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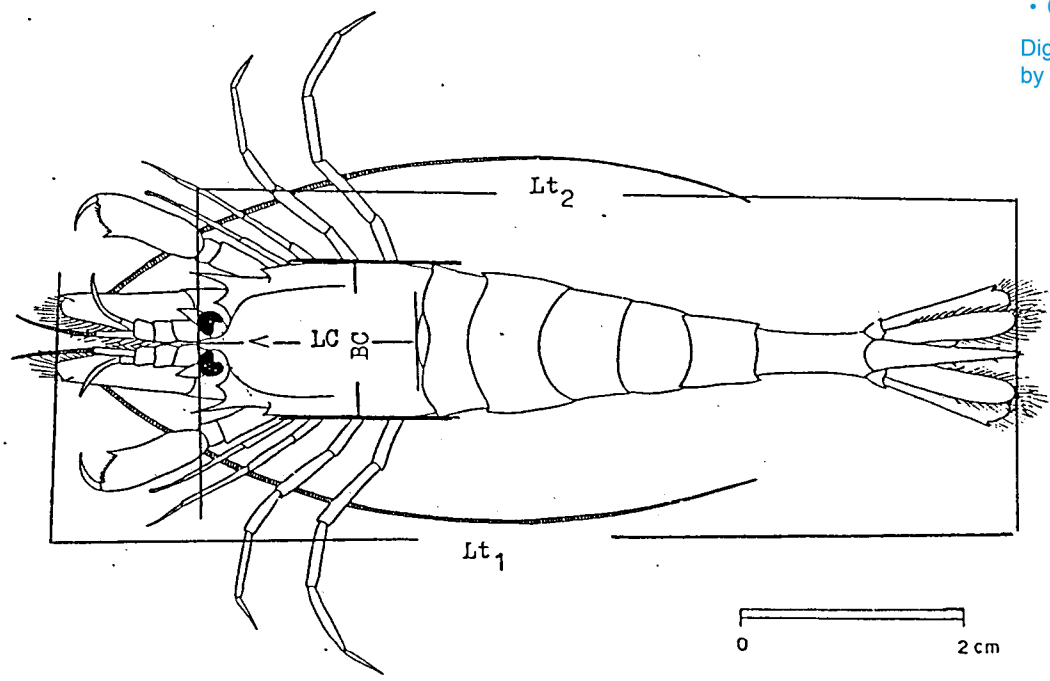

REPORT OF THE WORKING GROUP ON *CRANGON* FISHERIES AND LIFE HISTORY

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

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1. INTRODUCTION

At the 1992 Statutory Meeting the Shellfisch Committee recommended establishing a Study Group as concern arose about instability of *Crangon crangon* landings and uncertainties of the causes of this observation. The **„STUDY GROUP ON THE LIFE HISTORY, POPULATION BIOLOGY AND ASSESSMENT OF *CRANGON*"** met in 1993 and 1994 and delivered two reports at the Statutory meetings respectively (ICES 1993 and 1994a).

Despite the good progress in gathering data concerning the objectives of the Study Group, it became clear that there are considerable gaps in knowledge about the life cycle of *Crangon* in its range of distribution. As continuous work is required for obtaining sound databases it was recommended by the Shellfish Committee to terminate the SG and establish a new **„WORKING GROUP ON *CRANGON* FISHERIES AND LIFE HISTORY" (WGCRAN).**

The group met by correspondence in 1995 not having to deal with assessment matters directly, as this topic was transferred to the **„STUDY GROUP ON THE ASSESSMENT OF SHELLFISH STOCKS IN THE NORTH ATLANTIC".** Its first report was presented to the Annual Science Conference at Aalborg, Denmark (ICES 1995).

The first physical meeting of the members took place from June 4th to 7th 1996 at the Fisheries Research Centre in Hamburg. The terms of reference given to the „WORKING GROUP ON *CRANGON* FISHERIES AND LIFE HISTORY" (C. Res. 1995/2:45) were:

a) review and report on trends in population levels of shrimp and predator fish;
b) review changes in the exploitation patterns on *Crangon*, by-catch fish, and discards;
c) assess the possible effects of changes in exploitation activity and pattern on *Crangon* size composition and consequent recruitment potential;
d) analyse the demersal young fish and brown shrimp survey data series for trends in *Crangon* and predator abundance;
e) analyse existing effort data series to calculate LPUE time trends, allowing for documented changes in fishing power;
f) examine existing data series for trends in *Crangon* size composition;
g) examine the possible impact of the Danish closed nursery area and limited entry fishery on productivity of *Crangon*;
h) investigate the timing of larval production and settlement to identify the relative importance of recruitment of summer and winter egg production;
i) analyse changes in environmental parameters believed to have an impact on shrimps and their food organisms and predators.

Following members attended the meeting:

Bennett		(UK)
Damm		(D)
Neudecker (Chairman)		(D)
Redant		(B)
Sand Kristensen		(DK)
Temming		(D)
Berghahn	(guest)	(D)
van Marlen	(guest, partly)	(NL)
Polet	(guest)	(B)
Purps	(guest, partly)	(D)
Redcliff	(guest, partly)	(UK)
Riemann	(guest, partly)	(D)
Revill	(guest, partly)	(UK)

2. THE FISHERIES

General Information

All members of the WGCRAN were informed by the ICES secretariat or the chairman about the terms of reference of their group. The requested information on data by functional unit and country, as recommended by the former „Crangon Study Group", were presented at the meeting, or presented by correspondence when a member was not able to attend. However, The Netherlands neither appointed a member to the group, due to the unability of replacing the retired Dutch Crangon researcher because of lack of funding, nor were they able to send in the required and urgently needed data.
The group therefore regrets the incomplete status of data.
Furthermore, lack of manpower to computerize existing data and the continuing general trend of increasing duties, which reduces the capability of the single member to spend the required time to prepare the relevant information for the WGCRAN-meetings, hampered progress with respect to some of the given TOR's.
Thus, it still seems to be inevitable that members in their countries continue to acquire external funded projects which enable them to work on the given specific tasks.

Concerning the **FUNCTIONAL UNITS** some doubts came up concerning the value of the reported data. In some cases the reported data are referred to the position of the first haul of a cruise despite the fact that all following ones are done in a different location which should be allocated to e.g. the neighbouring FU. There seems to be no chance to avoid such bias under the generally given situation as any further specifying of data would require a much higher input of work for evaluating single haul data. Some progress might be possible for the formerly (ICES 1995) mentioned „long distance fishery" in the „Sylt Area", if geographical data should become compulsory to report on national level for Germany or within the EU logbook system. Then the catch will no longer be shifted to a far away FU biassing harbour based fishery information. Another problem is, and will probably remain, the **unallocated catches**.

Furtheron, it has not been possible, yet, to standardize **Fishing Effort**, though some improvements were made. It still varies from hp-corrected fishing hours per day to numbers of cruises or even boat-months if data are given at all. As a consequence the information on **LPUE** is still highly variable and not directly comparable. Here again the including of brown shrimp into the logbook system would improve the situation. All this information is listed in Tables 1 to 9 and Figures 1 to 45.

COUNTRIES

2.1 Denmark

2.1.1. Area fished

No change of information. (see ICES 1994a, page 4)

2.1.2. Long term trends in landings, effort and LPUE

The Danish brown shrimp fisheries data were given by month, year, Functional Unit and fleets. Unallocated data (area not specified) could not be used for the part of the Functional Units but were integrated in the countrywise Danish statistics, while German and Dutch landings were neglected. According to official information, these data are, respectively, incorporated in the foreign fleets statistics.

All recent data concerning Landings, Effort and LPUE, aggregated from each Functional Unit plus foreign fleets are listed in Tables 10, 11 and 12 and plotted in Figures 46, 47, and

53. They are recently recalculated data and differ partly from the former reports (ICES 1994a, 1995).

German vessels landed 385 tons of brown shrimps in Danish harbours in 1995, while for Dutch landings caught in Danish waters and landed in Danish harbours 824 tons were reported. The 1995 landings for Denmark (Danish fleet only) are 1883 tons, caught within 2496 days. This gives a LPUE value of 754 kg / day, while the reported CPUE value is 633 kg / day.
Industrial shrimps are not fished for by Danish vessels.

2.1.3. Seasonal fluctuations in landings, effort and LPUE

There was no further information on changes in seasonality (refer to Tables 13-15 and Figures 59, 63, 67). However, recent data are given on a monthly basis.

2.2. Germany

2.2.1. Areas fished

No changes in fishing grounds were observed since 1994, meaning that the „SYLT AREA" was fished by some larger vessels doing „long distance fishing", while the majority of the fleet stayed in the vicinity of their base harbours. No further progress was possible in working up of existing catch statistics backwards beyond 1985 concerning landings, effort (number of trips) and LPUE (tons per trip) to Functional Units 3 to 6. These data have to remain preliminary as it became obvious that they are partly combined fish and shrimping trips for some harbours. These effort data have to be checked for this type of bias. This may be possible within a general effort study before older data are included in the time series. The uncertainty due to the above mentioned long distance fishery which is done by some cutters at certain times will be dealt with in an effort study as well. It should give some information on the extent of this fishing practice and its share of the landings of certain ports and Functional Units.

2.2.2 Long term trends in landings, effort and LPUE

Landings dropped from 11358 tons in 1994 to 8902 tons in 1995 (Table 10 and Figures 46). Effort can still only be estimated roughly from the number of trips reported to the authorities (Table 11 and Figure 48). The total number of trips (25106) was in the same order of magnitude as in previous years but slowly decreasing. It has to be stated, however, that fishermen complain about their enormous strain encountered by fishing, pointing towards both a highly increased number of fishing hours as well as improved technical equipment. All this means nothing else but an increase of fishing effort which still needs to be documented. Uncorrected effort data from 1961 onwards (Table 1) were taken from Tiews (1971, 1983), as well as unpublished information by the fishery authorities. **Effort and LPUE data (table 11 and 12 and Figure 48 and 54) are thus misleading because of inadequate units and a not yet properly recorded shift.**
No foreign landings in German ports are known.

2.2.3. Seasonal fluctuations in landings, effort and LPUE

The 1995 seasonal pattern in landings showed a distinct spring peak. This is not an average situation in recent years and the autumn season gave lower landings than normal (Table 13 and Figures 60 and 68). This was partly due to fewer trips made because of lower catches (= poor LPUE's).

Seasonal effort and LPUE are plotted in Figures 64 and 68.

2.3. The Netherlands

No member was nominated to the WGCRAN with the consequence that **no official data were reported.**

2.3.1. Areas fished

No change of information. Compare Figure 2.3. and Figure 2.3.3.1. of the report ICES 1993 and further information given in ICES 1994a. No information on Functional Units.

2.3.2. Long term trends in landings, effort and LPUE

As no replacement of the „Crangon scientist" took place, **no official data were presented to the group.** This led to the unpleasing situation that total data could only be calculated for the total european shrimp fishery. The Netherlands hold an important share of approx. 40%, due to the direct information given by the Produkt chap Vis of Nederlands Vissersbond (Table 10).
The work up and computerisation of plenty of data available in high quality is necessary.

2.4. Belgium

2.4.1. Area fished

The Belgian shrimp trawlers fish mostly close to the Belgian coast, within the 12 miles zone. The so-called „Scheldt trawlers" also fish for Crangon in the Westerscheldt estuary and, together with vessels from Zeebrugge, in the southernmost part of the Dutch coastal waters. Vessels from Nieuwpoort, the most westerly Belgian fishing port, occasionally operate in the French 12 miles zone (POLET, 1992).
Shrimp trawlers fishing in the nearshore waters usually make relatively short trips, with an average duration of 8 - 14 hours, depending on weather conditions and catch rates. Most of the catches taken by these vessels are landed in Belgian ports. Trawlers operating on the „offshore" shrimp grounds and in the Dutch coastal waters make longer trips, with an average duration of 12 - 30 hours. Many of these vessels land their catches in foreign harbours, particularly in the southern Netherlands. The „nearshore" shrimp trawler fleet comprises the smallest vessels, and has an average engine power of about 220 HP (data for 1993-95). The „offshore" fleet consists of larger vessels, among them several Euro-cutters, and has an average engine power of about 290 HP.

2.4.2. Trends in landings, effort and LPUE

The quantities of Crangon landed in Belgian ports fell sharply from 1250 - 1600 tons per year in the mid-1970s to about 900 tons in the late 1970s, then gradually declined to a more or less stabilized level of 450 - 600 tons in the mid-1980s (Table 10). 1982 was an outstanding year for the Belgian shrimp fisheries, completely deviating from the overall downward trend observed between the mid-1970s and the mid-1980s.

Most noticeable is the rapid increase in the shrimp landings by Belgian trawlers in foreign ports, particularly since 1990. These landings went up from <100 tons per year in the late 1980s, to nearly 750 tons in 1995, thereby exceeding the shrimp landings in Belgian ports by almost 50%. As a result, the overall landings for 1995 (Belgian and foreign ports combined) rose to just over 1200 tons, the highest figure recorded since 1982.

Annual fishing effort of the shrimpers landing in Belgian ports has fluctuated without an obvious trend from the late 1970s to 1994, at a level of 30 - 40.10^3 hours at sea, or 6 - 8.10^6 HP-hours (Table 11). In 1995 however, the effort fell by almost 25% as compared to the average for the late 1980s and the early 1990s. Conversely, annual fishing effort of the vessels landing in foreign ports increased by almost 35%, to just over 16.10^3 hours at sea in 1995,

as opposed to around 12.10 ^{3} hours in 1993 and 1994.

Over the past years, the HP corrected LPUEs of the vessels landing in Belgian ports seems to have slightly recovered, after a long period of almost continuous decline, which started in the late 1970s. By 1990, the LPUEs had dropped to the lowest figure in the time series (0.059 kg/HP-hour). Since then, however, they have steadily increased again, to a value of 0.090 kg/HP-hour in 1995, but this figure is still far below the average for the mid- and late 1970s (about 0.125 kg/HP-hour) (Table 13).

As already pointed out in the 1994 Crangon Study Group Report (ICES 1994a), there are serious doubts concerning the reliability of the official landing figures for the Belgian shrimp trawler fleet. The landing records of shrimp are often incomplete, and verifiable information on the relative importance of the „grey" landings is extremely scarce. Nevertheless, it is believed that the observed long-term trends broadly reflect the true trends in landings and LPUE of the Belgian shrimp fishery.

2.4.3. Seasonal fluctuations in landings, effort and LPUE

Monthly fishing effort, landings and HP corrected LPUEs of the shrimp trawlers landing in Belgian ports, averaged over the past 10 years (1986-95), and separately for 1995, are shown in Figures 61, 65, and 69, respectively.
Particularly the data series for the landings and the LPUEs show a clear seasonal pattern, with a peak in late summer and early autumn, and much lower values in winter and early spring.

2.5. France

2.5.1. Areas fished

The information given in ICES 1993 and ICES 1994a has been improved and extended. Data were presented by Functional Unit as far as possible for the southern North Sea and the eastern Channel (FU 10, FU 14, FU 15) except for FU 16 where landings are very low. Authorities of other FU's do not report because of the difficulty to estimate catches (FU 17), or because of the great distance between their regions (Atlantic FU 18 and FU 19) and the markets of the North Sea.

French landings, effort and LPUE by year are listed in the tables 10 to 12, respectively, and plotted in Figures, 46, 51, and 57.

2.5.2. Long term trends in landings, effort and LPUE

Landings data for the French shrimp fisheries (Table 10) are available since 1970, effort data since 1985 (Table 11 and 12). However, they only contain information from ICES area IVc and VIId, the most important areas (Figures 5, 11, 17, 34, 39 and 45). Data for 1995 for total France were not complete at the time of report completion.

2.5.3. Seasonal fluctuations in landings, effort and LPUE

Seasonal data were worked up and presented for FU 10 from 1991 to 1994, for FU 14 from 1989 to 1995 and for FU 15 from 1985 to 1994. 1995 values for effort were not yet available and should be at hand for the next report. (Cf. tables 4 to 6).

2.6. United Kingdom

2.6.1. England and Wales

2.6.1.1 Areas fished

The main landings of brown shrimp in England and Wales continue to come from the Wash (FU 12), with small landings from the Humber (FU 13), the Thames (FU 11), the west coast (FU 20) and the Solway Firth (FU 21).

2.6.2. Trends in landings, effort and LPUE

The long-term landing trends (Figure 46, table 10) show clearly how the total landings from England and Wales increased to a peak of just over 2000 t in 1987, following a period (1973-86) when landings had averaged 661 t. This increase in landings followed aninvestment in larger vessels in the Wash (FU 12), and a considerable increase in fishing effort. Landings from the west coast functional units (FU 20, 21) have declined since 1983.

Since the 1987 peak landings of 1545 t from the Wash (FU 12), landings there have fluctuated between 426 and 1019 t (Figure 4, Table 11). Landings in the last three years (1993-95) have been in the range of 920 - 1019 t, which means: well above the 10 year average of 786 t. Fishing effort has risen in the last three years to 39310 hours fished in 1995, following a decline to 11766 h in 1992 (Figure 10, Table 2). LPUE (Figure 16, Table 3) for the last ten years shows a peak of 54 kg/h in 1993. Over the last two years LPUE has declined to 23 kg/h in 1995, below the 10 year average of 30 kg/h, but not as low as in 1990. In the small Humber (FU 13) fishery the LPUE shows a similar trend to that in the Wash, though it is lagged by one year (Figure 16, Table 3).

Fishermen in the Wash are alleging that aggregate extraction for beach replenishment on the Lincolnshire coast has reduced catch rates and necessitated both an extension of their fishing range as well as an increase in fishing time to maintain economic viability.

Landings on the west coast have declined from over 400 t in 1987-88 to only 16 t in 1995. Effort and consequently landings have increased in the Solway Firth (FU 21), where landings are also made into Scotland (see section 2.6.2.). Total landings from this functional unit were 158 t in 1995.

The seasonal trends in landings indicate peak landings in the autumn (Figure 34 and 35, Table 7) from both the east coast (FUs 11-13) and the west coast (FUs 20-21) fisheries. This seasonal pattern is also reflected in the fishing effort and the LPUE. 1995 seems to have been a typical year, with the seasonal pattern being similar to the 10 year average (Figures 38, 39 and 44, 45, Tables 8 and 9).

2.6.2. Scotland

No new or updated data were sent to the group because of computer problems leading to incompleteness of present data sets.

3. Trends in Population Levels of *Crangon* and Predator Fish

The national research project in Germany mentioned above (ICES 1995, chapter 3, page 3) started to computerize historic by-catch data from the shrimp fisheries. This project will be continued until 1998, making available, on computer, a set of data containing information on shrimp and bycatch from a total of 13000 hauls done in three different regions from 1955 to 1994. This sampling program is continued but suffers from some discontinuity in sampling. The trilateral Danish-German-Dutch Monitoring Programme of the Wadden Sea will use this data source for its purposes, which aim at population levels as well. The information drawn out of this series will be relative catch data only. Swept area data have been added to

the program since 1995 to improve the value of the series.

LPUE data are not yet sufficiently worked up for Germany to be used for proper population level studies. While detailed catch information is available, the effort information (number of cruises) has not been improved, yet: partly mixing of fish and shrimp trips, decrease of cruises because of decrease of number of boats and a certain degree of camouflaging by increased duration of trips. It seems necessary to wait for the effort study results until an acceptable LPUE time series may be obtainable for Germany (see also chapter 7).
The hp-corrected information given by Belgium seems to be the best available LPUE series (ICES 1993). A German thesis (Prawitt, 1995) demonstrated, however, that the fishing power of a vessel is independent of its engine power. The increasing of vessel engine power in our fleets would, therefore, introduce a decreasing LPUE trend possibly not reflecting the true stock situation. This needs further discussion.
Effort information based on fishing hours seems to be the best information. This level of information is, at present, delivered by the UK only, while DK and NL work on the basis of fishing days.

The diagrams (figures 53 to 58) drawn from table 12 show variable trends for LPUEs for the country -fleets, which may be caused by stock densities as well as by shifts in the target species of the fisheries themselves (Germany: strong decrease of industrial shrimp landings e.g. Belgium: possibly higher interest in valuable by-catch fish.).

The other possible source for population levels is the DYFS. Cf. chapter 6.

3.1. Stomach analyses

The Working Group was given a brief progress report on ongoing Belgian research with regard to the impact of demersal predators on brown shrimp. The data for this study were collected in the mid-1970s within the framework of a much larger study on the dynamics of the Crangon stock in the Belgian coastal waters (REDANT, 1978), but, due to insufficient computer facilities at the time, these data have never been analysed in sufficient detail to answer questions on, e.g., the size dependency or seasonality of predation on brown shrimp.

The original data base, which is currently being computerized, contains information on the stomach contents of about 10,000 fish, viz. cod (Gadus morhua), whiting (Merlangius merlangus), bib and poor cod (Trisopterus spp.), five-bearded rockling (Ciliata mustela), gurnards (Trigla spp.), pogge (Agonus cataphractus), sea snail (Liparis liparis), dab (Limanda limanda), flounder (Platichthys flesus) and plaice (Pleuronectes platessa). Data recorded include: location, date, and time of day of the fish samples taken; densities and size composition of Crangon at each location; size, body weight, sex, maturity stage, and stomach weight of each fish analysed; total weight, species composition, and individual size of the shrimps in each stomach.

Once computerized, this data base will help to provide information on, e.g., the numbers and sizes of Crangon eaten by different species and size classes of fish. This is of vital importance for the evaluation of, among others, the impact of predation on different size or age classes of Crangon at different times of the year, or the competition between predatory fish and the shrimp fisheries for the commercial size classes of Crangon.

In view of the workload associated with the computerization and quality check of nearly a quarter of a million of numerical data, however, it is unlikely that the results of this study will be available any earlier than by the next meeting of the Working Group.

4. Changes in exploitation pattern on *Crangon*, by-catch, fish and discards

No data are available to assess the exploitation pattern of shrimp and by-catch. However, a decline in average size of consumption sized shrimp in German commercial catches (Damm et al. 1995, poster; cf. chapter 7) might well relate to higher mortality, as could be expected in the light of a rising trend in fishing power of the fleet (Temming and Temming, 1992). Nevertheless, it is not possible at the momen to exclude changes in growth and/or natural mortality for explanation.

5. Effects of changes in exploitation activity and pattern on *Crangon* size composition and consequent recruitment potential

Reduction in average size (see chapter 5 and 8) result directly in reduced egg production capacity per individual, since this is related to length by a power of approx. 3,5 (Redant, 1972, see figure 71 for the Büsum samples).

6. Demersal Young Fish and Brown Shrimp Survey data series for trends in *Crangon* and predator abundance

Only German data for Schleswig-Holstein are worked up until now. The first preliminary results for shrimp were presented 1993 (ICES K:54) but gave no significant trend for the abundance of shrimps on an annual basis between 1974 and 1992. In the meantime, further evaluation was done and has been published in 1996 (Neudecker and Damm, ICES K:8). A decrease of abundance of brown shrimps could be found for some channel systems. Other species and predator fish are not yet analysed except for plaice and sole. Their abundance trends are published in ICES G:7 (Damm and Neudecker, 1996). Data available for the area Elbe and west of it up to the Belgian coast need to be computerized and analysed in the future.

7. Effort data series to calculate LPUE time trends, allowing for documented changes in fishing power

The German project on the impact of shrimping in the Wadden Sea of Schleswig-Holstein within the framework of the German ecosystem research was finished in 1994. The final report, which will be edited by the Federal Environmental Agency, is in press. Three issues of the report, which were considered to be important for the WG, were presented on the meeting.

1. It was demonstrated that the former effort measure of cruises given by analysing the data from the fisheries authorities of the federal states which will also be available on computer in the near future. For the increasing number of shrimp vessels, which operate no longer on the basis of day cruises, but on cruises of 2 to 3 days, the number of cruises can be translated into fishing days as a more appropriate effort measure by subtracting the registered lay days from the total number of days during the fishing season. It is also possible to separate the effort which goes into flatfish fisheries from shrimping activities.
2. For 0-group plaice a safe estimate, assuming no re-catch, a very low natural mortality rate and a high discard mortality of 80% was presented according to which about 5-10% (Max. 13%) of a yearclass was killed by German shrimping operations.
3. A new type of roller gear has been developed which reduces erosion of the rollers close to the shoes of the beam trawl to a minimum and thereby

- diminishes the impact of the gear on the bottom fauna,
- reduces the amount of empty shells and debris in the catches which facilitates the sieving of the catch and increases survival rates during the catch and catch processing procedure and thus in the discards,
- increases the durability of the roller gear,

- saves diesel during towing.

The final version, regarding a few objections by some fishermen, will be introduced by the Bundesforschungsanstalt für Fischerei in about a year's time.

Fishing power

A MSc thesis on fishing power and fishing effort of the shrimp fleet (PRAWITT, 1995) came to the conclusion that fishing power in shrimping operations was not significantly influenced by 10 selected parameters (a.o. engine power). A corresponding ICES paper is in preparation (PRAWITT et al., 1996, ICES B:9). The effect that increased engine power enables shrimpers to do hauls against the current in offshore areas, thereby considerably increasing the fishing time, was not considered in the thesis.

8. Existing data series for trends in *Crangon* size composition

Average size in samples from the German fishery is constantly decreasing in samples from Büsum (Schleswig-Holstein) and Norddeich/Neuharlingersiel (Niedersachsen), while there is a fluctuation in samples from Cuxhaven (Elbe estuary) (Figure 71). The decrease in the former two landing sites is in the range of 5 to 6mm over 40 years, where only shrimp >= 50 mm are included. Other similar data series exist e.g. in The Netherlands but they are not available to the WG.

9. Possible impact of the Danish closed nursery area and limited entry fishery on productivity of *Crangon*

The Working Group had a lengthy discussion on so-called „zero use" areas, and on the possible effects of their establishment on the Crangon stocks and the shrimp fisheries. Overall, the Working Group agreed to the statement made in ICES Cooperative Research Report 203 on the non-suitability of coastal zones with inhomogeneous conditions for closed area studies (ICES 1994b page 9). This is particularly true for the Danish, German and Dutch wadden areas, where most of the inshore shrimp fishing is taking place.

If, for whatever reason, „zero use" areas are to be established, it is recommended to first perform a baseline study on the Crangon population in the areas designated to be closed, and then to repeat this study well after their closure, in order to detect the possible effects of the „zero use" on the densities, population structure and reproductive potential of the Crangon stock in the area. In view of the high levels of geographical and temporal variability in Crangon populations, both the „pre-" and the „post-closure" study should last over a sufficiently long period of time, to obtain a reliable overall picture of the situation before and after closure. It is difficult to put an exact figure on the number or years to be included in such a comparative study, but, judging from previous investigations on the dynamics of Crangon stocks, a minimum duration of 5 years for both the „pre-" and the „post-closure" study seems to be advisable.

When setting up such comparative studies, it should be kept in mind that the closure of „traditional" shrimp fishing grounds will almost certainly provoke a diversion of fishing effort to those grounds which remain open to the fisheries, which, in turn, may result in a substantial increase in fishing pressure on the Crangon stock in these areas. Therefore, the „post-closure" study should not be started before fishing effort in the open areas has stabilised, or - preferably - before it has decreased to its original level.

The Working Group recognizes that there might be some validity in the argument that „zero use" areas could be beneficial to the Crangon stock in a much wider area, but it also felt that, because of the high levels of natural variability mentioned above, it might be very difficult to produce hard scientific evidence of such an effect. Furthermore, the Working Group is convinced that similar protective goals might be achieved (at a much

lower cost, and at a much lower risk of socio-economic distortion of a fishermen's community that is under heavy pressure already) by the introduction of e.g. more selective gear types, which combine higher escape rates of undersized shrimp with a reduction of the by-catch of unwanted species.

10. Timing of larval production and settlement to identify the relative importance of recruitment of summer and winter egg production

There is only one recent French study known to the WG dealing with this topic (Martin, 1995). It also describes the existance of a spring peak of larvae in the south of the North Sea like in other areas. The WG realizes that this study like all others before has too wide a sampling interval to detect the enormous larval peaks that need to occur according to simulations on single days in spring, as being the basis of the massive invasions on the tidal flats. Only new approaches, which are using continuous sampling devices in different depth strata and locations of the coastal region, might be able to help filling the gaps of knowledge in this crucial part of the *Crangon* life cycle.

11. Changes in environmental parameters believed to have an impact on shrimps and their food organisms and predators

No scientific information was presented to the group concerning this topic. It was common knowledge, however, that the recent strong and icy winter has had a severe impact on the Waddensea Ecosystem, leading to high mortalities of a lot of organisms and a subsequent succession of new recruitments. The fishermen's experience is that a high abundance of shrimps, mussels and young sole follows an ice-winter. The very low abundance and sometimes total absence of many species including predators of shrimp was also observed in the most recent 1996 spring surveys of the DYFS.

A periodic up and down of shrimp landings in the North Sea was found by adding up all European brown shrimp landings as done by the group (ICES 1995, Fig. 34). It was analysed by Neudecker and Purps (1996) and they demonstrated a six year period for the deviation of the mean catches of this species. Reasons for this or other influences guiding this phenomenon are not yet known.

12. RECOMMENDATIONS

As not all brown shrimp fishing countries appointed members to the working group for 1995/96 again, the WG urges that counterparts are named in future by all relevant countries in order to not seriously hamper the success of the WG.

Due to the little progress that is made in 1994/95 the recommendations of the former CRANGON STUDY GROUP are still valid.

12.1. Research

Topics for research

1. Trends in population levels of shrimp and predator fish.
2. Changes in the exploitation pattern on Crangon, bycatch fish, and discards.
3. The level and pattern of predation mortality on Crangon.
4. Changes in environmental parameters which could have an impact on the productivity of food species on Crangon.
5. Resolve certain conflicting aspects of the life cycle of Crangon while taking into account the geographic and hydrographic differences.
6. Assess the possible effects of changes in exploitation activity and pattern on Crangon size composition and subsequent recruitment potential.
7. Evaluate the role of Crangon in the ecology of North Sea estuarine and coastal areas.
8. Develop fishing and handling techniques to reduce the catches of bycatch fish and small shrimp, and improve the survival of discards.

12.2. Action List

1. Continuation in analysing the demersal young fish and brown shrimp survey data series for trends in Crangon and predator abundance.
2. Analyse existing effort data series to calculate LPUE time trends, allowing for documented changes in fishing power.
3. Examine existing data series for trends in Crangon size composition.
4. Initiate the collection of full fishery statistics by functional unit.
5. Examine the possible impact of Danish closed nursery area and limited entry fishery on productivity of Crangon.
6. Investigate the timing of larval production and settlement, in order to identify the relative importance recruitment of summer and winter egg production.
7. Continue the studies of the Crangon life cycle, paying particular attention to aspects of reproduction, recruitment, and growth.
8. Analyse changes in environmental parameters which are believed to have an impact on shrimps and their food organisms and predators.
9. Improve fish and shrimp selectivity in shrimp trawls by the study of (a) square meshes in codends, (b) sorting grids, (c) sieve (veil) net size and shape, (d) whole net mesh size, (e) ground rope and tickler chain configurations.

13. Future Meetings

The WG recommends, with regard to the time-consuming situation of working up historic data and the results arising from the presently ongoing projects as well as possibly incoming new projects, that it should meet by correspondence in 1997 and has its next physical meeting of four working days in June 1998 preferably taking place in Port en Bassin, France.

14. Acknowledgements

The WG acknowledges very much the support of the group by „AKTION SEEKLAR", a German foundation, which encouraged and supported research, leading to a better understanding of marine processes and enhancing the protection of marine ecosystems. Otherwise the presentation of the reports of the group at the Annual Science Conferences would not have been possible by one of its members. The WG also is grateful to the German Federal Research Center for Fisheries and its staff which has hosted the SG's and WG's meetings in the last years and especially Mr. M. Vogl who has served in preparing and updating many of the graphs and tables of the present as well as previous reports.

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Table 1: **10 year landings of brown shrimp per Functional Unit and years 1986 to 1995 in tonnes**

	FU 1	FU2				FU 3				FU 4	FU 5	FU 6			FU 7	FU 8	FU 9
Year	DK		NL	DE	Total	DE	DK	NL	Total	DE			NL	Total	NL		
86	103	750		773	1523	2700	2		2702	3155	2100	3269		3269			
87	219	998	235	933	2166	2731	60		2791	3591	1976	3369		3369			
88	57	1127	480	472	2079	2586	16		2602	3660	2005	2250		2250			
89	287	853	1067	326	2246	2079	15		2094	2867	1812	2138		2138			
90	240	339	448	141	928	1004	1		1005	1282	1257	1180		1180			
91	252	542	292	138	972	1912	5		1917	2913	2022	2102		2102			
92	514	1791	752	446	2989	1929	83		2012	2590	1645	1545		1545			
93	293	1119	331	169	1619	2073	26		2099	2593	1820	2602		2602			
94	400	1138	376	222	1736	2448	22		2470	3470	2416	3024		3024			
95	645	1188	824	385	2397	1993	50		2043	2536	1800	2188		2188			
mean	301	985	534	401	1866	2146	28		2174	2866	1885	2367		2367			

	FU 10				FU 11	FU 12	FU 13	FU 14	FU 15	FU 16	FU 17	FU 18	FU 19	FU 20	FU 21	
Year	NL	B	F	Total	UK			F						UK		Total
86		491	45	536	7	685		315	355	0				222	58	15029
87		533	41	574	5	1545		289	256	0				426	57	17264
88		498	82	580	6	702	25	213	199	0				432	27	14837
89		750	123	873	4	714	92	130	264	0				207	31	13758
90		447	49	496	13	468	55	82	92	0				127	49	7274
91		454	46	500	11	430	3	129	69	0				60	70	11450
92		579	45	624	5	426		100	88	0				45	82	12664
93		520	47	567	12	949	14	72	129	0				28	161	12957
94		660	56	716	29	1019	14	90	158	0				35	207	15782
95		513	34	547	24	921	4	53	72	0				24	158	13413
mean		545	57	601	11	786	30	147	168	0				161	90	0

FU 10: Belgium: Landings by Belgian shrimp trawlers in Belgian harbours only. Unallocated: Landings by Belgian shrimp trawlers in foreign harbours.
FU 21: Scottish and English data combined

Table 2: **10 year effort of Brown Shrimp Fisheries per Functional Unit and years 1986 to 1995**
NOTE: Effort units differ considerably among countries

	FU 1	FU2			FU 3			FU 4	FU 5	FU 6			FU 7	FU 8	FU 9
	DK		NL	DE	DE	DK	NL	DE			NL		NL		
Unit:	days	days		trips	trips	days		trips							
86	230	903			5122	3		6147	6191	12513					
87	479	1511			5584	70		6469	6872	11506					
88	202	1863			5427	32		6595	7362	11249					
89	574	2349			5429	41		6027	7071	12829					
90	574	1362			3498	8		3970	6380	11233					
91	1009	1730			3613	14		4215	6790	11961					
92	766	3140			3290	90		3901	6830	9389					
93	753	2699			3499	37		4199	6746	12330					
94	1448	2608			3473	45		4366	6553	11172					
95	n.a.	2395			2990	71		3655	6387	12074					
Mean	604	2056			4193	41		4954	6718	11626					

	FU 10			FU 11	FU 12	FU 13	FU 14	FU 15	FU 16	FU 17	FU 18	FU 19	FU 20	FU 21
	NL	B	F	UK			F						UK	
Unit:		1000 hp h	boat-months	hours			boat-months						hours	
86		5876	86	1696	15222		489	467	28				1600	362
87		5839	57	1765	25823		378	556	25				50	1848
88		6249	99	1727	18860	465	315	548	30				181	2669
89		7649	133	624	25686	3140	287	533	5				28	808
90		7559	52	2006	27943	2455	182	364	13				722	1721
91		6984	49	2032	20132	496	146	285	8				77	3390
92		7898	36	1067	11766		198	346	4				35	1372
93		7055	36	2097	23090	622	182	405	11				228	13313
94		7702	43	2095	33770	417	144	469	13				106	14820
95		5682		972	39310	316							14	9128
Mean		6849	66	1608	24160	1130	258	441	15				304	4943

FU 10: Belgium: Effort data for landings by Belgian shrimp trawlers in Belgian harbours only

Table 3: 10 year LPUE of Brown Shrimp Fisheries per Functional Unit and years 1986 to 1995
NOTE: Effort units differ considerably among countries

	FU 1	FU2			FU 3			FU 4	FU 5	FU 6		FU 7	FU 8	FU 9
	DK		NL	DE	DE	DK	NL	DE			NL	NL		
Unit:	t/day			t/trips	t/trips	t/day		t/trips						
86	0,45	0,83			0,53	0,70		0,51	0,34	0,26				
87	0,46	0,66			0,49	0,86		0,56	0,29	0,29				
88	0,28	0,60			0,48	0,51		0,55	0,27	0,20				
89	0,50	0,36			0,38	0,36		0,48	0,26	0,17				
90	0,42	0,25			0,29	0,13		0,32	0,20	0,11				
91	0,25	0,31			0,53	0,39		0,69	0,30	0,18				
92	0,67	0,57			0,59	0,92		0,66	0,24	0,16				
93	0,39	0,41			0,59	0,71		0,62	0,27	0,21				
94	0,28	0,44			0,70	0,48		0,79	0,37	0,27				
95		0,50			0,67	0,71		0,69	0,28	0,18				
Mean	0,41	0,49			0,52	0,58		0,59	0,28	0,20				

	FU 10			FU 11	FU 12	FU 13	FU 14	FU 15	FU 16	FU 17	FU 18	FU 19	FU 20	FU 21
	NL	B	F	UK			F						UK	
Unit:		kg/hp hour	kg/boat-month	kg/hour			kg / boat - month						kg / h	
86		0,084	523	3,83	32,66		643	760					0,95	0,16
87		0,091	719	2,61	54,36		764	461					274,32	0,03
88		0,080	828	3,32	29,76	53,61	678	364					26,66	0,01
89		0,098	925	5,84	25,79	29,16	454	495					0,68	0,04
90		0,059	942	6,10	15,59	21,16	449	253					17,51	0,03
91		0,065	945	5,26	18,14	6,62	881	242					21,25	0,02
92		0,073	1244	4,34	34,78		503	254					18,97	0,06
93		0,074	1301	5,49	40,02	21,90	398	317					13,95	0,01
94		0,086	1301	13,66	29,52	34,13	627	337					21,57	0,01
95		0,090		25,04	22,79	13,86							16,43	0,02
Mean		0,080	970	7,55	30,34	25,78	600	387					41,23	0,04

FU 10: Belgium: For landings by Belgian shrimp trawlers in Belgian harbours only
FU 21: Scottish data not available

Table 4: 10 year average of seasonal landings of brown shrimp fisheries per Functional Unit and years 1986 to 1995 in tonnes

	Country	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
FU 1	DK	9,76	10,67	19,53	74,15	92,82	19,17	12,64	11,28	15,06	15,69	13,54	6,85
FU 2		20,00	12,05	42,64	134,67	133,67	146,33	101,73	75,83	101,02	105,58	76,78	34,12
FU 3	DE	9,85	3,95	46,33	173,86	196,56	195,09	189,54	225,32	356,13	412,81	260,86	75,18
	DK	0,32	0,19	0,43	3,48	2,01	7,70	3,06	2,73	1,70	2,46	3,66	0,32
	NL												
	Total	10,17	4,14	46,76	177,34	198,57	202,79	192,60	228,05	357,83	415,27	264,52	75,50
FU 4	DE	24,39	17,33	73,61	227,26	193,44	201,55	215,75	378,54	541,52	575,86	322,64	93,82
FU 5		6,72	2,61	28,46	115,37	124,73	163,27	208,22	295,22	377,93	353,80	173,74	35,15
FU 6		3,96	0,87	28,80	164,67	161,99	184,63	211,37	274,77	423,87	535,46	308,54	67,54
	NL												
	Total	3,96	0,87	28,80	164,67	161,99	184,63	211,37	274,77	423,87	535,46	308,54	67,54
FU 7	NL												
FU 8													
FU 9													
FU 10	NL												
	B												
	F												
	Total	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
FU 11	UK	1,53	1,93	1,50	1,08	0,45	0,54	0,52	0,61	0,77	1,77	1,91	0,83
FU 12		34,44	22,31	30,00	45,37	50,67	51,36	47,85	70,47	138,27	118,60	115,53	61,10
FU 13		4,92	1,01	3,24	1,48	1,35	1,15	1,84	2,15	3,12	13,83	11,04	4,52
FU 14	F												
FU 15													
FU 16													
FU 17													
FU 18													
FU 19													
FU 20	UK	1,93	0,60	0,90	4,00	15,74	7,13	5,71	7,64	36,64	46,09	26,69	10,10
FU 21		3,04	3,86	2,58	5,72	9,02	8,93	10,15	9,27	12,07	12,93	14,52	8,40
	Mean	9,00	5,49	23,57	86,21	89,53	91,62	94,16	123,78	185,99	209,71	126,83	36,06
	Total	134,98	82,39	353,58	1293,12	1343,02	1374,27	1412,36	1856,65	2789,80	3145,60	1902,52	540,97

FU 21: Scottish data not available for 1995, so the 1985 - 94 have been combined with the 1986 - 95 English data

Table 5: 10 year average of seasonal effort of Brown Shrimp Fisheries per Functional Unit and years 1986 to 1995
NOTE: Effort units differ considerably among countries

	Country	Units	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
FU 1	DK	days	31	36	64	133	129	39	28	23	32	36	46	16
FU 2			55	42	104	220	235	235	196	156	172	188	146	68
FU 3	DE	trips	16	5	81	379	463	490	509	532	650	551	400	124
	DK	days	0	0	2	6	1	17	8	1	1	13	23	1
	NL													
FU 4	DE	trips	36	25	144	444	442	493	565	770	797	674	447	133
FU 5			32	21	157	602	754	823	883	959	979	867	553	89
FU 6			15	13	145	1142	1466	1462	1564	1422	1595	1539	994	269
	NL													
FU 7	NL													
FU 8														
FU 9														
FU 10	NL													
	B	hp-hour	1556	1472	1604	2207	2597	2876	3439	3597	3615	3787	2977	2142
	F	boat-month												
FU 11	UK	hours	81	83	89	220	245	198	244	204	176	183	129	54
FU 12			1202	1091	1501	2002	2516	2016	2056	2199	3098	2544	2465	1581
FU 13			135	55	103	109	71	80	210	126	107	384	347	197
FU 14	F	boat-month												
FU 15														
FU 16														
FU 17														
FU 18														
FU 19														
FU 20	UK	hours	8	10	25	21	13	108	105	59	61	49	229	8
FU 21			376	384	286	517	888	837	725	805	1035	906	910	785

FU 21: Scottish data not available for 1995, so the 1985 - 94 have been combined with the 1986 - 95 English data

Table 6: 10 year average of seasonal LPUE of brown shrimp fisheries per Functional Unit and years 1986 to 1995
NOTE: Effort units differ considerably among countries

	Country	Units	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
FU 1	DK	t/day	0,30	0,23	0,27	0,49	0,53	0,36	0,28	0,23	0,32	0,36	0,31	0,32
FU 2			0,29	0,22	0,28	0,44	0,43	0,45	0,33	0,31	0,43	0,40	0,39	0,33
FU 3	DE	t/trip	0,63	0,82	0,57	0,46	0,42	0,40	0,37	0,42	0,55	0,75	0,65	0,60
	DK	t/day	0,20	0,03	0,15	0,67	0,33	0,60	0,26	0,24	0,39	0,46	0,54	0,17
	NL													
FU 4	DE	t/trip	0,69	0,70	0,51	0,51	0,44	0,41	0,38	0,49	0,68	0,85	0,72	0,70
FU 5			0,21	0,13	0,18	0,19	0,17	0,20	0,24	0,31	0,39	0,41	0,31	0,40
FU 6			0,27	0,07	0,20	0,14	0,11	0,13	0,14	0,19	0,27	0,35	0,31	0,25
	NL													
FU 7	NL													
FU 8														
FU 9														
FU 10	NL													
	B	kg/hp-hour												
	F	kg/boat-month												
FU 11	UK	kg/hour	30,05	29,88	13,41	7,54	2,34	4,25	2,28	3,13	5,87	13,94	14,17	14,28
FU 12			25,97	22,45	20,68	20,26	18,69	20,47	22,36	30,10	40,17	49,86	45,94	33,88
FU 13			35,26	20,98	33,28	17,22	20,33	17,87	11,86	13,05	30,04	42,40	29,81	36,58
FU 14	F	kg/boat-month												
FU 15														
FU 16														
FU 17														
FU 18														
FU 19														
FU 20	UK	kg/hour	0,26	0,06	0,04	0,19	1,21	0,07	0,05	0,13	0,60	0,94	0,12	1,21
FU 21			0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,02	0,01

FU 21: Scottish data not available for 1995, so the 1985 - 94 have been combined with the 1986 - 95 English data

Table 7: 1995 Seasonal landings of Brown Shrimp Fisheries per Functional Unit in tonnes

	Country	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Total
FU 1	DK	22	20	36	137	232	57	46	36	36	15	8	2	645
FU 2		9	9	60	156	220	231	215	103	59	75	44	8	1188
FU 3	DE	1	4	28	242	380	189	173	201	208	362	205	35	2028
	DK	0	0	1	8	1	20	4	0	1	6	9	0	50
	NL													
	Total	1	4	29	250	380	209	177	201	209	368	214	36	2078
FU 4	DE	14	10	60	308	380	214	172	220	314	532	310	115	2651
FU 5		8	1	19	132	171	151	192	280	315	386	130	15	1800
FU 6		0	0	24	198	175	174	149	261	344	542	281	39	2188
	NL													
	Total	0	0	24	198	175	174	149	261	344	542	281	39	2188
FU 7	NL													0
FU 8														0
FU 9														0
FU 10	NL													
	B	24	16	13	13	11	18	55	80	83	130	45	26	513
	F													
	Total													
FU 11	UK	4	6	4	4	0	0	0	0	0	2	3	1	24
FU 12		72	73	66	67	67	27	41	77	150	142	98	41	921
FU 13		0	0	0	0	0	0	0	0	0	0	3	1	4
FU 14	F	2	3	1	2	7	3	2	7	11	10	4	3	53
FU 15														0
FU 16														0
FU 17														0
FU 18														0
FU 19														0
FU 20	UK	0	0	1	1	1	1	1	1	7	5	6	0	24
FU 21		6	6	4	14	22	26	21	14	11	11	13	9	158
	Mean	10	10	23	108	139	93	87	109	131	196	103	23	1032
	Total	163	152	368	1729	2221	1493	1398	1743	2093	3129	1654	371	16513

FU 21: Scottish data included

Table 8: 1995 seasonal effort of brown shrimp fisheries per Functional Unit
NOTE: Effort units differ considerably among countries

	Country	Units	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Total
FU 1	DK	days	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	0
FU 2			25	29	139	273	321	326	394	279	179	223	160	47	2395
FU 3	DE	trips	2	5	42	325	448	261	381	384	403	406	333	74	3064
	DK	days	0	0	2	6	1	17	6	1	1	13	23	1	71
	NL														
FU 4	DE	trips	21	19	86	394	460	373	368	538	475	518	403	132	3787
FU 5			22	22	113	509	786	756	885	935	872	909	496	82	6387
FU 6			0	3	220	861	1547	1670	1750	1301	1865	1780	817	260	12074
	NL														0
FU 7	NL														0
FU 8															0
FU 9															0
FU 10	NL														
	B	hours	1638	1351	1318	1509	1255	1615	2839	2767	2723	4079	2736	1786	25616
	F	boat-month													0
FU 11	UK	hours	177	167	98	106		27			12	149	160	76	972
FU 12			2472	3382	3075	3560	4027	2327	2360	2597	4701	5223	3869	1717	39310
FU 13													181	135	316
FU 14	F	boat-month	n.a.												0
FU 15			n.a.												0
FU 16			n.a.												0
FU 17			n.a.												0
FU 18			n.a.												0
FU 19			n.a.												0
FU 20	UK	hours											14		14
FU 21			637	658	392	889	1026	990	798	602	854	665	945	672	9128

FU 21: Scottish data not available

Table 9: 1995 seasonal LPUE of brown shrimp fisheries per Functional Unit
NOTE: Effort units differ considerably among countries

	Country	Units	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Total
FU 1	DK	t/day	0,46	0,52	0,53	0,76	0,86	0,75	0,52	0,42	0,37	0,26	0,30	0,19	5,94
FU 2			0,36	0,30	0,43	0,57	0,69	0,71	0,55	0,37	0,33	0,34	0,28	0,18	5,08
FU 3	DE	t/trip	0,31	0,89	0,67	0,75	0,85	0,72	0,45	0,52	0,52	0,89	0,62	0,48	7,67
	DK	t/day	0,00	0,00	0,40	1,25	0,50	1,20	0,70	0,30	1,00	0,49	0,39	0,12	6,34
	NL														
FU 4	DE	t/trip	0,67	0,53	0,70	0,78	0,83	0,57	0,47	0,41	0,66	1,03	0,77	0,87	8,28
FU 5			0,38	0,04	0,17	0,26	0,22	0,20	0,22	0,30	0,36	0,42	0,26	0,18	3,00
FU 6			0,00	0,16	0,11	0,23	0,11	0,10	0,09	0,20	0,18	0,30	0,34	0,15	1,98
	NL														
FU 7	NL														0,00
FU 8															0,00
FU 9															0,00
FU 10	NL														0,00
	B	kg/hour	0,015	0,012	0,010	0,009	0,009	0,011	0,019	0,029	0,031	0,032	0,017	0,015	0,206
	F	kg/boat-month													
FU 11	UK	kg/hour	20,51	35,19	36,12	34,66		14,11			17,58	16,08	20,96	16,83	212,05
FU 12			28,40	21,12	20,96	18,63	15,70	10,23	15,97	28,63	31,62	26,74	24,52	23,95	266,46
FU 13													16,22	10,70	26,91
FU 14	F	kg/boat-month													0,00
FU 15															0,00
FU 16															0,00
FU 17															0,00
FU 18															0,00
FU 19															0,00
FU 20	UK	kg/hour											16,43		16,43
FU 21			8,50	8,08	6,82	8,90	8,77	13,93	12,30	6,73	6,55	6,85	8,00	12,49	107,92

FU 21: Scottish data not available

Table 10: Long term landings of national fleets (not per geographical area), tonnes of consumption shrimp as presented to the Crangon WG

Tons	Denmark	Germany	Netherlands	Belgium	France	UK	Europe
Year	total	total	total	total	total	total	total
50		2637	2657				5294
51		3302	4734				8036
52		3286	4224				7510
53		4295	4157				8452
54		4456	3437				7893
55		5641	6358				11999
56		5412	5933				11345
57		5689	4401				10090
58		6501	4201				10702
59		4431	4726				9157
60		3603	4296				7899
61		4496	5587				10083
62		4012	5287				9299
63	67	7240	8045				15352
64	63	6800	8886				15749
65	131	5714	8047				13892
66	85	7576	7386				15047
67	100	4674	7405				12179
68	110	7807	6559				14476
69	175	8790	6749				15714
70	69	9668	7135	1396	2700	0	20935
71	57	6706	4243	958	2800	13	14722
72	54	7702	3893	918	2900	10	15426
73	143	6743	5102	1712	3000	7	16610
74	176	9483	6096	1321	2041	9	19069
75	329	8773	6103	1616	1922	1488	19909
76	660	13446	4060	1675	1632	1546	23799
77	720	7836	3506	970	1272	1095	15263
78	1419	9211	3901	683	1443	1367	17746
79	1252	12264	5023	1061	1890	1535	22782
80	2140	12952	4935	1067	1608	1140	23697
81	2821	10990	4380	957	1407	1202	21607
82	3107	14060	6074	1780	1157	1435	27240
83	1972	8777	5994	781	1029	1490	19906
84	770	8253	4180	787	1313	788	15945
85	744	13250	6268	706	997	803	22581
86	1138	11249	7078	498	1327	1901	23184
87	1734	11698	7903	627	956	3970	26680
88	1050	10500	6233	578	908	2188	21377
89	1467	8819	6975	812	757	1939	20706
90	652	4701	4760	489	502	1221	12283
91	855	8949	6896	560	450	1001	18605
92	2409	7705	7564	765	419	1033	19079
93	1510	9090	8123	785	507	1783	21536
94	1538	11358	8743	979	531	1158	24306
95	1883	8902	11457	1253	225	1058	24777

Dutch data 1995 given by Produktschap Vis of Nederlandse Vissersbond

Table 11: Long term effort data as presented to the Crangon Working Group
Note the different units of effort in countries which are not comparable

	Denmark	Germany	Nederlands	Belgium	France	U.K.	Europe
Year	No.vess.		total	total	total	total	total
Units	fish.days	no.trips	fish.days	HPhours	boat - months	fish.hours	
60							
61							
62							
63	3	58725					
64	3	51715					
65	3	43124					data
66	3	46830					in
67	3	40999					this
68	5	49839					form
69	7	49988	28738				not
70	5	46820	21041				compar-
71	2	36722	18554				able
72	5	44488	21685				
73	6	39303	19977	10058			
74	8	40137	22868	11138		978	
75	10	38347	26185	13783		1218	
76	14	36863	16928	12040		2476	
77	19	33131	18710	9501		1685	
78	33	26855	15899	5643		2184	
79	31	29041	15949	6242		2294	
80	31	28253	12882	7616		1492	
81	31	28586	12531	6973		1552	
82	31	24290	14757	6954		1319	
83	22	25484	16317	6303		750	
84	23	27404	17740	7532		6062	
85	24	29291	16228	6029	1198	14137	
86	412	30012	18564	5876	1070	15584	
87	2227	30490	17689	5839	1016	27001	
88	2216	30641	20060	6249	992	21200	
89	3166	31356	22070	7646	958	25782	
90	2024	25081	22172	7559	611	27713	
91	2765	24561	21748	6984	488	21668	
92	4004	24840	21175	7898	584	12566	
93	3522	26837	26086	7055	634	31849	
94	3558	25564		7702	669	41628	
95	2496	25106		5682		49740	

Danish effort data from 86 onwards: Fishing days
France: ICES IV and VII d only

Table 12: Long term LPUE data as presented to the Crangon WG
Note the different,not comparable effort units between countries

	Denmark	Germany	Netherlands	Belgium	France	U.K.	Europe
Year	total	total	total	total	total	total	total
Units	kg/day	t/trip	t/f.day	kg/hph	kg/b.month	kg/h	
60							
61							
62							
63	22,300	0,123					
64	21,000	0,131					
65	43,700	0,133					data
66	28,300	0,162					in
67	33,300	0,114					this
68	22,000	0,157					form
69	25,000	0,176	584,1				not
70	13,800	0,206	798,0				compar-
71	28,500	0,183	498,0				able
72	10,800	0,173	477,5				
73	23,800	0,172	343,3	0,161			
74	22,000	0,236	671,7	0,114		9,20	
75	32,900	0,229	741,5	0,114		10,67	
76	47,100	0,365	1057,6	0,133		8,48	
77	37,900	0,237	475,0	0,095		13,64	
78	43,000	0,343	472,9	0,109		9,16	
79	40,400	0,422	584,2	0,146		17,22	
80	69,000	0,458	981,4	0,122		20,91	
81	91,000	0,384	886,2	0,116		15,98	
82	100,600	0,579	797,5	0,202		20,32	
83	89,600	0,344	555,6	0,102		14,27	
84	33,500	0,300	592,3	0,085		27,32	
85	31,000	0,452	573,3	0,098	689	25,00	
86	10,496	0,375	775,2	0,084	667	48,25	
87	11,594	0,384	736,9	0,091	577	37,05	
88	8,431	0,343	659,5	0,080	499	21,60	
89	6,976	0,281	595,3	0,098	540	32,90	
90	2,787	0,187	453,0	0,059	367	21,85	
91	4,718	0,364	740,7	0,065	498	17,50	
92	9,349	0,310	810,5	0,073	399	41,65	
93	6,169	0,339	709,5	0,074	391	24,45	
94	6,176	0,444		0,086	456	15,20	
95		0,339		0,090			

F: ICES area IV and VII d only

Table 13: Seasonal Landings (tonnes) of consumption shrimp as presented to the Crangon Working Group

A: Data for 1995

tonnes Month	Denmark total	Germany total	Netherlands total	Belgium total	France total	U.K. total	Europe total
Jan	31	23		24		81	
Feb	29	16		16		85	
Mar	96	131		13		73	
Apr	301	880		13		80	no
May	456	1105		11		77	data
Jun	315	727		18		42	
Jul	266	686		55		52	
Aug	146	963		80		82	
Sep	96	1182		83		163	
Oct	96	1822		130		153	
Nov	63	927		45		117	
Dec	11	204		26		52	

B: 10 years average 1986 - 1995

tonnes Month	Denmark total	Germany total	Netherlands total	Belgium total	France total	U.K. total	Europe total
Jan	31	45		19		46	
Feb	23	25		14		30	
Mar	64	177		15		38	
Apr	217	681		22		58	no
May	237	677		27		77	data
Jun	182	745		37		69	
Jul	122	825		57		66	
Aug	97	1174		72		90	
Sep	124	1699		93		191	
Oct	129	1878		103		193	
Nov	99	1066		56		170	
Dec	43	272		29		85	

Table 14: Seasonal effort data as presented to the Crangon Working Group

A: Data for 1995

Month Units	DK total Fishdays	Germany total No.Trips	Netherlands total Fishdays	Belgium total hours	France total Boat-Month	U.K. total Fishhours	Europe total
Jan	25	45		1638		3286	
Feb	29	49		1351		4207	
Mar	141	461		1318		3565	no
Apr	280	2089		1509		4555	compar-
May	326	3241		1255		5053	able
Jun	349	3060		1615		3344	data
Jul	401	3384		2839		3158	
Aug	289	3158		2767		3199	
Sep	180	3615		2723		5567	
Oct	237	3613		4079		6037	
Nov	188	2049		2736		5169	
Dec	51	548		1786		2600	

B: 10 years average 1986 - 1995

Month Units	Denmark total days	Germany total No.Trips	Netherlands total Fishdays	Belgium total hours	France total Boat-Month	U.K. total hours	Europe total
Jan	86	98		1556		1801	
Feb	78	64		1472		1624	
Mar	168	526		1604		2003	no
Apr	353	2567		2207		2868	compar-
May	364	3124		2597		3733	able
Jun	274	3268		2876		3240	data
Jul	224	3521		3439		3339	
Aug	179	3683		3597		3393	
Sep	204	4021		3615		4476	
Oct	224	3632		3787		4065	
Nov	192	2394		2977		4080	
Dec	84	615		2142		2626	

Table 15: Seasonal LPUE data as presented to the Crangon WG

A: data for 1995

	Denmark	Germany	Netherlands	Belgium	France	U.K.
Month	total	total	total	total	total	total
Units	t/day	t/trip	t/day	kg/HPh	kg/boat-month	kg/h
Jan	0,82	0,51		0,068		57,41
Feb	0,82	0,32		0,055		64,38
Mar	1,36	0,28		0,049		63,90
Apr	3,58	0,42		0,043		62,18
May	3,05	0,34		0,042		24,47
Jun	3,81	0,24		0,049		38,28
Jul	1,98	0,20		0,089		28,27
Aug	1,75	0,30		0,129		35,36
Sep	1,70	0,33		0,134		55,75
Oct	1,59	0,50		0,136		49,67
Nov	1,36	0,45		0,073		86,13
Dec	0,73	0,37		0,063		63,96

B: 10 years average 1986 - 1995

	Denmark	Germany	Netherlands	Belgium	France	U.K.
Month	total	total	total	total	total	total
Units	t/day	t/trips	t/day	kg/HPh	kg/boat-month	kg/h
Jan	0,78	0,46		0,054		111,03
Feb	0,47	0,39		0,042		90,79
Mar	0,70	0,34		0,043		90,69
Apr	1,61	0,27		0,046		67,58
May	1,30	0,22		0,050		54,07
Jun	1,41	0,23		0,061		59,36
Jul	0,86	0,23		0,079		72,90
Aug	0,79	0,32		0,096		70,49
Sep	1,14	0,42		0,118		106,80
Oct	1,23	0,52		0,122		139,83
Nov	1,23	0,45		0,085		164,97
Dec	0,81	0,44		0,060		128,33

Table 16: Description of the Functional Units of the ICES „Crangon Working Group"

North Sea

1	Hvide Sande - Esbjerg, Denmark
2	Esbjerg - Sylt coast, Denmark
3	Northern Schleswig-Holstein Coast (Nordfriesland)
4	Southern Schleswig-Holstein Coast (Dithmarschen)
5	Eastern Niedersachsen Coast
6	Western Niedersachsen Coast (East-frisian Islands)
7	Dutch coast from Dollart-Ems to Terschelling, includin the adjacent part of the Waddensea
8	Dutch coast from Terschelling to Ijmuiden, including the adjacent part of the Waddensea
9	Easter Scheldt
10	Wester Scheldt and coastal area Flushing to Dunkerque
11	Thames Estuary, England
12	Wash Estuary, England
13	Humber Estuary, England

Channel

14	Baie de Somme - d'Authie et de Canche, France
15	Seine Estuary, France
16	Baie des Veys, France
17	Baie du Mont St. Michel, France

Biscay

18	Biscay - Loire Estuary and Baie de Vilaine, France
19	Biscay - Ile de Re to Gironde, France

Irish Sea

20	English & Welsh west coast and estuaries
21	Solway Firth, England & Scotland

Figures

Figure 1 10 years landings in FU 1 and FU 2
(AREA: off the Danish coast)

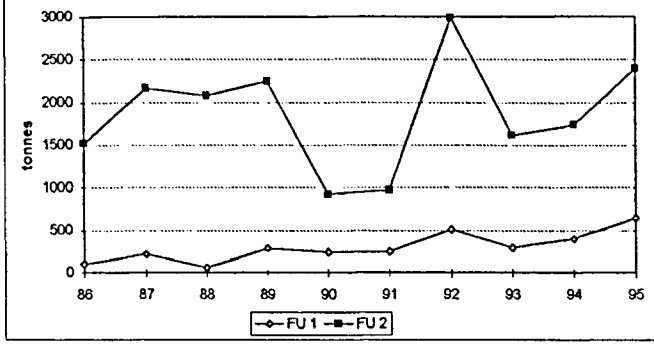


Figure 2 10 years landings in FU 3 to FU 6
(AREA: off the German coast)

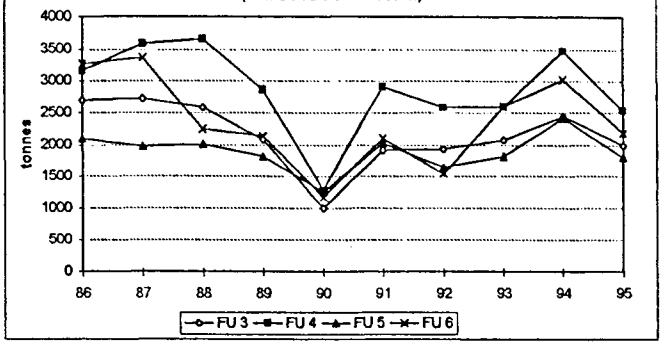


Figure 3 10 years landings in FU 10
(AREA: off the Belgian coast, without landings from The Netherlands)

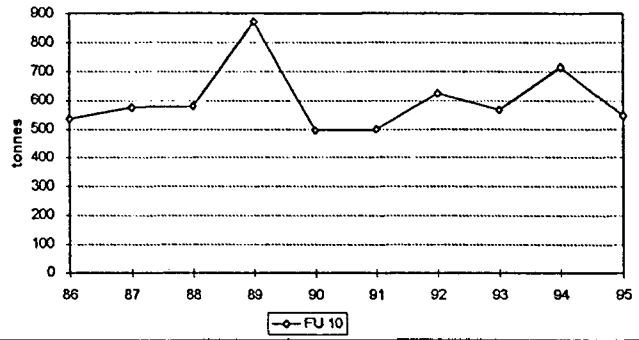


Figure 4 10 years landings in FU 11 to FU 13
(AREA: off English east coast)

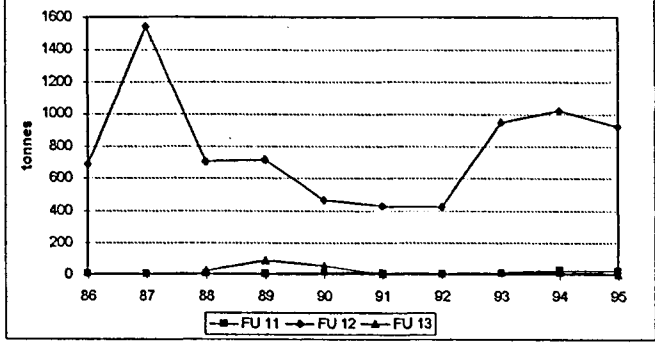


Figure 5 10 years landings in FU 14 and FU 15
(AREA: off French coast Southern North Sea, Channel)

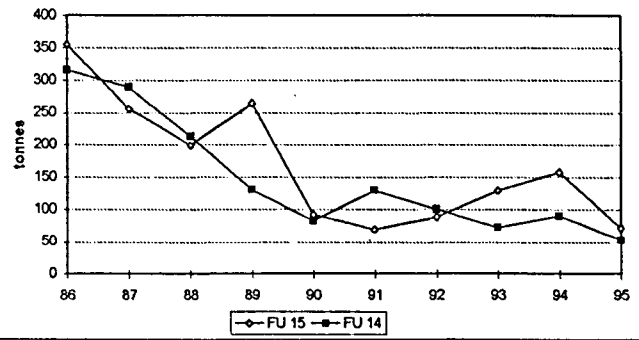


Figure 6 10 years landings in FU 1 and FU 2
(AREA: off British coast in Irish Sea, English and Scottish landings combined)

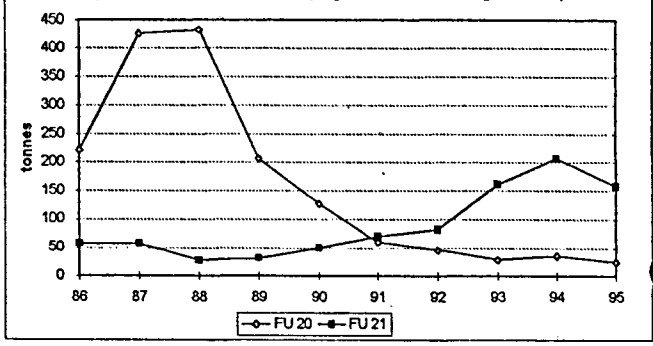


Figure 7 10 years effort in FU 1 and FU 2
(AREA: off Danish coast, only Danish effort information, no data for FU 1 for 1995)

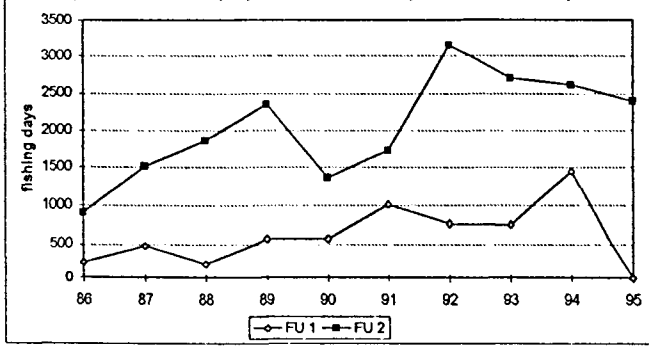


Figure 8 10 years effort in FU 3 to FU 6
(AREA: off German coast, only German effort information)

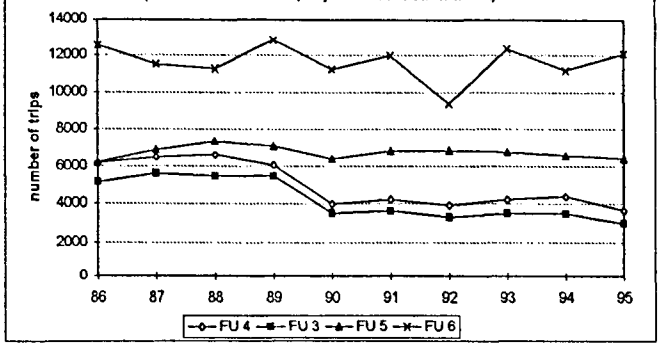


Figure 9 10 years effort in FU 10
(AREA: off Belgian coast, only allocatable Belgian effort information)

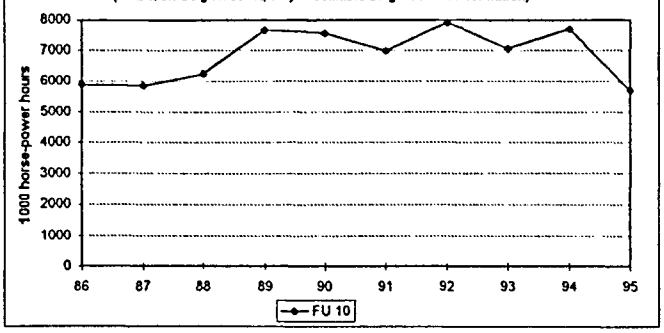


Figure 10 10 years effort in FU 11 to FU 13
(AREA: off English east coast)

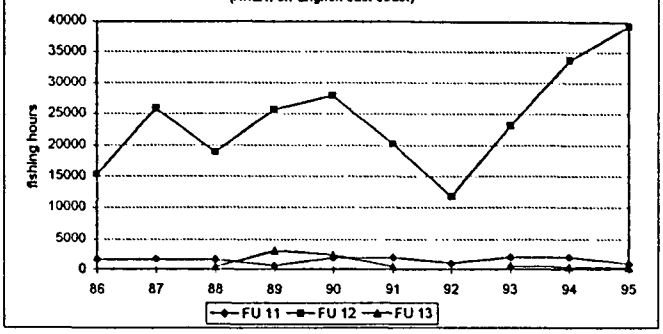


Figure 11 10 years effort in FU 14 to FU 16
(AREA: off French coast, Southern North Sea, Channel)

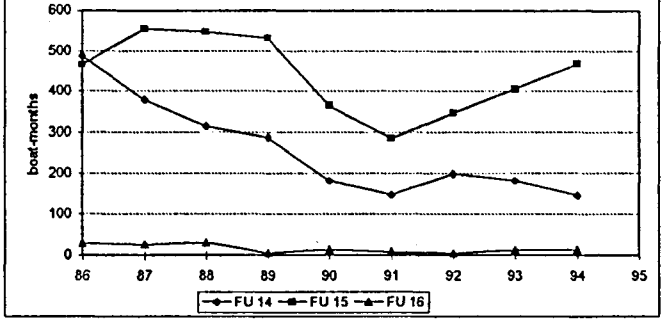


Figure 12 10 years effort in FU 20 and FU 21
(AREA: off British west coast, Scottish and English data combined)

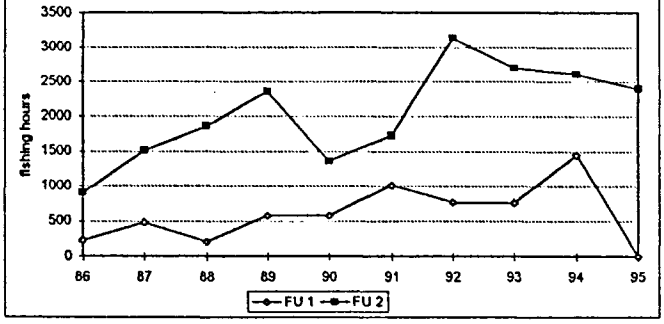


Figure 13 10 years LPUE in FU 1 and FU 2
(AREA: off Danish coast, only Danish effort information, no data for FU 1 for 1995)

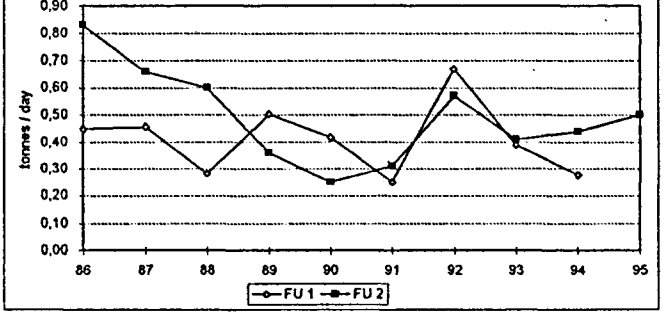


Figure 14 10 years LPUE in FU 3 to FU 6
(AREA: off German coast, only German effort information)

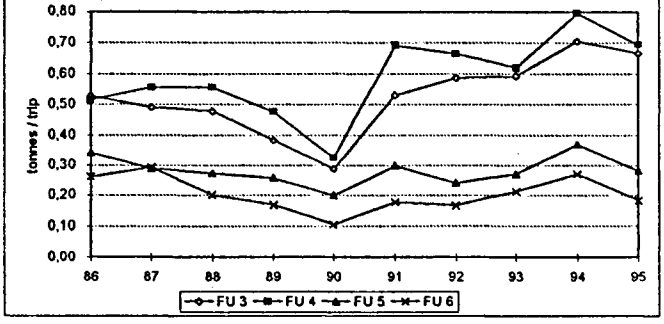


Figure 15 10 years LPUE in FU 10
(AREA: off Belgian coast, only allocatable Belgian effort information)

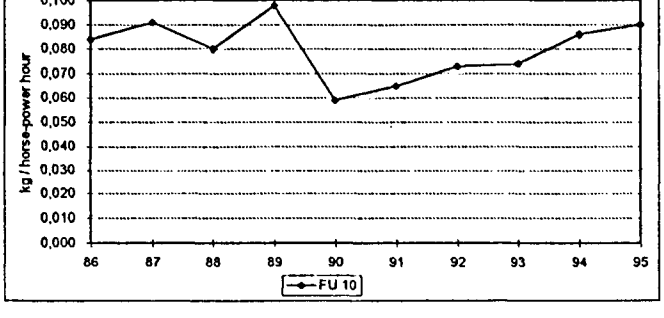


Figure 16 10 years LPUE in FU 11 to FU 13
(AREA: off English east coast)

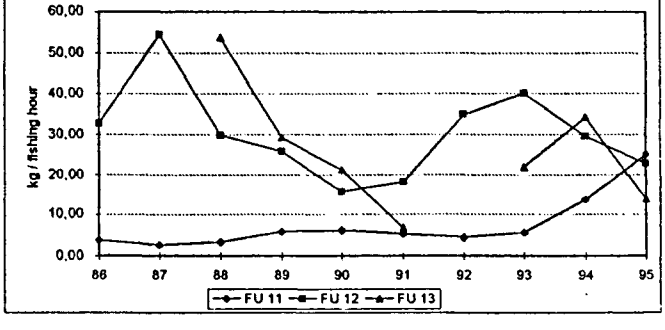


Figure 17 10 years LPUE in FU 14 and FU 15
(AREA: off French coast, Southern North Sea, Channel)

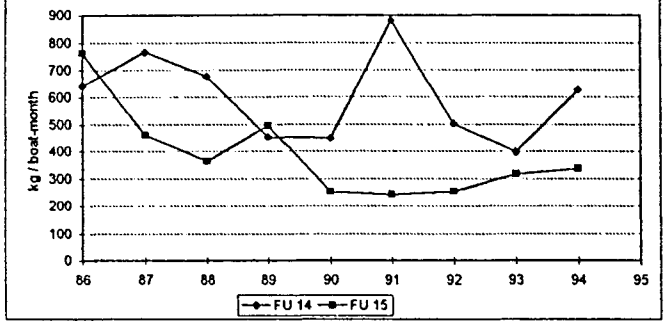


Figure 18 10 years LPUE in FU 20 and FU 21
(AREA: off British west coast, Scottish and English data combined)

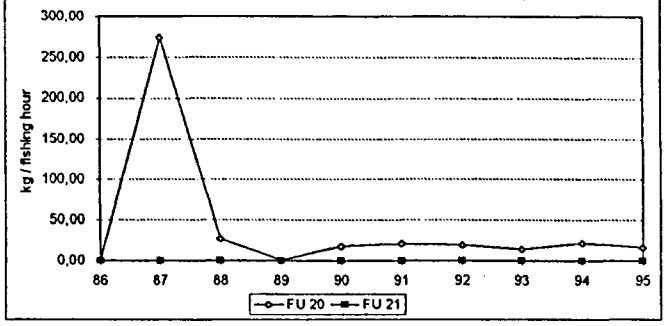


Figure 19 Average Seasonal Landings from 1986 to 1995
(AREA: off Danish coast, Danish data only)

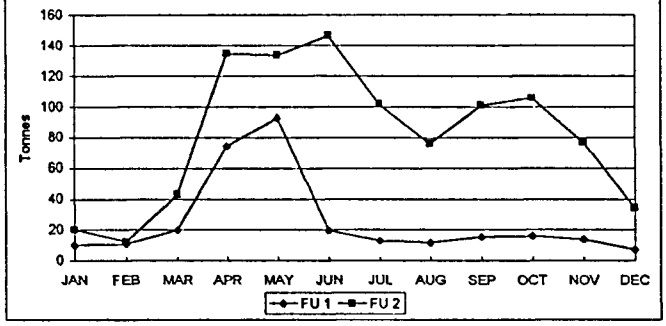


Figure 20 Average Seasonal Landings from 1986 to 1995
(AREA: off German coast, German and Danish data only)

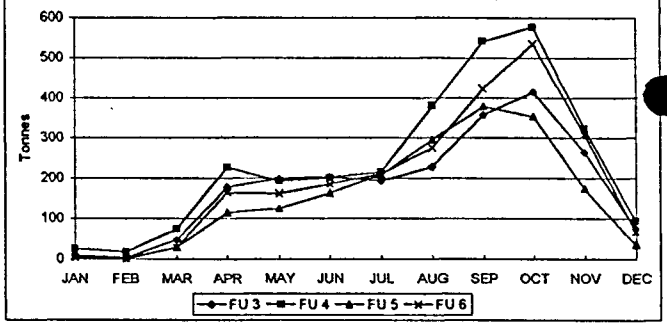


Figure 21 Average Seasonal Landings from 1986 to 1995
(AREA: off English east coast)

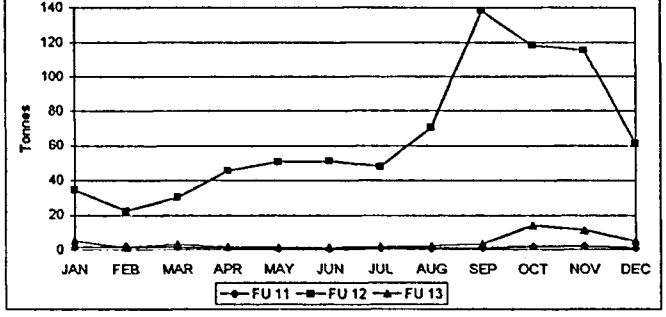


Figure 22 Average Seasonal Landings from 1986 to 1995
(AREA: off English west coast)

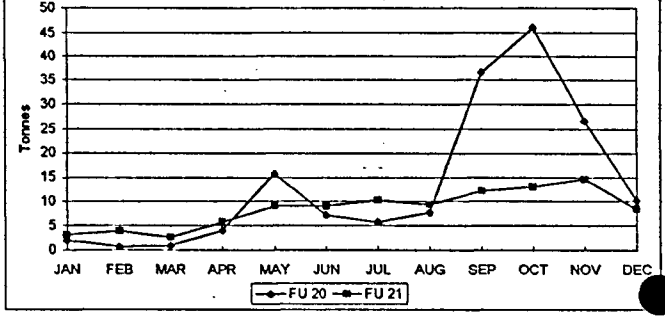


Figure 23 Average Seasonal Effort from 1986 to 1995
(AREA: off Danish coast, Danish data only)

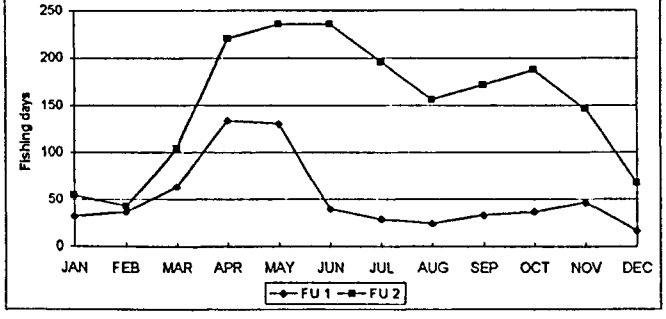


Figure 24 Average Seasonal Effort from 1986 to 1995
(AREA: off German coast, German data only)

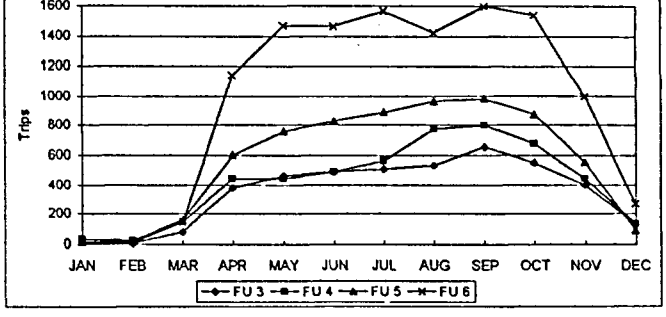


Figure 25 Average Seasonal Effort from 1986 to 1995
(AREA: off English east coast)

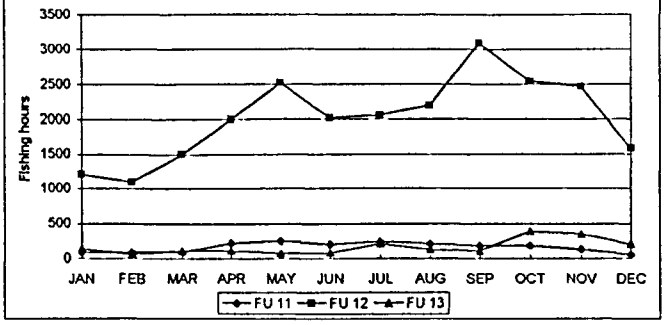


Figure 26 Average Seasonal Effort from 1986 to 1995
(AREA: off English west coast)

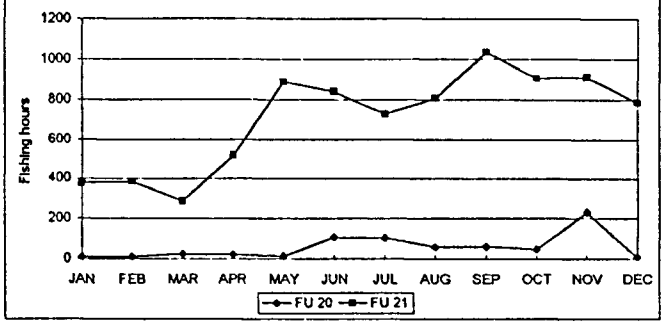


Figure 27 Average Seasonal LPUE from 1986 to 1995
(AREA: off Danish coast, Danish data only)

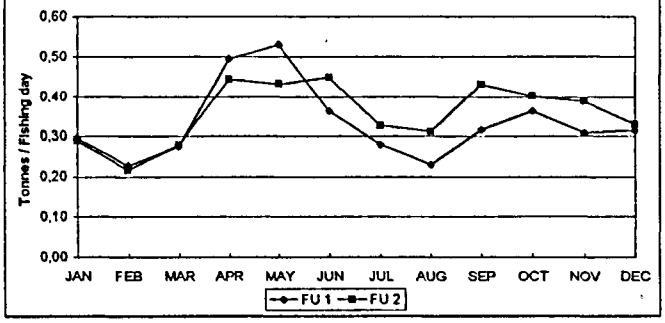


Figure 28 Average Seasonal LPUE from 1986 to 1995
(AREA: off German coast, German data only)

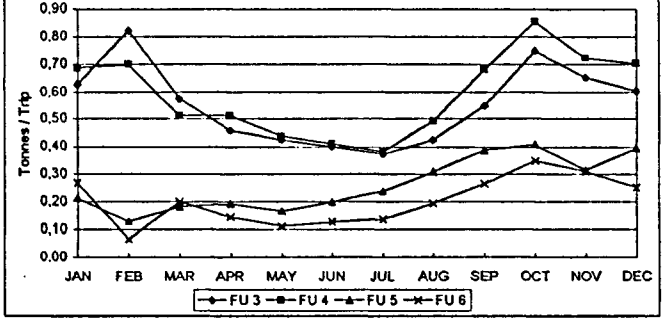


Figure 29 Average Seasonal LPUE from 1986 to 1995
(AREA: off English east coast)

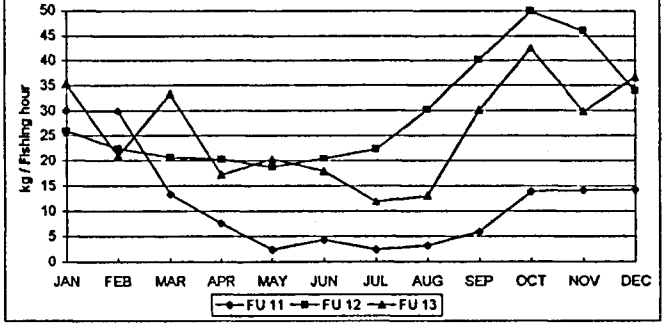


Figure 30 Average Seasonal LPUE from 1986 to 1995
(AREA: off English west coast)

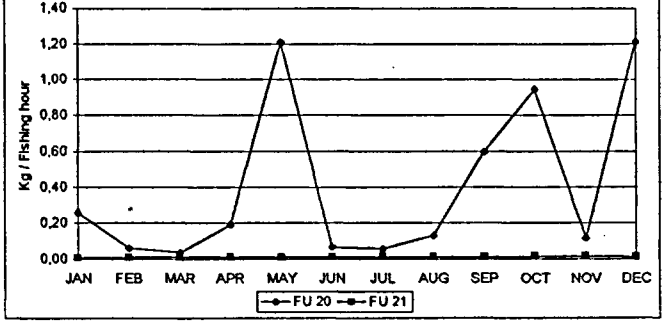


Figure 31 1995 Seasonal Landings in FU 1 and FU 2
(AREA: off Danish coast, Danish data only)

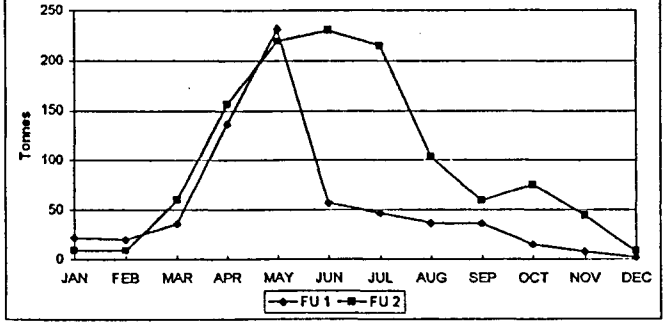


Figure 32 1995 Seasonal Landings
(AREA: off German coast, German and Danish data only)

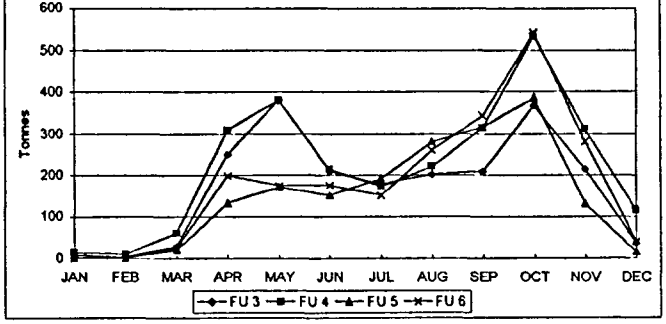


Figure 33 1995 Seasonal Landings
(AREA: off Belgian and French coast, Channel, Southern North Sea)

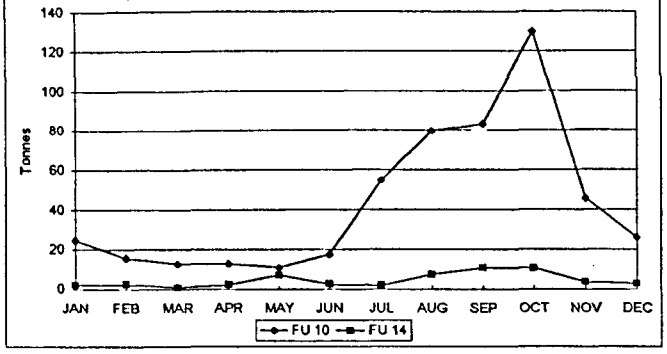


Figure 34 1995 Seasonal Landings
(AREA: off English east coast)

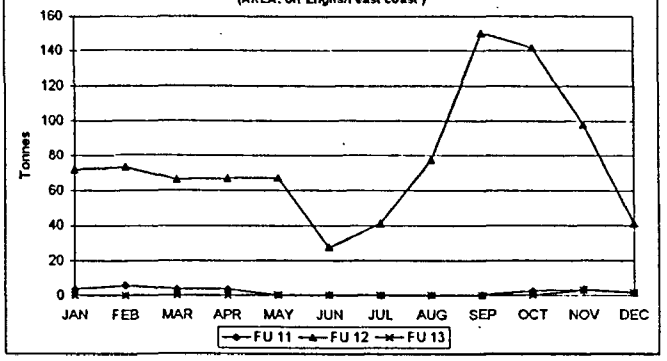


Figure 35 1995 Seasonal Landings
(AREA: off English west coast)

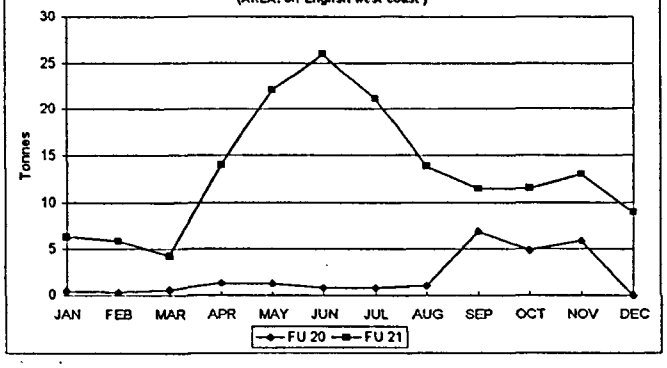


Figure 36 1995 Seasonal Effort
(AREA: off Danish coast, Danish data only)

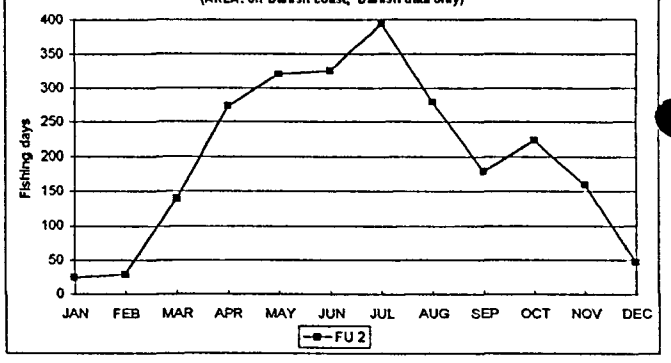


Figure 37 Average Seasonal Effort from 1986 to 1995
(AREA: off German coast, German data only)

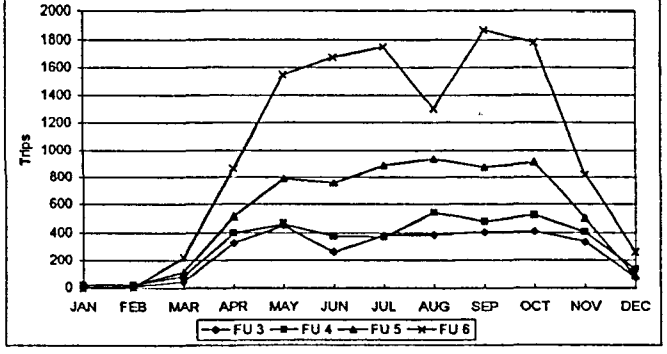


Figure 38 1995 Seasonal Effort
(AREA: off English east coast)

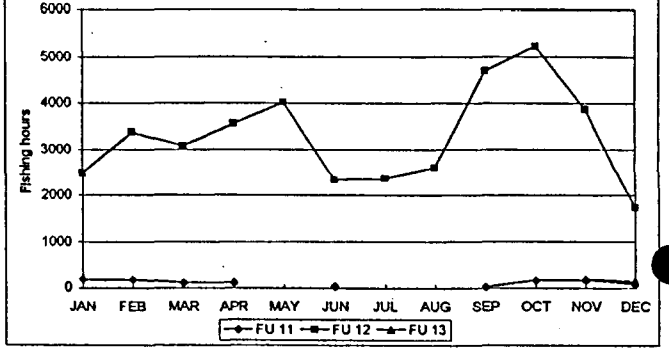


Figure 39 1995 Seasonal Effort
(AREA: off English west coast)

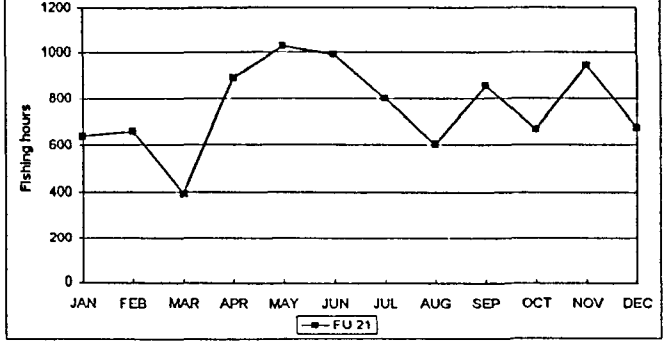


Figure 40 1995 Seasonal Effort
(AREA: off Belgian coast, only allocatable Belgian data)

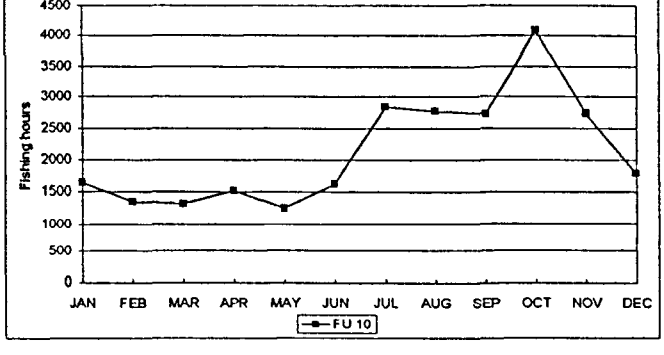


Figure 41 1995 Seasonal LPUE
(AREA: off Danish coast, Danish data only)

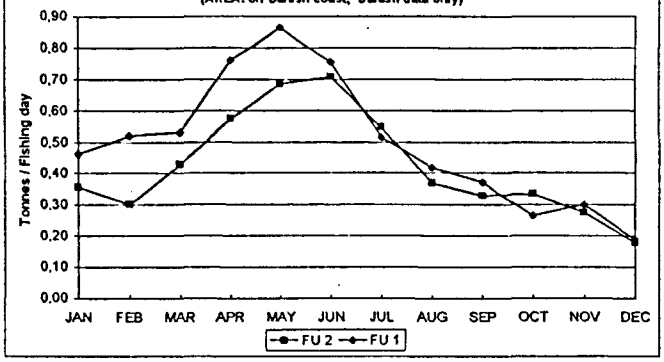


Figure 42 1995 Seasonal LPUE
(AREA: off German coast, German data only)

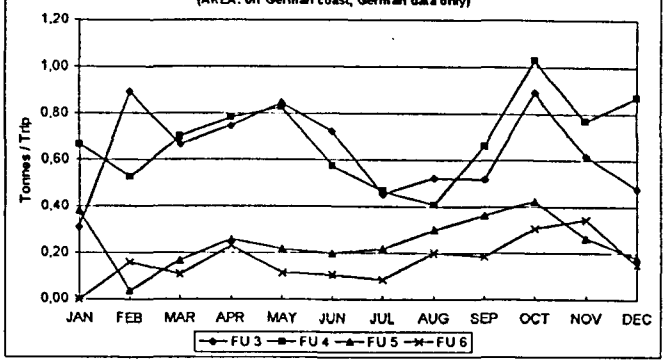


Figure 43 1995 Seasonal LPUE
(AREA: off Belgian coast, only allocatable Belgian data)

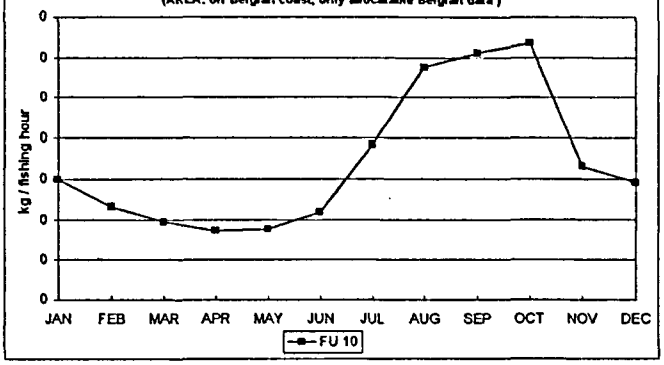


Figure 44 1995 Seasonal LPUE
(AREA: off English east coast)

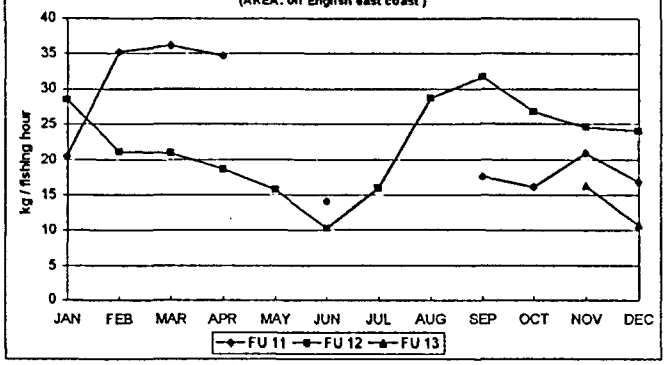


Figure 45 1995 Seasonal LPUE
(AREA: off English west coast)

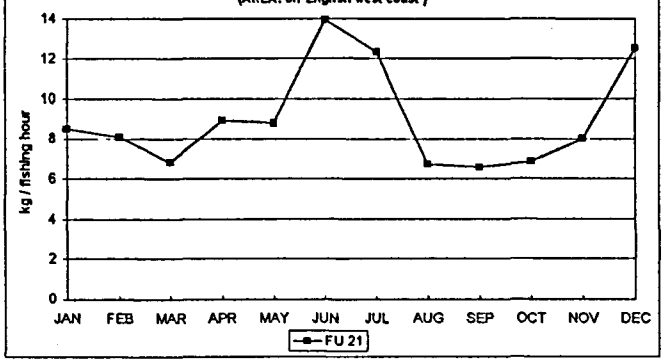


Figure 46 Long Term Landings of *C.crangon* in Europe and by Countries

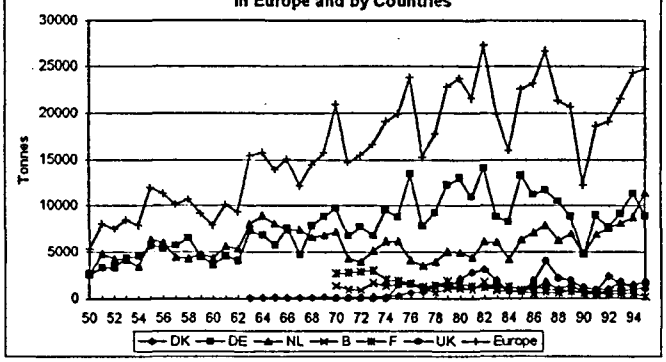


Figure 47 Long Term Effort on *C.crangon* by the Danish Shrimpers

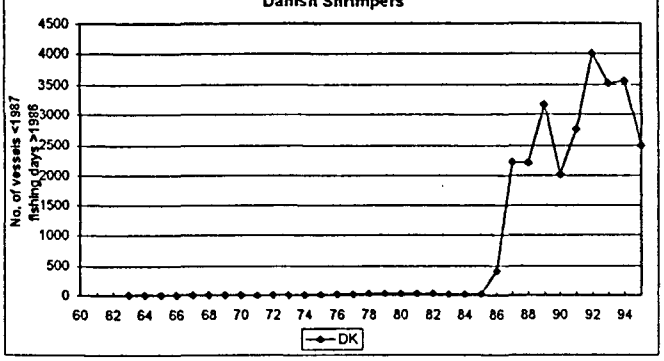


Figure 48 Long Term Effort on *C.crangon* by the German Shrimpers

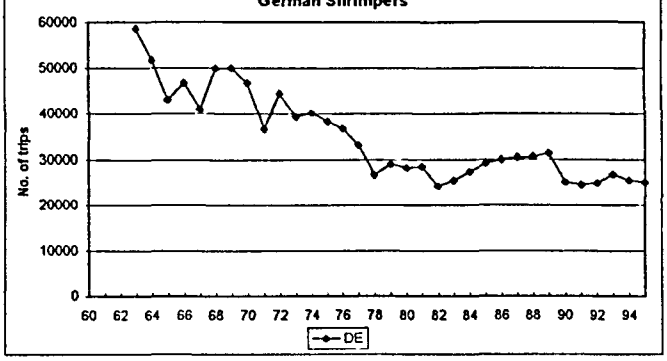


Figure 49 Long Term Effort on *C.crangon* by the Dutch Shrimpers

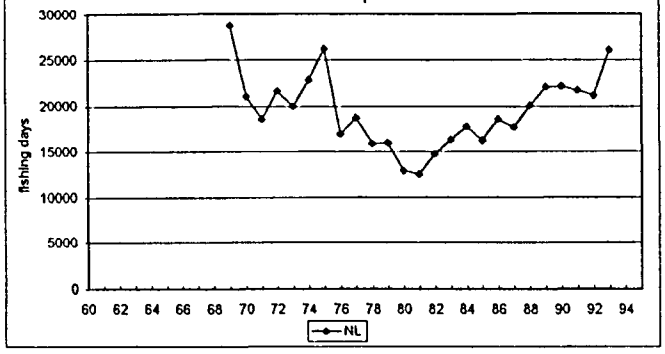


Figure 50 Long Term Effort on *C.crangon* by the Belgian Shrimpers

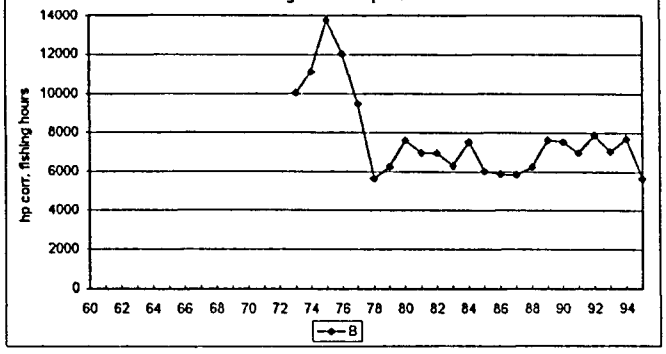


Figure 51 Long Term Effort on *C.crangon* by the French Shrimpers

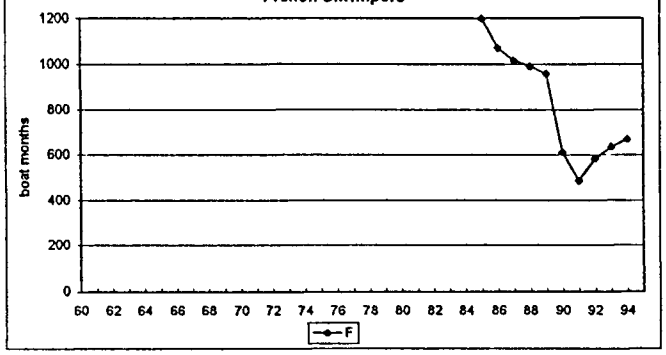


Figure 52 Long Term Effort on *C.crangon* by the British Shrimpers

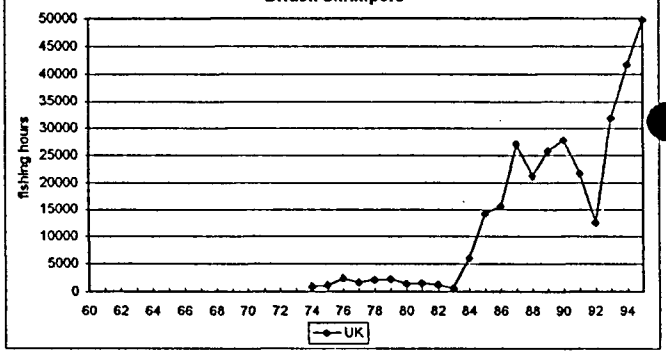


Figure 53 Long Term LPUE of *C.crangon* by the Danish Shrimpers

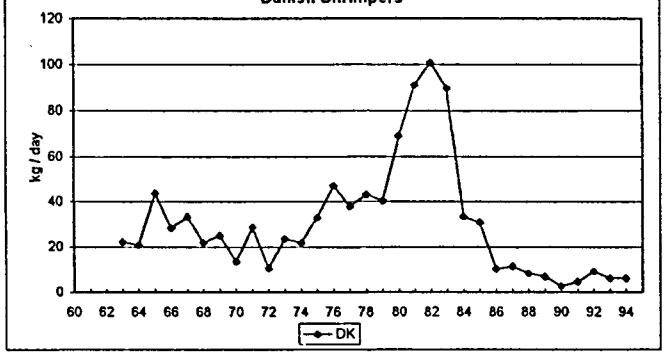


Figure 54 Long Term LPUE of *C.crangon* by the German Shrimpers

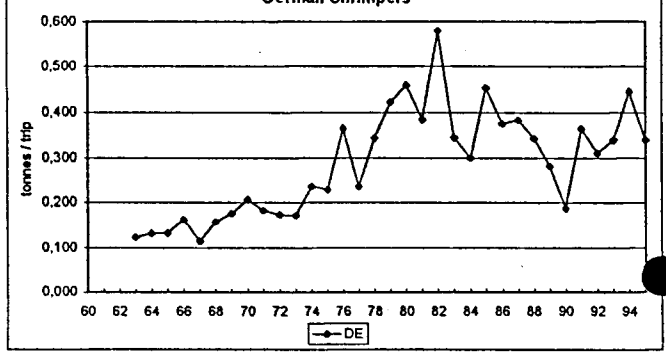


Figure 55 Long Term LPUE of *C.crangon* by the Dutch Shrimpers

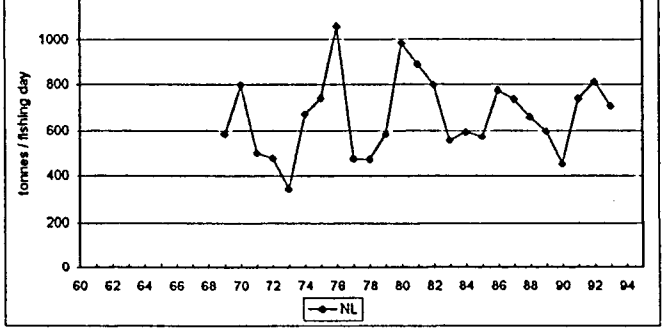


Figure 56 Long Term LPUE of *C.crangon* by the Belgian Shrimpers

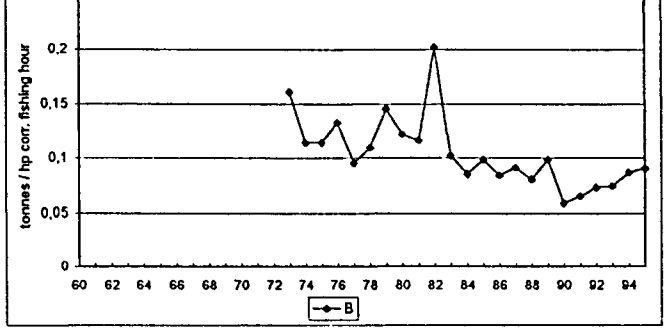


Figure 57 Long Term LPUE of *C.crangon* by the French Shrimpers

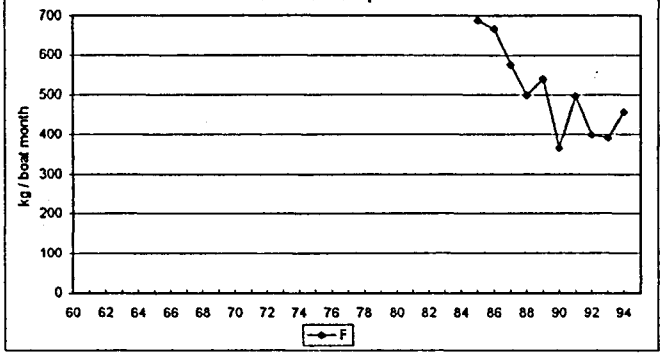


Figure 58 Long Term LPUE of *C.crangon* by the British Shrimpers

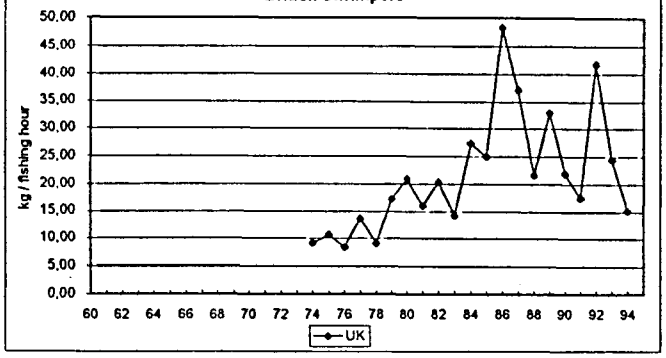


Figure 59 1995 and 10 years average seasonal landings of Danish shrimpers

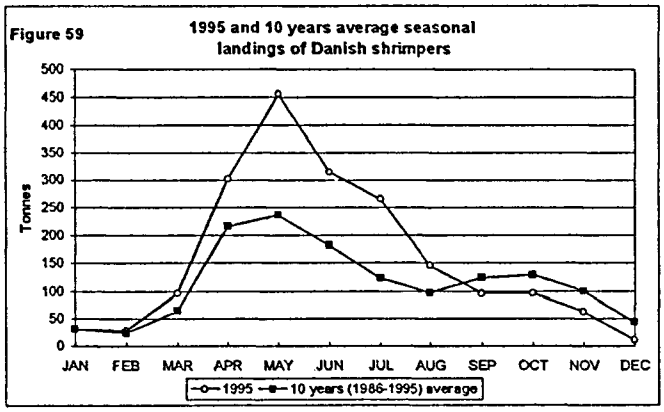


Figure 60 1995 and 10 years average seasonal landings of German shrimpers

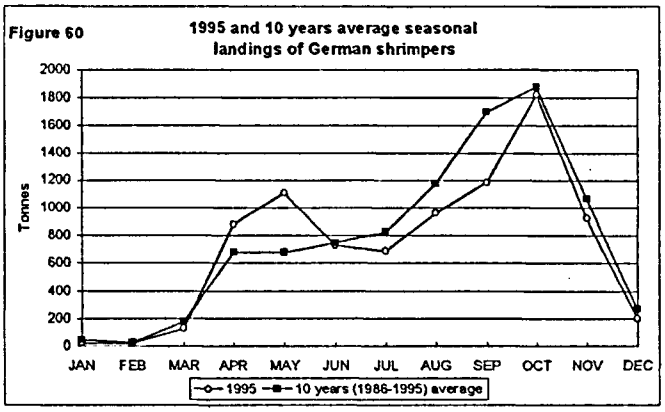


Figure 61 1995 and 10 years average seasonal landings of Belgian shrimpers

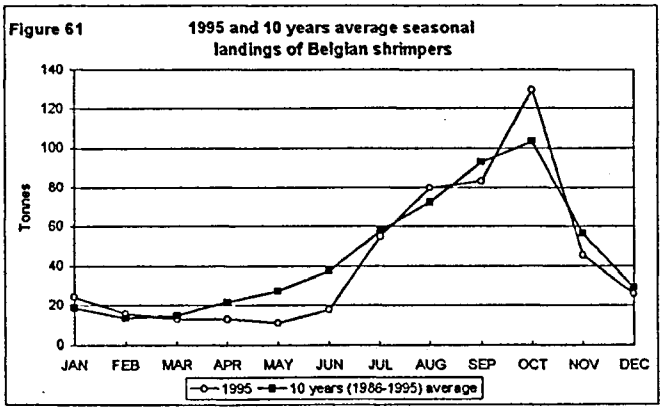


Figure 62 1995 and 10 years average seasonal landings of British shrimpers

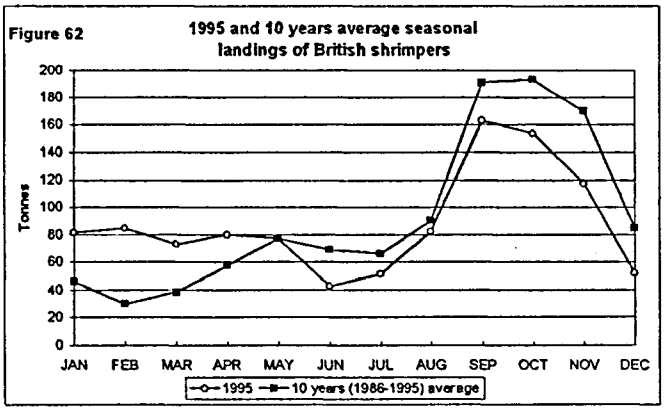


Figure 63 1995 and 10 years average seasonal effort of Danish shrimpers

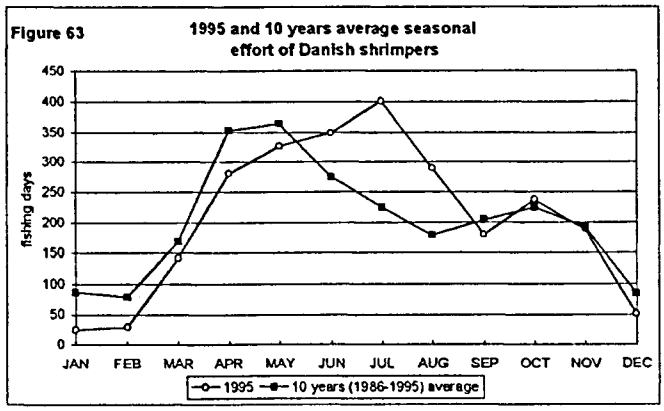


Figure 64 1995 and 10 years average seasonal effort of German shrimpers

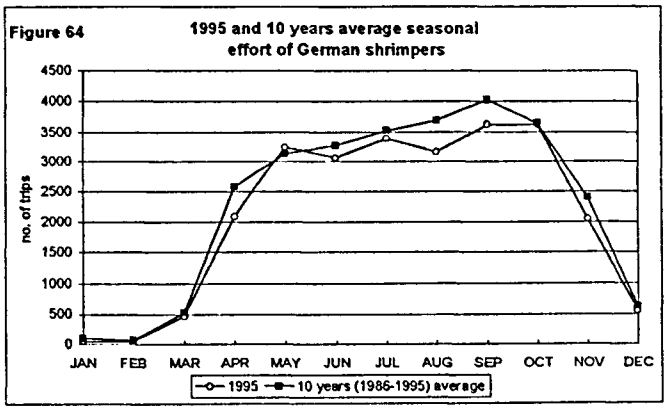


Figure 65 1995 and 10 years average seasonal effort of Belgian shrimpers

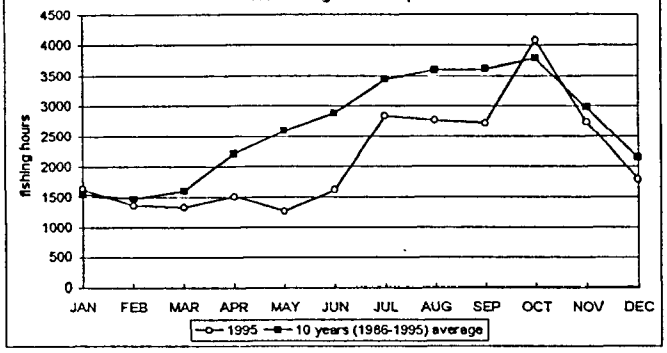


Figure 66 1995 and 10 years average seasonal effort of British shrimpers

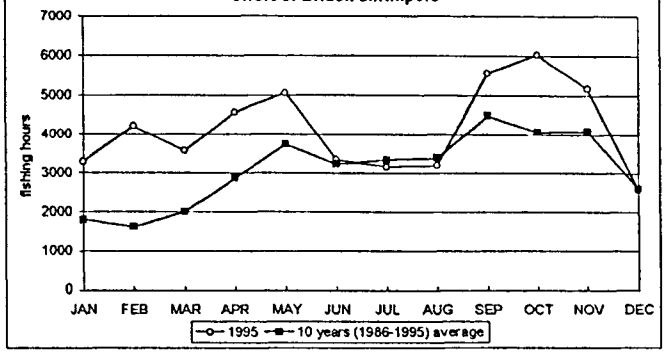


Figure 67 1995 and 10 years average seasonal LPUE of Danish shrimpers

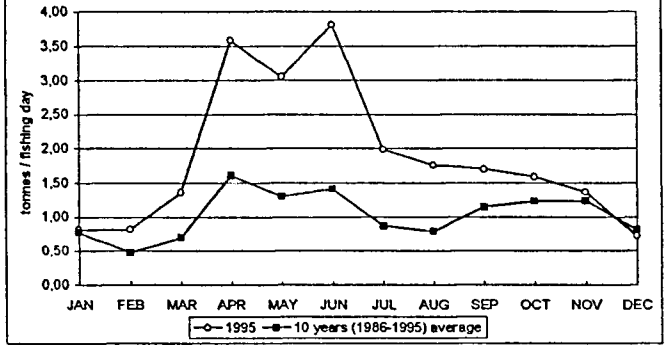


Figure 68 1995 and 10 years average seasonal effort of German shrimpers

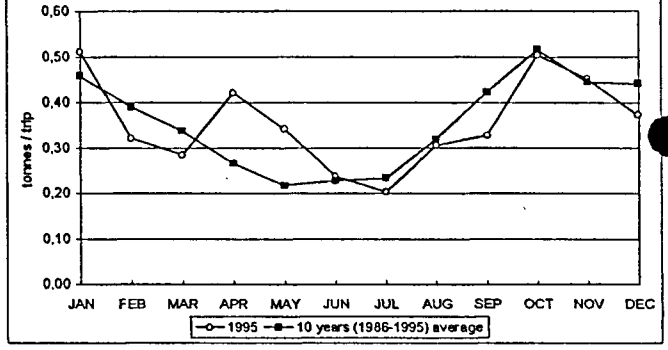


Figure 69 1995 and 10 years average seasonal effort of Belgian shrimpers

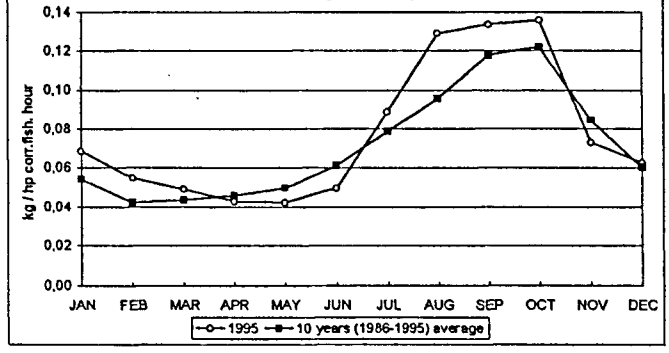
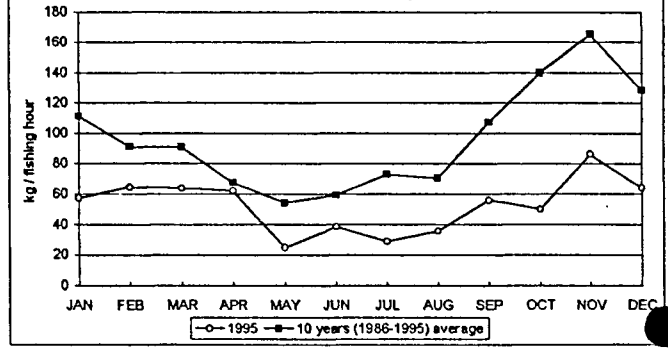


Figure 70 1995 and 10 years average seasonal effort of British shrimpers



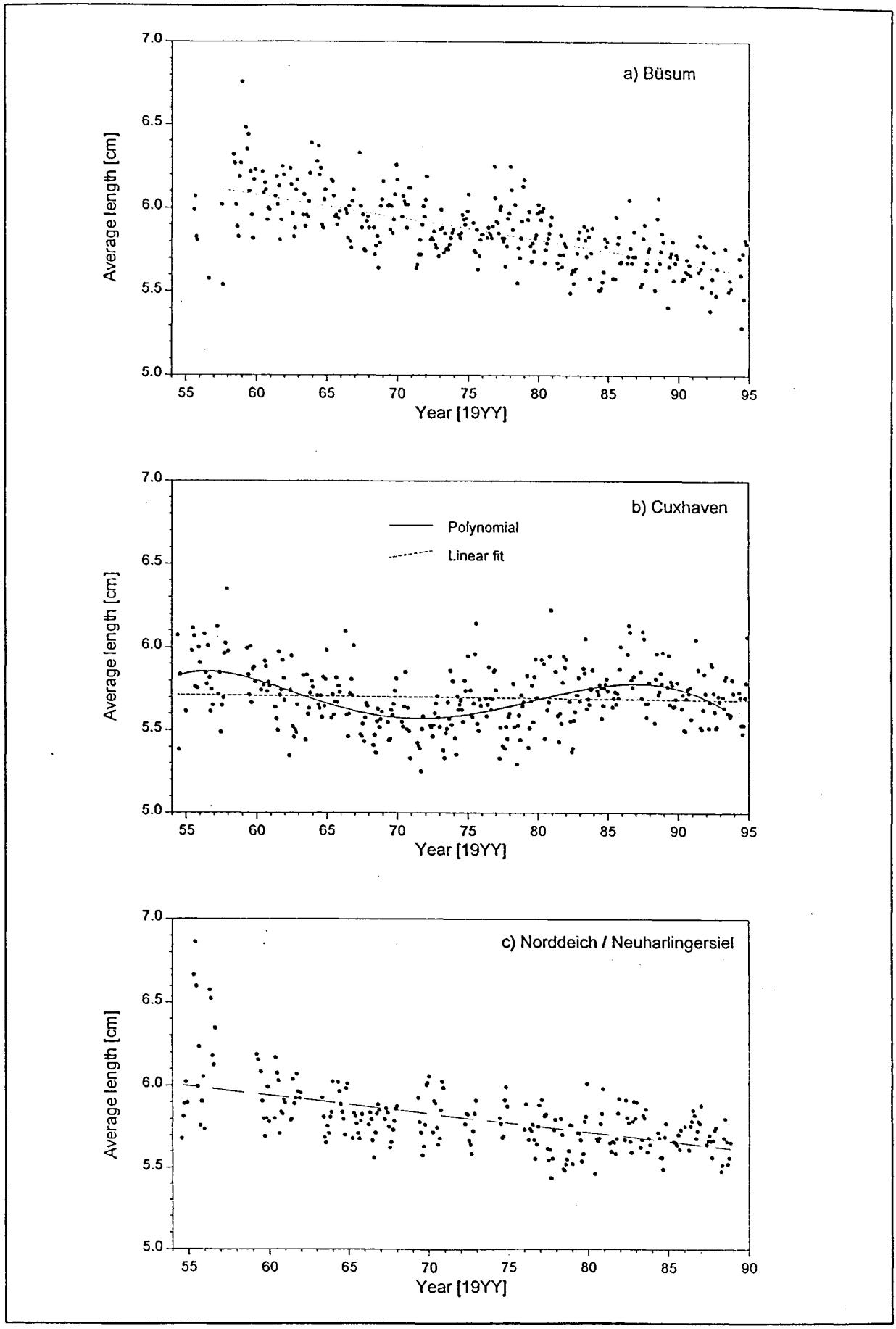


Figure 71: Monthly average lengths [cm] of shrimp >= 50 mm in unsorted samples from commercial catches from different sites. Linear trend lines fitted, smoothing polynomial fitted to the Cuxhaven series.

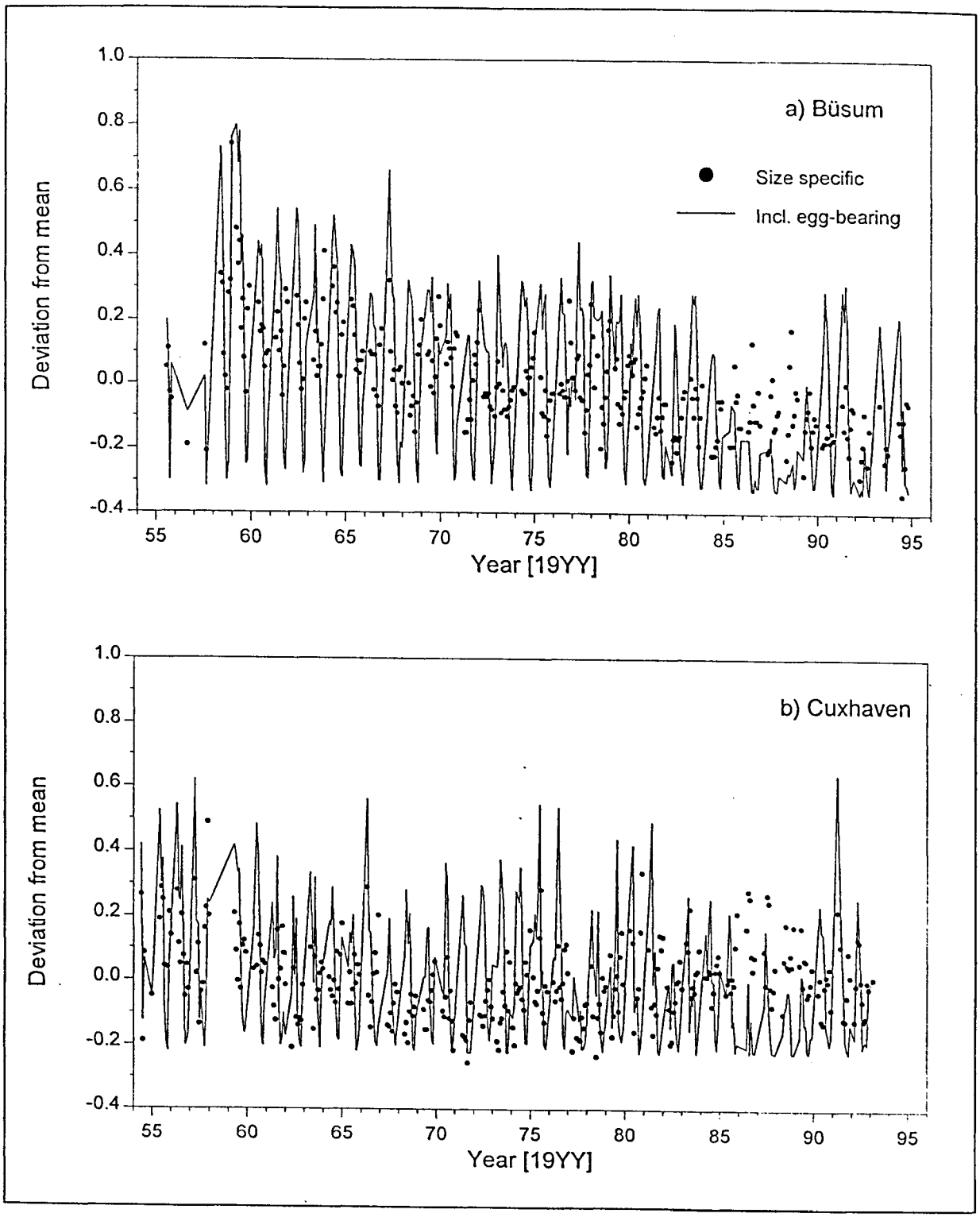


Figure 72: Monthly values (standardized to their respective means) of stock fecundity potential for samples from commercial catches from Büsum and Cuxhaven. Dots: Size-specific component, lines : potential regarding the observed fractions of egg-bearing at size.

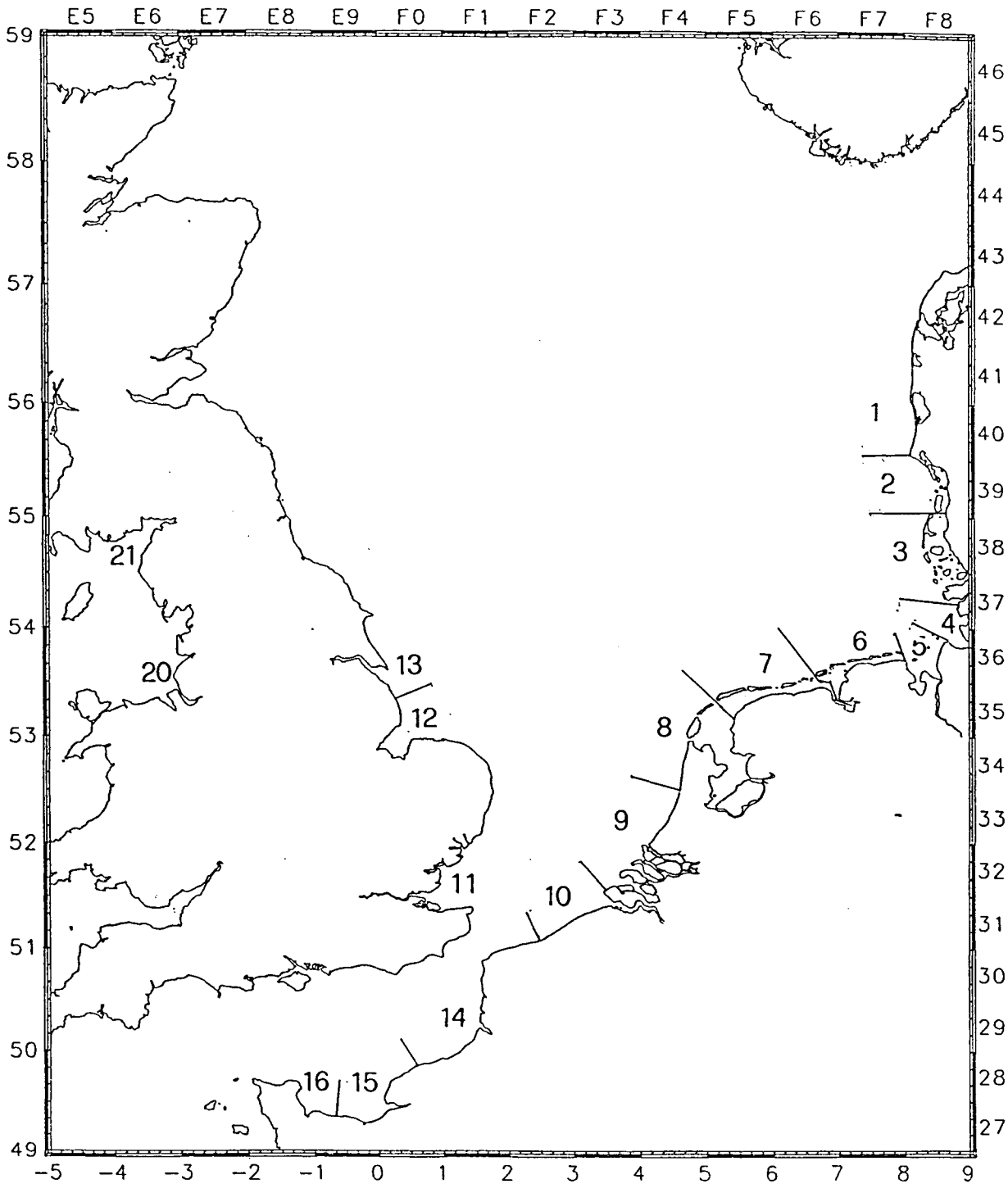


Figure 73a: Map giving the current definitions of Functional Units for the assessment of brown shrimp stocks (*Crangon crangon*) in European waters (see table 16)

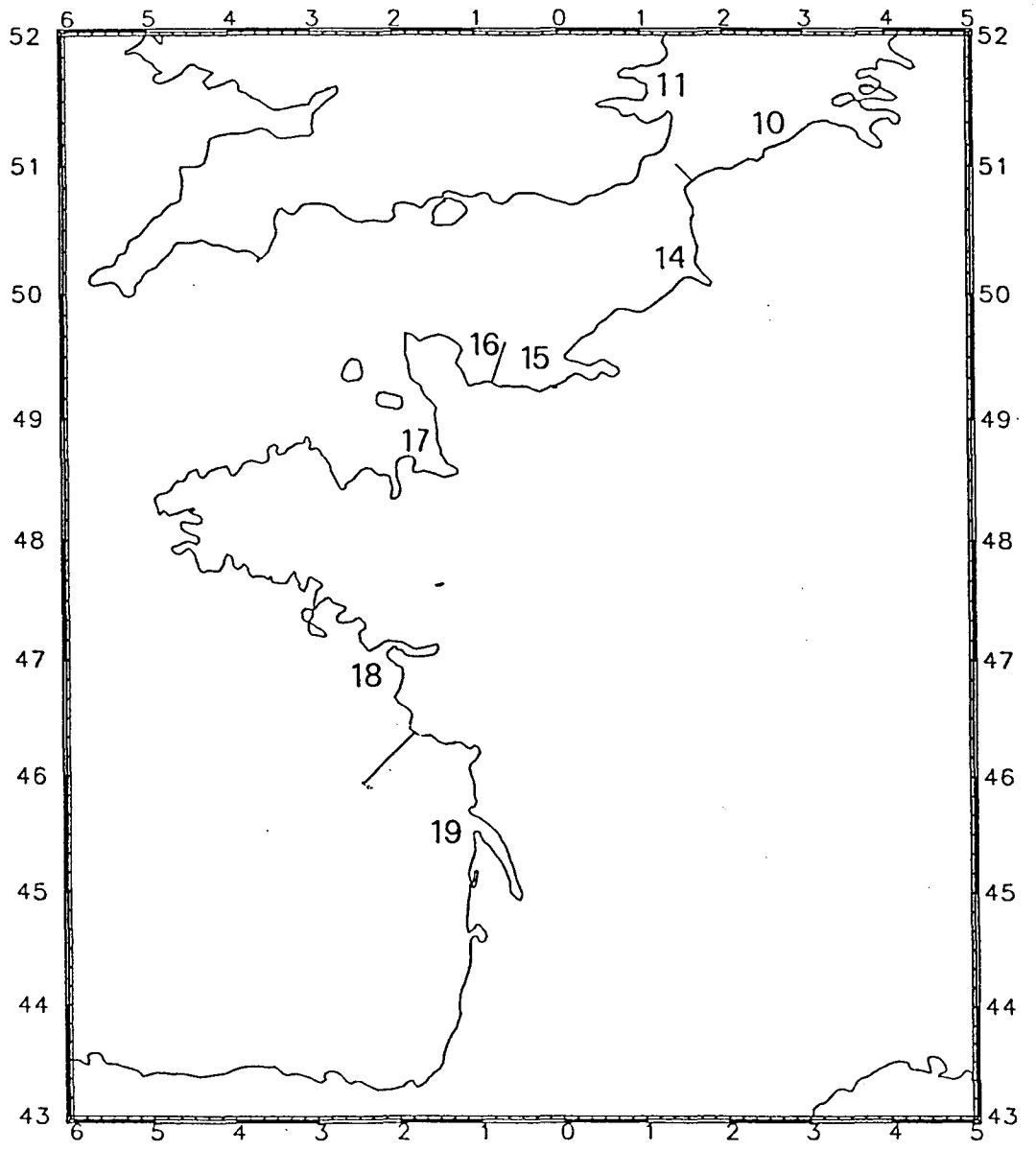


Figure 73b: Map giving the current definitions of Functional Units for the assessment of brown shrimp stocks (*Crangon crangon*) in European waters (see table 16)