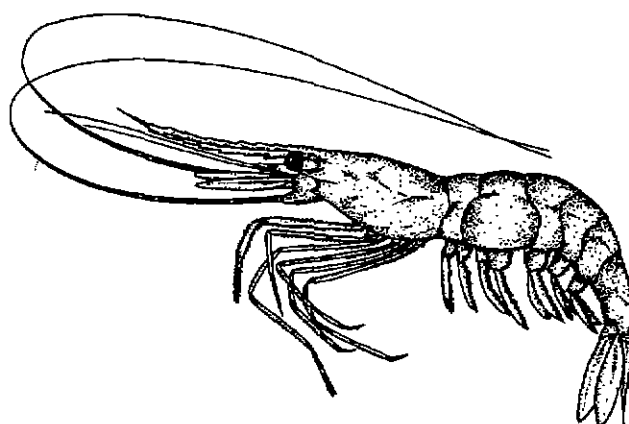


REVISED

REPORT OF THE
Pandalus Assessment Working Group

ICES Headquarters
1 - 4 September 1998



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International Council for the Exploration of the Sea
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TABLE OF CONTENTS

Section	Page
1 TERMS OF REFERENCE	1
2 PARTICIPANTS	1
3 PANDALUS STOCKS IN SUB-AREA IV AND DIVISION IIIA	1
3.1 Natural mortality	1
3.1.1 Landings	2
3.1.2 Discards	2
3.1.3 Effort	2
3.1.4 Assessment	2
3.1.4.1 Age distributions	2
3.1.4.2 Mean weight and maturity at age	2
3.1.4.3 Natural mortality	3
3.1.4.4 Assessment	3
3.1.4.5 Recruitment	3
3.1.4.6 Catch prediction	3
3.1.4.7 Management consideration	4
3.1.4.8 Assessment quality	5
3.2 Fladen Ground	5
3.3 Farn Deeps	5
4 BYCATCH	5
5 REFERENCES	5
Tables 3.1 - 4.2	6
Figures 3.1.1 - 3.2.1	26

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] (Chairman: Mr S. Tveite, Norway) will meet at ICES Headquarters from 1 - 4 September 1998 to:

- a) assess the status of the stocks of *Pandalus borealis* in the North Sea, Skagerrak and Kattegat and provide catch options for 1999;
- b) determine the predation mortality of *Pandalus* stocks;
- c) continue the work on determining the criteria for ageing;
- d) continue the work on the definition of population and assessment units;
- e) consider the reference points proposed by the SGPAFM, adopting those referents points or presenting alternatives with reasons for the alternative selection;
- f) consider the harvest control rules proposed by SGPAFM, taking into account uncertainties in the data, in the assessments and in the biological processes, and assuming a stock-recruitment relationship to estimate the probability of avoiding limit reference points;
- g) update informations on quantities of discards by gear type for stocks and fisheries considered by this group using the format proposed by the WGECO with a view to establishing a time series.

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.

The Working Group will report to ACFM before its October 1998 meeting and to the Living Resource Committee at the 1999 Annual Science Conference.”

2 PARTICIPANTS

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

Data from the Scottish and English shrimp fishery in the North Sea were supplied by T. Howell and Jon Elson.

3 PANDALUS STOCKS IN SUB-AREA IV AND DIVISION IIIA

A detailed overview of the various stocks is given in ICES (CM 1990/Assess:9) The Working Group considers 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 3.1.

3.1 Natural mortality

The level of natural mortality for *Pandalus* has been discussed at several occasions. The value used, i.e., 0.75 for Divisions 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 year's assessments.

3.1.1 Landings

Landings are given in Table 3.1 by area (Division IIIa and Sub-area IV) as officially reported to ICES. The landings increased in Skagerrak while there was a reduction in Sub-area IV.

Table 3.1.1 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 1996 level and are on a record high level viz. around 15 200 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 lose weight. The conversion factor to obtain live weight is 1.15. Official reported figures from Norway are given as landed weight. The same procedure has been adopted by Sweden 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. No conversion has been applied on the Norwegian landings by the Working Group. The underestimate of total landings by this omission is for 1997 roughly estimated to about 500 t. The Working Group felt this estimate too inaccurate to include in the assessment figures. When more accurate estimates become available, the landings for all years should be updated.

3.1.2 Discards

Discarded shrimps are of two categories:

The smallest size fractions from the sieving procedure is 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 proportion 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 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.

The estimate of total discards in 1997 of 2403 t was added to the total catch for assessment purpose.

3.1.3 Effort

Annual figures for landings per unit of effort (LPUE) and effort are given in Table 3.1.2 Total effort values have been estimated from LPUE data based on logbook records. Effort for all countries were similar to the 1996 level, while Danish and Norwegian LPUE were record high. Also the Swedish CPUE is record high when high grading is accounted for.

3.1.4 Assessment

3.1.4.1 Age distributions

Length frequencies in numbers caught per mm-group from Danish, Norwegian and Swedish quarterly samples were added to a common length distribution for the combined landings. Numbers at age were then estimated by splitting this common length frequency distributions into normal distributions using the Bhattacharya method as implemented in ELEFAN (Pauly 1987). Quarterly growths are shown in Figure 3.1.1. Total catch in numbers at age are given in Table 3.1.3.

3.1.4.2 Mean weight and maturity at age

Weights at age for 1997 were obtained by applying average Danish and Swedish mean weight per length group data to the length frequencies of each year class. The mean weights at age in the catch is given in Table 3.1.4. The same weights at age are used as stock weights.

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:

1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
0.62	0.09	0.20	0.30	0.68	0.73	0.73	0.68	0.70	0.64	0.45	0.46	0.51

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

3.1.4.3 Natural mortality

M was, as in previous years, set at 0.75 for all ages.

3.1.4.4 Assessment

An XSA was performed on the 1985–1997 dataset to estimate stock sizes and exploitation levels. Data on effort and catch per unit of effort by age for three commercial fleets and catch at age from the annual Norwegian shrimp survey was used for tuning (Table 3.1.5).

Default values were accepted, in most instances, as input variables in the XSA (Table 3.1.6). 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 3.1.7) 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 3.1.8. Spawning stock increased in 1997 due to the strong 1995 and 1996 year classes.

Summary results without SOP corrections are given in Table 3.1.9 and Figure 3.1.2

A retrospective XSA covering the period 1994–97 is presented in Figures 3.1.3. The pattern for fishing mortality shows a slight tendency of overestimation in earlier years.

The available biomass indices (total stock, SSB, survey CPUE and the combined commercial fleets) are compared in Figure 3.1.4. The series are expressed as percent of their 1985–1997 mean values. The trends are similar in all series.

3.1.4.5 Recruitment

The abundance indices of young shrimps obtained by the Norwegian survey in October 1997 are given in Table 3.1.10. The 1996 year class had a medium high 0-group index but turned out to be very strong as I-group. The 1997 0-group index is below average and was estimated by the XSA to be very small. A new and more reliable estimate of this year-class as I-group will be made during the 1998 surveys. The results will be made available to the October meeting of the ACFM.

3.1.4.6 Catch prediction

Input data for the prediction are shown in Table 3.1.11. The fishing pattern used for 1998 is the 1995–1997 average (not scaled to the 1997 level). Mean weights are averages for the period 1995–1997. Recruitment in 1998 - 2000 is the geometric average for the period 1985–1996.

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 1998 is predicted to 25,638 tonnes, whereas the agreed TAC is 18,800 t. Predicted *status quo* catches in 1999 is 17,116 t assuming mean recruitment (1985–1996) (Table 3.1.12).

An alternative prediction (Table 3.1.13) was run with the catch in 1998 restricted to 18,800 tonnes. Such a TAC constraint would require a reduction of fishing mortality in 1998 with about 35%.

3.1.4.7 Management consideration

Medium-term evaluation

Predictions of yield and spawning stock size for the period 1998-2007 were performed based on a model developed at the Danish Institute for Fisheries Research. It is implemented in Excel. The model includes uncertainties in the estimated population size in 1998, 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 by 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 Ricker function. Recruitment is assumed to be lognormally distributed around the Ricker curve using the variance observed in the historic data.

The values of the uncertainties used are given below:

Age	STOCK Log SE	Mean Weight Std.dev.	Maturity Std.dev.	SR - relation Std.dev. of Log values
1	0.16	0.37	0.21	0.408
2	0.12	0.27		
3	0.16	0.47		
4	0.13	0.77		
5	0.20	1.46		

The results are given as percentiles of the probability distributions after 200 runs for SSB, yield and recruitment under constant fishing mortality (Figure 3.1.5).

The results indicates that if current fishing mortality is applied continuously, both the yield and SSB will drop in 1999 and 2000 and thereafter stabilize of about 15 000 t for the yield and about 20 000 t for the SSB.

Long-term evaluation

A stock-recruitment relationship was calculated as a Ricker curve based on the 1986-1997 data points (Figure 3.1.6). The estimated values for the parameters are $a = 1.465$ and $b = 17.095$, when recruitment is expressed in billions and SSB in thousand tonnes. Maximum recruitment would consequently occur at around 17 000 t SSB. The rather narrow range of SSB (12,000-23,000 t), so far experienced, makes the estimation of the relationship unprecise.

The stock-recruitment relationship according to Beverton-Holt ($a = 0.108$ and $b = 0.0489$) indicated that recruitment would not decrease drastically until SSB is very low (ca 1 000 tonnes).

The Working Group decided to apply the relationship according to Ricker as long as the knowledge of stock behaviour at low levels is virtually lacking.

Equilibrium yield and SSB based on this S-R relationship and a Yield per recruit calculation are given on Figure 3.1.7.

Biological Reference Points

The lack of information for low stock sizes made the Working Group to propose the lowest observed biomass as the limit value. The F_{loss} was consequently proposed as the F_{lim} . The results from the Medium-term predictions resulted in a low probability (10%) to obtain SSB below 12 000 t if the current fishing mortality is applied. The expected value of SSB at this F was calculated to about 20 000 ton, which could be proposed as the B_{pa} .

It would imply that the overall uncertainty measure was $\sigma = 0.3$, which seems reasonable taking into account *inter alia* the problems in ageing.

The F_{loss} was estimated to be ca 1.5. The outcome of the Medium-term prediction with this level of exploitation gave an expected level of SSB of about 12 000 t. The overall uncertainty measure would in this case be $\sigma = 0.48$.

$B_{lim} = B_{loss}$	12 300 t
$B_{pa} = B_{lim} e^{1.645 \cdot \sigma}$	20 000 t
$F_{lim} = F_{loss}$	1.48
$F_{pa} = F_{lim} e^{-1.645 \cdot \sigma}$	0.67

The F_{med} was calculated to be 0.9.

The historical development of F and SSB in relation to the Precautionary approach reference points is illustrated in Figure 3.1.8

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. In recent years, a number of boats have voluntarily used both panels and grids in the shrimp gear to reduce the amount of by-catch.

3.1.4.8 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 Deep than in the Skagerrak indicating a considerable bias in sampling of commercial catches.

Estimates of discards (both their quantities and age composition) are uncertain.

3.2 Fladen Ground

Table 3.2.1 shows the landings from the Fladen Ground since 1972. This stock is almost only exploited by Denmark and Scotland. It is seen from Table 3.2.1 that the landings from the Fladen stock have been subject to large fluctuations since 1972. In 1997 the total landings declined again after two years (1995 and 1996) of increasing trends. However, both the Danish and Scottish CPUE figures for 1997 are relatively high (Table 3.2.2), and the declining catches (landings) may reflect less profitable fisheries rather than a decline in stock size.

No analytical assessment of the Fladen stock has been carried out since 1992. However, data for analytical assessments are available for the Danish fishery for the years 1985 - 1997. The Fladen stock is normally composed of at most 4 age groups of which the amount of the oldest is very small. Stock size depends to a very large extent on the recruitment, see the Working Group Reports for 1990 & 1991 (Anon. 1990 and 1991).

3.3 Farn Deep

In recent years *Pandalus* in the Farn Deep have been fished by UK vessels only. Total landings fell from 500 t in 1988 to nil in 1993. In recent years this fishery has been rather insignificant. In 1994 there was a small fishery of 4 tonnes, 171 t in 1995 and 60 t in 1996 while the landings again in 1997 fell to only 5 t. (Table 3.3.1).

4 BYCATCH

Figures for by-catch in the 1997 shrimp fishery are available from Danish and Swedish log books. However, log book information is usually unreliable for species other than the target species due to under or misreporting. This is especially true for information on discards. Therefore the data shown in Tables 4.1 and 4.2 must be viewed cautiously. The Danish log book data do not contain any discard data, but this does not mean that discarding of by-catch does not take place in the Danish shrimp fishery. The Swedish log books do contain data on discards, but there is no doubt that these figures are biased towards underreporting the amount of discards. No Norwegian data were available to this year's Working Group, but also here by-catch and discarding is a matter of concern.

At last year's WG meeting data were also available from a Danish project on discarding in the North Sea fisheries. And a first estimate of the total by-catch by species in the international shrimp fishery was obtained by raising the estimated total by-catch in the Danish Shrimp fishery to the total catch of shrimp by all nations (Anon., 1998). This project is continuing, but no further analyses of data on discarding in the shrimp fisheries have taken place since last year.

In recent years both panels and grids have become more popular in the shrimp gear to reduce the amount of by-catch.

5 REFERENCES

- Anon (1990). Report on the Working group on the assessment of Pandalus Stocks ICES C.M.1990/Assess:9.
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- Cook, R.M. (1995). A simple model for the analysis of research vessel data to determine stock trends. ICES CM 1995/D:12.
- 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 3.1 Nominal landings (tonnes) of *Pandalus borealis* in ICES Division IIIa and subarea IV as officially reported to ICES.

Year	Division IIIa				Sub-area IV					
	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	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	4389	2553	8915	1352	2425	176	41	35	4029
1995	2494	5181	2512	10187	4698	2972	166	217	1324	9377
1996	3664	5143	2091	10898	4063	2772	85	97	1899	8916
1997	3617	5451	2103	11171	3117	3112	285	52	365	6931

* Includes small amounts of other Pandalid shrimp

† 1970 to 1974 includes subarea IV.

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

1997 figures are preliminary.

Table 3.1.1 *Pandalus borealis* landings from divisions IIIa (Skagerrak) and IVa (eastern part). (Norwegian Deeps) as estimated by the Working Group

Year	Denmark	Norway	Sweden	Total	Estimated 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	584		12628
1986	4834	6490	1463	12787	477		13264
1987	4599	8343	1321	14263	808		15071
1988	3068	7661	1278	12007	830		12837
1989	3150	6411	1433	10994	1548		12542
1990	2479	6139	1540	10158	1723		11881
1991	3583	6106	1908	11597	765		12362
1992	3725	7136	2154	13015	713	15000	13728
1993	2915	7504	2300	12719	1340	15000	14059
1994	2118	6813	2719	11650	426	18000	12076
1995	2465	8153	2678	13296	642	16000	13938
1996	3868	7883	2371	14122	1282	15000	15404
1997	3747	8865	2598	15210	2403	18000	17613
1998						18800	

Table 3.1.2 National LPUE and effort as estimated by the Study Group , *Pandalus* division IIIa and IVa east

Year	Denmark		Norway		Sweden		combined effort index rel. to 1986
	LPUE kg/day	effort days	LPUE kg/hr	effort Khrs	LPUE kg/hr	effort Khrs	
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	1.20
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	31	243	25	91	1.27
1994	677	3120	31	218	33	82	1.17
1995	801	3076	35	255	39	76	1.26
1996	860	4626	37	214	32	74	1.06
1997	1034	3624	42	212	33	78	1.06

Table 3.1.3 Catch in numbers at age. Pandalus division IIIa and IVa east

Table 1	Catch		numbers		at		age				
YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993		
AGE											
0	36461	14935	11110	55226	109572	46434	13460	108487	42707		
1	1027292	975704	1252658	613709	1557375	1333575	816547	436766	1227845		
2	1260872	1045879	1173137	971146	681884	1094654	1108258	1477651	872517		
3	191514	508662	474785	429783	338637	158695	295515	579407	440173		
4	47929	22332	75088	164479	43328	38431	30660	19039	13896		
+gp	0	1444	712	4104	816	319	0	0	591		
TOTALNUM	2564066	2568957	2987491	2238448	2731614	2672107	2264441	2621349	2597729		
TONSLAND	12628	13264	15071	12837	12542	11881	12362	13728	14059		
SOPCOF	89	106	102	106	90	86	98	97	101		
YEAR	1994	1995	1996	1997							
AGE											
0	15713	22855	10000	10000							
1	581274	432136	1090621	2063258							
2	1242004	943017	997667	1634608							
3	288130	725522	427399	328225							
4	17674	57653	62322	38235							
+gp	0	1606	1494	7640							
TOTALNUM	2144794	2182790	2589503	4081968							
TONSLAND	12076	13938	15404	17613							
SOPCOF	109	103	111	90							

Table 3.1.4 Mean weight at age. Pandalus division IIIa and IVa east

Table	2 Catch		weights		at		age		(kg)				
YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	
AGE													
0	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0	0.001	0.001	
1	0.003	0.003	0.003	0.004	0.004	0.004	0.004	0.004	0.004	0.003	0.003	0.003	
2	0.005	0.005	0.005	0.006	0.006	0.006	0.005	0.006	0.005	0.006	0.006	0.006	
3	0.008	0.009	0.008	0.009	0.009	0.008	0.008	0.008	0.008	0.008	0.009	0.009	
4	0.012	0.011	0.011	0.012	0.011	0.011	0.012	0.013	0.012	0.012	0.012	0.011	
+gp	0.013	0.013	0.018	0.015	0.014	0	0	0.016	0	0.015	0.017	0.014	
SOPCOFAC	1.0588	1.0222	1.0632	0.8952	0.8607	0.9787	0.9731	1.0114	1.0911	1.0344	1.1092	0.9037	

Table 3.1.5 Extended Survivor analysis. Tuning input file. Pandalus division IIIa and IVa east

Pandalus IIIa-IVaE tuning file WG 1998

104

Denmark

85 97

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
3076	84689163	184810603	142186264	11298627	314731
4626	368911153	320439748	133624428	19647255	444115
3624	467822273	327745363	60262925	6524007	1266005

Norway

86 97

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
255	271284059	592002196	455464023	36192794	1008176
214	451278823	467627924	216509613	31702907	792571
212	1235209060	1050866818	219428660	26661280	5367507

Sweden

85 97

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49.0	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
61.0	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
76.0	84593442	184601719	142025557	11285857	314376
73.5	270431338	209600358	77265633	10972810	258048
78.2	360226746	255995555	48533106	5049850	1006615

Norwegian Surveys

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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

Table 3.1.6 Extended Survivor analysis.Tuning output. Pandalus division IIIa and IVa east
Lowestoft VPA Version 3.1

02/09/98 15:26:47

Extended Survivors Analysis

Pandalus IIIa & IVa E (run:XSASTV07/X07)

CPUE data from file/users/fish/ifad/ifapwork/wgpand/pan_sknd/FLEET.X07

Catch data for 13 years.1985 to 1997.Ages 0 to 5.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
FLT01:Denmark(Catc	1985	1997	1	4	0	1
FLT02:Norway(Catch	1986	1997	1	4	0	1
FLT03:Sweden(Catch	1985	1997	1	4	0	1
FLT04:NorwegianSur	1985	1997	0	4	0.83	0.92

Timeseries weights:

Tapered time weighting applied
Power=3 over 20 years

Catchability analysis:

Catchability independent of stocksize for all ages

Catchability independent of age for ages>=2

Terminal population estimation:

Survivor estimates shrunk towards the mean F
of the final 5years 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 30 iterations

Regression weights		0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1
Fishing mortalities											
Age		1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
0		0.005	0.008	0.003	0.001	0.006	0.004	0.002	0.001	0	0.002
1		0.206	0.331	0.229	0.138	0.098	0.159	0.118	0.099	0.131	0.143
2		0.646	0.77	0.878	0.602	0.841	0.57	0.461	0.562	0.71	0.588
3		1.29	1.111	0.846	1.629	2.462	1.781	0.77	1.291	1.286	1.276
4		0.968	0.826	0.672	0.786	0.819	0.787	0.544	0.677	0.652	0.684

Table 3.1.6 continued

XSA population numbers (Thousands)

AGE YEAR	0	1	2	3	4
1988	1.71E+07	4.81E+06	2.97E+06	8.63E+05	3.86E+05
1989	2.02E+07	8.03E+06	1.85E+06	7.35E+05	1.12E+05
1990	1.95E+07	9.48E+06	2.72E+06	4.04E+05	1.14E+05
1991	1.45E+07	9.19E+06	3.56E+06	5.35E+05	8.19E+04
1992	2.59E+07	6.82E+06	3.78E+06	9.22E+05	4.95E+04
1993	1.62E+07	1.21E+07	2.92E+06	7.70E+05	3.71E+04
1994	1.41E+07	7.60E+06	4.89E+06	7.80E+05	6.13E+04
1995	2.74E+07	6.67E+06	3.19E+06	1.46E+06	1.71E+05
1996	4.78E+07	1.29E+07	2.85E+06	8.60E+05	1.89E+05
1997	6.64E+06	2.26E+07	5.35E+06	6.63E+05	1.12E+05

Estimated population abundance at 1st Jan 1998

	0.00E+00	3.13E+06	9.25E+06	1.40E+06	8.74E+04
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Taper weighted geometric mean of the VPA populations:

	1.79E+07	9.32E+06	3.43E+06	7.93E+05	1.05E+05
--	----------	----------	----------	----------	----------

Standard error of the weighted Log (VPApopulations):

	0.5096	0.398	0.2923	0.3923	0.6515
1					

Log catchability residuals.

Fleet:FLT01:Denmark(Catc)

Age	1985	1986	1987
0	Nodata for this fleet at this age		
1	-0.05	-0.1	0.01
2	-0.04	-0.65	-0.41
3	0.61	0.26	-0.48
4	0.2	-0.11	-0.25

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
0	No data for this fleet at this age									
1	-0.1	0.45	0.39	-0.2	-0.47	-0.08	-0.15	-0.15	0.26	0.19
2	-0.32	-0.08	0.35	-0.11	0.28	-0.18	-0.16	0.21	0.52	0.11
3	0.33	0.26	0.32	0.83	1.28	0.89	0.34	1	1.05	0.76
4	0.06	-0.02	0.1	0.15	0.26	0.13	0	0.38	0.42	0.09

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

Age	1	2	3	4
Mean Log q	-4.9411	-3.593	-3.593	-3.593
S.E(Logq)	0.2686	0.3188	0.7958	0.2259

Regression statistics:

Table 3.1.6 continued

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

Age	Slope	t-value	Intercept	RSquare	NoPts	Regs.e	MeanQ
1	0.78	1.407	7.41	0.82	13	0.2	-4.94
2	1.29	-0.627	0.31	0.35	13	0.42	-3.59
3	1.08	-0.197	2.1	0.39	13	0.52	-2.97
4	0.98	0.229	3.64	0.93	13	0.19	-3.47
1							

Fleet:FLT02:Norway(Catch

Age	1985	1986	1987
0	Nodata for this fleet at this age		
1	99.99	0.18	0.43
2	99.99	-0.41	-0.03
3	99.99	0.5	-0.1
4	99.99	0.13	0.13

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
0	Nodata for this fleet at this age									
1	0.3	0.7	0.45	-0.27	-0.36	0.06	-0.23	-0.45	-0.42	0.05
2	0.04	0.13	0.37	-0.21	0.37	-0.07	-0.27	-0.13	-0.02	0.12
3	0.69	0.48	0.34	0.73	1.36	1	0.22	0.66	0.62	0.9
4	0.42	0.2	0.12	0.04	0.34	0.24	-0.11	0.05	-0.02	0.35

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

Age	1	2	3	4
Mean Log q	-0.9878	0.3952	0.3952	0.3952
S.E(Log q)	0.3846	0.2326	0.7728	0.2304

Regression statistics:

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

Age	Slope	t-value	Intercept	RSquare	NoPts	Regs.e	MeanQ
1	1.03	-0.087	0.55	0.51	12	0.42	-0.99
2	1.34	-0.994	-5.65	0.5	12	0.31	0.4
3	1.1	-0.276	-2.57	0.45	12	0.44	1.04
4	0.98	0.186	-0.36	0.94	12	0.17	0.55
1							

Fleet:FLT03:Sweden(Catch

Age	1985	1986	1987
0	Nodata for this fleet at this age		
1	-0.08	0.04	0.02
2	-0.06	-0.51	-0.39
3	0.59	0.4	-0.46
4	0.18	0.03	-0.23

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
0	Nodata for this fleet at this age									
1	0.05	0.71	0.51	-0.08	-0.51	-0.1	-0.11	-0.35	0.2	-0.13
2	-0.17	0.18	0.47	0.02	0.26	-0.19	-0.11	0.02	0.35	-0.19
3	0.48	0.53	0.44	0.96	1.25	0.88	0.38	0.81	0.76	0.49
4	0.21	0.25	0.22	0.28	0.23	0.12	0.05	0.2	0.09	-0.21

Table 3.1.6 continued

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

Age	1	2	3	4
MeanLogq	-1.0446	0.2944	0.2944	0.2944
S.E(Logq)	0.3307	0.2765	0.7529	0.2021

Regressionstatistics:

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

Age	Slope	t-value	Intercept	RSquare	NoPts	Regs.e	MeanQ
1	0.94	0.227	1.93	0.62	13	0.33	-1.04
2	1.92	-1.767	-14.44	0.29	13	0.48	0.29
3	1.23	-0.568	-4.2	0.41	13	0.5	0.91
4	1.02	-0.265	-0.68	0.94	13	0.18	0.41

Fleet:FLT04:NorwegianSur

Age	1985	1986	1987								
0	-0.35	-0.98	-0.82								
1	0.37	-0.57	0.5								
2	0.25	-0.85	0.15								
3	1.44	0.19	0.54								
4	1.41	0.14	0.64								
Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	
0	-0.45	0.92	0.14	-0.27	1.47	0.38	-0.07	-1.18	-0.06	0.52	
1	-1.06	0.32	-0.02	0.25	0.23	0.19	0.12	-0.07	0.02	-0.33	
2	-0.67	0.25	0.41	-0.02	0.24	0.04	-0.43	-0.21	0.49	0.1	
3	0.78	-1.05	0.06	1.23	2.11	1.45	0.77	1.41	1.39	1.92	
4	-0.4	-3.26	-1.53	0.28	1.19	0.62	2.01	-0.22	-0.19	2.36	

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

Age	0	1	2	3	4
Mean Log q	-12.4535	-9.9731	-9.2874	-9.2874	-9.2874
S.E(Logq)	0.765	0.402	0.3917	1.3574	1.5345

Regression statistics:

Ages with q independent of yearclassstrength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	NoPts	Regs.e	MeanQ
0	1.03	-0.061	12.32	0.29	13	0.83	-12.45
1	0.9	0.345	10.6	0.55	13	0.38	-9.97
2	2	-1.208	3.52	0.14	13	0.77	-9.29
3	0.82	0.303	9.25	0.24	13	0.74	-8.29
4	3.25	-0.939	3.34	0.02	13	4.94	-9.03

Table 3.1.6 continued

Terminal year survivor and F summaries:

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

Yearclass=1997

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01:Denmark(Catch)	1	0	0	0	0	0	0
FLT02:Norway(Catch)	1	0	0	0	0	0	0
FLT03:Sweden(Catch)	1	0	0	0	0	0	0
FLT04:NorwegianSur	5247197	0.799	0	0	1	0.281	0
F shrinkage mean	2556007	0.5				0.719	0.003

Weighted prediction:

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
3128509	0.42	0.61	2	1.439	0.002

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

Yearclass=1996

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01:Denmark(Catch)	11184672	0.3	0	0	1	0.296	0.119
FLT02:Norway(Catch)	9687950	0.402	0	0	1	0.165	0.137
FLT03:Sweden(Catch)	8107696	0.345	0	0	1	0.223	0.161
FLT04:NorwegianSur	7063085	0.372	0.112	0.3	2	0.193	0.183
F shrinkage mean	10688173	0.5				0.123	0.125

Weighted prediction:

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
9251203	0.16	0.08	6	0.503	0.143

1

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

Yearclass=1995

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01:Denmark(Catch)	1693965	0.223	0.077	0.34	2	0.256	0.509
FLT02:Norway(Catch)	1331009	0.241	0.254	1.05	2	0.226	0.612
FLT03:Sweden(Catch)	1353933	0.227	0.19	0.84	2	0.252	0.604
FLT04:NorwegianSur	1298875	0.276	0.277	1	3	0.168	0.623
F shrinkage mean	1206391	0.5				0.098	0.658

Weighted prediction:

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1402431	0.12	0.08	10	0.714	0.588

Table 3.1.6 continued

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

Yearclass=1994

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01:Denmark(Catc	111393	0.223	0.263	1.18	3	0.207	1.107
FLT02:Norway(Catch	87611	0.24	0.304	1.27	3	0.186	1.274
FLT03:Sweden(Catch	99287	0.226	0.248	1.1	3	0.206	1.185
FLT04:NorwegianSur	121399	0.276	0.305	1.1	4	0.127	1.05
F shrinkage mean	56631	0.5				0.274	1.606

Weighted prediction:

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
87378	0.16	0.13	14	0.823	1.276

1

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

Yearclass=1993

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01:Denmark(Catc	29697	0.236	0.105	0.44	4	0.271	0.634
FLT02:Norway(Catch	34859	0.241	0.12	0.5	4	0.264	0.562
FLT03:Sweden(Catch	23061	0.236	0.104	0.44	4	0.271	0.761
FLT04:NorwegianSur	41470	0.343	0.455	1.33	5	0.046	0.491
F shrinkage mean	15765	0.5				0.148	0.981

Weighted prediction:

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
26749	0.13	0.1	18	0.709	0.684

Table 3.1.7 Extended Survivor analysis.Fishing mortality at age. Pandalus division IIIa and IVa east

Run title : Pandalus IIIa & IVaE (run: XSASTV02/X02)

At 2-Sep-98 16:06:46

Table 8 Fishing mortality (F) at age

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	FBAR 95-97
AGE														
0	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.001
1	0.14	0.17	0.25	0.21	0.33	0.23	0.14	0.10	0.16	0.12	0.10	0.13	0.14	0.124
2	0.56	0.39	0.66	0.65	0.77	0.88	0.60	0.84	0.57	0.46	0.56	0.71	0.59	0.620
3	1.10	1.01	0.61	1.29	1.11	0.85	1.63	2.46	1.78	0.77	1.29	1.29	1.28	1.284
4	0.71	0.68	0.78	0.97	0.83	0.67	0.79	0.82	0.79	0.54	0.68	0.65	0.68	0.671
+gp	0.71	0.68	0.78	0.97	0.83	0.67	0.79	0.82	0.79	0.54	0.68	0.65	0.68	
FBAR 1-3	0.60	0.52	0.51	0.71	0.74	0.65	0.79	1.13	0.84	0.45	0.65	0.71	0.67	

Table 3.1.8 Extended Survivor analysis. Stock number at age. Pandalus division IIIa and IVa east

Run title : Pandalus IIIa & IVaE (run: XSASTV02/X02)

At 2-Sep-98 16:06:46

Table 10 Stock number at age (start of year)

YEAR	1985	1986	1987	1988	1989	Numbers*10**-4	1990	1991	1992	1993
AGE										
0	1889398	1718287	1018939	1708998	2023760		1952593	1445861	2585552	1615669
1	1147327	889983	810635	480549	803478		948425	919149	682052	1213873
2	430517	471354	353339	296823	184816		272500	356350	378055	292160
3	41789	116703	150770	86277	73464		40436	53485	92158	77023
4	13661	6577	20167	38587	11216		11428	8194	4954	3710
+gp		0	399	178	888		196	89	0	147
TOTAL	3522691	3203301	2354028	2612121	3096927		3225471	2783039	3742768	3202580
		1994	1995	1996	1997	1998	GMST 85-95	AMST 85-95		
AGE										
0		1414570	2735756	4783094	663756	0	1766337	1828127		
1		760253	667116	1290711	2258684	312851	822784	847532		
2		489004	319168	285423	534731	925120	338031	349462		
3		78039	145628	85952	66256	140243	79601	86888		
4		6130	17060	18925	11226	8738	10318	12880		
+gp		0	446	426	2102	3176				
TOTAL		2747999	3885173	6464530	3536755	1390126				

**Table 3.1.9 Extended Survivor analysis. Summary table without SOP corrections.
Pandalus division IIIa and IVa east**

Run title : Pandalus IIIa & IVaE (run: XSASTV02/X02)

At 2-Sep-98 16:06:46

Table 16 Summary (without SOP correction)

	RECRUITS	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 1- 3
Age 0						
1985	18893992	96436	21833	12628	0.5784	0.598
1986	17182880	77627	12298	13264	1.0785	0.5231
1987	10189392	67986	19344	15071	0.7791	0.5091
1988	17089986	57654	15759	12837	0.8146	0.714
1989	20237612	71453	15528	12542	0.8077	0.7372
1990	19525938	78722	16844	11881	0.7053	0.6512
1991	14458624	77786	20788	12362	0.5947	0.79
1992	25855540	80008	20821	13728	0.6593	1.1337
1993	16156702	88909	18938	14059	0.7424	0.8367
1994	14145710	75985	22627	12076	0.5337	0.4499
1995	27357600	52928	22382	13938	0.6227	0.6505
1996	47830928	113757	17957	15404	0.8578	0.7091
1997	6637560	113974	23855	17613	0.7383	0.6689
Arith.						
Mean	19658650	81017	19152	13646	0.7317	0.6901
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 3.1.10 Indices of 0,I and II-group shrimp from Norwegian trawl surveys in October and XSA values

Year-class	Survey			XSA		
	0-GR	I-GR	II-GR	0-GR	1-GR	2-GR
1983		20003	16347			4305
1984	3074	35741	6852		11473	4714
1985	2695	10456	11055	18894	8900	3533
1986	1305	26002	4150	17183	8106	2968
1987	909	3368	4470	10189	4805	1848
1988	2196	19514	9186	17090	8035	2725
1989	9933	18504	9958	20238	9484	3564
1990	4546	25208	11070	19526	9191	3781
1991	2240	19058	8903	14459	6821	2922
1992	22644	30753	10238	25856	12139	4890
1993	4763	18622	7590	16157	7603	3192
1994	2674	13839	12045	14146	6671	2854
1995	1702	28273	16964	27358	12907	5347
1996	9150	34738		47831	22587	
1997	2251			6638		

Table 3.1.11

The SAS System
 Pandalus in Divisions IIIa & IVa East (Skagerrak & Norwegian Deep)

08:50 Thursday, October 1, 1998

Multi fleet prediction with management option table: Input data

1998		Landings		discards						
Age	Exploit. pattern	Weight in catch	Exploit. pattern	Weight in catch	Stock size	Natural mortality	Maturity ogive	Prop. of F bef. spaw.	Prop. of M bef. spaw.	Weight in stock
1	0.0600	0.003	0.0600	0.003	3128.000	0.7500	0.0000	0.0000	0.0000	3.550
2	0.6200	0.006	0.0000	0.006	9251.000	0.7500	0.5100	0.0000	0.0000	5.650
3	1.2800	0.009	0.0000	0.009	1402.000	0.7500	1.0000	0.0000	0.0000	8.530
4	0.6700	0.012	0.0000	0.012	87.000	0.7500	1.0000	0.0000	0.0000	11.570
5+	0.6700	0.015	0.0000	0.015	32.000	0.7500	1.0000	0.0000	0.0000	14.680
Unit	-	Kilograms	-	Kilograms	Millions	-	-	-	-	Grams

1999		Landings		discards						
Age	Exploit. pattern	Weight in catch	Exploit. pattern	Weight in catch	Recruit-ment	Natural mortality	Maturity ogive	Prop. of F bef. spaw.	Prop. of M bef. spaw.	Weight in stock
1	0.0600	0.003	0.0600	0.003	8542.000	0.7500	0.0000	0.0000	0.0000	3.550
2	0.6200	0.006	0.0000	0.006	.	0.7500	0.5100	0.0000	0.0000	5.650
3	1.2800	0.009	0.0000	0.009	.	0.7500	1.0000	0.0000	0.0000	8.530
4	0.6700	0.012	0.0000	0.012	.	0.7500	1.0000	0.0000	0.0000	11.570
5+	0.6700	0.015	0.0000	0.015	.	0.7500	1.0000	0.0000	0.0000	14.680
Unit	-	Kilograms	-	Kilograms	Millions	-	-	-	-	Grams

2000		Landings		discards						
Age	Exploit. pattern	Weight in catch	Exploit. pattern	Weight in catch	Recruit-ment	Natural mortality	Maturity ogive	Prop. of F bef. spaw.	Prop. of M bef. spaw.	Weight in stock
1	0.0600	0.003	0.0600	0.003	8542.000	0.7500	0.0000	0.0000	0.0000	3.550
2	0.6200	0.006	0.0000	0.006	.	0.7500	0.5100	0.0000	0.0000	5.650
3	1.2800	0.009	0.0000	0.009	.	0.7500	1.0000	0.0000	0.0000	8.530
4	0.6700	0.012	0.0000	0.012	.	0.7500	1.0000	0.0000	0.0000	11.570
5+	0.6700	0.015	0.0000	0.015	.	0.7500	1.0000	0.0000	0.0000	14.680
Unit	-	Kilograms	-	Kilograms	Millions	-	-	-	-	Grams

Notes: Run name : MANJB004
 Date and time: 01OCT98:08:58

Table 3.1.12

Multi fleet prediction with management option table

Year: 1998								
landings			discards			Total	Stock biomass	Sp. stock biomass
F Factor	Reference F	Catch in weight	F Factor	Reference F	Catch in weight	Catch in weight		
1.0000	0.6533	25638	1.0000	0.0600	402	26041	76808	40092
-	-	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes

Year: 1999							Year: 2000			
landings			discards			Total	Stock biomass	Sp. stock biomass	Stock biomass	Sp. stock biomass
F Factor	Reference F	Catch in weight	F Factor	Reference F	Catch in weight	Catch in weight				
0.0000	0.0000	0	0.0000	0.0000	0	0	60333	26381	72726	31231
0.1000	0.0653	2335	0.1000	0.0660	115	2450		26381	70497	29135
0.2000	0.1307	4457	0.2000	0.0120	229	4686		26381	68482	27252
0.3000	0.1960	6389	0.3000	0.0180	342	6731		26381	66658	25558
0.4000	0.2613	8152	0.4000	0.0240	453	8605		26381	65002	24031
0.5000	0.3267	9761	0.5000	0.0300	564	10325		26381	63497	22653
0.6000	0.3920	11234	0.6000	0.0360	673	11907		26381	62126	21407
0.7000	0.4573	12584	0.7000	0.0420	781	13366		26381	60874	20279
0.8000	0.5227	13825	0.8000	0.0480	888	14713		26381	59728	19256
0.9000	0.5880	14965	0.9000	0.0540	994	15959		26381	58678	18326
1.0000	0.6533	16017	1.0000	0.0600	1099	17116		26381	57712	17480
1.1000	0.7187	16988	1.1000	0.0660	1202	18191		26381	56822	16708
1.2000	0.7840	17887	1.2000	0.0720	1305	19192		26381	55999	16003
1.3000	0.8493	18720	1.3000	0.0780	1407	20127		26381	55238	15357
1.4000	0.9147	19494	1.4000	0.0840	1507	21001		26381	54531	14764
1.5000	0.9800	20214	1.5000	0.0900	1607	21821		26381	53873	14219
1.6000	1.0453	20886	1.6000	0.0960	1705	22591		26381	53260	13716
1.7000	1.1107	21513	1.7000	0.1020	1802	23315		26381	52686	13252
1.8000	1.1760	22100	1.8000	0.1080	1899	23999		26381	52148	12823
1.9000	1.2413	22651	1.9000	0.1140	1994	24645		26381	51642	12424
2.0000	1.3067	23168	2.0000	0.1200	2089	25256		26381	51165	12054
-	-	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANJB004
 Date and time : 01OCT98:08:58
 Computation of ref. F: landings: Simple mean, age 1 - 3
 discards: F at age 1
 Basis for 1998 : F factors

Table 3.1.13

Pandalus in Divisions IIIa & IVa East(Skagerrak & Norwegian Deepse)

Multi fleet prediction with management option table

Year: 1998								
landings			discards			Total		
F Factor	Reference F	Catch in weight	F Factor	Reference F	Catch in weight	Catch in weight	Stock biomass	Sp.stock biomass
0.6506	0.4250	18533	0.6506	0.0390	267	18800	76808	40092
-	-	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes

Year: 1999									Year: 2000		
landings			discards			Total		Stock biomass	Sp.stock biomass	Stock biomass	Sp.stock biomass
F Factor	Reference F	Catch in weight	F Factor	Reference F	Catch in weight	Catch in weight	Stock biomass	Sp.stock biomass	Stock biomass	Sp.stock biomass	
0.0000	0.0000	0	0.0000	0.0000	0	0	66814	32706	76833	35338	
0.1000	0.0653	2840	0.1000	0.0060	115	2956	.	32706	74167	32805	
0.2000	0.1307	5419	0.2000	0.0120	229	5648	.	32706	71764	30534	
0.3000	0.1960	7763	0.3000	0.0180	342	8105	.	32706	69595	28495	
0.4000	0.2613	9897	0.4000	0.0240	453	10350	.	32706	67633	26661	
0.5000	0.3267	11844	0.5000	0.0300	564	12407	.	32706	65855	25010	
0.6000	0.3920	13622	0.6000	0.0360	673	14295	.	32706	64241	23522	
0.7000	0.4573	15250	0.7000	0.0420	781	16031	.	32706	62773	22178	
0.8000	0.5227	16741	0.8000	0.0480	888	17630	.	32706	61434	20962	
0.9000	0.5880	18112	0.9000	0.0540	994	19106	.	32706	60212	19861	
1.0000	0.6533	19372	1.0000	0.0600	1099	20471	.	32706	59093	18861	
1.1000	0.7187	20534	1.1000	0.0660	1202	21736	.	32706	58066	17953	
1.2000	0.7840	21607	1.2000	0.0720	1305	22912	.	32706	57122	17125	
1.3000	0.8493	22600	1.3000	0.0780	1407	24006	.	32706	56251	16370	
1.4000	0.9147	23520	1.4000	0.0840	1507	25027	.	32706	55447	15679	
1.5000	0.9800	24374	1.5000	0.0900	1607	25981	.	32706	54701	15047	
1.6000	1.0453	25169	1.6000	0.0960	1705	26874	.	32706	54009	14466	
1.7000	1.1107	25910	1.7000	0.1020	1802	27712	.	32706	53365	13931	
1.8000	1.1760	26602	1.8000	0.1080	1899	28501	.	32706	52763	13439	
1.9000	1.2413	27250	1.9000	0.1140	1994	29244	.	32706	52201	12983	
2.0000	1.3067	27856	2.0000	0.1200	2089	29945	.	32706	51673	12562	
-	-	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	

Notes: Run name : MANJB004
 Date and time : 01OCT98:08:58
 Computation of ref. F: landings: Simple mean, age 1 - 3
 discards: F at age 1
 Basis for 1998 : TAC constraints

Table 3.2.1 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	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	657	5265
1996	3858		32	1823	5713
1997	2892		9	365	3266

Table 3.2.2 *Pandalus borealis*, Fladen Ground. Reported LPUE (shrimp trawlers), and estimated effort.

Year	Denmark			UK (Scotland)			Combined index2	Denmark	Scotland	CPUE*E for Scotland	
	LPUE (ton./day)	Total effort (Days)	effort Index1	LPUE (kg/hour)	Total effort (hours)	effort Index1					
1982	0.96	295	0.10	74	4757	0.31	0.21	283	352	352	
1983	1.18	4855	1.61	89	20528	1.32	1.54	5729	1827	1827	
1984	0.97	4694	1.56	37	676	0.04	1.55	4553	25	25	
1985	1.21	3016	1.00	86	15593	1.00	1.00	3649	1341	1341	
1986	0.96	3558	1.18	71	4239	0.27	1.11	3416	301	301	
1987	1.24	5908	1.96	81	8469	0.54	1.84	7326	686	686	
1988	0.83	1298	0.43	44	1909	0.12	0.41	1077	84	84	
1989	0.99	2463	0.82	65	8415	0.54	0.77	2438	547	547	
1990	1.28	1313	0.44	106	3493	0.22	0.40	1681	365	370	
1991	1.50	281	0.09	124	429	0.03	0.09	422	53	53	
1992	1.44	1006	0.33	69	1685	0.11	0.32	1448	116	116	
1993	1.83	831	0.28	90	5229	0.34	0.29	1521	509	471	
1994	1.93	621	0.21	91	330	0.02	0.20	1207	35	30	1207
1995	2.00	2292	0.76	130	5038	0.32	0.71	4578	657	657	4578
1996	1.79	2168	0.72	62	11638	0.75	0.72	3858	717	717	3858
1997	2.86	1012	0.34	202	1810	0.12	0.31	2892	365	365	2892

Table 3.3.1 Landings (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

Table 4.1

**Reported catch by species in the Danish trawl-fishery
for *Pandalus* in 1997. Log book information**

FLADEN GRUND, Sub div. IVa

Species:	Quarter:				Total	% of total catch
	1	2	3	4		
Blue Whiting	0.0	0.0	0.0	0.0	0.0	0.0
Norway lobster	7.9	14.3	13.4	1.1	36.7	1.1
Northern shrimp (<i>Pandalus borealis</i>)	867.1	1771.5	230.3	22.8	2891.6	89.3
Angler fish (Monk fish)	22.3	32.7	3.1	0.4	58.5	1.8
Whiting	0.2	0.1	0.2	0.0	0.5	0.0
Haddock	6.1	1.9	5.0	0.5	13.6	0.4
Hake	0.0	0.0	0.0	0.0	0.0	0.0
Ling	0.5	0.1	0.0	0.3	0.9	0.0
Saithe	4.3	3.5	1.4	0.0	9.1	0.3
Witch flounder	0.1	0.3	0.0	0.0	0.4	0.0
Norway pout	0.0	0.0	0.0	0.0	0.0	0.0
Cod	67.0	115.7	23.9	3.2	209.8	6.5
Other market fish	0.1	0.2	0.0	0.0	0.2	0.0
Fish for reduction	5.3	8.0	2.7	0.2	16.2	0.5
TOTAL	980.9	1948.3	279.9	28.5	3237.7	100.0

Norwegian Deep, Sub div. IVa

Species:	Quarter:				Total	% of total catch
	1	2	3	4		
Blue Whiting	0.0	0.0	0.0	0.0	0.0	0.0
Norway lobster	7.9	6.2	0.0	1.0	15.1	4.3
Northern shrimp (<i>Pandalus borealis</i>)	116.7	132.4	1.7	24.9	275.7	78.5
Angler fish (Monk fish)	5.5	4.6	0.0	0.3	10.4	3.0
Whiting	0.6	0.0	0.0	0.0	0.6	0.2
Haddock	1.0	0.0	0.0	0.1	1.1	0.3
Hake	0.6	1.9	0.0	0.4	2.9	0.8
Ling	0.7	1.6	0.0	0.0	2.4	0.7
Saithe	13.3	2.1	0.0	1.8	17.3	4.9
Witch flounder	1.1	0.7	0.0	0.2	1.9	0.5
Norway pout	0.0	0.0	0.0	0.0	0.0	0.0
Cod	7.8	7.1	0.0	1.8	16.7	4.7
Other market fish	0.2	0.3	0.0	0.4	0.8	0.2
Fish for reduction	3.1	2.5	0.0	0.8	6.4	1.8
TOTAL	158.4	159.4	1.8	31.6	351.2	100.0

Table 4.1 continued. ...

Skagerrak, Sub div. IIIa.

Species:	Quarter:				Total	% of total catch
	1	2	3	4		
Blue Whiting	0.0	0.0	0.0	91.4	91.4	2.2
Norway lobster	10.5	6.5	11.3	9.1	37.5	0.9
Northern shrimp (<i>Pandalus borealis</i>)	785.0	929.1	870.1	887.4	3471.6	84.4
Angler fish (Monk fish)	7.4	5.7	2.6	2.4	18.1	0.4
Whiting	0.2	0.3	0.0	0.4	0.9	0.0
Haddock	2.9	0.6	0.0	5.4	8.9	0.2
Hake	0.3	0.1	1.9	3.6	5.9	0.1
Ling	0.3	0.0	0.0	0.1	0.4	0.0
Saithe	28.3	15.0	5.2	29.4	77.9	1.9
Witch flounder	14.4	6.0	2.6	9.8	32.7	0.8
Norway pout	33.0	0.0	0.0	47.9	80.9	2.0
Cod	38.0	48.9	15.3	76.9	179.1	4.4
Other market fish	1.4	1.6	0.4	1.5	4.9	0.1
Fish for reduction	27.8	29.3	16.8	28.5	102.4	2.5
TOTAL	949.4	1043.2	926.2	1193.8	4112.5	100.0

Table 4.2.

Reported Swedish landings and discards in the trawl-fishery for Pandalus.
(Tonnes)

1997

Norwegian Deepseas, Sub-div IVa

Species	Quarter:								Total	
	1		2		3		4			
	H. Cons.	Discards	H. Cons.	Discards	H. Cons.	Discards	H. Cons.	Discards	H. Cons.	Discards
Blue Whiting	0.4	4.5	0.4	0.8	0.0	0.0	0.1	1.4	0.9	6.7
Cod	9.4	0.0	1.2	0.0	0.0	0.0	1.0	0.0	11.6	0.0
Flounder	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Haddock	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0
Hake	0.3	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.4	0.0
Halibut	0.1	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.2	0.0
Ling	0.6	0.0	0.2	0.0	0.0	0.0	0.1	0.0	0.8	0.0
Monkfish	0.9	0.0	0.2	0.0	0.0	0.0	0.0	0.0	1.1	0.0
Northern pink shrimp	203.4	0.1	47.5	0.0	0.2	0.0	34.4	0.0	285.5	0.1
Norway lobster	0.4	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.5	0.0
Norway Pout	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Pollack	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0
Saithe	22.9	0.0	1.0	0.0	0.0	0.0	1.1	0.0	25.1	0.0
Skate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Skates, rays	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Spurdog / spiny dogfish	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0
Unknown Catches	3.9	5.5	1.3	0.5	0.0	0.0	1.9	0.8	7.1	6.9
Whiting	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0
Witch	0.3	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.4	0.0
Total	244.5	10.2	51.9	1.3	0.2	0.0	39.0	2.3	335.7	13.7

Table 4.2 continued...

Skagerrak, Sub-div IIIa

Species	Quarter:								Total	
	1		2		3		4			
	H. Cons.	Discards	H. Cons.	Discards	H. Cons.	Discards	H. Cons.	Discards	H. Cons.	Discards
Argentines	0.0	0.0	0.0	1.3	0.6	7.6	0.0	3.7	0.6	12.6
Blue Whiting	0.0	1.3	0.0	1.2	1.0	1.9	0.0	10.4	1.0	14.8
Brill	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Cod	20.2	0.0	22.2	0.0	4.7	0.0	23.2	0.0	70.3	0.0
Cuttlefish	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dab	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Edible crab	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Eel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Garfish	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Haddock	9.6	0.0	2.9	0.0	0.3	0.0	2.5	0.0	15.3	0.0
Hake	0.1	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.3	0.0
Halibut	0.1	0.0	0.1	0.0	0.2	0.0	0.1	0.0	0.4	0.0
Herring	0.1	0.0	0.0	0.0	0.0	1.0	0.2	0.0	0.3	1.0
Lemon Sole	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Ling	0.4	0.0	0.7	0.0	0.2	0.0	0.2	0.0	1.5	0.0
Loliginidae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lumpfish	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0
Mackerel	0.2	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.3	0.0
Monkfish	0.4	0.0	3.2	0.0	0.4	0.0	0.3	0.0	4.2	0.0
Northern pink shrimp	377.3	1.2	606.7	1.4	549.6	1.5	556.6	1.7	2090.2	5.8
Norway lobster	6.4	0.0	4.2	0.0	2.4	0.0	5.9	0.0	18.9	0.0
Norway Pout	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Paspiphea Spp	0.0	0.0	0.2	0.0	0.1	0.0	0.1	0.0	0.4	0.0
Plaice	0.7	0.0	0.3	0.0	0.0	0.0	0.1	0.0	1.1	0.0
Pollack	1.9	0.0	0.5	0.0	0.3	0.0	1.8	0.0	4.5	0.0
Rockfishes	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Round-nose Grenadier	0.0	1.3	1.0	1.0	0.0	1.2	0.0	4.8	1.0	8.3
Saithe	33.3	0.0	12.3	0.0	2.8	0.0	35.7	0.0	84.1	0.0
Skate	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.3	0.0
Skates, rays	0.5	0.0	1.2	0.0	0.7	0.0	0.2	0.0	2.6	0.0
Sole	0.1	0.0	0.1	0.0	0.0	0.0	0.2	0.0	0.4	0.0
Sprat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spurdog / spiny dogfish	1.5	0.0	3.0	0.0	1.2	0.0	1.4	0.0	7.2	0.0
Turbot	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0
Tusk	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Unknown Catches	5.2	1.5	7.3	4.2	4.4	2.4	5.6	0.9	22.5	9.0
Whiting	1.9	0.0	0.2	0.0	0.0	4.0	0.4	0.0	2.6	4.0
Witch	7.6	0.0	5.2	0.0	2.7	0.0	7.3	0.0	22.8	0.0
Total	468.4	5.2	671.9	9.0	571.7	19.7	642.1	21.6	2354.1	55.5

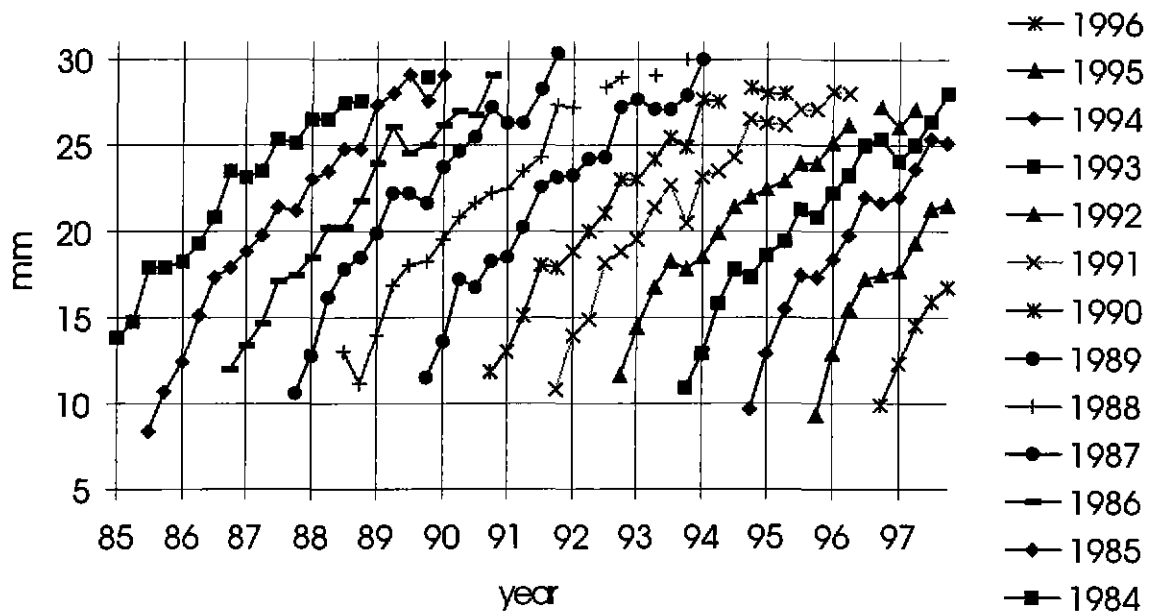


Figure 3.1.1 Mean quarterly carapace length mm for *Pandalus* in division IIIa and IVa east

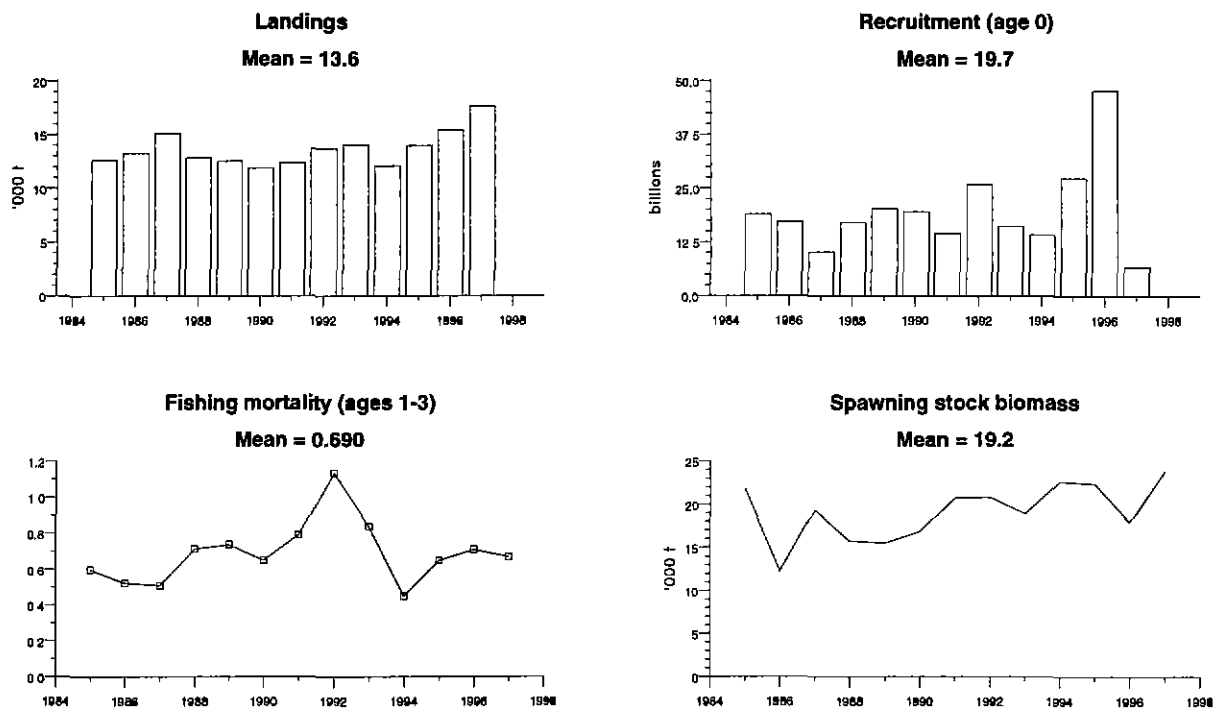


Figure 3.1.2 Landings, recruitment, fishing mortality and spawning stock biomass for *Pandalus* division IIIa and IVa east

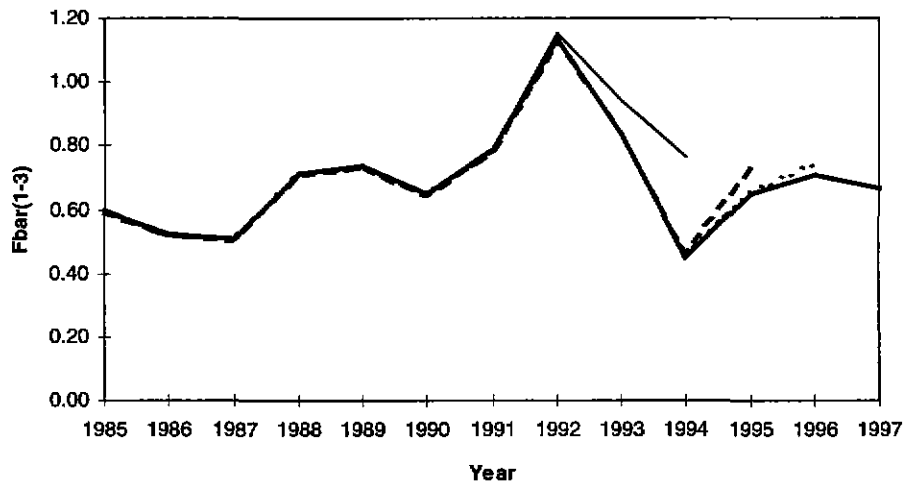
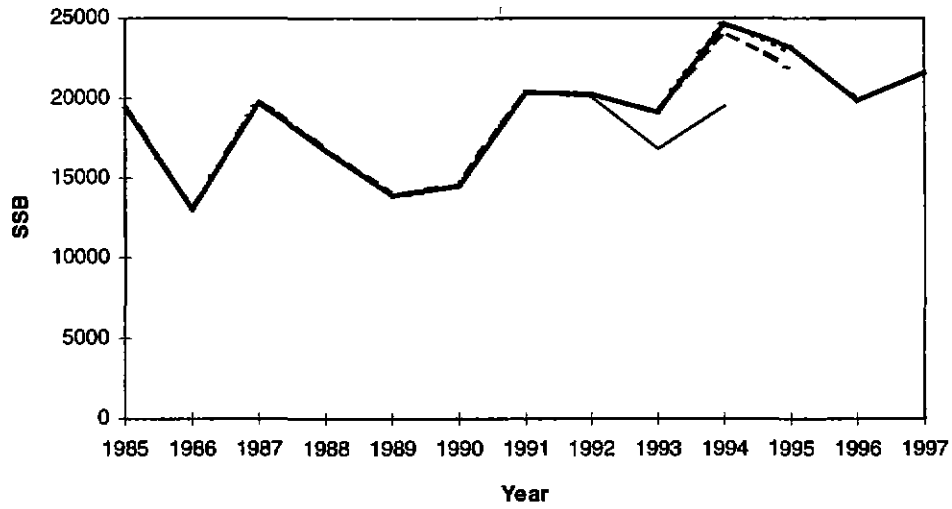
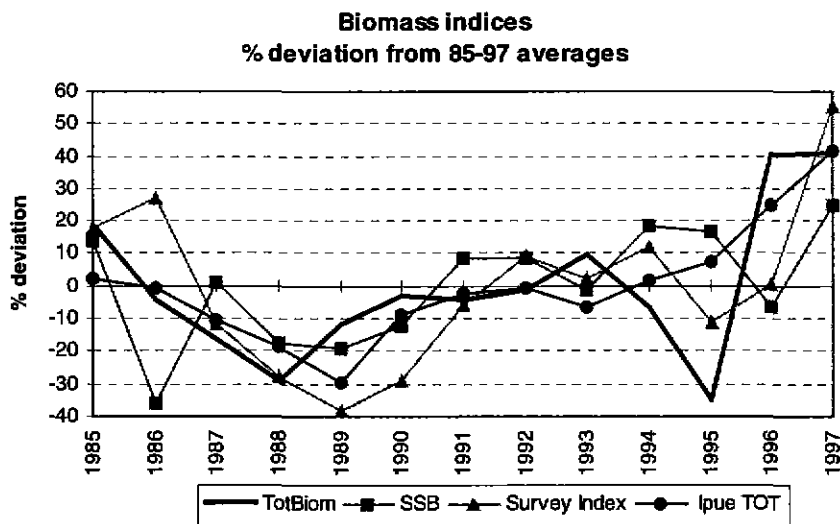


Figure 3.1.3 Retrospective analysis XSA estimated fishing mortality $F_{bar}(1-3)$ and SSB for Pandalus in division IIIa and IVa east



Figur 3.1.4 Biomass indeces for Pandalus in Div. IIIa and IVa east.

SSB, Stochastic forecast



Yield, Stochastic forecast

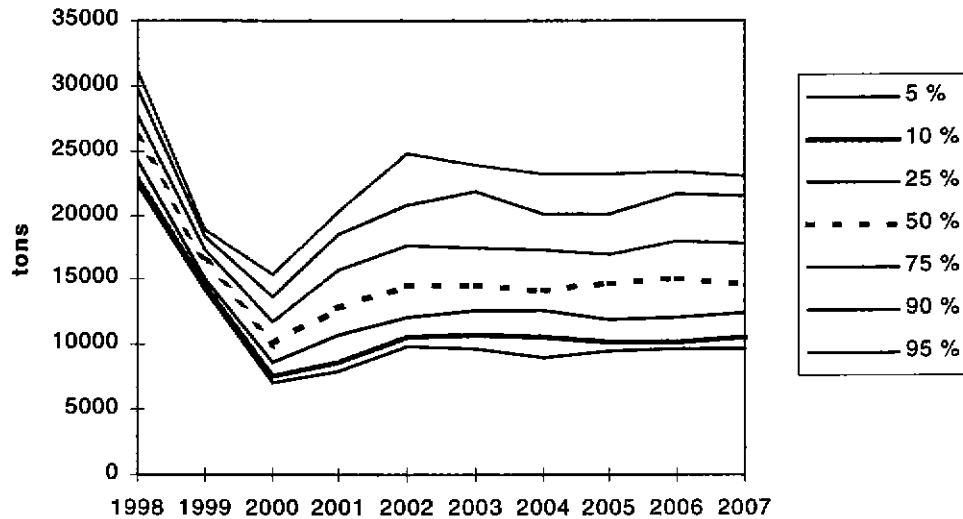


Figure 3.1.5 Medium term prediction at status quo fishing mortality. Percentiles of the distributions of yield and SSB. *Pandalus* in Div. IIIa and IVa east

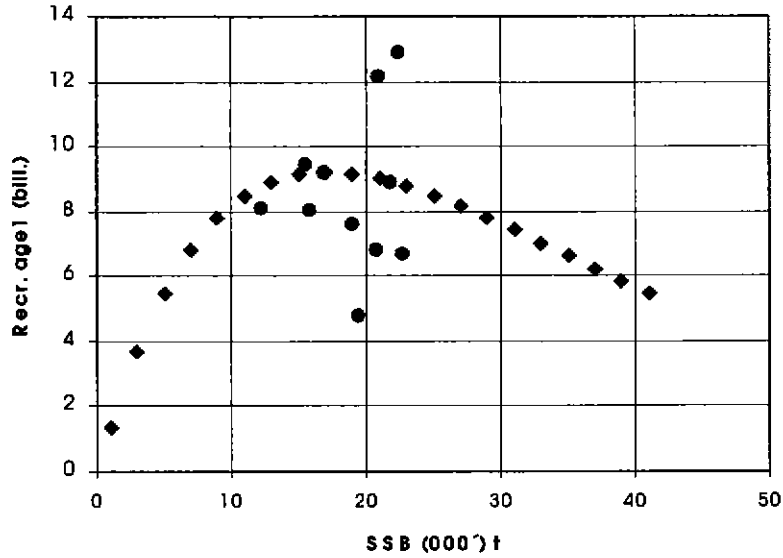


Figure 3.1.6 Stock recruitment relationship based on XSA results. Pandalus Div. IIIa and Iva east

Equilibrium Yield and SSB (Ricker S-R)

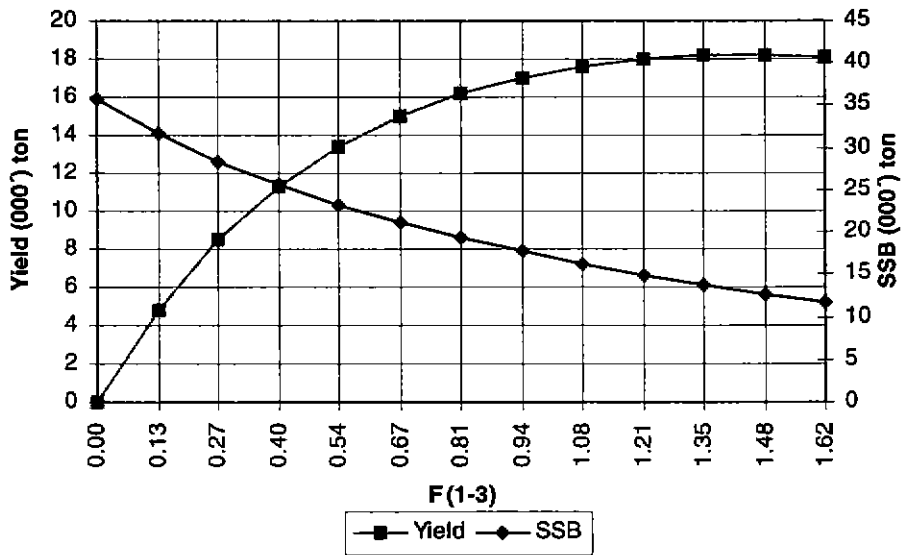


Figure 3.1.7 Equilibrium yield and Spawning Stock Biomass based on Ricker stock recruitment relationship. Pandalus Div. IIIa and IVa east.

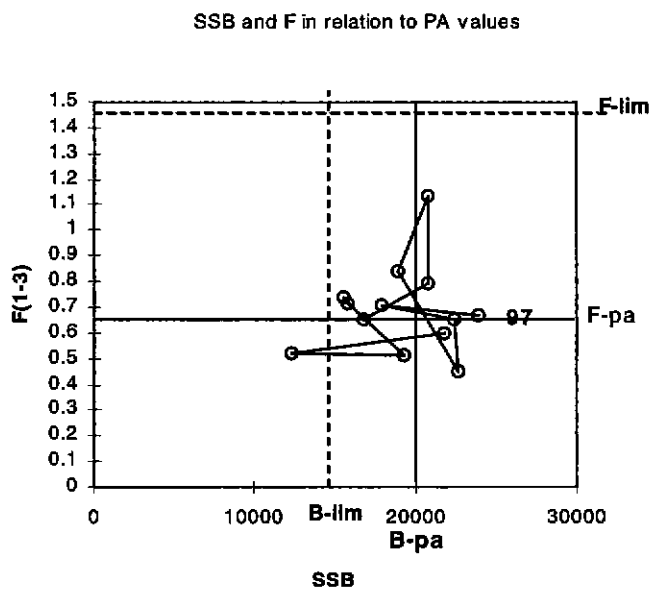


Figure 3.1.8 Historical development of F(1-3) and SSB in relation to Precautionary Approach points.

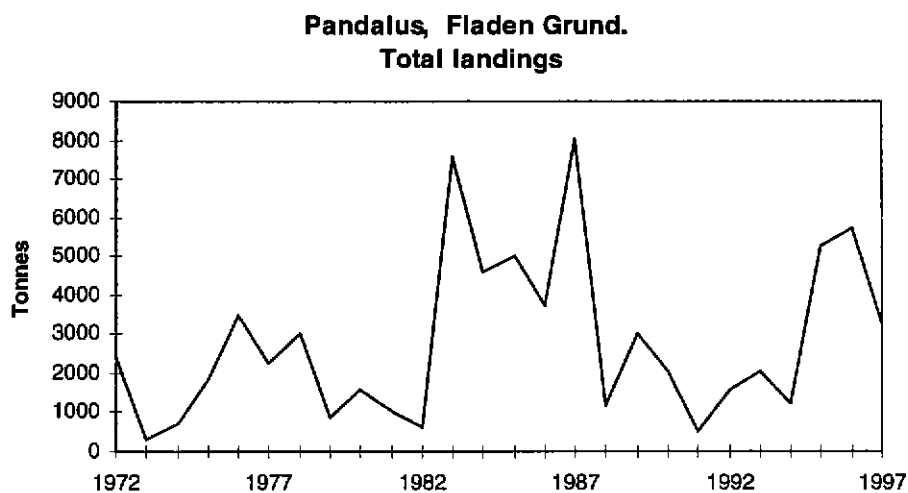
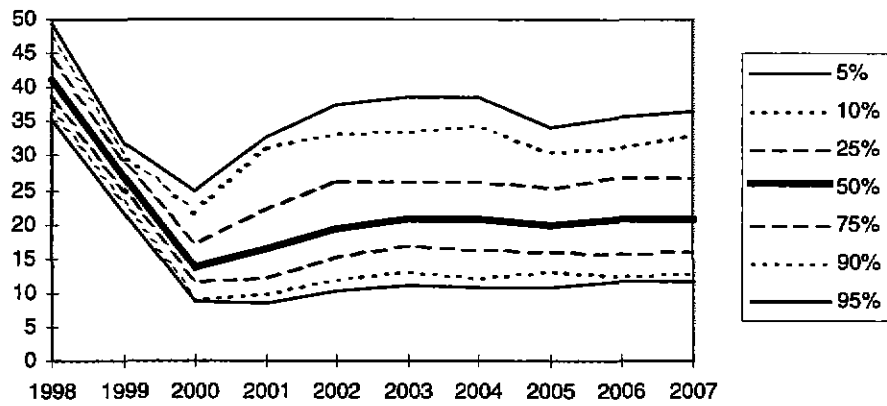


Figure 3.2.1 Total landings of Pandalus from Fladen Grund 1972-1997

SSB, Stochastic forecast



Yield, Stochastic forecast

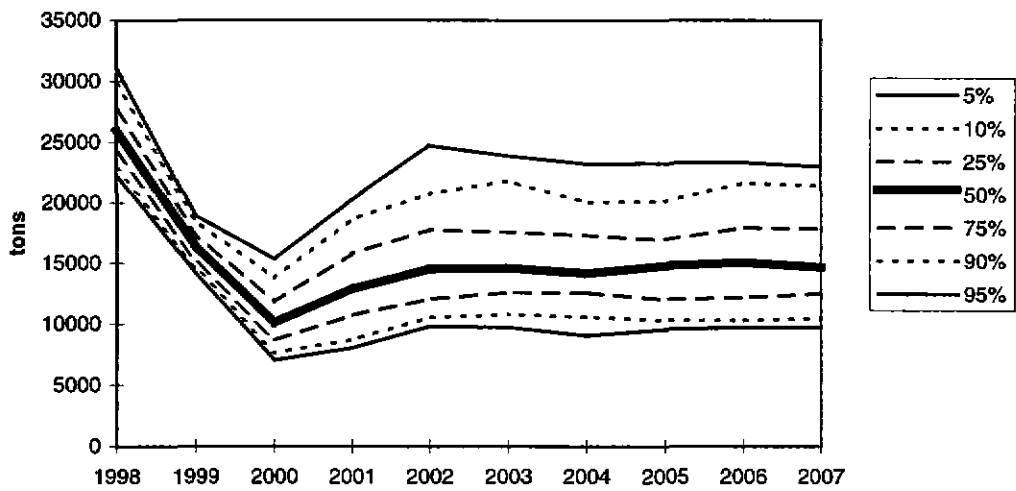


Figure 3.1.5. Medium term prediction at *status quo* fishing mortality. Percentiles of the distributions of yield and SSB. Pandalus in Div. IIIa and IVa East.

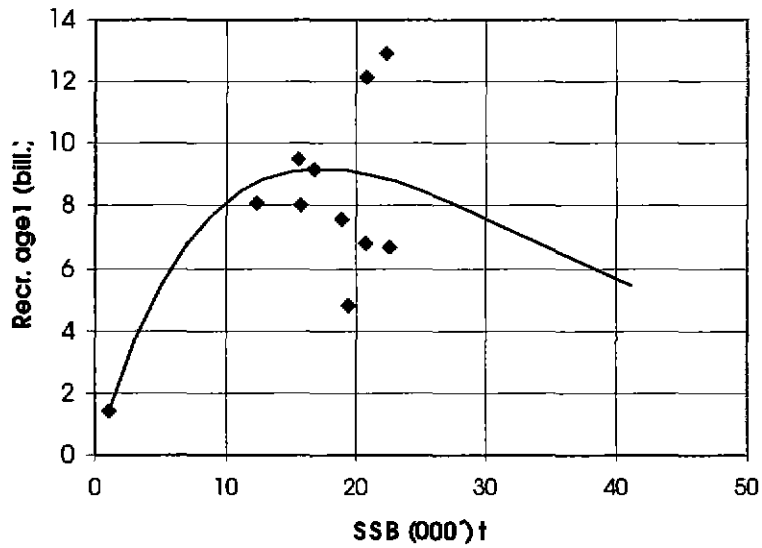


Figure 3.1.6 Stock recruitment relationship based on XSA results. Pandalus Div. IIIa and IVa East.

Equilibrium Yield and SSB (Ricker S-R)

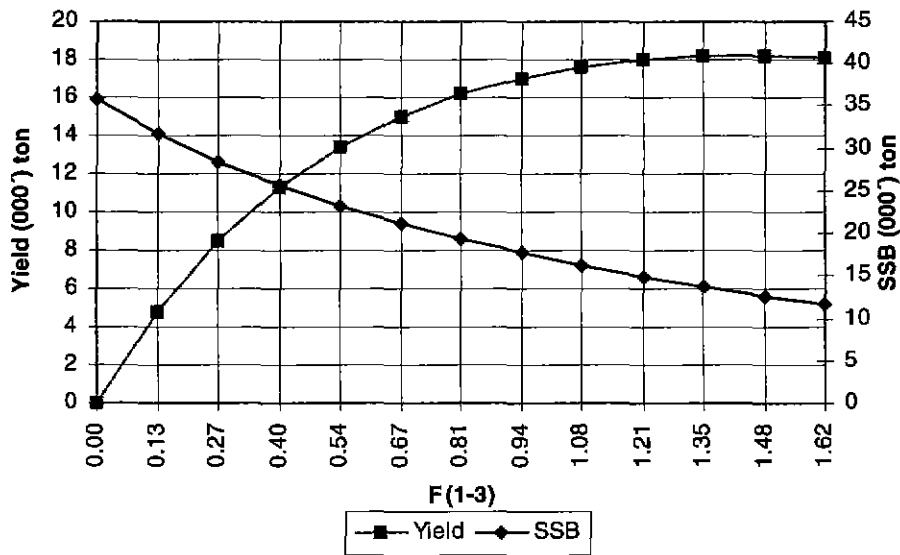


Figure 3.1.7 Equilibrium yield and Spawning Stock Biomass based on Ricker stock recruitment relationship. Pandalus Div. IIIa and IVa east.

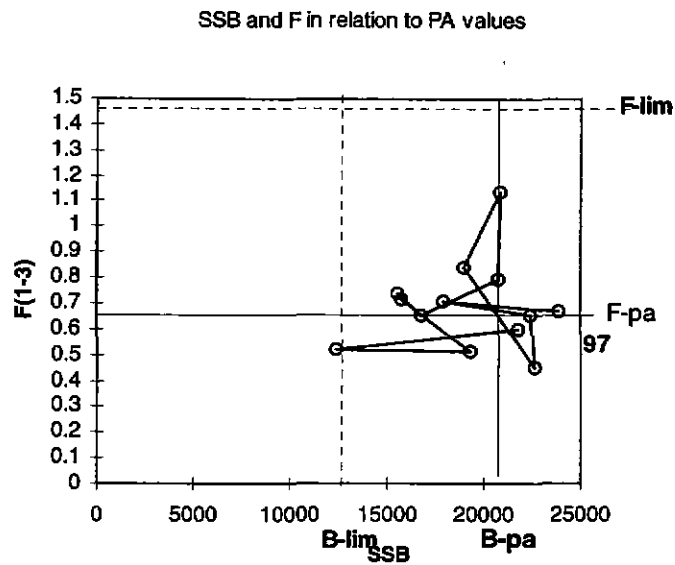


Figure 3.1.8 Historical development of F(1-3) and SSB in relation to PA reference points.

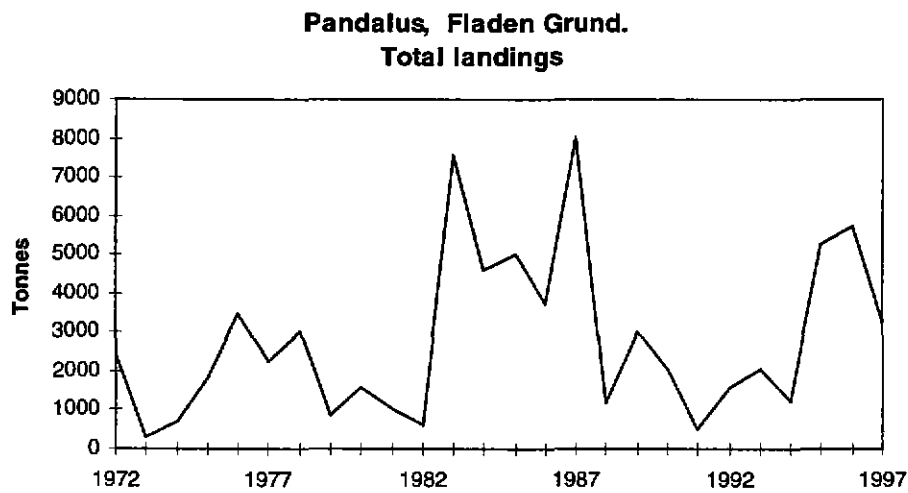


Figure 3.2.1 Total landings of Pandalus from Fladen Grund 1972-1997

