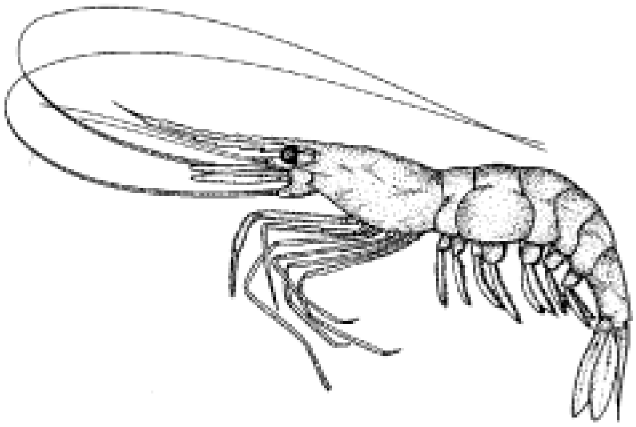
Advisory Committee on Fisheries Management **ICES CM 2001/ACFM:04**

REPORT OF THE

PANDALUS ASSESSMENT WORKING GROUP

Lysekil, Sweden
4–7 September 2000



https://doi.org/10.17895/ices.pub.19264106

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

Palægade 2–4 DK–1261 Copenhagen K Denmark

TABLE OF CONTENTS

1 TERMS OF REFERENCE

1.1 The terms of reference according to the 1999 Council resolution 1999/2ACFM14

The ***Pandalus* Assessment Working Group** [WGPAND] (Chair B. Sjöstrand, Sweden) will meet in Lysekil, Sweden from 4–7 September 2000 to:

- assess the status of the stocks of *Pandalus borealis* in the North Sea, Skagerrak and Kattegat and provide catch options for 2001;
- review progress in determining precautionary reference points;
- determine the predation mortality of *Pandalus* stocks;
- continue the work on determining the criteria for ageing.

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

WGPAND will report to ACFM before its October 2000 meeting and to the Living Resources Committee at the 2001 Annual Science Conference.

2 PARTICIPANTS

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

3 ASSESSMENT OF PANDALUS STOCKS IN THE NORTH SEA AND SKAGERRAK

The *Pandalus* WG has for many years recognised the *Pandalus* on Fladen ground and the *Pandalus* in IIIa and IVa East as separate stocks see ICES (1990). The shrimp in Div. IIIa and IVa E has been assessed since 1987. This has been made on age disaggregated catch data by VPA- XSA. Commercial CPUE at age was used for tuning at first, later stock indices at age from the Norwegian shrimp surveys were used.

The shrimp caught on Fladen has not been assessed since 1992, due to incomplete age data and the lack of separate, fishery independent data.

These XSA:s, on which advice have been based, have been characterised by poor precision in the estimates of F and N and consequently by non-favourable diagnostics (see Sect 4.6). This may mainly be due to large uncertainties in the ageing of the older age groups. However, an additional cause could be that the assumption of the Fladen stock being independent of the IIIa stock is wrong. The available age disaggregated data seems not, however, fit the XSA model very well.

A connected problem has been the treatment of natural mortality. Even if natural mortality is likely to be variable owing to the high suitability of shrimp as prey item for many fish species, it has been kept constant at 0.75 in the assessments.

In last years assessment the WG tried to include the dynamics of predators in the M values by letting it vary according to the summed SSB of roundfish in the North Sea (sum of cod, haddock, whiting and saithe). The WG also considered the weight of likely predator species caught in the Norwegian shrimp surveys. These indices were scaled to give an average M over the assessed time span of 0.75, in want of better estimates of the likely level of predation. This treatment of the predation resulted in but minor changes in the perception of shrimp biomass dynamics (Figure 3.3 in Anon. 2000).

At this year’s meeting several of the main input components to the assessment were subject to critical discussion and revisions in order to improve the assessment were suggested.

The Working Group decided to explore two new approaches:

- Apply a stock production model including predator components to Div. IIIa, IVaE data, see Sect.4.10
- Merge catches of the *Pandalus* on the Fladen Ground with the catches in Div. IIIa and IVa East.
- Apply a XSA using the pooled age data as basis, see Sect. 6.1.

The standard XSA covering only *Pandalus* in IIIa and IVa East is performed in order to maintain continuity with earlier assessments.

3.1 Definition of Stock / Assessment units

The WG has, so far, maintained the view that shrimps caught on the Fladen constitute a stock separated from the *Pandalus* in the Norwegian Deeps and Skagerrak. The main arguments for this separation were presented in ICES (1990):

- Geographical separation combined with hydrogaphical considerations.
- The Fladen shrimps are normally characterized by fewer age groups This difference was quantified by multivariate analyses of length frequency distributions (LFD) from the three areas, these suggested that especially the Fladen LFDs deviate from the other two (ICES, 1990).

However, it remains a fact that earlier investigations (e.g. Poulsen, 1970) have postulated, on basis of:

- Trends in size distribution of the shrimps in various parts of the entire North Sea – Skagerrak area
- Larval drift with the surface current in the northern North Sea,

that there must be close connections between the shrimps in the two areas. Furthermore, the WG has for several years in its data analyses observed that:

- There seems to be rather good correlation between the Norwegian Survey data on recruitment data for IIIa and IVa East and the LPUE in the Danish Fladen fishery. (Figure 3.1)
- There have frequently been similar patterns in fluctuations of the effort in the fisheries exploiting the two stocks support the concept of close connections, if not one single stock.

At this year's meeting the WG decided to investigate the outcomes an assessment with the two stocks combined into one single unit.

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

4.1 Catch, effort and Research Vessel data

Landings are given in Table 4.1 by area (Division IIIa and Sub-area IV) as officially reported to ICES. The landings in 1999 in both the Skagerrak and the Sub-area IV have decreased by 35% below the 1998 level.

Table 4.2 presents the landings and estimated discards for the assessment unit, i.e. Division IIIa and eastern part of Sub-area IVa. These landings have decreased compared to 1998 and are around 11 200 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 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 1999 was 156 tonnes. The Working Group has applied no conversion on the Norwegian landings. The underestimate of total landings by this omission was for 1999 roughly estimated to about 300 ton. The Working Group felt that this estimate was too inaccurate to include in the assessment figures. When more reliable data for estimations become available, the landings for all years should be updated.

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. The estimated amount for 1999 was 639 t.

More recently, quota restrictions and the substantial price difference between large, boiled shrimps and medium-sized fresh ones have resulted in high grading by discarding the latter. The amounts of discards in this category were in an earlier 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. 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. The amount of this type of discard could be around 1000 ton.

Annual figures for landings per unit of effort (LPUE) and effort are given in Table 4.3. Total effort values have been estimated from LPUE data based on logbook records. Danish effort was reduced compared to 1998, and Danish and Norwegian LPUE decreased (20-30%).

Catches in numbers at age per nautical mile as obtained in the Norwegian shrimp surveys were used as tuning (Table 4.4).

4.2 Age Determination

At the 1999 meeting of the WG the procedures for the indirect ageing of *Pandalus* were discussed thoroughly and the (two) applied methods for partitioning the length distributions into age groups were described in the 1999 WG report (ICES, 2000). Both methods assume that the sizes of the individuals belonging to the separate age groups are normally distributed.

The Danish and Norwegian length distributions have been separated into age groups by the Bhattacharya method (Bhattacharya, 1967). The method applied on the Swedish landings was described in the 1999 WG report. In this method the mean lengths at age are determined by a set of von Bertalanffy growth parameters for *Pandalus*. Assuming constant C.V. for each age group generates the standard deviation for each distribution. The calculated composite length distributions are then fitted to the observed length distributions by varying the proportions of age groups in a spread sheet routine. It was agreed that this method could be improved if some standardisation of obtaining the right von Bertalanffy parameters could be achieved. For instance by simultaneously analysing several sets of length frequency data from the same stock, see e.g. Fournier *et al.* (1990).

4.3 Age Distributions

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 slicing procedure. As in previous years, the mean lengths of the estimated age groups are used as a check of the consistency of the estimates, see Fig. 4.1.

Table 4.6 gives the catch-at-age data. Catches are dominated by shrimps of ages 1 and 2. The numbers of age 4 and older are likely to be underestimates, due to the way the Bhattacharya method operates.

4.4 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 4.7. These figures are also used as weight-at-age in the stock. The occasional missing values (years with no catch of a certain age group) have been substituted with average values for that age.

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 are:

1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
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	0.65

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

4.5 Natural mortality

In the standard assessment M=0.75 was used for all ages and years, as in previous years. The WG had no new information available to get an estimate of the level of M, and did last year explore the effects of M varying with time (Anon. 2000. ICES CM 2000/ACFM:2). The constant value was used this year (was M=0.75 for all ages and years) and further exploration of the effects of predation was done in connection with the Production model (Sect. 4.10).

4.6 Catch-at-age Analysis

XSAs were performed on the 1985-1999 data set to estimate stock sizes and exploitation levels. Indices from the Norwegian shrimp surveys (Table 4.4) were used for tuning.

The input settings in the XSA are shown in Table 4.9. Catchabilities were assumed to be independent of stock size for all ages, and independent of age for ages 2 and older. Survivor estimates shrunk towards the mean F for the final 5 years, but the effect of using the final 2 years was also explored.

The XSA diagnostics (Table 4.9) show that the log catchability residuals are quite high, especially for ages 3 and 4 (in the order of 1.5-2), and a marked increasing trend over time has been observed for these ages (Figure 4.2.).

Regression statistics show very high intercepts for the 0 and 1 groups, a slope of around 2 for the 2 group and poor correlation (low values of R^2).

Fishing mortalities, expressed as unweighted means over age groups 1-3, (Table 4.10) display high variation between years and a slight increasing trend over the years.

Stock size in terms of number at age is given in Table 4.11. Spawning stock biomass increased in 1998 due to the strong 1996 year class, but display a negative trend since 1995.

Summary results without SOP corrections are given in Table 4.12.

4.7 Recruitment

The abundance indices of young shrimps obtained by the Norwegian survey in October 1999 are shown in Table 4.13. It appears from the 0, 1and 2-group indices that the 1997 year class was below average. The 0-group index for the 1998 year class was below average, whereas the 1-group index for this year class indicates an average year class size. The 0-group index for the 1999 year class is on the same level as the 1998 0-group index, i.e. below average. However, preliminary results from a short Norwegian cruise in March indicate a higher level of this year class. As the WG considers the 0-group indices rather unreliable as predictors of later year class strength, a new and more reliable estimate of the 1999 year class as 1-group will be made during the survey in Oct. 2000. The results will (hopefully) be made available to the October meeting of the ACFM.

4.8 Catch prediction

Input data and results for the short-term prediction are shown in Table 4.14. The fishing pattern used for 1999 is the 1996-1998 average (not scaled to the 1999 level). Mean weights are averages for the period 1985-1998. Recruitment in 2000 - 2002 is the geometric average for the period 1985-1998.

The proportion mature for age group 2 in 2000-2002 is the average for 1997-1999.

This preliminary prediction results in a *status quo* landing in 2000 of 12 000 tonnes, whereas the agreed TAC is 9 100 for Div. IIIa alone and 16 210 tonnes for the whole of Div. IIIa and Area IV. Predicted *status quo* catches in 2001 is 10 800 tonnes assuming mean recruitment. Based on landings during the first 6 months of 2000 in Div. IIIa+IVaE (about 5 200 tonnes), an estimate for the whole year is about 9 600 t. Last year's short-term projection for 2000 was 11 500 tonnes.

4.9 Medium-term evaluation and Biological Reference Points

The large uncertainties of the assessment and the large influence of the natural mortality value led 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}).

Under these circumstances it was not found meaningful to present a medium-term prediction.

4.10 Application of a stock production model

Taking into account both the uncertainties connected with the ageing of shrimp and the large influence of predation on the shrimp stock, the Working Group decided to explore models based on aggregate data. The model applied here has been described and exemplified by Stefánsson *et al*. (1994). It is a form of stock production model, which also includes the effect of predation (referred to here as SPP).

The model is expressed as:

$$B_{t+1} = aB_t - C_t + bR_t - pD_t$$

$$\hat{U}_t = q(B_t + B_{t+1})/2$$

Where

B_t - (fishable) biomass of shrimp in year t

C_t - yearly landings

R_t - yearly recruitment indices

D_t - yearly index of predator biomass

U_t and $\hat{U}_t$ are the reported and predicted CPUE indices.

The parameters of the model (B_0, a, b, p and q) are estimated by a least-squares fit (performed by the Excel Solver). The expression to minimise is the sum of squared differences between observed and predicted CPUE values:

$$\Sigma(U_t - \hat{U}_t)^2$$

4.10.1 Input data

The input data cover the period 1985 to 1999 and consist of:

- Catches and CPUE for the area (Div. IIIa, IVaE) were used.
- The recruitment of 1-group shrimp was applied as the weight (numbers * average weight) per nautical mile in the Norwegian Surveys.
- Total weight of likely predator species (23 species) caught per nautical mile in the yearly Norwegian trawl surveys in Skagerrak and NE North Sea was chosen as in index of predation. The dominating species in this assembly are Roundnosed Grenadier, Greater argentine, Cod and Saithe.

Catches, recruitment index and predator indexes are presented in Table 4.15.

4.10.2 Results

Estimates of parameters and the corresponding SSE value are given below.

a	1.309
b	471.7
p	1912
q	0.00030
B_0	110 000
SSE	60

Estimated shrimp biomass and the amount consumed by predators are given in Table 4.16 together with the observed and calculated CPUE.

The relation between observed CPUE and estimated biomass is also illustrated in Figure 4.3. The regression indicates that 67% of the variation in biomass could be explained by CPUE.

Figure 4.4 presents the observed and estimated CPUE values for 1985-1999. The correlation between these series is 0.92.

A retrospective analysis was performed in order to investigate the stability in the estimated biomass. It was done by stepwise excluding the years 1999-1994 and is illustrated in Figure 4.6. The model gave very stable results for this period.

4.10.3 Comparisons between results from different models

The results of the catch-at-age and the production type models lead to different perceptions of stock development and especially of the split of total mortality between the contributions from harvesting and predation. The Figure 4.5 a-c illustrate this for Total Stock Biomass, Yield/Biomass (as a proxy for fishing mortality) and Tons Shrimp Eaten/Biomass (as a proxy for natural mortality).

The biomass estimates from the Production model are generally somewhat higher than from the XSA:s. The index of exploitation (Yield/Biomass) is lower, correspondingly the Predation/Biomass higher. Furthermore, the trend of the indices of exploitation from the SSP model is more in line with the trend in observed total effort. The “Natural mortality” is, of course, more variable.

4.10.4 Catch prediction based on the SSP model

The input needed to predict biomass in year 2001 and 2002 is the recruitment and predator indices for 2000. Such data from the Survey will become available to the ACFM meeting in October.

5 FLADEN GROUND

5.1 Catch, Effort and Research Vessel data

Table 5.1 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 fisheries exploit the shrimps on Fladen. Denmark accounts for the majority of landings. Note that also total Fladen landings, like landings in IIIa and IVa East, fell drastically in 1999, being only around 1/3 of the 1998 landings. In general, the shrimp fisheries on Fladen takes place mainly during the first half of the year.

Total effort for the Danish and Scottish Fladen fisheries is estimated from logbook data from these fisheries. Table 5.2 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. It appears that total effort has been at a relatively low level in 1997 and 1998, but dropped significantly further in 1999 along with the decline in landings in 1999.

5.2 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 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.

Catches from Fladen consist mainly of two 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. Lack of information on recruitment from surveys in this area has prevented the Working Group from making stock predictions for the Fladen.

6 COMBINED ASSESSMENT OF SHRIMPS IN DIV IIIA,IVA EAST AND FLADEN

6.1 Catch-at-Age Analysis

As mentioned in Sect. 5.2 data for analytical assessments of the Fladen stock have been collected as far as possible for these strongly fluctuating fisheries. Table 6.0 shows the catches by nation, and Table 6.1 gives catch in numbers at age for *Pandalus* from Skagerrak and IVa East combined with Fladen Ground. As mentioned above the Fladen fishery mainly takes place in the first two quarters, and in most years biological samples for ageing were only available for the first two quarters. Since 1992 no biological samples have been provided from the Scottish fishery and the age compositions are since then based on Danish data only. For those quarters where no biological samples were available, the age compositions were interpolated from the adjacent quarters with age compositions. For 1994, where no samples from the Fladen fishery were obtained, the quarterly catches were partitioned according to the corresponding age compositions in 1993 and 1992. Table 6.2 gives the combined mean weights in the catch, which are calculated as the weighted means of the two sets. These are also used as weights for the stock.

The XSA settings were identical to those used for Divisions IIIa+IVaE (Sect. 4.6). The F shrinkage to the mean was set to include the last two years and the two oldest age groups.

6.1.1 Main features of the output

The diagnostics from this assessment are similar to those presented in Sect. 4.6.

The pattern of log residuals from the assessments is given in Figure 4.2. The trend over time is evident in both assessments for the older ages.

Recruitment, fishing mortalities, SSB and total biomass are compared on Figures 6.1 a-d. The slightly higher F:s when the Fladen is included is counterbalanced by larger stock estimates.

It is thus obvious that the inclusion of the Fladen catches did not improve the XSA to any significant extent.

6.1.2 Stock production model

The Working Group intends at its next meeting to explore the possibilities of applying the SPP to this joint stock. Since the data on predators from the Norwegian surveys is not covering the Fladen sufficiently, appropriate data will be extracted from the IBTS database.

7 FARN DEEPS

In recent years, UK vessels have fished *Pandalus* in the Farn Deeps 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 recent years the *Pandalus* fishery in Farn Deeps has been negligible, see Table 7.1.

8 MESH SELECTION

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

9 BY-CATCH

By-catch data from logbooks are available for the Danish *Pandalus* fisheries for 1998 and 1999 as a continuation of the data series presented in previous working group reports.

10 REFERENCES

ICES. 1990. Report on the Working Group on the assessment of *Pandalus* Stocks ICES CM1990/Assess:9.

ICES. 1992. Report on the Working Group on *Nephrops* and *Pandalus* Stocks. ICES CM1992/Assess:8.

ICES. 2000. Report on the *Pandalus* Assessment Working Group. ICES C.M.2000/ACFM:2.

Bhattacharya, C.G. 1967. A simple method of resolution of a distribution into Gaussian components. Biometrics, 23:115-135.

Fournier, D.A., Sibert, J.R., Majkowski, J., and Hampton, J. 1990. MULTIFAN, a likelihood-based method for estimating growth parameters and age composition from multiple length frequency data sets, illustrated using data for Southern Bluefin Tuna (*Thunnus maccoyii*). Can. J. Fish. Aquat. Sci., 47, 1990.

Poulsen, E.M. 1970. On deep sea prawn in the North Sea-Skagerrak. Medd. Dan. Fish. Havunders. 7(1):22.

Stefánsson, G., Skúladóttir, U., and Pétursson, G. 1994. The use of a stock production type model in evaluating the offshore *Pandalus borealis* stock of North Icelandic waters, including the predation of Northern Shrimp by Cod. – ICES C.M. 1994/K:25, 13 pp.

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

	Division IIIa				Sub-area IV					
Year	Denmark	Norway	Sweden †	Total	Denmark	Norway	Sweden	UK (Engl.)*	UK (Scotl.)*	Total
1970	757	982	2740	4479	3460	1107		14	100	4681
1971	834	1392	2906	5132	3572	1265			438	5275
1972	773	1123	2524	4420	2448	1216		692	187	4543
1973	716	1415	2130	4261	196	931		1021	163	2311
1974	475	1186	2003	3664	337	767		50	432	1586
1975	743	1463	1740	3946	1392	604	261		525	2782
1976	865	2541	2212	5618	1861	1051	136	186	2006	5240
1977	763	2167	1895	4825	782	960	124	265	1723	3854
1978	757	1841	1529	4127	1592	692	78	98	2044	4504
1979	973	2489	1752	5214	962	594	34	238	309	2137
1980	1679	3498	2121	7298	1273	1140	38	203	406	3060
1981	2593	3753	2210	8556	719	1435	31	1	341	2527
1982	2920	3877	1421	8218	1069	1545	92		354	3060
1983	1571	3722	988	6281	5752	1657	112	65	1836	9422
1984	1717	3509	933	6159	4638	1274	120	277	25	6334
1985	4105	4772	1474	10351	4582	1785	128	415	1347	8257
1986	4686	4811	1357	10854	3896	1681	157	458	358	6550
1987	4140	5198	1085	10423	9223	3145	252	526	774	13920
1988	2278	3047	1075	6400	2647	4614	220	489	109	8098
1989	2527	3156	1304	6987	3298	3418	122	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
1999	1398	3985	2114	7497	1679	2756	182	46	479	5142

* Includes small amounts of other Pandalid shrimp
† 1970 to 1974 includes subarea IV.
Total 1988 - 1990 includes19, 21 and 51 t. by the Netherlands
1999 figures are preliminary.

Tabel 4.2 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	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
1999	2072	6726	2445	11243	639		11882

Tabel 4.3 National LPUE and total effort as estimated by the Working Group, for Pandalus division IIIa and IVa east

Year	Denmark LPUE kg/day	Total effort days	Norway LPUE kg/hr	Total effort Khrs	Sweden LPUE kg/hr	Total effort Khrs	combined effort index rel. to1986	average index
1984	452	3869	no data		25	40		
1985	719	5326	no data		32	49		
1986	556	8700	36	179	30	49	1.00	1.00
1987	499	9212	36	230	23	57	1.20	1.17
1988	432	7104	31	251	22	57	1.23	1.13
1989	441	7143	23	273	23	63	1.29	1.21
1990	591	4195	26	232	26	58	1.08	0.99
1991	645	5555	30	206	31	61	1.01	1.01
1992	641	5811	35	204	27	80	1.09	1.15
1993	571	5068	31	243	25	91	1.27	1.27
1994	677	3146	31	218	33	82	1.17	1.08
1995	801	3072	35	255	39	76	1.27	1.11
1996	860	4466	37	214	32	74	1.06	1.07
1997	1034	3770	42	212	33	78	1.06	1.07
1998	1023	3256	44	219	34	73	1.08	1.03
1999	833	2501	31	214	34	72	1.09	0.98

Table 4.4 Norwegian Shrimp Survey, catch in numbers at age per nautical mile.

	Age				
Year	**0**	**1**	**2**	**3**	**4**
1985	2694	35741	16347	3228	1443
1986	1304	10456	6853	2823	201
1987	909	26002	11055	7289	933
1988	2196	3368	4150	2935	533
1989	10247	20024	5791	466	10
1990	4546	18504	9186	980	66
1991	2240	25208	9958	2112	263
1992	22644	19058	11070	4232	382
1993	4763	30753	8903	3323	166
1994	2674	18622	10238	4135	1360
1995	1702	13839	7590	9288	365
1996	9150	28273	12045	5380	425
1997	2251	34738	16964	7145	3132
1998	3310	10956	13755	10271	1590
1999	3087	19384	5288	7159	448

Table 4.6 Catch in numbers at age. Pandalus division IIIa and IVa east

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

YEAR	AGE	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	0	17677	7397	2666	14136	31328	0	3947	25481	27172	666	2678	61140	19701	12695	4596
	1	1200771	1146414	1260489	1086554	2083644	2250093	1231759	1071420	1889578	671932	645975	1211633	2175622	903366	1431298
	2	1305436	1029705	1205579	923865	385493	910845	1035782	1289159	803781	1380397	970480	991351	1181917	1597910	758368
	3	187940	482651	390172	300195	173819	121106	326666	569130	262698	142951	851452	454614	295595	468092	297721
	4	52222	24060	198379	146037	13475	28150	22398	56541	14856	30450	32119	69501	27780	45725	25822
	+gp	34	1062	4848	679	171	3138	3251	925	619	0	9796	0	1999	2454	2669
TOTALNUM		2764080	2691289	3062133	2471466	2687930	3313332	2623803	3012656	2998704	2226396	2512500	2788239	3702614	3030242	2520474
TONSLAND		12602	13201	14876	12929	12101	11420	12106	13556	13475	11745	14605	14547	16109	15753	11881
SOPCOF %		85	98	105	102	106	88	97	88	93	95	93	89	94	96	96

Table 4.7 Mean weight at age. Pandalus division IIIa and IVa east

Catch weights at age (kg)

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
AGE															
0	0.0010	0.0012	0.0010	0.0010	0.0011	0.0010	0.0015	0.0010	0.0010	0.0010	0.0010	0.0007	0.0010	0.0007	0.0007
1	0.0032	0.0032	0.0024	0.0030	0.0034	0.0030	0.0033	0.0035	0.0035	0.0034	0.0033	0.0037	0.0031	0.0033	0.0033
2	0.0064	0.0054	0.0048	0.0054	0.0065	0.0053	0.0053	0.0052	0.0067	0.0060	0.0057	0.0067	0.0061	0.0055	0.0063
3	0.0104	0.0083	0.0077	0.0090	0.0099	0.0084	0.0079	0.0078	0.0088	0.0093	0.0090	0.0094	0.0094	0.0087	0.0089
4	0.0134	0.0139	0.0113	0.0117	0.0132	0.0106	0.0120	0.0094	0.0108	0.0117	0.0110	0.0138	0.0118	0.0133	0.0110
+gp	0.0167	0.0167	0.0151	0.0167	0.0180	0.0113	0.0134	0.0130	0.0139	0.0122	0.0136	0.0142	0.0137	0.0127	0.0137
SOPCOFAC	0.85	0.97	1.05	1.02	1.05	0.88	0.97	0.88	0.93	0.96	0.93	0.89	0.94	0.96	0.96

Table 4.9 Extended Survivor analysis.Tuning output. Pandalus division IIIa and IVa east

Lowestoft VPA Version 3.1

6/09/2000 12:14

Extended Survivors Analysis

Pandalus IIIa + IVa E Assessment, 2000 WG

CPUE data from file c:\ices2000\xsa00\panefs00.txt

Catch data for 15 years. 1985 to 1999. Ages 0 to 5.

Fleet,	First, Last,	First, Last,	Alpha,	Beta

Fleet	First year	Last year	First age	Last age	Alpha	Beta
Norsur	1985	1999	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

Prior weighting not applied

Tuning converged after 19 iterations

1
Regression weights

0.751	0.820	0.877	0.921	0.954	0.976	0.990	0.997	1.000	1.000

Fishing mortalities

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	0	0	0.001	0.002	0	0	0.004	0	0	0
1	0.374	0.241	0.324	0.221	0.138	0.149	0.211	0.34	0.29	0.28
2	0.651	0.583	0.928	0.938	0.482	0.603	0.738	0.66	1.01	0.82
3	0.939	1.191	2.545	1.08	0.882	1.65	1.718	1.17	1.55	1.35
4	0.863	0.941	1.826	1.047	0.648	1.117	1.297	0.9	1.3	1.11

Table 4.9 continued

1

XSA population numbers (Thousands)

AGE YEAR	0	1	2	3	4
1990	1.77E+07	1.05E+07	2.77E+06	2.89E+05	7.09E+04
1991	1.19E+07	8.36E+06	3.41E+06	6.83E+05	5.35E+04
1992	2.94E+07	5.63E+06	3.10E+06	8.99E+05	9.81E+04
1993	1.61E+07	1.39E+07	1.92E+06	5.79E+05	3.33E+04
1994	1.44E+07	7.58E+06	5.25E+06	3.55E+05	9.29E+04
1995	1.96E+07	6.79E+06	3.12E+06	1.53E+06	6.95E+04
1996	2.31E+07	9.28E+06	2.76E+06	8.06E+05	1.39E+05
1997	1.12E+07	1.09E+07	3.55E+06	6.24E+05	6.84E+04
1998	1.83E+07	5.28E+06	3.65E+06	8.65E+05	9.14E+04
1999	6.34E+06	8.65E+06	1.88E+06	6.25E+05	8.67E+04

Estimated population abundance at 1st Jan 2000

0.00E+00	2.99E+06	3.10E+06	3.91E+05	7.64E+04

Taper weighted geometric mean of the VPA populations:

1.55E+07	7.98E+06	2.87E+06	6.71E+05	8.53E+04

Standard error of the weighted Log(VPA populations) :

.4179	.3176	.3819	.4866	.6347

1

Log catchability residuals.

Fleet : Norsur

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
0	-0.35	-0.91	-0.8	-0.7	0.68	0.09	-0.22	1.19	0.23	-0.23
1	0.34	-0.58	0.58	-0.86	0.07	-0.21	0.21	0.40	-0.11	-0.08
2	-0.39	-0.85	0.38	-0.37	0.33	-0.06	-0.25	0.25	0.52	-0.74
3	0.93	-0.89	0.63	1.66	-0.82	0.21	0.34	1.94	0.86	1.40
4	1.02	-0.52	-0.4	0.21	-2.24	-1.15	0.59	1.13	0.69	1.42

Age	1995	1996	1997	1998	1999
0	-1.00	0.52	-0.15	-0.26	0.73
1	-0.26	0.20	0.36	-0.12	-0.06
2	-0.41	0.29	0.31	0.38	-0.08
3	1.41	1.57	1.63	2.00	1.79
4	0.81	0.42	2.78	2.16	0.78

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	-12.31	-9.75	-9.03	-9.03	-9.03
S.E(Log q)	0.65	0.34	0.42	1.47	1.45

Table 4.9 continued

Regression statistics :

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

Age	Slope	t-value	Intercept	Rsquare	No Pts	Reg s.e.	Mean Q
0	0.81	0.46	13.10	0.39	15	0.55	-12.31
1	0.77	0.93	11.20	0.62	15	0.26	-9.75
2	2.08	-1.64	2.71	0.19	15	0.82	-9.03
3	0.75	0.59	9.27	0.37	15	0.67	-7.89
4	0.88	0.21	8.69	0.25	15	1.16	-8.34
1							

Terminal year survivor and F summaries :

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

Year class = 1999

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Norsur	6209217	0.676	0	0	1	0.353	0
F shrinkage mean	2006161	0.5				0.647	0.002

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
2989863	0.4	0.91	2	2.26	0.001

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

Year class = 1998

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Norsur	2806657	0.313	0.085	0.27	2	0.659	0.301
F shrinkage mean	3759916.	0.5				0.341	0.233

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
3101103	0.27	0.13	3	0.486	0.276

1

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

Year class = 1997

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Norsur	350378	0.258	0.019	0.07	3	0.585	0.88
F shrinkage mean	456948	0.5				0.415	0.734

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
391244	0.26	0.1	4	0.388	0.817

Table 4.9 continued

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

Year class = 1996

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Norsur	127454	0.272	0.23	0.85	4	0.24	0.999
F shrinkage mean	64988	0.5				0.76	1.474

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
76400	0.39	0.31	5	0.803	1.351

1

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

Year class = 1995

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Norsur	18769	0.391	0.295	0.75	5	0.141	0.901
F shrinkage mean	12833	0.5	0.859	1.143			

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
13538	0.43	0.19	6	0.429	1.107

Table 4.10 Extended Survivor analysis.Fishing mortality at age. Pandalus division IIIa and IVa east

Run title : Pandalus IIIa + IVa E Assessment
2000 WG
At 6/09/2000 12:16

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	1999	FBAR 96-98
AGE																
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.19	0.25	0.33	0.49	0.42	0.37	0.24	0.32	0.22	0.14	0.15	0.21	0.34	0.29	0.28	0.28
2	0.42	0.48	0.97	0.95	0.65	0.65	0.58	0.93	0.94	0.48	0.60	0.74	0.66	1.01	0.82	0.81
3	0.92	0.52	0.69	1.98	0.99	0.94	1.19	2.55	1.08	0.88	1.65	1.72	1.17	1.55	1.35	1.48
4	0.69	0.53	0.90	1.56	0.90	0.86	0.94	1.83	1.05	0.65	1.12	1.30	0.89	1.30	1.11	1.16
+gp	0.69	0.53	0.90	1.56	0.90	0.86	0.94	1.83	1.05	0.65	1.12	1.30	0.89	1.30	1.11	
0 FBAR 1- 3	**0.51**	**0.42**	**0.66**	**1.14**	**0.68**	**0.65**	**0.67**	**1.27**	**0.75**	**0.50**	**0.80**	**0.89**	**0.73**	**0.95**	**0.82**	

Table 4.11 Extended Survivor analysis. Stock number at age. Pandalus division IIIa and IVa east

Run title : Pandalus IIIa + IVa E Assessment
2000 WG
At 6/09/2000 12:16

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
AGE																
0	1622675	1374028	860987	1885709	2225613	1769297	1191559	2940817	1608617	1437157	1964683	2313713	1121677	1834007	633628	0
1	1001850	765283	648536	406518	889774	1049152	835757	562581	1387392	757989	678819	927867	1088718	528489	865451	298986
2	557271	390713	282702	219715	117348	277093	340938	310126	192107	525489	311868	276254	355019	364746	187553	310110
3	45481	173515	113789	50681	40290	28937	68288	89859	57891	35502	153350	80616	62359	86467	62471	39124
4	15218	8567	48791	26934	3308	7085	5345	9806	3331	9291	6945	13918	6835	9140	8673	7640
+gp	9	358	1104	112	39	733	716	141	127	0	1936	0	455	444	673	1459
0 TOTAL	3242505	2712463	1955909	2589669	3276372	3132297	2442604	3913331	3249465	2765428	3117601	3612367	2635063	2823293	1758449	657320

Table 4.12 Extended Survivor analysis. Summary table without SOP corrections. PandalusdivisionIIIaandIVaeast

Run title : Pandalus IIIa + IVa E Assessment
2000 WG
At 6/09/2000 12:16

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS Age 0	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 1-3
1985	16226750	89891	28877	12602	0.436	0.509
1986	13740277	77249	17469	13201	0.756	0.416
1987	8609872	52008	17153	14876	0.867	0.664
1988	18857088	50260	10821	12929	1.195	1.139
1989	22256130	67199	10691	12101	1.132	0.685
1990	17692974	66900	17292	11420	0.660	0.655
1991	11915591	69552	19274	12106	0.628	0.672
1992	29408166	73035	17512	13556	0.774	1.266
1993	16086168	82992	11270	13475	1.196	0.746
1994	14371571	76004	26566	11745	0.442	0.500
1995	19646830	74212	23832	14605	0.613	0.801
1996	23137126	78228	20159	14547	0.722	0.889
1997	11216767	72935	17855	16109	0.902	0.725
1998	18340068	58878	20816	15753	0.757	0.950
1999	6336281	50998	14226	11881	0.835	0.815
Arith. mean	16522777	69356	18254	13394	0.794	0.762

Table 4.13 Indices of 0,I and II-group shrimp from Norwegian trawl surveys in October and XSA values Div. IIIa, IVaE

Year-class	Survey 0-GR	I-GR	II-GR	XSA (millions) 0-GR	1-GR	2-GR
1983		20003	16347			5573
1984	3074	35741	6852		10019	3907
1985	2695	10456	11055	16227	7653	2827
1986	1305	26002	4150	13740	6485	2197
1987	909	3368	4470	8610	4065	1173
1988	2196	19514	9186	18857	8898	2771
1989	9933	18504	9958	22256	10492	3409
1990	4546	25208	11070	176930	8358	3101
1991	2240	19058	8903	119156	5626	1921
1992	22644	30753	10238	294082	13874	5255
1993	4763	18622	7590	160862	7580	3119
1994	2674	13839	12045	143716	6788	2763
1995	1702	28273	16964	196468	9279	3550
1996	9150	34738	13755	231371	10887	3647
1997	2251	10956	5288	112168	5285	1876
1998	3310	19384		183401	8655	
1999	3087			63363	2990	
Mean	4894	20961	9858	117414	8263	3139

Table 4.14 Short term prediction. Input data and result

The SAS System 09:06 Wednesday, October 11, 2000
Pandalus in Divisions IIIa & IVa East(Skagerrak & Norwegian Deeps)

Prediction with management option table: Input data

Year: 2000

Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
0	16469.000	0.7500	0.0000	0.0000	0.0000	0.800	0.0000	0.800
1	2990.000	0.7500	0.0000	0.0000	0.0000	3.200	0.2800	3.200
2	3101.000	0.7500	0.5900	0.0000	0.0000	6.000	0.8100	6.000
3	391.000	0.7500	1.0000	0.0000	0.0000	9.000	1.4800	9.000
4	76.000	0.7500	1.0000	0.0000	0.0000	12.000	1.1600	12.000
5+	15.000	0.7500	1.0000	0.0000	0.0000	13.300	1.1600	13.300
Unit	Millions	-	-	-	-	Grams	-	Grams

Year: 2001

Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
0	16469.000	0.7500	0.0000	0.0000	0.0000	0.800	0.0000	0.800
1	.	0.7500	0.0000	0.0000	0.0000	3.200	0.2800	3.200
2	.	0.7500	0.5900	0.0000	0.0000	6.000	0.8100	6.000
3	.	0.7500	1.0000	0.0000	0.0000	9.000	1.4800	9.000
4	.	0.7500	1.0000	0.0000	0.0000	12.000	1.1600	12.000
5+	.	0.7500	1.0000	0.0000	0.0000	13.300	1.1600	13.300
Unit	Millions	-	-	-	-	Grams	-	Grams

Year: 2002

Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
0	16469.000	0.7500	0.0000	0.0000	0.0000	0.800	0.0000	0.800
1	.	0.7500	0.0000	0.0000	0.0000	3.200	0.2800	3.200
2	.	0.7500	0.5900	0.0000	0.0000	6.000	0.8100	6.000
3	.	0.7500	1.0000	0.0000	0.0000	9.000	1.4800	9.000
4	.	0.7500	1.0000	0.0000	0.0000	12.000	1.1600	12.000
5+	.	0.7500	1.0000	0.0000	0.0000	13.300	1.1600	13.300
Unit	Millions	-	-	-	-	Grams	-	Grams

Notes: Run name : MANHS10
Date and time: 11OCT00:09:08

The SAS System 09:06 Wednesday, October 11, 2000
Pandalus in Divisions IIIa & IVa East(Skagerrak & Norwegian Deeps)

Prediction with management option table

Year: 2000					Year: 2001					Year: 2002	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
1.0000	0.8567	45980	15608	11963	0.0000	0.0000	51022	10327	0	68698	21589
.	.	.	.	.	0.1000	0.0857	.	10327	1463	67190	20330
.	.	.	.	.	0.2000	0.1713	.	10327	2815	65800	19183
.	.	.	.	.	0.3000	0.2570	.	10327	4070	64516	18135
.	.	.	.	.	0.4000	0.3427	.	10327	5235	63326	17175
.	.	.	.	.	0.5000	0.4283	.	10327	6322	62222	16293
.	.	.	.	.	0.6000	0.5140	.	10327	7336	61193	15482
.	.	.	.	.	0.7000	0.5997	.	10327	8286	60233	14733
.	.	.	.	.	0.8000	0.6853	.	10327	9178	59335	14040
.	.	.	.	.	0.9000	0.7710	.	10327	10016	58493	13398
.	.	.	.	.	1.0000	0.8567	.	10327	10806	57702	12801
.	.	.	.	.	1.1000	0.9423	.	10327	11551	56957	12244
.	.	.	.	.	1.2000	1.0280	.	10327	12257	56255	11725
.	.	.	.	.	1.3000	1.1137	.	10327	12926	55590	11239
.	.	.	.	.	1.4000	1.1993	.	10327	13561	54961	10784
.	.	.	.	.	1.5000	1.2850	.	10327	14165	54365	10356
.	.	.	.	.	1.6000	1.3707	.	10327	14740	53798	9953
.	.	.	.	.	1.7000	1.4563	.	10327	15289	53259	9574
.	.	.	.	.	1.8000	1.5420	.	10327	15814	52746	9215
.	.	.	.	.	1.9000	1.6277	.	10327	16316	52255	8876
.	.	.	.	.	2.0000	1.7133	.	10327	16796	51787	8554
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANHS10
Date and time : 11OCT00:09:08
Computation of ref. F: Simple mean, age 1 - 3
Basis for 2000 : F factors

Table 4.15 Input data for the SPP model

Year	Catch tonnes	Recr. Index kg 1-gr / NM	Predator Index kg / NM
1985	12602	107.2	31.0
1986	13201	31.4	29.5
1987	14876	78.0	26.9
1988	12929	10.1	21.0
1989	12101	58.5	22.7
1990	11421	55.5	24.3
1991	12107	75.6	22.6
1992	13556	57.2	25.8
1993	13475	92.3	27.5
1994	11745	55.9	18.4
1995	14523	41.5	25.1
1996	14548	84.8	21.8
1997	16109	104.2	26.5
1998	15753	32.9	41.1
1999	11882	58.2	34.9
2000	*9600*		
Mean 85-99	13389	63	27

Table 4.16 CPUE from the shrimp fleet and output from the model

Year	Biomass tonnes	Obs CPUE kg/hr	Calc CPUE kg/hr	Shrimp Eaten tonnes
1985	110000	36.6	34.6	59262
1986	122759	31.9	34.0	56404
1987	105943	31.0	32.0	51438
1988	109214	27.6	30.2	40145
1989	94705	24.4	28.2	43447
1990	96083	30.0	28.0	46499
1991	94086	31.5	29.2	43169
1992	103604	33.1	30.0	49249
1993	99834	30.4	30.8	52560
1994	108218	32.0	34.0	35228
1995	121091	36.6	35.0	48059
1996	115568	37.6	37.0	41703
1997	135096	43.4	43.6	50578
1998	159380	44.1	42.8	78652
1999	129804	35.2	36.5	66655
2000	118871			
Mean 85-99	113692	34	34	50870

Table 5.1 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	1298	5906
1996	3858		32	1893	5783
1997	2892		9	365	3266
1998	2900		3	1365	4268
1999	1090		9	479	1578

Table 5.2 Pandalus borealis, Fladen Ground. Reported LPUE (shrimp trawlers), and estimated total effort.

Year	Denmark LPUE (ton./day)	Denmark Total effort (Days)	Denmark effort Index	UK (Scotland) LPUE (kg/hour)	UK (Scotland) Total effort (hours)	UK (Scotland) effort Index	Combined*) index
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	637	0.21	91	330	0.02	0.21
1995	2.00	2331	0.77	130	5038	0.32	0.72
1996	1.79	2155	0.71	62	11638	0.75	0.72
1997	2.86	1078	0.36	202	1810	0.12	0.33
1998	2.20	1405	0.47	134	4004	0.26	0.40
1999	1.62	606	0.20	107	4268	0.27	0.22

*) average weighted by total landings

Tabel 6.0 Pandalus borealis landings from divisions IIIa (Skagerrak), IVa (eastern part) and the Fladen Ground. (Norwegian Deeps) as estimated by the Working Group

Year	Denmark	Norway	Sweden	UK (Scotland)	Total	Estimated discards	Catch
1972	3221	2477	2524	187	8409		8409
1973	912	2333	2130	163	5538		5538
1974	812	1809	2003	434	5058		5058
1975	2125	2339	2003	525	6992		6992
1976	2756	3348	2529	1937	10570		10570
1977	1545	3116	2019	1692	8372		8372
1978	2349	2521	1609	2027	8506		8506
1979	1627	3084	1787	268	6766		6766
1980	2800	4638	2159	377	9974		9974
1981	3278	5184	2241	347	11050		11050
1982	4049	5042	1450	352	10893		10893
1983	7296	5369	1136	1827	15628		15628
1984	6300	4796	1022	25	12143		12143
1985	7476	6646	1571	1341	17034	558	17592
1986	8250	6490	1463	301	16504	414	16918
1987	11814	8343	1322	686	22165	723	22888
1988	4317	7663	1278	84	13342	750	14092
1989	5588	6436	1433	547	14004	1107	15111
1990	4160	6111	1612	365	12248	1226	13474
1991	4005	6150	1908	53	12116	497	12613
1992	5173	7136	2154	116	14579	541	15120
1993	4436	7409	2300	509	14654	889	15543
1994	4341	6813	2601	35	13790	214	14003
1995	7043	8930	2882	1298	20153	275	20429
1996	7726	7910	2371	1893	19900	318	20219
1997	6801	8574	2597	365	18337	1039	19376
1998	6230	9609	2469	1365	19674	348	20021
1999	3162	6735	2445	479	12821	639	13460

Table 6.1

Run title : Pandalus IIIa, IVa E Assessment + Fladen
2000 WG
At 6/09/2000 18:05

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

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
AGE															
0	17677	7397	2666	14136	31328	0	4048	25557	27172	1209	3018	64813	20865	13329	4596
1	1554771	1505414	1800489	1102554	2389644	2274212	1248071	1096829	1901859	709235	983652	1476239	2283875	961823	1560980
2	2180436	1615705	2680579	1236865	712493	1361800	1088881	1489778	1110221	1546423	1480594	1815673	1679334	2178633	948726
3	382940	642651	555172	331195	474819	161177	368678	684072	388490	206632	1328292	740038	470987	851427	366276
4	52222	24060	198379	146037	13475	28150	22398	56541	14856	30450	32119	69501	27780	45725	39909
+gp	34	1062	4848	679	171	3138	3251	925	619	0	9796	0	1999	2454	3385
0 TOTALNUM	4188080	3796289	5242133	2831466	3621930	3828477	2735327	3353702	3443217	2493949	3837471	4166264	4484840	4053391	2923872
TONSLAND	**17592**	**16918**	**22888**	**14090**	**15111**	**13473**	**12612**	**15120**	**15543**	**12987**	**20511**	**20330**	**19375**	**20021**	**13459**
SOPCOF %	93	100	109	102	101	90	98	89	93	96	95	92	95	97	96

Table 6.2

Run title : Pandalus IIIa, IVa E Assessment + Fladen
2000 WG
At 6/09/2000 18:05

Table Catch weight at age (kg)

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	AM 85-99
AGE																
0	0.0010	0.0012	0.0010	0.0010	0.0011	0.0011	0.0015	0.0010	0.0010	0.0008	0.0010	0.0007	0.0009	0.0007	0.0007	0.0010
1	0.0028	0.0028	0.0022	0.0030	0.0032	0.0030	0.0033	0.0034	0.0035	0.0034	0.0029	0.0035	0.0030	0.0032	0.0032	0.0031
2	0.0051	0.0047	0.0040	0.0048	0.0054	0.0049	0.0052	0.0051	0.0059	0.0058	0.0052	0.0055	0.0055	0.0049	0.0058	0.0052
3	0.0073	0.0075	0.0070	0.0087	0.0069	0.0077	0.0077	0.0075	0.0081	0.0086	0.0080	0.0081	0.0082	0.0074	0.0085	0.0078
4	0.0134	0.0139	0.0113	0.0117	0.0132	0.0106	0.0120	0.0094	0.0108	0.0117	0.0110	0.0138	0.0118	0.0133	0.0110	0.0119
+gp	0.0167	0.0167	0.0151	0.0167	0.0180	0.0113	0.0134	0.0130	0.0139	0.0139	0.0136	0.0136	0.0137	0.0127	0.0137	0.0144

Table 7.1 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
1998	5			5
1999	-	?	-	

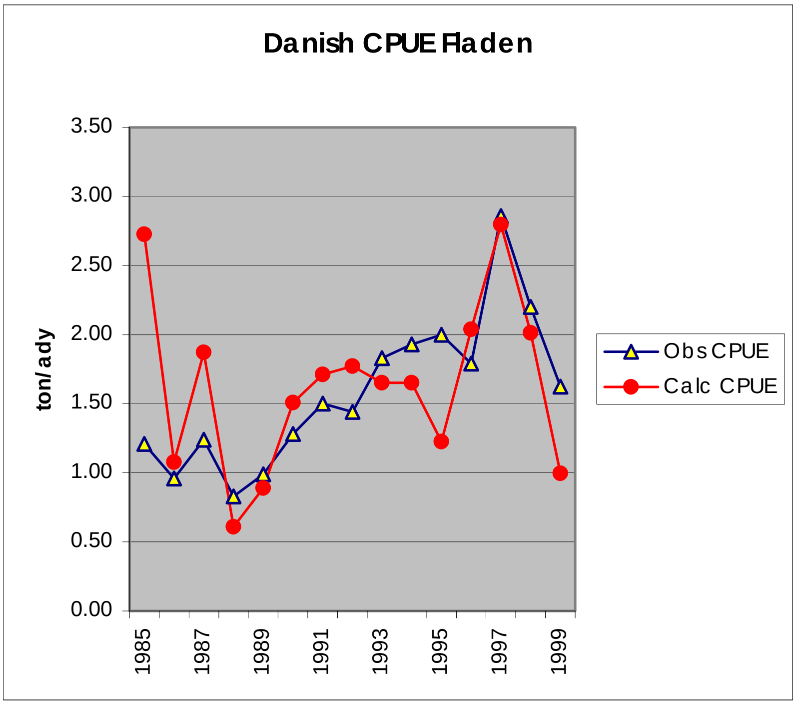


Figure 3.1 **Danish CPUE on Fladen and estimated CPUE from Norwegian recruitment indices in Div. IIIa and IVaE.**
The following formula was used:
DEN cpue = 0,00490* I-group index + 0,02245* II-group index

Correlation coef. 0.57

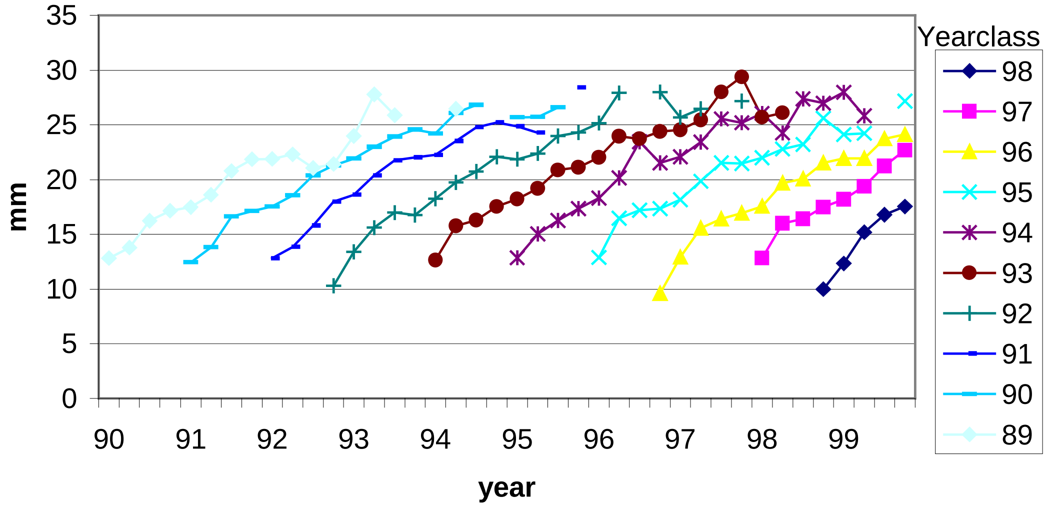
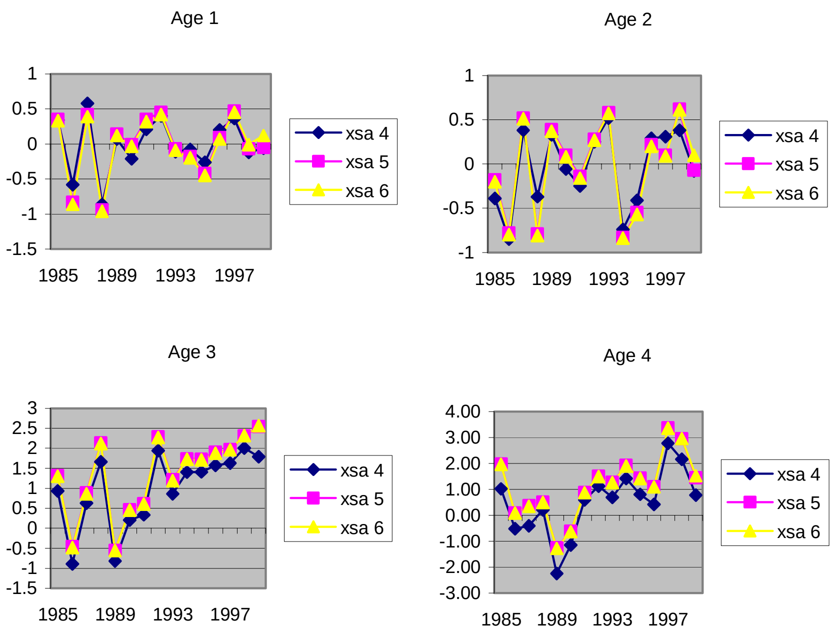


Figure 4.1 Mean quarterly carapace lenght (mm) for Pandalus in Div. IIIa and Iva East

Figure 4.2 **Log catchability residuals.**

xsa 4:	Div. IIIa and IVaE	F shrunk to lates 5 years
xsa 5:	Div. IIIa and IVaE + Fladen	F shrunk to lates 5 years
xsa 6:	Div. IIIa and IVaE + Fladen	F shrunk to lates 2 years



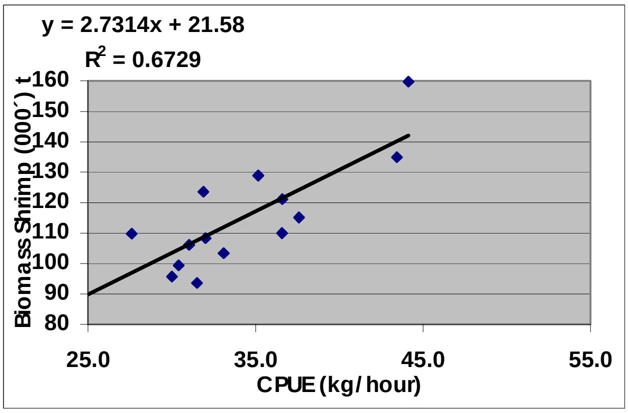


Figure 4.3 **Relation between observed CPUE and biomass estimated by the SPP model.**

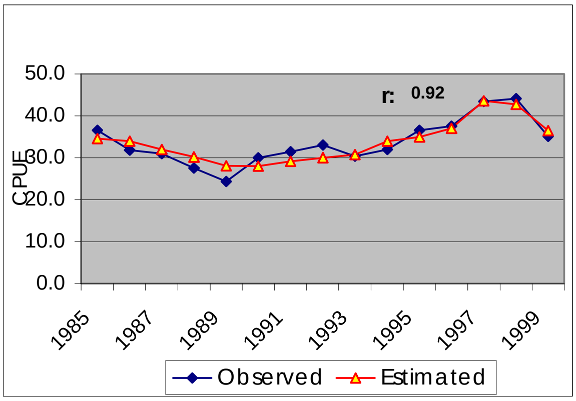


Figure 4.4 **Observed and estimated CPUE by the SPP model**

Figure 4.5 **Comparisons between output from XSA and SPP.**

a Total biomass

b Yield/Biomass and total effort

c Ton Shrimp eaten by predators

d Ton eaten/Biomass

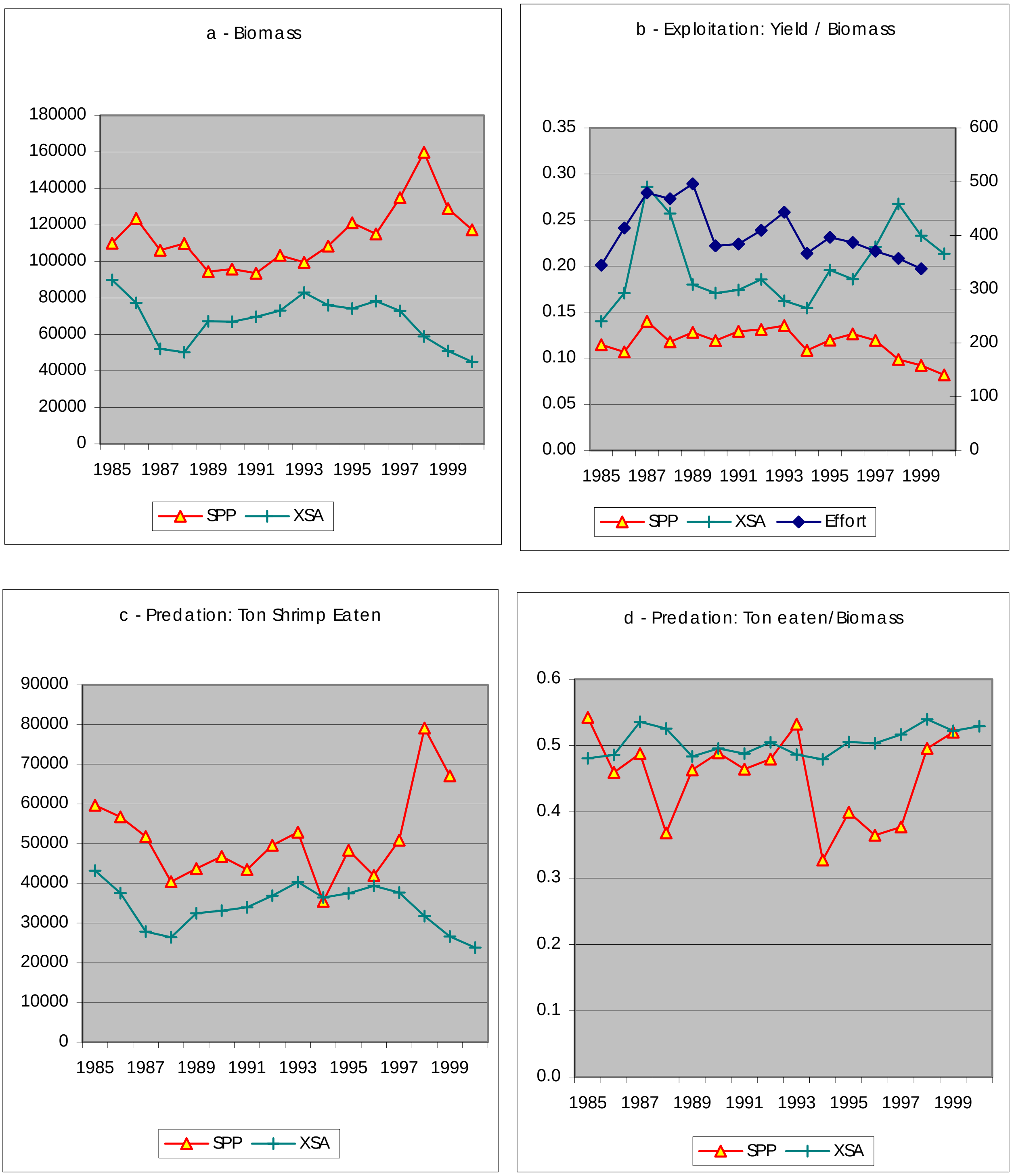


Figure 4.6 "Retrospective" estimation of Shrimp Biomass by SPP.

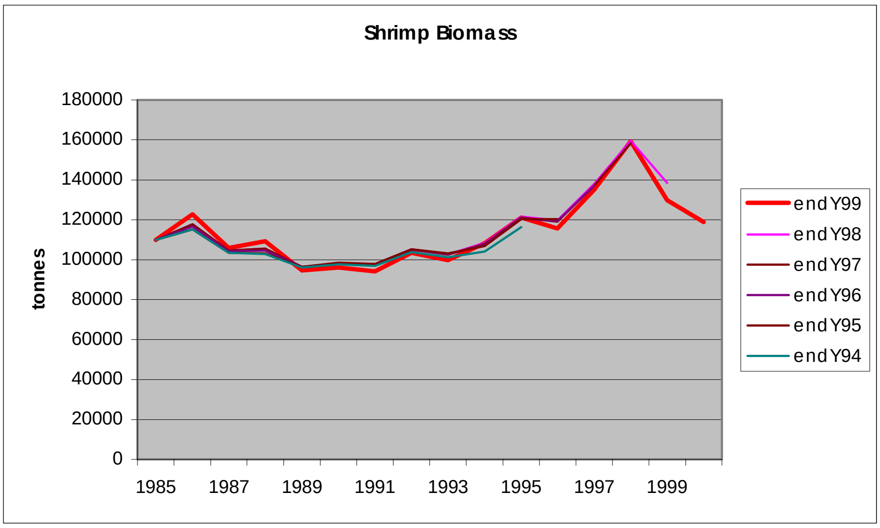


Figure 6.1 Comparisons of output from XSA with and without Fladen shrimps

xsa 4:	Div. IIIa and IVaE	F shrunk to latest 5 years
xsa 5:	Div. IIIa and IVaE + Fladen	F shrunk to latest 5 years
xsa 6:	Div. IIIa and IVaE + Fladen	F shrunk to latest 2 years