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

by

M. Ulmestrand, O. Eigaard, G. Søvik and Sten Munch-Petersen

**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, Swedish and Norwegian LPUE. Estimates of Swedish Danish and Norwegian discards are 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**

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**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 the recent 8 years no *Pandalus* fishery has taken place on Fladen Ground and only the stock in the Norwegian Deep and Skagerrak has been exploited. There is a discussion between EU and Norway that grid should be mandatory in all shrimp fisheries in Skagerrak and the North Sea. It has also been decided to introduce a discard ban in Skagerrak during 2014, The details are still not decided (eg. exceptions for certain gears and species) and it is difficult to predict what consequences it will have for the *Pandalus* fishery.

**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’ with maximums of approx. 40% in 2001 and 35% in 2011. The majority of sea boiled shrimp are landed in Swedish ports, where the demand is high. Minor amounts have also been landed in Norwegian ports. New analyses for the period 1987 to 2011 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 138 vessels in 1987 to only 13 vessels in 2011 (Fig. 3). Following a large decline from 1987 to 2006, fleet size seems to have stabilized at around 12-13 larger vessels.

#### 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 (2009). The effective effort by vessels has increased considerably. Following this development the nominal LPUE is standardized accordingly (Fig. 11). Since 2005, an increasing number of vessels have started using twin trawl, which today is the most common gear deployed. A Nordmøre grid has also voluntarily been used in the fishery. When the vessels quota situation allows it, the grid trawl is equipped with a large square mesh tunnel in order to retain large fish,

#### **1.1.2 The Norwegian *Pandalus* fishery (SCR Doc. 12/064)**

#### **1.1.3 The Swedish *Pandalus* fishery**

In 2011, a total of 64 trawlers reported landings of *Pandalus* ( $\geq 100\text{kg}$ ) in the Swedish logbooks. Of these, 38 landed more than 10 t *Pandalus* and can be considered specialised in this fishery. The trend in number of *Pandalus* trawlers from 1995 to 2011 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 118 GRT. The average engine effect is around 409 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 (about 99% *Pandalus*). The Nordmøre grid has also voluntarily been used outside the trawling border and then occasionally with a large square mesh tunnel in order to retain large fish.

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 show since a decreasing trend to 20% in 2011. The grid trawl with square mesh tunnel can be distinguished since 2011 in log books.

The Swedish specialized shrimp fleet ( $\geq 10\text{ t/yr}$ ) 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 single trawl size or trawl design until recent years according to the Swedish net manufacturer, but during the last six years the number of twin trawlers has increased from 5 to 23. These twin trawls have 50- 80% higher catch rate compared to vessels using single rigged trawls (Fig. 5). In 2011, the 23 shrimp trawlers using twin trawls caught 57% of the Swedish *Pandalus* landings. Swedish *Pandalus* landings (1990-2011) by trawl gear are given in Fig. 6.

The Swedish quota has been limiting the Swedish *Pandalus* fishery and in order to distribute landings over the year the fishers have voluntarily introduced rations per fisher per week, but in recent years the quota has not been restricting the fishery. The rations has sometimes 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

was presented in (SCR Doc. 11/67). Since 2008 Sweden has an on board discard sampling programme. This shows that previous Swedish estimations of discards (+ high grading) through adjusting Swedish size distribution in to the Danish (SCR Doc. 11/67) likely was an overestimation. Results from the on board discard sampling programme (Fig.7) shows that 12 to 22 % of the catch is discarded and it is a large variation between samples.

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 group (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.

Swedish log book data started to have available information on vessel level since 1995 and standardization of lpue was this year carried out from 1996 to 2011 when vessel data was more completely reported.

$$\log(LPUE) = YEAR * MONTH + GEAR\_CODE + NUMBER\_OF\_GEARS + a * kW + error$$

where a is the linear coefficient of the relationship between LPUE and kW. Gear code is trawl 1) without grid, 2) with grid (unblocked fish opening) or 3) with grid and large square mesh fish tunnel in order to retain marketable fish. Number of gears is either single or twin trawl. Further details on the standardization will be provided next year. The Swedish standardized lpue is presented together with the Norwegian and Danish in Figure ??

## 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 was the lowest in 35 years, while landings in 2011 increased slightly 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 2011 were around 8200 t, which is almost 3000 t less than in 2009.

Landings from Norway, Denmark and Sweden 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 give landed weight as a mixture of raw and boiled shrimp, but these can be separated in sale slip data. The shrimp lose weight when boiled, therefore the 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 been corrected. Norwegian, Swedish and Danish landings in 2011 consisted of respectively 58, 59 and 35% boiled shrimps, respectively.

### 1.2.2 Discards

An overview of the current practices of high grading and discarding of shrimp was given in SCR Doc. 11/67. The Swedish estimates of discards from on board sampling are during 2008-2011 from 12 to 22% of the catch. (figure XX).

### 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, Norwegian and Swedish) show the same trend since 2005: Increasing LPUEs up to 2007, followed by a decreasing trend. 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 when twin trawls has increased (Fig. 6). The Swedish LPUE has now been standardized according to 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 2000-2011. Further information on the Norwegian logbook data is given in SCR Doc. 12/68.

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 2011 was around 21 kg per 1000 t landed or 3623 specimens. An increasing amount of the Swedish and 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, 2010 and 2011, 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. 12/64)**

#### **1.5 Assessment of the *Pandalus* stock in Divisions 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 1987-2011 and survey indices from 2006-2012 and can be found in the 2012 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 implementation of a new assessment models.**

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**

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Results from the two research projects focusing on the genetic stock structure of northern shrimp in respectively the whole North Atlantic (POPBOREALIS) and the Skagerrak/North Sea area (Sustainable shrimp fishing in Skagerrak), were presented to the 2012 NIPAG working group. As the data set from the North Sea/Skagerrak is not yet finalized, and since the statistical analyses are still ongoing, the results are still preliminary. However, the results indicate that shrimp in some areas, especially around Iceland, Jan Mayen and in Gulf of Maine, and possibly also on Flemish Cap, constitute isolated populations, while shrimp in other areas like the Barents Sea and the eastern coast of Canada constitute large interbreeding populations. The genetic differences between samples within Skagerrak and the North Sea are small compared with the differences observed in the North Atlantic. A finalized data set is

expected before the end of 2012 such that conclusions on the stock structure in this area can be made as part of the benchmark process.

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

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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 Environmental considerations

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The average temperature (10 m above the bottom) in Skagerrak and Norwegian Deep in January/February from the Norwegian shrimp survey is presented in Figure 12. The bottom temperature was between 7 and 8 °C from 2006 to 2010. In 2006-2009 the bottom temperature was slightly higher in the Norwegian Deep compared with Skagerrak, while in 2010 the pattern was opposite (Fig. 5). The area was cooled down during the unusually cold winter 2009-2010, which led to cold water sinking into the Norwegian Deep and Skagerrak basin in late winter 2010, replacing the warmer bottom water. The bottom water was still unusually cold in early 2011, while the sparse 2012-CTD data indicate that bottom temperature was back to average level in January 2012.

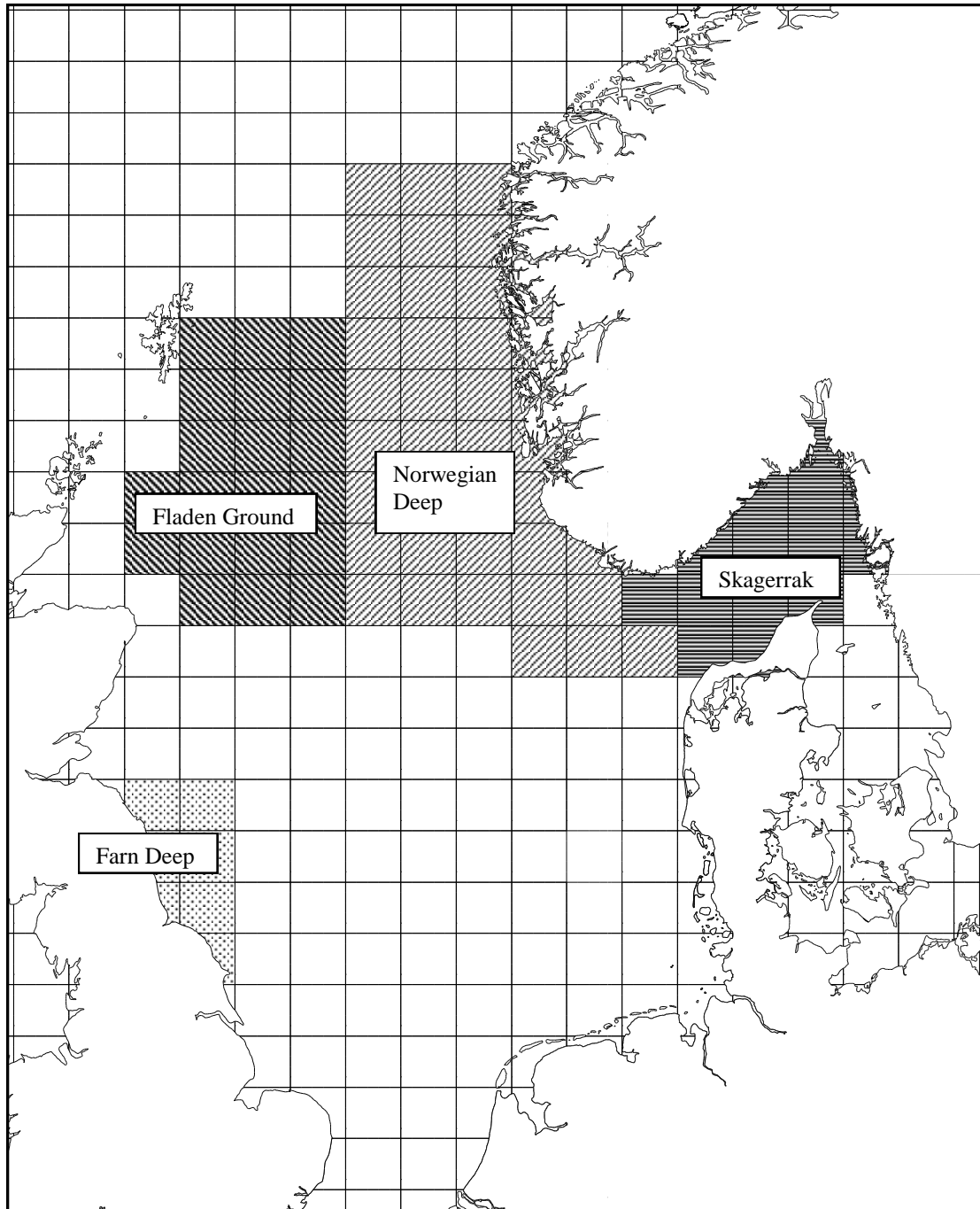
In 1963-65, a similar situation with unusually cold bottom water was observed first in Skagerrak and the year after in the Norwegian Deep. This coincided with drastically decreasing lpue in the *Pandalus* fishery (Rasmussen, 1967).

The cold water inflow during 2010, which lasted to 2011, may have contributed to the low lpue and biomass estimates observed during the same years.

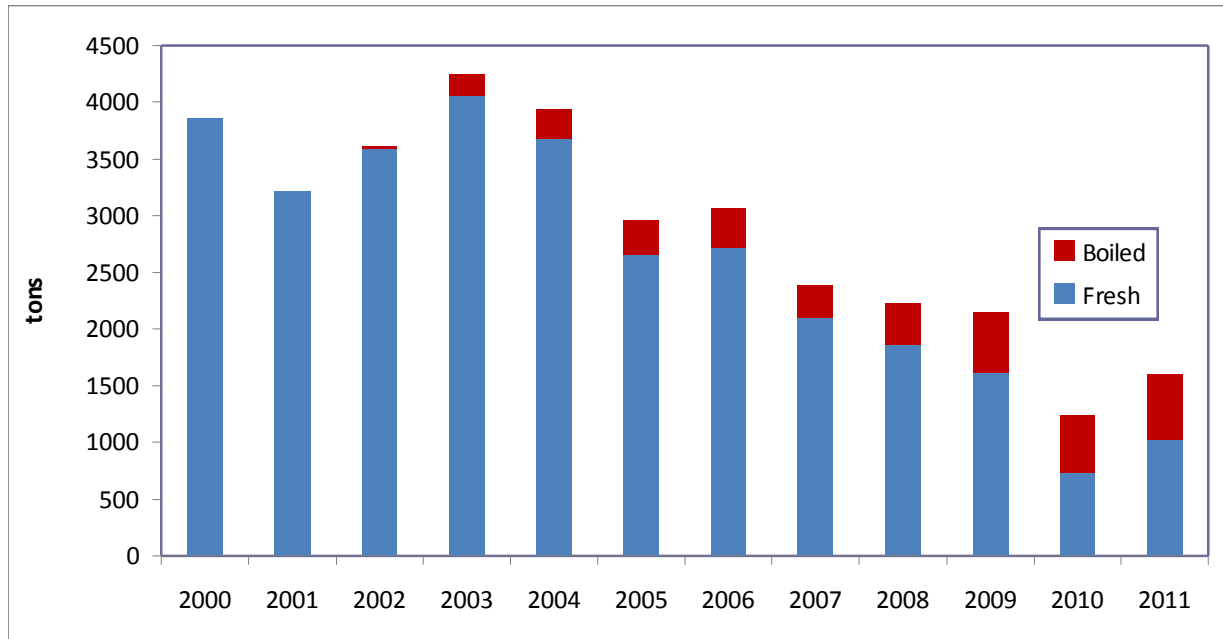
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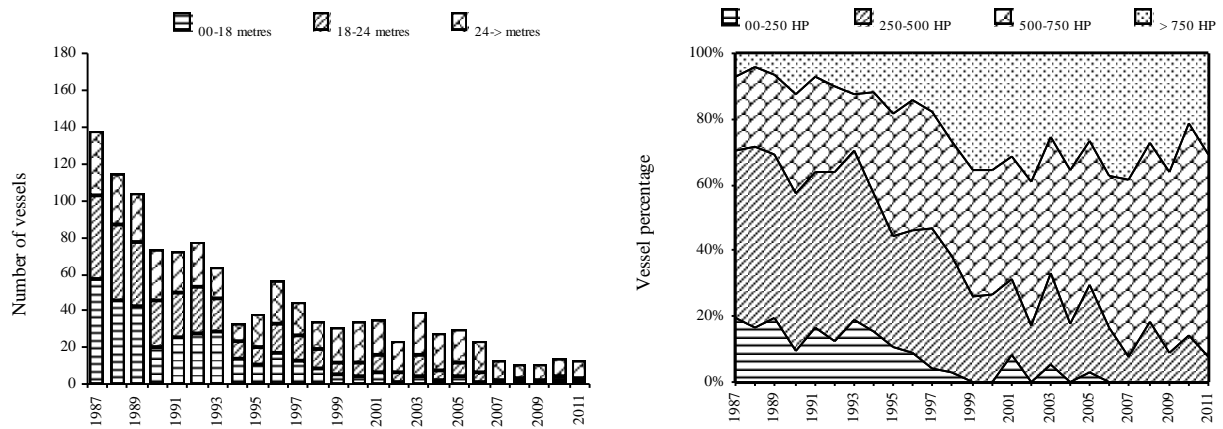
**Fig.1. The distribution of the *Pandalus* stocks in the North Sea area as defined by the ICES squares.**



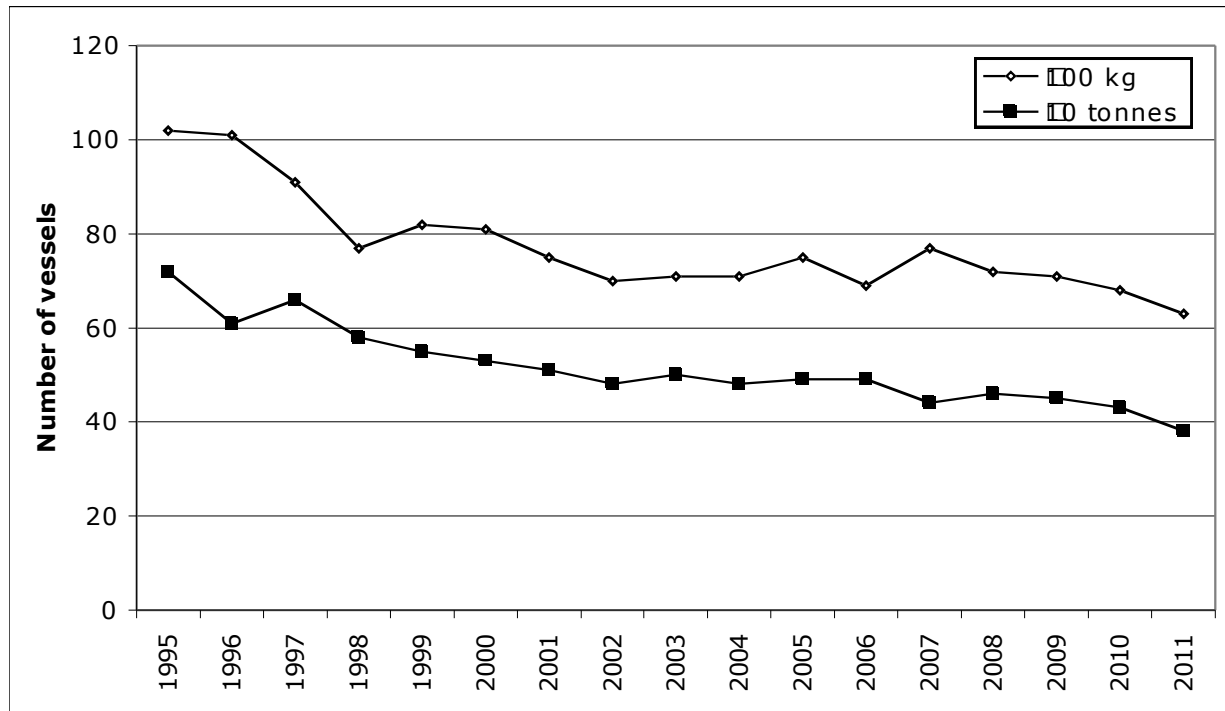




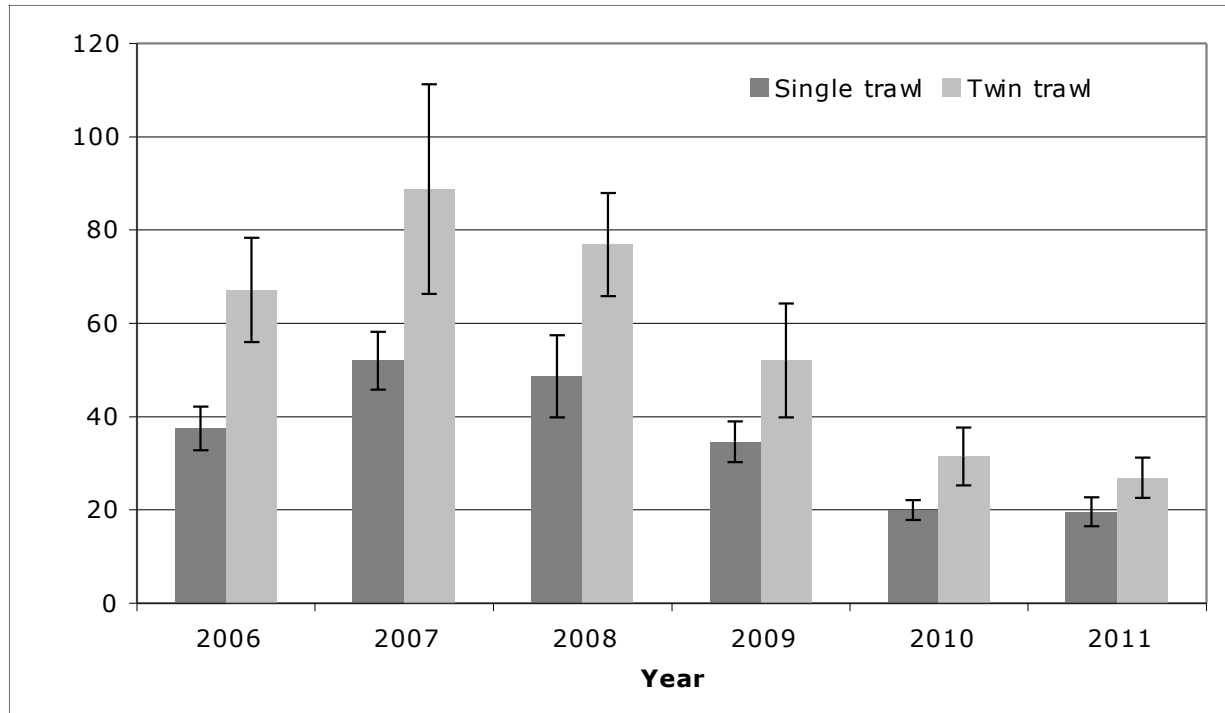
**Fig. 2.** Danish landings of *Pandalus* partitioned into the two landing categories 2000 to 2011.



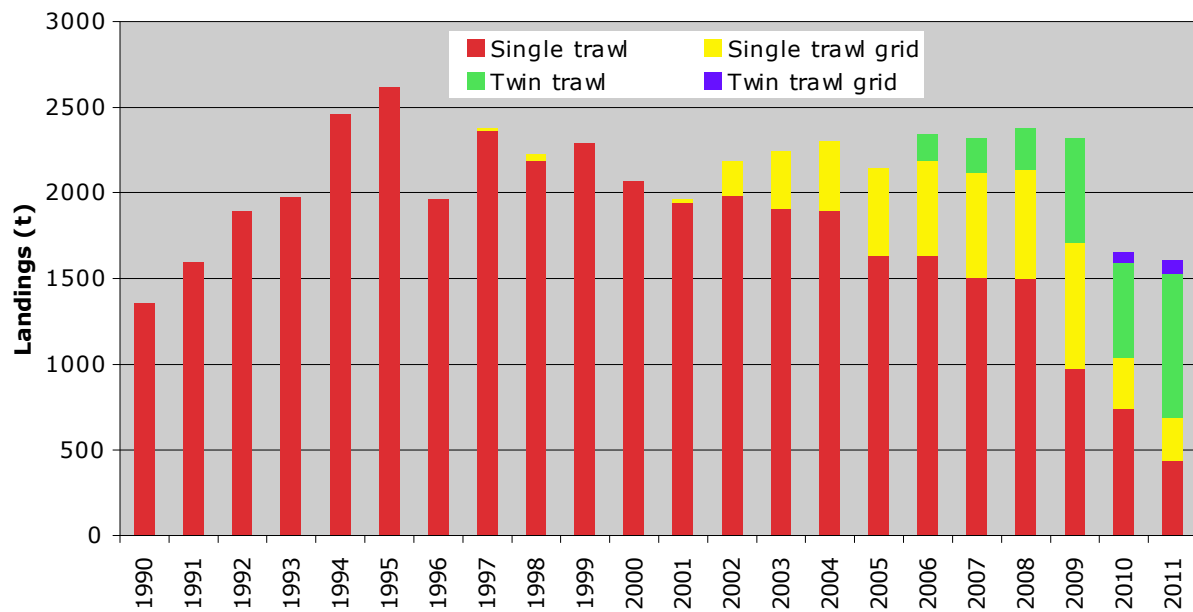
**Fig. 3.** Trend in numbers (left) and engine power (right) by size groups of Danish *Pandalus* trawlers from 1987 to 2011.



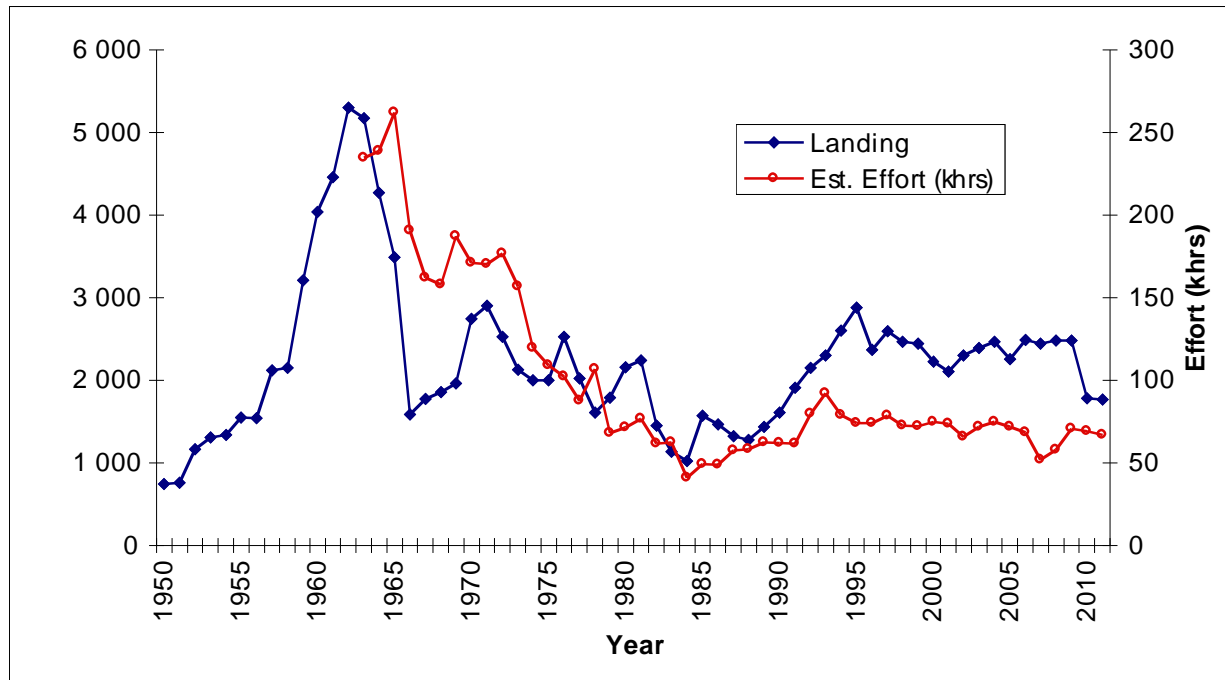
**Fig. 4.** Number of total Swedish *Pandalus* vessels during 1995 to 2011. Vessels landing  $\geq 10$  tonnes are considered as specialised *Pandalus* trawlers.



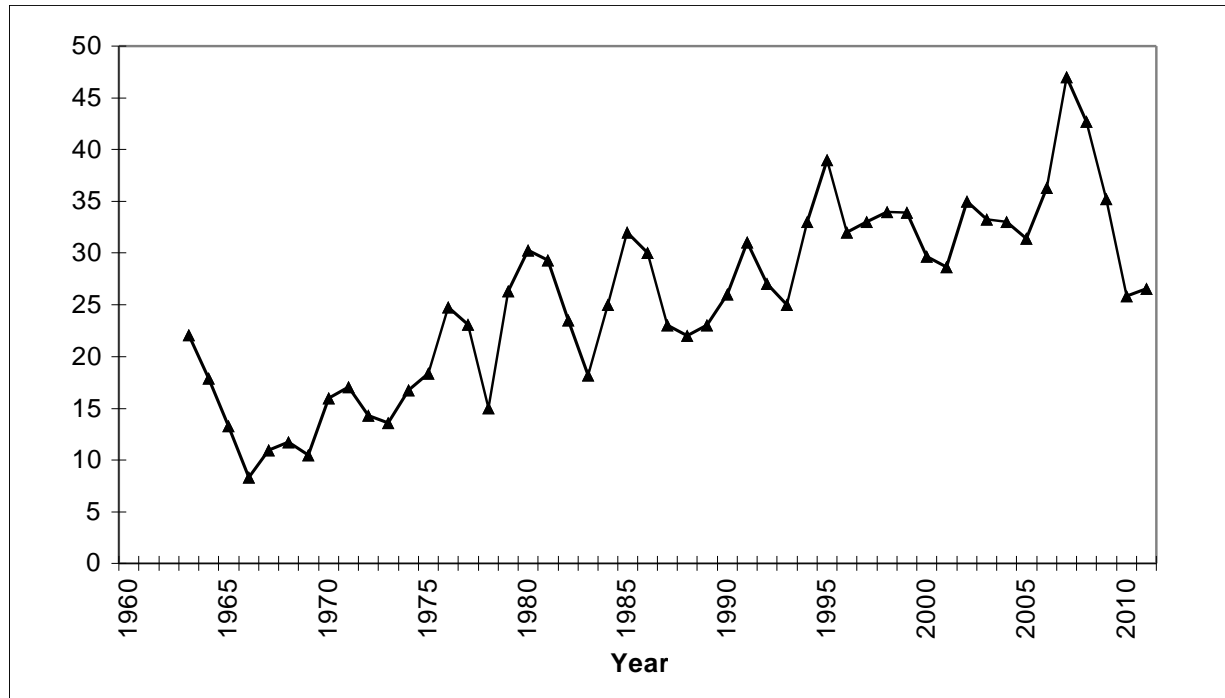
**Fig. 5.** LPUE for Swedish single and twin trawlers during 2006 - 2011. Error bars are 95% confidence interval.



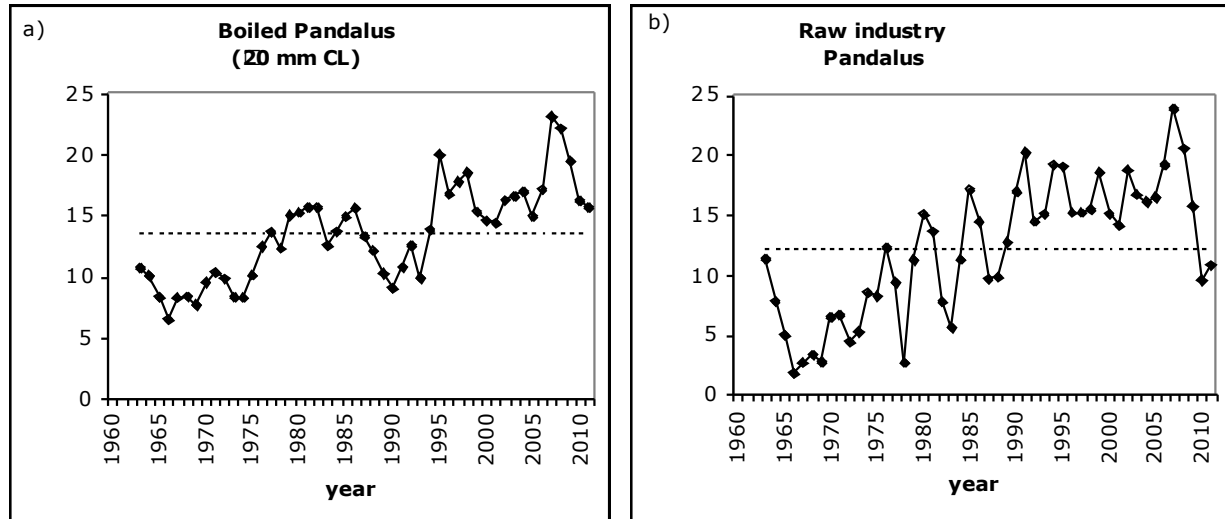
**Fig. 6.** Swedish *Pandalus* logbook landings per trawl type 1990-2011.



**Fig. 7.** Swedish yearly landings from IIIa and IVa east during 1950 to 2011 and estimated unstandardised effort during 1963 to 2011.



**Fig. 8.** Swedish unstandardised lpue (kg/hour) for areas IIIa and IVa east during 1963 to 2011.



**Fig. 9.** Unstandardised lpue for areas IIIa and IVa east during 1963 to 2011 partitioned into A: large shrimps (>20 mm) and B: small shrimps. Dotted lines show averages.

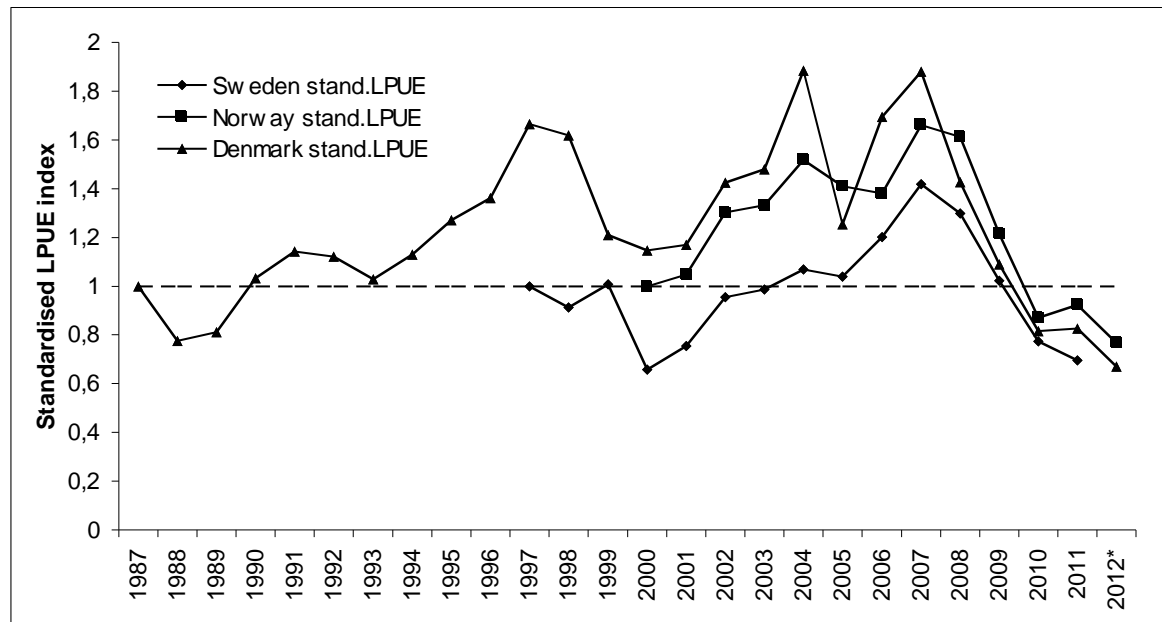


Fig.10. Comparison of Danish, Norwegian and Swedish trends in standardised LPUE, \* preliminary.

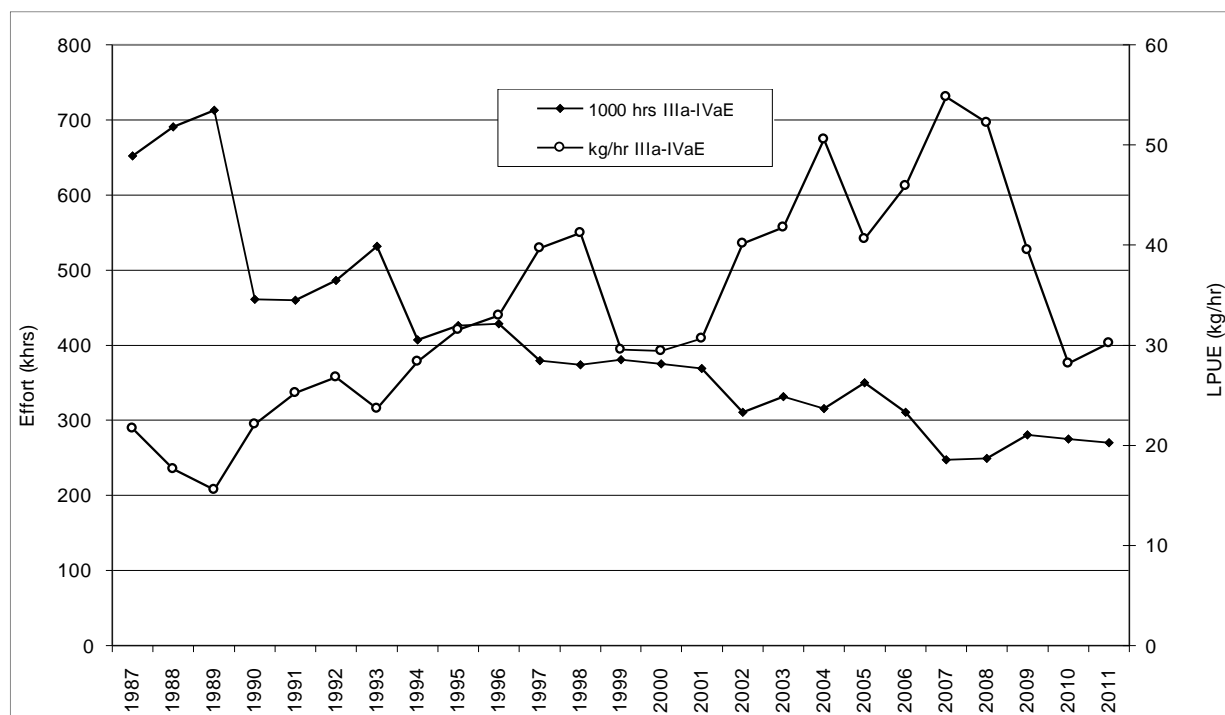


Fig. 11. Combined Norwegian, Swedish and Danish LPUE (kg/hr) and estimated total effort for 1987- 2011.

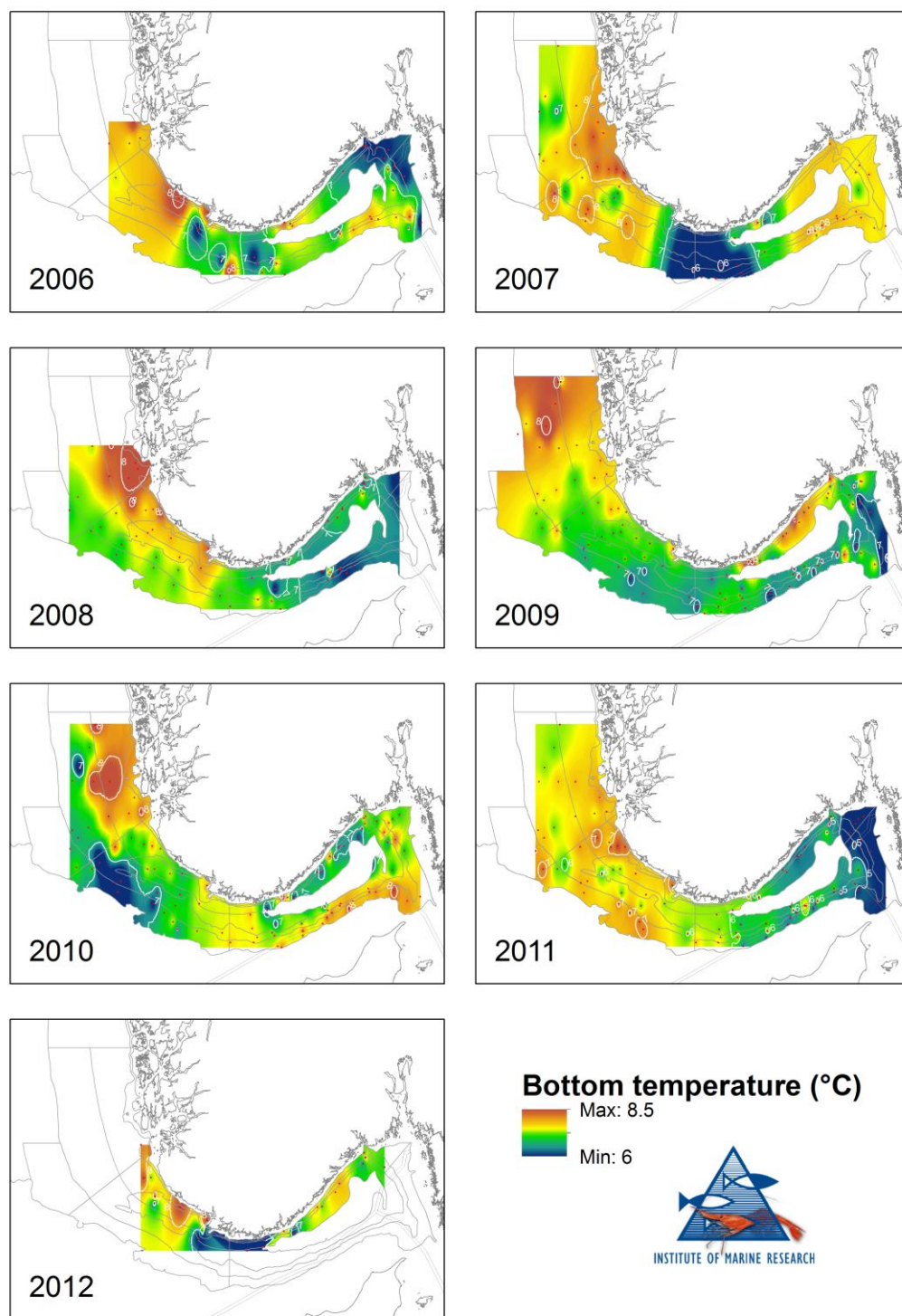


Figure 12. Temperatures (°C) measured with CTD on trawl stations during the 2006-2012 shrimp surveys in Skagerrak and the Norwegian Deep (ICES Divs. IIIa and IVa east). (From Søvik and Thangstad, 2012, SCR Doc 12/59).

**Table 1.** Nominal landings (tonnes) of *Pandalus borealis* in ICES Division IIIa and Subarea IV as officially reported to ICES.

Year	Division IIIa				Sub-area IV					
	Denmark	Norway	Sweden	Total	Denmark	Norway	Sweden	UK (Engl.)*	UK (Scotl.)*	Total
1970	757	982	2740	4479	3460	1107		14	100	4681
1971	834	1392	2906	5132	3572	1265			438	5275
1972	773	1123	2524	4420	2448	1216		692	187	4543
1973	716	1415	2130	4261	196	931		1021	163	2311
1974	475	1186	2003	3664	337	767		50	432	1586
1975	743	1463	1740	3946	1392	604	261		525	2782
1976	865	2541	2212	5618	1861	1051	136	186	2006	5240
1977	763	2167	1895	4825	782	960	124	265	1723	3854
1978	757	1841	1529	4127	1592	692	78	98	2044	4504
1979	973	2489	1752	5214	962	594	34	238	309	2137
1980	1679	3498	2121	7298	1273	1140	38	203	406	3060
1981	2593	3753	2210	8556	719	1435	31	1	341	2527
1982	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	1687	141	0	0	1937
2011*	1274	2693	1498	5465	260	1773	143	0	0	2176

\* Includes small amounts of other Pandalid shrimp  
1970 to 1974 includes subarea IV.  
Total 1988 - 1990 includes 19, 21 and 51 t. by the Netherlands  
\* preliminary.



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

Year	Denmark	Norway*)	Sweden *)	Total landings	Est. Sw high grading+ discards	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	1954	7266	2108	11328				14500	11328
2002	2470	7703	2301	12474				14500	12474
2003	3270	8178	2389	13837				14500	13837
2004	3944	9544	2464	15952				15690	15952
2005	2992	8959	2257	14208				15600	14208
2006	3111	8669	2488	14268				16200	14268
2007	2422	8686	2445	13553				16600	13553
2008	2274	8260	2479	13013	540			16300	13553
2009	2224	6364	2483	11071	337	115	36	16600	11560
2010	1301	4673	1781	7755	386	75	53	14558	8269
2011	1600	4800	1768	8168	504	235	123	11928	9030

\*) Swedish (all years) and Danish+Norwegian landings (2000-11) 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.

Year	Denmark		Norway		Sweden	
	LPUE kg/hr	effort Khrs	LPUE kg/hr	effort Khrs	LPUE kg/hr	effort Khrs
1987	14	328	36	230	23	57
1988	9	344	31	251	22	57
1989	10	338	23	273	23	63
1990	16	153	26	232	26	58
1991	21	173	30	206	31	61
1992	21	181	35	204	27	80
1993	16	178	31	243	25	91
1994	22	96	31	218	33	82
1995	29	85	35	255	39	76
1996	31	126	37	214	32	74
1997	49	80	42	212	33	78
1998	45	74	44	219	34	73
1999	26	80	32	219	34	72
2000	25	94	34	192	30	75
2001	24	80	34	214	29	74
2002	35	70	44	176	35	65
2003	38	87	48	171	33	72
2004	57	69	55	174	33	74
2005	30	99	52	173	31	68
2006	38	82	50	173	36	65
2007	44	55	65	134	47	52
2008	39	58	65	127	43	58
2009	30	73	50	128	35	71
2010	21	62	34	137	26	69
2011	22	72	39	123	27	67

**Table 4.** National sampling effort of commercial catches in 2011. *Pandalus* in ICES Divs. IIIa and IVa east.

<b>Denmark*)</b>		Numbers		
Quarter		Landings (tons)	samples	Weight (kg) measured-sexed
1		337	0	0,0
2		425	2	2,0
3		465	6	14,0
4		307	1	2,0
Total		1534	9	19,0

<b>Norway</b>		Numbers		
Quarter		Landings (tons)	samples	Weight (kg) measured-sexed
1		1188	21	39,1
2		1256	15	20,8
3		1305	9	15,4
4		718	10	16,5
Total		4466	55	91,9

<b>Sweden</b>		Numbers		
Quarter		Landings (tons)	samples	Weight (kg) measured-sexed
1		350	3	10,2
2		482	6	21,5
3		372	3	9,8
4		438	3	8,7
Total		1642	15	50,2

<b>Total</b>		Numbers			Sampling per 1000 ton landed	
Quarter		Landings (tons)	samples	Weight (kg) measured-sexed	Weight	Numbers
1		1875	24	49,3	26,3	4093,6
2		2163	23	44,3	20,5	3817,1
3		2142	18	39,3	18,3	3205,9
4		1463	14	27,2	18,6	3343,8
Total		7642	79	161,1	21,1	3623,0

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

Numbers*10**-6														
AGE\Year	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
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	12,7
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	903,4
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	1597,9
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	468,1
+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	48,2
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	3030,2

AGE\Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
0	4,6	88,1	0,1	3,9	2,4	5,7	13,7	4,8	0,1	1,2	0,1	4,9	0,1
1	1436,1	1270,7	904,7	922,3	668,7	1062,9	749,4	1021,4	433,1	701,9	555,1	297,9	304,4
2	720,1	836,3	824,5	858,4	1466,5	1251,4	1172,7	1149,2	1349,9	915,0	853,2	787,6	1136,5
3	318,3	199,3	390,0	581,8	283,8	477,6	410,1	379,0	220,1	673,7	592,9	238,2	221,3
+gp	43,3	39,2	68,3	101,8	0,0	50,4	0,0	28,5	0,0	0,0	16,5	0,0	0,0
TOTALNUM	2522,4	2433,5	2187,6	2468,3	2421,4	2847,9	2345,9	2582,8	2003,1	2291,9	2017,8	1328,6	1662,3

**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	1998
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	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
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
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	0,0087
+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	0,0133

YEAR	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
AGE													
0	0,0007	0,0007	0,0006	0,0008	0,0014	0,0017	0,0014	0,0014	0,0014	0,0010	0,0015	0,0011	0,0010
1	0,0033	0,0032	0,0031	0,0036	0,0035	0,0037	0,0038	0,0035	0,0032	0,0036	0,0049	0,0039	0,0036
2	0,0063	0,0063	0,0056	0,0054	0,0060	0,0061	0,0059	0,0061	0,0057	0,0059	0,0057	0,0059	0,0056
3	0,0088	0,0103	0,0085	0,0083	0,0082	0,0077	0,0092	0,0075	0,0075	0,0070	0,0069	0,0085	0,0073
+gp	0,0112	0,0139	0,0118	0,0113	0,0121	0,0107	0,0113	0,0123	0,0123	0,0123	0,0091	0,0123	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							D: Norwegian Deeps, Sub-div. IVA Ea Danish log book records						
Species:	2009		2010		2011		Species:	2009		2010		2011	
	Total	% of total catch	Total	% of total catch	Total	% of total catch		Total	% of total catch	Total	% of total catch	Total	% of total catch
Blue Whiting	0,0	0,0	0,0	0,0	0,0	0,0	Blue Whiting	0,0	0,0	0,0	0,0	0,0	0,0
Norway lobster	3,6	0,1	5,5	0,4	1,9	0,1	Norway lobster	1,1	0,5	0,3	0,2	0,4	0,1
<b>Pandalus</b>	2151,1	82,3	1139,9	81,6	1272,7	84,9	<b>Pandalus</b>	197,1	80,0	121,9	75,0	255,1	87,4
Angler fish	16,2	0,6	6,8	0,5	7,7	0,5	Angler fish	6,9	2,8	4,2	2,6	3,7	1,3
Whiting	0,0	0,0	0,0	0,0	0,1	0,0	Whiting	0,0	0,0	0,0	0,0	0,0	0,0
Haddock	16,5	0,6	3,2	0,2	5,6	0,4	Haddock	0,2	0,1	0,4	0,2	0,1	0,1
Hake	7,3	0,3	1,3	0,1	2,1	0,1	Hake	3,1	1,3	2,3	1,4	2,6	0,9
Ling	2,9	0,1	0,5	0,0	1,0	0,1	Ling	2,4	1,0	2,0	1,2	2,2	0,8
Saithe	286,2	11,0	164,4	11,8	133,0	8,9	Saithe	20,9	8,5	16,7	10,3	16,1	5,5
Witch flounder	37,1	1,4	14,2	1,0	15,7	1,0	Witch flounder	0,1	0,0	0,2	0,1	0,4	0,1
Norway pout	0,0	0,0	0,0	0,0	0,0	0,0	Norway pout	0,0	0,0	0,0	0,0	0,0	0,0
Cod	62,9	2,4	46,0	3,3	48,0	3,2	Cod	8,2	3,3	7,5	4,6	7,6	2,6
Other market fish	28,9	1,1	14,4	1,0	10,5	0,7	Other market fish	6,2	2,5	7,2	4,4	3,4	1,2
<b>Cod as % of shrimp:</b>	0,0	2,9	0,0	4,0	0,0	3,8	<b>Cod as % of shrimp:</b>	4,2		6,1		0,0	3,0

B: Skagerrak, Sub-div. IIIA. Swedish log book records							F: Norwegian Deeps, Sub-div. IVA Ea Norwegian sales slips data						
Species:	2009		2010		2011		Species:	2009		2010		2011	
	Total	% of total catch	Total	% of total catch	Total	% of total catch		Total	% of total catch	Total	% of total catch	Total	% of total catch
Blue Whiting	0,0	0,0	0,1	0,0	0,9	0,0	Blue Whiting	0,0	0,0	0,0	0,0	0,0	0,0
Norway lobster	8,1	0,5	8,2	0,4	9,5	0,5	Norway lobster	65,6	3,2	24,3	1,1	8,8	0,4
<b>Pandalus</b>	1235,4	77,3	1287,5	65,0	1283,5	64,6	<b>Pandalus</b>	1667,6	82,5	1687,8	77,2	1772,7	83,9
Angler fish	6,1	0,4	13,8	0,7	0,0	0,0	Angler fish	68,9	3,4	62,7	2,9	56,0	2,6
Whiting	3,9	0,2	11,0	0,6	8,0	0,4	Whiting	2,2	0,1	2,7	0,1	3,0	0,1
Haddock	12,9	0,8	13,2	0,7	17,8	0,9	Haddock	10,2	0,5	18,5	0,8	8,1	0,4
Hake	9,4	0,6	10,5	0,5	11,4	0,6	Hake	30,3	1,5	32,2	1,5	24,8	1,2
Ling	6,4	0,4	12,3	0,6	14,5	0,7	Ling	34,4	1,7	31,8	1,5	36,7	1,7
Saithe	156,5	9,8	361,5	18,3	385,8	19,4	Saithe	17,9	0,9	176,4	8,1	76,5	3,6
Witch flounder	27,7	1,7	27,4	1,4	33,4	1,7	Witch flounder	1,9	0,1	2,3	0,1	1,3	0,1
Norway pout	0,0	0,0	0,1	0,0	0,7	0,0	Norway pout	0,0	0,0	0,0	0,0	0,0	0,0
Cod	111,9	7,0	180,4	9,1	159,0	8,0	Cod	62,7	3,1	62,9	2,9	57,4	2,7
Other market fish	19,2	1,2	53,3	2,7	60,9	3,1	Other market fish	59,5	2,9	85,3	3,9	68,6	3,2
<b>Cod as % of shrimp:</b>	9,1		14,0		0,0	12,4	<b>Cod as % of shrimp:</b>	3,8		3,7		0,0	3,2

C: Skagerrak, Sub-div. IIIA Swedish log book records (sorting grid)							F: Skagerrak, Sub-div. IIIA. Norwegian sales slips data						
Species:	2009		2010		2011		Species:	2009		2010		2011	
	Total	% of total catch	Total	% of total catch	Total	% of total catch		Total	% of total catch	Total	% of total catch	Total	% of total catch
Blue Whiting	0,0	0,0	0,0	0,0	0,0	0,0	Blue Whiting	0,0	0,0	0,0	0,0	0,0	0,0
Norway lobster	2,6	0,3	2,3	0,6	1,9	0,6	Norway lobster	39,1	0,8	31,2	1,0	20,1	0,6
<b>Pandalus</b>	923,4	96,9	363,7	96,2	326,4	98,5	<b>Pandalus</b>	4267,0	86,5	2598,1	83,2	2693,2	83,9
Angler fish	0,4	0,0	0,2	0,0	0,0	0,0	Angler fish	35,4	0,7	35,6	1,1	36,3	1,1
Whiting	0,0	0,0	0,0	0,0	0,0	0,0	Whiting	5,0	0,1	4,2	0,1	4,1	0,1
Haddock	0,3	0,0	0,0	0,0	0,1	0,0	Haddock	51,0	1,0	24,7	0,8	32,3	1,0
Hake	0,9	0,1	0,2	0,1	0,0	0,0	Hake	23,7	0,5	10,6	0,3	10,1	0,3
Ling	0,6	0,1	0,1	0,0	0,0	0,0	Ling	33,1	0,7	28,4	0,9	31,3	1,0
Saithe	15,3	1,6	7,0	1,9	0,7	0,2	Saithe	137,8	2,8	116,0	3,7	104,0	3,2
Witch flounder	0,8	0,1	0,4	0,1	0,1	0,0	Witch flounder	21,4	0,4	17,6	0,6	18,4	0,6
Norway pout	0,0	0,0	0,0	0,0	0,0	0,0	Norway pout	0,0	0,0	0,0	0,0	0,0	0,0
Cod	8,5	0,9	2,5	0,7	0,3	0,1	Cod	198,1	4,0	156,0	5,0	151,4	4,7
Other market fish	0,6	0,1	1,6	0,4	1,8	0,5	Other market fish	122,0	2,5	100,7	3,2	108,4	3,4
<b>Cod as % of shrimp:</b>	0,9		0,7		0,0	0,1	<b>Cod as % of shrimp:</b>	4,6		6,0		0,0	5,6