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

by

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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, 2006): 1) the Norwegian Deep-Skagerrak stock which is confined to ICES Div. 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, UK and Norway 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 the Div. IVa east and Div. 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 landings from IVa east and IIIa have gradually become more important.

During recent years an increasing number of vessels have started processing (boiling) the shrimp aboard and landing them in Sweden thus obtaining a better price. The majority of the catches are, however, still landed in Danish fishing ports. Most of these shrimp are landed directly to a few large factories processing almost all sizes of shrimp.

The fishing vessels

In a study performed by Ulrich and Andersen (2004) all Danish fishing vessel were grouped in categories based on similarities in catch composition, gear used and area fished. According to their analyses of log book data on catch, effort as well as landing values from all the Danish fishing trips in 1999, a total of 14 vessels could be identified as being trawlers targeting *Pandalus* in the North Sea and/or Skagerrak in 1999. They accounted for the majority of the total *Pandalus* landings and had an average of 68 yearly trips targeting *Pandalus*. A larger poorly defined vessel group occasionally took part in the *Pandalus* fishery, but only accounted for small catches of *Pandalus*.

According to the above mentioned study, trawlers <24 m formerly made up app. 50% of the fleet, but during the five most recent years almost all of the smaller vessels have disappeared from the *Pandalus* fishery leaving only vessels >24 m located in Skagen, Hirtshals and Hanstholm.

This development in fleet structure agrees well with the 2004 interview information (from the industry) where Skagen, Hirtshals and Hanstholm were pointed out as being the major harbours of *Pandalus* trawlers in 2004 and 2005, Skagen being the home harbour of 6-7 vessels of approximately 100-200 GRT and Hirtshals and Hanstholm each having 2-3 somewhat larger *Pandalus* trawlers of between 200 and 300 GRT. The major landing harbours were the same.

Fishing Gear

The largest net manufacturer in Denmark (Cosmos Trawls) provides shrimp trawls to many of the Danish vessels. At present the two most common trawls are the "Sputnik" (or "Skagerrak") trawl and the "Fladen shrimp" trawl

differing mostly with respect to the height of their trawl opening. The Sputnik trawl has almost twice the height as that of the Fladen shrimp trawl but only a slightly larger width. The two trawls are chosen by turn depending on fishing area and time. The mesh size in the cod ends is almost exclusively 40 mm whole-mesh with a 70 mm square mesh window in the top panel.

Of particular interest is the information from this net manufactory that within the last 5-10 years almost all trawlers have been equipped with twin trawls. This change has allowed the individual vessels to increase the swept area (wing end to wing end) with approximately 50% without increased demands to the vessel's engine capacity and without any noticeably increase in fuel consumption.

The influence of twin trawls on fishing effort

The official Danish log book record do not provide any information on single/twin trawl riggings, but based on the information in the section above a preliminary simple model for the development of true effort is suggested based on the following assumptions for the introduction of twin trawls in the Danish *Pandalus* fleet:

- a simple linear introduction pattern over a 10 year period starting in 1994
- a final (2003) introduction among the *Pandalus* trawlers of app. 72% (10/14)
- a 100% application to *Pandalus* fishing operations after purchase
- a resulting 50% increase in swept area and catch rates

Standardisation of effort (and subsequently LPUE) is carried out by the following conversion:

$$Effort_{standardised}(t) = Effort_{nominal}(t) + (0.5 * Effort_{nominal}(t) * I_{factor}(t))$$

where the introduction factor (I_{factor}) = 1/14, 2/14, …..10/14, for t = 1994 to 2003

The resulting values for the standardised LPUEs are shown in Fig. 2 (Sect. 1.2.3) together with the trends for the unadjusted Danish, Swedish and Norwegian LPUEs, and the standardised Norwegian LPUEs. For assessment purposes the estimated total international LPUE is adjusted accordingly (Sect. 1.2.3).

1.1.2. **The Norwegian *Pandalus* Fishery** (SCR Doc. 06/62)

1.1.3. **The Swedish *Pandalus* Fishery**

In 2005, a total of about 70 trawlers reported landings of *Pandalus* in the Swedish log books. Of these, app. 50 landed more than 10 t *Pandalus* and can be considered specialised in this fishery.

The size of the vessels ranges between 11-34 m with an average of 21 m. GRT varies from 18 to 235, with an average of 103 GRT. The average engine effect is around 355 kW (92 kW-720 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 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.

This particular *Pandalus* trawl with grid can be distinguished from other shrimp trawls in the log books since 1997. The effort of this gear has shown an increasing trend and, in 2005, constituted 24% (17 khrs) of total Swedish *Pandalus* effort (68 khrs). In Sweden the use of twin trawls in the *Pandalus* fishery is not yet common. In 2004, for instance, twin trawls accounted for only 4% of the Swedish *Pandalus* landings. Swedish *Pandalus* landings (1990-2005) by trawl gear are given in Fig. 3.

There are two different Swedish markets for *Pandalus*, resulting in two different kinds of landings: a) higher value, larger sized shrimp sorted by a 10.5 mm sieve and boiled onboard before landed, and b) lower value smaller sized shrimp, sorted by 8.5 mm sieve, landed fresh and sold to the industry for further processing. Since the shrimp lose weight when boiled, these landings must be raised by a factor of 1.13 to obtain fresh weight for the landings statistics, see Sect. 1.2.1. Landings consist of app. equal proportions of boiled and fresh shrimp.

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* to increase the proportion of the more valuable boiled shrimp in the individual landings ration. The discard due to high grading of small *Pandalus* was in 2005 estimated to around 1500 t based on comparison of the length compositions in the Swedish and Danish landings (c.f. Table 2).

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 2005 decreased with app. 10% compared to 2004. Landings decreased in all three countries. In Sub-area IV total landings have decreased the last two years due to a drastic decrease in the Danish Fladen Ground fishery. The combined total landings from IIIa and IV were app. 11% lower in 2005 than in 2004.

Table 2 presents the landings and estimated Swedish high-grading for the assessment unit Skagerrak and the Norwegian Deep, i.e. Div. IIIa and the eastern part of Div. IVa. The landings in 2005 were around 13 700 t, a decrease of around 1 600 t compared to landings in 2004.

Landings from Norway and Sweden (and to a very small extent from Denmark) consist of a fraction of larger shrimp that are boiled on board and a remaining portion of smaller shrimp landed fresh. Official landings and log book data from Norway and Sweden give landed weight as a mixture of raw and boiled shrimp, but these can be separated in Swedish sale slip data. The Swedish landings figures (Table 2) have been adjusted with the conversion factor of 1.13 to obtain fresh weight for the years where sufficient information is available. The amount added for the last eight years has ranged between 100 and 200 t. The Working Group has not corrected the Norwegian landings due to lack of information on the proportion of raw and boiled shrimp landed. However, for 2005 such data are available and indicate an underestimate of 440 t. The Norwegian 2005 landings (Table 2) have not been corrected, but more detailed landings data (including mode of conservation) just received from the Norwegian Fisheries Directorate will be used to adjust landings figures for 2000-2006 in next year's assessment.

1.2.2. **Discards**

Discard of shrimp may take place in two ways: 1) as discard of small (<15 mm CL), not marketable shrimp since the processing plants do not accept them, and 2) as a result of high-grading, i.e. discard of medium sized, less valuable shrimp to improve the economic return of quotas.

In Sweden, quota restrictions and the substantial price difference between large, boiled shrimp and medium sized fresh ones together with a voluntary system of weekly rations (different for medium and large shrimp) have resulted in high grading at sea by discarding the medium sized ones.

The amount of discards in this category in the Swedish fisheries was estimated to around 1 500 t in 2005 based on comparison of length distributions in Swedish and Danish landings. The estimation is shown in Fig. 4a and 4b. The annual Danish length distribution is scaled to fit the yearly Swedish length distribution (Fig. 4.a) for the larger *Pandalus* sizes based on the assumption that there is no discarding of the valuable larger size groups (right hand side of the curve), and that the fisheries are conducted on the same *Pandalus* grounds. The higher numbers in the Danish smaller size groups are then multiplied with the mean weight of each size group, and the sum is considered as the weight of the Swedish discarding due to high grading (Fig. 4.b). Estimations based on such Swedish high grading are shown for the last four years in Table 2.

A Swedish onboard discard sampling project has been carried out for a few *Pandalus* trips during 2004 and 2005 and shows even higher estimates of discards (>2 500 t) but these are considered to be based on too few samples to be included in assessments.

The difference between the Swedish trend in LPUE in recent years compared to the Danish and Norwegian trends (Fig. 2) might be explained by the Swedish high grading, which does not occur in the Danish and Norwegian fisheries.

1.2.3. **Effort and LPUE**

Annual national figures for effort and landings per unit of effort (LPUE) are shown in Table 3 and Fig. 2. As Norwegian vessels <11 m are not required to deliver log books, total Norwegian effort have been estimated from total official landings and LPUE data from log book records. The Danish and Norwegian LPUE have shown an increasing trend from 2001 to 2004, but decreased in 2005. The Swedish LPUE remained at the same level from 2002 to 2004, possibly due to the discarding practices described above, but similar to the other two LPUE indices also shows a slight decrease in 2005.

The effect of technological creeping in the Danish *Pandalus* fishery (Sect.1.1.1) on Danish LPUE figures has been considered, and 'adjusted' LPUE indices are shown in Fig. 2. The Swedish shrimp trawls are still mainly single trawls. The quantitative information on the development of the Norwegian shrimp gear in Div. IIIa and IVa east is incomplete and can not be used for standardising the Norwegian LPUE. The Norwegian LPUE indices have, however, been standardised according to area, month and vessel for the years 2000-2006. At present the resolution of the Danish log book data as well as lack of data on technological development of gear, prevents GLM standardisation.

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 = 1 000 hours), see Table 3. The missing Norwegian data from 1984-85 were estimated by functional regression Norway-Sweden and the factor 1.12 applied. The estimated time series of total international effort (Khrs) and LPUE (Kg/hr) are shown in Table 4 and Fig. 5. As the Swedish LPUE may be underestimated due to highgrading (cf. Sect. 1.2.2) the converted Danish effort may also be slightly underestimated and the corresponding LPUEs overestimated.

1.3. **Biological Sampling of Landings**

1.3.1. **Sampling Frequency, 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 5. The overall sampling level 2005 was around 9 kg per 1 000 t landed or 1 700 specimens. Variations in the intensity between countries and seasons indicate that improvements could be made.

1.3.2. **Landings in Numbers-at-age**

The length data are pooled by quarter, and these national quarterly length distributions have then been partitioned into age compositions by the Bhattacharya method (software: FISAT). As in previous years the mean lengths by age group are used as a check of the consistency of the estimates. Due to lack of Norwegian length data for 2003 and 2004, the Norwegian total landings for those years were age distributed according to the combined Danish and Swedish age data.

Table 6 gives the "catch-at-age" data. Catches are dominated by shrimp of ages 1 and 2. The numbers of age 3 and older are likely to be underestimates, due to the way the Bhattacharya method operates. In general, the WG doubts the reliability of separation of the older age groups, i.e. those > = age 3.

1.3.3. **Mean Weights-at-age**

Weights-at-age for the Danish 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. The corresponding Norwegian and Swedish weights-at-age figures are based on quarterly length-weight relationships obtained from the Swedish length samples in which all shrimp are weighted individually. The mean weights-at-age in the catch is given in Table 7. In some years there were no recorded 0-group shrimp in the catches, then averages for the other years were used. The same procedure was applied for the +group (+gp) in 2005.

1.4. **Trawl Survey Data** (SCR Doc. 06/82)

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

1.5.1. **State of Stock in 2006 and 2007**

This year's assessment of the current state of stock is based on evaluation of LPUE from the fishery 1984-2006 and can be found in the 2006 WG report.

1.5.2. **Biological Reference Points**

The view of the WG 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 (ACFM, 1998) pointed out that there was not 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, predation accounts for at least twice as much removal from the *Pandalus* stock compared to fishery removals from1985-2002. 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.

Following the current NAFO definition (SCS Doc. 04/12), 30% B_{msy} could be used as a limit reference point (B_{lim}).

2. **The By-catch in the *Pandalus* Fisheries in the Subarea IV and Division IIIa**

In recent years there has been increasing focus on (mixed) fisheries with by-catches of species from stocks 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. The WGPAND has since the 1980s regularly compiled and presented relevant information on by-catch in the WG reports.

Tables 8 A - G give for the recent 3 years the available Danish, Norwegian and Swedish data on by-catch of the main species in the *Pandalus* fisheries landed for h.c. In the some years quantities of Norway pout and Blue whiting have also been recorded. For all 3 countries 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.

Tables 8 A - G also give cod percentage of *Pandalus* landings. It is believed that this is a better estimator than % of total catch, since log-book recordings probably not always are consistent in recordings of e.g. Norway pout and/or Blue whiting. Note 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. Note that trawls equipped with a selective grid, judging from the logbook records of landings by this gear type, seem to be very efficient in reducing by-catch, see Table 8 C.

3. **A Short Note on the *Pandalus* Stocks on Fladen Ground (Division IVa) and Farn Deep (Division IVb)**

3.1. **The Development in the Fishery for *Pandalus* on Fladen Ground**

This stock was not included in the terms of reference received by the WG from ACFM. However, a short description of the fishery is given, as a shrimp fishery may be conducted in this area in the future. The landings from the Fladen Ground are recorded since 1972. Since 1991 total landings have fluctuated between none in 2006 to more than 5 000 t (Table 9). The Danish fleet accounts 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 10 shows the effort and LPUE.

Since 1999 total Fladen landings have declined continuously, and since 2004 the Fladen Ground fishery was 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 may reflect a decline in the stock.

3.2. 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 (ICES, 2005).

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		378	5080
2001	1186	2959	1958	6103	2030	3952	154		465	6601
2002	1967	3709	2044	7720	1647	3622	143		70	5482
2003	2612	3736	2098	8446	1631	3979	144			5754
2004	3044	4638	2152	9834	884	4364	147	0	0	5391
2005	2485	4419	1996	8900	477	4087	148	0	0	4712

* Includes small amounts of other Pandalid shrimp

** 1970 to 1974 includes subarea IV.

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

2005 figures are preliminary.

Table 2. ***Pandalus*** **landings from divisions IIIa (Skagerrak) and IVa (eastern part) as estimated by the Working Group.*)**

Year	Denmark	Norway	Sweden	Total landings	Estimated Sw high-grading	Agreed TAC	Catch
1970	1102	1729	2742	5573			
1971	1190	2486	2906	6582			
1972	1017	2477	2524	6018			
1973	755	2333	2130	5218			
1974	530	1809	2003	4342			
1975	817	2339	2003	5159			
1976	1204	3348	2529	7081			
1977	1120	3004	2019	6143			
1978	1459	2440	1609	5508			
1979	1062	3040	1787	5889			
1980	1678	4562	2159	8399			
1981	2593	5183	2241	10017			
1982	3766	5042	1450	10258			
1983	1567	5361	1136	8064			
1984	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	6118	2225	10714		13000	
2001	1953	6895	2108	10956		14500	
2002	2466	7318	2301	12085	908	14500	12993
2003	3244	7715	2389	13348	868	14500	14216
2004	3905	8998	2464	15367	1797	15690	16151
2005	2952	8507	2257	13716	1483	15600	15199

*) Swedish landings have been corrected for loss in weight due to boiling.

Table 3. National LPUE and total effort. ***Pandalus*** **division IIIa and IVa east**

Year	Denmark		Denmark (Effort converted to hours)		Norway		Sweden	
	LPUE kg/day	effort days	LPUE kg/hr	effort Khrs	LPUE kg/hr	effort Khrs	LPUE kg/hr	effort Khrs
1984	452	3869	21.3	84.6	no data	0	25	40
1985	743	6053	34.0	132.4	no data	0	32	49
1986	556	8700	25.6	190.3	36	179	30	49
1987	499	9212	22.3	201.5	36	230	23	57
1988	432	7104	20.9	155.4	31	251	22	57
1989	441	7143	20.7	156.2	23	273	23	63
1990	591	4195	27.0	91.8	26	232	26	58
1991	645	5555	29.5	121.5	30	206	31	61
1992	641	5811	29.3	127.1	35	204	27	80
1993	571	5068	26.3	110.9	31	243	25	91
1994	677	3146	31.0	68.8	31	218	33	82
1995	801	3072	36.6	67.2	35	255	39	76
1996	860	4466	39.6	97.7	37	214	32	74
1997	1034	3770	47.4	82.5	42	212	33	78
1998	1023	3256	46.8	71.2	44	219	34	73
1999	833	2501	37.9	54.7	32	219	34	72
2000	870	2713	40.0	59.3	31	195	30	75
2001	840	2314	38.6	50.6	32	217	29	74
2002	1069	2306	48.9	50.4	39	186	35	65
2003	1073	3013	49.2	65.9	46	166	33	72
2004	1393	2788	64.0	61.0	57	159	33	74
2005	1135	2604	51.8	57.0	49	172	30	68

Table 4. Total international LPUE and effort in IIIa & IVa east as estimated by the Working Group

Year	LPUE kg/hr	effort Khrs
1984	22.5	339
1985	33.4	380
1986	34.7	369
1987	32.8	432
1988	30.0	406
1989	25.8	429
1990	31.5	324
1991	35.4	328
1992	39.3	331
1993	35.6	354
1994	40.3	287
1995	41.7	322
1996	45.3	312
1997	51.2	294
1998	53.1	290
1999	41.1	274
2000	42.1	254
2001	40.9	268
2002	51.1	236
2003	57.6	232
2004	69.9	220
2005	59.9	229

Table 5. Sampling of Pandalus in IVaE and IIIa 2005

Denmark		N:o		Numbers
Quarter	Landing (ton)	samples	Weight (kg)	measured-sexed
1	852	5	6.1	1502
2	788	6	7.5	1737
3	711	3	4.5	1005
4	601	4	5.6	1169
Total	2952	18	23.6	5413

Norway		N:o		Numbers
Quarter	Landing (ton)	samples	Weight (kg)	measured-sexed
1	2392	8	13.5	2480
2	2355	4	6.6	1213
3	2332	0	0.0	0
4	1427	3	4.7	1087
Total	8506	15	24.8	4780

Sweden		N:o		Numbers
Quarter	Landing (ton)	samples	Weight (kg)	measured-sexed
1	479	7	24	3648
2	629	7	20	3560
3	521	4	14	2167
4	628	7	22	3674
Total	2257	25	79.6	13049

Total		N:o		Numbers	Sampling per 1000 ton landed	
Quarter	Landing (ton)	samples	Weight (kg)	measured-sexed	Weight	Numbers
1	3723	20	43.5	7630	11.7	2049.2
2	3772	17	34.3	6510	9.1	1725.9
3	3564	7	18.1	3172	5.1	890.0
4	2656	14	32.2	5930	12.1	2232.7
Total	13715	58.0	128.0	23242	9.3	1694.6

Table 6. Catch in numbers at age. *Pandalus* in division IIIa and IVa east.

Numbers*10**-6

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
AGE											
0	17.7	7.4	2.7	14.1	31.3	0.0	3.9	25.5	27.2	0.7	2.7
1	1200.8	1146.4	1260.5	1086.6	2083.6	2250.1	1231.8	1071.4	1889.6	671.9	646
2	1305.4	1029.7	1205.6	923.9	385.5	910.8	1035.8	1289.2	803.8	1380.4	970.5
3	187.9	482.7	390.2	300.2	173.8	121.1	326.7	569.1	262.7	143.0	851.5
+gp	52.3	25.1	203.2	146.7	13.6	31.3	25.6	57.5	15.5	30.5	41.9
TOTALNUM	**2764.1**	**2691.3**	**3062.1**	**2471.5**	**2687.9**	**3313.3**	**2623.8**	**3012.7**	**2998.7**	**2226.4**	2512.5
TONSLAND	**13273**	**13233**	**14876**	**12929**	**12193**	**11421**	**12107**	**13556**	**13475**	**11761**	**13713**
SOPCOF%	89	97	105	102	106	88	97	88	93	95	87

YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
AGE										
0	61.1	19.7	12.7	4.6	88.1	0.0	3.9	2.4	5.7	13.6
1	1211.6	2175.6	903.4	1436.1	1270.7	1308.0	922.3	668.7	1062.9	795.0
2	991.4	1181.9	1597.9	720.1	836.3	826.2	858.4	1466.5	1251.4	1148.7
3	454.6	295.6	468.1	318.3	199.3	382.5	581.8	283.8	477.6	416.3
+gp	69.5	29.8	48.2	43.3	39.2	80.8	101.8	0.0	50.4	0.0
TOTALNUM	**2788.2**	**3702.6**	**3030.2**	**2522.4**	**2433.5**	**2597.5**	**2468.3**	**2421.4**	**2847.9**	**2373.7**
TONSLAND	**14436**	**16110**	**15753**	**11895**	**11401**	**11657**	**12339**	**13338**	**15815**	**13715**
SOPCOF%	99	84	90	99	97	81	88	99	104	109

Table 7. Mean weight at age in catches. *Pandalus* division IIIa and IVa east.

Catch weights at age (kg)

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
AGE											
0	0.0009	0.0012	0.0009	0.0009	0.0011	0.0009	0.0015	0.0010	0.0009	0.0009	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
2	0.0064	0.0054	0.0048	0.0054	0.0065	0.0053	0.0053	0.0052	0.0067	0.0060	0.0057
3	0.0104	0.0083	0.0077	0.0090	0.0099	0.0083	0.0079	0.0078	0.0088	0.0093	0.0089
+gp	0.0134	0.0140	0.0114	0.0117	0.0133	0.0106	0.0122	0.0095	0.0109	0.0117	0.0116

YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
AGE										
0	0.0007	0.0009	0.0007	0.0007	0.0007	0.0006	0.0008	0.0014	0.0017	0.0014
1	0.0037	0.0031	0.0033	0.0033	0.0032	0.0031	0.0036	0.0035	0.0037	0.0038
2	0.0067	0.0061	0.0055	0.0063	0.0063	0.0056	0.0054	0.0060	0.0061	0.0059
3	0.0094	0.0094	0.0087	0.0088	0.0103	0.0086	0.0083	0.0082	0.0077	0.0092
+gp	0.0138	0.0119	0.0133	0.0112	0.0139	0.0117	0.0113	0.0121	0.0107	0.0113

Table 8. By-catch, 2003-2005 in the Pandalus fisheries in the North Sea & Skagerrak

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

Species:	2003 Total	2003 % of total catch	2004 Total	2004 % of total catch	2005 Total	2005 % of total catch
Blue Whiting	0.0	0.0	0.0	0.0	50.0	1.6
Norway lobster	31.8	1.0	13.9	0.4	13.4	0.4
Pandalus	2612.1	83.0	3044.3	84.7	2516.8	80.8
Angler fish	6.7	0.2	7.3	0.2	7.3	0.2
Whiting	1.1	0.0	0.2	0.0	0.2	0.0
Haddock	81.0	2.6	36.7	1.0	13.2	0.4
Hake	5.0	0.2	4.0	0.1	5.9	0.2
Ling	1.0	0.0	1.2	0.0	1.0	0.0
Saithe	214.3	6.8	263.2	7.3	278.6	8.9
Witch flounder	43.6	1.4	50.1	1.4	56.9	1.8
Norway pout	0.0	0.0	0.0	0.0	0.0	0.0
Cod	89.1	2.8	113.2	3.1	118.7	3.8
Other market fish	62.2	2.0	61.3	1.7	52.2	1.7
Cod as % of shrimp:		3.4		3.7		4.7

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

Species:	2003 Total	2003 % of total catch	2004 Total	2004 % of total catch	2005 Total	2005 % of total catch
Blue Whiting	16.0	0.8	14.6	0.7	0.1	0.0
Norway lobster	10.1	0.5	5.9	0.3	7.7	0.4
Pandalus	1769.8	85.9	1754.4	80.0	1478.8	81.2
Angler fish	2.6	0.1	2.6	0.1	5.4	0.3
Whiting	3.5	0.2	2.8	0.1	3.7	0.2
Haddock	18.4	0.9	13.8	0.6	10.3	0.6
Hake	1.6	0.1	4.8	0.2	4.9	0.3
Ling	1.2	0.1	1.9	0.1	3.2	0.2
Saithe	144.5	7.0	270.5	12.3	167.4	9.2
Witch flounder	39.8	1.9	51.1	2.3	44.4	2.4
Norway pout	0.0	0.0	0.0	0.0	0.0	0.0
Cod	34.5	1.7	44.7	2.0	83.0	4.6
Other market fish	17.4	0.9	25.4	1.2	11.4	0.6
Cod as % of shrimp:		3.2		1.9		5.6

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

Species:	2003 Total	2003 % of total catch	2004 Total	2004 % of total catch	2005 Total	2005 % of total catch
Blue Whiting	0.0	0.0	0.0	0.0	0.0	0.0
Norway lobster	0.4	0.2	0.9	0.3	1.4	0.3
Pandalus	232.7	98.5	274.3	98.3	417.5	98.9
Angler fish	0.0	0.0	0.0	0.0	0.0	0.0
Whiting	0.1	0.0	0.0	0.0	0.0	0.0
Haddock	0.4	0.2	0.2	0.1	0.1	0.0
Hake	0.0	0.0	0.0	0.0	0.0	0.0
Ling	0.0	0.0	0.0	0.0	0.0	0.0
Saithe	2.0	0.8	2.5	0.9	1.3	0.3
Witch flounder	0.2	0.1	0.3	0.1	0.2	0.0
Norway pout	0.0	0.0	0.0	0.0	0.0	0.0
Cod	0.2	0.1	0.8	0.3	1.7	0.4
Other market fish	0.2	0.1	0.0	0.0	0.0	0.0
Cod as % of shrimp:		0.0		0.1		0.4

D:
Skagerrak, Sub-div. IIIA. Norwegian logbook records

Species:	2003* Total	2003* % of total catch	2004 Total	2004 % of total catch	2005 Total	2005 % of total catch
Blue Whiting	0.0	0.0	0.0	0.0	0.0	0.0
Norway lobster	28.0	0.7	20.6	0.4	23.9	0.5
Pandalus	3700.0	86.3	4638.0	87.8	4419.1	88.7
Angler fish	26.0	0.6	22.1	0.4	26.0	0.5
Whiting	14.0	0.3	11.2	0.2	6.6	0.1
Haddock	0.0	0.0	66.6	1.3	39.7	0.8
Hake	6.0	0.1	9.2	0.2	9.6	0.2
Ling	28.0	0.7	28.9	0.5	29.2	0.6
Saithe	58.0	1.4	64.8	1.2	74.5	1.5
Witch flounder	34.0	0.8	33.0	0.6	25.8	0.5
Norway pout	0.0	0.0	0.0	0.0	0.0	0.0
Cod	184.0	4.3	260.9	4.9	238.2	4.8
Other market fish	208.0	4.9	128.1	2.4	88.2	1.8
Cod as % of shrimp:		5.0		5.0		5.0

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

Species:	2003 Total	2003 % of total catch	2004 Total	2004 % of total catch	2005 Total	2005 % of total catch
Blue Whiting	0.4	0.0	0.1	0.0	45.0	6.3
Norway lobster	9.5	1.2	28.7	2.5	5.7	0.8
Pandalus	631.7	81.5	860.4	75.1	455.9	64.0
Angler fish	14.6	1.9	42.2	3.7	16.4	2.3
Whiting	1.8	0.2	2.2	0.2	0.6	0.1
Haddock	7.1	0.9	6.4	0.6	2.8	0.4
Hake	2.6	0.3	2.6	0.2	5.2	0.7
Ling	4.4	0.6	7.7	0.7	7.1	1.0
Saithe	59.6	7.7	137.7	12.0	133.5	18.7
Witch flounder	2.8	0.4	5.3	0.5	2.0	0.3
Norway pout	1.7	0.2	0.2	0.0	0.0	0.0
Cod	29.1	3.8	42.3	3.7	28.6	4.0
Other market fish	9.5	1.2	10.1	0.9	9.4	1.3
Cod as % of shrimp:		4.6		4.9		6.3

F:
Norwegian Deeps, Sub-div. IVA East Norwegian logbook records

Species:	2003* Total	2003* % of total catch	2004 Total	2004 % of total catch	2005 Total	2005 % of total catch
Blue Whiting	0.0	0.0	0.0	0.0	0.0	0.0
Norway lobster	15.0	0.3	12.8	0.3	12.0	0.3
Pandalus	3927.0	85.6	4360.5	85.6	4087.5	87.1
Angler fish	135.0	2.9	152.5	3.0	117.7	2.5
Whiting	11.0	0.2	4.4	0.1	2.3	0.0
Haddock	0.0	0.0	47.6	0.9	42.2	0.9
Hake	13.0	0.3	24.9	0.5	19.5	0.4
Ling	34.0	0.7	40.7	0.8	35.6	0.8
Saithe	164.0	3.6	237.9	4.7	193.6	4.1
Witch flounder	5.0	0.1	4.3	0.1	2.8	0.1
Norway pout	0.0	0.0	0.0	0.0	0.0	0.0
Cod	125.0	2.7	144.3	2.8	126.5	2.7
Other market fish	158.0	3.4	63.5	1.2	52.7	1.1
Cod as % of shrimp:		3.2		3.3		3.1

G:
Fladen Ground, Sub_div. IVA. Danish log book records

Species:	2003 Total	2003 % of total catch	2004 Total	2004 % of total catch	2005 Total	2005 % of total catch
Blue Whiting	0.0	0.0	0.0	0.0		
Norway lobster	21.7	1.9	0.9	3.1		
Pandalus	999.1	85.6	23.3	77.0		
Angler fish	19.8	1.7	1.5	5.0		
Whiting	0.6	0.0	0.0	0.0		
Haddock	28.4	2.4	0.4	1.2		
Hake	0.1	0.0	0.0	0.0		
Ling	0.2	0.0	0.0	0.0		
Saithe	42.9	3.7	4.3	14.2		
Witch flounder	1.7	0.1	0.0	0.0		
Norway pout	0.0	0.0	0.0	0.0		
Cod	47.4	4.1	2.5	8.2		
Other market fish	5.7	0.5	0.5	1.6		
Cod as % of shrimp:		4.7		10.6		

Table 9 **Landings in tonnes of *Pandalus* from the Fladen Ground (Division IVa) 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		1008
2004	23	0	0	0	23
2005	10	0	0	0	10

Table 10 ***Pandalus*, Fladen Ground. Reported LPUE (shrimp trawlers), and estimated total effort.**

Year	Recorded LPUE (ton./day)	Denmark Total effort (Days)	effort Index	UK (Scotland) LPUE (kg/hour)	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	-	-	-	-	-	-

*) average weighted by total landings

**) No directed shrimp fishery

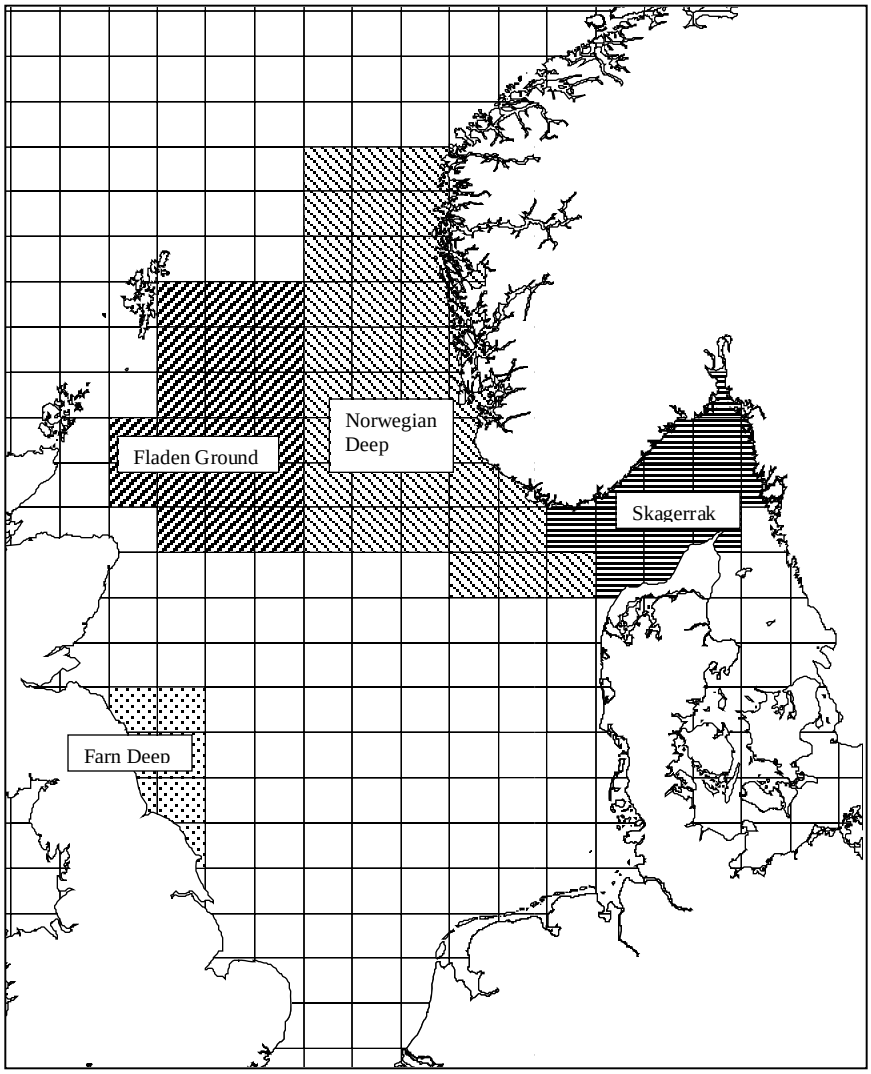

Fig. 1. The distribution of the *Pandalus* stocks in the North Sea area as defined by the ICES squares.

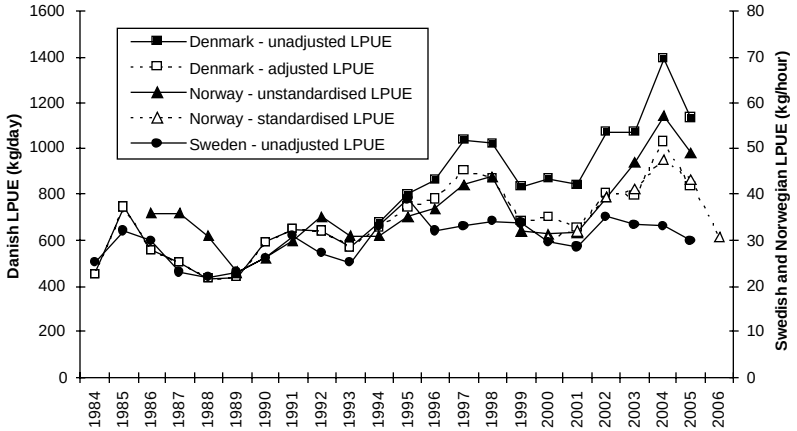

Fig. 2. Comparison of Danish, Norwegian and Swedish LPUEs, see text.

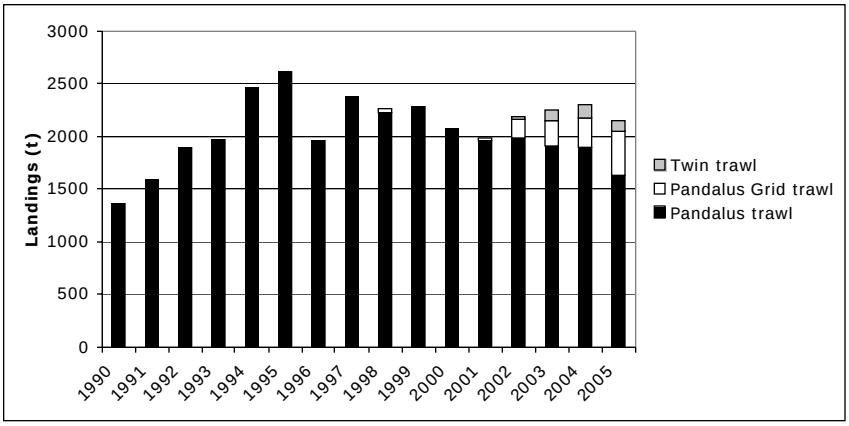

Fig. 3. Swedish *Pandalus* logbook landings per trawl type 1990-2005.

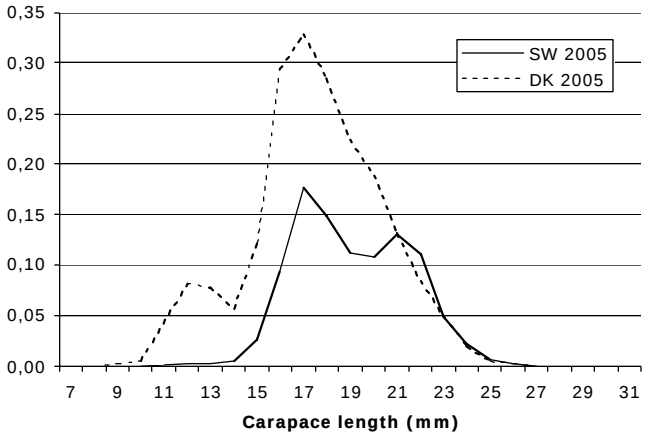

Fig. 4a. Swedish length frequency distribution for 2005 and corresponding Danish length frequency distribution (dotted line) adjusted to Swedish CL >21 mm.

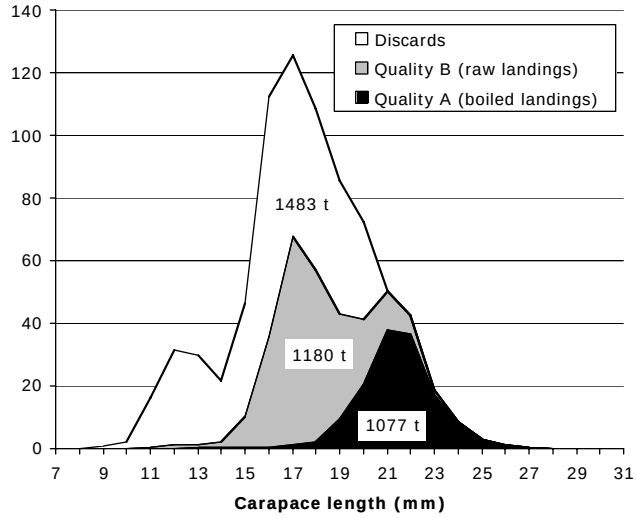

Fig. 4b. Size distribution of Swedish landings, separated into boiled and raw shrimps, and estimated discards due to high-grading.

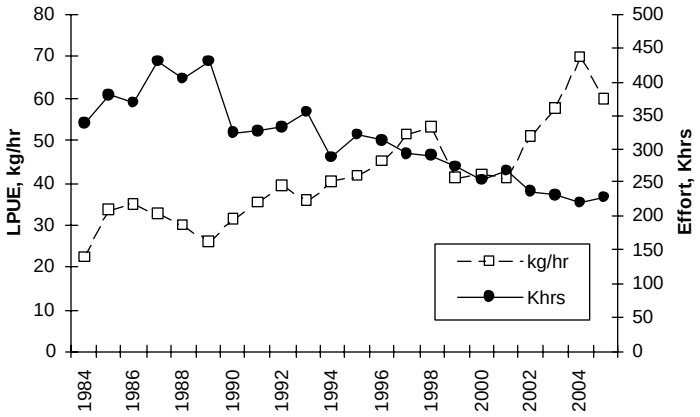

Fig. 5. Total international fishing effort (Khrs) and LPUE (kg/hr) for 1984 to 2005.