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The Norwegian Fishery for Northern Shrimp (*Pandalus borealis*) in the North Sea and Skagerrak (ICES Divisions IVa east and IIIa), 1970-2005

by

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Abstract

The resource of northern shrimp (*Pandalus borealis*) in the North Sea and Skagerrak is assessed as three separate stocks: 1) the North Sea-Skagerrak stock which is largely 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. Vessels from Denmark, Sweden, UK, and Norway exploit this resource. The Norwegian fishery is catch regulated by individual vessel quotas.

Information on the Norwegian shrimp fishery (fleet, regulations, gear, and prizes) was updated.

Norwegian catches have increased recently from 6 000 tons in 2000 to 9 000 tons in 2004, with a small drop to 8 500 tons in 2005. Annual discard of small shrimp may be in the range of 2-16% by weight.

Landings per unit effort (LPUE) increased from 31 to 53 kg/hr in 2000-2004, but decreased to 46 kg/hr in 2005. Standardised LPUE values calculated for 2000-2006 follow the same trend. Change in gear use from single to twin trawl might explain some of the increase in the LPUE, while the recent drop probably reflects a decrease in stock abundance.

The 2005 catch composition was evaluated using samples from shrimp fishers and the coast guard.

Introduction

The resource of northern shrimp (*Pandalus borealis*) in the North Sea and Skagerrak is assessed as three separate stocks (ICES, 2006): 1) the North Sea-Skagerrak stock which is largely 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 this resource. The Norwegian vessels fish the North Sea-Skagerrak stock, with minor catches from Fladen Ground in some years.

Since 1992 Norway and EU have negotiated quotas on shrimp in the North Sea and Skagerrak. In 1998 a general quota regulation system was initiated in the Norwegian shrimp fishery in this area, resulting in admittance regulation for vessels >11 m. Vessels <11 m have free admission to the shrimp fishery, but are subject to the same quota regulations as larger ones. In order to supply the market throughout the year the total Norwegian quota is evenly allocated to three four-month periods with respectively 40%, 30% and 30% of the quota. The vessels have a maximum period-quota and a trip-quota of 4 tons for each trip to sea.

The Norwegian fishery is conducted by multi-purpose fishing vessels mainly trawling south of 60°N. In 2005 a total of 293 vessels participated in the shrimp fishery south of 62°N with respectively 38, 93, 76, 47, 28 and 11 vessels in

the length categories <10 m, 10-10.9 m, 11-14.9 m, 15-20.9 m, 21-27.9 m, and >28 m. During the last ten years the fleet has changed considerably (Fig. 2). The number of trawlers <10 m have decreased, as has the number of vessels 11-20.99 m, while there has been an increase in vessels 10-10.99 m, and a minor increase in vessels >21 m. Small vessels dominate in the eastern Skagerrak, while the fleet in the west is more varied with a predominance of larger vessels. These changes can partly be explained by different condemnation arrangements in 1998-2005 to reduce the capacity of the fleet, resulting in 69 less shrimp permits. However, in several instances fishers have condemned vessels >11 m followed by a reinvestment in new vessels just <11 m, often with larger capacity. Few new large vessels can be explained by the required fishery permits for vessels >11 m. However, vessels with permits can be substituted by larger ones, increasing the capacity of the fleet.

In the Norwegian logbooks for 2005, 29 vessels, all >13 m, have reported shrimp catches. Eight vessels with engines <400 hp reported total catches of 254 tons, 15 vessels (400-699 hp) reported total catches of 818 tons, three vessels (700-999 hp) reported 400 tons, while three vessels (>1 000 hp) reported 396 tons. Vessels <11 m are not required to deliver logbooks. When landing statistics for all vessels are made available by the Fisheries Directorate, the description of the Norwegian fleet will be updated. Most catches are landed in ports along the Norwegian coast, while some are landed in Sweden. Subsequent processing takes place at two factories on the Skagerrak coast and one on the North Sea coast.

Two-, three- and four-bridle shrimp trawls are in use by Norwegian shrimp fishers in the Skagerrak and North Sea, the two-bridle one being used most frequently, also in twin trawls. Twin shrimp trawls are common on larger vessels, and, according to fisheries organizations, have been used by 20-30 trawlers the last five years. This change in gear can, however, not be read from the logbooks (Fig. 3), where only a single vessel in 2003, three vessels in 2004 and four in 2005, account for the majority of records of twin trawl.

In the Norwegian fishery for shrimp in this area the minimum mesh is 35 mm. The following restrictions apply: no fishing in waters shallower than 60 m, no fishing on Sundays and holy days, and, in the inner part of Skagerrak, no trawling within the 4 nm border between 20:00 and 05:00. In the North Sea bycatch of market fish is allowed, but the catch may nevertheless not contain more than 10% (by weight) cod and haddock combined. Furthermore, bycatch of >10% monkfish or >2.5% cod are not allowed. In Skagerrak there is a limitation that up to 50% of the catch by weight may consist of other market species. It is allowed to have up to 10% undersized shrimp (<6 cm total length = 15 mm carapace length (CL)) in the catch. Per 10 kg of shrimps it is not allowed to have more than eight undersized specimens of cod, twenty of haddock and three of redfish. Discarding is prohibited in Norwegian waters. Inclined grids for sorting out smaller fish and shrimp are not compulsory south of 62ºN, but are often used voluntarily. All vessels with a shrimp permit may also trawl for *Nephrops*. Some larger vessels fish mackerel and herring in addition to shrimp, and half of these also conduct industrial fishery (sandeel, blue whiting, Norway pout).

Two categories of shrimp dominate the market: In 2005 app. 40% of the total landings were delivered as boiled, fresh large shrimp (140-150 individuals per kg) for the Norwegian and Swedish market and 60% of the total as raw (smaller) shrimp for factory processing ashore (mostly 180-250 individuals per kg). The export of boiled shrimps to the Swedish market was substantially reduced in 2005 (to app. 1 000 tons) after Swedish assertions about dumping, resulting in smaller export quotas, but also higher prize. In 2005 the fisher got app. 52 NOK/kg for boiled shrimp and app. 10 NOK/kg for raw shrimp, but prices have increased in 2006, especially for boiled shrimp. Some high grading and discarding is assumed to take place. Especially shrimp sized below 15 mm CL are probably all discarded and may account for 5-10% of the catches.

The present paper updates available information derived from landings statistics, logbooks and catch sampling from the Norwegian trawl fishery for shrimp in Skagerrak and the North Sea (ICES Div. IIIa and IVa east).

Materials and Methods

Logbook data were analysed to show the spatial and temporal distribution of the fishery. In 2005 catches from logbooks only made up 32% and 13% of the respective landings in Div. IVa east and Div. IIIa since vessels <11 m are not required to deliver logbook data. Total fishing effort thus had to be estimated by applying catches per hour fished as calculated from logbooks to the nominal landings.

Landings per unit effort (2000-2006) were standardised to remove effects of monthly variations in fishing pattern, geographical variation, and changes in the composition of the fleet (e.g., Hvingel *et al*., 2000). The effect of the recent change in gear use could, however, not be accounted for as recording of twin trawl in logbooks is incomplete.

Until 2001 discards were estimated by assuming that all shrimp <15 mm CL were discarded. Length distributions of unprocessed catches from research surveys in March, June and October/November were used, whilst assuming that the amount of the 1-group was the same in the research trawl and the commercial trawl. For 2002-2005 discards have been estimated as the average of the estimated discard 1985 to 2001. From 2007 and onwards discards will be estimated by the difference in length distributions from unprocessed commercial catches (sampling initiated in 2005) and sorted commercial landings (sampling will be initiated in 2007).

Samples (app. 1.5 kg, 250-400 specimens) for resolving the size distribution of the 2005 catches were obtained from two shrimp fishers (7 samples) and from coast guard inspection of trawlers (8 samples). Samples were taken from the trawl before sorting, sorted by sexual characteristics, and measured to the nearest mm below.

Results

Spatial and Seasonal Distribution of Effort

The Norwegian shrimp fishery is conducted in the Norwegian Deep and Skagerrak in depths of 60 to 500 m. In 2005 most effort was allocated to waters off Egersund (29%) and Lindesnes (10%) (Fig. 4). However, as recorded effort from logbooks only make up a minor portion of the actual effort, the true fishing pattern is probably different, with more effort allocated to Div. IIIa. The fishery took place in all months (Fig. 5), but was most intense from March to July. Fishing effort thereafter declined throughout autumn and winter. Maximum and minimum effort was recorded in respectively July and January. Spatial and seasonal variations in the shrimp fishery in 2005 is similar to the pattern in 2004 (Hvingel, 2005a).

Landings

Total Norwegian landings (from Div. IIIa and Subarea IV) increased from 2 000 tons in 1970 to around 8 300 tons in 1987 (Fig. 6, Table 1). In the following years landings fluctuated around 7 500 tons with a maximum in 1998 of 9 611 tons and a minimum in 1990-1991 of about 6 100 tons. Since 2000 overall landings have increased continuously from about 6 000 tons to 9 000 tons in 2004, but dropped to 8 500 tons in 2005. In recent years landings have been equally divided between Skagerrak (Div. IIIa) and the Norwegian Deep (Div. IVa east).

In Skagerrak, the Norwegian landings peaked in 1998 at about 6 500 tons, decreased to 3 000 tons in 2001, increased thereafter to 4 638 tons in 2004, followed by a small drop to 4419 tons in 2005. In the Norwegian Deep landings have fluctuated around 3 000 tons in the 1990s, increased from 2 550 tons in 2000 to 4 360 tons in 2004, followed by a small drop to 4 087 tons in 2005 (Fig. 6, Table 1).

Generally, the Norwegian quota has been large enough, and, during the ten last years, has only been overfished twice (1997 and 2004). The utilization has been good (85-100%) except in 1999 (64%). From 2001 to 2004 reported landings went from 85% to 106% of the set quotas. In 2005 100% of the quota was landed: 8 507 tons from a quota of 8 530 tons. In 2006 the Norwegian quota has increased to 8 961 tons (3 742 and 5 219 tons in respectively the North Sea and Skagerrak).

Discards

Discard of shrimp may take place in two ways: 1) at sea, as a result of high-grading, i.e. discard of medium sized, less valuable shrimp to improve the economic return of quotas, and 2) at shore, as a "quality discard", since the processing plants do not accept shrimp smaller than app. 15 mm CL.

Estimates of discards due to high-grading was estimated for 1996 and 1997 based on separate quarterly length distributions for the categories large and medium sized and the selection ogive for the sieved ones (ICES, 1999). However, already next year the working group considered these estimates too inaccurate to be included in

assessments (ICES, 2000). Later Norwegian estimates of high grading are not available. Estimates of discards at shore varied from 2 to 16% of the catches, i.e., from 200 to 1 000 tons annually (Table 1).

Estimated Effort and Standardised Landings-per-unit-effort (LPUE)

After a relatively stable 1996 to 2001 period with total fishing efforts of around 200 Khrs/year, effort declined to 166 Khrs in 2003, mainly due to a reduction of effort spent in Div. IIIa by almost 50% over that period (Fig. 6b). In 2003 and 2004 an equal amount of about 80 Khrs was allocated to each of the two areas (Table 1). In 2005 total fishing effort has increased due to an increase in Div. IVa east.

Overall LPUE increased from 31 kg/hr in 2000 to 53 kg/hr in 2004 (Fig. 4c), but dropped to 46 kg/hr in 2005. The trend in LPUE the last six years is similar for both areas. Standardised LPUE values have been calculated for 2000-2006 (Fig. 7), and are seen to follow the same trend as the raw data. The time period of increasing LPUE (2000-2004) coincide with the period of increased use of twin trawls (last five years as reported by fisheries organizations), indicating that change in gear use might explain some of the increase.

The drop in overall LPUE from 2004 to 2005, however, probably reflects a decrease in stock abundance, as a decline in use of twin trawls seems unlikely. This is supported by the lower biomass index from the Norwegian research survey in May/June 2005 compared with the previous year's survey (Hvingel, 2005b).

Catch Composition

The length frequency distributions from respectively Div. IIIa and Div. IVa east from quarters 1-2 seem to indicate differences in recruitment between the two areas (Fig. 8 and 9). Comparisons with research survey data from 1988-2003 shows that the 1-group is lacking in Div. IVa east (North Sea), but not in Div. IIIa (Skagerrak). The low recruitment in Div. IVa east is in accordance with the low abundance of the 1-group in the overall length frequency distribution from the Norwegian research survey in May-June 2005 (Hvingel, 2005b).

Samples from both areas show a strong 2002 year-class (3-group) (Fig. 8 and 9). In January-March 45% of the sampled specimens from Div. IIIa (quarter 1) were either berried females or females with hatching eggs.

References

Hvingel, C. 2005a. The Norwegian Fishery for Northern Shrimp (*Pandalus borealis*) in the North Sea and Skagerrak (ICES Divisions IVa east and IIIa), 1970-2004. *NAFO SCR Doc*., No. 80, 7 p.

Hvingel, C. 2005b. Results of the Norwegian Bottom Trawl Survey for Northern Shrimp (*Pandalus borealis*) in Skagerrak and the Norwegian Deep (ICES Divisions IIIa and IVa) in 2004 and 2005. *NAFO SCR Doc*., No. 82, 8 p.

Hvingel, C., H. Lassen, and D. G. Parsons. 2000. A Biomass Index for Northern Shrimp (*Pandalus borealis*) in Davis Strait Based on Multiplicative Modelling of Commercial Catch-per-unit-effort Data (1976-97). *J. Northw. Atl. Fish. Sci*., **26**: 25-36.

ICES. 1999. Report of the *Pandalus* assessment working group, 1-4 September 1998. *ICES C.M. Doc., No.* 1999/ACFM:5, 33 p.

ICES. 2000. Report of the *Pandalus* assessment working group, 23-26 August 1999. *ICES C.M. Doc., No.* 2000/ACFM:2, 30 p.

ICES. 2006. *Pandalus* assessment working group report (WGPAND), 26 October – 3 November 2005. *ICES C.M. Doc., No.* 2006/ACFM:10, 60 p.

Table 1. Nominal landings from Div. IIIa and Subarea IV as well as separate landings from Div. IIIa and Div. IVa east, actual Total Allowable Catch (TAC), estimated discard (discard at sea are not included), Landings per Unit of Effort (LPUE) and number of trawling hours (effort) of the Norwegian shrimp fishery in ICES Div. IIIa and IVa east 1970-2005. Landings, TAC and discards are in tons (t), LPUE is kg per hours trawled and effort is in thousand hours.

	Landings (t)			TAC (t)	Disc. (t)	LPUE (kg/hr)			Effort (Khours)		
Year	Div. IIIa	Div. IVaE	Total	Total	Total	Div. IIIa	Div. IVaE	Total	Div. IIIa	Div. IVaE	Total
1970	982	747	2089								
1971	1392	1094	2657								
1972	1123	1354	2339								
1973	1415	918	2346								
1974	1186	623	1953								
1975	1463	876	2067								
1976	2541	807	3592								
1977	2167	837	3127								
1978	1841	599	2533								
1979	2489	551	3083								
1980	3498	1064	4638								
1981	3753	1430	5188								
1982	3877	1165	5422								
1983	3722	1639	5379								
1984	3509	1274	4783								
1985	4772	1874	6557		460						
1986	4811	1679	6492		338			36			179
1987	5198	3145	8343		634			36			230
1988	3047	4614	7661		645			31			251
1989	3156	3255	6574		920			24			266
1990	3006	3102	6152		990			27			230
1991	3441	2678	6156		376			30			205
1992	4257	2879	7202		414			35			202
1993	4089	3282	7538		695			31			238
1994	4388	2425	6814		157			31			218
1995	5181	2914	8060	8775	212			32			256
1996	5143	2735	7915	8160	253	43	31	37	119	89	213
1997	5460	3105	8572	8160	821	45	39	40	122	80	212
1998	6519	3087	9611	10505	279	45	40	44	144	78	219
1999	3987	2752	6748	10505	486	32	29	31	125	93	219
2000	3556	2562	6118	7110	521	31	32	31	114	81	195
2001	2959	3936	6911	8140	565	30	34	32	100	117	216
2002	3709	3612	7321	8040	*537	36	44	39	104	82	186
2003	3736	3979	7715	8040	*566	46	47	46	82	84	166
2004	4638	4360	9002	8530	*660	54	52	53	86	83	170
2005	4419	4087	8507	8530	*624	52	44	46	85	93	185
2006				8961							

*based on estimated mean discard percentage 1985 to 2001.

"Total" refers to the sum of Div. IIIa and Div. IVa east, except for "total landings" which includes landings from all of Sub-area IV

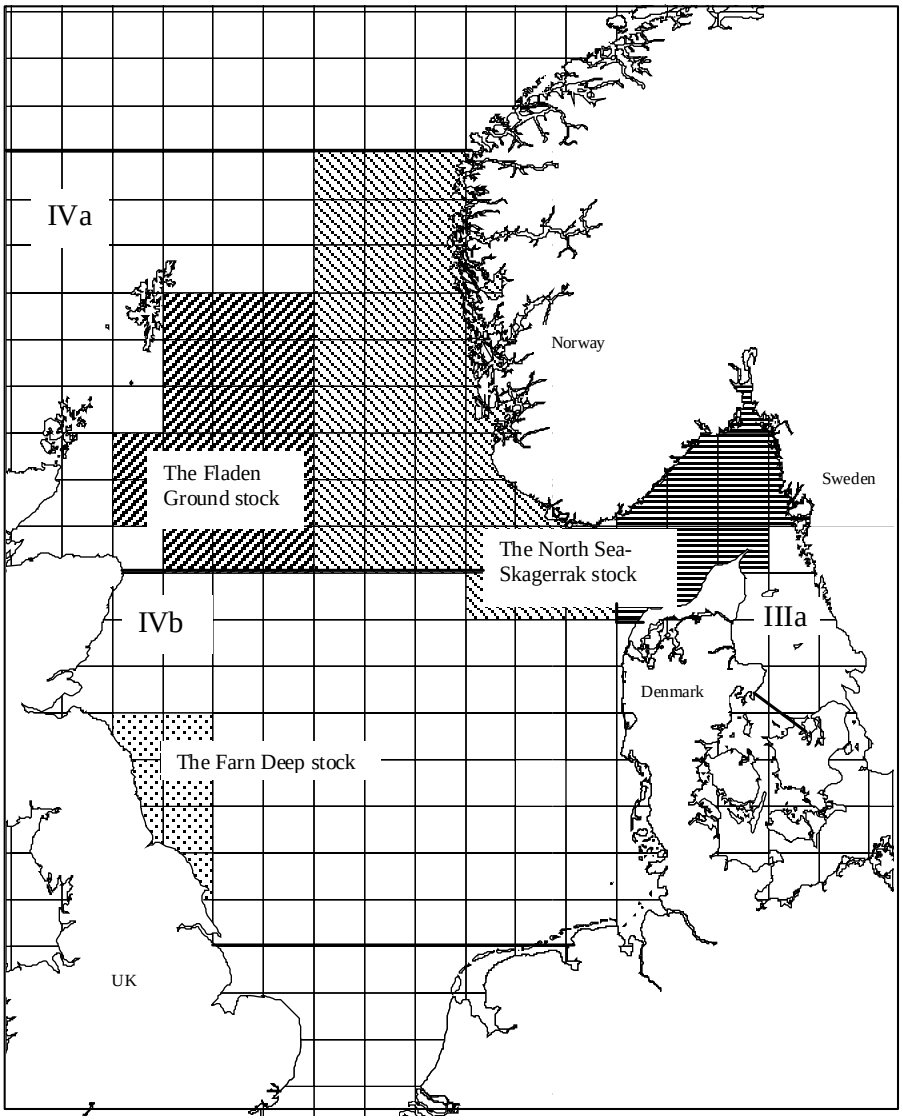

Fig. 1. Distribution of the Northern shrimp (*Pandalus borealis*) in the North Sea and Skagerrak and the defined assessment units. Grid is standard "ICES squares": 0.5^{o} lat. by 1^{o} long. (based on ICES, 2006).

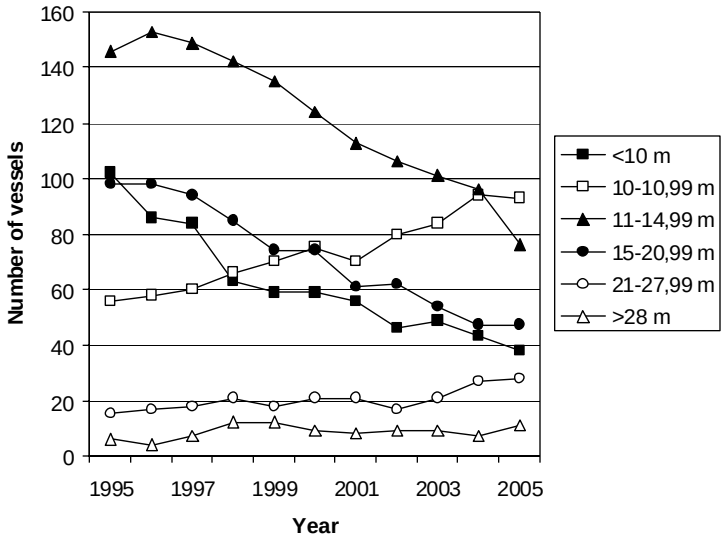

Fig. 2. Development in the Norwegian fleet fishing for shrimp in the North Sea and Skagerrak 1995-2005: number of vessels per length group (m).

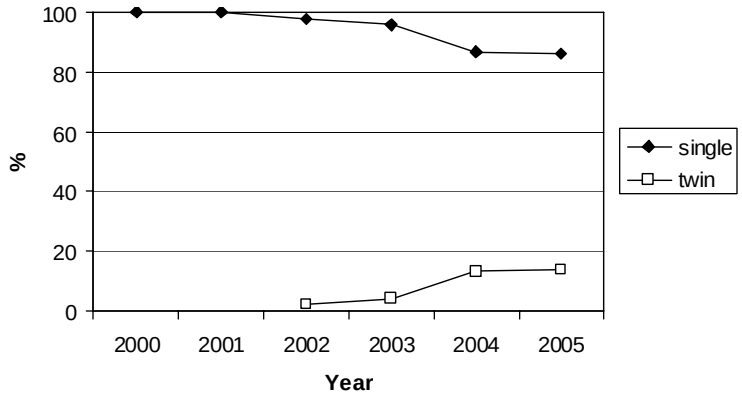

Fig. 3. The use of single and twin trawls (%) in the shrimp fishery in the North Sea and Skagerrak, 2000-2005, from Norwegian logbooks (daily records).

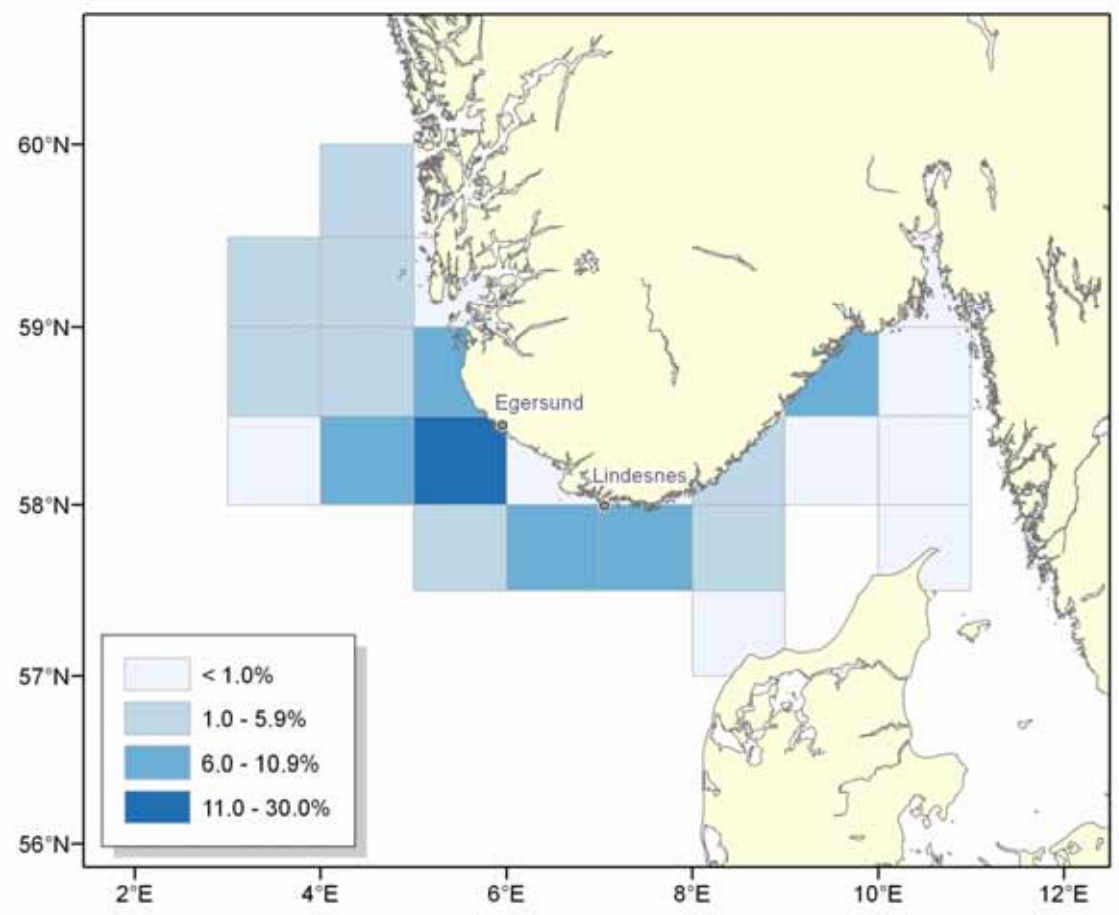

Fig. 4. The percentage distribution of recorded effort (trawling hours) by Norwegian shrimp trawls in 2005 in Skagerrak and the North Sea (ICES Div. IIIa and IVa east) by statistical squares (standard "ICES squares": 0.5° lat. by 1° long.). Effort by twin trawl is not included as "twin trawl" in logbooks is an ambiguous category. (Figure by Kareen Bröker).

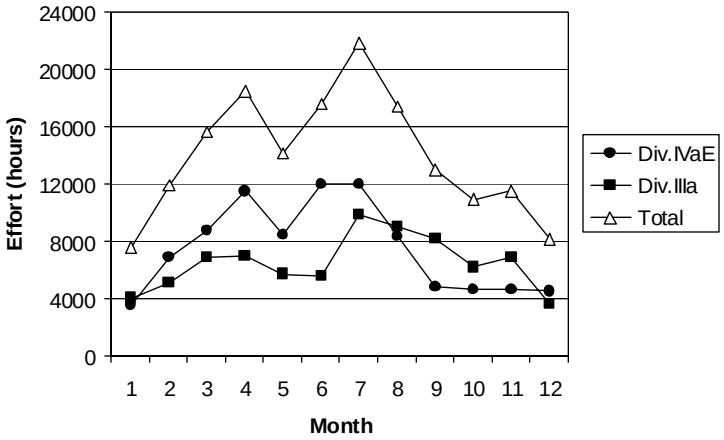

Fig. 5. Monthly distribution of estimated total effort (trawling hours) by the Norwegian shrimp fishery in 2005 in Skagerrak and the North Sea (ICES Div. IIIa and IVa east).

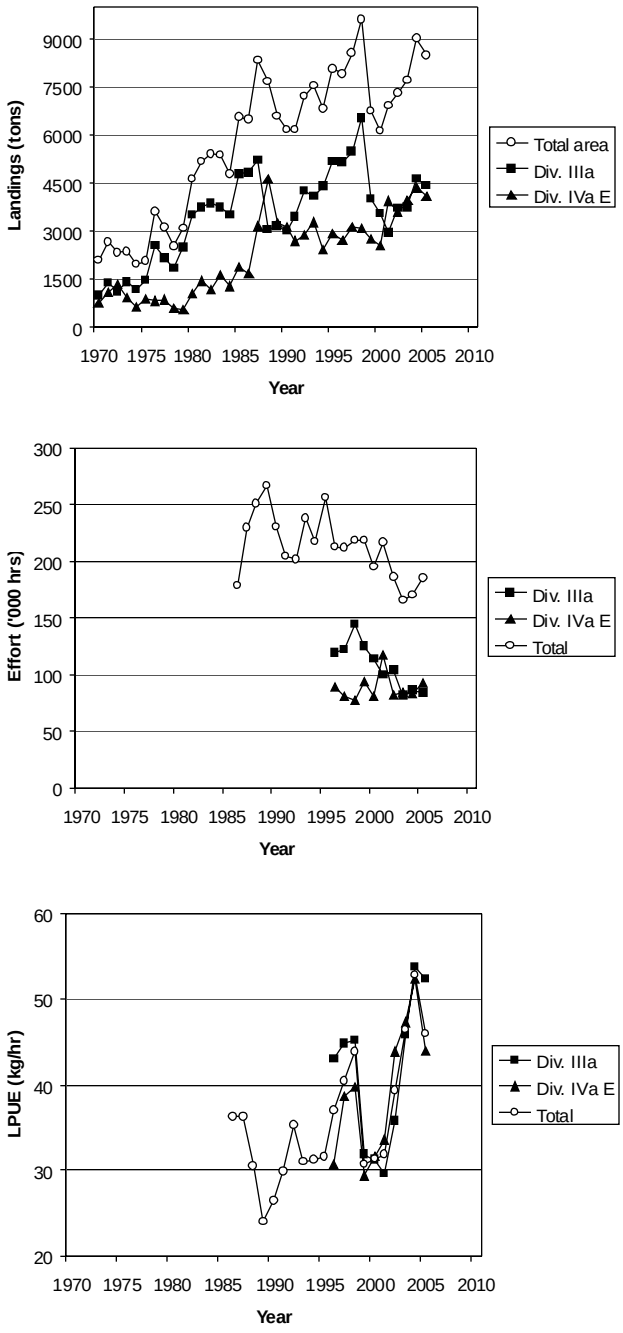

Fig. 6. Landings a), estimated total effort b), and landings-per-unit-effort (LPUE) c) of the Norwegian shrimp fishery in ICES Div. IIIa and IVa east. In a) "total area" include Div. IIIa and all of Subarea IV.

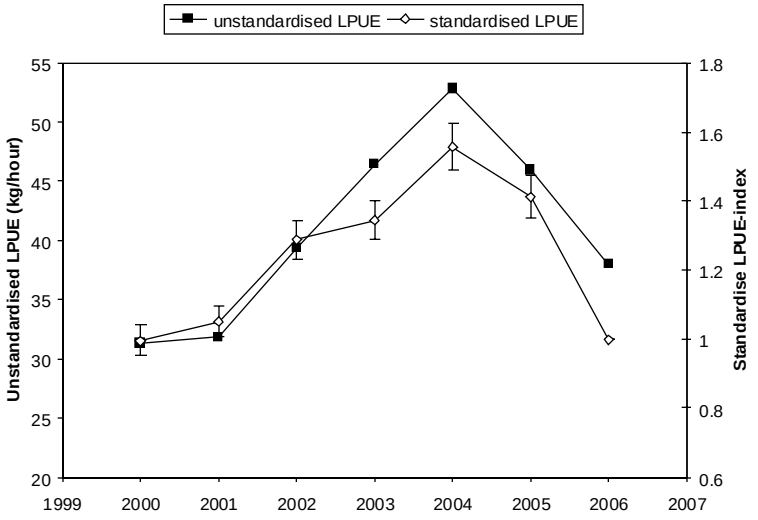

Fig. 7. Standardised LPUE-indices (with standard errors) for 2000-2006 for the Norwegian shrimp fishery in ICES Div. IIIa and IVa east, plotted together with unstandardised LPUE-values.

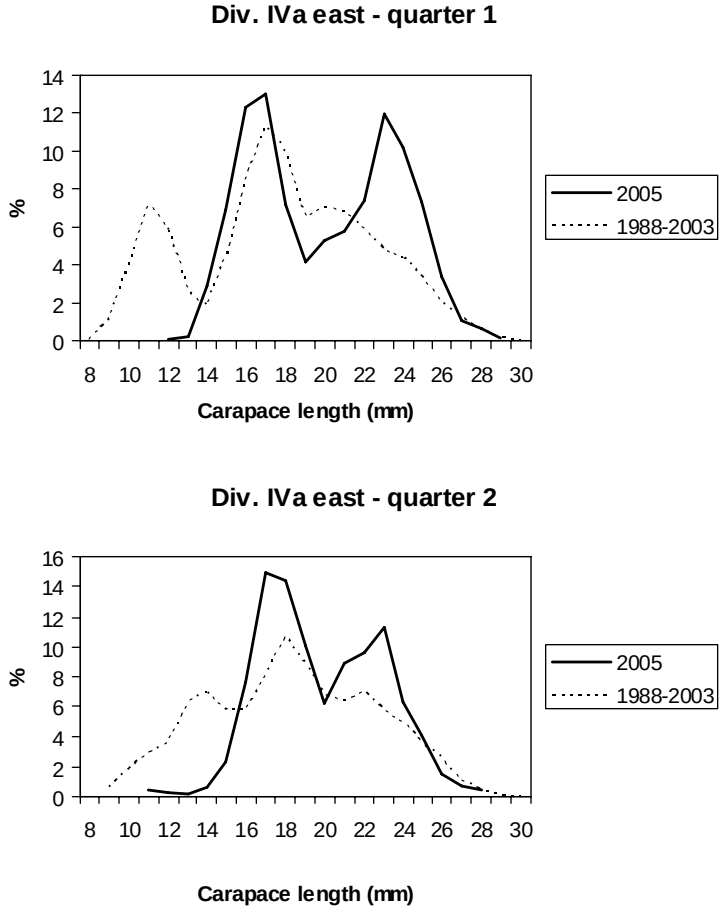

Fig. 8. Length frequency distributions from unsorted commercial catches from Div. IVa east (North Sea) from quarter 1 (4 samples) and quarter 2 (3 samples) compared with research survey data from the same area and time of year (using both a commercial-type trawl (36 mm mesh-size) and a research trawl (6 mm mesh-size lining net)).

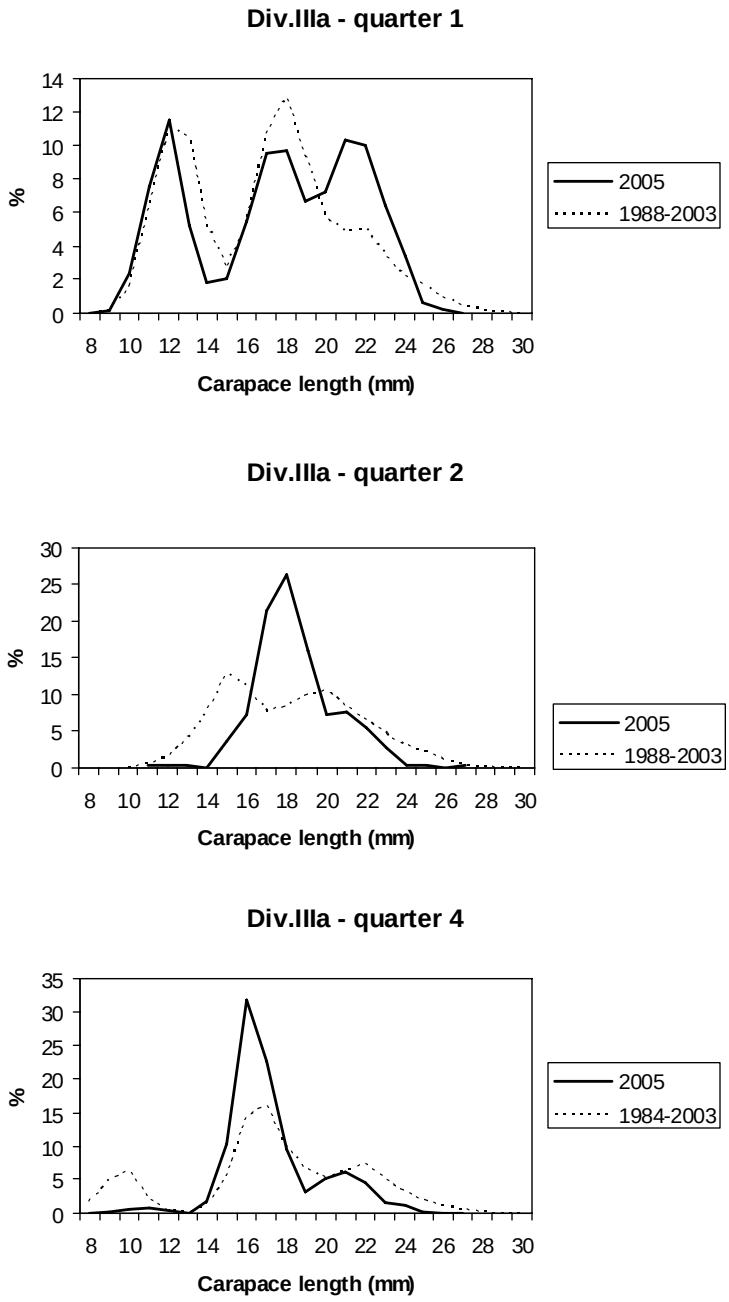

Fig. 9. Length frequency distributions from unsorted commercial catches from Div. IIIa (Skagerrak) from quarter 1 (4 samples), quarter 2 (1 sample) and quarter 4 (3 samples) compared with research survey data from the same area and time of year (using both a commercial-type trawl (36 mm mesh-size) and a research trawl (6 mm mesh-size lining net)).

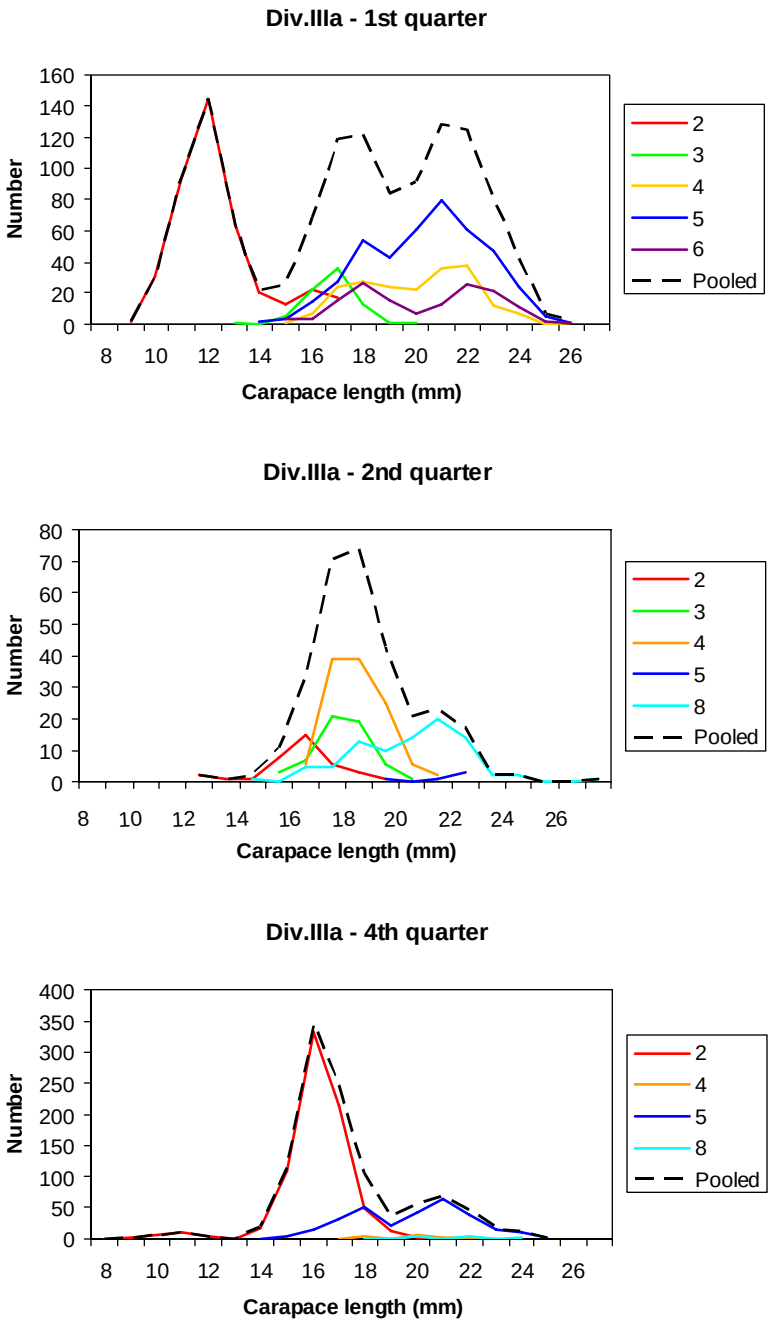

Fig. 10. Stage-based length frequency distributions based on the frequency distributions in Fig. 9 (Div. IIIa, Skagerrak). 2 = male; 3 = transitionals; 4 = primary female with head roe; 5 = berried female, 6 = female with hatching eggs; 7 = resting stage; 8 = secondary female with head roe.