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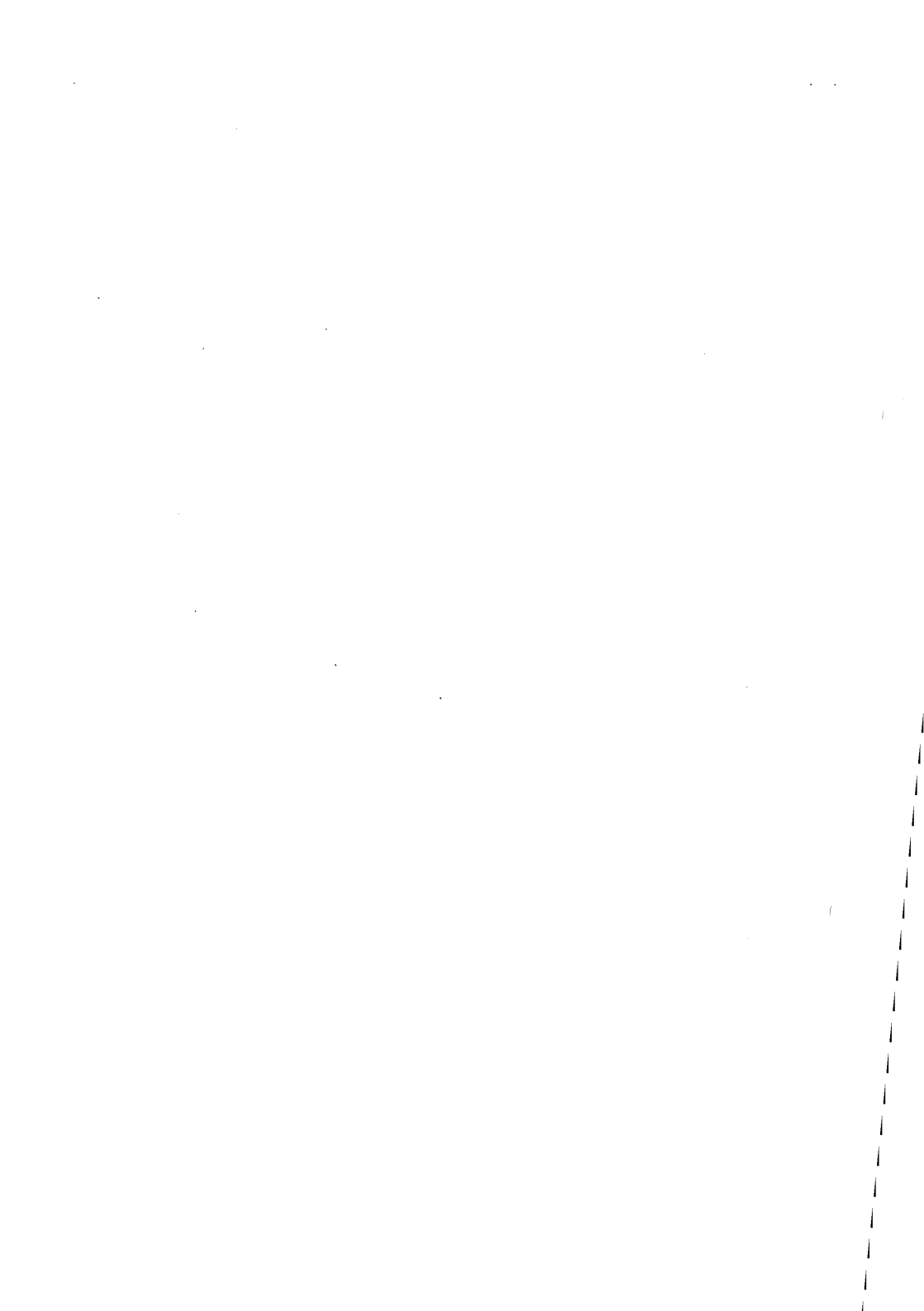
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REPORT OF THE WORKING GROUP ON THE ASSESSMENT OF PANDALUS STOCKS

Copenhagen, 9 - 12 February 1988

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1 INTRODUCTION

1.1 Participation

N. Bailey	UK (Scotland)
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P. Sand Kristensen (part-time)	Denmark
S. Munch-Petersen	Denmark
B. Sjöstrand (Chairman)	Sweden
S. Tveite	Norway

1.2 Terms of Reference

The Working Group on the Assessment of Pandalus Stocks (Chairman: Mr B. Sjöstrand) met at ICES Headquarters from 9-12 February 1988 (C.Res.1987/2:3:1) to assess the status of the stocks of Pandalus borealis in the North Sea, Skagerrak, and Kattegat.

2 PANDALUS STOCKS

The Working Group adopted the same separation of Pandalus stocks as last year: Division IIIa, eastern parts of Division IVa along the Norwegian Deeps, Fladen Ground in Division IVb, and Farn Deeps in Division IVb.

The biological differences between Pandalus in Division IIIa and in the Norwegian Deeps, on which the present separation is based, will be studied further.

3 DIVISION IIIa

3.1 The Fishery

3.1.1 Landings

The total landings for the period 1970-1987 are given in Table 3.1. The landings in 1987 were continuously high, almost 10,000 t. The Danish and Swedish landings decreased and the Norwegian landings increased in comparison to 1986.

3.1.2 Discards

Data on discarded amounts were not given, and consequently the assessment had to be based on landed quantities only.

3.1.3 Effort data

Data on effort and CPUE were provided and are given in Tables 3.2 and 3.3. The Norwegian logbook system has not yet reached full coverage, and since the data given are very similar to those by Sweden, Swedish CPUE data were used to estimate the Norwegian effort.

In order to obtain overall effort indices, the national effort estimates were expressed relative to their 1982 values and averaged (weighted by catches).

The total index increased about 30% in both 1986 and 1987 due to Danish and Norwegian effort increases. Table 3.3 gives the same data broken down to quarterly figures. The seasonal variations in effort are very marked with the highest intensity during the second and third quarters.

3.2 Assessment

3.2.1 Age distributions

Samples for length distributions provided by Norway and Denmark were converted to age distribution by splitting them into normal distributions by the NORM-SEP program (Macdonald and Pitcher, 1979) available on the ICES computer. Monthly age distributions were averaged over quarters. The total catch in numbers was based solely on Norwegian samples for the period 1984:2 to 1987:1. In 1987:2-4, the Norwegian and the Danish catches were accounted for directly and the Swedish catches raised according to the Norwegian age distributions. Mean length at age and age distributions in the Norwegian samples are given in Table 3.4. The catch-in-numbers-at-age data are given in Table 3.5.

3.2.2 Mean weight at age

Mean weights at age were obtained by applying a length-weight relationship to the mean-length-at-age values. The relation used (Anon., 1977) was:

$$W = 0.00264 CL^{2.551}$$

These mean weights were used both for the quarterly catch and the stock (Table 3.6).

In the yield-per-recruit calculations and predictions which were based on yearly data, mean weights for the catch were calculated as the 1984-1987 averages for quarters 2 and 3, whereas for the stock, the values from the first quarter were used.

3.2.3 Mortalities

A catch-curve analysis on the whole set of catch data gave an estimate of $Z \sim 1.5$ for fully-recruited age groups (Table 3.7).

Natural mortality was, as in last year's report, assumed to be 0.75. The VPA was tuned to the quarterly indices of effort. The resulting fit is demonstrated in Figure 3.1, and the quarterly fishing mortalities are given in Table 3.8. The resulting stock sizes are seen in Table 3.9.

Yearly fishing mortalities were calculated by summing over quarters and are given below, together with the yearly effort indices:

Age	1984		1985	1986	1987
	Quarters 2-4	Quarters 1-4			
0	0.001	-	0.008	+	0.001
1	0.201	-	0.118	0.286	0.503
2	0.364	-	0.657	0.295	1.214
3	0.182	-	1.048	1.091	0.377
4+	-	-	0.116	0.425	0.279
F _(1-3,u)	0.249	0.35	0.608	0.557	0.698
Effort index	-	0.94	1.10	1.34	1.62

3.2.4 Recruitment

The Norwegian trawl surveys in October 1984-1987 gave the following indices of 0-group shrimp:

Year class	Index
1984	328
1985	155
1986	143
1987	78

The 1987 year class was estimated to be about 1,800 million at the beginning of the fourth quarter based on these indices. When back calculated to the first quarter, it equals 3,160 million. Recruitment in 1989 was assumed to be on the 1986-1987 level of 8,000 million.

3.2.5 Yield-per-recruit yearly values

Input values are given in Table 3.10. The fishing pattern is the 1985-1987 average from the text table in Section 3.2.3.

$F_{0.1}$ was calculated to be 0.832 which is 30% higher than the 1985-1987 average level of fishing mortality.

Assuming a level of recruitment at the 1987 value (3,000 million), the long-term yield would be around 2,200 t, whereas a continuation of the apparently high level of recruitment experienced in 1984 would yield around 16,000 t under the prevailing conditions.

3.2.6 Prediction

A continuation of the 1987 exploitation level in 1988 predicts a yield of 4,000 t and a decline in the spawning stock to 6,000 t at 1 January 1989 (Table 3.11). The catch in 1989 with the 1987 F level was predicted to be 3,000 t with the spawning stock in 1990 decreasing to 4,000 t. In order to catch say 8,000 t in 1988, the level of F would have to be raised by a factor of 2.3.

4 DIVISION IVa - THE NORWEGIAN DEEPS

4.1 The Fishery

Data on total landings are given in Table 3.1. The increasing trend continued for all countries and the 1987 catch was about 4,000 t, which is almost twice the 1986 figure.

4.2 Catch and Effort

The Norwegian logbooks are still not used sufficiently to provide a proper distribution of CPUE through the year; however, the few data available seem to fit the Swedish data reasonably well. Swedish catch per hour was, therefore, used to calculate the Norwegian and the Swedish effort. The Danish CPUE is given in catch per day. In order to obtain comparable figures an index was calculated based on 1982 as the reference year. It is seen from Table 4.1 that the increased catch is mainly due to an increase in effort.

4.3 Surveys in 1984-1987

Norwegian trawl surveys were performed yearly in the October-November period from 1984 onwards. The numbers of shrimp in the different year classes were calculated using the swept-area method and splitting the length distributions into age groups by the NORM-SEP program (Macdonald and Pitcher, 1979). The results, shown in Table 4.2, must be taken as index figures. It is seen that the 1986 year class is comparatively abundant. Catch-curve analysis on the sum of the 1984, 1985 and 1987 results over ages 1-4 gave an estimate of $Z = 0.85$, much lower than the estimate for Z in Division IIIa.

The growth rate in the Norwegian Deeps is slower than in the Skagerrak area and the age group 4 is always present in sufficiently high numbers to be detected by the NORM-SEP method.

4.4 State of the Stock

The data presented for this stock were not sufficient for an analytical assessment. A few observations concerning the state of the stock, however, can be made.

Total mortality appears to be lower than in Division IIIa. The 1986 year class seems to be much bigger than in Division IIIa and will influence catches in 1987-1989. Fishing effort has increased

substantially (~ 100%) during the period 1982-1987. The Working Group could not, with the material at hand, estimate any appropriate TAC levels for this stock. If managers choose to regulate the shrimp fisheries in Division IIIa, unregulated fisheries in the Norwegian Deeps would be hazardous to that stock.

5 FLADEN GROUND

5.1 The Fishery

Table 5.1 gives the landings from Fladen Ground since 1970. It should be noted that the 1987 landings are the highest since 1970. Since 1983, the Danish landings have constituted more than 75% of the total.

5.2 Catch and CPUE Data

The CPUE data are shown in Tables 5.2 and 5.3. Both the Danish and Scottish CPUE figures refer to shrimp trawler catches. The Danish data are logbook records (catch per day). The total effort (Table 5.3) has been calculated from CPUE and total landings. In order to combine the Danish and Scottish effort, relative effort indices were made for each country.

The effort figures also reflect the seasonal variation in the fishery. Most of the fishing takes place in the first half of the year. The Danish effort was very high in 1987, one reason probably being catch restrictions in other fisheries.

5.3 Age-Based Assessment

5.3.1 Age distribution of the catch

The quarterly length distributions of total landings were obtained on the basis of Scottish length samples in the first and second quarters in 1984 and 1985, and length samples covering all quarters in 1987 provided by Denmark, Norway, and Scotland. The length distributions of the 1986 landings were obtained from an average of the 1984, 1985, and 1987 data.

The subsequent ageing was done by splitting the length distribution into likely age components by the method of Macdonald and Pitcher (1979). For all practical purposes and taking into account the biology of Fladen shrimp, the Working Group decided to distinguish three age groups in the landings (Table 5.4). For the landings in the first - third quarters, these age groups should be 1, 2, and 3, and in the fourth quarter, age groups 0, 1, and 2.

The estimated landings in number by these age groups (by quarter) are given in Table 5.5.

5.3.2 Mean weight at age

Mean weights at age in the catches were calculated by inserting the mean lengths at age in the length-weight relationship described in Section 3.2.2 and are given in Table 5.6.

5.3.3 Natural mortality

This was set at $M = 1.0$ (annual) (Anon., 1977) for the Fladen Ground.

5.3.4 Fishing mortality

Setting the level of fishing mortality (F) involved both the problem of tuning the VPA and at the same time having what would seem to be realistic values of F.

The level of F was determined by obtaining a rough estimate of Z. Applying the catch-curve method on quarterly catches of age group 2 for the years 1984-1987 (assuming constant Z) gives a total mortality of 1.68 per year (Table 5.7 and Figure 5.1). Accepting a natural mortality coefficient of 1.0 would indicate values of F around 0.7 per year, or less than 0.2 per quarter.

The estimated indices of total effort by quarters (Table 5.3) were used for tuning the VPA. Thus, the input Fs should be low, reflecting little fishing in the fourth quarter.

5.3.5 VPA

Fishing mortalities per quarter are shown in Table 5.8. The corresponding annual F values are shown below:

Age	1984	1985	1986	1987
0	-	-	-	0.03
1	0.05	0.11	0.06	0.13
2	0.67	0.46	0.74	0.92
3	0.91	1.42	0.37	1.35
F (1-3,u)	0.54	0.66	0.39	0.80

When comparing the fishing mortalities with effort indices, the result of the tuning seems to be satisfactory (Figure 5.2). The estimated stock biomass appears to have been remarkably stable during the recent 4 years, although a decline was observed during 1987 (Table 5.9).

The spawning stock biomass seems to be even more stable. The size of the SSB is determined by the maturity ogive based on Scottish data as shown below:

Age	Proportion mature
0	-
1	0.5
2	0.9
3	1.0

The estimated stock sizes for age group 0 are not used as measures of year-class strength, since the magnitude of these is largely determined by the very small catches of 0-group in the fourth quarter as estimated from the length samples.

5.4 Length-Based Assessment

An assessment of the Fladen Pandalus stock was also made using length composition data according to the method of Jones (1984) which incorporates the cohort approximation technique of Pope (1972). A program (LENCO) developed for use on hake (B. Jones and G. Howlett, MAFF) was utilized to carry out the analysis. Some supplementary analysis was also carried out using the shellfish length assessment program (R. Jones, DAFS).

5.4.1 Length distributions

The underlying principle of the method depends on the assumption that the length composition represents a steady-state situation with constant recruitment and mortality rates. It is recommended that an average length composition for as many years as possible be used. Sampling of Fladen length compositions since the 1981 mesh change has been sporadic, and coverage in most years has been limited to Scottish samples collected in the first and second quarters. In 1987, additional samples from Denmark and Norway provided coverage in all quarters. Data from 1984, 1985, and 1987 were used to generate an average length composition. Individual samples were expressed in terms of percentage and grouped by quarter (Table 5.10). Using the length-weight relationship described in Section 3.2.2, the percentage compositions were then raised to the quarterly landing figures to give total numbers at length landed in each quarter. Summing across quarters gave yearly distributions, and summing years gave a pooled distribution which was divided by 3 to give an average length distribution (Table 5.11). The 1987 percentage distributions were used for the third and fourth quarters in 1984 and 1985.

5.4.2 Cohort analysis based on length data

Fishing mortality arrays were generated by cohort analysis for natural mortalities of 0.5 and 1.0. In addition, the effects on yield of a change in mesh size from 30 mm to 35 mm were investigated with each natural mortality value.

Input parameters used for running the cohort analysis are shown below:

Parameter	Input value
L_{∞}	27.2
K^{∞}	0.41
F (terminal)	2.0
W	0.00264 $L^{2.551}$
Selection factor	0.44 (4.4 for LENCO execution)
L_{75}	14.8 (30-mm mesh)
	17.8 (35-mm mesh)

Growth parameters, length-weight relationship, and selection factor were based on Anon. (1977). L_{75} was derived using the slopes (at L_{50}) for 30-mm and 35-mm meshes calculated from selection ogives plotted in Howard *et al.* (1983).

Table 5.11 gives a summary of the cohort analysis results with natural mortalities of $M = 0.5$ and $M = 1.0$. Based on the average length composition and weight-at-length relationship, an average total catch of about 6,000 t under present steady-state conditions was predicted. Annual fishing mortalities were relatively low at length classes below 16 mm, but at many of the classes above this, values of F were much higher, exceeding the assumed natural mortality even when this was 1.0. The effect of the higher M was to increase the number of shrimp attaining each length such that the number attaining 8 mm (size of first recruitment) was about 3 times as high.

5.4.3 Mesh-size change

Owing to the high Fs, it was suggested (Anon., 1987) that an increase in the mesh size might be considered. Following the above cohort analysis, preliminary assessments of the effects of a change in mesh size were carried out.

The long-term percentage change in yield and stock biomass following an increase in mesh size from 30 mm to 35 mm is shown below.

M	Yield		Stock biomass
	Number	Weight	
0.5	-9.69	1.56	13.89
1.0	-16.69	-7.13	6.78

The immediate loss in yield is 19.61%.

The long-term benefits of such a change are clearly dependant on the level of natural mortality. With $M = 1.0$, long-term losses in yield in terms of weight and numbers were predicted, although there would be a modest increase in stock biomass. With $M = 0.5$, a marginal increase in yield (by weight) and a more substantial

increase in stock biomass were predicted. In both cases, there would be substantial immediate losses in yield approaching 20%.

5.4.4 Catch-curve estimates of Z based on length composition

The steady-state length composition was also used to provide a catch-curve estimate of total mortality (Z) of fully-recruited length classes (right-hand limb of distribution). A plot of \ln number against length yielded a curve diminishing to L_{∞} , so lengths were converted to age according to Pauly (1983). A plot of $\ln(N/\Delta t)$ against mean age yielded a regression with slope -2.24 (equivalent to $Z = 2.24$). Using the method of Beverton and Holt (1956), Z (derived from Z/K) = 2.05. Both of these estimates show reasonable agreement to the total mortalities (given by $F + M$) obtained from the cohort analysis.

Another method of obtaining Z using seasonal changes in the catch rates of adult Pandalus by Scottish vessels gave a slightly different result. A plot of \ln catch rate (numbers per hour fishing) (Table 5.12) against time (February-July 1987) gave rise to an annual Z of only 0.66 and a straight comparison of highest rate (early in the season) with lowest (later in the season) gave $Z = 1.09$. Differences between these estimates and the catch-curve or cohort estimates could arise if incorrect growth parameters were used in the calculation of the latter. A slower growth rate (presence of more year classes in the size composition than predicted) would reduce the F values somewhat. Analysis of catch data over longer periods would be worthwhile, and a careful consideration of the growth rate (and/or age composition) of the Fladen stock would also be beneficial.

5.5 Comparison of Age- and Length-Based Output

A crude comparison of the length-based assessment with the results from the age-based assessment (Section 5.3.5) was made by comparing the average numbers in the sea at any time under steady-state conditions (predicted by the length assessment) with the mean value of the average numbers in the sea predicted for each of the years used in the age-based assessment (Table 5.13). Since the age-based assessment included estimates of 0-group numbers present, it was necessary to rerun the length assessment including unexploited size classes < 8 mm to ensure comparability. These calculations suggested some similarity between the estimates from the two methods; an average of about 19.5 billion shrimp would be expected in the population. To what extent it is legitimate to compare the mean of the three age-based estimates of average number with the length-based steady-state average number is not clear and requires further investigation.

5.6 Recruitment

An index of recruitment based on the proportion of juvenile shrimp (ages 0 and 1+) < 15 mm (Anon., 1984) was calculated for the Fladen area using the overall 1987 length composition based on samples collected by various countries in each quarter. Numbers and weights of adults and juveniles are shown below for

1982-1987. In 1987, juveniles accounted for about 14% of the landings by weight and 25% by number, representing somewhat lower proportions than in previous years when it was concluded that catches were strongly dependant upon the recruiting year class. To some extent, the variations might arise from the use of length distributions not fully representative of annual landings. In earlier years when sampling was sporadic, this may have been a particular problem. A series of samples collected in Scotland in 1987 showed that the catch rate of juveniles (numbers per hour fishing) increased from February to July (Table 5.12) suggesting that these animals progressively recruit to the fished population. Length distributions collected at different times in different years might, therefore, be expected to show wide variations in the apparent level of recruitment. A reassessment of the data used in earlier calculations would be useful.

Year	Total catch split into adults and juveniles				
	Weight (tonnes)		Number (millions)		
	Juveniles	Adults	Juveniles	Adults	% juveniles
1982	136	499	80.1	139.9	36.4
1983	1,619	5,945	953.1	1,665.1	36.4
1984	908	3,683	587.0	903.5	39.4
1985	1,222	3,767	618.6	1,207.5	33.9
1986	796	2,923	467.1	816.0	36.4
1987	1,049	6,277	548.0	1,632.0	25.1

5.7 Management Considerations

From Table 5.5, it seems evident that the bulk of the catch consists of age group 2. However, during the 4-year period 1984-1987, the fraction of age group 3 gradually became smaller. In 1984, age group 3 contributed 24% of the total catch (annually), whereas in 1987, it was only 8%. The dependance of this fishery on the recruiting year class is very strong.

The observed year-to-year stability of the stock (Section 5.3.5) during the 4-year period for which age data are available is probably mainly due to a reasonably constant (high?) recruitment level. Therefore, a failure in recruitment in one year is likely to result in a collapse of the Fladen shrimp fishery for a period of at least 1-2 years.

Although no relevant assessment data on the Fladen shrimp are available for the 1970s, the Working Group wishes to point out that it is likely that a similar situation existed in the early 1970s when the fishery collapsed in 1973 (Table 5.1).

The only way of avoiding such situations is to make the fishery less dependent on a single year class. This can be achieved by decreasing the effort and/or increasing the mesh size. The cost of such measures is reduced catches.

6 FARN DEEPS

There was an increase in fishing effort on Pandalus borealis in the Farn Deeps area (Division IVb) during 1987 resulting in a 53% increase in the combined landings of English and Scottish boats over the 1986 landings (Table 6.1). Most of the landings were again made in England; about 28% were landed in Scotland (Eyemouth).

Most of the landings were made in the second and third quarters (April-September), and during this period, catch per unit effort (kg/hr) by Scottish boats was maintained at a fairly constant level. The overall catch rate (102 kg/hr) was only slightly lower than in 1986.

Samples from research vessels suggested that in the early part of the fishery (May) the catch was composed of roughly equal proportions of shrimp from age group 1 (12 mm approximately) and age groups >2 (17-18 mm approximately).

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Table 3.1 *Pandalus borealis* landings from Divisions IIIa and IVa (eastern part) ('000 tonnes).

Year	Skagerrak, Kattegat				Division IVa Norwegian Deep			
	Denmark ¹	Norway	Sweden	Total	Denmark ¹	Norway	Sweden	Total
1970	757	982	1,827	3,566	345	747	915	2,007
1971	834	1,392	1,548	3,774	356	1,094	1,358	2,808
1972	773	1,123	1,374	3,270	244	1,354	1,150	2,748
1973	716	1,415	1,194	3,325	39	918	936	1,893
1974	475	1,186	1,483	3,144	55	623	520	1,198
1975	733	1,576	1,751	4,060	84	763	252	1,099
1976	865	2,541	2,352	5,758	339	807	177	1,323
1977	763	2,257	1,906	4,926	357	747	113	1,217
1978	757	1,925	1,529	4,211	702	515	80	1,297
1979	973	2,612	1,752	5,337	89	428	35	552
1980	1,678	3,666	2,121	7,465	-	896	38	934
1981	2,593	3,943	2,210	8,746	-	1,240	31	1,271
1982	2,623	3,693	1,359	7,675	1,083	1,349	91	2,523
1983	1,325	3,723	1,037	6,085	242	1,638	99	1,979
1984	1,641	3,509	933	6,083	159	1,245	120	1,524
1985	3,677	4,772	1,474	9,923	340	1,841	130	2,311
1986	4,102	4,795	1,306	10,203	764	1,673	157	2,594
1987 ²	3,466	5,017	1,065	9,548	1,169	2,780	249	4,198

¹ 1982-1987 total Danish catch distributed on areas according to log-book data.

² Preliminary.

Table 3.2 Pandalus Division IIIa. CPUE and estimates of effort indices, 1982-1987.

Year	Denmark				Sweden				Norway			Total relative effort index ¹
	C/f (kg/day)	C (tonnes)	f (days)	Relative effort	C/f (kg/hr)	C (tonnes)	f (hrs)	Relative effort	C (tonnes)	f ³ (hrs)	Relative effort	
1982	561	2,623	4,677	1.00	28.8	1,359	47,187	1.00	3,693	128,229	1.00	1.00
1983	535	1,325	2,476	0.53	23.9	1,037	43,389	0.92	3,723	155,774	1.21	1.01
1984	474	1,641	3,462	0.74	25.3	933	36,877	0.78	3,509	138,696	1.08	0.94
1985	726	3,677	5,068	1.08	32.1	1,474	45,919	0.97	4,772	148,660	1.16	1.10
1986	571	4,102	7,185	1.54	29.3	1,306	44,588	0.94	4,795	163,652	1.28	1.34
1987 ²	495	3,466	7,002	1.50	21.5	1,065	49,596	1.05	5,017	233,349	1.82	1.62

¹ Weighted by landings.

² Preliminary.

³ According to Swedish CPUE.

Table 3.3 Pandalus Division IIIa. CPUE and estimates of effort indices by quarters.

Year	Quarter	Denmark				Sweden				Norway			Total rgl. effort ²	Total catch
		C/f (kg/day)	C (tonnes)	f (days)	Relative effort	C/f (kg/hr)	C (tonnes)	f (hrs)	Relative effort	C (tonnes)	f ¹ (hrs)	Relative effort		
1984	1	444	283	637	1.00	19.8	153	7.7	1.00	1,035	52.3	1.00	1.00	1,471
	2	311	253	814	1.28	17.8	182	10.2	1.32	777	43.6	0.83	1.00	1,212
	3	574	775	1,350	2.12	35.3	375	10.6	1.38	1,292	36.6	0.70	1.26	2,442
	4	502	330	657	1.03	27.2	193	7.1	0.92	426	15.7	0.30	0.68	949
1985	1	409	330	807	1.27	27.6	167	6.0	0.78	1,192	43.2	0.83	0.91	1,689
	2	628	889	1,416	2.22	28.8	428	14.9	1.94	1,456	50.6	0.97	1.52	2,773
	3	855	1,443	1,688	2.65	33.7	460	13.6	1.77	1,136	33.7	0.64	1.76	3,039
	4	875	1,015	1,160	1.62	37.8	386	10.2	1.32	934	24.7	0.47	1.11	2,335
1986	1	645	823	1,276	2.00	35.1	201	5.7	0.74	1,099	31.3	0.60	1.10	2,239
	2	484	1,266	2,616	4.10	25.7	445	17.3	2.25	1,150	44.7	0.85	2.46	2,919
	3	630	1,287	2,043	3.21	30.9	383	12.4	1.61	1,372	44.4	0.85	2.08	2,843
	4	580	726	1,252	1.96	30.2	277	9.2	1.19	1,174	38.9	0.74	1.41	1,851
1987 ³	1	456	622	1,364	2.14	25.6	200	7.8	1.01	1,628	63.6	1.22	1.44	2,450
	2	477	860	1,803	2.83	17.8	295	16.6	2.16	1,505	84.6	1.62	2.07	2,660
	3	535	1,016	1,899	2.98	21.7	291	13.4	1.74	1,001	46.1	0.88	1.91	2,308
	4	515	968	1,880	2.95	23.6	279	11.8	1.53	883	37.4	0.72	1.84	2,130

¹ According to Swedish CPUE.² Weighted by landings.³ Preliminary.

Table 3.4 Percentage age distribution and corresponding average mm carapace length for Pandalus borealis in Norwegian samples from commercial catches in the Skagerrak area.

Quarter Year		Year class															
		1987		1986		1985		1984		1983		1982		1981			
		%	mm	%	mm	%	mm	%	mm	%	mm	%	mm	%	mm		
1984	2	-	-	-	-	-	-	-	-	59.90	14.6	32.10	19.9	8.60	24.3		
	3	-	-	-	-	-	-	-	-	91.10	16.5	7.90	21.9	1.00	25.3		
	4	-	-	-	-	-	-	6.05	9.7	75.63	16.4	17.58	22.3	0.75	26.9		
1985	1	-	-	-	-	-	-	24.56	11.8	58.08	17.5	15.86	23.0	1.12	27.2		
	2	-	-	-	-	-	-	28.80	13.4	58.70	18.4	11.66	23.4	0.94	27.1		
	3	-	-	-	-	1.68	6.9	43.72	15.7	51.40	20.7	3.23	25.1	-	-		
	4	-	-	-	-	6.44	9.8	52.96	16.3	40.10	21.1	0.52	26.9	-	-		
1986	1	-	-	-	-	9.53	10.9	57.07	17.2	31.73	21.7	1.67	26.6	-	-		
	2	-	-	-	-	17.20	13.6	39.67	18.0	41.80	22.1	1.07	26.4	-	-		
	3	-	-	0.28	8.5	54.63	15.7	38.55	20.9	6.35	24.7	0.25	27.0	-	-		
	4	-	-	0.23	10.1	55.27	16.4	38.12	21.9	6.12	25.2	-	-	-	-		
1987	1	-	-	19.08	12.1	49.94	17.1	30.24	22.3	0.74	25.2	-	-	-	-		
	2	-	-	35.27	13.9	44.37	18.3	17.00	22.2	3.36	25.5	-	-	-	-		
	3	-	-	65.83	16.2	27.28	20.4	6.90	23.4	-	-	-	-	-	-		
	4	2.19	9.0	38.73	17.0	29.50	20.1	29.67	24.5	-	-	-	-	-	-		

Table 3.5 Pandalus in Division IIIa. Catch in numbers (millions) by age and quarter year.

Year	1984			1985				1986				1987			
	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
0	-	-	12.84	-	-	9.90	25.55	-	-	1.69	0.72	-	-	-	2.11
1	174.94	596.42	159.08	79.94	197.19	254.41	211.55	34.83	90.46	308.15	198.99	88.80	282.90	359.85	162.70
2	93.75	51.72	37.03	188.71	401.91	299.24	160.06	209.37	208.79	217.85	137.10	231.98	265.56	161.43	92.62
3	25.12	6.55	1.47	51.64	79.42	18.63	2.00	116.23	219.83	36.12	21.95	140.40	90.35	31.67	82.40
4+	-	-	-	3.57	6.16	-	-	6.23	5.79	1.69	-	3.25	20.02	-	-
Total	293.81	654.69	210.42	323.86	684.68	582.18	399.16	366.66	524.87	565.50	358.76	464.43	658.83	552.95	339.83

Table 3.6 Pandalus in Division IIIa. Mean weight at age of the catch (g) by age and quarter year.

Year	1984			1985				1986				1987			
	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
0	-	-	1.01	-	-	0.36	0.89	-	-	0.62	0.72	-	-	-	-
1	2.47	3.37	3.11	1.46	1.87	2.97	3.32	1.17	2.01	2.64	3.27	1.53	2.17	3.21	3.63
2	5.50	6.70	7.86	3.80	4.39	5.86	6.31	3.74	4.15	6.23	7.43	3.69	4.39	5.79	5.57
3	9.14	10.03	11.72	7.90	8.03	9.43	11.72	6.94	7.01	8.67	11.28	7.26	7.18	8.21	9.23
4+	-	-	-	12.06	12.17	-	-	11.28	10.96	11.83	-	10.00	10.22	-	-

Table 3.7 Catch-curve analysis. Age distributions 1984-1987 summed per quarter.

Age	Quarter				Total
	1	2	3	4	
0	-	-	17.6	13.6	31.2
1	53.4	148.3	254.1	231.7	687.5
2	165.3	171.1	126.9	123.1	586.4
3	77.9	75.7	16.6	31.6	201.8
4	3.5	5.0	0.4	-	8.9
Age range	2-4	2-4	1-4	1-4	average
Z	2.00	1.77	1.38	1.00	1.5

Table 3.8 Pandalus in Division IIIa. Fishing mortality per age and quarter year (M = 0.19 per quarter).

Age	1984			1985				1986				1987			
	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
0	-	-	0.001	-	-	0.002	0.006	-	-	+	+	-	-	-	0.001
1	0.029	0.127	0.045	0.008	0.026	0.041	0.043	0.009	0.030	0.131	0.116	0.029	0.119	0.215	0.140
2	0.146	0.111	0.107	0.068	0.198	0.219	0.172	0.054	0.069	0.094	0.078	0.189	0.337	0.348	0.340
3	0.127	0.043	0.012	0.209	0.562	0.241	0.036	0.179	0.588	0.174	0.150	0.106	0.090	0.041	0.140
4+	-	-	-	0.036	0.080	-	-	0.148	0.197	0.080	-	0.029	0.250	-	-
F _(1-3,u)	0.101	0.094	0.055	0.095	0.262	0.167	0.084	0.081	0.229	0.133	0.115	0.108	0.182	0.201	0.207

Table 3.9 Pandalus in Division IIIa. Stock size in numbers (millions) by age and quarter year. Biomass totals in tonnes. All values are given for first of each quarter.

Age	1984			1985				1986				1987				1988
	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1
0	18,278	15,153	12,562	-	7,342	6,086	5,037	-	6,032	5,001	4,144	-	2,592	2,148	1,781	-
1	6,779	5,461	3,986	10,403	8,551	6,910	5,498	4,152	3,411	2,745	1,996	3,435	2,767	2,037	1,363	1,475
2	754	540	401	3,160	2,449	1,666	1,110	4,365	3,429	2,653	2,002	1,475	1,012	599	351	982
3	231	169	134	299	201	95	62	775	537	247	172	1,535	1,145	867	690	207
4+	-	-	-	110	88	-	-	49	35	24	-	123	99	-	-	497
Total no.	26,042	21,323	17,083	13,972	18,630	14,757	11,706	9,342	13,444	10,670	8,314	6,567	7,615	5,652	4,185	-
Spawning stock no.	231	574	435	409	289	1,344	894	824	572	2,261	1,673	1,658	1,244	1,316	953	-
Total biom.	23,007	23,718	29,808	30,882	29,422	33,371	30,463	27,121	25,238	29,304	26,326	23,068	19,680	17,127	13,270	-
SSB	2,113	4,408	3,934	3,684	2,681	8,217	5,977	5,936	4,152	14,824	13,096	12,372	9,232	9,721	7,835	-

Table 3.10

List of input variables for the ICES prediction program.

PANULALUS IN DIV. IIIA. YEARLY FIGURES.

The reference F is the mean F for the age group range from 1 to 3

The number of recruits per year is as follows:

Year	Recruitment
1935	3159.0
1989	8000.0
1990	8000.0

Proportion of F (fishing mortality) effective before spawning: .7000

Proportion of M (natural mortality) effective before spawning: .7500

Data are printed in the following units:

Number of fish: millions
 weight by age group in the catch: gram
 Weight by age group in the stock: gram
 Stock biomass: tonnes
 Catch weight: tonnes

age	stock size	fishing pattern	natural mortality	maturity ogive	weight in the catch	weight in the stock
0	3159.0	.00	.75	.00	.000	.500
1	1475.0	.30	.75	.00	2.590	1.390
2	982.0	.72	.75	.75	5.330	3.740
3	207.0	.84	.75	1.00	8.400	7.370
4+	497.0	.29	.75	1.00	11.480	11.110

Table 3.11

Effects of different levels of fishing mortality on catch, stock biomass and spawning stock biomass.

PANDALUS IN DIV. IIIA. YEARLY FIGURES.

Year 1988					Year 1989					Year 1990	
fac- tor	ref. F	stock biomass	sp.stock biomass	catch	fac- tor	ref. F	stock biomass	sp.stock biomass	catch	stock biomass	sp.stock biomass
1.0	.62	14	10	4	.0	.00	12	6	0	16	6
					.1	.06			0	16	6
					.2	.12			1	15	5
					.4	.25			1	15	5
					.6	.37			2	14	4
					.8	.50			3	14	4
					1.0	.62			3	13	4
					1.2	.74			3	13	3
					1.4	.87			4	13	3
					1.6	.99			4	12	3
					1.8	1.12			5	12	3
					2.0	1.24			5	12	2

The data unit of the biomass and the catch is 1000 tonnes.

The spawning stock biomass is given for 1 January.

The reference F is the mean F for the age group range from 1 to 3

Table 4.1 Catch per unit effort of the Danish (kg/day) and Swedish (kg/hr) fisheries and calculated effort indices for the Norwegian Deeps within Division IVa.

Year	Denmark				Sweden				Norway			Total relative effort
	CPUE (kg/day)	Catch (tonnes)	Effort (days)	Relative effort	CPUE (kg/hr)	Catch (tonnes)	Effort (hrs)	Relative effort	Catch (tonnes)	Effort (hrs)	Relative effort	
1982	471	1,083	2,299	1.00	42.2	91	2,156	1.00	1,349	31,967	1.00	1.00
1983	470	242	515	0.22	34.5	99	2,870	1.33	1,638	47,478	1.88	1.32
1984	279	159	570	0.25	24.7	120	4,858	2.25	1,245	50,405	1.58	1.49
1985	465	340	731	0.32	30.1	130	4,319	2.00	1,841	61,163	1.91	1.68
1986	486	764	1,572	0.68	34.0 ²	157	4,618	2.14	1,623	49,206	1.54	1.31
1987 ¹	507	1,169	2,306	1.00	37.9 ³	249	6,566	3.05	2,780	73,351	2.29	1.98

¹ Preliminary.

² No fishing in the third quarter.

³ Data from November and December missing.

Table 4.2 Estimates of Pandalus borealis stock (millions), using the swept-area method on Norwegian survey data 1984-1987.

Year	Year class							
	1987	1986	1985	1984	1983	1982	1981	1980
<u>Norwegian Deeps</u>								
1984	-	-	-	3.1	1,278.7	727.9	270.6	26.7
1985	-	-	39.8	1,169.9	667.5	525.0	166.5	-
1986 ¹	-	4.4	341.2	382.8	214.0	31.1	-	-
1987	11.7	2,298.2	1,047.3	878.5	122.7	-	-	-
<u>Skagerrak</u>								
1984	-	-	-	328.1	702.4	187.3	35.2	-
1985	-	-	155.3	1,782.0	546.1	44.4	-	-
1986	-	143.2	698.0	305.7	48.6	-	-	-
1987	78.4	701.9	313.0	57.5	-	-	-	-

¹ The coverage was incomplete this year.

Table 5.1 Landings (t) of Pandalus borealis from Division IVa, the Fladen Ground.

Year	Denmark	Fed.Rep.of Germany	Norway	UK (Scotland)	Total
1970	3,115	-	-	103	3,218
1971	3,216	33	-	439	3,688
1972	2,204	-	-	187	2,391
1973	157	-	-	163	320
1974	282	-	-	434	716
1975	1,308	-	-	525	1,833
1976	1,552	-	-	1,937	3,459
1977	425	-	112	1,692	2,229
1978	890	-	81	2,027	2,998
1979	565	-	44	268	877
1980	1,122	-	76	377	1,575
1981	685	-	1	347	1,033
1982	283	-	-	352	635
1983	5,729	-	8	1,827	7,564
1984	4,553	-	13	25	4,591
1985	3,649	-	-	1,341	4,990
1986	3,416	-	-	301	3,717
1987	7,326	-	-	686	8,012

Table 5.2 Pandalus borealis CPUE from the Fladen Ground.

Year	Denmark ¹	UK (Scotland) ²
1970	-	31
1971	-	66
1972	117	69
1973	45	87
1974	122	124
1975	187	128
1976	105	115
1977	105	76
1978	-	81
1979	-	51
1980	-	44
1981	-	45
1982	0.96	74
1983	1.18	89
1984	0.97	37
1985	1.21	86
1986	0.96	71
1987	1.24	81

¹Denmark, 1972-1977: kg per hour.

1982-1987: tonnes per day.

²Scotland, kg per hour.

Table 5.3 *Pandalus*. Effort indices, Fladen Ground.

Year	Quarter	Denmark				UK (Scotland)				Combined index ²
		CPUE (t/day)	Total catch	f	Index ¹	CPUE (kg/h)	Total catch	f	Index ¹	
1984	1	1.27	2,809	2,212	1.68	-	-	-	-	1.68
	2	0.75	1,407	1,876	1.43	37	25	676	0.21	1.41
	3	0.57	273	479	0.36	-	-	-	-	0.36
	4	0.56	63	113	0.09	-	-	-	-	0.09
1985	1	1.16	1,742	1,502	1.14	72	359	4,986	1.58	1.22
	2	1.24	1,617	1,304	0.99	88	770	8,750	2.78	1.57
	3	1.47	289	197	0.15	114	212	1,869	0.59	0.34
	4	0.04	0.1	3	0.002	-	-	-	-	0.002
1986	1	1.12	1,130	1,009	0.77	72	80	1,111	0.35	0.74
	2	0.89	833	936	0.71	68	150	2,206	0.70	0.71
	3	0.94	1,255	1,335	1.02	77	71	922	0.29	0.98
	4	0.71	200	282	0.21	-	-	-	-	0.21
1987	1	1.21	2,336	1,931	1.47	89	131	1,473	0.47	1.42
	2	1.20	2,643	2,203	1.68	79	509	6,443	2.05	1.72
	3	1.43	2,014	1,408	1.07	78	45	577	0.18	1.05
	4	0.89	333	374	0.28	-	-	-	-	0.28

¹Relative to average effort in first-third quarters in 1985-1987.

²Weighted by total landings.

Table 5.4 Pandalus in Fladen Ground. Mean length at age and proportions of catch in each age group per quarter.

Age	1984				1985				1986				1987				
	1	2	3 ¹	4 ¹	1	2	3 ¹	4 ¹	1 ²	2 ²	3 ¹	4 ¹	1	2	3	4	
0	Mean	-	-	-	8.4	-	-	-	8.4	-	-	-	8.4	-	-	-	8.4
	Prop.	-	-	-	0.010	-	-	-	0.010	-	-	-	0.010	-	-	-	0.010
1	Mean	9.6	11.2	12.8	14.3	11.0	13.1	12.8	14.3	10.3	11.9	12.8	14.3	10.2	11.3	12.8	14.3
	Prop.	0.115	0.395	0.498	0.818	0.033	0.359	0.498	0.818	0.060	0.298	0.498	0.818	0.033	0.141	0.498	0.818
2	Mean	16.5	15.9	17.0	17.8	15.7	16.1	17.0	17.8	16.2	16.2	17.0	17.8	16.3	16.4	17.0	17.8
	Prop.	0.517	0.506	0.486	0.168	0.669	0.599	0.486	0.168	0.673	0.625	0.486	0.168	0.830	0.769	0.486	0.168
3+	Mean	20.3	19.6	20.2	21.8	17.9	19.3	20.2	21.8	19.3	19.4	20.2	21.8	19.8	19.5	20.2	21.8
	Prop.	0.368	0.099	0.015	0.003	0.298	0.041	0.015	0.003	0.266	0.076	0.015	0.003	0.133	0.089	0.015	0.003

¹ Values used from 1987.

² Average of 1984, 1985, and 1987 values used.

Table 5.5 Pandalus in Fladen Ground. Catch in numbers (millions) by age and quarter year.

Age	1984				1985				1986				1987			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
0	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
1	71	183	42	16	18	260	76	-	17	87	203	52	20	118	315	87
2	319	234	41	3	366	434	75	-	196	181	198	11	506	644	307	18
3+	227	46	13	-	163	30	2	-	77	22	61	-	81	75	9	-
Total	617	463	96	19	547	724	153	-	290	290	462	64	607	837	631	106

Table 5.6 Pandalus in Fladen Ground. Mean weight at age of the catch (g) by age and quarter year.

Age	1984				1985				1986				1987			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
0	-	-	-	0.61	-	-	-	0.61	-	-	-	0.61	-	-	-	0.61
1	0.85	1.24	1.77	2.32	1.20	1.87	1.77	2.32	1.00	1.45	1.77	2.32	0.99	1.29	1.77	2.32
2	3.38	3.07	3.66	4.10	2.97	3.17	3.66	4.10	3.21	3.19	3.66	4.10	3.28	3.34	3.66	4.10
3+	5.72	5.20	5.68	6.88	4.15	5.00	5.68	6.88	5.06	5.12	5.68	6.88	5.38	5.17	5.68	6.88

Table 5.7 Estimation of Z for age group 2. Data from Table 5.5 (see also Figure 5.1). Values given are % $C(2)/C$ and (in parentheses) $\ln[C(2)/C]$.

Quarter	t	Year			
		1984	1985	1986	1987
1	0.00	51.7 (3.95)	66.9 (4.20)	67.6 (4.21)	83.4 (4.42)
2	0.25	50.1 (3.91)	59.9 (4.09)	62.4 (4.13)	76.9 (4.34)
3	0.50	42.7 (3.75)	49.0 (3.89)	42.8 (3.76)	48.6 (3.88)
4	0.75	15.8 (2.76)	- (-)	17.2 (2.84)	17.0 (2.83)

Table 5.8 Pandalus in Fladen Ground. Fishing mortality per age and quarter year ($M = 0.25$ per quarter).

Age	1984				1985				1986				1987			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
0	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	0.03
1	0.01	0.03	0.01	+	+	0.08	0.03	-	+	0.01	0.04	0.01	+	0.02	0.08	0.03
2	0.25	0.32	0.09	0.01	0.14	0.25	0.07	-	0.14	0.20	0.37	0.03	0.18	0.38	0.33	0.03
3	0.58	0.23	0.10	-	0.92	0.45	0.05	-	0.12	0.05	0.20	-	0.38	0.77	0.20	-
$F_{(1-3,u)}$	0.28	0.19	0.07	+	0.35	0.26	0.05	-	0.09	0.09	0.20	0.01	0.19	0.39	0.20	0.02

Table 5.9 Pandalus in Fladen Ground. Stock size in numbers (millions) by age and quarter year. Biomass totals in tonnes. All values are given for first of each quarter.

Age	1984				1985				1986				1987				1988
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1
0	13,756	10,713	8,343	6,498	27,782	21,637	16,851	13,123	21,255	16,553	12,892	10,040	81	63	49	38	-
1	9,157	7,069	5,344	4,125	5,060	3,925	2,828	2,136	10,220	7,945	6,111	4,581	7,819	6,072	4,625	3,325	29
2	1,596	963	546	389	3,199	2,170	1,310	954	1,663	1,123	716	385	3,522	2,299	1,228	688	2,513
3	574	250	154	-	300	93	46	-	743	511	379	-	290	155	56	-	520
Total no.	25,083	18,995	14,388	11,012	36,341	27,825	21,035	16,213	33,882	26,133	20,097	15,005	11,711	8,589	5,958	4,051	-
Spawning stock no.	1,372	731	3,317	2,413	1,900	1,178	2,639	1,927	1,575	1,073	4,079	2,637	2,051	1,305	3,473	2,282	-
Total biom.	16,460	13,021	12,332	15,129	16,819	14,684	10,064	16,873	19,320	17,721	15,589	18,329	20,852	16,313	12,997	10,558	-
SSB	5,980	2,777	7,402	6,220	5,996	3,904	7,081	5,999	6,430	4,409	9,919	6,734	7,336	4,641	8,455	6,395	-

Table 5.10

Percentage length composition for each quarter in 1984, 1985 and 1987. Data for each quarter represents the average of the total number of samples taken in that quarter.

Quarter	1984				1985				1987			
	1	2	3	4	1	2	3	4	1	2	3	4
No. samples	1	2	0	0	1	2	0	0	2	4	2	1
Carapace length mm												
8	0.19	0.15							0.05		0.13	
9	2.34	0.40				0.09			0.27		0.79	
10	6.04	3.58			0.30	0.22			1.35	1.75		
11	1.95	13.42			1.34	0.95			1.27	3.60	1.17	0.00
12	0.97	14.64			1.34	4.24			0.55	4.16	8.67	0.28
13	0.00	7.07			0.74	11.82			0.18	2.84	17.84	6.55
14	0.00	3.30			3.28	11.67			0.85	1.66	17.73	26.44
15	2.73	8.93			15.20	13.46			8.29	5.37	4.86	29.70
16	14.03	15.28			23.99	20.45			24.34	18.71	6.15	15.55
17	17.74	16.34			25.63	21.58			25.70	30.65	17.50	6.18
18	14.42	7.32			12.67	9.89			20.32	18.05	15.88	5.82
19	7.21	4.38			7.45	2.99			5.91	6.04	6.60	5.79
20	9.75	2.98			5.51	1.43			5.58	3.56	2.35	1.93
21	12.67	3.25			1.94	0.75			4.14	2.54	0.89	0.51
22	7.21	0.42			0.30	0.27			1.04	0.35	0.33	0.22
23	2.53	0.29			0.15	0.17			0.47	0.06		
24	0.19				0.15					0.06		

Table 5.11

Length-based cohort analysis output results using the average length composition and assuming steady-state conditions. For each mm length group, the weight at length, weight landed, time interval (dt from growth curve), and annual fishing mortalities and numbers attaining length for input natural mortalities of 0.5 and 1.0 are given.

Carapace length mm	Numbers landed millions	Wt at length g	Weight landed tonnes	dt	M = 0.5		M = 1.0	
					F	Numbers attaining length	F	Numbers attaining length
8	0.8	0.620	0.5	0.130	0.002	3701	0.001	9788
9	6.7	0.824	6	0.138	0.015	3467	0.006	8599
10	26.7	1.063	28	0.146	0.059	3229	0.026	7486
11	45.5	1.341	61	0.155	0.103	2976	0.049	6443
12	75.2	1.659	125	0.166	0.177	2710	0.090	5474
13	103.5	2.019	209	0.178	0.256	2422	0.141	4568
14	108.1	2.422	262	0.192	0.286	2116	0.168	3728
15	138.0	2.872	396	0.209	0.398	1820	0.252	2978
16	271.3	3.368	914	0.229	0.919	1508	0.619	2293
17	351.3	3.914	1375	0.254	1.635	1090	1.131	1583
18	227.9	4.510	1028	0.284	1.697	631	1.165	921
19	92.8	5.158	479	0.320	1.100	336	0.763	498
20	67.0	5.860	393	0.370	1.2121	201	0.889	283
21	54.7	6.617	362	0.449	1.831	106	1.419	141
22	20.8	7.431	155	0.559	1.781	37	1.431	48
23	7.5	8.302	62	0.874	2.276	10	1.971	12
24	0.6	9.233	6		2.0	1	2.0	1

5859 tonnes

Table 5.12

Catch rates (numbers per hours fishing) of juveniles and adults in samples of Fladen Pandalus taken from Scottish boats each month between February and July 1987.

	Feb	Mar	Apr	May	Jun	Jul
Juveniles	688	2345	3091	2170	3736	9551
Adults	22098	14809	16754	17241	15983	14233

Table 5.13

Comparison of average number of Pandalus in the Fladen stock predicted by age based and length based assessments.

<u>Length-based assessment</u>		<u>Age-based assessment</u>		
Average = $N1-N2/Z1$ number		Average = $Nt-Nt+1/Zt$ number		
where N1= No. attaining length N2= No. attaining length+ grouping interval Z1= Total mortality while passing through length class		where Nt= No. at time t Nt+1= No. at time t+1 Zt= Total mortality over time interval		
<u>Carapace length mm</u>	<u>Average number (millions)</u>	<u>Age class</u> <u>Average numbers (millions)</u>		
		1984-85	1985-86	1986-87
1	1893.70			
2	1788.59			
3	1685.32			
4	1583.95	0	8694	17562
5	1484.53	1	5674	3060
6	1387.10	2	776	1682
7	1291.71	3	300	124
8	1198.37			542
9	1106.74	Total	15446	22428
10	1015.60			21166
11	924.01			
12	831.19			
13	736.37			
14	641.75			
15	546.97			
16	438.41			
17	310.70			
18	195.57			
19	121.66			
20	75.37			
21	38.56			
22	14.54			
23	3.80			
19314.53 million		Mean of 3 time periods = 19680 million		

Table 6.1 Landings (t) of Pandalus borealis from Division IVb, the Farn Deep.

Year	England	Scotland	CPUE kg/hr (Scotland)
1977	227.1	-	-
1978	90.9	2.3	no data
1979	235.0	34.3	no data
1980	203.3	17.3	60
1981	0.9	-	-
1982	-	-	-
1983	64.8	-	-
1984	30.7	-	-
1985	2.2	5.6	70
1986	137.3	57.2	127
1987	212.2	84.5	102

Figure 3.1 *Pandalus* in Division IIIa.
 Mean quarterly fishing mortality [$F_{(1-3,u)}$] and relative effort indices relative to quarter 2, 1984.

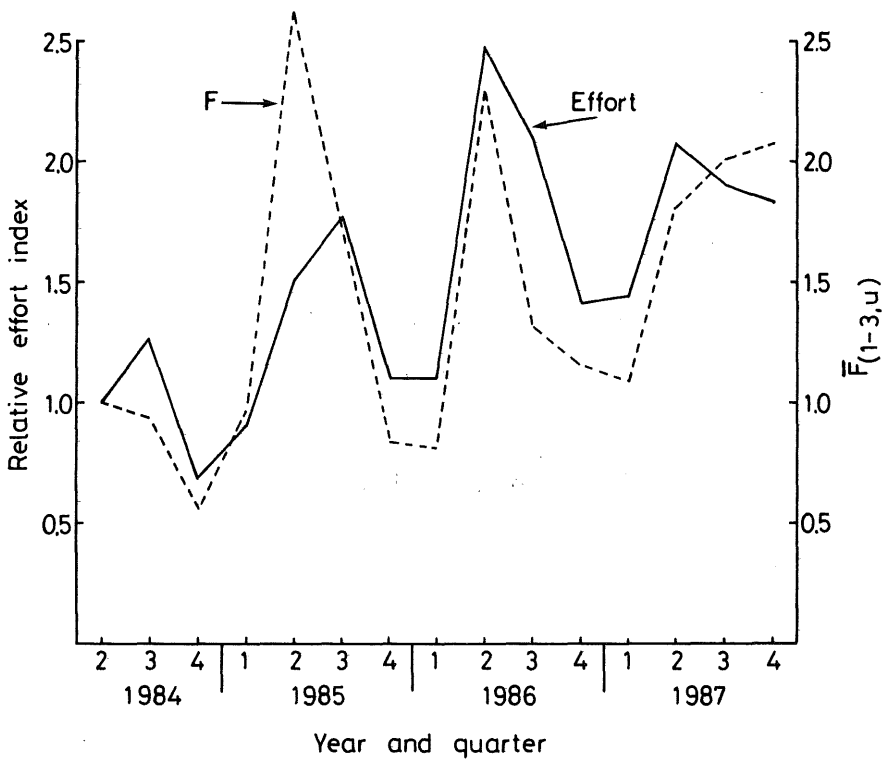


Figure 5.1 *Pandalus* in Fladen Ground.
Estimation of Z for age group 2
(see also Table 5.7).

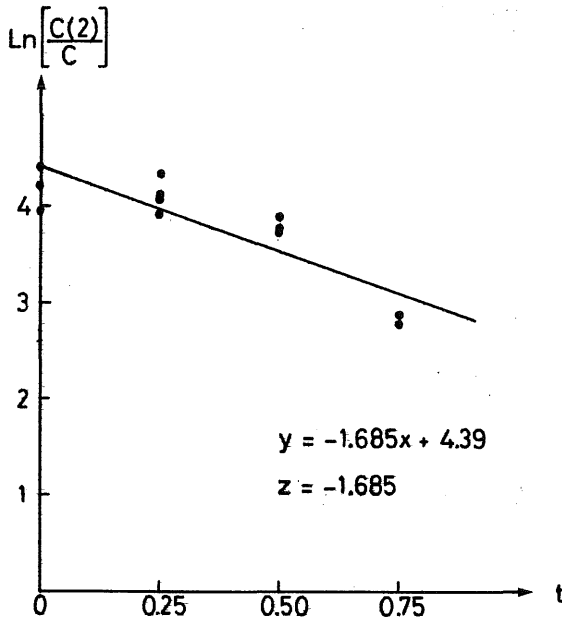


Figure 5.2 Fladen Ground fishery. Comparison of effort indices and average F.

