



NAFO/ICES *PANDALUS* ASSESSMENT GROUP MEETING – SEPTEMBER 2013

Discarding in the shrimp fisheries in Skagerrak and the Norwegian Deep (ICES Divs. IIIa and IVa east)

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In the *Pandalus* fisheries in Skagerrak, shrimp are discarded because of being non-marketable, either due to poor landing quality or too small size. However, smaller shrimp of low market value are also discarded (so called high-grading). This is mainly the case in the fisheries which are constrained by TACs and subsequent national quotas.

Estimates of the total amount of discards in the shrimp fisheries in IIIa and IVa east are based both on onboard sampling of catches (Denmark and Sweden) and indirect estimates (Norway). In fisheries management in the North Atlantic discarding has become an important issue in recent years. In some countries' EEZ a ban on discarding has been in force for many years, for instance in Norway. A discard ban is expected to be enforced in EU waters in the near future. It is therefore highly relevant with estimates of the existing discard practices and discard quantities to assess the possible impacts of such measures.

Discarding of shrimp in the Danish shrimp fishery.

It is well known that some discarding of shrimp (*Pandalus*) takes place in the Danish shrimp fishery. In the last 10 years the Danish landings of shrimp can be grouped into two components: 1) High quality large shrimp landed boiled and 2) smaller shrimp landed fresh, mainly to processing plants. The remaining fraction of the catch, the discards, consists mainly of shrimp too small for the plants or damaged, poor quality specimens. Only in recent years (since 2009) has it been possible, from the at-sea-sampling program, to obtain information on the size composition of the discarded shrimp as well as to quantify the amount of these discards. There have not been any records of high grading, probably because the TACs have not constrained the Danish shrimp fishery. In Denmark there is also a market for the smaller shrimp, because they are accepted by the Danish processing plants.

1. Estimates of total amount of discarded shrimp in the Danish fishery.

Discard sampling has been carried out onboard shrimp vessels during fishing trips since 2009. According to the sampling protocol samples are to be taken from each of the 3 catch components: 1) large shrimp (for at-sea boiling), 2) small shrimp ('raw shrimp') landed fresh for processing and 3) discards. Corresponding records (by trawl haul or fishing trip) of the totals of each of these catch components are recorded. However, many of the modern shrimp vessels are using sorting machines with closed systems, from where the discarded shrimp are led directly back into the sea, and it is sometimes complicated to obtain samples of discards and especially records of total discards on a trip may be almost impossible to

obtain. In such cases the observer has, from experience, to 'guesstimate' total amounts of discarded shrimp. The amount of total discards (by the entire fishery) is estimated from the ratio discarded shrimp/landed shrimp in the samples to total recorded shrimp landings. This is done on a quarterly basis (Table 1). Only since 2011 have samples of both the two different landings components (boiled and raw) been taken. Therefore the possible bias in the estimates of totals for the two first years (2009 and 2010) is considered to be larger than for the recent years 2011 and 2012. One could expect more discards in seasons with more small shrimps. This would be expected in the 4th and 1st quarters of the year, when larger amounts of respectively the 0- and 1-groups are caught by the fishery. The higher amount of discards in the 1st quarter of 2010 and 4th quarter of 2012 indicates this, but the time series is too short to confirm this pattern.

According to these sample data, total discards of shrimp in the Danish shrimp fishery seem to be at a rather low level, around 5% of the catch.

2. Size composition of discards.

Fig. 1 shows the length distribution of the various catch components in 2012 (% length frequencies). The discarded *Pandalus* are smaller than the landed ones as expected, but there is also a large overlap of the size distributions. Looking at the figures by quarter (Fig. 1 B) the modes of the length frequency distributions of the discards suggest that the majority belongs to the 1-group shrimp. However, in the 1st quarter age group 2 is also significant in the discards. In the 4th quarter a 0-group component is evident. The discard of larger shrimp probably consists of specimens in poor condition (damaged specimens), which do not meet the quality required for processing (boiling) at sea.

Discarding of shrimps in the Swedish shrimp fishery.

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 sometimes resulted in high grading at sea by discarding some medium sized ones, which fetch only 14% of the kg price for the (large) boiled shrimp. Because of this practice, the amount of discarded shrimp in the Swedish fishery is relatively larger than in the Danish and Norwegian fisheries.

In an earlier description of shrimp discarding in Skagerrak and the Norwegian Deep (SCR Doc. 11/67), the Danish and Swedish length compositions were compared to estimate the Swedish discards, assuming that no shrimps above 21 mm CL was discarded in either of the fisheries.

Since 2008 Sweden has conducted an at-sea-sampling program to get information of the catch composition and discarding level in the Swedish *Pandalus* fishery. The on-board sampling is considered a more reliable method of estimating discards, thus the above mentioned method of comparing length frequency distributions is no longer used. The Swedish sampling procedure is conducted in the same way as described in the Danish sampling above.

Table 3 shows landings (separated into boiled and fresh shrimps), discards and corresponding total catch during 2008-2012. Figure 3 shows the size composition of landings and discards from the at-sea-sampling program during 2012. The amount of discards may depend on the season (recruitment of small shrimp into the fishery) and Figure 4 shows the quarterly size distributions of the catch during 2012.

Data on weight on landings and discards from the Swedish onboard discard sampling program is presented in Figure 4.

Discarding of shrimps in the Norwegian shrimp fishery.

In 2007 and onwards Norwegian discards have been estimated by comparing length distributions from sorted landings with length distributions from unprocessed commercial catches. The annual length distribution from unprocessed catches was scaled to fit the annual length distribution from the landings for the larger sizes, based on the assumption that there is no discarding of the largest size groups (≥ 21 mm CL). The results were, however, often unreliable (e.g., negative estimates). Part of the explanation could be that the sampling of catches covered the whole fishery, while the sampling of landings only covered a small part of the fishery (samples from one fisher in IVa east, and from one landings location in IIIa).

As discarding is illegal in Norway, onboard sampling by observers as in Sweden and Denmark is difficult to organize, and it is highly unlikely that we will find shrimp fishers willing to record their discards. The Danish discard data are therefore considered the best available for estimating Norwegian discards in Skagerrak. Thus, from 2009 onwards Norwegian discards in Skagerrak are estimated using the Danish discards-to-landings ratio to Norwegian landings. The underlying assumptions are that the size structure of the shrimp stock is the same on the Danish and Norwegian fishing grounds, and that the level of discarding is the same in the two fisheries. The Danish at-sea-sampling-program has not covered the rather few fishing trips by Danish shrimp vessels in the Norwegian Deep. Norwegian discards from the Norwegian Deep is therefore estimated as the weight of all shrimp < 15 mm CL (MLS) in the catches, assuming that all shrimp $< MLS$ are discarded. The numbers pr length group in the Norwegian landings are multiplied by the mean weight pr length group (Danish data), where the length frequency distribution is obtained from catch sampling.

Estimated Norwegian annual discards in 2009-2012 from Skagerrak range from 78 to 248 t (Table 3), and in the Norwegian Deep from 15 to 40 t (Table 4). The Norwegian and Danish fisheries are partly overlapping (Fig. 5). Comparison of length frequency distributions in Danish and Norwegian catches from Skagerrak in 2009-2012 show that the size structure of the shrimp stock on the Danish and Norwegian fishing grounds is more or less similar (Fig. 6). Some of the quarterly length distributions differ in some years, but the annual distributions are similar, supporting the use of the Danish data to estimate Norwegian discards from Skagerrak. Length frequency distributions in Norwegian catches from the Norwegian Deep show that shrimp caught in this area are larger than shrimp caught in Skagerrak (Fig. 6).

Acknowledgement:

This work has been partly funded by the EU-Interreg IVA–152207 project: “Sustainable shrimp fisheries in Skagerrak”. The support is greatly appreciated.

References.

Munch-Petersen S., Eigaard O., Søvik, G. and M. Ulmestrand. 2011. The Northern shrimp (*Pandalus borealis*) Stock in Skagerrak and the Norwegian Deep (ICES Divisions IIIa and IVa East). NAFO SCR Doc. 11/069, 25 pp.

Table 1. Estimated discards (t) and corresponding landings (t) in the Danish shrimp fishery, per quarter.

Year	1 quarter			2 quarter			3 quarter			4 quarter			annual total		
	discards	landings	Catch	discards	landings	Catch	discards	landings	Catch	discards	landings	catch	discards	landings	catch
2009	11.9	678.2	690.1	11.8	629.7	641.5	10.7	494.4	505.1	6.4	633.1	639.5	40.8	2435.4	2476.2
2010	39.9	453.8	493.7	12.4	334.1	346.4	5.1	335.0	340.2	2.4	234.9	237.3	59.8	1357.8	1417.6
2011	17.1	356.3	373.5	53.5	443.5	497.0	32.3	482.7	514.9	26.0	318.2	514.9	128.9	1600.6	1729.5
2012	18.2	309.9	328.1	11.8	317.1	328.9	17.8	440.0	457.8	44.0	387.2	431.2	91.9	1454.1	1546.0

Table 2. Estimated discards (t), corresponding landings and catch and proportion discards in the Swedish shrimp fishery during 2008 to 2012.

Year	2008	2009	2010	2011	2012
<i>Boiled landings</i>	1041	1374	1123	1042	777
<i>Fresh landings</i>	1438	1109	657	726	745
Landings	2479	2483	1780	1768	1521
Discards	540	337	386	504	671
Catch	3019	2820	2166	2272	2192
% Discards	17.9	12.0	17.8	22.2	30.6

Table 3. Estimated discards (t), landings (t) and catches (t) in the Norwegian shrimp fishery in Skagerrak in 2009-2012, per quarter and annually.

year	Q 1			Q 2			Q 3			Q 4			Annual		
	disc.	land.	catch.	disc.	land.	catch.	disc.	land.	catch.	disc.	land.	catch.	disc.	land.	catch.
2009	26	1468	1494	21	1105	1127	21	944	965	10	1033	1043	78	4551	4629
2010	68	775	843	25	709	735	11	709	720	5	624	629	110	2817	2926
2011	33	695	729	87	725	812	54	822	877	53	647	700	227	2890	3117
2012	58	1002	1060	20	536	556	47	1159	1207	122	1072	1194	248	3768	4016

Table 4. Estimated discards (t), landings (t) and catches (t) in the Norwegian shrimp fishery in the Norwegian Deep in 2009-2012, per quarter and annually. There were no catch sampling in the third quarter in 2009.

year	Q 1			Q 2			Q 3			Q 4			Annual		
	disc.	land.	catch.	disc.	land.	catch.	disc.	land.	catch.	disc.	land.	catch.	disc.	land.	catch.
2009	9	592	601	5	560	565		474	474	1	186	187	15	1812	1827
2010	1	621	622	8	512	520	13	415	428	1	309	310	23	1857	1880
2011	7	582	589	5	625	630	4	580	584	3	124	127	19	1911	1930
2012	14	349	363	13	262	275	7	249	256	5	168	173	40	1028	1068

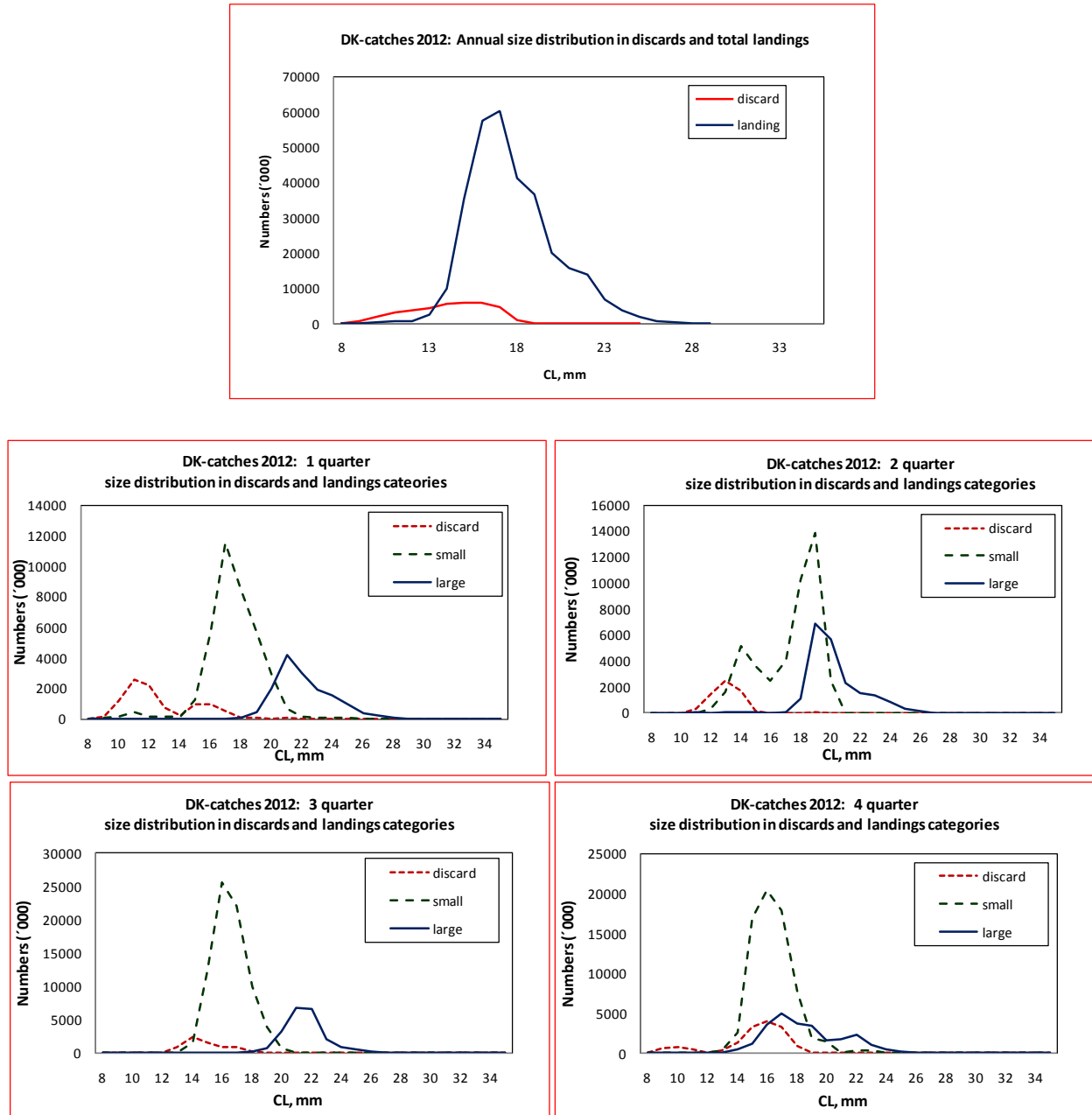


Fig. 1. Length distributions in landings and discards in the Danish shrimp fishery in 2012, annual (above) and quarterly.

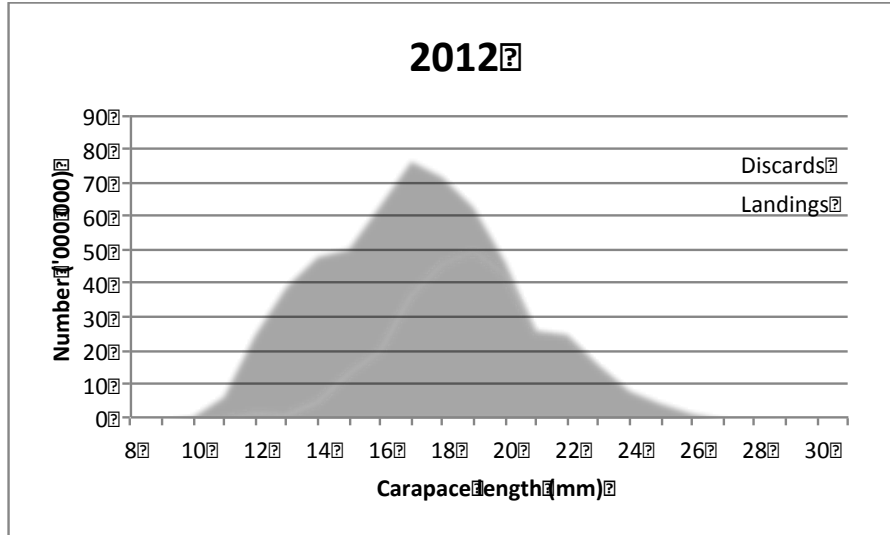


Fig. 2. Length distribution in landings and discards in the Swedish shrimp fishery in 2012.

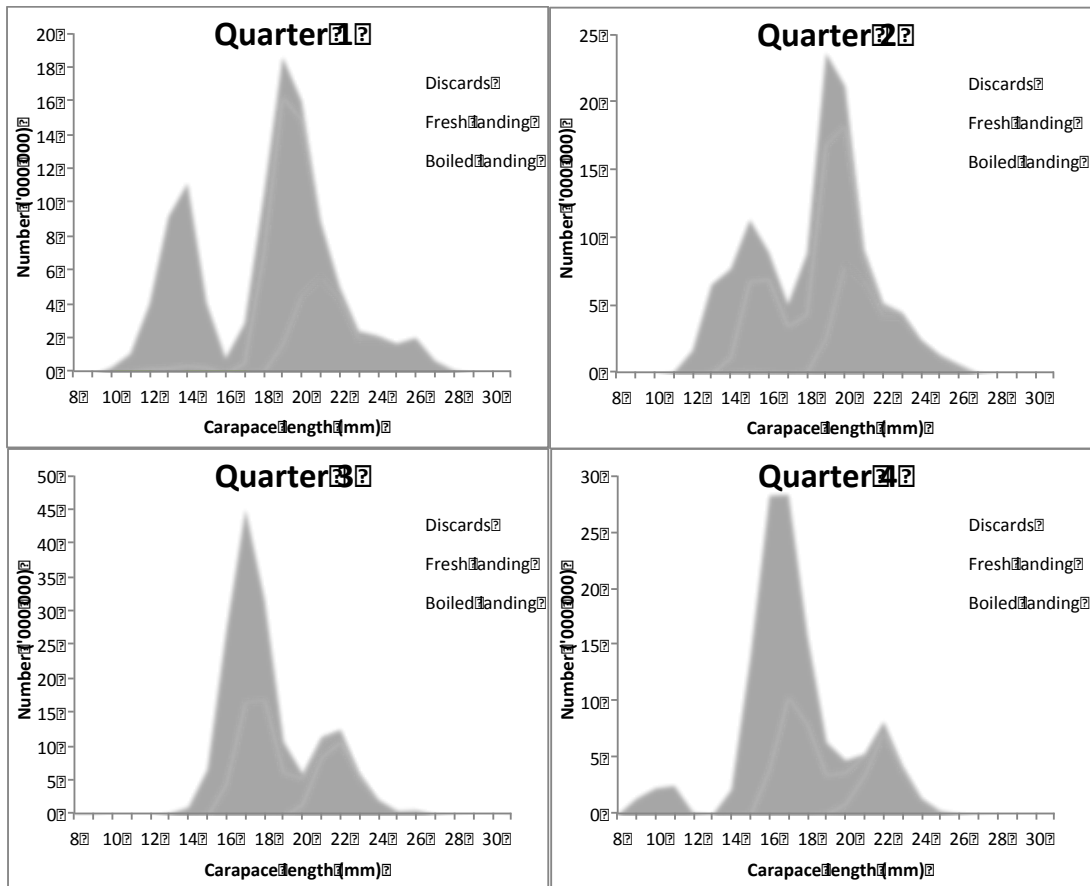


Fig. 3. Quarterly size distribution of Swedish landings separated into boiled and fresh *Pandalus* and estimated discards during 2012.

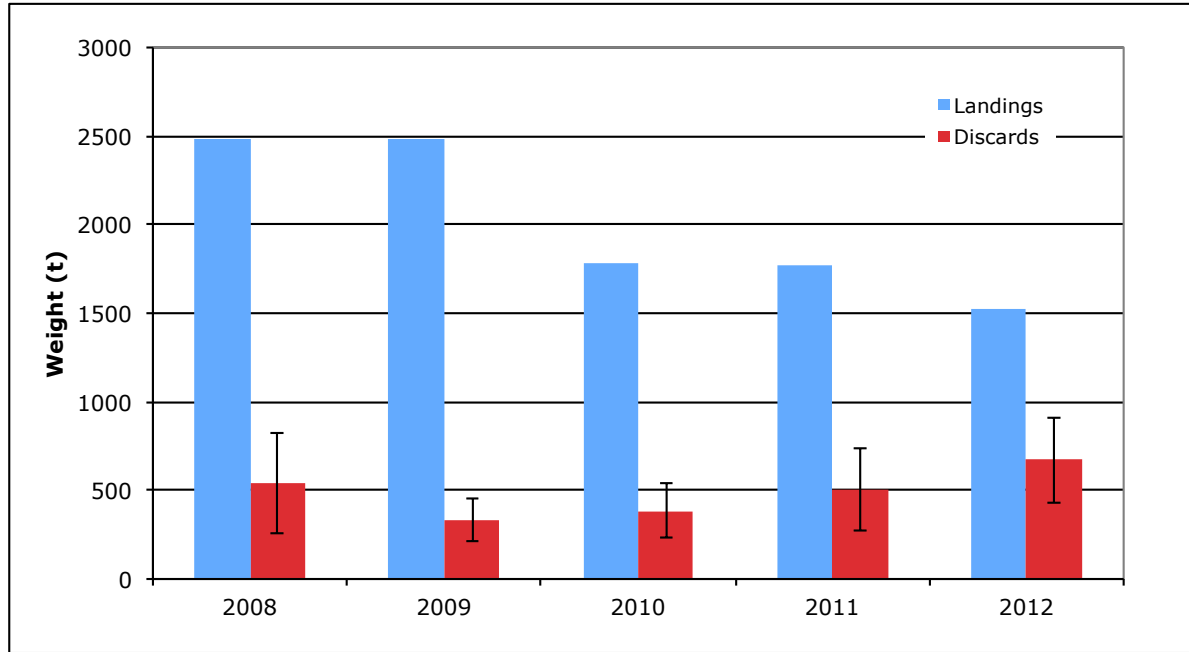


Figure 4. Swedish estimated *Pandalus* landings and discards during 2008 to 2012.

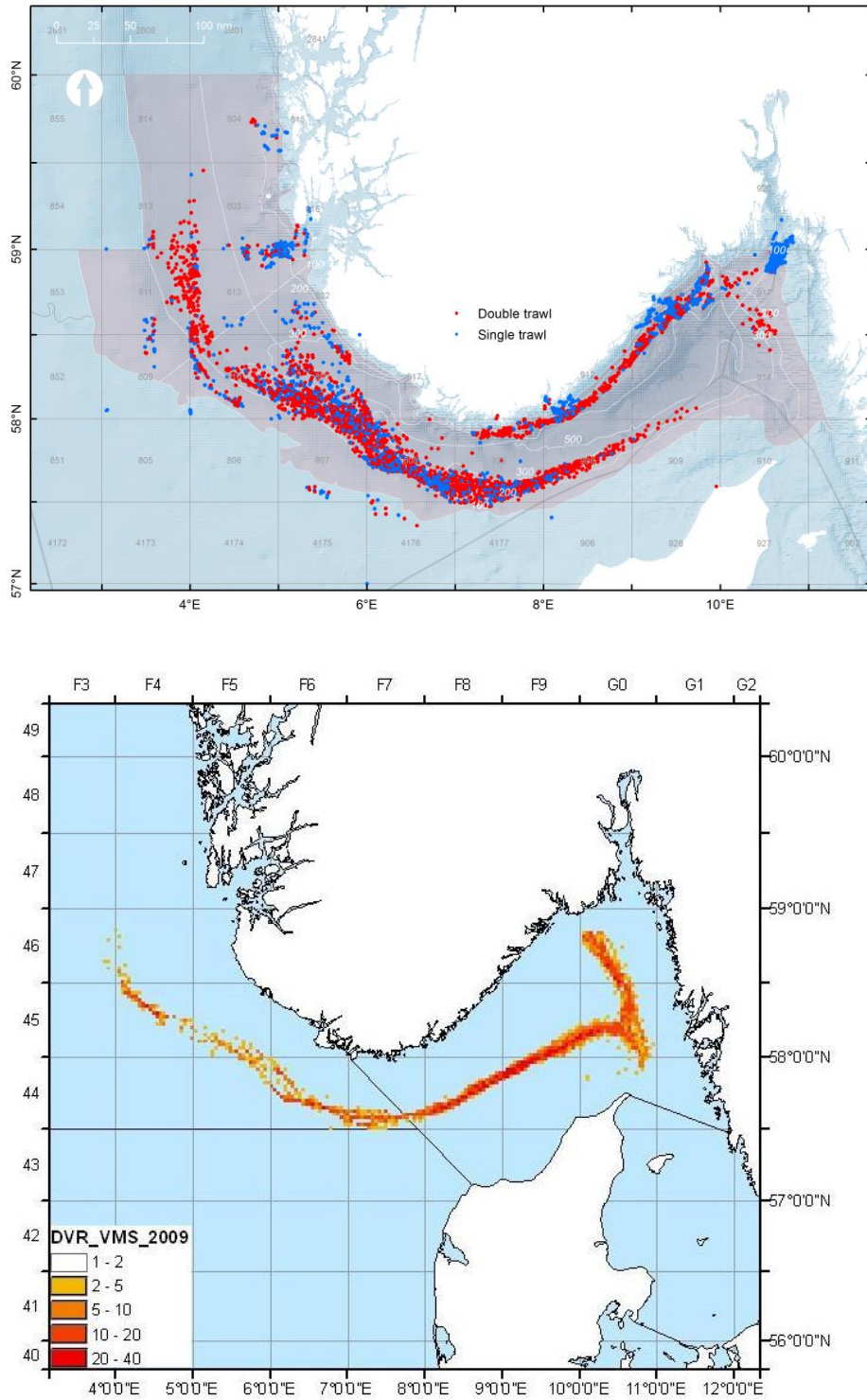


Fig. 5. Spatial distribution of the Norwegian (above) and Danish shrimp fisheries in Skagerrak and the Norwegian Deep in respectively 2012 and 2009. The Norwegian distribution map shows positions of trawl hauls from log books (red dots = twin trawl, blue dots = single trawl). The Danish distribution map is based on VMS data.

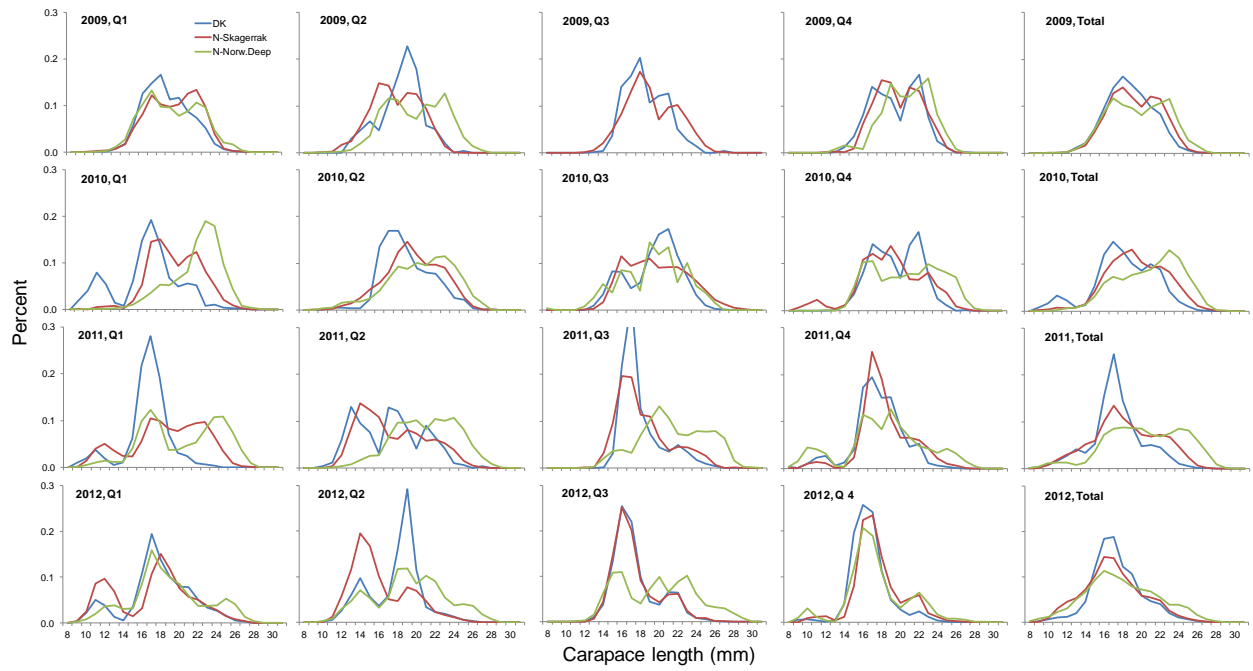


Fig. 6. Comparison of relative length frequency distributions in Danish shrimp catches from Skagerrak (blue line) and Norwegian shrimp catches from Skagerrak (red line) and the Norwegian Deep (green line) in 2009-2012, per quarter (Q1-Q4) and annually.