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27-29 May 2008

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Executive summary

Landings

The Working Group on *Crangon* Fisheries and Life History (WGCRAN) 2008 meeting was successfully held in RIVO, Texel, Netherlands in May 2008. Members from Denmark, Germany, the Netherlands, Belgium and the UK were in attendance. The effort and landings statistics for the *Crangon* directed fleets in these countries were updated for 2007. We note that Germany and the Netherlands continue to dominate the fisheries, with each of these nations landing around 12,000 tonnes and 16,000 tonnes of *Crangon* respectively in 2007. Denmark, the UK, Belgium and France together caught and landed the remaining 4,800 tonnes, thus totalling around 34,000 tonnes landed from the North Sea.

Calculating a biomass estimate of North Sea C. *crangon*

We (WGCRAN) have successfully progressed further in 2007-8 towards making an estimate of the stock biomass of *C. crangon* in the North Sea. The work was primarily undertaken by working group members from the Netherlands (Tulp and Van Overzee) and from Germany (Martin and Temming), the results are detailed in this report. In summary, two independent estimates were calculated, both estimates show strong year-to-year variations. In one estimate the biomass varied between 9,600 and 88,000 tonnes for the period 1970-2006 with a long-term average is 36,000 tonnes. In the other study, for the years 1987-2006, the estimate varied from 10 000 tonnes to >140 000 tonnes with an average biomass of 80,000 tonnes. The methods used to calculate surface area and the assumed catchability of *C. crangon* had a strong influence on the biomass estimate. Further information on *C. crangon* densities have been identified from surveys not previously used. This data will be assessed for its potential to improve further the accuracy of the biomass estimate over the next 12 months.

Other issues

We note that research on the *C. crangon* fisheries is underway in several nations and describe some of that important work herein.

Colleagues in Germany continue to develop innovative biological models related to *Crangon* populations (at the University of Hamburg) whilst their counterparts in the German Federal Institute continue to improve, expand upon and make better use of extensive *Crangon* survey data that is routinely conducted each year. This work is partly done in close collaboration with colleagues from the Danish institute.

Our Dutch colleagues continue to improve and develop the *C. crangon* biomass estimates. Furthermore, the Dutch Ministry has introduced legislation making it a requirement for the *C. crangon* fishery to be accredited by the Marine Stewardship Council as a sustainable fishery. One conclusion of the Marine Stewardship Council in a pre-assessment was that discard mortality should be reduced. In light of this, IMARES (NL) in cooperation with three groups of shrimp fishers and Kuiper & Burger have commenced some pilot projects to investigate ways to reduce the amount of discards through net adjustments and improve the survival of discards.

In a related issue, since 2007 the European Data Collection Regulation (DCR) has become mandatory for the *C. crangon* fishery. The German Federal Institute has developed a protocol for discard sampling the commercial catch (landed fraction) as well as the discard fraction of the *C. crangon* fishery, and the Dutch Ministry have

commissioned a discard programme, which also aims to provide more data for the MSC assessment.

Colleagues from Belgium are progressing with the development of innovative technologies to harvest brown shrimp by using an electric shrimp beam trawl. Having sufficiently developed the technology to begin testing, a series on intensive sea trials have commenced, preliminary results are detailed herein. Also in Belgium a new study has commenced to assess the impact of persistent organic pollutants on the North Sea *C. crangon* stock.

Altogether the WGCRAN continues in its tradition as a small but highly active and innovative working group.

1 Terms of Reference for the WGCRAN 2008 meeting:

The Working Group on *Crangon* Fisheries and Life History [WGCRAN] (Acting Chair: T. Catchpole, UK) met in RIVO, Texel, The Netherlands during the week of 27 May – 29 May 2008 under the following terms of reference. Details of progress made are also shown:

1) Collate and update landings and effort data;

2) Further improve the current swept-area estimate of *Crangon* biomass developed by Ingrid Tulp;

3) Develop an alternative estimate of *Crangon* biomass in the Wadden Sea area;

4) Explore and make available data sources required for the development of a *Crangon* biomass estimate;

5) Enhance knowledge of *Crangon* catchability;

6) Review of MSC certification process;

7) Review recent *Crangon* related R & D activity.

2 List of participants at the WGCRAN 2008 Meeting

A complete list of participants to the WGCRAN meeting is listed in Annex 1 of this report.

3 ToR a) Update of landings and effort data

3.1 Overview

Below are the summaries by country of the effort and catches in the North Sea *C. crangon* fishery in the most recent year, 2007, and information on how it relates to previous years. Although the same units are provided for effort (hp-days) and LPUE, it is important to note that each Member State has different methods for calculating the number of fishing days and hp days; therefore, the values provided are not directly comparable between countries. There is a recognized need for standardization in the method of calculation of these data.

3.2 Overview – Germany

German landings of consumption shrimp (*C. crangon*) have decreased to 12 173 tonnes in 2007, which is a reduction of 26% compared to landings from 2005, the highest ever recorded. The seasonal distribution of the landings followed the standard pattern in principle, i.e. very low landings in winter, increasing in spring, with a light depression in June/ July and the main autumn fishery. However, in 2007 the spring landings were the highest in the time-series with about 6000 tonnes, and the main season remained at a low level about half of that observed two years before, again 6000 tonnes. Accordingly, the extension of the main fishing season in autumn into November/December was persistent but remained also on a much lower level. The majority of brown shrimp landings originated from much of the Inner German Bight, i.e. the Jade-Weser, the Elbe estuary and north towards the peninsula of Eiderstedt where the influence of the Elbe River is high. Further north within the North Frisian Islands and west in the East Frisian Islands, catches were low, almost absent in the latter region except of the Ems estuary. Therefore the fleets concentrated mainly in the southeast of the German Bight. However, in winter the active part of the fleet mostly left the near coast areas and fished further off shore in the northern part of Germany as well as in the Danish waters.

The international producer's organization incorporating *Crangon* fishers from Denmark to the Netherlands established in 2005 tries to stabilize prices by temporary self imposed landing-limitations. However, only about half of the fleets are affiliated to that PO which is therefore not very effective. On the other hand the comparatively low abundance of shrimp made catch limitations (3 t per week) meaningless in 2007 especially during the autumn season and the landings have probably not been lowered by the PO´s catch limitations.

The main point is, however, that not only the annual landings have further decreased but also LPUE values indicating lower abundance. This is valid especially for the 2007 year class, which is one of the three lowest survey estimates in the past 30 years according to German DYFS data. Due to the correlation between of autumn and following spring landings this indicates also low landings for the 2008 spring season. The known climate effect (Winter NAODJF and SSTDJF) on the year classes of *C. crangon* will probably also lead to a lower stock and reduced landings for the period from July to June 2009.

3.3 Overview - The Netherlands

Total effort in the Netherlands in 2007 was 4.8 million hp days. This value is in the same range as the period since 1988. Total landings amounted 16 110 tonnes, which is together with 2005 the highest figure in the series. In recent years the landings of the

Dutch and German fleet were in the same order, but in 2007 the Dutch fleet landed ca. 33% more than the German fleet.

Landings and effort show peaks in March to May and September to November and that pattern is consistent over the years. LPUE is increasing since 2002, but seems stable in the last years. This pattern is not restricted to the Dutch shrimp fisheries but also appears in the German and Belgian fisheries and up to 2006 also in the Danish fisheries. The LPUE values are generally much higher in autumn than in spring. The number of vessels landing brown shrimp is fairly constant in the period 1995 to present with ± 210-230 vessels landing into Dutch harbours (that includes only vessels that land >1 tonne per year).

3.4 Overview – Denmark

The annual and monthly Danish landings of *C. crangon* and by other EU-vessels are reported by the industry. The data on landings from Danish waters are given for 2007 and the Danish landings amounts to 3958 tones and the landings by other EU-countries were 5296 tones. These landings are included in the respective national figures. The Danish landings decreased in 2007 compared to 2006 by 6.6%. Due to an invasion of gadoids, the landings generally went down during the autumn season 2007 although the effort was kept high.

Based on logbook information the reported catch, effort and LPUE for the Danish fleet is given. In 2007, 27 Danish vessels fished and landed *C. crangon*. Total fleet effort increased from around average 715 508 (hp-days) in 2006 to 918 083 in 2007. The LPUE the previous 12 years was in average 2.14. The LPUE peaked in 2006 at a value of 5.78 Kg/hp-day. In 2007 the Danish LPUE decreased to 4.34. The highest landings took place in April and May. The lowest landings were in August, September and December. The Danish effort is high in spring and in autumn.

Similar to the previous years, a large number of German vessels (49) and Dutch vessels (94) too fished shrimps in Danish waters and landed the catches in Danish harbours. There has been an increase in the number of vessels from other EU-countries fishing and landing *C. crangon* in 2007 compared to 2006 of around 20%. The Belgians have in 2007 doubled their activity in the Danish economical zone in North Sea and 4 Belgian vessels have fished and landed *C. crangon* in Danish waters. Although their landings represent only 0.7% of the total landings caught in Danish waters. The effort and LPUE data for the other EU-countries are based on logbook information from the respective EU-countries.

3.5 Overview – United Kingdom

The Wash fishery in the North Sea is the source of ~90% of the recorded landings for the UK with ICES squares F034 and F035 the most important areas for the UK *Crangon* fishery. Annual landings of *Crangon* have been variable over time with a recent trend of decreased landings since 2001, which was the year of the highest recorded landings (1 865 tonnes). UK landings in 2004 and 2005 were ~500 t in each year but the annual landing for 2006 was ~430 t, the lowest value since 1992. The low landings in 2006 were attributed to the success of The Wash cockle fishery (Cerastoderma edule), which provided a better economic alternative for much of the shrimp fleet. However, 2007 saw relatively high landings of brown at 1207 tonnes, the fourth largest landings since (accurate) records began in 1988. Moreover, the landings-per-unit-of-effort was the highest on record.

Since 1989, effort information in terms of hp-days is available for over 80% (and up to 99%) of the recorded landings. Total effort was estimated from the ratio of total landings to observed LPUE. Estimated total effort for 2004 and 2005 was lower than in previous years in line with landings at just over 500 000 hp-days. Estimated effort for 2006 was only ~250 000 hp-days because of the redirected effort into the alternative cockle fishery. Effort in 2007 was higher than in 2006, although still low compared with previous years. However, in October and November effort was relatively high and this correlates to the period when landings were considerably higher than in recent years.

3.6 Overview - Belgium

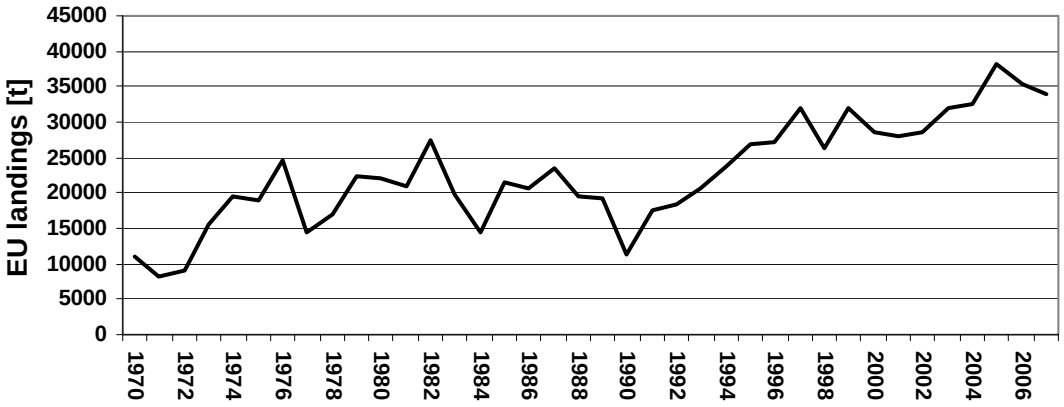
Crangon landings by Belgian shrimp trawlers into Belgian harbours decreased to 204 tonnes in 2007, which is a remarkable reduction of 50% compared to the landings from 2006. In line with the declining landings, the associated effort also decreased from 6.3 million hp-hours in 2006 to 3.9 million hp-hours in 2007. The number of active vessels has shown no change and stays constant around 25 vessels. The seasonal distribution of the landings (and effort) followed the standard pattern, i.e. very low landings in winter, increasing landings in spring and summer, followed by a strong autumn fishery. LPUE shows a minor decrease, but seems relatively stable in comparison with the last ten years. The 2007 data confirm again that the landings by the Belgian fleet have been declining over the last thirty years. They have been below 1000 tonnes since the mid eighties.

It has to be borne in mind that all data refer to landings (and associated effort) by Belgian shrimp trawlers into Belgian harbours only. Landings into foreign ports thus are not included. Over the past years however, these have been of major importance. In some years they even exceeded the landings into Belgian ports.

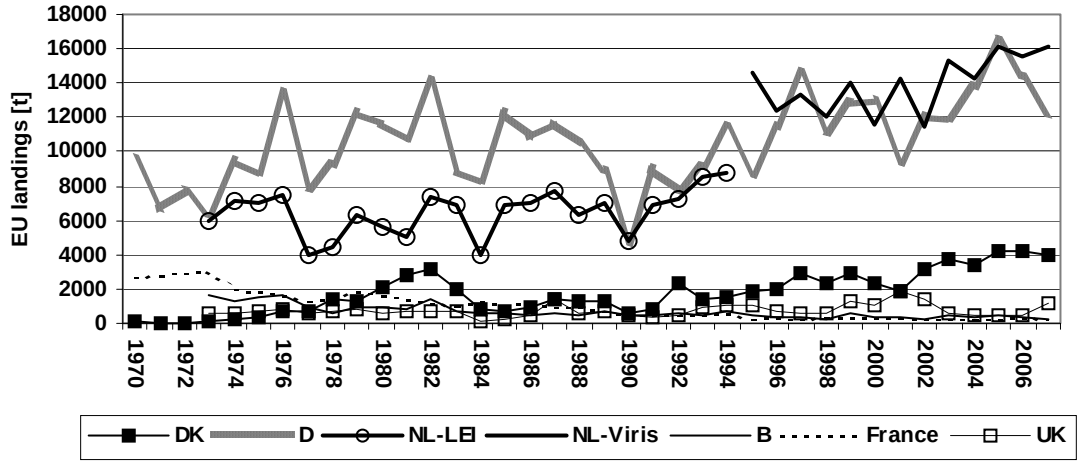
Up to the late 1990s, almost all landings into Belgian harbours came from the Belgian coastal waters. In recent years however, there has been a shift to the North, with a considerable part of the landings into Belgium now coming from the Southern Dutch coast and sometimes even as far North as the Danish coast. In the past, the LPUEs in the tables could be considered as being a reasonable index of the relative abundance of brown shrimp in the Belgian coastal waters, but because of the spatial shift in exploitation, this no longer is the case.

3.7 Total EU landings of *C. crangon*

Total landings of C.crangon from the North Sea [t] by all countries (no data for B since 2002 and F since 2004)



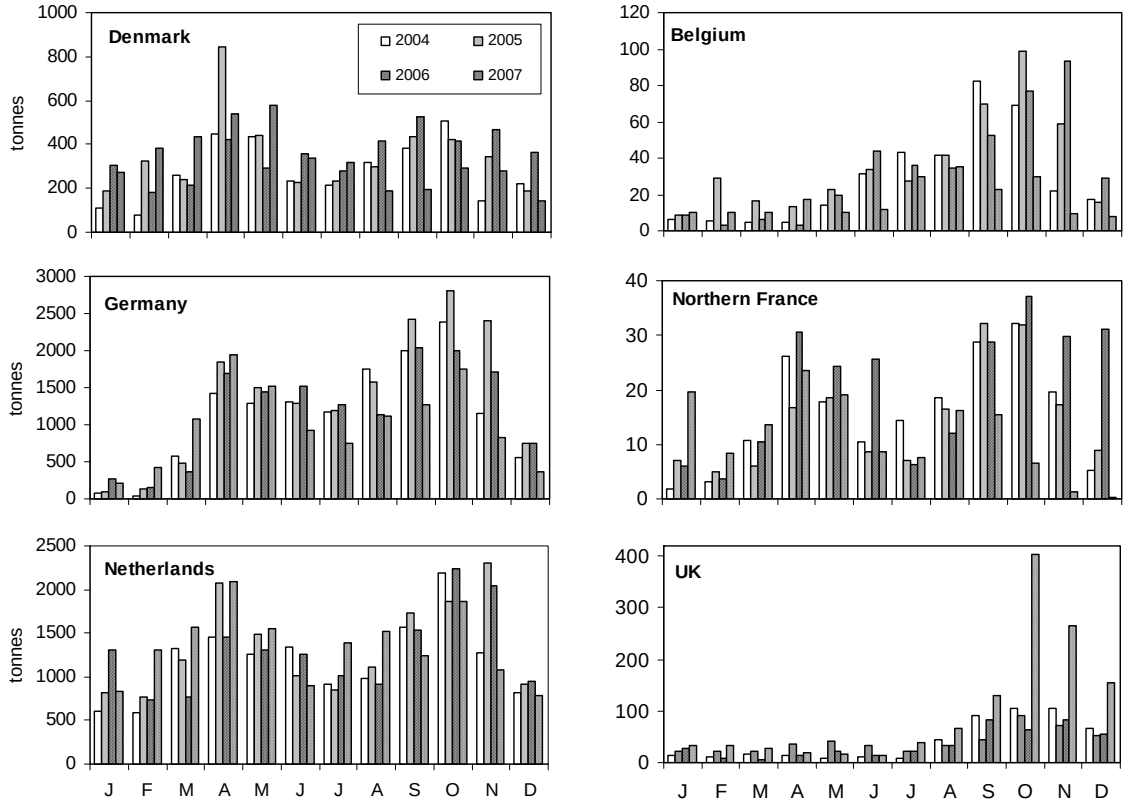
Total landings of C.crangon from the North Sea [t] by country (no data for B since 2002 and F since 2004)



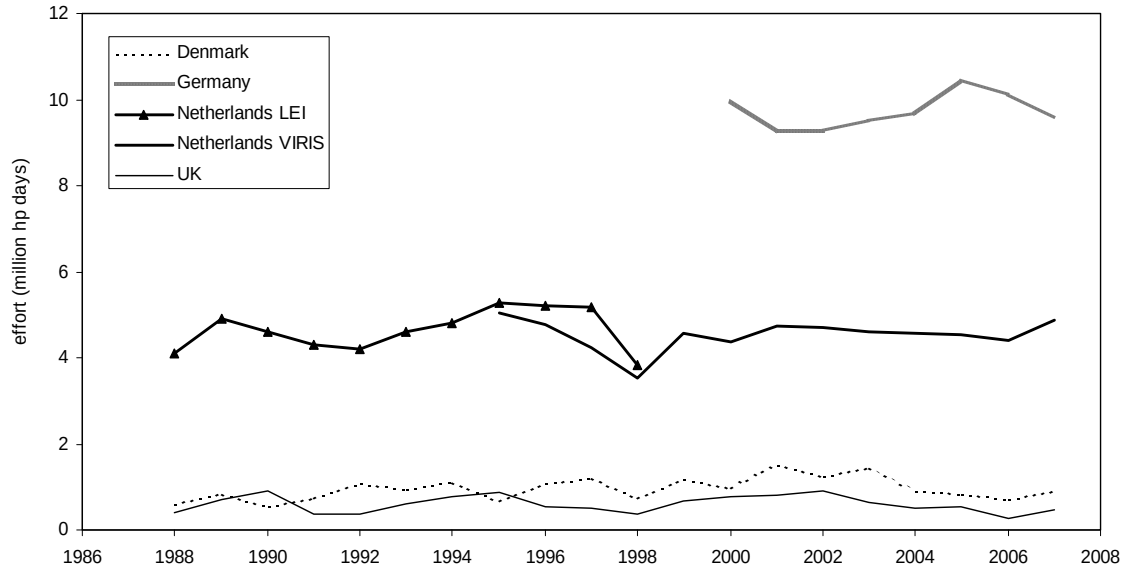
Legend:

All data are in landed (cooked) weight
DK official statistics
DE official statistics
NL-VIS from Producer organisations (inclusion of foreign landings unclear)
NL-VIRIS source VIRIS log book data (1995-2003) including landings in foreign harbours
BE official statistics
FR official statistics (France IV+VIId)
UK official statistics, including Irish sea landings

3.8 Seasonal EU landings of *C. crangon*

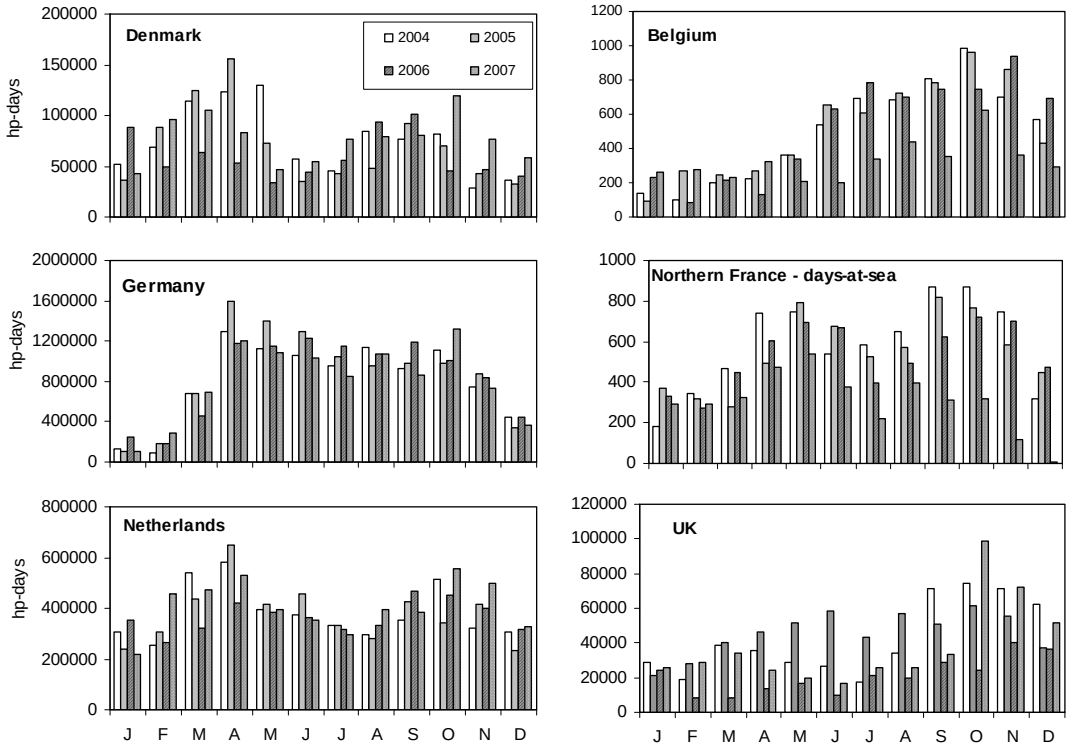


3.9 Total fleet effort in the EU *C. crangon* fishing fleets

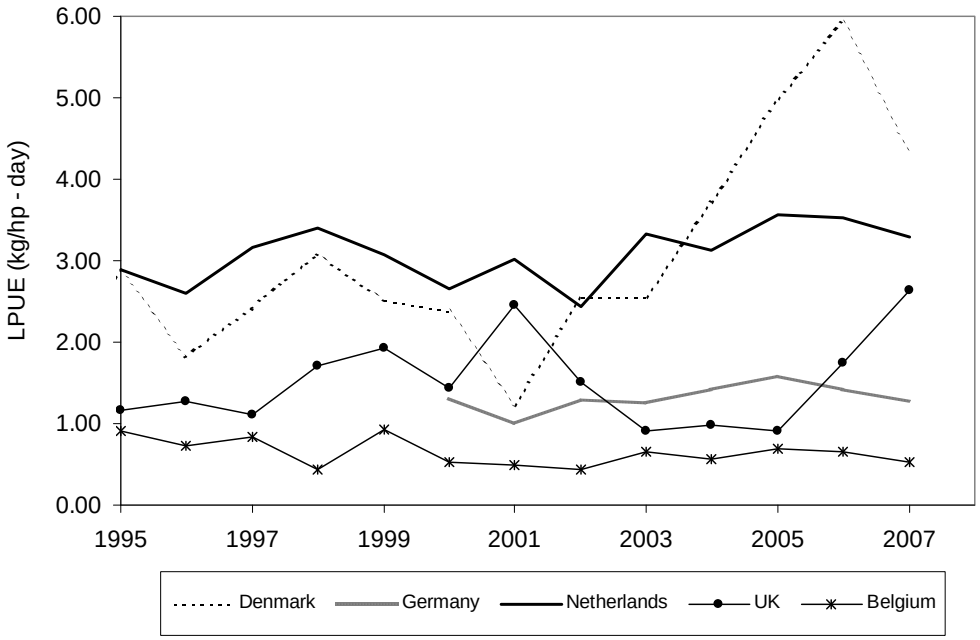


Legend: Netherlands LEI based on data collated by LEI institute; Netherlands VIRIS based on VIRIS data.

3.10 Seasonal fleet effort in the EU *C. crangon* fishing fleets

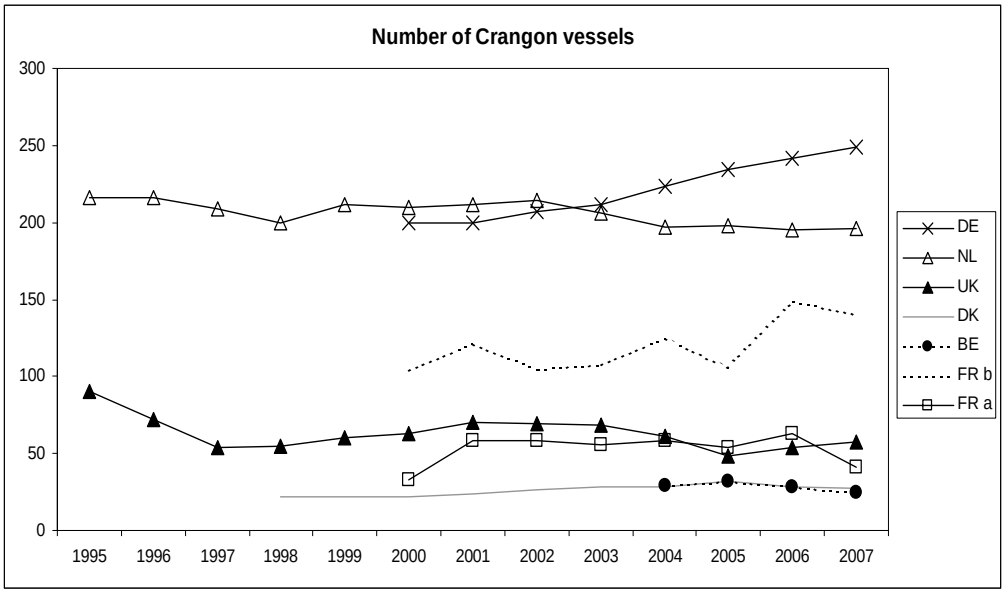


3.11 Landings per unit effort in the EU *C. crangon* fishing fleets



(DK) kg/hp-day; (NL) kg/hp-day; (DE) 1973 - 1994 effort LEI, catch PO, 1995 -2003 catch + effort VIRIS; (BE) kg / 10 hp-fishing hours

3.12 Number of active vessels in the EU *C. crangon* fisheries - time-series



Legend:

DL	**Threshold one tonne**
NL	**Number of Dutch vessels landing CSH into The Netherlands (>1t per year per vessel)**
BE	**2004 only 3 vessels catching *Crangon* all year in 2005/06 one vessel catching *Crangon***
FR a	**French vessels Area IV and VIIId only - from logbook data**
FR b	**All French vessels - from logbook data**
UK	**UK figures may be an underestimate**

4 ToR b) Further improve the current swept-area estimate of *Crangon* biomass developed by Ingrid Tulp

4.1 Swept area estimate of *Crangon crangon* stocks in the North Sea - Harriet Van Overzee and Ingrid Tulp

In the 2007 report of WGCRAN working group an attempt was made to produce a swept-area estimate of *Crangon crangon* biomass. Data from the Dutch DFS was used to produce estimates of *C. crangon* by DFS code and 5m depth strata. Missing values were imputed (Pannekoek & van Strien, 1998) after which the catches were converted into densities per standard area. This resulted in an estimate of the total biomass of *C. crangon* ranging between 5000 and 35000 tonnes for the period 1970-2006 for the DFS area. The total biomass estimated appeared to be considerably lower than estimated by Welleman & Daan (2001). Since the estimates were based on the same data it was concluded that the difference had to be methodological. It was suggested that this difference could to some extent be attributed to the fact that last year's study used a more up-to-date Length Weight relationship. In addition, it was not clear to which swept-area Welleman & Daan (2001) extrapolated the density values. This may result in a different estimate of biomass value.

It appears that the surface area used last year differs considerably from the area used by Welleman & Daan (2001). Therefore, this year swept-area estimates were made based on the surface area used by Welleman & Daan (2001) to see if that would explain the difference.

Methods

The surface area used by Welleman & Daan (2001) is described in ICES (1985). It appears that they extrapolated the density values to a much larger area than WGCRAN 2007. They used regions 1, 2, 3, 4, Scheldt estuary and the Waddensea (Figure 4.1). As the surface area is known for each region it was possible to recalculate the biomass estimate (Figure 4.2).

Data from the Dutch Demersal Fishery Survey were used to produce estimates of densities of *C. crangon* by DFS area code and 5 m depth strata (Figure 4.3). Methods for determining these values are explained in detail in the report of WGCRAN 2007 (ICES, 2007). In order to calculate the swept-area estimate we determined which DFS area fell within which region. For example, DFS areas 401, 402 and 403 fall within region 1. The average of the different DFS areas by depth class was taken and multiplied with the surface area of region 1 by depth class. This was done for all regions after which the total biomass was calculated.

Results

The total biomass estimates show strong year-to-year variations and varies between 9600 and 88000 tonnes for the period 1970-2006 (Figure 4.4). The long-term average is 36000 tonnes. Biomass estimates of *C. crangon* > 54 mm vary between 5700 and 46000 tonnes with a long-term average of 18000 tonnes (Figure 4.4).

Discussion

The range found for the biomass of *C. crangon* approaches the biomass range reported by Welleman & Daan (2001), who arrived at a range from 9000 to 60000 tonnes with a long-term average of 25000 tonnes. In comparison with the study carried out last year it is clear that the biomass calculated depends on the surface area that is used.

The difference that still appears may be caused by the fact that a more up to data LW relationship was used for this study. Welleman & Daan (2001) used van Lissa (1977). The latter results in 13% higher biomass for *Crangon* of 54 mm. From measurements we know that LW relationships can vary considerably between years and sites. In addition, Welleman & Daan (2001) used a rather crude way of estimating missing values. Overall, the resulting biomass values are quite sensitive to the way of calculation. In conclusion the estimate produced last year was correct given the surface area to which it was raised.

The swept-area estimate will be improved in various ways:

- Include data from the German Bight, Danish coast (north of Horns Reef) and Belgian coast. The Dutch DFS data does not include the German Bight, Danish coast or the Belgian coast. Data from these areas are partly available (not from the Danish coast) and can be used to improve the estimate.
- Include data from deeper areas. Currently the area covered by the estimate only covers part of the current fishing area (see contributions on VMS data). There are very limited data from further offshore. But during the meeting Mark Hufnagel presented a first estimate based on Callaway *et al*. (2002). Furthermore, data collected during the BTS survey with a 2 m beam trawl might be useful.
- Include a more realistic estimate of catchability (currently assumed to be 1.0).

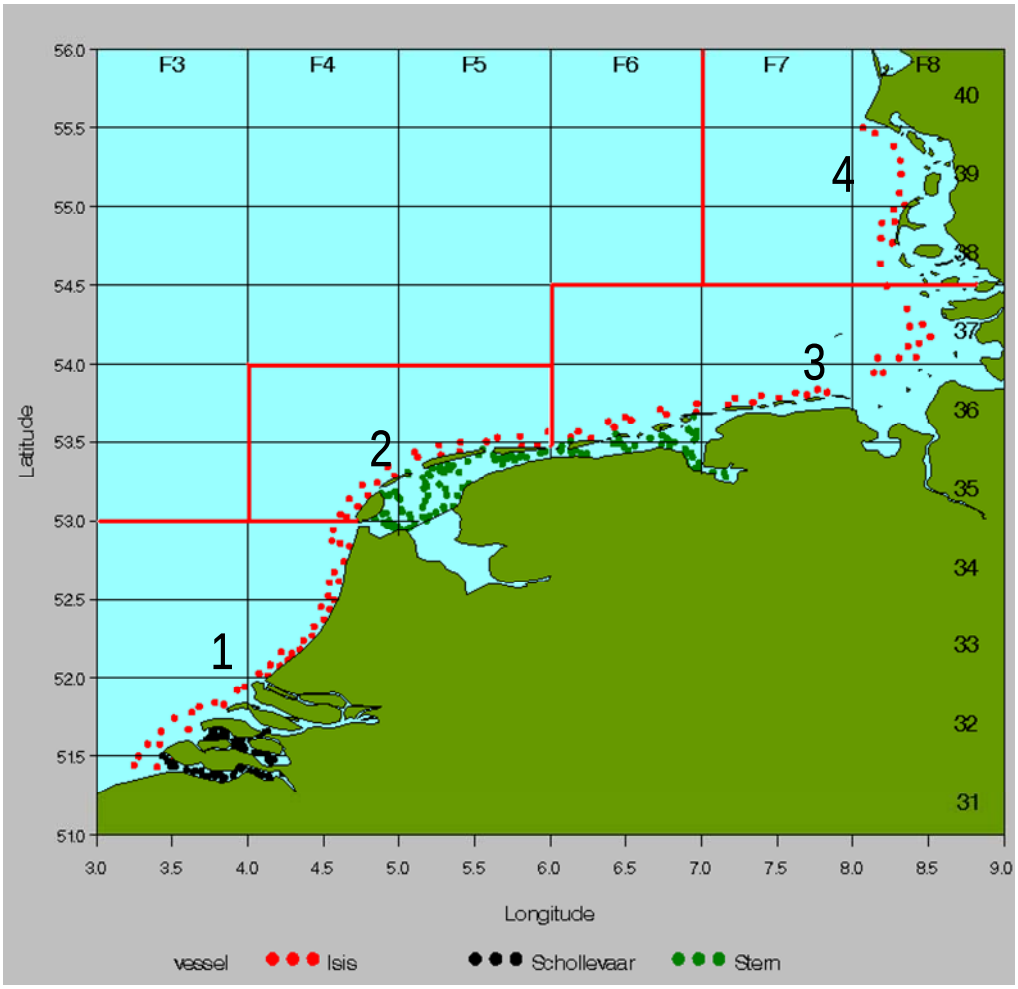


Figure 4.1: Sampling stations of Dutch research vessels (Isis, Schollevaar and Stern) performing the DFS in combination with the surface areas used (Regions 1, 2, 3, 4, Scheldt Estuary and Waddensea) by Welleman & Daan (2001) to extrapolate the density values (Figure from: http://www.surveyswageningenimares.wur.nl/UK).

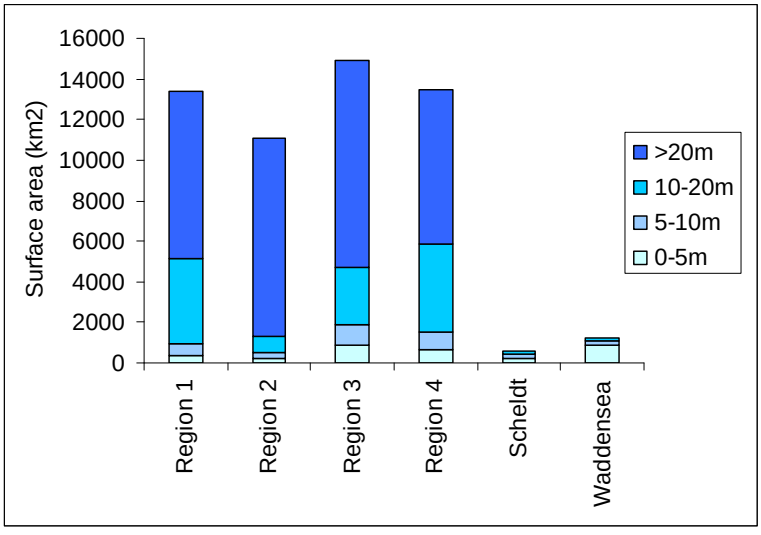


Figure 4.2: Surface area per region and depth strata.

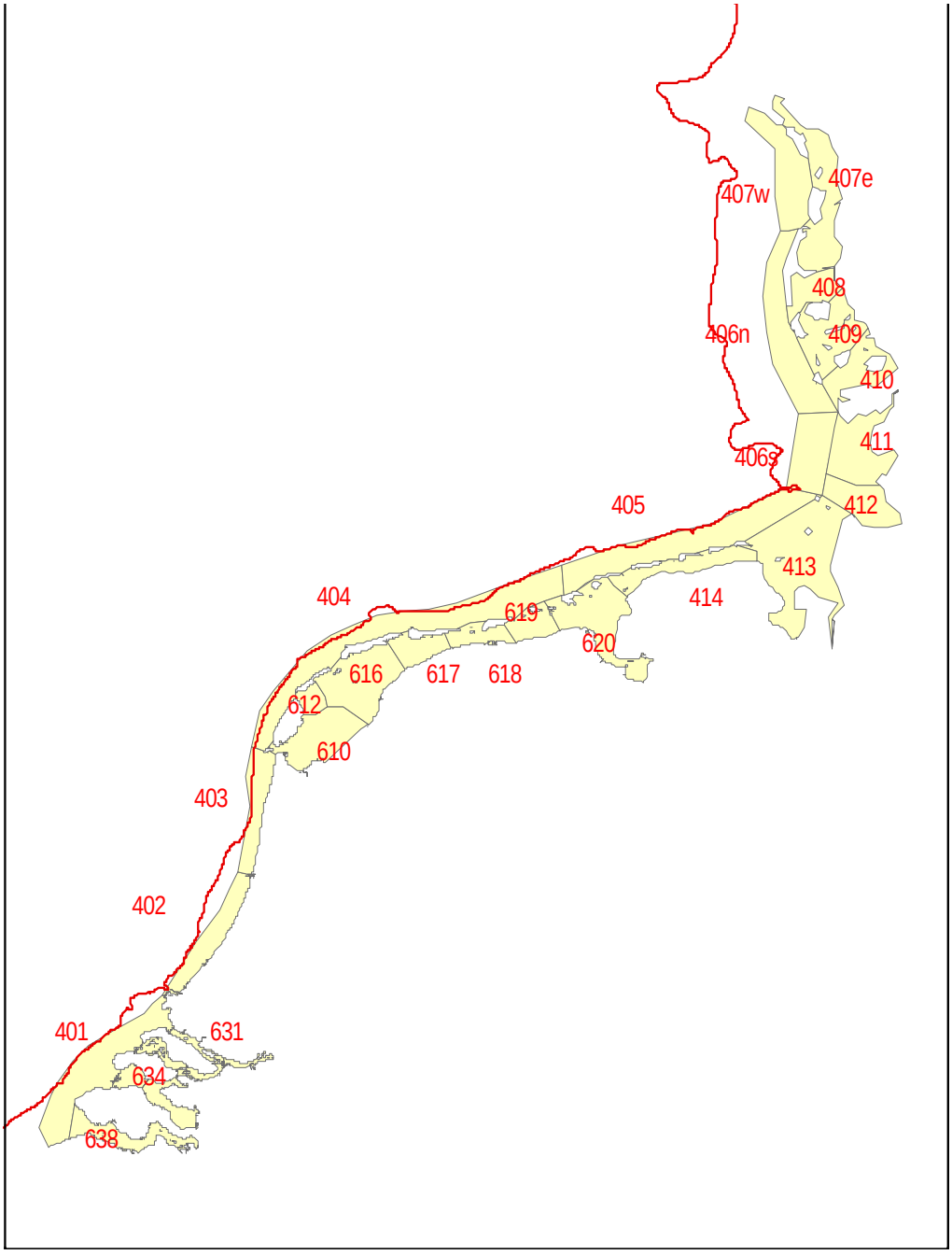


Figure 4.3: DFS areas.

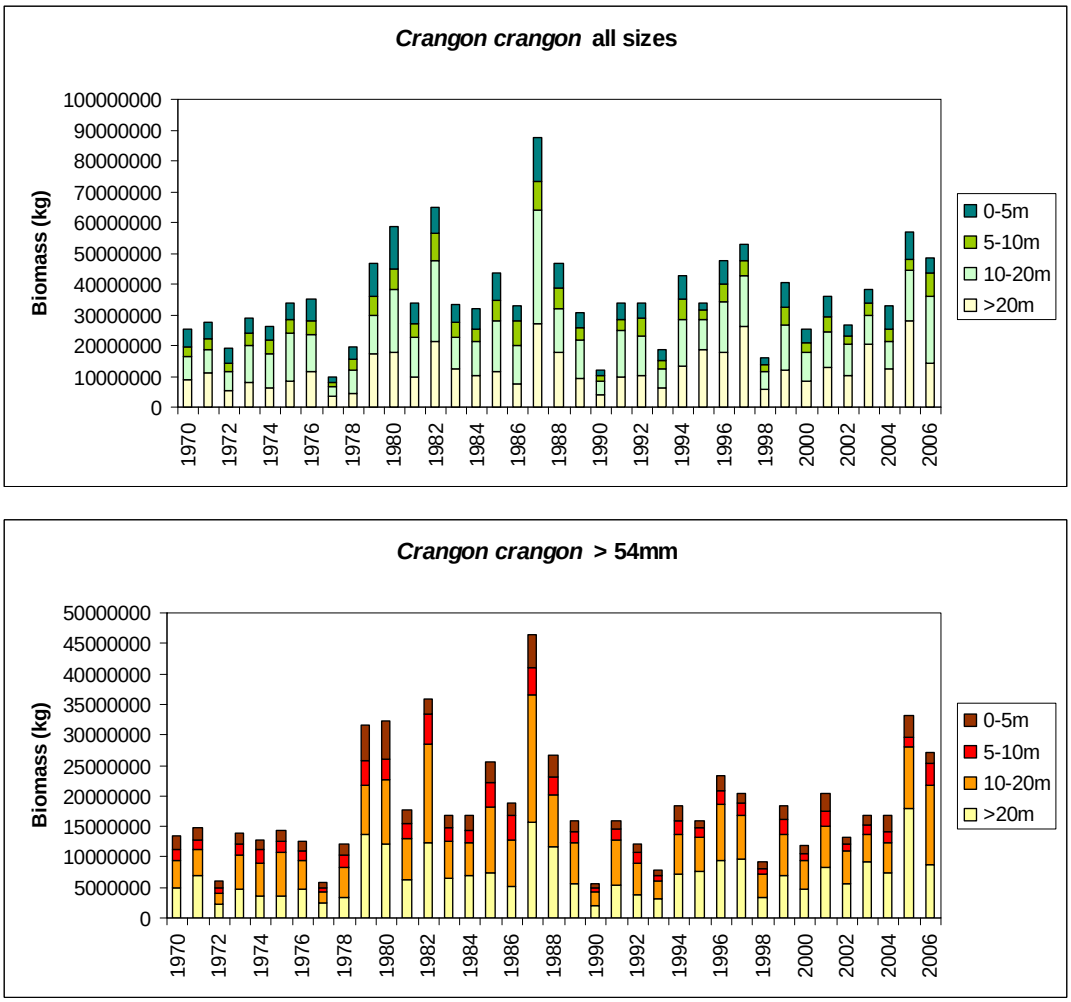


Figure 4.4: Results of swept-area estimates per year and depth class for *Crangon crangon* of all sizes (upper) and larger than 54 mm.

2007 Update

This year an update was made of the swept-area estimate reported in 2007. The results are based on data from the Dutch Demersal Fish Survey by DFS area code and 5 m depth strata for the period 1970-2007. Total stock abundance was estimated by the sum of the stratified arithmetic means of the catch weights multiplied by the surface of each depth stratum. The catchability of the gear is assumed to equal 1. Missing values were imputed using the programme TRIM (Pannekoek & van Strien, 1998). This resulted in an estimate of the *C. crangon* biomass per depth strata and year (Methods for determining this estimate are explained in more detail in the report of WGCRAN 2007).

The estimates show strong year-to-year variations. The total biomass for all sizes vary between 4100 and 37000 tonnes for the period 1970-2007. The long-term average is 17000 tonnes (Figure 4.5). Biomass estimates of *C. crangon* >54mm vary between 2000 and 17000 tonnes, with an overall long-term mean of 7000 tonnes. In 2007 the biomass estimate shows a steep decline in comparison with the previous two years. The total biomass even appears to be around the same low level as in 1990.

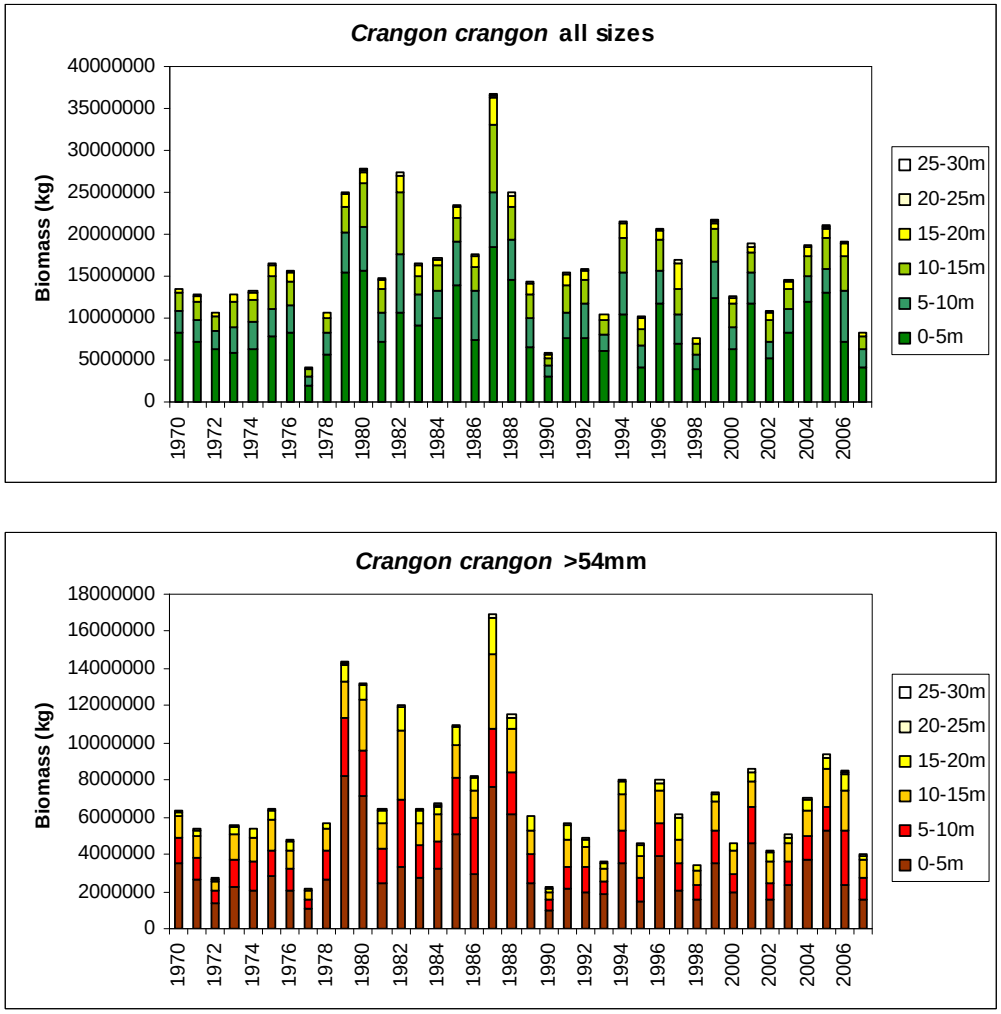


Figure 4.5: Results of swept-area estimates per year and depth class for *Crangon crangon* of all sizes (upper) and larger than 54 mm.

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5 ToR c) Develop an alternative estimate of *Crangon* biomass in the Wadden Sea area

5.1 Alternative biomass estimate of *Crangon crangon* in the Shleswig Holstein Wadden Sea – Meike Martin

Abstract

On the basis of corrected DYFS-Data, relevant variables affecting the distribution patterns in the Wadden Sea were analysed. The most significant factors are year, area and depth. The swept-area estimate was corrected for mesh selectivity and vulnerability. Retention rates were based on research by H. Polet (2000) and adapted to DYFS fishing gear. Vulnerability (catch efficiency) was estimated to be 0,35 based on a paper by H. Reiss (2006).

In a data based method, the densities of *Crangon crangon* within the Fries-areas were calculated for every depth strata. For the years 1987 through 2006, an average biomass of 80 000 tons of *C. crangon* bigger than 12 mm total length per year was estimated. Yet, the variability between years varied from 10 000 tons to >140 000 tons. Since the percentage of *C. crangon* bigger than 54 mm ranged from 2% - 10%, the standing stock of marketable shrimp in the German part of the Wadden Sea in the months September/October was estimated to be on average 4000 tons with a positive trend and very high variabilities (1000 – 8000 t) and exceeding the local landings.

This work is further described in an MSc Thesis by Meike Martin, University of Hamburg, Germany.

6 ToR d) Explore and make available data sources required for the development of a *Crangon* biomass estimate

The following relevant data to improve the *Crangon* biomass estimate were identified:

6.1 The BTS survey data

During the BTS survey (conducted in Autumn), every day two hauls with a 2m beam trawl with 4mm mesh (at a speed of 1 knot) are carried out to sample epibenthos. This has been done for the last 9 years and still continues. It is carried out under the MAFCONS program. This program is carried out in every second ICES Square. An extraction of the relevant has been requested. It is hoped that these data source will give more information on the catches of *Crangon* in water that is deeper than that covered by the DYFS surveys and areas where there is commercial fishing for *Crangon*. A data extraction has been requested.

7 ToR e) Enhance knowledge of *Crangon* catchability

7.1 A review of research on catch efficiency of beam trawls for *Crangon crangon* - Tom Catchpole

The term catching efficiency is generally defined as the number of individuals or the biomass of one or several species that is caught expressed as a proportion of the total population in the area fished.

Ansell *et al.*, 1999:

- *Crangon* catchability is higher at night than during daylight (widely recognized).
- *Crangon* abundance can be affected by tidal cycle.
- Buried *Crangon* show a reduced response to mechanical stimulation by tail flipping compared to individuals on the surface (K. Smith unpubl. obs). Buried shrimps show reduced sensitivity to mechanical stimulus, such as tickler chains, resulting in reduced catching efficiency of the trawl, and hence lower catches by day than by night.

Jeffrey and Revill, 2002:

- Seawater temperature can influence the vertical escape response of *Crangon* to towed gear.
- The catch distribution between three tiers of an experimental trawl (Figure 7.1) showed *Crangon* with a total body length >5 cm moved higher in the water column than smaller *Crangon*. At colder temperatures, a higher proportion of the catch was found in the lower tier.

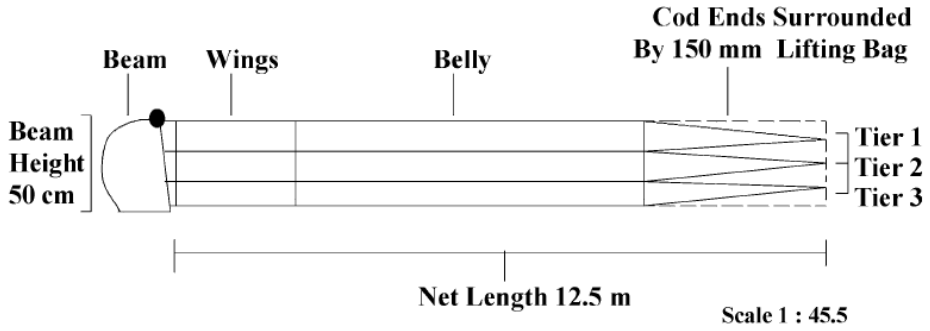


Figure 7.1: Schematic diagram of the three-tier beam trawl (side view).

- A large proportion of the small non-marketable *Crangon* (<5 cm) was in the bottom tier of the three-tier net, irrespective of seawater temperature.

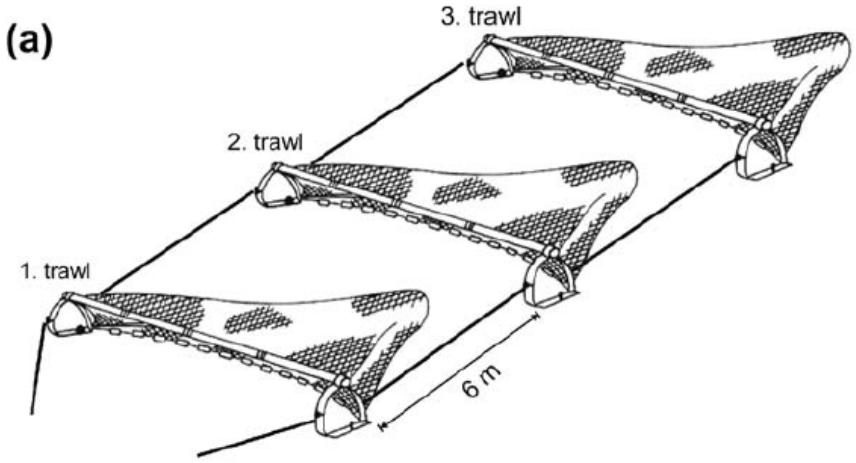
Addison *et al.*, 2003:

- Following research surveys in The Wash fishery, England, linear modelling techniques were used to examine the influence on *Crangon* catch-rates of 18 environmental and physical factors.
- When examining catches by fishing season, month and area, the significant factors effecting catchability were turbidity, depth, sediment type and light.

- Catch rate of *Crangon* remained relatively stable during daylight hours, suggesting that local depletion had not occurred due to consistently towing over the same ground.
- The highest proportion of the variance was explained for the smaller range of shrimps. Therefore, emergence behaviour of smaller shrimps may be more strongly influenced by environmental factors than that of larger shrimps.
- The fishery showed high variability on both an annual and monthly basis, and abundance varies significantly across geographical subareas of the fishery.

Reiss *et al.*, 2006:

- A rig of three beam trawls one behind the other was used to determine catching efficiency for *Crangon*, it was estimated on the basis of the sum of the catches of all three trawls relative to the numbers caught in the first trawl.
- A standard 2m sampling beam trawl with a chain mat attached and fitted with a 20mm stretched mesh and a codend liner of 4mm knotless mesh.



***Crangon* crangon catch efficiency (%)**

	Station 1	Station 2
Abundance	43±6	31±7
Biomass	40±6	28±5

Wennage *et al.*, 1997:

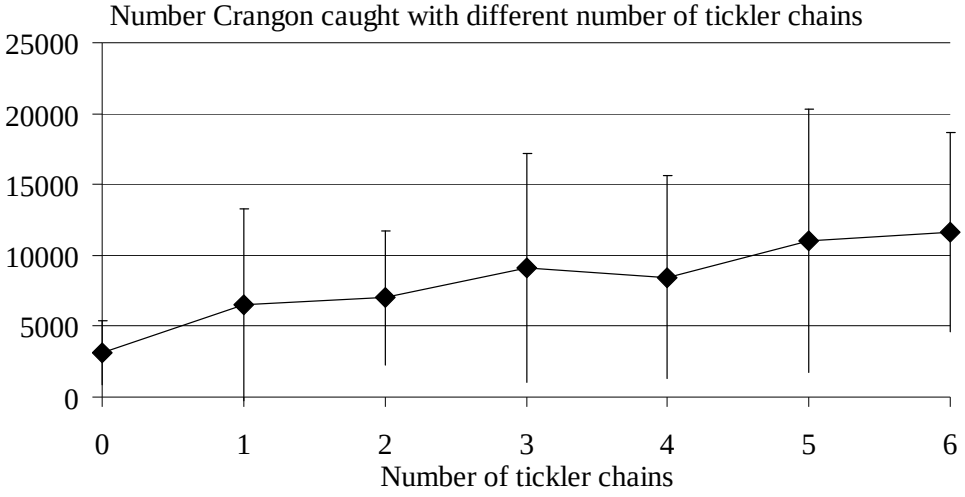
- The efficiencies of a 2m and a 1·5m beam trawl for catching brown shrimp were compared with that of a 1m^2 drop trap that was assumed to be 100% effective (Table 1).
- The 1.5m beam had a catch efficiency of 45-58%; the 2m beam 6-28% (by number).

Table 1. Summary details of gears and samples taken during efficiency measurements

	1·5m beam trawl	2m beam trawl	Drop trap
Dimensions	1·5m beam, 0·29m beam height, net 2·4m long	2m beam, 0·46m beam height, net 3·5m long	1x1x0·6m high
Tickler chain	One	Three	—
Mesh size	8mm stretched mesh with 3mm cod-end liner	20mm stretched mesh with 3mm cod-end liner	Solid aluminium sheet walls, 3mm mesh dipnets

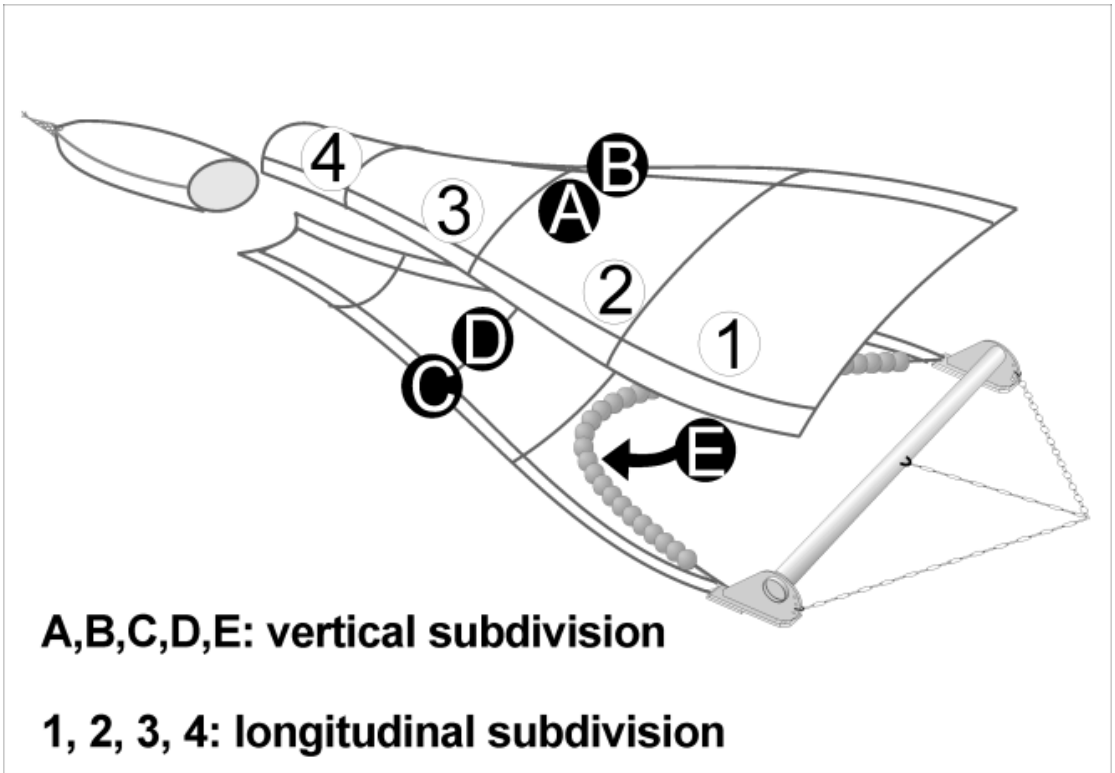
Creutzberg *et al.*, 1987:

- An analysis of groundrope effect on the efficiency of beam trawls; conducted hauls with different number of tickler chains.
- 5.5m beam length, as used by Dutch IBTS survey, 10mm codend, 8x7 hauls each with 0-6 tickler chains.
- Increasing number of tickler chains provided increased catches of *Crangon*

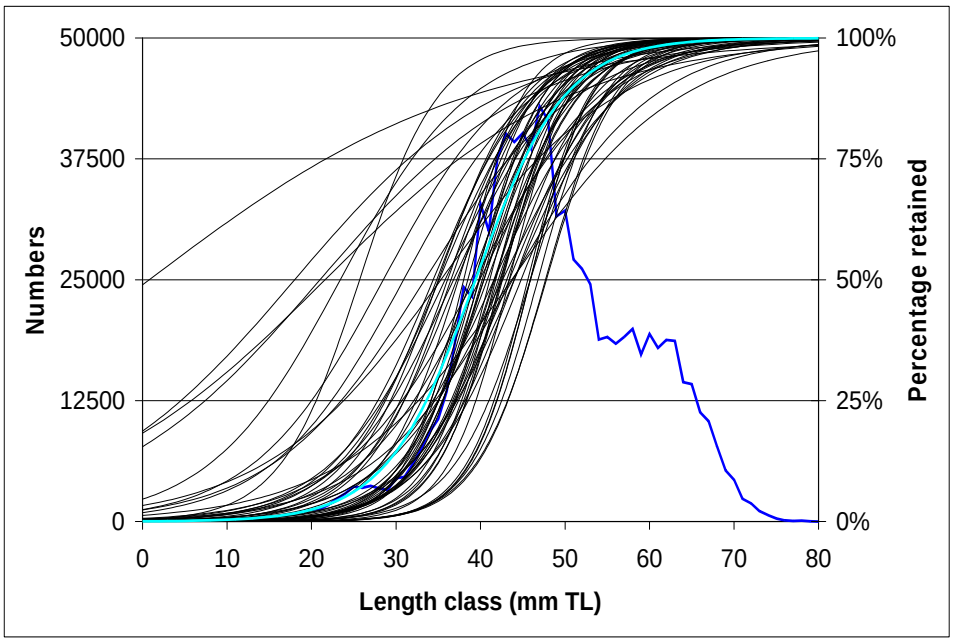


Polet, 2000:

- Estimating the selectivity of a commercial shrimp beam trawl (beam length of 8m, groundrope 9.8m, mesh size of 28mm in the front part decreasing to 22mm in the aft, 80mm lifting bag)
- Codend cover 11mm mesh size plus small mesh pockets at 16 locations on the trawl rigged with small floats or weights where necessary and two small mesh nets rigged to catch the animals escaping underneath the groundrope.



- 63 hauls, 59 for codend selectivity, in 39 the catches of the pockets were also measured.
- Codend selectivity: mean L50 for *Crangon* was 39.4 mm (37.0 – 41.8) and the SR was 11.6 mm (10.2 – 13.0).



- Codend selection ogive (light blue) shows that at least some individuals below 65mm length class and most below 40mm escape the trawl (population in dark blue).
- Haul duration, speed through the water, state of the sea, catch volume, clogging of the meshes, water temperature were all significantly correlated with L50.

- Most large *Crangon* end up in the codend but for smaller *Crangon* net selectivity is far more important than the codend selectivity (for *Crangon* <45mm TL, 44% escaped through the net meshes and only 23% through the codend meshes).
- 8% of all *Crangon* escape underneath the groundrope, without length dependency.
- Escape opportunities for shrimps decrease from the anterior part to the posterior part of the net, especially for the larger animals.

Conclusions

This is not an inclusive review, however, it is apparent that catch efficiency of beam trawls towards *Crangon crangon* is affected by many factors (sediment type, turbidity, light, temperature, tidal state, sea state, depth, behaviour, population structure, catch composition, catch volume, gear configuration). Therefore, the efficiency of beam trawls in catching *Crangon crangon* will be highly variable.

The data from previous work indicates that catchability of *Crangon* in beam trawls is in the range of 0-60%. This has implications for biomass estimates and even estimating an index of abundance. Only under the assumption that that catchability of *Crangon* is comparable between years can interannual differences in *Crangon* abundance be identified from survey or commercial data. In the biomass estimates presented herein catchability was assumed to be 35% and 100%.

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8 ToR f) Review of MSC certification process

8.1 Current projects on brown shrimp fisheries in the Netherlands related to developments in the Wadden Sea fisheries in general and the MSC certification process

1) 1. Pilot discard programme (financed by ministry)-(Ingrid Tulp)

2) 2. MSC related projects (financed by MSC project)-(Floor Quirijns)

1. Pilot discard project

The Dutch Ministry has commissioned a discard programme within the management supporting research programme to determine the bycatch (shrimp and non-shrimp) in the Dutch Wadden Sea shrimp fisheries. The aim is to get an estimate of discard percentage and the variation of that in space and time. The project will be carried out in 2008 and 2009. In every year five week trips (or more shorter trips if possible) will be made on board commercial vessels. The first trials were aimed at developing a workable protocol. Problems encountered were the fact that in the modern rotary sieves the discarded fraction is immediately flushed overboard at a high speed with a strong water current. It is difficult to sample this, while hanging overboard. The procedure to subsample the catch (one bucket) and first process the remaining catch and then the subsample runs into the problem that the rotary sieve is not at all clean of shrimps. Another problem is that on some vessels the discard fraction is discarded under water.

2. MSC related projects

One conclusion of the MSC pre-assessment was that discard mortality should be reduced. In cooperation with three groups of 5 shrimpfishers based at three different harbours, researchers of IMARES and Kuiper&Burger try to investigate the following subjects in a series of small pilot projects:

a) Reduction amount of discards through net adjustments

b) Improve survival discards:

- In the sorting process
- Due to bird predation

a) The aim is to find adjustments that reduce mortality. The results of pilots can be used in follow-up projects. We will not try to reinvent the wheel but to build on existing adjustments and previous research. The question is how to reduce discards, without loosing too many shrimps. There are several options for net adjustments. Escape panels on the bottom side of the net resulted in a high loss of brown shrimp. Sieve nets are already in use. A new approach is the so-called letterbox, a hole in the net (~1 meter width, height can be adjusted) in the top of the net. The first trials with this adjustment seem successful (less discards, few shrimp losses).

b) To evaluate the effect of the sorting process the survival rate is measured in several stages of the process: in fish that are just brought on deck and in fish at the end of the sorting process. We compare these to survival of a control group, consisting of fish that were obtained in a very short haul. We hope to identify the effects of the length of process and of the type of rotating riddle (by comparing ships with different systems).

Predation by birds will be investigated by recording bird behaviour using (video)cameras and compare trials where fish are discarded under water as opposed to over the water surface. Also the effect of bird scaring by means of long glittering ribbons will be investigated.

Another conclusion from the MSC-assessment, the worry on the effect on bottom disturbance will not be investigated within any of these programmes.

8.2 An update on the North Sea brown shrimp fishery MSC assessment

A presentation was made to the WGCRAN by two non Working Group Members conducting the Marine Stewardship Council assessment for the North Sea brown shrimp fishery. The assessment process and the progress that had been made in the assessment were given. Based on some of the principles outlined in the MSC criteria a number of questions were put to the WGCRAN members:

MSC Principle 1

A fishery must be conducted in a manner that does not lead to overfishing or depletion of the exploited populations and, for those populations that are depleted, the fishery must be conducted in a manner that demonstrably leads to their recovery.

*Can landing per unit of effort (LPUE) be used as a **reference point** to estimate of stock status. Yearly biomass production of the stock is estimated to be several times larger than the actual biomass of the stock, which makes a stock assessment based on VPA analysis impossible.*

Questions:

Is LPUE a reasonable reference instrument?

Can we define reference points, can LPUE serve as a surrogate?

Can we accept that the catch level is low enough in comparison to this reference level?

*Is it safe to assume that there is low risk that the **stock** is overexploited. The LPUE is stable or increasing? Catches have remained at a constant level during a number (how many) of years.*

*Can we adopt a **harvest control rule** that adapts to LPUE. For example, if LPUE-lim is passed, there will be a reduction of effort*

*What progress has been made with **stock assessment**?*

MSC Principle 2

Fishing operations should allow for the maintenance of the structure, productivity, function and diversity of the ecosystem (including habitat and associated dependent and ecologically related species) on which the fishery depends

Reduction of discards is being developed/tested that demonstrates that the quantity of discards. How can we demonstrate with sufficient certainty that these discards do not significantly hinder the recovery or status of the stock?

It is important to be able to identify if the fishery causes serious or irreversible harm to the key elements of ecosystem structure and function. This is a very difficult criteria to fulfil as it assumes an understanding of ecosystem functioning. Is it possible to design a conceptual model for the effect of shrimp fishing on the ecosystem?

MSC Principle 3

The fishery is subject to an effective management system that respects local, national and international laws and standards and incorporates institutional and operational frameworks that require use of the resource to be responsible and sustainable.

There are management systems in place, but we have noted that there is a lack of regular monitoring and little feedback between management and science. This is a point of concern, which we would like to discuss with the group.

WGCRAN response

Responses were made verbally by WGCRAN members to each of the points raised. In summary, it was made clear that the LPUE was not used as a reference point and would not be appropriate for this purpose. There is no relationship between the stock size in one year with the stock size in the next, therefore the utility of an annual assessment of the stock was questioned. A number of presentations were made (herein) which demonstrate the progress that has been made with estimating the stock size. The relationship between *Crangon* catches made by surveys at different times of the year (Autumn and Spring) is currently the only potential means to forecast catches within the same year. Due to the numerous anthropogenic and environmental effects on fish stocks it was considered that it was not possible to state whether discards from the *Crangon* fishery hinder the status of stocks (although some work to establish possible effects on fish stocks was undertaken in the ECODISC EU project). The group also highlighted the deficiencies in the discard data for the *Crangon* fishery and the scarcity of data on the bottom disturbance. To address these points WGCRAN put forward some proposed studies, which would aid the MSC assessment process (see Recommendations).

9 ToR g) Review recent *Crangon* related R & D activity

9.1 Update on Project 'PULSKOR'- Bart Verschueren

'Development and demonstration of a selective electro-trawl for the brown shrimp fishery, with the focus on reduction of discards and bottom impact'

The discarding practices associated with the brown shrimp fishery have been regarded as a problem for many years. The poor selectivity of the small-meshed nets produces very high amounts of unwanted bycatch. Especially the bycatch of very young flatfish species, like sole and plaice has a significant influence on the commercial fish stocks. Consequently the implementation of adequate selectivity enhancing measures could result in both ecological and commercial improvements.

Current technical modifications for bycatch reduction in the *Crangon* fishery, like sieve nets, focus on catch separation or filtering after species have entered the trawl. Damage incurred by contact, or stress caused during the capture and escape process may lead to higher discard and escapee mortality (ICES, 2000). Catchpole *et al*. (2007) has shown that sieve nets are satisfactory effective at reducing bycatch levels of cod and relatively large fish of all species, but less so at reducing 0 group plaice, which make up the largest component of the bycatch. Because of these drawbacks alternative measures are needed. A proposed measure is the use of electric pulses as means of stimulation for the target species. Whereas formerly tested modifications are based on physical size differences between the target species and the bycatch, is

the latter based on different behavioural responses. The purpose is to avoid the entrance of non-target and undersized species.

Experiments with electric pulses have been carried out in the past in many areas in the world. The main purpose of these experiments was to obtain higher commercial catches, with no or very little attention to selectivity and bycatches.

The potential of electric pulses as a means to develop a species selective electro-shrimp trawl was first studied in Polet (2003). The basic idea was to invoke selectively a startle response for shrimp with electric ticklers and to allow non-reacting species to escape underneath a raised groundrope (Figure 9.1.1). A feasibility study was set up aiming at the development of an experimental electro-trawl. This study enclosed observation experiments, survival tests and sea trials.

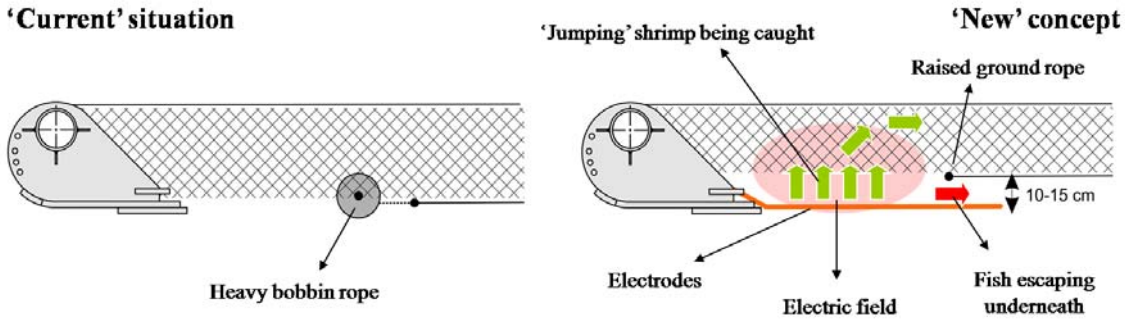

Figure 9.1.1– Shrimp beam trawl, altered for electro-fishing.

It was concluded that the experimental electro-trawl with raised groundrope and small meshes in the top panel gave satisfactory results. Losses of commercial shrimp catches were relatively small and part of the undersized commercial fish catch could escape and especially non-commercial fish and invertebrates were caught in lower numbers compared to standard nets (Polet, 2003).

It should, however, be borne in mind that the sea trials in this project only covered a short time range. For this reason, it was recommended to elaborate this research. An extensive range of sea trials on commercial vessels in different conditions should precede commercial application.

Therefore a national, follow-up project was initiated in January 2007 in Belgium, named "Pulskor". The objectives are the development of an electric shrimp trawl optimized for the use in commercial *Crangon* fisheries in the North Sea that:

- improves species and length selectivity
- reduces bycatches
- reduces bottom-impact
- improves catch quality
- creates possibilities for an eco-label

The project tasks are divided over a two-year period and are as follows:

2007

Development and construction of an optimized impulse generator, electrodes and supply cable winch

- integration of the gear in an altered shrimp beam trawl

- construction an installation of on-board infrastructure on a selected testing vessel

Spring and summer 2008:

- extensive experimental testing at sea in commercial circumstances

The development and construction of the new impulse generator, electric cable winch, other on-board infrastructure and the modified beam trawl itself was a long and tidy process en was ultimately finalized in March 2008. Extensive experimental testing at sea in commercial circumstances started in April. Due to hampering situations, so far only four short daytrips with the system were undertaken. Hereby the main focus was practical testing, adjusting and getting to know the gear. Catch data gathering was initially limited to measuring volumes of commercial shrimp and discarded shrimp. First preliminary results are satisfactory at the first sight but to premature to be shown at this WGCRAN meeting. An elaborate report on the results of the ongoing extensive testing will be finalized and presented by next year's meeting.

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9.2 Visualisation of VMS-data using OceanDataView® for Shrimping Activity - Thomas Neudecker and M. Stein

WGCRAN realized since many years, that it was not possible with existing data and methods to prove the regional activities of shrimping fleets in the southern North Sea in an acceptable manner (ICES WGCRAN, 2003, LRC/G:01). Either data were not available, could not be presented or were available only on an ICES square basis, an artificial regionalisation not taking into account naturally given structures. Nevertheless, on the basis of these ICES squares it was possible to demonstrate for the German fleet in principal, seasonal as well as annual shifts in distribution (ICES WGCRAN, 2007, LRC/G:08), i.e. the shift from inshore waters in summer and autumn to more offshore regions in winter and the north bound shift of the fleets into Danish waters in recent years especially in winter.

However, existing VMS data since 2004 give a much more precise database. Shrimpers above 15m in length need to deliver according to EU-regulations, position, direction, speed data etc. every two hours when active. Only one record per day is necessary during harbour lay days. This gives an enormous amount of data leading to the opportunity of plotting fairly precise fishing areas and places of lay times for each single vessel. For reasons of confidentiality data are transferred to anonymity and shall not be used for single vessels.

The oceanographic software ODV, OceanDataView® (SCHLITZER, R., 2004. Ocean Data View, http://odv.awi.de/), though developed for oceanographic needs, can be applied for visualization of VMS or any other data. It is freely available for public

scientific use. For the visualization of fishing positions and activity latitude, longitude, date, time, speed and a substitute for the official vessel number are needed. It deserves a special handling of the software by using the requested "BottomKnots" as well for the vessels speed and selections.

Table 1: Parameters used for visualizing VMS-data with ODV

No.	Vessel	Knots [nm/h]	Lat	Lon	Date	BottomKnots	Time
1	U	0	53.317	7.281	12/29/2004	0	14:30
2	M	0	53.317	7.281	12/29/2004	0	15:30
3	O	0	53.317	7.281	12/22/2004	0	16:30

ODV has incorporated already the GEBCO Bathymetry codes on one-minute grid level (http://www.bodc.ac.uk/data/online_delivery/gebco/) giving good land and depth contours. If special training is necessary it may be requested from **manfred.stein@vti.bund.de**.

For a first trial only the available data from a small shrimping fleet of six vessels were extracted from the VMS-database for the period January 2004 to April 2008. These data comprised 52803 stations with respective records from vessels registered for the harbour Ditzum (Ems River Estuary). As ODV allows for selection of data in various directions, speed was used for pinpointing fishing activity, assuming that the known speed during shrimping is between 2 and 4 knots, while harbour lay days or anchoring should naturally show 0 knots and travelling speeds are normally higher than 4 or 5 knots influenced by wind and tidal currents. The selection for 2 to 4 knots gives 27892 datasets, almost a splitting by half.

Figure 9.2.1 shows how well the selection for fishing speeds fits the known information of "about 3 knots". The recorded speeds reflected by a colour spectrum can also be plotted into a map as given in Figure 9.2.2.

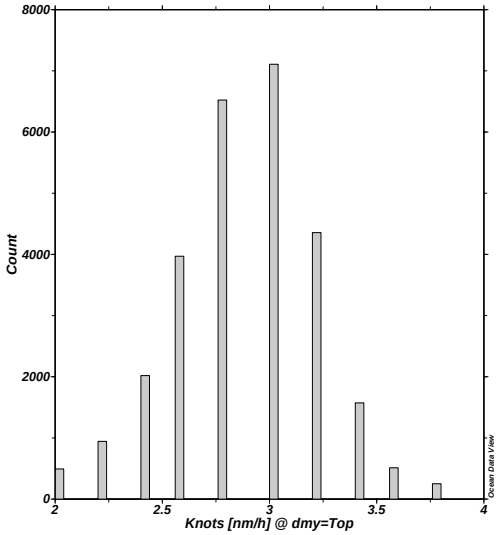


Figure 9.2.1: Frequency distribution of speeds between 2 and 4 knots reflecting towing speeds in the shrimping activity of a small German fleet of shrimpers calculated and plotted by ODV software

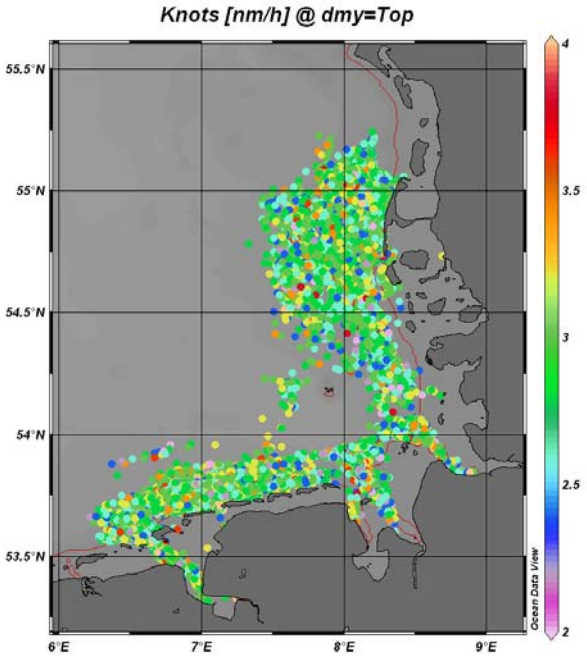


Figure 9.2.2: Regional distribution of positions and speed records between 2 and 4 knots reflecting the shrimping activity of a small German fleet of shrimpers calculated and plotted by ODV software.

From Figures 9.2.3 and 9.2.4 the geographical range of activity can be seen clearly. It goes from the Dutch area northwest of the island Schiermonnikoog, the outer Ems region, to the Danish waters west of Fanö. Due to overlapping of many positions especially in harbours and heavily fished areas the visual effect in the maps of the heavily reduced record number in Figure 9.2.4 is not intense. However, it can bee seen that many positions northwest of Helgoland are missing which are records of speeds more than 4 knots reflecting steaming periods from or to the fishing ground "Amrum Bank" west of Sylt and Amrum. Furthermore the general importance of certain areas for that small fleet can be seen, namely the river estuaries of Ems, Jade-Weser and Elbe as well as the regions off shore of the East Frisian and North Frisian Islands plus some spots west-northwest of Helgoland.

Besides the general regional information more detailed knowledge may be of interest e.g. the seasonal variations of the fishing activity by half year or even months. These data selections are plotted in Figure 9.2.5 (Jan-June) and Figure 9.2.6 (July- Dec) for all years combined. Besides the almost identical fishing (record) intensities in both periods it is shown, that the region of the eastern part of the East Frisian Islands is less fished in the second part of the year, while there seems to be some shift towards the coast and into the river estuaries. To get a better look at that, only finer selections by month can help. This has been done and the results are given in Figure 9.2.7. The lower numbers of records by month also show the seasonal activity pattern as reflected in Figure 9.2.8. Both figures show the very low number of records, which

reflects a very low fishing intensity, especially in January and February. The fishery is intensified in March. The regional distribution is off shore north of the East Frisian Islands respectively west of the North Frisian Islands. According to the depth contours given by ODV, depths down to 30 metres are fished further off shore. In April the fishery is fully developed but leaves out the Elbe estuary and partly the Jade-Weser region as well. The shift from off shore towards close to the shore is clearly seen from March to June. In July and August there is hardly any fishery by that fleet in the Sylt region. The number of records has in total gone down a bit (Figure 9.2.8), but the river estuaries, especially the Ems estuary becomes very important for the fleet based in that area. From September onwards counts in the Sylt region become more frequent again and towards December the off shore shift is clearly visible characterizing the winter situation in commercial shrimp distribution.

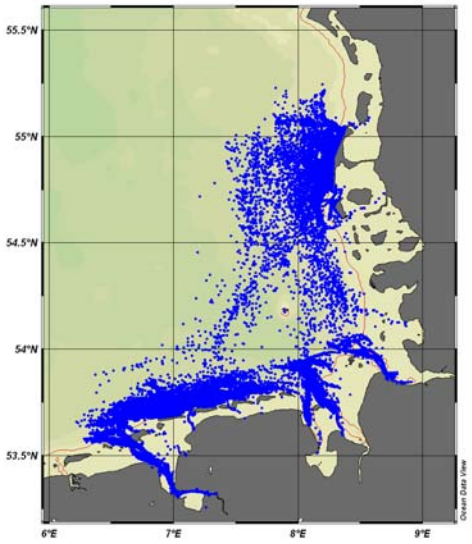


Figure 9.2.3: All VMS 52803 records for a small fleet of 6 German shrimpers from Ditzum in the period Jan 2004 to April 2008

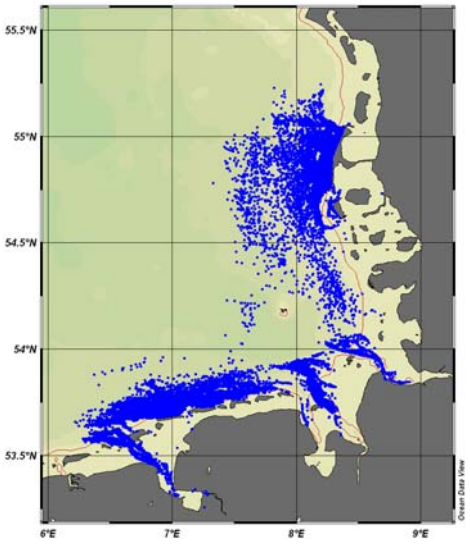


Figure 9.2.4: 27892 datasets selected for speeds between 2 and 4 knots reflecting fishing activity

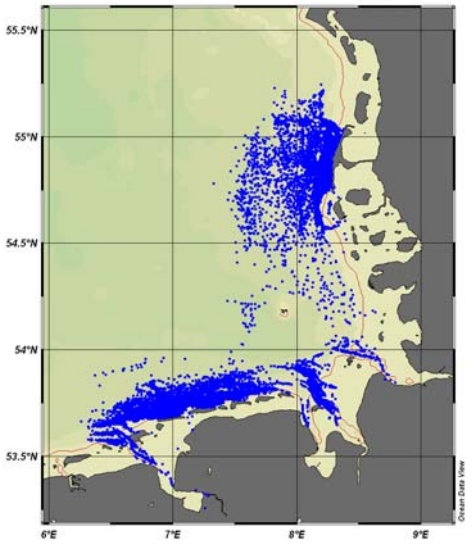


Figure 9.2.5: 13899 datasets selected for speeds between 2 and 4 knots and the period Jan – June reflecting fishing activity in 2004 - 08

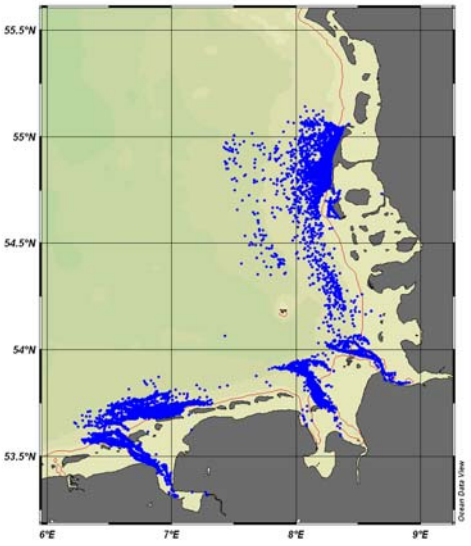
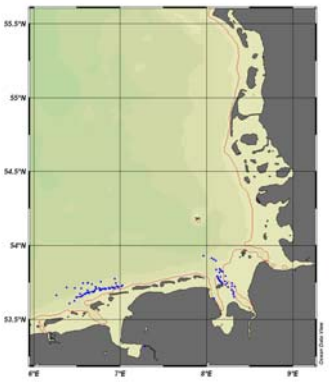
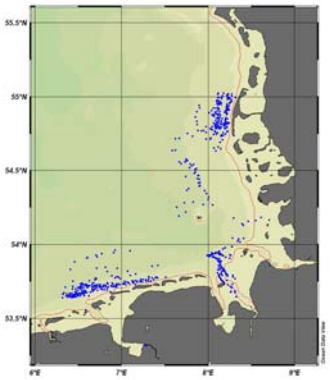


Figure 9.2.6: 13993 datasets selected for speeds between 2 and 4 knots and the period Jul – Dec reflecting fishing activity in 2004 - 08

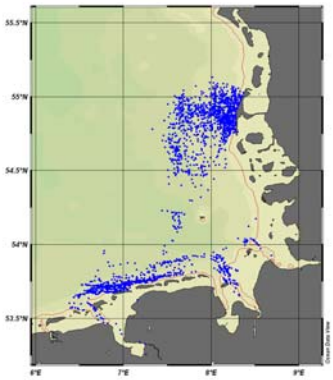
January



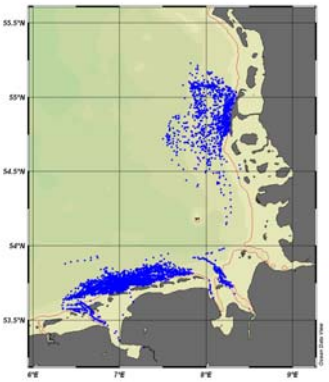
February



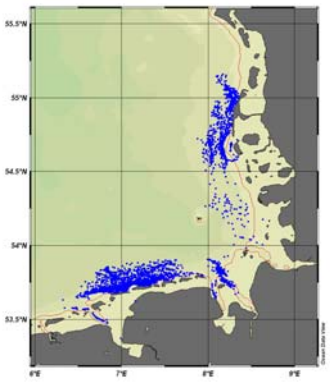
March



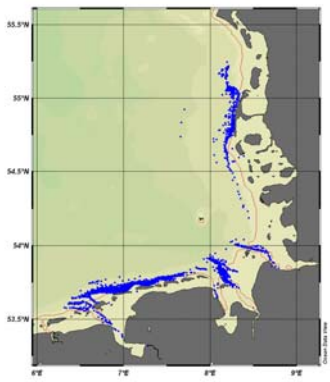
April



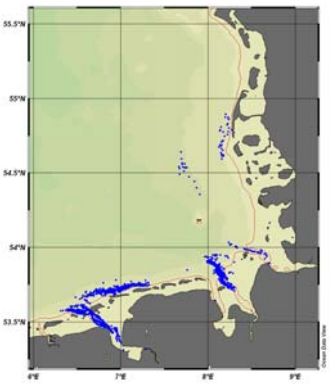
May



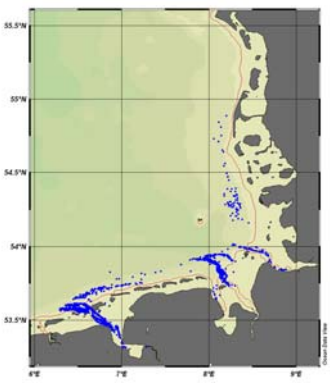
June



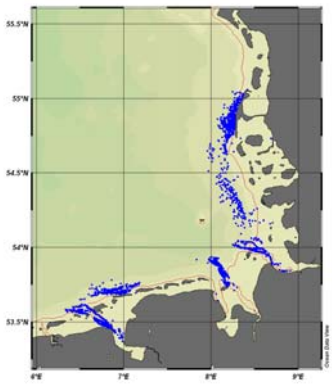
July



August



September



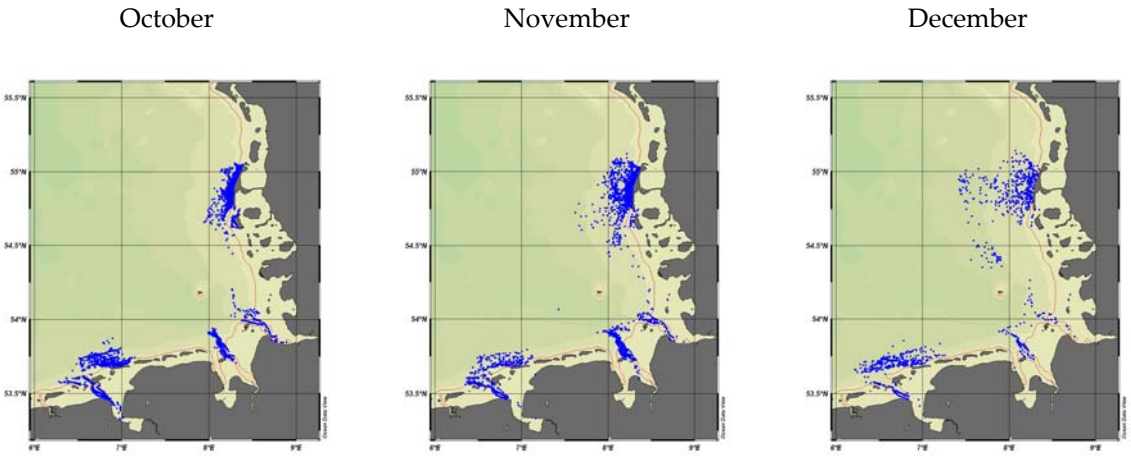


Figure 9.2.7: Monthly combined VMS records for the time January 2004 to April 2008 for a small fleet of 6 shrimpers.

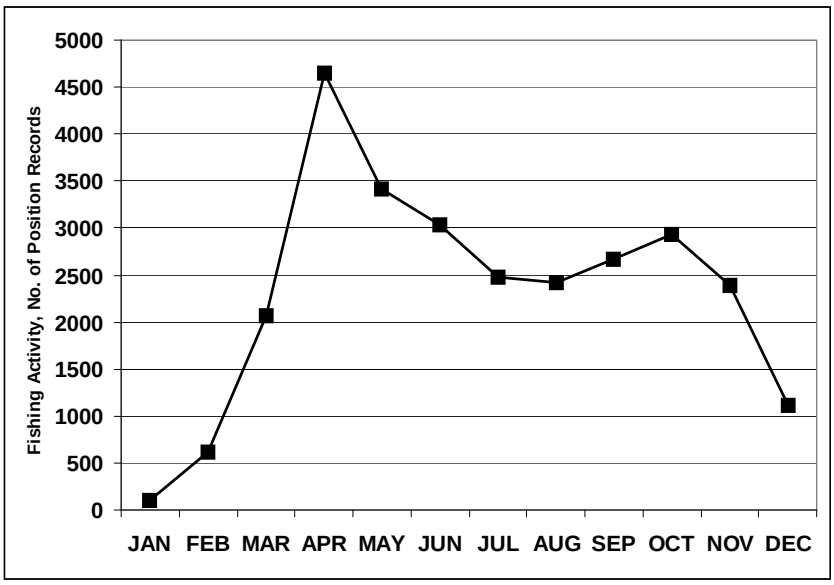


Figure 9.2.8: The monthly combined VMS records for the time January 2004 to April 2008 for a small fleet of 6 shrimpers show a bimodal curve which is biased by the 5 years data from 2004 to 2008 for January to April, while the rest accounts only for 4 years (2004 to 2008).

In this preliminary study, based on only few vessels from a specific harbour, seasonal shifts could be demonstrated from close to the shore fishing in summer to further off shore activities in the colder period, much better than in the previous ICES rectangle based approach.

The importance of the river estuaries could also clearly be seen at certain times of the year. This has implications on the relevance of river deepening.

Annual differences or shifts may also be detected though the time basis of four years seems to be a bit short and it is not possible to extrapolate to former periods. As it is known that fishermen from specific harbours have preferences for certain areas, it is not possible as well to extrapolate the findings from this preliminary study to the rest of the German or other fleets, which comprise a total of about 550 shrimping vessels active from the Channel to northern Jutland and in the German Bight.

However, it may be possible to get a more complete picture of the shrimping activities of the fleets by working up existing VMS data and following the regional changes of that fishery by extending the exercise to future data coming in daily due to the EU regulation.

9.3 Fishing intensity by Dutch shrimp vessels as recorded by VMS - Floor Quirijns and Ingrid Tulp

Since 2004 VMS data have been collected of Dutch shrimp trawlers of >15 m length. This selection includes ca. 50% of the vessels and 60% of the fishing effort. Based on the sailing speed a distinction can be made between vessels that are steaming and vessels that are fishing. In Figure 9.3.1 only vessels that were actually fishing have been included. The colours indicate the intensity of fishing (number of recordings per year) in the period 2005-2007. Apart from the Dutch coastal zone, fishing grounds in rather deep water off the Danish coast are important areas for the Dutch fleet. The intensity in the Dutch Wadden Sea is probably underrepresented because this area is mostly visited by the smaller vessels that do not have VMS on board.

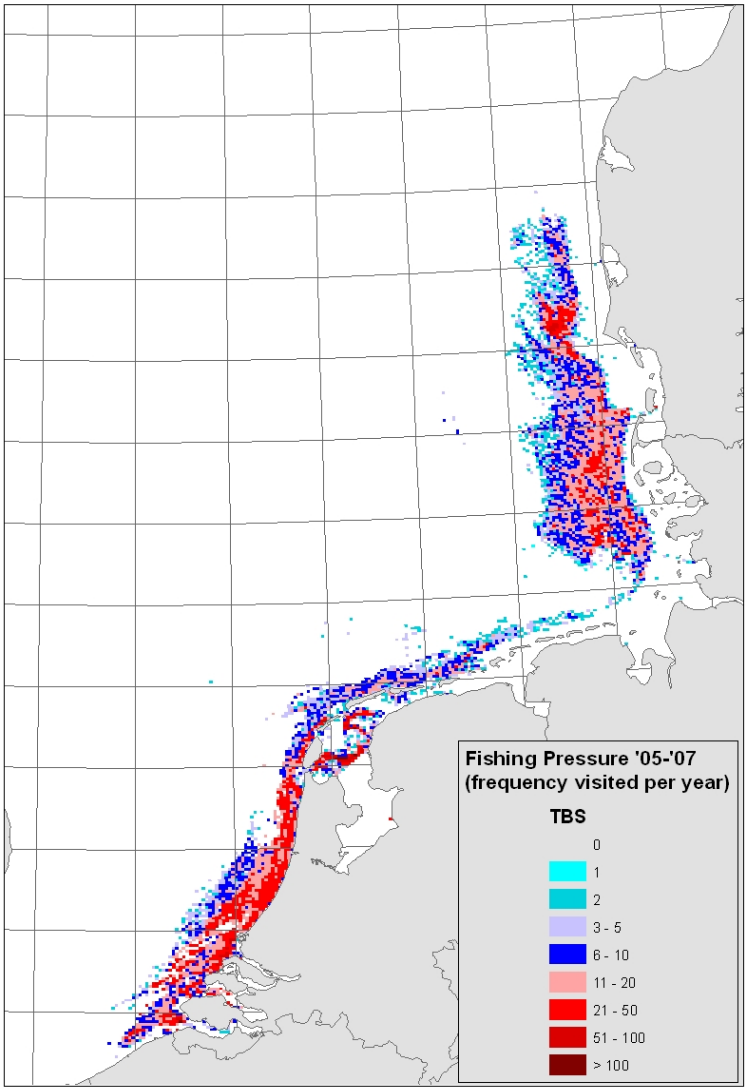


Figure 9.3.1

9.4 DCR Data Collection Regulation – Volker Siegel

Since 2007 the European Data Collection Regulation (DCR) has also become mandatory for the shrimp fishery on *Crangon crangon*. Since biological data collection has been carried out by observers in German waters during three commercial operations. In June 2007 and April 2008 data were sampled on shrimp vessels off North Frisia, while in August 2007 samples were collected in East Frisian waters. Preliminary results from 2007 were presented to the Working Group to demonstrate the feasibility as well as the shortcomings of the current DCR requirements in force. Data for length frequency distributions were separated by species (*Crangon crangon* and *Crangon allmanni*) as well as for sexes and ovigerous females. Data were obtained from the commercial fraction (market landing fraction) as well as from the discarded portion of the entire catch. Details on the sampling procedure are described in detail below.

The analysis of the species composition showed that most of the specimens collected were identified as *C. crangon*. In June 2007 about 1% of the discarded catch consisted of C. allmanni, but this species was neither found in the market samples of the June commercial operation nor in any of the discard or market samples from August 2007. However, fishing in June was carried out in 10 to 15 m water depth only, and a higher proportion of C. allmanni may be observed in the catches during other times of the season when fishing occurs in deeper water.

Length frequency distributions of *C. crangon* from discard samples show a clear dominance of smaller shrimps between 25 and 57 mm (Figure 9.4.1). It is interesting to note that a small amount of shrimp larger that 50 mm, which is of commercial size is discarded after first sieving of the catch. The discard fraction of the catch was dominated by male shrimp. Females of the discard samples were mostly non-ovigerous females. The retained commercial market samples consisted of shrimp larger than 45 mm and were almost exclusively female shrimp. In June the females in the market samples were egg-bearing females. In The situation was similar in August, however, due to the *Crangon* life cycle and the resting phase of the adult stock, female shrimp in August were not carrying eggs.

Quantitative analysis of the proportion of discard and market samples revealed that in June 2007 after the first sieving process 77.8 % of the total number of shrimp in the catch were discarded. The proportion was very similar in August 2007, reaching 78.8 % by number. If the length frequency distributions are converted into length weight distributions, the proportion of discarded shrimp could be estimated as 63.7 % of the total weight of the shrimp catch.

The Working Group noted the importance of the information derived from the commercial samples, especially the collection of data from the discard and market fraction of the catches and the separation of the shrimp sexes. These can supply additional information on the biology of the species and will facilitate future length based assessment of *Crangon*, which is known to show for example sex differentiation in growth rates.

Taking note of the current regulation for 100 length measurements per sample for each 500 t of landing weight and recognizing that this covers only the commercial fraction of the catch, the German representatives of the Working Group formulated the following recommendations:

- Include the discard fraction of the catch in the required length measurements, accordingly increase total sample size to 200 measurements.
- Request spreading of data collection effort across quarters of the year.
- Request species delineation (*C. crangon. and C.allmanni*).
- Request shrimp sex discrimination for discard and market samples.
- Request data collection along the routine protocols for DYFSurveys and standardize sampling on board commercial vessels (draft description of the German data collection on commercial shrimp vessels is attached as an example to the report of WGCRAN).

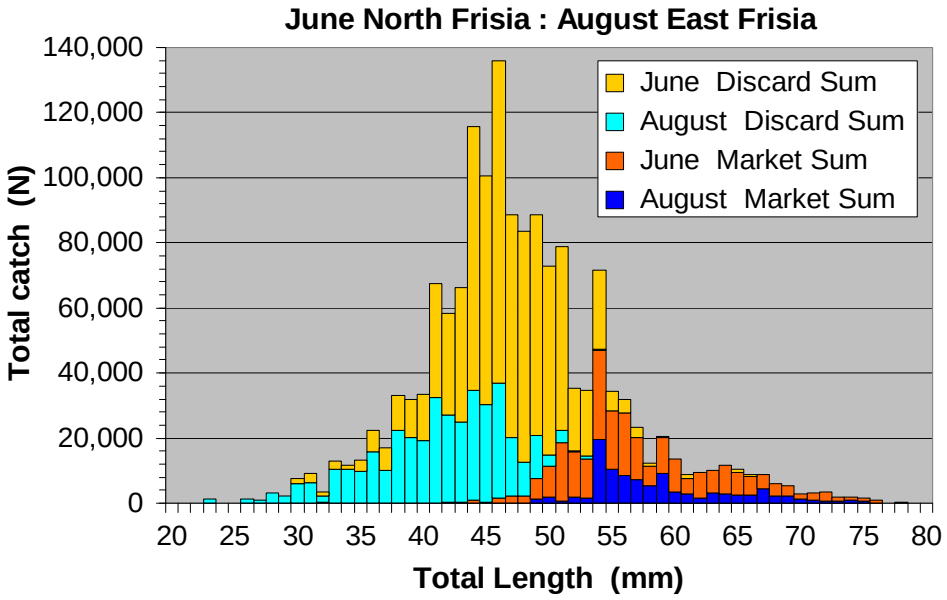


Figure 9.4.1: Length frequency data of brown shrimp collected during commercial fishing operations in June and August 2007 off the German coast.

9.5 Protocol to collect standardized scientific data from commercial shrimp fishing vessel (currently applied for the German scientific observers on shrimp vessels) – Volker Siegel

During each sampling it is essential that station data are recorded on standardized protocols as usually done during scientific cruises. Immediately after the haul comes on board and before it enters the sieving process, take a sample of the size of one basket from the total catch. This is usually the only chance to get an unbiased sample.

The sample has to be treated in the same way as the scientific sample during the DYF Surveys, i.e. the sample has to be sorted by the observer to the species level and weights are taken for each species. If time allows, length of all fish specimens have to be measured and recorded, otherwise freeze specimens for later analysis. The remainder of the one-basket-sample should consist of *Crangon crangon* only.

The next task is the separation of the shrimp discard and the market shrimp fraction from your sample. For this the shrimp of the sample have to be processed and sorted by the sorting sieves of the vessel (most probably after the fisherman has handled his catch). It is important to make sure that the sub samples of market shrimps as well as the undersized discard shrimps are collected in separate buckets after they passed the sieves/rotating sieves. This can be difficult for the discard fraction, because on some vessels the pipes transport the discarded fraction directly over board. It may be necessary to hold a basket over board in from of the pipe outlet. Let the sorting machine run for a few more minutes to make sure that all shrimps have passed the

sorting sieves. Both fractions market and discard shrimps have then to be weighted. Sub samples of 250 grammes should be frozen separately from both fractions for later length measurement and sex identification ashore.

The total weight of shrimp landed by the fisherman from that haul has to be recorded. The total weight of landed shrimp is available from the logbook. This allows the extrapolation of the one-basket-sample weight to total weight for all species and the proportion of the samples "discarded" vs. "market" shrimp weight can be used to calculate the total amount of discarded shrimp in that haul.

Since this task is very time consuming for a single observer, it is recommended to observe only every second haul. It is also recommended to freeze the sub samples as quickly as possible using a small portable freezer.

Final analysis in the laboratory covers the measurement of total length of *Crangon crangon* from the 250 grammes market and discard fraction. It is recommended to identify sex of the shrimp and separate females into ovigerous and non-egg-bearing females.

9.6 Assessing the impact of persistent organic pollutants on the North Sea brown shrimp (*Crangon crangon*) stock - Yves Verhaegen

Since the late 1980's the scientific and political community has become aware of the global impact of persistent organic pollutants (POP's, *e.g.* pesticides, PCB's, dioxines) on environmental and thus human health. Since then scientific-political interaction have supported regulatory action to assess and monitor demonstrated and potential POP's. While pollutant concentrations are being monitored in North Sea sediment and biota following the latest OSPAR Convention in 2001, deducing the actual biological effects from the concentrations measured is currently impossible due to a lack of scientific knowledge and many practical constraints: *e.g.* taxon and even population differences in sensitivity; sublethal effects, which are hard to monitor; the complex, combined action of pollutants which are encountered in complex mixtures in the natural environment; and abiotic effects on pollutant uptake.

Instead of trying to reliably extrapolate pollutant-effect relationships deduced from laboratory experiments on a limited amount of pollutants and species, directly measuring the effects on the health of one or several ecosystem key species has recently become possible using microarray technique. A microarray represents a high-throughput technique to relatively quantify alterations in gene transcription of multiple genes (up to 10.000 genes on one microarray-slide) between two populations (*e.g.* a laboratory control and the exposed population).

Brown shrimp could be an ideal species for such purposes: as crustaceans they are known to be very sensitive to environmental pollutants; their endocrinology is relatively well studied; previous results have shown that pollutants in brown shrimp attain concentrations which are comparable with the top-predators in the North sea ecosystem (*e.g.* plaice, cod); *C. crangon* has an overall high abundance and a wide distribution; the economic importance of brown shrimp further boosts the choice of *C. crangon* as biomarker.

Based on their alarming concentrations measured in shrimp and other North Sea biota and their potential sublethal toxicity, three chemical compounds, which currently are an important ecotoxicological research target, have been chosen as individual model compounds for this research: (a) PBDE 47, a flame retardant which has been used in large quantities in household and industrial products (b) TBT, a

biocide mostly used in antifouling paints, and (c) PFOS, a surfactant used in many household and industrial products, mostly as a water repellent. Through chronic toxicity tests the individual dose-dependent sublethal effects on shrimp will be examined. The toxicity tests applied will be based on the regulatory guidelines for toxicity testing with other crustaceans and fish. Because of the long life cycle duration compared with smaller crustaceans used in standard toxicity testing (*e.g.* Daphnia), two-generation or even whole life cycle tests are unpractical. Therefore we will further focus these tests on the presumably most pollutant- sensitive stages of the *C. crangon* life cycle: larval development, juvenile growth and adult reproduction (combined with egg development). While flow-through facilities are considered ideal for these purposes, we intend to implement the less expensive but more labour-intensive static-renewal approach, where 50-80% of the medium is refreshed on a 48-hour basis. Furthermore, due to their low water solubility, we prefer PBDE 47 and TBT to be administered through the food. Besides linking the exposure concentrations with standard endpoints (*e.g.* mortality, growth, moulting, behaviour), the effect on gene expression will also be analysed through the previously described microarray-technique. As almost none *C. crangon* genomic information is available however, we need an initial selection of potential pollution sensitive genes, as it is practically impossible for the purpose of this study to incorporate the full *C. crangon* genome in the study. To this end we will initially use gender-specific genes (*i.e.* genes of which the natural expression levels highly differ between the male and female population), which we will obtain through Suppression Substractive Hybridization PCR.

The second phase of the research will focus on the potential effects of these pollutants on the ecdysteroid endocrine system. Ecdysteroids act as the key hormones in arthropod physiology, and in our interest in the coordination of development, growth and reproduction. Pollutants can act on the ecdysteroid metabolism in different manners: on the ecdysteroid hormone and ecdysteroid receptor synthesis and breakdown and on the hormone-receptor interaction and receptor functioning. The hormone titres in control and exposed shrimp shall be analysed with hormone specific antibodies using the Enzyme-Linked ImmunoSorbent Assay (ELISA) technique. The receptor titres shall be analysed using Quantitative Real-Time Polymerase Chain Reaction (Q-PCR). The binding affinity of the pollutants with the receptor will be analysed in binding affinity studies, while the downstream molecular reaction (*i.e.* antagonistic or agonistic functioning) after ligand-receptor binding will be analyzed using a receptor deficient cell line with an ecdysteroid responsive reporter construct.

While these results will help us to better understand the concentration-dependent mode of action of the three model pollutants, the results should be the basis for the last phase: testing the microarray on spatial and temporal sampled field populations to obtain a first assessment of the impact of pollution on the North Sea shrimp population.

To conclude, the aim of this research thus is (1) to develop and initially test a high throughput tool to assess actual impact of the environmental pollution experienced by North Sea brown shrimp (2) to achieve a temporal and spatial preliminary pollution effect assessment of the Belgian Continental Flat using this tool and relating these effect data with the monitored pollutant concentrations and (3) to contribute to the knowledge of the concentration-dependant toxic mechanisms of the three model compounds: PBDE 47, TBT and PFOS.

9.7 Mortality of *Crangon crangon* estimated from length frequency distributions – Marc Hufnagl

The modified Wetherall *et al*., the Powell, Beverton & Holt, Jones & Zalinge, Hoenig, Ssentongo & Larkin, Miranda, the seasonal and the nonseasonal length converted catch curve for the calculation of total mortality from length frequency distributions were tested according to their applicability on *Crangon crangon*. The methods were evaluated with a mathematical model that creates length frequency distributions with known conditions and parameters like L_∞, k and Z. Seasonality of mortality, growth and spawning was varied and the influence on the results was determined.

Additionally long time dataseries (Demersal Young Fish Survey from Germany the Büsum bycatch series from Germany and the Demersal Fish Survey from the Netherlands) were used to determine the influence of the region and the depth where the animals were caught. Besides the influence of the use of 5 and 1 mm classes was investigated.

According to the findings the L_∞ was estimated with the Wetherall *et al*. method as the Powell method showed a higher deviation of the estimates from the assumed values. From previous articles that determined L_∞ and k of *Crangon crangon* and own laboratory trials (Hufnagl & Temming, publishing in progress) a function was derived that describes k in dependency of L_∞. This function was used to calculate k according to the L_∞ determined with the Wetherall *et al.* method.

Preliminary analysis of the results of the evaluation lead to four functions that can be used for estimating Z of *Crangon crangon* namely the Wetherall *et al*., Beverton & Holt, Ssentongo & Larkin, Hoenig for the DYFS and DFS data and the Wetherall *et al*., Beverton & Holt, Ssentongo & Larkin for the bycatch data as the Hoenig method showed bias due to the 5 mm size classes.

Analysing the long time dataseries delivered L_∞ values from 1970 to 2006 of about 85 mm. Before 1970 higher L_∞ between 85 and 95 mm occurred. Mortality varied between 4 and 9. For all years and all datasets a mean mortality of 5.3 was calculated.

Annex 1: List of participants

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Annex 2: Agenda

Agenda for ICES *Crangon* Working Group meeting 2008, Texel, The Netherlands

Tuesday, 27 May:

- Open meeting/welcome– Tom Catchpole/Henk van der Veer
- The visualization of VMS-data for a small subset of the German fleet 2004 to 2008 (Tom Neudecker)
- The effect of micro-pollutants on *Crangon* (Yves Verhaegen)
- Update on pulskor-electric beam trawl (Bart Verschueren)
- Beam trawl catch efficiency for *Crangon* (Tom Catchpole)
- The development of the Danish *Crangon* fishery (Per Sand Kristensen)
- *Crangon* mortality and density estimate in water depth greater than 20m (Marc Hufnagl)
- Standardising a (DCR) sampling protocol for the *Crangon* fishery, discussion led by Volker Siegel

Wednesday, 28 May (joined by MSC representatives):

- Summary of landings and effort data (Tom Catchpole +)
- 'Something' on effort-stock modelling (Chris Rückert)
- Estimating *Crangon* densities in Shleswig Holstein Wadden Sea (Meike Martin)
- Some advances in the swept-area biomass estimate (Harriet van Overzee)
- Advances in the MSC process – projects various, and VMS data (Ingrid Tulp)
- Update on the process of the MSC accreditation and identification of scientific bottlenecks (Paddy Walker + 1 from MSC)
- Discussion on MSC accreditation process

Thursday, 29 May:

- Member State fishery descriptions for WGCRAN 2008 report
- Historical film on the German shrimp fishery from 1955
- Select new chairperson
- ToRs for 2009

Annex 3: WGCRAN terms of reference for the next meeting

The **Working Group on *Crangon* Fisheries and Life History** [WGCRAN] (Acting Chair: T. Catchpole, UK) will meet in Oostende, Belgium from 11–15 May 2009 to:

a) combine German and Dutch data into one biomass estimate and evaluate the utility of the estimate;

b) explore *Crangon* catch data from the Dutch BTS survey in geographical areas not covered by the DYFS surveys with the aim of improving the *Crangon* biomass estimate;

c) make progress in updating the paper by Welleman & Daan;

d) explore available data on number of egg-bearing females and correlations with stock size;

e) provide annual VMS data (by quarter) from Member States to illustrate regions of fishing activity by *Crangon* vessels in the North Sea;

f) complete comprehensive sea trials of the electric shrimp beam trawl design, and investigate the effects of this fishing technology on the ecosystem;

g) review progress of MSC certification process;

h) collate and update landings and effort data, including numbers of active vessels;

i) review recent *Crangon* related Research & Developmentactivity.

WGCRAN will report by DATE to the attention of the XXXXX Committee.

Supporting Information

Priority:	*C. crangon* fisheries are economically important with landings value that rank this species in the top three species caught from the North Sea.
Scientific justification and relation to action plan:	Action Plan (Terms of Reference) a) combine German and Dutch data into one biomass estimate and evaluate the utility of the estimate; b) explore *Crangon* catch data from the Dutch BTS survey in geographical areas not covered by the DYFS surveys with the aim of improving the *Crangon* biomass estimate; c) make progress in updating the paper by Welleman & Daan; d) complete comprehensive sea trials of the electric shrimp beam trawl design, and investigate the effects of this fishing technology on the ecosystem; e) explore available data on number of egg-bearing females and correlations with stock size; f) review progress of MSC certification process; g) provide annual VMS data (by quarter) from Member States to illustrate regions of fishing activity by *Crangon* vessels in the North Sea; h) collate and update landings and effort data, including numbers of active vessels; i) review recent *Crangon* related R & D activity. Justification for the action plan TOR is as follows: Despite the economic importance and regional dependencies of this species, we still have much to learn and understand on the natural history of this species, particularly in respect of its ecology, stock dynamics, distribution etc. We (WGCRAN) know much more about the fishery itself, how much is caught, who catches it, where and when etc. Such information, has limited utility however, and ICES will continue to have a retarded capacity to produce sound

	effective management advice in relation to these fisheries, if we use such information in isolation. For the production of more robust and flexible managerial advice, we need to combine our current knowledge of fisheries landings, effort and fishing activity with a good supportive biological understanding of the *Crangon* stocks and their ecological interactions. To this end, we make this our priority for the WGCRAN. Substantial progress has been made in the development of a *Crangon* biomass estimate. Two independent studies have been completed and these now need to be reconciled. Moreover, additional information on *Crangon* densities from hitherto unused surveys conducted in areas commonly fished commercially by shrimp trawlers will further improve the biomass estimate. The final output of this work will be to update the only publication on a North Sea *C. crangon* biomass estimate by Welleman & Daan. Following a pre-assessment by the Marine Stewardship Council on the sustainability of the *C. crangon* fishery, attention has been drawn to its discarding practices, the sustainability of *C. crangon* stocks, and impacts upon benthic communities. Following a full assessment of the technical measures introduced to reduce discards in *C. crangon* fishery (see WGCRAN07), it was recognized that although discards had been significantly reduced the problem had not been completely resolved. Further modifications to the trawl design and catching process may offer one way to reduce discarding, in particular through the development of the electric shrimp beam trawl design. A comprehensive series of sea trials using this method will determine its usefulness in reducing discards. As part of the work the effects of this fishing technology on the ecosystem will also need to be investigated. The biology and behaviour of *C. crangon* does not lend itself to conventional stock assessment techniques therefore other methods are required. Further to a biomass estimate, data are available to investigate the ability to assess the stock size within each year through its correlation with the number of egg bearing females. A thorough analysis of this data is required before its usefulness in assessing the stock can be established. Further research has commenced as a response the MSC pre-assessment. It is therefore considered important to keep fully informed on the MSC certification process. It was also agreed that in addition to the landings, effort and number of active vessels, each Member State would provide VMS data from *C. crangon* vessels in order to identify areas impacted by the fishery and spatial patterns in fishing activity.
Resource requirements:	The research programmes which provide the main input to this group are already underway, and resources already committed. The additional resource required to undertake additional activities in the framework of this group is negligible.
Participants:	The Group is normally attended by ~12 members and guests.
Secretariat facilities:	None.
Financial:	No financial implications.
Linkages to advisory committees:	There are no obvious direct linkages with the advisory committees.
Linkages to other committees or groups:	There is linkage to the Living Resources Committee and WGBEAM
Linkages to other organizations:	CWSS = Common Wadden Sea Secretariat, TMAP= Trilateral Monitoring and Assessment Programme

Annex 4: Recommendations

RECOMMENDATION	FOR FOLLOW UP BY:
1. WGCRAN recommends that current surveys are extended to cover areas of deeper water that are currently not covered by the DYFS surveys but constitute the main *Crangon* fishing grounds.	Survey coordinators at Institut für Seefischerei Hamburg
2. WGCRAN welcomes the new regulations relating to DCR for the *Crangon* fishery (100 *C. crangon* length measurements per sample for each 500 t of landing weight) but recognizes that this covers only the commercial fraction of the catch, and therefore recommends that the sampling: o includes also the discard fraction of the catch in the required length measurements, accordingly increase total sample size to 200 measurements o is spread across quarters of the year and covers the major fishing areas o includes discarded fish species	Chair STECF Chair ICES
3. In response to the information presented on the MSC accreditation assessment, the WGCRAN recommends that studies be conducted to address specific information deficits on: o unfished areas (in Danish waters) to better understand the effect of *Crangon* fishing on the ecosystem o the short-term ecological effects of fishing disturbance by *Crangon* vessels o discard mortality of bycatch species caught in the *Crangon* fishery to put into context discard data collected as part of the DCR o exploring the utility of the correlation between Autumn survey catches and Spring survey and commercial catches as a management tool to assess the North Sea *Crangon* stock, including the implications of variable catchability during surveys	Wadden Sea Society (Paddy Walker)walker@waddenvereniging.nl North Sea Foundation (Esther Luiten) e.luiten@noordzee.nl Netherlands Ministry of Agriculture, Nature Management and Fisheries (Min. LNV) Ministerie van LNV Postbus 20401 2500 EK Den Haag The Netherlands infotiek@minlnv.nl.
4. WGCRAN recommends that a progress update on the current MSC certification process be given to the WGCRAN at the next meeting of the WGCRAN during May 11-15 2009.	Wadden Sea Society (Paddy Walker)walker@waddenvereniging.nl North Sea Foundation (Esther Luiten) e.luiten@noordzee.nl
5. WGCRAN recommends that the next meeting be held at ILVO, Oostende during the week of 11-15 May 2009.	Bart Verschueren bart.verschueren@ilvo.vlaanderen.be The Institute for Agricultural and Fisheries Research (ILVO) Ankerstraat 1, 8400 Oostende, Belgium Tel: +32 59 34 22 50 Fax: +32 59 33 06 29
6. WGCRAN recommends that Ingrid Tulp, IMARES, NL, becomes the next chairperson of WGCRAN to start with effect from September 2008 after approval at the ICES ASC.	ICES