	25208	9958	2112	263	
100	22644	19058	11070	4232	382	
100	4763	30753	8903	3323	166	
100	2674	18622	10238	4135	1360	
100	1702	13839	7590	9288	365	
100	9150	28273	12045	5380	425	
100	2251	34738	16964	7145	3132	
100	3310	10956	13755	10271	1590	

Table 3.9 Extended Survivor analysis. Tuning output. Pandalus division IIIa and IVa eastLowestoft VPA Version 3.1

25/08/1999 10:48

Extended Survivors Analysis

Pandalus IIIa + IVa E Assessment 1999 WG CPUE data from file c:\vpa\99\panefs99.dat

Catch data for 14 years. 1985 to 1998. Ages 0 to 5.

Fleet	First	Last	First	Last	Alpha	Beta
	year	year	age	age		
Norsur	1985	1998	0	4	0.833	0.917

Time series weights :

Tapered time weighting applied Power = 3 over 20 years

Catchability analysis :

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 2

Terminal population estimation :

Survivor estimates shrunk towards the mean F of the final 5 years or the 2 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 21 iterations

1

Regression weights										
	0.751	0.82	0.877	0.921	0.954	0.976	0.99	1	1	1

Table 3.9 Extended Survivor analysis. Tuning output. Pandalus division IIIa and IVa east (cont)

Fishing mortalities Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.42	0.37	0.24	0.32	0.22	0.14	0.15	0.20	0.27	0.27
2	0.65	0.65	0.58	0.92	0.94	0.48	0.60	0.71	0.62	0.66
3	0.99	0.94	1.19	2.54	1.07	0.88	1.63	1.66	1.06	1.26
4	0.90	0.86	0.93	1.82	1.03	0.63	1.09	1.24	0.80	0.95

XSA population numbers (10^6)

	AGE				
YEAR	0	1	2	3	4
1989	22300	8900	1170	403	33
1990	17700	10500	2770	290	71
1991	11900	8370	3410	683	54
1992	29500	5630	3110	899	98
1993	16200	13900	1920	583	34
1994	14700	7630	5270	357	95
1995	20400	6950	3140	1540	70
1996	28400	9660	2840	817	142
1997	12000	13400	3730	660	73
1998	12400	5640	4830	949	108

Estimated population abundance at 1st Jan 1999

0	5830	2040	1180	127

Taper weighted geometric mean of the VPA populations:

16700	8140	3080	685	89

Standard error of the weighted Log(VPA populations) :

0.3514	0.3492	0.4038	0.5192	0.6852
--------	--------	--------	--------	--------

Log catchability residuals.

Fleet : Norsur							
Age	1985	1986	1987	1988	1989	1990	1991
0	-0.27	-0.83	-0.72	-0.63	0.75	0.16	-0.15
1	0.37	-0.54	0.61	-0.83	0.11	-0.17	0.25
2	-0.32	-0.78	0.45	-0.30	0.40	0.00	-0.18
3	1.00	-0.82	0.70	1.73	-0.75	0.27	0.41
4	1.08	-0.45	-0.33	0.28	-2.17	-1.08	0.64
Age	1992	1993	1994	1995	1996	1997	1998
Ō	1.26	0.30	-0.18	-0.96	0.39	-0.15	0.21
1	0.44	-0.08	-0.05	-0.25	0.18	0.12	-0.17
2	0.32	0.59	-0.68	-0.36	0.30	0.29	-0.14
3	2.00	0.91	1.45	1.46	1.57	1.54	1.72
4	1.18	0.74	1.45	0.84	0.42	2.69	1.75

Table 3.9 Extended Survivor analysis. Tuning output. Pandalus division IIIa and IVa east (cont.)

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

Age	0	1	2	3	4
Mean Log q	-12.3808	-9.7903	-9.0948	-9.0948	-9.0948
S.E(Log q)	0.6287	0.3504	0.4218	1.3909	1.4071

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	NoPts	Regs.e	Mean Q
0	0.52	1.87	14.43	0.62	14.00	0.29	-12.38
1	0.79	0.84	11.07	0.63	14.00	0.28	-9.79
2	2.74	-2.35	-1.09	0.16	14.00	0.97	-9.09
3	0.77	0.56	9.27	0.39	14.00	0.68	-8.04
4	0.83	0.34	8.96	0.31	14.00	1.08	-8.47

1

Terminal year survivor and F summaries :

Age 0 Catchability constant w.r.t. time and dependent on age

Year class = 1998

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	Ν	Scaled Weights	Estimated F
Norsur	7175496	0.656	0	0	1	0.367	0
F shrinkage mean	5171434	0.5				0.633	0.002
Weighted predictio	n :						
Survivors		Int	Ext	Ν	Var	F	
at end of year		s.e	s.e		Ratio		
-	5832590	0.4	0.26	2	0.655	0.001	

Table 3.9 Extended Survivor analysis. Tuning output. Pandalus division IIIa and IVa east (cont.)

Age 1 Catchability constant w.r.t. time and dependent on age

Year class = 1997

Fleet Norsur	Estimated Survivors 1733449	Int s.e 0.319	Ext s.e 0.011	Var Ratio 0.03	N 2	Scaled Weights 0.653	Estimated F 0.306
F shrinkage mean	2785965	0.5				0.347	0.201
Weighted prediction	on :						
Survivors at end of year	2043842	Int s.e 0.27	Ext s.e 0.2	N 3	Var Ratio 0.729	F 0.265	

1

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

Year class = 1996

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	Ν	Scaled Weights	Estimated F
Norsur	1246618	0.261	0.13	0.5	3	0.621	0.632
F shrinkage mean	1083960	0.5				0.379	0.7
Weighted prediction	on :						
Survivors		Int	Ext	Ν	Var	F	
at end of year		s.e	s.e		Ratio		

0.1

4

0.39

0.657

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

0.25

1182297

Year class = 1995

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	Ν	Scaled Weights	Estimated F
Norsur	149758	0.26	0.331	1.27	4	0.348	1.147
F shrinkage mean	115852	0.5				0.652	1.329
Weighted prediction	on :						
Survivors		Int	Ext	Ν	Var	F	
at end of year		s.e	s.e		Ratio		
-	126682	0.34	0.2	5	0.587	1.264	

Table 3.9 Extended Survivor analysis. Tuning output. Pandalus division IIIa and IVa east (cont.)

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

Year class = 1994

1

3

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	Ν	Scaled Weights	Estimated F
Norsur	27813	0.319	0.374	1.17	5	0.222	0.756
F shrinkage mean	17970	0.5				0.778	1.011
Weighted predictic	on :						
Survivors		Int	Ext	Ν	Var	F	
at end of year		s.e	s.e		Ratio		
	19795	0.4	0.23	6	0.59	0.951	

Table 3.10 Extended Survivor analysis. Fishing mortality at age. Pandalus division IIIa and IVa east Run title : Pandalus IIIa + IVa E Assessment 1999 WG

At 25/08/1999 10:50

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 1995 1996 1997 1998 FBAR 96-98 AGE 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.00 0.00 0.19 0.25 0.33 0.49 0.42 0.37 0.24 0.32 0.22 0.14 0.15 0.2 1 0.27 0.27 0.25 2 0.42 0.48 0.97 0.95 0.65 0.65 0.58 0.92 0.94 0.48 0.6 0.71 0.62 0.66 0.66 3 0.92 0.52 0.69 1.98 0.99 0.94 1.19 2.54 1.07 0.87 1.63 1.66 1.06 1.26 1.33 0.69 0.52 0.9 1.55 0.9 0.86 0.93 1.82 1.03 0.63 1.09 1.24 0.80 0.95 1.00 4 0.69 0.52 0.9 1.55 0.9 0.86 0.93 1.82 1.03 0.63 1.09 1.24 0.80 0.95 +gp FBAR 1-0.51 0.42 0.66 1.14 0.68 0.65 0.67 1.26 0.74 0.5 0.79 0.86 0.65 0.73

Table 3.11 Extended Survivor analysis. Stock number at age. Pandalus division IIIa and IVa east

Run title : Pandalus IIIa + IVa E Assessment 1999 WG

1999 WC

At 25/08/1999 10:51

Terminal Fs derived using XSA (With F shrinkage)

Table 1	0 Stock	number a	t age (star	t of year)	Ν	umbers*10	**-4		
YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993
AGE									
0	1622541	1374144	861516	1886117	2226105	1772907	1193247	2946572	1618607
1	1001942	765219	648591	406768	889967	1049384	837462	563379	1390111
2	556795	390756	282672	219741	117466	277184	341048	310932	192484
3	45491	173290	113810	50667	40302	28992	68331	89911	58271
4	15280	8572	48684	26944	3301	7091	5372	9826	3355
+gp	9	358	1101	112	39	733	720	142	128
TOTAL	3242058	2712339	1956375	2590348	3277180	3136292	2446180	3920761	3262956
	1994	1995	1996	1997	1998	1999	GMST 85-96	AMST 85-96	
0	1471373	2044941	2842739	1197112	1236617	0	1725379	1821734	
1	762708	694982	965778	1338613	564121	583259	794675	831358	
2	526773	314097	283889	372927	482788	204384	294283	317820	
3	35680	153957	81669	65965	94926	118230	67233	78364	
4	9470	7029	14205	7332	10844	12668	9676	13261	
+gp	0	1962	0	491	537	2078			
TOTAL	2806005	3216968	4188279	2982440	2389833	920619			

Table 3.12	Extended Survivo	r analysis. Sumi	nary table wit	thout SOP co	rrections.		
	Pandalusdivision	IIIa and I Va					
Pup title	· Dandalus IIIa + IV	Jo E Assassment					
Kull title	. Fallualus IIIa \pm F	v a E Assessment					
	1999 WG						
At 25/08/	1999 10:51	M=0.75					
Table	16 Summary (v	without SOP corre	ection)				
	Terminal Fs derive	d using XSA (W	ith F shrinkage	;)			
	RECRUITS	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR1-3	М
	Age I						
1985	10019	73969	28866	12602	0.437	0.5093	0.75
1986	7652	77232	17451	13201	0.757	0.4163	0.75
1987	6486	43560	17142	14876	0.868	0.664	0.75
1988	4068	31788	10821	12929	1.195	1.1397	0.75
1989	8900	67219	10698	12101	1.131	0.6844	0.75
1990	10494	49578	17302	11420	0.660	0.6534	0.75
1991	8375	69647	19285	12106	0.628	0.6711	0.75
1992	5634	73168	17543	13556	0.773	1.2622	0.75
1993	13901	67385	11318	13475	1.191	0.7409	0.75
1994	7627	62195	26658	11745	0.441	0.4973	0.75
1995	6950	55686	23964	14605	0.610	0.7918	0.75
1996	9658	83973	20593	14547	0.706	0.8571	0.75
1997	13386	71116	18819	16109	0.856	0.6479	0.75
1998	5641	63304	25675	15753	0.614	0.7287	0.75
Arith.							
Mean	8485	63559	19009	13502	0.776	0.7332	0.75
0 Units	(Millions)	(Tonnes)	(Tonnes)	(Tonnes)			

Run title : Pandalus IIIa + IVa E Assessment

1999 WG

At 25/08/1999 13:36 VariableM

 Table 16
 Summary
 (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR1-3	Μ
	Age I						
1985	12318	89026	34082	12602	0.370	0.4518	0.88
1986	8601	86442	19263	13201	0.685	0.3915	0.86
1987	6624	44517	17511	14876	0.850	0.656	0.78
1988	3942	31370	10838	12929	1.193	1.1783	0.78
1989	7854	57481	9840	12101	1.230	0.7528	0.70
1990	8732	42132	15249	11420	0.749	0.7404	0.66
1991	6631	55417	16574	12106	0.730	0.7488	0.59
1992	4747	61096	15878	13556	0.854	1.35	0.62
1993	12289	60236	10426	13475	1.292	0.7788	0.64
1994	7602	61047	25886	11745	0.454	0.4933	0.69
1995	8086	61004	24983	14605	0.585	0.7398	0.76
1996	12953	110041	23510	14547	0.619	0.7363	0.83
1997	18350	94775	23880	16109	0.675	0.5398	0.96
1998	7340	78764	30223	15753	0.521	0.7351	1.11
Arith.							
Mean	9005	66668	19867	13502	0.772	0.7352	0.78
0 Units	(Millions)	(Tonnes)	(Tonnes)	(Tonnes)			

	Survey	-9		XSA		
Year-class	0-GR	I-GR	II-GR	0-GR	1-GR	2-GR
1983		20003	16347			556795
1984	3074	35741	6852		1001942	390756
1985	2695	10456	11055	1622541	765219	282672
1986	1305	26002	4150	1374144	648591	219741
1987	909	3368	4470	861516	406768	117466
1988	2196	19514	9186	1886117	889967	277184
1989	9933	18504	9958	2226105	1049384	341048
1990	4546	25208	11070	1772907	837462	310932
1991	2240	19058	8903	1193247	563379	192484
1992	22644	30753	10238	2946572	1390111	526773
1993	4763	18622	7590	1618607	762708	314097
1994	2674	13839	12045	1471373	694982	283889
1995	1702	28273	16964	2044941	965778	372927
1996	9150	34738	13755	2842739	1338613	482788
1997	2251	10956		1197112	564121	
1998	3310			1236617		

Table 3.13Indices of 0,I and II-group shrimp from Norwegian
trawl surveys in October and XSA values

Table 3.14

October 7, 1999 Pandalus in Divisions IIIa & IVa East(Skagerrak & Norwegian Deeps)

Multi fleet prediction with mangement option table: Input data

+	landi	ings	disca	ards						+
++	Exploit.	Weight	Exploit.	Weight	Stock	Natural	Maturity	Prop.of F	Prop.of M	Weight
Age	pattern	in catch	pattern	in catch	size	mortality	ogive	bef.spaw.	bef.spaw.	in stock
++	++	++	0 0000		+ 17253 000	++	0 0000	+	++	0 400!
	0.2125	0.003	0.0375	0.003	5833.000	0.7500	0.0000	0.0000	0.0000	3.200
2	0.6600	0.006	0.0000	0.006	2044.000	0.7500	0.6000	0.0000	0.0000	5.800
3	1.3300	0.009	0.0000	0.009	1182.000	0.7500	1.0000	0.0000	0.0000	8.800
4	1.0000	0.012	0.0000	0.012	127.000	0.7500	1.0000	0.0000	0.0000	12.000
5+	1.0000	0.012	0.0000	0.012	21.000	0.7500	1.0000	0.0000	0.0000	12.200
Unit	-	Kilograms	-	Kilograms	Millions	+	-	+	++	Grams
·								+		
2000	00 landings		disca	ards						
++	Exploit		Exploit	Weight	Recruit-	Natural !	Maturity	Prop of F	Prop of M!	Weight !
	pattern	in catch!	pattern	in catch	ment	mortality	ogive	bef spaw	bef_spaw	in stock!
++	+				+	++		+	+======+	
	0.0000	0.000	0.0000	0.000	17253.000	0.7500	0.0000	0.0000	0.0000	0.400
1 1	0.2125	0.003	0.0375	0.003		0.7500	0.0000	0.0000	0.0000	3.200
2	0.6600	0.006	0.0000	0.006		0.7500	0.6000	0.0000	0.0000	5.800
3	1.3300	0.009	0.0000	0.009		0.7500	1.0000	0.0000	0.0000	8.800
4	1.0000	0.012	0.0000	0.012		0.7500	1.0000	0.0000	0.0000	12.000
5+	1.0000	0.012	0.0000	0.012		0.7500	1.0000	0.0000	0.0000	12.200
++	+	Kilograms	-	Kilograms	Millions	++		+	++	Grams
+										+
2001	landi	ings	disca	ards						
++	Exploit	Weight !	Exploit	Weight	Recruit-	Natural !	Maturity	Prop of F	Prop of M!	Weight !
	nattern	in catch!	nattern	in catch	ment	mortality!	ogive	hef snaw	hef snaw	in stock!
++	+	111 Catten				++		+	++	!
	0.0000	0.000	0.0000	0.000	17253.000	0.7500	0.0000	0.0000	0.0000	0.400
1	0.2125	0.003	0.0375	0.003		0.7500	0.0000	0.0000	0.0000	3.200
2	0.6600	0.006	0.0000	0.006		0.7500	0.6000	0.0000	0.0000	5.800
3	1.3300	0.009	0.0000	0.009		0.7500	1.0000	0.0000	0.0000	8.800
4	1.0000	0.012	0.0000	0.012		0.7500	1.0000	0.0000	0.0000	12.000
5+	1.0000	0.012	0.0000	0.012		0.7500	1.0000	0.0000	0.0000	12.200
++	+	Kilograms	-	Kilograms	Millions	++		+	++ -	Grams

Notes: Run name : MANHS07 Date and time: 070CT99:14:57

The SAS System

14:57 Thursday,

October 7, 1999 Pandalus in Divisions IIIa & IVa East(Skagerrak & Norwegian Deeps)

Multi fleet prediction with mangement option table

+-					Year: 1999				+
+-		landings			discards		Total		
	F Factor	Reference F	Catch in weight	F Factor	Reference	Catch in weight	Catch in weight	Stock biomass	Sp.stock biomass
+-	1.0000	0.7342	13362	1.0000	0.0375	442	13805	49604	19295
+-	-	–	Tonnes	-	_	Tonnes	Tonnes	Tonnes	Tonnes

	Year: 2000								Year:	2001
	landings			discards		Total	-			
F	Reference	Catch in	F	Reference	Catch in	Catch in	Stock	Sp.stock	Stock	Sp.stock
Factor	F	weight	Factor	F	weight	weight	biomass	biomass	biomass	biomass
0.0000	++	+ 0	0.0000	++	0	0	+ 51903	13945	+68056	26145
0.1000	0.0734	1476	0.1000	0.0038	68	1544		13945	66488	24797
0.2000	0.1468	2857	0.2000	0.0075	135	2992		13945	65022	23546
0.3000	0.2203	4153	0.3000	0.0113	200	4353		13945	63651	22385
0.4000	0.2937	5371	0.4000	0.0150	264	5634		13945	62365	21304
0.5000	0.3671	6516	0.5000	0.0188	326	6842		13945	61158	20296
0.6000	0.4405	7595	0.6000	0.0225	387	7982		13945	60023	19356
0.7000	0.5139	8613	0.7000	0.0263	447	9060		13945	58955	18477
0.8000	0.5873	9575	0.8000	0.0300	505	10080		13945	57947	17654
0.9000	0.6608	10486	0.9000	0.0338	562	11048		13945	56995	16883
1.0000	0.7342	11348	1.0000	0.0375	618	11967		13945	56095	16159
1.1000	0.8076	12167	1.1000	0.0413	673	12840		13945	55244	15479
1.2000	0.8810	12944	1.2000	0.0450	727	13671		13945	54436	14839
1.3000	0.9544	13684	1.3000	0.0488	779	14463		13945	53669	14236
1.4000	1.0278	14388	1.4000	0.0525	830	15218		13945	52941	13667
1.5000	1.1013	15059	1.5000	0.0563	881	15940		13945	52248	13130
1.6000	1.1747	15700	1.6000	0.0600	930	16629		13945	51589	12621
1.7000	1.2481	16312	1.7000	0.0638	978	17290		13945	50960	12140
1.8000	1.3215	16897	1.8000	0.0675	1025	17922		13945	50360	11685
1.9000	1.3949	17457	1.9000	0.0713	1071	18528		13945	49787	11252
2.0000	1.4683	17994	2.0000	0.0750	1116	19110		13945	49239	10841
+	++	Tonnes	-	++	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANHS07 Date and time : 070CT99:14:57 Computation of ref. F: landings: Simple mean, age 1 - 3 discards: F at age 1 Basis for 1999 : F factors

Table 3.15 Input table for medium term evaluations

StartYear: 1999

	Stock		Nat.	Fishing	mW		mW	Prop.	
Age	(mill)	SD In	mort.	pattern	catch	SD	stock	Mature	SD
1	5641	0.27	0.75	0.24	2.13	0.17	1.46	0.00	0.00
2	4828	0.25	0.75	0.66	4.71	0.17	3.98	0.54	0.24
3	949	0.34	0.75	1.33	7.64	0.45	6.85	1.00	0.00
4	108	0.4	0.75	1.00	10.54	0.86	9.62	1.00	0.00
5	1.2	0.4	0.75	1.00	13.17	1.30	12.23	1.00	0.00

Table 3.16 Input table for long term evaluations

AGE	Ν	F pattern	M pattern	WEST	WECA	maturity
1	8186	0.24	1.00	2.13	3.13	0
2	3042	0.66	1.00	4.71	5.58	0.54
3	743	1.33	1.00	7.64	8.53	1
4	93	1.00	1.00	10.54	11.55	1
5	16	1.00	1.00	13.17	14.19	1
6	3	1.00	1.00	13.17	14.19	1

F (1-3): 0.74

Table 3.17 Long-term yield for fixed M levels, max F if SSB> Bloss

F/Z	Z (1-3)	Μ	F factor	Yield
0.00	1.40	1.4	0.00	0
0.09	1.43	1.3	0.17	1966
0.19	1.49	1.2	0.39	4420
0.29	1.55	1.1	0.61	6822
0.39	1.63	1	0.85	9315
0.47	1.71	0.9	1.09	11780
0.55	1.80	0.8	1.34	14277
0.63	1.89	0.7	1.60	16802
0.70	1.98	0.6	1.85	19328
0.76	2.06	0.5	2.10	21898

Table 3.18 Long term yield for fixed F (factor) levels, maximum M which give SSB > Bloss.

F/Z	Z (1-3)	F factor	Μ	Yield
0.05	1.41	0.1	1.34	1151
0.10	1.44	0.2	1.29	2293
0.15	1.46	0.3	1.24	3430
0.20	1.49	0.4	1.19	4567
0.24	1.52	0.5	1.15	5625
0.29	1.55	0.6	1.1	6757
0.33	1.58	0.7	1.06	7790
0.37	1.61	0.8	1.02	8810
0.41	1.65	0.9	0.98	9819
0.44	1.68	1	0.94	10821
0.48	1.71	1.1	0.89	11973
0.51	1.74	1.2	0.85	12620
0.54	1.79	1.3	0.82	13808
0.57	1.82	1.4	0.78	14803

Reference point	Deterministic	Median	95th percentile	80th percentile	Hist SSB < ref pt %
MedianRecruits	16205740	16205740	19089240	17729070	_
MBAL	0				0.00
Bloss	10698				
SSB90%R90%Surv	15420	15216	18266	17357	21.43
SPR%ofVirgin	39.97	40.43	48.46	45.70	
VirginSPR	0.00	0.00	0.00	0.00	
SPRIoss	0.00	0.00	0.00	0.00	
	Deterministic	Median	5th percentile	20th percentile	Hist F > ref pt %
FBar	0.73	0.72	0.65	0.69	35.71
Fmax	37.48	42.90	20.01	26.74	0.00
F0.1	0.76	0.78	0.58	0.66	28.57
Flow	0.23	0.23	0.00	0.08	100.00
Fmed	0.65	0.62	0.17	0.35	78.57
Fhigh	1.00	1.00	0.05	1.00	0.00
1 mgn	1.83	1.83	0.95	1.29	0.00
F35%SPR	1.83 0.90	1.83 0.92	0.95 0.62	1.29 0.74	14.29

Table 3.19 Precautionary Approach EXCEL add-in reference points

For estimation of Gloss and Floss:

A LOWESS smoother with a span of 0.5 was used. Stock recruit data were log-transformed A point representing the origin was included in the stock recruit data.

For estimation of the stock recruitment relationship used in equilibrium calculations:

A LOWESS smoother with a span of 1 was used.

Stock recruit data were un-transformed

No point representing the origin was included in the stock recruit data.

Pandalus IIIa + IVa E Assessment, 1999 WG

Steady state selection averaged over 5 years. FBar averaged from age 1 to 3

Number of iterations = 200 Random number seed = -99

Data source: C:\VPA\99\presur8598.

FishLab DLL used

FLVB32.DLL built on Aug 18 1998 at 08:57:43

26.08.99 10:48:00

Year	Denmark	Sweden	Norway	UK (Scotland)	Total
1972	2204			187	2391
1973	157			163	320
1974	282			434	716
1975	1308			525	1833
1976	1552			1937	3489
1977	425		112	1692	2229
1978	890		81	2027	2998
1979	565		44	268	877
1980	1122		76	377	1575
1981	685		1	347	1033
1982	283			352	635
1983	5729		8	1827	7564
1984	4553		13	25	4591
1985	3649			1341	4990
1986	3416			301	3717
1987	7326			686	8012
1988	1077		2	84	1163
1989	2438		25	547	3010
1990	1681	4	3	365	2053
1991	422		31	53	506
1992	1448			116	1564
1993	1521		38	509	2068
1994	1207		0	35	1242
1995	4578		30	1298	5906
1996	3858		32	1893	5783
1997	2892		9	365	3266
1998	2900		3	1365	4268

Table 4.1Landings in tonnes of Pandalus borealis from the Fladen Ground
(Division IVa) as estimated by the Study Group

Table 4.2Pandalus borealis, Fladen Ground. Reported LPUE
(shrimp trawlers), and estimated effort.

	Denmark		UK (Scotland)				
Year	LPUE	Total effort	effort	LPUE	Total effort	effort	Combined
	(ton./day)	(Days)	Index1	(kg/hour)	(hours)	Index1	index2
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
1995	2.00	2292	0.76	130	5038	0.32	0.71
1996	1.79	2168	0.72	62	11638	0.75	0.72
1997	2.86	1012	0.34	202	1810	0.12	0.31
1998	2.20	1229	0.41	134	4004	0.26	0.38

Table 5.1Landings (t) of Pandalus borealis from division IVb,
the Farn Deeps as estimated by the Working Group

Year	UK (England)	UK (Scotland)	Denmark	Total
1977	227		No data	
1978	91	2	-	93
1979	235	34	-	269
1980	203	17	-	220
1981	1		-	1
1982			-	0
1983	65		-	65
1984	30		-	30
1985	2	6	-	8
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
1995	171			171
1996	58	2		60
1997	5			5
1998	5			5





Figure 3.1. Mean quarterly carapace length (mm) for *Pandalus* in div IIIa and IVa east.



Figure 3.2 Total stock biomass (TSB) and spawning stock biomass (SSB) for *Pandalus* in div IIIa and IVa east with fixed (Std) and variable (VarM) natural mortality.



Figure 3.3 Log catchabillity residuals. Pandalus division IIIa and IVa east



Figure 3.4 Retrospective VPA. Pandalus division IIIa and IVa east









Figure 3.5 Medium term prediction at status quo fishing mortality. Percentiles of Spawning Stock Biomass, landings and I-group recruitment.



Figure 3.6 Historical development of Fishing mortality F (1-3) and Spawning Stock Biomass of *Pandalus* in div IIIa and IVa east in relation to Precautionary Approach reference points.