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5–7 June 2012

Porto, Portugal

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

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Executive summary

The Working Group on *Crangon* Fisheries and Life History (WGCRAN) 2012 meeting was successfully held at CIIMAR Porto, Portugal in June 2012. The meeting was chaired for the first year by Marc Hufnagl. Members from Germany, the Netherlands and Portugal were in attendance. Unfortunately Denmark, the UK, France and Belgium could not join the meeting but were represented via correspondence.

Brown shrimp is among the top three species caught from the North Sea with respect to landings; and hence *Crangon* fisheries are economically important. Besides *Crangon* is a major food item found in cod and whiting stomachs, is an important predator of in- and epifauna in intertidal areas and is also assumed to control plaice and mussel recruitment. These aspects underline the importance of this species with respect to trophic coupling, coastal ecology and economic value. Members of WGCRAN thus see the priority of this expert group in understanding the interactions between the brown shrimp population (structure and abundance) and human behaviour (mainly fishing effort) and between the shrimps and the environment (temperature, currents) as well as the ecosystem (trophic interactions).

ToRs and group discussion mainly dealt with: i) monitoring the population; ii) the investigation and development of (new) population status indices; iii) the impact of the shrimp fisheries on the population and the ecosystem. During the last 20 years WGCRAN has developed into a valuable platform for improving the cooperation between the member states in relation to survey planning, international data acquisition and research exchange. These points are also implemented in the new ToRs, which were already formulated with regard to the Multi-annual Management plan of SCICOM Expert Groups as on this year's meeting it was decided that WGCRAN shall already switch to the multi annual management from 2012 on.

Concerning brown shrimp biology and ecology 2011 was an extraordinary year. In spring and summer 2011 effort was significantly reduced - in relation to earlier years - due to a strike of the fishermen caused by low prices. The reduced fishing pressure in combination with a strong 2010 cohort lead to above average LPUE during late winter and early spring 2011. Total North Sea landings amounted to 33 000 t and thus remained on a high level despite the reduced effort.

For a better monitoring, a higher accuracy and a better comparability of national effort it was started to standardize the effort time-series and recalculate them. From 2012 on effort shall be reported in days at sea (das) and horse-power days at sea (hp-das), but das shall be calculated based on the real time a vessel outside the harbour.

Seasonal effort and thus LPUE values are now available for at least 10 years per country. Changes in seasonal effort were thus investigated in more detail. Dutch effort increased in spring and German effort decreased in autumn, Danish effort increased during the whole year. In 2011 the German and UK fleet spent only half the amount of time at sea (~1000 d/month, 15 000 hp days at sea /month) as compared to the long term average. Due to the low prices and the strike also Dutch and Danish effort was reduced but for these fleets mainly in May and not throughout the whole year. Total effort (sum of all countries) in horse-power days at sea and days at sea slightly decreased since 2002. LPUE were on a relatively constant level but increased in 2011.

From scientific demersal surveys, performed in autumn when the new cohort has fully grown into the adult and catchable size, total mortality and asymptotic length as well as the share of large animals was estimated based on length frequency distribu-

tions. Maximum length (L_∞) and the fraction of shrimps > 60 mm increased and annual total mortality Z decreased to 4.3–4.9 year^{-1} in relation to 2010: 4.9–6.1 year^{-1}. The autumn scientific surveys were also the basis for a population biomass and production estimate. A solid biomass estimate is the basis of all management advices and thus all factors (selectivity, catchability, behaviour etc.) that need to be included in the estimate were thoroughly discussed during the meeting.

Data from a vertical stow net indicated that a large fraction of the shrimp population is permanently in the water column and reanalysis of the German autumn and winter surveys revealed a quite complex nocturnal, seasonal, size and maturity dependent behaviour pattern. Both results are of high importance with respect to catchability and availability of the population to scientific survey gears and derived correction factors will be used in improving biomass estimates.

Estimates of the adult brown shrimp consumption by whiting and cod suggested that for commercial sized shrimps (>50 mm) fishing effort outweighs natural mortality, especially since the 1990s.

Altogether the WGCRAN continues in its tradition as a small but highly active and innovative working group that relates in many questions to the ICES science plan. WGCRAN is an important platform to monitor, discuss and examine the status of a commercially and biologically important but so far unmanaged stock.

1 ToR a) Analyze recent landings and effort trends in brown shrimp fisheries and evaluate implications for population status

Numbers and statistics in the following part refer to the landed fraction of shrimps. In general there a several processing and sieving processes carried out before which can so far not be enumerated. Especially since sieve sizes for the on land sieving are not controlled or standardized, there might be a bias in several years which can so far not be investigated or enumerated. The general procedure (see also Neudecker *et al.* 2006) on most cutters is as followed:

1) Catch
- 1st Sieving on board usually with drum sieves

  Fish bycatch and undersized discard

  Shrimps → Cooking
- 2nd Sieving on board (of the cooked fraction)

  Undersized shrimps discard

  Shrimps (~ commercial size)

2) Landing
- 3rd Sieving on land

  Crushed, industrial shrimps (undersized or smaller than the economically wanted size)

  Landings: Commercial shrimps

The landed fraction therefore is the result of normally 3 sieving processes. Each nation only reports the landed fraction of commercial sized shrimps. Minimum sieve width is 6.5 mm (EG 2406/96) but depending on the market situation also larger sieves (e.g. 6.8 mm) are used. Thus reported landings of commercial size is dependent on the market situation and can be about 45 mm or larger. The landings refer to the nationality of the cutter and do not represent the area where the shrimps were caught or landed. Thus, e.g. the Dutch landings could refer to a shrimp caught in German waters but landed in Denmark. An exception is the French data series, as French cutters are generally small and thus operate close to their home harbours.

1.1 Germany

1.1.1 Germany - Fleet and annual landings

German landings include consumption shrimp (excluding undersized shrimp) landed by German vessels in German and foreign harbours. As logbook data are used landings refer to the whole fleet.

The number of German fishing vessels (see also working document Annex 4) constantly decreased over the last decade from 268 in 2002 to 222 in 2011 (Figure 1.1) which is a reduction by 17%. The annual share of shrimpers landing 95% of all shrimps remained fairly constant and varied between 73 and 78% with higher shares during the last three years (2009–2011). Between 2009 and 2011 183 to 174 vessels contributed 95% to the German landings whereas 38 to 28 vessels (~12% of the fleet) landed < 1%, respectively (Figure 1.1).

German cutters are generally between 10 and 20 m long and only a very small fraction is shorter or longer than this size (Figure 1.2). Engine power of German cutters increased over time and the share of cutters with engines of more than 200 kW increased from about 25% in 2002 to about 50% in 2011 (Figure 1.3).

Landings of the German fleet constantly increased since the 1950s and were 13 139 t in 2011. This was 39.3% of all landings from the North Sea and from all countries (Figure 1.4).

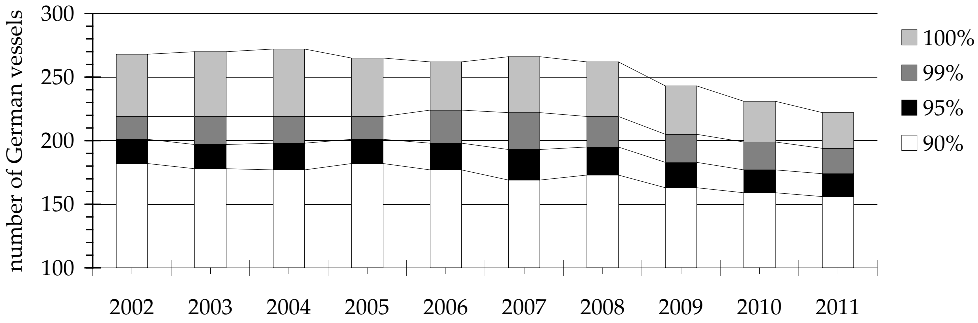

Figure 1.1. Number of active German shrimpers and fractions of the number of shrimpers that landed 100%, 99% 95 and 90% of the shrimps in relation to all shrimps landed by German vessels, respectively. Note, y-axis is truncated at 100 vessels.

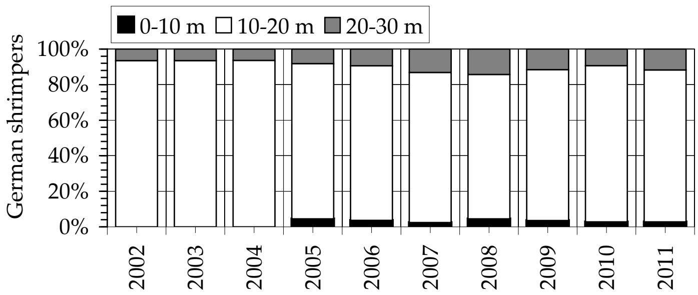

Figure 1.2. Shares of different length [total length m] classes in the German fleet.

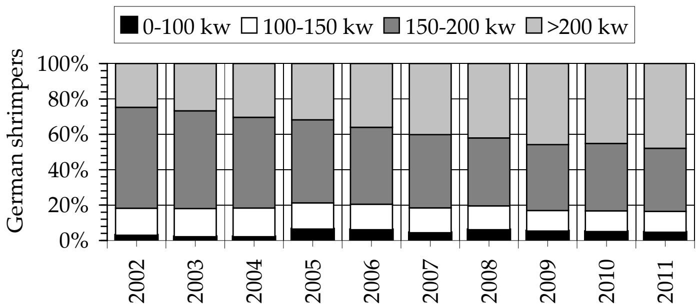

Figure 1.3. Shares of different power classes [kw] in the German fleet.

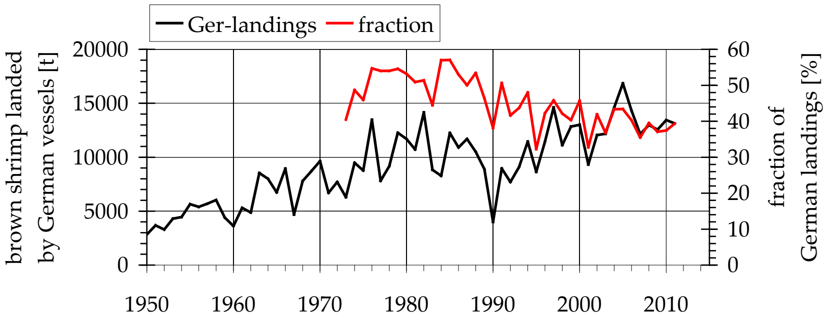

Figure 1.4. Consumption shrimps landed by German vessels over the period 1950 to 2011 in t (primary y-axis). Percentage of German landings in relation to total landings (whole North Sea, all nations).

1.1.2 Germany - Seasonal landings

Seasonal German landings were with exception of January, May, November and December higher in 2011 than in 2010. In comparison to the German long term average landings were higher in spring but on a comparable level during the main season in autumn (Figure 1-5).

Comparing 10 year averages of seasonal landings a positive trend for all month except September/ October, where landings remained constant, is obvious (Figure 1-6). Especially early in the season landings per month increased from 660 t to 1400 t. October landings remained on a comparable high level of ~1880 t per month but in September most shrimps were landed during the period 1980–1990.

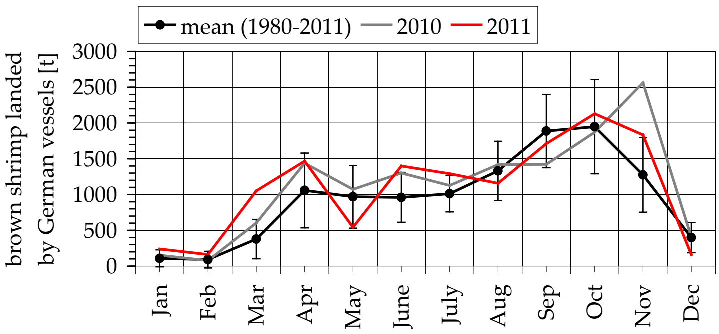

Figure 1.5. Consumption shrimps landed by German vessels per month. Black line - long term average since 1980, grey line - 2010 and red line - 2011.

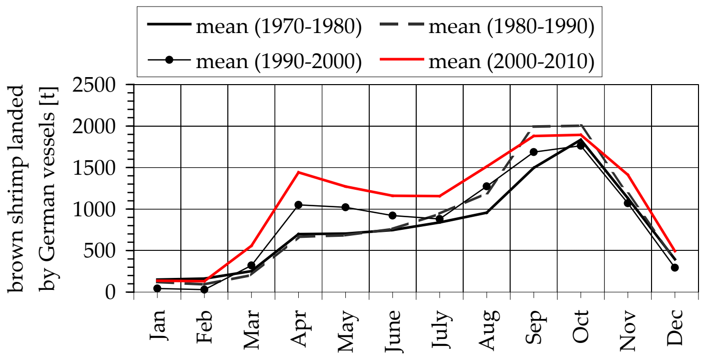

Figure 1.6. Decadal average of German seasonal landings (t).

1.1.3 Germany - Seasonal and total effort

German effort is calculated on minutes outside the harbour basis, subtracting the arrival time of the vessel from the departure time of the vessel. Trips spanning two month were allocated over both month.

German shrimpers normally go out fishing for less than a day (Figure 1.7). Between 65 and 72% of all trips were shorter than 1 day and about 25% of all trips were between 1 and 2 days long (Figure 1.8). Mean trip length remained constant from 2005 to 2011 and was on average 0.8 days at sea (Figure 1.9). The total number of trips per year dropped in 2011 to 11 557 in comparison to 15 732 (2010) to 18 755 (2005) trips per year before 2011. During winter trip length is about twice as long as during the rest of the year. The reason is that due to the weather conditions mainly larger vessels shrimp during that period.

During the period 2002 to 2011 vessels with larger engines generally spent more time at sea than vessels with smaller engines. Vessels with engine power less than 100 kW were about 0.24 ±0.13 days at sea (mean ± std) whereas vessels with > 200 kW spent 1.1±0.8 das shrimping.

	mean das	std	cov
0–100 kW	0.24	0.13	55.7%
100–150 kW	0.51	0.33	63.8%
150–200 kW	0.83	0.60	72.6%
>200 kW	1.10	0.80	72.8%

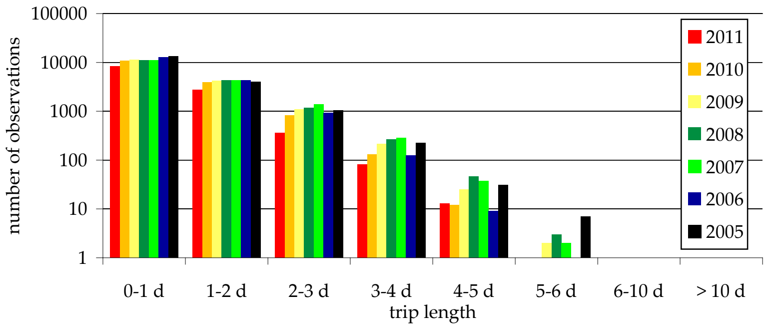

Figure 1.7. Trip-length of German shrimp fishers in days at sea shown for different years. Note that y-axis is log-scaled.

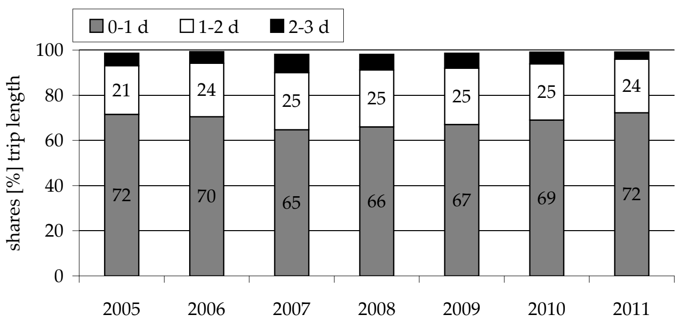

Figure 1.8. Shares of trip-length classes of German shrimp fishers in days at sea shown for different years.

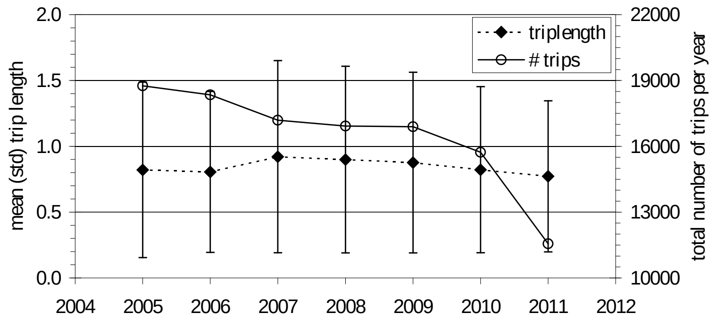

Figure 1.9. Mean (±std) trip-length of German shrimp fishers in days at sea and total number of trips per year.

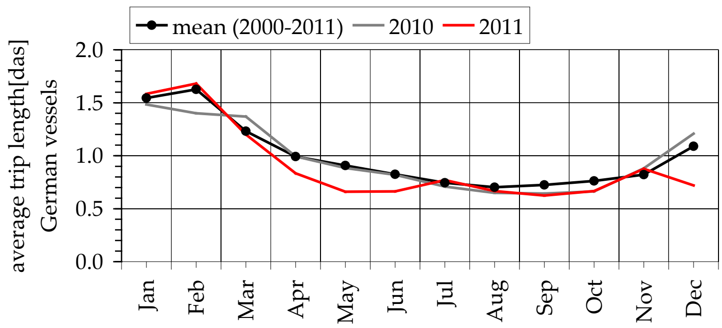

Figure 1.10. Average trip-length of German shrimp fishers in days at sea per month.

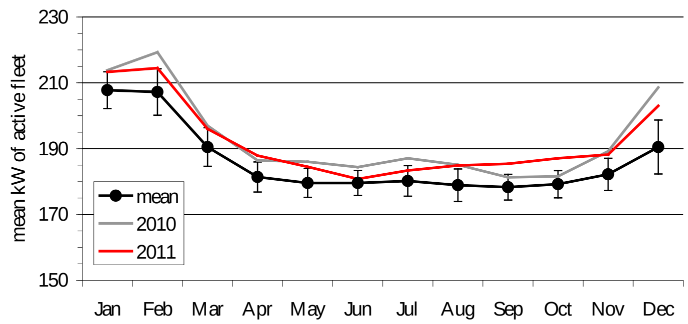

Figure 1.11. Average engine power of active German shrimpers.

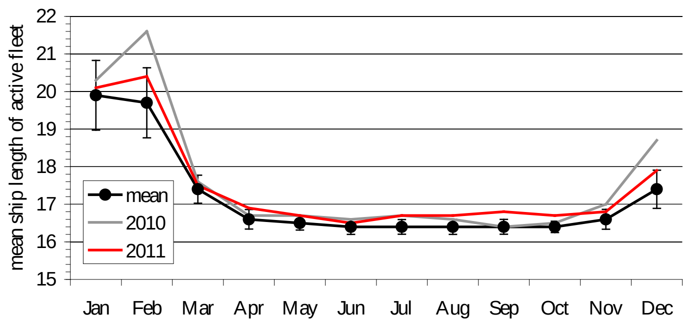

Figure 1.12. Average ship length of active German shrimpers.

Effort data on days at sea and horse-power days at sea are available for the period 2000–2011 and 2002–2011, respectively. To track changes in seasonal effort and to find out whether effort in one month increased or decreased we correlated the effort time-series with time (years).Thus for each month we obtain a slope which indicates the average change per year and r^2 as a goodness of fit criterion that indicates the significance of this trend. For the period January to April German seasonal effort remained on a constant level the past decade but decreased for the period May to November (Figure 1.13). Especially during the main season in autumn effort was reduced by up to 100 days each year (Figure 1.13). In May the strongest decrease in effort of 127 days/year was observed. This high decrease is partly due to the low 2011 May effort where during the strike fishing effort was significantly reduced (see also working documents in Annexes 5 and 6). However, even if 2011 is not considered still an effort reduction of 80 days at sea per year remains.

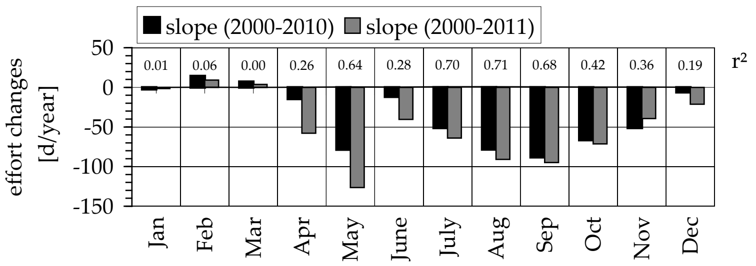

Figure 1.13. Slopes of the correlation of effort vs. time. Graph shows changes in German seasonal effort in days at sea/year for the period 2000 to 2011 and 2000 to 2010. Positive values indicate an increase negative values a decrease in days at sea. Numbers in the upper part of the graph are r^2 - values of the correlation of effort vs. time for the whole time-series 2000–2011.

Likely due to the increase in vessel power over time (Figure 1.3) and due to a shorter time-series (2002–2011) changes in horse-power days at sea (Figure 1.14) are less significant than the changes in days at sea (Figure 1.13).

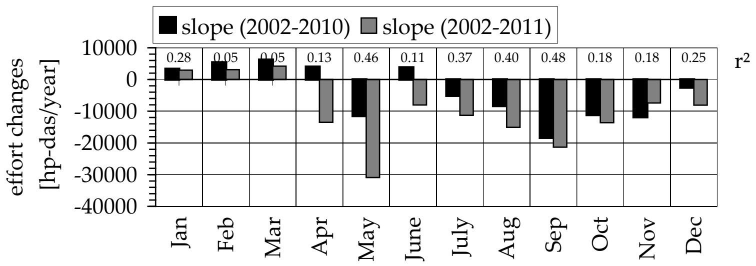

Figure 1.14. Slopes of the correlation of effort vs. time. Graph shows changes in German seasonal effort in horse-power days at sea/year for the period 2000 to 2011 and 2000 to 2010. Positive values indicate an increase negative values a decrease in hp-das. Numbers in the upper part of the graph are r^2 - values of the correlation of effort vs. time for the whole time-series 2000–2011.

During summer and autumn 2011 German shrimpers were about 1000 days at sea per month. This is only half as long as during previous years (Figure 1.15). In November effort was again on a comparable to earlier years but lower in December most likely due to weather conditions (Figure 1.17). During autumn and winter 2011 German fleet effort was comparable to 2010.

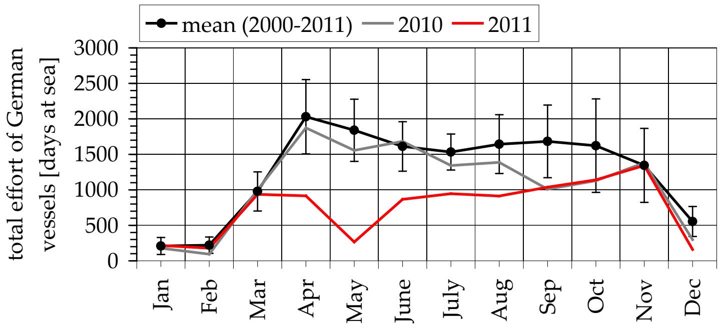

Figure 1.15. Total seasonal effort of German shrimpers in days at sea. Black line - long term average (and std) since 2000, grey line - 2010 and red line - 2011.

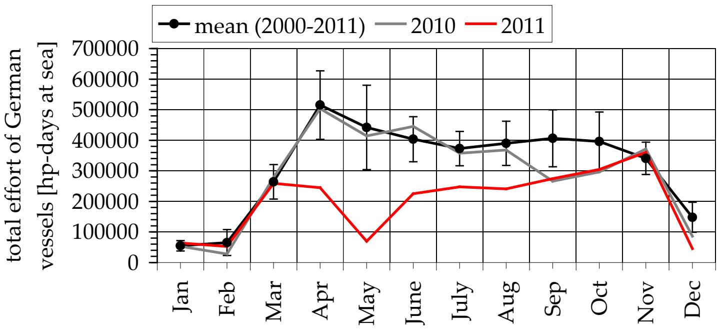

Figure 1.16. Total seasonal effort of German shrimpers in horse-power days at sea. Black line - long term average (and std) since 2000, grey line - 2010 and red line - 2011.

Effort in horse-power days at sea have been updated and recalculated based on hours at sea. In the 2010 WGCRAN report a wrong annual effort of about 10 million horse was reported for the German fleet. This has been corrected and the real level is usually less than 6 000 000 hp-das (Figure 1.16). Despite the longer trips of larger vessels and seasonal differences in trip length and average vessel power (Figure 1.10 to Figure 1.12) the seasonal effort pattern in hp-das (Figure 1.15) is comparable to the das pattern (Figure 1.16).

Changes in effort are visualized using standardized German seasonal effort as: $rel\,E_{m,y} = E_{m,y}/\bar{E}_m$, where $E_{m,y}$ is the effort per month and year in either days at sea or horse-power days at sea, and $\bar{E}_m$ the average effort per month for all available years. Overall patterns of days at sea (das) and horse-power days at sea (hp-das) are comparable (Figure 1.17). The general decline in effort already indicated in Figure 1.13 and in Figure 1.14 can also be seen in Figure 1.17. Between July and October for the period 2000 to 2003 German fisherman spent more days at sea than in later. Highest variability was determined for winter effort where interannual fluctuations exceed 100%.

German relative effort:

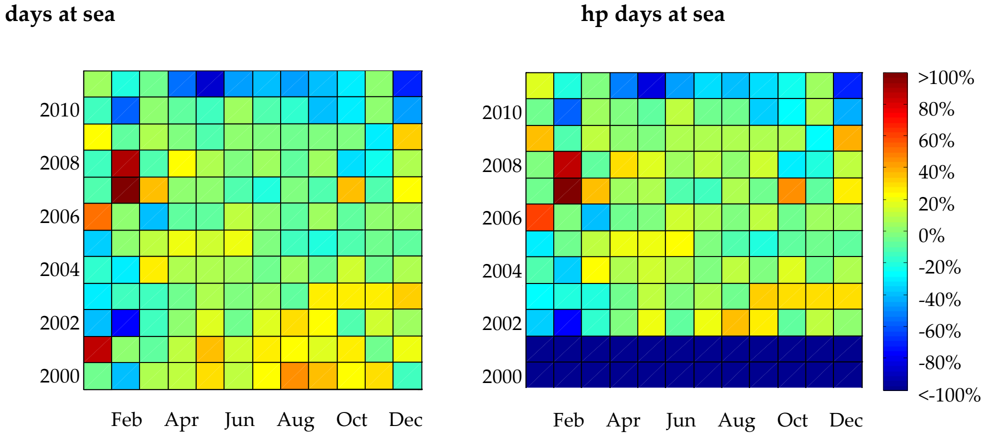

Figure 1.17. German seasonal relative effort in % deviation from monthly average over the period 2000 to 2011. Blue indicates lower effort, red higher effort than the average. Left panel days at sea, right panel hp days at sea.

1.1.4 Germany - Landings per unit effort

Landings per unit effort (LPUE) with effort in days at sea, were higher in 2011 than in 2010 and also in comparison to the long term average (2000–2011, Figure 1.18). German fisherman on average landed 760±430 kg per day at sea in May. In 2011 LPUE of 2030 kg commercial sized shrimps were reported. Higher LPUE were not only recorded for the strike period but also for earlier months (since Sep. 2010) indicating a strong 2010 year class. The reduced effort and thus the reduced fishing mortality in spring 2011 is likely also the reason why also summer LPUE remained on a higher level than usually observed.

Despite the strike the whole fleet was fishing in May, but with reduced effort as shown in the working document in Annex 5. Thus the high LPUE is a cross-section through all vessels and not a result of some larger more effective vessels. Using hp-das as unit effort to calculate LPUE a comparable pattern emerges.

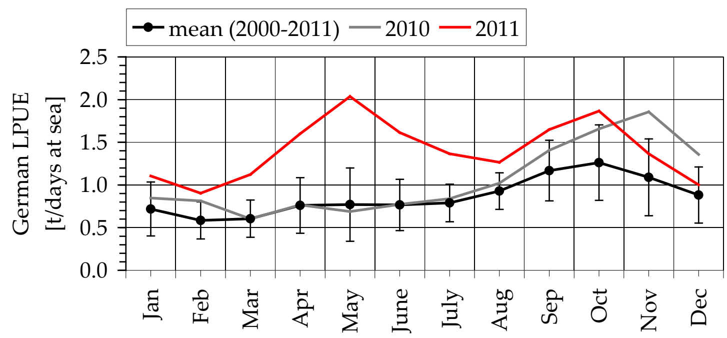

Figure 1.18. Landings per unit effort (LPUE) for the German fleet in t/days at sea. Black line - long term average (and std) since 2000, grey line - 2010 and red line - 2011.

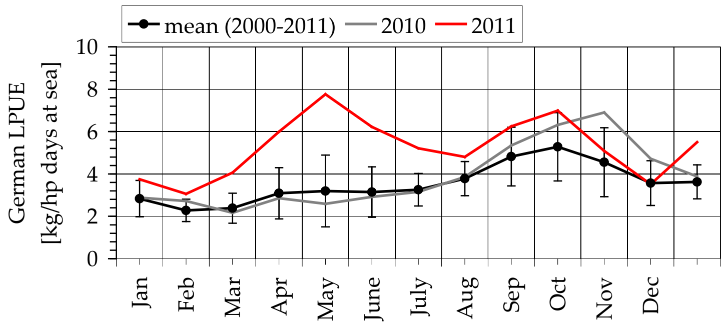

Figure 1.19. Landings per unit effort (LPUE) for the German fleet in kg/horse power days at sea. Black line - long term average (and std) since 2000, grey line - 2010 and red line - 2011.

German relative Landings per Unit Effort:

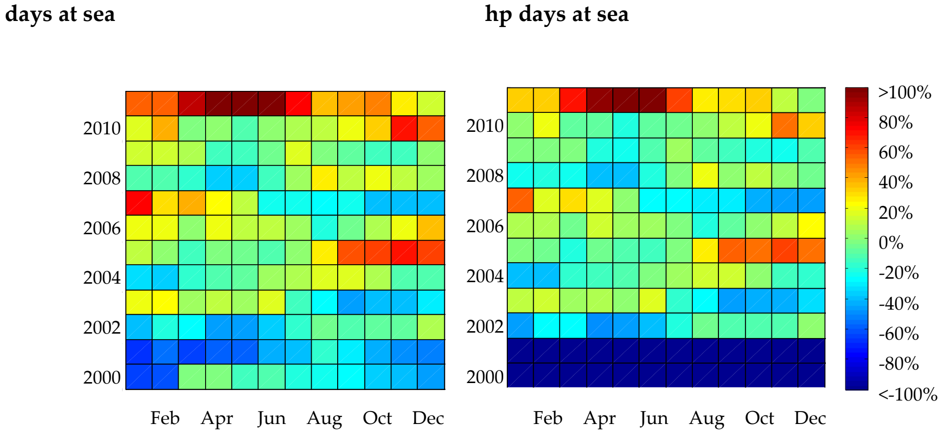

Figure 1.20. German seasonal relative landings per unit effort in % deviation from monthly average over the period 2000 to 2011. Blue indicates lower effort, red higher effort than the average. Left panel LPUE t/per days at sea, right panel LPUE per kg/hp days at sea.

Annual and seasonal relative LPUE patterns are comparable when das or hp-das are used as effort measure (Figure 1.20). Besides 2011 higher LPUE than average were observed in 2005, 2006 and 2007. Lower values were especially reported for 2000, 2001 and 2002.

Annual LPUE peaked in 2005 slightly decreased later and peaked in 2011 (Figure 1.21). Where the 2005 peak was to a large extent due to increased effort the peak in 2011 was due to a very large shrimp population.

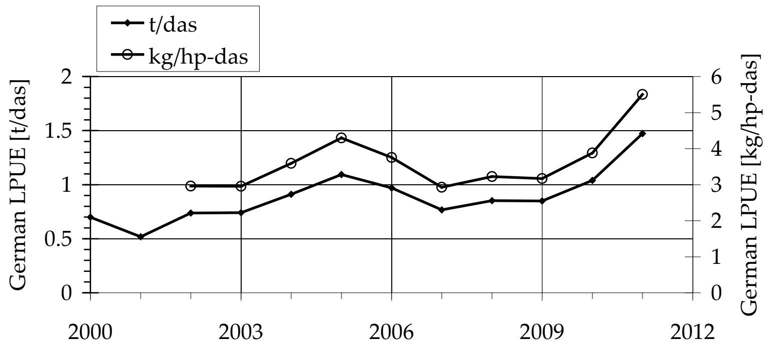

Figure 1.21. German annual landings per unit effort (LPUE) in kg/horse-power days at sea on the secondary y-axis and t/days at sea on the primary y-axis.

1.2 The Netherlands

1.2.1 Netherlands - Fleet and annual landings

The Dutch data from landings (excluding undersized shrimp) and effort are derived from the VIRIS (Visserij Registratie en Informatie Systeem) database which contains logbook data from all Dutch vessels landing both in Dutch and foreign harbours. Catches are registered by the fisherman in logbooks. These data are sent to the national inspection service (AID) and stored into the VIRIS database. Because the registration of ICES rectangles is not mandatory for *Crangon* fisheries, no trip specific information on rectangle is available. Days at sea for the Dutch data were calculated as arrival date minus departure date resulting in days at sea. Trips with identical dates of departure and arrival were included as one day. Thus in contrast to the remaining countries the effort is not fully comparable to the other countries.

Since 1995 there has been a constant decline in the number of Dutch shrimpers. In 1995 216 vessels were landing brown shrimp whereas in 2011 only 180 vessels were involved (Figure 1.22).

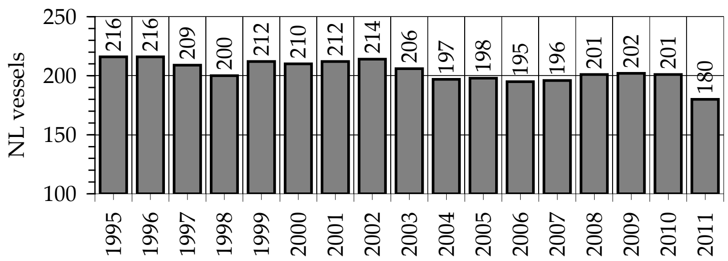

Figure 1.22. Number of Dutch shrimpers.

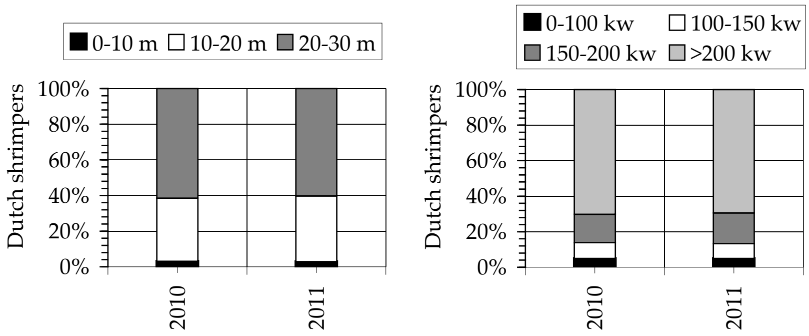

Figure 1.23. Shares of different power classes [kw] and length [total length m] in the Dutch fleet.

Most of the Dutch shrimpers have a total length of 20–30 m and between 200 and 300 kW engine power. About 30% of the fleet have less than 200 kW engine power. In comparison to the German fleet Dutch fisherman therefore have larger and more powerful ships.

Total Dutch landings in 2011 were 16005 tons and thus 700 t less than in 2010 where the highest Dutch landings of the whole time-series were reported (Figure 1.24). From the 1980s on the fraction of shrimps landed by Dutch fishermen, in relation to all North Sea landings, constantly increased and was 48% in 2011.

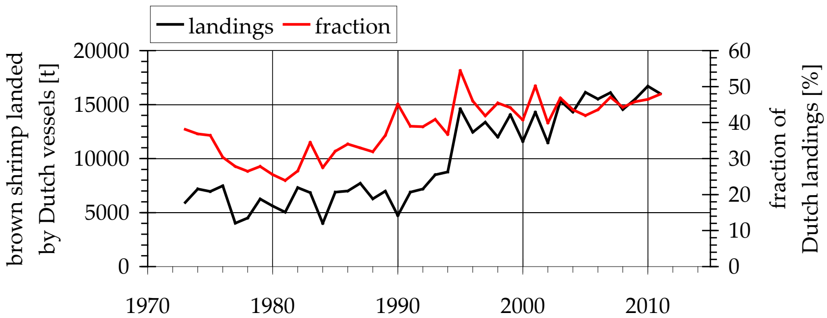

Figure 1.24. Consumption shrimps landed by Dutch vessels over the period 1973 to 2011 in t (primary y-axis). Percentage of Dutch landings in relation to total (whole North Sea, all nations) landings.

1.2.2 Netherlands - Seasonal landings

Seasonal landings in 2011 were comparable to 2010 but higher than the average landings (Figure 1.25). Between June and November landings in of the last two years were even outside the range of the monthly means plus 1 standard deviation (1973–2011). In May 2011 Dutch vessels landed less shrimps than the average.

Over the last 40 years landings increased and total landings of Dutch fisherman (Figure 1.26) were about doubled (June/July) to tripled (March–May) between 1990–2000 in comparison to the 17 years before. For the period 2000–2010 landings again increased - in the first half of the year by a factor of 1.5 (June) to 2.1 (February) and in the second half of the year between by 16–38%.

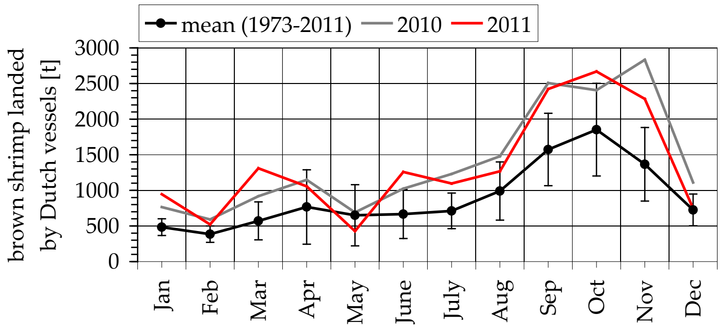

Figure 1.25. Consumption shrimps landed by Dutch vessels per month. Black line - long term average since 1973, grey line - 2010 and red line - 2011.

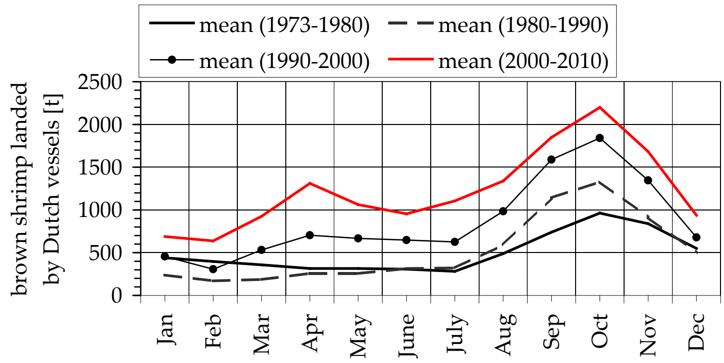

Figure 1.26. Decadal average of Dutch seasonal landings (t).

1.2.3 Netherlands - Seasonal effort

The average Dutch effort in days at sea peaks in April and October. Whereas in 2010 the effort was not different from this average patter the 2011 effort pattern is different, especially during April and May. In May Dutch fisherman were 291 days at sea in contrast to 1365 ± 452 das which is the May average (2003–2011). Seasonal effort in hp-das is comparable to the das effort pattern (Figure 1.28).

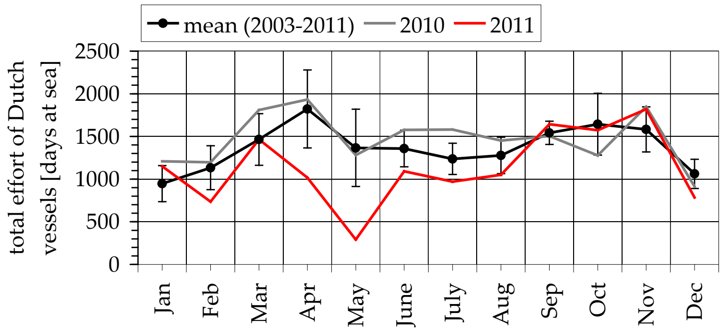

Figure 1.27. Total seasonal effort in days at sea of Dutch shrimpers. Black line - long term average (and std) since 2003, grey line - 2010 and red line - 2011.

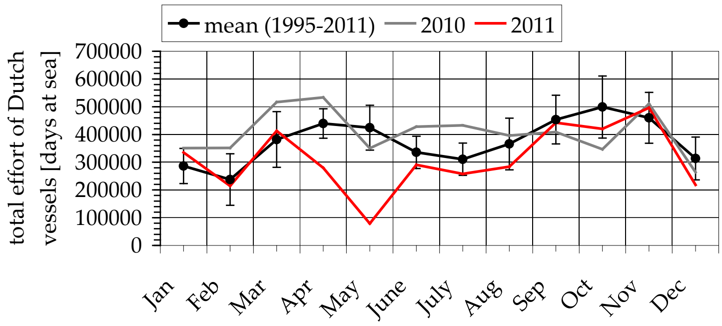

Figure 1.28. Total seasonal effort in horse power days at sea of Dutch shrimpers. Black line - long term average (and std) since 1995, grey line - 2010 and red line - 2011.

In comparison to the German fleet the effort of the Dutch fleet did not show pronounced changes over time. This is also indicated by the low r^2 values and the high sensitivity of the slope to the 2011 outliers (Figure 1.30). The Dutch times series of Days at Sea is shorter than the German time-series and starts in 2003. For the German fleet most of the changes in effort occurred before 2003. The Dutch effort time-series in hp-das is longer than the Dutch das series and starts in 1995 (Figure 1.28). Here an increase in effort, especially during the first half of the year was observed.

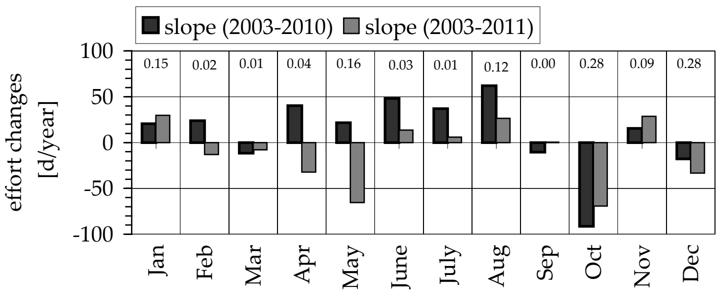

Figure 1.29. Slopes of the correlation of effort vs. time. Graph shows changes in Dutch seasonal effort in days at sea/year for the period 2003 to 2011 and 2003 to 2010. Positive values indicate an increase negative values a decrease in das. Numbers in the upper part of the graph are r^2 - values of the correlation of effort vs. time for the whole time-series 2003–2011.

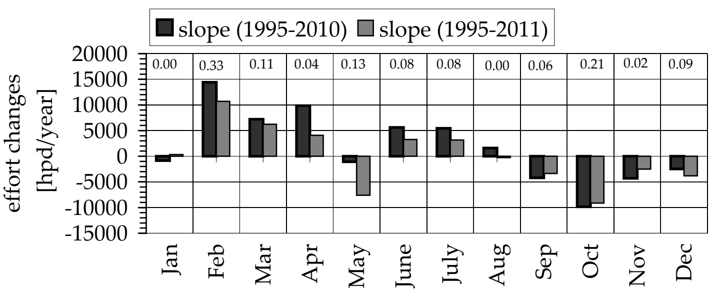

Figure 1.30. Slopes of the correlation of effort vs. time. Graph shows changes in Dutch seasonal effort in horse-power days at sea/year for the period 1995 to 2011 and 1995 to 2010. Positive values indicate an increase negative values a decrease in hp-das. Numbers in the upper part of the graph are r^2 - values of the correlation of effort vs. time for the whole time-series 1995–2011.

Changes in effort are visualized using standardized Dutch seasonal effort as: $rel\,E_{m,y} = E_{m,y}/\bar{E}_m$, where $E_{m,y}$ is the effort per month and year in either days at sea or horse-power days at sea, and $\bar{E}_m$ the average effort per month for all available years (Figure 1.31). Relative effort plots of das and hp-das follow comparable pattern. The low effort in 2011 indicated by the blue boxes is clearly visible. Additionally the decreasing trend hp-das in autumn and the increasing trend in spring is shown.

Dutch relative effort:

days at sea **hp-days at sea**

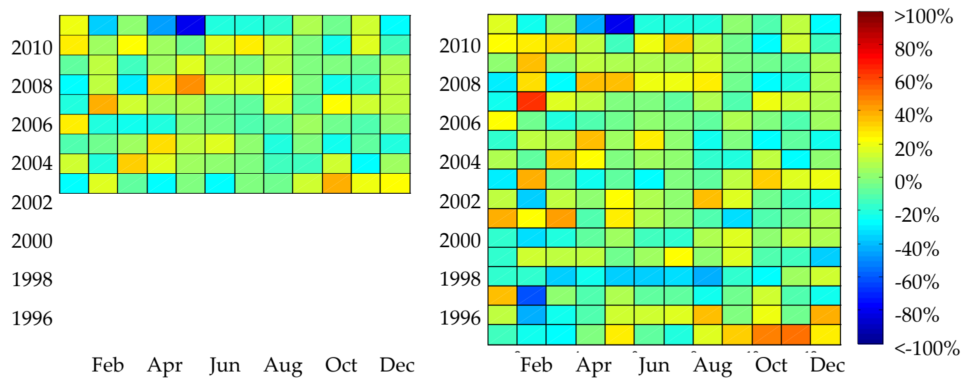

Figure 1.31. Dutch seasonal relative effort in % deviation from monthly average over the period 2003 to 2011 and 1995–2011, respectively. Left panel days at sea, right panel hp days at sea. Blue indicates lower effort, red higher effort than the average.

1.2.4 Netherlands - Landings Per Unit Effort

Although Dutch effort generally followed a pronounced bimodal distribution with high numbers of das in spring and autumn the average LPUE pattern is less pronounced. Highest LPUE mainly occur in October (Figure 1.32), May LPUE are only half the October value. The 2011 LPUE pattern is different from the long term average pattern and especially during the strike period in May LPUE increased to 1.5 t/das. The effort in kg/hp-das pattern was comparable to the LPUE in t/das pattern.

From the LPUE anomalies plots (Figure 1.34) the high value observed in May 2011 sticks out and also the strong 2010 year class is visible. High LPUE in comparison to the average were also observed in spring during 2005–2008 and also in 1998.

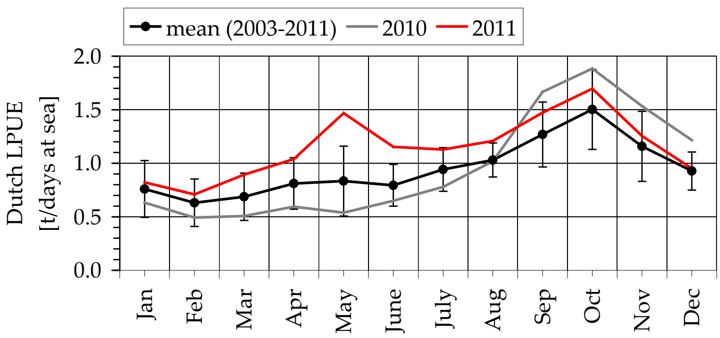

Figure 1.32. Landings per unit effort (LPUE) for the Dutch fleet in t/days at sea. Black line - long term average (and std) since 2000, grey line - 2010 and red line - 2011.

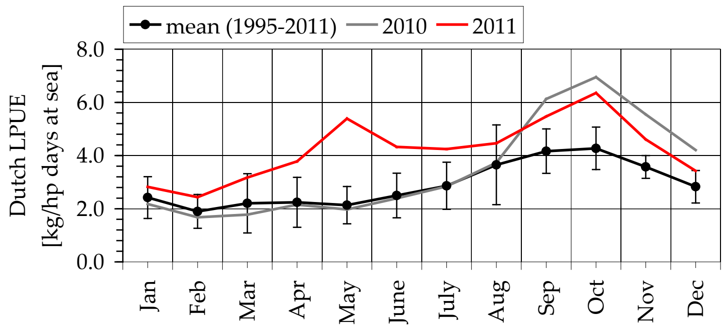

Figure 1.33. Landings per unit effort (LPUE) for the Dutch fleet in kg/horse power days at sea. Black line - long term average (and std) since 1995, grey line - 2010 and red line - 2011.

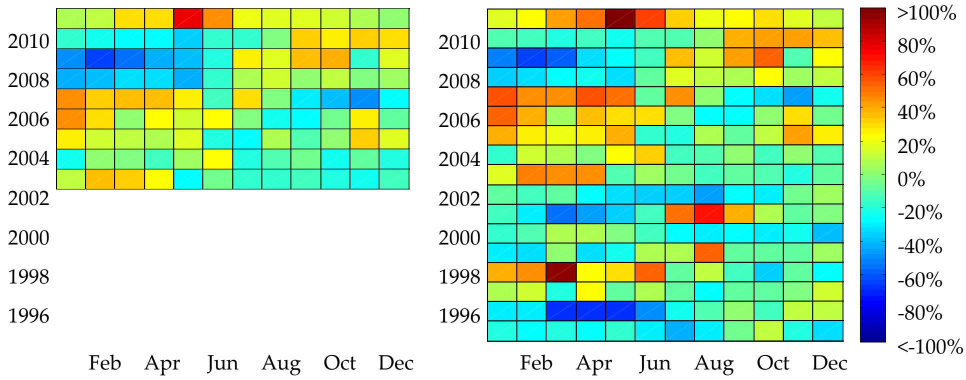

Figure 1.34. Dutch seasonal relative landings per unit effort (left: t/d; right: kg/horse power days) in % deviation from monthly average over the period 1995 to 2011. Blue indicates lower effort, red higher effort than the average.

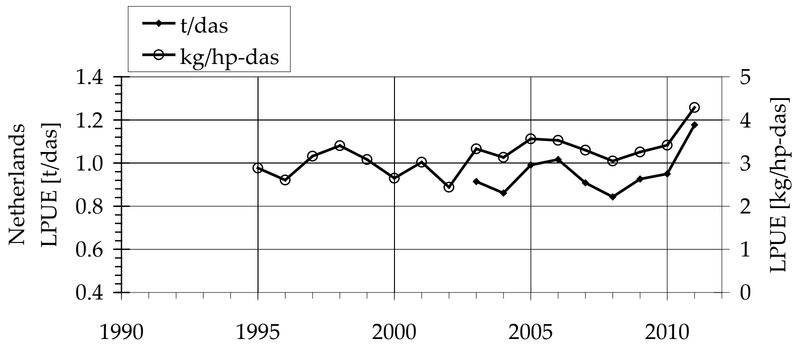

Figure 1.35. Dutch annual landings per unit effort (LPUE) in kg/horse-power days at sea on the secondary y-axis and t/days at sea on the primary y-axis.

1.3 Denmark

1.3.1 Denmark - Fleet and annual landings

Based on vessels register, logbook and sales slip information on the reported catch, effort and LPUE for the Danish fleet is given. LPUE are based on hours at sea and refer to the date the shrimper lands the shrimps.

On average 26 Danish ships are fishing shrimps. During the last three years the number of shrimpers remained constant and was 27 ships (Figure 1.36).

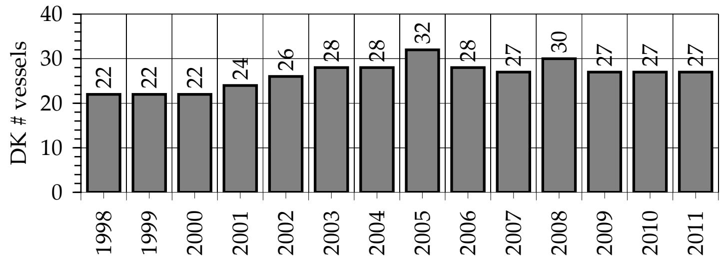

Figure 1.36. Number of Danish shrimpers per year.

The total Danish landings for 2011 amounted to 3005 tonnes comparable to 2010 where 3139 t were landed. This amount of shrimps landed by DK-fisherman accounts for 9% of the whole North Sea landings and thus Denmark ranks under the three most important shrimp fleets. Since 2005 Danish landings, comparable to the other nations, decreased.

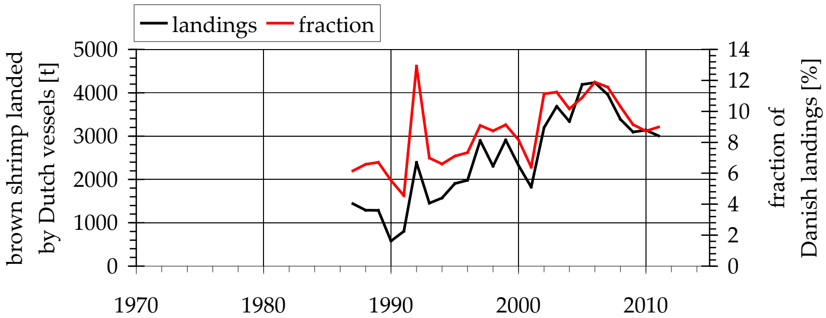

Figure 1.37. Consumption shrimps landed by Danish vessels over the period 1987 to 2011 in t (primary y-axis). Percentage of Danish landings in relation to total (whole North Sea, all nations) landings.

1.3.2 Denmark - Seasonal landings

In contrast to Germany and the Netherlands where high landings are mainly observed in autumn, Danish landings, on average, peak in spring (Figure 1.38). In 2010 and 2011 highest Danish landing values were observed in autumn. Lowest landings were in 2011 reported for May. These low values are, comparable to the German and Dutch fleet, again due to the strike and the reduced effort of the whole fleet.

Decadal averages in landings (Figure 1.39) increased since 1987. In all years high amounts of shrimps were landed in spring. Generally > 400 t are landed between 2000 and 2010 in April whereas usually about 300 t were landed in October.

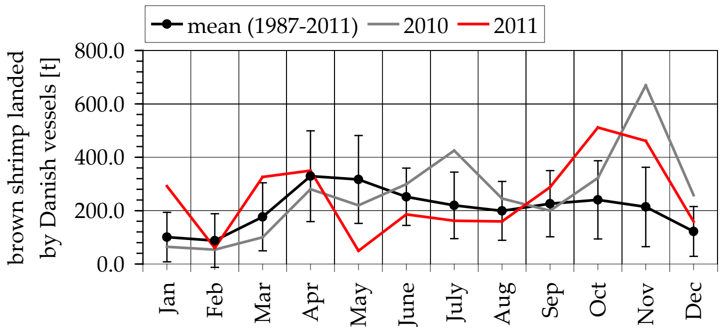

Figure 1.38. Consumption shrimps landed by Danish vessels per month. Black line - long term average since 1987, grey line - 2010 and red line - 2011.

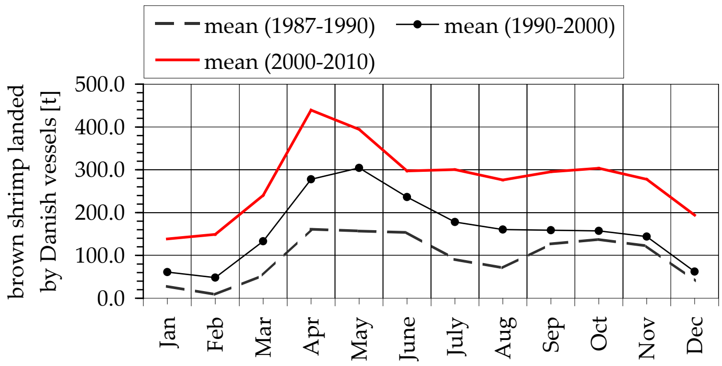

Figure 1.39. Decadal average of Danish seasonal landings (t).

1.3.3 Denmark - Seasonal effort

Effort of the Danish fleet has so far been only reported in hp-days at sea. For this report also the days at sea are included. Additionally, in contrast to earlier years, days at sea are now calculated directly based on the time outside the harbour.

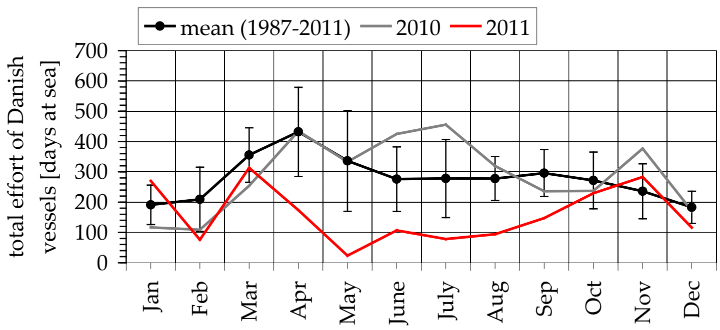

Figure 1.40. Total seasonal effort in days at sea of Danish shrimpers. Black line - long term average (and std) since 1987, grey line - 2010 and red line - 2011.

On average (1987–2011) seasonal effort of the Danish fleet peaks in April (11700 ± 37500 hp-das). During October effort was about 79 000 hp-das and during winter 42 000 hp-das (Figure 1.41). In 2011 lowest values of < 10 000 hp-das were observed in May. Later in 2011 effort increased gradually to 93 000 hp-das in November. The November value was again comparable to the 2011 value whereas during the remaining months the 2011 effort was lower than in 2010. The pattern of days at sea (Figure 1.40) is comparable to the seasonal hp-das pattern and Danish shrimpers spent about 300 days at sea between June and October (Figure 1.40).

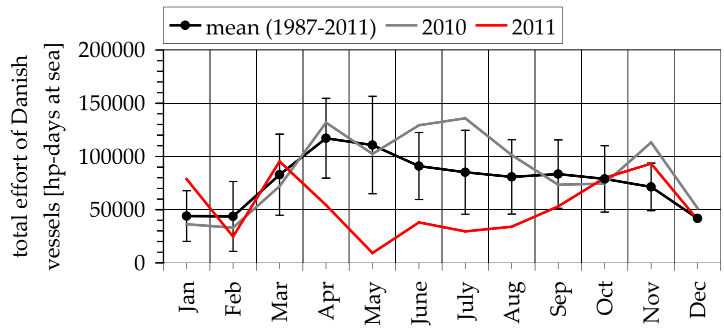

Figure 1.41. Total seasonal effort in horse power days at sea of Danish shrimpers. Black line - long term average (and std) since 1987, grey line - 2010 and red line - 2011.

Seasonal effort of the Danish fleet underwent changes over time (Figure 1.43) with most pronounced changes per year during winter. Between December and March effort increased by 2000–4000 hp-das per year (r^2 0.27–0.34). Although in the remaining months a positive slope was calculated when using hp-das as dependent and time as independent variable but r^2 values were all < 0.07. Including or neglecting the 2011 values did not lead to pronounced changes of the slopes indicating that the long term trend is not influenced by the 2011 low effort outliers.

From the effort anomalies plot (Figure 1.44) also no clear trend in effort can be detected. The years 2001 to 2003 are characterized by higher efforts over the whole year in comparison to the average whereas in other years effort is lower only during summer (2004–2007) or winter (1990–1991).

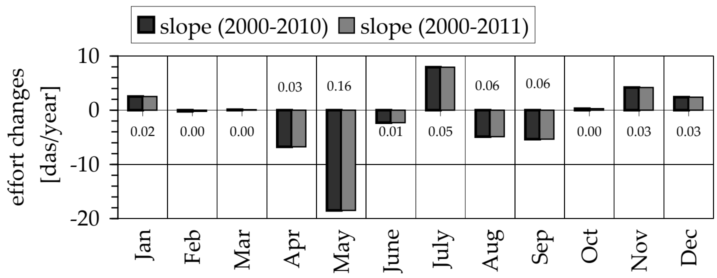

Figure 1.42. Slopes of the correlation of effort vs. time. Graph shows changes in Danish seasonal effort in days at sea/year for the period 2000 to 2011 and 2000 to 2010. Positive values indicate an increase negative values a decrease in das. Numbers in the upper part of the graph are r^2 - values of the correlation of effort vs. time for the whole time-series 2000–2011.

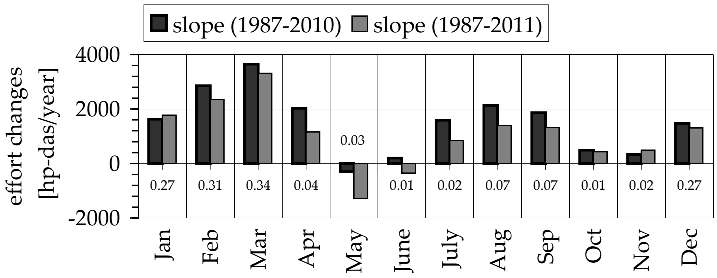

Figure 1.43. Slopes of the correlation of effort vs. time. Graph shows changes in Danish seasonal effort in horse-power days at sea/year for the period 1987 to 2011 and 1987 to 2010. Positive values indicate an increase negative values a decrease in hp-das. Numbers in the upper part of the graph are r^2 - values of the correlation of effort vs. time for the whole time-series 1987–2011.

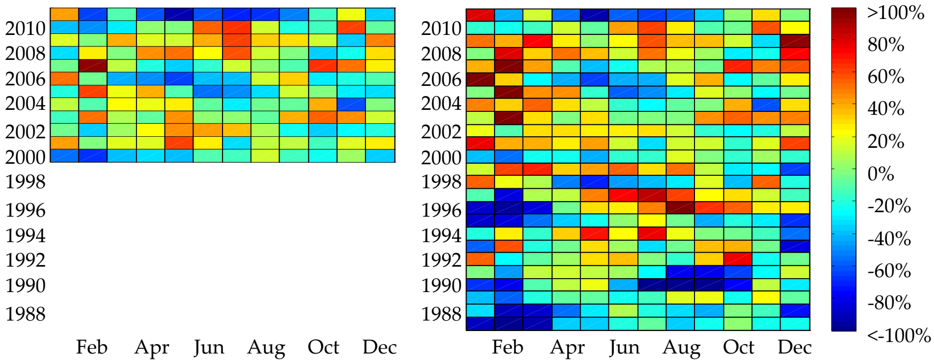

Figure 1.44. Danish seasonal relative effort left [t/days at sea] right [kg/hp-days at sea] in % deviation from monthly average over the period 2000-2011 and 1987 to 2011, respectively. Blue indicates lower effort, red higher effort than the average. Since 2000 days at sea are calculated based on hours at sea.

1.3.4 Denmark - Seasonal LPUE

Although Danish effort and landings peak in spring highest LPUE are not only observed in spring but also autumn (Figure 1.46). On average 3.04 kg are landed in May per horse-power day and 3.14 kg/hp-das in October and November. In 2011 LPUE in all month were between 1.4 (February) to 2.1 (July) and thus higher than the average. In April and October 6.4 kg/hp-das were landed. Comparable high LPUE in relation to the average (Figure 1.47) were observed during 2005–2007.

LPUE in t/d and kg/hp-das were comparable for the time span 2000 to 2011, peaked in 2006 declined towards 2009 and were in 2011 again on the level of 2006 (Figure 1.48).

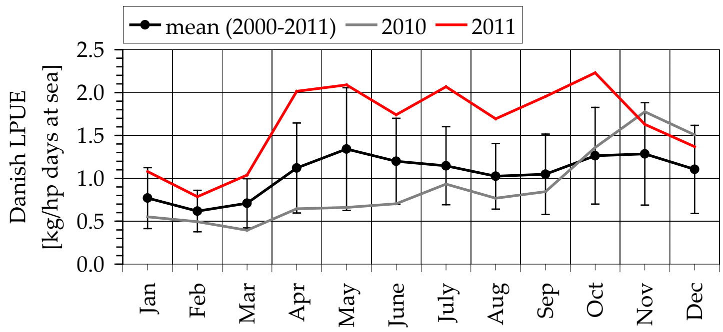

Figure 1.45. Landings per unit effort (LPUE) for the Danish fleet in t/ days at sea. Black line - long term average (and std) since 2000, grey line - 2010 and red line - 2011.

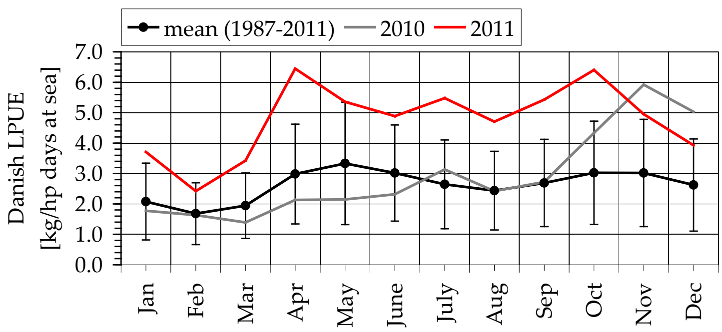

Figure 1.46. Landings per unit effort (LPUE) for the Danish fleet in kg/horse power days at sea. Black line - long term average (and std) since 1987, grey line - 2010 and red line - 2011.

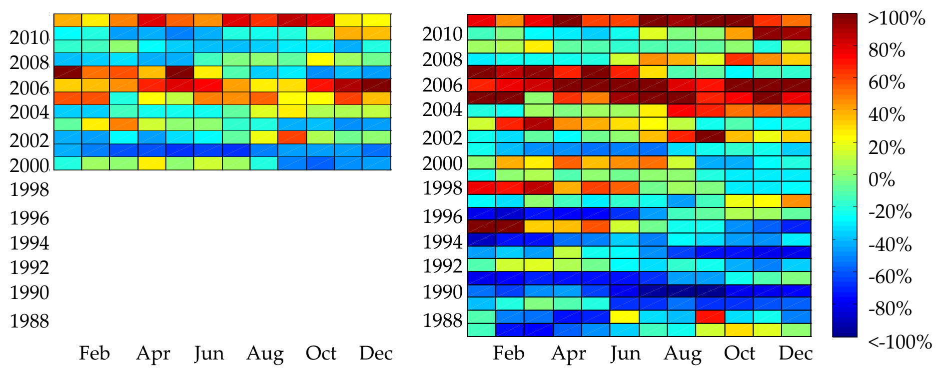

Figure 1.47. Danish seasonal relative landings per unit effort left in t/days at sea and right in kg/horse-power days at sea in % deviation from monthly average over the period 2000 to 2011 and 1987 to 2011, respectively. Blue indicates lower effort, red higher effort than the average.

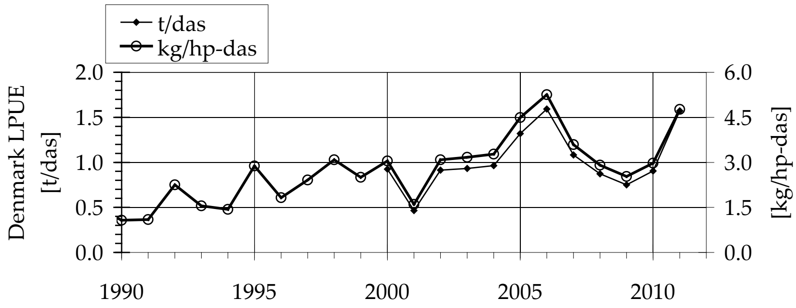

Figure 1.48. Danish annual landings per unit effort (LPUE) in horse-power days at sea on the secondary y-axis and t/days at sea on the primary y-axis.

1.4 The United Kingdom

1.4.1 United Kingdom - Fleet and annual landings

UK data contain landings from UK vessels into UK and foreign harbours. The majority of fishing record data for vessels landing shrimps into the UK is stored on official databases held by English and Scottish authorities. Historically these data have been combined but since 1997 Scottish landings have been zero or negligible and for some records implausible capture methods have led to doubts about their validity. As such UK landings presented in recent working group reports and for recent years (post 1997) have consisted exclusively of those by English and Welsh vessels. With improvements in reporting procedures from 1988 landings data are considered to provide a reasonable account of fishing activity by UK vessels and data prior to this year are considered less reliable.

Improvements in reporting have also led to most landings since 1988 being accompanied by corresponding effort information in the form of the engine power of the vessels and the days fished (rounded to the nearest whole day). Indeed since 2007 all landings have appropriate engine power and days fished information enabling computation of hp-days at sea for each landing and corresponding summation to month and year.

The Wash fishery in the North Sea is the source of typically around 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 the highest reported landings (1865 t) in 2001 and the lowest in 1984 (132 t). Low annual reported landings of around 500 t with periodic good years in excess of 1000 t are typical of this fishery and are thought to be influenced by environmental factors. Good recruitment in late summer can often provide a productive autumn fishery and high catch rates which can be sustained into the following spring (e.g. 1999/2000, 2001/2002 and 2007/2008 fishing seasons).

Since 1990, effort information in terms of hp-days is available for most of the reported landed shrimps (from 63% in the early years increasing to 100% in 2007 to 2010). Total effort was estimated from the ratio of total landings to observed LPUE. Estimated total effort has fluctuated between 252 000 hp-days in 2006 and 914 000 hp-days in 2001. Catch rates and prices of *Crangon* and other fishing opportunities (e.g. cockle fisheries, *Cerastoderma edule*), influence the levels of effort directed in any one year. Annual estimated fishing effort in 2009 and 2010 were the highest values in the last seven years, but they are not atypical for the series.

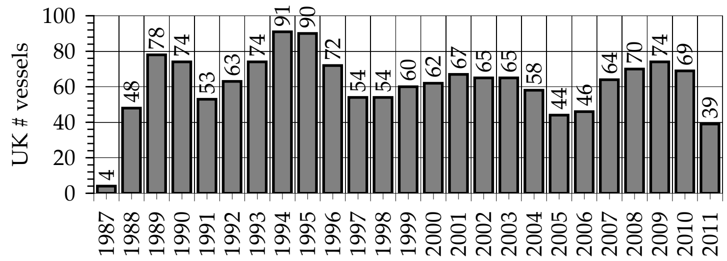

Figure 1.49. Number of UK shrimpers.

Since 1989 the number of UK vessels reported as fishing for brown shrimps has varied between 44 and 91 (Figure 1.49), depending on market forces and other fishing opportunities. Although this value is likely to be an underestimate of the true numbers of vessels operating in England and Wales it is considered a reasonable estimate of the size of the fleet. The recent high prices and landings of the main UK fishery have led to moderately high numbers of vessels (69 in 2010) prosecuting the fishery which, again due to the prices decreased in 2011 to 39 vessels.

The amount of consumption shrimps landed by UK vessels decreased from 872 t in 2010 to 364 t in 2011. In relation to the total North Sea landings this represents 1.1%.

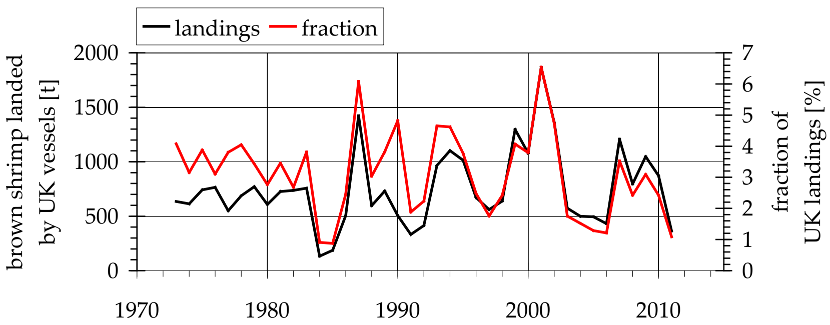

Figure 1.50. Consumption shrimps landed by UK vessels over the period 1973 to 2011 in t (primary y-axis). Percentage of UK landings in relation to total (whole North Sea all nations) landings.

1.4.2 United Kingdom - Seasonal landings

Over the period 1973–2011 UK landings were between 25 and 40 t per month (Figure 1.51). In October generally highest landings but also highest variability in landings was reported (143 ± 107 t). For 2010 the seasonal pattern was shifted by one month in relation to the average pattern and landings peaked in September. In 2011 seasonal landings were lower than the average and the 2010 values. Again highest landings were reported for September. Until July < 15 t per month were landed. Over time landings did not change considerably (Figure 1.52) and only during the last decade (2000–2010) higher amounts of shrimps were landed in autumn in comparison to the decades before.

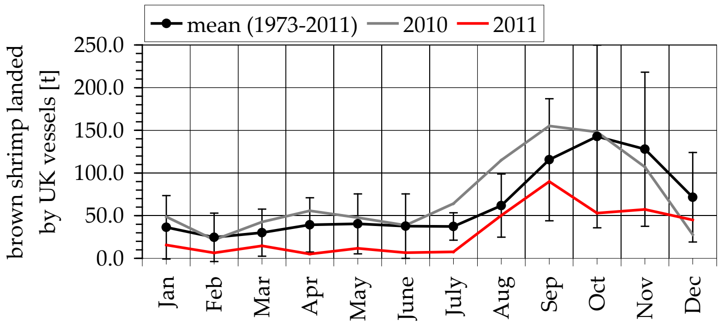

Figure 1.51. Consumption shrimps landed by UK vessels per month. Black line - long term average since 1987, grey line - 2010 and red line - 2011.

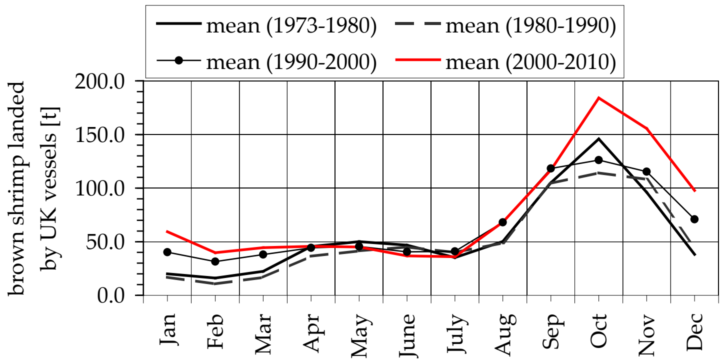

Figure 1.52. Decadal average of UK seasonal landings (t).

1.4.3 United Kingdom - Seasonal effort

Comparable to the UK landings also UK effort peaks during autumn (Figure 1.53) where UK fisherman spent about 70 000 hp-days at sea. In 2011 effort was reduced to 8% (June) to 57% (September) of the long term average effort. For the period October to June effort decreased between 1987 and 2010 (Figure 1.54).The strongest decrease of > 6000 hp-das per year ($r^2 = 0.66$) was hereby determined for December, lowest for January and February (Figure 1.54). Relative seasonal effort (in relation to the average for that month, Figure 1.55) again shows the low 2011 effort in relation to the remaining years. Comparable low effort was also observed in 1998, 2006 and 2007.

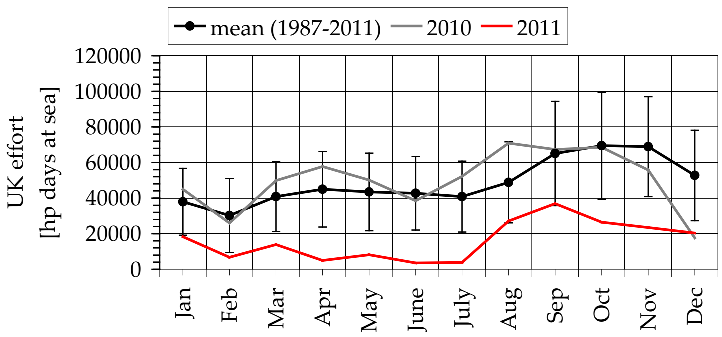

Figure 1.53. Total seasonal effort in horse power days at sea of UK shrimpers. Black line - long term average (and std) since 1987, grey line - 2010 and red line - 2011.

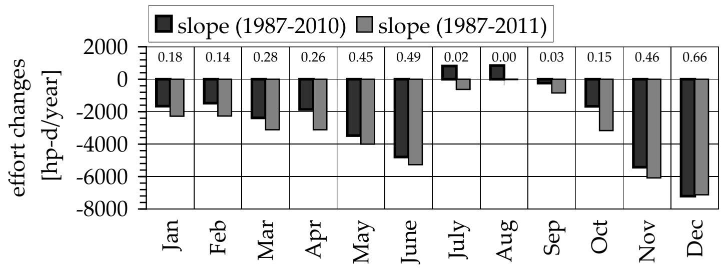

Figure 1.54. Slopes of the correlation of effort vs. time. Graph shows changes in UK seasonal effort in horse-power days at sea/year for the period 1987 to 2011 and 1987 to 2010. Positive values indicate an increase negative values a decrease in hp-das. Numbers in the upper part of the graph are r^2 - values of the correlation of effort vs. time for the whole time-series 1987–2011.

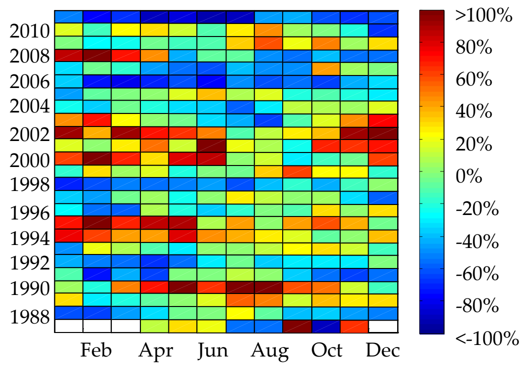

Figure 1.55. UK seasonal relative effort (kg/hp-days at sea) in % deviation from monthly average over the period 1987 to 2011. Blue indicates lower effort, red higher effort than the average.

1.4.4 United Kingdom - Seasonal landings per unit effort

UK LPUE were on average 1.33 kg per hp-das (Figure 1.56). In October (average of 1987 to 2011) 2.06 kg/hp-das were landed. In 2010 LPUE more or less directly followed the average pattern. In 2011 especially the summer LPUE (May to August) were higher than the average LPUE (Figure 1.56). These high LPUE during summer are unusual in comparison to other years (Figure 1.57) and a comparable situation was only observed in 2000 and 1987.

In contrast to Germany, the Netherlands and Denmark the 2011 UK annual LPUE values were not higher than the years before (Figure 1.58) but with 2 kg/hp-das comparable to the long-term average.

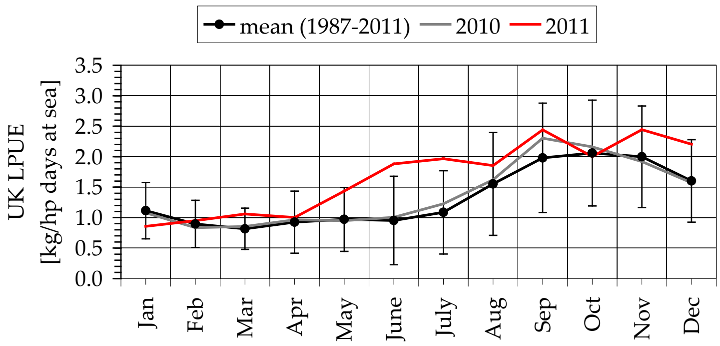

Figure 1.56. Landings per unit effort (LPUE) for the UK fleet in kg/horse power days at sea. Black line - long term average (and std) since 1987, grey line - 2010 and red line - 2011.

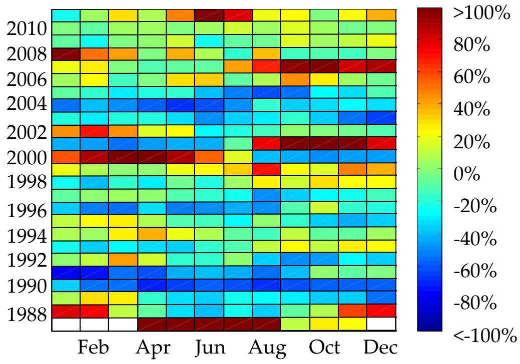

Figure 1.57. UK seasonal relative landings per unit effort in % deviation from monthly average over the period 1987 to 2011. Blue indicates lower effort, red higher effort than the average.

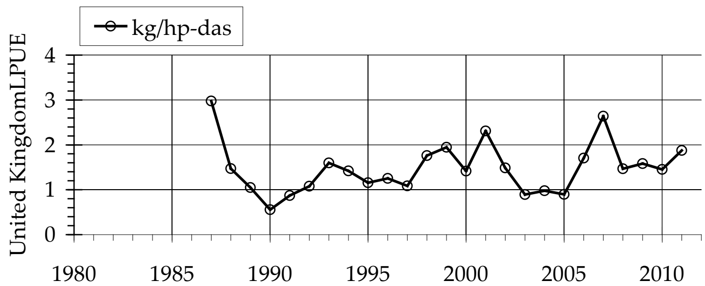

Figure 1.58. UK annual landings per unit effort (LPUE) in kg/horse-power days at sea.

1.5 Belgium

1.5.1 Belgium - Fleet and annual landings

Belgian logbook and landing data are managed by the federal 'Dienst Zeevisserij' in an Oracle database. While the EU electronic logbook is still not in service in Belgium, fishermen arbitrary fill in fishing hours and catch weight (cooked weight before sieving) daily for each ICES square visited. These data are then put manually into the electronic database by 'Dienst Zeevisserij' on a regular basis.

The data gathering on the landings in Nieuwpoort, Oostende and Zeebrugge are also done by 'Dienst Zeevisserij'. Only in Zeebrugge the landed shrimp are sieved, in Nieuwpoort there isn't even an operational sieving installation. The cooked weight data are converted to fresh weight using a correction factor of 1.25. The biology section of ILVO receives and stores these data on a monthly basis in an Access database called BelSamp. This database however is rather limited (detailed data are lost) and error prone. In pursuit of 'Dienst Zeevisserij', ILVO is planning to switch to a more advanced database in cooperation with VLIZ (The Flanders Marine Institute). As the weight measurement of the daily landings in the harbour are more accurate, the daily arbitrary catch weight for each square is corrected in Belsamp:

$$Corrected\ Catch\ weight_{square\ x} = Catch\ weight_{square\ x} \times \frac{Landig\ weight}{\sum_{all\ squares} catch\ weight}$$

The Belsamp database thus contains following data: Auction year; Auction month; Auction day; Dutch port name; Vessel ID; Vessel number; Vessel name; Vessel length [m]; Vessel GRT [t]; Vessel NRT [t]; Vessel engine power [kW]; Rectangle group code; Scientific species name; DZ species ID; ICES species abbreviation; Sum(Fresh weight (kg)); Fishing hours. While both databases contain all domestic and foreign activities of Belgian trawlers, the Belgian data used for the WGCRAN working group are currently related to the landings in Belgian harbours only. For example, in 2009 the total landing of Belgian shrimp trawlers in Belgian ports was 444 tons of cooked shrimp, while 824 tons were landed abroad. The Landings per Unit Effort (LPUE, in tons per horsepower fishing hours) used is calculated as follows:

$$LPUE = \frac{cooked\ weight\ [t]}{\frac{engine\ power\ [kW]}{736} x fishing\ hours}$$

Finally it should be noted that especially in Belgium a large but yet inestimable quantity of cooked commercially sized shrimp never reaches the official statistics. These shrimp are directly distributed to the local restaurants or sold in outdoor fishmarkets (such as the 'Vistrap' in Oostende). Moreover, it is likely that more and more shrimp trawlers will associate with the cooperative "Vlaamse Visserij Vereniging CVBA" (VVV) which was founded in 2007. In that case the caught shrimp are not landed at the fish market but are immediately processed by VVV for being marketed as 'Purus' shrimp.

Due to the high fraction of unreported landings Belgian LPUE are not easily comparable to those of other nations.

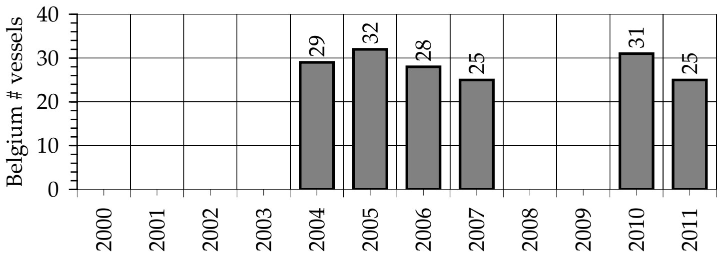

Figure 1.59. Number of Belgian shrimpers.

The Belgian fleet size is comparable to the Danish and varied between 25 and 32 (2005) ships. In 2011 25 ships were fishing shrimps (Figure 1.59).

Belgian landings in 2011 decreased in comparison to 2010 from 1650 to 754 t. In 2011 Belgian vessels landed 2.3% of all North Sea shrimps.

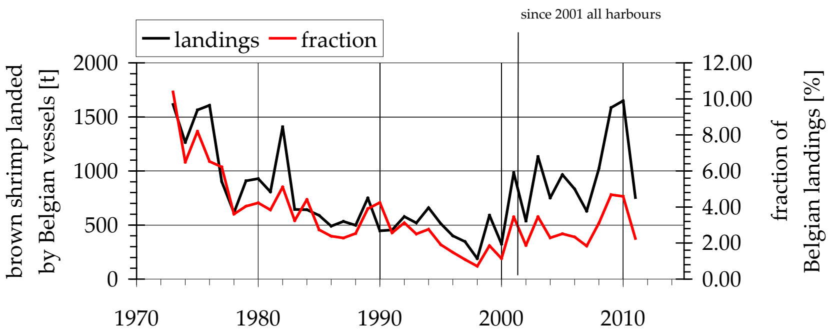

Figure 1.59. Consumption shrimps landed by Belgian vessels over the period 1973 to 2011 in t (primary y-axis). Percentage of Belgian landings in relation to total (whole North Sea, all nations) landings.

1.5.2 Belgium - Seasonal landings

Highest landings in Belgium occur on average during autumn. For the period 1973 to 2000 only landings in Belgium harbours were considered whereas from 2001 all landings from the Belgium fleet are included in the landings statistics. Before 2001 on average 135 698 t were landed by the Belgian fleet in Belgian harbours in September. From 2001 the average Belgian September landings volume was 205 042 ± 139 344 t including all ships and all harbours (Figure 1.61). In 2010 especially during September, October and November landings more than doubled the average landings whereas in 2011 landings were on average level with exception of August where 197 t were landed in contrast to an average value of 136 t (2001–2011).

Although the decadal averages are not exactly comparable as in years before 2000 foreign harbours were not included, an increase in autumn landings was determined over the last 30 years. In spring average landings between 2000 and 2010 were lower than the 10 years before and are now again on the level of the 1973–1980 period (Figure 1.62).

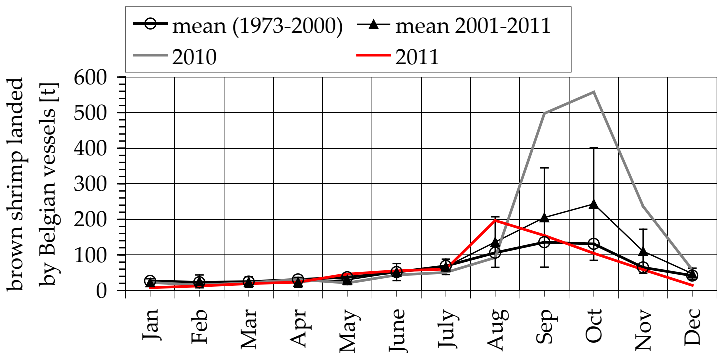

Figure 1.60. Consumption shrimps landed by Belgian vessels per month. Black line - long term average since 1973, grey line - 2010 and red line - 2011.

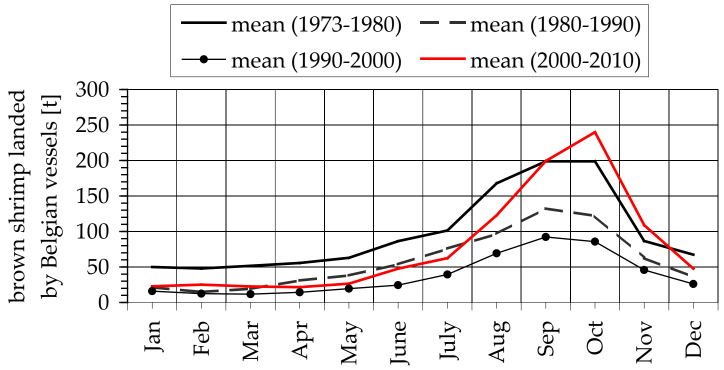

Figure 1.61. Decadal average of Belgian seasonal landings (t).

1.5.3 Belgium - Seasonal effort

Effort of the Belgian fleet steadily increases from January to August and is on average 900 000–950 000 hp-das per month between August and October (Figure 1.63). Since 1973 Belgian effort decreased between March and July by > 10000 hp-das a year (Figure 1.64). Effort data for 2011 were so far not available and will be included in the next report.

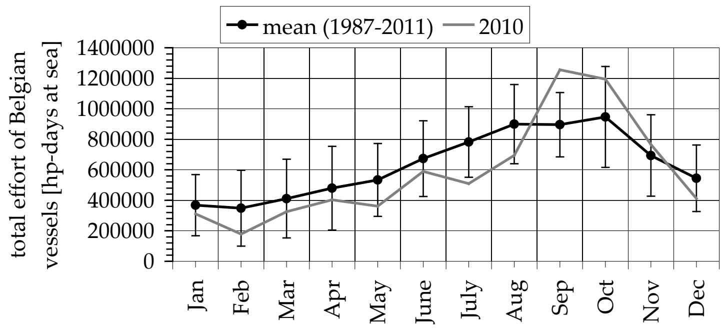

Figure 1.62. Total seasonal effort in horse power days at sea of Belgian shrimpers. Black line - long term average (and std) since 1973, grey line – 2010. Data for 2011 not available so far.

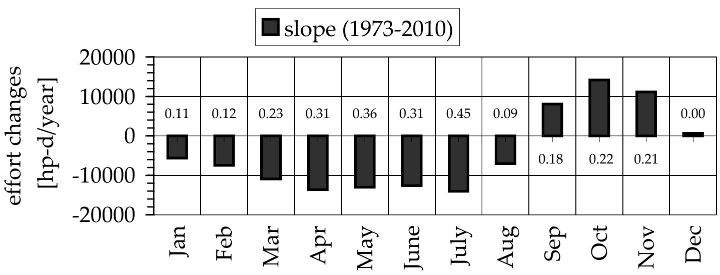

Figure 1.63. Slopes of the correlation of effort vs. time. Graph shows changes in Belgian seasonal effort in horse-power days at sea/year for the period 1973 to 2011 and 1973 to 2010. Positive values indicate an increase negative values a decrease in hp-das. Numbers in the upper part of the graph are r² - values of the correlation of effort vs. time for the whole time-series 1973–2011.

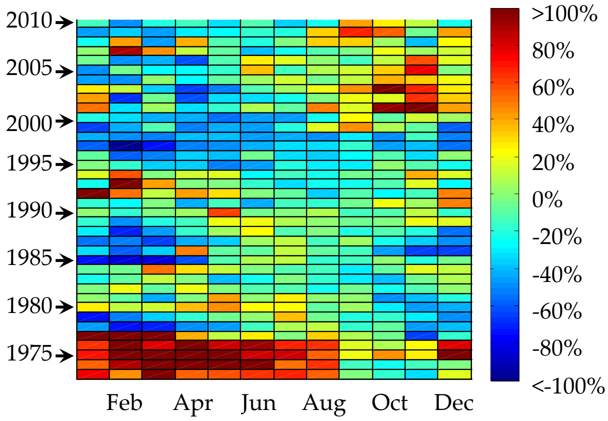

Figure 1.64. Belgian seasonal relative effort (kg/hp-days at sea) in % deviation from monthly average over the period 1973 to 2011. Blue indicates lower effort, red higher effort than the average.

Especially during the earliest available period (1973–1977) Belgium data are characterized by higher than the average efforts (Figure 1.65). In contrast to the high effort period in the 1970s a low effort period occurred in the first half of the year during the late 1990s which was followed by a higher than average period in the second half of the year.

1.5.4 Belgium - Seasonal landings per unit effort

Since 1985 there has been a steady increase in Belgian-LPUE. During the first half and second half of the year values of more than double the average LPUE were observed between 2003 and 2010 and between 2008 and 2011, respectively (Figure 1.67).

Over the whole time-series there is a general pattern of high LPUE before 1983, lower LPUE between 1985 and 2001 and higher values again after 2001.

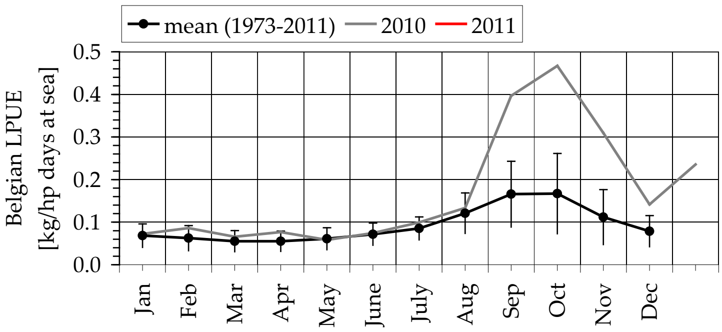

Figure 1.65. Landings per unit effort (LPUE) for the Belgian fleet in kg/horse power days at sea. Black line - long term average (and std) since 1973, grey line – 2010. Data for 2011 so far not available.

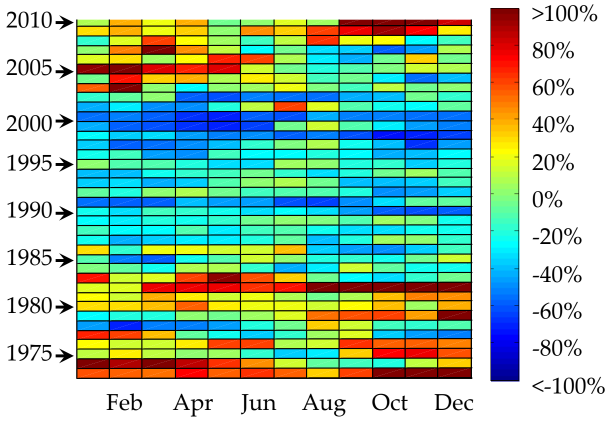

Figure 1.66. Belgian seasonal relative landings per unit effort (kg/hp-days at sea) in % deviation from monthly average over the period 1973 to 2011. Blue indicates lower effort, red higher effort than the average.

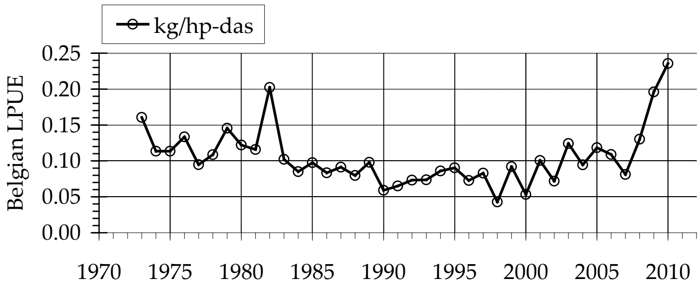

Figure 1.67. Belgian annual landings per unit effort (LPUE) in horse-power days at sea.

1.6 France

1.6.1 France - Fleet and total landings

French vessels are small (8–14 m), those longer than 10 meters fill out logbooks, the others monthly fishing declarations. All the declarations are computed by the French fishing administration and Ifremer has access to the database.

The landings concern only French vessels working in national coastal waters. The landings concern only commercial size. Total landings in 2010 were estimated at 231 tons with 88 coming from the areas VIId, IVc (Figure 1.69). For 2010 the total number of boats involved was 185 and 37, respectively. Both numbers include a majority of boats fishing part time on brown shrimp. After an increase of the landings in 2006, the recent production remained low, particularly in the northern part.

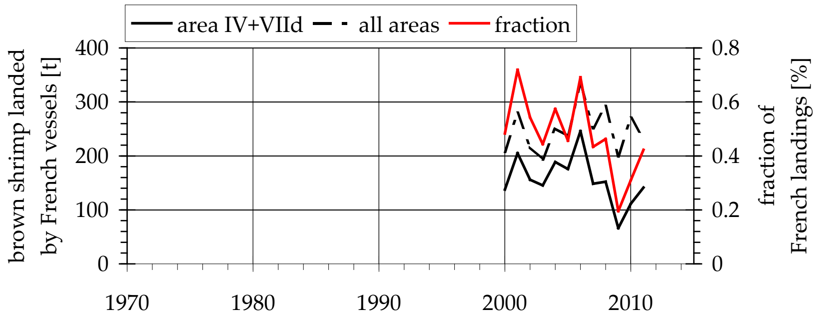

Figure 1.68. Consumption shrimps landed by French vessels over the period 2000 to 2011 in t (primary y-axis). Solid line indicates shrimps landed in ICES area IV and VIId and dotted line total amount of shrimps landed by the whole French fleet. Red line indicates the percentage of French landings in relation to total (whole North Sea all nations) landings.

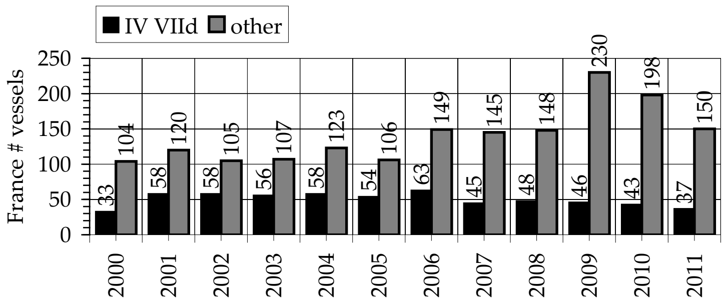

Figure 1.69. Number of French shrimpers fishing in area IV and VIId or in other areas.

1.6.2 France - Seasonal landings

French average landings vary seasonally between 4 and 24 t per month and were highest during autumn. In 2011 shrimps were especially landed during spring, whereas in autumn landings were less than average (Figure 1.71).

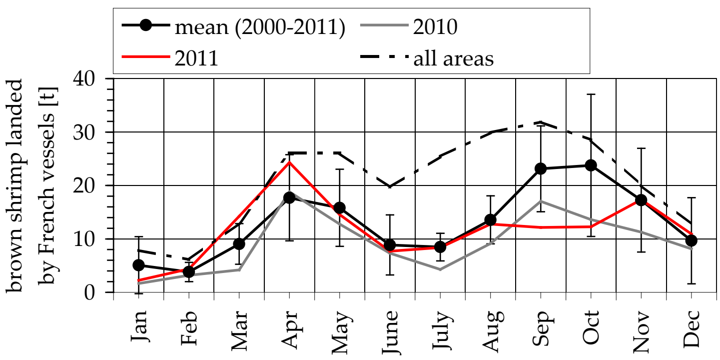

Figure 1.70. Consumption shrimps landed by French vessels per month. Black line - long term average since 2000 for ICES areas IV and VIId, dashed line - mean for all French vessels, grey line - 2010 (IV+VIId) and red line - 2011 (IV+VIId).

1.6.3 France - Seasonal effort

During the period 2000 to 2011 effort of the French fleet decreased between April and January. Effort decreased between 20 and 70 days at sea per year ($r^2 > 0.31$, Figure 1.72). Seasonal effort of the whole French fleet during summer (April–October) was generally > 1000 days at sea. The fraction of the French fleet that operates in area IV and VIId spent 434 das with highest average values of 615 das in September. In 2011 effort was lower than the average (Figure 1.73) and did not exceed 250 days at sea per month.

The trend indicated by the monthly regressions shown in Figure 1.72 also becomes obvious when annual and seasonal effort anomalies are considered (Figure 1.74). Between 2001 and 2007 generally higher effort and between 2008 and 2011 lower effort than average were reported.

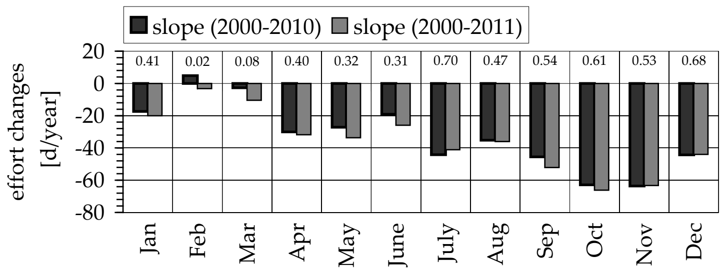

Figure 1.71. Slopes of the correlation of effort vs. time. Graph shows changes in French (area IV+VIId) seasonal effort in days at sea/year for the period 2000 to 2011 and 2000 to 2010. Positive values indicate an increase negative values a decrease in das. Numbers in the upper part of the graph are r^2 - values of the correlation of effort vs. time for the whole time-series 2000–2011.

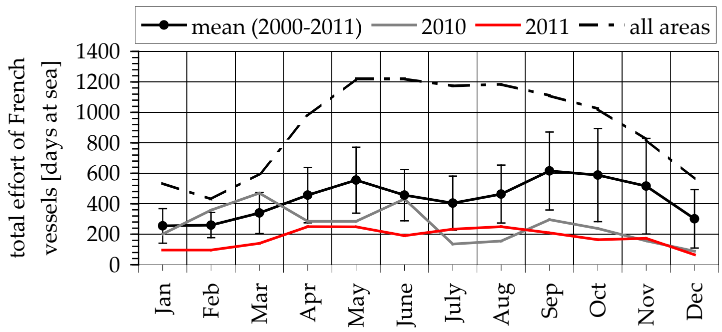

Figure 1.72. Total seasonal effort in days at sea of French shrimpers. Black line - long term average (and std) since 2000 (area IV+VIId), dashed line – effort of all active French brown shrimpers, grey line - 2010 and red line - 2011.

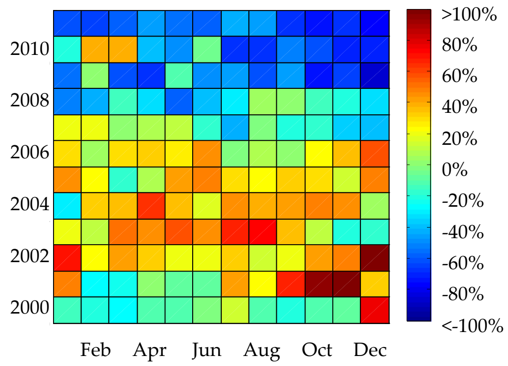

Figure 1.73. French seasonal relative effort (t/days at sea) in % deviation from monthly average over the period 2000 to 2011. Blue indicates lower effort, red higher effort than the average.

1.6.4 France - Seasonal landings per unit effort

French effort data on average peak in April and October (Figure 1.75). In 2011 highest LPUE were observed in December (0.165 t/das), March and April (0.1 t/das). In total LPUE were twice as high and in December 4 times higher in 2011 in comparison to the average of 2000–2011.

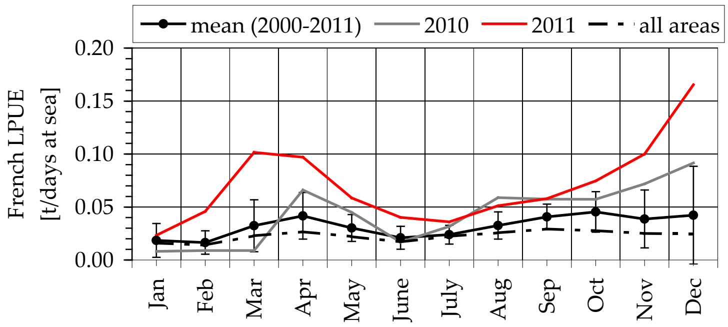

Figure 1.74. Landings per unit effort (LPUE) for the French fleet in kg/horse power days at sea. Black line - long term average (and std) since 2000 (area IV+VIId), dotted line – all active French brown shrimpers, grey line - 2010 and red line - 2011.

During the past 10 years especially during summer an increase in French LPUE (Figure 1.76) was observed, whereas during January–March 2008, 2009 and 2010 lower LPUE than average were reported.

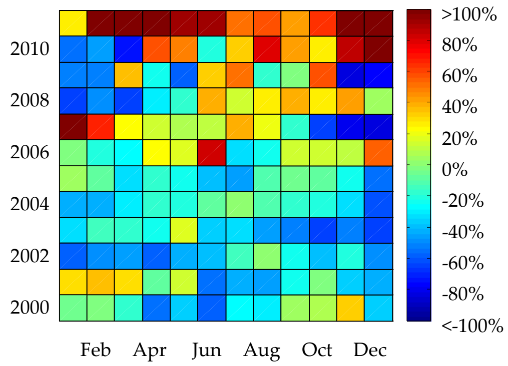

Figure 1.75. French seasonal relative landings per unit effort (days at sea) in % deviation from monthly average over the period 1973 to 2011. Blue indicates lower effort, red higher effort than the average.

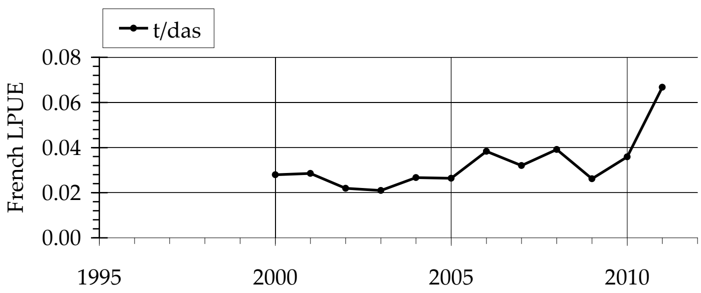

Figure 1.76. French annual landings per unit effort in t/days at sea.

1.7 Comparison all countries

1.7.1 All countries - Total landings, landing shares and vessels

In comparison to 2010 total reported landings by all countries and all seasons decreased by 2544 t to 33 408 t but remained on the high level of > 30 000 caught since 2003 (Figure 1.78). The Netherlands and Germany remain the most important nations landing brown shrimp and together contribute 87% of the total landed value. Over time the importance of the German fleet decreased whereas mainly the Dutch landings increased.

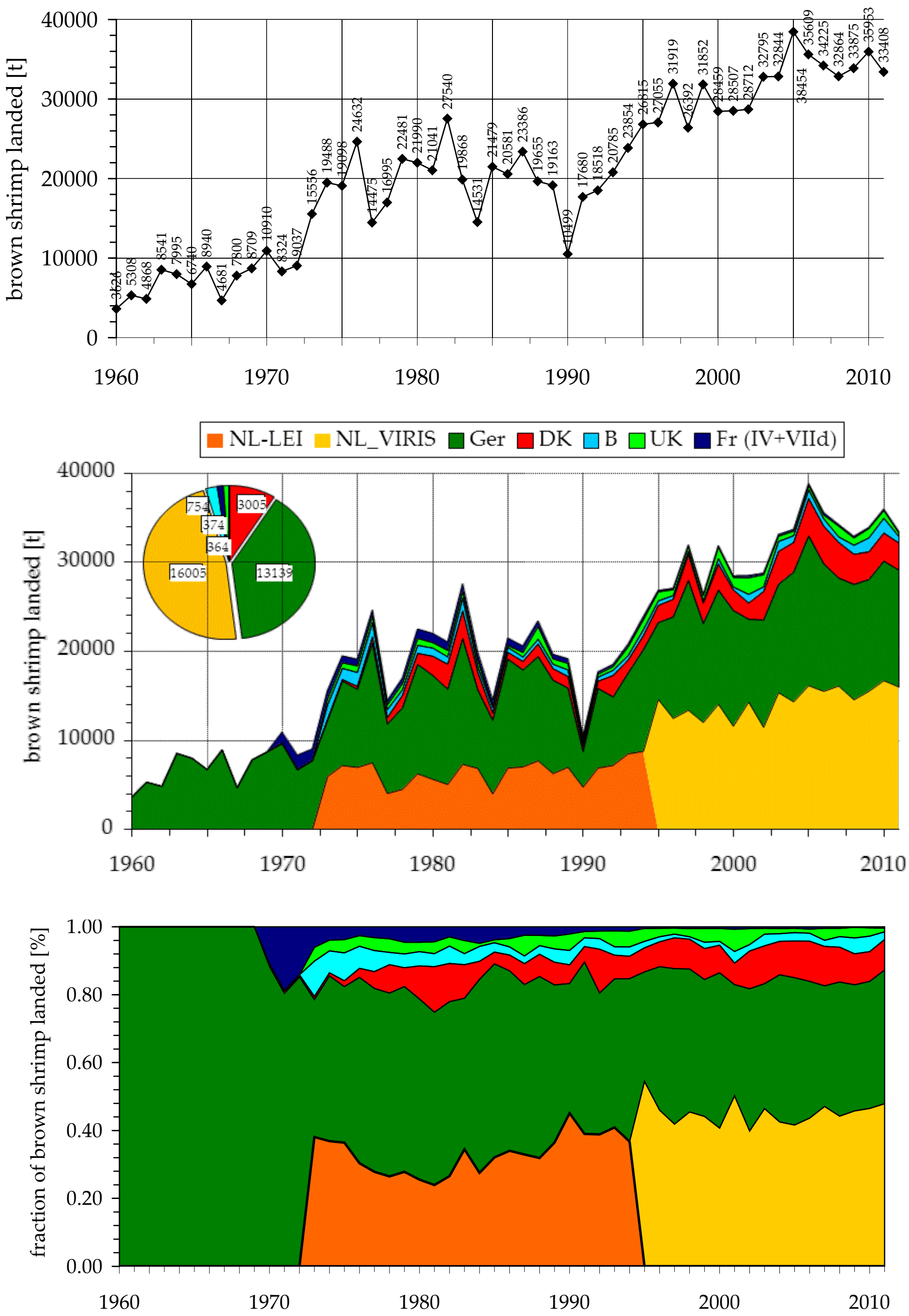

Figure 1.77. Upper panel landings of *Crangon crangon* from the North Sea [t]. Middle panel landings of *Crangon crangon* from the North Sea [t] by country. Insert pie chart landings in t per country for year 2011. Lower panel: contribution of single countries to the total amount of shrimps landed by all countries.

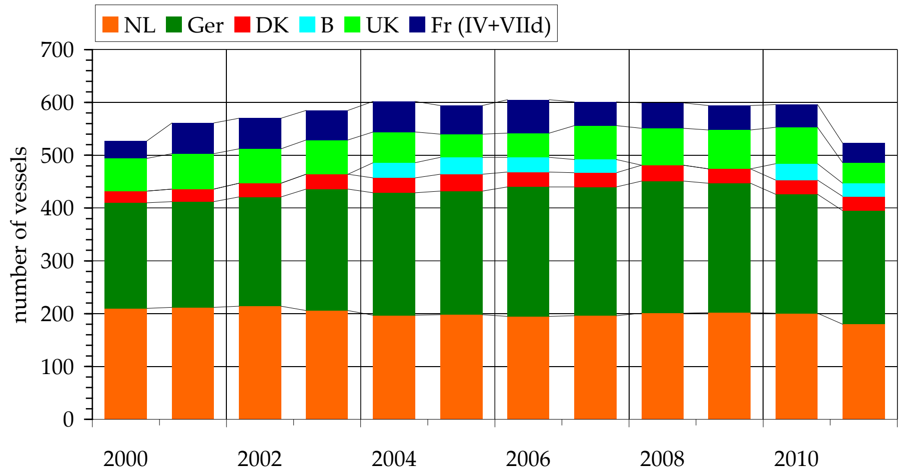

Figure 1.78. Number of active shrimpers by country.

1.7.2 All countries - Seasonal landings

Seasonal landings by all countries peaked in autumn during September, October and November. During these three months 44.5% of the total annual landings are landed (Figure 1.80). The strike in May lead to reduced landings during May where landings were on a level comparable to February and December. For nations not involved in the strike (Belgium, France and UK) landings increased from January 30 t to July 70 t and then peaked in August with 260 t.

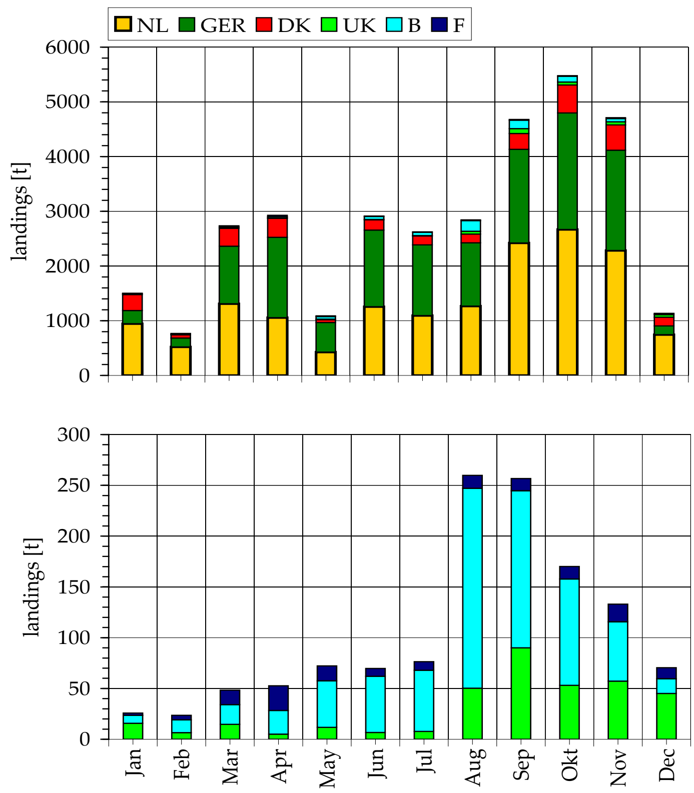

Figure 1.79. Landings of *Crangon* from the North Sea [t] by country and month. Upper panel: all countries, lower panel nations that contribute < 5% to the total landings.

1.7.3 All countries - Effort

So far the effort calculations are not standardized for all countries and have been reported either in days at sea (F), horse-power days-at-sea (UK, B) or both (NL, Ger, DK). Days-at-sea have been either calculated on the time the fisherman are outside the harbour (Ger, F, DK) or the days outside the harbour but setting those values where leaving and returning days are equal to 1 (UK, NL). In the previous chapters we saw that at least the trip length for German shrimpers is often shorter than a day and thus the latter calculation leads to an overestimation of the effort. These differences have to be kept in mind when considering the combined effort graphs below.

WGCRAN has started this year to standardize all effort calculations but as some time-series need to be recalculated this takes some time and is thus one of the ToRs for the following period. To compare the different time-series we used an average fleet engine power of 200 kW (~270 hp) following Figure 1.11. As the Belgian data have been in the process of being recalculated but were not available so far they are not shown in the graphs.

Total seasonal effort (das and hp-das) was low in 2011 in February, May and December (<1300 das, <300 000 hp-das) and highest in November (3700 das, 850 000 hp-das, Figure 1.81, Figure 1.83). Total annual effort is decreasing since 2002 and was now lowest in 2011.

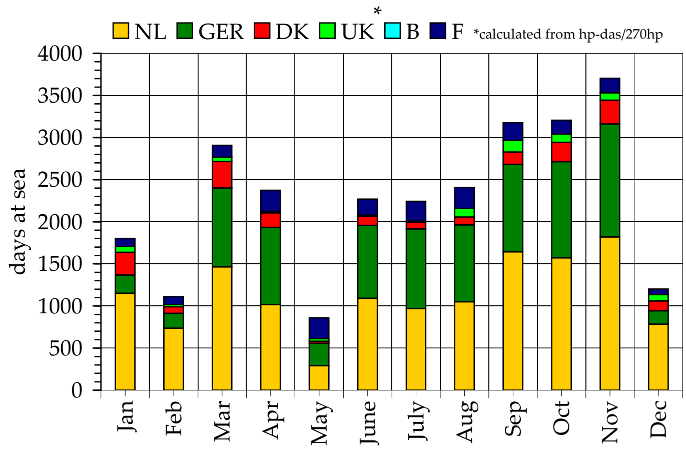

Figure 1.80. Effort in days at sea per country and month. See text for calculations.

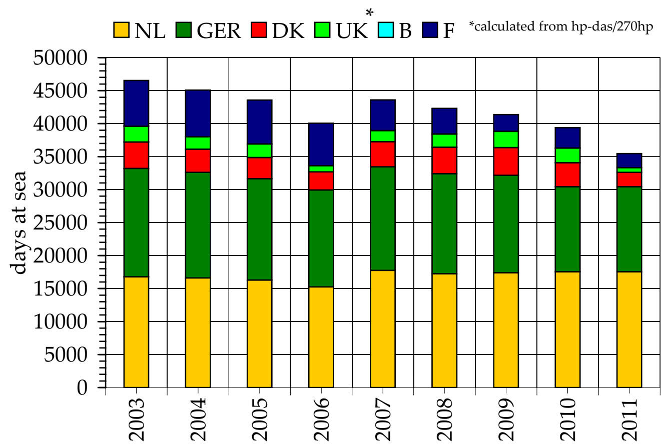

Figure 1.81. Effort in days at sea per country and year. See text for calculations.

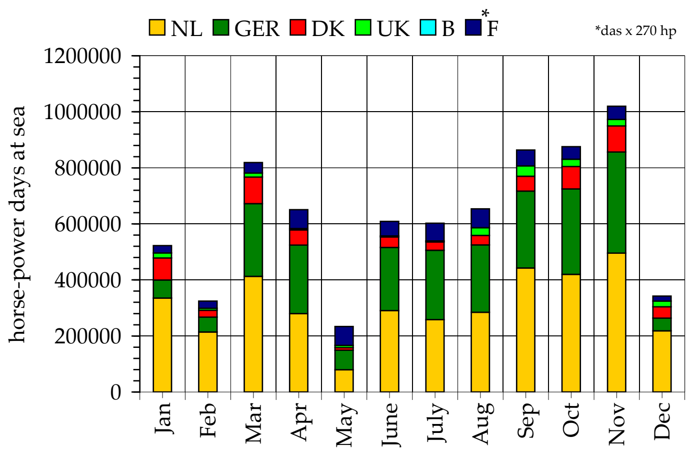

Figure 1.82. Effort in horse-power days at sea per country and month. See text for calculations.

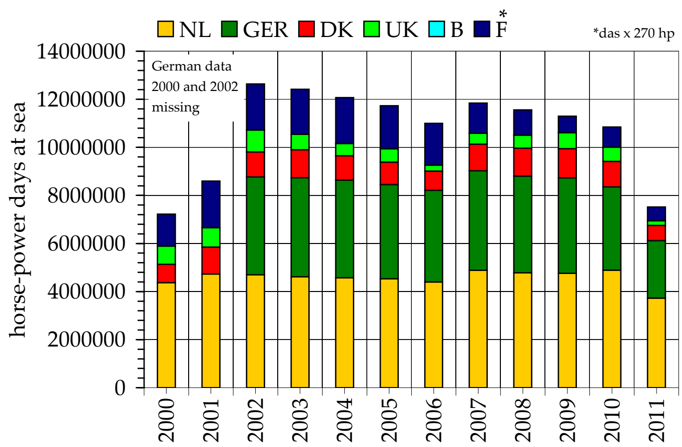

Figure 1.83. Effort in horse-power days at sea per country and year. See text for calculations.

1.7.4 All countries - Landings per unit effort

Dutch, German and Danish LPUE were on a comparable level during the last years and on average 0.92 t/das. UK values were slightly lower which might partly be due to the use of a constant engine power used in the calculations. French landings per day at sea are much lower. Danish and French fishers reported higher LPUE in 2011 whereas German and Dutch LPUE remained on the level of 2010 (Figure 1.85). LPUE in kg/hp-das (Figure 1.86) increased for all countries in 2010 and 2011 in comparison to earlier years. Danish LPUE were in 2011 on the level of 2006. In 2011 German and Dutch fisherman caught about 5 kg/hp-das.

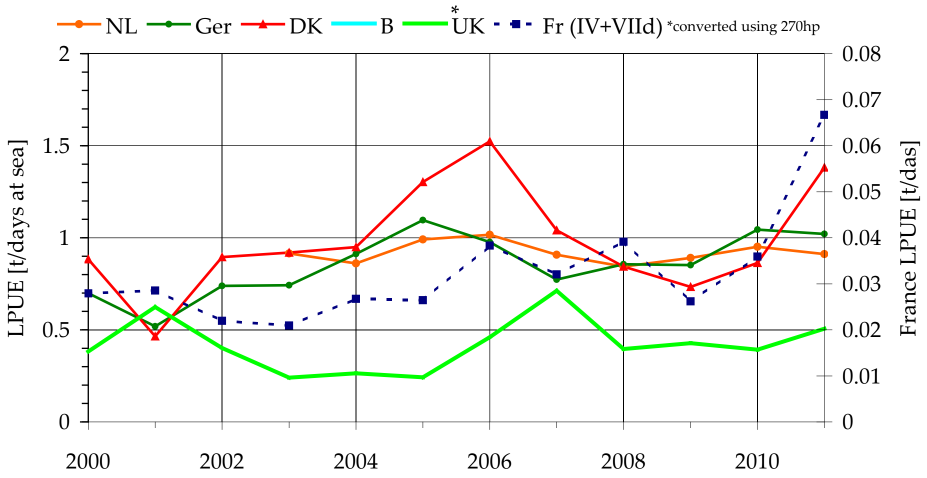

Figure 1.84. LPUE in tons of landed commercial sized shrimps per day at sea, country and year. See text for calculations. Note that French LPUE are lower and shown on the secondary axis.

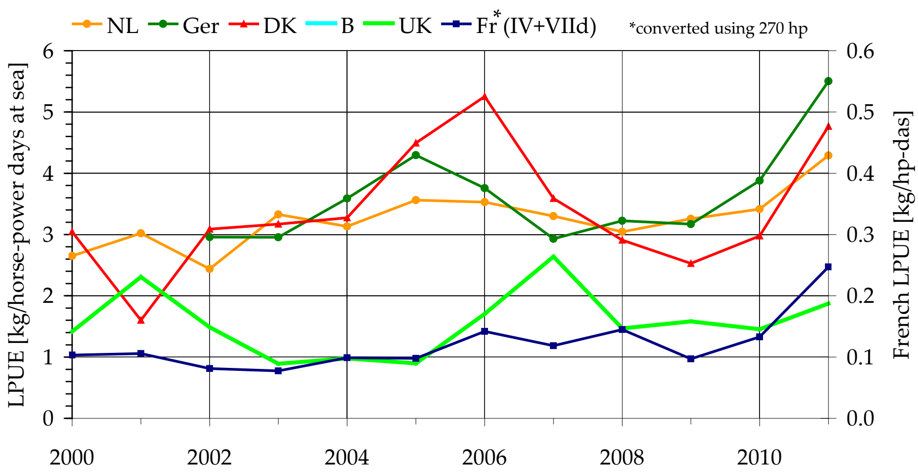

Figure 1.85. LPUE in kg landed commercial sized shrimps per horse-power day at sea, country and year. See text for calculations. Note that French LPUE are 10 times lower and shown on the secondary axis.

1.8 Normalized cohort/stock indices

For each country the longest available LPUE time-series was analyzed according to the predictive capacity of one single month LPUE in relation to the following months LPUEs. The rows of each table show the month which was used in the correlation as independent variable whereas the months in the columns were used as dependent variables. For example in the upper table the German LPUE in t/das over the period 2000–2012 were used. LPUE observed April were positive correlated to LPUE in January of the same year and the r^2 was 0.53. In contrast the correlation between July or August with January LPUEs was 0.3 or 0.03, respectively.

Assuming that LPUE derived from commercial landings represent biomass concentrations, the general idea for this analysis was, to test whether a high brown shrimp concentration in one month is related to another, at best far remote, month. Commercial LPUE have several restrictions as nets, vessels and are not standardized, area information is not included and captain effects are present. Additionally it can be assumed that fisherman fish at places where shrimp accumulate and are easy to catch. Further fleet size and vessel power as well as equipment change over time and get more efficient.

However, from all countries a clear cohort effect can be observed. High correlations are generally observed between all months before August and all months after August. This is in line with recent temperature and length dependent growth calculations. It can be assumed that the increase in seasonal LPUE in autumn is due the winter spawned cohort that reaches commercial size in the southern part of the North Sea. Thus before August the cohort from the previous year is fished whereas after August mainly the new cohort is fished.

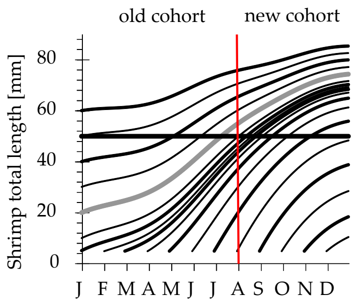

Figure 1.86. Length and growth of shrimps that started with 5 mm size in different month. Figure adopted from Hufnagl and Temming (2011).

Mainly due to this cohort change in summer no correlation between the old and the new cohort can be determined. This suggests that there is no connection between the cohort of one year and the next.

In general trends are stronger the closer the month is to the start month. High LPUE in autumn generally often carry on until June of the following year (Germany, Denmark). Highest number of correlations were determined for the German, UK and Danish time-series. Belgian and France time-series showed less clear patterns.

Germany (r^2 for LPUE in t/days at sea 2000–2011)

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug
Jan	1	0.81	0.60	0.53	0.41	0.32	0.30	0.03	0.09	0.10	0.10	0.08	0.24	0.22	0.16	0.09	0.06	0.08	0.20	0.15
Feb		1	0.48	0.46	0.36	0.33	0.40	0.09	0.22	0.26	0.34	0.28	0.48	0.46	0.58	0.46	0.42	0.43	0.48	0.16
Mar			1	0.89	0.81	0.71	0.50	0.04	0.06	0.06	0.02	0.00	0.03	0.02	0.01	0.00	0.00	0.00	0.03	0.11
Apr				1	0.93	0.87	0.58	0.08	0.14	0.15	0.08	0.02	0.08	0.02	0.05	0.05	0.04	0.02	0.03	0.06
May					1	0.94	0.70	0.17	0.17	0.18	0.06	0.01	0.09	0.03	0.03	0.03	0.01	0.00	0.01	0.04
June						1	0.79	0.19	0.17	0.21	0.07	0.04	0.14	0.08	0.11	0.13	0.09	0.05	0.07	0.08
July							1	0.55	0.47	0.52	0.28	0.23	0.55	0.72	0.40	0.43	0.29	0.28	0.32	0.04
Aug								1	0.78	0.78	0.46	0.36	0.24	0.34	0.16	0.22	0.16	0.19	0.22	0.00
Sep									1	0.94	0.80	0.62	0.42	0.48	0.31	0.38	0.29	0.26	0.22	0.00
Oct										1	0.85	0.75	0.57	0.51	0.46	0.51	0.38	0.35	0.24	0.01
Nov											1	0.88	0.59	0.50	0.63	0.69	0.59	0.54	0.34	0.00
Dec												1	0.79	0.66	0.71	0.73	0.54	0.48	0.29	0.01

Netherlands (r^2 for LPUE in kg/horse-power days at sea 1995–2011)

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug
Jan	1	0.84	0.51	0.69	0.47	0.19	0.01	0.02	0.25	0.15	0.01	0.04	0.07	0.07	0.10	0.05	0.06	0.08	0.09	0.02
Feb		1	0.67	0.78	0.48	0.32	0.00	0.06	0.28	0.23	0.00	0.07	0.07	0.08	0.12	0.05	0.09	0.13	0.06	0.07
Mar			1	0.62	0.53	0.45	0.00	0.01	0.24	0.22	0.03	0.17	0.01	0.01	0.01	0.01	0.00	0.03	0.05	0.22
Apr				1	0.68	0.38	0.02	0.05	0.16	0.05	0.00	0.04	0.03	0.02	0.06	0.01	0.06	0.12	0.15	0.16
May					1	0.55	0.07	0.00	0.03	0.00	0.01	0.03	0.05	0.00	0.01	0.00	0.02	0.00	0.09	0.13
June						1	0.09	0.04	0.00	0.00	0.01	0.02	0.01	0.00	0.11	0.00	0.07	0.01	0.01	0.16
July							1	0.52	0.22	0.10	0.03	0.03	0.11	0.15	0.01	0.04	0.02	0.04	0.01	0.04
Aug								1	0.31	0.08	0.00	0.06	0.09	0.14	0.02	0.04	0.01	0.06	0.16	0.16
Sep									1	0.67	0.09	0.33	0.01	0.02	0.00	0.00	0.03	0.00	0.09	0.09
Oct										1	0.21	0.44	0.00	0.00	0.01	0.01	0.06	0.00	0.00	0.06
Nov											1	0.48	0.46	0.30	0.18	0.49	0.54	0.22	0.06	0.03
Dec												1	0.17	0.19	0.20	0.40	0.36	0.33	0.00	0.18

Denmark (r^2 for LPUE in kg/ horse-power days at sea 1987–2011)

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug
Jan	1	0.83	0.59	0.62	0.78	0.62	0.47	0.29	0.17	0.11	0.17	0.08	0.01	0.01	0.01	0.04	0.07	0.11	0.13	0.15
Feb		1	0.69	0.75	0.80	0.67	0.44	0.30	0.10	0.11	0.18	0.11	0.02	0.03	0.03	0.08	0.15	0.11	0.14	0.10
Mar			1	0.71	0.70	0.51	0.38	0.17	0.09	0.09	0.07	0.08	0.02	0.01	0.01	0.03	0.07	0.06	0.13	0.10
Apr				1	0.81	0.77	0.59	0.37	0.18	0.27	0.31	0.25	0.13	0.11	0.05	0.13	0.30	0.20	0.16	0.11
May					1	0.71	0.46	0.24	0.11	0.14	0.21	0.14	0.06	0.05	0.03	0.05	0.15	0.12	0.14	0.10
June						1	0.72	0.53	0.41	0.39	0.48	0.38	0.24	0.24	0.17	0.24	0.42	0.31	0.23	0.15
July							1	0.84	0.62	0.64	0.60	0.55	0.35	0.36	0.25	0.41	0.44	0.56	0.51	0.38
Aug								1	0.66	0.67	0.63	0.58	0.35	0.47	0.35	0.53	0.52	0.59	0.41	0.24
Sep									1	0.71	0.58	0.55	0.40	0.45	0.37	0.41	0.46	0.44	0.30	0.18
Oct										1	0.87	0.91	0.66	0.55	0.52	0.52	0.69	0.62	0.45	0.25
Nov											1	0.90	0.61	0.55	0.57	0.64	0.77	0.67	0.46	0.26
Dec												1	0.73	0.63	0.58	0.62	0.76	0.64	0.51	0.28

United Kingdom (r^2 for LPUE in kg/ horse-power days at sea 1988–2011)

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug
Jan	1	0.81	0.55	0.38	0.36	0.12	0.05	0.03	0.00	0.01	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.06
Feb		1	0.75	0.57	0.45	0.22	0.12	0.01	0.00	0.02	0.00	0.00	0.00	0.01	0.02	0.04	0.03	0.04	0.00	0.07
Mar			1	0.83	0.65	0.38	0.22	0.00	0.03	0.10	0.03	0.02	0.04	0.09	0.07	0.05	0.05	0.02	0.00	0.14
Apr				1	0.72	0.45	0.23	0.00	0.00	0.05	0.02	0.01	0.01	0.01	0.02	0.01	0.01	0.00	0.03	0.28
May					1	0.73	0.41	0.08	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.02	0.02	0.02	0.15	0.39
June						1	0.69	0.13	0.04	0.00	0.02	0.04	0.05	0.04	0.05	0.08	0.09	0.10	0.28	0.41
July							1	0.41	0.26	0.13	0.25	0.26	0.35	0.21	0.25	0.19	0.27	0.22	0.24	0.31
Aug								1	0.71	0.55	0.55	0.46	0.53	0.40	0.37	0.34	0.39	0.12	0.07	0.04
Sep									1	0.87	0.72	0.59	0.55	0.48	0.33	0.19	0.24	0.06	0.06	0.06
Oct										1	0.81	0.70	0.69	0.60	0.44	0.24	0.33	0.09	0.07	0.05
Nov											1	0.93	0.73	0.69	0.60	0.35	0.37	0.11	0.07	0.02
Dec												1	0.74	0.68	0.60	0.37	0.41	0.15	0.10	0.04

Belgium (r^2 for LPUE in kg/ horse-power days at sea 1987–2011)

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug
Jan	1	0.79	0.50	0.50	0.43	0.22	0.12	0.00	0.06	0.14	0.17	0.30	0.06	0.19	0.15	0.29	0.41	0.36	0.07	0.01
Feb		1	0.61	0.54	0.45	0.27	0.18	0.00	0.10	0.15	0.15	0.31	0.18	0.37	0.35	0.49	0.57	0.44	0.13	0.08
Mar			1	0.77	0.41	0.12	0.08	0.00	0.08	0.08	0.08	0.24	0.17	0.26	0.30	0.39	0.48	0.36	0.15	0.24
Apr				1	0.62	0.38	0.17	0.02	0.20	0.22	0.21	0.34	0.09	0.10	0.28	0.43	0.53	0.30	0.07	0.15
May					1	0.64	0.22	0.06	0.06	0.08	0.11	0.16	0.09	0.12	0.38	0.44	0.42	0.23	0.03	0.00
June						1	0.48	0.15	0.17	0.22	0.21	0.19	0.11	0.14	0.41	0.40	0.24	0.08	0.00	0.01
July							1	0.35	0.27	0.22	0.11	0.20	0.01	0.03	0.13	0.09	0.02	0.01	0.09	0.01
Aug								1	0.36	0.15	0.02	0.00	0.00	0.01	0.01	0.03	0.00	0.04	0.01	0.01
Sep									1	0.86	0.62	0.43	0.01	0.00	0.00	0.01	0.05	0.08	0.00	0.23
Oct										1	0.87	0.64	0.01	0.00	0.00	0.04	0.06	0.10	0.01	0.20
Nov											1	0.76	0.01	0.00	0.01	0.03	0.08	0.08	0.02	0.19
Dec												1	0.00	0.02	0.07	0.09	0.15	0.15	0.03	0.27

France (r^2 for LPUE in t/days at sea 2000–2011)

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug
Jan	1	0.32	0.10	0.06	0.05	0.01	0.03	0.00	0.03	0.15	0.06	0.01	0.02	0.06	0.12	0.10	0.05	0.02	0.00	0.01
Feb		1	0.79	0.51	0.50	0.13	0.07	0.07	0.04	0.03	0.19	0.36	0.02	0.09	0.13	0.22	0.13	0.00	0.03	0.00
Mar			1	0.45	0.30	0.24	0.18	0.03	0.04	0.16	0.14	0.34	0.08	0.30	0.53	0.12	0.04	0.18	0.02	0.10
Apr				1	0.82	0.40	0.26	0.44	0.33	0.21	0.46	0.77	0.12	0.37	0.29	0.34	0.16	0.43	0.36	0.46
May					1	0.18	0.06	0.28	0.18	0.05	0.47	0.69	0.07	0.27	0.31	0.06	0.01	0.24	0.19	0.07
June						1	0.28	0.16	0.33	0.29	0.16	0.37	0.26	0.00	0.00	0.03	0.00	0.05	0.49	0.24
July							1	0.50	0.23	0.18	0.06	0.15	0.11	0.01	0.02	0.19	0.12	0.05	0.27	0.47
Aug								1	0.58	0.16	0.45	0.45	0.00	0.32	0.52	0.40	0.24	0.46	0.26	0.13
Sep									1	0.63	0.65	0.55	0.10	0.32	0.51	0.33	0.13	0.26	0.35	0.09
Oct										1	0.36	0.38	0.05	0.10	0.12	0.28	0.14	0.01	0.19	0.21
Nov											1	0.85	0.15	0.56	0.83	0.20	0.09	0.11	0.08	0.02
Dec												1	0.33	0.75	0.84	0.40	0.21	0.23	0.33	0.07

Brown shrimp are a short-lived species where not age can be determined as no hard structures are available or lost during moulting. Thus a classical stock assessment of the population is not possible. However as shown in this report several stock indices are available from the commercial fishing fleet and scientific surveys which are mainly conducted in autumn. From the latter surveys swept area biomass estimates and mortality rates can be derived, whereas from the commercial data a crude concentration index can be determined. Additionally the effort can be used as an approximation of F acting on the population. In an overexploited stock effort would increase whereas LPUE would decrease or remain constant, biomass would decrease and mortality increase. In a normally exploited stock it could be imagined that at constant effort LPUE is constant or increasing, mortality is constant or decreasing and biomass is constant or increasing. Thus we focused in this chapter on changes of these stock indicators, namely LPUE, effort, biomass and mortality, to analyze pressures on and status of the brown shrimp stock.

Based on the result of the correlation tables shown before it is useful to analyze data per cohort and not per year, as a larger cohort (year class) might be followed by a weaker one which would on average result in an average cohort if an annual mean would be calculated. As LPUE data are so far not available on a similar effort basis for each nation a standardized LPUE was calculated as:

st. LPUE = mean $LPUE_{Aug\text{-}Jul,year}$ / mean $LPUE_{Aug\text{-}Jul\ all\ years}$

Similarly an effort index was calculated. From the so far uncorrected swept area biomass (see chapter 1) and the mortality estimate (see chapter 3) also a standardized index was calculated. Mortality and biomass were derived from autumn samples and thus refer to the year class in which the survey was taken. LPUEs and effort were calculated for the period August year 1 until July year 2 and plotted against year 1 the year when the cohort started.

The mean effort index peaked in 2001 and decrease towards 2010, whereas the LPUE index increased steadily since 1990 and mortality decreased. The swept area biomass index increased since 2006.

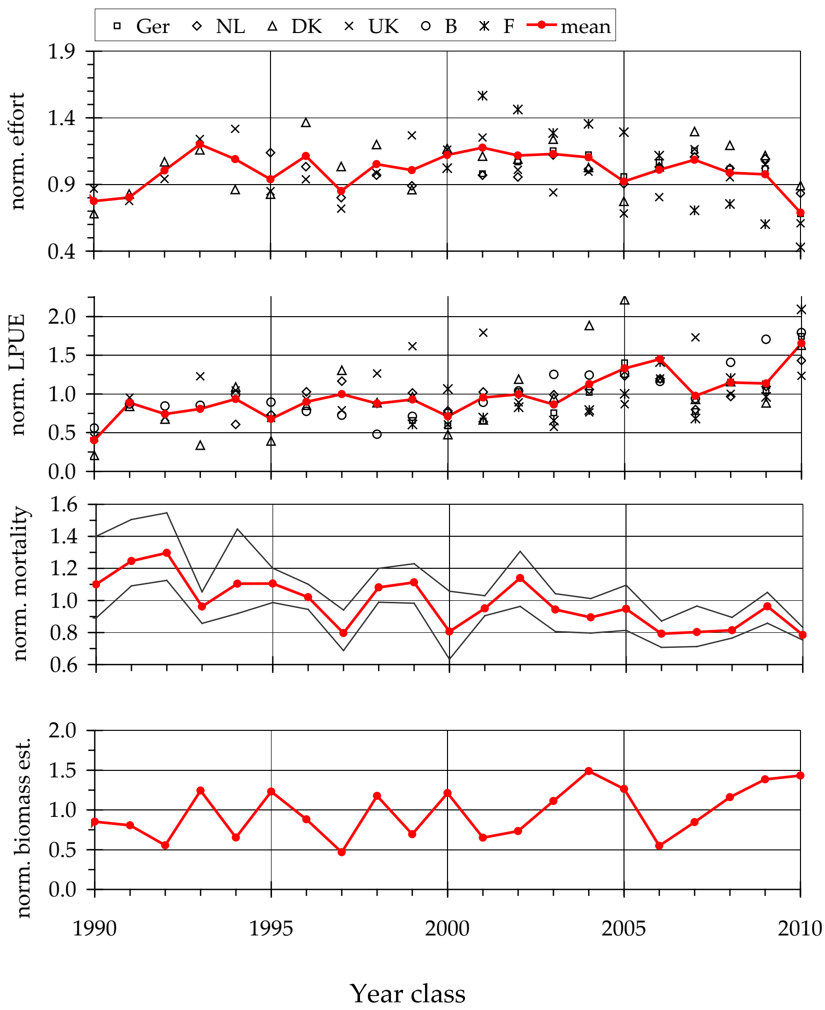

Figure 1.87. Normalized to year class and long term average indices. Panel effort, LPUE mortality and biomass indices plotted against year class (see text for description). Effort data: Ger and Fr - days at sea, NL, DK, UK, B – horse-power days at sea. Red line average, dots values per country, black lines minimum and maximum values.

2 ToR b) Analyze recent VMS and survey data on the spatial distributions of the resource and directed fishing activity, in order to determine whether there have been shifts in the main distribution areas

For 2011 no update on VMS maps was performed as not all national VMS data were updated. Currently different methods to interpolate VMS-pings are being evaluated to analyze the spatial bias that might occur when combining VMS and logbook data. When this evaluation is finished and updated VMS data are available from all countries spatial effort and LPUE estimates will be generated for the available period.

Below and updated analysis of recent VMS data are shown for 2005 and 2008 representing an above and about average effort year. Highest LPUE are generally found close to the Frisian islands in the Elbe estuary and close to Büsum. LPUE decrease with depth and towards North and West. Despite the overall decreased LPUE spatial distributions are comparable between the years. However, high spatial variability occurred within each year and LPUE varied between 0 and 80 kg caught per horsepower hour (Figure 2.1).

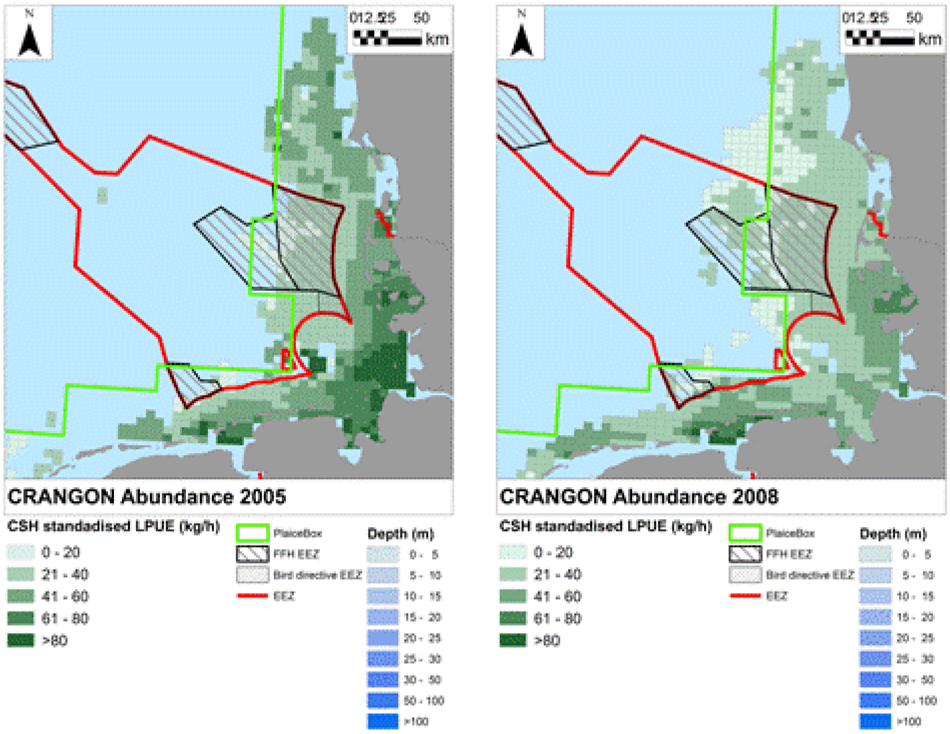

Figure 2.1. Density graphs of standardized LPUE in kg/hp-hour for 2005 (left) and 2008 (right).

3 ToR c) Use data from Dutch and German scientific surveys in 2011 to generate updated mortality estimates

Estimation of $\theta = Z/K$ and L_∞ was performed following the publication of Hufnagl *et al.* (2010) applying length-based methods developed by Beverton and Holt (1956), Jones and van Zalinge (1981), Ssentongo and Larkin (1973), Powell (1979), Wetherall *et al.* (1987) and the length-converted catch curve (Pauly, 1983). As these methods are based on several assumptions that are not valid for the brown shrimp (seasonality in growth, mortality and recruitment, variability of K and L_∞) artificially generated length frequency distributions (LFDs) with known growth and mortality parameters were generated to evaluate the applicability of the different methods (Hufnagl *et al.*, accepted in the ICES *Journal of Marine Science*).

For the mortality time-series presented in Hufnagl *et al.* (2010) four dataseries from Germany and the Netherlands were used. The German Bycatch Series was initiated to monitor the bycatch in the commercial brown shrimp fishery, but data about the brown shrimp itself, i.e. length distributions in the catches, were also collected. The data span the periods 1955–1996 (Büsum) and 1958–1993 (East Friesian), and were recorded weekly or monthly (Meyer-Waarden and Tiews, 1965). Shrimp total length was recorded to the lower 5 mm. In 1993 the series was stopped and only the autumn surveys are available since then.

For the updates, calculated here in this report for the year 2011, data from the German Demersal Young Fish Survey (DYFS) and the Dutch Demersal Fish Survey (DFS) were used. The DYFS is a scientific survey performed by the von Thünen Institut (former Bundesforschungsanstalt für Fischerei), Germany, every autumn since 1974 (Neudecker, 2001). Until 1996 shrimps were only categorized in three size classes, but thereafter, length data at 1 mm resolution were collected. The survey covers mainly shallow waters (mean depth 5–6.6 m), which are influenced by tides. A 3-m beam trawl with mesh size of 20 mm (stretched mesh), without a tickler chain, was used. Standard tows of 15 min were carried out with the prevailing tidal current at a towing speed of 2–4 knots over the ground, with a mean distance covered of ~0.75 nautical miles (Neudecker *et al.*, 1998).

The Dutch Demersal Fish Survey (DFS) covers the coastal zone from the border between the Netherlands and Belgium up to Esbjerg (DK), including the Dutch Wadden Sea, Ems-Dollard Estuary, and Schelde Estuary (Wester-/Oosterschelde). The survey has been conducted each autumn since 1970. A 6-m and a 3-m beam trawl with tickler chains and 20 mm mesh (in the codend) has been used (van Keeken *et al.*, 2008). The catches of the DFS are performed in deeper water (mean depth 8.4–10.5 m) on a fixed station grid.

No correction was made for gear selectivity because only shrimps above the size of full selection (>45 mm total length) were used, corresponding to the peak in numbers at length as suggested by Sparre and Venema (1989). This length is defined as the cut-off length L_c. As a result the mortality estimate refers to adult shrimps (Figure 3.1). L_∞ and the share of large shrimps increased in 2011 whereas mortality decreased to values below the long term average of Z=5.6±1 per year.

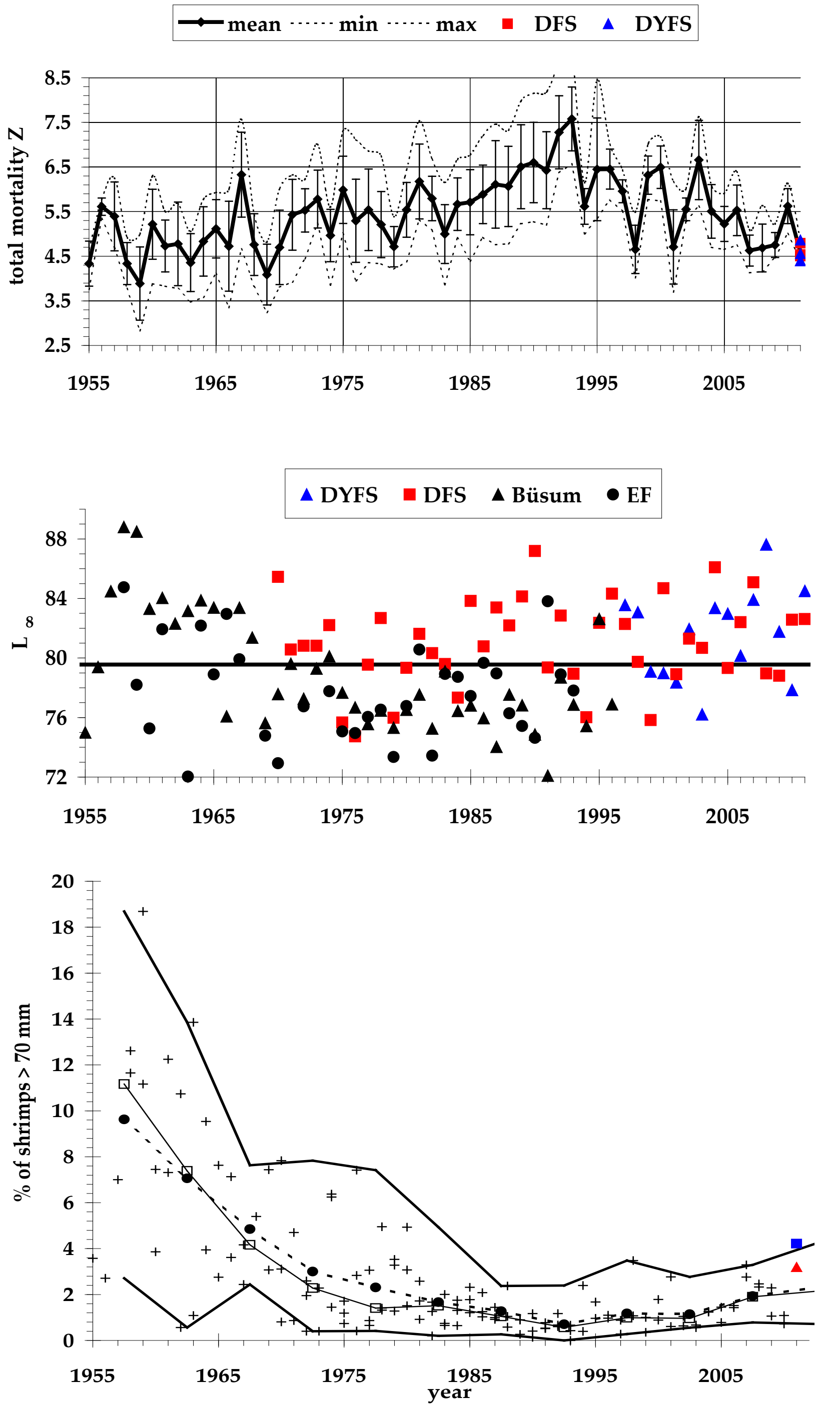

Figure 3.1. Upper panel: mean and standard deviation of total mortality estimated with the length-based methods of Beverton& Holt, Jones & Zalinge, Ssentongo & Larkin and the length converted catch curve. The mean was calculated as mean of these methods and mean of four different surveys. Middle panel: asymptotic length [mm total length] of brown shrimp estimated with the Wetherall and the Powell method using the German bycatch data series the demersal young fish survey and the demersal fish survey. Lower panel: Fraction of shrimps larger than 70 mm total length.

4 ToR d) Begin drafting a common publication on biomass estimates, including estimates of adult and juvenile biomass for potential later use in brown shrimp assessment (MSY, Production and F/M estimations)

The biomass estimate was thoroughly discussed during the meeting as several biases and uncertainties still exist and remain. It was concluded that the final biomass and production estimate shall contain:

1) The swept area biomass estimate
2) A correction between the gears used in the Dutch and the German surveys
3) A correction for net selectivity
4) A correction for gear catchability
5) A correction for behavior and shrimp availability
6) A correction to convert the autumn to an annual average biomass
7) An error estimate that includes all afore mentioned correction factors

Concerning 1)

A preliminary swept area biomass estimate and interannual variability has been presented in the WGCRAN report 2011.

Concerning 2)

A correction between the German 3 m beam trawl without tickler chain and the Dutch 6 m beam trawl with tickler chain is still needed and of high importance. Preliminary studies have been conducted on a German scientific cruise to derive such a factor. About 25 hauls were performed but these numbers were too small due to unclassifiable bottom structure and area effects. More data are needed for a statistical analysis but can only be carried out if fundings are available. For plaice a correction factor exists to allow for a comparative analysis of the Dutch and German surveys but for Crangon such a factor is lacking. A delegate from WGCRAN will join WGBEAM in 2013 to discuss this issue.

Concerning 3)

Mesh selectivity shall be calculated according to Polet (2000) following the procedure described in the WGCRAN (2008) and Martin (2008). Although the focus will be on large shrimps of > 50 mm there might be an effect of the selectivity if 50 mm shrimps are not fully vulnerable to the gear.

Concerning 4)

Gear catchability shall be corrected using the results of the electric beam trawl (see also next section)

Concerning 5)

Shrimp availability in relation to water depth shall be corrected using new results from a staggered stow net (see chapter 8) and a reanalysis of different German surveys.

Concerning 6)

The German and Dutch surveys are carried out during autumn where the biomass of adult shrimps normally peaks (see LPUE section or Hufnagl and Temming (2011)).

To convert the autumn biomass to an average annual biomass the Crangon life cycle model shall be used (Rückert 2011).

Concerning 7)

If applicable an error propagation including all correction factors shall be used.

The annual biomass estimate will then be used to calculate the annual production rate and the whole equation will then read:

$$\bar{P} = \left[C \cdot B \cdot \sum_{i=50}^{L_{max}} \left(a \cdot L_i^b \cdot s_i\right)\right] \cdot F \cdot Z$$

With C = catchability correction, B = Behavior correction, i = length of the shrimp, L_{max} = maximum shrimp length, s_i mesh selectivity for a shrimp of size i, F the factor converting the autumn biomass to an average annual biomass, Z total mortality which is needed to convert B to P as Z=P/B.

5 ToR e) Evaluate currently available options for increasing the selectivity of beam trawls, including consideration of the electric beam trawl/letter box options

The Study group on electric trawling SGELECTRA is dealing with this effort and a detailed can be found on the ICES webpage under:

http://www.ices.dk/reports/SSGESST/2012/SGELECTRA12.pdf

Report of the Study Group on Electrical Trawling (SGELECTRA) 2012, ICES CM 2012/SSGESST:06, REF. SCICOM & ACOM, 54 pages.

Potential impacts of the pulse gear were discussed during the WGCRAN meeting. The concern was stated that if the pulse gear has a higher efficiency and will be used by several shrimpers of the fleet the potential resulting changes in effort and LPUE will make these time-series meaningless and a harvest control rule will not be applicable. At the moment several longer term field studies are being conducted that test the pulse gear and final results are not available so far.

6 ToR f) Evaluate whether the general MSC principles and the planned MSC assessment are a suitable and effective approach for the brown shrimp management

The idea of a heuristic harvest control rule is viewed as an improvement over the current unregulated status of the fishery. Monthly measurements of LPUE are probably the only approach given the short life span of brown shrimp. If the brown shrimp stock is decreasing any immediate reduction in fishing mortality will allow a larger fraction of the stock to reach maturity. This approach can serve as a valid starting point in a process of developing a best practice management, i.e. an adaptive management approach. An adaptive management approach suggests that fishing takes place, predefined data are collected & analysed, and management plans adapted from insights gained along this way: learning by doing, planned and controlled. The quality of such an adaptive approach depend very much on how this adaptive management approach is planned, monitored, improved and enforced. For managing shrimp stocks three basic questions are relevant:

- What are the stock dynamics and how do we keep track of it?
- How much can be taken by the fishery?

- Should the harvest control rule be improved, and how? Or are there better alternatives?

Adaptive management of shrimp fisheries combines research addressing the first two questions, aimed at answering the questions at the third bullet point. I.e., the approach involves a continuous search for new and better insights and better management. Research on questions 1 and 2 will lead to novel insights and new research; new insights may lead to an adjustment of the management or harvest control rule; this in turn will affect the stocks, the data and therefore the information available for questions 1 and 2.

The success of the current approach, is crucially dependent on a stable relationship between LPUE and true stock densities. This is not necessarily guaranteed in the current management scheme using a harvest control rule based on commercial LPUE values.

A key point to the success for the current HCR using LPUEs is the participation of the total fleet. If only parts of the fleet are participating in the plan, other unregulated parts can compensate for potential effort reductions of the participating fleet. A further main difficulty is related to the potential bias and error of the LPUE measures due to effects from either inconsistent catch of fishing effort estimates. Catches are currently guessed by fishermen but may alternatively be estimated at the landing site after standardized sieving. However, catch is also sieved on board and the fractions sieved out after cooking are part of the total catch, but may not be included in the catch guesses. Even more problematic is the definition of fishing effort as simple fishing hours, given the wide range of factors influencing the catch success: boat size and design, gear design, navigational equipment and skill of skipper. Gear design alone can have a dramatic impact, if the introduction of electric beam trawls (pulse gear) is considered. In this case the agreed effort reductions in mere fishing hours become meaningless. Likewise there is a risk that self-reported fishing hours are biased. Total time at sea may be easier to control, but also the potential of using VMS data could be explored to monitor actual fishing hours. These factors are even more relevant if only a small reference fleet is monitored for the LPUE development. The suggested improvements are to include all vessels in the monitoring by means of automated analysis of electronic log books. In addition the final solution would be to use a fleet based standardised survey with fixed stations and standardised gear and catch analysis procedures. If combined with size analysis such a survey, if conducted in summer, could also be used to predict the likely stock conditions in autumn. If the procedure for the LPUE monitoring is optimised, also the heuristic reference points need to be updated, especially with the incoming data of the Dutch fleet, for which such data are currently not available.

If management is only conducted with effort reductions, such as setting predefined limits of hours per week, this may not led to a reduction in actual fishing mortality if the technological improvements are introduced. This - in combination with considerations on by-catch and bottom impact minimisation - may require additional measures such as the control of total landings of the fleet. The by-catch and bottom impact aspects alone are reasons to reduce the effort to the minimum needed to catch the maximum sustainable yield. Since recent data suggest very low levels of predator stocks and point at a reversion of the relation between natural and fishing mortality the potential of the application of Y/R analysis and the application of proxy reference points F-max or F0.1 should be evaluated. For the same reasons a monitoring of the development of predator stocks, especially cod and whiting in the coastal areas is essential, as a recovery of these stocks would directly impact on the Y/R analysis.

7 ToR g) Compile and summarize new national bycatch/discards data from the DCR on: Fish and all shrimp fractions including crushed undersized shrimps

In 2011, 8 observer trips directed on brown shrimp were planned and 7 trips were carried out by Germany. Sampling trips were undertaken in April, May, June, July (2 trips), October and November. The fractions of market shrimps and discarded shrimps and all other by-catch were determined, weighed and measured. The mean discard fraction of brown shrimp amounted to 49.9% ±10.6% of the total brown shrimp catch in weight. This fraction comprises all discarding of undersized and crushed brown shrimp which occurs on board. The proportion of caught fish was between 3.7 and 23% in relation to the total brown shrimp catch (landings and discards). Smelt, plaice, goby, whiting and flounder were the most caught fish species.

Additional data on undersized and crushed shrimps were obtained from a commercial brown shrimp processing company (see working document in Annex 7). During the main season in autumn the share of large shrimps was lower than in winter and spring again indicating the new cohort growing into commercial size in autumn.

Results of only 8 trips are not enough to analyze seasonal and spatial differences as especially the bycatch of small plaice underlies strong seasonal variations. Thus more data from different ships and seasons are needed. The high fraction of discarded undersized and crushed shrimps also indicates that solutions for a reduction need to be found for biological and economic reasons. A closer investigation of catchability and the effects of mesh size and structure are thus recommended.

In the Netherlands in 2011, 7 Sampling trips with observers were undertaken in March, May, June, July, August and October 2011. Data are currently being analysed and a report with the results of 4 year monitoring discards in *Crangon* fisheries in the Netherlands is due to be finished in autumn 2012. Additionally, in 2012 a 2 year project has started in the Netherlands to monitor discards in *Crangon* fisheries in cooperation with the fishermen. A reference fleet of 24 vessels along the whole Dutch coastline once per month take a sample from their (fish and benthic) discards. These samples are picked up at the harbour and analysed at the lab. In this way we hope to get > 400 samples / year of the (composition of) discards in *Crangon* fisheries.

8 ToR h) Review recent *Crangon* related Research & Development activity

8.1 Abundance and catchability patterns of brown shrimp in the North Sea

K. Schulte[1]

Recent publications indicate that activity of brown shrimps is dependent on depth (e.g. Havinga 1930, Boddeke 1976), external factors like tide (Boddeke 1976, Al-Adhub & Naylor 1975, Cattriijse 1997), daytime (Hagerman 1970, Al-Adhub & Naylor 1975, Addison *et al.* 2003) and season (Havinga 1930, Lloyd & Yonge 1947, van der Baan 1975) as well as individual factors like size (e.g. Beukema 1992, Boddeke 1976,

[1] Johann Heinrich von Thünen Institut (vTI), Institut für Seefischerei , Palmaille 9, 22767 Hamburg

Hartsuyker 1966) or reproductive state (e.g. Havinga 1930). It is assumed that these patterns evolved over time due to an interplay of predator avoidance, feeding activity and reproduction but so far only fragmented knowledge and studies are available. Thus the aim of this study focused on a better understanding of the behaviour and migration patterns in relation to environmental parameters. A reanalysis of the German autumn and winter surveys revealed a quite complex nocturnal, seasonal, size and maturity dependent behaviour pattern. A pronounced difference between berried and unberried females was detected especially in shallow areas, and nocturnal activity changed with water depth. Moreover, data from a vertically resolving stow were analyzed and the results indicated that a large fraction of the shrimp population is permanently in the water column. Both results are of high importance with respect to catchability and availability of the population to scientific survey gears and derived correction factors will be used in improving biomass estimates.

8.2 Energy reserves of the brown shrimp *Crangon crangon* (Linnaeus, 1758)

C. Moreira [2,3], M. J. Almeida[2], J. Campos[2] and A. P. Carvalho[1,2]

The brown shrimp *Crangon crangon* is a highly abundant epibenthic crustacean along European shallow waters from Norway to Morocco [1]. Along this large range of distribution *C. crangon* is exposed to a great range of abiotic and food conditions. Environmental changes in temperature and food conditions will affect the energy available for the different physiological processes and determine rates of growth and reproduction. During food shortage periods, animals have to rely on their reserves. These reserves can be mobilized by several paths, stored in several organs and in different compounds. Besides the class of reserves that are mobilized, the sequence of substrates used varies considerably within Crustacea [2] and it is not settled whether glycogen [3] or proteins [4] are the main reserve of *C. crangon* and which is the first to be mobilized.

To clarify this issue, a starvation experiment was conducted in order to estimate brown shrimp's energy reserves and how they are allocated. Animals collected in Minho estuary (N Portugal) were kept in starvation until the last animal died or was sacrificed. Besides 6 animals from the 3 aquaria sacrificed at day zero (initial estimates), six individuals per aquaria were sacrificed, measured and weighed every week; about 3 sacrificed shrimps were used for calorimetric determination and 3 for total proteins using isotope-ratio mass spectrometry (IRMS) and total lipids applying a commercial kit (Spinreact), resulting in a total 145 individuals analyzed for calorimetry and 144 for proteins and lipids. Shrimps survived up to six weeks. In the first week proteins (percentage in dry weight) decreased while lipids increased up to the fourth week decreasing onwards; in the last week the percentage of proteins decreased further. This suggests that lipids are not the main reserve compound used in short-term starvation, whereas structural proteins are mainly used as a last resource in long-term starvation, supporting the work of Cuzon & Ceccaldi [3]. Carbohidrates and oxygen consumption rates are being analyzed and will provide information to support these preliminary results.

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8.3 Contrasting natural and fishing mortality, an update of Welleman & Daan (2001)

A. Temming[4], M. Hufnagl[4]

Despite a decrease in fleet size and decreasing effort brown shrimp (*Crangon crangon*) landings between 2001–2010 were about 40% higher than 10 years before. Meanwhile the main predators cod (*Gadus morhua*) and whiting (*Merlangius merlangus*) decreased by 58% and 25% in numbers (MSVPA), respectively. The latter numbers, available on a quarterly basis, we combined with experimental data on brown shrimp consumption by these predators and field stomach content data to estimate natural mortality of adult (>50 mm) brown shrimp following the procedure presented by Welleman & Daan (2001). Contrasting these consumption estimates to the annual commercial landings we found that fishing mortality was higher than natural mortality. Further calculations and verifications need to be done to finally confirm this result.

9 GAPs in knowledge and future work

During the week the group has identified several gaps in knowledge that needs attention in the coming years:

Study of sievage percentages in Germany:

- Percentages of auction-sievages in other member-countries besides Germany;
- Loss of shrimp after second sieving on board (after cooking);
- Study square messes for selectivity of small shrimp under water.

Compare DFS surveys in Netherlands and Germany: exercise on net-comparison of 3m and 6m beam trawl.

- Repeat the exercise in Dutch waters with possibly another vessel (make an additional request to WGBEAM)

Draw the potential for the Y/R simulation model to use it for MSY management in Shrimp fisheries.

- New biomass estimates per DFS defined area with DFS data (swept area estimate);
- Estimate the mean biomass over the year (use model);
- Investigate gear selectivity of DFS gear.

Gear selectivity projects:

- Performance of the hovercran without the bobbin rope, or an alternative of the bobbin rope;
- Evaluate additional data on the performance of the Letterbox: a gear adjustment to decrease the bycatch of plaice.

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Annex 2: Agenda and ToRs for the 2012 meeting

Terms of Reference for the WGCRAN 2012 meeting

a) Analyze recent landings and effort trends in brown shrimp fisheries and evaluate implications for population status;

b) Analyze recent VMS and survey data on the spatial distributions of the resource and directed fishing activity, in order to determine whether there have been shifts in the main distribution areas;

c) Use data from Dutch and German scientific surveys in 2011 to generate updated mortality estimates;

d) Begin drafting a common publication on biomass estimates, including estimates of adult and juvenile biomass for potential later use in brown shrimp assessment (MSY, Production and F/M estimations);

e) Evaluate currently available options for increasing the selectivity of beam trawls, including consideration of the electric beam trawl/letter box options;

f) Evaluate whether the general MSC principles and the planned MSC assessment are a suitable and effective approach for the brown shrimp management;

g) Compile and summarize new national bycatch/discards data from the DCR on:

   i. Fish

   ii. all shrimp fractions including crushed undersized shrimps

h) Report on developments in ongoing brown shrimp research in the ICES area.

Tuesday - May 5

9:00 Opening and welcome

9:15 Update on new ICES and Expert group structure

9:30 ToR a) Analyze recent landings and effort trends in brown shrimp fisheries and evaluate implications for population status;

10:00 Tom Neudecker, J. Berkenhagen und S. Helmert (2012) Was there an effect of the effort reduction in the shrimp fishery in spring and summer on LPUE data in the second part of the year?

Tom Neudecker, J. Berkenhagen und S. Helmert The seasonality of German LPUE data from 2000 until 2011.

11:00 -11:15 ---- Coffee Break ----

11:15 ToR b) Analyze recent VMS and survey data on the spatial distributions of the resource and directed fishing activity, in order to determine whether there have been shifts in the main distribution areas;

Tom Neudecker Distribution and abundance of brown shrimp (Crangon crangon) within the German Bight in winter 2012 (WCS).

Tom Neudecker Distribution and abundance of brown shrimp (Crangon crangon) along the German Coast in autumn 2011 from DYFS

Katharina Schulte: Activity patterns and catchability of brown shrimps in the North Sea

12:30 - 13:30 ---- Lunch Break ----

13:30 ToR c) Use data from Dutch and German scientific surveys in 2011 to generate updated mortality estimates;

Axel Temming and Marc Hufnagl: Update of the Length based total mortality and the Welleman & Daan natural mortality estimate.

14:00 ToR e) Evaluate currently available options for increasing the selectivity of beam trawls, including consideration of the electric beam trawl/letter box options;

14:30 ToR f) Evaluate whether the general MSC principles and the planned MSC assessment are a suitable and effective approach for the brown shrimp management;

Josien Steenbergen: The current state of the art on different discussions in the management (or lack thereof) in the Dutch shrimp fisheries.

15:00 – 15:15 ---- Coffee Break ----

15:15 g) Compile and summarize new national bycatch/discards data from the DCR on (i) fish and (ii) all shrimp fractions including crushed undersized shrimps;

15:45 h) Report on developments in ongoing brown shrimp research in the ICES area;

18:00 End day 1

Wednesday - May 6

9:00 d) Begin drafting a common publication on biomass estimates, including estimates of adult and juvenile biomass for potential later use in brown shrimp assessment (MSY, Production and F/M estimations)

Ingrid Tulp (and Volker Siegel) Crangon crangon swept area estimates based on scientific surveys.

9:30 Workshop and Discussion on biomass estimate, time for working on publication and improving the estimates

1. General update of the swept area estimate: Volker, Ingrid

2. Mesh selectivity

Axel: results from the Y/R model + earlier selectivity data Meike Martin presented in Texel 2008

Tom, Volker, Ingrid, Andy: Length frequency distributions from surveys for estimating Lc50

3. Catchability/Sensitivity of shrimps to the gear

Bart + Netherlands: Electric beam trawl

Katharina + Andy: Day night temperature etc. effects

4. Other estimates e.g. via mortality or predation

Marc, Axel: Improvement of Welleman an Daan, Back-calculation using total mortality

12:30 - 13:30 ---- Lunch Break ----

13:30 Discussion on

- Short information on what is the objective of existing surveys: DFS, DYFS, winter survey

- Discussion on whether there is a need and benefit of coordinating existing surveys

- Next date and joint meeting with WGBEAM

16:00 Tom Neudecker and U. Damm (2012) Information on the online Crangon page of vTI opened in 2012

18:00 Dinner / social event

Thursday - May 7th

Continuing discussion, working on joint publications, cooperations and report

Annex 3: WGCRAN draft resolution for multi-annual ToRs

The **Working Group on *Crangon* fisheries and life history** (WGCRAN), chaired by Marc Hufnagl, Germany, will meet in Copenhagen, Denmark, 3–7 June 2013, to work on ToRs and generate deliverables as listed in the Table below.

WGCRAN will report on the activities of 2013 (the first year) by 1 August 2013 to SSGEF.

ToR descriptors

TOR	Description	Background	Science Plan topics addressed	Duration	Expected Deliverables
a	Evaluation of the stock status.	Report and evaluate population status indicators like recent landings and effort trends in the brown shrimp fisheries or length based mortality estimates from Dutch and German scientific surveys. Generate a standardized LPUE time series of higher accuracy for all nations with horse power days calculated based on hours at sea for the future but also for the past where possible.	141, 143, 131, 134, 161, 162, 212, 311, 321	year 1,2 and 3	A timeseries of standardize stock indicators shall be delivered by all WGCRAN members as an annual report.
b	Derive shrimp and effort distribution indicators using VMS data.	Combine VMS, landings and effort data to gain a brown shrimp population distribution indicator and to monitor regional distribution and regional shifts in fishing effort. Evaluate potential variability of the results by comparing different VMS data interpolation methods.	133,141,143, 144, 146, 212, 311	year 1 and 2	Results shall be summarized in a peer-reviewed paper. Lead persons: Katharina Schulte, Torsten Schulze
c	Estimation of the brown shrimp biomass using scientific surveys	Publish a common publication on brown shrimp biomass estimates and annual production rates. Besides the survey based swept area estimates the publication shall also include correction factors based on new or existing information on gear selectivity, catchability and behaviour aspects.	141,143, 212, 311	year 1 and 2	Results shall be summarized in a peer-reviewed paper. Lead persons: Ingrid Tulp, Volker Siegel
d	Estimate brown shrimp natural mortality rates and the role of fishing.	Publish predation rates of cod and whiting on brown shrimp and discuss the role of fishing in relation to natural mortality.	141,143, 212, 311, 312, 334	year 1 and 2	Results shall be summarized in a peer-reviewed paper. Lead persons: Axel Temming, Marc Hufnagl

e	Parameterization and use of a population model to adress biological and management relevant questions.	Parameterize and use a Crangon crangon population model to investigate e.g. seasonal brown shrimp biomass dynamics, the implications of fishing effort alterations (including closures), mesh size and mesh selectivity on the population structure. The model shall be further developed to act as a decision aid for management rules and aspects.	141, 145, 134, 311, 312, 334	year 2 and 3	Results shall be summarized in a peer-reviewed paper. Lead persons: Marc Hufnagl, Axel Temming, Chris Rückert
f	Analyze the implications of the pulse-gear on the Crangon stock, shrimp-fisheries and the environment.	The on-going introduction of the electric beam trawl might have strong implications on the relation of the nominal effort and the fishing mortality of brown shrimp. Existing literature and new results on the ecosystem and population impact of the introduction of the electric beam trawl into the fisheries shall therefore be reviewed and compiled.	141, 134, 213, 214	year 2 and 3	Results shall be summarized in a public available report or a peer-reviewed paper. Lead persons: Bart Verschueren, Axel Temming
g	Examine the life cycle dynamics of shrimps and compare them among ICES regions.	Gain a better understanding of the life cycle dynamics and history of brown shrimps in the different ICES regions with special focus on latitudinal gradients and the comparison of the North Sea core distribution area and the Portugese Minho estuary at the most western distribution margin. This will include the application and further development of in situ growth methods, maturity and mortality estimates as well as the analysis of starvation and condition indices. Especially in the North Sea also the maturation and spawning process of brown shrimp shall be investigated to gain a better understanding the recruitment process.	141,145, 146, 134, 131,212, 311	year 3	Results shall be summarized in a peer-reviewed paper. Lead persons: Joana Campos, Axel Temming, Volker Siegel
h	Review potential methods for a brown shrimp management and suggest a suitable management plan.	Generate a common publication on existing data and possible methods to assess and manage the brown shrimp population in the ICES region. This shall include i.) A compilation of existing brown shrimp information from commercial data and scientific surveys ii.) a review of suitable management methods gained from ICES recommendations on	134, 131, 133, 311, 312	year 2 and 3	Results shall be summarized in a peer-reviewed paper. Lead persons: Josien Steenbergen, Axel Temming

		management of data poor and lower trophic level species and iii.) an identification and avaluation (e.g overview table) of possible management strategies.			
i	Enumeration and analyze bycatch and discard fractions.	Gather, compile and evaluate information on the onboard and ashore sieving fractions and processes and new national bycatch/discards data from e.g. DCF and the Dutch "Effects of shrimp fisheries on the Natura 2000 sites" - Project on i.) Fish and ii.) all shrimp fractions including undersized shrimps.	161, 162, 141, 143, 212, 214, 215, 311	year 1,2 and 3	Results shall be summarized in a peer-reviewed paper. Lead persons: Josien Steenbergen, Ingrid Tulp
j	Support information on ongoing research and national legislations.	Exchange of information on national legislation, laws (e.g concerning Natura 2000) and developments (MSC process) concerning the brown shrimp fisheries in the whole North Sea for an improved cooperation and coordination of research and advice efforts. Presentations on developments and on-going brown shrimp research in the ICES area.	312, 311, 313	year 1,2 and 3	Important results shall be summarized in the annual reports. All members

Summary of the Work Plan

Year 1	For manuscript planned under ToR b, c, d and i data analysis shall be finished and a draft version shall exist. All effort time series of all countries required for ToR a shall be provided in a standardized and updated way.
Year 2	For manuscript planned under ToR b, c, d and i shall be in submittable to peer reviewed journals. Data and text for manuscripts under ToR e, f and h shall be available. Stock indicators shall be updated and reevaluated.
Year 3	Manuscripts falling uder ToR e-j shall be in a submittable form. For a set of stock indicators a sound and proofen time-series shall exist that can be used to evaluate the status of the brown shrimp population.

Supporting information

Priority	Crangon fisheries are economically important with landings value ranking this species among the top three species caught from the North Sea. The priority of WGCRAN is to understand the interactions between the brown shrimp population (structure and abundance) and human behaviour (mainly fishing effort) the environment and the ecosystem. One important aspect is and will be the monitoring, investigation and development of population status indices.
Resource requirements	The research programmes which provide the main input to this group are already underway, and resources are 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 some 10 members and guests.
Secretariat facilities	None.

Financial	No financial implications.
Linkages to ACOM and groups under ACOM	WGCRAN aims at a permanent linkage with ACOM after year 2 when sound and proven stock indicators have been developed and a good management plan has been developed under ToR h.
Linkages to other committees or groups	There is a linkage to WGBEAM as similar surveys are used. WGELECTRA as the use of the pulse gear by a larger fraction of the fisherman might have implications on the stock, WGINOSE by providing data for the integrated assessment. WGSAM as the SMS key runs will be used to estimate natural mortality of brown shrimp. Members of WGCRAN are also members in the these groups.
Linkages to other organizations	CWSS = Common Wadden Sea Secretariat; TMAP = Trilateral Monitoring and Assessment Programme; RCM –NSEA

Annex 4: What is an active fishing vessel in shrimp fishery?

Thomas Neudecker[5], Jörg Berkenhagen und Solveig Helmert

WGCRAN requests data for the number of active fishing vessel per year and country. However, no strict information is given defining the term active vessel. It could be any vessel that is registered as a shrimper or any other definition as e.g. any vessel landing more than 500 or 1000 tons of shrimp per year. Another approach – as applied the years before – could be the number of those vessels that have contributed to a certain percentage of the annual landings. To demonstrate the differences and the development of the last years German log book data had been extracted and lined up by vessel according to different measures (Figure 0.1, Table 0.1).

Table 0.1. Number of shrimping vessels in Germany for the period 2002 to 2011:

Measure	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Difference	2011-2(
No. Of vessels that landed shrimp	268	270	272	265	262	266	262	243	231	222		-46	-17,16
No. Of vessels more than 500 t landings	243	246	251	247	248	250	244	228	217	208		-35	-14,40
No. Of vessels more than 1000 t landings	237	238	239	240	242	244	239	223	215	208		-29	-12,24
No. Of vessels landing 100 % of shrimp	268	270	272	265	262	266	262	243	231	222		-46	-17,16
No. Of vessels landing 99 % of shrimp	219	219	219	219	224	222	219	205	199	194		-25	-11,42
No. Of vessels landing 95 % of shrimp	201	197	198	201	198	193	195	183	177	174		-27	-13,43
No. Of vessels landing 90 % of shrimp	182	178	177	182	177	169	173	163	159	156		-26	-14,29

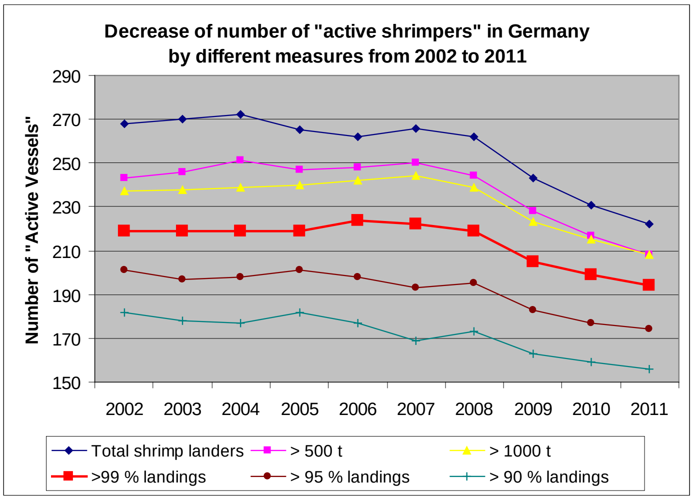

Figure 0.1. Numbers of vessels active in German shrimp fisheries by different measures as: vessels registered for shrimping in general, those contributing more than 500 tons or more than 1000 tons versus those vessels that contributed to 99%, 95% or 90% of the landings in the years 2002 to 2011.

The results can be quite different. For Germany we find – no matter what measure we take – a stable situation until 2006 or 2007 when a decline in vessel number starts and continues until 2011 reflecting the critical economic situation that has been reported from the shrimp fishery in recent years.

Another graph (Figure 0.2) shows the difference between the landings of consumption shrimp, corresponding "crushed shrimp" that were too small for the human market and the amount of industrial shrimp that are landed in Germany in the second part of the year to serve for the need of special animal food stuff for aquaria, e.g..

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While the amount of "crushed shrimp" remains low there is a significant difference in the numbers of vessels landing shrimp and an increase in the total tonnage of consumption shrimp by vessel while the amount of industrial shrimp has decreased.

The differences in consumption shrimp may not only be due to the increase of the efficiency of the vessels but also by very different stock sizes of brown shrimp for both years compared. However, it can also be seen that there is a certain number of vessels not or hardly contributing to the landings which was higher in 2002 than in 2011.

These almost or really inactive vessels should not be included in our counts of shrimpers.

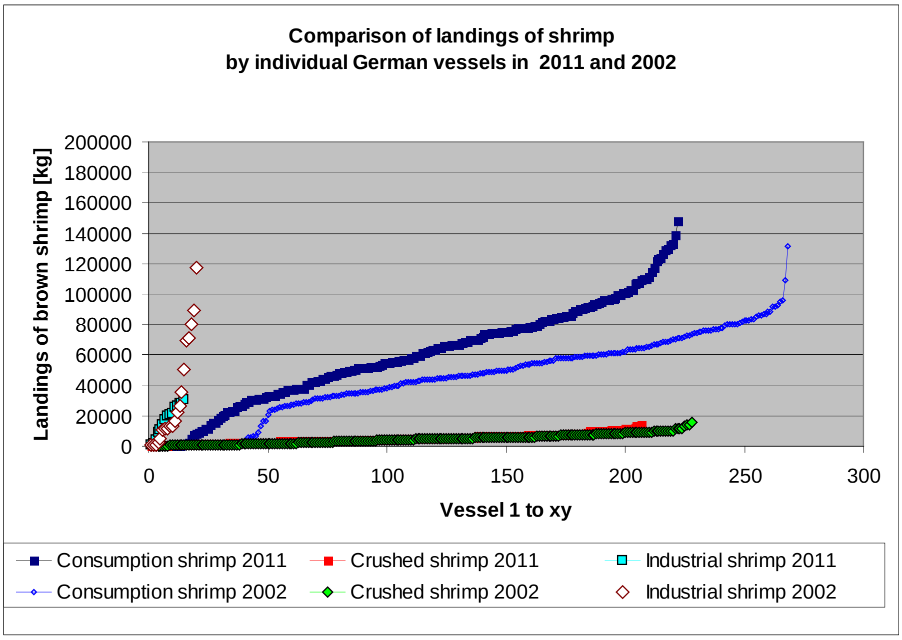

Figure 0.2. Cumulative German landings of brown shrimp per vessel.

Annex 5: On the seasonality of Landings per Unit of effort (LPUE) in German Shrimp Fishery and the effect of "strike" in 2011, Part 1

Thomas Neudecker[6], Jörg Berkenhagen und Solveig Helmert

The questions were whether the extreme increase of LPUE values in summer of 2011 were caused by

1) biological effects (low fishing mortality and growth);
2) fishery effects (best fishermen with high individual fishing capacity continued to fish) or by;
3) biological and fishery effects together.

We had seen a general and unusual low level of effort in 2011 in German shrimp fishery with an absolute minimum of hours at sea in May (Figure 1).

Despite or just because of the low effort, LPUE values in May had shown an unusual high level equivalent to the high autumn peaks of years 2005, 2010 and 2011 (Figure 2).

Biological reasons as high growth rates in combination with extremely low fishing mortality were identified as possible causes for the extremely high LPUE values as we can assume a growth rate of approx. 0.5 mm per day resulting in 15 mm increase of length for an individual. That increase in length results in an approx. doubling of weight of the shrimp and therefore the biomass of the stock which would perfectly fit to the observed LPUEs in May 2011.

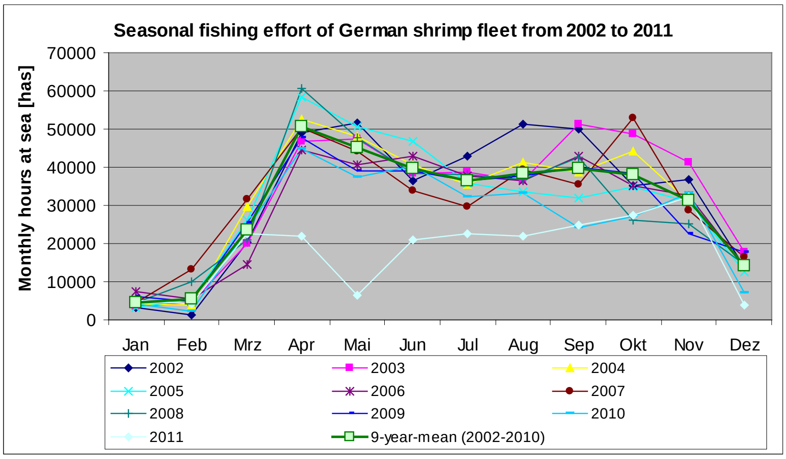

Figure 1. Seasonality of effort (hours at sea) 2002 to 2011 – monthly comparison. Extreme situations can be observed for 2011 (minimum values almost throughout the year and "strike" in May) and reduced effort in 2005 and 2010 (September) for autumn fishery.

Nevertheless, an effect of the still active shrimpers cannot been ignored as it would have been a possibility that only the best shrimpers with high fishing efficiency could have created the high values as they are expected to have extremely high individual LPUE values for the vessels in general. In that case biological effects would have been marginal.

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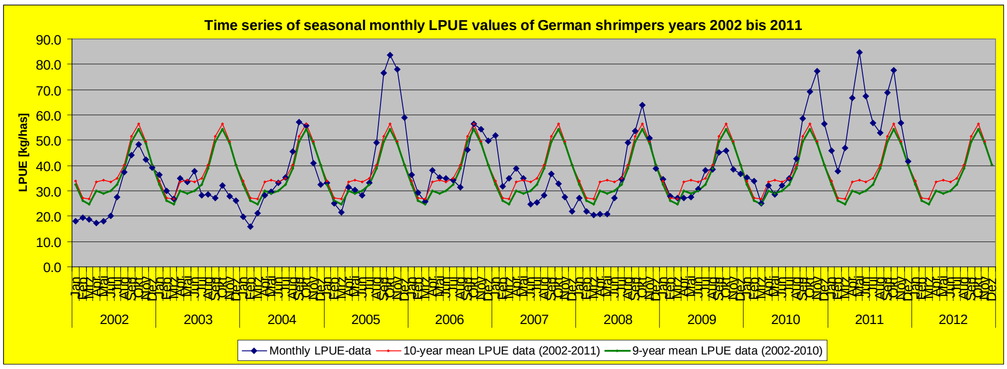

Figure 2. Time-series of LPUE data (kg/hour at sea) 2002 to 2011 (blue line) and mean values (green line for 9-year average and red for 10-year average including 2011). Extreme situations can be observed for 2005 (maximum values in autumn season) and similar situations in 2010 and 2011. However, there is a totally different situation in 2011: LPUEdata remain above average all year and show an extreme peak in April, especially May and June.

To check for that logbook data were extracted for May 2011 and individual LPUE values for each single vessel were calculated.

Contrary to the assumption that few highly efficient vessels had been active during the "strike-period" 189 shrimpers were found of having been active to various extent representing almost the entire fleet. Their individual LPUE values in that period ranged from 12.9 to 321 kg per hour at sea (has) with a mean of 84.9 (Figure 3). There are few outstanding vessels in the fleet with extremely high LPUEs, but the key information is that the high LPUEs in May 2011 are NOT a result of few efficient active vessels in that particular period.

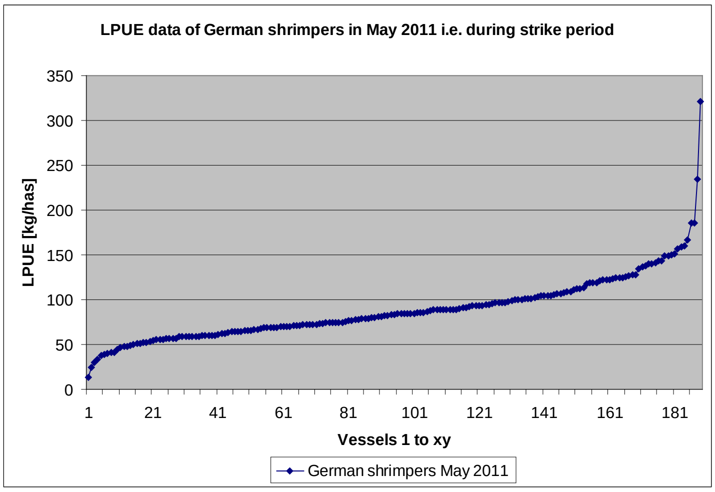

Figure 3. LPUE data from May 2011 for each active German shrimper active (189 vessels).

The data were also checked for effects of individual activity (Figure 4) and for effects of engine power (Figure 5) and length over all for each vessel (Figure 6).

There is no correlation of any of these parameters to LPUE.

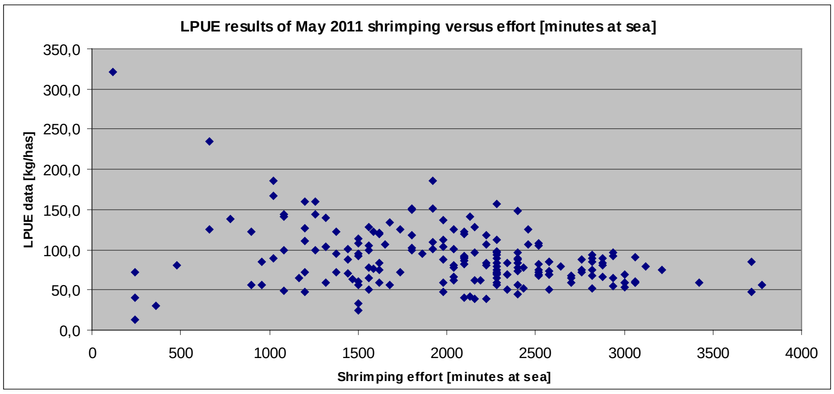

Figure 4. LPUE data from May 2011 for each active German shrimper and the time of activity.

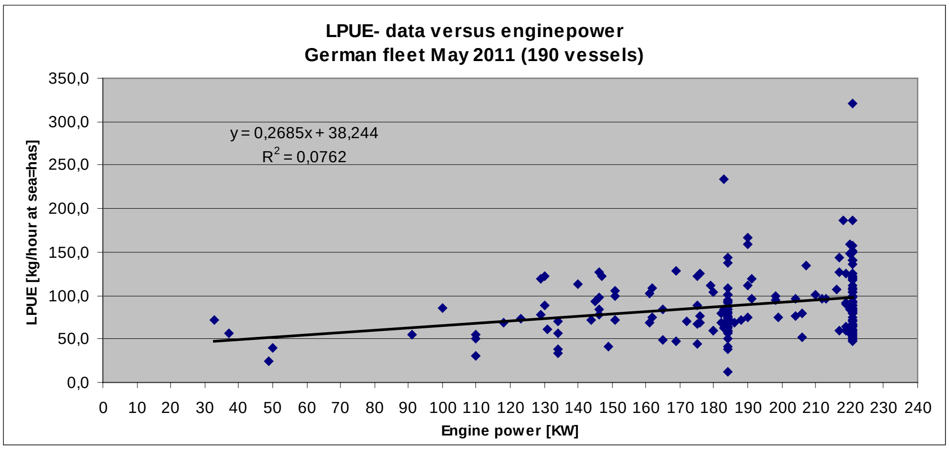

Figure 5. LPUE data from May 2011 for each active German shrimper versus the corresponding engine power.

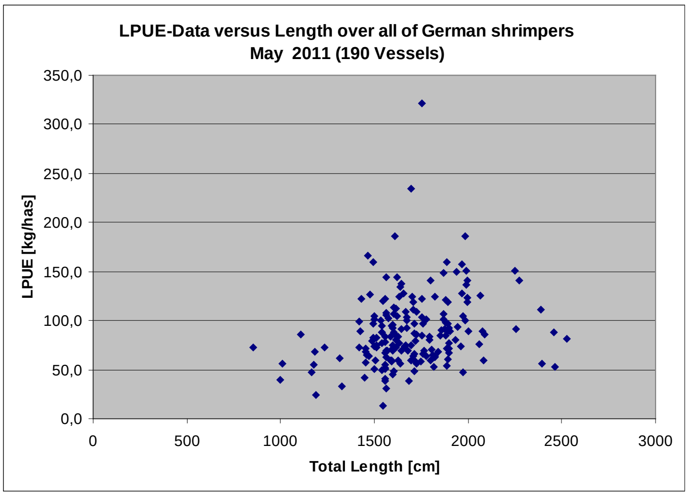

Figure 6. LPUE data from May 2011 for each active German shrimper and the time of activity.

Annex 6: On the seasonality of Landings per Unit of effort (LPUE) in German Shrimp Fishery and the effect of "strike" in 2011, Part 2

Thomas Neudecker[7], Jörg Berkenhagen und Solveig Helmert

In this short communication landings per unit of effort data (LPUE) based on hours at sea are presented for the German fleet from 2002 to 2011 on a monthly basis.

Landing data (Figures 1 and 2) and corresponding effort data (Figures 3 and 4) by month are given first to demonstrate the variability between years.

Data show a baseline pattern of higher LPUEs in autumn, lower LPUEs in spring and a further decrease in early summer. Then the recruitment of the new year-class leads to again increasing LPUEs in autumn.

That general pattern has been demonstrated for earlier years by LPUE data on landings and fishing trips or calculated fishing hours gathered from questionnaires (EU-RESCUE-Study 1994). WGCRAN reports also regularly gave these seasonal data for the fleets of different countries but by varying effort measures.

The more recent log book data - with information of time and hours at sea for each single trip - show a high variability which may be important to be known for possible management regimes in the fishery. The information presented here on monthly mean values for the period 2002 to 2010 is meant to be a basis for further investigations towards possible correlations with environmental factors and catch or landings predictions. Earlier logbook data for 2000 and 2001 were not given by product, i.e. split into consumption shrimp, industrial and so called "crushed" shrimp, and therefore could not be used.

The 2011 data added to the time-series on the other hand show the effect of the economic crisis in shrimp fishery:

The fleet drastically reduced fishing effort and totally unusual LPUE values occurred during and after the "strike" period. The results were almost normal landings except from May 2011 when only few shrimp were landed.

The questions arose whether the extreme increase of LPUE values in summer of 2011 were caused by:

1) biological effects (low fishing mortality and growth);
2) fishery effects (best fishermen with high individual fishing capacity continued to fish);
3) biological and fishery effects both caused the LPUE increase in "undue" time.

Furthermore higher LPUEs occurred throughout 2011 which could have been caused by the same effects keeping up a high stock level for the whole year.

We shall try to answer them by investigating data provided from a sieving station and log book information.

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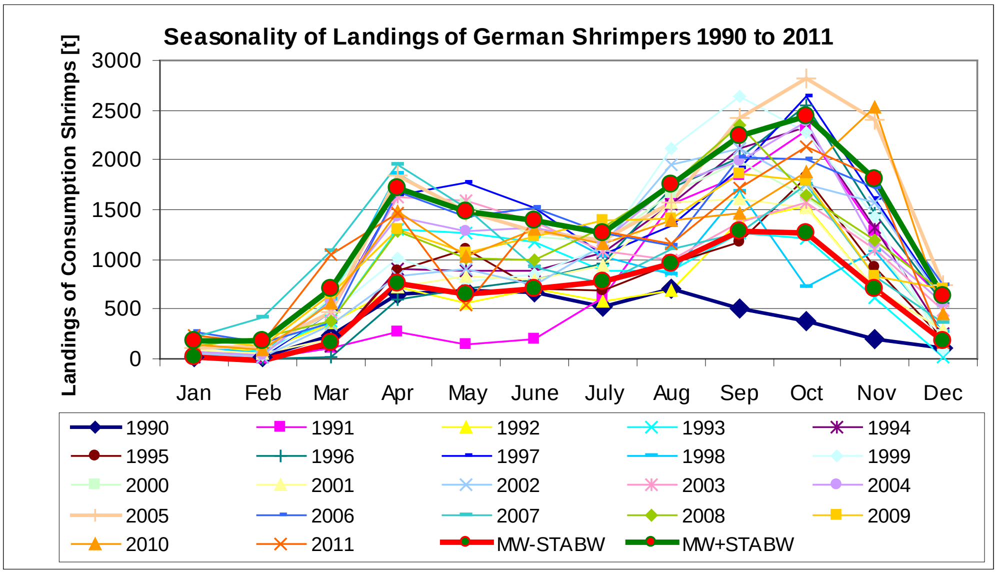

Figure 1. Seasonality of landings 1990 to 2011 – monthly comparison. Extreme situations can be observed for 1991 and 1990 (minimum values) and 1999 (September), 2005 (October) and 2010 (November) for autumn maxima.

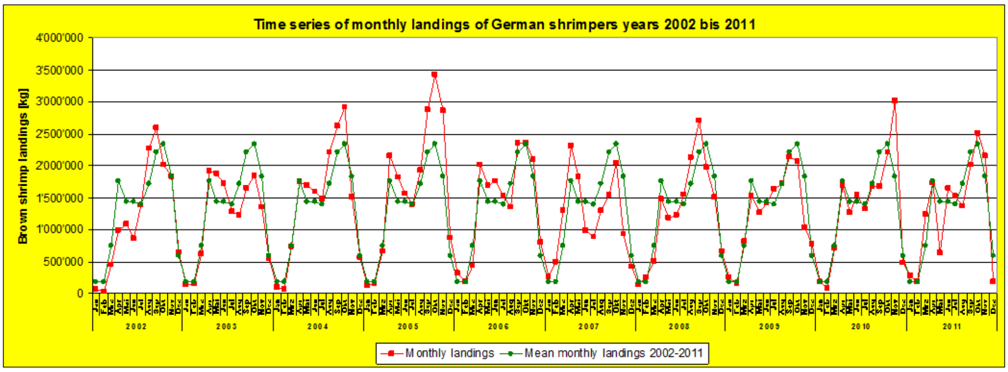

Figure 2. Time-series of monthly landings 2002 to 2011. Above average landings occurred especially in autumn 2005.

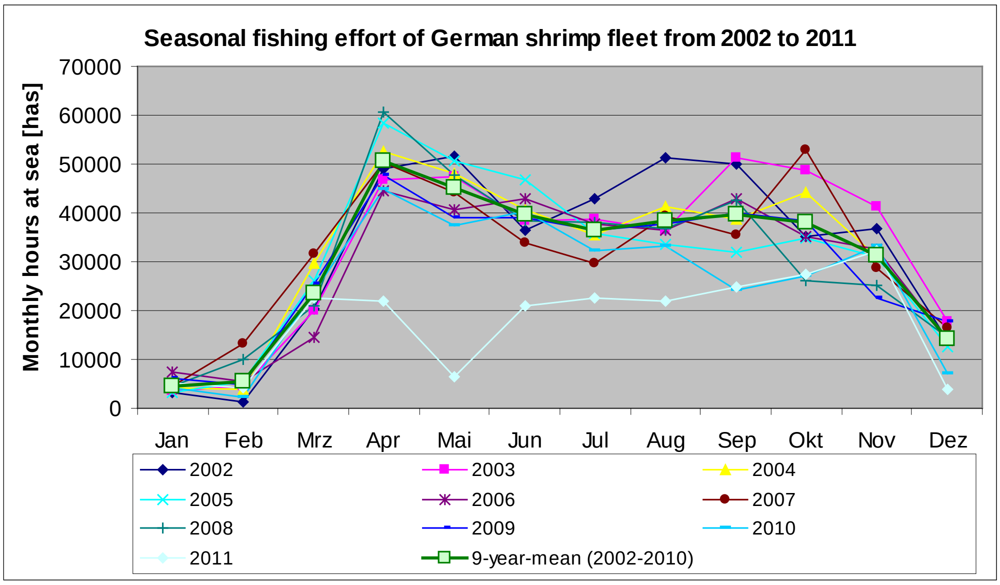

Figure 3. Seasonality of effort (hours at sea) 2002 to 2011 – monthly comparison. Extreme situations can be observed for 2011 (minimum values almost throughout the year and "strike" in May) and reduced effort in 2005 and 2010 (September) for autumn fishery.

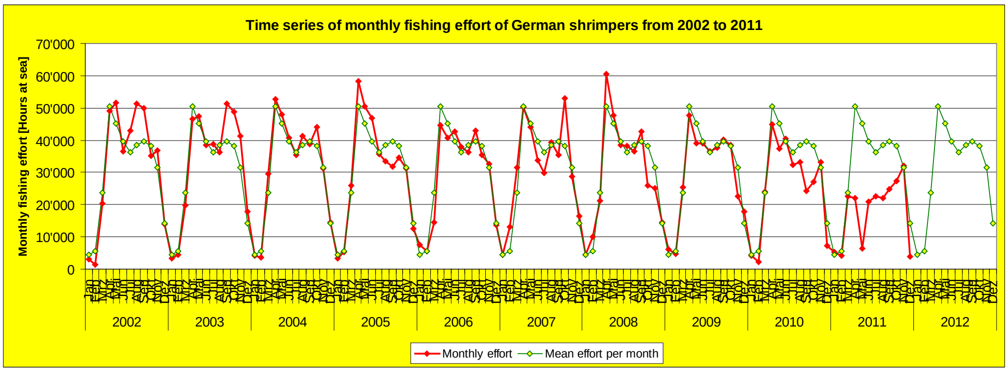

Figure 4. Time-series of effort (hours at sea) 2002 to 2011 (red line) and mean values (green line). Extreme situations can be observed for 2011 (minimum values almost throughout the year and "strike" in May) and reduced effort in 2005 and 2010 (September) for autumn fishery, while autumn fishery in 2002 and 2003 indicate increased effort.

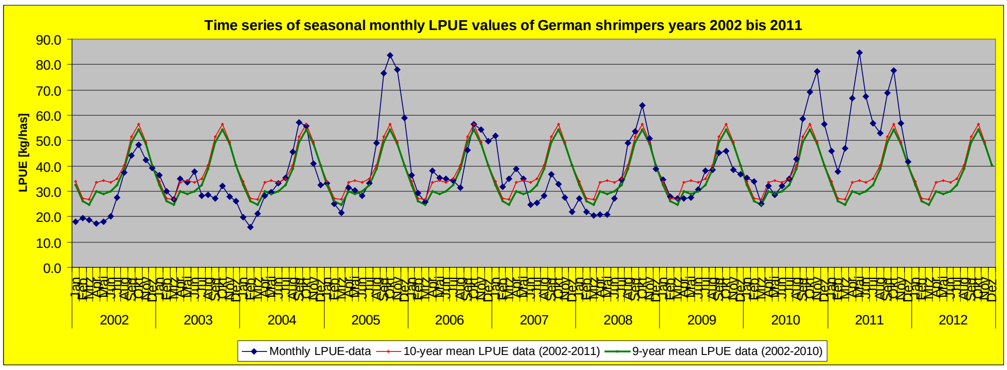

Figure 5. Time-series of LPUE data (kg/hour at sea) 2002 to 2011 (blue line) and mean values (green line for 9-year average and red for 10-year average including 2011). Extreme situations can be observed for 2005 (maximum values in autumn season) and similar situations in 2010 and 2011. However, there is a totally different situation in 2011: LPUEdata remain above average all year and show an extreme peak in April, especially May and June.

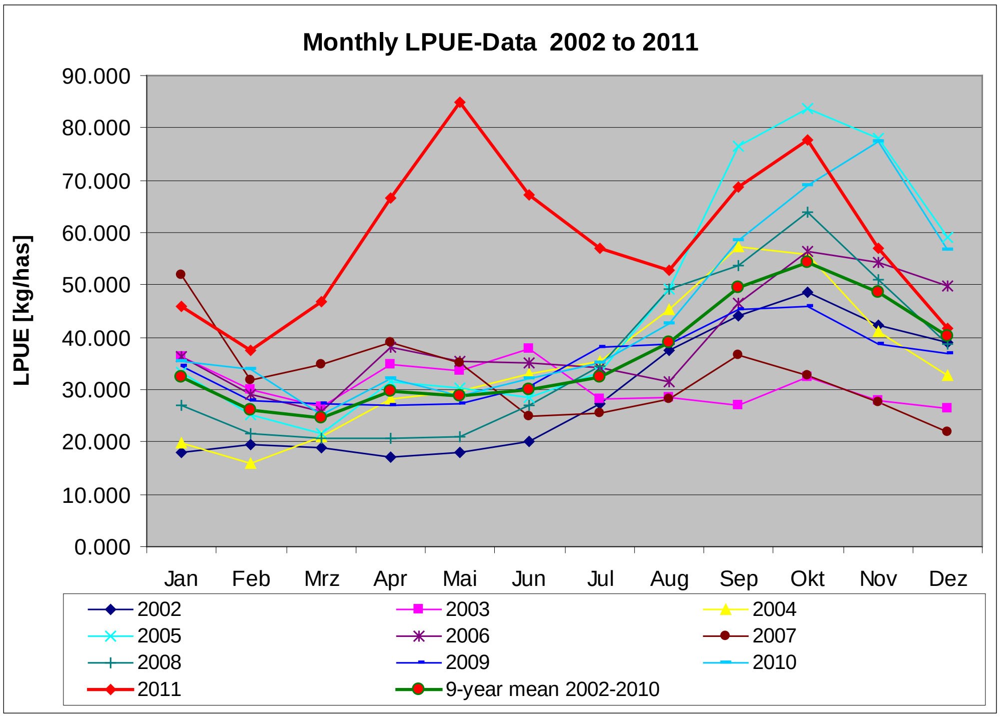

Figure 6. Seasonal LPUE data (kg/hour at sea) 2002 to 2011 and mean, monthly comparison over the course of the year.

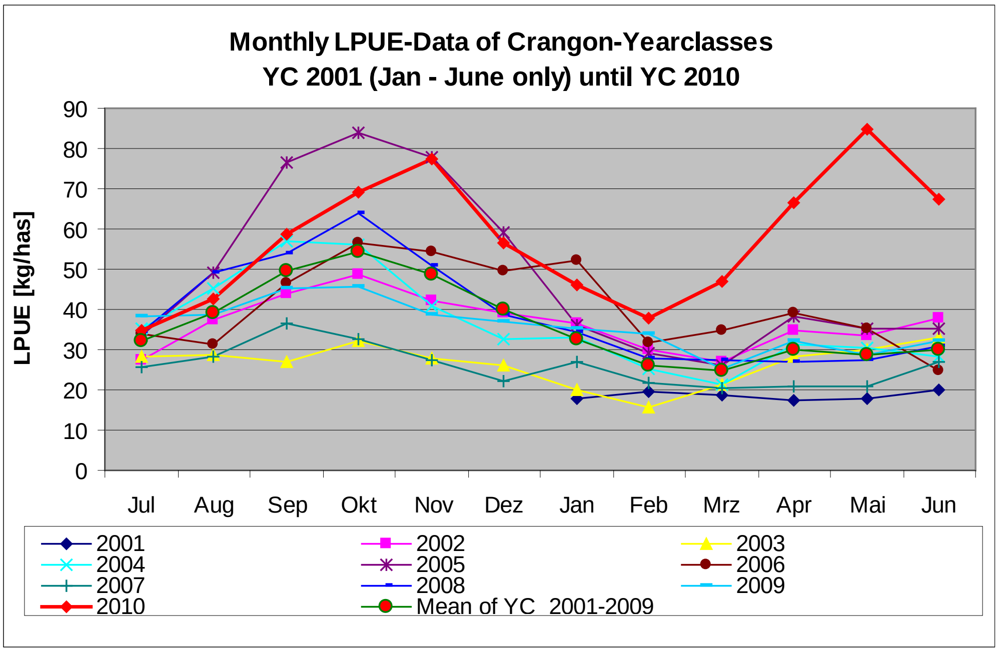

Figure 7. Seasonal LPUE data (kg/hour at sea) 2002 to 2011 and mean; comparison of monthly data. The start of the lines in July take into account the year classes which grow into the fishery in autumn and their development until following June. Extremes are obvious for the strong year classes 2005 and 2010 while YC 2001 and 2003 plus 2007 are on the very low side.

Annex 7: Effects of the shrimpers strike in 2011 on the sieving results of a commercial sieving station – preliminary results

Thomas Neudecker[8] and Mark Nijhof[9]

In this short communication for the first time commercial sieving data are presented to ICES WGCRAN originating from a major brown shrimp processing company (Heiploeg BV) buying and processing possibly the highest share in brown shrimp landings from the entire North Sea, i.e. brown shrimp from Denmark, Germany, The Netherlands and further countries that are landing only smaller amounts of shrimp (Aviat *et al.* 2010). Nevertheless the data represent a very high share of all brown shrimp landings since 2008 for the majority of the fishing grounds.

Data were provided only recently and have preliminary status as weekly sievings still need to be crosschecked in detail for plausibility and for continuity in sieve widths.

Principally all shrimp landed since 2008 had been sieved on a calibrated first sieve with 6.8 mm bar width. Smaller shrimp going through the sieve were rejected, crushed and therefore no longer available to peeling stations and the consumption market. These amounts were never accurately weighed though causing a gap in information.

The fraction of remaining consumption shrimp (they represent 100% of the consumption fraction while “crushed shrimp” are not taken into account any more) were graded by further sieves with bar widths of 8.5 and 9.5 mm. The shares “above 8.5 mm” or “above 9.5 mm” were recorded for every single consignment and pooled to weekly percentages.

So three grades exist for brown shrimp in that company:

Between 6.8 and 8.5 mm: Grade „3“

Between 8.5 and 9.5 mm: Grade „2“

Larger than 9.5 mm: Grade „1“

Results of weekly data on shares of the different grades (“large shrimp” >8.5 mm sieve, or >9.5 mm sieve respectively) are given in Figure 1.

Following information can be drawn from the graph:

1) There are “zero data” in years 2010 and 2011. They correspond with times of the end of Ramadan for weeks 38 (2010) and 34 (2011) and Christmas (week 51 and 52) when no shrimp were sieved and brought to the peeling stations in Morocco for religious festivity reasons.
2) There is a period of “zero data” in 2011 in week 17 to 20 when due to limited landings by the fleets (it was called “strike”) no sievings took place in that company.
3) There is a period from winter over spring until early summer (around week 19) were a high share of approx. 50% of large shrimp are within the consumption shrimp in four out of five years. From that week smaller shrimp dominate the sievings giving room for only approx. 10 to 20% of

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"large shrimp" until approx. week 38 when the share of "large shrimp" increases again up to approx. 50% by approx. week 45 to 49. That general trend is valid for the year 2008, 2009, 2010 and 2012. Year 2010 data are inconsistent and were split in size grades >8.5 mm for the first half year and >9.5 mm for the second half of 2010. So, not matching the same grades throughout the year they still show the same trend as in previous years and 2012 until spring.

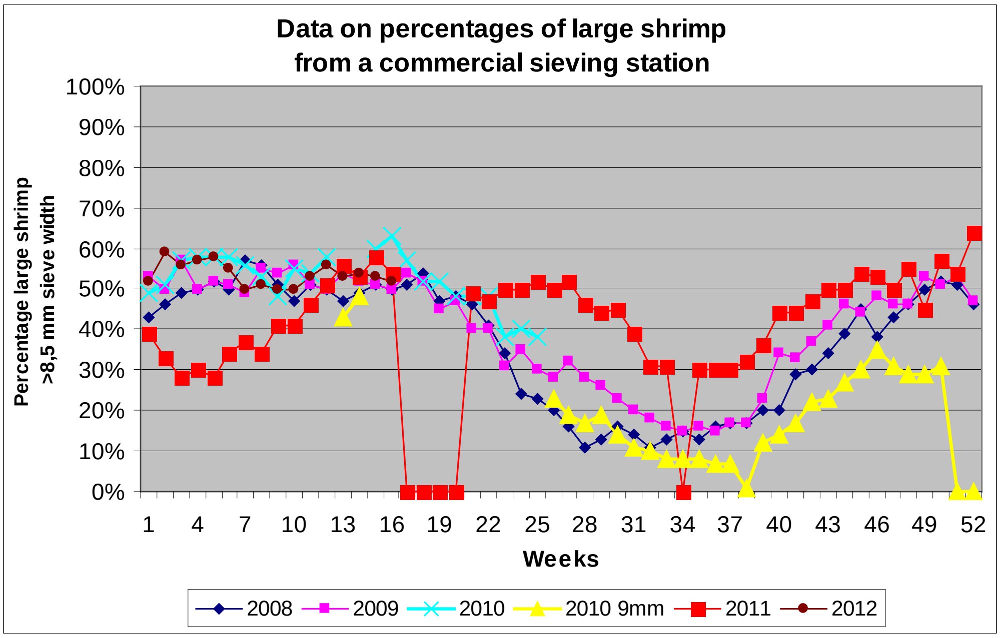

Figure 1. Seasonality of the shares of "large shrimp" in the sievings of commercial sieving stations on land by weekly data for the years 2008 to 2012 (week 16).

4) Data from 2011 differ for the time February to March as the share of large shrimp is below the previous years. The reason is unknown and might be caused by (A) intensive fishing, meaning that the large shrimp in the population might have been fished off already or (B) a higher amount of smaller shrimp came into the fished areas or (C) a shift of the fleet into areas of low concentrations of large shrimp occurred. VMS data must be available for proving but were not possible to be checked yet. Option B can however not exclusively be in place as the absolute quantity of the larger size groups was also noticeably reduced in that period.

5) In 2011 the share of large shrimp remained at a high level around 50 % after the "strike" in May. The levelling off occurred later in the year around end of July beginning of August, but only to the level of 30% instead of 10 to 15% as in previous years and remained higher until the end of the year. These observations indicate a positive effect of the "closed season" around May, as fishing intensity was drastically reduced (compare Working Document 5) reducing fishing mortality at the same rate and leaving the shrimp to survive and grow. Additionally to that growth rate of the shrimp increases intensely at that time of the year adding to the biomass of the stock. Another reason for the shift in the line of percentages might by the prolonged winter and SST effects on behaviour and migration pattern of brown shrimp which is not the focus of any scientific investigation so far and therefore largely unknown. A further important observation by fish-

ermen gives another likely reason for the higher share of large shrimp in the sieving fractions: a low and retarded reproduction rate and therefore low level of recruiting young shrimp, i.e. year-class 2011, must lead to a shift to higher shares of larger shrimp originating from the previous year-class. That observation should find its reflections in scientific survey data (length-frequency-distributions) gathered by the international DYFS/DFS programme officially coordinated by WGBEAM.

6) The shift and higher share of large shrimp in 2011 is however not caused by reduced amounts of so called “crushed shrimp” (undersized shrimp <6,8 mm carapace-width to be crushed as market intervention) as reported by the log-book system. The data might theoretically be biased due to a changing behaviour by the fishermen in the course of the implications given by the MSC process. The sieving processes on-board were certainly changed in 2011 as the percentage of undersized shrimp had to be reduced by the management system started in 2011. That change resulted in lower levels of undersized shrimp in the landings. Inevitably, the previous large amounts of undersized shrimp have led to an increased relative volume of the ‘Grade 3’ fraction before, as the auction sieves do not eliminate 100% of the undersized shrimp. This effect is however marginal. It has been noted in addition that the increased percentage of larger shrimp was well explained by the large absolute availability of this ‘Grade 1’ in the purchased volume compared to previous years, rendering the possible biasing effect of the on-board sieving negligible.

The question that arose whether the extreme increase of LPUE values in summer of 2011 were possibly caused by biological effects (low fishing mortality and growth) might find indeed an answer in the shifts of sieving data. However, as standardised data are not clearly available yet one has to be careful in attributing the obvious shift of percentages entirely to the effect of extremely low fishing effort in May 2011.

Fishery or fleet and effort effects will be dealt with in another WD No. 5.