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The Northern shrimp (*Pandalus borealis)* Stock in Skagerrak and the Norwegian Deep (ICES Divisions IIIa and IVa East)

by

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Abstract

This paper presents the Danish, Swedish, and Norwegian fisheries data used in the annual assessment of the shrimp stock in Skagerrak and the Norwegian Deep. Long term fluctuations/trends in landings and trends in national LPUE's are presented and described. Increasing gear efficiency has been taken into account in analyses of the Danish and Norwegian LPUE. Estimation of Swedish discards due to high grading indicates that a significant amount of the Swedish catches may be discarded. Estimates of Danish and Norwegian discards are also presented. Age compositions of the annual landings since 1985 are presented. A short overview of the Fladen Ground shrimp fishery is presented.

1 The *Pandalus borealis* stock in Skagerrak and the Norwegian Deep

1.1 The *Pandalus* fisheries in the North Sea and Skagerrak

In the North Sea and Skagerrak three geographically separated aggregations of the northern shrimp (*Pandalus borealis)* are recognised and assessed as three separate stocks (ICES, 1990): 1) the Norwegian Deep-Skagerrak stock which is confined to ICES Divs. IVa east and IIIa, 2) the Fladen Ground stock in ICES Div. IVa west, and 3) the Farn Deep stock in ICES Div. IVb west (Fig. 1). Vessels from Denmark, Sweden, Norway and UK exploit these resources. The Fladen ground stock has been exploited by Danish and UK (Scottish) vessels. In recent years only the stock in the Norwegian Deep and Skagerrak has been exploited.

1.1.1 The Danish *Pandalus* fishery.

Historically, the Danish *Pandalus* fishery has targeted both the shrimp stock in Divs. IVa east and IIIa and the stock on Fladen Ground. In the period 1994 to 1999 the fisheries in the two areas were of about the same size, but since 2000 the Fladen fishery has declined and came to a stop during 2004. Virtually no shrimp landings have been recorded from Fladen since 2004 (Sect. 4). At present, all Danish shrimp landings come from IVa east and IIIa. Since 'at sea' boiled shrimps fetch better prices, an increasing number of Danish vessels now land boiled shrimp. Fig. 2 shows that an increasing fraction of the Danish shrimp catches since 2000 has been landed as 'sea boiled shrimp'. Notice that in 2010, with low catches, the fraction of shrimp landed fresh decreased substantially compared to previous years. In 2005–2007, 19–27% of total Danish shrimp landings were landed in Swedish ports, a significant part of these being boiled shrimp because the demand for this product traditionally has been high in

Sweden. In 2008 and 2009 the amount decreased to around 10%. Minor amounts have also been landed in Norwegian ports. New analyses for the period 1987 to 2010 of the Danish logbook data on catch and corresponding effort, vessel size from the vessel register, and economical data of landings on single trip basis have been made. Results show that the number of vessels participating in the *Pandalus* fishery has decreased from 191 vessels in 1987 to only 12 vessels in 2010 (Fig. 3) It is the smaller vessels which have left the *Pandalus* fishery, and the average vessel size has increased from 20 to 26 m in the period and average horse power from 415 to around 700 (Fig. 3).

Gear development in the Danish shrimp fishery and its influence on effort.

The technological improvements of the fishing fleet and their implication for the effective effort have been described in SCR Doc. 08/75. The effective effort by vessels has increased considerably. Following this development the nominal LPUE is standardised accordingly. The difference between standardised LPUE and the logbook recorded LPUE for the period 1987-2010 is shown in Fig. 10.

1.1.2 The Norwegian *Pandalus* fishery (SCR Doc. 11/68)

1.1.3 The Swedish *Pandalus* fishery

In 2010, a total of 68 trawlers reported landings of *Pandalus* (≥100kg) in the Swedish logbooks. Of these, 43 landed more than 10 t *Pandalus* and can be considered specialised in this fishery. The trend in number of *Pandalus* trawlers from 1995 to 2010 is shown in Fig. 4.

The size of the vessels ranges between 12-34 m with an average of 22 m. GRT varies from 18 to 343, with an average of 115 GRT. The average engine effect is around 406 kW (92-738 kW). The larger trawlers are normally fishing in the eastern and central part of Skagerrak. The smaller trawlers are mostly fishing in the Swedish coastal zone inside a 'trawling border' where special regulations apply for the use of trawls: Trawling is in these areas restricted to waters deeper than 60 m and there are special limits in the length of ground rope and in the size of the trawl and trawl doors. Furthermore, the trawls to be used inside this border must be equipped with a species selective Nordmøre grid of 19 mm bar space and an unblocked fish opening in the trawl roof. This has resulted in very clean landings from these trawls (99% *Pandalus*). The Nordmøre grid may also be used outside the trawling border as an alternative to the EU legislated 70 mm square mesh panel in shrimp trawls. There is a suggestion that grid should be legislated in EU council regulation in all shrimp fisheries in Skagerrak and the North Sea from 2012.

This particular *Pandalus* trawl with grid can be distinguished from other shrimp trawls in the logbooks back to 1997. The landings from this gear has shown an increasing trend from 9% of total landings in 2002 to 32 % in 2009, but fell to 18% of total landings in 2010.

The Swedish specialized shrimp fleet (≥ 10 t/yr) shows a slightly decreasing trend and has been of around 40-50 vessels during the last decade according to logbooks (see fig. 4) and there has not been any major change in trawl size or trawl design until recent years according to the Swedish net manufacturer. During the last five years the number of twin trawlers has increased from 5 to 15. These twin trawls have 50- 80% higher catch rate compared to vessels using single rigged trawls (Fig. 5). In 2010, the 15 shrimp trawlers using twin trawls caught 37% of the Swedish *Pandalus* landings. Swedish *Pandalus* landings (1990-2010) by trawl gear are given in Fig. 6.

The TACs are limiting the Swedish *Pandalus* fishery and in order to distribute landings over the year the fishers have voluntarily introduced rations per fisher per week. This has resulted in high-grading of the catch, i.e. discarding less valuable smaller *Pandalus* (16% of the price of boiled shrimp) to increase the proportion of the more valuable boiled shrimp in the individual landings ration. The estimates of high grading and discarding in Denmark, Norway and Sweden are presented in SCR Doc. 11/67.

During the years 1963 to 1983 the Swedish National Board of Fisheries conducted an inquire investigation to on average of 190 shrimp trawling trips per year. The inquiry gives information of kg landed and discarded shrimps, trawling duration, location, trawl size, etc. This information on yearly lpue has then been used to estimate the total

Swedish un-standardized effort given the total landings. Corresponding information on effort and lpue for 1984 to 2010 comes from the logbooks (Figs. 7 and 8).

There are two different Swedish markets for *Pandalus*, resulting in two different kinds of landings: high value large shrimps boiled onboard and smaller low value shrimps landed raw to the industry for further processing. The shrimps are sorted twice, firstly by a sieve of 10 mm bar space meaning an L50 of approximately 20 mm carapace length and secondly by a 7.5 - 8 mm sieve to get the low quality part. Shrimps going through the 7.5 mm sieve are discarded. The high quality sizes are thus 3+ age groups (females) and the low quality sizes < 20 mm CL are mainly males less than 3 years old. The long term trends with un-standardised effort for these categories are shown in Fig. 9.

1.2 Landings, catch and effort data (IVa East and IIIa)

1.2.1 Landings

Landings, as officially reported to ICES, are shown in Table 1 by area (Division IIIa and Sub-area IV). In Skagerrak the landings for 2010 decreased by around 3000 t compared to 2009, due to a decrease in landings from all countries. In Sub-area IV landings have decreased since 1995 and the 2010 landings are the lowest in 35 years. Table 2 presents the landings and estimated catch for the assessment unit 'Skagerrak and the Norwegian Deep' (ICES Div. IIIa and Div. IVa East). Total landings in 2010 were around 7700 t, which is more than 3000 t less than in 2009.

Landings from Norway and Sweden (and to a lesser extent from Denmark, see Sect. 1.1.1) consist of a fraction of larger shrimp that are boiled on board and a remaining portion of smaller shrimp landed fresh. Official landings and logbook data from Norway and Sweden give landed weight as a mixture of raw and boiled shrimp, but these can be separated in Swedish and Norwegian sale slip data. The shrimp lose weight when boiled, therefore the Swedish and Norwegian boiled landings figures have been corrected with a conversion factor of 1.13 to obtain fresh weight for the years where sufficient information is available (Table 2). The amount added to the Swedish landings (all years) has ranged between 100 and 200 t, while the amount added to the Norwegian landings for the last eleven years has ranged between 320 and 550 t. The Danish landings figures corresponding to boiled shrimps landed in Swedish ports have not yet been corrected. Norwegian and Swedish landings in 2010 consisted of respectively 69 and 63 % boiled shrimps.

1.2.2 Discards

An overview of the current practices of high grading and discarding of shrimp is given in SCR Doc. 11/67.

1.2.3 Effort and LPUE

Annual national figures for effort and landings per unit of effort (LPUE) based on logbook records are shown in Table 3 and Fig. 10. Notice that the figures for un-standardised (Danish, Norwegian and Swedish) as well as the standardised LPUEs (Danish and Norwegian) show the same trend since 2005: Increasing LPUEs up to 2007, followed by a decrease until 2010. The standardisation of the Danish effort data has taken development both in vessel size and gear into account (SCR Doc. 08/75). From Fig. 10 it is seen that the Swedish un-standardised LPUEs are similar to the Danish standardised. This is explained by the fact that there have been no significant changes in the Swedish shrimp fleet for many years and the vessels are still mainly using single trawls, except for the two most recent years (Fig. 6). The information in Norwegian log books from Divs. IIIa and IVa east on the use of trawl gear is not correct. In order to include gear type (single and twin trawl) as a variable in the standardisation of the Norwegian LPUE, the incorrect recordings of gear type in the log books were corrected based on interviews with ship owners (SCR Doc. 11/68). The Norwegian LPUE indices have thus been standardised according to area, month, gear, and vessel for the years 2000-2010. Further information on the Norwegian logbook data is given in SCR Doc. 11/68.

In order to obtain the same effort unit for all three countries, i.e. 'fishing hours', the Danish unit 'fishing days' was converted to 'hours' on basis of functional regressions between Danish-Norwegian and Danish-Swedish LPUE.

These two regression coefficients were averaged to get Danish kg/hr as well as the total Danish effort in hours (unit=1000 hours, Table 3). The Norwegian, Swedish and Danish effort and LPUE data were combined to give a time series of total international effort and LPUE (kg per hour) (Fig. 11).

1.3 Biological sampling of landings and catches

1.3.1 Sampling frequency and intensity

Information on the size and subsequently age distribution of the landings are obtained by sampling the landings. The biological samples also provide information on sex distribution and maturity.

National sampling effort is presented in Table 4. The overall sampling level in 2010 was around 20 kg per 1000 t landed or 3331 specimens. An increasing amount of the Danish samples are taken as at-sea samples during fishing trips. In this way samples of discards and information on discarding are also provided. Notice that in 2009 and 2010, according to mutual agreement between Denmark and Sweden, some samples from Danish shrimp landings in Sweden have been included in the Swedish samples.

1.3.2 Catches in numbers at age

The length data have been pooled by quarter, and the national quarterly length distributions have then been partitioned into age compositions by the Bhattacharya and Norm Sep methodology (Bhattacharya 1967) (software: FISAT).

Table 5 gives the "catch-at-age" data on an annual basis. Catches are dominated by shrimp of ages 1 and 2. Separation of age group 3 from older groups is often uncertain due to lack of distinct modes in the length distributions. For this *Pandalus* stock the number of distinguishable size groups rarely exceeds 4, and the WG doubts the reliability of separation of the age groups older than age 3.

1.3.3 Mean weights at age

Weights-at-age for the Danish and Norwegian catches were derived from the length samples of the catches, where the weights of the measured shrimp in each sample are recorded by length group (mm CL). The Swedish weight at length figures are derived from individually measured shrimps. The mean weights-at-age in the catches are given in Table 6.

1.4 Trawl survey data (SCR Doc. 11/64)

1.5 Assessment of the *Pandalus* stock in Divisons IIIa and IVa East.

1.5.1 State of Stock in 2010 and 2011

This year's assessment of the current state of stock is based on evaluation of Danish and Norwegian standardised LPUE from the fishery 1987-2010 and survey indices from 2006-2011 and can be found in the 2011 NIPAG report.

1.5.2 Biological Reference Points. MSY evaluation

The view of NIPAG is that the data on the stock-recruitment relationship from previous assessments did not support establishment of a SSB reference value for this *Pandalus* stock based on this relationship (ICES, 2003). In 1998 ICES (ICES 1999) pointed out that there was no basis for establishment of a B_{lim} on basis of the available S-R data. Considering the major impact from predation, such a poor relationship is likely.

According to previous assessments (1985-2002), predation accounts for at least twice as much removal from the *Pandalus* stock compared to fishery removals. Such dynamics also render it problematic to establish a reference value for *F* (or *Y/B*), at least if the relative magnitudes of *F* and *M* (predation) are independent of stock size.

This year's assessment does not provide basis for MSY evaluation of the stock.

1.5.3 Progress on implemenmtation of a new assessment model.

The results from a length based stochastic assessment model for *Pandalus* in ICES Divs. IIIa and IVa East was presented to this year's NIPAG (working doc.). The input data are both survey and commercial catch in numbers by length group, covering the period 1988 -2010. The output from the model confirms the perception of the dynamics of this stock from previous applications of cohort models (VPA/XSA): The estimated magnitudes of the SSB are similar to previous estimates. The magnitudes of the estimated fishing mortalities (with constant M) are on average at the same level as M. The model appears to reproduce/predict the observed catches reasonably well, but survey predictions are less convincing at present. The estimated VBGE parameters confirm previous estimates.

Further work on application of the model is continuing, and hopefully an improved assessment will be presented at next year's ICES benchmark assessment WG.

2 Genetic investigations of northern shrimp

The working group has recommended genetic investigations to determine if the Norwegian Deep/Skagerrak stock and the Fladen Ground stock comprise one common or two separate stocks.

In 2008 a pilot study was carried out based on one sample from the Norwegian Deep, two samples from fjords on the Swedish west coast, and one sample from the Barents Sea (Bear Island). In 2009 two additional samples have been analyzed, one from the northeast Barents Sea and one from northeast Skagerrak. Seven microsatellite DNA loci were analyzed. During the quality control of the data, two of these seven markers were discarded due to abnormal behavior. Thus, five markers were included in the statistical analysis of the data.

There is a substantial genetic difference between the Barents Sea samples and the samples from the North Sea and Skagerrak. In addition to the north-south component, there seems to be a less pronounced east-west component.

Two 3-year projects (financed by the Norwegian Research Council and EU/Interreg IVA) are now studying the genetic population structure in *Pandalus borealis* in all of the North Atlantic with a special emphasis on the North Sea and Skagerrak

3 By-catch in the *Pandalus* fisheries in Subarea IV and Division IIIa

In recent years there has been increasing focus on (mixed) fisheries with by-catches of species subject to recovery plans or under special surveillance. The fisheries for *Pandalus* in the North Sea area cannot be classified as mixed fisheries as for instance some of the fisheries for *Nephrops*. The current by-catch regulations in force for the gears used in the fisheries for *Pandalus* restrict the amounts of by-catch. Nevertheless several valuable fish species, e.g. cod, witch flounder and anglerfish, are landed as by-catch. WGPAND has since the 1980s regularly compiled and presented relevant information on by-catch in the WG reports.

Tables 7 A - F give for the three most recent years the available Danish, Norwegian and Swedish data on by-catch of the main species in the *Pandalus* fisheries landed for human consumption (h.c.) In some years significant quantities of Norway pout and Blue whiting have also been recorded. For Denmark and Sweden the data are from log book

records, and are only recorded landings, i.e. not the discarded by-catch. Both the Danish and Swedish log book records cover nearly all the recorded *Pandalus* landings. The Norwegian data come from the landings statistics.

Tables 7 A - F also give cod percentage of *Pandalus* landings. It is believed that this is a better estimator than % of total catch, since logbook recordings probably not always are consistent in recordings of e.g. Norway pout and/or blue whiting. Notice that for Skagerrak the percentages of landed total h.c. by-catch are similar for all 3 countries (excluding trawls with selective grids). Rough estimates give magnitudes of around 500 t of cod landed annually from the *Pandalus* fisheries in this area. Notice that trawls equipped with a selective grid, judging from the logbook records of landings from this gear type, seem to be very efficient in reducing by-catch (Table 7 C).

4 A short note on the *Pandalus* Stocks on Fladen Ground (Division IVa) and Farn Deep (Division IVb)

4.1 The development in the fishery for *Pandalus* on Fladen Ground.

A short description of the fishery is given, as a shrimp fishery may be conducted in this area in the future. Table 8 and Fig. 12 show the shrimp landings from Fladen Ground since 1972. Since 1991 total landings have fluctuated between none in 2006-2010 to nearly 6000 t. The Danish fleet has accounted for the majority of landings while the Scottish fleet stands for a minor part. The fishery has taken place mainly during the first half of the year, with the highest activity in the second quarter. Table 9 shows the effort and LPUE.

Since 1999 total Fladen landings have declined continuously, and since 2004 the Fladen Ground fishery has been practically non-existing with total recorded landings of less than 25 t. Interview information from the fishing industry obtained in 2004 gives the explanation that this decline is caused by low shrimp abundance, low prices on small shrimp characteristic for the Fladen Ground, and high fuel prices. This stock has not been surveyed for several years, and the decline in this fishery could also reflect a decline in the stock.

4.2 The *Pandalus* Stock in the Farn Deep (Division IVb)

The WG has not provided advice on this small stock because no catches have been recorded since 1998. Since 1991, only UK vessels have fished *Pandalus* in the Farn Deeps. Total landings fell from 500 t in 1988 to none in 1993. In 1995 and 1996 again about 100 t were reported. In the past 10 years the *Pandalus* fishery in Farn Deeps has been negligible.

References

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ICES 1999. Report of the Pandalus assessment working group, 1-4 September 1998. ICES CM 1999/ACFM:5. 33 pp.

ICES 2003. Report of the Pandalus assessment working group, 26-29 August 2003. ICES CM 2004/ACFM:05. 42 pp.

Munch-Petersen, S., Ulmestrand, M., Søvik, G. and Eigaard, O. 2011. Discarding in the shrimp fisheries in Skagerrak and the Norwegian Deep (ICES Divs. IIIa and IVa east). NAFO SCR Doc. 11/67, 11 pp.

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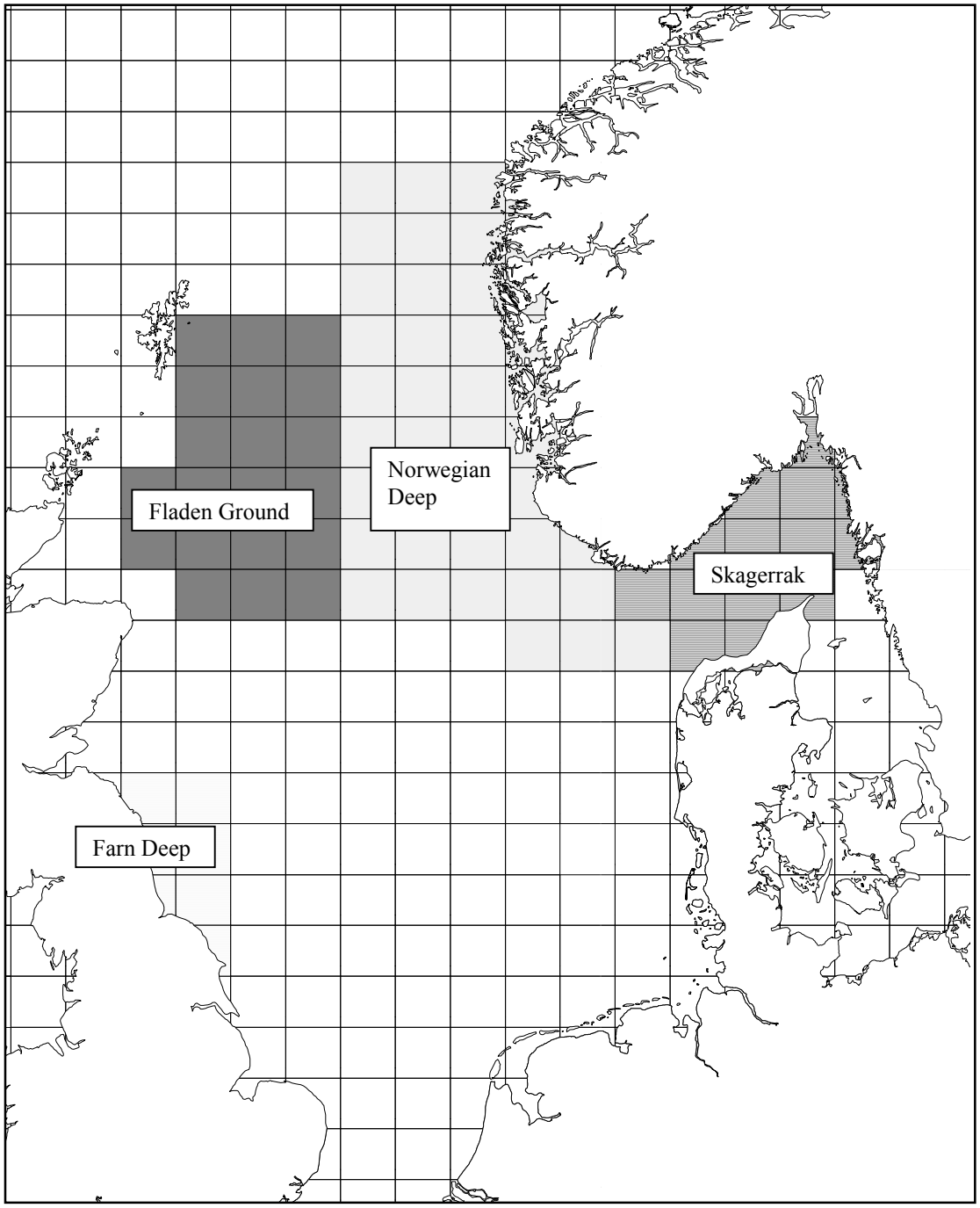
Thangstad, T. and Søvik, G. 2011. The Norwegian Fishery for Northern Shrimp (*Pandalus borealis*) in the North Sea and Skagerrak (ICES Divisions IVa east and IIIa), 1970-2011. - NAFO SCR Doc. 11/68, 26 pp.

Fig.1. The distribution of the *Pandalus* stocks in the North Sea area as defined by the ICES squares.



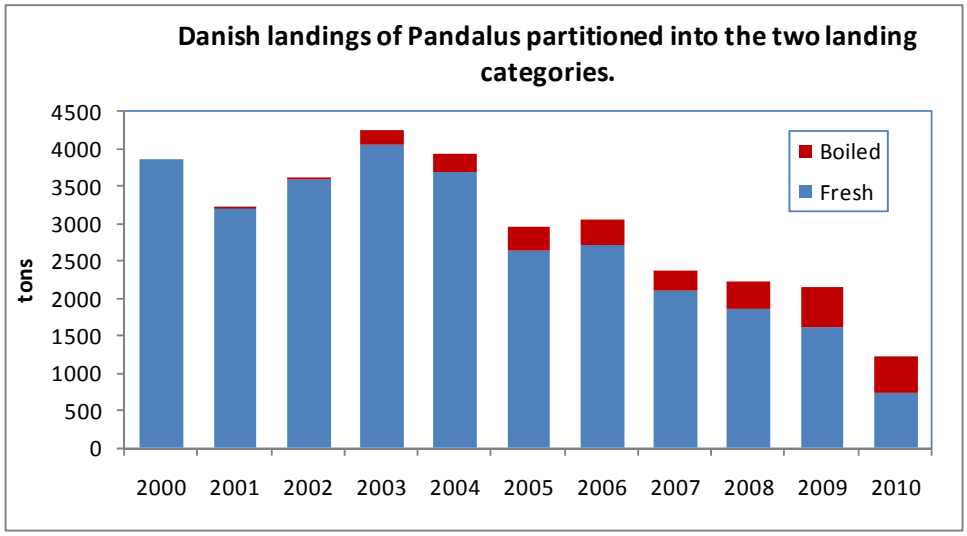


Fig. 2.

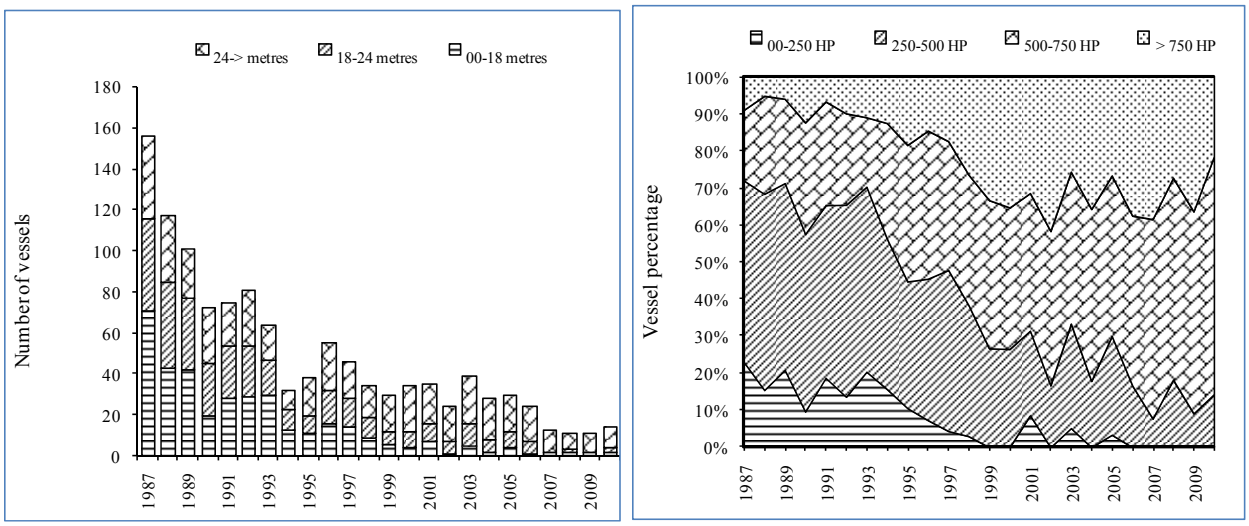


Fig. 3. Trend in numbers (left) and engine power (right) by size groups of Danish *Pandalus* trawlers from 1987 to 2010.

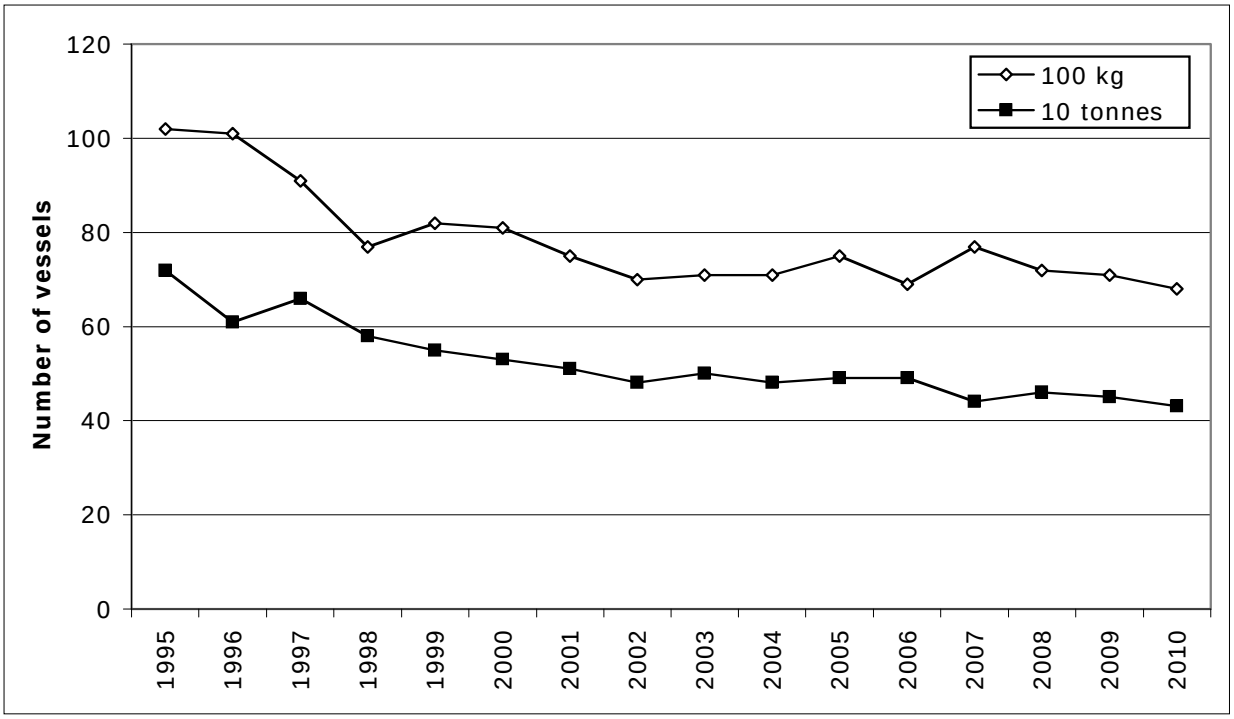


Fig. 4. Number of total Swedish *Pandalus* vessels during 1995 to 2010. Vessels landing ≥10 tonnes are considered as specialised *Pandalus* trawlers.

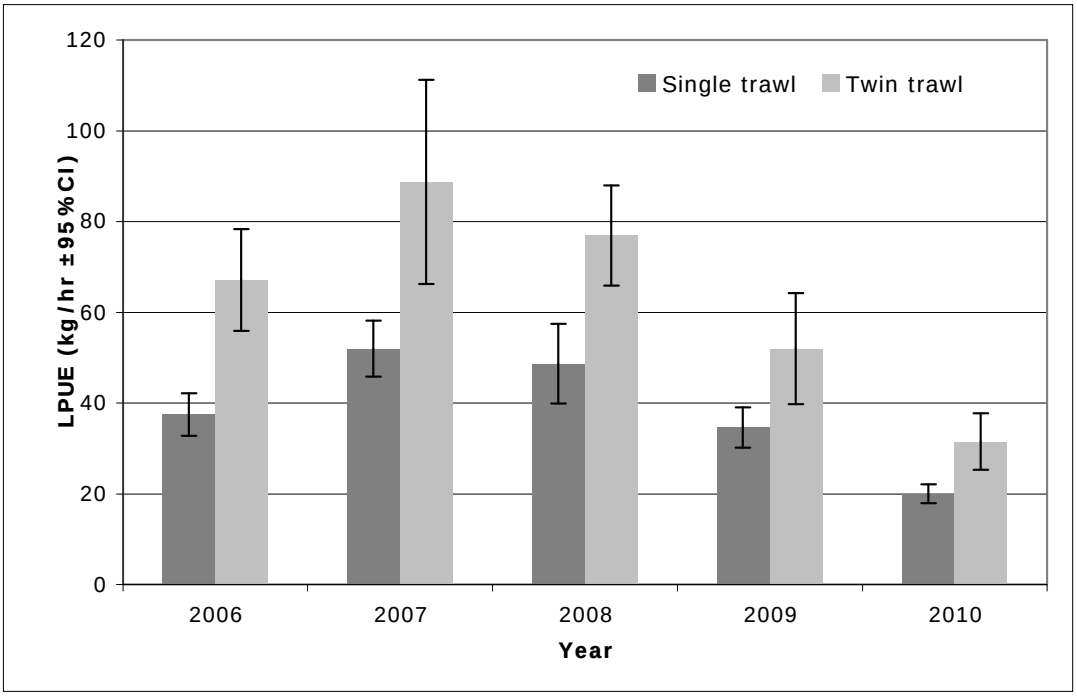


Fig. 5. LPUE for Swedish single and twin trawlers during 2006 - 2010. Error bars are 95% confidence interval.

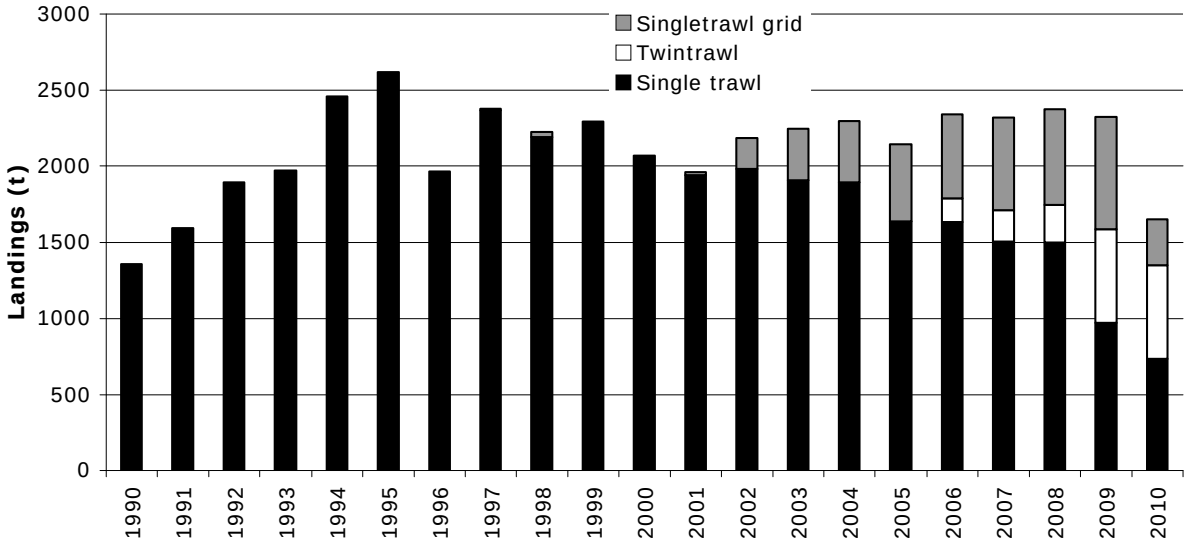


Fig. 6. Swedish *Pandalus* logbook landings per trawl type 1990-2010.

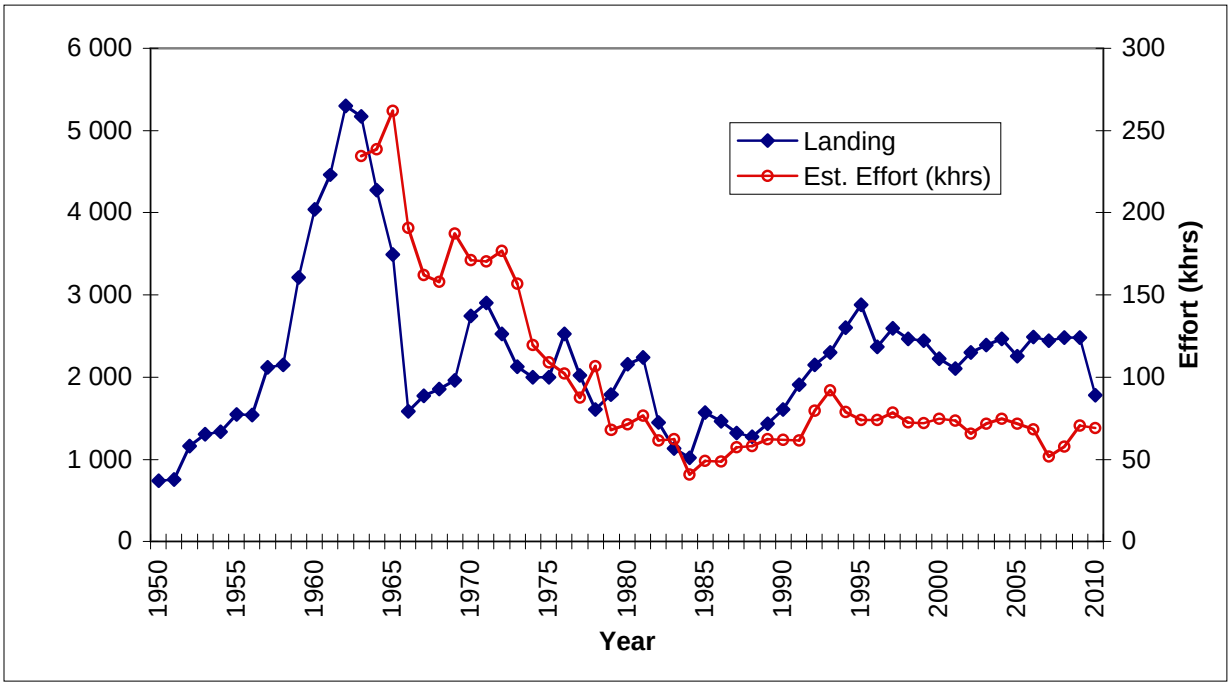


Fig. 7. Swedish yearly landings from IIIa and IVa east during 1950 to 2010 and estimated unstandardised effort during 1963 to 2010.

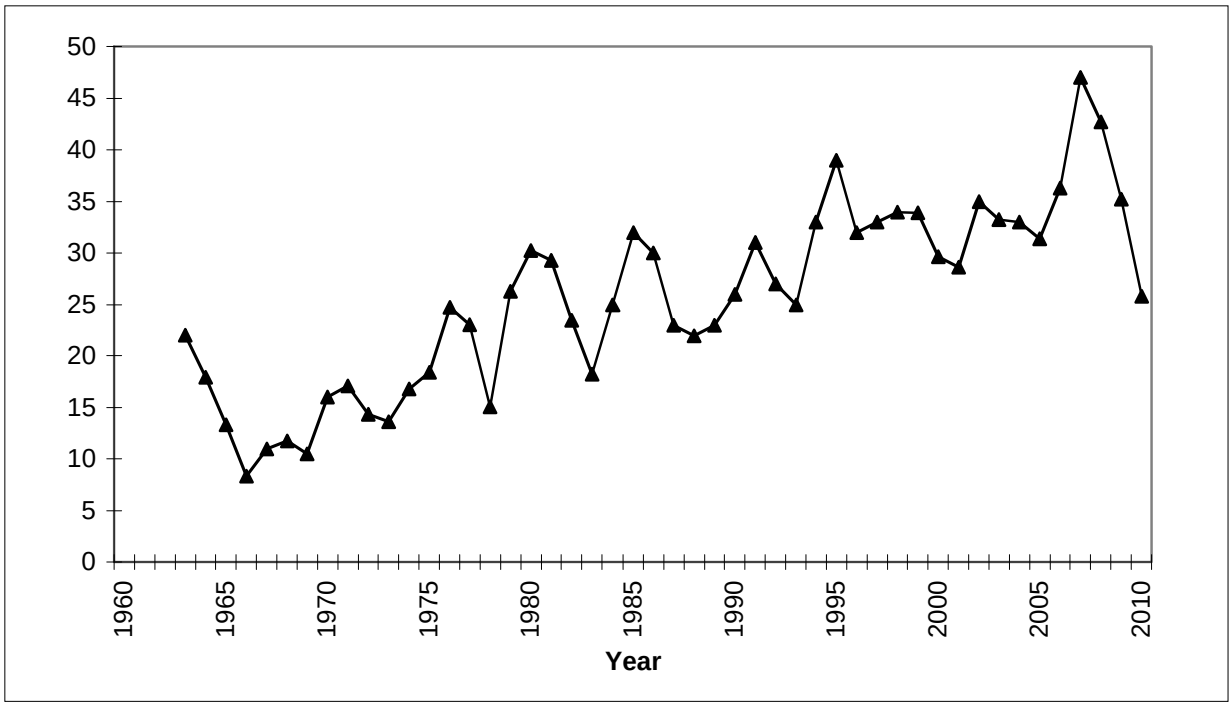


Fig. 8. Swedish unstandardised lpue (kg/hour) for areas IIIa and IVa east during 1963 to 2010.

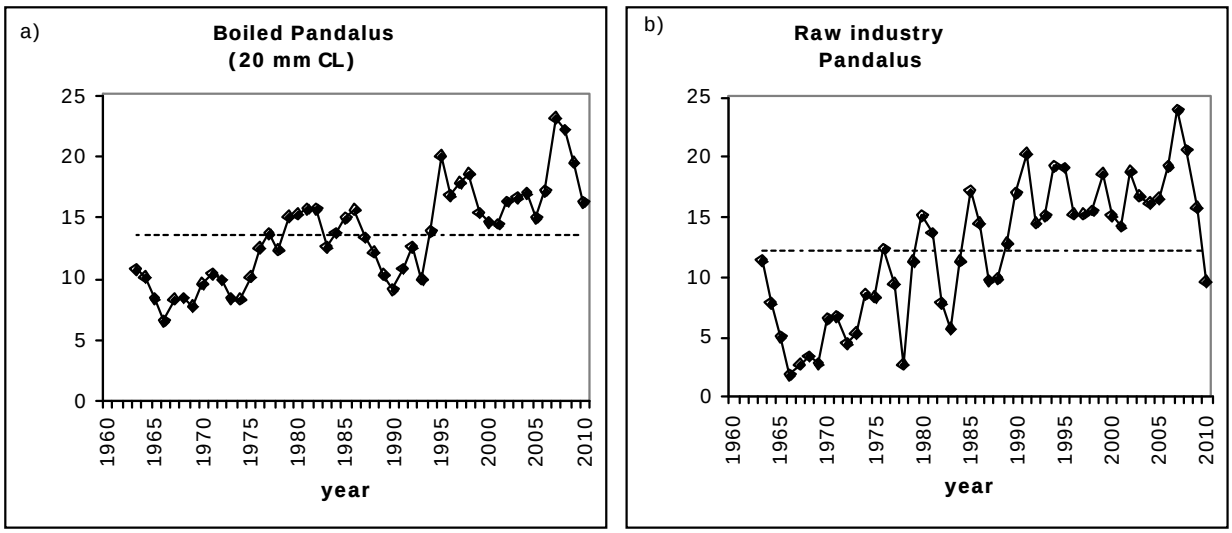


Fig. 9. Un-standardised lpue for areas IIIa and IVa east during 1963 to 2010 partitioned into A: large shrimps (>20 mm) and B: small shrimps. Dotted lines show averages.

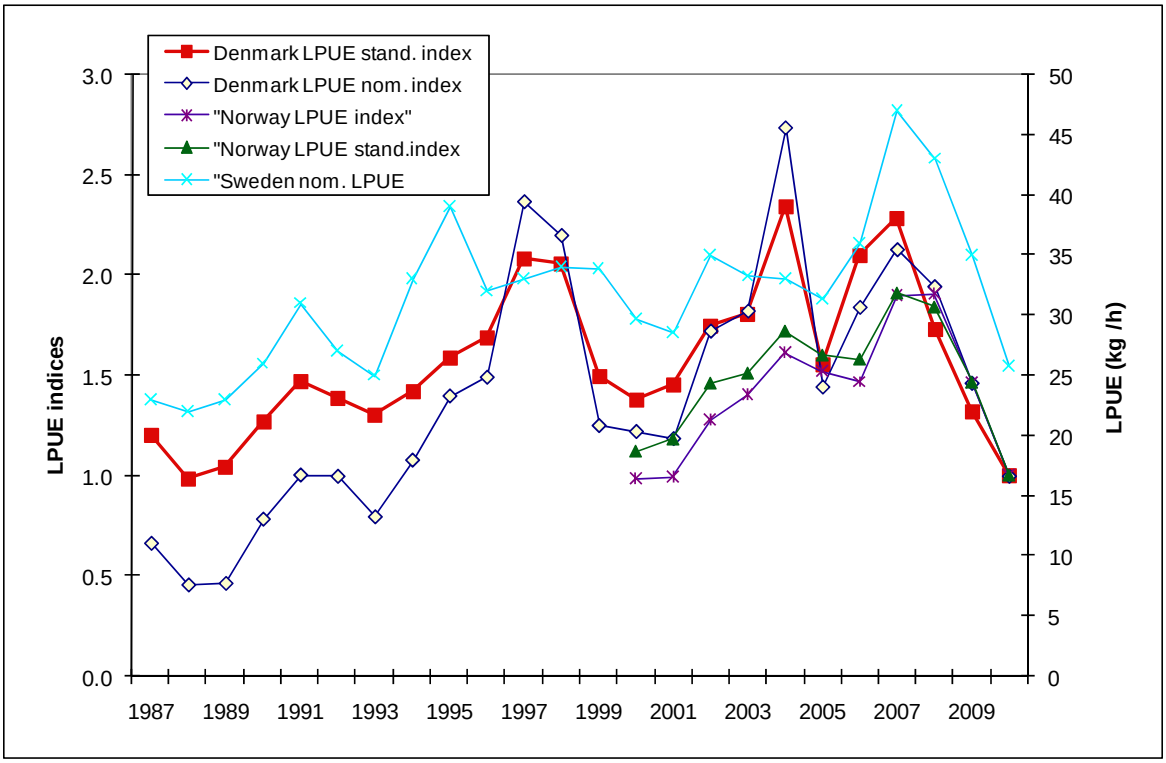


Fig.10. Comparison of Danish, Norwegian and Swedish trends in LPUE, standardised and unstandardised time series.

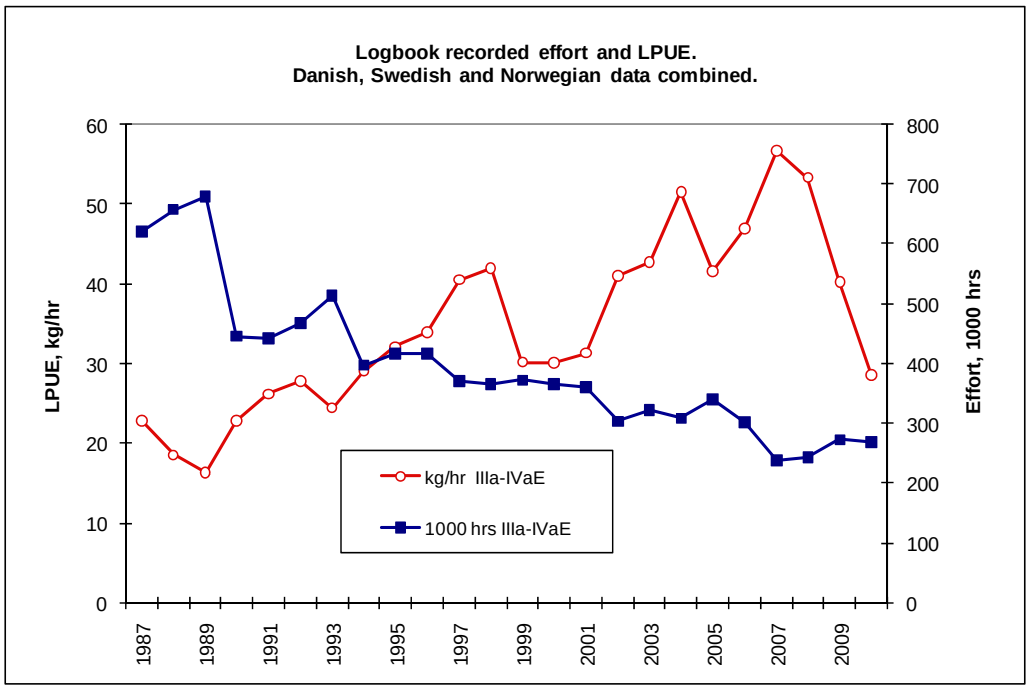


Fig. 11. Combined Norwegian, Swedish and Danish LPUE (kg/hr) and estimated total effort for 1987- 2010.

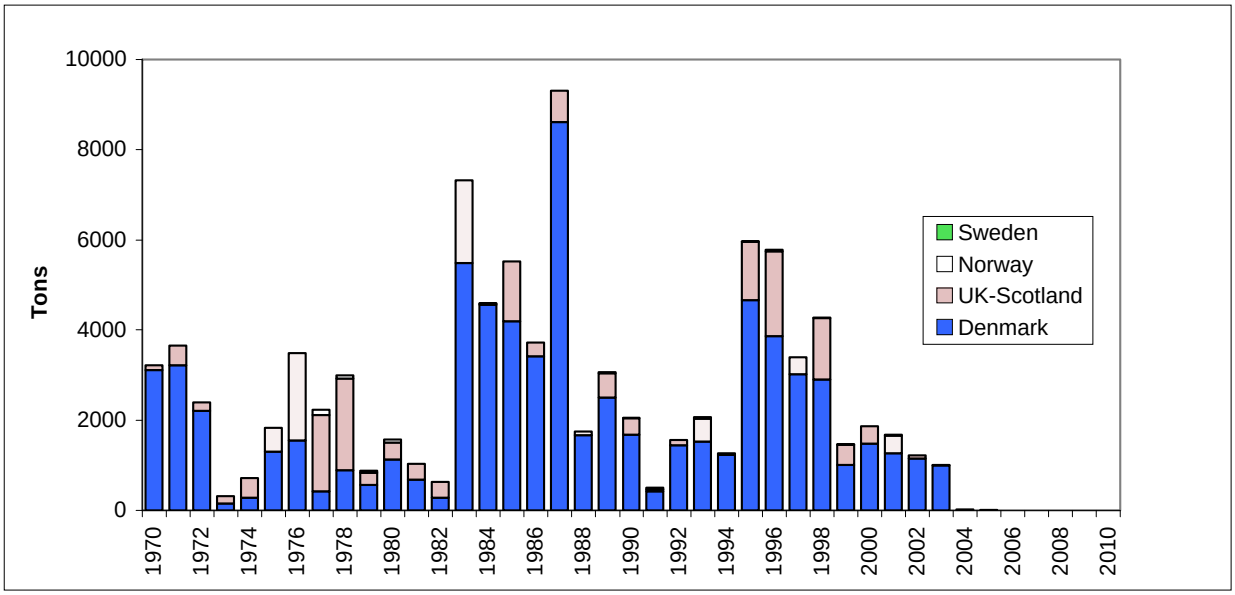


Fig. 12. Total shrimp landings from the Fladen Ground, 1970 – 2010.

Table 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	2985	3877	1421	8283	1069	1545	92		354	3060
1983	1571	3722	988	6281	5724	1657	112	65	1836	9394
1984	1717	3509	933	6159	4638	1274	120	277	25	6334
1985	4105	4772	1474	10351	4582	1785	128	415	1347	8257
1986	4102	4811	1357	10270	4288	1681	157	458	358	6942
1987	3466	5198	1085	9749	9642	3145	252	526	774	14339
1988	2246	3047	1075	6368	2656	4614	220	489	109	8107
1989	2527	3156	1304	6987	3298	3418	122	364	579	7802
1990	2277	3006	1471	6754	2080	3146	137	305	365	6084
1991	3258	3441	1747	8446	747	2715	161	130	54	3807
1992	3293	4257	2057	9607	1880	2945	147	69	116	5157
1993	2451	4089	2133	8673	1985	3449	167	29	516	6146
1994	2001	4388	2553	8942	1362	2426	176	41	35	4040
1995	2421	5181	2512	10114	4698	2879	166	217	1324	9284
1996	3664	5143	1985	10792	4063	2772	82	97	1899	8913
1997	3617	5460	2281	11358	3314	3112	316	52	365	7159
1998	2933	6519	2086	11538	3297	3092	187	55	1364	7995
1999	1398	3987	2114	7499	1679	2761	182	46	479	5147
2000	1898	3556	1890	7344	1956	2562	184	0	378	5080
2001	1186	2959	1958	6103	2030	3955	154	0	465	6604
2002	1967	3709	2044	7720	1647	3622	143	0	70	5482
2003	2612	3736	2098	8446	1631	3994	144	0	0	5769
2004	3044	4638	2152	9834	884	4364	147	0	0	5391
2005	2485	4419	1996	8900	477	4087	148	0	0	4712
2006	2837	5177	2235	10249	224	3037	141	0	0	3402
2007	2285	5928	2164	10377	95	2307	160	0	0	2562
2008	2155	5744	2246	10145	104	2039	114	0	0	2257
2009	1931	4268	2157	8356	224	1672	169	0	0	2065
2010	1119	2598	1511	5228	109	1710	141	0	0	1960

* Includes small amounts of other Pandalid shrimp

† 1970 to 1974 includes subarea IV.

Total 1988 - 1990 includes19, 21 and 51 t. by the Netherlands

2010 figures are preliminary.

Table 2. *Pandalus borealis* landings and catches in ICES Divs. IIIa (Skagerrak) and IVa east (Norwegian Deep) as estimated by the Working Group. Norweigian figures have been revised since last year.

Year	Denmark	Norway*)	Sweden *)	Total landings	Est. Sw high grading	Est. Norw discards	Est. Danish discards	TAC	Est. 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	1804	5361	1136	8301					
1984	1800	4783	1022	7605					
1985	4498	6646	1571	12715					
1986	4866	6490	1463	12819					
1987	4488	8343	1322	14153					
1988	3240	7661	1278	12179					
1989	3242	6411	1433	11086					
1990	2479	6108	1608	10195					
1991	3583	6119	1908	11610					
1992	3725	7136	2154	13015				15000	
1993	2915	7371	2300	12586				15000	
1994	2134	6813	2601	11548				18000	
1995	2460	8095	2882	13437				16000	
1996	3868	7878	2371	14117				15000	
1997	3909	8565	2597	15071				15000	
1998	3330	9606	2469	15406				18800	
1999	2072	6739	2445	11256				18800	
2000	2371	6444	2225	11040				13000	
2001	1953	7266	2108	11327	375			14500	11702
2002	2466	7703	2301	12470	908			14500	13378
2003	3244	8178	2389	13811	868			14500	14679
2004	3905	9544	2464	15913	1797			15690	17710
2005	2952	8959	2257	14168	1483			15600	15651
2006	3061	8669	2488	14218	1186			16200	15404
2007	2380	8686	2445	13511	1124	526		16600	15161
2008	2259	8260	2479	12998	2003	1408		16300	16409
2009	2155	6364	2483	11002	678	115	36	16600	11831
2010	1229	4673	1781	7683	558	63	30	14558	8334

*) Swedish (all years)and Norwegian landings (2000-09) have been corrected for loss in weight due to boiling.

Table 3. National LPUE and total effort. *Pandalus* in ICES Divs. IIIa and IVa east.

	Denmark		Norway		Sweden	
Year	LPUE kg/hr	effort Khrs	LPUE kg/hr	effort Khrs	LPUE kg/hr	effort Khrs
1987	13	347	36	179	30	49
1988	9	364	36	230	23	57
1989	9	358	31	251	22	57
1990	15	162	23	273	23	63
1991	20	183	26	232	26	58
1992	19	192	30	206	31	61
1993	16	188	35	204	27	80
1994	21	102	31	243	25	91
1995	27	90	31	218	33	82
1996	29	133	35	255	39	76
1997	46	85	37	214	32	74
1998	43	78	42	212	33	78
1999	24	85	44	219	34	73
2000	24	100	32	219	34	72
2001	23	85	33	195	30	75
2002	33	74	33	206	29	74
2003	35	92	44	168	35	65
2004	53	74	47	163	33	72
2005	28	105	55	164	33	74
2006	36	86	50	173	36	65
2007	41	58	65	134	47	52
2008	38	60	65	127	43	58
2009	28	76	50	128	35	71
2010	19	63	34	137	26	69

Table 4. National sampling effort of commercial catches in 2010. *Pandalus* in ICES Divs. IIIa and IVa east.

Denmark*)				Numbers
Quarter	Landings (tons)	samples	Weight (kg)	measured-sexed
1	402	3	3,5	901
2	296	4	6,0	1360
3	296	7	9,7	2487
4	235	0	0,0	0
Total	1229	14	19,1	4748

Norway				Numbers
Quarter	Landings (tons)	samples	Weight (kg)	measured-sexed
1	1280	11	16,4	2176
2	1119	14	18,8	3028
3	1031	6	9,4	1576
4	856	10	16,9	2450
Total	4286	41	61,5	9230

Sweden				Numbers
Quarter	Landings (tons)	samples	Weight (kg)	measured-sexed
1	489	7	28,5	4288
2	474	2	8,1	1374
3	431	4	13,7	1994
4	386	5	18,4	2662
Total	1780	18	68,7	10318

Total				Numbers	Sampling per 1000 ton landed	
Quarter	Landings (tons)	samples	Weight (kg)	measured-sexed	Weight	Numbers
1	2170	21	48,3	7365	22,3	3393,4
2	1889	20	32,9	5762	17,4	3050,2
3	1759	17	32,8	6057	18,6	3443,9
4	1477	15	35,3	5112	23,9	3462,2
Total	7295	73,0	149,3	24296	20,5	3330,6

*) Following a Danish Swedish agreement, samples from Danish shrimp landings in Sweden in 2 and 3 q have been included in the Swedish samples

Table 5. Catch in numbers at age. *Pandalus* in Divs. IIIa and IVa east.

Numbers*10**-6

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE													
0	17,7	7,4	2,7	14,1	31,3	0,0	3,9	25,5	27,2	0,7	2,7	61,1	19,7
1	1200,8	1146,4	1260,5	1086,6	2083,6	2250,1	1231,8	1071,4	1889,6	671,9	646,0	1211,6	2175,6
2	1305,4	1029,7	1205,6	923,9	385,5	910,8	1035,8	1289,2	803,8	1380,4	970,5	991,4	1181,9
3	187,9	482,7	390,2	300,2	173,8	121,1	326,7	569,1	262,7	143,0	851,5	454,6	295,6
+gp	52,3	25,1	203,2	146,7	13,6	31,3	25,6	57,5	15,5	30,5	42,0	69,5	29,8
TOTALNUM	2764,1	2691,3	3062,1	2471,5	2687,9	3313,3	2623,8	3012,7	2998,7	2226,4	2512,5	2788,2	3702,6
CATON	13273	13233	14876	12929	12193	11421	12107	13556	13475	11761	13713	14436	16110

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
AGE													
0	12,7	4,6	88,1	0,1	3,9	2,4	5,7	13,7	4,8	0,1	1,2	0,1	4,9
1	903,4	1436,1	1270,7	904,7	922,3	668,7	1062,9	749,4	1021,4	433,1	701,9	555,1	297,9
2	1597,9	720,1	836,3	824,5	858,4	1466,5	1251,4	1172,7	1149,2	1349,9	915,0	853,2	787,6
3	468,1	318,3	199,3	390,0	581,8	283,8	477,6	410,1	379,0	220,1	673,7	592,9	238,2
+gp	48,2	43,3	39,2	68,3	101,8	0,0	50,4	0,0	28,5	0,0	0,0	16,5	0,0
TOTALNUM	3030,2	2522,4	2433,5	2187,6	2468,3	2421,4	2847,9	2345,9	2582,8	2003,1	2291,9	2017,8	1328,6
CATON	15753	11895	11401	11657	12339	13338	15815	13715	13763	10750	12541	11816	7881

Table 6. Mean weight at age in catches. *Pandalus* in Divs. IIIa and IVa east.

Catch weights at age (kg)

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE													
0	0,0009	0,0012	0,0009	0,0009	0,0011	0,0009	0,0015	0,0010	0,0009	0,0009	0,0009	0,0007	0,0009
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
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
3	0,0104	0,0083	0,0077	0,0090	0,0099	0,0083	0,0079	0,0078	0,0088	0,0093	0,0089	0,0094	0,0094
+gp	0,0134	0,0140	0,0114	0,0117	0,0133	0,0106	0,0122	0,0095	0,0109	0,0117	0,0116	0,0138	0,0119

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
AGE													
0	0,0007	0,0007	0,0007	0,0006	0,0008	0,0014	0,0017	0,0014	0,0014	0,0014	0,0010	0,0015	0,0011
1	0,0033	0,0033	0,0032	0,0031	0,0036	0,0035	0,0037	0,0038	0,0035	0,0032	0,0036	0,0049	0,0039
2	0,0055	0,0063	0,0063	0,0056	0,0054	0,0060	0,0061	0,0059	0,0061	0,0057	0,0059	0,0057	0,0059
3	0,0087	0,0088	0,0103	0,0085	0,0083	0,0082	0,0077	0,0092	0,0075	0,0075	0,0070	0,0069	0,0085
+gp	0,0133	0,0112	0,0139	0,0118	0,0113	0,0121	0,0107	0,0113	0,0123	0,0123	0,0123	0,0091	0,0123

Table 7. By-catch, 2007-2009 in the *Pandalus* fisheries in the Norwegian Deep & Skagerrak

A:
Skagerrak, Sub-div. IIIA. Danish log book records

Species:	2008 Total	2008 % of total catch	2009 Total	2009 % of total catch	2010 Total	2010 % of total catch
Blue Whiting	0,0	0,0	0,0	0,0	0,0	0,0
Norway lobster	8,9	0,4	3,6	0,1	5,5	0,4
Pandalus	2120,4	84,5	2151,1	82,3	1139,9	81,6
Angler fish	13,2	0,5	16,2	0,6	6,8	0,5
Whiting	0,0	0,0	0,0	0,0	0,0	0,0
Haddock	13,0	0,5	16,5	0,6	3,2	0,2
Hake	5,3	0,2	7,3	0,3	1,3	0,1
Ling	1,4	0,1	2,9	0,1	0,5	0,0
Saithe	213,5	8,5	286,2	11,0	164,4	11,8
Witch flounder	39,9	1,6	37,1	1,4	14,2	1,0
Norway pout	0,0	0,0	0,0	0,0	0,0	0,0
Cod	63,2	2,5	62,9	2,4	46,0	3,3
Other market fish	29,5	1,2	28,9	1,1	14,4	1,0
Cod as % of shrimp:		3,0		0,0		2,9		0,0		4,0

D:
Norwegian Deeps, Sub-div. IVA Danish log book records

Species:	2008 Total	2008 % of total catch	2009 Total	2009 % of total catch	2010 Total	2010 % of total catch
Blue Whiting	0,0	0,0	0,0	0,0	0,0	0,0
Norway lobster	0,9	0,7	1,1	0,5	0,3	0,2
Pandalus	87,6	68,9	197,1	80,0	121,9	75,0
Angler fish	7,0	5,5	6,9	2,8	4,2	2,6
Whiting	0,0	0,0	0,0	0,0	0,0	0,0
Haddock	0,1	0,1	0,2	0,1	0,4	0,2
Hake	4,5	3,5	3,1	1,3	2,3	1,4
Ling	3,3	2,6	2,4	1,0	2,0	1,2
Saithe	14,6	11,5	20,9	8,5	16,7	10,3
Witch flounder	0,3	0,2	0,1	0,0	0,2	0,1
Norway pout	0,0	0,0	0,0	0,0	0,0	0,0
Cod	4,9	3,9	8,2	3,3	7,5	4,6
Other market fish	3,9	3,1	6,2	2,5	7,2	4,4
Cod as % of shrimp:		5,6		4,2		6,1

B:
Skagerrak, Sub-div. IIIA. Swedish log book records

Species:	2008 Total	2008 % of total catch	2009 Total	2009 % of total catch	2010 Total	2010 % of total catch
Blue Whiting	0,0	0,0	0,0	0,0	0,1	0,0
Norway lobster	6,5	0,3	8,1	0,5	8,2	0,4
Pandalus	1743,1	84,3	1235,4	77,3	1287,5	65,0
Angler fish	6,0	0,3	6,1	0,4	13,8	0,7
Whiting	3,4	0,2	3,9	0,2	11,0	0,6
Haddock	21,8	1,1	12,9	0,8	13,2	0,7
Hake	15,9	0,8	9,4	0,6	10,5	0,5
Ling	5,2	0,3	6,4	0,4	12,3	0,6
Saithe	137,0	6,6	156,5	9,8	361,5	18,3
Witch flounder	25,7	1,2	27,7	1,7	27,4	1,4
Norway pout	0,0	0,0	0,0	0,0	0,1	0,0
Cod	77,0	3,7	111,9	7,0	180,4	9,1
Other market fish	27,2	1,3	19,2	1,2	53,3	2,7
Cod as % of shrimp:		4,4		9,1		14,0

F:
Norwegian Deeps, Sub-div. IVA Norwegian sales slips data

Species:	2008 Total	2008 % of total catch	2009 Total	2009 % of total catch	2010 Total	2010 % of total catch
Blue Whiting	0,0	0,0	0,0	0,0	0,0	0,0
Norway lobster	75,3	2,9	65,6	3,2	24,3	1,1
Pandalus	2038,9	77,4	1667,6	82,5	1687,8	77,2
Angler fish	67,4	2,6	68,9	3,4	62,7	2,9
Whiting	4,6	0,2	2,2	0,1	2,7	0,1
Haddock	24,1	0,9	10,2	0,5	18,5	0,8
Hake	36,3	1,4	30,3	1,5	32,2	1,5
Ling	27,5	1,0	34,4	1,7	31,8	1,5
Saithe	218,7	8,3	17,9	0,9	176,4	8,1
Witch flounder	3,4	0,1	1,9	0,1	2,3	0,1
Norway pout	0,0	0,0	0,0	0,0	0,0	0,0
Cod	96,1	3,6	62,7	3,1	62,9	2,9
Other market fish	41,9	1,6	59,5	2,9	85,3	3,9
Cod as % of shrimp:		4,7		3,8		3,7

C:
Skagerrak, Sub-div. IIIA. Swedish log book records (sorting grid)

Species:	2008 Total	2008 % of total catch	2009 Total	2009 % of total catch	2010 Total	2010 % of total catch
Blue Whiting	0,0	0,0	0,0	0,0	0,0	0,0
Norway lobster	3,4	0,5	2,6	0,3	2,3	0,6
Pandalus	633,6	99,3	923,4	96,9	363,7	96,2
Angler fish	0,0	0,0	0,4	0,0	0,2	0,0
Whiting	0,0	0,0	0,0	0,0	0,0	0,0
Haddock	0,0	0,0	0,3	0,0	0,0	0,0
Hake	0,0	0,0	0,9	0,1	0,2	0,1
Ling	0,0	0,0	0,6	0,1	0,1	0,0
Saithe	0,0	0,0	15,3	1,6	7,0	1,9
Witch flounder	0,1	0,0	0,8	0,1	0,4	0,1
Norway pout	0,0	0,0	0,0	0,0	0,0	0,0
Cod	0,3	0,0	8,5	0,9	2,5	0,7
Other market fish	0,3	0,0	0,6	0,1	1,6	0,4
Cod as % of shrimp:		0,0		0,9		0,7

F:
Skagerrak, Sub-div. IIIA Norwegian sales slips data

Species:	2008 Total	2008 % of total catch	2009 Total	2009 % of total catch	2010 Total	2010 % of total catch
Blue Whiting	0,0	0,0	0,0	0,0	0,0	0,0
Norway lobster	36,7	0,6	39,1	0,8	31,2	1,0
Pandalus	5742,5	88,6	4267,0	86,5	2598,1	83,2
Angler fish	33,0	0,5	35,4	0,7	35,6	1,1
Whiting	5,9	0,1	5,0	0,1	4,2	0,1
Haddock	43,6	0,7	51,0	1,0	24,7	0,8
Hake	24,0	0,4	23,7	0,5	10,6	0,3
Ling	38,2	0,6	33,1	0,7	28,4	0,9
Saithe	159,5	2,5	137,8	2,8	116,0	3,7
Witch flounder	29,4	0,5	21,4	0,4	17,6	0,6
Norway pout	0,0	0,0	0,0	0,0	0,0	0,0
Cod	258,8	4,0	198,1	4,0	156,0	5,0
Other market fish	107,1	1,7	122,0	2,5	100,7	3,2
Cod as % of shrimp:		4,5		4,6		6,0

Table 8. Landings in tonnes of *Pandalus borealis* from the Fladen Ground (Division IVa west) as estimated by the Working Group

Year	Denmark	Norway	Sweden	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	4188			1341	5529
1986	3416			301	3717
1987	8620			686	9306
1988	1662	2		84	1748
1989	2495	25		547	3067
1990	1681	3	4	365	2053
1991	422	31		53	506
1992	1448			116	1564
1993	1521	38		509	2068
1994	1229	0		35	1264
1995	4659	15		1298	5972
1996	3858	32		1893	5783
1997	3022	9		365	3396
1998	2900	3		1365	4268
1999	1005	9		456	1470
2000	1482			378	1860
2001	1263	18		397	1678
2002	1147	9		70	1226
2003	999	8	1	0	1008
2004	23	0	0	0	23
2005	10	0	0	0	10
2006	0	0	0	0	0
2007	0	0	0	0	0
2008	0	0	0	0	0
2009	0	0	0	0	0
2010	0	0	0	0	0

Table 9. *Pandalus borealis*, Fladen Ground. Reported LPUE (shrimp trawlers) and estimated total effort.

Year	Recorded LPUE (ton./day)	Denmark Total effort (Days)	effort Index	LPUE (kg/hour)	UK (Scotland) Total effort (hours)	effort Index
1982	0.96	295	0.10	74	4757	0.31
1983	1.18	4855	1.61	89	20528	1.32
1984	0.97	4694	1.56	37	676	0.04
1985	1.21	3016	**1.00**	86	15593	**1.00**
1986	0.96	3558	1.18	71	4239	0.27
1987	1.24	5908	1.96	81	8469	0.54
1988	0.83	1298	0.43	44	1909	0.12
1989	0.99	2463	0.82	65	8415	0.54
1990	1.28	1313	0.44	106	3493	0.22
1991	1.50	281	0.09	124	429	0.03
1992	1.44	1006	0.33	69	1685	0.11
1993	1.83	831	0.28	90	5656	0.36
1994	1.93	637	0.21	91	386	0.02
1995	2.00	2331	0.77	130	9949	0.64
1996	1.79	2155	0.71	62	30532	1.96
1997	2.86	1078	0.36	202	1807	0.12
1998	2.20	1405	0.47	97	14145	0.91
1999	1.62	606	0.20	107	4263	0.27
2000	1.79	830	0.28	121	3128	0.20
2001	2.20	577	0.19	*)	-	-
2002	1.62	711	0.24	*)	-	-
2003	1.70	598	0.20	*)	-	-
2004	0.92	27	0.01	*)	-	0.01
2005	*)	-	-	*)	-	-
2006	*)	-	-	*)	-	-
2007	*)	-	-	*)	-	-
2008	*)	-	-	*)	-	-
2009	*)	-	-	*)	-	-
2010	*)	-	-	*)	-	-

*) No directed shrimp fishery