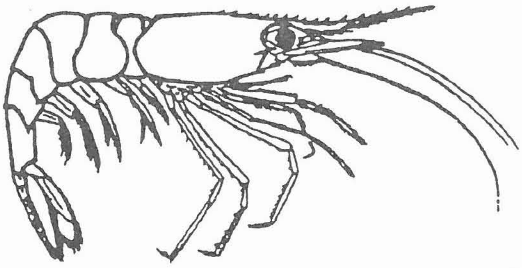
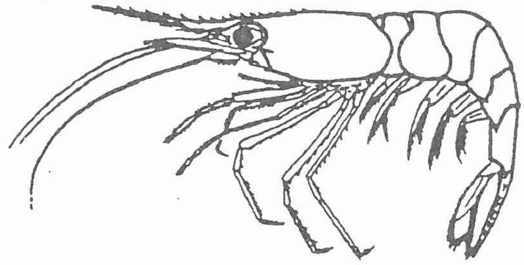
INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA
CONSEIL INTERNATIONAL POUR L´ EXPLORATION DE LA MER

C.M. 1993/Assess :11

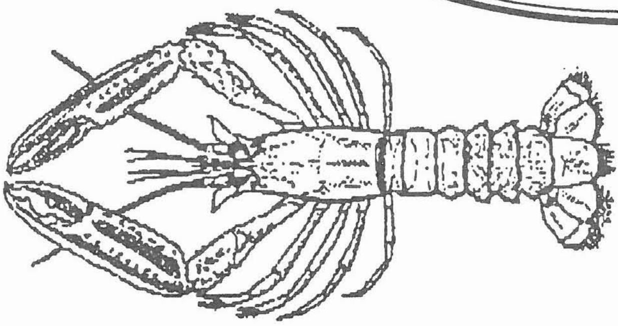
Part 1

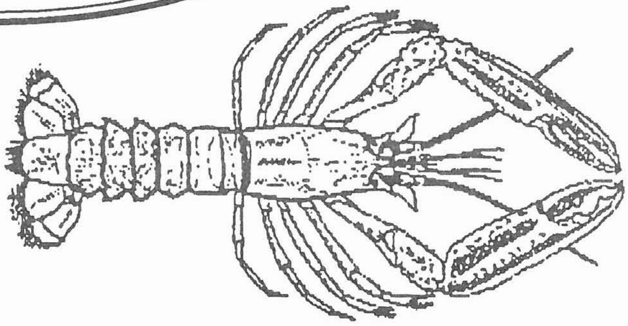




WORKING GROUP ON *Nephrops* AND *Pandalus* STOCKS

OOSTENDE, 24 FEBRUARY - 4 MARCH 1993





CONTENTS

1 TERMS OF REFERENCE AND INTRODUCTORY NOTES

The Working Group on *Nephrops* and *Pandalus* Stocks met in Ostende, Belgium from 24 February to 4 March 1993 to act upon ICES Council Resolution 1992/2:8:1 which states that the terms of reference will be to:

a) Assess the status of those stocks of *Nephrops* in the ICES area where new methodology or new data justify a new assessment;

b) Identify by stock the data requirements, including biological parameters, for assessments;

c) Assess the status of stocks of *Pandalus borealis* in the North Sea, Skagerrak, and Kattegat, if possible taking account of varying predation mortality;

d) Investigate the scope for correction of effort data and the improvement of effort indices.

The Working Group addressed each of the above terms of reference. The results and discussions are contained in Sections 3 to 6.

Section 3 provides an overview of input data and contains a table which presents 'shortfalls' in input parameter values and draws attention to data requirements (TOR b). This section also contains a discussion of the scope for correction of effort data and the improvement of effort indices (TOR d).

Section 4 provides details of the methods employed by the Working Group. Sections 5 and 6 present the assessment results and catch possibilities for *Nephrops* and *Pandalus*, respectively (TOR a and TOR c).

Section 7 highlights a number of subjects which the Study Group on Life Histories and Assessment Methods of *Nephrops* Stocks could take up. An agenda for investigations on *Pandalus* at the Study Group on Life Histories and Assessment Methods of *Pandalus* Stocks in the North Atlantic has already been drawn up.

Following the text section of the report, the Tables and Figures may be found for all sections. This year, four appendices are added which detail investigations on the methodological approaches employed in the assessment of *Nephrops*.

2 PARTICIPANTS

The following scientists attended the meeting of the Working Group:

M. Afonso Dias	UK, Scotland
N. Bailey (Chairman)	UK, Scotland
D. Bennett	UK,England
R. Briggs	UK, Northern Ireland
Ms A. Caramelo	Portugal
C. Chapman	UK, Scotland
C. Farina	Spain
P. Hillis	Ireland
Ms M. Thessalou-Legaki (part-time)	UK, Scotland
S. Munch-Petersen	Denmark
F. Redant	Belgium
B. Sjöstrand	Sweden
Ms C. Talidec	France
S. Tveite	Norway
M. Ulmestrand	Sweden

There was a communication from a non participant; R. Meixner, Germany, notified the Working Group that there were only negligible landings of *Nephrops* and *Pandalus* by German boats.

3 INPUT DATA AND BIOLOGICAL PARAMETERS

3.1 Introduction

Two terms of reference this year addressed aspects of input data, their availability, quality and usefulness; one (item b) related to biological inputs, the other (item d) to effort data. Following a full discussion by the Working Group it was decided that details of the availability and general quality of data should be included in the sections for each Functional Unit but that this section (Section 3) should also be included as an introduction to, and overview of, the data used by the Working Group. It was also felt that the specific question of scope for correction of the effort data properly belonged within this section. This section deals mostly with *Nephrops*; for the present, details of inputs for *Pandalus* assessments are contained within Section 6 which deals exclusively with this species. In the following notes some reference is, however, made to *Pandalus* for comparative purposes.

Assessments are complicated by certain aspects of the biology and life history of *Nephrops*. The inability to age them directly, their availability to capture being dependent upon emergence behaviour, and the heterogeneity of the populations, for example, all create assessment modelling problems. Until the recent introduction of TACs for some areas, statistics collection for *Nephrops* was not necessarily of the highest priority for national officials. Improvements in both biological studies and statistics collection are being reported to the Working Group.

Early meetings of the Working Group in the 1980s, before assessments were requested, concentrated on the biology of *Nephrops*. To complement the present Assessment Working Group a Study Group was set up to tackle aspects of the biology and assessments which the Working Group was unable to deal with. This Study Group reported in 1992 (Anon., 1992b) drawing attention to a number of topics which required further attention. The responsibility for improving the coverage and reliability of fishery statistics lies with the individual countries, as do the research requirements to improve the biological inputs. However, the Study Group does have an important role to perform in collating the existing data, making comparisons between areas, and advising on how to improve the statistics collection and the biological studies (see Section 7).

The quality of the fishery and biological data inputs varies considerably between the 31 functional units for which assessments are attempted. Some of the units have a long history of research studies which have yielded good quality fisheries statistics and biological knowledge. Others have only recent basic fishery data (sometimes only an estimate of landings) and depend upon comparison with similar units for biological inputs.

3.2 Fishery Data

All Functional Units considered have at least some data of this type. There are two types of data, landings and effort.

3.2.1 Landings

The readily available nominal landings provided by ICES are referred to in the chapter on *Pandalus* assessments but since these landings are aggregated according to major ICES boundaries which do not reflect the rather patchy distribution of *Nephrops*, they are not presented for this species. Instead landings information contained within Section 5 is provided by Working Group members and is based on the various national data collection services. Updated information was this year provided by participants for Units 3-31. Units 1 and 2, Iceland and Faroes, were not this year represented and updated information was not received.

The quality of this information is difficult to judge although it is known that for some countries at least, more care has been taken since the introduction of TAC management regimes.

Last year the subject of unreported landings was raised (Section 5; Anon.,1992a) and this year problems associated with 'black' landings and misreported landings were also discussed although it was not possible to quantify these or make a judgement on the extent of the problem. It is to be hoped that all countries will continue to attempt to collect representative landings statistics.

3.2.2 Fishing effort and scope for data correction

The Working Group conducted a full discussion on this topic (Term of Reference d) and attempted to identify for each FU the scope for correction of effort data and improvement of effort indices. The outcome from the discussion is summarised in Table 3.2.1. This lists for each FU and main fleets the units employed for effort recording, together with notes on the extent to which effort is directed at *Nephrops*, and the availability and use of vessel/gear characteristics for correcting effort data. Unfortunately, there was insufficient time at this Working Group to proceed further and consider particular data sets in detail and it was felt that this could be deferred to the next *Nephrops* Study Group meeting.

In most FUs, *Nephrops* trawling usually forms part of a mixed fishery with demersal fish and this complicates the recording of fishing effort. Various 'rules' are employed by countries in an attempt to separate *Nephrops*-directed trips, usually based on the relative weight (eg.FU 15) or value (eg. FUs 11-13) of the two components. To some extent past and present EC and/or national legislation on mesh sizes, permitted by-catch limits, multi-rig bans and one-net rules are tending to separate *Nephrops* fishing from demersal fish trawling. This trend could simplify effort recording in the future.

It is clear from Table 3.2.1 that data exist on vessel characteristics in most fleets and FUs, though this information is used infrequently to correct effort data, the exceptions being FUs 15 (N.Ireland), 16 and 25 (Spain). Although data exist for other fleets, it could be difficult to extract. There is also the question of how the information should be used to correct effort and CPUE indices, since a simple 1:1 relationship between catchability and particular vessel characteristics cannot be assumed. This topic requires further investigation along the lines of earlier studies (eg. Bundy, 1990; Large, 1992; Stewart *et al.*, 1993). Such studies could lead to major multi-disciplinary research projects in which collaboration between different countries could be beneficial.

In contrast to the amount of information available on vessel characteristics there is relatively little detailed information concerning the classification of fishing gear used in different FUs. Apart from the separation of multi-rig and single trawls by some countries (see Tables 3.2.2 and 5.6.3) and information on mesh size, other characteristics of the gears in use are seldom recorded. The study by Bundy (1990), described in last year's report (Anon., 1992a) showed that gear type was highly variable, even within a single fishery. Further studies of this kind are needed before the influence of gear and vessel parameters on catchability can be fully understood and allowed for in deriving effort indices.

Effort data are used in both the calculation of the abundance indices of CPUE and LPUE and are now used in the tuning process of the VPA. This year a tuning run was made for FU 11, using effort data 'corrected' for Horse Power changes. There is clearly more scope for trials of this type and this would form a suitable activity for the Study Group.

3.3 Length Compositions

In the absence of age data, length composition data provide the basis for making analytical assessments. Collection of these data is by the individual laboratories and sampling strategies have been mainly developed to meet local requirements and features of the fisheries. In some cases catch length compositions are collected, in others both landings and discard length compositions are monitored. Many of the Functional Units have at least some length data although they are still lacking for FUs 10, 18&19 and 30.

To evaluate the quality of data for each unit, use is made of a summary table (for example see Table 5.4.1) to provide a record of the length sampling programme for catch, landings, and discards by quarter for the last year and annually for the last 10 years. The introductory section of text for each Functional Unit is this year concerned with input data and its quality and contains comments on these tables.

Comparison of these tables reveals that sampling strategies can vary quite widely between Functional Units. In some cases rather few large samples are taken (Table 5.8.1), in others large numbers of small samples are taken (Table 5.15.1). Differences may reflect peculiarities in the way the *Nephrops* are landed in different places (for example in a series of 'categories'). Setting aside, however, the differences caused by practical considerations, a review of sampling is probably timely and if possible statistical analysis and simulation should be carried out to try to ascertain the benefits of different strategies for sampling populations with different characteristics (for example ones of a heterogeneous nature). This work could be addressed by the *Nephrops* Study Group with input perhaps from the Methods Working Group.

3.4 Biological Input Parameters

3.4.1 General comments

Discussion of input parameters centered on those biological parameters required to conduct the LCA and Slicing/VPA methods used at recent Working Groups; there was no discussion of parameters associated with mesh selectivity etc. For each Functional Unit it was decided to include details of the sources of the parameter values in use, whether these were based on observations, borrowed or assumed. Thus, for each FU, the second part of the data quality table contains information on discard survival rate and male and female growth, size of maturity, natural mortality rates and length-weight relationships; a short section of explanatory text is also included and, in line with an ACFM request, comments provided on the general quality and usefulness of the values.

By way of an overview of these input values, Table 3.4.1 summarises all the currently used values of the parameters listed above. In order to provide an illustration of where there are shortfalls in these data, Table 3.4.2 has been included. This indicates, for each stock and for each parameter, whether the value used is based on direct observation, borrowed or assumed etc. The Working Group hopes that this will help to focus attention on those areas of data collection requiring particular attention. It is quite clear from Table 3.4.2 and the tables in the individual sections that improvements in the quality of both the fishery statistics and the biological data are required to enable more complete and reliable assessments to be undertaken for many of the Functional Units.

A cursory examination of Table 3.4.2 shows that the type of data most universally available is that of weight-length relationships (and even for these rather basic data, some Functional Units rely on 'borrowed values'). As regards the more critical growth parameters there are fewer direct observations and mortality and discard survival values are mostly based on a consensus view (to maintain some consistency throughout assessments) with one or two key references providing some guidance. The following three sections provide some general notes on growth parameters, natural mortality and discard survival.

3.4.2 Growth

Figure 3.4.1 shows the male and female von Bertalanffy growth curves in use throughout the Functional Units. Each curve is described by one or more sets of K and L_{inf} values.

For most stocks, the males and females are dealt with differently. Male growth is described by one growth curve while female growth is described by two; the transition between the two occurring at the length of first maturity. Growth of immature females is similar to that of males so the male growth parameter values are used, while in mature females growth slows down markedly and 'mature' female parameter values of L_{inf} and K are used. This results in a characteristic 'joint' in the female growth curve. The broad principle of this difference is supported by, amongst others, the studies of Bailey and Chapman (1983), Chapman (1982), Tully *et al.* (1989) and more recently by the observations in France using radioisotope methods reported at recent Working Group meetings (Anon., 1991a and 1992a). The data summary tables provide details of the growth parameters and transition length. For some stocks (FUs 3,5,16,25 and 31) a single growth curve is used to describe female growth.

Many of the values used for the growth parameters (particularly those for stocks in Sub-areas IV and VI) derive from the growth studies in Scottish waters cited above. The range of these values is exemplified in the plot showing 'Fastest and slowest FUs 6-13' (Figure 3.4.1).

It is worth considering the rationale behind these values which are adapted from the comparative study of two populations in the Clyde and Sound of Jura (FU 13) described by Bailey and Chapman (1983). Predictions of growth rates for other stocks are based on postulated relationships between growth and the particle size composition of sediments (see for example Anon., 1988; Bailey et.al.,1986; Chapman and Howard, 1988). As an example of this approach the growth parameters for the North Minch (FU11) were revised at this Working Group on the basis of new information on the sediment composition of the grounds. Table 4.6.1 shows that the North Minch grounds comprise a mixture of different sediment types and growth rates can be expected to vary widely over the ground. Selecting the most appropriate growth curve is therefore difficult. Since the relative proportions of different sediment strata in the North Minch appear to be rather similar to those on the Clyde grounds (Table 4.6.1) higher values for L_{inf} seem more appropriate. A full consideration of Scottish growth parameters, including the rationale behind the use of two growth curves for females, was given in an earlier Working Group Report (Anon., 1989).

3.4.3 Mortality

In common with many other species there is very little information on natural mortality rates in *Nephrops*. Morizur applied catch curve analysis methods to length composition data from 'unexploited/quasi exploited' stocks in order to estimate M. These results were reported in Morizur (1982) and have been widely used since then by the Working Group. For most FUs the input data table contains a value of 0.3 for M in males (and immature females) based on Morizur. A value of 0.2 on mature females has been adopted on the grounds that the reduced emergence of ovigerous females for much of the year reduces predation on them. This idea is supported by the generally lower total mortalities shown by the various assessments in most Functional Units.

Theoretical studies by Jones compared LCA estimates of stock size under different values of M with direct estimates of population density in order to try to 'tune' the value of M (Anon., 1980). This subject is alluded to in Section 4.

3.4.4 Discard survival rate

Unlike fish, not all *Nephrops* discards are killed by the fishing and on deck handling process. This implies that some estimate of discard survival is required in order to estimate the true removals (removals = landings + dead discards) from the stock.

The estimation of discard survival is a complex problem since many factors are involved. The work which the Working Group relies upon is that of Guéguen and Charuau (1975) who examined discard mortality in the Bay of Biscay (FU 23&24). Mortalities were assessed on deck and in submarine cages. The value obtained was close to 25% survival and this figure has been used for almost all FUs.

It is clear that more work is required on this subject.

4 METHODS EMPLOYED IN THE ASSESSMENT OF STOCKS

A range of methods were employed at this Working Group and these are described in this section. It should be noted that not all methods were applied to all stocks; Section 5.1 summarises the assessment methods applied to each stock.

Developmental work on *Nephrops* assessment has recently concentrated on the methods used. In this section reference is made to a series of appendices to the report which deal with various aspects of the methodology of assessment.

4.1 Examination of Trends in Fishery Data

As in previous Working Group reports, use is made of the trends in fishery data (landings and effort) to provide a picture of developments in both the *Nephrops* and *Pandalus* fisheries; the approach is purely descriptive. Rather more attention is once again paid to the indices of abundance, catch per unit effort (CPUE) (where available) and landings per unit effort (LPUE). Again the approach is of a descriptive nature using trends in the data to provide a crude assessment of the stock. For *Nephrops* the abundance indices data continue to be an important element of the assessment despite, in some cases, reservations about the usefulness of the effort series (see Section 3.2.2).

4.2 Other Uses of Catch (or Landings) and Effort Data

At the 1991 Working Group (Anon., 1991a) the idea was introduced of using relationships between landings and effort as a basis for making predictions of likely landing levels; this approach is again mentioned below (Section 4.7). For one stock, however, (FU3 see section 5.6) a plot of this type using a more complete data set than in previous years produced a scatter of data with a distinct dome shape reminiscent of the type which are exploited by the 'surplus production' approach to assessment.

It was at first thought that this should be used predictively but recent reviews of the subject, including that by Hilborn and Walters (1992) (in which they describe the models as 'biomass dynamic') suggested that this would be premature and that erroneous results would be obtained. The basic problem is that plots of this type are rarely representative of a stock in equilibrium even though that is a fundamental assumption in the model.

It was decided on this occasion to point out the potential for further investigation utilising some of the more recent methods of analysis described in Hilborn and Walters (eg 'difference' and regression models and observation error/ time series fitting methods) which do not make the same assumptions. It is recommended that the *Nephrops* Study Group take this up.

4.3 Making Use of Length Data Directly

4.3.1 Trends in mean size

As in previous years, trends in mean size were examined for *Nephrops*. Reservations about the usefulness of these include, for landings length compositions, problems associated with market trends which can cause fluctuations in the sizes landed that have nothing to do with the state of the stock itself. An additional consideration affecting all length distributions is that that quite dramatic changes in fishing effort produce only rather small changes in mean size (Anon., 1991a). It would probably be worth the Study Group investigating whether other parameters of the distributions (eg the upper quartile) better indicate changing condition of the stocks.

4.3.2 Length cohort analysis

The method used was that of Jones using the program implementation described in Anon. (1991a).; there were no new technical developments in this method.

This year, some LCA assessments were based on relatively short reference periods owing to changes in fishing effort which prevented the use of longer periods. From the converged parts of more 'successful' VPAs (see below) it appears that a characteristic of *Nephrops* populations is relatively constant recruitment levels from year to year. In these circumstances the use of quite short reference periods seems justified. Some interesting results were again obtained where comparison was made between LCAs of two time periods.

4.4 Conversion of Length Data to Age

4.4.1 Deconvolution

As in previous Working Groups, *Pandalus* quarterly length distributions were deconvoluted into putative age groups using the Elefan implementation of the Bhattacharya (1967) method. This method is not suitable for most *Nephrops* populations.

This year a study was carried out on *Nephrops* commercial sample data from the Republic of Ireland using the MIX program of MacDonald and Pitcher (1979). The results of this are reported in Appendix 1. The data for this study were characterised by having a somewhat restricted overall length distribution with some evidence of visible modes. It was possible to exploit these features to come up with reasonable age compositions. Further studies are required although it is noteworthy that the exercise was extremely time consuming and may not prove suitable for extensive data sets with many samples.

4.4.2 Slicing

As in 1992, pseudo age-based assessments carried out on some *Nephrops* stocks were made on 'age compositions' derived from slicing length compositions in a 'knife-edged' manner as described previously (Anon., 1991a and 1992a). There were no developments in this technique.

4.5 VPA

There were two VPA programs used by the Working Group.

4.5.1 Lowestoft tuning package

The standard Lowestoft Tuning Package (PC version) was employed for the assessment of *Pandalus*. There were no significant changes and the approach was as in 1992 (Anon., 1992a).

4.5.2 Slicing/VPA method developed in Aberdeen

The slicing/VPA method described before (Anon., 1991a and 1992a) was again used and there were no significant changes to the program implementation.

At the last Working Group (Anon., 1992a) and in the Report of the Study Group on *Nephrops* (Anon., 1992b) it was pointed out that sensitivity analysis of the method and validation of the results would be worthwhile exercises. This year two studies were carried out which addressed these issues.

Appendix 2 describes a study in which the sensitivity of the method to input growth parameter values was investigated. Results suggested that although variation in parameter values produced profound changes in the magnitude of outputs such as Fbar, N at age and recruitment, the trends in the results were broadly the same. These results were encouraging and further analysis using methods such as FAST (Bailey and Kunzlik, 1989) would be beneficial.

Appendix 3 presents a preliminary simulation study in which the slicing/VPA method was applied to catch data from various types of simulated population and the results compared with the 'true' population characteristics to see how well the method recovered these. Results were encouraging with trends in Fbar and recruitment present in the simulated populations, evident in the VPA results. For this type of validation of the method there is scope for a more rigorous approach; the *Nephrops* Study Group affords an opportunity for this although expertise from members of the Methods Working Group would be extremely helpful.

4.6 Other Approaches

In the report of the *Nephrops* Study Group, the need for fishery independent data was pointed out, both for direct estimation of stock abundance and in order to provide constraints for analytical assessments. Some aspects of these data were used at this Working Group meeting.

4.6.1 Stock surveys

Since *Nephrops* are relatively sedentary in habits, and usually distributed in discrete patches governed by the occurrence of suitable mud sediments, there are ways of assessing the stocks which do not require extensive fishery data. One such method is the estimation of seasonal larval production from a series of plankton surveys. This information, together with fecundity, sex ratio and maturity data, can be used to estimate the abundance and biomass of the spawning stock. This method has been used to estimate stock biomass in the Irish Sea (Nichols and Thompson, 1988), the Farn Deeps (Milligan and Nichols, 1988) and the Clyde (Smith, 1987).

Another approach is to use underwater TV and photographic cameras to estimate the density of *Nephrops* burrows (Bailey and Chapman, 1983; Chapman, 1985). This method has been used recently to calculate stock abundance and biomass on the Fladen ground. Full details are given in Section 5.8 and Appendix 4.

4.6.2 Areas of mud and effort/landings per unit area

An essential ingredient for the abundance calculations on the Fladen Ground was an estimate of the area of sea bed over which the *Nephrops* stock was distributed. This was based on the area of muddy habitat derived from sea bed sediment charts published by the British Geological Survey (BGS). These charts are available for most waters around the UK and reasonable information is now available on ground area and distribution for most *Nephrops* stocks in the region. It is worth noting that the level of sampling on which the sediment charts are drawn up is considerably higher than that for the population data, so that considerable confidence attaches to the areas. Estimates of ground area for Scottish stocks are given in Table 4.6.1. This information can be used to derive landings/area and effort/area indices which may be considered as a measure of the 'fishing pressure' on a stock. Trends in these indices for the main Scottish stocks are shown in Figure 5.4.7. These indices can provide useful additional information when comparing the present state of stocks (see Sections 5.4, 5.7, 5.8 and 5.10.2).

An estimate of stock abundance from larval or TV surveys could also be useful as an independent check on the results from analytical assessments. The LCA and VPA both provide estimates of the numbers of *Nephrops* in a population and these can be converted to density when the area of the ground is known. This approach was applied to some stocks at previous *Nephrops* Working Groups (Anon., 1980; 1990a) and was used by Jones (1979) to set limits on certain input paramaters. For a recent example, consider the LCA and VPA outputs for the Firth of Forth stock, given in Section 5.10. Estimates of *Nephrops* population numbers are given by summing male and female numbers per length (LCA) or age group (VPA) (Tables 5.10.25, 5.10.26, 5.10.30 & 5.10.35). The density calculations are set out in the text table below:

	LCA	VPA
Ref. period	1989-1992	1989-1991
Av. nos. ('000)	729,998	771,729
Area (km^2)	992.7	992.7
Density (N/M^2)	0.73	0.78

The estimates given by the two methods of analysis are consistent and are considered to be of the right order of magnitude for this stock.

The BGS sediment charts also provide information on the composition of sediments on the grounds. Muddy sediments are classified in three bands, according to the relative proportions of sand, silt and clay particles, as muddy sand, sandy mud and mud (see key in Table 4.6.1). As Table 4.6.1 shows, the relative proportions of these sediment strata vary from ground to ground. This is potentially useful information in choosing input parameters for the assessments since there is some evidence that *Nephrops* growth, maturity, size composition, and possibly recruitment, may be linked in some way with the sedimentary environment. Where direct measurements of these parameters are lacking for a stock, it may be possible to use sediment information to predict reasonable values. The adoption of this approach in estimating growth parameters for Scottish stocks was mentioned in Section 3.4.2. A major problem with this approach may arise when a *Nephrops* stock is distributed across a range of different sediment bands. This is the situation on the West coast of Scotland (FU's 11-13) and at Fladen (FU 7), whereas for the Moray Firth and Firth of Forth, the area of *Nephrops* distribution consists mainly of one type of sediment (Table 4.6.1). Where sediments are variable the choice of suitable input parameters is likely to be difficult, and achieving adequate and representative sampling coverage of the landings and discards becomes more problematical.

4.7 Catch Predictions

Three methods were used to make predictions of suitable catch options. The choice used for each FU depended on the quality of the assessments and the effort data available.

Where the 'age'-based VPA appeared to perform well, a short term prediction along finfish lines and described for the Firth of Forth last year (Anon., 1992a) was carried out. The main difficulty in making this type of prediction was the lack of any recruitment index. It has already been pointed out , however, that from VPA estimates at least, recruitment in *Nephrops* appears to be fairly constant so average values were input for the prediction years. For the 2nd and 3rd prediction years (in this case, 1994 and 1995) a range of effort multipliers were included. In the final presentation of options, however, only the *status quo* and +/- 20% options were quoted.

Short-term predictions of the type described above were, as usual, made for *Pandalus*; in this case a recruitment index was available.

For *Nephrops* stocks where the VPA did not perform well but where there was a good relationship between landings and effort, then predictions were made based on a regression relationship between these two; this technique was described in 1991 (Anon., 1991a). Catch options were calculated for the *status quo* situation based on average effort for the reference period of the most recent LCA (in most cases) and again the predictions for +/- 20% of this effort level were also made.

For stocks where the relationship between landings and effort was poor (or where there were no effort data available), then an option based on mean landings for a reference period (usually that of the most recent LCA) was calculated. Additional options based on values +/- 20% of the mean were also included, although it is important to note that these limits are not necessarily the same as those derived from effort limits of the same magnitude.

In some cases the calculations involve the incorporation of the most recently updated effort or landings figures, a practice which was last year criticised by ACFM on the grounds that it could lead to a steady upward ' drift' in the recommendation. The Working Group wishes to point out that examples are included this year where the opposite is the case, ie. the recommendation leads to a drop in landings (see for example Section 5.10.1 or 5.13.1).

4.8 Judging the Status of Stock

As before it was decided that most attention should be paid to the male component of the stock since in most cases this was perceived as the most vulnerable component and since most assessments of females suggested that F was generally low and the stock was not overexploited.

With this in mind the full range of information was taken into account in making a judgement. For stocks where the VPA appeared to perform well this was used to give some idea of trends in the stock. In other cases the shape of the LCA Y/R curve was considered and trends in fishery data (such as CPUE) were also considered. There was no attempt this year to use as a basis for the judgement the same pieces of information for all stocks; each one was dealt with on the merits of the assessments applied.

4.9 Future Developments

There are a number of developments which could be incorporated in the future. In addition to those items already identified as work for the Study Group, these future developments could also be added.

In the first instance an 'age-based' long term prediction along Y/R lines would be useful, both for the *Nephrops* and *Pandalus* assessments. For the latter it may be possible to develop a quarterly based model.

A second area of investigation is in the treatment of males and females. For analytical assessments the sexes are dealt with separately, yet in examining CPUE and LPUE trends they are mostly dealt with together. The experience in the Botney Gut (Functional Unit 5) is that more meaningful comments can be made by dealing with the sexes separately at all stages and this should be encouraged. Again the Study Group is a forum where recalculated data could be examined and discussed prior to including this information as routine.

5 ASSESSMENTS AND CATCH POSSIBILITIES FOR *NEPHROPS*

5.1 General Introductory Notes

5.1.1 Functional units and management areas

The Functional Units are defined by the groupings of rectangles given in Table 5.1.1 and illustrated in Figures 5.1.1 to 5.1.3. There were no changes to the descriptions given last year (Anon., 1992a)

The Management Areas have been described using, as far as possible, existing ICES Sub-area and Division boundaries. The main difficulty in keeping to this aim was in Divisions IVa, IVb,c, and VIIa/VIIg. The Management Areas are described, together with the Functional Units they contain, in Table 5.1.2, and are shown by ICES Sub-area, Division and/or Working Group boundaries in Figures 5.1.1 to 5.1.3

The Working Group notes that current TACs are set for rather large areas based on ICES Sub-areas or divisions. The Working Group wishes to reiterate its view that *Nephrops* are more appropriately managed at a smaller scale. It is aware that management at the individual unit level is probably impracticable but again recommends that the Management Areas described are adopted. Specific examples of potential problems inherent in the current system are:

i) Sub-Area IV North Sea: The rapidly developing Fladen Ground fishery could cause problems for other fisheries within the North Sea under the existing single TAC arrangement. It is conceivable that the TAC could be taken early from this ground prior to the full potential being realised on other grounds.

   The opposite of this is also a potential problem, ie that effort towards taking the North sea TAC could be directed disproportionately at some of the Functional Units (eg Firth of Forth and Farn Deeps) where in fact effort limitation is desirable.

ii) Sub-Area VII: In this area the TAC covers a large area and offers no restrictive effect for some of the fisheries contained within it.

5.1.2 Assessments

Table 5.1.3 summarises the types of assessment carried out for the different Functional Units and gives some idea of the general 'quality' of these assessments. A column is also included to show the nature of the prediction method employed for each stock.

As in 1991, assessments were conducted on males and females separately, these frequently gave rather different results. The reasons for adopting this approach have been discussed before (Anon., 1991a) and are based on the greater availability and probably vulnerabilty of males. Combined assessments would mask any problems in one or other of the components.

Once again full details of tuning output have been excluded from the Report although with the more widespread use of the 'age'-based approach these diagnostics will be included in the future. Tuning inputs are summarised in Table 5.1.4.

5.1.3 Management considerations; provision of catch options

There are one or two general considerations related to the presentation of recommendations etc. Firstly, it seems unlikely at the present time that any of the *Nephrops* stocks under consideration are in imminent danger of collapse (although for three, FUs 6, 8 and 13, there is slightly more concern). There remains, however, concern that effort transfer from other fisheries could be detrimental. Consequently, most catch options recommended are of the *status quo* type.

In line with ACFM's directions, the Working Group has offered a recommendation for most stocks which is based on a collective discussion made in the light of the assessment results and their quality, and also bearing in mind the quality of the input data and parameter values and any special considerations relevant to the Functional Unit in question.

In offering catch options the Working Group is aware that these may not be the most desirable method of controlling the levels of effort on *Nephrops*. A more satisfactory approach would be to attempt to control effort directly and the Group would urge that possibilities for this be investigated.

Where other management measures appear to be appropriate these have also been mentioned although no attempt has been made to provide specific advice on these issues.

5.1.4 Section layout

The remainder of the stock assessment section (Section 5) is organised according to Management Area and then by Functional Units contained within each area.

For each Functional Unit, new sections have been added covering input data (length compositions and input parameter values) and also comments on the quality of these data. As before, information on landings, effort, LPUE and mean size precedes a description of the length-based assessment where appropriate or notes explaining the reasons for not repeating it. This is followed by sections on the age-based approach (where appropriate) for males and females. Where other methods have been adopted these are included here. Some comments on the general quality of the assessment are then included and on the potential for making a prediction. Catch possibilities are then given with a justification for the method adopted; for the cases where a plot of landings on effort was calculated, regression parameters are summarised in Table 5.1.5. Where appropriate guidance is given on the option which the Working Group as a whole regards as the most appropriate.

Summaries of the catch possibilities for the Management Area are then given together with tables which summarise, for the Area as a whole, the recent history of landings (by Functional Unit and by country).

By way of a quick reference, Working Group recommendations on catch options are summarised in Table 5.1.6

5.2 Management Area Va (Area A)

Functional Units - Iceland (1)

5.2.1 Iceland (Functional Unit 1)

Data and biological inputs

No recent data were presented for the Iceland stock so a table of detailed sampling information and input parameters has not been presented.

Landings/catches, effort, LPUE/CPUE and mean size

Information on fishery statistics and mean size of *Nephrops* in the Icelandic fishery is given in Tables 5.2.1. to 5.2.3. These figures are reproduced from the 1992 Working Group report covering the period up to 1991 since updated catch statistics for 1992 were not provided at this meeting.

There was no other information presented for Iceland.

5.2.2 Summary of Management Area Va

Managed by national TACs, further advice not given.

5.3 Management Area Vb (non EC) (Area B)

Functional Units Faroes (2)

5.3.1 Faroes (Functional Unit 2)

Information on landings, effort and LPUE of the Faroese creel fishery is given in Table 5.3.1. These figures are reproduced from the 1990 Working Group report covering the period to 1989; updated catch statistics for this stock have not been provided since then.

5.3.2 Summary of Management Area Vb (non EC)

Managed by national TACs, further advice not given.

5.4 Management Area VIa (Area C)

Functional Units	North Minch	11
	South Minch	12
	Firth of Clyde	13

5.4.1 North Minch (Functional Unit 11)

Data and biological inputs

Sampling the length composition

The length composition of commercial trawl landings was obtained by monthly sampling at the ports of Ullapool, Stornoway and Lochinver. The level of trawl sampling is summarised on a quarterly basis in Table 5.4.1. In 1992 the number of trawlers sampled per quarter varied from 8 to 16 (average sample - 483 *Nephrops*). The landing samples include some collected during discard sampling trips on board commercial trawlers during each quarter. The 1992 trawl landing and discard samples were raised to fleet level and combined to estimate total removals, assuming a discard survival of 25%. A similar procedure was followed for 1990 and 1991 data. In the absence of reliable discard data for earlier years an average was estimated from the combined 1990 and 1991 data and this was applied retrospectively to landings data in earlier years. In the creel fishery only limited sampling of the landings was possible (Table 5.4.1) and it was assumed there were few or no discards (in any case their survival is likely to be high).

Input parameters

Input parameters were the same as in previous years apart from small changes in the growth parameters (see comments below). Since separate VPA's were carried out on the trawl and creel components of the stock it was also possible to use different growth parameters for the two stock components. For the trawl component L_{inf} was changed from 66 to 70 mm in males and immature females, and from 58 to 60 in mature females. The Scottish creel fisheries are mainly based on inshore populations of *Nephrops* which are thought to be fast growing so the same growth parameters as for the Clyde stock were used (Table 3.4.1). Details of the input parameters for the trawl and creel assessments are given in Table 5.4.1.

Comments on the quality of inputs

Sampling data for the trawl fishery are considered reasonable but the absence of discard data before 1990 is a potential problem. Sampling of the creel fishery could be improved. Although specific growth parameters and size at maturity are not available for this stock, the inputs used are based on interpolation from observations in other Scottish areas (see Section 3.4.2). Reservations about the quality of natural mortality and discard survival rates have also been dealt with in Section 3.

Landings, effort, LPUE, mean size

Landings data were reported from U.K. vessels alone. Total 1992 landings were 3,482 t representing a 25% increase on the previous year. 84% of the landings were by *Nephrops* trawlers, 12% by creel and 4% by other trawl methods (Table 5.4.2). Since 1987 landings in the creel fishery have remained fairly stable, in the range 400-500 t.

The rise in 1992 landings reflected a small increase in effort by *Nephrops* trawlers but was mainly due to an increase in trawl LPUE (Table 5.4.3). The rise in LPUE was not due to increased use of multi-rig gear which accounts for less than 4% of effort in this fishery. A comparison between single and multi-rig LPUE data is given in Table 3.2.2. A full time series of *Nephrops* trawl landings, effort and LPUE data are shown in Figures 5.4.1 to 5.4.3. Figure 5.4.3 also shows a comparison of uncorrected LPUE with the same data corrected for HP changes (up to 1990).

The mean size of males and females in trawl landings has remained fairly constant (Table 5.4.4).

Assessments

Length-based assessment (trawl only)

In view of the small change in growth parameters and the comments in Section 4 it was considered that an LCA using data for the most recent years was worth while. The previous LCA, carried out last year (Anon., 1992a), used a long reference period, from 1980 to 1991, during which fishing effort had varied. Also, averaged 1990 and 1991 discard data were applied retrospectively to the earlier years. This year the LCA was carried out using length data for the most recent four year period, 1989-92, for three years of which annual discard data were available (Table 5.4.1).

LCA outputs for males and females are given in Tables 5.4.5 and 5.4.6. The LCA results were similar to those given in the 1991 and 1992 Reports. Annualized fishing mortalities (averaged across the lower 75% of the length range) were 0.415 and 0.024 for males and females, respectively. The long-term Y/R curve for males (Figure 5.4.4) was flat-topped, with current F slightly above F_{max}, suggesting fishing effort could be maintained around current levels. The Y/R relationship for females was virtually linear, with current F well below F_{max} (Figure 5.4.4).

Age-based assessment

In last year's VPA, a multi-fleet approach was adopted incorporating data for the Scottish trawl and creel fisheries. However, there was some doubt about the extent to which both fleets exploit the same parts of the stock. Since creel gear is vulnerable to damage by trawl gear, much creeling is carried out in different areas to trawling, while creeling is partially protected on some inshore grounds by a 6 month closure on the use of mobile gear. Separate assessments for the two fleets were therefore carried out this year.

Males - trawl fishery:

The slicing procedure generated 11 'nominal age' groups (11 = plus group). Catch and weight at age data are given in Tables 5.4.7 and 5.4.8. Tuning of the VPA was carried out using uncorrected *Nephrops* trawl effort data and excluding historical F (for tuning details see Table 5.1.4.). The variances were small relative to mean input F. F at age and numbers at age are given in Tables 5.4.9 and 5.4.10, respectively. Mean F was calculated over ages 3-8 (Table 5.4.11) and the values are plotted against fishing effort in Figure 5.4.5. The correlation coefficient is low (r=0.226, P=N.S.) suggesting the VPA has not performed well. An additional assessment using effort data corrected for HP changes made no difference to the results. Table 5.4.11 suggests that annual mean F was high in 1985 and 1988 but has since fallen. The male component of total stock biomass (TSB) appears to have increased in the mid-1980s and then declined. Recruitment seems to have remained reasonably stable.

Males - creel fishery:

The slicing procedure generated 11 nominal age groups (11 =plus group). Catch and weight at age data are given in Tables 5.4.12 and 5.4.13. In the absence of reliable effort data historical F was used to tune the VPA. For fully recruited age groups (>3) the variances were small relative to mean input F. F at age and numbers at age data are given in Tables 5.4.14 and 5.4.15. Mean F, calculated over ages 3-8 (Table 5.4.16), seems to have been high between 1985-1988 and in 1991. TSB and recruitment appear to have remained fairly stable.

Females - trawl fishery:

The slicing procedure gave 14 'nominal age' groups (14 = plus group). Catch and weight at age data are given in Tables 5.4.17 and 5.4.18. Tuning of input F was carried out as for males. The variances were relatively high compared to mean F. F at age and numbers at age are given in Tables 5.4.19 and 5.4.20 respectively. Much lower fishing mortalities resulted than in males. Annual mean F values were calculated over ages 3-11 (Table 5.4.21) and these values are plotted against trawl effort data in Figure 5.4.5. Again the correlation coefficient between mean F and effort is low and not statistically significant ($r=0.285$). The VPA appears to have performed badly, as in the males, and this may account for the much larger TSB estimates in females (Table 5.4.21) compared to males (Table 5.4.11). Although some elevation of female biomass relative to males is to be expected, in view of their much lower mortality rates, the very large disparity given by the VPA was not considered realistic.

Further analysis of trawl data suggested a significant correlation between combined male and female TSB and overall LPUE (Figure 5.4.6). This correlation ($r=0.649$, $P<0.05$), however, was largely dependent on questionable high values for LPUE and female biomass in 1983 and 1984.

Females - creel fishery:

The slicing procedure produced 14 nominal age groups (14 = plus group). Catch and weight at age data are given in Tables 5.4.22 and 5.4.23. Tuning of the VPA was carried out as for creel caught males. The variances were large relative to mean input F. F at age and numbers at age given by the VPA are shown in Tables 5.4.24 and 5.4.25. Comparison of the summary Tables 5.4.16 and 5.4.26 shows that estimates of mean F are very low in females compared to the males, a similar result to the trawl VPA. Also, bearing in mind the difference in mortalities there is reasonable consistency between male and female TSB and recruitment up to 1988.

Other aspects

Using the muddy ground area estimates in Table 4.6.1 (see Section 4.6.1 for discussion) fishing pressure indices have been derived and are shown in Figure 5.4.7. This suggests that landings/area in the North Minch are currently higher than for other Scottish stocks and that effort/area is also high. These indices are overestimates, however, because some areas of muddy substrate are not taken into account (Table 4.6.1).

Comments on the quality of the assessments

The updated LCA is likely to provide a better estimate of the present state of this stock than last year's analysis over a long reference period using retrospective discard data. The trawl component VPA gave disappointing results, with no correlation between Fbar and fishing effort (Figure 5.4.5) and some inconsistencies between the sexes in the estimates of TSB. The poor performance of the VPA may stem from the difficulties, mentioned earlier, of achieving a representative level of sampling and deriving the most appropriate growth parameters when stocks are distributed over a range of sediment strata (Section 4.6.1). The VPA results were better for males last year using the multi-fleet approach (Anon. 1992a). The creel VPA results must be regarded as preliminary in view of the low level of sampling (Table 5.4.1) and the absence of effort data.

Catch options

With reservations about the VPA it was considered unwise to use the results for a short term prediction. Also, the relationship between effort and landings is rather poor ($r=0.544$, p = NS; Table 5.1.5, Figure 5.4.8). Therefore, the simplest way to derive appropriate catch options is to take an average of the total landings over the revised reference period. From Table 5.4.2 the average total landings in the period 1989-1992 are estimated to be 3,000 t and the range of possible catch options (average ± 20%) are set out below:

Catch option	Predicted landings (t)
Av. - 20%	2,400
Av. landings	3,000
+ 20%	3,600

The LCA results for males suggested that exploitation of this stock over the revised assessment period was slightly above optimum, though the Y/R curve was very flat-topped. LPUE in 1992 showed some improvement on the previous two years (Table 5.4.3), though the long term trend of corrected LPUE shows a gradual decline (Figure 5.4.3). The Working Group saw no reason to change the basis of the advice given in last year's Report (Anon., 1992a). This was to maintain fishing effort at the average level for the revised reference period used in the current LCA (1989-92), with a catch limitation of 3,000 t.

5.4.2 South Minch (Functional Unit 12)

Data and biological inputs

Sampling the length composition

The length composition of commercial trawl landings was obtained by monthly sampling at the ports of Mallaig and Portree. The level of sampling is summarised on a quarterly basis in Table 5.4.27. In 1992 the number of trawlers sampled per quarter varied from 11 to 14 (average sample - 587 *Nephrops*). The landing samples include some obtained during discard sampling trips on board commercial trawlers during each quarter. The 1992 landing and discard samples were raised to trawl fleet level and combined to estimate the total removals as described for the North Minch. Only limited sampling was possible in the creel fishery (8 vessels during 1992, Table 5.4.27), though a better level of sampling was achieved before 1988. In the creel fishery it was assumed there were few discards and their survival was assumed to be 100%.

Input parameters

For analysis of the trawl fishery all input parameters remained the same as in previous years (Tables 3.4.1 and 5.4.27). As for the North Minch, separate VPAs were carried out on the trawl and creel stock components so that different growth curves could be used. The Clyde growth curve was applied to the creel component (Tables 3.4.1 and 5.4.27).

Comments on the quality of inputs

The rationale behind the choice of growth parameters is the same as for the North Minch and because of the variation in sediment strata (Table 4.6.1) similar reservations apply. The lack of trawl discard data prior to 1990, and the recent low level of sampling in the creel fishery are likely to affect the the assessments.

Landings, effort, LPUE, mean size

Landings data were reported from U.K. vessels alone. Total 1992 landings of 4,048 t, although slightly down compared to the previous year, remained high in terms of the historical series (Table 5.4.28 and Figure 5.4.1). 83% of landings were by *Nephrops* trawlers, 12% by creel and 5% by other trawl gear. Over the period, landings in the creel fishery have been fairly stable, in the range 400-600 t.

Compared to the previous year there was a 15% decline in fishing effort by *Nephrops* trawlers but an increase in LPUE (Table 5.4.29). Over the reference period, and in the longer time series (Figure 5.4.3), LPUE has tended to fluctuate, with alternating peaks and troughs. A comparison between LPUE data of single and multi-rig *Nephrops* trawlers in this fishery is given in Table 3.2.2. In terms of hours fished the proportion of effort using multi-rig gear in 1992 was about 10%, little changed from the previous year. A full time series of landings, effort and LPUE data are shown in Figures 5.4.1 to 5.4.3.

The mean size of males and females in trawl landings has fluctated without obvious trend (Table 5.4.30).

Assessments

Length-based assessment (trawl only)

The LCA was carried out using the most recent four year reference period (1989-92), as explained above for the North Minch. Output from the analyses are given in Tables 5.4.31 and 5.4.32. Annualized fishing mortalities (averaged over the lower 75% of the length range) were 0.445 and 0.039 for males and females respectively. Long-term yield and biomass per recruit curves for both sexes are shown in Figure 5.4.9. The Y/R curve for males was very flat-topped, more so than in the previous analysis (Anon., 1991a). Current F for males lies above Fmax, as shown previously. The Y/R relationship for females was virtually linear, with current F well below F_{max}.

Age-based assessments

Separate VPAs were conducted on the Scottish trawl and creel components of the stock using data for the period 1980-1992 (1981-1992 for creel).

Males - trawl fishery:

The slicing procedure produced 11 'nominal age' groups (11 = plus group). Catch and weight at age data are given in Tables 5.4.33 and 5.4.34. Tuning of the VPA was carried out using *Nephrops* trawl effort data and historical F was included (Table 5.1.4 summarises input choices). The variances were small relative to the estimates of mean input F. F at age and numbers at age estimates from the VPA are given in Tables 5.4.35 and 5.4.36, respectively. Annual mean F was calculated on age groups 3-8 (Table 5.4.37) and these values are plotted against trawl effort in Figure 5.4.10. The correlation coefficient between annual mean F and effort was not significant (r=0.248) suggesting that the VPA has not performed well. Table 5.4.37 suggests that mean F has fallen since 1989 but TSB and recruitment have varied relatively little over the reference period.

Males - creel fishery:

The slicing procedure gave 11 nominal age groups (11 = plus group). Catch and weight at age outputs are given in Tables 5.4.38 and 5.4.39. In the absence of effort data the VPA was tuned using historical F. For fully recruited age groups (>3) the variances were small relative to mean input F. F at age and numbers at age estimated by the VPA are given in Tables 5.4.40 and 5.4.41. Mean F, calculated over ages 3-8 appears to have fallen in the period since 1989 while TSB has increased slightly (Table 5.4.42). No Fbar/effort plot was possible because of the lack of suitable effort data.

Females - trawl fishery:

The slicing procedure generated 14 'nominal age' groups (14 = plus group). Catch and weight at age data are given in Tables 5.4.43 and 5.4.44. Tuning of input F was carried out as in the males. The variances were rather large compared to the low values of mean input F. F at age estimates and numbers at age are presented in Tables 5.4.45 and 5.4.46 respectively. Annual mean F was calculated over age groups 3-11 (Table 5.4.47). The estimates of mean F are very low in comparison with males. The correlation between mean F and trawl effort data (Figure 5.4.10) was low ($r=0.543$) and was not statistically significant suggesting that the VPA had not performed very well. The VPA results appear to suggest that the estimates of TSB for females are much larger than in males (by a factor of 2-3), and have gradually increased over the reference period. This seems unrealistic, as is the negative correlation between the combined male and female TSB and LPUE data (Figure 5.4.11).

Females - creel fishery:

The slicing procedure gave 14 nominal age groups (14=plus group). Catch and weight at age output from the VPA are given in Tables 5.4.48 and 5.4.49. Tuning of the VPA was carried out as for creel males. For all ages the variances were rather large relative to the low mean input F values. F at age and numbers at age estimated by the VPA are given in Tables 5.4.50 and 5.4.51 respectively. The summary Table 5.4.52 confirms the trawl VPA results in showing much lower estimates of mean F in females compared to males (Table 5.4.42). The TSB estimates reveal a declining trend (Table 5.4.52) which is somewhat inconsistent with the males.

Other aspects

Trends in landings/area and effort/area indices for the South Minch are shown in Figure 5.4.7. This suggests that the fishing pressure on this stock is moderate in comparison to some other stocks in Scottish waters.

Comments on the quality of the assessments

As for the North Minch, the updated LCA using data for the most recent period (1989-92) is considered a better indicator of the state of the South Minch stock than the analysis performed over a longer reference period (Anon., 1991a). The trawl VPA gave disappointing results, with no correlations between Fbar and effort (Figure 5.4.10) and between TSB and LPUE (Figure 5.4.11), and disparity between the sexes in TSB trends over the reference period (Tables 5.4.37 and 5.4.47). The separate trawl VPA gave rather poorer results than the multi-fleet approach adopted last year. The poor performance of the trawl VPA may have arisen for similar reasons given earlier for the North Minch. The creel VPA results must be treated with caution in view of the low sampling coverage in recent years and the lack of reliable effort data.

Catch options

Given the doubts concerning the validity of the VPA the results could not be used to provide a short term prediction. Instead, the acceptable relationship ($r=0.814$ $p<0.01$) between *Nephrops* trawler landings and effort has been used, as in previous years (Figure 5.4.12; for equation parameters see Table 5.1.5). Effort (Table 5.4.29) was averaged over the revised LCA reference period (1989-92) and used to predict *Nephrops* trawl landings. An equation to raise these landings to the whole fleet, derived from the data in Table 5.4.28, is as follows:

Total landings = 0.994 * *Nephrops* Trawl + 766.2

The range of possible catch options (for average effort and ± 20% of average effort) are tabulated below:

Effort factor	Calculated effort	Predicted landings (t) *Nephrops* trawl	Total
0.8	110.0	3,006	3,754
1.0	137.5	3,413	4,160
1.2	165.0	3,819	4,562

This year's LCA results broadly confirmed those given in the 1991 Report (Anon., 1991a), suggesting that this stock could benefit from a reduction in fishing effort. The new LCA, however, gave a Y/R curve rather more flat-topped (Figure 5.4.9) than that presented in the 1991 Report suggesting that the long-term gains from an effort reduction would be very small. Although fishing effort has risen steadily (Figure 5.4.2), the effort is not particularly high in comparison with other stocks when related to the area of muddy sediments available (Figure 5.4.7). The long-term data series (uncorrected for possible changes in fishing power) shows that LPUE has fluctuated without obvious trend (Figure 5.4.3). With these considerations in mind the Working Group felt rather less pessimistic than previously (Anon. 1991a; 1992a) about the present state of the stock and considered that maintaining effort at the average for the new reference period would be appropriate (effort factor = 1.0), giving a recommended catch option of 4,160 t.

5.4.3 Firth of Clyde (Functional Unit 13)

Data and biological inputs

Sampling the length composition

The length composition of commercial trawl landings was obtained by sampling at the Clyde ports of Ayr, Campbeltown and Tarbert. The level of sampling is summarised in Table 5.4.53. In 1992 the number of vessels sampled per quarter varied from 13 to 16 boats (531 *Nephrops* per sample). The landing samples include some collected on board trawlers during quarterly discard sampling (Table 5.4.53). The landings and discard samples were raised to fleet level and combined to estimate total removals as described for the North Minch data. No sampling of the small creel fishery was carried out in 1992.

Input parameters

The same input parameters were used as in previous years (Tables 3.4.1 and 5.4.53). The Working Group was made aware of the occurrence of a parasitic dinoflagellate infection in *Nephrops* from Scottish waters. The parasite is thought to belong to the genus *Hematodinium*, known to cause mortality problems in various crab species. The prevalence of the infection was particularly high in the Clyde (Field *et al.*, 1992). Further investigations are underway and it was too early to say what the implications are likely to be for the long-term viability of the stock. At this stage it was considered premature to take account of the infection in a revision of input mortality or perhaps growth parameters.

Comments on the quality of inputs

Comments given earlier for the North and South Minches apply similarly to the Clyde.

Landings, effort, LPUE, mean size

Landings data were reported from U.K. vessels alone. 1992 landings were 2,786 t, slightly lower than the previous year. 90% of the landings were made by *Nephrops* trawlers, 9% by other trawl methods and less than 1% by creel (Table 5.4.54). Fishing effort by *Nephrops* trawlers was lower in 1992 than the previous year, but still remains at a high level and LPUE continued to fall (Table 5.4.55). In 1992 LPUE was lower than at any time since the mid-1970s (Figure 5.4.3) despite the fact that 30% of hours fished by *Nephrops* trawlers was attributable to the use of multi-rig gear (see Table 3.2.2). A full time series of landings, effort and LPUE data are given in Figures 5.4.1 to 5.4.3.

The mean size of males and females in trawl landings has fluctuated without any obvious trend (Table 5.4.56).

Assessments

Length-based assessment

The LCA was carried out using length composition data for the trawl fishery over the most recent four year period (1989-92), as described for the Minch stocks. Output from the LCA is given in Tables 5.4.57 and 5.4.58 for males and females, respectively. The LCA results were very similar to those obtained in previous years (Anon., 1991a; 1992a). Annualized fishing mortalities (averaged across the lower 75% of the length range) were 0.396 and 0.032 for males and females, respectively. The long-term Y/R curve for males (Figure 5.4.13) was again rather flat-topped and suggested that current F was about 20-30% above F_{max}. For females the Y/R relationship was virtually linear (Figure 5.4.13).

Age-based assessment

A trawl fleet assessment was carried out using Scottish data from 1980-1992.

Males:

The slicing procedure generated 11 'nominal age' groups (11 = plus group). Catch and weight at age data are given in Tables 5.4.59 and 5.4.60. Tuning of the VPA was carried out using trawl effort data and historical F was included (see Table 5.1.4 for details). The variances were small relative to the value of input F. F at age and numbers at age estimated by the VPA are given in Tables 5.4.61 and 5.4.62, respectively. Mean F was calculated over ages 3-8 (Table 5.4.63) and the values are plotted against trawl fishing effort in Figure 5.4.14. The correlation between mean F and effort was not significant ($r=0.190$) suggesting that the analysis had not performed well. The VPA results are similar to those obtained last year (Anon., 1992a), suggesting that mean F increased sharply in 1988-1990 (Table 5.4.63), though the analysis is probably too unreliable to make comments on trends in other indicators of stock condition.

Females:

The slicing procedure gave 14 'nominal age' groups (14 = plus group). Catch and weight at age data are given in Tables 5.4.64 and 5.4.65. Tuning of input F was carried out as for males (see Table 5.1.4 for details). For some ages (>5) the variances were large relative to mean input F. F at age and numbers at age estimates from the VPA are given in Tables 5.4.66 and 5.4.67, respectively. Annual mean F values were calculated over ages 3-11 (Table 5.4.68) and these are plotted against trawl effort data in Figure 5.4.14. This relationship was not significant ($r=0.510$), indicating that the analysis had not performed well. Estimates of mean F were much lower than in males but like the males there was evidence of elevated values in the period 1988-1990 (Table 5.4.68). There was evidence of a decline in TSB but, in view of the large disparity with male TSB, these results are probably unrealistic (Tables 5.4.63 and 5.4.68). Nevertheless, there was a significant correlation ($r=0.707$, $P<0.01$) between the combined TSB for males and females and LPUE data (Figure 5.4.15).

Other aspects

On the basis of landings and effort per unit area of ground, the fishing pressure on the Clyde stock is relatively high (Figure 5.4.7).

Comments on the quality of the assessments

The comments given earlier on the assessment of the Minch stocks are equally relevant to the Clyde. The updated LCA is likely to offer a more reliable guide to the present state of the stock than the VPA. It is interesting to note that the VPA seems to perform badly in stocks, like the Clyde and North and South Minches, that are distributed over a range of sediment types (Table 4.6.1). Large biological variations in size composition, growth and other parameters are characteristic within these stocks (Anon., 1988), creating immense problems for sampling and choice of inputs.

Catch options

With doubts about the performance of the VPA the results were considered unsuitable for making short-term predictions. Also, the correlation coefficient between *Nephrops* trawl landings and effort data (Table 5.1.5) was rather small ($r=0.497$, $p=$ NS), making the plot in Figure 5.4.16 unsuitable for prediction purposes. Catch options were therefore derived by averaging the total landings over the current LCA reference period. From Table 5.4.54 the average total landings in the period 1989-92 were 2,885 t and the range of possible catch options (average $\pm$ 20% of landings) are set out below:

Catch option	Predicted landings (t)
Av. - 20%	2,308
Av. landings	2,885
Av. + 20%	3,462

The new LCA applied to the recent four-year reference period produced virtually the same result as given in the 1992 Report, showing a fairly flat-topped Y/R curve and suggesting that fishing effort on the male component was above F_{max}. As for the other grounds in Management Area C the VPA results were difficult to interpret. In last year's Report the Working Group recommended that fishing effort should be held at the 1990 level (for *Nephrops* trawlers = 153.4 thousand hours fishing).

Since then effort has risen further and, as Table 5.4.55 shows, LPUE is currently at a very low level. The long-term data series shows that current LPUE is approaching the low values of 1975-1976 (Figure 5.4.3). LPUE in the most recent years would be further reduced if allowances were applied for the use of multi-trawls and other changes in fishing power (Table 3.2.2). The effort per unit area of ground index also shows high values in recent years (Figure 5.4.7). Although the effects cannot yet be quantified, the *Hematodinium* infection mentioned earlier may place additional pressure on the stock.

With these points in mind the Working Group considered that a reduction in fishing effort was desirable. The recommended catch option in this case is 2,308 t (average for reference period less 20%).

5.4.4 Summary of Management Area VIa

The recent landings in FU 11, 12, 13 and other ICES rectangles forming Management Area C are given by unit in Table 5.4.69 and by country in Table 5.4.70. For convenience the catch options for the area as a whole are provided below. These include 697 t for other rectangles (the maximum recorded, see Table 5.4.69).

	Predicted landings (t) for each option		
FU	0.8	1.0	1.2
11	2,400	3,000	3,600
12	3,328	4,160	4,992
13	2,308	2,885	3,462
Other rectangles		697 max.	

The recommended catch option, allowing for a 20% cut in landings in the Clyde is:

$$3{,}000 + 4{,}160 + 2{,}308 + 697 = 10{,}165 \text{ t.}$$

5.5 Management Area Vb (EC) and VIb (Area D)

Functional Units None

5.5.1 Summary of Management Area Vb (EC) and VIb

Zero TAC to prevent misreporting.

5.6 Management Area IIIa (Area E)

Functional Units Skagerrak (3)
Kattegat (4)

Although separate fishery descriptions are provided for these two sea areas, for assessment purposes they are presently treated together; the following sections are arranged accordingly with fishery sections for each FU followed by a combined assessment section.

5.6.1 Skagerrak (Functional Unit 3)

Fishery data

Three countries prosecute this FU (Table 5.6.1) - Sweden, Denmark and Norway. Danish LPUE (kg/day) from log book data are available from 1987-1992 and are divided by Danish landings data for estimation of total Danish effort. Swedish effort and landings are available from log book data for 1978-1992. No Norwegian effort data are available.

Landings

After an increase in total Skagerrak landings by more than 100% during the 1980s, landings have decreased by about 35% from 2,933 t in 1991 to about 1,900 t in 1992 (Table 5.6.2). The landings in 1992 are the lowest recorded during the recent 10-year period. Denmark and Sweden dominate the *Nephrops* fishery in the Skagerrak (60% and 34%, respectively of total landings). The Norwegian fishery has decreased by about 43% to 111 t in the last 2 years and comprises 6% of total landings in 1992. The landings from the Swedish creel fishery have also decreased, from 151 t in 1991 to 114 t in 1992, a level similar to the average level for the 7 years of creel landing data. For management purposes it would seem reasonable to assess this fishery separately, when adequate data are available. Long-term trends in landings are given in Figure 5.6.1.

Effort and LPUE

Table 5.6.3 gives the Swedish effort data for the Skagerrak since 1983. Effort data are available for an overall period 1978-1992 and in the three recent years they have been separated into single trawl and twin trawl data. The conversion of twin trawl LPUE to single trawl LPUE indicates that total Swedish trawling effort (as single trawl units) in the Skagerrak has decreased slightly during the last year but has increased by 160% from 50,000 to 130,000 trawling hours per year during the last ten years. Danish effort data are available for the period 1987-1992 and are assumed to be mainly twin trawl effort for the whole period (Table 5.6.4). The total Danish effort in the Skagerrak (days trawling) is estimated from log book data on LPUE and landings and shows a decreasing trend during the 6 years of effort data. Long-term trends in effort are presented in Figure 5.6.2.

LPUE in both the Danish and Swedish Skagerrak fishery has a decreasing trend. The Swedish LPUE fell drastically in both single and twin trawl during the last year. Long-term trends in Swedish LPUE are presented in Figure 5.6.3 and the trend in LPUE for the units combined and Denmark and Sweden combined (using relative effort) is presented in Figure 5.6.4

5.6.2 Kattegat (Functional Unit 4)

Fishery data

Danish LPUE (kg/day) from log book data are available from 1987-1992 and are divided into Danish landings data for estimation of total Danish effort. Swedish log book data on effort and landings are available from 1978-1992.

Landings

From 1983 to 1992 the total landings have fluctuated between 1,000 and 2,000 t (Table 5.6.5). Since 1985 a decreasing trend is observed and total landings for 1992 have decreased by 24% since last year to the lowest level in the recent ten year period. Long-term trends in total landings are presented in Figure 5.6.1. Denmark dominates the Kattegat *Nephrops* fishery accounting for 89% of total landings, the remaining 11% being landed by Sweden. In the period after 1987 (especially in 1988) the southeastern Kattegat suffered from severe hypoxic conditions and the landings from this period onward are markedly lower. The grounds affected by oxygen deficiency in the south eastern Kattegat seem not yet to have recovered and the *Nephrops* fishing fleet is still mainly located in the northern parts of the Kattegat. There is a slightly increasing Danish *Nephrops* fishery in the central part of the Kattegat.

Effort and LPUE

Total Danish effort is estimated from log book LPUE and landings. Danish effort in 1992 is the lowest recorded during the 6 years of data (Table 5.6.6) while LPUE is also presently low. The Swedish single trawl effort increased slightly until 1987 but has fallen from 1989 onwards while the effort was switched to twin trawl which has increased. The standardized total effort was stable during the period 1978-90 and increased in 1991 and 1992 (Figure 5.6.2). LPUE for the Swedish trawlers shows a decreasing trend during the recent ten years (Table 5.6.7 and Figure 5.6.3).

5.6.3 Skagerrak and Kattegat combined (Functional Units 3+4 = IIIa)

Length data and biological inputs

For the Skagerrak, length frequency data are available from Sweden for 1990-1992; from Denmark for 1991-1992 and from Norway for 1992; these data were raised to total landings for each country. Sweden sampled landings and discards separately, Denmark and Norway sampled catches. For the Kattegat, length frequency data are available from Sweden for 1990-1992 and from Denmark for 1991 and 1992. These were raised to total landings for each country and summed.

Sweden sampled landings and discards separately and Denmark sampled catches. Details of the sampling are given in Table 5.6.1 for the areas combined.

Quality of input parameters

There is still no information on the growth parameters from the Skagerrak-Kattegat area so the input growth parameters (L_{inf} and K) were based on the corresponding parameters for the *Nephrops* stocks in Division IVa, also taking into account the observed maximum length in the samples. Natural mortality was set to 0.3 for males and 0.2 for females. All length groups were assumed to represent mature individuals. All input parameters were the same as last year except for the female L_{inf} which for technical reasons was changed from 64 to 65 mm. Details of input parameters are given in Table 5.6.1.

Size distribution in catch (Skagerrak and Kattegat combined)

The size distributions of the total catch from Denmark, Sweden and Norway are presented in Figure 5.6.5. These graphs show the difference in size composition and also the difference in sex composition between the areas. The size distribution for all countries combined shows that a large proportion of the catch (70% in numbers) are undersized and discarded. The current minimum landing size (13cm total length corresponding to 40 mm CL) in relation to the mesh size in use (70 mm diamond mesh) results in a large catch of, and probably a high fishing mortality on, undersized, discarded *Nephrops*. As recommended before (Anon., 1991a), avoidance of discardings with its attendant mortality should be a primary aim of management and improvements in gear selectivity are an obvious way forward. The mesh assessments (Anon., 1990a) incorporating discards suggest that there are higher long-term gains in Y/R to be made from improvements in selectivity than from reduction in fishing effort.

Assessment

Length cohort analysis

The available national length frequency data were raised to total landings for each country and summed to total landings from the Skagerrak and Kattegat combined. The average length distribution of the three years of length data provided the basis for the LCA.

LCA results

Output from the LCA is given for males and females in Table 5.6.8 and Table 5.6.9. The mean F for males and females are similar to last year (0.28 and 0.11 resp.). The assessment for males indicates, as last year, an increase of about 10 % in long-term yield if effort is reduced by 40 %, while the curve for females indicates optimal exploitation at the present effort level (Figure 5.6.6). The results from this assessment are similar to those from last year's assessment for both males and females.

Age-based assessment

The Working Group regards 5 years of length data to be the minimum for providing a meaningful age-based assessment. In the case of Skagerrak and Kattegat only three years of length distribution are available and no age-based assessment was, therefore, carried out on this stock.

Other approaches: Application of effort and LPUE data

Since the uncertainty about the input parameters in the LCA for IIIa renders this analysis rather speculative, the Working Group again this year decided to assess the *Nephrops* fishery in Division IIIa on the basis of the available effort and LPUE data (even if the trends in Danish and Swedish effort are not consistent for 1992). Last year's correlation between total landings and relative effort was made for the five (1987-1991) years of available effort data for both Denmark and Sweden. These few data points seem to be around the optimum effort point and therefore could be approximated by a linear relationship. The more extensive data series available now suggests a rather different picture where a linear relationship is probably not appropriate.

Considering the relationship between Swedish landings and effort data (with data going back to 1978) and the relationship between the total landings and raised effort figures, curves resembling the parabolic shape of a "surplus production" model are obtained (Figures 5.6.7 and 5.6.8). Note that the curves fitted are illustrative and should not be used in a predictive manner. As indicated in the methods (Section 4), discussion of appropriate techniques for the fitting of surplus production models are urgently required.

Since these annual landings figures probably do not reflect equilibrium yields, a sophisticated biological interpretation of the graphs would be premature. However, the graph does suggest an optimum effort level and does indicate that the effort level in 1992 is beyond this optimum level. Although the LCA is considered speculative, it is noteworthy that, qualitatively at least, similar conclusions are drawn. Possible development of this model could provide a quantitative effort option in the future but for the present this is not considered advisable.

Quality of assessment

The Working Group is, as last year, of the opinion that the LCA for both males and females are probably too uncertain to base any management recommendations on, since the results seem to be very sensitive to relatively small changes in the growth parameters, which themselves are not based on any growth investigations in Division IIIa, but have been taken from *Nephrops* stocks in Division IVa.

The consistent picture from the LCA, LPUE trends and the landings/effort plot, however, is taken as indicative that effort is too high and needs to be controlled.

Catch options

The Working Group is of the opinion that attention should be paid to the observed relationship between effort and landings described above and the trend in LPUE (see Figure 5.6.4). Both sets of observations suggest that the stock is declining. Furthermore, the curve indicates that a decrease in effort may increase the yield on a long-term basis. Some control of effort is required and, in the absence of an obvious way to make a formal prediction, a catch option for Division IIIa in line with this would be to maintain the 1992 landing level (2,900 t). This could be a first step in stabilizing total effort even if such a measure would not improve the present stock size according to the data.

5.6.4 Summary of Management Area IIIa

Landings by Functional Unit and by country are given in Tables 5.6.10 and 5.6.11, respectively, for this Management Area.

There are two pertinent comments to make about management in this area:

a) On the basis of the observed increased Swedish effort in recent years, while both the Danish and Swedish LPUE (Tables 5.6.3, 5.6.4, 5.6.6, and 5.6.7) show a markedly decreasing trend, the Working Group recommends that there should not be any further increase in total effort. A catch option which would be consistent with this objective is to restrict landings to the 1992 level, ie. 2,900 t.

b) The large amount of undersized *Nephrops* in the Division IIIa catches reflects the fact that the MLS does not correspond with the current legal mesh size with standard diamond-shaped meshes. This underlines the need for investigations on gear selectivity and survival of escaping *Nephrops* because a change to more selective trawls could be the better conservation measure.

5.7 Management Area IVa 44-48 E6-E7 + 44E8 (Area F)

Functional Units	Moray Firth	(9)
	Noup	(10)

5.7.1 Moray Firth (Functional Unit 9)

Data and biological inputs

<u>Sampling the length composition</u>

In 1992, regular monthly sampling of commercial trawl landings was carried out at the Moray Firth ports of Lossiemouth, Buckie, Peterhead, Fraserburgh and Burghead. Details of the sampling on a quarterly basis are given in Table 5.7.1. The number of boats sampled in 1992 varied from 9 to 15 (average sample 465 *Nephrops*). The landing samples include some collected during discard sampling trips on board commercial fishing vessels during the 1st, 2nd and 3rd quarters of the year. The landing and discard samples were raised to fleet level and combined to estimate total removals, as described for the North Minch.

<u>Input parameters</u>

All input parameters remained the same as in previous years (Tables 3.4.1 and 5.7.1).

Comments on the quality of inputs

In general this stock is well sampled, apart from the discards in the 4th quarter of 1992. The sedimentary composition across the ground is more uniform than for other Scottish grounds (Table 4.6.1) which, for the stock, probably means less biological variation in growth parameters and size composition.

Landings, effort, LPUE, mean size

Landings data were reported by Scotland alone. Total landings in 1992 were 1,572 t, slightly higher than in the previous year but well below the peak landings of 1989 (Table 5.7.2). Most of the landings (80%) were made by *Nephrops* trawlers. Fishing effort by these vessels has fallen since 1990 but there was an increase in overall LPUE in 1992 (Table 5.7.3). A comparison between vessel LPUE when using single and multi-rig trawls is given in Table 3.2.2. This shows that 39% of hours fished by *Nephrops* trawlers was attributed to use of multi-rig gear. This represents a reduction in the use of this type of gear compared to the previous year (see Anon., 1992a, Table 6.4). A full time series of data on landings, effort and LPUE are given in Figures 5.4.1 to 5.4.3.

Mean size in males and females has fluctuated without obvious trend (Table 5.7.4).

Assessments

Length-based assessment

The last LCA was carried out at the 1991 Working Group (Anon., 1991a). Since then better discard data have been obtained and it was considered worthwhile to repeat the LCA using data for the most recent four year reference period (1989-1992). Outputs from the LCA for males and females are given in Tables 5.7.5 and 5.7.6, respectively. Annualized fishing mortalities (averaged across the lower 75% of the length range) were 0.195 and 0.014 for males and females respectively. Figure 5.7.1 shows that the Y/R curve for males was fairly flat-topped with current F well below F_{max}. This represents a different result to that obtained in 1991 where F was found to be close to F_{max} (Anon., 1991a). In females the Y/R relationship was virtually linear (Figure 5.7.1), as it was previously (Anon., 1991a).

Age-based assessment

A single fleet assessment was carried out using Scottish data from 1980-1992.

Males:

The slicing procedure generated 9 'nominal age' groups (9 = plus group). Catch and weight at age data are given in Tables 5.7.7 and 5.7.8. Tuning of the VPA was carried out using Scottish *Nephrops* trawl effort data and historic F was included (Table 5.1.4 summarises the input choices for tuning). The variances were relatively small compared to the tuned value of F. F at age and number at age estimates from the VPA are given in Tables 5.7.9 and 5.7.10, respectively. Annual mean F values were calculated for ages 3-7 (Table 5.7.11) and are plotted against effort data in Figure 5.7.2. This relationship is significant ($r=0.761$, $P<0.01$) suggesting that the VPA has performed reasonably well. Mean F peaked in 1989 following increased effort but effort has recently fallen (Table 5.7.3). The results in Table 5.7.11 suggest that the TSB of the male component of the stock increased during the mid-1980s and recruitment was also higher. The VPA appears to have given similar results to last year.

Females:

The slicing procedure gave 16 'nominal age' groups (16 = plus group). Catch and weight at age data are given in Tables 5.7.12 and 5.7.13. Tuning of input F was carried out as for males (see Table 5.1.4 for inputs). The magnitude of the variances were generally larger or comparable to the value of input F. F at age and number at age are given in Tables 5.7.14 and 5.7.15, respectively. Annual mean F was calculated over age groups 3-10 (Table 5.7.16) and these values are plotted against effort in Figure 5.7.2. The linear relationship is significant ($r=0.726$, $P<0.01$) suggesting that the VPA performed reasonably well. Comparison between Tables 5.7.11 and 5.7.16 shows that mean F values for females are much lower than for males. Also, the TSB estimates in females are greater than in males which is consistent with the lower mortalities. TSB and recruitment follow similar trends to the males with higher values in the mid-1980s. In most years there is reasonable consistency in male and female numbers at the early ages. As in the males, the VPA results are consistent with those obtained last year. No correlation was found between LPUE data (Table 5.7.3) and the combined male and female TSB (Figure 5.7.3).

Other aspects

The estimate of ground area for this stock is 2091 km^2 (Table 4.6.1). Trends in landings and fishing effort/area indices are shown in Figure 5.4.7. This suggests that both indices are quite low in comparison with some other Scottish stocks.

Comments on the quality of the assessments

The updated LCA should provide an improved estimate of the present state of the stock and to some extent this is borne out by the results. The analysis on males indicates that current F is now below F_{max} on the Y/R curve (Figure 5.7.1) and this is consistent with the recent fall in fishing effort (Table 5.7.3). The VPA appears to have performed reasonably well, and this may possibly be linked to the more homogeneous nature of the stock and its environment.

Catch options

In last year's Report (Anon., 1992a) catch predictions were based on the relationship between *Nephrops* trawl landings and effort, updated in Figure 5.7.4 (Table 5.1.5). However, since the VPA gave good and consistent results it was considered appropriate to carry out a short-term prediction as outlined in Section 4.7. Details for this are set out in Tables 5.7.17 and 5.7.18 for males and females separately. Note that in addition to overwriting the '1' and '2' 'age' groups with average numbers from earlier years, it was also necessary to treat the '3' group in the same way. This was because of unusually low catches of '2' group in the most recent data year which led to very low estimates of stock size. Addition of the male and female components to provide overall predictions for the three effort options (relative F: 0.8, 1.0, 1.2) are given in the text table below. Note that length compositions used in the VPA were raised to the landings by '*Nephrops*' and 'Light' trawlers which account for 89% of the total landings. The figures presented below are raised by a factor of 1/0.89 to correct for this.

	TSB and Landings Predictions (t)					
Effort factor	1993		1994		1995	
	TSB	Landings	TSB	Landings	TSB	Landings
0.8				1,347	13,411	1,485
1.0	12,322	1,611	12,677	1,622	13,010	1,675
1.2				1,877	12,637	1,822

The LCA results on males (Figure 5.7.1) suggest that exploitation may now be below optimum and this is consistent with a recent fall in fishing effort (Table 5.7.3) and with the fall in fishing mortality estimated by the VPA (Table 5.7.11). Other indices of stock condition, LPUE (Table 5.7.3), landings/area and effort/area (Figure 5.4.7) also point to a reasonably healthy state. On this basis the Working Group suggests that an increase in fishing effort (effort factor 1.2) would be acceptable for this stock providing a catch option of 1,877 t in 1994. It should be noted that this is below the precautionary TAC of 2,076 t set in the last two years (ACFM Report, 1992) for 1992 and 1993. These were based on relatively high average effort in the reference period 1985-1990. The present predictions are lower because they roll forward from 1992 when effort and landings were below the reference period averages formerly used as the basis of the advice.

5.7.2 Noup (Functional Unit 10)

Data and biological inputs

No biological data exist for this stock and no sampling of the landings has taken place to date.

Landings, effort, LPUE, mean size

Landings data were reported by Scotland. 1992 landings from this small fishery were 180 t of which 31% were taken by *Nephrops* trawlers (Table 5.7.19). LPUE has fluctuated without obvious trend (Table 5.7.20). 23% of the fishing effort by *Nephrops* trawlers was attributed to the use of multi-rig trawls (Table 3.2.2). No mean size data are available.

Assessments

There are no length composition data for the stock and no analytical assessments were possible. The area of sediment suitable for *Nephrops* has been calculated from BGS charts and this has been used to estimate landings and effort per unit area of ground. The total area of muddy sediment is about 400 Km^2 (Table 4.6.1), giving for 1990 (the peak year for total landings; Table 5.7.19) very low estimates of *Nephrops* Trawl landings/area (0.253 t/Km^2) and effort/area (0.007 thousand hours/Km^2) compared to other Scottish grounds (see Figure 5.4.7).

Catch options

The relationship between landings and effort is shown in Figure 5.7.5. For the present the maximum landings in the reference period (217 t) were considered to be an appropriate catch option for this stock. In view of the ground area calculations above there may be some scope for increasing effort in the future.

5.7.3 Summary of Management Area IVa 44-48 E6-E7 + 44E8

The recent landings in FU 9,10 and other ICES rectangles forming Management Area F are given in Tables 5.7.21 and 5.7.22. For convenience the options for each element of the Area are set out in the text table below:

	Catch options (t)		
FU	0.8	1.0	1.2
9	1,347	1,622	1,877
10		217 max.(1990 landings)	
Other		69 max. (1990 landings	

To obtain the appropriate catch options for this Management Area the recommended option for the Moray Firth should be added to the maximum landings for the Noup and for the "other rectangles":

$$1,877 + 217 + 69 = 2,163$$

5.8 Management Area IVa Remainder (Area G)

Functional Units Fladen (7)

5.8.1 Fladen Ground (Functional Unit 7)

Data and biological inputs

In 1992 little sampling was possible for this stock (Table 5.8.1). Sampling of the landings at Scottish ports was limited to 4 samples during the year (454 *Nephrops* per sample). One catch sample was available from a Danish research vessel cruise in the the 4th quarter of the year. Also, it has not been possible to sample discards in this fishery. No analytical assessments were performed at this Working Group, though input parameters used in the past are included in Tables 3.4.1 and 5.8.1 for completeness.

Comments on the quality of inputs

Although LCA and VPA assessments have been carried out on the stock in the past (Anon.,1991a; 1992a), the results must be treated with caution in view of the low level of sampling, the lack of discard data and the general lack of knowledge of biological parameters (Table 5.8.1). A different approach to the assessment of this stock is outlined below (for details see Appendix 4).

Landings, effort, LPUE and mean size

Landings data were reported by Scotland, Denmark and Belgium (Table 5.8.2). In 1992 there was a large fall in landings, from 4,241 t in the previous year to 3,265 t of which 2,936 t were landed in Scotland (Table 5.8.2). Landings in the Danish fishery were only recorded since 1986 (Table 5.8.2).

The decline in landings mainly reflected a 50% reduction in fishing effort by UK *Nephrops* trawlers, the main component of the fleet (Table 5.8.3). In 1992 there was a marked increase in LPUE by UK *Nephrops* trawlers, to 46.7 kg/hour, the highest value recorded since 1984. A large proportion of the UK fleet were large vessels using multi-rig trawls (see Table 3.2.2). This partly accounts for the high LPUE (Table 5.8.3) compared to other grounds around Scotland (Figure 5.4.3). In 1992 there was also a large increase in LPUE reported by Danish trawlers (Table 5.8.4). A long time series of landings, effort and LPUE data by Scottish *Nephrops* trawlers are shown in Figures 5.4.1 - 5.4.3.

In Scottish landings, the mean size appears to have increased steadily in males and more recently in females (Table 5.8.5).

Assessments

In the 1991 Report the Working Group drew attention to the difficulties of assessing this stock, whose geographical boundaries were poorly known, when fishing effort appeared to be expanding onto new parts of the ground and when biological sampling was limited and unlikely to be fully representative of the whole stock. During a cruise of the SOAFD Research Vessel SCOTIA in June/July 1992, an underwater TV camera was tried as an alternative approach for the assessment of this stock. Details of the method and results are given in Appendix 4.

The results of the survey confirmed the widespread distribution of *Nephrops*, formerly suggested on the basis of sediment information alone (Anon., 1991a). The stock is estimated to extend over an area of about 30,000 km^2 (Table 4.6.1) and, allowing for 90% burrow occupancy, a tentative estimate for the stock biomass is about 95-110 thousand t. Figure 5.4.7 suggests that fishing pressure on the stock is currently very low in comparison with other Scottish stocks.

At this stage it is too early to make definitive statements on the size and potential of this stock. However, in order to view the biomass estimate in the context of possible exploitation rates, it is useful to make comparisons with the adjacent Moray Firth ground, where the fishery is apparently being exploited below the optimum level at present (Section 5.7.1). Figure 5.4.7 shows that current landings/area from the Moray Firth are around 0.75 t/km^2. Assuming that the same level of production was achieved on the Fladen ground, the landings from there could be over 20,000 t, representing about 1/5 of the total biomass. To put this potential production into perspective, the total 1992 landings into Scotland from all grounds in Management Areas C, F, G, and I were about 17,500 t.

Comments on the quality of the assessment

Several factors which may affect the accuracy of the assessment are discussed in Appendix 4. These include burrow identification which is somewhat subjective. The estimates of burrow density may even be conservative in that they are mostly below the range of estimates for other grounds (see for example Bailey and Chapman, 1983). It should also be noted that the total stock biomass will be underestimated since the burrows of pre-recruits to the fishery were likely to have been missed during the analysis of the TV tapes.

Catch options

The relationship between landings and effort for *Nephrops* trawlers at Fladen is given in Table 5.1.5 and plotted in Figure 5.8.1. The Working Group repeated the view expressed last year (Anon., 1992a) that the high correlation coefficient for this relationship ($r=0.972$, $P<0.001$) might indicate that the high level of effort in 1991 was sustainable and suggested that the maximum landings of 4,240 t (Table 5.8.2) could form the basis of a catch option, if one was required. The range of possible catch options is set out below:

Catch option	Predicted landings (t)
max - 20%	3,392
maximum	4,240
max + 20%	5,088

The evidence from the TV survey, the low estimates of fishing pressure compared to other stocks (Figure 5.4.7) and the form of the relationship in Figure 5.8.1 suggests that the Fladen stock is currently under-exploited. There seems to be no biological reason for curbing the expansion of this fishery and a catch option of 5,088 t would be appropriate. This would allow a modest expansion of the fishery provided the marketing problems experienced in 1992 could be avoided.

The Working Group again expressed the view that TACs should be separately allocated to Management Areas, and not aggregated. Otherwise it would be difficult to balance expansion of landings at Fladen with the need to hold or reduce landings elsewhere in the North Sea. This issue is also referred to in the sections covering other North Sea stocks, for example Management Area I, and also has relevance to ICES Sub-area VII.

5.8.2 Summary of Management Area IVa remainder

The recent landings in FU7 and other ICES rectangles forming Management Area G are given in Tables 5.8.6 and 5.8.7. The addition of the maximum landings (1991) of 135 t for other rectangles (Table 5.8.6) to the above option for FU7 gives a recommended overall catch option of 5,223 t.

5.9 Management Area IVb,c East of 1°East (Area H)

Functional Units Botney Gut-Silver Pit (5)

5.9.1 Botney Gut - Silver Pit (Functional Unit 5)

Data and biological inputs

Landings and effort statistics are available for Belgium (landings since the early 1950s, landing and effort data by vessel class and gear type since 1981), Denmark (since 1988 for both landings and effort), and the UK (landings only).

Length frequency data are currently being collected from market samples of the landings by Belgian *Nephrops* trawlers only. A routine auction sampling programme has been in operation since 1986 (Table 5.9.1). As a rule two samples of 200-300 whole *Nephrops* (100 per market category, viz. "small", if landed, "medium" and "large") are taken every month, the first one between the 10th and the 15th, the second between the 20th and the 30th of each month.

Nephrops tails were sampled from April 1992 onwards but for technical reasons these data are not yet included in the length frequency calculations. For the time being it is assumed that the length distributions of tails are similar to those for whole *Nephrops*. The proportion of tails in the Belgian *Nephrops* landings gradually increased from about 13% (on a whole-weight basis) in 1986 to 25% in 1991, but decreased slightly to 20% in 1992.

Because of quality requirements, Belgian fishermen usually keep the smallest *Nephrops* (25-35 mm CL) from the very last hauls only; the others are discarded at sea. The numbers of "small" *Nephrops* discarded were estimated from the quantities of "smalls" actually landed, using a raising factor based on the ratio between (a) the total number of fishing hours by the Belgian *Nephrops*-directed trawler fleet and (b) the number of fishing hours from which the "smalls" were kept for auctioning. This almost certainly gives an underestimate of the true discards, since the length distribution of the "smalls" is truncated to the left, due to the size-selection by the fishermen.

General comments on the quality of the inputs

The biological and technical input parameters to the LCA and VPA are summarized in Table 5.9.1.

Except for the length-weight relationships, most parameters applied to the Botney Gut - Silver Pit stock were "borrowed" from other stocks or fisheries (viz. K, L_{inf}), or chosen for consistency with the other assessments (viz. discard survival and natural mortality).

Ongoing EC-funded research, carried out by the Fisheries Research Station (Belgium) and the Institute for Fisheries Technology and Aquaculture (DIFTA, Denmark), is expected to yield stock-specific gear selection parameters and better estimates of the discards by the end of 1993.

Landings, effort and LPUE

Over the past years total international landings from the Botney Gut - Silver Pit area first rose from about 380 t in 1986 to 759 t in 1991, then fell abruptly to 512 t in 1992 (Table 5.9.2). Most of these (75-90 %) were taken by Belgian trawlers.

Long-term effort and LPUE data series are available for the Belgian *Nephrops*-directed otter trawl fleet only. Landings by these vessels steadily rose from 378 t in 1986 to 570-585 t in 1990 and 1991, then fell again to 470 t in 1992. Over the same period of time total effort increased from 52,000-53,000 hours trawling in 1986 and 1987, to about 85,000 hours in 1991 and 1992 (Table 5.9.3).

The average LPUEs (calculated on a yearly basis) of the Belgian *Nephrops* trawlers increased from 7.1 kg/hour in 1986 to 8.7 kg/hour in 1989, then started to decrease again, to 5.6 kg/hour in 1992; an almost 35 % decrease over a period of three years (Table 5.9.3). An even sharper drop is seen in the LPUEs of Danish trawlers, which fell from just under 300 kg/day in 1991 to about 160 kg/day in 1992 (Table 5.9.4).

A break-down of the landings and LPUE figures by sex reveals peculiar features which have a major bearing on the interpretation of the trends in landings and LPUE, and of the results of both LCA and VPA. The landings of male *Nephrops* remained fairly constant over the past 7 years, fluctuating without obvious trend between 300 and 375 t (Figure 5.9.1). The landings of females, however, jumped from just over 100 t in 1987 and 1988, to 200-210 t in the years 1989-91, then fell again by about 50 % to only 96 t in 1992.

Male LPUEs increased slightly from 5.6 kg/hour in 1986 to 6.5 kg/hour in 1988 (Figure 5.9.2). From then onwards they gradually decreased to 4.0 kg/hour in 1991 but most recently they increased by about 10% to 4.4 kg/hour in 1992. Female LPUEs rose sharply from about 1.9 kg/hour in 1987 and 1988 to almost 3.2 kg/hour in 1989. In 1990 and 1991 they slowly decreased to 2.5 kg/hour, and in 1992 they fell by nearly 55% to only 1.1 kg/hour.

The reason(s) for the sudden and massive increase of female *Nephrops* in the landings in 1989-1991 are still unclear, but it is very unlikely that this phenomenon is to any extent fishery-related. The most plausible explanation seems to be that the females just became much more accessible to trawling than in the previous years. Female *Nephrops* were most abundant in the landings during the summer months of 1989, 1990 and 1991, when they represented 50-65% of the landings in numbers (market categories "medium plus large"), as compared to only 30-40% in the preceding years (Figure 5.9.3).

Several hypotheses can be advanced to explain the increase in catchability, such as major changes in the periodicity of the reproductive cycle, or in the environmental conditions which trigger the emergence of the females (e.g. oxygen depletion), but all of these need further investigation.

The recent decrease in both the landings and the LPUEs of female *Nephrops* seems, at least in part, to be due to a change in the seasonal distribution of fishing effort in the Botney Gut - Silver Pit area. In the years 1986-1991 the effort peaked in the 3rd quarter, closely followed by the 2nd or 4th (Figure 5.9.4). In 1992, however, the effort was much more evenly spread over the seasons, with a slight predominance of the 1st and the 2nd quarter.

The sex-ratios of *Nephrops* catches and landings are known to vary seasonally, in connection with the egg-bearing condition of the females. During winter, when most of the females are berried and hiding in their burrows, the landings mainly comprise males, whereas during summer, when the majority of the females are non-berried, the landings may consist of up to 80% females (depending on the size-class). Any major shift in the seasonal distribution of fishing effort, therefore, is likely to have an immediate impact on the overall sex composition of catches and landings.

In the summer of 1992 the proportions of female *Nephrops* in the landings were almost as high as in 1989-1991 (see Figure 5.9.3). Compared to the other years, however, relatively more effort was made in the months with low female abundances (the 1st and the 2nd quarter), and less in the months with high female abundances (the 3rd quarter) (see Figure 5.9.4). As a consequence, the overall quantities of female *Nephrops* landed remained far below the figures for 1989-1991.

These findings are of major importance with respect to the length- and age-based assessments. Both methods use the numbers of individuals removed from a population to provide information on exploitation pressure, exploitation pattern and trends in stock size. In the case of the Botney Gut females, however, the "apparent" changes in abundance are not caused by true changes in stock size but most of all by changes in their catchability.

Mean sizes

Mean sizes of *Nephrops* landed are available for the Belgian fleet only. Owing to the peculiar discarding practice on the Belgian *Nephrops* trawlers, mean sizes are given separately for the market categories "small" and "medium plus large".

The mean sizes of "small" males and females remained fairly stable over the last 10 years, at values between 30.0 and 33.0 mm for the males, and between 29.0 and 32.0 mm for the females (Figures 5.9.5)

The mean sizes of "medium plus large" males decreased from 39.5 - 43.0 mm in 1989 and 1990, to 37.0 - 42.0 mm in 1991, then stabilized (Figure 5.9.6). The mean sizes of "medium plus large" females, on the other hand, increased by roughly 2.0 mm from 1988 to 1990. Since then they remained fairly stable at a level between 38.0 and 42.0 mm.

Assessments

<u>Length-based assessment</u>

Reference period: 1989-1992

Because of the changes in fishing effort, which started to increase in 1989 (after having remained at roughly the same level in 1986-1988), and because of the changes in the exploitation pattern of the females, which also became apparent from 1989 onwards, LCAs were run with the data for 1989-1992 only.

Output from the LCAs for males and females are given in Tables 5.9.5 and 5.9.6. Mean Fs, calculated over the lower 75% of the length range, were 0.20 for the males and 0.07 for the females. The results of the Y/R and B/R analysis show that current F is close to F_{max} for the males, and well below F_{max} for the females (Figure 5.9.7). The predicted long-term gain in landings with an increase in effort from current F to F_{max} is very small, especially for the males (about 1.5%).

Mean Fs for males and females from the LCAs for 1986-1988 (as given in last year's Working Group Report), and for 1989-1992 are summarized in the text table below :

	Males	Females
Reference period 1986-1988	0.19	0.11
Reference period 1989-1992	0.20	0.07

The mean Fs for the females clearly decreased from 1986-1988 to 1989-1992; those for the males remained almost constant.

The results of the Y/R and B/R analysis suggest that current F is getting closer to F_{max} for the males, whereas it remains far below F_{max} for the females. The results for the males seem to be in line with the overall trend in effort, which was predicted to give only slightly larger landings for substantial increases in effort (Anon., 1990a, 1991a and 1992a). The evaluation of the output for the females is much more difficult, especially against the recent changes in catchability of female *Nephrops* and in the seasonal distribution of fishing effort.

<u>Age-based assessment</u>

Reference period: 1986-1992

Multi-fleet age-based assessments, involving the Belgian and the Danish otter trawl fleets, were run for males and females separately, with "nominal" age distributions of the removals for 1986-1992.

The age distributions of the removals by the Belgian fleet were calculated from the length distributions of the actual landings, plus 75% of the estimated discards at length, assuming 25% discard survival. Removals by the Danish fleet were estimated under the assumption that their length composition was similar to that of the removals by the Belgian fleet.

Slicing of the length frequency distributions into age groups was done using the method described in Section 4.3 of last year's Working Group Report (Anon., 1992a). The lower boundary of nominal age group 1 corresponds to a size of 24mm, for both males and females. The number of nominal age groups was set at 13 for the males and 16 for the females, the oldest age group being a plus group.

Effort data were available for the Belgian *Nephrops*-directed otter trawlers only (see Table 5.9.3).

Historic F was excluded from the assessments of both males and females. Inputs to the VPA and tuning options are summarized in Table 5.1.4.

Males:

Catches and weights at age for the males are given in Tables 5.9.7 and 5.9.8, respectively. Tuned Fs ranged between 0.28 and 0.56, and were highest in the age groups 7 and 8 (0.52 and 0.56). The variances around F were generally small as compared to the values of tuned F.

F at age and numbers at age are given in Tables 5.9.9 and 5.9.10. Values of F tend to be highest in the age groups 4-9, although this pattern is not equally evident in all years. The age-wise values of F clearly increased from 1987 to 1990 or 1991 (depending on the age class), then decreased again in most age groups.

Fbar (3-10) went up gradually with increasing effort, from 0.24 in 1986 to 0.52 in 1990 and 0.51 in 1991, then slightly decreased to 0.48 in 1992 (Table 5.9.11). The regression of Fbar on effort, as shown in Figure 5.9.8, is highly significant ($R = 0.86$ with $0.05 > P > 0.01$).

Females:

Catches at age and weights at age for female *Nephrops* are given in Tables 5.9.12 and 5.9.13. Tuned Fs ranged between 0.17 and 0.30, and were highest in the age groups 7 to 10 (with values between 0.26 and 0.30). Variances around F were mostly of the same order or larger than the corresponding values of tuned F.

Values of F at age and numbers at age are given in Tables 5.9.14 and 5.9.15, respectively. In general, fishing mortalities gradually increased from very low levels in 1986-1988 to peak values in 1991 but this trend was discontinued in 1992. Fbar (3-13) quickly rose from 0.07 in 1986 to 0.52 in 1991, then sharply dropped to 0.24 in 1992 (Table 5.9.16). Fbar was found to be correlated with fishing effort ($R = 0.85$ with $0.05 > P > 0.01$) (Figure 5.9.8) but because of the large variances around tuned F, there is some doubt on the significance of this relationship.

General comments on the quality of the assessments

The Working Group had serious doubts about the validity of both the LCA and the VPA on female *Nephrops* for this particular stock, especially in view of the major changes in catchability of the females and in the seasonal distribution of fishing effort over the past year(s).

Adding just one year with relatively low female landings to the reference period resulted, amongst others, in pushing up the values of Fbar by a factor of 2.5 to 9.5 (for the first and the last year in the data series respectively), and in estimates of the female stock biomass (TSB) which are 3.0 to 6.0 times smaller than the ones given by last year's assessment (cf. Table 5.9.18 in Anon., 1992a).

Because of the uncertainties on the impact of the changes in catchability of the females on the output of both the length- and the age-based assessments, the Working Group decided to base its management advice for the Botney Gut - Silver Pit stock on the results for the males only, and to disregard, at least for the time being, the results for the females. This approach is in line with earlier recommendations by the Working Group which have generally stated that more attention should be paid to the males.

Catch options

The relationships between landings and effort over the years used in the VPA (viz. 1986-1992) are shown in Figure 5.9.9 for total landings, and in Figures 5.9.10 and 5.9.11 for males and females separately. The correlations are generally poor, with values of R below 0.6 (for total landings) or below 0.5 (for males and females separately), indicating that the regressions are of little use for predictive purposes.

Therefore it was decided to calculate the catch options as the mean (and mean plus and minus 20%) of the landings over carefully selected, representative time periods, taking into account the differences in catchability and exploitation pattern between males and females. The catch options for the males were calculated as the mean $\pm$ 20% of the landings over the reference period for the LCA (1989-1992), viz. 352, 440 and 528 t. Those for the females were calculated under different assumptions with respect to their catchability:

(a) as the mean and mean $\pm$ 20% over the years 1987, 1988 and 1992, corresponding to low female catch levels, viz. 88, 110 and 132 t, and

(b) as the mean and mean $\pm$ 20% over the years 1989, 1990 and 1991, corresponding to high female catch levels, viz. 212, 265 and 318 t.

The overall catch options (males and females combined) for the Botney Gut- Silver Pit stock are summarized in the text table below:

	Assuming low female catch levels	Assuming high female catch levels
Mean - 20%	440	565
Mean	550	705
Mean + 20%	660	845

The results of the LCA show that current F on the males is very close to F_{max}, and that no room is left for substantial increases in fishing effort. With respect to the males the Working Group reiterates its recommendation to restrict fishing effort to a level corresponding to the landings in 1989-1992.

The landings of the females are much more difficult to predict, in view of the uncertainties on their catchability in the coming year(s). The results of the LCA, however, suggest that current F on the females is far below F_{max}. Therefore, there seems to be no strong case to adopt a restrictive or conservative approach with respect to the catch level of the females.

This would set the proposed TAC for the Botney Gut - Silver Pit stock at 705 t, i.e. at a figure corresponding to the mean of the landings over 1989-1992 for the males, and the high catch level option for the females.

5.9.2 Summary of Management Area IVb,c East of 1°East

Recent landings from Functional Unit 5 and from other rectangles in Management Area H are given in Table 5.9.17, and landings by country in Table 5.9.18. Taking into account the landings from statistical rectangles outside the Botney Gut - Silver Pit (195 t in 1992) would set the overall TAC for the Area at 900 t. This is very close to last year's recommendation (920 t).

5.10 Management Area IVb,c West of 1°East (Area I)

Functional Units	Farn Deeps	(6)
	Firth of Forth	(8)

5.10.1 Farn Deeps (Functional Unit 6)

Data and biological inputs

Landings and effort statistics and length compositions of landings, catch, and discards were available for 1992 (Table 5.10.1). As the main fishing season occurs from October to March the data for catches and some other statistics have been based on seasons for the year ending 30 June.

For the years 1990-1992, discard data were only available during the peak of the fishing season in November, so the 1990/1991 and 1991/1992 discards were estimated from the November samples, corrected to seasonal values average over the period 1985 to 1989. The removals for the period 1984/1985 to 1991/1992 were estimated using a discard survival of 0.25.

The biological inputs for growth, maturity, length/weight relationship, and natural mortality (Table 5.10.1) were as used last year (Table 3.4.1, Anon.,1992a).

Comments on General Quality of Inputs

The quality of statistics collection was believed to be similar to previous years. Since *Nephrops* is a TAC species, the UK Fisheries Inspectorate attempts to census the landings and effort of all vessels landing in the UK. The effort series has not been corrected for changes in fishing power, but a plot of GRT and HP is shown in Figure 5.10.1. Mean GRT declined between 1982 and 1989 but subsequently showed a slight increase. HP is more variable but has increased in the past 3 years. A directed effort series was estimated, taking those vessels where the *Nephrops* value exceeded 50% of the total value of the landing. LPUE calculated from this directed effort, compared with that from the effort of all vessel trips where *Nephrops* were landed, was found to have a higher LPUE, but with the same annual trends (Figure 5.10.2).

The length compositions of the landings were sampled at the most important ports in NE England on a monthly basis. In the last season 13 and 20 samples were taken respectively in quarters 3 and 4 of 1991, and 4 and 3 samples were taken in quarters 1 and 2 of 1992 (Table 5.10.1). In addition 10 discards samples were taken at the main port of North Shields in November 1991, which is the normal peak of the seasonal landings.

The biological inputs (Table 5.10.1) are either derived from other functional units (discard mortality, natural mortality), directly based on observations in the Farn Deeps (length/weight, size at maturity), or determined from Farn Deeps data with reference to estimates from other functional units (growth).

Landings and Catches

Landings from this unit (Table 5.10.2, 5.10.3, long-term trends Figure 5.10.3) are made mainly by UK vessels. The total landings by calendar year have continued to decline from the peak of 3,099 t in 1989 to 1,462 t in 1992 (provisional value), the lowest of the last 10 years and 32% below the average landings of 2,141 t. On a seasonal basis, landings peaked in 1990/1991 and fell markedly in 1991/1992.

Effort

The fishing effort by season recorded for UK trawlers (Table 5.10.3, long-term trends Figure 5.10.4), showed a steady threefold increase between seasons 1974/1975, and 1989/1990 to a peak of 133,000 hours trawling. There was a slight reduction to a level of 127,000 hours in 1990/1991 and a further decline of 28% in the 1991/1992 season to a level of 92,000 hours fished.

CPUE/LPUE

CPUE data (Table 5.10.3, Figure 5.10.5) available from 1984/1985, are calculated from discard sampling during the main fishing season (October-March), except for seasons 1990/1991-1991/1992, when they are based on samples collected in November only. CPUE has been variable but has declined to a relatively low level of 24 kg/h trawling in 1991/1992. The LPUE (Table 5.10.3 and Figure 5.10.5) shows no clear trend over the period, but in 1991/1992 fell to 16 kg/h trawling, which is close to the lowest value seen in the time series.

Mean Size

The decline in the mean size of the landings over the last 10 years seems to have stopped with mean sizes for both males and females of around 32 mm (carapace length) in the last four seasons (Table 5.10.4). Recent estimates of the mean sizes of the catch are restricted to estimates for November and, therefore, two data series are shown, one for November samples only, and the other based on more comprehensive seasonal coverage. The November data series shows a decline in mean size (sexes combined) from 28.8mm CL in the 1985/1987 seasons to 24.9mm CL in the last two seasons. The seasonal mean size series also shows a slight decline.

Assessments

Length-based assessment

With two seasons of additional length data since the last LCA was performed (Anon., 1991a) it was decided to update the length-based assessment. Other inputs remained as before (Table 3.4.1). There has been a rising trend in fishing effort until 1991/1992 when it fell. The LCA was performed on (a) the whole, (b) the first half, and (c) the second half of the 8-season period to see if higher Fs could be detected in the later period. The LCA outputs for males and females from these runs are given in Tables 5.10.5 to 5.10.10.

Annualised mean F values for the lower 75% of the length range were:-

Time Series	Seasons 1-8	Seasons 1-4	Seasons 5-8
Males	0.34	0.31	0.40
Female	0.08	0.08	0.09

The mean Fs for the later period were indeed higher, and this is clearly seen to occur over the whole length range (Figure 5.10.6). The exploitation pattern for the females shows a sharp reduction at the size at maturity when, in winter fisheries like the Farn Deeps, the ovigerous females stay in their burrows and are less available to trawls.

The Y/R and B/R curves for all the runs are given in Figures 5.10.7 to 5.10.9. These show that for males the recent F has been well to the right of F_{max} on the Y/R curves, and predict that reductions in effort by up to 50% could result in modest long-term increases in Y/R of up to 14%. By contrast, for the females the results predict higher yields if effort is increased, with F_{max} around 50% higher than the current level, corresponding to a 10% increase in Y/R. The male Y/R curve for the period 1-4 was flatter, and that for years 5-8 more domed than for the whole period (1-8). This is a reflection of the lower and higher fishing mortalities estimated for the two shorter periods.

Age-based assessment

The age-based assessment was up-dated with the addition of a further season's (1991/1992) length data. Since over 99% of the landings are made by the UK fleet a single fleet assessment was made. Effort data (hours fished) on a seasonal basis were available for the same period as the length data. It should be noted that all year references in the Tables and Figures refer to the first year of the season (e.g. 1991 = 1991/1992), and not to calendar year.

Males:

The length compositions of the males were split into 10 nominal ages and a plus group (11+) using the parameters in Table 3.4.1, producing outputs of the catch at age (Table 5.10.11) and weight at age (Table 5.10.12). These were input to the VPA with the tuning and output choices as given in Table 5.1.4. The historic F was excluded and a zero weighted mean q used.

The tuning output gave F estimates with reasonably small variances and the F at age by year array is given in Table 5.10.13. Numbers at age are given in Table 5.10.14. The mean F(3-7) values (Table 5.10.15) ranged from 0.43 to 0.63 with, in general, an increasing trend up to 1990/1991 and a decrease in 1991/1992.

The plot of mean F(3-7) on effort (Figure 5.10.10) gave a significant correlation ($r = 0.82$, 6 df, $0.01 < P < 0.05$). The TSB and R seem to have been reasonably stable and fluctuated without trend until 1989/1990. The TSB for the last two seasons has declined.

Females:

The length compositions of the females were split into 14 nominal ages and a plus group (15+) using the parameters in Table 3.4.1 and producing the catch at age (Table 5.10.16) and weight at age (Table 5.10.17). These were input to the VPA with the tuning and output choices as given in Table 5.1.4. The historic F was excluded and a zero weighted mean q used.

The tuning output gave quite low F estimates with fairly high variances and the F at age by year array and numbers at age are given in Tables 5.10.18 and 5.10.19, respectively. The mean F(3-10) values (Table 5.10.20) ranged from 0.07 to 0.32, with an increasing trend up to 1990/1991 and a drop in 1991/1992. The plot of mean F(3-10) on effort (Figure 5.10.10) gave a significant correlation ($r = 0.81$, 6 df, $0.01 < P < 0.05$). The TSB, SSB and recruitment have been declining over the time period.

Comparison of males and females

The mean Fs on males were higher than those on females. This is consistent with the greater availability of males than females, and was also observed in the LCA. This is also reflected in the larger TSBs for females (Tables 5.10.15 and 5.10.20). Mean recruitment of males and females at nominal age 1 was within 1% of the 50:50 sex ratio expected at that age.

Combining the male and female stock biomass estimates there was a significant ($r = 0.75$, $df = 6$, $0.01 < p < 0.05$) correlation with the CPUE series, while the LPUE series was not significant at the 5% level ($r = 0.68$, $df = 6$, $0.05 < p < 0.1$) (Table 5.10.3, Figure 5.10.11).

General comments on the quality of the assessment

Data collection and research efforts on this functional unit have been maintained at a high level for several years. The landings and effort statistics are thought to be reasonably complete and reliable. There has been an intensive length sampling programme since 1983, particularly for the landings. A reduction in sampling levels for discards for 1990-1992 has necessitated some adjustment to mean seasonal values, but this is unlikely to have had any significant impact on the assessments. Some of the biological inputs are dependent upon estimates from other Functional Units. Given the highly domed shape of the male Y/R curve and the need for a 50% reduction in effort to achieve F_{max}, together with the confirmatory trends in F(bar), and TSB from the VPA, as well as the decline in CPUE and mean size, only major changes to the biological inputs would be likely to change the perception of the state of exploitation and the appropriate management requirements.

Catch options

The VPA seemed to be internally consistent, with significant correlations between F(bar) and effort for both male and female *Nephrops*, and between CPUE and TSB. Unfortunately the arrangement of data involving fishing seasons ending 30 June (originally to fit in with the main fishing period from October to March) precludes the calculation of annual catch options using a short-term prediction approach. Consideration will be given to reorganising the database to annual periods for next year.

For this year the short-term trends in F(bar), TSB, SSB, and R are taken, together with the results of the new LCA and the LPUE/CPUE and mean size trends, to provide guidance on the state of exploitation of this functional unit. There was a significant ($L = 290.8 + 19.32*E$; $r = 0.87$, $df = 11$, $p < 0.01$) relationship between annual landings(L) and effort(E) (Figure 5.10.12), and this has been used for predictive purposes to estimate catch options. The LCA indicated that F had been higher in the latter half of the 8-season period for which data were available. Effort had been steadily increasing for many years, but in 1991/1992 the effort fell substantially. The period 1988 to 1992 was taken as the reference period for calculating mean effort for catch options, as this reflects both the recent period with increasing F and the 1991/1992 fall in fishing effort.

Using the regression of landings on effort (Figure 5.10.12) raised to the total international landings(IL) ($IL = -64.62 + 1.070*L$; $r = 0.99$, $df = 10$, $p < 0.01$), with mean effort for 1988-1992, the *status quo* option, together with other options with a 20% increase or decrease in effort are:-

Effort Factor	Mean Effort ($h*10^{-3}$)	Predicted Landings
0.8	84	1,979
1.0	105	2,412
1.2	126	2,846

The landings from this functional unit have fallen from a peak of 3,099 t in 1989 to 1,462 t (provisional) in 1992. Effort fell by 28% in 1991/92, CPUE and LPUE have fallen to the lowest values of the last 10 seasons, and mean size has declined. The LCA yield per recruit analysis shows that for males effort would need to be reduced by 50% to achieve F_{max}, but for females effort is well below F_{max}. The LCA showed that F in the last four seasons was higher than in the previous seasons. The VPA, which is time lagged by the use of seasons (the last being 1991/1992), has shown higher levels of F for males than for females, and an increasing trend in F(bar) for both males and females until 1990/91. The TSB estimates from the VPA show a declining trend in currentrecent years, particularly for the more heavily exploited males, and there is a significant relationship between TSB and CPUE, which itself has declined. All of these factors lead to the conclusion that the early signs of overexploitation are now becoming apparent, following a period when fishing effort climbed towards a peak in 1989. The evidence to hand now suggests that this Functional Unit cannot sustain the high levels of effort seen in the late 1980s. The effort has fallen in the last three years, particularly in 1992.

It is recommended that effort in this fishery should not be allowed to rise again to the high levels of the late 1980s. As a first step towards preventing large effort increases a target effort level of 84,000 hours, equivalent to a 20% reduction in mean effort (1988-1992), should be the management aim. A catch option of 1,979 t corresponds with this effort target, but direct effort control, targeted at this Functional Unit, would be a more effective approach.

5.10.2 Firth of Forth (Functional Unit 8)

Data and biological inputs

Sampling the length composition

The length composition of commercial trawl landings was obtained by regular monthly sampling at the ports of Pittenweem and Eyemouth. The level of sampling is summarised on a quarterly basis in Table 5.10.21. In 1992 the number of samples per quarter varied from 15 to 18 (average 461 *Nephrops* per sample). The landing samples include some collected during discard sampling trips on board commercial fishing vessels during each quarter. The trawl landings and discard samples were raised to fleet level and combined to estimate total removals, as described for the North Minch.

Input parameters

All input parameters remained the same as in previous years (Tables 3.4.1 and 5.10.21).

Comments on the quality of inputs

Adequate sampling of the landings is usually achieved in this fishery, though improved discard sampling is desirable. Discard practices have recently varied greatly in response to changing market demands for different size categories of *Nephrops*. The relatively uniform sedimentary environment (Table 4.6.1) probably means input parameters are better estimated for this stock than for some others.

Landings, effort, LPUE, mean size

Landings data were reported by U.K. vessels only. 1992 Landings were 1,721 t, representing a rise of over 300 t compared to the previous year (Table 5.10.22), but still below the high landings of 1988-90. Over 97% of the landings were made by *Nephrops* trawlers. Fishing effort (in terms of hours fishing) by these vessels in 1992 was virtually unchanged from the previous year and the increase in landings was largely accounted for by an increase in LPUE (Table 5.10.23). According to Table 3.2.2 use of multi-rig gear accounts for about 12% of fishing hours though the data suggest no difference in LPUE between single and multi-gears used in this fishery. LPUE still remains at a relatively low level in comparison to the longer time series in Figure 5.4.3. Longer time series of landings and effort data are shown in Figures 5.4.1 and 5.4.2.

During recent years, there has been a steady decline in mean size, particularly of the males (Table 5.10.24).

Assessments

Length-based assessment

A length-based assessment was last carried out in 1991 using a long reference period and retrospective discard data (Anon., 1991a). With improved discard data it was thought useful to repeat the LCA over the most recent four year period (1989-1992). Output from the LCA for males and females are given in Tables 5.10.25 and 5.10.26, respectively. Annualized fishing mortalities (averaged over the lower 75% of the length range) were 0.630 and 0.091 for males and females, respectively.

The long-term Y/R curve for males (Figure 5.10.13) suggests that current F is well above F_{max}, confirming previous results (Anon., 1991a). In females the Y/R relationship was virtually linear, with current F well below F_{max} (Figure 5.10.13).

Age-based assessment

A single fleet assessment was carried out using Scottish data from 1981-1992.

Males:

The slicing procedure generated 11 'nominal age' groups (11 = plus group). Catch and weight at age data are given in Tables 5.10.27 and 5.10.28. Tuning of the VPA was carried out using *Nephrops* trawl effort data, and excluding historic F (see Table 5.1.4 for input choices). The variances about F were small compared to the magnitude of tuned input F values. F at age and numbers at age are given in Tables 5.10.29 and 5.10.30. Annual mean F was calculated on age groups 3-8 (Table 5.10.31) and these values are plotted against effort in Figure 5.10.14. The relationship was highly significant ($r=0.94$, $P<0.001$) suggesting that the VPA has performed well. Fishing mortality estimates from the VPA were very similar to those obtained last year (Anon., 1992a). Mortality on the male component of this stock has been very high compared to other Scottish stocks, particularly in 1984 and in the period 1988-90 (Table 5.10.31). The TSB of the males appears to have increased during the early 1980s but has declined since then. There has been no obvious trend in recruitment.

Females:

The slicing procedure gave 16 'nominal age' groups (16 = plus group). Catch and weight at age data are given in Tables 5.10.32 and 5.10.33. Tuning of input F was carried out as for the males (Table 5.1.4 for inputs). F at age was very much lower than in males (Table 5.10.34) and the variances on the estimates of input F were relatively high. Numbers at age are given in Table 5.10.35. Annual mean F was calculated over ages 3-10 (Table 5.10.36) and the values are plotted against effort in Figure 5.10.14. This relationship was statistically significant ($r = 0.651$, $P<0.05$) suggesting that the VPA was reasonably well behaved. TSB of the female component was slightly higher than in males (consistent with lower mortalities on the former) and appears to have peaked in the mid-1980s (Table 5.10.36). Recruitment of females was reasonably consistent with the males (Tables 5.10.31 and 5.10.36). Figure 5.10.15 shows a significant correlation ($r = 0.635$, $P< 0.05$) between LPUE (Table 5.10.23) and combined male and female TSB, estimated from the VPA. Note in Figure 5.10.15 the departure from the line of the 1992 datum point, which may indicate that one or both variables have been poorly estimated.

Other aspects

From BGS sediment charts the estimated area of the Firth of Forth ground is about 990 km^2 (Table 4.6.1), making it the smallest in Scottish waters apart from the Noup. Landings and effort/area indices are shown in Figure 5.4.7. Both are currently very high; the latter index is higher than for all other Scottish grounds.

Comments on the quality of the assessments

As for other stocks, the updated LCA over a shorter, recent, reference period should provide a more accurate guide to the present state of the stock. The VPA performed particularly well for this stock, confirming the results of last year (Anon., 1992a). The uniformity of the sedimentary environment (Table 4.6.1) probably contributes to the quality of the analyses, as discussed earlier.

Catch options

In the last two years (Anon., 1991a; 1992a) catch predictions for this stock were estimated from the linear plot of landings against fishing effort shown in Figure 5.10.16. However, since the VPA performed well it is possible to use the results to make short-term predictions and this approach was adopted this year (for details see Section 4.7). Outputs from the prediction analysis for males and females are given in Tables 5.10.37 and 5.10.38. Combining the male and female components from these tables provides predictions for TSB and landings in the current and following two years. In the text table below predictions are given for *status quo* effort and for factors 0.8 and 1.2:

Effort factor	1993		1994		1995	
	TSB	Landings	TSB	Landings	TSB	Landings
0.8				1,428	9834	1,530
1.0	9494	1,770	9432	1,698	9432	1,672
1.2				1,942	9068	1,767

These figures suggest that under *status quo* fishing mortality, TSB would fall slightly while landings in the prediction years should be around 1,672-1,698 t. A 20% reduction in effort (effort factor 0.8) should give rise to an increase in biomass, while landings at first fall to 1,428 t in 1994 and then begin to recover from 1995.

All the available evidence suggests that the Firth of Forth stock could derive some long-term benefit from a reduction in fishing effort. The updated LCA and VPA suggest that fishing mortality on males is much higher in this stock than in other stocks in Scottish waters. A similar picture emerges with other indicators of stock condition, such as LPUE, and landings and effort/area (Figures 5.4.3 and 5.4.7). The male Y/R curve derived from the LCA suggests that current F is well above F_{max} (Figure 5.10.13) and that a 50% reduction in fishing effort would be needed to maximise a long-term gain in yield. In view of these results the Working Group recommended that fishing effort should be maintained at 20% below *status quo* (effort factor 0.8), giving a preferred catch option for 1994 of 1,428 t.

5.10.3 Summary of Management Area IVb,c West of 1°East

The recent *Nephrops* landings in Functional Units 6 and 8 and from other ICES rectangles forming Management Area I are given in Tables 5.10.39 and 5.10.40. Total landings from the area reached a peak of 5,342 t in 1988 but have since fallen to their lowest level (3,449 t) in the last 10 years. The maximum landings in the reference period are considered appropriate for the landings from 'other' rectangles. The range of possible catch options for each FU and the area as a whole are summarised in the text table below :

	Predicted landings (t) per effort factor		
FU	0.8	1.0	1.2
6	1,979	2,412	2,846
8	1,428	1,698	1,942
Other rectangles		352	

The Working Group recommended catch option for Management Area I as a whole, based on a 20% effort reduction in both FUs, is:

$$1,979 + 1,428 + 352 = 3,759 \text{ t.}$$

An important comment on this Management Area

This Management Area I (comprising two FUs) is one of four in the North Sea. At present there is a single unallocated TAC for the whole of Sub-area IV. The Working Group and ACFM have pointed out that such a large grouping of Functional Units and Management Areas is not satisfactory. It does not allow for the management of Functional Units in a way which takes account of the different levels of exploitation which may exist within such a large grouping.

The Farn Deeps (FU6) and Firth of Forth (FU8) are examples of this problem. The recommended catch options for both FUs are set to accomplish a 20% reduction in effort. At present there is little to stop a large proportion of the North Sea fishing effort switching to these areas and attempting to take the whole North Sea TAC from them. The present TAC management regime, based on the whole North Sea, will not be capable of achieving the effort reduction recommended for this Management Area.

5.11 Management Area VIIa (excluding 33E2-33E5) (Area J)

Functional Units	Irish Sea East	(14)
	Irish Sea West	(15)

5.11.1 Irish Sea East (Functional Unit 14)

Data and biological inputs

Landings and effort statistics and length compositions of landings, catch, and discards were available for 1992. Details of these data and biological inputs are given in Table 5.11.1. There were no changes to biological input parameter values used previously.

Comments on general quality of inputs

The quality of statistics collection was believed to be on a par with previous years. Because *Nephrops* is a TAC species, the UK Fisheries Inspectorate attempt to census the landings and effort of all vessels landing in the UK. The effort, CPUE, and LPUE series are based on directed *Nephrops* voyages, where the weight of *Nephrops* landed is more than 25% of the total landing. Following two years (1989,1990) without length samples, the sampling programme restarted in 1991 and continued with a further 27 samples of landings and 12 of discards in 1992 (Table 5.11.1). The seasonal stratification has improved, though there is room for further progress.

Discard mortality, natural mortality, the length/weight relationship, and size at maturity are based on Irish Sea biological studies (Table 5.11.1). The growth inputs are based on those estimated for the western Irish Sea, with some adjustment, referring to comparable Scottish growth results, to take account of the larger size distribution in the eastern Irish Sea.

Landings

Following the recent period when the total international landings (Table 5.11.2) from the eastern Irish Sea nearly doubled from the lowest of the last 10 years (431 t in 1989) to 859 t in 1991, they have fallen in 1992 by 43% to 488 t. Most of these landings were made into England, though the majority of them (77% of the directed landings in Figure 5.11.1A) continue to be made by visiting Northern Irish vessels. The landings peaked in May and June 1992, and then declined to the lowest landings seen in the second half of the year during the last 10 years. The ratio of whole *Nephrops* to tails (on a whole weight equivalent basis) in the landings has averaged 51:49 in the last 5 years. Prior to that period landings were mainly of tails. In 1992 the proportion of tails increased to 62%.

Fishing effort

Fishing effort in 1992 by directed, voyages which caught 84% of the landings into England, decreased by 12% to 17,366 trawling hours (Table 5.11.3). The effort of English and visiting Northern Irish vessels fell by 22% and 6%, respectively (Figure 5.11.1B).

Landings per unit effort (LPUE)

The overall LPUE in 1992, based on *Nephrops*-directed voyages, fell by 24% to 20 kg/h trawling (Table 5.11.3). The LPUE of both Northern Irish and English vessels landing into Whitehaven fell by similar amounts to values close to the total. Vessels landing into Fleetwood continue to have the lowest LPUE (Figure 5.11.1C).

There has been some uncertainty in interpreting recent LPUE trends in this fishery due to suspected changes in discarding practice. It has not been clear whether the reduction in LPUE observed in 1987-1989 was due to a reduction in stock abundance, or due to a change in discarding practice as the ratio of whole to tails in the landings increased to about 50:50. This ratio has remained at about 50:50 for some five years, but in 1992 the proportion of tails in the landings increased to 62%.

Sampling of discards was again attempted in 1992 by boarding vessels at sea. A second (one was estimated last year) fishermens' discard ogive was calculated by pooling the 12 samples collected in June 1992. This gave a mean selection length of 26mm CL, and a selection range of 3mm CL, close to the 1991 values of 28mm and 5mm, respectively. As there appears to be little change in the discarding practice in 1992, the observed reduction in LPUE is probably the result of a decrease in stock abundance and/or availability.

Mean size

Sampling of the landings improved in 1992 with a total of 27 samples being collected over a period of 7 months. The mean sizes of 32.2 and 32.8mm CL for males and females, respectively, were similar to those estimated last year, and in the first two years (1985, 1986) of the series (Table 5.11.4), when mainly tails were being landed. There was an increase in the mean sizes in 1987 and 1988 which seemed to be associated with the increased landings of whole *Nephrops*, and a possible change in discard practice.

Assessments

Length-based assessment

Due to the lack of samples of the landings in 1989 and 1990 there has been no change in recent years to the length cohort assessment originally reported in the 1990 Working Group Report (Anon., 1990a) and summarised in 1991 (Anon., 1991a).

With the availability of new landings length data for both 1991 and 1992, together with discard estimates in 1992, it was considered worthwhile to rerun the length cohort assessment. The new landings data were added to the previous time series (1985-1988). The 1992 discard pattern was considered to be the best available and was applied to all years to calculate removals with a discard survival factor of 0.25. This is not an ideal approach, as there are believed to have been some changes in discard practice during the time series, but there are no data for the earlier years.

Annualised mean F values for the lower 75% of the length range (Tables 5.11.5 and 5.11.6) were 0.27 for males and 0.19 for females, an increase compared with the values of 0.21 and 0.15 estimated in the 1990 length cohort assessment (Anon., 1990a, 1991a). The addition of two new years of length data and the new discard data made a slight difference to the yield and biomass-per-recruit curves (Figure 5.11.2) compared with the previous assessment. The long-term Y/R curves for both males and females are both flat-topped, with current F close to F_{max}. The previous assessment suggested current F was above F_{max}.

Age-based assessment

The time series of length compositions of the landings is relatively short and, in particular, there is a gap with no data for 1989 and 1990. The data were considered to be inadequate for an annual age-based assessment.

General comments on the quality of the assessment

There have been some improvements in the sampling of the length distributions of the landings and discards. The data series is still fragmented, with usable discard data only available for the last year. The quality of some of the biological data is dependent upon inputs from other functional units (Table 5.11.1). As the long-term Y/R curve is flat-topped, Y/R is relatively insensitive to quite large changes in fishing effort. The LCA provides an acceptable guide to the state of exploitation of this functional unit. Only major changes to the length data or biological inputs would be likely to change the perception of the state of exploitation and influence the choice of appropriate management measures.

Prediction and catch options

There is no age-based assessment. The data inputs for the LCA were considered to be good enough to allow the state of exploitation to be assessed. The updated landings (L) on effort (E) plot (Figure 5.11.3) was significant ($L = -40.64 + 28.29*E$; $r = 0.79$, $p<0.01$), and was used to estimate catch options.

Using the average effort (18,572 hours) over the LCA reference period (1985-1992), the predicted landings (L), raised to the international landings (IL), were 634 tonnes ($IL = 140.7 + 1.017*L$; $r = 0.92$, $p<0.01$). The *status quo* option, together with other options with a 20% increase or decrease in mean effort are :-

Effort factor	Mean Effort ($hr*10^{-3}$)	Predicted factor
0.8	14.9	527
1.0	18.6	634
1.2	22.3	740

Landings in 1992 decreased by 43% to 488 t, compared with 1991, and were well below last year's ACFM-recommended landings option of 595 t. Both effort and LPUE fell in 1992. The Y/R curves from the LCA suggest current F is at about F_{max}, and that fishing effort should not be allowed to increase. A *status quo* landings option of 634tt is recommended for 1994.

15.11.2 Irish Sea West (Functional Unit 15)

Data and biological input parameters

The data used were numbers of *Nephrops* landed, caught and discarded in samples taken by Ireland and Northern Ireland. These data were raised to total numbers using the landed tonnage.

UK (Northern Ireland)

Because around 80% of Northern Ireland *Nephrops* landings are landed as tails for the 'scampi' market, the carapace length distribution of these landings is obtained by sampling the discarded heads or cephalothorax at sea aboard commercial vessels. Approximately 50 kg of total catch and discards are taken from each haul sampled and a sub-sample of 200-300 *Nephrops* removed for carapace length measurement. Between 4 to 6 voyages have been sampled per month since 1981. In addition to sampling commercial catches and discards at sea, Nephrops landed whole are monitored throughout the year by removing samples of 100-200 individuals from commercial landings. Sampling details are given in Table 5.11.7.

Republic of Ireland

Sampling levels ranged from 4-10 per month during the peak fishery period in June-August to 1-2 during the off-season. Samples consisted of components representing unsorted catch, large landed whole *Nephrops*, small landed *Nephrops*, discarded heads of tailed *Nephrops* and small whole discards. From these, length frequency distributions were obtained for males and immature, maturing, mature and egg-bearing females. Details of sampling by the Republic of Ireland are included in Table 5.11.7.

Input for K and L_{inf} for males and juvenile females were taken from growth data obtained by fitting normal curves to polymodal length frequency distributions (Tully, Hillis and McMullan, 1989). Growth data for mature female *Nephrops* were from tagging results (Hillis, 1979, 1987). Female maturity was taken to occur at 24mm knife edged (Briggs, 1988). Length-weight relationships were those of Pope and Thomas (1955). These parameters were the same as those used in the assessments performed at previous Working Group meetings.

Natural mortality for males was set at $M = 0.3$ for males. For females natural mortality of $M = 0.3$ was used for immature animals (under 24mm carapace length) and $M = 0.2$ for mature *Nephrops*. Input parameters are summarised in Table 5.11.7.

Landings, effort, LPUE/CPUE

Total international *Nephrops* landings from Functional Unit 15 in 1992 were 7,675 t which is lower than the 1991 value of 9,463 t (Table 5.11.8). This reduction reflects a drop in UK landings from 6,024 t in 1991 to 5,102 t in 1992 and a drop in Republic of Ireland landings from 3,366 t to 2,553 t over this period. Landings by Northern Ireland vessels were 5,058 t which was 65.9% of the total landings and 99.1% of the UK landings from this Functional Unit. The market-driven trend in Northern Ireland towards the landing of detached tails from small *Nephrops* and larger animals whole, continued in 1992 with 22.6% being landed as whole animals. The long-term trend in landings in the Northern Ireland fishery is shown in Figure 5.11.4.

Landings and catches per unit effort for the Northern Ireland fleet calculated from live weight per hour fishing showed a slight rise in 1991 to 29.5 kg per hour compared to the record low figure of 28.8 kg per hour in 1990; no data were available for 1992 at the time of the meeting. The time series of Northern Ireland CPUE and LPUE data is given in Table 5.11.9.

The historical trend of a decline in the proportion of *Nephrops* discarded showed signs of levelling out in 1991 and 1992 as indicated below, with data from the Republic of Ireland fishery.

Year	1984	1985	1986	1987	1988	1989	1990	1991	1992
% discarded	43	40	34	29	24	24	16	20	19

Mean Sizes

Although the mean size of *Nephrops* in catches (landings plus discards) by both the Northern Ireland (Table 5.11.10) and Republic of Ireland fisheries (5.11.11) is relatively stable, landings have shown a downward trend in mean size of individuals over the period 1984-1991. This downward trend was thought to be mainly due to a reduction in discarding, as the industry took advantage of the lower minimum landing size (25mm CL to 20mm CL). The 1992 data, however, suggested that the decline in mean size of landed *Nephrops* has stopped, accompanied by the stabilising of the proportion discarded discussed above. The size of *Nephrops* landed therefore appears to be driven by market practices and is not a good indication of the size of *Nephrops* in catches or in the stock.

Assessment

Length-based assessment

The length-based assessment performed at the 1991 meeting used landed and discarded *Nephrops* size composition data from the Northern Ireland and Ireland fleets averaged over the years 1987-1990. This period was selected because it represents a period of relative 'steady state' since the most recent increase in mesh size to 70mm in 1986.

The only new data available at the 1992 and 1993 meetings were recent size compositions for the two fleets. When these data were compared and combined with those used at the 1991 meeting, no change in the previously used distribution (1987-1990) was seen. The LCA assessment was therefore not repeated. The carapace length composition of 1992 catches by the Northern Ireland and the Republic of Ireland are shown in Figure 5.11.5.

Age-based assessment

The new software available from the 1992 meeting was used to slice the Northern Ireland and Republic of Ireland size composition data (landings + 90% of discards) into nominal ages. These represent the total estimated *Nephrops* removals from the stock by the fishery, assuming a discard mortality of 90%. These data were used to carry out Laurec-Shepherd tuned multi-fleet assessments of male and female *Nephrops* (separately) using Northern Ireland and Republic of Ireland data for the period 1984-1992. Input choices for the tuning are given in Table 5.1.4. The Northern Ireland effort data were used for tuning with Q fixed while the Republic of Ireland data (no effort) were excluded. Historical F was included and mean F (Fbar) was calculated for nominal age classes 3-5.

Males:

Tables 5.11.12 and 5.11.13 show the catch numbers and the mean weight of male *Nephrops* at each nominal age. Table 5.11.14 gives F-at-age values and shows a range of F=0.15 to 0.3 at age 2 to values of up to about 0.8 for the middle ages (3-8) for recent years. These values are similar to those generated by the LCA performed by the 1991 meeting. Number at age is given in Table 5.11.15. Stock biomass and SSB are relatively stable (Table 5.11.16) at around 18,000 t over the assessment period. Mean F(3-5) does not appear to exhibit a trend and has a negative correlation (r = -.11) with fishing effort (Figure 5.11.6). The assessment suggested that recruitment has been stable over the period 1984-1989 with a reduction in 1990 and 1991.

Females:

Tables 5.11.17 and 5.11.18 show the catch numbers and the mean weight of female *Nephrops* at each nominal age. Table 5.11.19 gives F-at-age values of 0.3 to 0.5

for 2-year olds to values around 0.9 for 4 year olds in recent years. These values are similar to those generated by the LCA performed by the 1991 meeting. Numbers at age are given in Table 5.11.20. According to this assessment stock biomass indicates a decline from 10,686 t in 1984 to 6,965 t in 1992. SSB rose from 5,910 t in 1984 to 6,553 t in 1986 and then dropped slowly to 4,025 t in 1992 (Table 5.11.21). Mean F(3-5) is stable over this period and has a significant correlation ($r=0.75, P<0.05$) with effort (Figure 5.11.6). Recruitment appears to have been relatively stable over the assessment period (Table 5.11.21).

Catch options

Although the results from the age-based analysis did not conflict strongly with those from the 1991 LCA (Anon., 1991a) it was considered that further exploration of their application to this stock was required before they could be used for predictive purposes. The poor correlation of Fbar and effort for male *Nephrops* ($r=-.11$) therefore resulted in the decision that the age-based assessment could not be used as a basis for a short-term prediction.

A plot of landings against effort (Figure 5.11.7) could not be used for a catch prediction due to evidence of a time trend as in the 1992 assessment.

The meeting agreed that in view of uncertainties in this assessment catch options based upon the average landings over the reference period used in the LCA (1987-90) plus or minus 20% of this value should be provided. This formula gives catch options for 1994 of:

Option	Landings (t)
-20%	6,770
mean(87-90)	8,463
+20%	10,156

The results of the previously performed LCA were used as a basis for the management advice. These results gave a relatively flat-topped yield per recruit curve and suggested that the current level of F was about 20% beyond F_{max} for males and 10-20% beyond F_{max} for females. It was concluded that although effort should be stabilised, the shape of the yield per recruit curve indicated that reduction in fishing effort to F_{max} would produce only small long-term gains; a *status quo* management strategy is therefore recommended. The catch option of 8,463 t is consistent with this aim.

Calculations using the MIX (MacDonald and Pitcher, 1979) length slicing model discussed in Appendix 1 is an example of the application of an alternative method for slicing length composition data into nominal ages. Further analysis may indicate whether the mortality levels in the assessment are at a reasonable level.

5.11.3 Summary of Management Area VIIa (excluding 33E2-33E5)

Summaries of the recent landings from this Management Area are given by Functional Unit and Country in Tables 5.11.22 and 5.11.23. The *status quo* option, together with other options of a 20% increase or decrease in mean effort (1985-1992) for FU14 and mean landings (1987-90) for FU15 are:-

	Effort/Landings Factor		
Catch option (t)	0.8	1.0	1.2
FU14	527	634	740
FU15	6770	8463	10156

By combining the recommended *status quo* catch option for FU14 (Irish Sea East) with FU15 (Irish Sea West) tonnes, and allowing for the small quantities from other rectangles, an overall recommended catch option is obtained as follows:

634 + 8463 = 9,097 t.

5.12 Management Area VIId,e (Area K)

Functional Units None

5.12.1 Summary of Management Area VIId,e

Zero TAC to prevent misreporting.

5.13 Management Area VIIb,c,j,k(Area L)

Functional Units		
	Porcupine Bank	(16)
	Aran Islands	(17)
	NW and W Ireland	(18)
	SW Ireland	(19)

5.13.1 Porcupine Bank (Functional Unit 16)

Data and biological inputs

Landings, effort and length compositions of landings were available for 1992. There were no new biological inputs and the same values as last year were used (Table 3.4.1). Fleets of four countries (Spain, France, UK and Ireland) are involved in the *Nephrops* fishery of Porcupine Bank but a long series of length composition are available only for Spain (1980-1992) (see Table 5.13.1

for details). Length composition data of Spanish landings were applied to the French landings (1983-1992) and UK landings (1984-1992). The 1991 length composition of Irish landings was applied to the 1989, 1990 and 1992 landings of that country. Details of Irish sampling will be provided next year.

Comments on general quality of inputs

Length composition data are collected on a monthly basis at La Coruña (NW Spain) by a routine sampling programme. In 1992 three samples per month were taken, averaging 247 individuals each sample. The application of these samples to the French and UK landings was made under the assumption that their length compositions were similar to that of the Spanish fleet. The length composition of 1991 Irish landings differed significantly from the Spanish data. The fact that the same set of 1991 Irish length data was applied to other years (1989, 1990 and 1992) probably disturbs the structure of the data and therefore the slicing procedure. Because the sex-ratio of 1991 Irish samples was 1:1.24 the females analysis may be more affected. Discards are negligible (<1%). Natural mortality is assumed to be similar to that for those stocks with low predation. L_{inf} for both sexes is based on the size distributions. K values for females represent inconsistency with other stocks, but were maintained for lack of new information. Table 5.13.1 gives details of inputs.

Landings, effort, CPUE and LPUE

Landings were reported by Spain, France, UK and Ireland.

Spain

Landings by Spanish vessels from Porcupine Bank during 1992 were 822 t, the lowest for the historical series (Table 5.13.2). This represents a decrease by 40% compared to the 1986-1991 average landings. After declining in 1986, landings show a gradual decreasing trend from 1987 to 1992. The drop of landings in 1992 is probably related to decreased fishing effort more than other factors, since CPUE has increased (see below).

Total trawl fishing effort has shown a decreasing trend since 1989 and dropped notably in 1992. However, the CPUE of the two components of the Spanish fleet in 1992 increased significantly compared with 1991 (Table 5.13.3).

The CPUE of trawls directed to *Nephrops* decreased steadily from 1982 to 1991, but increased in 1992 above the level of the two previous years. The CPUE of the trawlers directed at hake fishing, which take *Nephrops* as a by-catch, declined in 1986, but has remained fairly steady in the period 1986-1990. After the lowest value in 1991, CPUE increased again in 1992 to a level similar to that in the period cited. The CPUE of the total trawl fleet showed a similar pattern. A longer time series of landings, effort and CPUE data is given in Figure 5.13.1.

France

The exploitation of the *Nephrops* stock in the Porcupine Bank area by French vessels started only recently, viz. 1981-1982. This fishery is clearly seasonal, with most fishing taking place during the summer months. For three consecutive years (1984-86) it yielded fairly large catches around 1,000 t a year (Table 5.13.2). For unknown reasons, however, the LPUE suddenly dropped in 1987 (Table 5.13.4). The fishery became less and less attractive to French vessels and total effort steadily decreased until in 1990, fishing effort fell to only 238 days. An increasing effort trend has been observed since then (reference port Saint Guénolé) to 495 days in 1992, with a higher LPUE (385 Kg/day) although still not comparable to the LPUE obtained from 1982 to 1986 (average around 800 Kg/day) (Table 5.13.4). The progressive decline of this fishery is probably related to the decrease in catchability of *Nephrops* and to the bad weather conditions in the area (most French vessels operating in the area are fairly small, with an overall length between 20m and 25m), rather than to overexploitation of the stock.

Republic of Ireland

Irish landings, mainly at Rossaveel, were 223 t in 1992. Prior to 1989, the Porcupine Bank and Aran Grounds were not differentiated in the landings statistics. In this relatively distant water fishery, conducted mainly by rather small boats, 91% of the landings were made during June-July, the time of year when the weather is most reliable. There are no data on effort.

UK

Records by English vessels landing in UK and in Spain from Porcupine Bank are given in Table 5.13.2. The fishing effort dropped in 1989-1990 because of the legal questions affecting joint ventures. Landings increased in 1992.

Mean size

There were no mean size data from the Republic of Ireland, France or UK.

Spain

The mean size of males fluctuated without trend over the period 1982-1992 (values ranged between 38.7mm and 41.0mm Carapace length) (Table 5.13.5). The mean size of females was fairly stable (around an average of 34.3mm) during the period 1981-1987. An increase to 38.4mm CL in 1988 was followed by a slight decrease in 1989. The mean size in 1992 was comparable to the average of the reference period cited. Mean size for both males and females remains quite stable in 1992 compared with 1991 data.

Assessments

Length-based assessment

Due to the recent trends in both landings and effort it was considered necessary to perform a length-based assessment with Spanish length composition data for the period 1988-1992. The reference period for previous LCA(Anon., 1991a) was 1981-90. As there were no new biological data the input parameters to the 1993 analysis remain unchanged. Mean F values calculated over the lower 75% of the length ranges were 0.46 for males and 0.36 for females (Tables 5.13.6 and 5.13.7). The results of the prediction show a slight difference in the Y/R and biomass curves (Figure 5.13.2) compared with the previous assessment. The long-term Y/R curves for both males and females are both flat topped, with current F close to F_{max} in females and current F 40% above F_{max} in males, however, a reduction in effort to F_{max} would give a small long-term gain of 6% in Y/R and 51% in biomass/recruit.

Aged-based assessment

A multifleet age-based assessment was performed for males and females separately.

Males:

Catch at age was estimated for males by slicing length compositions of males into 10 "nominal ages" (11 plus group), for the period 1981-1992 in an initial run and for the period 1983-1992 in a second run. 'Age' compositions were generated for each fleet and a tuning file created. Tables 5.13.8 and 5.13.9 give combined catch at age and mean weight at age. The fishing effort index from Spanish vessels was used for tuning. The input choices are given in Table 5.1.4. The catchability coefficient was fixed for this fleet; other fleets were excluded, as was historic F. Excluding 1981-1982 data, the analysis improved and the second run was chosen. Variance in F was small compared to tuned input F. Tables 5.13.10 and 5.13.11 give F at age and numbers at age. Fbar (ages 3-8), total stock biomass, spawning stock biomass and log recruitment are given in Table 5.13.12. Fbar values ranged from 0.46 to 0.81. TSB and R show a decreasing trend up to 1989 and 1987 respectively and an increasing trend since then. The plot of mean F(3-8) on fishing effort (Figure 5.13.3) gave a significant correlation coefficient ($r = 0.695$, $p < 0.05$) suggesting that the VPA was reasonable.

Females:

The length compositions of the females for the period 1983-1992 were split into 6 nominal ages and a plus group. Catch and weight at age are given in Tables 5.13.13 and 5.13.14 respectively. Tuning of input F was carried out as for the males and F at age and numbers at age are given in Tables 5.13.15 and 5.13.16 respectively. Annual mean F was calculated over ages 2-5 and values fluctuated from 0.16 to 0.71 (Table 5.13.17). TSB seems to have been stable from 1983-1988, to have dropped in 1989 and to have again maintained stability up to 1991, but at a level about half that of the first period. TSB and R are lower than for the males. The plot of mean F(2-5) on effort (Figure 5.13.3) gives unsatisfactory results, showing a decrease of Fbar with increase of effort.

General comments on quality of assessment

The assessment of males performed reasonably well when data for the earliest years were excluded. At present it is difficult to justify the exclusion of these data but further examination may reveal an explanation for their apparent effect. The assessment for females cannot be considered as reliable. The K parameter and size of maturity should be revised. Also, the Irish length compositions influence the F at age, and, therefore, Fbar, which result generally in a high level since 1989.

Catch options

The VPA was considered unsuitable as a basis for a short-term prediction; however, the landings/effort relationship used previously (Anon., 1992a) was again considered suitable. The reference period was taken as that used in the LCA ie 1988-1992.

Relationships between landings and effort from Spanish finfish trawlers (Table 5.1.5 and Figure 5.13.4) and between total international landings and landings from finfish trawlers over the period 1982-1992 were used. The equation for the latter is as follows:

Total int. landings = 1.44 * Landings finfish + 809 ($r^2 = 0.92$)

Taking the average effort from 1988-1992 and applying ±20% gives the following international landings options:

Effort factor	Finfish effort	Predicted total int. landings (t)
0.8	64,963	1,551
1.0	81,204	2,224
1.2	97,444	2,898

The results of the length-based assessment gave a rather flat-topped Y/R curve and suggested that the long-term gains from an effort reduction would be small. The VPA suggested that TSB of the males increased from 1989. However, the VPA of females showed large differences in biomass estimates relative to males and no correlation between effort and Fbar was found. With these considerations in mind, it is recommended that fishing effort be maintained at the average level for the reference period used in the LCA (1988-92), similar to previous advice.

The resulting prediction, 2,224 t represents a 7% reduction compared to the value obtained in 1992 (2,400 t), but is consistent with the decreasing trend in landings and effort since 1989.

5.13.2 Aran Grounds (Galway Bay) (Functional Unit 17)

Data and input parameters

Landings data for this stock are available but there were no effort data and there was no sampling of length compositions in 1992. Details of the sampling carried out in 1990 and 1991 will be provided at a later date.

A summary of input data used in previous length-based assessments is given in Table 5.13.18.

General comments on quality of inputs

Most input parameter values are 'borrowed' from other stocks and the length data, such as they are, are limited.

Landings and effort

Landings were reported by Ireland, France and United Kingdom (Table 5.13.19). Irish information showed that in 1992 catches in this area decreased sharply to their lowest level recorded since data for this area were first separated from those for the Porcupine Bank in 1989. For the first time since then, at 108 t, they were less than the Irish Porcupine Bank landings (223 t); the smaller French landings also showed a decrease by 30 t to 4 t). Total international landings, which had been fluctuating downwards from 828 t in 1989 fell to 114 t, very much lower than that recorded for any other recent year. As happens in most years, the Irish fleet operated during most of the year, apart from July (when effort was diverted to the Porcupine Bank) August and September. Effort and mean size data are unavailable for this fishery in 1992. The great reduction in landings in 1992 was mainly due to a reduction in effort, resulting from a fall in the price for small *Nephrops* causing a switch of effort to other species. (This did not affect the Porcupine Bank fishery where the *Nephrops* are normally large.)

Assessments

Due to discontinuation of the Irish sampling programme in 1992, no data are available for assessments. In view of the limited base of the assessment carried out on data of 1991, it is not considered realistic to attempt to assess the stock one year later with no addition to the biological information available. Assessments last year suggested that the stock was fully exploited with F close to F_{max} for both males and females.

Catch options

In the absence of an age-based assessment there was no scope for carrying out a short-term prediction and the lack of effort data precludes the use of the predicted landings against effort plot. For this stock options based on the average landings (and average ±20%) over the period of the most recent LCA were appropriate. The reference period of this was 1990 to 1991 giving catch options for 1994 as follows:

Option	Landings(t)
-20%	358
Mean	448
+20%	538

Last year it was recommended that effort should not be increased and the same recommendation is again appropriate; accordingly a level of about 450 t is suggested.

This value is slightly lower than last year's (575 t) since the rather high landings of 1989 (included last year in the mean of the then most recent three years 1989-1991) were this time excluded.

5.13.3 Republic of Ireland Coast (NW, W and SW) (Functional Units 18 and 19)

Data and input parameters

There has been no sampling of length compositions from these units and there are no input parameter values available. In view of the size of the landings (see below) it would be desirable to sample these stocks.

Landings

Table 5.13.20 gives landings for these two Functional Units. Total landings in 1992 were again over 800 t, mostly from FU 19. Landings are currently the highest in the series.

Catch options

In the absence of any assessments or effort data the only type of catch options possible are those based on average landings. Since there has been no LCA the reference period is arbitrary. It is suggested that a mean of the last three years is appropriate, this gives options as follows:

Option	Landings (t)
-20%	602
mean	752
+20%	902

Last year, options based on the maximum landings of 725 t were advised but this was before revised 1991 landings and landings for 1992 were available. These suggest that the fisheries have expanded to over 800 t. It is considered that a more cautious approach is now required and a catch option based on the mean landings for the three most recent years is considered appropriate. This amounts to 2 t for FU18 and 752 t for FU19, a total of 754 t; the latter is a very slight increase on the corresponding value for last year.

5.13.4 Summary of Management Area VIIb,c,j,k

Summaries of the recent landings from this Management Area are given by Functional Unit and Country in Tables 5.13.21 and 5.13.22. The *status quo* option, together with other options of a 20% increase or decrease in mean effort (1988-1992) for FU16 and mean landings (1990-1991) for FU17 and mean landings (1990-1992) for FUs 18-19 are given below :

Effort/landings factor	FU16 Catch option (t)	FU17 Catch option (t)	FU18+19 Catch option (t)
0.8	1,551	358	602
1.0	2,224	448	754
1.2	2,898	538	902

By combining the recommended *status quo* catch option for each unit and allowing for the quantities from other rectangles (maximum landings of 317 are considered appropriate), an overall catch option as follows is obtained:

$$2{,}224 + 448 + 754 + 317 = 3{,}743 \text{ t.}$$

5.14 Management Area VIIf,g,h and VIIa: rectangles 33E2-E5(Area M)

Functional units Celtic Sea (20-22)

5.14.1 Celtic Sea (Functional Units 20-22)

Data and Biological inputs

Length compositions of French landings and discards were available from 1984 to 1992. The biological parameters which were used are given in Table 5.14.1 and remain unchanged from last year as no new data were available.

Comments on general quality of inputs

Length composition data of the French landings are collected throughout the year on a monthly basis in the three main home ports of Celtic Sea *Nephrops* trawlers which are Concarneau, Loctudy and St Guénolé. The number of vessels taking part in this fishery (about 100) is much smaller than in the Bay of Biscay. 5-6 samples of 100 *Nephrops* each are measured every month. In 1991 samples of discards were obtained from a number of commercial vessels thanks to an EC contract; discard sampling cannot be performed every year owing to financial constraints and 1992 discards length distribution was derived from 1991 discards data. Irish catches are not sampled. Initial values of growth parameters obtained from studies on the stock were modified at the 1991 Working Group in order to obtain more realistic results in the LCA and to be consistent with the nearby stocks. Other inputs have been obtained from studies on the stock, with references given in Table 5.14.1.

Landings

Landings were reported by France, Ireland and UK. In recent years French landings have accounted for about 80% of the total. The French *Nephrops* fishery in the Celtic Sea is prosecuted by vessels landing their catches in the southern part of Brittany. Over the last 10 years, landings have fluctuated around 3,000 t/year, with peaks of over 3,500 t in a number of years, viz. in 1983, 1984, 1985 and 1990 (3,762 t) (Table 5.14.2). In 1991 they dropped to 2,652 t for unexplained reasons. They increased again in 1992 reaching 3,477 t. Discarding is substantial in this fishery, the commercial minimum landing size being clearly above the legal minimum landing size set by the EC (35mm CL as opposed to 25mm CL). Irish landings were of 1,011 t in 1992, which was the highest value ever reached since 1983, well above the mean of 9 previous years, 408 t.

Effort

Fishing effort (reference port Saint Guénolé) has steadily increased over the past years from about 4,100 days fishing in 1985 to 5,460 days in 1990 and dropped slightly to 5,075 days in 1991 (Table 5.14.3). The effort figure of 4,168 days for 1992 is provisional because it does not include data for October and December 1992. Nevertheless, the switch to tuna fishing in summer, already observed in 1991, happened again in 1992. French total effort data were available from 1984 to 1991 (Table 5.14.3). Since the EC log-book is compulsory for all vessels which fish in this area, effort records are expected to be better than in the Bay of Biscay. Total effort decreased from 247,637 hours in 1984 to 183,203 hours in 1988, then increased to 280,163 hours in 1990 (maximum value of the series) and decreased slightly to 264,226 hours in 1991. There were no Irish effort data.

LPUE

LPUE values of French *Nephrops* trawlers, which were fluctuating around 250kg/day until 1990, suddenly dropped to 181 kg/day in 1991 but recovered to a value of 227 Kg/day in 1992, which is more in accordance with the average from 1983 to 1990. LPUE in Kg/hr has fluctuated around 14 and shows no particular trend; the 1991 value was abnormally low. The trends in landings, effort and LPUE are shown in Figure 5.14.1.

Mean size

Length compositions from French sampling provided information on the mean size. The mean sizes of males and females landed remained fairly stable over the period 1984-1992 (38-39mm for the males and 35-36mm for the females) (Table 5.14.4). No mesh change occurred over this period.

Assessments

Length cohort analysis

As no new parameters were available, it was considered unnecessary to repeat a length-based assessment by simply adding the 1992 length composition.

Age-based assessment

The age-based assessment performed last year gave fairly good results for males, considering the significant correlation between mean F and effort. On the other hand, it did not work for females. It was therefore decided to perform another age-based assessment for males only, to judge the relevance of trying a short-term prediction.

Males:

As there are French and Irish vessels involved in the fishery, a multi-fleet assessment was performed as last year. Since the French total effort figure was not available for 1992, the value used for tuning was an estimate. French distributions of dead discards and landings were applied to Irish landings in order to derive Irish length distributions. This probably gave overestimates of discards for Ireland, since the minimum landing size is set at 35mm in France for commercial reasons. The length distributions were split into 6 'nominal age' groups (plus-group at 7). Catch and weight at age are given in Tables 5.14.5 and 5.14.6. Inputs chosen for the tuning procedure are given in Table 5.1.4. As no effort data were available for the Irish fleet it was excluded from the tuning. Variances of F obtained from effort data were low compared to tuned F values. F at age and numbers at age are given in Tables 5.14.7 and 5.14.8. The lowest values of Fbar (Table 5.14.9) are 0.26 and 0.30; these correspond to the low total effort values in 1986 and 1988. For the other years, Fbar fluctuated between 0.34 and 0.47, with a range of values slightly smaller than those obtained last year except in 1988 (same value). The regression of Fbar against effort (Figure 5.14.2) gave a non significant correlation. It was then decided not to go further in the assessment.

General comments on quality of assessment

As already mentioned last year, the unreliability of age-based assessments for the Celtic Sea may be due to the impossibility of sampling separately the 3 Functional Units because vessels can fish in the 3 areas on the same trip. The variations of proportions of effort allocated to the 3 Units may also vary from year to year. This may confound the assessment process. The total effort series may also contain non-*Nephrops*-directed effort, since trips retained for the series are those in which at least 10% of *Nephrops* in value is found. Input growth parameters may also limit the usefulness of the results as mentioned above.

Catch options

The quality of the age-based assessment precluded the application of short-term prediction methods, so it was first decided to use the relationship between landings and effort to calculate catch options, as last year when there was quite a good correlation coefficient. The 1991 values of landings and effort, however, were very unusual and led to a non-significant value of r (Table 5.1.5). It was then decided not to use this relationship but instead to take the average total landings (from Table 5.14.2) of the reference period used in the last 1991 LCA (1987-1990). This gave a value of 3,559 t with a ± 20% range of 2,847-4,271 t.

The last LCA performed in 1991 showed that F was close to F_{max} and a *status quo* effort was advised. There is little reason to change this advice so that predicted landings of 3,559 t are suggested. This figure is in fact very close to last year's recommendation based on the landings/effort plot.

5.14.2 Summary of Management Area VIIf,g,h and VIIa 33E2-E5

Summaries of the recent landings for this Management Area are given by Functional Unit and Country in Tables 5.14.10 and 5.14.11 respectively. The catch options for this area have been obtained by using a regression between the total landings (TL1) for the FU (Table 5.14.2) and total landings including 'other rectangles' (TL2) (see table 5.14.10). The value of 3,559 t was put in the relationship:

$$TL2 = 0.946 * TL1 + 253$$

The resulting options are an average of 3,620 t with a ± 20% range of 2,896 to 4,344 t. As discussed above the average is considered appropriate and is very close to previous recommendations.

5.15 Management Area VIIIa,b (Area N)

Functional units Bay of Biscay (23-24)

5.15.1 Bay of Biscay (Functional Units 23+24)

Data and biological inputs

Length compositions of French discards and landings were available from 1984 to 1992. Table 5.15.1 gives details of sampling.

New values of growth parameters were tried this year according to new growth data results from radioisotope measurements in the carapace (not published yet). These indicate that males moult twice a year without any size effect. Females moult twice a year before reaching sexual maturity. Afterwards, it is still difficult to determine moult frequency: large females (carapace length greater than 35 mm) moult either once or twice a year. The same growth parameters were used for males and immature females as follows: the K value chosen was greater than that used previously (0.14 instead of 0.11) and the value of L_{inf} was kept unchanged. The lower value of 0.11 was applied to mature females without changing the L_{inf} value either. The corresponding curves are plotted in Figure 3.4.1 For consistency with other stocks, different values of M were applied to immature and mature females (0.3 and 0.2 respectively). The other inputs were the same as those used last year and given in Table 5.15.1

Comments on general quality of inputs

Length frequency data are being collected throughout the year on a monthly basis from samples of landings taken in the northern part of the Bay of Biscay. These represent 70-80% of the overall landings from Divisions VIIIa and VIIIb. The fishery in this area is prosecuted by a large fleet of over 300 inshore trawlers landing between 50 and 100 Kg/day fished during daily trips for most of them. Each month, 20-30 samples of around 15-20 animals each are taken. Discards are not regularly sampled; a discard sampling programme was performed in 1985 and length compositions from 1984 to 1990 were derived from it; a second programme was performed in 1991 on a number of commercial fishing vessels thanks to an EC contract. 1991 discard data were used to derive 1992 discard length compositions.

Input parameters values have been obtained from different studies on the stock; references are given in Table 5.15.1

Landings

Landings from these units were predominantly by French vessels and Spain reported landings from rectangles outside the Functional Units but inside the Management Area (see below). Over the past ten years, *Nephrops* landings from this area averaged 5,300 t, the largest catches having been taken in 1983, 1988 and 1992 (Table 5.15.2).

Effort

Fishing effort (reference port Lesconil) dropped from 6,481 days in 1983 to 5,137 days in 1986. Following a period of stability in the years 1987 to 1989 at around 5,500 days (Table 5.15.3) effort has dropped to below 5,000 days since then. The decrease went along with a gradual change in the fishing practices of the Bay of

Biscay *Nephrops* trawlers, which have tended to divert their effort to finfish in the seasons of reduced *Nephrops* availability (autumn - winter).

Total effort data were available (Table 5.15.3) but only from 1984 to 1991. The steady increase from 470,991 hours in 1984 to 753,129 hours in 1988 is more due to improvements in fishery statistic records than to a real increase in effort. A lot of vessels fish in coastal areas and are not required to submit an EC log-book, implying that a national recording system is also desirable at present. Total effort has been decreasing from 1989 to 1991, as observed in the partial effort series. Total effort is expected to be stabilized from now on due to the fleet control implemented in the EC. The time series of landings, effort and LPUE data are shown in Figure 5.15.1.

LPUE

LPUE shows no particular trend (Table 5.15.3); instead it has fluctuated around 100 Kg/day throughout the reference period (1983-1992), with peak values in 1983 and 1988.

Mean size

Although selectivity for *Nephrops* is poor, mesh increases are expected to produce mean size increases. This seems to have happened for males in 1986 (mesh increase from 45 to 50mm) and for both sexes in 1990 (mesh increase from 50 to 55mm) (Table 5.15.4). Mean sizes unexpectedly decreased in 1992 and it is difficult to identify explanatory factors, for example changes in sorting practices or gear characteristics. It is therefore difficult to interpret mean size series. Average length compositions from 1987 to 1989 (before the last mesh increase) and from 1991 to 1992 years have been plotted in Figure 5.15.2. Shifts of modes towards the right can be observed for both sexes, but the female one is more marked.

Assessments

Length cohort analysis

Because of the consecutive mesh size increases, from 45 to 50mm in 1986 and again from 50 to 55mm in 1990, it was decided to perform 2 length-based assessments before and after the last mesh increase. The years when mesh increases occurred were excluded, and length compositions were averaged over 3 years for the first period (1987-1989) and over 2 years for the second period (1991-1992).

Male and female results for the periods before and after the change are given in Tables 5.15.5-5.15.8 and Figures 5.15.3 and 5.15.4. The male Y/R curve for the first period (1987-1989) shows that current F was 60% above F_{max}. The gains obtained by decreasing effort to F_{max} would be 27% for landings and 122% for long-term biomass. The Y/R curve for the second period (1991-1992) is less domed with current F 50% above F_{max}, and long-term gains by reducing effort to F_{max} are 16% and 95% for landings and biomass, respectively.

The female Y/R curves are flat-topped. Current F for the first period was 30% above F_{max}, but with a small long-term gain (5%) obtained for landings by decreasing effort to F_{max}. Low values of F (less than 0.2) were observed for lengths greater than 35 mm. Current F for the second period is at F_{max}. The last mesh increase has improved the exploitation pattern of the stock. No new mesh assessment was performed but it could be useful to perform one in future years, since the effect of mesh increase on the exploitation pattern is likely to be beneficial.

Age-based assessment

Since the age-based assessment did not perform well last year, mainly because of unsatisfactory total effort series and growth parameters, it was decided that it was not worth repeating the assessment. The effort series is not likely to be improved unless coastal vessels are required to submit a log-book, which is not the case at the present time. The new values of growth parameters used this year were set taking in account new data on growth but did not result from any statistical fit as explained above.

General comments on quality of assessment

The main source of unreliability in the assessment is still the growth parameters for which revision is in progress as explained above. Moreover, the fact that discards are not regularly sampled makes the length compositions of catches less reliable.

Catch options

Owing to the lack of a reliable age-based assessment, short-term predictions were not possible. However, for this stock it is possible to use the relationship between landings and effort. A significant correlation was obtained so the equation of the regression was used (Figure 5.15.5, Table 5.1.5). The average effort of the last 3 years for which effort data were available (1989-1991) was put into the relationship:

$$\text{Landings} = .005855 * \text{effort} + 1487$$

and gave a value of 5,516 t with $\pm$ 20% effort changes corresponding to catch options of 4,710-6,321 t.

The conclusion from the length-based assessment is that effort should be reduced, but on the other hand the series of landings and LPUE do not show any decreasing trend and do not lead to any particular worry about the fishery. Accordingly, the recommendation for this stock is to maintain *status quo* effort by taking the average landings.

5.15.2 Summary of Management Area VIIIa,b

Summaries of the recent landings from this Management Area are given by Functionnal Unit and country in Tables 5.15.9 and 5.15.10. There were landings made by France and Spain from statistical rectangles outside the Functional Units but inside the Management Area. A regression was calculated between Total and Functional Unit landings in order to obtain a catch option value for the Management Area. By putting the catch option retained for France in this relationship:

Total landings = FU landings * 1.0087 + 10

an overall value of 5,574 with a ± 20% range of 4,761-6,386 t was obtained. This results in a reduction in the catch option level given last year.

5.16 Management Area VIIIc (Area O)

Functional Units North Galicia (25)
Cantabrian Sea (31)

5.16.1 North Galicia (Functional Unit 25)

Data and biological inputs

Length compositions were available for 1984-1992. All input parameters remained the same as in previous years (Table 5.16.1).

Comments on general quality of inputs

The quality of statistics collection follows the same general tendency of most previous years. Landings are sampled on a monthly basis at La Coruña. In 1992 the sampling level averaged 6 samples per month and 81 individuals per sample (Table 5.16.1). Effort data were available for the period of analysis (1984-1992).

L_{inf} of males and females is based on length frequency data. Uncertainties appear in the K growth parameter used for males and females, compared with that of other stocks. The values used in previous analyses were maintained for lack of new information.

Landings, Effort and CPUE

Landings were reported by Spain only. Landings from the North Galician *Nephrops* fishery have fluctuated between 289 and 514 t over the period 1983-1992. Landings in 1992 were 427 t, slightly above the 1991 landings, continuing the increasing trend after the minimum of 289 t reached in 1990 (Table 5.16.2).

Table 5.16.3 gives the fishing effort and CPUE for 1983 - 1992 (port of reference La Coruña). A decreasing trend in fishing effort occurred during the period 1982-1987. Then, after an increase during 1988-1989, effort remained steady in 1990 but dropped slightly again in 1991 and 1992.

CPUE (there are no discards) fluctuated without trend (Table 5.16.3). The 1992 value is above the mean level of the reference period and maintains the recovery which began in 1991, after the minimum of 1990. A longer time series of landings, effort and CPUE are shown in Figure 5.16.1

Mean Size

Table 5.16.4 gives the mean size of *Nephrops* males and females in the landings. Since 1983 mean sizes of both males and females have fluctuated, with a peak in 1989 for males and in 1990 for females, but a clear trend is not observed.

Assessments

<u>Length-based assessment</u>

There was no new information about the input biological parameters so, for this reason, a new length-based assessment was not made and the 1991 LCA remained unchanged. As indicated an earlier report (Anon., 1991a) the Y/R curves indicate that current F is 40% above F_{max} for both males and females. A reduction in current levels of effort to F_{max} predicted a small gain (≤ 5% for both sexes) in long-term landings.

<u>Age-based assessment</u>

Landings were reported by Spain only so a single fleet assessment was done.

Males:

Length compositions were split into 9 'nominal age' groups (10 = plus group) using the slicing technique. Resulting catch at age and weight at age are shown in Tables 5.16.5 and 5.16.6, respectively. These were used as input to the VPA tuning which used Spanish effort data and historic F. Choices for tuning input are given in Table 5.1.4. The tuning output gave F estimates with reasonably small variances. Tables 5.16.7 and 5.16.8 show F at age and N at age. The mean F(2-8) ranged from 0.51 to 1.07 fluctuating without a clear trend (Table 5.16.9). The plot of Fbar (2-8) on effort (Figure 5.16.2) gave a significant correlation ($r = 0.784$, $p<0.05$), improving the previous analysis (Anon., 1992a). The TSB fluctuated with a decreasing trend up to 1989 and an increase subsequently. The recruitment fluctuated with similar pattern but with the lowest value in 1987 (Table 5.16.9).

Females:

Length compositions were split into 10 'nominal age' groups with a plus group at 11. The resulting catch at age and weight at age are given in Tables 5.16.10 and 5.16.11. These were input to the VPA tuning which, as for the males, used Spanish effort data and historic F. Choices for tuning input are given in Table 5.1.4. The tuning output gave F estimates with reasonably small variances compared to the magnitude of input F. Tables 5.16.12 and 5.16.13 show F at age and N at age. F bar (3-5) for females (Table 5.16.14) fluctuated from 0.39 to 0.76 without trend. The plots of Fbar on effort gave a poor correlation (r=0.07) (Figure 5.16.2). TSB fluctuated without trend (Table 5.16.14) and seems to have been relatively stable. Recruitment fluctuated for females from 1984 to 1990 showing a minimum in 1988. The values of TSB and R were lower than for males .

General comments on quality of assessment

Sampling level and data collection seems to be at an acceptable level for assessment purposes. The quality of biological inputs is not really adequate, since no experimental data exist to support the estimate of growth parameters. However, in terms of fishing effort, the LCA provides a guide to the state of exploitation of this FU. Greater success could probably be achieved in terms of acceptability of the assessment with significant changes and new information about growth and exploitation pattern inputs.

Catch options

Although improvements were made in the VPA of males compared with the previous analysis, the null correlation of Fbar and effort for females indicated that age-based assessments were not successful for this element of the stock and were unlikely to prove reliable in making short-term predictions of catches.

Since the relationship between landings and effort is poor (Table 5.1.5, Figure 5.16.3), the mean value of the landings over the LCA reference period 1984-1990 (± 20 %) is suggested instead (Table 5.16.2). The estimate is 411 t, with a ± 20% range of 329-493 t.

More attention is paid to the indicators from LCA reported in the 1991 Report (Anon., 1991a). Because the reduction in fishing effort would produce a small long-term gain, the recommended management strategy would be to maintain fishing effort at the average level for the reference period used in LCA (1984-1990). The option of 411 t is consistent with this recommendation.

5.16.2 Cantabrian Sea (Functional Unit 31)

Data and biological inputs

There is no new information concerning biological parameters for this stock and they remain as in Table 3.4.1. Length composition data from monthly sampling of landings at Avilés and Santander were raised to area landings. In 1992 the sampling level was 2 - 3 samples per month, averaging 136 individuals each. Table 5.16.15 gives details.

Comments on general quality of inputs

Table 5.16.15 shows that most values used previously were borrowed.

Landings, effort and CPUE

Nephrops landings data are available from 1983 to 1991 (Table 5.16.16). Landings doubled from 1983 to 1985 and remained around 130 t between 1985-89. Landings increased in 1990 reaching a peak of 185 t and decreased in the following years, being in 1992 half the 1990 level.

Effort and CPUE (there are no discards) of the trawlers of Avilés are available for the period 1983-1992 (Table 5.16.17). Effort decreased by 38% compared to 1991 data. CPUE fluctuated between 2.4 and 6.9 kg/BHP*day/100 since 1983, with an increasing trend between 1985-1990. CPUE in 1992 is somewhat below that of the previous year.

Mean size

Data on mean size of males and females for 1988-1992 are shown in Table 5.16.18. In this period mean sizes appear to be stable around the mean of 41mm carapace length for males and 38mm for females.

Assessment

<u>Length-based assessment</u>

Because the input parameters remain unchanged and the 1992 length composition data showed little difference from the average for 1988-1990, the LCA carried out in 1991 was not repeated.

The Y/R results of the 1991 LCA showed that current F was 30% above F_{max} for males and well below F_{max} for females. A reduction in effort towards F_{max} was predicted to lead to small gains in long-term landings for males (about 3%) while for females it would give losses of about 10%.

Age-based assessment

The length composition data series available is too short (1988-1992) for a reliable age-based assessment. For this reason this analysis was not carried out.

Catch options

No short-term prediction was possible and the relationship between landings and effort was not considered suitable because effort data are available only for the fleet of Avilés. The mean value in the reference period of LCA (1988-1990) is retained. This amounts to 158 t, with a ± 20% range of 126 - 190 t. The results of the previously performed LCA (Anon., 1991a) form the basis for the management option and, for the time being, maintenance of the current level of effort is recommended.

5.16.3 Summary of Management Area VIIIc

Summaries of the recent landings from this Management Area are given by Functional Unit and country in Tables 5.16.19 and 5.16.20. The catch option for the area as a whole is given by adding the catch option for FU25, ie 411 t, to the catch option for FU31, ie 158 t. There were no landings from "other" rectangles. The overall catch option amounts to 569 t, with a ± 20% range of 455 - 683 t.

5.17 Management Area VIIId,e (Area P)

Functional Units None

5.17.1 Summary of Management Area VIIId,e

Zero TAC to prevent misreporting.

5.18 Management Area IXa (Area Q)

Functional Units West Galicia (26)
North Portugal (27)
SW and S Portugal (28 and 29)
Gulf of Cadiz (30)

5.18.1 West Galicia (Functional Unit 26)

Data and biological inputs

Landings were sampled at the port of Marín on a monthly basis. 2 samples per month were taken in 1992, averaging 239 individuals per sample (Table 5.18.1). Landings and length compositions used in LCA were for 1991-1992. The input parameter values were as used last year (Table 3.4.1). Sources of these are given in Table 5.18.1.

Comments on general quality of inputs

The comments made for Functional Unit 25 about biological inputs also apply in this case.

Landings, effort and CPUE

Landings data were reported by Spanish vessels only. Landings in 1992 were 584 t representing a slight increase compared with the previous year (Table 5.18.2). A plot of long-term landings is shown in Figure 5.18.1.

CPUE data (discards are considered negligible) are available for the fleets of Muros and Riveira since 1984 and for the fleet of Marín since 1990 (Table 5.18.3). These data show fluctuations with low values in 1990. The figure for Marín is high due to the fact that one trip for Marín vessels is of three days duration, in contrast to the daily trips made by the vessels of Muros and Riveira.

Mean size

The mean size of males and females in the landings are given in Table 5.18.4 for 1983, 1985-1986 and 1988-1991. Mean sizes of males and females fluctuated without trend until 1988. A fall in the mean size of both sexes occurred in 1989 and continued in 1990. Afterwards, mean sizes began an increasing trend and in 1992 were slightly above the means of the period preceding the fall.

Assessment

Length-based assessment

The two years of additional length compositions since the last LCA (Anon., 1991a) were compared with the length data set used in the previous analysis, when the reference period was 1989-1990. The mean size of both males and females shows indications of changes in size compositions between the periods 1989-1990 and 1991-1992, and this evidence was corroborated when comparing the overall length distributions for males and females of the two periods. It was decided to perform a length-based assessment with more recent length data (1991-1992). Tables 5.18.5 and 5.18.6 give LCA results for males and females, respectively.

Annualised mean F values for the lower 75% of the length range were 0.66 and 0.38 for males and females respectively. The Y/R curve for males (Figure 5.18.2) indicates that current F is 50% above F_{max}, and long-term gains from a reduction in effort to F_{max} would be 16% for landings and 126% for biomass. The Y/R curve for females is flat-topped. Current F is 40% above F_{max} but with a small long-term gain from a reduction of effort to F_{max} (<6% for landings and 58% for biomass).

Age-based assessment

No age-based assessment was made because of the lack of length compositions in 1984 and 1987 which left gaps in the series of years.

General comments on quality of assessment

The LCA results show some inconsistency with the recent trend in mean size for both sexes. Other FUs with similar ranges of mean sizes show rather different states of exploitation: ie long-term curves flat-topped and current F close to F_{max}. Although the level of data on landings and sampling may be acceptable, the revision of biological inputs and incorporation of new information probably make the assessment more reliable.

Catch options

Owing to the lack of a VPA there was no scope for making short-term predictions of the type found in finfish assessments. The complete effort data series is short and prevents the use of a landings and effort relationship. Catch options were therefore provided on the basis of average catches (and average catches $\pm$ 20%) over the reference period of the LCA (1991-1992).

These options are 566 t, with a $\pm$ 20% range of 453 - 679 t.

The new LCA applied to the reference period 1991-1992 produced slightly different results from those of the previous analysis. Although the results were questionable, it was felt that effort should be at least stabilised because such indications as there were suggested that a reduction in fishing effort to F_{max} would produce long-term gains. The *status quo* option of 566 t is suggested as the appropriate one. This option is slightly higher than that proposed last year (514 t).

5.18.2 North Portugal (North of Cape Espichel) - Functional Unit 27

Data and biological inputs

No biological parameters are available for this Functional Unit. The length/catch composition for the period 1985-1992 was estimated from a few samples collected from one Portuguese harbour, Matosinhos. In 1987 there was no sampling (Table 5.18.7).

Comments on general quality of inputs

Only 3 samples were collected in 1991, corresponding to a total of 100 individuals measured, ranging from 24 to 44 mm carapace length (both males and females). During 1992 only 5 samples in July and August, with a mean of 26 individuals per sample, were used for measurements, ranging from 24 to 50mm carapace length for females and from 22 to 61mm for males (Table 5.18.7).

Some of the boats fishing this stock land in the Spanish harbours of Vigo and Marin and there is no information on landings composition from these.

Landings

Table 5.18.8 and Figure 5.18.3 show the evolution of total estimated landings during 1983-1992 and by gear (trawl and creel) since 1983. Total landings from this stock have fluctuated between 14 and 96 t per year. The maximum landing of 96 t was reached in 1988 and the lowest in 1984 and 1985 (14 and 15 t per year, respectively). Landings increased from 1986 to 1988 (maximum landing) and have fluctuated since then; there is an increase of about 10% in the trawl landings in 1992 compared with 1991.

Effort

There are no data available on fishing effort for 1992. Fishing hours were estimated assuming that the 1992 value of CPUE (kg/hour) was the same as that of 1991. Table 5.18.9 and Figure 5.18.3 show the changes in the estimated fishing effort from 1985 to 1992. Estimated trawling fishing hours increased in the period 1985-1987, from 5.4 to 14.2 thousand. During 1988-1991 trawling fishing hours decreased to a mean level corresponding to half of the 1987 level.

Since 1987, the total number of trawlers catching *Nephrops* and landing in Portuguese harbours has been kept stable (around 8 per year); from these boats only one has a licence to fish crustaceans.

LPUE

The estimated LPUE has fluctuated during the period 1985-1991, from 2 kg/h in 1985 to 7 kg/h in 1989. In 1990 it decreased by 50% when compared with 1989. In 1992 LPUE is assumed to be the same as that in 1991 (Table 5.18.9, Figure 5.18.3).

Mean size

Mean carapace length data for males and females, from trawl landings and from research surveys, are available for 1985-1992; there were no surveys in 1989 (Table 5.18.10). The mean sizes in the landings have decreased since 1989, while in the surveys they have fluctuated.

Results on *Nephrops* from the demersal surveys in the period 1989-1992 were presented in a Working Paper (Silva, A.). The mean size for both sexes during this period has fluctuated without obvious trend.

Assessments

As no new information about growth parameters was presented there seemed to be little reason to repeat the length cohort analysis performed at the 1991 Working Group.

The results from the LCA performed in 1991 indicated that the current level of F for males was 20% beyond the level of F_{max} and for females was far below the level of F_{max}. For males a reduction in effort from the current level to F_{max} would increase the long-term landings by 2%. In females increases in effort by as much as 50% would increase the long-term yield by only 7% and would decrease long-term biomass by 26. Reductions in effort would increase long-term biomass of both males and females.

Catch options

Since VPA applied to this stock is at present questionable there is no prospect of making a short-term prediction. Since effort data are considered somewhat unreliable the landings/effort plot, which was last year not significant, has not been repeated this year. Instead, the options are based on average landings. Taking the LCA reference period (1985-1990) gave an average of 60 t but this contained two rather low figures in the early years which were not considered representative.

Instead an average based on catches for a more representative period (1987-1992) is included. At 71 t this is practically the same as for the period 1987-1991 considered in last year's report. The ±20% range is 56-84 t.

The LCA of 1991 is taken as a guide and this suggested that effort should be stabilised. For catch option purposes, an amount of 70 t is proposed for 1994.

5.18.3 South West and South Portugal (Functional Units 28 and 29)

Data and biological inputs

The input biological parameters were the same as those used at the 1990 Working Group (Table 5.18.11). For females two growth curves were considered, setting the transition length at 26mm carapace length. The values of $L\infty$ were chosen to be greater than the largest sizes in the samples, i.e., 70 and 65 mm for males and females, respectively. Values of k were calculated from Ford-Walford plots, based on the chosen values of $L\infty$ and annual growth increments using Bhattacharya's method for all males and for females <26mm. Tagging experiments (Figueiredo, 1989) provided the growth increments for females ≥ 26mm (i.e. the size at 50% maturity).

Length compositions of *Nephrops* catches were estimated from samples taken from trawl landings at the most important fishing ports where the Portuguese boats landed in 1992, Vila Real de Santo Antonio in Portugal and Ayamonte in Spain. A sampling programme, conducted by Portugal, was started in 1992 in Ayamonte.

Comments on general quality of inputs

In the 1984-1986 period, the average number of samples measured annually was 150 per sex; since then the average number of samples has decreased reaching, in 1991, the lowest level of 25 samples per year and, in 1992, 38. In the period 1984-1992 for each sample an average of 45 individuals were measured except for 1991 when 38 individuals were measured (Table 5.18.11).

No sampling of creel catches took place; however, it should be emphasized that this fishery only contributes about 2% of the total catches.

During the 1992 Working Group length frequency distributions for 1984-1990 were revised according to the new estimates of the catches for that period and they correspond to an improvement in catch estimates. A new project is in progress for revision of the effort data based on logbook information from the crustacean boats and also from numbers of days landed information.

Landings

Table 5.18.12 and Figure 5.18.4 show total landings by gear (trawl and creel) since 1983. Total landings from South West and South Portugal have fluctuated between 257 and 509 t per year.

Since 1983 the estimated catches have increased from 257 t to around 500 t in 1987. Since then the catches have fluctuated around an average level of 441 t per year. For 1992 the catch was 472 t which is similar to 1991; 3 Spanish trawlers were fishing this stock during 1992, but information from them is not available. Most of the landings come from trawlers.

Effort

There are no data available on fishing effort for 1992. Fishing hours were calculated assuming that the 1992 value of LPUE (kg/h) was the same as that of 1991. Table 5.18.13 and Figure 5.18.4 show the fishing effort and LPUE estimated in the 1992 Working Group.

Fishing effort increased between 1983-1985 and decreased from 1985 to 1989 reaching a minimum in 1989 of 52,000 hours. The total number of trawlers which caught *Nephrops* increased from 30 in 1983 to 41 in 1986/1987. Since then the number of trawlers catching

Nephrops has been kept stable (around 37 per year). This is a mixed fishery for *Nephrops* and shrimps.

LPUE

Catch per unit effort increased from 1983 to 1989. Since 1989 CPUE has fluctuated around an average value of 12 t per trawler and 7.5 Kg/hour.

Mean size

Mean carapace length data, for males and females, from trawl landings and from research survey catches are available for 1983-1992 and are presented in Table 5.18.14. The mean size of *Nephrops* in the landings for both sexes has remained fairly constant.

Assessments

Length-based assessment

LCA was carried out for males and females for the reference period 1988-1992.

Results derived from LCA carried out using the mean length composition of the period 1988-1992 indicated that the results from last year remain valid. Tables 5.18.15 and 5.18.16 give the results. For males the current level of F is 50% above the level of F_{max} and for females current F is 30-40% above F_{max} (Figure 5.18.5). In males a reduction in current F to F_{max} would improve long-term landings by 13% and biomass by 117%. For females decreasing fishing effort to F_{max} would hardly affect long-term yield (only 3%) but would increase long-term biomass by 76-48%.

Age-based assessments

A single fleet assessment was carried out using Portuguese data from 1984-1992.

Males:

The slicing procedure generated 10 "nominal age" groups (10 = plus group). Tables 5.18.17 and 5.18.18 show catch at age and mean weight at age which were used as input to the VPA.

Terminal fishing mortality was tuned using estimated fishing effort data. The tuning input choices (Table 5.1.4) were similar to last year's report. Tables 5.18.19 and 5.18.20 present the F at age matrix and population in numbers (thousands) at age respectively.

The average fishing mortality for ages 2-5, as well as Total Stock Biomass (TSB), Spawning Stock biomass (SSB) and log Recruitment are presented in Table 5.18.21. The plot of Fbar versus fishing effort is presented in Figure 5.18.6. The relationship is not statistically significant. This could be due to the estimated effort data. For males the level of fishing mortality (F bar) has remained relatively stable around a value of 0.6 in the period 1984-1992. The same value for length range (24 - 50mm) was obtained from the LCA analysis in the period 1988-1992.

Females:

The slicing procedure generated 10 "nominal age" groups (10 = plus group). Tables 5.18.22 and 5.18.23 show catch at age and mean weight at age which were used as input to the VPA.

Terminal fishing mortality was tuned using estimated fishing effort data. The tuning input choices were similar to last year. Tables 5.18.24 and 5.18.25 present the F at age matrix and population in numbers (thousands) at age respectively. Fishing mortality rates were about 0.5 for the whole period. A value of 0.3 was obtained from LCA analysis for a length range (24-48mm) during 1988-1992.

The average fishing mortality (Fbar) for ages 3-8, as well as Total Stock Biomass (TSB), Spawning Stock biomass (SSB) and log Recruitment are presented in Table 5.18.26. The plot of Fbar versus fishing effort is presented in Figure 5.18.6. The relationship is not statistically significant. The VPA results indicate that the level of fishing mortality for both sexes has been relatively stable.

Comments on quality of assessment

There is some doubt about the reliability of these assessments because of the quality of the effort data which are estimated. It is hoped that the aforementioned revisions of these data will result in improvements.

Catch options

Using the "age"-based assessment results, a short-term prediction was attempted for males and females. There is no recruitment index so an average is taken of the 1984-1990 recruits at "age 1". Also, since the 2-year-old numbers at the start of 1992 are not reliably estimated, the average of "2-year-olds" has been taken over the same period, and used to overwrite the stock size at the start of prediction year 1993. Fishing pattern is the average for 1988-1992 and F values are scaled to the 1992 level. The results suggested that under *status quo* conditions of fishing mortality the SSB and catches remain constant in 1994 and 1995 for females and males. Owing to the uncertainty in the VPA results, the prediction is not used as a basis for providing catch options. The results, however, are included for illustrative purposes in Tables 5.18.27 and 5.18 28.

In view of the uncertainty about the estimated effort data, the plot of landings against effort has not this year been repeated. Instead the catch option is based again on average landings. The average of the 1993 LCA reference period (1988-1992) is 441 tonnes with a ± 20 % range of 352-529 t. As a guide to the most appropriate option, the 1993 LCA results were referred to. These suggested that effort should be at least stabilised so that the option of 441 t is to be preferred.

At the 1992 Working Group a value of 450 t was recommended as the catch option for 1993 based on 1987-1991 average catch data. Since this year's recommendation is so close, it is suggested that for practical reasons 450 t is maintained. Landings for this stock have been relatively stable over a number of years. The 1994 recommended catch maintains this position.

5.18.4 Gulf of Cadiz (Functional Unit 30)

Data and input parameters

There are no length data and no input parameter values available for this stock.

Landings

The table of landings was updated (Table 5.18.2). Landings fluctuated with a peak of 302 t in 1988, followed by a minimum of 139 t. Since 1989 landings recovered and remained above the 200 t in the 3 most recent years.

Assessments

There were insufficient data to carry out any assessments.

Catch option

The catch option adopted in previous years was the maximun landing in the time series (i.e. 302 t). This option is retained, although it should be noted that it is above the average landings of the most recent 3 years (228 t).

5.18.5 Summary of Management Area IXa

Summaries of the landings for this Management Area are given by Functional Unit in Table 5.18.29 and by Country in Table 5.18.30. The options for this Area, based on average landings, are summarised below for the reference periods 1991-1992 (FU26), 1987-1992 (FU27) and 1988-1992 (FU28-29). For FU30, maximum landings are again proposed. There were no landings from other rectangles.

	Average landings options		
FU	0.8	1.0	1.2
26	453	566	679
27	56	70	84
28-29	352	450	529
30		302 max.	

Total recommended landings for this Management Area are given by:

566 + 70 + 450 + 302 = 1,388 t

5.19 Management Area IXb and X (Area R)

Functional Units None

5.19.1 Summary of Management Area IXb and X

Zero TAC to prevent misreporting.

6 ASSESSMENTS AND CATCH POSSIBILITIES FOR *PANDALUS*

6.1 *Pandalus* stocks in Sub-area IV and Division IIIa

A detailed overview of the various stocks is given in Anon. (1990b). The Working Group groups them into three assessment units (Figure 6.1.1):

1. Skagerrak and Norwegian Deeps combined.
2. Fladen Ground.
3. Farn Deeps.

Nominal landings for Division IIIa and Sub-area IV are shown in Table 6.1.1.

6.2 Natural Mortality

The level of natural mortality for *Pandalus* has been discussed on several occasions. The values used by the Working Group, i.e. 0.75 for Division IIIa, IVa East and 1.0 for the Fladen Ground are not well founded. Based on stock sizes of predators in the North Sea estimated by MSVPA, estimates of total consumption by cod, whiting, haddock and saithe and diet data, Daan (1991) estimated the annual amount of *Pandalus* consumed by these fish species. These results have not so far been used for further analyses in order to estimate the natural mortality. The issue is, however, included in the terms of reference for the Study Group on Life Histories and Assessment of *Pandalus* Stocks in the North Atlantic at its September 1993 meeting.

At this meeting the Working Group made a rough comparison between the yearly amounts consumed as estimated by Daan (*op.cit.*) for the total North Sea and the amounts of *Pandalus* in Division IIIa, IVaE estimated to have died from causes other than fishing. These quantities were calculated from the estimates of stock sizes and fishing mortalities from the VPA and with a M-value of 0.75 applied. The figures are in tonnes:

Year	1985	1986	1987	1988	1989	1990	1991	1992
Dead:	46,710	42,217	29,053	25,271	30,476	34,644	36,535	30,158
Daan (1991)	37,619	34,162	31,221	31,673	32,512			

From this exercise it appears that the concern expressed in last year's report that the natural mortality could exceed fishing mortality several fold may be exaggerated.

6.3 Skagerrak and the Norwegian Deeps

6.3.1 Landings

Landings from the Skagerrak (Division IIIa) and Sub-area IV are shown separately in Table 6.1.1. Table 6.3.1 gives the landings since 1970 and discards since 1985 from the Skagerrak and Norwegian Deeps combined. The landings have remained high, above 10,000 t, since 1985. The total landings increased in 1992 to 13,000 t mainly due to increased catches in the Skagerrak area.

6.3.2 Discards

On board Norwegian and Swedish vessels the catches are sorted into three size categories. The larger ones are boiled on board, the intermediate-sized shrimps are landed raw for industrial peeling, while the smallest ones are discarded. The Norwegian samples for length distributions are taken before sorting on board, while the Swedish ones are from the landings. By comparing the length frequencies from both countries and the figures available for discarded weight (Swedish fishermen are obliged to report discards), it was found appropriate to consider shrimps smaller than 15 mm as the discarded proportion. By applying the length/weight relationship on quarterly length frequencies the weight portions discarded were calculated, combined for Norway and Sweden. Danish vessels are landing their total catches and no changes were made in Danish figures (Table 6.3.1.).

6.3.3 Effort

Quarterly and annual figures for landings and effort are given in Table 6.3.2. Total effort values have been estimated from LPUE data based on log-book records. The proportion of landings included in log-book data varied from high (ca 95%) for Denmark and Sweden to low (ca 30%) for the Norwegian landings in 1992. In all countries both fishing effort and landings increased in 1992 as given below:

	% increase effort	% increase landings
Denmark	7	4
Norway	3	16
Sweden	32	12

6.3.4 Assessment

6.3.4.1 Age distributions

National quarterly samples of length frequencies from Division IIIa and the Norwegian Deeps were split into normal distributions. Each normal distribution, assumed to represent an age group, is described by its mean length, standard deviation, and proportion of total sample size. The mean lengths of the age groups are given in Figure 6.3.1. A maximum of six age groups were identified. The new quarterly national catches including discards (in tonnes) were converted to catch in numbers at age by applying the number of shrimps per kg in the samples together with the age distributions. The Danish figures remain the same, while the Norwegian figures give an increase in number of all year classes. The calculated Swedish discards are not included in any length measurements. Average weights for the 0- and 1-group were chosen and, using Norwegian quarterly samples, national figures of catch in numbers were used to produce yearly data (Table 6.3.3.). All discards were considered to be catch since none of them will survive. Norwegian age distributions have in earlier reports been applied on landings only. They were this year used to estimate discarded amounts by applying a length/weight relationship to that part of the length distribution that was below 15 mm CL. This was done for all quarterly landings back to 1985. The Swedish discards for 1991-92 were estimated from log-books. For 1985-1990 they were assumed to be the same proportion of the catch as the Norwegian ones. To allocate them to numbers at age a fixed scheme was used with the following values for number/kilo:

	Age group	
Quarter	0-group	1-group
1		571
2		400
3		222
4	1000	

The Norwegian discards in numbers were calculated as the percentage of the total numbers caught below 15 mm carapace length according to quarterly samples. All were assumed to belong to the 1-group in the first three quarters and to the 0-group in the 4th quarter of the year, like the Swedish calculated discards.

6.3.4.2 Mean weight at age

The Norwegian weights at age have been obtained by applying quarterly length/weight relationships based on Swedish data from 1990, while the Danish and Swedish mean weights have been obtained from mean weights per mm group on the length frequencies of each year-class (see Table 6.3.4.) The mean weights at age in the stock were assumed to be equal to mean weights in the catch.The maturity ogive is estimated as the proportion of intersexes and females in the 2-group in the first quarter of the year, and is as follows:

1985	1986	1987	1988	1989	1990	1991	1992
0.62	0.09	0.20	0.30	0.68	0.73	0.73	0.68

The 0- and 1-groups are assumed to be immature, and the 3-group and older groups fully mature.

6.3.4.3 Natural mortality

As in previous years the M has been set at 0.75 for all ages (cf. Section 6.2).

6.3.4.4 VPA

The level of fishing mortality in 1992 was estimated by tuning with national effort data. Input for the tuning is given in Table 6.3.5. For all three fleets the terminal catchability (q) was estimated as the mean since no trend was obvious. F for the oldest non-plus age group (age 4) was set at the mean of age groups 2 and 3. The results are shown in Table 6.3.6. The resulting values of mean F (Table 6.3.7) indicate a decrease in 1992. The estimated stock sizes show no conspicuous changes in 1992 (Table 6.3.8).

6.3.4.5 Recruitment

The abundance indices of young shrimps obtained by the Norwegian survey in October are given in Table 6.3.9. A description of the survey methods was given in an earlier report (Anon.,1991b). The total 1992 index is high mainly due to catches in western Skagerrak (6 times higher than obtained before) but the year class was also ranked first or second in the data series in other areas. The survey results for the 0-group were regressed against the 0-group from the VPA (logarithms of both variables were used) and the results are given in Figure 6.3.2. This gave a correlation of 0.88. This improved covariation is most probably an effect of the inclusion of the discards in the VPA. The corresponding regression between log survey 0-group and log VPA 1-group values showed a correlation of 0.72 (Figure 6.3.3). The 1992 year class as 1-group was estimated to be about 20,000 millions, which is the largest observed so far. Taking into account the inherent uncertainties in estimating the 0-group, the Working Group decided to apply a more conservative estimate. The figure chosen, 11,000 millions, is the size of the 1989 year class, which is above average. A new estimate of the 1992 year class will be available prior to the November 1993 ACFM meeting and can be provided if requested.

6.3.4.6 Catch prediction

Input data for the prediction are shown in Table 6.3.10.The fishing pattern used is the 1985-1990 average scaled to the 1992 level. Mean weights are averages for the period 1985-92, and recruitment in 1993 and 1994 is the average for the period 1985-1990.The average proportions of 0- and 1- group that have been landed were 4.2% and 63.5%, respectively. These proportions were applied to the predicted catches in 1993 and 1994. The *status quo* landings are predicted to be 14,000 t in 1993 and 13,800 t in 1994 (Table 6.3.11). The associated discards are predicted to be 1,800 t and 1,300 t.

6.3.4.7 Management considerations

Due to a series of good year classes the stock is assessed to be at a high level. As the survey in October 1992 also indicated that the 1992 year class is large, the stock will remain at a high level over the years of prediction. The selection properties in traditional shrimp trawls are not very good; resulting in high catches of small individuals. The on-going developments of sorting grids and other means of facilitating the escape of small shrimps and juvenile fish should be encouraged.

6.3.4.8 Assessment quality

The assessment this year has been made more realistic by including estimates of discards. This has led to a revison of the Total Stock Biomass (an increase of around 20%), the fishing mortalities and numbers of young shrimps.

6.4 Fladen Ground

6.4.1 The fishery

Table 6.4.1 shows the landings from the Fladen Ground since 1972. Total landings increased threefold in 1992 to a total of 1,564 t from 506 t in 1991. It appears from the table that for the last 10 years the majority of the landings have been made by the Danish fishery. The main part of the fishery takes place in the 2nd quarter. The main reason for the large fluctuations in the fishery during 1990-1992 seems to have been fluctuations in prices for Fladen shrimps in the period.

6.4.2 Effort data

Total effort, both for the Danish and Scottish fisheries, has been estimated from CPUE data for shrimp trawlers. Table 6.4.2 shows the annual figures estimated from annual CPUE figures, whereas Table 6.4.3 gives quarterly figures. The quarterly effort figures also indicate that the 2nd quarter is the peak season for this fishery.

In order to combine the Danish and Scottish effort, relative effort indices were calculated for each country and combined indices calculated (see Table 6.4.2).

6.4.3 Assessment

Since the sampling of the Fladen fishery in 1992 has been at a very low level and since no specific request for a standard assessment has been made, the Working Group decided not to present VPA results in this year's report. However, to maintain continuity, the updated database is available at ICES.

6.4.3.1 Age distribution of the catch

The age distribution of the catch (landings) has been estimated from (Danish) data on length composition of the catch using the Bhattacharya method. However, in 1992 only very few length samples covering the Fladen fishery were available, and only for the 2nd and 4th quarters. Thus the estimated age composition of the landings in the 2nd quarter has been raised to the total landings from the 1st to the 3rd quarters, while landings from the 4th quarter were assigned to ages on the basis of length data from the Danish *Pandalus* survey.

The results of the splitting of the length distribution into age components are shown in Table 6.4.4. The figures for the 4th quarter are derived from the Danish trawl survey, and only ages 1 and 2 are assumed to contribute to the landings. Figure 6.4.1 shows the estimated mean lengths of the putative age groups; the pattern seems to be reasonably consistent from year to year.

Table 6.4.5 gives the catch in numbers by age group for the period 1984 to 1992. It is seen that, compared to the catch in 1990 and 1991, age group 3 has recently been more abundant in the catches. The greater abundance of large shrimps seems to have encouraged the Danish shrimp fishery on Fladen in 1992.

6.4.4 Management considerations

The Working Group decided this year not to give any advice on the management of this stock but refers to the statements given in previous Working Group reports.

The Danish survey data on 0-group shrimps only cover the most recent years, and have not been correlated with VPA estimates. The 1992 0-group index was lower than the 1991 0-group index.

6.5 Farn Deeps

In 1992 only English vessels fished for *Pandalus* at the Farn Deeps. Total landings amounted to 1 tonne (Table 6.5.1). This decline in the fishery is believed to be a consequence of the rather low market price for Pandalid shrimp. No other information was available for this fishery.

7 WORK THAT COULD BE TAKEN UP BY THE STUDY GROUP

Throughout this report there are numerous suggestions of topics that could be taken up at a future meeting of the *Nephrops* Study Group. This section summarises these ideas and reiterates the topics listed in the last two years (Anon., 1991a and 1992a) which were considered suitable for the Study Group's attention. It is hoped that the Study Group will be able to make use of these suggestions in advising on suitable Terms of Reference for a meeting in the autumn of this year. Prior to the 1993 ICES Statutory Meeting, a brief Study Group Report (prepared by correspondence) will review the progress made by this Working Group and will recommend suitable Terms of Reference.

At this stage the most pressing issues are those related to methodological validation and development and those concerning the more critical input parameters such as growth and natural and discard mortality.

a. Attempt the application of other deconvolution or slicing techniques, which may perform better than the one used during this meeting, and/or the improvement of the existing technique. Appendix 1 provides an example of a different approach.

b. Investigate sensitivity of the age-based assessments to variations in input parameters and age groups, and to the choice of the tuning options. Appendix 2 provides an example of one approach, the application of FAST analysis might also be worthwhile.

c. Attempt to validate the current method. Appendix 3 demonstrates one approach which could be refined by a more rigorous simulation technique. Use of independent stock estimates (eg TV or larval surveys) to validate or tune the analytical assessments (see Section 4.6.2).

d. Develop a long-term prediction routine (eg Y/R) for the age-based approach.

e. Review standard procedures for *Nephrops* sampling, and for collating input length and age distributions. Application of statistical methods would be useful.

f. Review usefulness of the traditional stock indicators, eg mean size, and assess whether alternative parameters would be better. An exercise to examine the CPUE and LPUE data series for males and females separately is also required in the light of the findings in FU5 (see Section 5.9).

g. The possible need for correction of effort data and a study of whether appropriate units are being used requires attention. This work would benefit by input from statisticians.

h. Investigate potential of 'Surplus Production'/ 'Biomass Dynamic models'.

i. Update input parameters such as growth, natural and discard mortality incorporating new information if available.

8 NEXT VENUE

An invitation was extended from the President of INIP, Lisbon, Portugal to the *Nephrops/Pandalus* Working Group to hold its next meeting in Lisbon.

9 REFERENCES

Anon. (1980). Report of the *Nephrops* Working Group. ICES, Doc. C.M.1980/K:2 (mimeo).

Anon. (1985). Report of the Irish Sea and Bristol Channel Working Group. ICES, C.M.1985/Assess:10 (mimeo).

Anon. (1988). Report of the Study Group on *Nephrops*. ICES, Doc. C.M.1988/K:29 (mimeo).

Anon. (1989). Report of the Working Group on *Nephrops* Stocks. ICES Doc. C.M.1989/Assess: 18 (mimeo).

Anon. (1990a). Report of the Working Group on *Nephrops* stocks. ICES Doc. C.M.1990/Assess:16 (mimeo).

Anon. (1990b). Report of the Working Group on the Assessment of *Pandalus* Stocks. ICES, Doc. C.M. 1990/Assess:9 (mimeo).

Anon. (1991a). Report of the Working Group on the Assessment of *Nephrops* Stocks. ICES, Doc. C.M. 1991/Assess:11 (mimeo).

Anon. (1991b). Report of the Working Group on the Assessment of *Pandalus* Stocks. ICES, Doc. C.M 1991/Assess:8 (mimeo).

Anon. (1992a). Report of the Working Group on *Nephrops* and *Pandalus* stocks. ICES, Doc. C.M. 1992/Assess:8 (mimeo).

Anon. (1992b). Report of the Study Group on Life Histories and Assessment Methods of *Nephrops* Stocks. ICES, Doc. C.M.1992/K:9 (mimeo).

Bailey, N. (1984). Some aspects of reproduction in *Nephrops*. ICES, Doc. C.M.1984/K:33 (mimeo).

Bailey, N. and Chapman, C.J. (1983). A comparison of density, length composition and growth of two *Nephrops* populations off the west coast of Scotland. ICES, Doc. C.M.1983/K:42 (mimeo).

Bailey, N. and Kunzlik, P.A. (1989). Investigation of the sensitivity of the Jones' Length Based Cohort Analysis to input parameters using the FAST method. ICES, Doc. C.M.1989/D:24 (mimeo).

Bailey, N., Howard, F.G. and Chapman, C.J. (1986). Clyde *Nephrops*: biology and fisheries. Proc. Roy. Soc. Edin., 90B:501-518.

Bhattacharya, C.G. (1967). A simple method of resolution of a distribution into Gaussian components. Biometrics, 23:115-135.

Bennett, D.B. (1983). Irish Sea *Nephrops* biometrics, with particular reference to tails. ICES, Doc. C.M. 1983/K:6 (mimeo).

Brander, K.M. and Bennet, D.B. (1986). Interactions between Norway lobster (*Nephrops norvegicus* (L.)) and cod (*Gadus morhua* L.) and their fisheries in the Irish Sea. Can. Spec. Publ. Fish. Aquat. Sci., 92, 269.

Brander, K.M. and Bennett, D.B. (1989). Norway lobsters in the Irish Sea: Modelling one component of a multispecies resource. In: Marine Invertebrate Fisheries: Their Assessment and Management (Ed. J.F. Caddy). John Wiley & Sons, pp.183-202.

Briggs, R. (1988). A preliminary analysis of maturity data for Northwest Irish Sea *Nephrops*. ICES, Doc. C.M.1988/K: 21 (mimeo).

Bundy, A. (1990). A study of the North Minch *Nephrops* fishery. MSc Thesis, University College of North Wales, U.K. pp 1-97.

Chapman, C.J. (1982). *Nephrops* tagging experiments in Scottish waters 1977-1979. ICES, Doc. C.M. 1982/K:22 (mimeo).

Chapman, C.J. (1985). Observing Norway lobster *Nephrops norvegicus* (L.) by towed sledge fitted with photographic and television cameras. In: Underwater photography and television for scientists (Eds. J.D.George, G.I.Lythgoe and J.N. Lythgoe). Clarenden Press, Oxford. pp.100-108.

Chapman, C.J. and Howard, F.G. (1988). Environmental influences on Norway lobster (*Nephrops norvegicus*) populations and their implications for fishery management. Symp. Zool. Soc. Lond., 59: 343-353.

Charuau, A. and Morizur, A. (1982). Etude sur les pêcheries bretonnes de langoustine de Mer Celtique. Rapp. interne ISTPM; mimeo. 3 volumes, 490 pp.

Conan, G.Y. (1978). Average growth curves and life history in a *Nephrops* population from Northern Bay of Biscay. ICES, Doc. C.M.1978/K:21 (mimeo).

Conan, G.Y. and Morizur, Y. (1979). Long-term impact of a change in mesh size from 45-50 to 70 mm on yield in weight and fecundity per recruit for Norway lobster populations. Is there a simple solution to a complex problem: a simulation model. ICES, Doc. C.M. 1979/K:43 (mimeo).

Daan, N. (1991). Consumption of *Pandalus* in the North Sea by MSVPA predators. ICES, Doc. C.M.1991/K: 26 (mimeo).

Fariña, A.C. (1984). Informe de la Campaña "Sisargas 83". Inf. Téc. Inst. Esp. Oceanogr., No. 25.

Fernandez, A., Fariña, A.C. and Renes, E. 1986. Efectos de un cambio de malla en la pesquería de la cigala (*Nephrops norvegicus* L.) de Galicia. Bol. Inst. Esp. Oceangr., 3:57-74.

Field, R.H., Chapman, C.J., Taylor, A.C., Neil, D.M. and Vickerman, K. (1992). Infection of the Norway lobster *Nephrops norvegicus* by a *Hematodinium*-like species of dinoflagellate on the west coast of Scotland. Dis. Aquat. Org., 13:1-15.

Figueiredo, M.J. (1989). Preliminary results of the tagging experiments on *Nephrops norvegicus* in Portuguese waters. ICES, Doc. C.M.1989/K:25 (mimeo).

Guéguen, J. and Charuau, A. (1975): Essai de détermination du taux de survie des langoustines hors taille rejetées lors des opération de pêche commerciale. ICES, Doc. C.M.1975/K:12 (mimeo).

Hilborn, R. and Walters C.J. (1992). Quantitative fisheries stock assessment. Chapman and Hall, New York and London. pp.1-570.

Hillis, J.P. (1979). Growth studies on the prawn *Nephrops norvegicus*. Rapp. P.-V. Reun. Cons. int. Explor. Mer., 175:170-175.

Hillis, J.P. (1987). A study of the catch composition in the Irish *Nephrops* fishery with special attention to growth and maturity. ICES, Doc. C.M.1987/K: 22 (mimeo).

Howard, F.G. and Hall, W.B. (1983). Some observations on the biometrics of *Nephrops norvegicus* (L.) in Scottish waters. ICES, Doc. C.M.1983/K:36 (mimeo).

Jones, R. (1979). An analysis of a *Nephrops* stock using length composition data. Rapp. P.-v. Réun. Cons. int. Explor. Mer, 175: 259-269.

Large, P.A. (1992). Use of a multiplicative model to estimate relative abundance from commercial CPUE data. ICES J. mar. Sci., 49:253-261.

MacDonald, P.D.M. and Pitcher, T.J. (1979). Age groups from size frequency data: a versatile and efficient method of analyzing distribution mixtures. J. Fish. Res. Bd. Can., 36:987-1001.

Milligan, S.P. and Nichols, J.H. (1988). *Nephrops* larvae surveys off the North-East coast of England in 1987. ICES, Doc. C.M.1988/K:5 (mimeo).

Morizur, Y. (1982). Estimation de la mortalité pour quelques stocks de la langoustine, *Nephrops norvegicus* (L.). ICES, Doc. C.M.1982/K:10 (mimeo).

Nichols, J.H. and Thompson, B.M. (1988). Quantitative sampling of crustacean larvae and its use in stock size estimation of commercially exploited species. Symp. Zool. Soc. Lond., 59:157-175.

Pope, J. and Thomas, H.J. (1955). Some biometric observations on *Nephrops norvegicus* (L). ICES, Shellfish Cttee 1955, paper no.180 (mimeo).

Powell, D.G. (1979). Estimation of mortality and growth parameters from the length frequency of a catch. Rapp. P.-v. Réun. Cons. int. Explor. Mer, 175:167-169.

Smith, R.S.M. (1987). The biology of larval and juvenile *Nephrops norvegicus* (L.) in the Firth of Clyde. PhD Thesis, University of Glasgow. pp.1-264.

Stewart, D.A., Agnew, D.J., Boyd, R.J., Briggs, R.P. and Toland, P. (1993). The derivation of changes in *Nephrops* catch per unit effort values for the Northern Ireland fishing fleet. Fish. Res. (in press).

Tully, O., Hillis, J.P. and McMullan, D. (1989). Fitting normal curves to polymodal length frequencies to assess growth in *Nephrops*. ICES, Doc. C.M.1989/K: 32 (mimeo).

Table 3.2 1 Summary by FU and fleet of units employed for fishing effort measurement and the scope for correcting effort on the basis of changes in vessel and gear efficiency

MA Functional Unit	Fleet	Units	Degree to which effort is Directed at Nephrops	Vessel characteristics. Extent of data and use in calculation of index	Gear characteristics. Extent of data and use in calculation of index
A Iceland(1)	Information not available for this stock				
B Faroes (2)	Information not available for this stock				
C N.Minch (11) S.Minch (12) F.Clyde (13)	UK (Scot)	Hours (days **)	Generally good data.Based on value of species in landings.Retrospective.	Available but difficult to extract. Not routinely used. Studies planned	Single/multi trawls distinguished.Other features not recorded.One small study in North Minch (Anon.,1992;&Table 3.2.2)
D None					
E Skag/Katt(3,4)	Norway	Data not available			
	Sweden	Hours	Generally good data fleet directed at Nephrops	Available but not used	Data on net type and mesh size available. Single/multi distinguished.
	Denmark	Days	Good inform. on effort but target species can change unexpectedly	HP not available. Length and weight known but data usually pooled.	Limited data on gear
F Moray Firth (9) Noup (10)	As for FU11-13 "				
G Fladen (7)	"				
H Botney Gut (5)	Belgium	hours voyages**	Good inform. on effort but target species may change, depending on Nephrops availability	Vessel-wise data available	Limited data on gear characteristics
I Farn Deeps (6)	UK(Eng.& Wales)	hours (days**)	Most trips Nephrops directed	HP and size known but not currently used (see 5.10.1	Mesh size only
Firth Forth (8)	see FU11-13				
J Irish Sea E (14)	UK(Eng.& Wales)	hours (days**)	Selection is based on % Nephrops in landings	Sizes and HP known but not used	
Irish Sea W (15)	UK(N.Ire)	hours & HP hours	Nephrops landings by Nephrops directed trips only	HP and tonnages known and have been used in study (Stewart et al	Details of mesh size and net type known
	Ireland	No data	collected on a routine basis (some one off studies)		
K None					
L Porc. Bank (16)	Spain	HP days	Nephrops directed & Hake directed (4/5 Nephrops come from latter)	HP and tonnage available	Little variation in trawl over many years, but rigging can vary. Data not collected
Aran Ground(17)	No data available				
Irish Coast(18,19)	No data available				
M Celt.Sea (20-22)	France	hours	Nephrops directed trips-those with > 10% Nephrops	HP, tonnage, length & age available but not used	Mesh size only (from logbooks)
N Biscay (23,24)	France	hours	as for FU20-22. Recent increases in effort probably due to improved data collection	as for FU20-22	No information
O N .Galicia (25)	Spain	HP days (trips**)	Mixed fishery, directed data difficult to extract	HP and tonnage	as for FU16
Cantabrian(31)	"	days (trips**)	Mixed fishery (as FU25)	Limited data	as for FU16
P None					
Q W.Galicia (26)	Spain	days (trips**)	Mixed fishery (as FU25)	Limited data	as for FU16
N.Portugal(27)	Portugal	hours	Mixed fishery (only 1 vessel with crust.licence	Good data.	Only little information
SW S Port(28,29)	"	hours	Mixed fishery. Data from logbooks. More in future	Good data	No data
G. Cadiz (30)	Spain	No data			
R None					

** alternative units available

Table 3.2.2. Landings, effort('000 Hrs) and LPUE(Kg./Hr) of Scottish single & multi-rig nets on different grounds 1992. Prop.= proportion of total effort attributable to multiple-rigged gear.

	Single net			Multi net			
Ground(FU)	mt.	hours	LPUE	mt.	hours	LPUE	prop.(%)
Farn Deeps(6)	35	2.1	16.5	1	0.04	25.0	1.8
Fladen(7)	340	9.4	36.3	1448	28.9	50.0	75.4
F.Forth(8)	1480	63.3	23.4	198	8.5	23.3	11.8
Moray F.(9)	617	24.8	24.9	651	16.1	40.4	39.4
Noup(10)	33	1.4	23.0	23	0.4	53.9	23.0
N.Minch(11)	2755	93.2	29.6	167	3.7	45.6	3.8
S.Minch(12)	2993	111.3	26.9	379	12.0	31.5	9.7
Clyde(13)	1564	112.1	14.0	950	47.8	19.8	29.9
E.Irish(14)	1	0.05	19.2	2	0.04	52.6	42.2
W.Irish(15)	2	0.1	20.2	6	0.3	19.8	75.3
Totals(6-15)	9820	417.7	23.5	3825	117.8	32.5	22.0
Totals(7-13)	9782	415.5	23.5	3816	117.4	32.5	22.0

Table 3.4.1 Input parameters used in assessments of male and female Nephrops. For some Functional units, growth and natural mortality parameters are given for immature females (above) and mature females (below). TL = Transition length (equivalent to length of first maturity).

Ma	Functional Unit	Grp. Int.	Dis. Surv.	MALES K	MALES L∞	MALES M	MALES a	MALES b	FEMALES K	FEMALES L∞	FEMALES M	TL	FEMALES a	FEMALES b
A	Iceland(1)	2	-	0.11	80	0.2	.00113	2.867						
B	Faroes (2)	Data not available												
C	N.Minch (11)*	2	0.25	0.16	70	0.3	.00028	3.24	0.16 0.06	70 60	0.3 0.2	25	.00084	2.91
	S.Minch (12)*	2	0.25	0.161	68	0.3	.00028	3.24	0.16 0.06	68 59	0.3 0.2	26	.00089	2.91
	F.Clyde (13)	2	0.25	0.16	73	0.3	.00028	3.24	0.16 0.06	73 62	0.3 0.2	27	.000845	2.91
D	None													
E	Skag/Katt(3,4)	2	0.25	0.16	75	0.3	.00051	3.08	0.10	65	0.2		.0018	2.71
F	Moray Firth (9)	2	0.25	0.165	62	0.3	.00028	3.24	0.165 0.06	62 56	0.3 0.2	23	.00074	2.91
	Noup (10)	No data available												
G	Fladen (7)	2	0.25	0.16	66	0.3	.00030	3.25	0.16 0.10	66 56	0.3 0.2	25	.00074	2.91
H	Botney Gut (5)	2	0.25	0.165	62	0.3	.00030	3.24	0.08	60	0.2		.00135	2.82
I	Farn Deeps (6)	2	0.25	0.16	66	0.3	.00038	3.17	0.16 0.06	66 58	0.3 0.2	24	.00091	2.89
	Firth Forth (8)	2	0.25	0.163	66	0.3	.00028	3.24	0.163 0.065	66 58	0.3 0.2	25	.00085	2.91
J	Irish Sea E (14)	2	0.25	0.16	60	0.3	.00029	2.94	0.16 0.10	60 56	0.3 0.2	24	.00029	2.92
	Irish Sea W (15)	2	0.10	0.16	60	0.3	.00032	3.21	0.16 0.10	60 56	0.3 0.2	24	.00068	2.96
K	None													
L	Porc. Bank (16)	2	na	0.14	75	0.2	.00009	3.55	0.16	60	0.2		.00009	3.55
	Aran Grounds(17)	2	na	0.15	60	0.3	.00032	3.21	0.15 0.10	60 50	0.3 0.2	24	.00068	2.96
	Irish Coast(18,19)	No data available												
M	Celt.Sea (20-22)	2	0.25	0.17	68	0.3	.00009	3.55	0.17 0.10	68 49	0.3 0.2	24	.00009	3.55
N	Biscay (23,24)	2	0.30	0.14	76	0.3	.00039	3.18	0.14 0.11	76 56	0.3 0.2	25	.00081	2.97
O	N.Galicia (25)	2	na	0.12	80	0.2	.00043	3.16	0.15	65	0.2		.00043	3.16
	Cantabrian(31)	5	na	0.15	90	0.2	.00043	3.16	0.10	70	0.2		.00043	3.16
P	None													
Q	W.Galicia (26)	5	na	0.15	85	0.2	.00043	3.16	0.15 0.10	85 70	0.2 0.2	24	.00043	3.16
	N.Portugal(27)	2	na	0.20	70	0.2	.00028	3.22	0.20 0.068	70 65	0.2 0.1	26	.00056	3.03
	SW S Port(28,29)	2	na	0.20	70	0.2	.00028	3.22	0.20 0.068	70 65	0.2 0.1	26	.00056	3.03
R	None													

na = Not applicable

* = growth parameters for assessment of creel components as for Clyde

Table 3.4 2 Summary of sources of data for the various input parameters listed in Table 3.4.1. Information presented in categorical form with five categories listed at the foot of the Table. Note that + indicates data collected in the FU, any other symbol indicates data from another area, a best guess value or a value chosen for consistency.

MA	Functional Unit	Dis. Surv.	MALES K	MALES L∞	MALES M	MALES a	MALES b	FEMALES K	FEMALES L∞	FEMALES TL	FEMALES M	FEMALES a	FEMALES b
A	Iceland(1)	Not available											
B	Faroes (2)	Not available											
C	N.Minch (11)	C	A	A	C	+	+	{A A	A A	 A	C C	+	+
	S.Minch (12)	C	A	A	C	+	+	{A A	A A	 A	C C	+	+
	F.Clyde (13)	C	+	+	C	+	+	{+ +	+ +	 +	C C	+	+
D	None												
E	Skag/Katt(3,4)	C	B	B	C	+	+	B	B		C	+	+
F	Moray Firth (9)	C	A	A	C	+	+	{A A	A A	 A	C C	+	+
	Noup (10)	Not available											
G	Fladen (7)	C	A	A	C	B	B	{A A	A A	 A	C C	B	B
H	Botney Gut (5)	C	B	B	C	+	+	B	B		C	+	+
I	Farn Deeps (6)	C	+B	+B	C	+	+	{+B +B	+B +B	 +	C C	+	+
	Firth Forth (8)	C	A	A	C	+	+	{A A	A A	 A	C C	+	+
J	Irish Sea E (14)	C	B	B	C	+	+	{B B	B B	 B	C C	+	+
	Irish Sea W (15)	CA	+	+	C	B	B	{+ +	+ +	 +	C C	B	B
K	None												
L	Porc. Bank (16)	na	B	+	G	B	B	G	+		G	B	B
	Aran Grounds(17)	na	B	B	C	B	B	{B B	B B	 G	C C	B	B
	Irish Coast(18&19)	Not available											
M	Celt.Sea (20-22)	C	C	+	C	+	+	{C C	+ +	 B	C C	+	+
N	Biscay (23,24)	+	+	+	C	+	+	{+ +	+ +	 B	C C	+	+
O	N.Galicia (25)	na	A	A	A	+	+	A	A		A	+	+
	Cantabrian(31)	na	B	B	B	B	B	B	B		B	B	B
P	None												
Q	W.Galicia (26)	na	A	A	A	+	+	{C A	A A	 G	A A	+	+
	N.Portugal(27)	na	B	B	B	B	B	{B B	B B	 B	B B	B	B
	SW S Port(28,29)	na	+	+	CA	+	+	{+ +	+ +	 +	CA CA	+	+
R	None												

+ = data collected in FU
A = data based on another area but **ADAPTED** in the light of additional information
B = **BORROWED** from adjacent similar stock
C = data chosen for **CONSISTENCY** with other stocks
G = data assumed or **GUESSED**

na = not applicable

Table 4.6.1 Area of muddy sediments (KM2) on Scottish Nephrops grounds and proportions (%) of different sediment types, muddy sand (MS), sandy mud (SM) and mud (M). Data derived from British Geological Survey charts.

Ground (FU)	Sediment Type (%)			
	MS	SM	M	Total Area
Fladen (7)	64.4	31.8	3.8	32932.4
Firth Forth (8)	80.8	19.0	0.2	992.7
Moray Firth (9)	90.5	9.0	0.5	2091.0
Noup (10)	100.0			398.5
North Minch (11)	40.4	31.1	28.5	1652.2*
South Minch (12)	40.0	54.0	6.0	5071.3*
Clyde (13)	32.8	34.4	32.8	2462.0

* Note: These areas under estimated since some inshore regions and sea lochs were not covered by the charts.

Sediment key: MS=10-50% silt/clay; SM=50-90% silt/clay; M=90-100% silt/clay.

Table 5.1.1 - Nephrops Functional Units and description by Statistical Rectangles

No.	Name	ICES Division	Statistical Rectangles
1	Iceland - South coast	Va	55-56 C6-D0;55-56 D2-D4
2	Faroe Islands	Vb	53E3
3	Skagerrak	IIIa	47G0;46F9-G1;45F8-G1;44F7-G0;43F8-F9
4	North and Central Kattegat	IIIa	44G1;42-43 G0-G2;41G1-G2
5	Botney Gut and Silver Pit	IVb,c	36-37 F1-F4;35F2-F3
6	Farn Deeps	IVb	38-40 E8-E9;37E9
7	Fladen Ground	IVa	44-49 E9-F1;45-46E8;44-45F2
8	Firth of Forth	IVb	40-41E7;41E6
9	Moray Firth	IVb	44-45 E6-E7;44E8
10	Noup	IVb	47E6
11	North Minch	VIa	44-46 E3-E4
12	South Minch	VIa	41-43 E3-E4;42E2
13	Clyde	VIa	39-40 E4-E5
14	Irish Sea East	VIIa	35-38E6;38E5
15	Irish Sea West	VIIa	35-37 E4-E5;38E4
16	Porcupine Bank	VIIc,k	34D6-D8;33D5-D8;32D5-D6
17	Aran Islands	VIIb	34-35 D9-E0
18	NW and W Ireland	VIIb	37D9-E1;36D9
19	SW Ireland	VIIg,j	31-33 D9-E0
20	NW Labadie, Baltimore and Galley	VIIg,j	
21	Jones and Cockburn	VIIg,h,j	28-32 E1-E2;31-33E3;31E4
22	Smalls	VIIg	
23	Bay of Biscay North	VIIIa	22-24 E6-E7;23-24E5
24	Bay of Biscay South	VIIIb	20-21 E7-E8;19E8
25	North Galicia	VIIIc	15E0-E1;16E1
26	West Galicia	IXa	13-14 E0-E1
27	North Portugal North of Cape Espichel)	IXa	6-12E0;9-12E1
28	SW Portugal (Alentejo)	IXa	3-5 E0-E1
29	S Portugal (Algarve)	IXa	2E0-E2
30	Gulf of Cadiz	IXa	2-3 E2-E3
31	Cantabrian Sea	VIIIc	16E4-E7

Table 5.1.2 Description of Management Areas together with their Nephrops Working Group labels and the Functional Units contained within them

Working Group Label	Management Area Description	Functional Units	
A	Va	1	Iceland
B	Vb (non EC)	2	Faroe Islands
C	VIa	11	North Minch
		12	South Minch
		13	Clyde
D	Vb (EC) + VIb		None
E	IIIa	3+4	Skagerrak and Kattegat
F	IVa: rect. 44-48 E6-E7 + 44E8	9	Moray Firth
		10	Noup
G	IVa: remainder	7	Fladen
H	IVb,c E of 1° E	5	Botney Gut
I	IVb,c W of 1° E	6	Farn Deeps
		8	Firth of Forth
J	VIIa: excluding rect. 33 E2-E5	14	Irish Sea East
		15	Irish Sea West
K	VIId,e		None
L	VIIb,c,j,k	16	Porcupine Bank
		17	Aran Grounds
		18+19	Irish coast
M	VIIf,g,h and VIIa 33E2-E5	20+21+22	Celtic Sea
N	VIIIa,b	23+24	Bay of Biscay
O	VIIIc	25	North Galicia
		31	Cantabrian Sea
P	VIIId,e		None
Q	IXa	26	West Galicia
		27	N Portugal
		28+29	S and SW Portugal
		30	Gulf of Cadiz
R	IXb + X		None

Table 5.1.3 Summary of Nephrops Assessments carried out by WG.

Key to assessment types: L = LCA (length based), A = VPA ('age' based), O = other. Note (L) indicates that LCA not repeated in 1993, earlier assessment referred to.
Key to quality: + = acceptable and used, ? = questionable, x = assessment did not perform well.
Key to prediction types: ST = short term (along finfish lines), LE = plot of landings and effort, XL = mean landings (or some other level from the landings series).

MA	FU		Assessment Type			Quality			Prediction Type
						L	A	O	
A	1	Iceland	None						
B	2	Faroe Islands	None						
C	11	North Minch	L	A[1]	-	+	x	-	XL
	12	South Minch	L	A[1]	-	+	x	-	LE
	13	Clyde	L	A	-	+	x	-	XL
D	None								
E	3+4	Skagerrak & Kattegat	L	-	O	?	-	?	XL
F	9	Moray Firth	L	A	-	+	+	-	ST
	10	Noup	None						XL
G	7	Fladen	(L)		O	?	-	?	XL
H	5	Botney Gut	L	A	-	+[4]	?[4]	-	XL
I	6	Farn Deeps	L[3]	A	-	+	+	-	LE
	8	Firth of Forth	L	A	-	+	+	-	ST
J	14	Irish Sea East	L	-	-	+	-	-	LE
	15	Irish Sea West	(L)	A	-	+	x	-	XL
K	None								
L	16	Porcupine Bank	L	A	-	+	?[4]	-	LE
	17	Aran Grounds	(L)	-	-	?	-	-	XL
	18+19	Irish coast	None						XL
M	20-22	Celtic Sea	(L)	A[2]	-	+	x	-	LE
N	23&24	Bay of Biscay	L[3]	-	-	+	-	-	LE
O	25	North Galicia	(L)	A	-	?	?[4]	-	XL
	31	Cantabrian Sea	(L)	-	-	?	-	-	XL
P	None								
Q	26	West Galicia	L	-	-	?	-	-	XL
	27	N Portugal	(L)	-	-	+	-	-	XL
	28&29	S&SW Portugal	L	A	-	+	x	-	XL
	30	Gulf of Cadiz	None						XL
R	None								

1 Separate 'age' based assessments for trawl and creel
2 Males only
3 Includes a comparison of two reference periods
4 Serious doubts about the usefulness of the female assessment.

Table 5.1.4 Input choices for slicing and for tuning of VPA

	FU5	FU6	FU8	FU9	FU11	FU11c	FU12	FU12c	FU13	FU15	FU16	FU20-22	FU25	FU28,29
Years of Length data	86-92	84-91	81-92	80-92	80-92	81-92	80-92	81-92	80-92	84-92	81-92	84-92	84-92	84-92
Grouping interval	1	2	2	2	2	2	2	2	2	2	2	1	2	2
No. Ages Groups*														
male	13	11	11	9	11	11	11	11	11	12	11	7	10	10
female	16	15	16	16	14	14	14	14	14	12	7	-	10	10
2 curves for fem.?	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	-		N	Y
(* inc. plus gp.)														
Effort Units	Hours	Hours	Hours	Hours	Hours	None	Hours	None	Hours	Hours	BHP Day*100	Hours	Fdays	Hours
Years for analysis	86-92	84-91	81-92	80-92	80-92	81-92	80-92	81-92	80-92	84-92	83-92	84-92	84-92	84-92
Tuning age range														
male	2-10	2-7	2-8	2-7	2-8	2-8	2-8	2-8	2-8	3-8	2-8	1-5	2-8	1-8
female	2-13	2-10	2-13	2-13	2-11	2-11	2-11	2-11	2-11	3-8	2-5		2-5	1-8
F Fixed on oldest?	N	N	N	N	N	N	N	N	N	N	N	N	N	N
No.ages for mean.	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Downweighting exp.	3	0	3	3	3	3	3	3	3	3	3	0	0	0
Yrs. prior to last for max.wt	2	2	2	2	2	2	2	2	2	2	2	0	2	0
Multi-fleet **	Y	N	N	N	N	N	N	N	N	Y	Y	Y	N	N
Fleet names and Fix Q (Y/N) or exclude fleet E	Bel. Y Den. E	Eng. Y	ScT. Y	ScT. Y	ScT. Y		ScT. Y		ScT. Y	NI. Y I. E	Sp. Y Fr. E UK. E Ir. E	Fr. Y I. E	Sp.Y	Po.Y
Hist F (Y/N/E)	E	E	E	Y	E	Y	Y	Y	Y	Y	E	E	Y(M)E(F)	Y
Take Logs?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Age range FBAR														
males	3-10	3-7	3-8	3-7	3-8	3-8	3-8	3-8	3-8	3-5	3-8	2-6	2-8	2-5
females	3-13	3-10	3-10	3-10	3-11	3-11	3-11	3-11	3-11	3-5	2-5		3-5	3-8
FBAR vs effort														
male r	0.860	0.820	0.940	0.761	0.226		0.248		0.190	-0.11	0.695	0.563	0.784	0.092
female r	0.854	0.810	0.651	0.726	0.285		0.543		0.510	0.75	-0.16		0.074	0.044

c=creel

** Bel. = Belgium
Den. = Denmark
ScT. = Scotland Trawl
ScC. = " Creel
NI. = Northern Ireland
I. = Ireland
Sp. = Spain
Fr. = France
Po. = Portugal

Table 5.1.5 Regression parameters and correlation coefficients for the relationship between landings(t) and effort(t) for the Functional Units regarded as having adequate effort data.

Functional Unit	Landings(t) vs Effort(t)			
	r	slope	intercept	
5 Botney Gut(tot)	0.585	3.02	287.10	
male	0.481	0.96	282.40	
female	0.482	2.06	4.73	
6 Farn Deeps	0.870	19.32	290.80	
7 Fladen Grund	0.961	37.20	-17.96	
8 F. of Forth	0.909	27.20	-189.16	
9 Moray Firth	0.878	21.56	472.72	
10 Noup	0.935	25.66	5.55	
11 North Minch	0.544	18.15	1132.66	
12 South Minch	0.814	14.78	1380.52	
13 F. of Clyde	0.497	20.37	43.62	
14 Irish Sea E	0.790	28.29	-40.64	
15 Irish Sea W	0.940	19.64	1898.43	
16 Porc.Bank (FT)	0.877	28.83	-1355.79	
20-22 Celtic Sea	0.653	9.64	905.00	
23-24 Biscay	0.714	5.86	1487.00	
25 N. Galicia	0.333	5.10	203.58	1992 values

FT = Finfish Trawl

Table 5.1.6 - Summary of Working Group recommended catch options for Management Area Listed

Management Area		Catch Options (Tonnes)	Text Section For Details
A	Va	Managed by National TAC	5.2.2
B	Vb (non EC)	Managed by National TAC	5.3.2
C	VIa	10165	5.4.4
D	Vb (EC) + VIb	Zero TAC	5.5.1
E	IIIa	2900	5.6.3
F	IVa: rect. 44-48 E6-E7 + 44E8	2163	5.7.3
G	IVa: remainder	5223	5.8.2
H	IVb,c E of 1° E	900	5.9.2
I	IVb,c W of 1° E	3759	5.10.3
J	VIIa: excluding rect. 33 E2-E5	9097	5.11.3
K	VIId,e	Zero TAC	5.12.1
L	VIIb,c,j,k	3743	5.13.4
M	VIIf,g,h and VIIa 33E2-E5	3620	5.14.2
N	VIIIa,b	5574	5.15.2
O	VIIIc	569	5.16.3
P	VIIId,e	Zero TAC	5.17.1
Q	IXa	1388	5.18.5
R	IXb + X	Zero TAC	5.19.1

Table 5.2.1- Iceland (Functional Unit 1) : catches and landings (in tonnes), effort (in '000 hours trawling), CPUE and LPUE (in kg/hour trawling), of Icelandic Nephrops trawlers, TAC (in tonnes), 1983-92

Year	Catches	Landings	Effort	CPUE	LPUE	TAC
1983	2 891	2 672	55.9	51.7	47.8	2700
84	2 698	2 459	53.9	50.1	45.6	2400
85	2 628	2 385	42.3	62.1	56.4	2300
86	2 882	2 564	41.8	68.9	61.3	2500
87	2 980	2 712	51.6	57.8	52.6	2700
1988	2 496	2 240	56.1	44.5	39.9	2600
89	2 100	1 841	51.1	41.1	36.0	2100
90	1 939	1 660	41.5	46.7	40.0	2100
91 (*)	NA	2 160	51.3	NA	42.1	2100
92	NA	NA	NA	NA	NA	NA

(*) provisional

Table 5.2.2 Iceland (Functional Unit 1) : Landings (in tonnes), effort (in '000 creel hauls) and LPUE (in g/creel haul),1989-1991

Year	Landings	Effort	LPUE
1989	25	113.1	221
1990	31	103.0	301
1991 (*)	10	NA	NA
1992	NA	NA	NA

(*) provisional

Table 5.2.3 Iceland (Functional Unit 1) : mean sizes (CL in mm) of male and female Nephrops in catches, 1983-92

Year	Males	Females
1983	44.8	34.1
84	44.4	35.0
85	44.5	35.4
86	43.7	35.6
87	45.5	37.2
1988	44.7	36.5
89	44.0	35.7
90	41.6	35.6
91 (*)	42.1	35.6
92	NA	NA

(*) provisional

Table 5.3.1 Faroes (Functional Unit 2) : landings (in tonnes), effort (in '000 creeldays) and LPUE (in g/creelday), 1983-92

Season	Landings	Effort	LPUE
1983/84	93	1 454	64
84/85	50	1 697	30
85/86	43	784	55
86/87	80	822	97
87/88	91	934	97
1988/89	74	960	77
89/90 (*)	53	747	72
90/91	NA	NA	NA
91/92	NA	NA	NA
92/93	NA	NA	NA

(*) provisional

Table 5.4.1 Input data and parameters: North Minch

FU	11	MA	C
FLEET	UK Scotland	GEAR	Nephrops and Light trawl

1992	NUMBER OF SAMPLES				Mean
	Qtr 1	Qtr 2	Qtr 3	Qtr 4	No./sample
Catch					
Landings	8	12	11	16	483
Discards	4	3	4	2	552

	NUMBER OF SAMPLES									
YEAR	92	91	90	89	88	87	86	85	84	83
Catch										
Landings	47	57	53	42	43	33	37	34	50	28
Discards	13	14	13							

FLEET	UK Scotland	GEAR	Creel

1992	NUMBER OF SAMPLES				Mean
	Qtr 1	Qtr 2	Qtr 3	Qtr 4	No./sample
Catch					
Landings	0	2	1	1	428
Discards					

	NUMBER OF SAMPLES									
YEAR	92	91	90	89	88	87	86	85	84	83
Catch										
Landings	4	4	10	4	5	2	3	4	7	10
Discards										

INPUT PARAMETERS Trawl		
Parameter	Value	Source
Discard Survival	0.25	Gueguen and Charuau,1975; Anon.,1985
MALES		
Growth - K	0.16	Adapted from Bailey and Chapman, 1983
Growth - L(inf)	70	"
Nat. Mort. - M	0.3	Morizur, 1982
Length/weight - a	0.00028	Howard and Hall, 1983
Length/weight - b	3.24	"
FEMALES		
Immature Growth		
K	0.16	as for males
L(inf)	70	"
Nat.Mort. - M	0.3	"
Size at Maturity	26	Adapted from Bailey, 1984
Mature Growth		
K	0.06	as for males
L(inf)	60	"
Nat.Mort. - M	0.2	assumed *
Length/weight - a	0.000845	as for males
Length/weight - b	2.91	"

* based on Morizur, 1982 and assuming lower mature female rate

Note: For Creel assessment inputs see Clyde (Table 5.4.53)
except for discard survival which is assumed 100%

Table 5.4.2 North Minch (Functional Unit 11) : landings (in tonnes), by gear,1983-92, all UK

Year	Nephrops Trawl	Other Trawl	Creel	Total
1983	2 784	95	317	3 196
84	3 449	161	534	4 144
85	3 236	117	708	4 061
86	2 642	202	538	3 382
87	3 458	144	482	4 084
1988	3 449	149	437	4 035
89	2 603	112	490	3 205
90	1 941	133	469	2 543
91	2 221	130	438	2 789
92(*)	2 922	146	414	3 482

(*)provisional

Table 5.4.3 North Minch (Functional Unit 11) : landings (in tonnes), effort (in '000 hours trawling) and LPUE (in kg/hour trawling) of Scottish Nephrops trawlers, 1983-92. Single and Multi-rig trawls combined (see Table 3.2.2)

Year	Landings	Effort	LPUE
1983	2 784	64.5	43.2
84	3 449	79.3	43.5
85	3 236	96.8	33.4
86	2 642	93.0	28.4
87	3 458	121.2	28.5
1988	3 449	115.0	30.0
89	2 603	87.9	29.6
90	1 941	79.8	24.3
91	2 221	93.1	23.9
92(*)	2 922	96.9	30.2

(*) provisional

Table 5.4.4 North Minch (Functional Unit 11) : mean sizes (CL in mm) of male and female Nephrops in Scottish landings, 1983-92

Year	Males	Females
1983	32.6	29.2
84	32.6	29.1
85	33.8	29.2
86	32.5	32.5
87	32.8	31.4
1988	32.6	31.4
89	30.1	30.1
90	33.3	31.7
91	34.7	31.8
92	34.3	29.9

Table 5.4.5 LCA. North Minch (Functional Unit 11): Males
Cohort Analysis Output. Reference period 1989-1992

L INFINITY = 70.0000 K = .1630

COHORT ANALYSIS BY POPE'S APPROXIMATION

SIZE MM	REMOVALS	M	DT	FDT	F	Z	NO. ATTAINING	AVE. NO. IN SEA	BIOMASS kg
17.0	581.7	.3000	.2360	.0042	.0179	.3179	143240.6	32566.5	106037.2
19.0	1442.2	.3000	.2454	.0113	.0461	.3461	132888.8	31268.1	143232.9
21.0	2135.0	.3000	.2557	.0183	.0717	.3717	122065.7	29770.3	185710.8
23.0	3376.5	.3000	.2668	.0322	.1206	.4206	110998.9	28011.3	231644.8
25.0	5205.2	.3000	.2789	.0563	.2017	.5017	99217.4	25823.9	276782.8
27.0	7092.3	.3000	.2922	.0898	.3074	.6074	86261.5	23095.3	314716.2
29.0	8515.7	.3000	.3068	.1318	.4294	.7294	72233.7	19857.4	338375.1
31.0	8982.9	.3000	.3230	.1783	.5519	.8519	57749.1	16305.2	342465.1
33.0	8148.5	.3000	.3409	.2176	.6382	.9382	43858.2	12796.6	327108.1
35.0	6724.2	.3000	.3610	.2521	.6984	.9984	31852.0	9654.0	296983.8
37.0	4949.0	.3000	.3836	.2692	.7018	1.0018	22213.0	7074.1	259283.6
39.0	3484.5	.3000	.4091	.2810	.6867	.9867	15126.3	5092.1	220381.0
41.0	2437.8	.3000	.4384	.2980	.6798	.9798	10101.9	3600.2	182500.4
43.0	1543.4	.3000	.4722	.2903	.6149	.9149	6574.4	2520.6	148557.4
45.0	957.6	.3000	.5115	.2774	.5423	.8423	4268.2	1773.8	120741.4
47.0	591.2	.3000	.5581	.2636	.4723	.7723	2774.1	1257.7	98269.5
49.0	341.7	.3000	.6140	.2330	.3795	.6795	1802.7	905.0	80706.3
51.0	200.6	.3000	.6824	.2072	.3036	.6036	1187.7	664.3	67270.4
53.0	96.7	.3000	.7679	.1483	.1932	.4932	786.8	502.9	57551.9
55.0	68.0	.3000	.8779	.1555	.1771	.4771	538.8	386.4	49750.6
57.0	35.8	.3000	1.0249	.1255	.1225	.4225	354.4	294.8	42524.2
59.0	24.9	.3000	1.2311	.1396	.1134	.4134	229.9	221.8	35704.2
61.0	16.5	.3000	1.5418	.1626	.1054	.4054	138.2	158.4	28360.1
63.0	24.6	.3000			.1500	.4500	73.9	158.4	31432.7

Table 5.4.6 LCA. North Minch (Functional Unit 11): Females
Cohort Analysis Output. Reference period 1989-1992

LOWER CURVE LINF= 70.0000 K= .1600

UPPER CURVE LINF= 60.0000 K= .0600

TRANSITION LENGTH= 25.0000

COHORT ANALYSIS BY POPE'S APPROXIMATION

SIZE MM	REMOVALS	M	DT	FDT	F	Z	NO. ATTAINING	AVE. NO. IN SEA	BIOMASS kg
17.0	424.9	.3000	.2404	.0009	.0037	.3037	495353.6	114846.4	431684.8
19.0	2206.1	.3000	.2500	.0050	.0199	.3199	460474.7	110649.2	565134.7
21.0	2441.6	.3000	.2605	.0060	.0230	.3230	425073.3	106183.1	715668.3
23.0	3965.6	.3000	.2718	.0106	.0391	.3391	390776.1	101458.8	880867.8
25.0	5582.2	.2000	.2841	.0162	.0572	.2572	356371.5	97648.2	1070146.0
27.0	8023.5	.2000	1.0420	.0272	.0262	.2262	331258.6	307518.5	4181264.0
29.0	8226.5	.2000	1.1115	.0358	.0322	.2322	261713.0	256395.5	4261277.0
31.0	7077.4	.2000	1.1910	.0402	.0338	.2338	202185.1	210182.6	4214922.0
33.0	5716.5	.2000	1.2827	.0434	.0338	.2338	153048.7	169608.6	4057495.0
35.0	4137.8	.2000	1.3897	.0428	.0308	.2308	113389.5	134802.1	3808407.0
37.0	2343.2	.2000	1.5162	.0337	.0222	.2222	82273.8	105901.7	3501707.0
39.0	1463.8	.2000	1.6681	.0299	.0179	.2179	58739.3	82147.7	3153527.0
41.0	768.3	.2000	1.8538	.0229	.0124	.2124	40838.0	62580.1	2768842.0
43.0	411.5	.2000	2.0861	.0186	.0089	.2089	27548.6	46583.0	2359831.0
45.0	227.6	.2000	2.3850	.0163	.0069	.2069	17817.3	33542.7	1933882.0
47.0	114.5	.2000	2.7842	.0140	.0050	.2050	10878.8	23078.6	1506013.0
49.0	41.5	.2000	3.3445	.0095	.0028	.2028	6147.0	14927.5	1096973.0
51.0	22.2	.2000	4.1886	.0109	.0026	.2026	3119.3	8806.4	725395.9
53.0	16.2	.2000	5.6079	.0215	.0038	.2038	1335.1	4461.6	410167.4
55.0	55.5	.2000			.0300	.2300	425.7	4461.6	455955.5

Table 5.4.7 VPA. North Minch (Functional Unit 11): Males Trawl
Catch (000's) at 'nominal age'. 1980 - 1992

Catch-at age data

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	1687.	2056.	2377.	8447.	17886.	12875.	11962.	6708.	9506.	18911.	2996.	2001.	5107.
2	21549.	24598.	19795.	38658.	48193.	34107.	37813.	51038.	34529.	29554.	17046.	21124.	25713.
3	21866.	24059.	18657.	23058.	40354.	30983.	30379.	40302.	35781.	15883.	17486.	27284.	27681.
4	7291.	7811.	9297.	8673.	13864.	14462.	11132.	13186.	15321.	5774.	6860.	11441.	12740.
5	3001.	3160.	4512.	3150.	4974.	5732.	3210.	4197.	5242.	2487.	1921.	3937.	4763.
6	1271.	1315.	1903.	1514.	1706.	2087.	888.	1494.	1491.	962.	597.	1223.	1650.
7	497.	515.	954.	807.	434.	727.	232.	473.	484.	418.	214.	362.	585.
8	184.	189.	261.	182.	107.	220.	29.	118.	146.	122.	103.	128.	191.
9	76.	77.	99.	144.	25.	80.	12.	41.	55.	51.	82.	53.	81.
10	32.	32.	65.	80.	0.	55.	6.	26.	24.	22.	39.	33.	33.
11	13.	13.	72.	89.	14.	72.	1.	61.	23.	104.	53.	54.	41.

Table 5.4.8 VPA. North Minch (Functional Unit 11): Males Trawl
Mean weight (kg) at 'nominal age'. 1980 - 1992

Weight-at-age dat

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0070	.0070	.0070	.0060	.0060	.0050	.0060	.0080	.0060	.0060	.0070	.0070	.0070
2	.0160	.0150	.0150	.0150	.0150	.0150	.0150	.0150	.0150	.0140	.0150	.0160	.0150
3	.0260	.0260	.0260	.0260	.0260	.0260	.0260	.0260	.0260	.0260	.0260	.0260	.0260
4	.0410	.0410	.0410	.0410	.0410	.0410	.0410	.0410	.0410	.0420	.0410	.0410	.0410
5	.0580	.0580	.0590	.0580	.0580	.0580	.0570	.0580	.0570	.0580	.0570	.0580	.0580
6	.0760	.0760	.0760	.0770	.0760	.0760	.0750	.0760	.0760	.0760	.0760	.0760	.0760
7	.0940	.0950	.0960	.0950	.0930	.0940	.0930	.0940	.0950	.0950	.0950	.0950	.0940
8	.1130	.1130	.1110	.1120	.1120	.1130	.1090	.1120	.1120	.1120	.1140	.1130	.1130
9	.1310	.1310	.1310	.1310	.1290	.1320	.1310	.1310	.1310	.1310	.1310	.1320	.1310
10	.1460	.1460	.1480	.1460	.1620	.1470	.1450	.1480	.1460	.1470	.1470	.1460	.1460
11	.1690	.1690	.1620	.1720	.1880	.1750	.1990	.1750	.1740	.1950	.1720	.1850	.1830

Table 5.4.9 VPA. North Minch (Functional Unit 11): Males Trawl
Fishing mortality (F) at 'nominal age'. 1980 - 1992

F-at-age

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0143	.0156	.0130	.0478	.1064	.0702	.0698	.0546	.0707	.1339	.0230	.0173	.2000
2	.2803	.3313	.2275	.3341	.4675	.3386	.3373	.5304	.4870	.3643	.1912	.2482	.3557
3	.6190	.6598	.5116	.5091	.8041	.7216	.6556	.8442	1.0606	.4935	.4314	.5991	.6796
4	.5262	.5348	.6681	.5427	.7665	.9061	.7196	.7788	1.1271	.5387	.4656	.6424	.7247
5	.5225	.5196	.7937	.5723	.8082	1.0195	.5891	.7671	.9926	.6213	.3881	.6119	.7045
6	.6156	.5207	.7985	.7960	.8236	1.1976	.4708	.6984	.8043	.5537	.3299	.5211	.6481
7	.5757	.6256	1.0788	1.1811	.6401	1.3003	.4364	.5646	.5861	.6330	.2533	.3850	.5819
8	.4716	.5105	.8927	.7017	.5270	.9400	.1587	.4675	.3823	.3180	.3523	.2649	.4057
9	.5344	.4193	.6342	5.8889	.2073	1.1784	.1245	.4018	.4692	.2509	.4152	.3492	.3000
10	.5272	.5185	.8685	2.5905	.4581	1.1394	.2398	.4779	.4792	.4006	.3403	.3330	.4292
11	.5272	.5185	.8685	2.5905	.4581	1.1394	.2398	.4779	.4792	.4006	.3403	.3330	.4292

Table 5.4.10 VPA. North Minch (Functional Unit 11): Males Trawl
Population numbers (000's) at 'nominal age'. 1980 - 1992

N-at-age

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	137115.	153521.	213692.	209091.	204607.	219509.	205035.	146031.	160879.	174133.	152695.	135350.	32446.
2	101334.	100125.	111961.	156261.	147664.	136280.	151595.	141654.	102438.	111045.	112838.	110540.	98548.
3	54007.	56720.	53253.	66064.	82884.	68537.	71955.	80148.	61738.	46630.	57148.	69045.	63887.
4	20362.	21543.	21722.	23651.	29414.	27475.	24674.	27673.	25525.	15836.	21088.	27499.	28097.
5	8427.	8912.	9349.	8250.	10182.	10124.	8225.	8901.	9409.	6126.	6845.	9806.	10716.
6	3153.	3702.	3927.	3132.	3449.	3362.	2706.	3381.	3062.	2583.	2438.	3440.	3940.
7	1296.	1262.	1629.	1309.	1047.	1121.	752.	1252.	1246.	1015.	1100.	1298.	1513.
8	559.	540.	500.	410.	298.	409.	226.	360.	527.	514.	399.	632.	655.
9	211.	259.	240.	152.	151.	130.	118.	143.	167.	266.	277.	208.	359.
10	90.	92.	126.	94.	0.	91.	30.	77.	71.	77.	154.	135.	109.
11	35.	35.	140.	106.	43.	118.	5.	183.	69.	360.	209.	220.	135.

Table 5.4.11 VPA. North Minch (Functional Unit 11): Males Trawl
Yield (tonnes),Fbar,Total stock biomass (tonnes),1980 - 1992
spawning stock biomass (tonnes), Ln recruitment

Year,	Yield,	Fbar,	TSB,	SSB,	Log R
		3- 8			
1980,	1579.1,	.5551,	5780.3,	5780.3,	11.83
1981,	1699.6,	.5618,	5966.8,	5966.8,	11.94
1982,	1745.2,	.7906,	6585.1,	6585.1,	12.27
1983,	2027.8,	.7172,	7227.6,	7227.6,	12.25
1984,	2924.1,	.7283,	7814.5,	7814.5,	12.23
1985,	2589.9,	1.0142,	7095.7,	7095.7,	12.30
1986,	2162.1,	.5050,	7173.8,	7173.8,	12.23
1987,	2842.1,	.6868,	7505.0,	7505.0,	11.89
1988,	2622.5,	.8255,	6144.1,	6144.1,	11.99
1989,	1483.6,	.5264,	5298.9,	5298.9,	12.07
1990,	1225.0,	.3701,	5932.1,	5932.1,	11.94
1991,	1922.5,	.5041,	6751.6,	6751.6,	11.82
1992,	2164.6,	.6241,	5743.2,	5743.2,	10.39

Table 5.4.12 VPA. North Minch (Functional Unit 11): Males Creel
Catch (000's) at 'nominal age'. 1981 - 1992

Catch-at age data

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	0.	0.	0.	1.	0.	3.	0.	1.	40.	11.	2.	1.
2	65.	53.	41.	213.	237.	671.	351.	399.	1187.	487.	886.	841.
3	477.	581.	606.	1833.	2078.	1965.	1610.	1902.	2186.	1946.	2362.	2039.
4	912.	1237.	1405.	1874.	3754.	1775.	1997.	1679.	1601.	1598.	1998.	1753.
5	861.	717.	1283.	1398.	1915.	883.	1533.	1198.	568.	638.	1528.	733.
6	684.	264.	785.	619.	698.	569.	413.	499.	154.	248.	654.	238.
7	314.	71.	324.	204.	193.	188.	228.	227.	58.	64.	168.	69.
8	138.	36.	165.	78.	92.	103.	92.	84.	27.	34.	78.	16.
9	77.	15.	26.	30.	30.	47.	27.	37.	13.	17.	40.	3.
10	37.	9.	11.	15.	19.	23.	13.	26.	8.	11.	9.	4.
11	36.	11.	23.	12.	25.	14.	12.	26.	16.	15.	3.	4.

Table 5.4.13 VPA. North Minch (Functional Unit 11): Males Creel
Mean weight (kg) at 'nominal age'. 1981 - 1992

Weight-at-age dat

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0000	.0000	.0000	.0110	.0000	.0110	.0000	.0110	.0080	.0080	.0110	.0060
2	.0180	.0190	.0200	.0190	.0180	.0180	.0180	.0180	.0180	.0180	.0180	.0190
3	.0320	.0320	.0320	.0310	.0320	.0300	.0310	.0300	.0300	.0310	.0300	.0290
4	.0470	.0470	.0470	.0470	.0470	.0460	.0470	.0470	.0460	.0460	.0470	.0470
5	.0670	.0660	.0670	.0660	.0650	.0670	.0650	.0660	.0650	.0660	.0670	.0650
6	.0870	.0850	.0860	.0860	.0860	.0860	.0860	.0860	.0850	.0850	.0840	.0850
7	.1070	.1070	.1070	.1050	.1070	.1050	.1070	.1050	.1070	.1070	.1060	.1050
8	.1290	.1290	.1280	.1290	.1280	.1290	.1280	.1290	.1290	.1290	.1290	.1270
9	.1480	.1490	.1480	.1490	.1490	.1480	.1480	.1490	.1500	.1490	.1470	.1530
10	.1660	.1650	.1630	.1640	.1650	.1650	.1660	.1670	.1650	.1660	.1640	.1670
11	.1950	.2030	.2060	.2020	.2030	.1910	.1900	.1900	.2060	.2000	.1900	.1860

Table 5.4.14 VPA. North Minch (Functional Unit 11): Males Creel
Fishing mortality (F) at 'nominal age'. 1981 - 1992

F-at-age

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0000	.0000	.0000	.0001	.0000	.0002	.0000	.0001	.0027	.0007	.0001	.2000
2	.0059	.0042	.0029	.0174	.0225	.0778	.0355	.0358	.1164	.0444	.0745	.0416
3	.0652	.0741	.0671	.1924	.2602	.2916	.3022	.3045	.3122	.3173	.3495	.2732
4	.2279	.2674	.2877	.3393	.8610	.4176	.6177	.6775	.5147	.4468	.7186	.5395
5	.4652	.3163	.5554	.5876	.8005	.5739	.9095	1.1495	.5860	.4505	1.2503	.7357
6	.7348	.2823	.7833	.6593	.7690	.6801	.6686	1.0475	.4791	.6342	1.4649	.7547
7	.9399	.1674	.7654	.5427	.5014	.5515	.7447	1.2012	.3473	.4256	1.5572	.6543
8	1.1686	.2850	.8238	.4730	.5791	.6256	.6567	.7989	.4853	.4039	1.8145	.6671
9	.9649	.4168	.3851	.3798	.3834	.7744	.3793	.6922	.2913	.7403	1.4248	.3000
10	1.0245	.2897	.6581	.4651	.4880	.6505	.5936	.8974	.3746	.5233	1.5988	.5404
11	1.0245	.2897	.6581	.4651	.4880	.6505	.5936	.8974	.3746	.5233	1.5988	.5404

Table 5.4.15 VPA. North Minch (Functional Unit 11): Males Creel
Population numbers (000's) at 'nominal age'. 1981 - 1992

N-at-age

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	19748.	22040.	19338.	16638.	13969.	15717.	17680.	16825.	17555.	19259.	32201.	6.
2	12751.	14630.	16327.	14326.	12324.	10348.	11641.	13098.	12464.	12970.	14258.	23853.
3	8734.	9390.	10792.	12060.	10429.	8927.	7092.	8323.	9362.	8219.	9191.	9804.
4	5151.	6062.	6459.	7476.	7371.	5956.	4940.	3884.	4547.	5076.	4433.	4801.
5	2648.	3038.	3437.	3589.	3945.	2308.	2906.	1973.	1461.	2013.	2405.	1601.
6	1494.	1232.	1640.	1461.	1477.	1313.	963.	867.	463.	602.	950.	510.
7	583.	531.	688.	555.	560.	507.	493.	366.	225.	212.	237.	163.
8	225.	169.	333.	237.	239.	251.	216.	173.	82.	118.	103.	37.
9	141.	52.	94.	108.	109.	99.	100.	83.	58.	37.	58.	12.
10	66.	40.	25.	47.	55.	55.	34.	50.	31.	32.	13.	10.
11	64.	51.	54.	37.	75.	33.	30.	50.	57.	43.	5.	11.

Table 5.4.16 VPA. North Minch (Functional Unit 11): Males Creel
Yield (tonnes),Fbar,Total stock biomass (tonnes),1981 - 1992
spawning stock biomass (tonnes), Ln recruitment

Year,	Yield,	Fbar,	TSB,	SSB,	Log R
		3- 8			
1981,	252.5,	.6003,	1194.0,	1194.0,	9.89
1982,	165.8,	.2321,	1271.8,	1271.8,	10.00
1983,	305.8,	.5471,	1492.2,	1492.2,	9.87
1984,	335.3,	.4657,	1663.1,	1663.1,	9.72
1985,	476.8,	.6285,	1416.5,	1416.5,	9.54
1986,	307.3,	.5234,	1284.3,	1284.3,	9.66
1987,	329.8,	.6499,	1039.8,	1039.8,	9.78
1988,	314.6,	.8632,	1148.9,	1148.9,	9.73
1989,	227.1,	.4541,	1049.3,	1049.3,	9.77
1990,	224.6,	.4464,	1117.2,	1117.2,	9.87
1991,	373.8,	1.1925,	1385.9,	1385.9,	10.38
1992,	236.4,	.6041,	1138.0,	1138.0,	1.85

Table 5.4.17 VPA. North Minch (Functional Unit 11): Females Trawl
Catch (000's) at 'nominal age'. 1980 - 1992

Catch-at age data

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	2149.	1068.	3266.	11378.	11833.	11940.	9524.	3776.	3156.	19323.	4443.	2698.	8365.
2	3461.	2263.	5551.	12446.	8357.	8289.	8451.	4833.	4463.	5689.	4207.	3842.	8586.
3	6935.	3725.	10428.	16285.	10515.	11912.	11021.	6290.	6263.	9132.	5283.	5279.	10637.
4	8502.	4057.	8005.	16861.	9610.	10000.	12444.	7610.	8499.	8826.	5247.	5608.	10042.
5	6427.	3707.	7642.	10041.	7542.	6580.	11687.	6684.	9228.	8503.	5443.	4257.	6803.
6	3962.	2820.	6172.	6931.	5167.	4368.	9766.	5738.	8131.	7599.	5181.	3138.	4304.
7	2115.	1741.	4380.	4558.	3093.	2823.	7861.	4573.	6418.	6319.	4608.	2336.	2703.
8	835.	546.	2613.	1244.	1294.	1450.	6179.	3005.	4490.	4753.	3828.	1688.	1641.
9	356.	696.	787.	601.	592.	746.	4191.	1683.	2734.	2763.	1688.	1077.	1085.
10	225.	519.	456.	396.	409.	505.	3427.	1141.	2088.	2231.	1142.	868.	850.
11	92.	246.	192.	175.	227.	239.	2557.	511.	1360.	1695.	603.	637.	576.
12	46.	105.	102.	91.	115.	146.	1703.	286.	736.	838.	496.	434.	372.
13	30.	56.	70.	62.	76.	114.	1404.	207.	517.	537.	458.	363.	300.
14	57.	58.	138.	56.	77.	136.	3288.	320.	760.	1426.	715.	963.	795.

Table 5.4.18 VPA. North Minch (Functional Unit 11): Females Trawl
Mean weight (kg) at 'nominal age'.1980 - 1992

Weight-at-age dat

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0080	.0080	.0080	.0070	.0070	.0070	.0070	.0080	.0080	.0060	.0080	.0080	.0080
2	.0110	.0110	.0110	.0110	.0110	.0110	.0110	.0110	.0110	.0110	.0110	.0110	.0110
3	.0140	.0140	.0140	.0140	.0140	.0140	.0140	.0140	.0140	.0140	.0140	.0140	.0140
4	.0160	.0160	.0160	.0160	.0160	.0160	.0160	.0160	.0160	.0160	.0160	.0160	.0160
5	.0190	.0190	.0190	.0190	.0190	.0190	.0190	.0190	.0190	.0190	.0190	.0190	.0190
6	.0220	.0220	.0220	.0220	.0220	.0220	.0220	.0220	.0220	.0220	.0220	.0220	.0220
7	.0250	.0240	.0250	.0240	.0250	.0250	.0250	.0250	.0250	.0250	.0250	.0250	.0250
8	.0280	.0280	.0280	.0280	.0280	.0280	.0280	.0280	.0280	.0280	.0280	.0280	.0280
9	.0320	.0330	.0320	.0320	.0320	.0330	.0330	.0330	.0330	.0330	.0320	.0330	.0330
10	.0340	.0340	.0340	.0340	.0340	.0340	.0350	.0340	.0350	.0350	.0340	.0350	.0350
11	.0390	.0390	.0390	.0390	.0390	.0390	.0390	.0390	.0390	.0390	.0390	.0390	.0390
12	.0410	.0410	.0420	.0420	.0410	.0420	.0420	.0420	.0420	.0410	.0430	.0420	.0420
13	.0440	.0440	.0440	.0440	.0440	.0440	.0440	.0440	.0440	.0440	.0440	.0440	.0440
14	.0550	.0530	.0530	.0510	.0520	.0540	.0580	.0550	.0550	.0700	.0560	.0580	.0560

Table 5.4.19 VPA. North Minch (Functional Unit 11): Females Trawl
Fishing mortality (F) at 'nominal age'.1980 - 1992

F-at-age

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0110	.0049	.0167	.0617	.0738	.0922	.0850	.0334	.0245	.1154	.0244	.0129	.1000
2	.0247	.0151	.0335	.0863	.0620	.0716	.0921	.0598	.0530	.0592	.0350	.0279	.0548
3	.0650	.0335	.0893	.1300	.0976	.1180	.1283	.0918	.1025	.1461	.0717	.0561	.1005
4	.1319	.0492	.0934	.2035	.1055	.1267	.1740	.1227	.1725	.2051	.1170	.1012	.1436
5	.1506	.0781	.1231	.1624	.1318	.0977	.2138	.1333	.2144	.2610	.1882	.1313	.1716
6	.1525	.0912	.1803	.1567	.1175	.1050	.2053	.1544	.2375	.2748	.2510	.1577	.1900
7	.1190	.0927	.1995	.1962	.0971	.0869	.2780	.1398	.2584	.2934	.2669	.1712	.1979
8	.0829	.0407	.1957	.0798	.0783	.0602	.2772	.1624	.1982	.3099	.2907	.1475	.1746
9	.0660	.0920	.0759	.0628	.0496	.0591	.2464	.1127	.2178	.1802	.1719	.1236	.1333
10	.0694	.1295	.0803	.0497	.0554	.0544	.4149	.0978	.1990	.2776	.1051	.1254	.1356
11	.0513	.1007	.0645	.0400	.0363	.0415	.4207	.0989	.1617	.2462	.1118	.0785	.1146
12	.0629	.0761	.0550	.0396	.0332	.0296	.4563	.0746	.2015	.1417	.1052	.1099	.0600
13	.0610	.1019	.0665	.0431	.0416	.0418	.4302	.0904	.1873	.2216	.1073	.1045	.1033
14	.0610	.1019	.0665	.0431	.0416	.0418	.4302	.0904	.1873	.2216	.1073	.1045	.1033

Table 5.4.20 VPA. North Minch (Functional Unit 11): Females Trawl
Population numbers (000's) at 'nominal age'. 1980 - 1992

N-at-age

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	227569.	252007.	227775.	219853.	192189.	156622.	134962.	132924.	150922.	204550.	212843.	242795.	101490.
2	156327.	166737.	185772.	165929.	153130.	132249.	105813.	91833.	95237.	109102.	135013.	153870.	177545.
3	121492.	124858.	134466.	147075.	124624.	117831.	100798.	79010.	70825.	73945.	84191.	106733.	122502.
4	75738.	93212.	98855.	100685.	105736.	92550.	85732.	72591.	59014.	52339.	52312.	64164.	82621.
5	50600.	54345.	72654.	73715.	67254.	77904.	66759.	58983.	52572.	40661.	34905.	38099.	47475.
6	30823.	35637.	41150.	52594.	51307.	48265.	57848.	44138.	42266.	34736.	25643.	23677.	27355.
7	20760.	21666.	26634.	28132.	36816.	37349.	35578.	38570.	30967.	27288.	21607.	16334.	16557.
8	11569.	15090.	16168.	17863.	18929.	27353.	28032.	22060.	27457.	19581.	16661.	13546.	11269.
9	6137.	8719.	11861.	10885.	13503.	14331.	21086.	17395.	15354.	18437.	11760.	10200.	9569.
10	3702.	4704.	6511.	9001.	8369.	10521.	11059.	13494.	12724.	10110.	12606.	8107.	7380.
11	2035.	2828.	3383.	4920.	7011.	6483.	8157.	5980.	10019.	8538.	6271.	9292.	5856.
12	830.	1583.	2093.	2597.	3869.	5535.	5091.	4385.	4434.	6978.	5465.	4591.	7033.
13	553.	638.	1201.	1622.	2043.	3064.	4400.	2641.	3332.	2968.	4958.	4027.	3368.
14	1069.	664.	2363.	1465.	2073.	3659.	10302.	4074.	4893.	7885.	7735.	10690.	8923.

Table 5.4.21 VPA. North Minch (Functional Unit 11): Females Trawl
Yield (tonnes),Fbar,Total stock biomass (tonnes),1980 - 1992
spawning stock biomass (tonnes), Ln recruitment

Year,	Yield,	Fbar,	TSB,	SSB,	Log R
		3-11			
1980,	602.9,	.0987,	9454.1,	7633.5,	12.34
1981,	400.1,	.0786,	10534.8,	8518.7,	12.44
1982,	887.7,	.1225,	11733.0,	9910.8,	12.34
1983,	1250.7,	.1201,	11868.5,	10329.6,	12.30
1984,	900.0,	.0854,	11669.7,	10324.4,	12.17
1985,	903.4,	.0833,	11571.5,	10475.1,	11.96
1986,	2001.5,	.2621,	11513.0,	10568.2,	11.81
1987,	897.9,	.1237,	9805.3,	8741.9,	11.80
1988,	1250.2,	.1958,	9607.2,	8399.8,	11.92
1989,	1460.5,	.2438,	9331.2,	8103.9,	12.23
1990,	877.3,	.1749,	9373.4,	7670.7,	12.27
1991,	663.9,	.1214,	10161.0,	8218.7,	12.40
1992,	969.8,	.1513,	9780.9,	8969.0,	11.53

Table 5.4.22 VPA. North Minch (Functional Unit 11): Females Creel
Catch (000's) at 'nominal age'. 1981 - 1992

Catch-at age data

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	0.	0.	0.	1.	0.	7.	3.	2.	67.	48.	4.	45.
2	2.	4.	2.	11.	18.	21.	41.	33.	214.	116.	39.	171.
3	18.	27.	11.	20.	150.	69.	123.	103.	492.	215.	161.	337.
4	44.	64.	29.	69.	370.	125.	206.	154.	731.	246.	335.	477.
5	53.	91.	48.	217.	409.	193.	261.	219.	924.	411.	455.	602.
6	142.	183.	121.	424.	896.	245.	372.	335.	901.	558.	457.	560.
7	140.	262.	170.	538.	1107.	293.	411.	400.	995.	913.	509.	494.
8	154.	277.	180.	572.	1078.	282.	410.	385.	918.	846.	457.	412.
9	153.	266.	171.	567.	955.	260.	408.	372.	840.	730.	388.	335.
10	115.	209.	129.	499.	631.	221.	420.	385.	779.	594.	276.	230.
11	102.	143.	86.	441.	430.	155.	339.	309.	525.	344.	174.	166.
12	96.	112.	66.	413.	337.	124.	297.	271.	406.	227.	127.	136.
13	77.	64.	35.	367.	209.	94.	64.	124.	232.	87.	102.	84.
14	343.	157.	72.	2138.	630.	425.	156.	379.	511.	271.	449.	224.

Table 5.4.23 VPA. North Minch (Functional Unit 11): Females Creel
Mean weight (kg) at 'nominal age'.1981 - 1992

Weight-at-age dat

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0000	.0000	.0110	.0110	.0000	.0090	.0110	.0110	.0090	.0090	.0100	.0100
2	.0140	.0140	.0130	.0120	.0140	.0120	.0120	.0130	.0120	.0120	.0130	.0120
3	.0150	.0150	.0150	.0150	.0150	.0150	.0150	.0150	.0150	.0140	.0150	.0150
4	.0170	.0180	.0180	.0180	.0170	.0180	.0170	.0180	.0170	.0180	.0180	.0170
5	.0210	.0210	.0210	.0210	.0210	.0200	.0210	.0210	.0200	.0200	.0200	.0200
6	.0240	.0240	.0240	.0240	.0240	.0240	.0240	.0240	.0240	.0240	.0240	.0240
7	.0280	.0280	.0280	.0280	.0280	.0280	.0280	.0280	.0280	.0280	.0280	.0280
8	.0310	.0310	.0310	.0310	.0310	.0310	.0310	.0310	.0310	.0310	.0310	.0310
9	.0340	.0340	.0340	.0340	.0340	.0340	.0340	.0340	.0340	.0340	.0340	.0340
10	.0390	.0390	.0390	.0390	.0390	.0390	.0390	.0390	.0390	.0390	.0390	.0390
11	.0420	.0420	.0420	.0420	.0420	.0420	.0420	.0420	.0420	.0410	.0420	.0420
12	.0450	.0450	.0450	.0450	.0450	.0450	.0440	.0450	.0450	.0450	.0450	.0450
13	.0510	.0510	.0510	.0510	.0510	.0510	.0510	.0510	.0510	.0510	.0510	.0510
14	.0620	.0580	.0570	.0670	.0590	.0630	.0590	.0590	.0580	.0630	.0610	.0620

Table 5.4.24 VPA. North Minch (Functional Unit 11): Females Creel
Fishing mortality (F) at 'nominal age'.1981 - 1992

F-at-age

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0000	.0000	.0000	.0001	.0000	.0003	.0001	.0001	.0012	.0006	.0000	.1000
2	.0001	.0001	.0001	.0007	.0011	.0013	.0024	.0014	.0063	.0027	.0006	.0015
3	.0011	.0018	.0005	.0015	.0122	.0054	.0094	.0074	.0270	.0078	.0046	.0068
4	.0038	.0047	.0024	.0037	.0354	.0125	.0197	.0146	.0660	.0168	.0150	.0169
5	.0053	.0096	.0043	.0217	.0267	.0232	.0327	.0261	.1134	.0480	.0391	.0337
6	.0203	.0230	.0157	.0479	.1173	.0200	.0569	.0535	.1426	.0929	.0691	.0617
7	.0369	.0472	.0267	.0896	.1699	.0511	.0423	.0800	.2218	.2102	.1147	.0991
8	.0410	.0953	.0414	.1179	.2600	.0595	.0937	.0507	.2652	.2978	.1545	.1279
9	.0596	.0927	.0786	.1774	.2935	.0918	.1143	.1153	.1488	.3493	.2162	.1621
10	.0450	.1080	.0592	.3419	.3053	.1017	.2098	.1504	.3726	.1492	.2150	.1921
11	.0862	.0729	.0592	.2928	.5578	.1136	.2233	.2352	.3143	.2798	.0594	.1936
12	.1133	.1290	.0436	.4376	.3809	.3064	.3303	.2803	.5514	.2177	.1574	.0600
13	.0812	.1031	.0539	.3569	.4140	.1736	.2541	.2217	.4123	.2154	.1438	.1484
14	.0812	.1031	.0539	.3569	.4140	.1736	.2541	.2217	.4123	.2154	.1438	.1484

Table 5.4.25 VPA. North Minch (Functional Unit 11): Females Creel
Population numbers (000's) at 'nominal age'. 1981 - 1992

N-at-age

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	42267.	23624.	22567.	23625.	23929.	25664.	33708.	50769.	63751.	90203.	174760.	548.
2	20351.	31312.	17501.	16718.	17501.	17727.	19007.	24969.	37609.	47170.	66782.	129462.
3	18387.	16660.	25633.	14327.	13677.	14312.	14495.	15525.	20414.	30598.	38515.	54642.
4	12962.	15037.	13616.	20977.	11712.	11062.	11655.	11756.	12617.	16268.	24857.	31388.
5	10904.	10573.	12254.	11121.	17111.	9254.	8944.	9356.	9486.	9670.	13097.	20048.
6	7799.	8880.	8574.	9989.	8909.	13640.	7403.	7087.	7462.	6934.	7547.	10311.
7	4257.	6257.	7105.	6910.	7796.	6487.	10946.	5726.	5500.	5297.	5173.	5766.
8	4214.	3359.	4887.	5663.	5173.	5386.	5046.	8589.	4327.	3607.	3515.	3776.
9	2919.	3311.	2500.	3838.	4121.	3265.	4155.	3762.	6685.	2718.	2193.	2466.
10	2874.	2252.	2471.	1892.	2632.	2516.	2439.	3034.	2745.	4717.	1569.	1446.
11	1360.	2249.	1655.	1907.	1101.	1588.	1861.	1619.	2137.	1548.	3326.	1036.
12	983.	1021.	1712.	1277.	1165.	516.	1160.	1218.	1048.	1278.	958.	2567.
13	1086.	719.	735.	1342.	675.	652.	311.	683.	754.	494.	842.	670.
14	4850.	1765.	1510.	7814.	2035.	2934.	763.	2094.	1658.	1537.	3693.	1784.

Table 5.4.26 VPA. North Minch (Functional Unit 11): Females Creel
Yield (tonnes),Fbar,Total stock biomass (tonnes),1981 - 1992
spawning stock biomass (tonnes), Ln recruitment

Year,	Yield,	Fbar,	TSB,	SSB,	Log R
		3-11			
1981,	57.7,	.0332,	2115.8,	2115.8,	10.65
1982,	64.5,	.0506,	2153.2,	2153.2,	10.07
1983,	38.3,	.0320,	2370.3,	2122.1,	10.02
1984,	287.1,	.1216,	2829.1,	2569.2,	10.07
1985,	241.4,	.1976,	2097.0,	2097.0,	10.08
1986,	91.4,	.0532,	2235.6,	2004.6,	10.15
1987,	114.5,	.0891,	2269.3,	1898.5,	10.43
1988,	122.0,	.0814,	2648.1,	2089.6,	10.84
1989,	260.1,	.1857,	2808.6,	2234.8,	11.06
1990,	176.5,	.1613,	3238.3,	2426.5,	11.41
1991,	127.1,	.0986,	4924.5,	3176.9,	12.07
1992,	119.3,	.0993,	4283.2,	4277.7,	6.31

Table 5.4.27 Input data and parameters: South Minch

FU	12	MA	C
FLEET	UK Scotland	GEAR	Nephrops and Light trawl

1992	NUMBER OF SAMPLES				Mean
	Qtr 1	Qtr 2	Qtr 3	Qtr 4	No./sample
Catch					
Landings	10	14	14	11	587
Discards	2	3	6	4	751

	NUMBER OF SAMPLES									
YEAR	92	91	90	89	88	87	86	85	84	83
Catch										
Landings	49	66	56	40	46	61	69	52	48	13
Discards	15	8	13							

FLEET	UK Scotland	GEAR	Creel

1992	NUMBER OF SAMPLES				Mean
	Qtr 1	Qtr 2	Qtr 3	Qtr 4	No./sample
Catch					
Landings	1	0	5	2	360
Discards					

	NUMBER OF SAMPLES									
YEAR	92	91	90	89	88	87	86	85	84	83
Catch										
Landings	8	10	14	5	5	21	18	30	34	47
Discards										

INPUT PARAMETERS	Trawl	
Parameter	Value	Source
Discard Survival	0.25	Gueguen and Charuau,1975; Anon.,1985
MALES		
Growth - K	0.161	Adapted from Bailey and Chapman, 1983
Growth - L(inf)	68	"
Nat. Mort. - M	0.3	Morizur, 1982
Length/weight - a	0.00028	Howard and Hall, 1983
Length/weight - b	3.24	"
FEMALES		
Immature Growth		
K	0.161	as for males
L(inf)	68	"
Nat.Mort. - M	0.3	"
Size at Maturity	26	Adapted from Bailey, 1984
Mature Growth		
K	0.06	as for males
L(inf)	59	"
Nat.Mort. - M	0.2	assumed *
Length/weight - a	0.00089	as for males
Length/weight - b	2.91	"

* based on Morizur, 1982 and assuming lower mature female rate

Note: For Creel assessment inputs see Clyde (Table 5.4.53) except for discard survival which is assumed 100%

Table 5.4.28 South Minch (Functional Unit 12) : landings (in tonnes), by gear, 1983-92, all UK

Year	Nephrops Trawl	Other Trawl	Creel	Total
1983	2 500	296	456	3 252
84	2 952	394	593	3 939
85	2 973	366	488	3 827
86	2 600	253	464	3 317
87	2 881	376	450	3 707
1988	3 465	351	494	4 310
89	3 665	299	451	4 415
90	3 604	227	381	4 212
91	3 466	287	454	4 207
92 (*)	3 372	189	487	4 048

(*)provisional

Table 5.4.29 South Minch (Functional Unit 12) : landings (in tonnes), effort (in '000 hours trawling) and LPUE (in kg/hour trawling) of Scottish Nephrops trawlers, 1983-92. Single and multi-rig trawls combined (see Table 3.2.2)

Year	Landings	Effort	LPUE
1983	2 500	75.4	33.2
84	2 952	87.1	33.9
85	2 973	125.0	23.8
86	2 599	102.3	25.4
87	2 880	124.2	23.2
1988	3 465	118.4	29.3
89	3 665	132.2	27.7
90	3 604	148.8	24.2
91	3 466	145.7	23.8
92(*)	3 372	123.4	27.3

(*) provisional

Table 5.4.30 South Minch (Functional Unit 12) : mean sizes (CL in mm) of male and female Nephrops in Scottish landings, 1983-92

Year	Males	Females
1983	32.9	30.0
84	31.6	26.9
85	32.7	28.8
86	33.5	28.3
87	32.2	29.7
1988	31.4	30.0
89	32.0	30.0
90	32.4	29.9
91	32.9	28.8
92	34.2	30.6

Table 5.4.31 LCA. South Minch (Functional Unit 12): Males
Cohort Analysis Output. Reference period 1989-1992

L INFINITY = 68.0000 K = .1610

COHORT ANALYSIS BY POPE'S APPROXIMATION

SIZE MM	REMOVALS	M	DT	FDT	F	Z	NO. ATTAINING	AVE. NO. IN SEA	BIOMASS kg
15.0	16.1	.3000	.2389	.0001	.0003	.3003	225590.1	52010.1	120180.5
17.0	165.7	.3000	.2485	.0008	.0033	.3033	209971.0	50256.1	170086.6
19.0	939.9	.3000	.2588	.0050	.0194	.3194	194728.5	48375.4	230334.9
21.0	3503.1	.3000	.2701	.0206	.0761	.3761	179275.7	46043.0	298545.8
23.0	6548.0	.3000	.2824	.0431	.1526	.4526	161958.2	42931.1	369023.9
25.0	8951.7	.3000	.2958	.0679	.2296	.5296	142526.9	39026.5	434781.4
27.0	10424.9	.3000	.3106	.0939	.3023	.6023	121859.9	34522.5	488981.8
29.0	12979.4	.3000	.3270	.1449	.4431	.7431	101066.9	29338.3	519643.5
31.0	13153.7	.3000	.3452	.1921	.5565	.8565	79265.4	23685.5	517089.9
33.0	12070.5	.3000	.3655	.2436	.6665	.9665	58978.4	18159.1	482486.3
35.0	10321.1	.3000	.3883	.3066	.7896	1.0896	41427.3	13117.0	419423.6
37.0	6954.8	.3000	.4142	.3185	.7688	1.0688	27134.5	9081.7	345990.0
39.0	4649.0	.3000	.4438	.3356	.7562	1.0562	17427.7	6175.1	277789.7
41.0	3022.9	.3000	.4780	.3535	.7396	1.0396	10905.5	4108.1	216455.7
43.0	1861.2	.3000	.5179	.3612	.6975	.9975	6634.8	2683.6	164400.1
45.0	1122.2	.3000	.5650	.3690	.6531	.9531	3958.0	1729.2	122344.0
47.0	648.5	.3000	.6216	.3684	.5926	.8926	2309.9	1102.0	89496.3
49.0	363.5	.3000	.6908	.3624	.5246	.8246	1326.2	698.4	64741.9
51.0	207.3	.3000	.7774	.3718	.4783	.7783	750.2	437.6	46057.0
53.0	136.1	.3000	.8888	.4775	.5373	.8373	409.6	256.8	30545.6
55.0	44.7	.3000	1.0376	.3125	.3011	.6011	194.6	150.2	20106.5
57.0	20.5	.3000	1.2464	.2700	.2167	.5167	104.3	95.9	14372.4
59.0	8.3	.3000	1.5610	.2125	.1362	.4362	54.8	62.0	10379.3
61.0	7.8	.3000	2.0899	.4818	.2306	.5306	27.7	35.0	6517.7
63.0	4.6	.3000			.3000	.6000	9.1	35.0	7223.8

Table 5.4.32 LCA. South Minch (Functional Unit 12): Females
Cohort Analysis Output. Reference period 1989-1992

LOWER CURVE LINF= 68.0000 K= .1610

UPPER CURVE LINF= 59.0000 K= .0600

TRANSITION LENGTH= 26.0000

COHORT ANALYSIS BY POPE'S APPROXIMATION

SIZE MM	REMOVALS	M	DT	FDT	F	Z	NO. ATTAINING	AVE. NO. IN SEA	BIOMASS kg
13.0	4.4	.3000	.2301	.0000	.0000	.3000	591029.7	131391.2	252471.2
15.0	41.3	.3000	.2389	.0001	.0003	.3003	551608.0	127173.5	360411.7
17.0	327.9	.3000	.2485	.0007	.0027	.3027	513414.6	122894.2	490667.7
19.0	1200.1	.3000	.2588	.0026	.0101	.3101	476218.4	118445.1	642580.1
21.0	4510.0	.3000	.2701	.0107	.0398	.3398	439484.4	113418.2	811980.8
23.0	9568.8	.3000	.2824	.0252	.0893	.3893	400947.5	107216.7	988758.5
25.0	13826.7	.3000	.2958	.0411	.1388	.4388	359209.1	99655.0	1160071.0
27.0	16968.7	.2000	1.0756	.0618	.0574	.2574	315477.1	296412.1	4280938.0
29.0	16090.3	.2000	1.1499	.0785	.0682	.2682	239174.4	236651.4	4177775.0
31.0	12066.3	.2000	1.2351	.0809	.0655	.2655	175694.1	185015.7	3941015.0
33.0	7261.2	.2000	1.3340	.0678	.0508	.2508	126573.8	143508.9	3646662.0
35.0	3653.4	.2000	1.4502	.0478	.0329	.2329	90578.3	111471.0	3345147.0
37.0	2361.2	.2000	1.5885	.0438	.0276	.2276	64613.6	86135.1	3025265.0
39.0	1515.8	.2000	1.7560	.0410	.0233	.2233	45012.7	65385.8	2666189.0
41.0	711.9	.2000	1.9631	.0289	.0147	.2147	30410.1	48711.3	2289278.0
43.0	330.5	.2000	2.2255	.0209	.0094	.2094	19950.7	35491.0	1909759.0
45.0	138.9	.2000	2.5692	.0144	.0056	.2056	12519.0	24985.4	1530116.0
47.0	56.1	.2000	3.0387	.0104	.0034	.2034	7381.4	16730.1	1159645.0
49.0	16.9	.2000	3.7191	.0062	.0017	.2017	3978.4	10409.1	812508.6
51.0	7.9	.2000	4.7947	.0068	.0014	.2014	1879.3	5778.1	505555.8
53.0	1.8	.2000	6.7578	.0049	.0007	.2007	715.4	2646.1	258400.3
55.0	20.5	.2000			.0250	.2250	184.3	2646.1	287246.3

Table 5.4.33 VPA. South Minch (Functional Unit 12) Males Trawl
Catch (000's) at 'nominal age'. 1980-1992

Catch-at age data

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	3090.	3438.	15517.	2173.	6190.	12022.	5038.	7490.	3922.	4618.	7816.	2707.	2502.
2	19084.	19416.	38828.	30705.	47010.	33696.	20632.	44034.	42108.	29087.	43135.	27491.	19892.
3	27117.	20659.	30500.	39637.	36693.	29820.	21798.	35532.	43861.	33310.	38651.	35056.	36823.
4	12200.	16636.	12361.	19629.	14779.	18016.	14215.	14839.	15706.	17322.	16114.	19474.	20780.
5	6603.	10749.	6145.	5755.	5413.	8321.	6605.	6219.	6548.	6679.	5208.	6684.	6231.
6	2380.	4811.	2617.	1413.	1853.	3231.	2189.	2996.	2278.	2415.	1847.	1928.	2002.
7	889.	2001.	1626.	487.	688.	1008.	745.	1500.	875.	799.	687.	658.	729.
8	399.	748.	1000.	203.	209.	343.	242.	546.	546.	271.	197.	214.	377.
9	180.	388.	382.	86.	74.	99.	116.	220.	301.	142.	133.	90.	129.
10	135.	185.	161.	51.	44.	42.	77.	144.	65.	36.	33.	25.	54.
11	101.	142.	59.	61.	30.	33.	120.	101.	30.	40.	36.	25.	47.

Table 5.4.34 VPA. South Minch (Functional Unit 12): Males Trawl
Mean weight (kg) at 'nominal age'. 1980-1992

Weight-at-age dat

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0050	.0060	.0050	.0060	.0060	.0050	.0060	.0060	.0060	.0060	.0060	.0060	.0060
2	.0130	.0120	.0120	.0130	.0120	.0120	.0120	.0120	.0120	.0120	.0120	.0120	.0120
3	.0220	.0220	.0220	.0220	.0210	.0220	.0220	.0210	.0210	.0220	.0220	.0220	.0220
4	.0350	.0360	.0360	.0350	.0350	.0360	.0360	.0350	.0350	.0350	.0350	.0350	.0350
5	.0510	.0510	.0510	.0500	.0500	.0510	.0500	.0510	.0500	.0510	.0500	.0500	.0500
6	.0670	.0670	.0670	.0660	.0670	.0670	.0670	.0680	.0670	.0670	.0670	.0660	.0670
7	.0830	.0840	.0850	.0840	.0840	.0830	.0830	.0840	.0840	.0830	.0830	.0840	.0840
8	.1010	.1010	.1010	.1010	.1010	.1010	.1010	.1010	.1020	.1010	.1020	.1010	.1010
9	.1180	.1170	.1170	.1180	.1180	.1170	.1180	.1180	.1160	.1160	.1160	.1160	.1170
10	.1300	.1310	.1300	.1310	.1310	.1310	.1300	.1310	.1300	.1300	.1310	.1310	.1310
11	.1690	.1560	.1630	.1680	.1560	.1540	.1680	.1550	.1560	.1650	.1690	.1550	.1640

Table 5.4.35 VPA. South Minch (Functional Unit 12): Males Trawl
Fishing mortality (F) at 'nominal age'. 1980-1992

F-at-age

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0176	.0161	.0762	.0113	.0371	.0678	.0232	.0375	.0198	.0203	.0393	.0235	.2000
2	.2165	.1630	.2819	.2367	.3997	.3224	.1767	.3207	.3390	.2215	.2974	.2100	.2669
3	.4842	.4329	.4662	.5894	.5575	.5436	.4029	.5886	.7006	.5596	.5814	.4752	.5431
4	.4274	.7192	.5727	.7191	.5189	.6796	.6232	.6044	.6491	.7766	.6702	.7633	.6628
5	.4847	.9830	.7436	.6630	.5008	.7224	.6574	.7127	.6804	.7411	.6500	.7622	.6844
6	.3805	.9334	.8031	.4234	.5280	.7357	.4755	.8366	.7211	.6645	.5314	.6123	.6228
7	.3597	.7361	1.2026	.3755	.4251	.7107	.4172	.8173	.7279	.6947	.4527	.4129	.5652
8	.3562	.6692	1.2891	.5082	.3067	.4407	.4127	.7105	.9663	.5955	.4100	.2767	.5021
9	.3224	.8098	1.0494	.3750	.3965	.2618	.2931	.9655	1.4155	.8518	.7678	.3724	.3000
10	.3461	.7383	1.1803	.4195	.3761	.4710	.3743	.8311	1.0366	.7140	.5435	.3540	.4558
11	.3461	.7383	1.1803	.4195	.3761	.4710	.3743	.8311	1.0366	.7140	.5435	.3540	.4558

Table 5.4.36 VPA. South Minch (Functional Unit 12): Males Trawl
Population numbers (000's) at 'nominal age'. 1980-1992

N-at-age

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	204460.	249245.	244238.	223249.	196665.	212000.	254626.	235602.	232026.	265461.	234615.	134946.	15896.
2	112865.	148808.	181686.	167656.	163517.	140390.	146762.	184295.	168122.	168513.	192683.	167111.	97651.
3	80812.	67336.	93657.	101533.	98027.	81219.	75338.	91110.	99068.	88740.	100032.	106025.	100348.
4	40174.	36888.	32356.	43526.	41720.	41580.	34935.	37304.	37467.	36425.	37563.	41435.	48832.
5	19661.	19410.	13312.	13520.	15709.	18393.	15612.	13877.	15100.	14502.	12411.	14237.	14308.
6	8621.	8970.	5380.	4688.	5161.	7052.	6617.	5993.	5041.	5665.	5120.	4800.	4922.
7	3377.	4365.	2613.	1785.	2274.	2255.	2503.	3047.	1923.	1816.	2159.	2230.	1928.
8	1529.	1746.	1549.	582.	909.	1101.	821.	1222.	997.	688.	672.	1017.	1093.
9	751.	793.	662.	316.	259.	495.	525.	402.	445.	281.	281.	330.	571.
10	528.	403.	261.	172.	161.	129.	282.	290.	114.	80.	89.	97.	169.
11	395.	309.	95.	204.	109.	99.	441.	203.	52.	90.	98.	97.	148.

Table 5.4.37 VPA. South Minch (Functional Unit 12): Males Trawl
Yield (tonnes),Fbar,Total stock biomass (tonnes),1980-1992
spawning stock biomass (tonnes), Ln recruitment

Year,	Yield,	Fbar,	TSB,	SSB,	Log R
		3- 8			
1980,	1953.2,	.4154,	7912.5,	7912.5,	12.23
1981,	2512.9,	.7456,	8418.2,	8418.2,	12.43
1982,	2462.6,	.8462,	8171.7,	8171.7,	12.41
1983,	2440.8,	.5464,	8564.4,	8564.4,	12.32
1984,	2381.9,	.4728,	8143.7,	8143.7,	12.19
1985,	2550.4,	.6388,	7827.5,	7827.5,	12.26
1986,	1876.2,	.4981,	7891.3,	7891.3,	12.45
1987,	2601.5,	.7117,	8455.7,	8455.7,	12.37
1988,	2656.8,	.7409,	8231.8,	8231.8,	12.35
1989,	2339.8,	.6720,	8239.3,	8239.3,	12.49
1990,	2465.8,	.5493,	8507.5,	8507.5,	12.37
1991,	2354.9,	.5504,	7982.5,	7982.5,	11.81
1992,	2366.0,	.5967,	6614.7,	6614.7,	9.67

Table 5.4.38 VPA. South Minch (Functional Unit 12) Males Creel
Catch (000's) at 'nominal age'. 1981-1992

Catch-at age data

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	0.	0.	0.	27.	1.	1.	79.	0.	34.	99.	0.	1.
2	96.	90.	87.	660.	381.	91.	1266.	210.	592.	1677.	61.	208.
3	1173.	1194.	1545.	2951.	2101.	1402.	2856.	1646.	1175.	2577.	1130.	1344.
4	1852.	1913.	2372.	3256.	2268.	2052.	2175.	2168.	2025.	1286.	2086.	2209.
5	1239.	1090.	1316.	1359.	1191.	1236.	875.	1057.	1348.	819.	1588.	2004.
6	599.	446.	581.	419.	566.	542.	317.	501.	492.	479.	765.	743.
7	290.	178.	201.	155.	170.	164.	105.	183.	218.	148.	256.	265.
8	146.	75.	77.	75.	76.	78.	38.	123.	115.	43.	92.	110.
9	74.	26.	31.	26.	15.	22.	6.	59.	20.	20.	18.	53.
10	51.	11.	13.	11.	8.	11.	4.	20.	11.	9.	2.	23.
11	60.	7.	8.	4.	1.	8.	1.	20.	8.	3.	0.	58.

Table 5.4.39 VPA. South Minch (Functional Unit 12): Males Creel
Mean weight (kg) at 'nominal age'. 1981-1992

Weight-at-age dat

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0080	.0080	.0000	.0070	.0080	.0080	.0070	.0000	.0070	.0070	.0000	.0040
2	.0160	.0160	.0170	.0150	.0160	.0160	.0150	.0160	.0140	.0140	.0170	.0170
3	.0280	.0280	.0280	.0270	.0270	.0280	.0260	.0270	.0270	.0260	.0280	.0270
4	.0430	.0430	.0430	.0420	.0420	.0430	.0420	.0420	.0440	.0420	.0430	.0440
5	.0610	.0610	.0610	.0600	.0610	.0610	.0610	.0610	.0610	.0610	.0620	.0610
6	.0820	.0820	.0820	.0820	.0820	.0820	.0820	.0820	.0820	.0820	.0820	.0820
7	.1040	.1030	.1020	.1030	.1030	.1030	.1030	.1050	.1040	.1020	.1040	.1030
8	.1230	.1220	.1230	.1230	.1220	.1230	.1210	.1230	.1230	.1230	.1200	.1240
9	.1450	.1440	.1440	.1440	.1430	.1440	.1430	.1440	.1420	.1440	.1430	.1440
10	.1630	.1630	.1630	.1620	.1620	.1630	.1620	.1630	.1620	.1620	.1620	.1640
11	.1970	.1930	.1870	.1930	.1820	.1910	.1990	.1940	.2040	.1900	.1800	.1970

Table 5.4.40 VPA. South Minch (Functional Unit 12): Males Creel
Fishing mortality (F) at 'nominal age'. 1981-1992

F-at-age

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0000	.0000	.0000	.0015	.0000	.0001	.0043	.0000	.0016	.0067	.0000	.2000
2	.0076	.0064	.0063	.0522	.0292	.0059	.0908	.0156	.0303	.1143	.0057	.0239
3	.1520	.1359	.1588	.3377	.2601	.1586	.2902	.1820	.1264	.1983	.1167	.1834
4	.4416	.4444	.4896	.6608	.5359	.4932	.4424	.4214	.4002	.2213	.2733	.3920
5	.6693	.5792	.7254	.6662	.6214	.7318	.4578	.4539	.5764	.3137	.5276	.5195
6	.7869	.6218	.8231	.6143	.7578	.7494	.4714	.5922	.4482	.4696	.6180	.5764
7	.8686	.6557	.7420	.6195	.6246	.5875	.3504	.6301	.6432	.2613	.5665	.5114
8	1.0216	.6587	.7687	.8035	.8415	.7646	.2908	1.0469	1.3190	.2770	.2873	.5847
9	1.2258	.5623	.7211	.7443	.4137	.7039	.1271	1.1790	.5412	1.0247	.2035	.3000
10	1.0386	.6256	.7439	.7224	.6266	.6853	.2561	.9520	.8345	.5210	.3524	.4654
11	1.0386	.6256	.7439	.7224	.6266	.6853	.2561	.9520	.8345	.5210	.3524	.4654

Table 5.4.41 VPA. South Minch (Functional Unit 12): Males Creel
Population numbers (000's) at 'nominal age'. 1981-1992

N-at-age

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	22248.	21672.	20256.	20706.	23884.	22743.	21227.	30994.	24230.	17052.	13747.	6.
2	14740.	16482.	16055.	15006.	15316.	17693.	16848.	15657.	22961.	17921.	12548.	10184.
3	9594.	10837.	12132.	11819.	10552.	11020.	13029.	11398.	11419.	16503.	11842.	9243.
4	5938.	6105.	7008.	7668.	6247.	6026.	6966.	7221.	7039.	7455.	10027.	7807.
5	2892.	2828.	2900.	3182.	2934.	2708.	2726.	3316.	3510.	3495.	4426.	5652.
6	1249.	1097.	1174.	1040.	1211.	1168.	965.	1278.	1560.	1461.	1892.	1935.
7	567.	421.	436.	382.	417.	420.	409.	446.	524.	738.	677.	755.
8	258.	176.	162.	154.	152.	165.	173.	213.	176.	204.	421.	284.
9	118.	69.	68.	56.	51.	49.	57.	96.	55.	35.	114.	234.
10	89.	26.	29.	24.	20.	25.	18.	37.	22.	24.	9.	69.
11	104.	18.	17.	10.	3.	18.	5.	37.	17.	9.	1.	178.

Table 5.4.42 VPA. South Minch (Functional Unit 12): Males Creel
Yield (tonnes),Fbar,Total stock biomass (tonnes),1981-1992
spawning stock biomass (tonnes), Ln recruitment

Year,	Yield,	Fbar, 3-8	TSB,	SSB,	Log R
1981,	317.8,	.6567,	1359.5,	1359.5,	10.01
1982,	254.4,	.5160,	1347.9,	1347.9,	9.98
1983,	312.6,	.6179,	1269.2,	1269.2,	9.92
1984,	373.9,	.6170,	1359.5,	1359.5,	9.94
1985,	307.7,	.6069,	1334.1,	1334.1,	10.08
1986,	281.6,	.5808,	1371.9,	1371.9,	10.03
1987,	281.6,	.3838,	1353.2,	1353.2,	9.96
1988,	294.3,	.5544,	1268.7,	1268.7,	10.34
1989,	295.1,	.5856,	1542.0,	1542.0,	10.10
1990,	259.5,	.2902,	1556.3,	1556.3,	9.74
1991,	324.3,	.3982,	1544.6,	1544.6,	9.53
1992,	383.8,	.4612,	1462.8,	1462.8,	1.85

Table 5.4.43 VPA. South Minch (Functional Unit 12): Females Trawl
Catch (000's) at 'nominal age'. 1980-1992

Catch-at age data

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	341.	2401.	4280.	425.	1061.	2178.	1085.	1580.	448.	416.	4323.	1743.	981.
2	17844.	17379.	22685.	14441.	36398.	28488.	14914.	21201.	20629.	29193.	50826.	39720.	26327.
3	7389.	4911.	7509.	7369.	9978.	12761.	6217.	6641.	8602.	15642.	16084.	13343.	14439.
4	5341.	4182.	5928.	5562.	7644.	10303.	5837.	5760.	7462.	13976.	12879.	9957.	13469.
5	3174.	3332.	3340.	4261.	5161.	7100.	5235.	4506.	5772.	10239.	10321.	6363.	10394.
6	2063.	2544.	1933.	2852.	3314.	3989.	3913.	3037.	6037.	7069.	5766.	3389.	5549.
7	1194.	1843.	1039.	1427.	1734.	2370.	2763.	1778.	3513.	3648.	3662.	2041.	3443.
8	773.	1466.	671.	876.	1025.	1565.	2076.	1204.	2367.	2240.	2621.	1574.	2331.
9	436.	1114.	463.	618.	526.	888.	1347.	789.	1543.	1437.	1752.	1444.	1312.
10	249.	668.	303.	304.	355.	479.	831.	479.	1004.	1014.	1079.	1159.	877.
11	179.	503.	243.	188.	292.	326.	640.	365.	803.	857.	828.	1053.	715.
12	33.	190.	221.	54.	106.	149.	360.	147.	465.	434.	365.	402.	305.
13	28.	180.	220.	50.	100.	143.	350.	140.	454.	419.	350.	381.	292.
14	63.	169.	853.	41.	107.	85.	550.	164.	926.	768.	731.	333.	452.

Table 5.4.44 VPA. South Minch (Functional Unit 12): Females Trawl
Mean weight (kg) at 'nominal age'.1980-1992

Weight-at-age dat

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0060	.0050	.0050	.0050	.0060	.0050	.0050	.0060	.0060	.0060	.0050	.0050	.0050
2	.0120	.0110	.0110	.0120	.0110	.0110	.0110	.0110	.0110	.0120	.0110	.0110	.0120
3	.0160	.0160	.0160	.0160	.0160	.0160	.0160	.0160	.0160	.0160	.0160	.0160	.0160
4	.0180	.0190	.0180	.0190	.0190	.0190	.0190	.0190	.0190	.0190	.0190	.0190	.0190
5	.0220	.0220	.0220	.0220	.0220	.0220	.0220	.0220	.0220	.0220	.0220	.0220	.0220
6	.0250	.0250	.0250	.0250	.0250	.0250	.0250	.0250	.0250	.0250	.0250	.0250	.0250
7	.0280	.0290	.0280	.0280	.0280	.0280	.0290	.0280	.0280	.0280	.0280	.0280	.0280
8	.0310	.0310	.0310	.0310	.0310	.0310	.0310	.0310	.0310	.0310	.0310	.0320	.0310
9	.0350	.0350	.0350	.0350	.0350	.0350	.0350	.0350	.0350	.0350	.0350	.0350	.0350
10	.0380	.0380	.0390	.0380	.0390	.0380	.0380	.0380	.0390	.0390	.0380	.0390	.0390
11	.0410	.0410	.0410	.0410	.0410	.0410	.0410	.0410	.0410	.0410	.0410	.0410	.0410
12	.0460	.0470	.0470	.0470	.0470	.0470	.0470	.0470	.0470	.0470	.0470	.0470	.0470
13	.0470	.0470	.0470	.0470	.0470	.0470	.0470	.0470	.0470	.0470	.0470	.0470	.0470
14	.0630	.0580	.0620	.0570	.0570	.0580	.0640	.0570	.0610	.0640	.0600	.0570	.0580

Table 5.4.45 VPA. South Minch (Functional Unit 12): Females Trawl
Fishing mortality (F) at 'nominal age'. 1980-1992

F-at-age

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0020	.0127	.0219	.0019	.0052	.0100	.0043	.0061	.0014	.0011	.0122	.0067	.1000
2	.1706	.1509	.1770	.1063	.2442	.2064	.0974	.1218	.1145	.1282	.2027	.1644	.1461
3	.1125	.0684	.0951	.0846	.1051	.1338	.0668	.0605	.0701	.1260	.1021	.0793	.0875
4	.1150	.0859	.1101	.0946	.1186	.1504	.0834	.0814	.0894	.1554	.1450	.0848	.1072
5	.0944	.0975	.0916	.1077	.1193	.1541	.1063	.0856	.1095	.1702	.1645	.0990	.1197
6	.1013	.1019	.0753	.1054	.1144	.1273	.1190	.0828	.1579	.1898	.1366	.0745	.1174
7	.0687	.1236	.0551	.0732	.0862	.1119	.1221	.0728	.1300	.1351	.1420	.0655	.1009
8	.0721	.1128	.0604	.0600	.0689	.1045	.1354	.0717	.1308	.1145	.1357	.0835	.0991
9	.0655	.1410	.0472	.0725	.0465	.0785	.1229	.0697	.1235	.1095	.1231	.1030	.0929
10	.0644	.1354	.0516	.0396	.0543	.0543	.0980	.0586	.1189	.1115	.1121	.1119	.0839
11	.0376	.1791	.0667	.0409	.0484	.0646	.0955	.0568	.1317	.1411	.1252	.1524	.0935
12	.0169	.0510	.1113	.0189	.0291	.0315	.0941	.0285	.0954	.0975	.0822	.0824	.0600
13	.0397	.1220	.0766	.0332	.0440	.0502	.0959	.0480	.1154	.1167	.1065	.1156	.0791
14	.0397	.1220	.0766	.0332	.0440	.0502	.0959	.0480	.1154	.1167	.1065	.1156	.0791

Table 5.4.46 VPA. South Minch (Functional Unit 12): Females Trawl
Population numbers (000's) at 'nominal age'. 1980-1992

N-at-age

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	193559.	220340.	228174.	261407.	238709.	253050.	289320.	299021.	378521.	431081.	412750.	303623.	11901.
2	131144.	143099.	161165.	165351.	193289.	175927.	185589.	213400.	220160.	280030.	318995.	302052.	223429.
3	76470.	81917.	91164.	100027.	110145.	112169.	106026.	124731.	139966.	145460.	182498.	192953.	189845.
4	54145.	55946.	62637.	67866.	75248.	81182.	80335.	81196.	96128.	106833.	104992.	134912.	145939.
5	38809.	39515.	42032.	45938.	50548.	54717.	57182.	60507.	61281.	71972.	74875.	74354.	101475.
6	23591.	28912.	29347.	31401.	33769.	36732.	38401.	42096.	45475.	44968.	49703.	52005.	55137.
7	19800.	17454.	21377.	22284.	23137.	24660.	26478.	27913.	31726.	31792.	30451.	35497.	39521.
8	12245.	15134.	12629.	16564.	16957.	17378.	18053.	19188.	21249.	22808.	22741.	21631.	27220.
9	7575.	9327.	11069.	9734.	12772.	12959.	12817.	12909.	14623.	15264.	16654.	16257.	16291.
10	4390.	5809.	6632.	8645.	7412.	9981.	9808.	9280.	9858.	10581.	11201.	12056.	12008.
11	5346.	3370.	4153.	5157.	6802.	5748.	7740.	7281.	7165.	7166.	7749.	8198.	8825.
12	2144.	4215.	2307.	3181.	4053.	5306.	4412.	5760.	5632.	5142.	5095.	5598.	5763.
13	801.	1726.	3280.	1690.	2556.	3222.	4209.	3287.	4583.	4191.	3819.	3842.	4221.
14	1781.	1616.	12751.	1382.	2735.	1909.	6621.	3848.	9354.	7677.	7966.	3363.	6540.

Table 5.4.47 VPA. South Minch (Functional Unit 12): Females Trawl
Yield (tonnes),Fbar,Total stock biomass(tonnes)
spawning stock biomass (tonnes), Ln recruitment 1980-1992

Year,	Yield,	Fbar,	TSB,	SSB,	Log R
		3-11			
1980,	648.2,	.0813,	8210.4,	5475.3,	12.17
1981,	709.2,	.1162,	8675.2,	5999.4,	12.30
1982,	781.1,	.0726,	10017.7,	7104.0,	12.34
1983,	679.2,	.0754,	10302.5,	7011.3,	12.47
1984,	1048.3,	.0846,	11361.7,	7803.3,	12.38
1985,	1176.3,	.1088,	11468.9,	8268.5,	12.44
1986,	910.8,	.1055,	12224.0,	8735.9,	12.58
1987,	804.1,	.0711,	13187.4,	9045.9,	12.61
1988,	1184.4,	.1180,	15031.6,	10338.7,	12.84
1989,	1656.4,	.1392,	16779.6,	10832.8,	12.97
1990,	1851.4,	.1318,	17158.1,	11585.4,	12.93
1991,	1375.2,	.0949,	17123.9,	12283.3,	12.62
1992,	1507.4,	.1002,	16361.2,	13620.6,	9.38

Table 5.4.48 VPA. South Minch (Functional Unit 12): Females Creel Catch (000's) at 'nominal age'. 1981-1992

Catch-at age data

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	0.	0.	0.	7.	0.	0.	10.	0.	5.	16.	0.	1.
2	63.	206.	103.	585.	146.	201.	825.	155.	211.	614.	17.	64.
3	132.	311.	228.	507.	252.	394.	460.	353.	110.	337.	51.	130.
4	218.	437.	439.	620.	462.	592.	537.	758.	103.	282.	113.	215.
5	279.	561.	724.	756.	737.	887.	795.	1122.	344.	432.	259.	303.
6	306.	589.	694.	668.	677.	889.	814.	939.	588.	547.	563.	242.
7	289.	500.	598.	573.	564.	782.	732.	824.	643.	458.	606.	254.
8	254.	396.	502.	470.	452.	661.	620.	693.	631.	356.	568.	263.
9	175.	241.	370.	286.	297.	476.	410.	422.	526.	242.	420.	246.
10	110.	148.	202.	153.	203.	317.	247.	304.	345.	167.	350.	191.
11	79.	104.	124.	91.	159.	241.	172.	248.	260.	132.	316.	165.
12	54.	50.	59.	55.	86.	117.	86.	142.	126.	75.	192.	135.
13	49.	45.	53.	51.	78.	106.	77.	128.	123.	69.	175.	128.
14	99.	50.	53.	87.	118.	167.	72.	147.	369.	126.	337.	496.

Table 5.4.49 VPA. South Minch (Functional Unit 12): Females Creel Mean weight (kg) at 'nominal age'.1981-1992

Weight-at-age dat

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0060	.0070	.0000	.0060	.0000	.0000	.0060	.0000	.0070	.0070	.0000	.0040
2	.0150	.0140	.0150	.0130	.0140	.0150	.0130	.0150	.0130	.0130	.0150	.0150
3	.0180	.0180	.0180	.0180	.0180	.0180	.0170	.0180	.0170	.0170	.0180	.0180
4	.0210	.0210	.0210	.0210	.0210	.0210	.0210	.0210	.0210	.0210	.0210	.0210
5	.0240	.0240	.0240	.0240	.0240	.0240	.0240	.0240	.0240	.0240	.0240	.0240
6	.0280	.0280	.0280	.0280	.0280	.0280	.0280	.0280	.0280	.0280	.0280	.0280
7	.0310	.0310	.0310	.0310	.0310	.0310	.0310	.0310	.0310	.0310	.0310	.0320
8	.0340	.0340	.0340	.0340	.0340	.0340	.0340	.0340	.0340	.0340	.0340	.0340
9	.0390	.0390	.0390	.0390	.0390	.0390	.0390	.0390	.0390	.0390	.0390	.0390
10	.0420	.0420	.0410	.0410	.0420	.0420	.0420	.0420	.0420	.0420	.0420	.0420
11	.0450	.0450	.0450	.0450	.0450	.0450	.0450	.0450	.0450	.0450	.0450	.0450
12	.0510	.0510	.0510	.0510	.0510	.0510	.0510	.0510	.0510	.0510	.0510	.0510
13	.0520	.0520	.0520	.0520	.0520	.0520	.0520	.0520	.0520	.0520	.0520	.0520
14	.0660	.0630	.0610	.0630	.0650	.0630	.0610	.0610	.0640	.0640	.0650	.0700

Table 5.4.50 VPA. South Minch (Functional Unit 12): Females Creel
Fishing mortality (F) at 'nominal age'. 1981-1992

F-at-age

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0000	.0000	.0000	.0002	.0000	.0000	.0008	.0000	.0004	.0015	.0000	.1000
2	.0019	.0063	.0036	.0232	.0066	.0124	.0699	.0188	.0209	.0567	.0021	.0156
3	.0054	.0120	.0091	.0233	.0131	.0233	.0375	.0407	.0175	.0443	.0063	.0211
4	.0116	.0223	.0210	.0309	.0266	.0386	.0401	.0800	.0149	.0567	.0188	.0329
5	.0202	.0375	.0467	.0456	.0465	.0653	.0667	.1100	.0473	.0801	.0676	.0641
6	.0287	.0540	.0594	.0554	.0524	.0727	.0786	.1047	.0775	.0987	.1424	.0835
7	.0416	.0600	.0713	.0638	.0605	.0788	.0788	.1066	.0969	.0796	.1511	.0881
8	.0517	.0739	.0789	.0736	.0655	.0935	.0827	.0997	.1111	.0713	.1341	.0906
9	.0473	.0633	.0915	.0588	.0607	.0911	.0772	.0744	.1023	.0567	.1124	.0790
10	.0426	.0513	.0693	.0496	.0540	.0850	.0625	.0754	.0804	.0427	.1086	.0683
11	.0501	.0518	.0554	.0405	.0668	.0838	.0605	.0822	.0854	.0398	.1060	.0682
12	.0454	.0404	.0376	.0314	.0488	.0637	.0390	.0654	.0545	.0321	.0748	.0600
13	.0465	.0483	.0545	.0407	.0569	.0779	.0542	.0746	.0736	.0383	.0967	.0657
14	.0465	.0483	.0545	.0407	.0569	.0779	.0542	.0746	.0736	.0383	.0967	.0657

Table 5.4.51 VPA. South Minch (Functional Unit 12): Females Creel
Population numbers (000's) at 'nominal age'. 1981-1992

N-at-age

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	50894.	44349.	39810.	34587.	25413.	19044.	13014.	15926.	17384.	12570.	6400.	12.
2	39000.	37703.	32854.	29492.	25617.	18827.	14108.	9633.	11798.	12874.	9299.	4741.
3	26828.	28837.	27753.	24251.	21345.	18851.	13775.	9746.	7002.	8559.	9011.	6874.
4	20774.	21846.	23328.	22516.	19397.	17247.	15077.	10861.	7660.	5633.	6704.	7332.
5	15388.	16812.	17491.	18702.	17873.	15463.	13585.	11858.	8209.	6179.	4358.	5386.
6	11896.	12347.	13256.	13667.	14630.	13968.	11859.	10405.	8697.	6411.	4669.	3335.
7	7813.	9463.	9577.	10227.	10587.	11367.	10634.	8975.	7672.	6590.	4755.	3316.
8	5565.	6136.	7297.	7301.	7856.	8159.	8601.	8047.	6606.	5701.	4982.	3347.
9	4172.	4327.	4666.	5521.	5553.	6025.	6084.	6482.	5963.	4839.	4347.	3567.
10	2901.	3258.	3325.	3486.	4262.	4279.	4503.	4611.	4927.	4407.	3744.	3181.
11	1792.	2276.	2534.	2540.	2716.	3306.	3218.	3464.	3501.	3722.	3457.	2750.
12	1333.	1396.	1769.	1963.	1997.	2080.	2489.	2480.	2612.	2632.	2928.	2546.
13	1185.	1043.	1097.	1395.	1558.	1557.	1598.	1960.	1902.	2025.	2087.	2225.
14	2402.	1162.	1106.	2392.	2355.	2462.	1512.	2256.	5725.	3701.	4030.	8599.

Table 5.4.52 VPA. South Minch (Functional Unit 12): Females Creel
Yield (tonnes),Fbar,Total stock biomass(tonnes)
spawning stock biomass (tonnes), Ln recruitment 1981-1992

Year,	Yield,	Fbar,	TSB,	SSB,	Log R
		3-11			
1981,	67.5,	.0332,	3596.7,	2706.4,	10.84
1982,	104.9,	.0473,	3673.9,	2835.6,	10.70
1983,	124.6,	.0558,	3465.3,	2972.5,	10.59
1984,	132.8,	.0490,	3693.0,	3102.1,	10.45
1985,	129.2,	.0496,	3437.8,	3079.2,	10.14
1986,	180.1,	.0702,	3281.5,	2999.1,	9.85
1987,	162.4,	.0650,	2966.0,	2704.5,	9.47
1988,	190.2,	.0860,	2644.1,	2499.6,	9.68
1989,	156.0,	.0704,	2653.5,	2378.4,	9.76
1990,	109.6,	.0633,	2262.8,	2007.5,	9.44
1991,	149.6,	.0941,	1996.7,	1857.3,	8.76
1992,	112.2,	.0662,	2035.3,	1964.1,	2.50

Table 5.4.53 Input data and parameters: Firth of Clyde

FU	13	MA	C
FLEET	UK Scotland	GEAR	Nephrops and Light trawl

1992	NUMBER OF SAMPLES				Mean
	Qtr 1	Qtr 2	Qtr 3	Qtr 4	No./sample
Catch					
Landings	13	15	16	13	531
Discards	2	2	3	6	835

	NUMBER OF SAMPLES									
YEAR	92	91	90	89	88	87	86	85	84	83
Catch										
Landings	57	76	53	44	42	51	30	55	54	54
Discards	13	18	13							

INPUT PARAMETERS

Parameter	Value	Source
Discard Survival	0.25	Gueguen and Charuau,1975; Anon.,1985
MALES		
Growth - K	0.16	Bailey and Chapman, 1983
Growth - L(inf)	73	"
Nat. Mort. - M	0.3	Morizur, 1982
Length/weight - a	0.00028	Howard and Hall, 1983
Length/weight - b	3.24	"
FEMALES		
Immature Growth		
K	0.16	as for males
L(inf)	73	"
Nat.Mort. - M	0.3	"
Size at Maturity	27	Bailey, 1984
Mature Growth		
K	0.06	as for males
L(inf)	62	"
Nat.Mort. - M	0.2	assumed *
Length/weight - a	0.000845	as for males
Length/weight - b	2.91	"

* based on Morizur, 1982 and assuming lower mature female rate

Table 5.4.54 Clyde (Functional Unit 13) : landings (in tonnes), by gear,1983-92, all UK

Year	Nephrops Trawl	Other Trawl	Creel	Total
1983	3 889	136	53	4 078
84	3 069	163	77	3 309
85	3 921	301	64	4 286
86	4 074	189	79	4 342
87	2 859	84	64	3 007
1988	3 505	114	43	3 662
89	2 577	193	36	2 806
90	2 731	156	24	2 911
91	2 838	175	25	3 038
92(*)	2 514	262	10	2 786

(*)provisional

Table 5.4.55 Clyde (Functional Unit 13) : landings (in tonnes), effort (in '000 hours trawling) and LPUE (in kg/hour trawling) of Scottish Nephrops trawlers, 1983-92. Single and multi-rig trawls combined (see Table 3.2.2)

Year	Landings	Effort	LPUE
1983	3 889	149.9	25.9
84	3 069	140.0	21.9
85	3 921	155.7	25.2
86	4 074	168.9	24.1
87	2 859	144.3	19.8
1988	3 505	150.7	23.3
89	2 577	150.0	17.2
90	2 731	153.4	17.8
91	2 838	165.0	17.2
92(*)	2 514	159.9	15.7

(*) provisional

Table 5.4.56 Clyde (Functional Unit 13) : mean sizes (CL in mm) of male and female Nephrops in Scottish landings, 1983-92

Year	Males	Females
1983	31.9	30.0
84	29.2	26.9
85	30.5	28.8
86	30.6	28.3
87	31.3	29.7
1988	33.7	30.7
89	35.4	33.1
90	33.1	31.9
91	30.4	29.2
92	32.1	30.3

Table 5.4.57 LCA. Firth of Clyde (Functional Unit 13): Males
Cohort Analysis Output. Reference period 1989-1992

L INFINITY = 73.0000 K = .1600

COHORT ANALYSIS BY POPE'S APPROXIMATION

SIZE MM	REMOVALS	M	DT	FDT	F	Z	NO. ATTAINING	AVE. NO. IN SEA	BIOMASS kg
15.0	48.8	.3000	.2193	.0003	.0013	.3013	171198.5	36333.5	81061.4
17.0	527.5	.3000	.2273	.0034	.0150	.3150	160249.7	35151.0	114862.5
19.0	1630.1	.3000	.2359	.0114	.0483	.3483	149176.8	33780.9	155298.2
21.0	4089.9	.3000	.2451	.0314	.1280	.4280	137412.0	31977.1	200192.1
23.0	6235.6	.3000	.2551	.0538	.2108	.5108	123727.3	29596.9	245634.4
25.0	8914.6	.3000	.2660	.0893	.3357	.6357	108608.9	26579.3	285900.2
27.0	10094.0	.3000	.2778	.1219	.4387	.7387	91712.9	23035.5	315026.3
29.0	11347.8	.3000	.2908	.1728	.5943	.8943	74696.8	19124.2	327049.5
31.0	11038.9	.3000	.3049	.2239	.7344	1.0344	57593.9	15062.4	317496.2
33.0	8542.9	.3000	.3206	.2400	.7486	1.0486	42013.7	11438.8	293447.2
35.0	6766.2	.3000	.3379	.2706	.8009	1.1009	30019.4	8471.0	261524.9
37.0	4348.7	.3000	.3572	.2507	.7017	1.0017	20693.6	6214.5	228594.0
39.0	2853.9	.3000	.3789	.2342	.6181	.9181	14468.7	4630.3	201114.0
41.0	1857.3	.3000	.4034	.2146	.5319	.8319	10217.8	3501.3	178118.6
43.0	1199.4	.3000	.4312	.1926	.4466	.7466	7305.0	2693.2	159299.3
45.0	814.3	.3000	.4632	.1802	.3890	.6890	5294.2	2099.4	143411.8
47.0	551.7	.3000	.5003	.1679	.3356	.6356	3847.7	1648.9	129292.2
49.0	383.9	.3000	.5438	.1611	.2962	.5962	2799.7	1300.4	116383.2
51.0	261.7	.3000	.5957	.1524	.2558	.5558	2024.4	1026.6	104332.8
53.0	181.4	.3000	.6585	.1482	.2251	.5251	1453.8	809.4	92954.2
55.0	132.0	.3000	.7361	.1546	.2100	.5100	1028.9	631.4	81587.9
57.0	101.0	.3000	.8346	.1767	.2118	.5118	706.8	480.1	69499.3
59.0	77.0	.3000	.9634	.2144	.2226	.5226	461.1	349.0	56396.8
61.0	44.5	.3000	1.1395	.2103	.1845	.4845	278.7	244.1	43852.1
63.0	29.3	.3000	1.3946	.2548	.1827	.4827	160.5	162.9	32434.8
65.0	20.4	.3000	1.7980	.3939	.2191	.5191	81.9	95.7	21051.3
67.0	12.9	.3000			.2000	.5000	32.2	95.7	21051.3

Table 5.4.58 LCA. Firth of Clyde (Functional Unit 13): Females
Cohort Analysis Output. Reference period 1989-1992

LOWER CURVE LINF= 73.0000 K= .1600

UPPER CURVE LINF= 62.0000 K= .0600

TRANSITION LENGTH= 27.0000

COHORT ANALYSIS BY POPE'S APPROXIMATION

SIZE MM	REMOVALS	M	DT	FDT	F	Z	NO. ATTAINING	AVE. NO. IN SEA	BIOMASS kg
13.0	3.0	.3000	.2119	.0000	.0000	.3000	582415.7	119564.2	218620.4
15.0	25.2	.3000	.2193	.0000	.0002	.3002	546543.4	116007.2	312846.3
17.0	1082.6	.3000	.2273	.0022	.0096	.3096	511716.1	112313.2	426707.7
19.0	2594.7	.3000	.2359	.0057	.0240	.3240	476939.4	108308.3	559133.8
21.0	4700.5	.3000	.2451	.0111	.0453	.3453	441851.5	103853.8	707504.3
23.0	7717.7	.3000	.2551	.0199	.0782	.3782	405993.5	98743.6	866523.8
25.0	8944.7	.3000	.2660	.0256	.0961	.3961	368649.8	93070.2	1030956.0
27.0	8827.7	.2000	.2778	.0277	.0998	.2998	331780.2	88441.4	1215465.0
29.0	8462.8	.2000	1.0420	.0313	.0300	.2300	305261.8	282840.8	4751402.0
31.0	6675.9	.2000	1.1115	.0316	.0284	.2284	240210.9	235804.8	4779649.0
33.0	5256.5	.2000	1.1910	.0323	.0271	.2271	186356.4	194463.1	4702164.0
35.0	3856.0	.2000	1.2827	.0313	.0244	.2244	142191.4	158484.0	4525665.0
37.0	2616.9	.2000	1.3897	.0286	.0206	.2206	106625.4	127618.3	4265208.0
39.0	1729.5	.2000	1.5162	.0260	.0171	.2171	78474.6	101380.6	3933746.0
41.0	1064.7	.2000	1.6681	.0225	.0135	.2135	56461.3	79235.3	3543487.0
43.0	700.5	.2000	1.8538	.0216	.0116	.2116	39543.9	60635.4	3104775.0
45.0	444.4	.2000	2.0861	.0207	.0099	.2099	26711.8	45123.2	2629556.0
47.0	255.6	.2000	2.3850	.0190	.0080	.2080	17239.2	32415.0	2138038.0
49.0	168.3	.2000	2.7842	.0214	.0077	.2077	10498.0	22196.3	1648695.0
51.0	107.8	.2000	3.3445	.0259	.0077	.2077	5888.1	14194.9	1181840.0
53.0	78.8	.2000	4.1886	.0416	.0099	.2099	2939.2	8189.3	760976.0
55.0	33.2	.2000	5.6079	.0489	.0087	.2087	1219.9	4031.7	416454.9
57.0	42.0	.2000			.0250	.2250	378.4	4031.7	461228.7

Table 5.4.59 VPA. Firth of Clyde (Functional Unit 13): Males
Catch (000's) at 'nominal age'. 1980-1992

Catch-at age data

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	441.	2791.	13383.	16697.	71674.	35487.	33983.	10924.	2835.	2494.	13779.	12624.	3362.
2	16896.	32156.	44893.	61476.	66398.	62316.	67987.	49161.	23531.	10067.	32247.	57008.	37264.
3	19759.	26356.	20370.	36603.	24015.	28951.	25565.	25732.	31546.	16524.	27001.	32201.	33308.
4	11882.	8066.	6100.	11307.	7600.	8321.	9730.	7185.	11358.	9368.	7345.	6838.	9538.
5	5343.	3315.	2198.	4281.	2768.	2951.	3476.	2092.	4952.	3700.	2511.	1467.	2490.
6	2186.	1255.	864.	1309.	990.	900.	1586.	691.	2454.	1658.	942.	401.	678.
7	1051.	740.	529.	666.	354.	291.	789.	344.	1069.	907.	374.	119.	193.
8	538.	364.	280.	390.	212.	168.	339.	170.	417.	514.	228.	38.	58.
9	387.	169.	147.	216.	96.	82.	149.	89.	209.	291.	147.	11.	28.
10	288.	88.	98.	109.	50.	48.	64.	31.	145.	186.	90.	6.	13.
11	351.	155.	138.	182.	89.	61.	46.	80.	152.	217.	161.	12.	15.

Table 5.4.60 VPA. Firth of Clyde (Functional Unit 13): Males
Mean weight (kg) at 'nominal age'. 1980-1992

Weight-at-age dat

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0080	.0060	.0060	.0060	.0050	.0050	.0060	.0060	.0060	.0060	.0060	.0060	.0070
2	.0140	.0140	.0120	.0130	.0120	.0120	.0120	.0130	.0140	.0130	.0130	.0130	.0140
3	.0250	.0250	.0250	.0240	.0250	.0250	.0250	.0250	.0250	.0260	.0250	.0250	.0250
4	.0420	.0410	.0410	.0420	.0410	.0410	.0410	.0410	.0420	.0420	.0410	.0410	.0410
5	.0600	.0610	.0610	.0600	.0610	.0600	.0610	.0600	.0610	.0610	.0600	.0600	.0600
6	.0830	.0830	.0830	.0820	.0820	.0820	.0820	.0820	.0820	.0830	.0820	.0820	.0820
7	.1040	.1030	.1040	.1040	.1040	.1030	.1030	.1040	.1030	.1040	.1030	.1030	.1020
8	.1220	.1240	.1230	.1240	.1240	.1240	.1240	.1220	.1220	.1230	.1240	.1210	.1220
9	.1460	.1440	.1450	.1450	.1440	.1450	.1440	.1440	.1450	.1450	.1450	.1440	.1450
10	.1630	.1640	.1640	.1630	.1630	.1630	.1630	.1650	.1630	.1630	.1630	.1640	.1630
11	.2000	.1950	.1980	.1990	.2030	.2120	.1950	.1960	.1960	.2010	.2030	.1960	.1980

Table 5.4.61 VPA. Firth of Clyde (Functional Unit 13): Males
Fishing mortality (F) at 'nominal age'. 1980-1992

F-at-age

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0033	.0162	.0749	.0845	.3441	.1777	.1952	.1138	.0293	.0171	.0724	.0905	.2000
2	.2230	.3924	.4326	.6455	.6288	.6509	.6867	.5403	.4274	.1534	.3544	.5353	.4681
3	.6327	.7328	.5268	.8897	.6504	.7216	.7078	.7015	.9531	.6975	.8909	.8364	.8089
4	.7896	.6655	.4160	.7280	.5203	.5613	.6550	.4985	.9229	1.0159	.9214	.6809	.7426
5	.7333	.6068	.4306	.6650	.4408	.4437	.5529	.3157	.9050	1.0913	1.0144	.5304	.6538
6	.6045	.4241	.3504	.5641	.3527	.2796	.5184	.2230	.8678	1.0859	1.1371	.4841	.5734
7	.5717	.4793	.3583	.5690	.3263	.1845	.4782	.2238	.7236	1.1536	.9167	.4586	.5184
8	.5106	.4493	.3783	.5559	.4006	.2845	.3811	.1975	.5220	1.1445	1.3237	.2320	.4850
9	.7446	.3330	.3694	.6429	.2875	.2975	.4968	.1816	.4472	1.0180	1.6855	.2099	.3000
10	.6089	.4205	.3686	.5892	.3381	.2555	.4520	.2009	.5643	1.1054	1.3086	.3002	.4345
11	.6089	.4205	.3686	.5892	.3381	.2555	.4520	.2009	.5643	1.1054	1.3086	.3002	.4345

Table 5.4.62 VPA. Firth of Clyde (Functional Unit 13): Males
Population numbers (000's) at 'nominal age'. 1980-1992

N-at-age

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	153826.	200843.	214236.	238133.	282531.	251143.	220741.	117207.	113431.	170251.	228000.	168542.	21364.
2	97309.	113577.	146386.	147256.	162125.	148362.	155755.	134530.	77489.	81603.	123978.	157112.	114058.
3	48026.	57680.	56831.	70355.	57207.	64047.	57326.	58066.	58058.	37437.	51853.	64434.	68141.
4	24705.	18898.	20534.	24857.	21410.	22115.	23059.	20925.	21330.	16582.	13807.	15760.	20683.
5	11687.	8310.	7196.	10035.	8892.	9426.	9345.	8873.	9415.	6279.	4448.	4070.	5910.
6	5495.	4159.	3355.	3466.	3823.	4239.	4480.	3982.	4794.	2822.	1562.	1195.	1774.
7	2754.	2224.	2016.	1751.	1460.	1990.	2374.	1976.	2361.	1491.	706.	371.	545.
8	1536.	1152.	1020.	1044.	734.	781.	1226.	1090.	1171.	848.	349.	209.	174.
9	837.	683.	544.	518.	443.	364.	435.	620.	663.	514.	200.	69.	123.
10	719.	294.	363.	279.	202.	246.	200.	196.	383.	314.	138.	27.	41.
11	876.	519.	512.	466.	357.	309.	145.	503.	402.	365.	247.	52.	49.

Table 5.4.63 VPA. Firth of Clyde (Functional Unit 13): Males
Yield (tonnes),Fbar,Total stock biomass (tonnes),
spawning stock biomass (tonnes), Ln recruitment.1980-1992

Year,	Yield,	Fbar,	TSB,	SSB,	Log R
		3- 8			
1980,	2083.3,	.6404,	6877.0,	6877.0,	11.94
1981,	1953.4,	.5597,	6483.7,	6483.7,	12.21
1982,	1738.2,	.4101,	6597.0,	6597.0,	12.27
1983,	2819.6,	.6620,	7486.6,	7486.6,	12.38
1984,	2420.5,	.4485,	6934.2,	6934.2,	12.55
1985,	2324.3,	.4125,	6917.4,	6917.4,	12.43
1986,	2564.0,	.5489,	7029.7,	7029.7,	12.30
1987,	1914.8,	.3600,	6179.5,	6179.5,	11.67
1988,	2360.1,	.8157,	5703.5,	5703.5,	11.64
1989,	1605.8,	1.0314,	4828.0,	4828.0,	12.05
1990,	1841.2,	1.0340,	5454.6,	5454.6,	12.34
1991,	2044.9,	.5371,	5741.1,	5741.1,	12.03
1992,	2009.9,	.6303,	4909.0,	4909.0,	9.97

Table 5.4.64 VPA. Firth of Clyde (Functional Unit 13): Females
Catch (000's) at 'nominal age'. 1980-1992

Catch-at age data

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	327.	2238.	12725.	15179.	63158.	20558.	40584.	4973.	2138.	2824.	10278.	8765.	1056.
2	14335.	31571.	40626.	62445.	87328.	96320.	100082.	48734.	31357.	13579.	34021.	50031.	22195.
3	3908.	8144.	6974.	13809.	8160.	13547.	9966.	8018.	10284.	4710.	9905.	8863.	7465.
4	4030.	6945.	5025.	8569.	4859.	8518.	7824.	4793.	7793.	4956.	6841.	6352.	5457.
5	3600.	5111.	3522.	4958.	2454.	5334.	5766.	2729.	5001.	5462.	4913.	3988.	3292.
6	2888.	2974.	1853.	3803.	1023.	3202.	3684.	1542.	2618.	4362.	3791.	2413.	2164.
7	2614.	2093.	1522.	2664.	677.	2179.	2482.	1105.	1776.	3495.	2755.	1623.	1493.
8	2326.	1604.	1345.	1853.	521.	1551.	1685.	863.	1405.	2746.	1999.	1153.	1034.
9	1655.	1239.	897.	1301.	287.	1022.	995.	634.	1299.	1726.	1401.	831.	605.
10	1190.	921.	695.	811.	213.	675.	724.	494.	1068.	1174.	1073.	545.	392.
11	976.	770.	598.	585.	178.	511.	594.	427.	957.	916.	915.	411.	292.
12	876.	539.	391.	496.	105.	279.	264.	311.	664.	578.	542.	226.	165.
13	810.	512.	363.	458.	97.	256.	241.	296.	607.	539.	503.	208.	154.
14	2537.	1579.	772.	1130.	348.	736.	598.	1437.	1986.	2096.	1222.	510.	553.

Table 5.4.65 VPA. Firth of Clyde (Functional Unit 13): Females
Mean weight (kg) at 'nominal age'.1980-1992

Weight-at-age dat

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0070	.0060	.0060	.0050	.0050	.0050	.0050	.0060	.0070	.0050	.0050	.0050	.0060
2	.0120	.0120	.0100	.0110	.0100	.0110	.0100	.0110	.0120	.0110	.0110	.0110	.0120
3	.0170	.0170	.0170	.0170	.0170	.0170	.0170	.0170	.0170	.0170	.0170	.0170	.0170
4	.0200	.0200	.0200	.0200	.0200	.0200	.0200	.0200	.0200	.0210	.0200	.0200	.0200
5	.0240	.0240	.0240	.0240	.0240	.0240	.0240	.0240	.0240	.0240	.0240	.0240	.0240
6	.0280	.0280	.0280	.0280	.0270	.0280	.0280	.0280	.0280	.0280	.0280	.0280	.0280
7	.0310	.0310	.0310	.0310	.0310	.0310	.0310	.0310	.0310	.0310	.0310	.0310	.0310
8	.0340	.0340	.0340	.0340	.0340	.0340	.0340	.0340	.0340	.0340	.0340	.0340	.0340
9	.0390	.0390	.0390	.0390	.0390	.0390	.0390	.0390	.0390	.0390	.0390	.0390	.0390
10	.0420	.0420	.0420	.0420	.0420	.0420	.0420	.0420	.0420	.0420	.0420	.0420	.0420
11	.0450	.0450	.0450	.0450	.0450	.0450	.0450	.0450	.0450	.0450	.0450	.0450	.0450
12	.0510	.0510	.0510	.0510	.0510	.0510	.0510	.0510	.0510	.0510	.0510	.0510	.0510
13	.0520	.0520	.0520	.0520	.0520	.0520	.0520	.0520	.0520	.0520	.0520	.0520	.0520
14	.0680	.0660	.0650	.0680	.0740	.0710	.0680	.0750	.0740	.0740	.0670	.0680	.0740

Table 5.4.66 VPA. Firth of Clyde (Functional Unit 13): Females
Fishing mortality (F) at 'nominal age'. 1980-1992

F-at-age

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0022	.0127	.0661	.0665	.2480	.0863	.2350	.0408	.0218	.0226	.0714	.1174	.1000
2	.1722	.3383	.3702	.5922	.7446	.8464	.8700	.5551	.4320	.2080	.4590	.6527	.5467
3	.0670	.1481	.1223	.2195	.1479	.2534	.1989	.1575	.2275	.1113	.2450	.2191	.1973
4	.0942	.1626	.1282	.2169	.1117	.2269	.2276	.1385	.2259	.1632	.2338	.2452	.2037
5	.1081	.1658	.1159	.1799	.0887	.1723	.2365	.1155	.2097	.2445	.2412	.2078	.1937
6	.1077	.1223	.0833	.1767	.0511	.1598	.1727	.0914	.1547	.2854	.2675	.1789	.1663
7	.1580	.1061	.0849	.1653	.0430	.1463	.1792	.0717	.1445	.3175	.2940	.1751	.1603
8	.1683	.1373	.0920	.1411	.0440	.1310	.1610	.0871	.1225	.3461	.3028	.1923	.1612
9	.1507	.1271	.1060	.1207	.0291	.1139	.1162	.0838	.1829	.2172	.2982	.1982	.1463
10	.1253	.1172	.0974	.1318	.0260	.0887	.1101	.0777	.1979	.2502	.2036	.1810	.1352
11	.1337	.1116	.1039	.1113	.0385	.0804	.1049	.0877	.2118	.2600	.3152	.1119	.1391
12	.1356	.1016	.0759	.1175	.0261	.0782	.0544	.0734	.1909	.1912	.2418	.1190	.0600
13	.1308	.1095	.0920	.1197	.0301	.0822	.0896	.0795	.1999	.2335	.2532	.1371	.1113
14	.1308	.1095	.0920	.1197	.0301	.0822	.0896	.0795	.1999	.2335	.2532	.1371	.1113

Table 5.4.67 VPA. Firth of Clyde (Functional Unit 13): Females
Population numbers (000's) at 'nominal age'. 1980-1992

N-at-age

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	170812.	205867.	229847.	272673.	330784.	287181.	223039.	143936.	114856.	146054.	172338.	91356.	12812.
2	104442.	126259.	150585.	159381.	189007.	191224.	195159.	130632.	102371.	83248.	105769.	118873.	60184.
3	66492.	65133.	66688.	77035.	65305.	66496.	60765.	60568.	55547.	49232.	50087.	49509.	45847.
4	49407.	50914.	45987.	48312.	50642.	46114.	42256.	40777.	42365.	36222.	36061.	32096.	32558.
5	38702.	36816.	35428.	33122.	31841.	37081.	30089.	27555.	29066.	27672.	25191.	23369.	20564.
6	31154.	28440.	25538.	25830.	22653.	23856.	25554.	19447.	20100.	19295.	17742.	16205.	15543.
7	19682.	22903.	20604.	19237.	17723.	17623.	16647.	17604.	14532.	14097.	11875.	11116.	11094.
8	16520.	13759.	16864.	15496.	13350.	13899.	12465.	11394.	13416.	10297.	8402.	7246.	7639.
9	13015.	11430.	9819.	12594.	11018.	10460.	9982.	8688.	8550.	9718.	5964.	5082.	4895.
10	11127.	9165.	8241.	7230.	9139.	8761.	7642.	7276.	6541.	5830.	6403.	3623.	3412.
11	8584.	8037.	6673.	6121.	5189.	7289.	6564.	5605.	5512.	4394.	3717.	4277.	2476.
12	7601.	6149.	5885.	4924.	4483.	4087.	5507.	4839.	4203.	3651.	2774.	2220.	3131.
13	7271.	5434.	4548.	4466.	3585.	3576.	3095.	4270.	3682.	2843.	2469.	1783.	1614.
14	22790.	16761.	9668.	11022.	12924.	10272.	7688.	20726.	12056.	11065.	6002.	4376.	5782.

Table 5.4.68 VPA. Firth of Clyde (Functional Unit 13): Females
Yield (tonnes),Fbar,Total stock biomass (tonnes),
spawning stock biomass (tonnes), Ln recruitment.1980-1992

Year,	Yield,	Fbar,	TSB,	SSB,	Log R
		3-11			
1980,	1066.4,	.1237,	11217.1,	8768.1,	12.05
1981,	1274.9,	.1331,	10628.3,	7878.0,	12.23
1982,	1111.0,	.1038,	9910.3,	7025.3,	12.35
1983,	1777.0,	.1626,	10337.0,	7220.4,	12.52
1984,	1614.4,	.0645,	10464.6,	6920.6,	12.71
1985,	2072.0,	.1525,	10396.5,	6857.1,	12.57
1986,	2068.0,	.1674,	9292.6,	6225.9,	12.32
1987,	1174.0,	.1012,	9204.6,	6904.0,	11.88
1988,	1369.1,	.1864,	8145.2,	6112.8,	11.65
1989,	1173.0,	.2439,	7209.5,	5563.5,	11.89
1990,	1384.8,	.2668,	6693.7,	4668.6,	12.06
1991,	1255.4,	.1900,	5899.9,	4135.5,	11.42
1992,	840.3,	.1670,	4879.0,	4079.9,	9.46

Table 5.4.69 Nephrops landings (tonnes by Functional Unit plus other rectangles in Management Area (VIa) - (Area C)

Year	FU11	FU12	FU13	Other rectangles	Total
1983	3196	3252	4078	194	10720
1984	4144	3939	3309	4	11396
1985	4061	3827	4286	286	12460
1986	3382	3317	4342	259	11300
1987	4084	3707	3007	452	11250
1988	4035	4310	3662	697	12704
1989	3205	4415	2806	556	10982
1990	2543	4212	2911	406	10072
1991	2789	4207	3038	503	10537
1992	3482	4048	2786	415	10731

Table 5.4.70 Total Nephrops landings (t) by country in Management Area (VIa) - (Area C)

Year	UK	Spain	Ireland	TOTAL
1983	10720	0		10720
1984	11396	0		11396
1985	12460	0		12460
1986	11296	4		11300
1987	11250	?		11250
1988	12704	?		12704
1989	10975	7		10982
1990	10071	1		10072
1991	10485	19	33	10537
1992	10700*	18	13	10731

* includes 30 t by UK registered vessels landed in Spain

Table 5.6.1 Data and Biological Inputs: Skagerrak and Kattegat

FU	3 and 4	MA	IIIa (Area E)

FLEET	Swedish	GEAR	Trawl

1992	NUMBER OF SAMPLES				Mean
	Qtr 1	Qtr 2	Qtr 3	Qtr 4	No./sample
Catch					
Landings	2	2	2	2	592
Discards	2	2	2	2	698

	NUMBER OF SAMPLES									
YEAR	92	91	90	89	88	87	86	85	84	83
Catch										
Landings	8	8	6							
Discards	8	8	6							

FLEET	Danish	GEAR	Trawl

1992	NUMBER OF SAMPLES				Mean
	Qtr 1	Qtr 2	Qtr 3	Qtr 4	No./sample
Catch		1			
Landings			4	1	475
Discards			4	1	

	NUMBER OF SAMPLES									
YEAR	92	91	90	89	88	87	86	85	84	83
Catch	1									
Landings	5	4								
Discards	5	4								

FLEET	Norwegian	GEAR	Trawl

1992	NUMBER OF SAMPLES				Mean
	Qtr 1	Qtr 2	Qtr 3	Qtr 4	No./sample
Catch	2	1	1	1	197
Landings					
Discards					

INPUT PARAMETERS		
Parameter	Value	Source
Discard Survival	0.25	Borrowed from stocks in IVa
MALES		
Growth - K	0.16	"
Growth - L(inf)	75	"
Nat. Mort. - M	0.3	
Length/weight - a	0.00051	Swedish observations (unpub.)
Length/weight - b	3.08	
FEMALES		
Immature Growth	NA	All length groups assumed to be mature
K	NA	
L(inf)	NA	
Nat.Mort. - M	NA	
Size at Maturity	23	
Mature Growth		
K	0.1	Borrowed from stocks in IVa
L(inf)	65	"
Nat.Mort. - M	0.2	"
Length/weight - a	0.0018	Swedish observations(unpub.)
Length/weight - b	2.71	"

Table 5.6.2 Skagerrak (Functional Unit 3) : landings (in tonnes), by country, 1983-92

Year	Denmark	Norway	Sweden Trawl	Sweden Creel	Total
1983	1 589	51	560		2 200
84	1 749	97	830(**)		2 676
85	1 334	72	785(**)		2 191
86	1 054	64	800	100	2 018
87	1 385	80	865	110	2 440
1988	1 260	89	886	114	2 349
89	1 795	70	643	65	2 603
90	1 749	146	860	110	2 865
91	1 639	194	949	151	2 933
92(*)	1 151	111	524	114	1 900

(*) provisional
(**) may include catches by creels

Table 5.6.3 Skagerrak (Functional Unit 3) : catches and landings (in tonnes), effort (in '000 hours trawling), CPUE and LPUE (in kg/hour trawling) of Swedish Nephrops trawlers 1983-92

Single Trawl. Twin Trawl (1990 - 92) in parenthesis.

Year	Catches	Landings	Effort	CPUE	LPUE
1983	?	497	51.6	?	9.6
84	?	745	69.3	?	10.8
85	?	642	66.0	?	9.7
86	?	715	74.0	?	9.7
87	?	775	91.3	?	8.5
1988	?	700	108.8	?	6.4
89	?	555	97.1	?	5.7
90	729(302)	490(203)	73.5(17.1)	9.9(17.7)	6.7(11.9)
91	676(740)	401(439)	71.4(39.5)	9.5(18.7)	5.6(11.1)
92	360(370)	231(238)	73.7(34.1)	4.9(10.9)	3.1(7.0)

Table 5.6.4 Skagerrak (Functional Unit 3) : effort (in days trawling), LPUE (in kg/day trawling) of Danish Nephrops trawlers 1987-92

Year	Effort	LPUE
1987	16591	84.1
1988	15569	81.6
1989	21642	82.4
1990	22812	76.3
1991	22162	73.3
1992	15328	75.6

Table 5.6.5 Kattegat (Functional Unit 4) : landings (in tonnes), by country, 1983-92

Year	Denmark	Sweden	Total
1983	1 330	142	1 472
84	1 842	194	2 036
85	1 609	189	1 798
86	1 593	214	1 807
87	1 454	151	1 605
1988	1 204	160	1 364
89	1 222	91	1 313
90	1 349	127	1 476
91	1 185	130	1 315
92(*)	901	111	1 012

(*) provisional

Table 5.6.6 Kattegat (Functional Unit 3) : effort (in days trawling), LPUE (in kg/day trawling) of Danish Nephrops trawlers 1987-92

Year	Effort	LPUE
1987	17520	84.2
1988	14276	86.7
1989	18858	65.2
1990	17164	78.7
1991	17182	68.6
1992	13434	65.9

Table 5.6.7 Kattegat (Functional Unit 4) : catches and landings (in tonnes), effort (in '000 hours trawling), CPUE and LPUE (in kg/hour trawling) of Swedish Nephrops trawlers,Single 1983-92 Twin Trawl (1990-1992) in parenthesis.

Year	Catches	Landings	Effort	CPUE	LPUE
1983	?	87	11.7	?	7.4
84	?	127	13.7	?	9.3
85	?	99	11.6	?	8.5
86	?	137	16.2	?	8.5
87	?	109	19.4	?	5.6
1988	?	100	16.8	?	6.0
89	?	67	19.6	?	3.4
90	114(25)	77(17)	14.2(1.9)	8.0(13.2)	5.4(9.1)
91	66(93)	39(55)	10.3(8.8)	6.4(10.6)	3.7(6.2)
92(*)	44(101)	28(65)	11.6(14.2)	3.8(7.1)	2.4(4.6)

* Provisional

Table 5.6.8 LCA. Skagerrak/Kattegat (Functional Unit 3&4): Males
Cohort Analysis Output. Reference period 1990-1992

L INFINITY = 75.0000 K = .1600

COHORT ANALYSIS BY EXACT CALCULATION

SIZE MM	REMOVALS	M	DT	FDT	F	Z	NO. ATTAINING	AVE. NO. IN SEA	BIOMASS kg
16.0	15.8	.3000	.2155	.0001	.0003	.3003	255611.1	53348.9	167678.8
18.0	26.3	.3000	.2232	.0001	.0005	.3005	239590.6	51731.1	229025.0
20.0	429.0	.3000	.2315	.0020	.0086	.3086	224045.1	50058.9	301638.4
22.0	1181.3	.3000	.2404	.0059	.0245	.3245	208598.3	48243.7	384709.3
24.0	1995.8	.3000	.2500	.0108	.0432	.3432	192943.7	46230.5	476599.9
26.0	3647.5	.3000	.2605	.0217	.0831	.3831	177078.2	43894.3	573559.6
28.0	4888.3	.3000	.2718	.0323	.1187	.4187	160260.9	41169.0	670387.4
30.0	7412.8	.3000	.2841	.0556	.1956	.4956	143022.0	37906.9	758022.6
32.0	10084.5	.3000	.2977	.0886	.2977	.5977	124237.2	33879.3	821348.2
34.0	10899.8	.3000	.3126	.1162	.3718	.6718	103988.9	29317.7	851979.5
36.0	11207.3	.3000	.3290	.1502	.4565	.7565	84293.8	24552.5	846696.4
38.0	9388.8	.3000	.3473	.1628	.4687	.7687	65720.8	20032.7	812435.3
40.0	9131.0	.3000	.3678	.2123	.5773	.8773	50322.3	15817.7	748319.1
42.0	6477.0	.3000	.3908	.2082	.5328	.8328	36446.0	12156.3	665968.9
44.0	4435.3	.3000	.4168	.1971	.4729	.7729	26322.1	9379.8	591096.9
46.0	3476.8	.3000	.4466	.2160	.4837	.7837	19072.9	7187.2	517833.1
48.0	2458.3	.3000	.4810	.2180	.4533	.7533	13440.0	5423.0	444237.0
50.0	1648.3	.3000	.5211	.2105	.4039	.7039	9354.8	4081.0	378137.1
52.0	908.5	.3000	.5686	.1650	.2902	.5902	6482.3	3131.0	326606.4
54.0	754.8	.3000	.6255	.1961	.3135	.6135	4634.5	2407.5	281487.1
56.0	454.0	.3000	.6952	.1730	.2488	.5488	3157.4	1824.8	238162.7
58.0	296.0	.3000	.7823	.1667	.2131	.5131	2156.0	1389.2	201631.8
60.0	292.0	.3000	.8944	.2605	.2913	.5913	1443.3	1002.5	161237.6
62.0	216.0	.3000	1.0441	.3470	.3323	.6323	850.5	650.0	115465.2
64.0	127.0	.3000	1.2542	.4189	.3340	.6340	439.5	380.2	74366.1
66.0	57.0	.3000	1.5707	.4372	.2784	.5784	198.4	204.8	43970.5
68.0	40.0	.3000			.3000	.6000	80.0	204.8	48140.1

Table 5.6.9 LCA. Skagerrak/Kattegat (Functional Unit 3&4): Females
Cohort Analysis Output. Reference period 1990-1992

L INFINITY = 65.0000 K = .1000

COHORT ANALYSIS BY EXACT CALCULATION

SIZE MM	REMOVALS	M	DT	FDT	F	Z	NO. ATTAINING	AVE. NO. IN SEA	BIOMASS kg
16.0	4.5	.2000	.4167	.0000	.0000	.2000	357964.8	143125.4	556552.0
18.0	57.8	.2000	.4349	.0002	.0004	.2004	329335.2	137148.6	720918.4
20.0	298.5	.2000	.4546	.0010	.0023	.2023	301847.7	131106.5	903880.6
22.0	1494.8	.2000	.4763	.0057	.0120	.2120	275327.8	124730.4	1100341.0
24.0	2227.5	.2000	.5001	.0095	.0189	.2189	248886.4	117898.0	1303756.0
26.0	3516.0	.2000	.5264	.0167	.0318	.2318	223078.2	110554.0	1506062.0
28.0	5220.3	.2000	.5557	.0283	.0510	.2510	197451.4	102415.8	1693316.0
30.0	7612.5	.2000	.5884	.0481	.0817	.2817	171748.0	93125.0	1844714.0
32.0	10221.0	.2000	.6252	.0776	.1241	.3241	145510.5	82348.6	1932419.0
34.0	9183.5	.2000	.6669	.0861	.1291	.3291	118819.7	71149.8	1958262.0
36.0	8585.3	.2000	.7146	.1014	.1419	.3419	95406.3	60485.9	1935324.0
38.0	7102.8	.2000	.7696	.1080	.1404	.3404	74723.8	50592.4	1866996.0
40.0	7280.5	.2000	.8338	.1476	.1770	.3770	57502.6	41142.6	1738635.0
42.0	6051.5	.2000	.9097	.1710	.1880	.3880	41993.6	32188.0	1547627.0
44.0	5084.0	.2000	1.0008	.2101	.2099	.4099	29504.5	24222.0	1317310.0
46.0	3329.5	.2000	1.1123	.2094	.1883	.3883	19576.1	17681.3	1081864.0
48.0	2590.3	.2000	1.2516	.2602	.2079	.4079	12710.3	12458.7	853448.2
50.0	1568.3	.2000	1.4310	.2678	.1871	.3871	7628.3	8381.4	639886.4
52.0	871.0	.2000	1.6705	.2640	.1580	.3580	4383.7	5511.6	467020.6
54.0	380.5	.2000	2.0067	.2111	.1052	.3052	2410.4	3617.0	338845.2
56.0	231.0	.2000	2.5131	.2518	.1002	.3002	1306.5	2305.4	237925.4
58.0	133.0	.2000	3.3647	.3450	.1025	.3025	614.4	1297.0	146969.2
60.0	111.0	.2000			.2000	.4000	222.0	1297.0	160864.9

Table 5.6.10 Nephrops landings (tonnes by Functional Unit plus other rectangles in Management Area (E) - (IIIa)

Year	FU3	FU4	Other rectangles	Total
1983	2200	1472		3672
1984	2676	2036		4712
1985	2191	1798		3989
1986	2018	1807		3825
1987	2440	1605		4045
1988	2349	1364		3713
1989	2603	1313		3916
1990	2865	1476		4341
1991	2933	1315		4248
1992	1900	1012		2912

Table 5.6.11 Total Nephrops landings (t) by country in Management Area (E) - (IIIa)

Year	Denmark	Norway	Sweden	TOTAL
1983	2919	51	702	3672
1984	3591	97	1024	4712
1985	2943	72	974	3989
1986	2647	64	1114	3825
1987	2839	80	1126	4045
1988	2464	89	1160	3713
1989	3017	70	829	3916
1990	3098	146	1097	4378
1991	2824	194	1230	4248
1992	2052	111	749	2912

Table 5.7.1 Input data and parameters: Moray Firth

FU	9	MA	F
FLEET	UK Scotland	GEAR	Nephrops and Light trawl

1992	NUMBER OF SAMPLES				Mean
	Qtr 1	Qtr 2	Qtr 3	Qtr 4	No./sample
Catch					
Landings	15	9	11	14	465
Discards	1	4	2	0	625

	NUMBER OF SAMPLES									
YEAR	92	91	90	89	88	87	86	85	84	83
Catch										
Landings	49	46	78	44	42	84	67	59	63	60
Discards	7	9	8							

INPUT PARAMETERS		
Parameter	Value	Source
Discard Survival	0.25	Gueguen and Charuau,1975; Anon.,1985
MALES		
Growth - K	0.165	Adapted from Bailey and Chapman, 1983
Growth - L(inf)	62	"
Nat. Mort. - M	0.3	Morizur, 1982
Length/weight - a	0.00028	Howard and Hall, 1983
Length/weight - b	3.24	"
FEMALES		
Immature Growth		
K	0.165	as for males
L(inf)	62	"
Nat.Mort. - M	0.3	"
Size at Maturity	23	Adapted from Bailey, 1984
Mature Growth		
K	0.06	as for males
L(inf)	58	"
Nat.Mort. - M	0.2	assumed *
Length/weight - a	0.00074	as for males
Length/weight - b	2.91	"

* based on Morizur, 1982 and assuming lower mature female rate

Table 5.7.2 Moray Firth (Functional Unit 9) : landings (in tonnes), by gear, 1983-92, all UK

Year	Nephrops Trawl	Other Trawl	Total
1983	850	90	940
84	960	209	1 170
85	1 908	173	2 081
86	1 933	210	2 143
87	1 723	268	1 991
1988	1 638	321	1 959
89	2 102	474	2 576
90	1 700	338	2 038
91	1 284	233	1 517
92(*)	1 268	304	1 572

(*)provisional

Table 5.7.3 Moray Firth (Functional Unit 9) : landings (in tonnes), effort (in '000 hours trawling) and LPUE (in kg/hour trawling) of Scottish Nephrops trawlers, 1983-92. Single and multi-rig trawls combined (see Table 3.2.2)

Year	Landings	Effort	LPUE
1983	850	21.4	39.7
84	960	23.2	41.4
85	1 908	49.2	38.8
86	1 933	51.6	37.5
87	1 723	70.6	24.4
1988	1 638	60.9	26.9
89	2 102	69.6	30.2
90	1 700	58.4	29.1
91	1 284	47.1	27.3
92(*)	1 268	40.9	31.0

(*) provisional

Table 5.7.4 Moray Firth (Functional Unit 9) : mean sizes (CL in mm) of male and female Nephrops in Scottish landings, 1983-92

Year	Males	Females
1983	33.8	31.3
84	32.3	31.0
85	31.0	29.8
86	30.9	28.9
87	30.9	29.6
1988	31.2	30.8
89	30.2	29.2
90	32.4	32.0
91	32.0	29.7
92(*)	33.3	31.3

Table 5.7.5 LCA. Moray Firth (Functional Unit 9): Males
Cohort Analysis Output. Reference period 1989-1992

L INFINITY = 62.0000 K = .1600

COHORT ANALYSIS BY POPE'S APPROXIMATION

SIZE MM	REMOVALS	M	DT	FDT	F	Z	NO. ATTAINING	AVE. NO. IN SEA	BIOMASS kg
11.0	1.2	.3000	.2500	.0000	.0000	.3000	217708.2	52442.7	46725.1
13.0	23.3	.3000	.2605	.0001	.0005	.3005	201974.2	50599.4	74287.9
15.0	42.8	.3000	.2718	.0002	.0009	.3009	186771.1	48741.0	110296.4
17.0	122.3	.3000	.2841	.0007	.0026	.3026	172106.0	46858.8	155307.4
19.0	662.5	.3000	.2977	.0044	.0148	.3148	157926.1	44875.4	209249.5
21.0	2790.4	.3000	.3126	.0205	.0657	.3657	143800.7	42473.2	269701.1
23.0	4704.8	.3000	.3290	.0393	.1194	.4194	128266.9	39420.2	331834.2
25.0	8574.7	.3000	.3473	.0843	.2427	.5427	111732.6	35368.0	385871.3
27.0	8387.5	.3000	.3678	.1007	.2738	.5738	92537.4	30680.3	425568.3
29.0	10238.4	.3000	.3908	.1565	.4005	.7005	74933.8	25614.9	444308.3
31.0	9322.9	.3000	.4168	.1913	.4590	.7590	56989.5	20363.5	435368.8
33.0	6821.3	.3000	.4466	.1931	.4324	.7324	41532.9	15820.9	411663.3
35.0	5326.3	.3000	.4810	.2122	.4411	.7411	29945.4	12116.3	379410.5
37.0	3624.7	.3000	.5211	.2070	.3971	.6971	20966.0	9161.4	341806.3
39.0	1936.3	.3000	.5686	.1562	.2748	.5748	14579.4	7071.2	311520.0
41.0	1158.4	.3000	.6255	.1290	.2062	.5062	10515.1	5637.8	290910.2
43.0	536.3	.3000	.6952	.0809	.1163	.4163	7661.3	4624.4	277434.2
45.0	218.2	.3000	.7823	.0437	.0559	.3559	5736.0	3916.6	271371.9
47.0	112.9	.3000	.8944	.0302	.0338	.3338	4342.1	3357.5	267025.5
49.0	42.3	.3000	1.0441	.0155	.0148	.3148	3221.5	2866.6	260228.9
51.0	19.6	.3000	1.2542	.0103	.0082	.3082	2319.0	2412.4	248663.5
53.0	11.5	.3000	1.5707	.0093	.0059	.3059	1575.6	1965.1	228905.0
55.0	10.6	.3000	2.1030	.0150	.0071	.3071	974.5	1509.6	197842.9
57.0	73.0	.3000			.0500	.3500	510.8	1509.6	221665.4

Table 5.7.6 LCA. Moray Firth (Functional Unit 9): Females
Cohort Analysis Output. Reference period 1989-1992

LOWER CURVE LINF= 62.0000 K= .1650

UPPER CURVE LINF= 56.0000 K= .0600

TRANSITION LENGTH= 23.0000

COHORT ANALYSIS BY POPE'S APPROXIMATION

SIZE MM	REMOVALS	M	DT	FDT	F	Z	NO. ATTAINING	AVE. NO. IN SEA	BIOMASS kg
11.0	6.3	.3000	.2425	.0000	.0000	.3000	760035.5	177732.5	181480.1
13.0	13.2	.3000	.2526	.0000	.0001	.3001	706709.5	171891.8	274873.1
15.0	21.6	.3000	.2635	.0000	.0001	.3001	655128.8	166004.8	391520.3
17.0	71.8	.3000	.2755	.0001	.0004	.3004	605305.6	160063.0	531836.8
19.0	350.2	.3000	.2887	.0007	.0023	.3023	557214.8	154025.4	695399.2
21.0	1332.9	.3000	.3031	.0027	.0090	.3090	510656.9	147749.4	880279.1
23.0	3868.3	.2000	.3191	.0086	.0270	.2270	464998.8	143113.2	1098346.0
25.0	7155.2	.2000	1.1115	.0187	.0168	.2168	432507.0	427205.6	4138605.0
27.0	9408.0	.2000	1.1910	.0317	.0266	.2266	339893.4	354783.0	4264197.0
29.0	9116.7	.2000	1.2827	.0408	.0318	.2318	259500.6	287938.3	4230258.0
31.0	6370.3	.2000	1.3897	.0387	.0279	.2279	192763.2	229612.7	4070304.0
33.0	4422.4	.2000	1.5162	.0373	.0246	.2246	140444.2	180468.8	3816368.0
35.0	2370.0	.2000	1.6681	.0284	.0170	.2170	99906.9	139817.0	3491762.0
37.0	1623.4	.2000	1.8538	.0285	.0154	.2154	69560.7	106317.1	3107548.0
39.0	990.7	.2000	2.0861	.0265	.0127	.2127	46663.1	78614.8	2667740.0
41.0	615.5	.2000	2.3850	.0264	.0111	.2111	29941.3	56107.1	2194409.0
43.0	268.7	.2000	2.7842	.0198	.0071	.2071	18097.9	38292.7	1714776.0
45.0	146.0	.2000	3.3445	.0203	.0061	.2061	10166.9	24571.5	1252280.0
47.0	97.5	.2000	4.1886	.0295	.0070	.2070	5103.7	14294.5	824568.9
49.0	30.4	.2000	5.6079	.0251	.0045	.2045	2144.2	7155.0	464788.1
51.0	75.7	.2000			.0250	.2250	681.2	7155.0	520981.1

Table 5.7.7 VPA. Moray Firth (Functional Unit 9): Males
Catch (000's) at 'nominal age'. 1980-1992

Catch-at age data

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	12.	18.	65.	176.	438.	704.	334.	1119.	567.	384.	184.	112.	0.
2	927.	963.	3837.	4843.	13185.	38129.	25200.	36348.	21482.	17974.	8078.	7959.	909.
3	8983.	8578.	5656.	8064.	15912.	31287.	28655.	32129.	19697.	41000.	20747.	21540.	11078.
4	11665.	9518.	5710.	6939.	11482.	16407.	14446.	15436.	12520.	21882.	18931.	15474.	16509.
5	5536.	7045.	3443.	3348.	5168.	7993.	5189.	6734.	6066.	9228.	8411.	5966.	7993.
6	1263.	4155.	1964.	1697.	2352.	2874.	2124.	2430.	2779.	3449.	2357.	1542.	2640.
7	154.	1755.	822.	695.	772.	787.	796.	853.	960.	989.	541.	362.	596.
8	14.	697.	379.	372.	293.	312.	265.	488.	518.	325.	201.	105.	153.
9	0.	393.	345.	704.	238.	189.	95.	345.	628.	532.	149.	49.	50.

Table 5.7.8 VPA. Moray Firth (Functional Unit 9): Males
Mean weight (kg) at 'nominal age'. 1980-1992

Weight-at-age dat

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0020	.0020	.0030	.0030	.0030	.0030	.0030	.0030	.0030	.0030	.0020	.0030	.0030
2	.0090	.0100	.0070	.0070	.0070	.0070	.0080	.0070	.0070	.0080	.0080	.0080	.0090
3	.0150	.0140	.0140	.0140	.0140	.0140	.0140	.0140	.0140	.0140	.0140	.0140	.0150
4	.0240	.0240	.0240	.0240	.0240	.0240	.0230	.0230	.0240	.0230	.0240	.0240	.0240
5	.0340	.0360	.0350	.0350	.0350	.0350	.0350	.0350	.0350	.0350	.0340	.0340	.0350
6	.0460	.0480	.0470	.0470	.0470	.0470	.0470	.0470	.0470	.0470	.0470	.0470	.0470
7	.0600	.0610	.0610	.0610	.0610	.0610	.0610	.0620	.0610	.0600	.0610	.0610	.0610
8	.0680	.0730	.0720	.0730	.0720	.0720	.0710	.0730	.0740	.0730	.0720	.0710	.0710
9	.0000	.0880	.0980	.1060	.1000	.0920	.0890	.0930	.0980	.1350	.0960	.0950	.0870

Table 5.7.9 VPA. Moray Firth (Functional Unit 9): Males
Fishing mortality (F) at 'nominal age'. 1980-1992

F-at-age

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0002	.0002	.0006	.0012	.0024	.0042	.0019	.0059	.0037	.0027	.0024	.0122	.2000
2	.0204	.0185	.0557	.0601	.1247	.3342	.2269	.3191	.1655	.1729	.0791	.1524	.1452
3	.2749	.2962	.1597	.1767	.3189	.5465	.5122	.5704	.3216	.6137	.3464	.3486	.3676
4	.5276	.5961	.3699	.3362	.4604	.7289	.6026	.6630	.5192	.8252	.7474	.5359	.5608
5	.4696	.8266	.5089	.4365	.5111	.7876	.6147	.7312	.6904	1.1024	1.0827	.6424	.6784
6	.2792	.9183	.6647	.5809	.7244	.6902	.5657	.7652	.9106	1.3901	1.1788	.6694	.7691
7	.0932	.9033	.5206	.6013	.6595	.6563	.4681	.5325	.9428	1.2318	1.0328	.6385	.6878
8	.2807	.8827	.5647	.5396	.6316	.7114	.5495	.6763	.8479	1.2414	1.0981	.6501	.7118
9	.2807	.8827	.5647	.5396	.6316	.7114	.5495	.6763	.8479	1.2414	1.0981	.6501	.7118

Table 5.7.10 VPA. Moray Firth (Functional Unit 9): Males
Population numbers (000's) at 'nominal age'. 1980-1992

N-at-age

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	82010.	110537.	129577.	175385.	208480.	193689.	206607.	220423.	176814.	166076.	87863.	10604.	1.
2	52978.	60744.	81872.	95937.	129778.	154069.	142883.	152771.	162330.	130499.	122702.	64932.	7760.
3	42961.	38449.	44172.	57366.	66925.	84870.	81709.	84362.	82251.	101912.	81330.	83986.	41304.
4	32506.	24175.	21182.	27892.	35613.	36042.	36400.	36265.	35326.	44176.	40870.	42611.	43906.
5	16901.	14207.	9867.	10840.	14762.	16648.	12882.	14761.	13844.	15570.	14339.	14340.	18470.
6	5961.	7828.	4605.	4394.	5190.	6560.	5610.	5161.	5264.	5142.	3830.	3597.	5588.
7	1996.	3340.	2315.	1755.	1821.	1863.	2437.	2360.	1779.	1569.	949.	873.	1365.
8	64.	1347.	1003.	1019.	713.	698.	716.	1130.	1027.	513.	339.	250.	342.
9	0.	759.	912.	1928.	579.	423.	257.	799.	1245.	841.	253.	116.	112.

Table 5.7.11 VPA. Moray Firth (Functional Unit 9): Males
Yield (tonnes),Fbar,Total stock biomass (tonnes),
spawning stock biomass (tonnes), Ln recruitment 1980-1992

Year,	Yield,	Fbar, 3- 7	TSB,	SSB,	Log R
1980,	679.6,	.3289,	3038.3,	3038.3,	11.31
1981,	1003.7,	.7081,	3203.0,	3203.0,	11.61
1982,	567.3,	.4448,	2953.1,	2953.1,	11.77
1983,	655.0,	.4263,	3641.9,	3641.9,	12.07
1984,	975.3,	.5348,	4306.5,	4306.5,	12.25
1985,	1603.5,	.6819,	4806.5,	4806.5,	12.17
1986,	1293.3,	.5527,	4681.0,	4681.0,	12.24
1987,	1533.1,	.6524,	4808.2,	4808.2,	12.30
1988,	1229.6,	.6769,	4704.5,	4704.5,	12.08
1989,	1862.2,	1.0327,	5016.8,	5016.8,	12.02
1990,	1268.4,	.8776,	4050.9,	4050.9,	11.38
1991,	1046.4,	.5670,	3488.4,	3488.4,	9.27
1992,	1026.0,	.6127,	2769.4,	2769.4,	-.45

Table 5.7.12 VPA. Moray Firth (Functional Unit 9): Females
Catch (000's) at 'nominal age'. 1980-1992

Catch-at age data

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	22.	39.	141.	616.	51.	1247.	3430.	1458.	541.	326.	292.	174.	1.
2	1596.	3474.	12585.	7343.	5016.	26592.	61374.	25840.	16047.	15406.	7777.	10352.	1313.
3	1909.	2970.	3594.	2237.	2799.	9193.	23416.	8878.	6751.	11576.	5641.	7740.	2079.
4	3764.	3498.	3809.	2585.	2946.	8613.	18734.	7922.	6333.	12500.	6569.	8300.	3794.
5	3001.	3735.	3305.	2627.	2858.	6949.	13263.	5733.	6524.	10617.	5999.	6742.	5316.
6	2288.	3348.	2923.	2309.	2355.	5360.	9044.	4301.	5695.	7445.	5266.	4710.	4903.
7	1662.	2891.	2505.	2001.	1948.	4174.	6081.	3285.	4916.	4986.	4562.	3196.	4147.
8	837.	2231.	1712.	1662.	1660.	3155.	3710.	2321.	4147.	3122.	3563.	2112.	2864.
9	678.	1524.	1160.	1127.	1034.	2062.	2497.	1542.	2506.	1746.	2676.	1282.	1832.
10	599.	1191.	902.	880.	748.	1558.	1939.	1183.	1754.	1122.	2265.	899.	1350.
11	273.	498.	411.	585.	537.	984.	1353.	787.	1125.	850.	1697.	420.	536.
12	244.	462.	378.	535.	491.	886.	1234.	726.	1043.	795.	1565.	386.	487.
13	102.	282.	219.	287.	263.	399.	642.	425.	637.	526.	913.	219.	241.
14	98.	261.	208.	272.	248.	375.	611.	404.	612.	521.	871.	208.	228.
15	57.	32.	89.	102.	81.	110.	258.	169.	341.	466.	395.	90.	81.
16	144.	141.	302.	431.	264.	342.	860.	683.	1488.	1679.	1573.	283.	283.

Table 5.7.13 VPA. Moray Firth (Functional Unit 9): Females
Mean weight (kg) at 'nominal age'.1980-1992

Weight-at-age dat

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0020	.0020	.0020	.0030	.0020	.0030	.0030	.0030	.0030	.0030	.0030	.0030	.0030
2	.0080	.0070	.0060	.0060	.0070	.0060	.0070	.0070	.0070	.0070	.0070	.0070	.0080
3	.0100	.0100	.0100	.0100	.0100	.0100	.0100	.0100	.0100	.0100	.0100	.0100	.0100
4	.0120	.0120	.0120	.0120	.0120	.0120	.0120	.0120	.0120	.0120	.0120	.0120	.0120
5	.0140	.0140	.0140	.0140	.0140	.0140	.0140	.0140	.0140	.0140	.0140	.0140	.0140
6	.0160	.0160	.0160	.0160	.0160	.0160	.0160	.0160	.0160	.0160	.0160	.0160	.0160
7	.0180	.0180	.0180	.0180	.0180	.0180	.0180	.0180	.0180	.0180	.0180	.0180	.0180
8	.0210	.0210	.0210	.0210	.0210	.0210	.0210	.0210	.0210	.0210	.0210	.0210	.0210
9	.0240	.0230	.0230	.0230	.0230	.0230	.0230	.0230	.0230	.0230	.0230	.0230	.0230
10	.0250	.0250	.0250	.0250	.0250	.0250	.0250	.0250	.0250	.0250	.0250	.0250	.0250
11	.0290	.0290	.0290	.0290	.0290	.0290	.0290	.0290	.0290	.0290	.0290	.0290	.0290
12	.0300	.0300	.0300	.0300	.0300	.0300	.0300	.0300	.0300	.0300	.0300	.0300	.0300
13	.0340	.0340	.0340	.0340	.0340	.0340	.0340	.0340	.0340	.0340	.0340	.0340	.0340
14	.0340	.0340	.0340	.0340	.0340	.0340	.0340	.0340	.0340	.0340	.0340	.0340	.0340
15	.0390	.0390	.0390	.0390	.0390	.0390	.0390	.0390	.0390	.0390	.0390	.0390	.0390
16	.0440	.0450	.0460	.0470	.0460	.0440	.0460	.0470	.0480	.0510	.0470	.0460	.0460

Table 5.7.14 VPA. Moray Firth (Functional Unit 9): Females
Fishing mortality (F) at 'nominal age'. 1980-1992

F-at-age

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0002	.0002	.0008	.0030	.0002	.0047	.0154	.0072	.0031	.0030	.0047	.0115	.1000
2	.0118	.0349	.1093	.0601	.0340	.1630	.3756	.1706	.1135	.1272	.1003	.2524	.1248
3	.0288	.0287	.0485	.0268	.0309	.0850	.2239	.0894	.0648	.1183	.0662	.1452	.0775
4	.0700	.0676	.0467	.0446	.0447	.1252	.2489	.1097	.0850	.1639	.0911	.1310	.0983
5	.0751	.0919	.0842	.0411	.0635	.1411	.2880	.1119	.1239	.2001	.1104	.1273	.1160
6	.0677	.1123	.0965	.0779	.0471	.1625	.2750	.1422	.1550	.2029	.1442	.1186	.1285
7	.0771	.1144	.1150	.0885	.0872	.1100	.2798	.1516	.2394	.1973	.1845	.1222	.1455
8	.0632	.1409	.0918	.1040	.0985	.1983	.1349	.1635	.2902	.2355	.2112	.1218	.1534
9	.0792	.1563	.1011	.0804	.0869	.1706	.2382	.0762	.2664	.1905	.3252	.1093	.1476
10	.1432	.1942	.1305	.1037	.0703	.1827	.2401	.1693	.1166	.1828	.4023	.1721	.1607
11	.1048	.1697	.0948	.1170	.0850	.1244	.2388	.1446	.2408	.0760	.4606	.1196	.1472
12	.1522	.2584	.1883	.1719	.1360	.1965	.2262	.1946	.2894	.2680	.1952	.1783	.1979
13	.1010	.2632	.1877	.2132	.1195	.1562	.2136	.1131	.2612	.2321	.5604	.0376	.1613
14	.5097	.4013	.3170	.3740	.2879	.2497	.3785	.2019	.2363	.3540	.7412	.2361	.0500
15	.2535	.3067	.2303	.2523	.1807	.2004	.2723	.1696	.2620	.2844	.4983	.1505	.1363
16	.2535	.3067	.2303	.2523	.1807	.2004	.2723	.1696	.2620	.2844	.4983	.1505	.1363

Table 5.7.15 VPA. Moray Firth (Functional Unit 9): Females
Population numbers (000's) at 'nominal age'. 1980-1992

N-at-age

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	158098.	189363.	196563.	234926.	275254.	304846.	260247.	234805.	201575.	127347.	72387.	17627.	11.
2	157966.	117103.	140250.	145496.	173507.	203870.	224763.	189843.	172693.	148865.	94060.	53374.	12909.
3	74083.	115651.	83776.	93137.	101499.	124240.	128320.	114363.	118576.	114213.	97113.	63029.	30719.
4	61383.	58928.	92000.	65346.	74230.	80568.	93427.	83986.	85625.	90990.	83073.	74419.	44629.
5	45693.	46861.	45090.	71885.	51167.	58116.	58199.	59638.	61619.	64391.	63235.	62089.	53448.
6	38498.	34703.	34998.	33935.	56478.	39313.	41318.	35726.	43658.	44569.	43160.	46363.	44757.
7	24658.	29455.	25394.	26018.	25701.	44114.	27358.	25696.	25374.	30613.	29787.	30591.	33712.
8	15077.	18689.	21509.	18532.	19496.	19285.	32354.	16931.	18078.	16351.	20575.	20279.	22165.
9	9809.	11588.	13291.	16066.	13675.	14466.	12949.	23146.	11771.	11072.	10578.	13638.	14700.
10	4946.	7419.	8115.	9835.	12137.	10264.	9986.	8355.	17559.	7383.	7493.	6256.	10010.
11	3021.	3509.	5002.	5831.	7259.	9262.	7000.	6431.	5775.	12795.	5035.	4103.	4312.
12	1903.	2227.	2424.	3725.	4247.	5459.	6696.	4514.	4557.	3716.	9709.	2601.	2980.
13	1171.	1338.	1408.	1644.	2568.	3035.	3672.	4372.	3042.	2793.	2327.	6539.	1781.
14	270.	867.	842.	956.	1088.	1866.	2125.	2428.	3197.	1918.	1813.	1088.	5156.
15	278.	133.	475.	502.	538.	668.	1190.	1192.	1625.	2067.	1102.	707.	703.
16	706.	584.	1613.	2123.	1759.	2069.	3960.	4818.	7092.	7448.	4387.	2226.	2448.

Table 5.7.16 VPA. Moray Firth (Functional Unit 9): Females
Yield (tonnes),Fbar,Total stock biomass (tonnes),
spawning stock biomass (tonnes), Ln recruitment 1980-1992

Year,	Yield,	Fbar,	TSB,	SSB,	Log R
		3-10			
1980,	265.0,	.0755,	5668.1,	4088.2,	11.97
1981,	420.0,	.1133,	5923.0,	4724.6,	12.15
1982,	435.9,	.0893,	6171.9,	4937.3,	12.19
1983,	368.0,	.0709,	6804.1,	5226.4,	12.37
1984,	351.6,	.0661,	7344.9,	5579.9,	12.53
1985,	870.1,	.1469,	8294.0,	6156.3,	12.63
1986,	1691.0,	.2411,	8783.2,	6429.2,	12.47
1987,	802.5,	.1267,	7976.7,	5943.4,	12.37
1988,	908.1,	.1677,	8054.2,	6240.6,	12.21
1989,	1053.8,	.1864,	7709.5,	6285.4,	11.75
1990,	880.1,	.1919,	6645.5,	5769.9,	11.19
1991,	628.3,	.1309,	5593.8,	5167.3,	9.78
1992,	502.7,	.1284,	4661.4,	4558.1,	2.39

Table 5.7.17 Short Term Prediction: Moray Firth Males (FU9)

MOST RECENT DATA YR = 1992 1ST PRED YR = 1993
REFERENCE F = MEAN OF AGES 3 TO 8
F PATTERN = MEAN OF YEARS 1987 TO 1991
AGE 1 RECRUITS FOR PRED YRS = MEAN 1980 TO 1990
AGE 2 RECRUITS FOR 1993 = MEAN 1980 TO 1990

PROPORTION OF F AND M BEFORE SPAWNING = .40

INPUTS SUMMARY

AGE	M	WT	STOCK JAN1 1992	F	STOCK JAN1 1993	F PATTERN
1	.3	.0030	.6	.2000	159769.2	.0054
2	.3	.0090	7759.7	.1452	116960.1	.1778
3	.3	.0150	41304.1	.3676	69664.4	.4401
4	.3	.0240	43905.7	.5608	21185.7	.6581
5	.3	.0350	18470.4	.6784	18564.8	.8498
6	.3	.0470	5587.9	.7691	6943.2	.9828
7	.3	.0610	1364.6	.6878	1918.4	.8757
8	.3	.0710	341.5	.7118	508.2	.9028
9	.3	.0870	111.7	.7118	164.8	.9028
				.6292		.7849

PREDICTION YEAR 1993 STATUS QUO: FACTOR=1

AGE	STOCK JAN1	SCAL F	TSB	SSB	CATCH	PROP	LANDINGS
1	159769.2	.0043	479.3	424.4	1.8	.5900	1.1
2	116960.1	.1425	1052.6	881.9	121.2	.3039	36.8
3	69664.4	.3528	1045.0	804.8	270.8	.8448	228.8
4	21185.7	.5276	508.5	365.2	182.5	.9988	182.2
5	18564.8	.6813	649.8	438.8	282.0	1.0000	282.0
6	6943.2	.7879	326.3	211.2	156.7	1.0000	156.7
7	1918.4	.7020	117.0	78.4	51.9	1.0000	51.9
8	508.2	.7237	36.1	24.0	16.3	1.0000	16.3
9	164.8	.7237	14.3	9.5	6.5	1.0000	6.5
			4228.9	3238.1	1089.7		962.4

1994 (TSB AT JAN 1 = 4402.2)					1995			
FACTOR	REFF	SSB	CATCH	LANDINGS	TSB	SSB	CATCH	LANDINGS
.0	.0000	3904.4	.0	.0	5951.2	5278.2	.0	.0
.2	.1258	3790.5	269.7	241.3	5617.0	4817.9	387.4	357.5
.4	.2517	3681.2	514.2	458.3	5314.7	4418.0	679.5	621.6
.6	.3775	3576.4	736.0	654.0	5040.6	4069.5	898.1	814.0
.8	.5034	3475.8	937.8	830.5	4791.9	3764.9	1060.1	951.4
1.0	.6292	3379.3	1121.5	990.0	4565.7	3497.9	1178.6	1046.8
1.2	.7551	3286.7	1289.2	1134.4	4359.8	3262.9	1263.7	1110.2
1.4	.8809	3197.7	1442.4	1265.3	4171.9	3055.6	1323.1	1149.1
1.6	1.0068	3112.3	1582.7	1384.1	4000.3	2872.1	1362.9	1169.7
1.8	1.1326	3030.3	1711.4	1492.1	3843.2	2709.1	1387.8	1176.3
2.0	1.2585	2951.5	1829.6	1590.4	3699.2	2563.9	1401.3	1172.7

Table 5.7.18 Short Term Prediction: Moray Firth Females (FU9)

MOST RECENT DATA YR = 1992 1ST PRED YR = 1993
REFERENCE F = MEAN OF AGES 3 TO 10
F PATTERN = MEAN OF YEARS 1987 TO 1991
AGE 1 RECRUITS FOR PRED YRS = MEAN 1981 TO 1990
AGE 2 RECRUITS FOR 1993 = MEAN 1981 TO 1990

PROPORTION OF F AND M BEFORE SPAWNING = .40

INPUTS SUMMARY

AGE	M	WT	STOCK JAN1 1992	F	STOCK JAN1 1993	F PATTERN
1	.3	.0030	10.9	.1000	209731.4	.0059
2	.3	.0080	12909.3	.1248	161045.0	.1528
3	.2	.0100	30718.9	.0775	109088.7	.0968
4	.2	.0120	44629.4	.0983	23275.2	.1161
5	.2	.0140	53447.9	.1160	33118.0	.1347
6	.2	.0160	44756.7	.1285	38966.4	.1526
7	.2	.0180	33712.4	.1455	32224.3	.1790
8	.2	.0210	22164.8	.1534	23864.7	.2045
9	.2	.0230	14699.6	.1476	15566.2	.1935
10	.2	.0250	10009.6	.1607	10383.8	.2086
11	.2	.0290	4312.2	.1472	6978.6	.2083
12	.2	.0300	2980.4	.1979	3047.3	.2251
13	.2	.0340	1781.5	.1613	2001.9	.2409
14	.2	.0340	5156.0	.0500	1241.3	.3539
15	.2	.0390	703.3	.1363	4015.5	.2730
16	.2	.0460	2447.8	.1363	2251.3	.2730
				.1284		.1607

PREDICTION YEAR 1993 STATUS QUO: FACTOR=1

AGE	STOCK JAN1	SCAL F	TSB	SSB	CATCH	PROP	LANDINGS
1	209731.4	.0047	629.2	557.0	2.6	.0740	.2
2	161045.0	.1221	1288.4	1088.2	128.3	.2060	26.4
3	109088.7	.0773	1090.9	976.3	73.7	.2670	19.7
4	23275.2	.0928	279.3	248.4	22.5	.4150	9.3
5	33118.0	.1076	463.7	410.0	43.0	.6630	28.5
6	38966.4	.1219	623.5	548.1	65.0	.9260	60.2
7	32224.3	.1430	580.0	505.7	70.2	.9690	68.1
8	23864.7	.1634	501.2	433.4	68.6	.9830	67.5
9	15566.2	.1546	358.0	310.7	46.6	.9960	46.4
10	10383.8	.1667	259.6	224.2	36.2	1.0000	36.2
11	6978.6	.1665	202.4	174.8	28.2	1.0000	28.2
12	3047.3	.1799	91.4	78.5	13.7	1.0000	13.7
13	2001.9	.1925	68.1	58.2	10.8	1.0000	10.8
14	1241.3	.2828	42.2	34.8	9.5	1.0000	9.5
15	4015.5	.2181	156.6	132.5	27.9	1.0000	27.9
16	2251.3	.2181	103.6	87.6	18.5	1.0000	18.5
			6737.9	5868.3	665.3		471.1

1994 (TSB AT JAN 1 = 6880.4) 1995

FACTOR	REFF	SSB	CATCH	LANDINGS	TSB	SSB	CATCH	LANDINGS
.0	.0000	6283.9	.0	.0	7700.9	7041.1	.0	.0
.2	.0257	6226.1	140.5	96.2	7555.9	6843.8	154.4	105.0
.4	.0514	6169.0	277.3	189.5	7414.8	6653.6	298.0	201.4
.6	.0771	6112.5	410.5	280.2	7277.5	6470.2	431.6	289.7
.8	.1027	6056.6	540.3	368.2	7143.8	6293.3	555.7	370.6
1.0	.1284	6001.3	666.7	453.7	7013.6	6122.6	671.0	444.5
1.2	.1541	5946.6	789.9	536.7	6886.9	5958.0	778.0	511.9
1.4	.1798	5892.6	909.8	617.4	6763.5	5799.1	877.3	573.4
1.6	.2055	5839.1	1026.7	695.7	6643.4	5645.7	969.4	629.3
1.8	.2312	5786.2	1140.6	771.7	6526.4	5497.7	1054.7	680.0
2.0	.2569	5733.8	1251.6	845.6	6412.5	5354.8	1133.7	725.9

Table 5.7.19 Noup (Functional Unit 10) : landings (in tonnes), by gear, 1983-92, all UK

Year	Nephrops Trawl	Other Trawl	Total
1983	9	6	15
84	75	36	111
85	2	20	22
86	46	22	68
87	12	32	44
1988	23	53	76
89	24	61	85
90	101	116	217
91	110	86	196
92(*)	56	124	180

(*)provisional

Table 5.7.20 Noup (Functional Unit 10) : landings (in tonnes), effort (in '000 hours trawling) and LPUE (in kg/hour trawling) of Scottish Nephrops trawlers, 1983-92. Single and multi-rig trawls combined (see Table 3.2.2)

Year	Landings	Effort	LPUE
1983	9.2	0.3	30.7
84	75.3	2.0	36.9
85	1.5	< 0.1	25.0
86	45.7	0.7	62.6
87	12.3	0.7	18.1
1988	23.3	1.0	34.3
89	23.7	0.9	25.8
90	101.0	2.9	34.6
91	110.0	4.8	23.1
92(*)	56.0	1.9	30.1

(*) provisional

Table 5.7.21 Nephrops landings (tonnes by Functional Unit plus other rectangles in Management Area (IVa 44-48 E6-E7 + 44E8) - (Area F)

Year	FU9	FU10	Other rectangles	Total
1983	940	15	1	956
1984	1170	111	3	1284
1985	2081	22	15	2118
1986	2143	68	44	2255
1987	1991	44	30	2065
1988	1959	76	45	2080
1989	2576	85	44	2705
1990	2038	217	69	2324
1991	1517	196	65	1778
1992	1572	180	43	1795

Table 5.7.22 Total Nephrops landings (t) by country in Management Area (IVa 44-48 E6-E7 + 44E8) - (Area F)

Year	UK	TOTAL
1983	956	956
1984	1284	1284
1985	2118	2118
1986	2255	2255
1987	2065	2065
1988	2080	2080
1989	2705	2705
1990	2324	2324
1991	1778	1778
1992	1795	1795

Table 5.8.1 Input data and parameters: Fladen Ground

FU	7	MA	G
FLEET	UK Scotland	GEAR	Nephrops and Light trawl

1992	NUMBER OF SAMPLES				Mean
	Qtr 1	Qtr 2	Qtr 3	Qtr 4	No./sample
Catch					
Landings	0	1	1	2	454
Discards					

NUMBER OF SAMPLES										
YEAR	92	91	90	89	88	87	86	85	84	83
Catch										
Landings	4	12	9	11	3	4	5	2	1	6
Discards										

INPUT PARAMETERS		
Parameter	Value	Source
Discard Survival	0.25	Gueguen and Charuau,1975; Anon.,1985
MALES		
Growth - K	0.16	Adapted from Bailey and Chapman, 1983
Growth - L(inf)	66	"
Nat. Mort. - M	0.3	Morizur, 1982
Length/weight - a	0.0003	After Howard and Hall, 1983
Length/weight - b	3.25	"
FEMALES		
Immature Growth		
K	0.16	as for males
L(inf)	66	"
Nat.Mort. - M	0.3	"
Size at Maturity	25	Adapted from Bailey, 1984
Mature Growth		
K	0.1	as for males
L(inf)	56	"
Nat.Mort. - M	0.2	assumed *
Length/weight - a	0.00074	as for males
Length/weight - b	2.91	"

* based on Morizur, 1982 and assuming lower mature female rate

Table 5.8.2 Fladen (Functional Unit 7) : landings (in tonnes), by country, 1983-92, all gears

Year	UK	Denmark	Belgium	Total
1983	693	?	?	≥ 693
84	649	?	?	≥ 649
85	1 141	7	?	1 148
86	1 493	50	0	1 543
87	1 398	323	0	1 721
1988	1 493	81	0	1 574
89	2 133	230	0	2 363
90	2 302	290	2	2 594
91	3 796	445	0	4 241
92(*)	2 936	327	2	3 265

(*) provisional

Table 5.8.3 Fladen (Functional Unit 7) : landings (in tonnes), effort (in '000 hours trawling) and LPUE (in kg/hour trawling) of Scottish Nephrops trawlers, 1983-92. Single and multi-rig trawls combined (see Table 3.2.2)

Year	Landings	Effort	LPUE
1983	548	15.4	35.5
84	549	11.4	48.2
85	1 016	26.6	38.2
86	1 398	37.8	37.0
87	1 024	41.6	24.6
1988	1 306	41.7	31.3
89	1 719	47.1	36.5
90	1 703	43.4	39.2
91	3 024	78.5	38.5
92(*)	1 788	38.3	46.7

(*) provisional

Table 5.8.4 Fladen (Functional Unit 7) : effort (in days trawling) and LPUE (in kg/day trawling) of Danish Nephrops trawlers, 1988-92.

Year	Effort	LPUE
1988	934	86.7
89	1 876	122.6
90	3 323	89.0
91	3 786	116.1
92(*)	2 363	144.2

(*) provisional

Table 5.8.5 Fladen (Functional Unit 7) : mean sizes (CL in mm) of male and female Nephrops in Scottish landings, 1983-92

Year	Males	Females
1983	36.2	30.9
84	30.2	28.6
85	35.2	31.6
86	31.3	28.7
87	31.5	29.5
1988	30.0	29.4
89	33.6	31.5
90	32.6	29.4
91	34.2	31.9
92	35.0	33.1

Table 5.8.6 Nephrops landings (tonnes) by Functional Unit plus other rectangles in Management Area IVa Remainder - (Area G)

Year	FU7	Other rectangles	Total
1983	≥ 693	≥10	≥ 703
1984	≥ 649	≥ 8	≥ 657
1985	1148	≥34	≥1182
1986	1543	≥17	≥1560
1987	1721	≥13	≥1734
1988	1574	54	1628
1989	2363	66	2429
1990	2594	79	2673
1991	4241	135	4376
1992	3265	83	3348

Table 5.8.7 Total Nephrops landings (t) by country in Management Area IVa Remainder - (Area G)

Year	UK	Denmark	Belgium	TOTAL
1983	703	?	?	703
1984	657	?	?	657
1985	1182	?	?	1182
1986	1510	50	0	1560
1987	1411	323	0	1734
1988	1501	127	0	1628
1989	2154	275	0	2429
1990	2318	353	>2	2673
1991	3848	528	0	4376
1992	2977	369	>2	3348

Table 5.9.1 Input Data and parameters: Botney Gut

FU	5	MA	H
FLEET	Belgium	GEAR	trawl (otter+Nephrops)

1992	NUMBER OF SAMPLES				Mean	
	Qtr 1	Qtr 2	Qtr 3	Qtr 4	No./sample	
Catch						
Landings	6	6	6	6	200-300	*
Discards						

NUMBER OF SAMPLES **										
YEAR	92	91	90	89	88	87	86	85	84	83
Catch										
Landings	24	24	24	24	24	24	24	18	14	10
Discards										

INPUT PARAMETERS		
Parameter	value	Source
Discard Survival	0.25	Gueguen and Charuau, 1975
MALES		
Growth - K	0.165	Taken from Scottish stocks
Growth - L(inf)	62	"
Nat. Mort. - M	0.3	Morizur, 1982
Length/weight - a	0.0003	Redant (unpublished)
Length/weight - b	3.24	"
FEMALES		
Immature Growth		Not used, all sizes mature
K		
L(inf)		
Nat.Mort. - M		
Size at Maturity		
Mature Growth		
K	0.08	as for males
L(inf)	60	"
Nat.Mort. - M	0.2	assumed ***
Length/weight - a	0.00135	as for males
Length/weight - b	2.82	"

* ie 100 per market category

** length data prior to 1986 not used in assessmnets because of lack of precision in landings statistics

*** based on Morizur, 1982 and assuming lower female rate

Table 5.9.2 Botney Gut - Silver Pit (Functional Unit 5) : landings (in tonnes), by country, 1983-92

Year	Belgium	Denmark	UK	Total
1983	633(†)	?	3	≥ 636
84	612(†)	?	1	≥ 613
85	680(†)	?	< 1	≥ 680
86	378	?	4	≥ 382
87	427	?	6	≥ 433
1988	483	59	4	546
89	554	90	1	645
90	585	161	1	747
91	573	184	2	759
92(*)	470	30	12	512

(*) provisional
(†) data are for sub areas IVb and c, assumed Botney Gut/Silver Pit

Table 5.9.3 Botney Gut - Silver Pit (Functional Unit 5) : landings (in tonnes), effort (in '000 hours trawling) and LPUE (in kg/hour trawling) of Belgian Nephrops trawlers, 1983-92

Year	Landings	Effort	LPUE
1983	628(†)	38.6	16.3
84	600(†)	54.0	11.1
85	669(†)	62.2	10.8
86	378	53.6	7.1
87	427	52.3	8.2
1988	481	57.9	8.3
89	552	63.6	8.7
90	573	72.9	7.9
91	550	85.3	6.4
92(*)	470	84.5	5.6

(*) provisional
(†) data are for sub areas IVb and c, assumed Botney Gut/Silver Pit

Table 5.9.4 Botney Gut (Functional Unit 5) : effort (in days trawling) and LPUE (in kg/day trawling) of Danish Nephrops trawlers, 1988-92.

Year	Effort	LPUE
1988		285.1
89		200.2
90	1 770	208.0
91	620	295.6
92(*)	146	159.4

(*) provisional

Table 5.9.5 LCA. Botney Gut/Silver Pit (Functional Unit 5): Males
Cohort Analysis Output. Reference period 1989-1992

L INFINITY = 62.0000 K = .1650

COHORT ANALYSIS BY EXACT CALCULATION

SIZE MM	REMOVALS	M	DT	FDT	F	Z	NO. ATTAINING	AVE. NO. IN SEA	BIOMASS kg
24.0	61.5	.3000	.3277	.0015	.0046	.3046	43191.4	13469.7	136711.0
26.0	417.3	.3000	.3464	.0113	.0326	.3326	39089.0	12790.0	166574.8
28.0	1071.8	.3000	.3674	.0330	.0899	.3899	34834.6	11924.5	195763.2
30.0	2156.5	.3000	.3911	.0787	.2011	.5011	30185.5	10721.7	218472.7
32.0	2402.0	.3000	.4181	.1086	.2597	.5597	24812.4	9250.5	230818.5
34.0	1516.5	.3000	.4491	.0861	.1916	.4916	19635.3	7913.2	238920.2
36.0	1702.5	.3000	.4851	.1233	.2542	.5542	15744.8	6697.4	242102.0
38.0	1540.3	.3000	.5273	.1486	.2819	.5819	12033.1	5464.4	234268.3
40.0	1235.0	.3000	.5776	.1644	.2845	.5845	8853.6	4340.2	218803.5
42.0	977.0	.3000	.6385	.1857	.2908	.5908	6316.5	3359.9	197643.9
44.0	651.0	.3000	.7138	.1820	.2550	.5550	4331.5	2553.0	174011.0
46.0	503.0	.3000	.8093	.2151	.2658	.5658	2914.6	1892.5	148511.8
48.0	329.0	.3000	.9342	.2276	.2436	.5436	1843.9	1350.7	121319.4
50.0	221.0	.3000	1.1050	.2644	.2392	.5392	1109.6	923.7	94449.9
52.0	126.0	.3000	1.3524	.2854	.2110	.5110	611.5	597.1	69153.8
54.0	62.0	.3000	1.7435	.2965	.1701	.4701	306.4	364.6	47611.1
56.0	54.0	.3000			.2000	.5000	135.0	364.6	53452.5
				TOTAL BIOMASS INCLUDES LENGTHS ABOVE				+GP	94706.8

Table 5.9.6 LCA. Botney Gut/Silver Pit (Functional Unit 5): Females
Cohort Analysis Output. Reference period 1989-1992

L INFINITY = 60.0000 K = .0800

COHORT ANALYSIS BY EXACT CALCULATION

SIZE MM	REMOVALS	M	DT	FDT	F	Z	NO. ATTAINING	AVE. NO. IN SEA	BIOMASS kg
24.0	93.0	.2000	.7145	.0023	.0032	.2032	43912.1	29203.3	345109.0
26.0	318.5	.2000	.7578	.0091	.0120	.2120	37978.3	26587.5	390352.4
28.0	942.3	.2000	.8067	.0320	.0397	.2397	32342.0	23723.5	426064.3
30.0	1031.5	.2000	.8624	.0430	.0499	.2499	26655.0	20679.4	448241.5
32.0	800.3	.2000	.9264	.0416	.0449	.2449	21487.7	17808.4	460435.3
34.0	688.3	.2000	1.0005	.0453	.0453	.2453	17125.7	15194.1	463747.9
36.0	908.0	.2000	1.0876	.0783	.0720	.2720	13398.6	12615.2	450356.8
38.0	1080.8	.2000	1.1914	.1296	.1088	.3088	9967.6	9935.9	411472.8
40.0	808.0	.2000	1.3170	.1425	.1082	.3082	6899.7	7468.9	356158.3
42.0	681.0	.2000	1.4723	.1866	.1267	.3267	4597.9	5373.7	293082.0
44.0	317.0	.2000	1.6691	.1400	.0839	.2839	2842.1	3778.3	234254.9
46.0	259.0	.2000	1.9269	.1927	.1000	.3000	1769.5	2589.4	181487.6
48.0	140.0	.2000	2.2790	.1916	.0841	.2841	992.6	1665.3	131276.5
50.0	57.0	.2000	2.7893	.1533	.0550	.2550	519.5	1037.0	91510.9
52.0	33.0	.2000	3.5960	.1976	.0549	.2549	255.1	600.6	59073.8
54.0	34.0	.2000			.1000	.3000	102.0	600.6	65578.3
				TOTAL BIOMASS INCLUDES LENGTHS ABOVE				+GP	180062.5

Table 5.9.7 VPA. Botney Gut- Silver Pit (Functional Unit 5): Catch (000's) at 'nominal age'. 1986-1992

Males

Catch-at age data

Age	1986	1987	1988	1989	1990	1991	1992
1	1043.	1445.	1981.	1751.	1731.	3972.	1300.
2	2999.	3248.	3312.	2942.	4952.	8241.	3779.
3	1990.	2256.	2284.	2282.	3440.	4097.	3434.
4	1617.	1488.	1971.	1812.	2224.	2184.	2170.
5	832.	889.	1213.	1172.	1204.	964.	1059.
6	462.	505.	720.	655.	764.	488.	560.
7	288.	250.	449.	385.	395.	259.	267.
8	124.	166.	249.	257.	196.	175.	114.
9	62.	67.	135.	131.	118.	86.	53.
10	33.	43.	64.	61.	55.	63.	28.
11	16.	40.	45.	53.	40.	23.	12.
12	14.	14.	17.	25.	15.	17.	8.
13	7.	40.	23.	62.	45.	33.	14.

Table 5.9.8 VPA. Botney Gut- Silver Pit (Functional Unit 5): Mean weight (kg) at 'nominal age'. 1986-1992

Males

Weight-at-age dat

Age	1986	1987	1988	1989	1990	1991	1992
1	.0170	.0170	.0170	.0160	.0170	.0170	.0170
2	.0250	.0250	.0240	.0250	.0250	.0240	.0250
3	.0370	.0380	.0380	.0380	.0380	.0370	.0380
4	.0510	.0500	.0510	.0510	.0510	.0500	.0500
5	.0640	.0650	.0650	.0640	.0640	.0640	.0640
6	.0780	.0780	.0780	.0780	.0780	.0780	.0780
7	.0910	.0910	.0910	.0910	.0910	.0910	.0910
8	.1030	.1030	.1030	.1030	.1020	.1030	.1020
9	.1140	.1150	.1140	.1140	.1150	.1150	.1150
10	.1240	.1240	.1240	.1240	.1230	.1240	.1240
11	.1330	.1340	.1340	.1340	.1340	.1330	.1330
12	.1420	.1420	.1420	.1420	.1420	.1420	.1420
13	.1550	.1600	.1570	.1590	.1580	.1640	.1590

Table 5.9.9 VPA. Botney Gut- Silver Pit (Functional Unit 5): Fishing mortality (F) at 'nominal age'. 1986-1992

Males

F-at-age

Age	1986	1987	1988	1989	1990	1991	1992
1	.0444	.0597	.0765	.0586	.0513	.1727	.2000
2	.1854	.2109	.2104	.1732	.2601	.4084	.2764
3	.2067	.2314	.2518	.2455	.3525	.4014	.3344
4	.2842	.2632	.3654	.3652	.4527	.4483	.4351
5	.2312	.2798	.4010	.4359	.5006	.4083	.4622
6	.2632	.2396	.4330	.4448	.6505	.4406	.5018
7	.2693	.2486	.3911	.4954	.6053	.5451	.5227
8	.2394	.2745	.4737	.4618	.5805	.6878	.5606
9	.1991	.2201	.4263	.5591	.4507	.6214	.5139
10	.2043	.2319	.3781	.3941	.5484	.5249	.4721
11	.1954	.4554	.4490	.7086	.5466	.5352	.2000
12	.1996	.3024	.4178	.5539	.5152	.5605	.3953
13	.1996	.3024	.4178	.5539	.5152	.5605	.3953

Table 5.9.10 VPA. Botney Gut- Silver Pit (Functional Unit 5): M
Population numbers (000's) at 'nominal age'. 1986-1

N-at-age

Age	1986	1987	1988	1989	1990	1991	1992
1	27754.	28801.	31074.	35586.	40016.	28856.	8261.
2	20419.	19668.	20099.	21325.	24863.	28162.	17986.
3	12272.	12567.	11799.	12064.	13286.	14200.	13867.
4	7512.	7393.	7387.	6795.	6992.	6918.	7041.
5	4637.	4188.	4209.	3797.	3494.	3294.	3273.
6	2294.	2726.	2345.	2088.	1819.	1569.	1622.
7	1402.	1306.	1589.	1127.	991.	703.	748.
8	672.	794.	755.	796.	509.	401.	302.
9	395.	392.	447.	348.	372.	211.	149.
10	206.	240.	233.	216.	147.	175.	84.
11	102.	124.	141.	118.	108.	63.	77.
12	88.	62.	58.	67.	43.	46.	27.
13	42.	177.	77.	166.	128.	89.	49.

Table 5.9.11 VPA. Botney Gut- Silver Pit (Functional Unit 5): Males
Yield (tonnes),Fbar,Total stock biomass (tonnes),
spawning stock biomass (tonnes), Ln recruitment 1986-1992

Year,	Yield,	Fbar,	TSB,	SSB,	Log R
		3-10			
1986,	393.3,	.2372,	2595.1,	2595.1,	10.23
1987,	429.7,	.2486,	2642.5,	2642.5,	10.27
1988,	537.4,	.3901,	2633.7,	2633.7,	10.34
1989,	511.3,	.4252,	2616.1,	2616.1,	10.48
1990,	624.8,	.5177,	2772.6,	2772.6,	10.60
1991,	696.0,	.5097,	2551.7,	2551.7,	10.27
1992,	517.2,	.4753,	1953.4,	1953.4,	9.02

Table 5.9.12 VPA. Botney Gut- Silver Pit (Functional Unit 5): Catch (000's) at 'nominal age'. 1986-1992

Females

Catch-at age data

Age	1986	1987	1988	1989	1990	1991	1992
1	153.	274.	221.	415.	164.	597.	213.
2	594.	936.	947.	876.	767.	1961.	804.
3	1229.	1448.	1868.	978.	754.	2108.	562.
4	1152.	1150.	821.	988.	458.	1495.	401.
5	524.	785.	671.	1024.	668.	818.	374.
6	324.	564.	579.	1080.	996.	940.	368.
7	277.	336.	549.	1206.	1023.	1089.	357.
8	212.	253.	283.	642.	886.	579.	391.
9	154.	189.	178.	450.	842.	690.	215.
10	75.	95.	103.	346.	401.	550.	129.
11	50.	61.	100.	130.	282.	284.	75.
12	32.	30.	68.	98.	216.	291.	62.
13	19.	18.	36.	85.	159.	219.	60.
14	13.	11.	30.	83.	116.	135.	42.
15	8.	6.	29.	55.	72.	92.	26.
16	48.	26.	58.	137.	149.	206.	115.

Table 5.9.13 VPA. Botney Gut- Silver Pit (Functional Unit 5): Mean weight (kg) at 'nominal age'.1986-1992

Females

Weight-at-age dat

Age	1986	1987	1988	1989	1990	1991	1992
1	.0140	.0140	.0140	.0140	.0140	.0140	.0140
2	.0180	.0180	.0180	.0180	.0180	.0180	.0180
3	.0230	.0220	.0220	.0220	.0220	.0220	.0220
4	.0270	.0270	.0270	.0270	.0280	.0270	.0270
5	.0320	.0320	.0320	.0320	.0320	.0320	.0320
6	.0370	.0370	.0370	.0370	.0370	.0370	.0370
7	.0420	.0420	.0420	.0420	.0420	.0420	.0420
8	.0470	.0470	.0470	.0470	.0470	.0470	.0470
9	.0510	.0510	.0510	.0510	.0520	.0520	.0510
10	.0570	.0570	.0570	.0570	.0570	.0570	.0570
11	.0610	.0610	.0610	.0610	.0620	.0620	.0610
12	.0650	.0650	.0660	.0660	.0660	.0660	.0660
13	.0700	.0700	.0700	.0710	.0700	.0700	.0710
14	.0740	.0740	.0750	.0750	.0740	.0740	.0740
15	.0780	.0790	.0790	.0780	.0780	.0790	.0790
16	.0990	.0950	.0930	.0950	.0940	.0920	.0990

Table 5.9.14 VPA. Botney Gut- Silver Pit (Functional Unit 5): Fishing mortality (F) at 'nominal age'. 1986-1992

Females

F-at-age

Age	1986	1987	1988	1989	1990	1991	1992
1	.0106	.0270	.0226	.0495	.0260	.0921	.2000
2	.0374	.0828	.1226	.1171	.1214	.4821	.1725
3	.1064	.1203	.2356	.1796	.1398	.5632	.2457
4	.1122	.1373	.0927	.1884	.1195	.4489	.1943
5	.0690	.1041	.1108	.1600	.1878	.3226	.1911
6	.0708	.0986	.1041	.2612	.2307	.4364	.2350
7	.0724	.0976	.1313	.3259	.4221	.4234	.2940
8	.0829	.0875	.1114	.2233	.4234	.4511	.2636
9	.0903	.0987	.0819	.2592	.5089	.6913	.2998
10	.0622	.0736	.0717	.2261	.3879	.7502	.2603
11	.0609	.0661	.1039	.1209	.2904	.5251	.2073
12	.0468	.0478	.0975	.1404	.3024	.5485	.2065
13	.0330	.0338	.0730	.1694	.3536	.5697	.2034
14	.0579	.0238	.0718	.2425	.3694	.5735	.2000
15	.0459	.0351	.0808	.1841	.3418	.5639	.2033
16	.0459	.0351	.0808	.1841	.3418	.5639	.2033

Table 5.9.15 VPA. Botney Gut- Silver Pit (Functional Unit 5): Fe
Population numbers (000's) at 'nominal age'.1986-199

N-at-age

Age	1986	1987	1988	1989	1990	1991	1992
1	16018.	11342.	10912.	9473.	7034.	7475.	1290.
2	17834.	12977.	9038.	8734.	7382.	5611.	5582.
3	13405.	14064.	9780.	6546.	6361.	5353.	2837.
4	11947.	9867.	10209.	6327.	4478.	4528.	2495.
5	8663.	8743.	7042.	7619.	4290.	3253.	2366.
6	5216.	6620.	6451.	5161.	5315.	2911.	1929.
7	4367.	3978.	4911.	4759.	3254.	3455.	1541.
8	2942.	3326.	2955.	3526.	2813.	1747.	1853.
9	1962.	2217.	2495.	2164.	2309.	1508.	911.
10	1366.	1467.	1644.	1882.	1367.	1136.	618.
11	927.	1051.	1116.	1253.	1229.	759.	439.
12	769.	714.	805.	824.	909.	753.	368.
13	639.	601.	557.	598.	586.	550.	356.
14	256.	506.	476.	424.	413.	337.	255.
15	202.	198.	405.	362.	272.	234.	155.
16	1167.	844.	827.	897.	564.	523.	689.

Table 5.9.16 VPA. Botney Gut- Silver Pit (Functional Unit 5): Females
Yield (tonnes),Fbar,Total stock biomass (tonnes),
spawning stock biomass (tonnes), Ln recruitment 1986-1992

Year,	Yield,	Fbar, 3-13	TSB,	SSB,	Log R
1986,	147.4,	.0734,	2447.5,	2447.5,	9.68
1987,	181.3,	.0878,	2298.8,	2298.8,	9.34
1988,	200.6,	.1103,	2141.1,	2141.1,	9.30
1989,	310.0,	.2049,	1941.2,	1941.2,	9.16
1990,	326.1,	.3060,	1579.6,	1579.6,	8.86
1991,	419.8,	.5209,	1254.7,	1254.7,	8.92
1992,	147.4,	.2364,	804.5,	804.5,	7.16

Table 5.9.17 Nephrops landings (tonnes by Functional Unit plus other rectangles in Management Area (H) - (IVb & IVc East of 1° East)

Year	FU5	Other rectangles	Total
1983	≥636	?	≥636
1984	≥613	?	≥613
1985	≥680	≥1	≥681
1986	≥382	≥10	≥392
1987	≥433	≥4	≥437
1988	546	73	619
1989	645	131	776
1990	747	123	870
1991	759	167	926
1992	512	196	708

Table 5.9.18 Total Nephrops landings (t) by country in Management Area (H) - (IVb & IVc East of 1° East)

Year	Belgium	Denmark	UK	TOTAL
1983	633	?	3	≥636
1984	612	?	1	≥613
1985	680	?	1	≥681
1986	388	?	4	≥392
1987	431	?	6	≥437
1988	491	122	5	619
1989	563	210	3	776
1990	600	266	4	870
1991	606	315	5	926
1992	481	208	18	708

Table 5.10.1 Input data and parameters: Farn Deeps

FU 6	MA I
FLEET UK	GEAR Trawl

1992 *	NUMBER OF SAMPLES				Mean
	Qtr 1	Qtr 2	Qtr 3	Qtr 4	No./sample
Catch	0	0	0	10	230
Landings	4	3	13	20	258
Discards	0	0	0	10	103

	NUMBER OF SAMPLES									
YEAR**	92	91	90	89	88	87	86	85	84	83
Catch	10	10	26	31	37	36	8	15	0	0
Landings	40	48	74	70	44	49	70	52	57	56
Discards	10	10	26	31	37	36	8	15	0	0

INPUT PARAMETERS		
Parameter	Value	Source
Discard Survival	0.25	Anon, 1985
MALES		
Growth - K	0.16	Macer (unpublished) and comparison
Growth - L(inf)	66	with Scottish stocks
Nat. Mort. - M	0.3	Morizur, 1982
Length/weight - a	0.00038	Farn Deeps observations (Macer unpub.)
Length/weight - b	3.17	"
FEMALES		
Immature Growth		
K	0.16	as for males
L(inf)	66	"
Nat.Mort. - M	0.3	"
Size at Maturity	24mm	50% berried
Mature Growth		
K	0.06	as for males
L(inf)	58	"
Nat.Mort. - M	0.2	assumed (based on Morizur, 1982)
Length/weight - a	0.00091	as for males
Length/weight - b	2.89	"

* 1991/1992 season

** Seasons

Table 5.10.2 Farn Deeps (Functional Unit 6) : landings (in tonnes), by country, 1983-92

Year	UK	Denmark	Belgium	Total
1983	2 078	+	?	≥ 2 078
84	1 483	+	?	≥ 1 483
85	2 028	+	?	≥ 2 028
86	2 015	+	0	≥ 2 015
87	2 193	+	0	≥ 2 193
1988	2 494	10	0	2 504
89	3 098	1	0	3 099
90	2 498	+	0	2 498
91	2 061	1	1	2 063
92(*)	1 462	0	<1	1 462

(*) provisional

Table 5.10.3 Farn Deeps (Functional Unit 6) : catches and landings (in tonnes), effort (in '000 hours trawling), CPUE and LPUE (in kg/hour trawling) of UK Nephrops trawlers, 1983-92

Season	Catches	Landings	Effort	CPUE	LPUE
1982/83	?	2 278	76	?	30
83/84	?	1 922	75	?	26
84/85	3 236	1 600	63	51	25
85/86	4 163	2 175	96	43	23
86/87	3 061	2 140	94	33	23
1987/88	4 868	2 131	110	44	19
88/89	5 080	2 614	118	43	22
89/90	4 608	2 814	133	35	21
90/91	5 020	2 972	127	40	23
91/92(*)	2 242	1 478	92	24	16

(*) provisional
Figures are for years ending June 30th

Table 5.10.4 Farn Deeps (Functional Unit 6) : mean sizes (CL in mm) of male and female Nephrops in English catches and landings, 1983-92

Season	Catch		Landings		Catch (Nov samples)*	
	Males	Females	Males	Females	Males	Females
1982/83	NA	NA	36.9	34.7	NA	NA
83/84	NA	NA	36.5	33.9	NA	NA
84/85	29.6	27.1	35.6	33.9	NA	NA
85/86	30.1	28.7	35.2	33.7	29.3	28.3
86/87	30.5	29.6	34.7	33.2	28.6	29.1
1987/88	28.1	26.1	35.0	32.4	26.5	26.0
88/89	28.1	26.8	32.7	32.1	27.8	25.9
89/90	28.7	28.0	32.2	31.3	28.6	27.6
90/91	NA	NA	31.7	31.4	24.8	24.4
91/92	NA	NA	33.7	32.9	26.3	24.2

(*) Samples available for November only

Table 5.10.5 LCA. Farn Deeps (Functional Unit 6): Males
Cohort Analysis Output. Seasons 1-8

L INFINITY = 66.0000 K = .1600

COHORT ANALYSIS BY POPE'S APPROXIMATION

SIZE MM	REMOVALS	M	DT	FDT	F	Z	NO. ATTAINING	AVE. NO. IN SEA	BIOMASS kg
12.0	48.0	.3000	.2359	.0002	.0008	.3008	277632.8	63218.3	83724.0
14.0	150.0	.3000	.2451	.0006	.0025	.3025	258619.3	61102.1	127460.6
16.0	836.3	.3000	.2551	.0036	.0142	.3142	240138.7	58876.8	182744.7
18.0	2615.0	.3000	.2660	.0124	.0464	.3464	221639.1	56320.5	248845.3
20.0	5994.0	.3000	.2778	.0314	.1130	.4130	202127.1	53053.4	322088.7
22.0	11810.3	.3000	.2908	.0709	.2439	.5439	180214.0	48464.3	392753.4
24.0	15444.0	.3000	.3049	.1110	.3641	.6641	153854.6	42470.9	448496.7
26.0	15381.3	.3000	.3206	.1375	.4288	.7288	125650.9	35921.8	484331.0
28.0	15278.0	.3000	.3379	.1762	.5215	.8215	99470.2	29350.7	496516.5
30.0	12154.5	.3000	.3572	.1865	.5222	.8222	75357.7	23327.6	487688.9
32.0	10209.3	.3000	.3789	.2136	.5638	.8638	56178.8	18153.7	462853.3
34.0	8049.0	.3000	.4034	.2372	.5880	.8880	40497.3	13729.8	421963.2
36.0	5937.8	.3000	.4312	.2533	.5875	.8875	28305.2	10141.4	371815.4
38.0	3827.5	.3000	.4632	.2389	.5159	.8159	19304.7	7446.2	322664.7
40.0	2502.8	.3000	.5003	.2281	.4559	.7559	13229.7	5510.9	279898.3
42.0	1808.8	.3000	.5438	.2440	.4487	.7487	9064.2	4049.2	239230.4
44.0	1115.0	.3000	.5957	.2258	.3790	.6790	6032.6	2955.6	201736.2
46.0	772.0	.3000	.6585	.2378	.3612	.6612	4025.7	2149.2	168411.8
48.0	466.0	.3000	.7361	.2229	.3028	.6028	2604.7	1548.5	138506.0
50.0	281.0	.3000	.8346	.2114	.2533	.5533	1671.3	1117.1	113447.4
52.0	180.0	.3000	.9634	.2200	.2284	.5284	1053.2	795.2	91245.2
54.0	104.0	.3000	1.1395	.2168	.1903	.4903	633.0	552.7	71331.5
56.0	75.0	.3000	1.3946	.2948	.2114	.5114	362.1	361.0	52194.4
58.0	34.0	.3000	1.7980	.2889	.1607	.4607	177.4	216.9	34989.5
60.0	31.0	.3000			.2000	.5000	77.5	216.9	34989.5

Table 5.10.6 LCA. Farn Deeps (Functional Unit 6): Females
Cohort Analysis Output. Seasons 1-8

LOWER CURVE LINF= 66.0000 K= .1600

UPPER CURVE LINF= 58.0000 K= .0600

TRANSITION LENGTH= 24.0000

COHORT ANALYSIS BY POPE'S APPROXIMATION

SIZE MM	REMOVALS	M	DT	FDT	F	Z	NO. ATTAINING	AVE. NO. IN SEA	BIOMASS kg
12.0	4.5	.3000	.2359	.0000	.0001	.3001	368999.7	84029.9	127887.5
14.0	293.3	.3000	.2451	.0009	.0036	.3036	343786.3	81212.5	187034.8
16.0	875.8	.3000	.2551	.0029	.0112	.3112	319129.2	78273.3	258981.0
18.0	2929.8	.3000	.2660	.0104	.0391	.3391	294771.2	74976.3	342302.9
20.0	6997.3	.3000	.2778	.0275	.0988	.3988	269347.6	70834.2	432070.0
22.0	12308.3	.3000	.2908	.0548	.1885	.4885	241096.7	65348.6	518700.3
24.0	14159.0	.2000	.3049	.0723	.2372	.4372	209175.1	59716.1	603391.6
26.0	11739.5	.2000	1.0756	.0741	.0689	.2689	183065.5	170995.4	2158973.0
28.0	9463.0	.2000	1.1499	.0806	.0701	.2701	137088.6	135505.5	2104057.0
30.0	8671.0	.2000	1.2351	.1027	.0832	.2832	100489.0	104735.7	1972601.0
32.0	8428.0	.2000	1.3340	.1461	.1096	.3096	70830.4	77410.5	1747209.0
34.0	5349.0	.2000	1.4502	.1415	.0976	.2976	46867.9	55202.5	1477330.0
36.0	4298.5	.2000	1.5885	.1809	.1139	.3139	30441.3	38076.9	1196860.0
38.0	2176.8	.2000	1.7560	.1512	.0861	.2861	18488.6	25520.7	934235.6
40.0	1236.0	.2000	1.9631	.1444	.0736	.2736	11186.9	16991.7	718911.2
42.0	656.8	.2000	2.2255	.1341	.0602	.2602	6538.7	11046.1	536445.4
44.0	330.8	.2000	2.5692	.1241	.0483	.2483	3664.0	6959.3	385508.7
46.0	167.0	.2000	3.0387	.1243	.0409	.2409	1936.0	4171.4	262072.9
48.0	61.0	.2000	3.7191	.0999	.0268	.2268	931.1	2338.9	165785.9
50.0	28.0	.2000	4.7947	.1198	.0250	.2250	400.5	1174.8	93491.5
52.0	9.0	.2000	6.7578	.1392	.0206	.2206	136.2	478.3	42545.2
54.0	4.0	.2000			.0300	.2300	30.7	478.3	42545.2

Table 5.10.7 LCA. Farn Deeps (Functional Unit 6): Males
Cohort Analysis Output. Seasons 1-4

L INFINITY = 66.0000 K = .1600

COHORT ANALYSIS BY POPE'S APPROXIMATION

SIZE MM	REMOVALS	M	DT	FDT	F	Z	NO. ATTAINING	AVE. NO. IN SEA	BIOMASS kg
14.0	42.0	.3000	.2451	.0002	.0007	.3007	246750.8	58310.2	121636.8
16.0	266.3	.3000	.2551	.0012	.0047	.3047	229215.8	56265.8	174640.5
18.0	1388.5	.3000	.2660	.0068	.0257	.3257	212069.7	54035.5	238749.1
20.0	4478.5	.3000	.2778	.0243	.0875	.3875	194470.1	51221.9	310969.3
22.0	8897.8	.3000	.2908	.0547	.1881	.4881	174623.0	47333.5	383589.3
24.0	11733.8	.3000	.3049	.0845	.2772	.5772	151518.8	42365.9	447387.8
26.0	12934.0	.3000	.3206	.1130	.3523	.6523	127063.7	36757.2	495595.1
28.0	14485.8	.3000	.3379	.1600	.4734	.7734	103085.8	30654.8	518577.8
30.0	11039.8	.3000	.3572	.1587	.4442	.7442	79377.8	24900.5	520571.2
32.0	9964.5	.3000	.3789	.1904	.5024	.8024	60847.0	19880.1	506871.0
34.0	7943.3	.3000	.4034	.2082	.5162	.8162	44895.1	15430.1	474218.0
36.0	6237.3	.3000	.4312	.2307	.5349	.8349	32301.3	11696.8	428843.7
38.0	4223.5	.3000	.4632	.2243	.4842	.7842	22535.2	8752.2	379259.4
40.0	2737.8	.3000	.5003	.2086	.4170	.7170	15671.6	6587.9	334598.2
42.0	1964.5	.3000	.5438	.2165	.3982	.6982	10947.8	4953.8	292677.0
44.0	1243.0	.3000	.5957	.2003	.3362	.6362	7489.2	3713.3	253447.8
46.0	861.0	.3000	.6585	.2050	.3114	.6114	5126.8	2779.2	217774.9
48.0	562.0	.3000	.7361	.2022	.2747	.5747	3427.8	2057.5	184030.0
50.0	351.0	.3000	.8346	.1950	.2337	.5337	2245.3	1512.2	153573.3
52.0	230.0	.3000	.9634	.2043	.2120	.5120	1438.3	1093.8	125513.2
54.0	140.0	.3000	1.1395	.2097	.1840	.4840	878.2	769.2	99281.7
56.0	102.0	.3000	1.3946	.2857	.2049	.5049	505.9	506.5	73224.3
58.0	47.0	.3000	1.7980	.2824	.1570	.4570	250.2	306.7	49477.7
60.0	44.0	.3000			.2000	.5000	110.0	306.7	49477.7

Table 5.10.8 LCA. Farn Deeps (Functional Unit 6): Females
Cohort Analysis Output. Seasons 1-4

LOWER CURVE LINF= 66.0000 K= .1600

UPPER CURVE LINF= 58.0000 K= .0600

TRANSITION LENGTH= 24.0000

COHORT ANALYSIS BY POPE'S APPROXIMATION

SIZE MM	REMOVALS	M	DT	FDT	F	Z	NO. ATTAINING	AVE. NO. IN SEA	BIOMASS kg
14.0	115.5	.3000	.2451	.0004	.0016	.3016	306866.2	72508.5	166989.4
16.0	496.0	.3000	.2551	.0018	.0071	.3071	284998.0	69938.0	231402.2
18.0	1714.0	.3000	.2660	.0068	.0255	.3255	263520.5	67146.7	306557.1
20.0	4627.5	.3000	.2778	.0202	.0726	.3726	241662.0	63781.3	389049.3
22.0	8621.8	.3000	.2908	.0422	.1452	.4452	217898.1	59425.2	471683.9
24.0	11442.0	.2000	.3049	.0636	.2086	.4086	191443.4	54888.3	554609.7
26.0	12066.5	.2000	1.0756	.0828	.0770	.2770	169018.3	157218.9	1985032.0
28.0	10188.3	.2000	1.1499	.0955	.0831	.2831	125466.8	123145.0	1912130.0
30.0	8455.0	.2000	1.2351	.1116	.0903	.2903	90608.4	94045.1	1771255.0
32.0	7328.0	.2000	1.3340	.1419	.1064	.3064	63303.4	69321.7	1564638.0
34.0	4204.0	.2000	1.4502	.1228	.0847	.2847	42066.1	49980.0	1337567.0
36.0	3314.0	.2000	1.5885	.1503	.0946	.2946	27838.9	35316.2	1110083.0
38.0	1584.8	.2000	1.7560	.1147	.0653	.2653	17434.5	24473.2	895892.4
40.0	1008.0	.2000	1.9631	.1189	.0606	.2606	10941.6	16813.6	711375.3
42.0	574.8	.2000	2.2255	.1159	.0521	.2521	6560.4	11174.3	542670.6
44.0	318.8	.2000	2.5692	.1166	.0454	.2454	3743.6	7134.2	395197.4
46.0	164.0	.2000	3.0387	.1182	.0389	.2389	1992.9	4305.4	270491.7
48.0	69.0	.2000	3.7191	.1096	.0295	.2295	964.2	2412.2	170977.1
50.0	28.0	.2000	4.7947	.1167	.0243	.2243	410.7	1206.4	96011.2
52.0	11.0	.2000	6.7578	.1676	.0248	.2248	140.1	486.8	43303.7
54.0	4.0	.2000			.0300	.2300	30.7	486.8	43303.7

Table 5.10.9 LCA. Farn Deeps (Functional Unit 6): Males
Cohort Analysis Output. Seasons 5-8

L INFINITY = 66.0000 K = .1600

COHORT ANALYSIS BY POPE'S APPROXIMATION

SIZE MM	REMOVALS	M	DT	FDT	F	Z	NO. ATTAINING	AVE. NO. IN SEA	BIOMASS kg
12.0	95.3	.3000	.2359	.0003	.0014	.3014	290373.8	66114.2	87559.2
14.0	257.3	.3000	.2451	.0010	.0040	.3040	270444.3	63883.8	133263.3
16.0	1406.5	.3000	.2551	.0058	.0229	.3229	251021.8	61478.0	190818.2
18.0	3840.8	.3000	.2660	.0174	.0656	.3656	231171.6	58595.9	258898.9
20.0	7508.5	.3000	.2778	.0380	.1369	.4369	209750.6	54875.8	333152.1
22.0	14724.5	.3000	.2908	.0864	.2972	.5972	185775.2	49584.6	401831.7
24.0	19153.5	.3000	.3049	.1374	.4506	.7506	156161.4	42562.7	449465.6
26.0	17829.5	.3000	.3206	.1632	.5092	.8092	124212.3	35074.5	472907.8
28.0	16068.5	.3000	.3379	.1941	.5743	.8743	95830.3	28037.6	474303.8
30.0	13270.3	.3000	.3572	.2185	.6118	.9118	71317.2	21744.2	454585.8
32.0	10453.3	.3000	.3789	.2419	.6385	.9385	51491.5	16418.5	418612.5
34.0	8155.0	.3000	.4034	.2746	.6807	.9807	36083.1	12020.8	369437.8
36.0	5639.0	.3000	.4312	.2845	.6598	.9598	24294.3	8578.5	314516.5
38.0	3429.8	.3000	.4632	.2600	.5613	.8613	16060.5	6134.2	265814.1
40.0	2267.0	.3000	.5003	.2571	.5140	.8140	10777.4	4428.8	224938.4
42.0	1653.0	.3000	.5438	.2878	.5291	.8291	7172.4	3139.6	185492.8
44.0	986.0	.3000	.5957	.2691	.4518	.7518	4569.2	2194.0	149749.6
46.0	683.0	.3000	.6585	.2987	.4536	.7536	2919.7	1515.6	118763.0
48.0	371.0	.3000	.7361	.2654	.3605	.6605	1777.6	1036.3	92689.4
50.0	210.0	.3000	.8346	.2456	.2942	.5942	1093.1	719.3	73045.6
52.0	130.0	.3000	.9634	.2557	.2654	.5654	665.7	494.5	56745.2
54.0	68.0	.3000	1.1395	.2344	.2057	.5057	386.1	334.4	43162.9
56.0	47.0	.3000	1.3946	.3106	.2227	.5227	217.0	214.9	31064.1
58.0	21.0	.3000	1.7980	.3048	.1695	.4695	104.7	127.1	20500.7
60.0	18.0	.3000			.2000	.5000	45.0	127.1	20500.7

Table 5.10.10 LCA. Farn Deeps (Functional Unit 6): Females
Cohort Analysis Output. Seasons 5-8

LOWER CURVE LINF= 66.0000 K= .1600

UPPER CURVE LINF= 58.0000 K= .0600

TRANSITION LENGTH= 24.0000

COHORT ANALYSIS BY POPE'S APPROXIMATION

SIZE MM	REMOVALS	M	DT	FDT	F	Z	NO. ATTAINING	AVE. NO. IN SEA	BIOMASS kg
12.0	9.0	.3000	.2359	.0000	.0001	.3001	407934.1	92895.7	141380.5
14.0	470.3	.3000	.2451	.0013	.0052	.3052	380056.4	89762.9	206726.8
16.0	1255.3	.3000	.2551	.0037	.0145	.3145	352657.2	86460.5	286070.0
18.0	4144.5	.3000	.2660	.0133	.0502	.3502	325463.4	82663.1	377397.0
20.0	9366.3	.3000	.2778	.0335	.1205	.4205	296518.5	77749.5	474251.6
22.0	15994.5	.3000	.2908	.0654	.2250	.5250	263822.5	71138.8	564660.4
24.0	16874.3	.2000	.3049	.0799	.2621	.4621	226473.7	64415.4	650874.6
26.0	11412.5	.2000	1.0756	.0668	.0621	.2621	196706.9	184377.4	2327932.0
28.0	8739.5	.2000	1.1499	.0684	.0594	.2594	148383.2	147524.5	2290682.0
30.0	8887.8	.2000	1.2351	.0958	.0775	.2775	110108.1	115138.2	2168524.0
32.0	9527.3	.2000	1.3340	.1500	.1124	.3124	78152.5	85259.2	1924360.0
34.0	6494.8	.2000	1.4502	.1575	.1086	.3086	51513.3	60224.6	1611731.0
36.0	5283.8	.2000	1.5885	.2084	.1312	.3312	32926.1	40671.3	1278407.0
38.0	2769.0	.2000	1.7560	.1859	.1059	.3059	19456.6	26434.6	967691.9
40.0	1464.0	.2000	1.9631	.1704	.0868	.2868	11371.3	17068.9	722177.7
42.0	737.0	.2000	2.2255	.1534	.0689	.2689	6475.9	10845.2	526689.1
44.0	341.0	.2000	2.5692	.1322	.0515	.2515	3559.5	6736.3	373156.4
46.0	170.0	.2000	3.0387	.1318	.0434	.2434	1865.6	4006.4	251708.0
48.0	53.0	.2000	3.7191	.0903	.0243	.2243	890.5	2246.2	159216.6
50.0	29.0	.2000	4.7947	.1291	.0269	.2269	386.7	1130.0	89933.0
52.0	6.0	.2000	6.7578	.0949	.0140	.2140	130.3	465.4	41396.6
54.0	4.0	.2000			.0300	.2300	30.7	465.4	41396.6

Table 5.10.11 VPA. Farn Deeps (Functional Unit 6): Males
Catch (000's) at 'nominal age'. 1984-1991

Age	1984	1985	1986	1987	1988	1989	1990	1991
1	959.	294.	773.	4297.	1979.	7150.	10290.	1700.
2	24949.	22403.	16733.	49859.	53636.	33035.	75371.	22766.
3	23328.	51120.	21028.	49284.	61764.	52535.	40813.	19743.
4	19633.	24707.	14513.	21735.	20882.	23391.	20813.	16873.
5	7875.	9494.	7492.	10446.	7973.	8299.	7700.	5905.
6	3233.	3656.	3222.	4019.	3395.	2971.	3458.	1923.
7	1393.	1485.	1541.	1770.	1531.	1254.	1312.	812.
8	619.	826.	717.	788.	690.	483.	493.	340.
9	265.	382.	386.	386.	283.	211.	233.	118.
10	134.	245.	236.	193.	170.	98.	103.	80.
11	198.	395.	377.	288.	216.	121.	120.	125.

Table 5.10.12 VPA. Farn Deeps (Functional Unit 6): Males
Mean weight (kg) at 'nominal age'. 1984-1991

Age	1984	1985	1986	1987	1988	1989	1990	1991
1	.0050	.0050	.0040	.0050	.0050	.0050	.0040	.0050
2	.0100	.0110	.0100	.0100	.0110	.0110	.0100	.0100
3	.0190	.0190	.0190	.0180	.0180	.0190	.0190	.0200
4	.0310	.0310	.0310	.0310	.0310	.0310	.0310	.0310
5	.0440	.0450	.0450	.0450	.0450	.0440	.0450	.0440
6	.0610	.0600	.0600	.0600	.0600	.0600	.0600	.0600
7	.0750	.0760	.0760	.0760	.0760	.0750	.0760	.0760
8	.0910	.0910	.0910	.0910	.0910	.0910	.0910	.0910
9	.1060	.1070	.1070	.1060	.1070	.1060	.1060	.1070
10	.1190	.1190	.1190	.1190	.1190	.1190	.1190	.1190
11	.1540	.1520	.1510	.1480	.1500	.1470	.1480	.1520

Table 5.10.13 VPA. Farn Deeps (Functional Unit 6): Males
Fishing mortality (F) at 'nominal age'. 1984-1991

Age	1984	1985	1986	1987	1988	1989	1990	1991
1	.0052	.0013	.0027	.0162	.0091	.0355	.0625	.1000
2	.1541	.1795	.1089	.2709	.3183	.2306	.7059	.2131
3	.2943	.6080	.2857	.6015	.7227	.6756	.5606	.4540
4	.5258	.6634	.3892	.6118	.6374	.7791	.7247	.5441
5	.5035	.5992	.4894	.6156	.5423	.6503	.7435	.5268
6	.4552	.5275	.4735	.6084	.4692	.4509	.7223	.4690
7	.3928	.4427	.5034	.5938	.5643	.3560	.4155	.4130
8	.3220	.4852	.4511	.5986	.5567	.3917	.2582	.2000
9	.2509	.3800	.5003	.5331	.5082	.3695	.3754	.1000
10	.3219	.4360	.4849	.5751	.5431	.3724	.3497	.2377
11	.3219	.4360	.4849	.5751	.5431	.3724	.3497	.2377

Table 5.10.14 VPA. Farn Deeps (Functional Unit 6): Males
Population numbers (000's) at 'nominal age'. 1984-1991

Age	1984	1985	1986	1987	1988	1989	1990	1991
1	213185.	252993.	326968.	310020.	251471.	236833.	196225.	20628.
2	201489.	157107.	187169.	241559.	225970.	184592.	169324.	136557.
3	105125.	127955.	97262.	124349.	136483.	121769.	108583.	61923.
4	54860.	58020.	51610.	54149.	50482.	49081.	45904.	45918.
5	22757.	24020.	22140.	25907.	21757.	19772.	16683.	16475.
6	10117.	10189.	9773.	10054.	10370.	9371.	7644.	5876.
7	4916.	4754.	4454.	4509.	4053.	4805.	4422.	2750.
8	2581.	2459.	2262.	1994.	1845.	1708.	2493.	2162.
9	1374.	1385.	1121.	1067.	812.	783.	855.	1427.
10	558.	792.	702.	504.	464.	362.	401.	435.
11	827.	1279.	1123.	751.	587.	444.	467.	682.

Table 5.10.15 VPA. Farn Deeps (Functional Unit 6): Males
Yield (tonnes),Fbar,Total stock biomass (tonnes),
spawning stock biomass (tonnes), Ln recruitment 1984-1991

Year,	Yield,	Fbar,	TSB,	SSB,	Log R
		3- 7			
1984,	2085.1,	.4343,	9340.2,	9340.2,	12.27
1985,	2949.7,	.5682,	9937.0,	9937.0,	12.44
1986,	1859.1,	.4282,	9127.5,	9127.5,	12.70
1987,	3104.8,	.6062,	10459.9,	10459.9,	12.64
1988,	3183.4,	.5872,	10072.0,	10072.0,	12.44
1989,	2855.6,	.5824,	9189.2,	9189.2,	12.38
1990,	2968.9,	.6333,	7944.0,	7944.0,	12.19
1991,	1663.1,	.4814,	5921.9,	5921.9,	9.93

Table 5.10.16 VPA. Farn Deeps (Functional Unit 6): Females
Catch (000's) at 'nominal age'. 1984-1991

Catch-at age data

Age	1984	1985	1986	1987	1988	1989	1990	1991
1	985.	688.	591.	6470.	4128.	6045.	9548.	2414.
2	3496.	1686.	2619.	11296.	9036.	4303.	18404.	7127.
3	11415.	4264.	4406.	15254.	16117.	8908.	31220.	8986.
4	11414.	10471.	4646.	17393.	24670.	16533.	19233.	4343.
5	10280.	8466.	7423.	17268.	16220.	12967.	9547.	2868.
6	5117.	7285.	7915.	15131.	9601.	13119.	6516.	1683.
7	4342.	7015.	7136.	10424.	7021.	11435.	7548.	2243.
8	4705.	6345.	6271.	6977.	6259.	9674.	8777.	2890.
9	5245.	5372.	5555.	4894.	6257.	8222.	9577.	3337.
10	2148.	2967.	3682.	2295.	4372.	5249.	5507.	2007.
11	1939.	2448.	3228.	1945.	3692.	4394.	4996.	1880.
12	1718.	1901.	2749.	1577.	2974.	3492.	4457.	1746.
13	604.	1098.	1693.	847.	1768.	2054.	2491.	876.
14	357.	920.	1458.	685.	1501.	1735.	2055.	684.
15	1532.	2284.	3433.	1592.	3245.	2807.	3942.	1427.

Table 5.10.17 VPA. Farn Deeps (Functional Unit 6): Females
Mean weight (kg) at 'nominal age'.1984-1991

Weight-at-age dat

Age	1984	1985	1986	1987	1988	1989	1990	1991
1	.0050	.0050	.0050	.0050	.0050	.0050	.0050	.0050
2	.0070	.0070	.0070	.0070	.0070	.0070	.0070	.0070
3	.0090	.0090	.0090	.0090	.0090	.0090	.0090	.0090
4	.0110	.0110	.0110	.0110	.0110	.0110	.0110	.0110
5	.0140	.0140	.0140	.0140	.0140	.0140	.0140	.0140
6	.0160	.0160	.0170	.0160	.0160	.0160	.0160	.0160
7	.0190	.0190	.0190	.0190	.0190	.0190	.0190	.0200
8	.0220	.0220	.0220	.0210	.0220	.0220	.0220	.0220
9	.0240	.0240	.0240	.0240	.0240	.0240	.0240	.0240
10	.0290	.0290	.0290	.0290	.0290	.0290	.0290	.0290
11	.0310	.0300	.0310	.0310	.0310	.0300	.0310	.0310
12	.0330	.0330	.0330	.0330	.0330	.0330	.0330	.0330
13	.0360	.0370	.0370	.0370	.0370	.0370	.0370	.0370
14	.0390	.0390	.0390	.0390	.0390	.0390	.0390	.0390
15	.0530	.0510	.0510	.0510	.0520	.0500	.0500	.0490

Table 5.10.18 VPA. Farn Deeps (Functional Unit 6): Females
Fishing mortality (F) at 'nominal age'. 1984-1991

F-at-age

Age	1984	1985	1986	1987	1988	1989	1990	1991
1	.0038	.0034	.0041	.0513	.0322	.0299	.0348	.1000
2	.0150	.0084	.0166	.1060	.0993	.0449	.1266	.0346
3	.0529	.0227	.0273	.1263	.2163	.1343	.5179	.0840
4	.0630	.0628	.0311	.1428	.3081	.3593	.4732	.1233
5	.0657	.0607	.0578	.1543	.1919	.2638	.3637	.1175
6	.0497	.0606	.0741	.1599	.1203	.2343	.2051	.0996
7	.0561	.0891	.0777	.1319	.1036	.2055	.2053	.1008
8	.0788	.1086	.1072	.1014	.1092	.2025	.2405	.1129
9	.1202	.1213	.1309	.1141	.1242	.2044	.3159	.1352
10	.0662	.0924	.1143	.0732	.1414	.1456	.2052	.1003
11	.0878	.1001	.1377	.0814	.1614	.2061	.2009	.1000
12	.0944	.1163	.1557	.0922	.1721	.2259	.3327	.1000
13	.0495	.0804	.1440	.0656	.1418	.1725	.2494	.1000
14	.0772	.0989	.1458	.0797	.1584	.2015	.2610	.1000
15	.0772	.0989	.1458	.0797	.1584	.2015	.2610	.1000

Table 5.10.19 VPA. Farn Deeps (Functional Unit 6): Females
Population numbers (000's) at 'nominal age'. 1984-

N-at-age

Age	1984	1985	1986	1987	1988	1989	1990	1991
1	301476.	238040.	167677.	149550.	150474.	236987.	323246.	29287.
2	259429.	222491.	175752.	123710.	105249.	107937.	170385.	231286.
3	244182.	209239.	180635.	141524.	91099.	78021.	84487.	122909.
4	206174.	189617.	167452.	143905.	102120.	60078.	55850.	41209.
5	178118.	158501.	145796.	132894.	102144.	61437.	34342.	28486.
6	116423.	136555.	122130.	112669.	93246.	69023.	38638.	19544.
7	87698.	90700.	105228.	92850.	78614.	67688.	44706.	25768.
8	68420.	67883.	67931.	79715.	66624.	58032.	45124.	29808.
9	50987.	51773.	49856.	49963.	58973.	48903.	38803.	29047.
10	36957.	37017.	37546.	35812.	36494.	42642.	32636.	23163.
11	25417.	28320.	27631.	27420.	27250.	25938.	30182.	21763.
12	21018.	19061.	20979.	19713.	20695.	18984.	17281.	20213.
13	13803.	15659.	13892.	14699.	14718.	14265.	12400.	10144.
14	5296.	10756.	11830.	9849.	11270.	10456.	9829.	7911.
15	22716.	26702.	27856.	22889.	24370.	16914.	18849.	16519.

Table 5.10.20 VPA. Farn Deeps (Functional Unit p): Females
Yield (tonnes),Fbar,Total stock biomass (tonnes),
spawning stock biomass (tonnes), Ln recruitment 1984-1991

Year,	Yield,	Fbar, 3-10	TSB,	SSB,	Log R
1984,	1091.3,	.0691,	21001.3,	19493.9,	12.62
1985,	1220.8,	.0773,	20492.5,	19302.3,	12.38
1986,	1349.5,	.0775,	19377.7,	18539.4,	12.03
1987,	1704.0,	.1255,	17405.3,	16657.5,	11.92
1988,	1934.3,	.1644,	15566.3,	14814.0,	11.92
1989,	2024.6,	.2187,	13427.1,	12242.1,	12.38
1990,	2304.4,	.3159,	12293.0,	10676.8,	12.69
1991,	749.3,	.1092,	9411.4,	9264.9,	10.28

Table 5.10.21 Input data and parameters: Firth of Forth

FU	8	MA	I
FLEET	UK Scotland	GEAR	Nephrops and Light trawl

1992	NUMBER OF SAMPLES				Mean
	Qtr 1	Qtr 2	Qtr 3	Qtr 4	No./sample
Catch					
Landings	15	18	18	18	461
Discards	1	2	6	3	619

	NUMBER OF SAMPLES									
YEAR	92	91	90	89	88	87	86	85	84	83
Catch										
Landings	69	62	71	44	37	67	61	89	46	49
Discards	12	6	7							

INPUT PARAMETERS		
Parameter	Value	Source
Discard Survival	0.25	Gueguen and Charuau,1975; Anon.,1985
MALES		
Growth - K	0.163	Adapted from Bailey and Chapman, 1983
Growth - L(inf)	66	"
Nat. Mort. - M	0.3	Morizur, 1982
Length/weight - a	0.00028	Howard and Hall, 1983
Length/weight - b	3.24	"
FEMALES		
Immature Growth		
K	0.163	as for males
L(inf)	66	"
Nat.Mort. - M	0.3	"
Size at Maturity	25	Adapted from Bailey, 1984
Mature Growth		
K	0.065	as for males
L(inf)	58	"
Nat.Mort. - M	0.2	assumed *
Length/weight - a	0.00085	as for males
Length/weight - b	2.91	"

* based on Morizur, 1982 and assuming lower mature female rate

Table 5.10.22 Firth of Forth (Functional Unit 8) : landings (in tonnes), by gear,1983-92, all UK

Year	Nephrops Trawl	Other Trawl	Total
1983	1 681	41	1 722
84	2 078	56	2 134
85	1 908	61	1 969
86	2 204	59	2 263
87	1 582	92	1 674
1988	2 455	73	2 528
89	1 833	52	1 885
90	1 901	30	1 931
91	1 359	43	1 402
92	1 678	43	1 721

(*)provisional

Table 5.10.23 Firth of Forth (Functional Unit 8) : landings (in tonnes), effort (in '000 hours trawling) and LPUE (in kg/hour trawling) of Scottish Nephrops trawlers, 1983-92. Single and multi-rig trawls combined (see Table 3.2.2)

Year	Landings	Effort	LPUE
1983	1 681	60.7	27.7
84	2 078	84.7	24.5
85	1 908	73.9	25.8
86	2 204	74.7	29.5
87	1 582	62.1	25.5
1988	2 455	94.8	25.9
89	1 833	78.7	23.3
90	1 901	81.8	23.1
91	1 359	69.4	19.6
92(*)	1 678	71.8	23.4

(*)provisional

Table 5.10.24 Firth of Forth (Functional unit 8) : mean sizes of male and female Nephrops (CL in mm) in Scottish landings, 1983-92

Year	Males	Females
1983	34.5	32.9
84	34.2	31.4
85	33.3	31.0
86	31.8	30.4
87	32.3	31.2
1988	30.1	29.4
89	30.4	30.4
90	31.4	30.3
91	31.2	30.1
92	31.9	29.7

Table 5.10.25 LCA. Firth of Forth (Functional Unit 8): Males
Cohort Analysis Output. Reference period 1989-1992

L INFINITY = 66.0000 K = .1630

COHORT ANALYSIS BY POPE'S APPROXIMATION

SIZE MM	REMOVALS	M	DT	FDT	F	Z	NO. ATTAINING	AVE. NO. IN SEA	BIOMASS kg
15.0	6.3	.3000	.2454	.0000	.0002	.3002	137999.9	32651.9	73628.1
17.0	86.4	.3000	.2557	.0007	.0027	.3027	128198.1	31538.9	104163.7
19.0	1691.7	.3000	.2668	.0150	.0560	.3560	118650.0	30196.6	140307.8
21.0	2401.7	.3000	.2789	.0235	.0842	.3842	107898.7	28537.8	180574.4
23.0	5027.4	.3000	.2922	.0557	.1907	.4907	96934.6	26387.2	221342.2
25.0	8972.6	.3000	.3068	.1186	.3867	.6867	83987.4	23235.0	252605.5
27.0	10446.4	.3000	.3230	.1757	.5442	.8442	68033.0	19231.8	265826.8
29.0	11550.4	.3000	.3409	.2675	.7846	1.0846	51798.2	14762.1	255156.6
31.0	9986.1	.3000	.3610	.3489	.9666	1.2666	35787.8	10368.4	220895.0
33.0	6739.8	.3000	.3836	.3785	.9868	1.2868	22654.9	6858.3	177826.2
35.0	4568.1	.3000	.4091	.4327	1.0575	1.3575	13829.5	4341.6	135474.1
37.0	2761.5	.3000	.4384	.4646	1.0598	1.3598	7935.9	2620.7	97433.4
39.0	1556.6	.3000	.4722	.4815	1.0198	1.3198	4372.1	1536.2	67440.8
41.0	872.2	.3000	.5115	.5136	1.0040	1.3040	2344.5	875.2	45001.5
43.0	423.0	.3000	.5581	.4816	.8630	1.1630	1203.3	494.0	29532.9
45.0	233.6	.3000	.6140	.5232	.8521	1.1521	628.7	276.7	19106.5
47.0	124.3	.3000	.6824	.5877	.8612	1.1612	309.9	146.1	11575.1
49.0	49.0	.3000	.7679	.4966	.6468	.9468	140.3	76.6	6926.8
51.0	25.7	.3000	.8779	.5668	.6456	.9456	67.8	40.5	4155.6
53.0	8.7	.3000	1.0249	.4187	.4085	.7085	29.6	21.5	2500.9
55.0	3.2	.3000	1.2311	.3077	.2499	.5499	14.3	12.8	1671.0
57.0	2.2	.3000	1.5418	.4873	.3161	.6161	7.3	7.2	1058.6
59.0	.7	.3000	2.0642	.4145	.2008	.5008	2.8	3.6	590.8
61.0	.3	.3000			.1000	.4000	1.0	3.6	657.0

Table 5.10.26 LCA. Firth of Forth (Functional Unit 8): Females
Cohort Analysis Output. Reference period 1989-1992

LOWER CURVE LINF= 66.0000 K= .1630

UPPER CURVE LINF= 58.0000 K= .0650

TRANSITION LENGTH= 25.0000

COHORT ANALYSIS BY POPE'S APPROXIMATION

SIZE MM	REMOVALS	M	DT	FDT	F	Z	NO. ATTAINING	AVE. NO. IN SEA	BIOMASS kg
15.0	.3	.3000	.2454	.0000	.0000	.3000	163130.1	38598.8	104338.9
17.0	69.3	.3000	.2557	.0005	.0019	.3019	151550.2	37288.1	142002.7
19.0	1328.7	.3000	.2668	.0099	.0371	.3371	140294.5	35793.9	185221.0
21.0	2289.5	.3000	.2789	.0188	.0674	.3674	128227.2	33992.6	232122.9
23.0	5069.7	.3000	.2922	.0468	.1603	.4603	115738.9	31642.7	278337.9
25.0	8624.5	.2000	.3068	.0920	.2999	.4999	101173.0	28777.9	319532.8
27.0	8665.9	.2000	1.0260	.1173	.1143	.3143	86787.5	76115.5	1048543.0
29.0	6550.2	.2000	1.0994	.1236	.1125	.3125	62866.0	58492.4	984930.4
31.0	4555.4	.2000	1.1840	.1222	.1032	.3032	44589.2	44357.4	901231.7
33.0	3232.1	.2000	1.2828	.1256	.0979	.2979	31140.7	33200.8	804703.0
35.0	2147.8	.2000	1.3996	.1236	.0883	.2883	21250.9	24473.4	700516.5
37.0	1510.0	.2000	1.5397	.1325	.0860	.2860	14195.2	17679.0	592257.7
39.0	934.8	.2000	1.7112	.1294	.0756	.2756	9138.3	12466.9	484883.7
41.0	557.8	.2000	1.9256	.1262	.0656	.2656	5702.1	8595.7	385318.0
43.0	311.1	.2000	2.2016	.1203	.0547	.2547	3419.5	5762.6	295764.3
45.0	171.0	.2000	2.5701	.1202	.0468	.2468	1951.9	3714.9	216996.7
47.0	76.5	.2000	3.0872	.1061	.0344	.2344	1035.2	2274.7	150388.1
49.0	35.8	.2000	3.8664	.1110	.0287	.2287	502.1	1288.7	95950.5
51.0	17.5	.2000	5.1765	.1522	.0294	.2294	207.4	628.3	52437.2
53.0	12.6	.2000			.0500	.2500	63.3	628.3	58524.2

Table 5.10.27 VPA. Firth of Forth (Functional Unit 8): Males
Catch (000's) at 'nominal age'. 1981-1991

Catch-at age data

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	146.	6387.	632.	17245.	7255.	6515.	3787.	36873.	9484.	2834.	1720.	1094.
2	2848.	6944.	7705.	14441.	12858.	28624.	20425.	46156.	25870.	30846.	24503.	22411.
3	10103.	10351.	19501.	20878.	24517.	27876.	21673.	25097.	21318.	28250.	23194.	32298.
4	6301.	6553.	10656.	15247.	10988.	9496.	8513.	11950.	7422.	8659.	7064.	11280.
5	2667.	2787.	4046.	6396.	3863.	3512.	2930.	4256.	2319.	2067.	1671.	2709.
6	992.	1384.	1636.	2317.	1316.	1083.	919.	1433.	652.	589.	405.	545.
7	315.	427.	597.	636.	358.	306.	341.	483.	249.	179.	107.	116.
8	122.	187.	253.	202.	104.	102.	107.	136.	88.	42.	33.	24.
9	51.	79.	91.	59.	38.	37.	31.	50.	42.	11.	8.	5.
10	22.	23.	36.	27.	18.	19.	12.	19.	12.	4.	1.	2.
11	31.	34.	35.	49.	13.	20.	14.	16.	11.	6.	1.	1.

Table 5.10.28 VPA. Firth of Forth (Functional Unit 8): Males
Mean weight (kg) at 'nominal age'. 1981-1991

Weight-at-age dat

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0050	.0050	.0060	.0050	.0050	.0050	.0050	.0050	.0050	.0060	.0060	.0060
2	.0130	.0110	.0120	.0110	.0120	.0120	.0120	.0110	.0110	.0120	.0120	.0120
3	.0210	.0210	.0210	.0210	.0210	.0200	.0210	.0210	.0210	.0210	.0200	.0200
4	.0330	.0330	.0330	.0340	.0330	.0330	.0330	.0330	.0330	.0330	.0330	.0330
5	.0470	.0480	.0480	.0480	.0480	.0470	.0480	.0470	.0470	.0470	.0470	.0470
6	.0630	.0630	.0630	.0630	.0630	.0630	.0630	.0630	.0630	.0630	.0620	.0620
7	.0780	.0790	.0790	.0780	.0780	.0780	.0790	.0780	.0780	.0780	.0780	.0780
8	.0940	.0940	.0930	.0920	.0930	.0930	.0930	.0930	.0940	.0920	.0930	.0920
9	.1060	.1060	.1060	.1060	.1080	.1070	.1060	.1070	.1060	.1050	.1030	.1060
10	.1220	.1180	.1210	.1220	.1200	.1210	.1220	.1200	.1170	.1230	.1220	.1210
11	.1460	.1640	.1450	.1590	.1370	.1450	.1490	.1450	.1450	.1460	.1410	.1350

Table 5.10.29 VPA. Firth of Forth (Functional Unit 8): Males
Fishing mortality (F) at 'nominal age'. 1981-1991

F-at-age

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0014	.0660	.0061	.1507	.0603	.0634	.0288	.2738	.0707	.0192	.0146	.2000
2	.0503	.0961	.1177	.2067	.1786	.3977	.3221	.6427	.3534	.3844	.2546	.2967
3	.3547	.2901	.4765	.6003	.7330	.8282	.6847	.9689	.8203	.9569	.6402	.7135
4	.5351	.4650	.6235	1.0107	.8692	.8302	.7601	1.2786	1.0538	1.1749	.7841	.8804
5	.5412	.5488	.6749	1.1779	.9139	.9089	.7757	1.4134	1.1426	1.2040	.8844	.9514
6	.5695	.6954	.8562	1.3237	.9865	.8352	.7450	1.4355	1.0466	1.3077	.9693	.9778
7	.4750	.5901	.8733	1.2191	.8689	.7571	.8110	1.4756	1.3934	1.1473	1.0974	.9996
8	.4563	.6647	1.0123	1.0092	.7570	.7675	.7614	1.1085	1.7317	1.1959	.7833	.9291
9	.5811	.6992	.9496	.8078	.5840	.7953	.6276	1.2673	1.8006	1.4705	.8642	.3000
10	.5041	.6513	.9451	1.0120	.7366	.7733	.7333	1.2838	1.6419	1.2712	.9149	.7429
11	.5041	.6513	.9451	1.0120	.7366	.7733	.7333	1.2838	1.6419	1.2712	.9149	.7429

Table 5.10.30 VPA. Firth of Forth (Functional Unit 8): Males
Population numbers (000's) at 'nominal age'. 1981-1991

N-at-age

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	118232.	115501.	120927.	142182.	143338.	122504.	154096.	176966.	160542.	172555.	137397.	6952.
2	67052.	87463.	80097.	89041.	90598.	99976.	85176.	110912.	99694.	110814.	125393.	100306.
3	38814.	47234.	58854.	52749.	53644.	56140.	49757.	45724.	43210.	51864.	55891.	72014.
4	17370.	20166.	26179.	27072.	21439.	19093.	18167.	18588.	12855.	14095.	14758.	21828.
5	7287.	7535.	9384.	10397.	7300.	6659.	6166.	6294.	3834.	3320.	3225.	4991.
6	2608.	3142.	3224.	3540.	2372.	2168.	1988.	2103.	1134.	906.	738.	987.
7	952.	1093.	1161.	1015.	698.	655.	697.	699.	371.	295.	182.	207.
8	381.	439.	449.	359.	222.	217.	228.	229.	118.	68.	69.	45.
9	132.	179.	167.	121.	97.	77.	75.	79.	56.	16.	15.	23.
10	64.	54.	66.	48.	40.	40.	26.	29.	16.	7.	3.	5.
11	88.	80.	64.	86.	29.	42.	31.	25.	15.	9.	2.	3.

Table 5.10.31 VPA. Firth of Forth (Functional Unit 8): Males
Yield (tonnes),Fbar,Total stock biomass (tonnes),
spawning stock biomass (tonnes), Ln recruitment 1981-1991

Year,	Yield,	Fbar,	TSB,	SSB,	Log R
		3- 8			
1981,	694.2,	.4886,	3502.6,	3502.6,	11.68
1982,	830.8,	.5423,	3922.7,	3922.7,	11.66
1983,	1244.3,	.7528,	4608.6,	4608.6,	11.70
1984,	1740.3,	1.0568,	4585.2,	4585.2,	11.86
1985,	1382.0,	.8548,	4232.0,	4232.0,	11.87
1986,	1522.8,	.8212,	4105.1,	4105.1,	11.72
1987,	1242.3,	.7563,	3950.2,	3950.2,	11.95
1988,	1964.1,	1.2801,	4198.2,	4198.2,	12.08
1989,	1209.8,	1.1980,	3532.8,	3532.8,	11.99
1990,	1420.8,	1.1645,	4165.6,	4165.6,	12.06
1991,	1117.6,	.8598,	4154.1,	4154.1,	11.83
1992,	1467.0,	.9086,	3725.5,	3725.5,	8.85

Table 5.10.32 VPA. Firth of Forth (Functional Unit 8): Females
Catch (000's) at 'nominal age'. 1981-1991

Catch-at age data

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	413.	2152.	1144.	5292.	1213.	3367.	550.	29517.	6245.	2821.	2809.	1340.
2	222.	792.	646.	2121.	1891.	5376.	2455.	11129.	5114.	6299.	5867.	3432.
3	685.	1089.	1681.	3862.	3129.	12464.	5727.	11789.	8118.	11372.	8758.	6955.
4	1543.	1471.	2895.	4793.	5423.	13832.	6552.	10914.	8461.	9899.	7700.	7748.
5	1895.	1212.	3744.	4817.	5020.	11213.	6013.	7384.	6224.	6534.	5382.	6063.
6	1984.	1476.	3608.	4039.	3845.	7402.	4743.	5886.	4427.	4610.	3951.	3554.
7	1779.	1296.	3206.	2950.	2765.	4978.	3573.	4789.	3693.	3327.	2667.	2093.
8	1557.	1075.	2391.	2101.	1826.	3306.	2519.	3658.	3013.	2442.	1791.	1270.
9	1375.	900.	1419.	1501.	1043.	2080.	1612.	2568.	2311.	1812.	1227.	788.
10	880.	659.	1105.	804.	552.	1264.	977.	1657.	1749.	1149.	628.	403.
11	711.	587.	881.	608.	416.	944.	686.	1443.	1427.	897.	484.	320.
12	511.	503.	616.	378.	257.	566.	343.	1192.	1047.	600.	315.	223.
13	303.	277.	375.	273.	139.	361.	229.	618.	648.	420.	216.	135.
14	232.	200.	293.	237.	99.	291.	190.	423.	513.	359.	183.	105.
15	139.	107.	152.	129.	67.	168.	93.	278.	281.	204.	118.	69.
16	420.	379.	382.	333.	168.	501.	253.	972.	737.	632.	403.	262.

Table 5.10.33 VPA. Firth of Forth (Functional Unit 8): Females
Mean weight (kg) at 'nominal age'.1981-1991

Weight-at-age dat

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0050	.0050	.0060	.0050	.0060	.0060	.0060	.0050	.0060	.0060	.0070	.0060
2	.0090	.0090	.0090	.0090	.0090	.0090	.0090	.0090	.0090	.0090	.0090	.0090
3	.0110	.0110	.0110	.0110	.0110	.0110	.0110	.0110	.0110	.0110	.0110	.0110
4	.0140	.0140	.0140	.0140	.0140	.0140	.0140	.0140	.0140	.0140	.0140	.0140
5	.0170	.0170	.0170	.0170	.0170	.0170	.0170	.0170	.0170	.0170	.0170	.0170
6	.0200	.0200	.0200	.0200	.0200	.0200	.0200	.0200	.0200	.0200	.0200	.0200
7	.0230	.0230	.0230	.0230	.0230	.0230	.0230	.0230	.0230	.0230	.0230	.0220
8	.0260	.0260	.0250	.0260	.0250	.0250	.0250	.0260	.0260	.0260	.0260	.0250
9	.0290	.0290	.0290	.0290	.0290	.0290	.0290	.0290	.0290	.0290	.0290	.0290
10	.0340	.0340	.0340	.0340	.0340	.0340	.0340	.0340	.0340	.0340	.0340	.0340
11	.0350	.0360	.0350	.0350	.0350	.0350	.0350	.0360	.0350	.0350	.0350	.0350
12	.0390	.0390	.0390	.0390	.0390	.0390	.0390	.0390	.0390	.0390	.0390	.0390
13	.0420	.0420	.0430	.0430	.0420	.0430	.0430	.0420	.0430	.0430	.0430	.0420
14	.0450	.0450	.0450	.0450	.0450	.0450	.0450	.0450	.0450	.0450	.0450	.0450
15	.0500	.0490	.0490	.0490	.0500	.0490	.0490	.0500	.0490	.0490	.0500	.0500
16	.0620	.0620	.0600	.0590	.0580	.0600	.0600	.0610	.0590	.0610	.0610	.0610

Table 5.10.34 VPA. Firth of Forth (Functional Unit 8): Females
Fishing mortality (F) at 'nominal age'. 1981-1991

F-at-age

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0038	.0190	.0105	.0504	.0123	.0338	.0051	.2270	.0533	.0254	.0299	.1000
2	.0028	.0095	.0074	.0256	.0241	.0732	.0328	.1414	.0588	.0737	.0712	.0488
3	.0093	.0170	.0250	.0560	.0478	.2175	.1040	.2167	.1454	.1793	.1390	.1129
4	.0340	.0247	.0574	.0922	.1040	.3055	.1698	.2934	.2384	.2648	.1772	.1756
5	.0553	.0338	.0810	.1276	.1318	.3226	.2108	.2933	.2712	.2926	.2250	.2062
6	.0841	.0556	.1332	.1178	.1424	.2917	.2194	.3285	.2872	.3308	.2891	.2275
7	.1211	.0726	.1642	.1534	.1104	.2763	.2230	.3594	.3537	.3638	.3244	.2447
8	.1463	.0999	.1855	.1542	.1340	.1867	.2192	.3734	.4036	.4189	.3405	.2525
9	.1927	.1180	.1854	.1700	.1066	.2221	.1305	.3632	.4292	.4542	.3852	.2463
10	.1750	.1330	.2077	.1520	.0869	.1820	.1541	.1922	.4523	.3942	.2797	.2093
11	.1970	.1695	.2634	.1687	.1097	.2101	.1420	.3561	.2519	.4435	.2862	.2244
12	.2178	.2083	.2695	.1720	.0999	.2136	.1098	.3894	.4754	.1594	.2744	.2069
13	.2212	.1755	.2371	.1834	.0882	.1980	.1252	.2939	.3802	.3549	.0792	.1808
14	.2807	.2229	.2850	.2315	.0933	.2681	.1521	.3569	.4234	.3750	.2568	.0500
15	.2391	.2016	.2632	.1952	.0936	.2263	.1289	.3464	.4259	.2961	.2032	.1458
16	.2391	.2016	.2632	.1952	.0936	.2263	.1289	.3464	.4259	.2961	.2032	.1458

Table 5.10.35 VPA. Firth of Forth (Functional Unit 8): Females
Population numbers (000's) at 'nominal age'. 1981-1991

N-at-age

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	125460.	132282.	126315.	124492.	114714.	117215.	126025.	167266.	139058.	130240.	110394.	16255.
2	87112.	92587.	96144.	92592.	87693.	83938.	83951.	92889.	98745.	97668.	94066.	79376.
3	81826.	71121.	75088.	78132.	73889.	70086.	63873.	66511.	66021.	76230.	74281.	71722.
4	50868.	66373.	57244.	59956.	60483.	57672.	46163.	47130.	43843.	46738.	52169.	52923.
5	38826.	40251.	53011.	44255.	44764.	44629.	34786.	31893.	28776.	28283.	29363.	35778.
6	27101.	30078.	31858.	40024.	31891.	32126.	26464.	23068.	19473.	17963.	17283.	19197.
7	17166.	20399.	23294.	22831.	29128.	22645.	19648.	17398.	13598.	11964.	10565.	10597.
8	12587.	12451.	15532.	16183.	16034.	21355.	14064.	12871.	9944.	7816.	6808.	6253.
9	8632.	8902.	9224.	10564.	11356.	11482.	14507.	9247.	7254.	5437.	4209.	3965.
10	6030.	5829.	6477.	6274.	7296.	8358.	7528.	10424.	5265.	3866.	2827.	2344.
11	4371.	4144.	4178.	4309.	4413.	5476.	5704.	5284.	7042.	2742.	2134.	1750.
12	2872.	2939.	2864.	2628.	2980.	3237.	3634.	4052.	3030.	4482.	1441.	1312.
13	1676.	1891.	1954.	1791.	1812.	2208.	2141.	2666.	2247.	1542.	3129.	897.
14	1039.	1100.	1299.	1262.	1221.	1358.	1483.	1546.	1627.	1258.	885.	2367.
15	716.	643.	721.	800.	820.	910.	850.	1043.	886.	872.	708.	561.
16	2171.	2284.	1813.	2062.	2073.	2722.	2301.	3641.	2329.	2708.	2410.	2123.

Table 5.10.36 VPA. Firth of Forth (Functional Unit 8): Females
Yield (tonnes),Fbar,Total stock biomass (tonnes),
spawning stock biomass (tonnes), Ln recruitment 1981-1991

Year,	Yield,	Fbar,	TSB,	SSB,	Log R
		3-10			
1981,	357.2,	.1022,	5955.6,	5328.3,	11.74
1982,	296.9,	.0693,	6307.1,	5645.7,	11.79
1983,	534.3,	.1299,	6745.2,	5987.3,	11.75
1984,	595.5,	.1279,	6720.9,	6098.5,	11.73
1985,	503.0,	.1080,	6747.0,	6058.7,	11.65
1986,	1160.4,	.2505,	6792.1,	6088.8,	11.67
1987,	677.8,	.1788,	6141.3,	5385.2,	11.74
1988,	1326.2,	.3025,	6228.8,	5392.4,	12.03
1989,	974.4,	.3226,	5617.8,	4783.4,	11.84
1990,	909.7,	.3373,	5362.5,	4581.1,	11.78
1991,	689.2,	.2700,	5137.5,	4364.7,	11.61
1992,	562.1,	.2094,	4332.2,	4234.7,	9.70

Table 5.10.37 Short Term Prediction: Firth of Forth Males (FU8)

MOST RECENT DATA YR = 1992 1ST PRED YR = 1993
REFERENCE F = MEAN OF AGES 3 TO 8
F PATTERN = MEAN OF YEARS 1987 TO 1991
AGE 1 RECRUITS FOR PRED YRS = MEAN 1981 TO 1990
AGE 2 RECRUITS FOR 1993 = MEAN 1981 TO 1990

PROPORTION OF F AND M BEFORE SPAWNING = .40

INPUTS SUMMARY

AGE	M	WT	STOCK JAN1 1992	F	STOCK JAN1 1993	F PATTERN
1	.3	.0060	6951.6	.2000	142684.3	.0814
2	.3	.0120	100305.7	.2967	92082.4	.3914
3	.3	.0200	72013.8	.7135	55232.0	.8142
4	.3	.0330	21827.9	.8804	26136.5	1.0103
5	.3	.0470	4991.2	.9514	6704.5	1.0840
6	.3	.0620	986.6	.9778	1427.9	1.1008
7	.3	.0780	207.3	.9996	274.9	1.1849
8	.3	.0920	44.9	.9291	56.5	1.1161
9	.3	.1060	23.5	.3000	13.1	1.2060
10	.3	.1210	4.8	.7429	12.9	1.1690
11	.3	.1350	2.6	.7429	2.6	1.1690
				.9086		1.0517

PREDICTION YEAR 1993 STATUS QUO: FACTOR=1

AGE	STOCK JAN1	SCAL F	TSB	SSB	CATCH	PROP	LANDINGS
1	142684.3	.0704	856.1	738.2	50.3	.2700	13.6
2	92082.4	.3382	1105.0	856.0	276.2	.6300	174.0
3	55232.0	.7034	1104.6	739.5	490.5	.9020	442.4
4	26136.5	.8728	862.5	539.5	443.2	.9850	436.6
5	6704.5	.9365	315.1	192.2	169.4	1.0000	169.4
6	1427.9	.9511	88.5	53.7	48.0	1.0000	48.0
7	274.9	1.0237	21.4	12.6	12.2	1.0000	12.2
8	56.5	.9643	5.2	3.1	2.8	1.0000	2.8
9	13.1	1.0420	1.4	.8	.8	1.0000	.8
10	12.9	1.0100	1.6	.9	.9	1.0000	.9
11	2.6	1.0100	.4	.2	.2	1.0000	.2
			4361.8	3136.8	1494.6		1300.9

1994 (TSB AT JAN 1 =	4221.6)				1995			
FACTOR	REFF	SSB	CATCH	LANDINGS	TSB	SSB	CATCH	LANDINGS
.0	.0000	3744.3	.0	.0	5998.3	5320.0	.0	.0
.2	.1817	3589.8	361.9	317.4	5526.6	4673.4	533.5	482.4
.4	.3635	3443.9	678.3	592.4	5115.4	4140.0	893.6	798.5
.6	.5452	3306.1	955.7	831.3	4756.0	3697.7	1132.1	998.7
.8	.7269	3175.9	1199.4	1039.3	4441.1	3329.2	1285.5	1118.8
1.0	.9086	3052.8	1414.4	1220.8	4164.4	3020.3	1379.6	1183.7
1.2	1.0904	2936.4	1604.4	1379.5	3920.6	2760.1	1433.0	1211.3
1.4	1.2721	2826.2	1772.9	1518.8	3705.2	2539.5	1458.4	1213.8
1.6	1.4538	2722.0	1922.8	1641.2	3514.3	2351.4	1464.9	1200.0
1.8	1.6356	2623.3	2056.6	1749.2	3344.5	2190.0	1459.0	1175.9
2.0	1.8173	2529.8	2176.4	1844.6	3193.2	2050.6	1445.2	1145.7

Table 5.10.38 Short Term Prediction: Firth of Forth Females (FU8)

MOST RECENT DATA YR = 1992 1ST PRED YR = 1993
REFERENCE F = MEAN OF AGES 3 TO 10
F PATTERN = MEAN OF YEARS 1987 TO 1991
AGE 1 RECRUITS FOR PRED YRS = MEAN 1981 TO 1990
AGE 2 RECRUITS FOR 1993 = MEAN 1981 TO 1990

PROPORTION OF F AND M BEFORE SPAWNING = .40

INPUTS SUMMARY

AGE	M	WT	STOCK JAN1 1992	F	STOCK JAN1 1993	F PATTERN
1	.3	.0060	16254.6	.1000	130306.7	.0681
2	.2	.0090	79375.7	.0488	91332.0	.0756
3	.2	.0110	71721.9	.1129	61889.6	.1569
4	.2	.0140	52922.8	.1756	52450.2	.2287
5	.2	.0170	35777.8	.2062	36350.6	.2586
6	.2	.0200	19197.0	.2275	23834.1	.2910
7	.2	.0220	10597.4	.2447	12519.3	.3249
8	.2	.0250	6253.1	.2525	6793.2	.3511
9	.2	.0290	3965.1	.2463	3977.3	.3525
10	.2	.0340	2344.3	.2093	2537.5	.2945
11	.2	.0350	1749.7	.2244	1556.9	.2959
12	.2	.0390	1312.4	.2069	1144.6	.2817
13	.2	.0420	896.7	.1808	873.7	.2467
14	.2	.0450	2366.6	.0500	612.8	.3128
15	.2	.0500	560.7	.1458	1843.1	.2801
16	.2	.0610	2122.8	.1458	1899.0	.2801
				.2094		.2823

PREDICTION YEAR 1993 STATUS QUO: FACTOR=1

AGE	STOCK JAN1	SCAL F	TSB	SSB	CATCH	PROP	LANDINGS
1	130306.7	.0505	781.8	679.6	33.3	.2300	7.7
2	91332.0	.0561	822.0	742.0	40.7	.4500	18.3
3	61889.6	.1164	680.8	599.9	67.9	.5780	39.3
4	52450.2	.1697	734.3	633.4	104.1	.7740	80.6
5	36350.6	.1918	618.0	528.3	98.1	.7650	75.0
6	23834.1	.2159	476.7	403.6	84.2	.7910	66.6
7	12519.3	.2410	275.4	230.9	53.7	.8560	45.9
8	6793.2	.2605	169.8	141.3	35.5	.9270	32.9
9	3977.3	.2615	115.3	95.9	24.2	.9800	23.7
10	2537.5	.2184	86.3	73.0	15.4	1.0000	15.4
11	1556.9	.2195	54.5	46.1	9.8	1.0000	9.8
12	1144.6	.2089	44.6	37.9	7.7	1.0000	7.7
13	873.7	.1830	36.7	31.5	5.6	1.0000	5.6
14	612.8	.2321	27.6	23.2	5.2	1.0000	5.2
15	1843.1	.2078	92.2	78.3	15.7	1.0000	15.7
16	1899.0	.2078	115.8	98.4	19.8	1.0000	19.8
			5131.8	4443.1	620.7		469.0

1994 (TSB AT JAN 1 = 5210.1) 1995

FACTOR	REFF	SSB	CATCH	LANDINGS	TSB	SSB	CATCH	LANDINGS
.0	.0000	4781.2	.0	.0	5940.6	5455.6	.0	.0
.2	.0419	4725.4	135.7	102.9	5796.3	5257.8	156.8	121.0
.4	.0838	4670.3	266.6	201.9	5657.1	5069.7	298.4	229.1
.6	.1256	4616.1	393.1	297.3	5522.8	4890.8	426.0	325.6
.8	.1675	4562.6	515.2	389.1	5393.1	4720.5	541.0	411.5
1.0	.2094	4509.9	633.1	477.6	5268.0	4558.4	644.3	487.8
1.2	.2513	4458.0	747.0	562.8	5147.2	4404.1	737.1	555.4
1.4	.2931	4406.8	857.1	644.9	5030.5	4257.1	820.4	615.1
1.6	.3350	4356.3	963.5	724.0	4917.8	4117.0	894.8	667.6
1.8	.3769	4306.6	1066.3	800.2	4809.0	3983.5	961.3	713.5
2.0	.4188	4257.6	1165.7	873.6	4703.9	3856.2	1020.6	753.6

Table 5.10.39 Nephrops landings (tonnes by Functional Unit plus other rectangles in Management Area (IVb,c West of 1° East) (Area I)

Year	FU6	FU8	Other rectangles	Total
1983	2076	1722	98	3898
1984	1483	2134	77	3694
1985	2028	1969	107	4104
1986	2015	2263	143	4421
1987	2193	1674	138	4005
1988	2504	2528	310	5342
1989	3099	1885	156	5140
1990	2498	1931	131	4560
1991	2061	1402	352	3815
1992	1462	1721	>265	3449

Table 5.10.40 Total Nephrops landings (t) by country in Management Area (IVb,c West of 1° East) (Area I)

Year	UK	Denmark	Belgium	TOTAL
1983	3898	+	?	3898
1984	3694	+	?	3694
1985	4104	+	?	4104
1986	4421	+	0	4421
1987	4005	+	0	4005
1988	5330	12	0	5342
1989	5138	2	0	5140
1990	4555	1	4	4556
1991	3815	1	3	3819
1992	3445	3	<1	3449

Table 5.11.1 Input data and parameters: Irish Sea east

FU	Irish Sea east 14	MA	J
FLEET	UK	GEAR	Trawl

1992	NUMBER OF SAMPLES				Mean
	Qtr 1	Qtr 2	Qtr 3	Qtr 4	No./sample
Catch	0	12	0	0	322
Landings	0	13	9	5	258
Discards	0	12	0	0	103

	NUMBER OF SAMPLES									
YEAR	92	91	90	89	88	87	86	85	84	83
Catch	12	11	0	0	0	0	0	0	0	0
Landings	27	13	3	3	18	17	24	25	28	35
Discards	12	11	0	0	0	0	0	0	0	0

INPUT PARAMETERS		
Parameter	Value	Source
Discard Survival	0.25	Anon, 1985
MALES		
Growth - K	0.16	Irish Sea West data and Bailey and Chapman 1983
Growth - L(inf)	60	"
Nat. Mort. - M	0.3	Brander and Bennett, 1986,1989
Length/weight - a	.00029	Bennett, 1983
Length/weight - b	2.94	"
FEMALES		
Immature Growth		
K	0.16	as growth above
L(inf)	60	
Nat.Mort. - M	0.3	Brander and Bennett, 1986,1989
Size at Maturity	24	Briggs, 1988
Mature Growth		
K	0.1	as growth above
L(inf)	56	
Nat.Mort. - M	0.2	Brander and Bennett, 1986, 1989
Length/weight - a	.00029	Bennett, 1983
Length/weight - b	2.92	"

Table 5 11.2 . Irish Sea East (Functional Unit 14) : landings (in tonnes), by country 1983-92

Year	England & Wales	Northern Ireland	Scotland	Ireland	Total
1983	763	1	1		765
84	602	3	14		619
85	498	10	11		519
86	664	7	15		686
87	445	22	4		471
1988	462	32	3		497
89	394	36	1		431
90	549	70	11		630
91	728	87	25	19	859
92(*)	415	64	4	5	488

(*) provisional

Table 5.11.3 Irish Sea East (Functional Unit 14) : effort (in '000 hours trawling) and LPUE (in kg/hour trawling) of Nephrops directed voyages by UK trawlers, 1983-92

Year	Effort	LPUE
1983	24.1	28
84	21.9	24
85	14.7	29
86	19.6	29
87	22.4	15
1988	18.9	19
89	18.2	17
90	17.6	25
91	19.8	26
92(*)	17.4	20

(*) provisional

Table 5.11.4 Irish Sea East (Functional Unit 14) : mean sizes (CL in mm) of male and female Nephrops from UK vessels landing in England and Wales, 1985-92

Year	Males	Females
1985	32.0	29.3
86	32.2	29.5
87	35.9	32.5
88	37.9	36.4
89 (*)	?	?
90 (*)	?	?
91	32.1	33.5
92	32.2	32.8

(*) Inadequate sampling to allow estimation of mean size

Table 5.11.5 LCA. Irish Sea East (Functional Unit 14): Males
Cohort Analysis Output. Reference period 1985-1992

L INFINITY = 60.0000 K = .1600

COHORT ANALYSIS BY POPE'S APPROXIMATION

SIZE MM	REMOVALS	M	DT	FDT	F	Z	NO. ATTAINING	AVE. NO. IN SEA	BIOMASS kg
14.0	4.9	.3000	.2778	.0001	.0004	.3004	48974.4	13054.0	10860.5
16.0	58.7	.3000	.2908	.0014	.0047	.3047	45053.3	12535.8	15068.5
18.0	130.9	.3000	.3049	.0033	.0109	.3109	41233.8	11996.1	19997.4
20.0	169.4	.3000	.3206	.0048	.0148	.3148	37504.0	11436.3	25586.4
22.0	768.6	.3000	.3379	.0241	.0714	.3714	33903.6	10766.9	31475.2
24.0	1345.8	.3000	.3572	.0486	.1362	.4362	29904.4	9892.4	36952.3
26.0	2055.7	.3000	.3789	.0889	.2345	.5345	25589.7	8777.2	41111.6
28.0	2325.1	.3000	.4034	.1258	.3119	.6119	20898.0	7469.9	43168.0
30.0	2256.0	.3000	.4312	.1595	.3698	.6698	16327.6	6115.0	42992.9
32.0	1971.8	.3000	.4632	.1897	.4096	.7096	12231.6	4828.5	40798.3
34.0	1525.9	.3000	.5003	.2068	.4133	.7133	8805.3	3704.8	37214.9
36.0	1150.1	.3000	.5438	.2263	.4161	.7161	6162.6	2775.9	32833.3
38.0	902.2	.3000	.5957	.2696	.4526	.7526	4174.9	2004.2	27674.5
40.0	634.1	.3000	.6585	.3045	.4624	.7624	2666.6	1380.5	22081.8
42.0	475.8	.3000	.7361	.3993	.5424	.8424	1614.1	885.5	16291.6
44.0	257.6	.3000	.8346	.4099	.4912	.7912	868.2	530.3	11152.9
46.0	146.6	.3000	.9634	.4742	.4922	.7922	448.6	302.3	7223.9
48.0	82.8	.3000	1.1395	.6348	.5571	.8571	209.1	152.1	4108.5
50.0	39.3	.3000	1.3946	.9552	.6849	.9849	78.7	59.7	1814.1
52.0	9.3	.3000	1.7980	.9372	.5212	.8212	19.9	18.7	637.3
54.0	2.8	.3000			.5000	.8000	4.6	18.7	637.3

Table 5.11.6 LCA. Irish Sea East (Functional Unit 14): Females
Cohort Analysis Output. Reference period 1985-1992

LOWER CURVE LINF= 60.0000 K= .1600

UPPER CURVE LINF= 56.0000 K= .1000

TRANSITION LENGTH= 24.0000

COHORT ANALYSIS BY POPE'S APPROXIMATION

SIZE MM	REMOVALS	M	DT	FDT	F	Z	NO. ATTAINING	AVE. NO. IN SEA	BIOMASS kg
14.0	8.2	.3000	.2778	.0002	.0007	.3007	42635.4	11363.8	8955.9
16.0	38.5	.3000	.2908	.0010	.0035	.3035	39218.0	10914.0	12396.3
18.0	47.6	.3000	.3049	.0014	.0046	.3046	35905.3	10455.9	16433.1
20.0	217.7	.3000	.3206	.0070	.0218	.3218	32720.9	9966.8	20981.3
22.0	696.9	.3000	.3379	.0252	.0744	.3744	29513.1	9367.9	25720.9
24.0	1815.5	.3000	.3572	.0765	.2142	.5142	26005.4	8486.9	29725.6
26.0	2450.4	.2000	.6899	.1293	.1874	.3874	21641.7	13102.1	57454.3
28.0	2553.3	.2000	.7411	.1815	.2449	.4449	16565.3	10457.6	56497.9
30.0	2208.8	.2000	.8004	.2242	.2801	.4801	11912.5	7916.6	51965.3
32.0	1589.8	.2000	.8701	.2406	.2765	.4765	8111.4	5777.6	45520.8
34.0	1326.7	.2000	.9531	.3179	.3336	.5336	5358.5	4003.3	37454.0
36.0	830.9	.2000	1.0536	.3376	.3204	.5204	3222.4	2613.5	28759.0
38.0	573.5	.2000	1.1778	.4253	.3611	.5611	1862.4	1605.1	20597.5
40.0	305.1	.2000	1.3353	.4503	.3372	.5372	961.7	916.5	13609.5
42.0	154.9	.2000	1.5415	.4862	.3154	.5154	469.3	499.2	8519.0
44.0	69.4	.2000	1.8232	.4991	.2737	.4737	212.0	258.9	5045.5
46.0	33.8	.2000	2.2314	.6407	.2871	.4871	89.4	121.6	2691.2
48.0	11.7	.2000	2.8768	.7305	.2539	.4539	30.1	48.4	1210.0
50.0	5.8	.2000			.5000	.7000	8.2	48.4	1210.0

Table 5.11.7 Data and input parameters: Irish Sea West

FU 15	MA J
FLEET UK N Ireland	GEAR Trawl

1992	NUMBER OF SAMPLES				Mean
	Qtr 1	Qtr 2	Qtr 3	Qtr 4	No./sample
Catch	11	16	6	2	200
Landings	11	16	6	2	200
Discards	11	16	6	2	150

	NUMBER OF SAMPLES									
YEAR	92	91	90	89	88	87	86	85	84	83
Catch	35	59	57	68	57	67	58	79	86	70
Landings	35	59	57	68	57	67	58	79	86	70
Discards	35	59	57	68	57	67	58	79	86	70

FLEET Rep. Ireland	GEAR Trawl

1992	NUMBER OF SAMPLES				Mean
	Qtr 1	Qtr 2	Qtr 3	Qtr 4	No./sample
Catch	5	7	13	6	572
Landings	5	7	14	4	536
Discards	5	7	14	4	227

	NUMBER OF SAMPLES									
YEAR	92	91	90	89	88	87	86	85	84	83
Catch	31	30	33	41	38	34	18	23	14	
Landings	30	29	35	38	29	16	18	21	15	
Discards	31	27	34	35	31	22	21	26	15	

INPUT PARAMETERS		
Parameter	Value	Source
Discard Survival	0.1	Anon. 1991 (expected high predation by cod)
MALES		
Growth - K	0.16	Hillis, 1979 and Anon.,1991
Growth - L(inf)	60	"
Nat. Mort. - M	0.3	Brander and Bennet,1986,1989
Length/weight - a	0.00032	Pope and Thomas, 1955 (Scottish stocks)
Length/weight - b	3.21	"
FEMALES		
Immature Growth		
K	0.16	Hillis,1979 and Anon.,1991
L(inf)	60	"
Nat.Mort. - M	0.3	as for males
Size at Maturity	24	Briggs, 1988
Mature Growth		
K	0.1	Hillis,1979 and Anon.1991
L(inf)	56	"
Nat.Mort. - M	0.2	as for males
Length/weight - a	0.00068	"
Length/weight - b	2.96	"

Table 5.11.8 Irish Sea West (Functional Unit 15) : landings (in tonnes), by country, 1983-92

Year	UK	Rep. of Ireland	Isle of Man	France	Total
1983	4 954	3 747	170	27	8 898
84	4 156	2 704	169	41	7 070
85	4 394	1 991	3	42	6 430
86	5 243	3 404	7	93	8 747
87	5 043	4 141	18	55	9 257
1988	5 283	2 870	39	62	8 254
89	5 580	2 458	8	19	8 065
90	5 535	2 709	25	8	8 277
91	6 024	3 366	61	12	9 463
92(*)	5 102	2 553	14	6	7 675

(*) provisional

Table 5.11.9 Irish Sea West (Functional Unit 15) : catches and landings (in tonnes), effort (in '000 hours trawling), CPUE and LPUE (Kg/hour) of Northern Ireland Nephrops trawlers, 1983-92

Year	Catches	Landings	Effort	CPUE	LPUE
1983	6 466	4 949	NA	NA	NA
84	5 221	4 027	124.81	41.8	32.3
85	5 442	4 310	119.10	45.7	36.2
86	6 194	5 197	152.23	40.7	34.1
87	5 770	4 990	164.51	35.1	30.3
1988	5 707	5 220	156.37	36.5	33.4
89	6 169	5 517	191.43	32.2	28.8
90	5 683	5 505	189.87	29.9	29.0
91	6 133	5 925	200.55	30.6	29.5
92	5 707	5 058	NA	NA	NA

(*) provisional

Table 5.11.10 Irish Sea West (Functional Unit 15) : mean sizes (CL in mm) of male and female Nephrops in Northern Ireland catches, 1983-92

Year	Males	Females
1983	24.5	22.2
84	26.2	23.2
85	25.9	23.0
86	26.5	23.6
87	26.8	23.9
1988	27.5	24.5
89	26.4	23.8
90	26.3	24.0
91	26.6	25.2
92	26.7	24.9

Table 5.11.11 Irish Sea West (Functional Unit 15) : mean weight (in grams) of Nephrops in Republic of Ireland catches, landings and discards, 1984 to 1992

Year	Catch	Landings	Discards
1984	10.9	16.2	7.6
1985	10.5	14.9	7.7
1986	11.0	14.4	7.5
1987	11.4	14.9	7.2
1988	12.3	14.8	8.0
1989	11.5	13.3	8.1
1990	11.2	12.5	7.2
1991	10.8	12.3	7.3
1992	11.3	13.0	7.2

Table 5.11.12 VPA. Irish Sea west (Functional Unit 15): Males
Catch (000's) at 'nominal age'. 1984-1992

Catch-at age data

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	8284.	11189.	6726.	9963.	2568.	5594.	6642.	3822.	3757.
2	133842.	174052.	166030.	138850.	89384.	146184.	123015.	135958.	99270.
3	174318.	182242.	232930.	240732.	172901.	211160.	184563.	229118.	175121.
4	81585.	67915.	80199.	106710.	84641.	61710.	71844.	80000.	85406.
5	27150.	22141.	25963.	36868.	26146.	17281.	21184.	25246.	25554.
6	10094.	6241.	8103.	10184.	6033.	5869.	7534.	9235.	8236.
7	2817.	1822.	2218.	3857.	2666.	3798.	2548.	3097.	2525.
8	1566.	728.	809.	1601.	1076.	729.	702.	1223.	826.
9	601.	154.	312.	561.	188.	127.	240.	241.	218.
10	363.	156.	152.	510.	205.	270.	307.	151.	123.
11	89.	9.	56.	204.	149.	230.	96.	85.	69.
12	77.	0.	33.	1397.	36.	60.	40.	72.	27.

Table 5.11.13 VPA. Irish Sea west (Functional Unit 15): Males
Mean weight (kg) at 'nominal age'.1984-1992

Weight-at-age dat

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0030	.0020	.0030	.0020	.0030	.0030	.0020	.0020	.0020
2	.0060	.0060	.0060	.0060	.0060	.0060	.0060	.0060	.0060
3	.0120	.0110	.0110	.0120	.0120	.0110	.0120	.0120	.0120
4	.0200	.0200	.0200	.0200	.0200	.0190	.0200	.0200	.0200
5	.0300	.0300	.0300	.0300	.0290	.0300	.0300	.0300	.0290
6	.0410	.0410	.0400	.0400	.0410	.0410	.0410	.0400	.0410
7	.0520	.0520	.0520	.0520	.0520	.0510	.0520	.0520	.0520
8	.0640	.0630	.0640	.0640	.0640	.0630	.0630	.0630	.0630
9	.0750	.0730	.0740	.0750	.0750	.0770	.0760	.0750	.0750
10	.0830	.0850	.0870	.0870	.0860	.0860	.0840	.0860	.0860
11	.0950	.0880	.0930	.0950	.0940	.0940	.0940	.0940	.0940
12	.1030	.0000	.1060	.1190	.1000	.1040	.1040	.1120	.1030

Table 5.11.14 VPA. Irish Sea west (Functional Unit 15): Males
Fishing mortality (F) at 'nominal age'. 1984-1992

F-at-age

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0078	.0113	.0085	.0118	.0029	.0058	.0084	.0074	.2000
2	.2262	.2510	.2569	.2691	.1548	.2504	.1888	.2633	.3000
3	.6732	.6199	.7128	.8333	.7202	.7472	.6543	.7246	.7292
4	.8365	.7028	.7113	1.0169	.9560	.7100	.7147	.7741	.7653
5	.8578	.6565	.7456	1.0178	.8806	.5892	.6536	.6839	.7028
6	.7350	.5525	.6142	.8785	.5028	.5644	.6381	.7791	.5682
7	.4797	.3110	.4382	.7826	.6923	.8014	.5872	.6832	.5752
8	.6514	.2433	.2473	.7590	.5962	.4632	.3704	.7252	.4383
9	.5844	.1321	.1737	.3039	.2014	.1405	.3046	.2338	.3000
10	1.9646	.3282	.2068	.5369	.1935	.5616	.6684	.3598	.2000
11	1.0668	.2345	.2093	.5333	.3304	.3884	.4478	.4396	.3128
12	1.0668	.2345	.2093	.5333	.3304	.3884	.4478	.4396	.3128

Table 5.11.15 VPA. Irish Sea west (Functional Unit 15): Males
Population numbers (000's) at 'nominal age'. 1984-1992

N-at-age

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	1226939.	1150640.	921171.	981507.	1027674.	1118676.	919534.	598428.	23874.
2	761023.	901809.	842785.	676631.	718543.	759110.	823921.	675491.	440037.
3	405041.	449651.	519751.	482881.	382986.	455957.	437784.	505383.	384588.
4	163234.	153047.	179213.	188781.	155478.	138068.	160012.	168591.	181404.
5	53433.	52389.	56144.	65188.	50589.	44277.	50285.	58009.	57589.
6	22044.	16787.	20130.	19734.	17453.	15535.	18197.	19378.	21687.
7	8457.	7830.	7156.	8069.	6073.	7820.	6545.	7122.	6586.
8	3727.	3877.	4250.	3420.	2733.	2251.	2599.	2695.	2664.
9	1550.	1440.	2252.	2459.	1186.	1115.	1049.	1330.	967.
10	466.	640.	935.	1402.	1344.	718.	718.	573.	780.
11	153.	48.	342.	563.	607.	821.	303.	273.	296.
12	132.	0.	201.	3861.	146.	213.	128.	232.	117.

Table 5.11.16 VPA. Irish Sea west (Functional Unit 15): Males
Yield (tonnes),Fbar,Total stock biomass (tonnes),
spawning stock biomass (tonnes), Ln recruitment 1984-1992

Year,	Yield,	Fbar,	TSB,	SSB,	Log R
		3- 5			
1984,	6118.1,	.7892,	19740.3,	19740.3,	14.02
1985,	5515.7,	.6597,	18794.4,	18794.4,	13.96
1986,	6497.7,	.7232,	20556.4,	20556.4,	13.73
1987,	7964.5,	.9560,	19795.8,	19795.8,	13.80
1988,	5574.0,	.8523,	18049.2,	18049.2,	13.84
1989,	5448.7,	.6821,	18302.4,	18302.4,	13.93
1990,	5581.4,	.6742,	18176.9,	18176.9,	13.73
1991,	6584.8,	.7275,	17942.3,	17942.3,	13.30
1992,	5711.0,	.7324,	14180.2,	14180.2,	10.08

Table 5.11.17 VPA. Irish Sea west (Functional Unit 15): Females
Catch (000's) at 'nominal age'. 1984-1992

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	12436.	18480.	13535.	13879.	7264.	8107.	6476.	10021.	8135.
2	169110.	205356.	233893.	180126.	129210.	161848.	159675.	189315.	128019.
3	129953.	117128.	145160.	150244.	118789.	114331.	127785.	126332.	111843.
4	60809.	53431.	57589.	52310.	59535.	50749.	51346.	45780.	53627.
5	21416.	18315.	23182.	19286.	25513.	18571.	17809.	12665.	13141.
6	7960.	5181.	8504.	9128.	9863.	8686.	6328.	6158.	4086.
7	3475.	2136.	3600.	3488.	4083.	5305.	3921.	3951.	2373.
8	1749.	945.	1317.	1973.	1638.	3209.	2362.	2461.	1301.
9	919.	523.	765.	648.	955.	1980.	1318.	963.	741.
10	643.	485.	235.	615.	392.	1519.	1256.	910.	664.
11	312.	95.	563.	150.	190.	854.	749.	562.	416.
12	687.	184.	757.	123.	640.	2245.	1348.	2025.	856.

Table 5.11.18 VPA. Irish Sea west (Functional Unit 15): Females
Mean weight (kg) at 'nominal age'. 1984-1992

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0020	.0020	.0020	.0020	.0020	.0020	.0020	.0020	.0020
2	.0050	.0050	.0050	.0050	.0050	.0050	.0050	.0050	.0050
3	.0080	.0080	.0080	.0080	.0080	.0080	.0080	.0080	.0080
4	.0110	.0110	.0110	.0110	.0110	.0110	.0110	.0110	.0110
5	.0150	.0150	.0150	.0150	.0150	.0150	.0150	.0150	.0150
6	.0190	.0180	.0190	.0190	.0190	.0190	.0190	.0190	.0190
7	.0220	.0220	.0230	.0220	.0220	.0220	.0220	.0230	.0220
8	.0260	.0260	.0260	.0270	.0260	.0260	.0260	.0260	.0260
9	.0300	.0310	.0300	.0300	.0300	.0300	.0300	.0300	.0300
10	.0340	.0340	.0350	.0340	.0340	.0340	.0340	.0340	.0340
11	.0380	.0370	.0380	.0360	.0380	.0370	.0370	.0380	.0380
12	.0410	.0410	.0400	.0000	.0410	.0410	.0410	.0410	.0410

Table 5.11.19 VPA. Irish Sea west (Functional Unit 15): Females
Fishing mortality (F) at 'nominal age'.1984-1992

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0160	.0227	.0206	.0250	.0118	.0123	.0102	.0150	.2000
2	.3955	.4409	.4909	.4625	.3790	.4375	.3938	.5096	.3000
3	.6181	.5667	.7006	.7421	.6912	.7408	.8123	.6747	.7047
4	.6792	.5621	.6117	.5934	.7602	.7328	.9174	.7953	.6919
5	.5357	.4448	.5110	.4248	.6580	.5713	.6240	.6070	.5580
6	.4551	.2363	.3827	.3877	.4016	.4914	.3881	.4571	.4005
7	.4343	.2103	.2563	.2666	.2999	.3927	.4311	.4484	.3193
8	.5561	.2002	.1939	.2177	.1929	.4081	.3038	.5319	.2591
9	.1760	.3182	.2470	.1379	.1554	.3757	.2921	.1948	.3000
10	.7296	.1324	.2311	.3214	.1155	.3938	.4353	.3366	.2000
11	.4872	.2169	.2240	.2257	.1546	.3926	.3437	.3544	.2530
12	.4872	.2169	.2240	.2257	.1546	.3926	.3437	.3544	.2530

Table 5.11.20 VPA. Irish Sea west (Functional Unit 15): Females
Population numbers (000's) at 'nominal age'. 1984-1992

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	904597.	952173.	767175.	650028.	714415.	768400.	739115.	777650.	51684.
2	593343.	659438.	689481.	556688.	469659.	523000.	562267.	541976.	567473.
3	307862.	295950.	314324.	312610.	259686.	238162.	250144.	280934.	241176.
4	134597.	135843.	137474.	127705.	121848.	106507.	92947.	90896.	117136.
5	56471.	55872.	63395.	61049.	57759.	46640.	41900.	30407.	33594.
6	23842.	27058.	29320.	31137.	32682.	24488.	21566.	18380.	13567.
7	10805.	12383.	17492.	16371.	17299.	17907.	12265.	11977.	9527.
8	4483.	5730.	8216.	11083.	10267.	10494.	9900.	6525.	6262.
9	6262.	2105.	3840.	5541.	7298.	6931.	5712.	5982.	3138.
10	1353.	4300.	1254.	2456.	3952.	5115.	3897.	3492.	4031.
11	887.	534.	3084.	815.	1458.	2883.	2825.	2065.	2042.
12	1950.	1040.	4147.	669.	4916.	7579.	5084.	7443.	4207.

Table 5.11.21 VPA. Irish Sea west (Functional Unit 15): Females
Yield (tonnes),Fbar,Total stock biomass (tonnes),
spawning stock biomass (tonnes), Ln recruitment 1984-1992

Year,	Yield,	Fbar,	TSB,	SSB,	Log R
		3- 5			
1984,	3268.8,	.6110,	10721.2,	5945.3,	13.72
1985,	3072.8,	.5245,	11083.8,	5882.2,	13.77
1986,	3706.6,	.6078,	11574.6,	6592.9,	13.55
1987,	3351.2,	.5868,	10434.9,	6351.4,	13.38
1988,	3056.4,	.7032,	9940.1,	6163.0,	13.48
1989,	3197.0,	.6817,	9859.6,	5707.8,	13.55
1990,	3109.5,	.7845,	9495.4,	5205.9,	13.51
1991,	3121.5,	.6923,	9444.8,	5179.6,	13.56
1992,	2603.9,	.6515,	7774.0,	4833.3,	10.85

Table 5.11.22 Nephrops landings (tonnes by Functional Unit plus other rectangles in Management Area (J) - (VIIa excluding rectangles 33E2-E5)

Year	FU14	FU15	Other rectangles	Total
1983	765	8898		9663
1984	619	7070		7689
1985	519	6430		6949
1986	686	8747		9433
1987	471	9257		9728
1988	497	8254		8751
1989	431	8065		8496
1990	630	8277	<1	8907
1991	859	9463		10322
1992	488	7675	2	8165

Table 5.11.23 Total Nephrops landings (t) by country in Management Area (J) - (VIIa excluding rectangle 33E2-E5)

Year	UK	Isle of Man	Republic of Ireland	France	Belgium	TOTAL
1983	5719	170	3747	27	<1	9663
1984	4775	169	2704	41	0	7689
1985	4913	3	1991	42	0	6949
1986	5929	7	3404	93	<1	9433
1987	5514	18	4141	55	0	9728
1988	5780	39	2870	62	0	8751
1989	6011	8	2458	19	0	8496
1990	6165	25	2709	8	0	8907
1991	6864	61	3385	12	<1	10322
1992	5587	14	2558	6	<1	8165

Table 5.13.1 Data and Input Parameters: Porcupine Bank

FU 16	MA L (VII b,c,j,k)
FLEET Spain	GEAR Trawl

1992	NUMBER OF SAMPLES				Mean
	Qtr 1	Qtr 2	Qtr 3	Qtr 4	No./sample
Catch					
Landings	9	8	9	10	247
Discards					

	NUMBER OF SAMPLES									
YEAR	92	91	90	89	88	87	86	85	84	83
Catch										
Landings	36	36	36	35	29	20	21	19	11	25
Discards										

FLEET Rep.Ireland	GEAR Trawl

	NUMBER OF SAMPLES									
YEAR	92	91	90	89	88	87	86	85	84	83
Catch										
Landings	0	10	16	35	0	0	0	0	0	0
Discards										

INPUT PARAMETERS		
Parameter	Value	Source
Discard Survival	-	Discards considered negligible
MALES		
Growth - K	0.14	based on values in other areas (Anon. 1991)
Growth - L(inf)	75	based on maximum sizes observed in samples
Nat. Mort. - M	0.2	Anon.1990 (estimated)
Length/weight - a	0.00009	based on Celtic Sea (FU 20-22)
Length/weight - b	3.55	"
FEMALES		
Immature Growth		Not applicable - few below CL50 mat.
K		
L(inf)		
Nat.Mort. - M		
Size at Maturity	24	Spanish observations from sampling
Mature Growth		
K	0.16	Anon.1991
L(inf)	60	based on maximum sizes observed
Nat.Mort. - M	0.2	As for males
Length/weight - a	0.00009	"
Length/weight - b	3.55	"

Table 5.13.2 Porcupine Bank (Functional Unit 16) : landings (in tonnes), by country, 1983-92

Year	France	Spain	UK (a)	UK (b)	Ireland (c)	Total
1983	615	2 811	0	0	?	3 426
84	1 067	2 504	38	0	?	3 609
85	1 181	2 738	34	0	?	3 953
86	1 060	1 462	47	0	?	2 569
87	609	1 677	150	3	?	2 439
1988	600	1 555	173	1	?	2 329
89	324	1 417	16	1	350	2 108
90	336	1 349	23	6	169	1 883
91	348	1 021	70	4	170	1 613
92(*)	569	822	147	2	223	1 763

(*) provisional
(a) English vessels, landed in Spain and Ireland
(b) English vessels, landed in UK
(c) Prior to 1989 Irish Porcupine landings not distinguished from those of Aran Islands (see Table 5.13.10)

Table 5.13.3 Porcupine Bank (Functional Unit 16) : total effort (all gears combined) and CPUE (in kg per fishing day * BHP / 100) for the two components of Spanish trawl fleet and combined, 1983-92

Year	Total effort	Nephrops trawl	Finfish trawl	Total CPUE
1983	107 643	97.7	18.5	26.1
84	113 535	94.7	16.6	22.1
85	115 331	74.6	18.5	23.7
86	95 269	61.8	10.9	15.4
87	104 530	60.8	12.7	16.0
1988	108 856	43.8	10.8	14.3
89	104 825	45.1	10.8	13.5
90	96 299	35.5	11.5	14.0
91	85 220	33.4	8.9	12.0
92(*)	58 516	40.2	11.0	14.0

(*) provisional

Table 5.13.4 Porcupine Bank (Functional Unit 16) : effort (in days fishing) and LPUE (in kg/day) of French Nephrops trawlers, home port Saint Guénolé, 1983-92

Year	Effort	LPUE
1983	359	868
84	748	760
85	783	752
86	591	802
87	511	493
1988	329	512
89	311	331
90	238	367
91	434	348
92	491	385

Table 5.13.5 Porcupine Bank (Functional Unit 16) : mean sizes (CL in mm) of male and female Nephrops in Spanish catches, 1983-92

Year	Males	Females
1983	40.8	34.0
84	39.7	33.1
85	38.7	33.5
86	40.8	34.9
87	39.5	35.1
1988	40.7	38.4
89	40.5	36.5
90	41.0	36.8
91	39.4	34.5
92	39.1	34.2

Table 5.13.6 LCA. Porcupine Bank (Functional Unit 16): Males
Cohort Analysis Output. Reference period 1988-1992

L INFINITY = 75.0000 K = .1400

COHORT ANALYSIS BY EXACT CALCULATION

SIZE MM	REMOVALS	M	DT	FDT	F	Z	NO. ATTAINING	AVE. NO. IN SEA	BIOMASS kg
22.0	1.8	.2000	.2748	.0000	.0002	.2002	40826.9	10914.7	70773.0
24.0	7.8	.2000	.2858	.0002	.0007	.2007	38642.2	10731.4	93554.7
26.0	87.4	.2000	.2977	.0025	.0083	.2083	36488.1	10531.3	120654.9
28.0	305.4	.2000	.3106	.0092	.0297	.2297	34294.4	10281.0	151799.7
30.0	731.0	.2000	.3247	.0239	.0737	.2737	31932.8	9922.1	185635.8
32.0	1656.6	.2000	.3402	.0604	.1776	.3776	29217.1	9327.7	217883.1
34.0	2515.0	.2000	.3572	.1069	.2992	.4992	25695.0	8406.9	241992.2
36.0	2908.2	.2000	.3760	.1512	.4020	.6020	21498.6	7234.4	253652.8
38.0	3045.4	.2000	.3969	.2040	.5139	.7139	17143.5	5925.5	250455.1
40.0	2948.2	.2000	.4203	.2713	.6454	.8454	12913.0	4567.7	230571.0
42.0	2486.0	.2000	.4466	.3374	.7556	.9556	9051.3	3290.3	196682.7
44.0	1576.2	.2000	.4764	.3271	.6867	.8867	5907.2	2295.2	161231.7
46.0	1142.6	.2000	.5104	.3703	.7254	.9254	3872.0	1575.2	129119.9
48.0	754.8	.2000	.5497	.3989	.7256	.9256	2414.3	1040.2	98865.0
50.0	476.6	.2000	.5956	.4259	.7151	.9151	1451.5	666.4	73006.2
52.0	314.8	.2000	.6498	.5054	.7777	.9777	841.6	404.8	50827.9
54.0	169.6	.2000	.7149	.5204	.7280	.9280	445.8	233.0	33365.6
56.0	83.8	.2000	.7945	.4977	.6265	.8265	229.6	133.8	21747.1
58.0	41.8	.2000	.8940	.4790	.5358	.7358	119.1	78.0	14336.5
60.0	16.4	.2000	1.0221	.3456	.3382	.5382	61.7	48.5	10031.7
62.0	6.0	.2000	1.1932	.2092	.1753	.3753	35.6	34.2	7939.7
64.0	5.8	.2000	1.4334	.3438	.2399	.4399	22.7	24.2	6266.3
66.0	3.6	.2000	1.7951	.4299	.2395	.4395	12.1	15.0	4337.8
68.0	3.0	.2000			.2400	.4400	5.5	.0	.0

Table 5.13.7 LCA. Porcupine Bank (Functional Unit 16): Females
Cohort Analysis Output. Reference period 1988-1992

L INFINITY = 60.0000 K = .1600

COHORT ANALYSIS BY EXACT CALCULATION

SIZE MM	REMOVALS	M	DT	FDT	F	Z	NO. ATTAINING	AVE. NO. IN SEA	BIOMASS kg
22.0	1.2	.2000	.3379	.0002	.0005	.2005	7334.6	2396.4	15538.8
24.0	12.6	.2000	.3572	.0019	.0053	.2053	6854.1	2360.9	20582.1
26.0	35.0	.2000	.3789	.0057	.0151	.2151	6369.3	2317.6	26552.7
28.0	149.2	.2000	.4034	.0268	.0665	.2665	5870.8	2245.3	33151.5
30.0	339.2	.2000	.4312	.0695	.1611	.3611	5272.5	2105.4	39390.1
32.0	614.4	.2000	.4632	.1536	.3317	.5317	4512.3	1852.5	43272.5
34.0	686.8	.2000	.5003	.2284	.4566	.6566	3527.4	1504.1	43294.9
36.0	721.8	.2000	.5438	.3552	.6532	.8532	2539.7	1105.1	38745.5
38.0	457.4	.2000	.5957	.3606	.6054	.8054	1596.9	755.6	31936.7
40.0	361.2	.2000	.6585	.4909	.7455	.9455	988.4	484.5	24456.2
42.0	159.2	.2000	.7361	.3876	.5265	.7265	530.3	302.4	18074.0
44.0	65.2	.2000	.8346	.2576	.3086	.5086	310.6	211.2	14839.6
46.0	42.2	.2000	.9634	.2580	.2678	.4678	203.2	157.6	12918.0
48.0	42.0	.2000	1.1395	.4459	.3913	.5913	129.5	107.3	10201.8
50.0	42.0	.2000			.3500	.5500	66.0	.0	.0

Table 5.13.8 VPA. Porcupine Bank (Functional Unit 16): Males
Catch (000's) at 'nominal age'. 1983-1992

Catch-at age data

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	23.	0.	39.	30.	10.	5.	0.	3.	0.	5.
2	2370.	4579.	6059.	1478.	2177.	707.	316.	775.	1126.	1396.
3	12298.	19573.	22871.	7939.	11053.	7557.	5590.	6684.	8080.	10578.
4	16332.	20818.	20922.	14246.	13208.	13427.	11532.	10006.	8350.	11420.
5	12646.	12470.	12199.	11126.	9358.	9471.	7320.	6591.	5418.	6205.
6	7092.	5790.	5493.	5074.	3326.	3579.	2960.	2623.	2477.	2292.
7	3553.	3484.	2412.	1930.	986.	1708.	1042.	952.	1038.	929.
8	1479.	1620.	1024.	731.	526.	814.	356.	397.	371.	468.
9	442.	722.	413.	275.	363.	230.	109.	123.	200.	142.
10	286.	229.	230.	92.	80.	99.	29.	42.	71.	50.
11	164.	155.	226.	66.	73.	72.	13.	29.	63.	53.

Table 5.13.9 VPA. Porcupine Bank (Functional Unit 16): Males
Mean weight (kg) at 'nominal age'.1983-1992

Weight-at-age dat

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0060	.0000	.0060	.0050	.0060	.0060	.0000	.0060	.0000	.0060
2	.0140	.0130	.0140	.0140	.0140	.0140	.0150	.0140	.0140	.0150
3	.0240	.0240	.0240	.0250	.0240	.0250	.0260	.0250	.0240	.0260
4	.0400	.0390	.0390	.0400	.0400	.0400	.0400	.0400	.0390	.0420
5	.0580	.0580	.0580	.0580	.0580	.0580	.0570	.0570	.0580	.0600
6	.0810	.0790	.0800	.0800	.0790	.0800	.0800	.0790	.0800	.0840
7	.1040	.1050	.1030	.1030	.1030	.1040	.1020	.1030	.1020	.1090
8	.1260	.1270	.1280	.1260	.1290	.1260	.1260	.1270	.1270	.1340
9	.1520	.1520	.1520	.1520	.1520	.1510	.1510	.1510	.1530	.1590
10	.1760	.1760	.1760	.1760	.1770	.1750	.1760	.1760	.1760	.1870
11	.2100	.2170	.2190	.2230	.2280	.2320	.2070	.2190	.2440	.2270

Table 5.13.10 VPA. Porcupine Bank (Functional Unit 16): Males
Fishing mortality (F) at 'nominal age'. 1983-1992

F-at-age

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0002	.0000	.0005	.0005	.0002	.0001	.0000	.0000	.0000	.2000
2	.0263	.0562	.0965	.0249	.0430	.0164	.0070	.0135	.0150	.0183
3	.1937	.3108	.4318	.1766	.2604	.2055	.1739	.2003	.1895	.1893
4	.4498	.5783	.6413	.5281	.4950	.5782	.5495	.5323	.4113	.4441
5	.6737	.7489	.8169	.8715	.8110	.8167	.7340	.7131	.6239	.6167
6	.7327	.7697	.9119	1.0210	.7115	.8757	.6605	.6442	.6505	.5938
7	.8077	1.0365	.8885	1.0161	.5531	1.0411	.6919	.4604	.5758	.5457
8	.7182	1.1657	1.0587	.7574	.8853	1.3296	.6351	.6257	.3263	.5593
9	.7131	.9783	1.1625	.9653	1.1478	1.4071	.6182	.4719	.7611	.2000
10	.7464	1.0602	1.0366	.9130	.8621	1.2593	.6484	.5193	.5544	.4350
11	.7464	1.0602	1.0366	.9130	.8621	1.2593	.6484	.5193	.5544	.4350

Table 5.13.11 VPA. Porcupine Bank (Functional Unit 16): Males
Population numbers (000's) at 'nominal age'. 1983-1992

N-at-age

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	112772.	88633.	81045.	69707.	58450.	60840.	77856.	102167.	103529.	31.
2	100847.	92309.	72566.	66319.	57044.	47845.	49807.	63743.	83645.	84763.
3	76809.	80422.	71444.	53948.	52960.	44739.	38533.	40493.	51487.	67464.
4	49378.	51812.	48254.	37980.	37018.	33419.	29826.	26513.	27135.	34878.
5	28153.	25783.	23791.	20804.	18337.	18474.	15346.	14095.	12747.	14724.
6	14886.	11751.	9981.	8606.	7125.	6672.	6683.	6030.	5655.	5592.
7	6980.	5857.	4456.	3283.	2538.	2864.	2276.	2826.	2592.	2416.
8	3148.	2548.	1701.	1500.	973.	1195.	828.	933.	1460.	1193.
9	946.	1257.	650.	483.	576.	329.	259.	359.	408.	863.
10	593.	379.	387.	166.	151.	150.	66.	114.	183.	156.
11	339.	258.	379.	120.	138.	108.	31.	79.	162.	163.

Table 5.13.12 VPA. Porcupine Bank (Functional Unit 16): Males
Yield (tonnes),Fbar,Total stock biomass (tonnes),
spawning stock biomass (tonnes), Ln recruitment 1983-1992

Year,	Yield,	Fbar,	TSB,	SSB,	Log R
		3- 8			
1983,	2997.4,	.5960,	10187.6,	10187.6,	11.63
1984,	3277.1,	.7683,	8826.9,	8826.9,	11.39
1985,	3129.1,	.7915,	8203.7,	8203.7,	11.30
1986,	2204.0,	.7285,	6696.7,	6696.7,	11.15
1987,	1885.0,	.6194,	6060.1,	6060.1,	10.98
1988,	1920.4,	.8078,	5644.6,	5644.6,	11.02
1989,	1440.9,	.5741,	4744.8,	4744.8,	11.26
1990,	1342.1,	.5293,	5359.2,	5359.2,	11.53
1991,	1259.2,	.4629,	5241.0,	5241.0,	11.55
1992,	1548.4,	.4915,	6470.4,	6470.4,	3.43

Table 5.13.13 VPA. Porcupine Bank (Functional Unit 16): Females
Catch (000's) at 'nominal age'. 1983-1992

Catch-at age data

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	58.	39.	180.	5.	50.	3.	0.	1.	7.	27.
2	1209.	1242.	3462.	914.	1442.	302.	118.	137.	836.	347.
3	3062.	1320.	7607.	2300.	4023.	1592.	1207.	1311.	3575.	1942.
4	2279.	1094.	5915.	2793.	5164.	1621.	2922.	2183.	2551.	1562.
5	828.	512.	2213.	1131.	2302.	1420.	1555.	1053.	635.	464.
6	385.	268.	700.	456.	781.	1037.	584.	277.	193.	153.
7	253.	24.	199.	302.	240.	1080.	159.	115.	59.	28.

Table 5.13.14 VPA. Porcupine Bank (Functional Unit 16): Females
Mean weight (kg) at 'nominal age'.1983-1992

Weight-at-age dat

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0070	.0090	.0070	.0090	.0070	.0090	.0000	.0070	.0090	.0070
2	.0130	.0120	.0130	.0130	.0130	.0130	.0140	.0140	.0130	.0130
3	.0210	.0210	.0210	.0210	.0210	.0210	.0220	.0220	.0210	.0210
4	.0310	.0310	.0310	.0310	.0320	.0320	.0320	.0320	.0310	.0310
5	.0440	.0440	.0430	.0430	.0430	.0460	.0440	.0430	.0430	.0430
6	.0550	.0570	.0550	.0560	.0550	.0550	.0540	.0550	.0560	.0550
7	.0820	.0690	.0820	.0770	.0850	.0890	.0770	.0800	.0780	.0690

Table 5.13.15 VPA. Porcupine Bank (Functional Unit 16): Females
Fishing mortality (F) at 'nominal age'. 1983-1992

F-at-age

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0019	.0017	.0122	.0004	.0060	.0003	.0000	.0001	.0007	2.0000
2	.0736	.0517	.2046	.0790	.1513	.0447	.0170	.0150	.0831	.0417
3	.3419	.1074	.5017	.2036	.5768	.2484	.2521	.2628	.6488	.2808
4	.6241	.1964	.9471	.3466	.9461	.4855	.9794	.9829	1.2157	.6677
5	.3662	.2734	.7578	.4643	.5373	.7569	1.2850	1.3022	.9040	.7569
6	.4440	.1924	.7355	.3382	.6867	.4969	.8388	.8493	.9228	.5685
7	.4440	.1924	.7355	.3382	.6867	.4969	.8388	.8493	.9228	.5685

Table 5.13.16 VPA. Porcupine Bank (Functional Unit 16): Females
Population numbers (000's) at 'nominal age'. 1983-1992

N-at-age

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	33212.	25178.	16391.	13810.	9340.	9459.	12382.	14121.	11439.	33.
2	18770.	27139.	20579.	13257.	11302.	7602.	7742.	10138.	11560.	9359.
3	11602.	14277.	21099.	13731.	10029.	7954.	5951.	6232.	8176.	8710.
4	5361.	6748.	10498.	10459.	9171.	4612.	5080.	3787.	3923.	3499.
5	2961.	2352.	4540.	3334.	6055.	2915.	2324.	1562.	1160.	952.
6	1175.	1681.	1465.	1742.	1716.	2897.	1120.	526.	348.	385.
7	774.	152.	417.	1155.	526.	3019.	305.	219.	106.	70.

Table 5.13.17 VPA. Porcupine Bank (Functional Unit 16): Females
Yield (tonnes),Fbar,Total stock biomass (tonnes),
spawning stock biomass (tonnes), Ln recruitment 1983-1992

Year,	Yield,	Fbar,	TSB,	SSB,	Log R
		2- 5			
1983,	229.4,	.3514,	1144.7,	1144.7,	10.41
1984,	116.4,	.1573,	1271.0,	1271.0,	10.13
1985,	539.4,	.6028,	1460.8,	1460.8,	9.70
1986,	244.2,	.2734,	1239.1,	1239.1,	9.53
1987,	431.1,	.5529,	1115.9,	1115.9,	9.14
1988,	307.7,	.3839,	1060.7,	1060.7,	9.15
1989,	233.9,	.6334,	588.1,	588.1,	9.42
1990,	170.3,	.6407,	612.7,	612.7,	9.56
1991,	207.8,	.7129,	624.2,	624.2,	9.34
1992,	124.2,	.4368,	480.2,	480.2,	3.50

Table 5.13.18 Data and input parameters: Aran Grounds (Galway Bay)

FU	17	MA L	(VIIb,c,j,k)
FLEET	Ireland	GEAR	Trawl

1992*	NUMBER OF SAMPLES				Mean
	Qtr 1	Qtr 2	Qtr 3	Qtr 4	No./sample
Catch					
Landings					
Discards					

NUMBER OF SAMPLES										
YEAR	92*	91	90	89	88	87	86	85	84	83
Catch										
Landings	0	20	24	0	0	0	0	0	0	0
Discards										

INPUT PARAMETERS		
Parameter	Value	Source
Discard Survival		Not applicable, discards neglibible
MALES		
Growth - K	0.15	based on FUs 15 and 16
Growth - L(inf)	60	based on FU 15
Nat. Mort. - M	0.3	assumed, in line with other stocks
Length/weight - a	.00032	based on Scottish data (Pope and Thomas, 1955)
Length/weight - b	3.21	"
FEMALES		
Immature Growth		
K	0.15	as for males
L(inf)	60	"
Nat.Mort. - M	0.3	"
Size at Maturity	24	
Mature Growth		
K	0.1	"
L(inf)	50	
Nat.Mort. - M	0.2	
Length/weight - a	0.00068	as for males
Length/weight - b	2.96	"

* No sampling in 1992

Table 5.13.19 Aran Islands (Functional Unit 17) : landings (tonnes) by country, 1983-92

Year	France	Ireland (a)	UK	Total
1983	210	795	0	1005
84	131	267	0	398
85	324	1665	0	1989
86	207	838	0	1045
87	147	1030	0	1177
1988	62	691	0	753
89	14	814	0	828
90	27	317	1	345
91	30	489	0	519
92(*)	4	108	2	114

(*) Provisional
(a) Prior to 1989 the Irish Aran landings presented are for Aran and the Porcupine Bank combined.

Table 5.13.20 Republic of Ireland coast (Functional Units 18 and 19) : landings (in tonnes) by the Republic of Ireland, 1983-92

Year	FU 18			FU 19		
	Ireland	UK	Total	Ireland	UK	Total
1983	4	0	4	488	<1	488
84	90	0	90	408	2	410
85	22	0	22	673	1	674
86	8	0	8	474	<1	474
87	9	0	9	725	2	727
1988	13	1	14	601	1	602
89	11	<1	11	652	1	653
90	5	0	5	569	2	571
91 (*)	0	<1	0	860	5	865
92 (*)	1	<1	1	808	12	820

(*) provisional

Table 5.13.21 Nephrops landings (tonnes) by Functional Unit plus other rectangles in Management Area (VIIb,c,j,k) - (Area L)

Year	FU16	FU17	FU18	FU19	Other rectangles	Total
1983	3426	1005	4	488	174	5097
1984	3609	398	90	410	266	4773
1985	3953	1989	22	674	208	6846
1986	2569	1045	8	474	135	4231
1987	2439	1177	9	727	170	4522
1988	2329	753	14	602	187	3885
1989	2108	828	11	653	143	3743
1990	1883	345	5	571	114	2918
1991	1613	519	0	865	196	3193
1992(*)	1763	114	1	820	317	3015

Table 5.13.22 Total Nephrops landings (t) by country in Management Area VIIb,c,j,k (Area L)

Year	Spain	France	Republic of Ireland	UK	TOTAL
1983	2979	825	1287	6	5097
1984	2690	1198	765	120	4773
1985	2889	1505	2360	92	6846
1986	1542	1267	1320	102	4231
1987	1735	756	1764	267	4522
1988	1617	662	1305	301	3885
1989	1505	338	1827	73	3743
1990	1436	363	1060	59	2918
1991	1152	378	1519	144	3193
1992	1015	573	1140	287	3015

Table 5.14.1 Data and input parameters: Celtic Sea

FU	20-22	MA	M
FLEET	French	GEAR	Trawl

1992	NUMBER OF SAMPLES				Mean
	Qtr 1	Qtr 2	Qtr 3	Qtr 4	No./sample
Catch	18	18	20	12	84
Landings	18	18	20	12	84
Discards	0	0	0	0	0

	NUMBER OF SAMPLES									
YEAR	92	91	90	89	88	87	86	85	84	83
Catch	68	45	37	38	29	69	40	45	56	39
Landings	68	35	37	38	29	69	40	35	56	39
Discards	0	10	0	0	0	0	0	10	0	0

INPUT PARAMETERS		
Parameter	Value	Source
Discard Survival	0.25	Gueguen and Charuau, 1975
MALES		
Growth - K	0.17	chosen for consistency with other stocks
Growth - L(inf)	68	French observations (Powell's method 1979)
Nat. Mort. - M	0.3	Morizur, 1982
Length/weight - a	0.000095	Charuau,1982
Length/weight - b	3.55	"
FEMALES		
Immature Growth		
K	0.17	chosen for consistency with other stocks
L(inf)	68	see males above
Nat.Mort. - M	0.3	as for males
Size at Maturity	24	chosen for consistency with other stocks
Mature Growth		
K	0.1	chosen for consistency with other stocks
L(inf)	49	French observations(Powell's method)
Nat.Mort. - M	0.2	assumed *
Length/weight - a	0.000095	as for males
Length/weight - b	3.55	"

* based on Morizur, 1982 and assuming lower female rate

Table 5.14.2 Celtic Sea (Functional Units 20, 21 and 22) : landings (in tonnes), by country, 1983-92

Year	France FU 20-22	Ireland FU 22	UK FU 20-22	Belgium FU 20-22	Total
1983	3 667	510	65	<1	4 242
84	3 653	253	36	2	3 944
85	3 599	222	3	0	3 824
86	2 638	167	<1	0	2 805
87	2 806	329	<1	<1	3 135
1988	2 672	239	2	0	2 913
89	3 083	784	15	0	3 882
90	3 762	528	15	1	4 306
91	2 652	644	13	2	3 311
92(*)	3 477	1011	75	0	4 563

(*) provisional

Table 5.14.3 Celtic Sea (Functional Units 20, 21 and 22) : effort (in days fishing) and LPUE (in kg/day) of French Nephrops trawlers, home port Saint Guénolé, 1983-92. Estimated total effort in hours fished and LPUE in Kg/hour.

Year	Effort (days)	LPUE (kg/day)	Estimated Total eff.	LPUE
1983	5 743	242	-	-
84	4 169	268	247637	15
85	4 106	282	245600	15
86	4 205	233	208263	13
87	4 656	263	205094	14
1988	4 595	256	183203	15
89	4 953	240	210374	15
90	5 460	230	280163	13
91	5 075	181	264226	10
92(*)	4 168	227	250000(1)	14

(*) provisional (1) estimated

Table 5.14.4- Celtic Sea (Functional Units 20, 21 and 22) : mean sizes (CL in mm) of male and female Nephrops in French landings, 1983-92

Year	Males	Females
1983	?	?
84	39.0	36.3
85	39.2	36.9
86	39.3	37.5
87	38.8	35.1
1988	35.7	34.7
89	38.9	36.0
90	39.7	35.4
91	38.7	34.6
92	37.6	34.7

Table 5.14.5 VPA. Celtic Sea (Functional Unit 20-22): Males
Catch (000's) at 'nominal age'. 1984-1992

Catch-at age data

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	248.	228.	147.	232.	292.	349.	318.	2253.	6408.
2	23845.	21596.	13738.	23303.	32612.	33459.	29637.	30834.	70505.
3	41868.	37529.	23075.	39986.	65802.	58638.	48973.	45169.	76173.
4	23930.	23270.	13840.	22700.	19426.	36422.	29408.	22203.	42472.
5	11224.	10616.	6421.	8483.	7352.	16350.	16325.	10897.	14062.
6	4791.	4860.	3011.	4619.	2964.	6364.	7780.	5184.	5639.
7	5297.	4523.	2801.	4806.	2569.	5025.	6099.	4117.	4253.

Table 5.14.6 VPA. Celtic Sea (Functional Unit 20-22): Males
Mean weight (kg) at 'nominal age'.1984-1992

Weight-at-age dat

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0060	.0060	.0060	.0060	.0060	.0060	.0060	.0050	.0050
2	.0140	.0140	.0130	.0140	.0140	.0140	.0140	.0130	.0120
3	.0240	.0240	.0240	.0240	.0240	.0240	.0240	.0240	.0240
4	.0410	.0400	.0400	.0400	.0390	.0410	.0410	.0400	.0400
5	.0600	.0600	.0600	.0600	.0600	.0600	.0610	.0610	.0600
6	.0820	.0820	.0820	.0820	.0820	.0810	.0820	.0820	.0810
7	.1040	.1040	.1040	.1230	.1210	.1210	.1180	.1180	.1200

Table 5.14.7 VPA. Celtic Sea (Functional Unit 20-22): Males
Fishing mortality (F) at 'nominal age'. 1984-1992

F-at-age

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0011	.0008	.0004	.0007	.0010	.0010	.0008	.0034	.0012
2	.1688	.1408	.0693	.0906	.1496	.1664	.1188	.1115	.1560
3	.4383	.4901	.2453	.3285	.4435	.4915	.4390	.2989	.4937
4	.5205	.5308	.3795	.4578	.2947	.5380	.5604	.4118	.5783
5	.5242	.5258	.3042	.4795	.2941	.4903	.5638	.4727	.5691
6	.4944	.5156	.3097	.4219	.3441	.5066	.5211	.3945	.5471
7	.4944	.5156	.3097	.4219	.3441	.5066	.5211	.3945	.5471

Table 5.14.8 VPA. Celtic Sea (Functional Unit 20-22): Males
Population numbers (000's) at 'nominal age'. 1984-1992

N-at-age

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	256260.	320441.	419699.	365713.	399948.	412568.	455729.	762470.	6027134.
2	177002.	189629.	237192.	310794.	270727.	251588.	305337.	337339.	562913.
3	135082.	110765.	122027.	163956.	210305.	172699.	157808.	200860.	223541.
4	67388.	64553.	50259.	70732.	87450.	99982.	78257.	75363.	110354.
5	31437.	29662.	28124.	25475.	33152.	48248.	43244.	33099.	36983.
6	14045.	13787.	12987.	15370.	11683.	18301.	21889.	18229.	15284.
7	15528.	12831.	12082.	15994.	10124.	14451.	17160.	14478.	11526.

Table 5.14.9 VPA. Celtic Sea (Functional Unit 20-22): Males
Yield (tonnes),Fbar,Total stock biomass (tonnes),
spawning stock biomass (tonnes), Ln recruitment 1984-1992

Year,	Yield,	Fbar,	TSB,	SSB,	Log R
		2- 6			
1984,	3938.5,	.4292,	14673.3,	14673.3,	12.45
1985,	3641.1,	.4406,	14062.5,	14062.5,	12.68
1986,	2210.4,	.2616,	14549.7,	14549.7,	12.95
1987,	3674.2,	.3557,	18065.7,	18065.7,	12.81
1988,	3790.1,	.3052,	18459.9,	18459.9,	12.74
1989,	5475.6,	.4386,	20367.6,	20367.6,	12.93
1990,	5151.3,	.4406,	20462.7,	20462.7,	13.03
1991,	3959.9,	.3379,	21255.1,	21255.1,	13.54
1992,	6216.0,	.4688,	51509.8,	51509.8,	15.61

Table 5.14.10 Nephrops landings (tonnes by Functional Unit plus other rectangles in Management Area (M) - (VIIf,g,h, & VIIa rectangles 33E2-E5)

Year	FU20+21+22	Other rectangles	Total
1983	4242	8	4250
1984	3944	1	3945
1985	3824	0	3824
1986	2805	0	2805
1987	3135	235	3370
1988	2911	155	3066
1989	3882	98	3980
1990	4304	75	4379
1991	3311	2	3313
1992	4563	3	4566

Table 5.14.11 Total Nephrops landings (t) by country in Management Area (M) - (VIIf,g,h & VIIa rectangles 33E2-E5)

Year	France	Republic of Ireland	UK	Belgium	Total
1983	3667	510	73	?	4250
1984	3653	253	39	?	3945
1985	3599	222	3	?	3824
1986	2638	167	<1	0	2805
1987	3041	329	<1	0	3370
1988	2825	239	2	0	3066
1989	3185	784	11	<1	3980
1990	3832	528	18	1	4379
1991	2652	644	15	2	3313
1992	3477	1011	78	0	4566

Table 5.15.1 Data and input parameters: Bay of Biscay

FU	23 & 24	MA	N
FLEET	French	GEAR	Trawl

1992	NUMBER OF SAMPLES				Mean
	Qtr 1	Qtr 2	Qtr 3	Qtr 4	No./sample
Catch	108	110	106	58	16
Landings	108	110	106	58	16
Discards	0	0	0	0	0

	NUMBER OF SAMPLES									
YEAR	92	91	90	89	88	87	86	85	84	83
Catch	382	265	208	346	252	341	315	352	338	302
Landings	382	223	208	346	252	329	315	352	338	302
Discards	0	42	0	0	0	12	0	0	0	0

INPUT PARAMETERS		
Parameter	Value	Source
Discard Survival	0.3	Gueguen and Charuau, 1975
MALES		
Growth - K	0.14	Adapted from Conan and Morizur, 1979 *
Growth - L(inf)	76	"
Nat. Mort. - M	0.3	Morizur, 1982
Length/weight - a	0.00039	Conan, 1978
Length/weight - b	3.18	"
FEMALES		
Immature Growth		
K	0.14	see males above: Note that new unpublished
L(inf)	76	data have led to changes in K *
Nat.Mort. - M	0.3	Morizur, 1982
Size at Maturity	25	
Mature Growth		
K	0.11	see note for immatures above
L(inf)	56	"
Nat.Mort. - M	0.2	assumed **
Length/weight - a	0.00081	Conan, 1978
Length/weight - b	2.97	"

* previously, K on males =0.11 and on mature females =0.14
** based on Morizur, 1982 and assuming lower female rate

Table 5.15.2 Bay of Biscay (Functional Units 23 and 24) : landings (in tonnes) by the French fleet, 1983-92

Year	France FU 23	France FU 24	Belgium 23 & 24	Total
1983	5 566	342	0	5 908
84	4 485	198	0	4 683
85	4 281	312	0	4 593
86	3 968	367	0	4 335
87	5 074	473	0	5 597
1988	6 019	658	0	6 745
89	4 600	630	0	5 295
90	4 603	358	1	4 961
91	4 352	401	<1	4 753
92	5 214	508	0	5 722

(*) provisional

Table 5.15.3 Bay of Biscay North (Functional Unit 23) : effort (in days fishing) and LPUE (in kg/day) of French Nephrops trawlers, home port Lesconil, 1983-92. Estimated total effort in hours fished and LPUE in Kg/hr.

Year	Effort (days)	LPUE kg/day	Estimated total eff	LPUE kg/hr
1983	6 481	109	-	-
84	5 673	87	470991	10
85	5 603	88	568815	8
86	5 137	95	534346	8
87	5 673	106	620735	9
1988	5 433	119	753129	9
89	5 449	95	712895	7
90	4 929	87	676085	7
91	4 588	84	675091	7
92	4 998	96	675000(1)	8

(1) estimated value

Table 5.15.4 Bay of Biscay (Functional Units 23 and 24) : mean sizes (CL in mm) of male and female Nephrops in French landings, 1983-92

Year	Males	Females
1983	?	?
84	26.9	27.0
85	26.1	26.7
86	27.3	27.7
87	28.8	26.3
1988	28.5	26.2
89	29.2	26.8
90	31.2	27.9
91	30.7	28.4
92	29.8	27.8

Table 5.15.5 LCA. Bay of Biscay (Functional Unit 23 & 24): Males Cohort Analysis Output. Ref. period 1987-1989

L INFINITY = 76.0000 K = .1400

COHORT ANALYSIS BY EXACT CALCULATION

SIZE MM	REMOVALS	M	DT	FDT	F	Z	NO. ATTAINING	AVE. NO. IN SEA	BIOMASS kg
14.0	109.0	.3000	.1161	.0002	.0018	.3018	543346.1	62014.7	120602.1
15.0	894.8	.3000	.1181	.0017	.0147	.3147	524632.8	60804.8	146224.0
16.0	2477.0	.3000	.1201	.0050	.0417	.3417	505496.4	59457.7	174478.3
17.0	4568.5	.3000	.1221	.0096	.0789	.3789	485182.0	57892.6	204890.0
18.0	10647.5	.3000	.1242	.0237	.1907	.4907	463245.3	55828.6	235828.4
19.0	10008.8	.3000	.1264	.0237	.1873	.4873	435847.9	53439.4	266929.2
20.0	29449.3	.3000	.1287	.0761	.5910	.8910	409805.9	49831.7	291873.7
21.0	22568.3	.3000	.1311	.0650	.4962	.7962	365407.0	45478.0	309991.6
22.0	29938.1	.3000	.1335	.0973	.7290	1.0290	329195.4	41067.1	323524.8
23.0	21693.7	.3000	.1361	.0803	.5900	.8900	286937.2	36769.0	332680.1
24.0	18521.9	.3000	.1387	.0773	.5571	.8571	254212.8	33244.3	343467.9
25.0	22341.9	.3000	.1414	.1065	.7532	1.0532	225717.7	29662.8	348097.8
26.0	18050.6	.3000	.1443	.0996	.6902	.9902	194476.9	26151.0	346871.4
27.0	18154.4	.3000	.1473	.1166	.7915	1.0915	168581.0	22935.8	342305.3
28.0	16309.3	.3000	.1504	.1235	.8210	1.1210	143545.8	19865.2	332187.7
29.0	13425.4	.3000	.1536	.1202	.7822	1.0822	121277.0	17163.9	320326.7
30.0	13129.5	.3000	.1570	.1402	.8929	1.1929	102702.4	14703.7	305141.7
31.0	9326.3	.3000	.1605	.1189	.7408	1.0408	85161.8	12589.3	289525.0
32.0	8973.5	.3000	.1642	.1365	.8309	1.1309	72058.7	10799.0	274338.3
33.0	7223.3	.3000	.1681	.1320	.7856	1.0856	59845.6	9194.2	257230.5
34.0	6224.1	.3000	.1721	.1370	.7957	1.0957	49864.0	7822.1	240326.4
35.0	5583.7	.3000	.1764	.1494	.8468	1.1468	41293.2	6593.8	221884.5
36.0	4168.2	.3000	.1808	.1364	.7541	1.0541	33731.4	5553.9	204174.8
37.0	3478.2	.3000	.1855	.1372	.7394	1.0394	27877.0	4704.1	188477.3
38.0	2870.9	.3000	.1905	.1374	.7215	1.0215	22387.6	3979.2	173366.1
39.0	2218.1	.3000	.1957	.1285	.6568	.9568	18923.0	3377.3	159661.2
40.0	2074.4	.3000	.2012	.1463	.7272	1.0272	15691.6	2852.5	146026.9
41.0	1487.8	.3000	.2071	.1280	.6183	.9183	12761.5	2406.3	133131.8
42.0	1271.9	.3000	.2132	.1328	.6227	.9227	10551.8	2042.5	121903.8
43.0	1121.1	.3000	.2198	.1434	.6522	.9522	8667.2	1718.9	110474.0
44.0	852.0	.3000	.2268	.1338	.5901	.8901	7030.4	1443.7	99752.7
45.0	694.2	.3000	.2342	.1336	.5702	.8702	5745.3	1217.4	90279.6
46.0	656.9	.3000	.2422	.1569	.6479	.9479	4685.9	1013.9	80580.9
47.0	481.0	.3000	.2507	.1438	.5737	.8737	3724.9	838.5	71310.5
48.0	348.3	.3000	.2598	.1288	.4960	.7960	2992.3	702.2	63816.1
49.0	284.5	.3000	.2696	.1296	.4809	.7809	2433.3	591.5	57366.4
50.0	301.5	.3000	.2801	.1735	.6192	.9192	1971.4	486.9	50326.0
51.0	216.3	.3000	.2916	.1602	.5495	.8495	1523.9	393.6	43300.6
52.0	119.7	.3000	.3040	.1111	.3656	.6656	1189.5	327.4	38291.3
53.0	110.3	.3000	.3175	.1266	.3987	.6987	971.6	276.7	34365.3
54.0	118.9	.3000	.3323	.1747	.5258	.8258	778.3	226.2	29798.1
55.0	95.5	.3000	.3485	.1861	.5340	.8340	591.5	178.9	24973.9
56.0	87.1	.3000	.3664	.2324	.6344	.9344	442.3	137.2	20279.1
57.0	62.7	.3000	.3862	.2368	.6131	.9131	314.1	102.2	15973.6
58.0	57.8	.3000	.4083	.3247	.7952	1.0952	220.8	72.7	11997.5
59.0	43.2	.3000	.4330	.3934	.9084	1.2084	141.2	47.6	8292.8
60.0	20.9	.3000	.4610	.3104	.6733	.9733	83.7	31.1	5708.8
61.0	18.9	.3000	.4928	.4753	.9645	1.2645	53.4	19.6	3791.5
62.0	17.9	.3000			.5000	.8000	28.6	19.6	3791.5

Table 5.15.6 LCA. Bay of Biscay (Functional Unit 23 & 24): Females Cohort Analysis Output. Reference period 1987-1989.

LOWER CURVE LINF= 76.0000 K= .1400

UPPER CURVE LINF= 56.0000 K= .1100

TRANSITION LENGTH= 25.0000

COHORT ANALYSIS BY EXACT CALCULATION

SIZE MM	REMOVALS	M	DT	FDT	F	Z	NO. ATTAINING	AVE. NO. IN SEA	BIOMASS kg
15.0	684.8	.3000	.1181	.0023	.0195	.3195	303385.8	35152.5	98468.6
16.0	878.0	.3000	.1201	.0031	.0255	.3255	292155.2	34397.1	116034.2
17.0	4295.9	.3000	.1221	.0157	.1285	.4285	280958.0	33423.7	134304.8
18.0	8810.3	.3000	.1242	.0342	.2757	.5757	266634.6	31966.6	151524.7
19.0	11800.0	.3000	.1264	.0496	.3927	.6927	248232.9	30048.1	166561.8
20.0	18832.3	.3000	.1287	.0882	.6851	.9851	227418.4	27490.1	176809.6
21.0	18113.6	.3000	.1311	.0967	.7378	1.0378	200339.1	24550.0	181918.5
22.0	19835.8	.3000	.1335	.1229	.9207	1.2207	174860.4	21543.3	182740.7
23.0	18126.1	.3000	.1361	.1329	.9769	1.2769	148561.6	18554.6	179110.7
24.0	15514.9	.3000	.1387	.1356	.9775	1.2775	124869.2	15871.8	173421.1
25.0	13985.7	.2000	.1414	.1457	1.0300	1.2300	104592.7	13578.9	167107.0
26.0	12077.9	.2000	.3082	.1527	.4954	.6954	87891.3	24381.8	336404.2
27.0	10490.3	.2000	.3190	.1655	.5187	.7187	70937.0	20222.8	311503.7
28.0	9146.1	.2000	.3306	.1832	.5542	.7542	56402.1	16504.4	282708.1
29.0	6186.0	.2000	.3431	.1572	.4583	.6583	43955.2	13499.1	256194.7
30.0	5027.4	.2000	.3566	.1606	.4505	.6505	35069.3	11159.9	233866.1
31.0	2935.0	.2000	.3711	.1159	.3123	.5123	27809.9	9398.8	216788.3
32.0	2509.9	.2000	.3869	.1203	.3109	.5109	22995.2	8072.8	204333.4
33.0	1705.0	.2000	.4041	.0987	.2443	.4443	18870.8	6980.5	193342.8
34.0	1352.0	.2000	.4229	.0936	.2213	.4213	15769.6	6108.7	184660.2
35.0	946.6	.2000	.4435	.0779	.1756	.3756	13195.9	5391.4	177426.8
36.0	795.9	.2000	.4663	.0775	.1662	.3662	11170.9	4788.6	171154.0
37.0	642.3	.2000	.4915	.0743	.1511	.3511	9417.4	4251.5	164671.6
38.0	564.7	.2000	.5196	.0779	.1500	.3500	7924.8	3765.2	157704.9
39.0	374.0	.2000	.5511	.0616	.1118	.3118	6607.1	3345.7	151236.2
40.0	383.5	.2000	.5867	.0758	.1292	.3292	5564.0	2968.5	144541.6
41.0	191.8	.2000	.6272	.0455	.0725	.2725	4586.7	2644.4	138440.9
42.0	196.6	.2000	.6737	.0559	.0829	.2829	3866.0	2371.4	133256.8
43.0	136.3	.2000	.7277	.0469	.0645	.2645	3195.1	2114.9	127352.8
44.0	185.8	.2000	.7910	.0732	.1001	.3001	2635.8	1855.9	119570.1
45.0	184.3	.2000	.8665	.1014	.1170	.3170	2078.8	1575.0	108401.7
46.0	74.2	.2000	.9578	.0530	.0553	.2553	1579.5	1342.1	98541.8
47.0	78.4	.2000	1.0708	.0729	.0681	.2681	1236.9	1151.3	90047.5
48.0	89.2	.2000	1.2139	.1143	.0941	.2941	928.2	947.6	78853.1
49.0	50.4	.2000	1.4014	.0931	.0664	.2664	649.5	759.6	67165.3
50.0	19.9	.2000	1.6575	.0535	.0323	.2323	447.2	615.2	57723.4
51.0	182.6	.2000			.3000	.5000	304.3	615.2	61188.4

Table 5.15.7 LCA. Bay of Biscay (Functional Unit 23 & 24): Males Cohort Analysis Output. Reference period 1991-1992.

L INFINITY = 76.0000 K = .1400

COHORT ANALYSIS BY EXACT CALCULATION

SIZE MM	REMOVALS	M	DT	FDT	F	Z	NO. ATTAINING	AVE. NO. IN SEA	BIOMASS kg
13.0	.0	.3000	.1143	.0000	.0000	.3000	368876.7	41443.6	64195.6
14.0	.0	.3000	.1161	.0000	.0000	.3000	356443.6	40686.7	79124.9
15.0	103.3	.3000	.1181	.0003	.0026	.3026	344237.5	39925.4	96013.0
16.0	452.6	.3000	.1201	.0014	.0116	.3116	332156.6	39139.2	114853.9
17.0	857.2	.3000	.1221	.0027	.0224	.3224	319962.3	38309.4	135582.4
18.0	2377.8	.3000	.1242	.0079	.0636	.3636	307612.2	37363.5	157829.1
19.0	2031.3	.3000	.1264	.0071	.0559	.3559	294025.2	36348.5	181560.7
20.0	5546.6	.3000	.1287	.0203	.1579	.4579	281089.2	35131.8	205773.5
21.0	5263.9	.3000	.1311	.0205	.1562	.4562	265002.4	33714.8	229810.3
22.0	8844.6	.3000	.1335	.0368	.2758	.5758	249623.3	32079.8	252723.0
23.0	8121.1	.3000	.1361	.0365	.2684	.5684	231153.1	30264.9	273832.3
24.0	12573.9	.3000	.1387	.0619	.4460	.7460	213950.9	28191.5	291265.0
25.0	16894.3	.3000	.1414	.0937	.6622	.9622	192919.5	25512.4	299392.1
26.0	14749.2	.3000	.1443	.0937	.6496	.9496	168371.5	22705.7	301171.3
27.0	13665.8	.3000	.1473	.1000	.6787	.9787	146810.6	20136.3	300524.9
28.0	13898.6	.3000	.1504	.1185	.7883	1.0883	127103.9	17632.0	294843.3
29.0	11884.9	.3000	.1536	.1195	.7779	1.0779	107915.6	15277.8	285126.3
30.0	10680.7	.3000	.1570	.1273	.8107	1.1107	91447.4	13174.6	273408.1
31.0	9003.6	.3000	.1605	.1278	.7963	1.0963	76814.3	11306.2	260017.8
32.0	7351.0	.3000	.1642	.1243	.7570	1.0570	64418.9	9711.2	246701.9
33.0	5840.0	.3000	.1681	.1171	.6969	.9969	54154.5	8380.4	234461.2
34.0	5458.3	.3000	.1721	.1303	.7573	1.0573	45800.5	7207.7	221450.2
35.0	4382.4	.3000	.1764	.1253	.7105	1.0105	38179.8	6168.0	207556.9
36.0	3922.9	.3000	.1808	.1348	.7452	1.0452	31947.1	5264.2	193524.9
37.0	3621.1	.3000	.1855	.1516	.8171	1.1171	26444.9	4431.5	177552.4
38.0	2772.9	.3000	.1905	.1423	.7470	1.0470	21494.4	3711.9	161723.3
39.0	2382.3	.3000	.1957	.1499	.7659	1.0659	17607.8	3110.3	147038.0
40.0	2109.0	.3000	.2012	.1648	.8190	1.1190	14292.4	2575.2	131827.3
41.0	1502.2	.3000	.2071	.1458	.7042	1.0042	11410.9	2133.2	118023.1
42.0	1389.1	.3000	.2132	.1679	.7875	1.0875	9268.8	1764.0	105281.9
43.0	1159.8	.3000	.2198	.1778	.8089	1.1089	7350.4	1433.8	92150.8
44.0	919.3	.3000	.2268	.1802	.7947	1.0947	5760.5	1156.8	79930.0
45.0	790.1	.3000	.2342	.2007	.8569	1.1569	4494.2	922.0	68378.7
46.0	553.8	.3000	.2422	.1831	.7561	1.0561	3427.5	732.3	58202.9
47.0	405.9	.3000	.2507	.1727	.6890	.9890	2654.0	589.2	50108.5
48.0	441.5	.3000	.2598	.2500	.9623	1.2623	2071.3	458.7	41690.2
49.0	244.2	.3000	.2696	.1865	.6919	.9919	1492.2	353.0	34231.5
50.0	192.6	.3000	.2801	.1931	.6894	.9894	1142.1	279.4	28882.6
51.0	119.6	.3000	.2916	.1556	.5337	.8337	865.6	224.1	24651.0
52.0	114.5	.3000	.3040	.1939	.6377	.9377	678.8	179.6	21001.1
53.0	95.9	.3000	.3175	.2189	.6895	.9895	510.4	139.1	17275.0
54.0	94.5	.3000	.3323	.3088	.9292	1.2292	372.8	101.7	13399.7
55.0	30.9	.3000	.3485	.1406	.4035	.7035	247.8	76.6	10692.2
56.0	26.4	.3000	.3664	.1548	.4224	.7224	193.9	62.4	9224.7
57.0	23.8	.3000	.3862	.1854	.4800	.7800	148.8	49.6	7754.8
58.0	29.1	.3000	.4083	.3283	.8040	1.1040	110.1	36.2	5974.4
59.0	9.7	.3000	.4330	.1586	.3662	.6662	70.2	26.4	4598.5
60.0	12.2	.3000	.4610	.2852	.6186	.9186	52.6	19.8	3630.6
61.0	6.3	.3000	.4928	.2197	.4458	.7458	34.4	14.2	2748.3
62.0	6.6	.3000	.5293	.3560	.6726	.9726	23.8	9.9	2009.9
63.0	1.5	.3000	.5717	.1228	.2147	.5147	14.2	7.1	1512.4
64.0	6.6	.3000			.5000	.8000	10.6	7.1	1512.4

Table 5.15.8 LCA. Bay of Biscay (Functional Unit 23 & 24): Females Cohort Analysis Output. Reference period 1991-1992.

LOWER CURVE LINF= 76.0000 K= .1400

UPPER CURVE LINF= 56.0000 K= .1100

TRANSITION LENGTH= 25.0000

COHORT ANALYSIS BY EXACT CALCULATION

SIZE MM	REMOVALS	M	DT	FDT	F	Z	NO. ATTAINING	AVE. NO. IN SEA	BIOMASS kg
13.0	.0	.3000	.1143	.0000	.0000	.3000	275951.1	31003.4	57594.0
14.0	132.8	.3000	.1161	.0005	.0044	.3044	266650.2	30429.4	69907.8
15.0	516.8	.3000	.1181	.0020	.0173	.3173	257388.5	29826.7	83549.9
16.0	834.5	.3000	.1201	.0034	.0286	.3286	247923.6	29184.1	98448.9
17.0	1846.2	.3000	.1221	.0079	.0649	.3649	238333.9	28462.6	114369.7
18.0	3209.0	.3000	.1242	.0144	.1163	.4163	227948.7	27597.6	130815.3
19.0	4521.7	.3000	.1264	.0215	.1702	.4702	216460.1	26568.6	147274.3
20.0	6176.1	.3000	.1287	.0314	.2436	.5436	203967.2	25354.0	163070.4
21.0	5380.1	.3000	.1311	.0293	.2234	.5234	190183.9	24090.9	178516.0
22.0	7709.1	.3000	.1335	.0453	.3393	.6393	177575.7	22725.4	192768.4
23.0	8446.5	.3000	.1361	.0543	.3991	.6991	163047.3	21161.5	204275.1
24.0	12420.2	.3000	.1387	.0894	.6444	.9444	148252.3	19272.9	210582.6
25.0	14080.5	.2000	.1414	.1163	.8221	1.0221	130050.3	17127.3	210774.8
26.0	13872.8	.2000	.3082	.1358	.4407	.6407	112544.2	31475.6	434273.0
27.0	13271.1	.2000	.3190	.1604	.5027	.7027	92376.3	26399.7	406648.8
28.0	13847.6	.2000	.3306	.2152	.6509	.8509	73825.2	21275.1	364426.7
29.0	9745.6	.2000	.3431	.1994	.5811	.7811	55722.6	16770.6	318284.2
30.0	7333.9	.2000	.3566	.1961	.5500	.7500	42622.8	13334.9	279447.3
31.0	4634.7	.2000	.3711	.1593	.4293	.6293	32621.9	10796.6	249028.4
32.0	3572.9	.2000	.3869	.1550	.4007	.6007	25827.9	8916.7	225692.5
33.0	2442.6	.2000	.4041	.1325	.3279	.5279	20471.7	7449.9	206345.4
34.0	2126.8	.2000	.4229	.1438	.3401	.5401	16539.1	6253.2	189026.6
35.0	1149.2	.2000	.4435	.0956	.2156	.4156	13161.6	5331.4	175449.9
36.0	880.2	.2000	.4663	.0879	.1885	.3885	10946.2	4668.5	166864.4
37.0	655.9	.2000	.4915	.0784	.1594	.3594	9132.3	4114.6	159369.0
38.0	662.5	.2000	.5196	.0955	.1837	.3837	7653.5	3605.5	151016.7
39.0	395.1	.2000	.5511	.0688	.1249	.3249	6269.9	3163.8	143015.2
40.0	338.9	.2000	.5867	.0709	.1209	.3209	5242.0	2803.4	136499.2
41.0	217.4	.2000	.6272	.0547	.0872	.2872	4342.4	2492.3	130481.8
42.0	184.8	.2000	.6737	.0560	.0831	.2831	3626.5	2224.4	124993.9
43.0	171.5	.2000	.7277	.0634	.0871	.2871	2996.8	1967.9	118501.0
44.0	119.1	.2000	.7910	.0544	.0687	.2687	2431.8	1732.8	111639.9
45.0	73.6	.2000	.8665	.0416	.0480	.2480	1966.1	1532.9	105504.0
46.0	77.6	.2000	.9578	.0552	.0576	.2576	1585.9	1346.1	98832.3
47.0	76.7	.2000	1.0708	.0712	.0665	.2665	1239.1	1154.3	90283.9
48.0	70.7	.2000	1.2139	.0891	.0734	.2734	931.5	962.3	80075.3
49.0	39.5	.2000	1.4014	.0701	.0500	.2500	668.4	790.2	69869.6
50.0	48.7	.2000	1.6575	.1292	.0779	.2779	470.9	625.4	58683.7
51.0	178.2	.2000			.3000	.5000	297.1	625.4	62206.4

Table 5.15.9 Nephrops landings (tonnes) by Functional Unit plus other rectangles in Management Area (N) - (VIIIa,b)

Year	FU23	FU24	Other rectangles	Total
1983	5566	342		5908
1984	4485	198		4683
1985	4281	312		4593
1986	3968	367	99	4434
1987	5074	473	114	5661
1988	6019	658	137	6814
1989	4600	630	142	5372
1990	4603	358	88	5103
1991	4352	401	55	4808
1992	5214	508	47	5769

Table 5.15.10 Total Nephrops landings (t) by country in Management Area (N) - (VIIIa,b)

Year	France	Spain	Belgium	TOTAL
1983	5908	?	?	5908
1984	4683	?	?	4683
1985	4593	?	?	4593
1986	4335	99	0	4434
1987	5597	64	0	5661
1988	6745	69	0	6814
1989	5295	77	0	5372
1990	5015	87	1	5103
1991	4753	55	<1	4808
1992	5722	47	0	5769

Table 5.16.1 Data inputs and parameters

FU	25	MA	O (VIIIc)
FLEET	Spain	GEAR	Trawl

1992	NUMBER OF SAMPLES				Mean
	Qtr 1	Qtr 2	Qtr 3	Qtr 4	No./sample
Catch					
Landings	19	18	19	17	81
Discards					

	NUMBER OF SAMPLES									
YEAR	92	91	90	89	88	87	86	85	84	83
Catch										
Landings	73	73	70	52	37	23	35	14	14	40
Discards										

INPUT PARAMETERS		
Parameter	Value	Source
Discard Survival	-	not applicable, few discards
MALES		
Growth - K	0.12	based on Fernandez et al., 1986
Growth - L(inf)	80	Fernandez et al., 1986
Nat. Mort. - M	0.2	"
Length/weight - a	0.00043	Farina, 1984
Length/weight - b	3.16	"
FEMALES		
Immature Growth		Not applicable, few below CL50 mat.
K		
L(inf)		
Nat.Mort. - M		
Size at Maturity		
Mature Growth		
K	0.15	as for males
L(inf)	65	"
Nat.Mort. - M	0.2	"
Length/weight - a	0.00043	"
Length/weight - b	3.16	"

Table 5.16.2 North Galicia (Functional Unit 25) : landings (in tonnes) by the Spanish fleet, 1983-92

Year	Spain	Total
1983	430	430
84	514	514
85	477	477
86	364	364
87	412	412
1988	445	445
89	376	376
90	289	289
91	416	416
92	427	427

(*) provisional

Table 5.16.3 North Galicia (Functional Unit 25) : effort (in days fishing) and CPUE (in kg per day * BHP / 100) of Spanish "bacas", home port La Coruña 1983-92

Year	Effort	CPUE
1983	6 343	12.2
84	6 260	14.7
85	6 015	14.1
86	5 017	11.4
87	4 266	15.4
1988	5 246	13.2
89	5 753	10.1
90	5 710	6.7
91	5 135	12.5
92	5 127	13.4

(*) provisional

Table 5.16.4 North Galicia (Functional Unit 25) : mean sizes (CL in mm) of male and female Nephrops in Spanish catches, 1983-92

Year	Males	Females
1983	34.7	32.2
84	35.2	32.0
85	35.8	33.1
86	35.1	32.1
87	37.2	35.6
1988	37.9	36.0
89	40.9	38.7
90	37.5	39.4
91	34.8	33.3
92	37.1	34.9

Table 5.16.5 VPA. North Galicia (Functional Unit 25): Males
Catch (000's) at 'nominal age'. 1984-1992

Catch-at age data

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	72.	134.	149.	43.	10.	0.	4.	34.	14.
2	2680.	1765.	1552.	866.	566.	82.	347.	2179.	898.
3	4606.	2953.	2682.	1722.	2684.	954.	1462.	3235.	2915.
4	1847.	1923.	1561.	1525.	2557.	1292.	1048.	1591.	2178.
5	835.	826.	589.	682.	1311.	924.	440.	633.	995.
6	561.	345.	144.	368.	202.	464.	152.	179.	291.
7	125.	76.	43.	58.	56.	149.	53.	36.	70.
8	30.	34.	6.	10.	12.	65.	28.	6.	33.
9	5.	9.	3.	10.	9.	16.	6.	4.	4.
10	6.	16.	4.	9.	23.	25.	13.	5.	4.

Table 5.16.6 VPA. North Galicia (Functional Unit 25): Males
Mean weight (kg) at 'nominal age'.1984-1992

Weight-at-age dat

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0110	.0100	.0100	.0110	.0100	.0000	.0100	.0100	.0110
2	.0190	.0190	.0180	.0180	.0200	.0210	.0200	.0190	.0190
3	.0290	.0300	.0300	.0310	.0310	.0320	.0310	.0290	.0310
4	.0440	.0450	.0460	.0450	.0460	.0470	.0450	.0450	.0460
5	.0640	.0640	.0630	.0650	.0640	.0650	.0640	.0640	.0640
6	.0890	.0860	.0840	.0860	.0870	.0870	.0870	.0860	.0850
7	.1070	.1080	.1080	.1060	.1070	.1090	.1110	.1070	.1110
8	.1260	.1330	.1260	.1300	.1310	.1300	.1300	.1280	.1280
9	.1590	.1540	.1700	.1590	.1620	.1550	.1560	.1560	.1540
10	.1820	.2460	.1700	.2100	.2190	.2010	.2230	.2230	.2030

Table 5.16.7 VPA. North Galicia (Functional Unit 25): Males
Fishing mortality (F) at 'nominal age'. 1984-1992

F-at-age

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0054	.0112	.0160	.0064	.0011	.0000	.0002	.0020	.1000
2	.2854	.1776	.1738	.1217	.1089	.0113	.0323	.1786	.0690
3	.7379	.5841	.4451	.2967	.6645	.2693	.2836	.4630	.3834
4	.8396	.8117	.7158	.4929	.9668	.8060	.5325	.5687	.6592
5	.9237	1.2518	.6350	.8152	1.0868	1.2593	.7249	.7283	.8722
6	1.6308	1.4263	.7677	1.1142	.6112	1.8288	.7187	.7540	.9162
7	1.2185	1.1670	.6752	.8372	.4802	1.3750	1.3329	.3605	.7671
8	1.1379	1.5290	.2200	.3197	.4138	1.9345	1.1635	.5382	.6601
9	1.3291	1.3741	.5543	.7570	.5017	1.7128	1.0717	.5509	.7811
10	1.3291	1.3741	.5543	.7570	.5017	1.7128	1.0717	.5509	.7811

Table 5.16.8 VPA. North Galicia (Functional Unit 25): Males
Population numbers (000's) at 'nominal age'. 1984-1992

N-at-age

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	14647.	13217.	10332.	7428.	9824.	14726.	17903.	18161.	162.
2	11852.	11927.	10701.	8324.	6043.	8034.	12056.	14654.	14839.
3	9620.	7294.	8176.	7363.	6034.	4437.	6504.	9557.	10035.
4	3539.	3765.	3330.	4289.	4481.	2542.	2775.	4010.	4924.
5	1505.	1251.	1369.	1332.	2145.	1395.	930.	1334.	1859.
6	749.	489.	293.	594.	483.	592.	324.	369.	527.
7	191.	120.	96.	111.	160.	215.	78.	129.	142.
8	48.	46.	31.	40.	39.	81.	44.	17.	74.
9	7.	13.	8.	20.	24.	21.	10.	11.	8.
10	9.	23.	10.	19.	64.	32.	21.	13.	7.

Table 5.16.9 VPA. North Galicia (Functional Unit 25): Males
Yield (tonnes),Fbar,Total stock biomass (tonnes),
spawning stock biomass (tonnes), Ln recruitment 1984-1992

Year,	Yield,	Fbar,	TSB,	SSB,	Log R
		2- 8			
1984,	388.9,	.9677,	1013.3,	1013.3,	9.59
1985,	310.6,	.9925,	896.0,	896.0,	9.49
1986,	237.5,	.5189,	822.5,	822.5,	9.24
1987,	225.1,	.5711,	814.7,	814.7,	8.91
1988,	327.7,	.6189,	831.6,	831.6,	9.19
1989,	225.4,	1.0692,	616.1,	616.1,	9.60
1990,	154.1,	.6840,	854.9,	854.9,	9.79
1991,	269.5,	.5130,	1055.4,	1055.4,	9.81
1992,	309.4,	.6182,	1013.0,	1013.0,	5.09

Table 5.16.10 VPA. North Galicia (Functional Unit 25): Females
Catch (000's) at 'nominal age'. 1984-1992

Catch-at age data

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	265.	434.	312.	187.	6.	0.	88.	84.	13.
2	2216.	1892.	2159.	1055.	658.	96.	814.	2009.	749.
3	1924.	1771.	1531.	1790.	1246.	1001.	1231.	2005.	1688.
4	358.	914.	557.	1184.	707.	1200.	773.	613.	857.
5	223.	306.	179.	428.	351.	625.	475.	222.	267.
6	32.	133.	46.	248.	120.	236.	199.	92.	81.
7	6.	70.	37.	169.	103.	95.	61.	51.	15.
8	2.	33.	18.	36.	28.	45.	25.	22.	3.
9	3.	11.	1.	22.	11.	18.	9.	12.	4.
10	1.	17.	1.	19.	8.	17.	9.	8.	1.

Table 5.16.11 VPA. North Galicia (Functional Unit 25): Females
Mean weight (kg) at 'nominal age'.1984-1992

Weight-at-age dat

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0120	.0110	.0110	.0120	.0120	.0000	.0120	.0130	.0130
2	.0190	.0180	.0190	.0190	.0200	.0210	.0190	.0190	.0200
3	.0290	.0290	.0290	.0300	.0290	.0310	.0300	.0290	.0300
4	.0420	.0430	.0410	.0420	.0430	.0430	.0430	.0420	.0420
5	.0560	.0570	.0580	.0570	.0590	.0580	.0580	.0580	.0580
6	.0700	.0730	.0700	.0740	.0730	.0720	.0720	.0720	.0710
7	.0880	.0860	.0910	.0860	.0860	.0860	.0860	.0870	.0830
8	.0940	.1020	.0950	.0970	.0980	.1020	.1020	.1000	.1050
9	.1210	.1110	.1170	.1190	.1170	.1120	.1120	.1160	.1170
10	.1210	.1490	.1320	.1350	.1300	.1440	.1380	.1360	.1210

Table 5.16.12 VPA. North Galicia (Functional Unit 25): Females
Fishing mortality (F) at 'nominal age'. 1984-1992

F-at-age

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0307	.0483	.0446	.0340	.0015	.0000	.0098	.0166	.1000
2	.4030	.3148	.3560	.2081	.1611	.0273	.1447	.3208	.2000
3	.6196	.6587	.4538	.5651	.4045	.3911	.5629	.6251	.4893
4	.3396	.6883	.4453	.7759	.4577	.8714	.5978	.6148	.6045
5	.5128	.5470	.2721	.7414	.5561	.9705	1.1094	.3392	.6021
6	.1662	.6672	.1457	.7443	.4748	.9315	1.0159	.6578	.2000
7	.1357	.6563	.3892	1.1643	.8227	.8750	.6666	.7977	.2000
8	.0929	2.1186	.3402	.8239	.5988	1.1238	.6157	.5442	.1000
9	.1316	1.1474	.2917	.9109	.6321	.9768	.7661	.6665	.1667
10	.1316	1.1474	.2917	.9109	.6321	.9768	.7661	.6665	.1667

Table 5.16.13 VPA. North Galicia (Functional Unit 25): Females
Population numbers (000's) at 'nominal age'. 1984-1992

N-at-age

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	9686.	10132.	7886.	6150.	4802.	8123.	9912.	5642.	154.
2	7322.	7690.	7904.	6174.	4866.	3925.	6650.	8036.	4543.
3	4549.	4006.	4596.	4533.	4106.	3391.	3127.	4711.	4774.
4	1364.	2004.	1697.	2390.	2109.	2243.	1878.	1458.	2064.
5	608.	795.	824.	890.	901.	1092.	768.	846.	646.
6	230.	298.	377.	514.	347.	423.	339.	207.	493.
7	56.	159.	125.	267.	200.	177.	136.	100.	88.
8	24.	40.	68.	69.	68.	72.	60.	57.	37.
9	23.	18.	4.	39.	25.	31.	19.	27.	27.
10	13.	27.	6.	35.	19.	29.	18.	18.	10.

Table 5.16.14 VPA. North Galicia (Functional Unit 25): Females
Yield (tonnes),Fbar,Total stock biomass (tonnes),
spawning stock biomass (tonnes), Ln recruitment 1984-1992

Year,	Yield,	Fbar,	TSB,	SSB,	Log R
		3- 5			
1984,	132.0,	.4907,	506.1,	506.1,	9.18
1985,	169.8,	.6313,	543.0,	543.0,	9.22
1986,	130.6,	.3904,	533.1,	533.1,	8.97
1987,	191.6,	.6942,	555.3,	555.3,	8.72
1988,	123.2,	.4728,	472.4,	472.4,	8.48
1989,	154.9,	.7443,	407.9,	407.9,	9.00
1990,	138.7,	.7567,	511.3,	511.3,	9.20
1991,	151.7,	.5264,	507.9,	507.9,	8.64
1992,	125.2,	.5653,	410.8,	410.8,	5.04

Table 5.16.15 Data and input parameters: Cantabrian Sea

FU 31	MA O (IIIc)
FLEET Spain	GEAR Trawl

1992	NUMBER OF SAMPLES				Mean
	Qtr 1	Qtr 2	Qtr 3	Qtr 4	No./sample
Catch					
Landings	6	6	9	8	136
Discards					

	NUMBER OF SAMPLES									
YEAR	92	91	90	89	88	87	86	85	84	83
Catch										
Landings	29	24	35	38	17					
Discards										

INPUT PARAMETERS		
Parameter	Value	Source
Discard Survival		Not applicable, few discards
MALES		
Growth - K	0.15	based on other stocks, (Anon.,1991)
Growth - L(inf)	90	Maximum size observed in samples
Nat. Mort. - M	0.2	assumed the same as FU25
Length/weight - a	0.00043	" (based on Farina,1984)
Length/weight - b	3.16	"
FEMALES		
Immature Growth		Not applicable, few below CL50 mat.
K		
L(inf)		
Nat.Mort. - M		
Size at Maturity		
Mature Growth		
K	0.1	as for males
L(inf)	70	"
Nat.Mort. - M	0.2	"
Length/weight - a	0.00043	"
Length/weight - b	3.16	"

Table 5.16.16 Cantabrian Sea (Functional Unit 31) : landings (in tonnes) by the Spanish fleet, 1983-92

Year	Spain	Total
1983	63	63
84	100	100
85	128	128
86	127	127
87	118	118
1988	151	151
89	139	139
90	185	185
91	108	108
92(*)	93	93

(*) provisional

Table 5.16.17 Cantabrian Sea (Functional Unit 31) : effort (in no. of trips) and CPUE (in kg/(bhp*days)/100) of trawlers; home port Avilés, 1983-92

Year	Effort	CPUE
1983	2 724	3.1
84	2 338	3.9
85	2 207	2.4
86	2 407	3.1
87	1 869	4.5
1988	2 077	5.9
89	1 611	5.3
90	2 013	6.9
91	1 798	3.6
92	1 118	3.2

Table 5.16.18 Cantabrian Sea (Functional Unit 31) : mean sizes (CL in mm) of male and female Nephrops in Spanish catches, 1988-92

Year	Males	Females
1988	40.3	36.9
89	42.3	39.2
90	42.2	37.9
91	40.9	36.6
92	41.6	39.3

Table 5.16.19 Nephrops landings (tonnes) by Functional Unit plus other rectangles in Management Area (O) - (VIIIc)

Year	FU25	FU31	Other rectangles	Total
1983	430	63		493
1984	514	100		614
1985	477	128		605
1986	364	127		491
1987	412	118		530
1988	445	151		596
1989	376	139		515
1990	289	185		474
1991	416	108		524
1992	427	93		520

Table 5.16.20 Total Nephrops landings (t) by country in Management Area (O) - (VIIIc)

Year	Spain	TOTAL
1983	493	493
1984	614	614
1985	605	605
1986	491	491
1987	530	530
1988	596	596
1989	515	515
1990	474	474
1991	524	524
1992	520	520

Table 5.18.1 Data inputs and parameters: West Galicia

FU 26	MA Q
FLEET Spain	GEAR Trawl

1992	NUMBER OF SAMPLES				Mean
	Qtr 1	Qtr 2	Qtr 3	Qtr 4	No./sample
Catch					
Landings	8	6	6	6	239
Discards					

	NUMBER OF SAMPLES									
YEAR	92	91	90	89	88	87	86	85	84	83
Catch										
Landings	26	35	38	29	18		40			
Discards										

INPUT PARAMETERS		
Parameter	Value	Source
Discard Survival		Not applicable, few discards
MALES		
Growth - K	0.15	based on Fernandez et al. 1986
Growth - L(inf)	85	Fernandez et al,1986
Nat. Mort. - M	0.2	"
Length/weight - a	0.00043	Farina, 1984
Length/weight - b	3.16	"
FEMALES		
Immature Growth		
K	0.15	as for males
L(inf)	85	"
Nat.Mort. - M	0.2	"
Size at Maturity	24	
Mature Growth		
K	0.1	based on other FU's
L(inf)	70	Fernandez et al.,1986
Nat.Mort. - M	0.2	"
Length/weight - a	0.00043	as for males
Length/weight - b	3.16	"

Table 5.18.2 West Galicia (Functional Unit 26) and Gulf of Cadiz (Functional Unit 30) : landings (in tonnes) by the Spanish fleet, 1983-92

Year	West Galicia	Gulf of Cadiz
1983	786	?
84	604	?
85	750	257
86	657	221
87	671	302
1988	640	139
89	626	174
90	401	220
91	549	225
92(*)	584	240

(*) provisional

Table 5.18.3 West Galicia (Functional Unit 26) : CPUE data (in kg/trip) of Spanish trawlers, home ports Muros and Riveira, 1984-92 and Marin 1990-1992

Year	Muros	Riveira	Marin
1984	21.3	20.2	?
85	33.5	30.7	?
86	23.9	28.0	?
87	20.3	25.3	?
1988	15.4	22.0	?
89	16.4	27.4	?
90	14.5	20.6	103.3
91	26.4	29.6	117.5
92(*)	28.9	26.5	113.0

(*) provisional

Table 5.18.4 West Galicia (Functional Unit 26) : mean sizes (CL in mm) of male and female Nephrops in Spanish catches, 1983-92

Year	Males	Females
1983	35.8	33.1
84	?	?
85	34.3	31.3
86	36.6	31.9
87	?	?
1988	35.0	32.9
89	29.9	28.5
90	26.0	24.8
91	31.7	30.4
92	36.4	33.3

Table 5.18.5 LCA. West Galicia (Functional Unit 26): Males
Cohort Analysis Output. Reference period 1991-1992

L INFINITY = 85.0000 K = .1500

COHORT ANALYSIS BY EXACT CALCULATION

SIZE MM	REMOVALS	M	DT	FDT	F	Z	NO. ATTAINING	AVE. NO. IN SEA	BIOMASS kg
20.0	117.0	.2000	.5336	.0071	.0134	.2134	17333.2	8742.1	70466.5
25.0	1570.0	.2000	.5801	.1136	.1958	.3958	15467.7	8016.9	121832.7
30.0	3449.0	.2000	.6354	.3533	.5560	.7560	12294.3	6203.1	159819.3
35.0	3017.0	.2000	.7024	.5491	.7818	.9818	7604.7	3859.2	156279.3
40.0	1908.0	.2000	.7852	.7657	.9751	1.1751	3815.8	1956.6	117675.3
45.0	914.0	.2000	.8902	1.0443	1.1731	1.3731	1516.5	779.1	66594.5
50.0	246.0	.2000	1.0277	.9162	.8915	1.0915	446.7	275.9	32357.4
55.0	64.0	.2000	1.2155	.6712	.5522	.7522	145.5	115.9	18116.7
60.0	13.0	.2000	1.4876	.2956	.1987	.3987	58.3	65.4	13312.2
65.0	5.0	.2000	1.9179	.2053	.1071	.3071	32.2	46.7	12118.5
70.0	6.0	.2000	2.7031	.5514	.2040	.4040	17.9	29.4	9564.4
75.0	3.0	.2000			.2000	.4000	6.0	.0	.0

Table 5.18.6 LCA. West Galicia (Functional Unit 26): Females
Cohort Analysis Output. Reference period 1991-1992

LOWER CURVE LINF= 85.0000 K= .1500

UPPER CURVE LINF= 70.0000 K= .1000

TRANSITION LENGTH= 24.0000

COHORT ANALYSIS BY EXACT CALCULATION

SIZE MM	REMOVALS	M	DT	FDT	F	Z	NO. ATTAINING	AVE. NO. IN SEA	BIOMASS kg
15.0	25.0	.2000	.4941	.0020	.0040	.2040	13346.0	6272.3	22850.3
20.0	693.0	.2000	.5336	.0624	.1170	.3170	12066.5	5923.8	47749.1
25.0	2710.0	.2000	1.1778	.3517	.2986	.4986	10188.7	9076.3	137932.5
30.0	2243.0	.2000	1.3353	.5896	.4416	.6416	5663.5	5079.7	130875.7
35.0	1037.0	.2000	1.5415	.6785	.4402	.6402	2404.5	2356.0	95406.9
40.0	391.0	.2000	1.8232	.7126	.3908	.5908	896.3	1000.4	60168.0
45.0	184.0	.2000	2.2314	1.2539	.5619	.7619	305.2	327.4	27986.5
50.0	32.0	.2000	2.8768	1.2483	.4339	.6339	55.7	73.7	8648.1
55.0	6.0	.2000			.4000	.6000	9.0	.0	.0

Table 5.18.7 Data input and parameters: North Portugal

FU 27	MA Q
FLEET Portugal	GEAR Trawl

1992	NUMBER OF SAMPLES				Mean
	Qtr 1	Qtr 2	Qtr 3	Qtr 4	No./sample
Catch			5		26
Landings					
Discards					

	NUMBER OF SAMPLES									
YEAR	92	91	90	89	88	87	86	85	84	83
Catch	5	3	7	18	48		3	30		
Landings										
Discards										

INPUT PARAMETERS		
Parameter	Value	Source
Discard Survival		Not applicable, few discards
MALES		
Growth - K	0.2	Inputs 'borrowed' from FU 28,29
Growth - L(inf)	70	"
Nat. Mort. - M	0.2	"
Length/weight - a	0.00028	"
Length/weight - b	3.22	"
FEMALES		
Immature Growth		
K	0.2	"
L(inf)	70	"
Nat.Mort. - M	0.2	"
Size at Maturity	26	"
Mature Growth		
K	0.068	"
L(inf)	65	"
Nat.Mort. - M	0.1	"
Length/weight - a	0.00056	"
Length/weight - b	3.03	"

Table 5.18.8 N Portugal (Functional Unit 27), : landings (in tonnes), by gear, all Portugal 1983-92

Year	Trawl	Creel	Total
1983	?	?	19
84	?	?	14
85	11	4	15
86	28	9	37
87	52	19	71
1988	55	41	96
89	66	22	88
90	31	17	48
91	40	14	54
92(*)	44	15	59

(*) provisional

Table 5.18.9 N Portugal (Functional Unit 27), : effort and CPUE for Portuguese trawl fishery, 1985-1992

Year	No. Trawlers	Tonnes /Trawler	Estimated Fishing hours	CPUE Kg/hr
1985	2	5.3	5362	2.0
1986	3	9.5	6538	4.3
1987	7	7.5	14208	3.7
1988	10	5.5	12251	4.5
1989	7	9.4	9400	7.0
1990	9	3.5	8970	3.5
1991	8	5.0	7499	5.3
1992*	8	6.0	8302**	5.3

* Provisional **Estimated from CPUE (assumed = to 1991)

Table 5.18.10 N Portugal (Functional Unit 27), : mean sizes (CL in mm) of male and female Nephrops in Portuguese trawl landings and research trawl surveys, 1985-92

Year	Landings		Research Surveys	
	Males	Females	Males	Females
1985	40.3	36.6	42.6	39.9
86	40.3	40.9	47.0	39.4
87	No sampling		41.7	41.2
88	41.3	41.0	39.5	33.0
89	40.8	40.7	No surveys	
90	39.6	39.1	42.2	40.0
91	34.4	34.2	38.7	33.2
92	35.0	35.4	40.9	35.6

Table 5.18.11 Data and input parameters: SW and S Portugal

FU	28&29	MA	Q (XIa)
FLEET	Portugal	GEAR	Trawl

1992	NUMBER OF SAMPLES				Mean
	Qtr 1	Qtr 2	Qtr 3	Qtr 4	No./sample
Catch					
Landings	0	12	8	18	45
Discards					

	NUMBER OF SAMPLES									
YEAR	92	91	90	89	88	87	86	85	84	83
Catch										
Landings	38	23	31	38	81	68	113	179	150	
Discards										

INPUT PARAMETERS		
Parameter	Value	Source
Discard Survival		Not applicable, few discards
MALES		
Growth - K	0.2	Portuguese data, Bhattacharya method
Growth - L(inf)	70	and tagging release. Anon., 1990
Nat. Mort. - M	0.2	
Length/weight - a	0.00028	Figueiredo, M.J. pers comm (1986)
Length/weight - b	3.22	"
FEMALES		
Immature Growth		
K	0.2	as for males
L(inf)	70	"
Nat.Mort. - M	0.2	"
Size at Maturity	26	"
Mature Growth		
K	0.068	"
L(inf)	65	"
Nat.Mort. - M	0.1	"
Length/weight - a	0.00056	"
Length/weight - b	3.03	"

Table 5.18.12 SW Portugal (Functional Unit 28), and S Portugal (Functional Unit 29) landings (in tonnes) by country and gear, 1983-92

Year	Portugal			Spain	Total
	Trawl	Creel	Total	Trawl	
1983	257	0	257	0	257
84	458	0	458	0	458
85	509	0	509	0	509
86	465	0	465	0	465
87	498	11	509	0	509
1988	405	15	420	0	420
89	463	6	469	0	469
90	363	4	367	0	367
91	473	5	478	0	478
92(*)	471	1	472	NA	472

* provisional

Table 5.18.13 SW Portugal (Functional Unit 28), and S Portugal (Functional Unit 29) effort and CPUE in the Portuguese trawl fishery 1983-1992

Year	Number Trawlers	Tonnes/ Trawler	Estimated Fishing hours	CPUE kg/hr
1983	30	8.6	74557	3.5
84	37	12.4	91581	5.0
85	39	13.0	104553	4.9
86	41	11.3	89358	5.2
87	41	12.1	83220	6.0
1988	38	10.7	61327	6.6
89	34	13.6	52032	8.9
90	37	9.8	58584	6.2
91	39	12.1	63962	7.4
92*	39	12.1	63787**	7.4

*provisional ** estimated from CPUE (assumed = to 1991)

Table 5.18.14 SW Portugal (Functional Unit 28), and S Portugal (Functional Unit 29) :mean sizes (CL in mm) of male and female Nephrops in Portuguese trawl landings and research trawl surveys, 1983-92

Year	Landings		Research Surveys	
	Males	Females	Males	Females
1983	36.0	32.0	36.0	32.0
84	33.5	30.4	36.0	32.0
85	37.3	34.2	36.0	30.0
86	36.6	32.7	36.0	32.0
87	34.0	31.9	34.0	31.0
1988	35.1	32.5	37.3	34.4
89	37.4	33.5	33.6	29.9
90	37.5	33.6	34.1	39.4
91	36.6	31.9	37.5	31.7
92	36.6	33.0	37.8	33.6

Table 5.18.15 LCA. SW & S Portugal (Functional Unit 28 & 29): Males
Cohort Analysis Output. Reference period 1988-1992

L INFINITY = 70.0000 K = .2000

COHORT ANALYSIS BY EXACT CALCULATION

SIZE MM	REMOVALS	M	DT	FDT	F	Z	NO. ATTAINING	AVE. NO. IN SEA	BIOMASS kg
18.0	6.0	.2000	.1961	.0005	.0023	.2023	13437.0	2583.4	9483.0
20.0	31.1	.2000	.2041	.0025	.0121	.2121	12914.3	2579.7	13069.9
22.0	85.7	.2000	.2128	.0071	.0334	.2334	12367.2	2567.4	17435.0
24.0	290.3	.2000	.2223	.0255	.1149	.3149	11768.0	2526.1	22437.5
26.0	422.0	.2000	.2326	.0402	.1727	.3727	10972.4	2444.7	27821.2
28.0	617.0	.2000	.2440	.0649	.2660	.4660	10061.4	2320.1	33234.6
30.0	959.2	.2000	.2565	.1160	.4523	.6523	8980.3	2120.8	37657.0
32.0	846.6	.2000	.2703	.1215	.4495	.6495	7596.9	1883.5	40902.2
34.0	903.2	.2000	.2858	.1575	.5510	.7510	6373.6	1639.3	43025.0
36.0	714.1	.2000	.3031	.1543	.5091	.7091	5142.5	1402.7	44027.4
38.0	589.3	.2000	.3227	.1585	.4912	.6912	4147.9	1199.7	44613.6
40.0	721.4	.2000	.3450	.2544	.7376	.9376	3318.6	978.1	42728.3
42.0	524.8	.2000	.3705	.2566	.6926	.8926	2401.6	757.7	38584.8
44.0	519.6	.2000	.4002	.3748	.9365	1.1365	1725.3	554.8	32705.2
46.0	366.8	.2000	.4351	.4289	.9858	1.1858	1094.8	372.1	25232.3
48.0	178.1	.2000	.4766	.3355	.7039	.9039	653.5	253.0	19623.7
50.0	117.3	.2000	.5268	.3426	.6503	.8503	424.8	180.4	15912.1
52.0	77.1	.2000	.5889	.3570	.6062	.8062	271.4	127.3	12706.0
54.0	62.3	.2000	.6677	.4978	.7456	.9456	168.8	83.6	9402.4
56.0	37.7	.2000	.7708	.5967	.7741	.9741	89.8	48.7	6143.0
58.0	20.2	.2000	.9116	.7251	.7954	.9954	42.4	25.4	3581.5
60.0	13.6	.2000			.7874	.9874	17.1	.0	.0

Table 5.18.16 LCA. SW & S Portugal (Functional Unit 28 & 29): Females
Cohort Analysis Output. Reference period 1988-1992

LOWER CURVE LINF= 70.0000 K= .2000

UPPER CURVE LINF= 65.0000 K= .0680

TRANSITION LENGTH= 26.0000

COHORT ANALYSIS BY EXACT CALCULATION

SIZE MM	REMOVALS	M	DT	FDT	F	Z	NO. ATTAINING	AVE. NO. IN SEA	BIOMASS kg
18.0	8.8	.2000	.1961	.0009	.0043	.2043	10545.4	2027.1	8505.3
20.0	37.2	.2000	.2041	.0038	.0184	.2184	10131.2	2022.5	11491.9
22.0	94.6	.2000	.2128	.0100	.0471	.2471	9689.5	2008.6	15035.7
24.0	320.0	.2000	.2223	.0362	.1631	.3631	9193.2	1963.0	18917.6
26.0	653.0	.2000	.2326	.0821	.3528	.5528	8480.5	1851.0	22523.3
28.0	761.5	.1000	.8172	.1123	.1375	.2375	7457.3	5539.3	83696.4
30.0	1016.4	.1000	.8653	.1894	.2188	.3188	6141.9	4644.5	85891.2
32.0	1151.4	.1000	.9194	.2984	.3245	.4245	4661.0	3548.1	79301.1
34.0	969.9	.1000	.9808	.3882	.3958	.4958	3154.8	2450.2	65451.9
36.0	593.3	.1000	1.0509	.3873	.3685	.4685	1939.9	1609.8	50889.0
38.0	424.2	.1000	1.1318	.4728	.4178	.5178	1185.6	1015.4	37650.3
40.0	180.3	.1000	1.2262	.3415	.2785	.3785	659.9	647.3	27927.8
42.0	140.4	.1000	1.3378	.4460	.3334	.4334	414.8	421.1	20990.9
44.0	90.3	.1000	1.4718	.5366	.3646	.4646	232.3	247.7	14167.3
46.0	48.2	.1000	1.6357	.5837	.3568	.4568	117.2	135.1	8815.2
48.0	19.4	.1000	1.8406	.4775	.2594	.3594	55.5	74.8	5536.8
50.0	7.8	.1000	2.1044	.3566	.1695	.2695	28.7	46.0	3847.5
52.0	5.0	.1000	2.4567	.4216	.1716	.2716	16.3	29.1	2736.7
54.0	1.4	.1000	2.9510	.2142	.0726	.1726	8.3	19.3	2026.6
56.0	1.6	.1000	3.6958	.4722	.1278	.2278	5.0	12.5	1466.2
58.0	.8	.1000	4.9481	.6125	.1238	.2238	2.2	6.5	840.0
60.0	.4	.1000			.1275	.2275	.7	.0	.0

Table 5.18.17 VPA. SW and South Portugal (Functional Unit 28&29): Males
Catch (000's) at 'nominal age'. 1984-1991

Catch-at age data

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	1779.	539.	1135.	1360.	767.	1126.	247.	808.	612.
2	5461.	3189.	2431.	5234.	3513.	2213.	2495.	3779.	3280.
3	1449.	2387.	2566.	1716.	2323.	2007.	1930.	2326.	2510.
4	843.	977.	1435.	916.	558.	1886.	1306.	1740.	1292.
5	371.	548.	442.	309.	279.	617.	397.	599.	515.
6	202.	334.	197.	135.	174.	224.	92.	164.	120.
7	131.	151.	106.	185.	88.	79.	49.	102.	51.
8	87.	44.	25.	67.	44.	36.	20.	29.	27.
9	27.	15.	17.	26.	14.	19.	4.	2.	9.
10	14.	10.	12.	18.	19.	16.	0.	4.	8.

Table 5.18.18 VPA. SW and South Portugal (Functional Unit 28&29): Males
Mean weight (kg) at 'nominal age'.1984-1991

Weight-at-age dat

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0110	.0100	.0090	.0100	.0100	.0090	.0100	.0090	.0100
2	.0170	.0200	.0200	.0170	.0190	.0190	.0200	.0190	.0200
3	.0350	.0350	.0340	.0350	.0330	.0350	.0350	.0350	.0350
4	.0540	.0530	.0550	.0540	.0530	.0550	.0540	.0540	.0540
5	.0740	.0770	.0740	.0740	.0770	.0740	.0740	.0720	.0720
6	.0970	.0960	.0970	.1000	.0960	.0950	.0950	.0960	.0950
7	.1170	.1150	.1140	.1160	.1160	.1160	.1170	.1170	.1160
8	.1350	.1330	.1340	.1330	.1340	.1340	.1330	.1280	.1360
9	.1460	.1490	.1520	.1500	.1470	.1510	.1440	.1410	.1460
10	.1710	.1700	.1660	.1820	.1860	.1790	.1570	.1740	.1770

Table 5.18.19 VPA. SW and South Portugal (Functional Unit 28&29): Males
Fishing mortality (F) at 'nominal age'. 1984-1991

F-at-age

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.1503	.0591	.0730	.1082	.0671	.0962	.0176	.0612	.2000
2	.6254	.4359	.4052	.5498	.4440	.2794	.3178	.4007	.3735
3	.4717	.6237	.7641	.5617	.5067	.4938	.4195	.5522	.5092
4	.4554	.6825	.9993	.6949	.3571	1.0463	.7050	.8439	.6909
5	.4093	.6099	.7784	.6047	.4694	.8557	.6492	.8500	.6547
6	.5203	.8038	.4610	.5789	.8422	.8774	.2855	.6216	.4000
7	.7385	.9584	.6487	1.0952	.9684	1.3134	.4702	.5895	.4000
8	1.2757	.6022	.4008	1.2141	.8570	1.6373	1.6936	.5831	.3000
9	.8448	.7881	.5035	.9627	.8892	1.2760	.8165	.5981	.3667
10	.8448	.7881	.5035	.9627	.8892	1.2760	.8165	.5981	.3667

Table 5.18.20 VPA. SW and South Portugal (Functional Unit 28&29): Males
Population numbers (000's) at 'nominal age'. 1984-1991

N-at-age

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	14031.	10361.	17778.	14605.	13024.	13525.	15596.	14985.	3711.
2	12825.	9885.	7996.	13531.	10731.	9971.	10058.	12546.	11540.
3	4217.	5618.	5233.	4366.	6393.	5636.	6174.	5992.	6880.
4	2523.	2154.	2465.	1995.	2038.	3153.	2816.	3323.	2824.
5	1211.	1310.	891.	743.	815.	1168.	907.	1139.	1170.
6	545.	658.	583.	335.	332.	417.	406.	388.	399.
7	273.	265.	241.	301.	154.	117.	142.	250.	171.
8	130.	107.	83.	103.	82.	48.	26.	73.	114.
9	52.	30.	48.	46.	25.	29.	8.	4.	33.
10	27.	19.	33.	31.	36.	24.	1.	10.	30.

Table 5.18.21 VPA. SW and South Portugal (Functional Unit 28&29): Males
Yield (tonnes),Fbar,Total stock biomass (tonnes),
spawning stock biomass (tonnes), Ln recruitment 1984-1991

Year,	Yield,	Fbar,	TSB,	SSB,	Log R
		2- 5			
1984,	289.1,	.4905,	860.4,	860.4,	9.55
1985,	305.7,	.5880,	828.5,	828.5,	9.25
1986,	296.8,	.7367,	807.3,	807.3,	9.79
1987,	285.9,	.6028,	786.3,	786.3,	9.59
1988,	240.4,	.4443,	787.0,	787.0,	9.47
1989,	312.8,	.6688,	836.5,	836.5,	9.51
1990,	237.5,	.5229,	852.2,	852.2,	9.65
1991,	330.0,	.6617,	922.4,	922.4,	9.61
1992,	290.2,	.5571,	828.7,	828.7,	8.22

Table 5.18.22 VPA. SW and South Portugal (Functional Unit 28&29): Females
Catch (000's) at 'nominal age'. 1984-1991

Catch-at age data

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	2463.	691.	1232.	2113.	1178.	1301.	339.	990.	807.
2	2531.	855.	843.	2352.	1246.	741.	538.	1392.	641.
3	1400.	1031.	840.	1436.	1263.	877.	910.	1326.	1480.
4	1059.	1208.	1760.	1195.	1432.	667.	890.	1132.	1915.
5	583.	1399.	890.	959.	1276.	767.	860.	888.	750.
6	488.	1075.	484.	584.	580.	525.	448.	292.	846.
7	277.	699.	455.	476.	652.	367.	287.	168.	391.
8	144.	430.	88.	181.	95.	255.	169.	168.	48.
9	51.	171.	205.	106.	65.	185.	136.	119.	65.
10	91.	153.	311.	499.	103.	425.	278.	177.	185.

Table 5.18.23 VPA. SW and South Portugal (Functional Unit 28&29): Females
Mean weight (kg) at 'nominal age'.1984-1991

Weight-at-age dat

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0110	.0110	.0100	.0110	.0110	.0100	.0110	.0110	.0110
2	.0150	.0140	.0150	.0150	.0140	.0140	.0150	.0150	.0140
3	.0190	.0190	.0190	.0190	.0190	.0190	.0190	.0190	.0190
4	.0230	.0230	.0230	.0230	.0230	.0230	.0230	.0230	.0230
5	.0280	.0270	.0270	.0270	.0270	.0270	.0270	.0270	.0280
6	.0320	.0320	.0320	.0320	.0320	.0320	.0320	.0320	.0320
7	.0370	.0370	.0370	.0370	.0370	.0370	.0370	.0370	.0370
8	.0430	.0430	.0430	.0430	.0430	.0430	.0430	.0430	.0430
9	.0460	.0460	.0490	.0470	.0480	.0480	.0480	.0480	.0490
10	.0610	.0580	.0570	.0680	.0640	.0640	.0580	.0620	.0580

Table 5.18.24 VPA. SW and South Portugal (Functional Unit 28&29): Females
Fishing mortality (F) at 'nominal age'. 1984-1991

F-at-age

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.2682	.0887	.1307	.2018	.1567	.1009	.0278	.1530	.2000
2	.3114	.1332	.1412	.3707	.1668	.1328	.0524	.1443	.1332
3	.2404	.1799	.1680	.3355	.3098	.1522	.2140	.1587	.2014
4	.2549	.2998	.4636	.3385	.5774	.2383	.2037	.3967	.3203
5	.2303	.5497	.3350	.4386	.6424	.6200	.4828	.2864	.4405
6	.3333	.7457	.3293	.3406	.4587	.5274	.8070	.2655	.4290
7	.2120	.9752	.7293	.5509	.6911	.5218	.5449	.7226	.5959
8	.3377	.5170	.2631	.6401	.1781	.5649	.4290	.6315	.4059
9	.2942	.7457	.4404	.5103	.4425	.5379	.5935	.5397	.4768
10	.2942	.7457	.4404	.5103	.4425	.5379	.5935	.5397	.4768

Table 5.18.25 VPA. SW and South Portugal (Functional Unit 28&29): Females
Population numbers (000's) at 'nominal age'. 1984-1991

N-at-age

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	11499.	8968.	11070.	12717.	8934.	14929.	13647.	7682.	4896.
2	9914.	7199.	6719.	7953.	8509.	6254.	11049.	10866.	5397.
3	6868.	6571.	5702.	5279.	4967.	6516.	4955.	9487.	8511.
4	4936.	4887.	4967.	4361.	3415.	3297.	5063.	3620.	7325.
5	2973.	3461.	3276.	2827.	2813.	1735.	2351.	3737.	2203.
6	1805.	2137.	1807.	2121.	1650.	1339.	844.	1313.	2540.
7	1522.	1170.	917.	1177.	1365.	944.	715.	341.	911.
8	528.	1114.	399.	400.	614.	619.	507.	375.	150.
9	211.	341.	601.	278.	191.	465.	318.	299.	181.
10	375.	304.	913.	1307.	300.	1068.	649.	443.	510.

Table 5.18.26 VPA. SW and South Portugal (Functional Unit 28&29): Females
Yield (tonnes),Fbar,Total stock biomass (tonnes),
spawning stock biomass (tonnes), Ln recruitment 1984-1991

Year,	Yield,	Fbar,	TSB,	SSB,	Log R
		3- 8			
1984,	172.3,	.2681,	771.8,	645.3,	9.35
1985,	200.2,	.5445,	723.0,	624.4,	9.10
1986,	169.3,	.3814,	713.0,	602.3,	9.31
1987,	222.2,	.4407,	766.7,	626.8,	9.45
1988,	178.2,	.4763,	624.3,	526.1,	9.10
1989,	153.5,	.4374,	678.4,	529.1,	9.61
1990,	127.6,	.4469,	718.1,	568.0,	9.52
1991,	146.4,	.4102,	724.4,	639.9,	8.95
1992,	168.5,	.3988,	681.1,	627.2,	8.50

Table 5.18.27 Short Term Prediction: South West and South Portugal Males (FU28 & 29)

MOST RECENT DATA YR = 1992 1ST PRED YR = 1993
REFERENCE F = MEAN OF AGES 2 TO 5
F PATTERN = MEAN OF YEARS 1988 TO 1992
AGE 1 RECRUITS FOR PRED YRS = MEAN 1984 TO 1990
AGE 2 RECRUITS FOR 1993 = MEAN 1984 TO 1990

PROPORTION OF F AND M BEFORE SPAWNING = .25

INPUTS SUMMARY

AGE	M	WT	STOCK JAN1 1992	F	STOCK JAN1 1993	F PATTERN
1	.2	.0100	3710.9	.2000	14131.6	.0884
2	.2	.0200	11539.8	.3735	10713.9	.3631
3	.2	.0350	6880.4	.5092	6503.5	.4963
4	.2	.0540	2824.4	.6909	3385.3	.7286
5	.2	.0720	1169.8	.6547	1158.9	.6958
6	.2	.0950	398.6	.4000	497.6	.6053
7	.2	.1160	170.5	.4000	218.8	.7483
8	.2	.1360	113.5	.3000	93.6	1.0142
9	.2	.1460	33.2	.3667	68.9	.7893
10	.2	.1770	30.0	.3667	35.9	.7893
				.5571		.5710

PREDICTION YEAR 1993 STATUS QUO: FACTOR=1

AGE	STOCK JAN1	SCAL F	TSB	SSB	CATCH	PROP	LANDINGS
1	14131.6	.0863	141.3	131.6	10.6	1.0000	10.6
2	10713.9	.3543	214.3	186.6	58.3	1.0000	58.3
3	6503.5	.4842	227.6	191.8	79.8	1.0000	79.8
4	3385.3	.7109	182.8	145.6	85.3	1.0000	85.3
5	1158.9	.6789	83.4	67.0	37.7	1.0000	37.7
6	497.6	.5906	47.3	38.8	19.3	1.0000	19.3
7	218.8	.7301	25.4	20.1	12.1	1.0000	12.1
8	93.6	.9896	12.7	9.5	7.4	1.0000	7.4
9	68.9	.7701	10.1	7.9	5.0	1.0000	5.0
10	35.9	.7701	6.4	5.0	3.1	1.0000	3.1
			951.2	803.7	318.5		318.5

1994 (TSB AT JAN 1 = 939.0) 1995

FACTOR	REFF	SSB	CATCH	LANDINGS	TSB	SSB	CATCH	LANDINGS
.0	.0000	893.2	.0	.0	1339.3	1274.0	.0	.0
.2	.1114	872.1	77.3	77.3	1238.6	1148.3	109.3	109.3
.4	.2228	851.6	146.5	146.5	1148.3	1038.7	188.3	188.3
.6	.3342	831.6	208.5	208.5	1067.4	943.0	244.5	244.5
.8	.4457	812.3	264.2	264.2	994.6	859.2	283.4	283.4
1.0	.5571	793.4	314.2	314.2	929.2	785.7	309.4	309.4
1.2	.6685	775.2	359.3	359.3	870.3	721.2	325.8	325.8
1.4	.7799	757.4	399.9	399.9	817.1	664.3	334.9	334.9
1.6	.8913	740.1	436.6	436.6	769.1	614.2	338.8	338.8
1.8	1.0027	723.3	469.8	469.8	725.7	569.8	338.8	338.8
2.0	1.1141	707.0	499.8	499.8	686.4	530.4	336.0	336.0

Table 5.18.28 Short Term Prediction: South West and South Portugal Females (FU28 & 29)

MOST RECENT DATA YR = 1992 1ST PRED YR = 1993
REFERENCE F = MEAN OF AGES 3 TO 8
F PATTERN = MEAN OF YEARS 1988 TO 1992
AGE 1 RECRUITS FOR PRED YRS = MEAN 1984 TO 1990
AGE 2 RECRUITS FOR 1993 = MEAN 1984 TO 1990

PROPORTION OF F AND M BEFORE SPAWNING = .25

INPUTS SUMMARY

AGE	M	WT	STOCK JAN1 1992	F	STOCK JAN1 1993	F PATTERN
1	.2	.0110	4896.3	.2000	11680.6	.1277
2	.1	.0140	5396.9	.1332	8228.3	.1259
3	.1	.0190	8510.8	.2014	4274.3	.2072
4	.1	.0230	7324.5	.3203	6296.0	.3473
5	.1	.0280	2202.7	.4405	4811.2	.4944
6	.1	.0320	2539.5	.4290	1283.0	.4975
7	.1	.0370	910.7	.5959	1496.2	.6153
8	.1	.0430	149.7	.4059	454.1	.4419
9	.1	.0490	180.5	.4768	90.3	.5181
10	.1	.0580	509.8	.4768	387.7	.5181
				.3988		.4339

PREDICTION YEAR 1993 STATUS QUO: FACTOR=1

AGE	STOCK JAN1	SCAL F	TSB	SSB	CATCH	PROP	LANDINGS
1	11680.6	.1174	128.5	118.7	12.9	1.0000	12.9
2	8228.3	.1157	115.2	109.1	12.0	1.0000	12.0
3	4274.3	.1905	81.2	75.5	13.4	1.0000	13.4
4	6296.0	.3192	144.8	130.4	37.8	1.0000	37.8
5	4811.2	.4544	134.7	117.3	47.0	1.0000	47.0
6	1283.0	.4573	41.1	35.7	14.4	1.0000	14.4
7	1496.2	.5655	55.4	46.9	22.9	1.0000	22.9
8	454.1	.4061	19.5	17.2	6.2	1.0000	6.2
9	90.3	.4762	4.4	3.8	1.6	1.0000	1.6
10	387.7	.4762	22.5	19.5	8.1	1.0000	8.1
			747.3	674.1	176.3		176.3

1994 (TSB AT JAN 1 = 740.7) 1995

FACTOR	REFF	SSB	CATCH	LANDINGS	TSB	SSB	CATCH	LANDINGS
.0	.0000	719.3	.0	.0	931.1	905.0	.0	.0
.2	.0798	709.1	38.8	38.8	887.7	849.7	49.3	49.3
.4	.1595	699.0	74.9	74.9	847.3	799.1	89.2	89.2
.6	.2393	689.2	108.5	108.5	809.7	752.9	121.4	121.4
.8	.3191	679.5	139.8	139.8	774.7	710.5	147.2	147.2
1.0	.3988	670.0	169.0	169.0	742.0	671.6	167.8	167.8
1.2	.4786	660.7	196.3	196.3	711.5	636.0	184.0	184.0
1.4	.5584	651.5	221.8	221.8	683.0	603.2	196.8	196.8
1.6	.6381	642.5	245.6	245.6	656.4	572.9	206.6	206.6
1.8	.7179	633.7	267.9	267.9	631.5	545.1	214.1	214.1
2.0	.7977	625.0	288.8	288.8	608.1	519.4	219.6	219.6

Table 5.18.29 Nephrops landings (tonnes) by Functional Unit plus other rectangles in Management Area (Q) - (IXa)

Year	FU26	FU27	FU28+29	FU30	Other rectangles	Total
1983	786	19	257	?		1062
1984	604	14	458	?		1076
1985	750	15	509	257		1531
1986	657	37	465	221		1380
1987	671	71	509	302		1553
1988	640	96	420	139		1295
1989	626	88	469	174		1357
1990	401	48	367	220		1036
1991	549	54	479	225		1307
1992	584	59	472	240		1353

Table 5.18.30 Total Nephrops landings (t) by country in Management Area (Q) - (IXa)

Year	Portugal	Spain	TOTAL
1983	276	786	1062
1984	472	604	1076
1985	524	1007	1531
1986	502	878	1380
1987	580	973	1553
1988	516	779	1295
1989	557	800	1357
1990	415	621	1036
1991	533	774	1307
1992	531	824	1355

Table 6.1.1 Nominal landings (tonnes) of Pandalus borealis in ICES Division IIIa and Sub-area IV as officially reported to ICES.

Year	Division IIIa				Sub-area IV					
	Denmark	Norway	Sweden	Total	Denmark	Norway	Sweden	UK(Engl)[1]	UK(Scotl)[2]	Total
1970	757	982	2,740[3]	4,479	3,460	1,107	...	14	100	4,681
1971	834	1,392	2,906[3]	5,132	3,572	1,265	...	-	438	5,275
1972	773	1,123	2,524[3]	4,420	2,448	1,216	...	692	187	4,543
1973	716	1,415	2,130[3]	4,261	196	931	...	1,021	163	2,311
1974	475	1,186	2,003[3]	3,664	337	767	..	50	432	1,586
1975	743	1,463	1,740	3,946	1,392	604	261	-	525	2,782
1976	865	2,541	2,212	5,618	1,861	1,051	136	186	2,006	5,240
1977	763	2,167	1,895	4,825	782	960	124	265	1,723	3,854
1978	757	1,841	1,529	4,127	1,592	692	78	98	2,044	4,504
1979	973	2,489	1,752	5,214	962	594	34	238	309	2,137
1980	1,679	3,498	2,121	7,298	1,273	1,140	38	203	406	3,060
1981	2,593	3,753	2,210	8,556	719	1,435	31	1	341	2,527
1982	2,920	3,877	1,421	8,218	1,069	1,545	92	-	354	3,060
1983	1,571	3,722	988	6,281	5,725	1,657	112	65	1,836	9,395
1984	1,717	3,509	933	6,159	4,638	1,274	120	277	25	6,334
1985	4,105	4,772	1,474	10,351	4,582	1,785	128	415	1,347	8,257
1986	4,686	4,811	1,357	10,854	3,896	1,681	157	458	358	6,550
1987	4,140	5,198	1,085	10,423	9,223	3,145	252	526	774	13,920
1988	2,278	3,047[4]	1,075	6,400	2,647	4,614[4]	220	489	109	8,098[5]
1989	2,527	3,156	1,304	6,987	3,298	3,418	122	353	590	7,802[5]
1990	2,277	3,006	1,471	6,754	2,079	3,146	137	304	365	6,031
1991	3,256	3,809	1,747	8,812	750	2,310	161	64	54	3,339
1992[6]	3,294	4,567	2,019	9,880	1,881	2,561	135	31	116	4,724

[1] Includes other Pandalid shrimp.
[2] Includes small amounts of other Pandalid shrimp.
[3] Includes Sub-area IV.
[4] Working Group figure.
[5] Includes respectively for 1988 and 1989, 19 and 21 tonnes by the Netherlands.
[6] Preliminary.

Table 6.3.1 Pandalus borealis landings and discards from divisions IIIa (Skagerrak) and IVa (eastern part)(Norwegian Deeps) as estimated by the Working Group

Year	Denmark	Norway	Sweden	Total Landings	Estimated discards
1970	1,102	1,729	2,742	5,573	-
1971	1,190	2,486	2,906	6,582	-
1972	1,017	2,477	2,524	6,018	-
1973	755	2,333	2,130	5,218	-
1974	530	1,809	2,003	4,342	-
1975	817	2,339	2,003	5,159	-
1976	1,204	3,348	2,529	7,081	-
1977	1,120	3,004	2,019	6,143	-
1978	1,459	2,440	1,609	5,508	-
1979	1,062	3,040	1,787	5,889	-
1980	1,678	4,562	2,159	8,399	-
1981	2,593	5,183	2,241	10,017	-
1982	3,766	5,042	1,450	10,258	-
1983	1,567	5,361	1,136	8,064	-
1984	1,747	4,783	1,022	7,552	-
1985	3,827	6,646	1,571	12,044	584
1986	4,834	6,490	1,463	12,787	477
1987	4,599	8,343	1,321	14,263	808
1988	3,068	7,661	1,278	12,007	830
1989	3,150	6,411	1,433	10,994	1548
1990	2,479	6,139	1,540	10,158	1723
1991	3,583	6,119	1,917	11,619	765
1992	3,725	7,148	2,154	13,027	727

Table 6.3.2 Catch (tonnes) and effort by fleet, year and quarter for Pandalus borealis in Div.IIIa and IVa E

	Denmark		Norway		Sweden	
Quarter	Catch	effort	Catch	effort	Catch	effort
Year	(t)	days	(t)	(Khrs)	(t)	(Khrs)
1	336	827	1402		183	8,6
2	264	898	1053	no	234	12,4
3	800	1410	1751	data	393	11,3
4	347	735	577		213	8,0
1984	**1747**	**3869**	**4783**		**1022**	**40,2**
1	410	1002	1679		208	7,4
2	909	1476	2051	no	491	17,0
3	1482	1688	1600	data	484	14,5
4	1026	1160	1316		387	10,1
1985	**3827**	**5326**	**6646**		**1571**	**48,9**
1	914	1451	1661	40,8	282	8,3
2	1656	3482	1660	50,9	500	18,8
3	1464	2343	1664	47,4	383	12,4
4	800	1424	1505	40,0	299	9,7
1986	**4834**	**8700**	**6490**	**179,2**	**1463**	**49,2**
1	1069	2192	2687	57,5	328	11,3
2	1511	3188	2722	77,5	388	19,3
3	1051	1952	1336	37,3	312	14,1
4	968	1880	1598	57,7	293	12,5
1987	**4599**	**9212**	**8343**	**230,1**	**1321**	**57,2**
1	1111	2296	2675	61,4	296	11,5
2	1094	2616	2254	78,0	429	20,6
3	502	1240	1623	61,2	268	12,1
4	361	953	1109	50,0	285	12,7
1988	**3068**	**7104**	**7661**	**250,5**	**1278**	**56,9**
1	529	1545	1707	58,9	297	13,0
2	1037	2633	1476	70,6	461	21,9
3	1111	2039	2071	80,6	391	14,6
4	473	1260	1157	63,2	264	13,4
1989	**3150**	**7477**	**6411**	**273,3**	**1413**	**62,8**
1	373,1	650	1454	39,4	346	10,4
2	649,7	1554	1777	84,8	333	18,8
3	884,6	1161	1568	57,6	509	15,8
4	571,7	871	1340	50,0	354	13,3
1990	**2479**	**4236**	**6139**	**231,8**	**1542**	**58,3**
1	764	1317	1758	51,2	494	14,4
2	1024	1932	1305	53,0	497	18,4
3	991	1194	1759	57,1	516	15,0
4	804	1044	1297	39,9	411	13,2
1991	**3583**	**5487**	**6119**	**201,1**	**1917**	**61,0**
1	1192	1724	2658	53,2	706	20,4
2	912	1880	1743	55,9	536	24,5
3	901	1259	1645	63,3	503	20,4
4	720	1012	1102	35,1	409	15,0
1992	**3725**	**5875**	**7148**	**207,4**	**2154**	**80,3**

Table 6.3.3 Virtual Population Analysis. Catch in numbers at age. Pandalus borealis in Div.IIIa and IVa E

Run title : Pandalus IIIa + IVb Assessment

At 17/03/1993 13:40

Traditional vpa Terminal Fs estimated using Laurec-Shepherd

Table 1 Catch numbers at age Numbers*10**- 6

YEAR,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
AGE								
0,	40,	14,	13,	52,	100,	23,	49,	64,
1,	790,	931,	952,	627,	1490,	1599,	1232,	1053,
2,	1328,	1001,	1006,	658,	664,	1084,	1130,	1265,
3,	267,	560,	589,	402,	423,	147,	311,	611,
4,	121,	36,	124,	269,	58,	44,	31,	10,
+gp,	0,	2,	12,	1,	0,	4,	0,	0,
TOTALNUM,	2546,	2544,	2696,	2009,	2735,	2901,	2753,	3003,
TONSLAND,	12628,	13234,	15072,	12857,	12542,	11852,	12323,	13734,
SOPCOF %,	93831,	95433,	109653,	103360,	88213,	96311,	100858,	95615,

Table 6.3.4 Virtual Population Analysis. Catch weights at age (kg). Pandalus borealis in Div.IIIa and IVa E

Run title : Pandalus IIIa + IVb Assessment

At 17/03/1993 13:40

Traditional vpa Terminal Fs estimated using Laurec-Shepherd

Table 2 Catch weights at age (kg)

YEAR,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
AGE								
0,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,
1,	.0030,	.0033,	.0026,	.0029,	.0034,	.0030,	.0031,	.0033,
2,	.0054,	.0055,	.0046,	.0054,	.0066,	.0053,	.0051,	.0049,
3,	.0092,	.0085,	.0086,	.0091,	.0093,	.0082,	.0071,	.0074,
4,	.0123,	.0125,	.0116,	.0127,	.0128,	.0104,	.0099,	.0105,
+gp,	.0162,	.0161,	.0142,	.0000,	.0000,	.0137,	.0000,	.0000,

Table 6.3.5 Virtual Population Analysis. Tuning input file. Pandalus borealis in Div.IIIa and IVa E

```
PANDALUS IIIA-IV TUNING-REVISED (DISCARDS INCLUDED)
103
DENMARK
85,92
1,1
1,5
5326,274,405,54,16,0
8700,342,362,203,11,.2
9212,300.5,297.7,171.5,35.6,3.2
7105,74.6,244.6,111.1,54.8,0
7477,382.8,184.4,79.8,10.7,0
4236,447.8,247.6,10.6,0,0
5487,316,423,70,3,0
5875,244,474,94,0,0
NORWAY
86,92
1,1
1,5
179,455.2,528.5,291.5,20.4,1.4
230,522.4,624.0,367.1,78.0,8.3
251,429.5,355.3,253.0,192.6,0.6
273,867.5,391.6,308.6,40.1,0
232,884.3,700.6,102.8,41.0,3.7
201,681.2,526.8,182.8,24.2,0
207,609.9,579.8,435.4,5.5,0
SWEDEN
85,92
1,1
1,5
49.0,148.0,170.9,25.2,8.4,0.01
49.2,133.2,110.5,65.0,4.0,0.18
57.1,129.0,84.0,50.2,10.0,0.9
56.9,122.8,57.9,37.8,21.6,0.11
62.8,239.8,88.3,34.1,7.5,0.00
58.3,267.2,135.4,33.2,2.6,0.2
61.0,234.7,179.8,58.5,3.8,0
80.3,199.3,211.1,82.0,5.0,0
```

Table 6.3.6 Virtual Population Analysis. Tuning output.
Pandalus borealis in Div.IIIa and IVa E

```
VPA Version 3.0 (MSDOS)

At 17/03/1993  13:33

Pandalus IIIa + IVb Assessment

CPUE data from file IIIAEF92.DAT

Disaggregated Qs
Log transformation
The final F is the (reciprocal variance-weighted) mean of the raised fleet F's.
No trend in Q (mean used)

Terminal Fs estimated using  Laurec-Shepherd

Tuning converged after    8 iterations

Total of the absolute F residuals for all ages in the
last year, between iterations  7 and   8 =   .000

Regression weights
     , 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000

Oldest age F = 1.000*average of 2 younger ages.

Fishing mortalities
  Age,  1985,  1986,  1987,  1988,  1989,  1990,  1991,  1992

    0,  .003,  .001,  .002,  .005,  .006,  .001,  .004,  .010
    1,  .083,  .186,  .223,  .235,  .342,  .220,  .170,  .207
    2,  .425,  .261,  .606,  .448,  .849,  .931,  .452,  .501
    3,  .803,  .629,  .458, 1.150, 1.317,  .972, 2.106, 1.002
    4,  .614,  .445,  .532,  .799, 1.083,  .952, 1.279,  .751

Log catchability residuals

 Fleet : DENMARK

 Age ,  1985,  1986,  1987,  1988,  1989,  1990,  1991,  1992
   1 ,  -.37,   .00,  -.02,  -.69,   .41,   .62,   .01,   .04
   2 ,  -.05,  -.86,  -.28,  -.09,   .21,   .67,   .18,   .22
   3 ,   .02,  -.13,  -.73,   .40,   .10,  -.59,  1.06,  -.13

 Fleet : NORWAY

 Age ,  1985,  1986,  1987,  1988,  1989,  1990,  1991,  1992
   1 ,      ,  -.11,  -.05,   .13,   .26,  -.07,  -.19,   .03
   2 ,      ,  -.53,   .22,  -.31,   .33,   .68,  -.23,  -.17
   3 ,      ,  -.43,  -.82,   .02,   .22,   .04,   .78,   .20

 Fleet : SWEDEN

 Age ,  1985,  1986,  1987,  1988,  1989,  1990,  1991,  1992
   1 ,  -.58,  -.05,  -.07,   .36,   .44,   .11,  -.07,  -.15
   2 ,   .04,  -.61,  -.19,  -.44,   .52,   .62,   .09,  -.03
   3 ,  -.23,  -.27, -1.05,  -.02,  -.14,   .66,  1.21,  -.15


                        SUMMARY STATISTICS FOR AGE  1
Fleet , Pred.  , SE(q),Partial,Raised,   SLOPE    ,    SE     ,INTRCPT,  SE
      ,  q     ,      ,   F   ,  F    ,           ,  Slope ,          ,Intrcpt
 1  ,-11.76  ,  .432, .0460 , .1985,   .710E-01,  .614E-01,-11.758,   .144
 2  , -7.48   ,  .162, .1165 , .2012,  -.223E-02,  .314E-01, -7.482,   .057
 3  , -7.48   ,  .334, .0454 , .2400,   .419E-01,  .497E-01, -7.477,   .111
 Fbar      SIGMA(int.)    SIGMA(ext.)    SIGMA(overall)  Variance ratio
  .207       .138           .476E-01        .138           .118

                        SUMMARY STATISTICS FOR AGE  2
Fleet , Pred.  , SE(q),Partial,Raised,   SLOPE    ,    SE     ,INTRCPT,  SE
      ,  q     ,      ,   F   ,  F    ,           ,  Slope ,          ,Intrcpt
 1  ,-10.57  ,  .475, .1507 , .4023,   .122E+00,  .555E-01,-10.571,   .158
 2  , -6.64   ,  .454, .2717 , .5928,   .426E-01,  .859E-01, -6.636,   .161
 3  , -6.84   ,  .449, .0862 , .5166,   .761E-01,  .634E-01, -6.837,   .150
 Fbar      SIGMA(int.)    SIGMA(ext.)    SIGMA(overall)  Variance ratio
  .501       .265           .112            .265           .178

                        SUMMARY STATISTICS FOR AGE  3
Fleet , Pred.  , SE(q),Partial,Raised,   SLOPE    ,    SE     ,INTRCPT,  SE
      ,  q     ,      ,   F   ,  F    ,           ,  Slope ,          ,Intrcpt
 1  ,-10.42  ,  .596, .1758 ,1.1430,   .598E-01,  .904E-01,-10.417,   .199
 2  , -5.87   ,  .546, .5846 , .8203,   .183E+00,  .669E-01, -5.870,   .193
 3  , -6.24   ,  .712, .1563 ,1.1647,   .154E+00,  .925E-01, -6.242,   .237
 Fbar      SIGMA(int.)    SIGMA(ext.)    SIGMA(overall)  Variance ratio
 1.002       .350           .118            .350           .114
```

Table 6.3.7 Virtual Population Analysis. Fishing mortality at age. Pandalus borealis in Div.IIIa and IVa E

Run title : Pandalus IIIa + IVb Assessment

At 17/03/1993 13:40

Traditional vpa Terminal Fs estimated using Laurec-Shepherd

Table 8 Fishing mortality (F) at age

YEAR,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	FBAR 85-90
AGE									
0,	.0035,	.0014,	.0021,	.0049,	.0059,	.0014,	.0042,	.0100,	.0032,
1,	.0831,	.1855,	.2234,	.2348,	.3418,	.2202,	.1697,	.2071,	.2148,
2,	.4247,	.2612,	.6062,	.4482,	.8486,	.9314,	.4516,	.5008,	.5867,
3,	.8028,	.6287,	.4579,	1.1497,	1.3170,	.9725,	2.1064,	1.0015,	.8881,
4,	.6137,	.4449,	.5320,	.7989,	1.0828,	.9520,	1.2790,	.7512,	.7374,
+gp,	.6137,	.4449,	.5320,	.7989,	1.0828,	.9520,	1.2790,	.7512,	
FBAR 1- 3,	.4369,	.3584,	.4291,	.6109,	.8358,	.7080,	.9092,	.5698,	
FBAR 2- 4,	.6137,	.4449,	.5320,	.7989,	1.0828,	.9520,	1.2790,	.7511,	

Table 6.3.8 Virtual Population Analysis. Stock number, total and spawning biomass. Pandalus borealis in Div.IIIa and IVa E

Run title : Pandalus IIIa + IVb Assessment

At 17/03/1993 13:40

Traditional vpa Terminal Fs estimated using Laurec-Shepherd

Table 10 Stock number at age (start of year) Numbers*10**-6

YEAR,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	AMST 85-90
AGE										
0,	16414,	14135,	8905,	15240,	24158,	23541,	16796,	9136,	0,	17065,
1,	14013,	7727,	6668,	4198,	7164,	11344,	11105,	7901,	4273,	8519,
2,	5315,	6091,	3032,	2519,	1568,	2404,	4299,	4427,	3034,	3488,
3,	655,	1642,	2216,	781,	760,	317,	447,	1293,	1267,	1062,
4,	361,	139,	414,	662,	117,	96,	57,	26,	224,	298,
+gp,	0,	8,	40,	2,	0,	9,	0,	0,	6,	
TOTAL,	36758,	29741,	21274,	23402,	33766,	37712,	32705,	22783,	8804,	
TOTALBIO,	97,	89,	65,	56,	67,	74,	77,	67,	'000 tonnes	
TOTSPBIO,	21,	14,	20,	14,	10,	9,	14,	18,	'000 tonnes	

Table 6.3.9 Indices of 0- and 1-group shrimp from Norwegian trawl surveys in October, VPA values and regression equation

	Survey		VPA
Year-class	0-gr (IIIa)	1-gr(IIIa)	1-gr
1983		7023	
1984	3077	20902	14013
1985	1813	6914	7727
1986	1432	5988	6668
1987	675	2541	4198
1988	2002	8714	7164
1989	9388	10743	11344
1990	4052	12116	11105
1991	1877	10739	**7529**
1992	19967		**20037**

Bold figures estimated from the following equation

$$\ln(\text{VPA 1-gr}) = 0.414 \ln(\text{0-gr index}) + 5.806$$

Table 6.3.10 Pandalus borealis IIIa and IVa E. Prediction input.

List of input variables for the prediction

PANDALUS IN SKAGERRAK (IIIA) AND NORWEGIAN DEEP (IVA E)
The reference F is the mean F (non weighted) for the age group range 1 to 3

The number of 0 Group recruits per year is as follows:

Year	Recruitment
1993	17065
1994	17065
1995	17065

The number of 1 Group shrimps from the 1992 year class is taken to be 11000

Proportion of F (fishing mortality) effective before spawning: .200
Proportion of M (natural mortality) effective before spawning: .250

Data are printed in the following units:

Number of fish:	millions
Weight by age group in the catch:	gram
Weight by age group in the stock:	gram
Stock biomass:	000 tonnes
Catch weight	000 tonnes

age	stock size	fishing pattern	natural mortality	maturity ogive	Wt in the catch	Wt in the stock
0	17065	0.003	0.75	.00	1.00	1.00
1	11000	0.217	0.75	.00	3.08	3.08
2	3034	0.594	0.75	0.68	5.35	5.35
3	1267	0.899	0.75	1.00	8.41	8.41
4	224	0.746	0.75	1.00	11.58	11.58
5+	6	0.746	0.75	1.00	15.05	15.05

Table 6.3.11 Pandalus borealis IIIa and IVa E. Prediction results.

Effects of different levels of fishing mortality on catch, stock biomass and spawning stock biomass.

PANDALUS IN SKAGERRAK (IIIA) AND NORWEGIAN DEEP (IVA E)

Year 1993						Year 1994						Year 1995	
factor	ref F	stock biomass	sp.stock biomass	catch	land	factor	ref F	stock biomass	sp.stock biomass	catch	land	stock biomass	sp.stock biomass
1.0	0.57	81	17	16	14	.0	.00	74	21	0	0	85	31
						.2	.11		21	4	3	81	27
						.4	.23		20	7	6	78	24
						.6	.34		19	10	9	75	21
						.8	.46		19	13	12	72	19
						1.0	.57		18	15	14	70	16
						1.2	.68		18	17	16	68	15
						1.4	.80		17	19	18	66	13
						1.6	.91		17	21	19	64	12
						1.8	1.03		16	23	21	63	11
						2.0	1.14		16	25	22	61	9

The data unit of the biomass and the catch is 1000 tonnes.
The spawning stock biomass is given for the time of spawning.
The spawning stock biomass for 1995 has been calculated with the same fishing mortality as for 1994.
The reference F is the mean F (non-weighted) for the age group range from 1 to 3.

Table 6.4.1 Landings (t) of Pandalus borealis from the Fladen Ground (Division IVa) as estimated by the Working Group.

Year	Denmark	Sweden	Norway	UK (Scotland)	Total
1972	2,204	-	-	187	2,391
1973	157	-	-	163	320
1974	282	-	-	434	716
1975	1,308	-	-	525	1,833
1976	1,552	-	-	1,937	3,489
1977	425	-	112	1,692	2,229
1978	890	-	81	2,027	2,998
1979	565	-	44	268	877
1980	1,122	-	76	377	1,575
1981	685	-	1	347	1,033
1982	283	-	-	352	635
1983	5,729	-	8	1,827	7,564
1984	4,553	-	13	25	4,591
1985	3,649	-	-	1,341	4,990
1986	3,416	-	-	301	3,717
1987	7,326	-	-	686	8,012
1988	1,077	-	2	84	1,163
1989	2,438	-	25	547	3,010
1990	1,681	4	3	365	2,053
1991	422	-	31	53	506
1992[1]	1,448	-	-	116	1,564

[1]Provisional

Table 6.4.2 Pandalus borealis, Fladen Ground. Reported CPUE (shrimp trawlers), and estimated total effort.

Year	Denmark			UK (Scotland)			
	CPUE (t per day)	Total effort (Days)	Index[1]	CPUE (kg per hour)	Total effort (hours)	Index[1]	Combined index[2]
1982	0.96	295	0.10	74	4757	0.31	0.22
1983	1.18	4855	1.61	89	20528	1.32	1.54
1984	0.97	4694	1.56	37	676	0.04	1.55
1985	1.21	3016	1.00	86	15593	1.00	1.00
1986	0.96	3558	1.18	71	4239	0.28	1.11
1987	1.24	5908	1.96	81	8469	0.54	1.84
1988	0.83	1298	0.43	44	1909	0.12	0.41
1989	0.99	2463	0.82	65	8415	0.54	0.77
1990	1.28	1313	0.44	106	3493	0.22	0.40
1991	1.50	281	0.09	124	429	0.03	0.08
1992	1.44	1006	0.33	69	1680	0.11	0.31

[1]Relative to 1985.
[2]Weighted by total landings.

Table 6.4.3 Pandalus. Quarterly CPUE and estimated effort(f), Fladen Ground.

		Denmark			UK (Scotland)		
Year	Quarter	CPUE (t/day)	Total catch	f	CPUE (kg/h)	Total catch	f
1984	1	1.27	2,809	2,212	-	-	-
	2	0.75	1,407	1,876	37	25	676
	3	0.57	273	479	-	-	-
	4	0.56	63	113	-	-	-
1985	1	1.16	1,742	1,502	72	359	4,986
	2	1.24	1,617	1,304	88	770	8,750
	3	1.47	289	197	114	212	1,869
	4	0.04	0.1	3	-	-	-
1986	1	1.12	1,130	1,009	72	80	1,111
	2	0.89	833	936	68	150	2,206
	3	0.94	1,255	1,335	77	71	922
	4	0.71	200	282	-	-	-
1987	1	1.21	2,336	1,931	89	131	1,473
	2	1.20	2,643	2,203	79	509	6,443
	3	1.43	2,014	1,408	78	45	577
	4	0.89	333	374	-	-	-
1988	1	0.886	637	719	46	2	40
	2	0.775	366	434	44	76	1,744
	3	0.748	37	49	-	-	-
	4	0.466	37	79	-	-	-
1989	1	0.916	546	596	53	24	453
	2	0.924	1,088	1,177	57	302	5,298
	3	1.273	671	527	83	221	2,663
	4	0.732	133	182	-	-	-
1990	1	1.59	201	126	-	-	-
	2	1.26	1,436	1,132	105	350	3,345
	3	0.52	44	84	151	148	148
	4	-	-	-	-	-	-
1991	1	1.56	57	36	73	6	82
	2	1.47	336	229	134	47	348
	3	-	-	-	-	-	-
	4	1.64	29	18			
1992	1	1.48	426	288	167	2	15
	2	1.61	816	507	85	61	716
	3	1.02	182	178	54	49	898
	4	0.61	24	39	57	4	71

Table 6.4.4 Pandalus, Fladen Ground, 1992
Mean carapace lengths (mm) at age and proportions at age. Estimated by the Bhattacharya method.

Year class	Age		Quarter 2 DK-samples	Quarter 4 DK-samples[1]
1992	0	$\bar{x}$	-	9.48
		prop.		0.01
1991	1	$\bar{x}$	13.00	15.60
		prop.	0.06	0.65
1990	2	$\bar{x}$	18.22	20.07
		prop.	0.59	0.34
1989	3	$\bar{x}$	21.41	
		prop.	0.34	

[1]Survey data

Table 6.4.5 Virtual Population Analysis. Catch in numbers at age. Pandalus borealis in Fladen Ground (IVa).

Run title : Pandalus FLADEN Assessment

At 18/03/1993 12:15

Table 1 Catch numbers at age Numbers*10**-6

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
AGE									
1,	312,	354,	359,	540,	16,	306,	43,	11,	24,
2,	597,	875,	586,	1475,	313,	327,	480,	53,	200,
3,	286,	195,	160,	165,	31,	201,	23,	46,	115,
+gp,	0,	0,	0,	0,	0,	0,	0,	0,	0,
TOTALNUM,	1195,	1424,	1105,	2180,	360,	834,	546,	110,	339,
TONSLAND,	4591,	4990,	3717,	8012,	1163,	3010,	2053,	506,	1564,

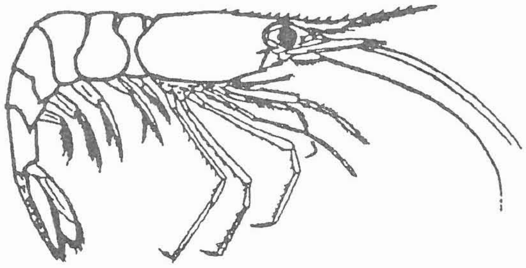
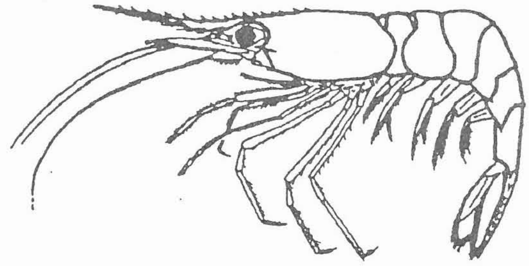
Table 6.5.1 Landings (t) of Pandalus borealis from Division IVb, the Farn Deeps as estimated by the Working Group.

Year	UK (England)	UK (Scotland)	Denmark	Total	CPUE kg/hr (Scotland)
1977	227	-	No data	-	-
1978	91	2	-	-	No data
1979	235	34	-	-	No data
1980	203	17	-	-	60
1981	1	-	-	-	-
1982	-	-	-	-	-
1983	65	-	-	-	-
1984	30	-	-	-	-
1985	2	6	-	-	70
1986	137	57	106	300	127
1987	212	86	92	390	101
1988	91	25	384	500	67
1989	168	8	72	248	44
1990	144	+	1	145	-
1991	3	-	-	3	-
1992	1	-	-	1	-

INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA
CONSEIL INTERNATIONAL POUR L´ EXPLORATION DE LA MER

C.M. 1993/Assess :11

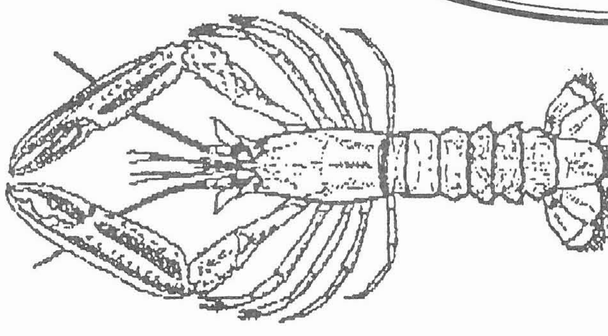
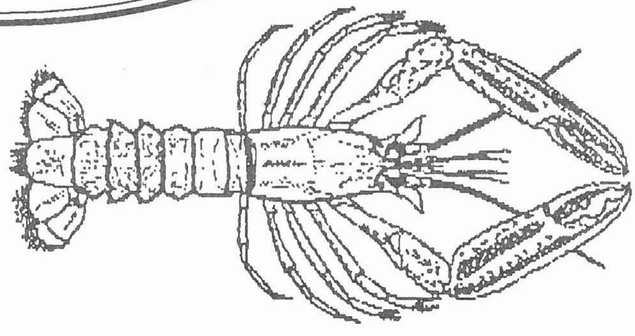
Part 2

WORKING GROUP ON *Nephrops* AND *Pandalus* STOCKS

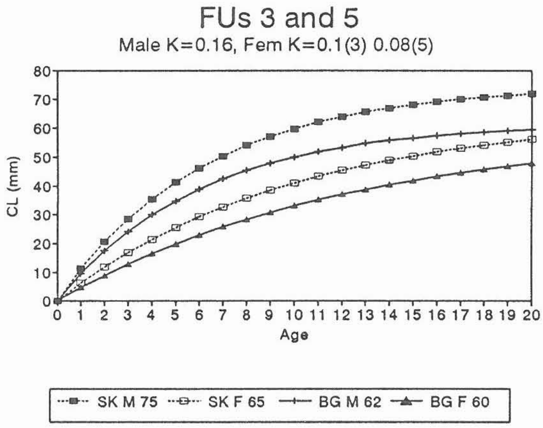
OOSTENDE, 24 FEBRUARY - 4 MARCH

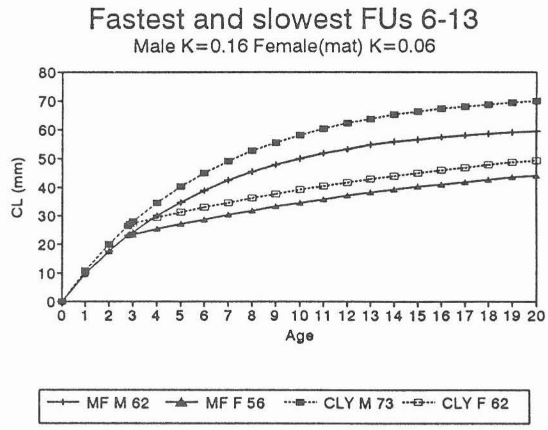
1993

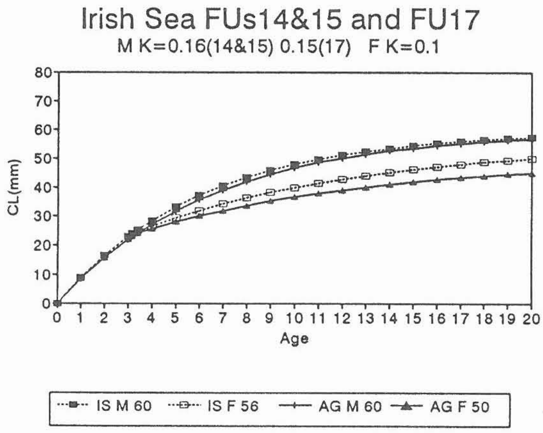



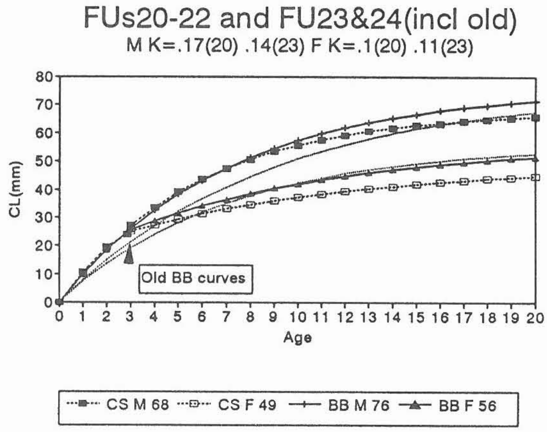
b 93

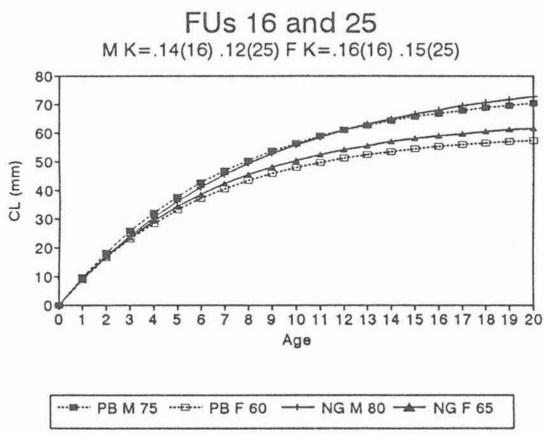
Figure 3.4.1 Von Bertalanffy growth curves used in the assessments of various Functional Units (parameter values are as given in Table 3.4.1). Note that for FUs 3,5,16,25 and 31, 'single' growth curves are used for females . For females in other FUs the growth curve is composed of two components (pre and post maturity length); female parameters given are for mature animals, immature females take male values.For FU 23&24 growth curves used previously ('Old BB values') are shown.

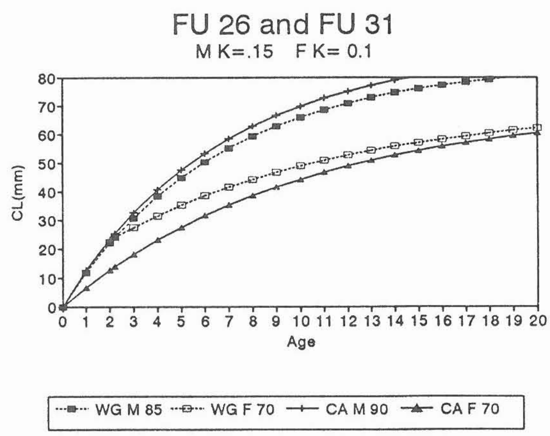












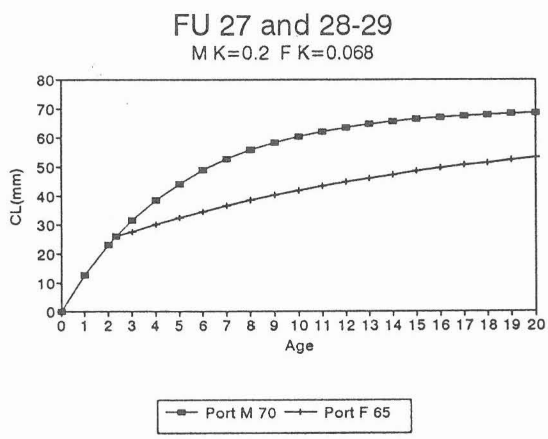


Figure 5.1.1 Nephrops Functional Units and Management Areas A and B

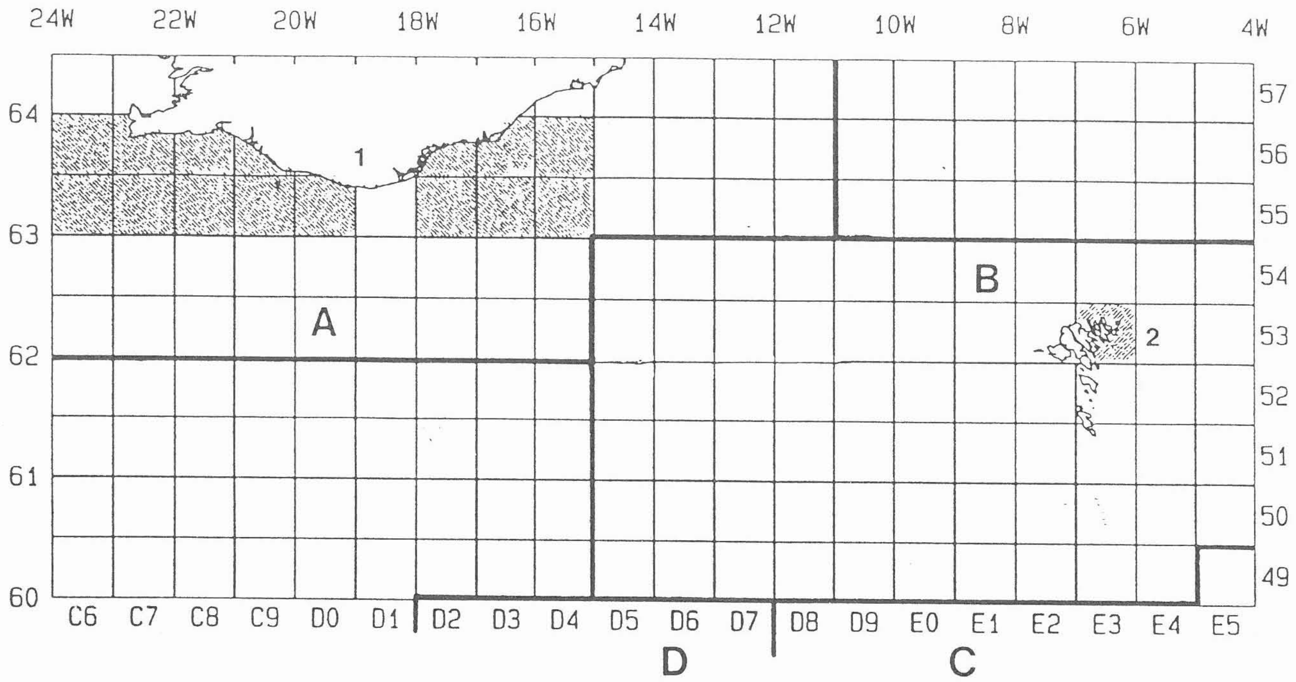


Figure 5.1.2 Nephrops Functional Units and Management Area E

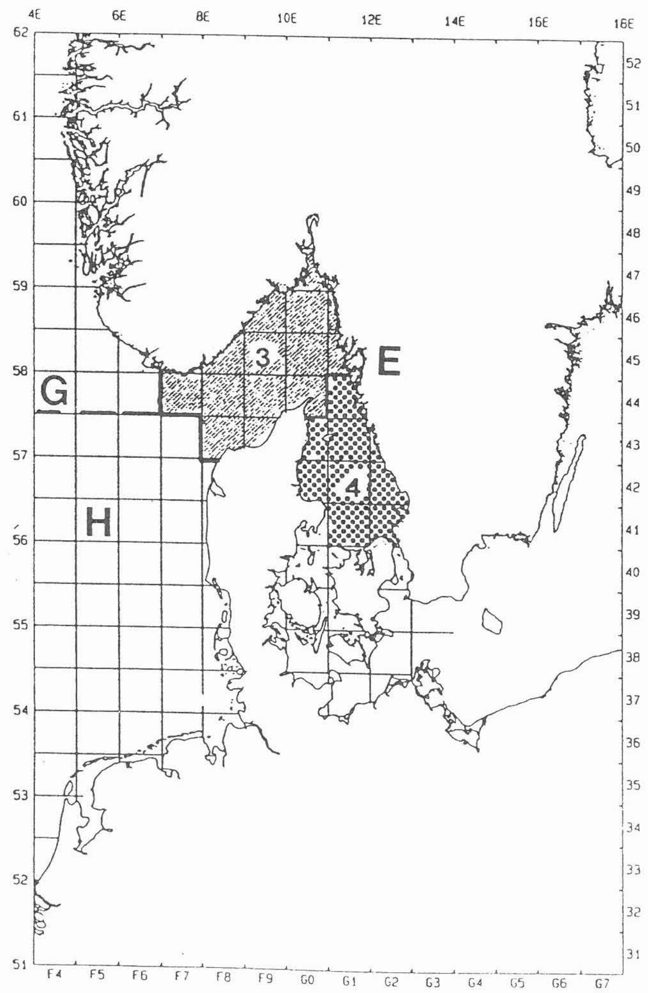


Figure 5.1.3 Nephrops Functional Units and Management Areas C to R

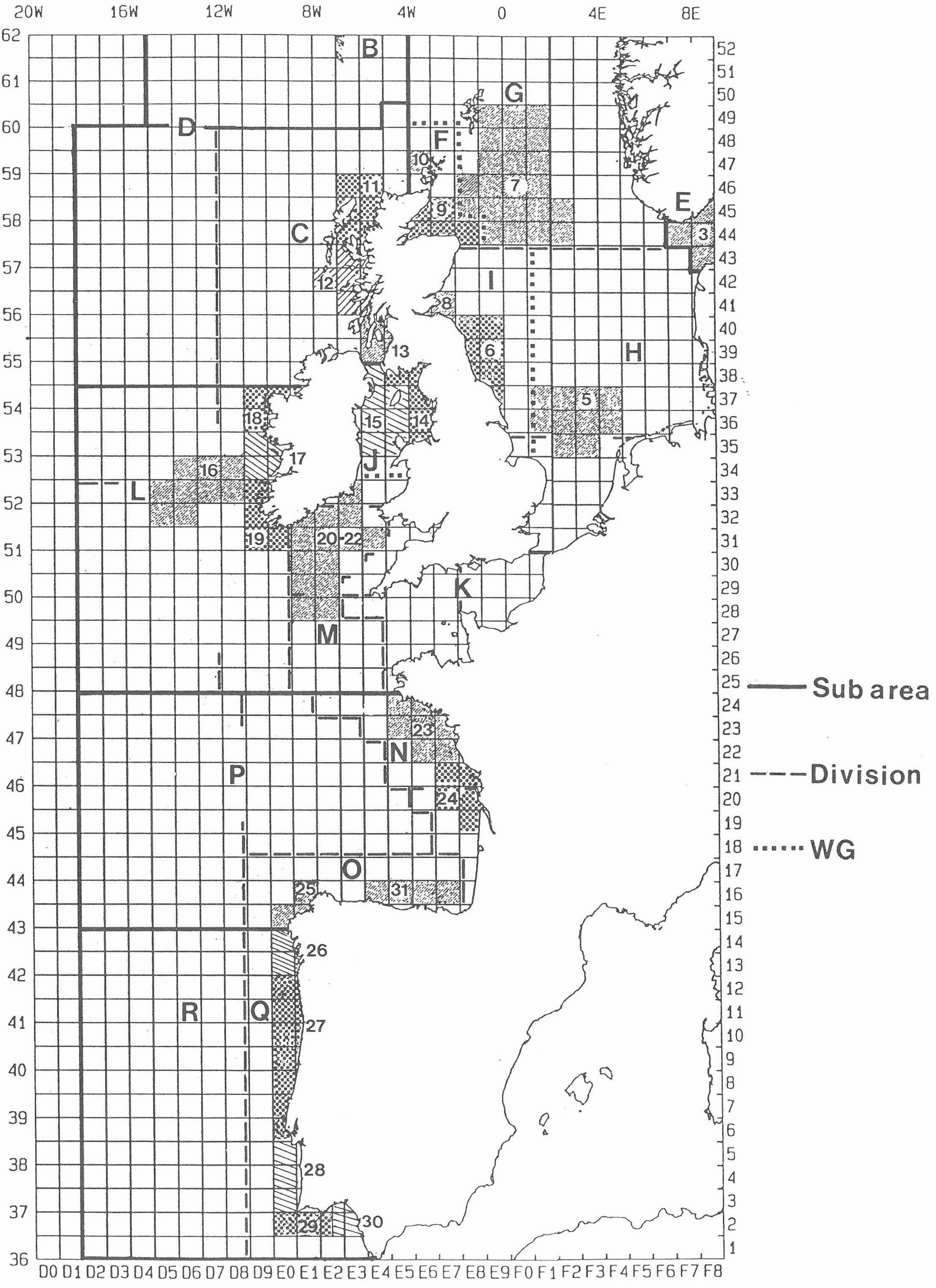


Figure 5.4.1 Functional Units 7-9 and 11-13 : Landings (tonnes) 1965-1992 by Nephrops trawlers.

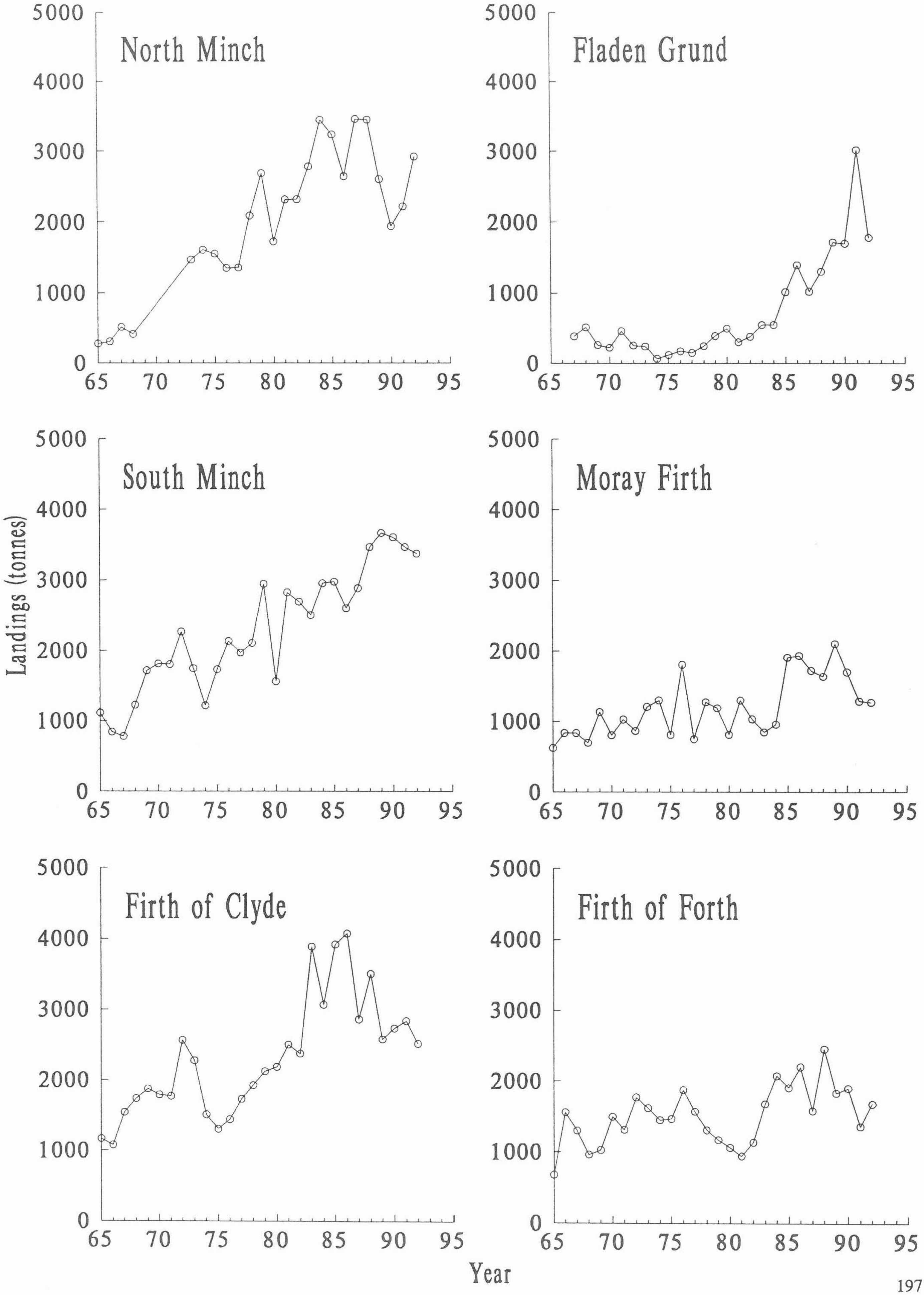


Figure 5.4.2 Functional Units 7-9 and 11-13 : Effort (hours fished) 1965-1992 by Nephrops trawlers.

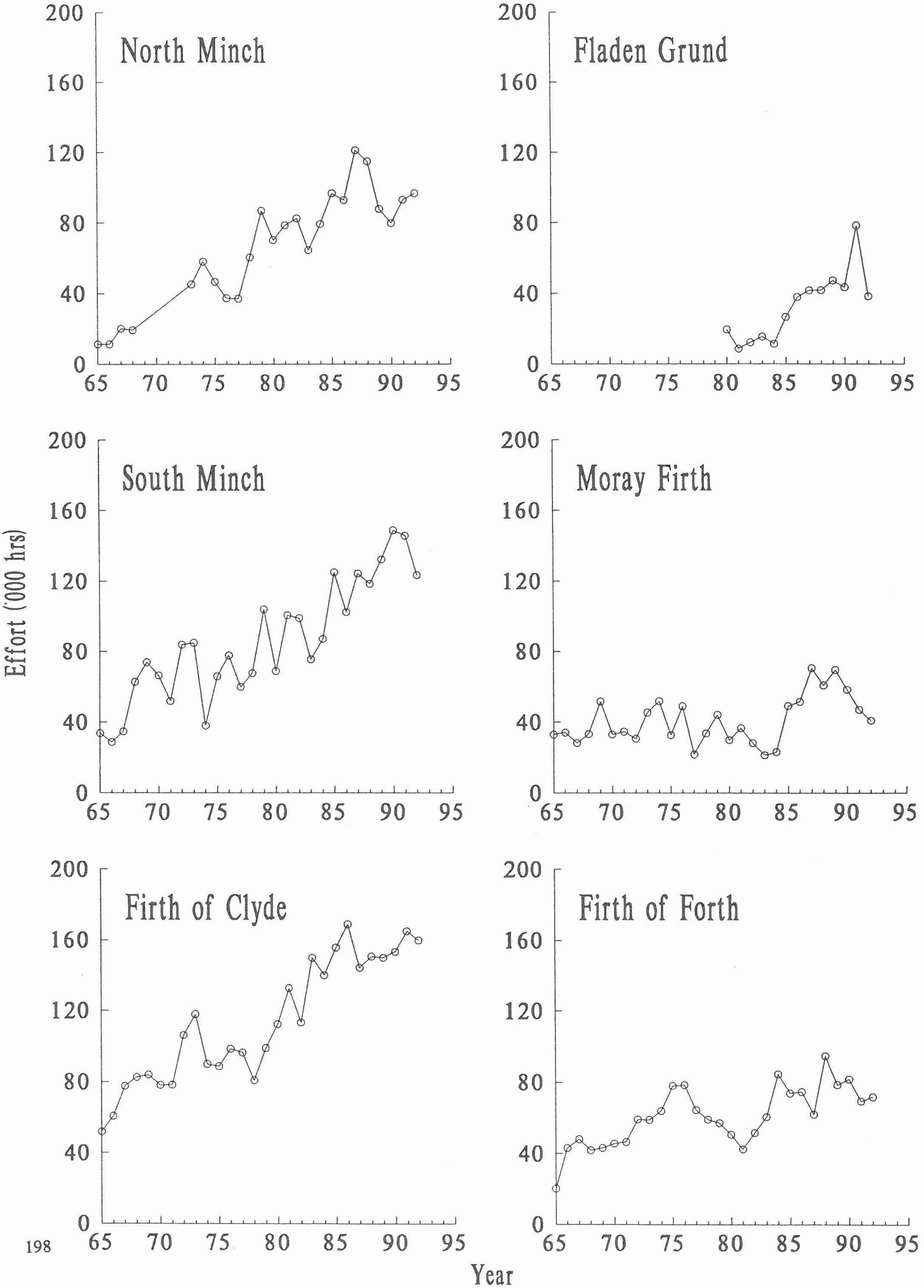


Figure 5.4.3 Functional Units 7-9 and 11-13 : LPUE (kg/hour) 1965-1992 by Nephrops trawlers.

C = Corrected for Horse-Power changes; U = Uncorrected

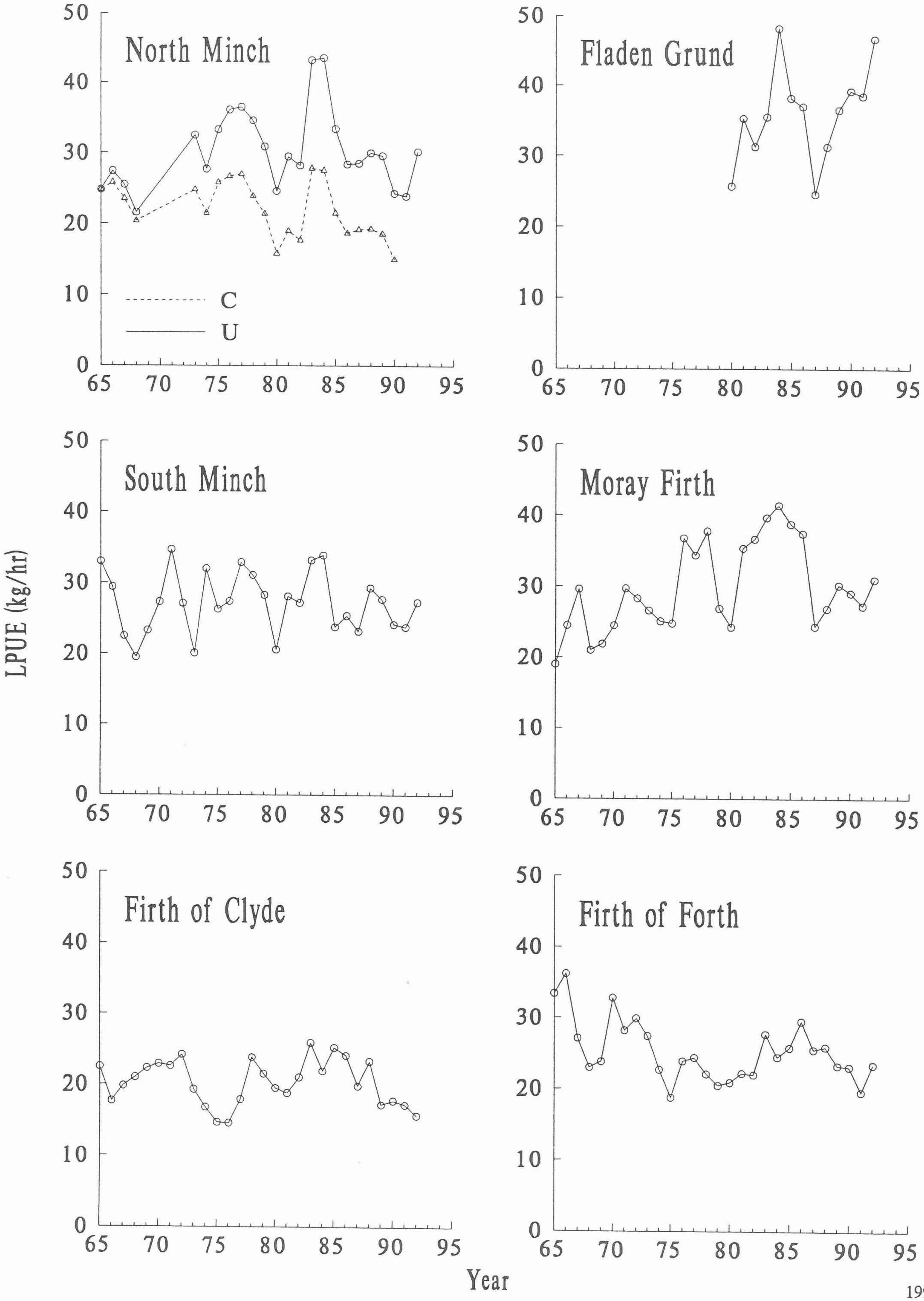


Figure 5.4.4 Functional Unit :   North Minch (11)
Percentage changes in long term landings and stock biomass and in short term landings following various percentage changes in fishing effort. Separate plots shown for males and females.

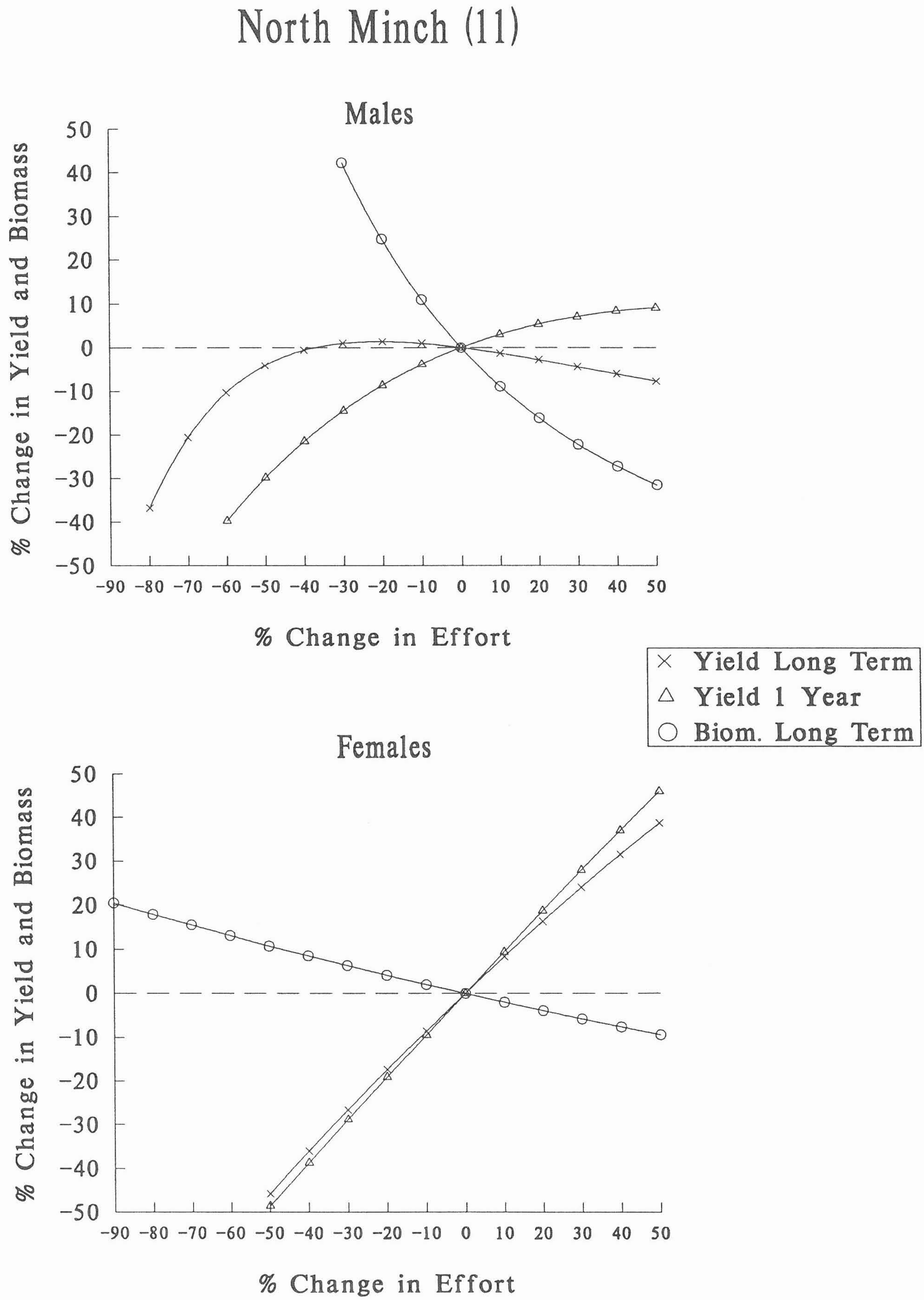


Figure 5.4.5 Functional Unit : North Minch (11)
Relationships between Fbar from VPA and fishing effort for male and female Nephrops

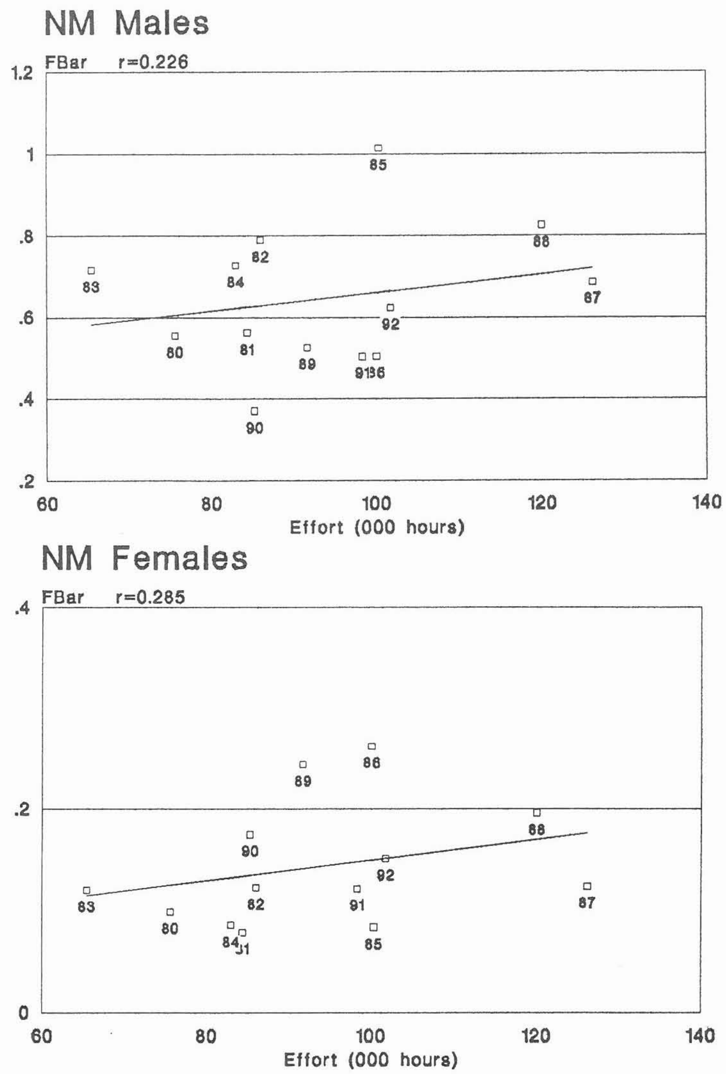


Figure 5.4.6 FU: North Minch (11)
Relationship between LPUE and combined male and female TSB

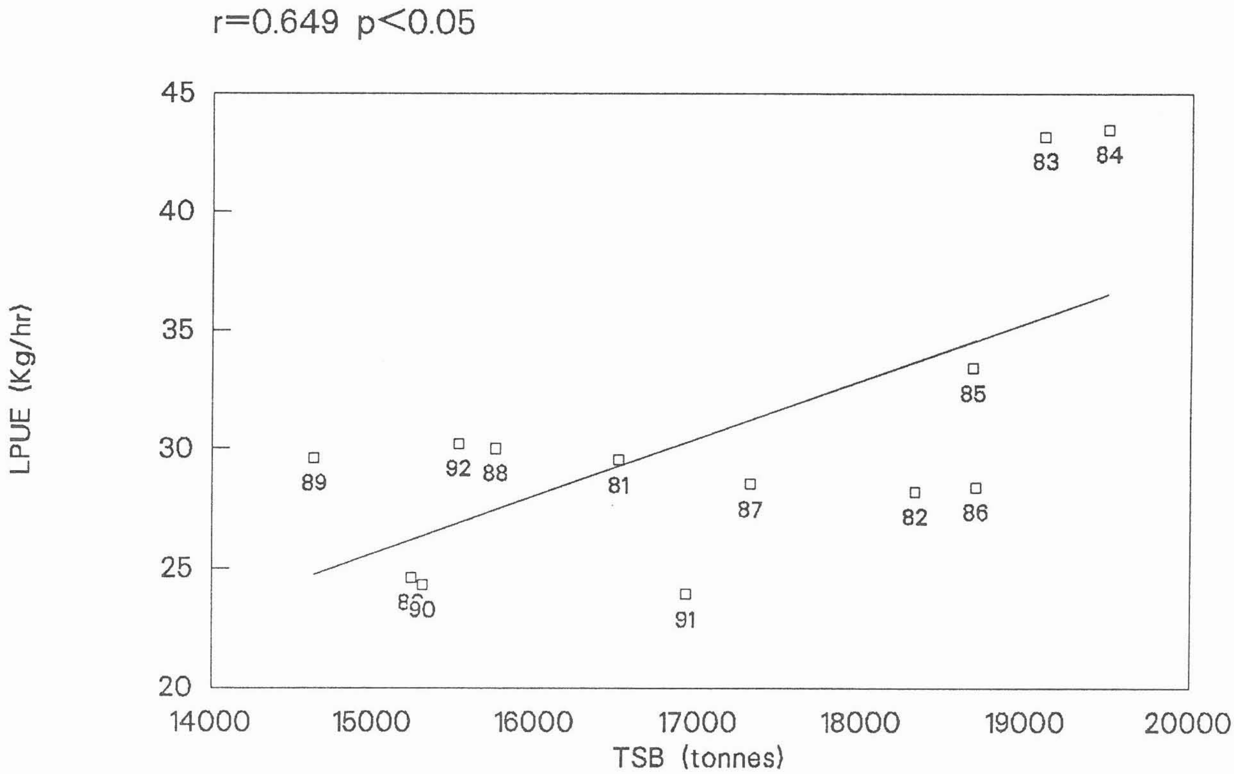
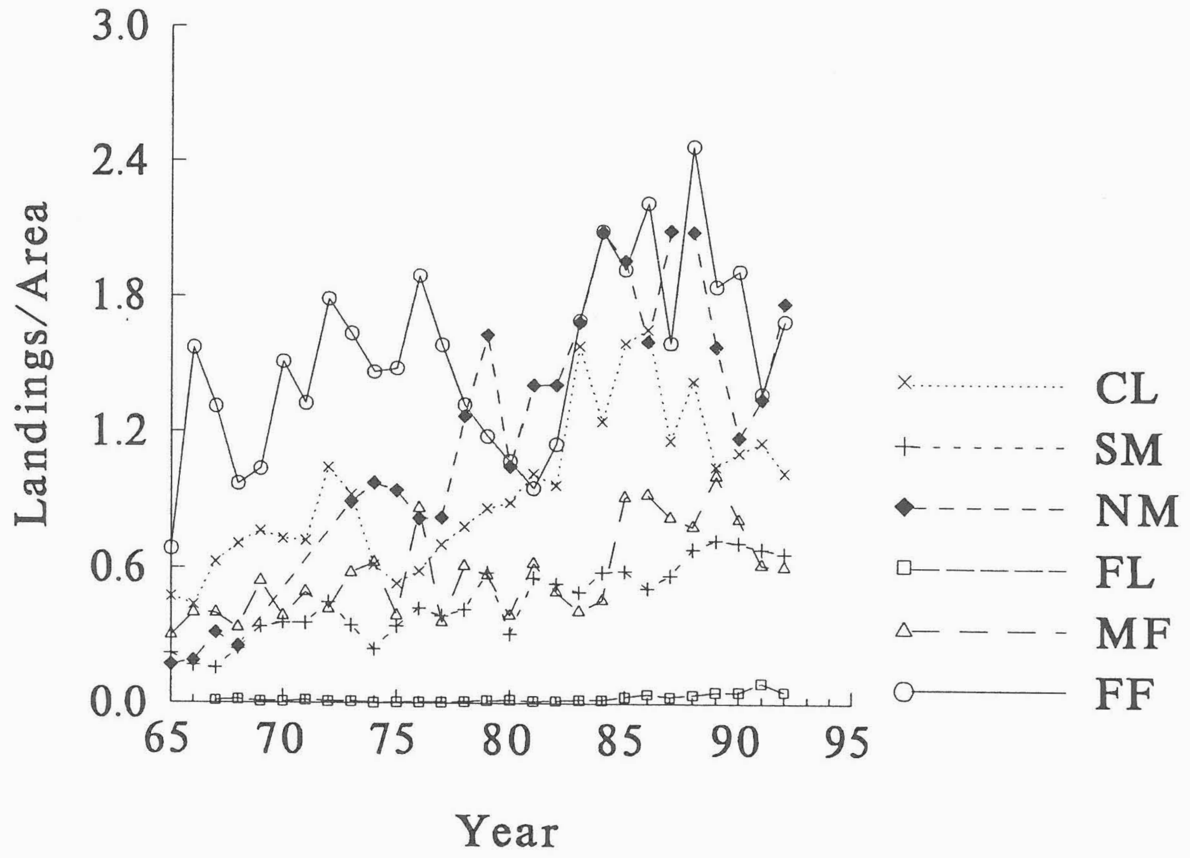


Figure 5.4.7 Nephrops Trawl Landings per unit area (tonnes per Km2) and Effort per unit area ('000 hours per Km2) on various Nephrops grounds in Scottish waters



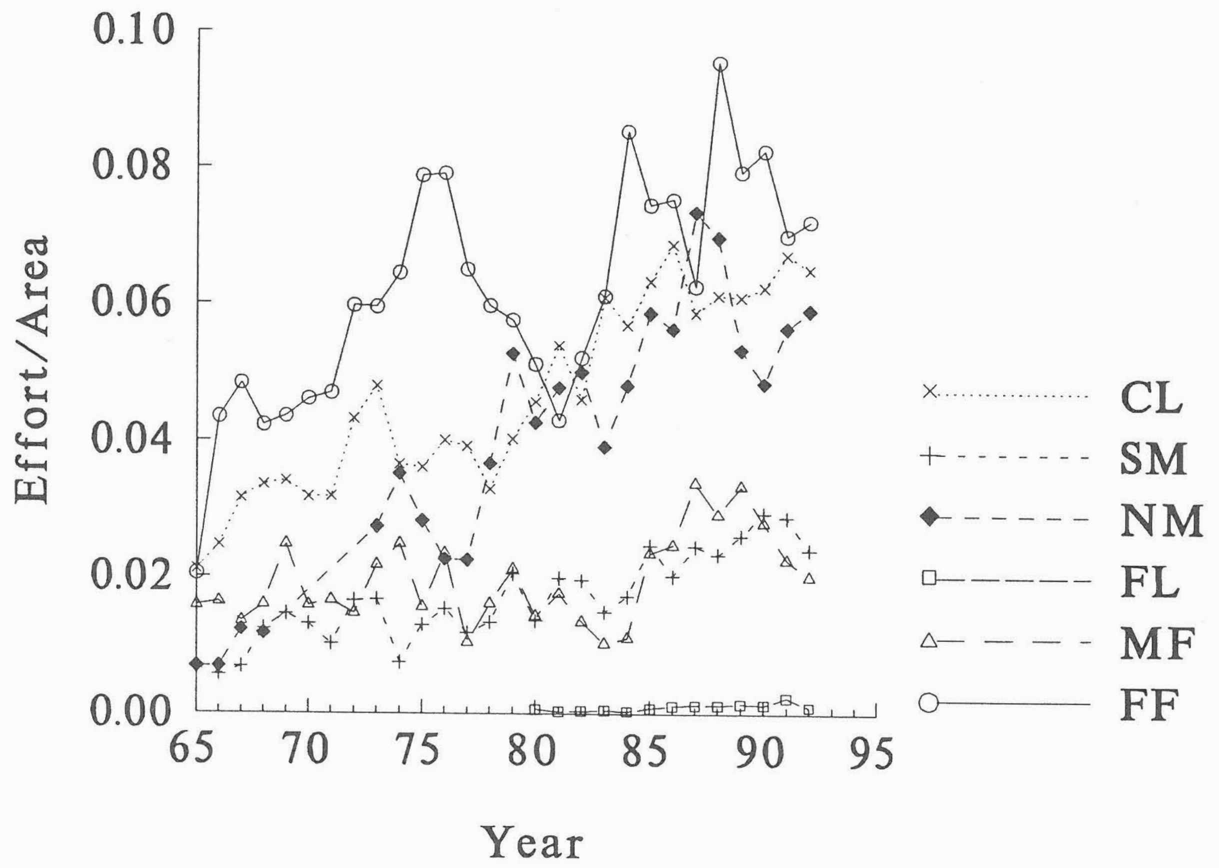


Figure 5.4.8 Functional Unit : North Minch (11)
Relationships between Landings(t) and Effort(t)
Least Squares linear regression line shown.

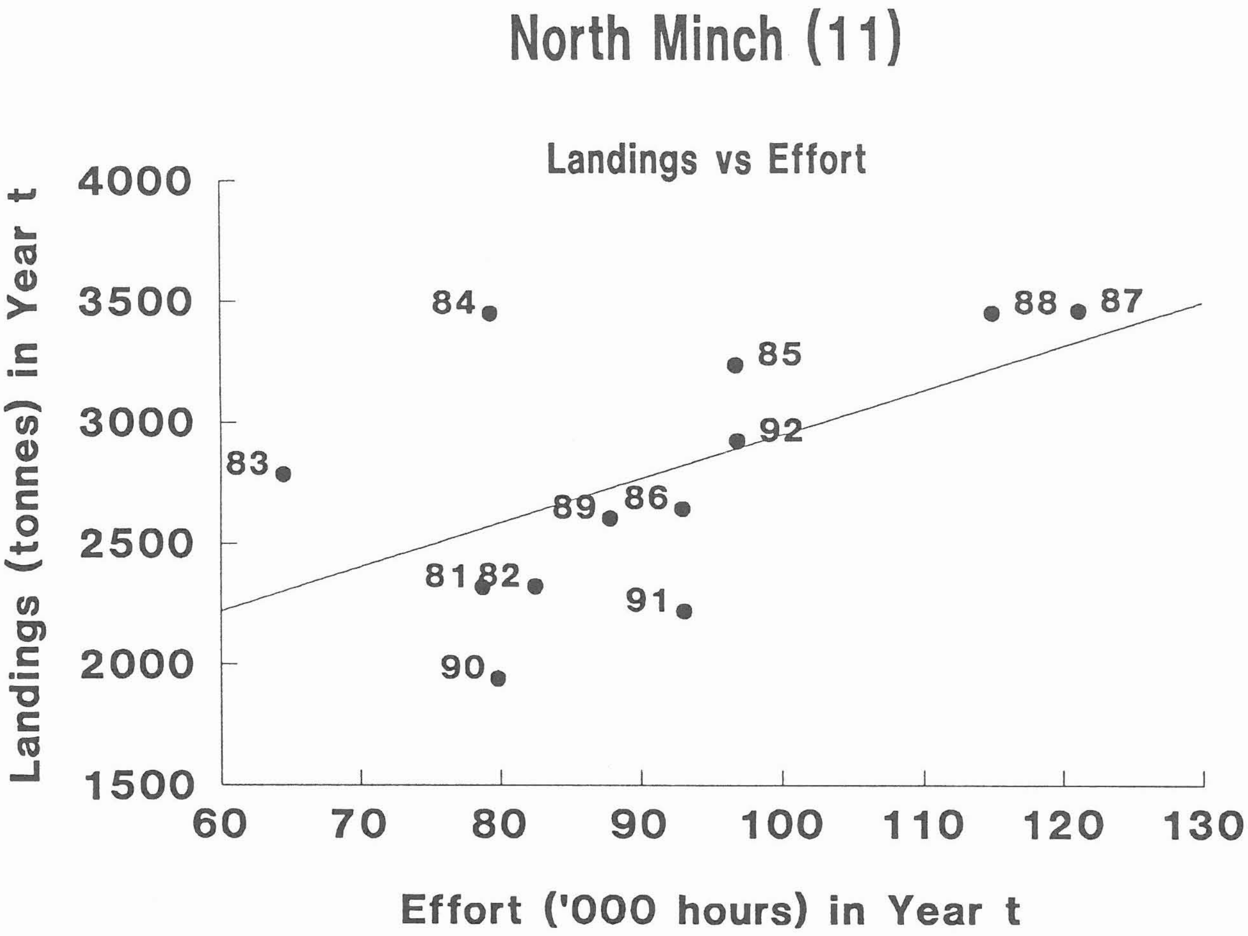


Figure 5.4.9 Functional Unit : South Minch (12)
Percentage changes in long term landings and stock biomass and in short term landings following various percentage changes in fishing effort. Separate plots shown for males and females.

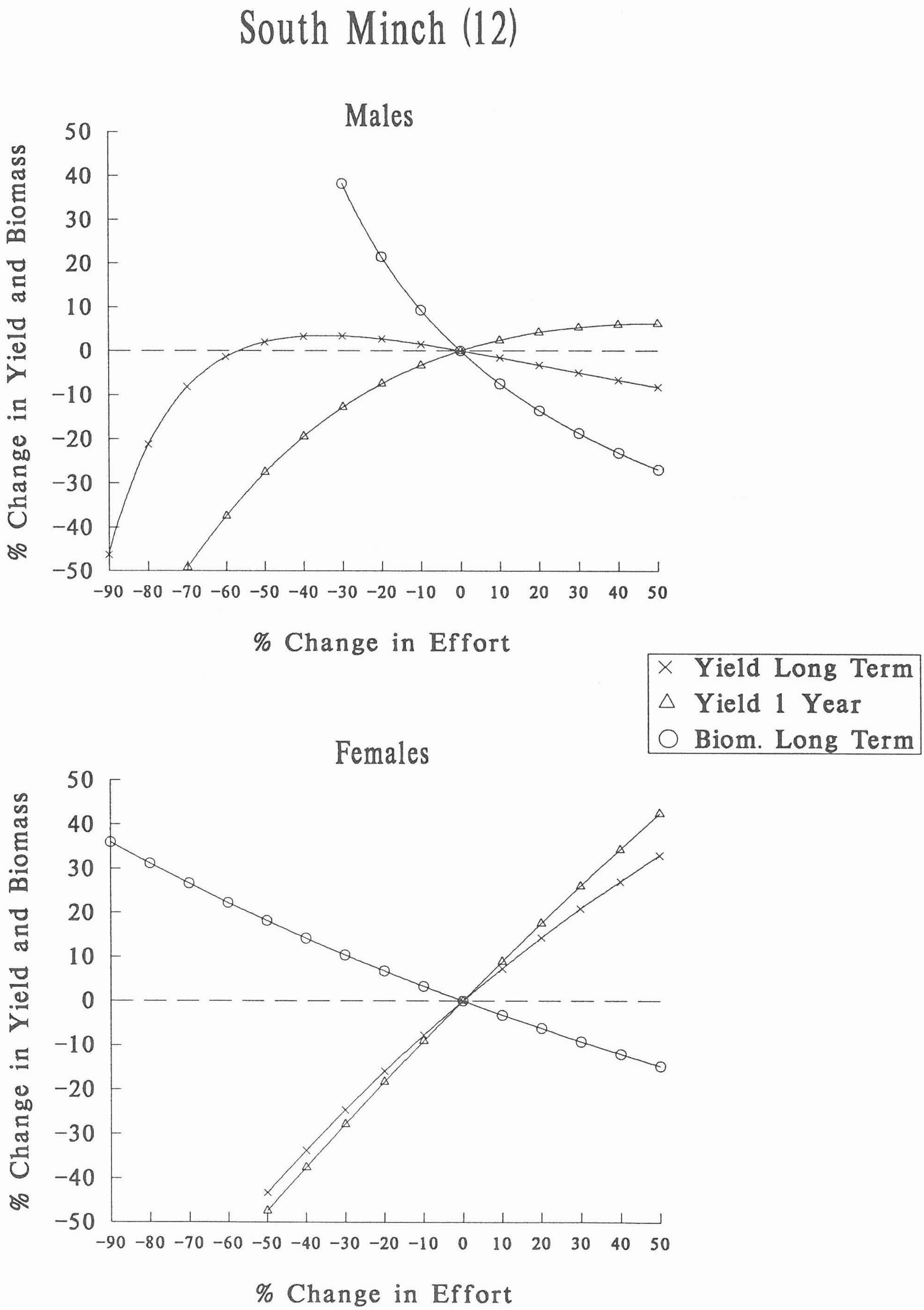
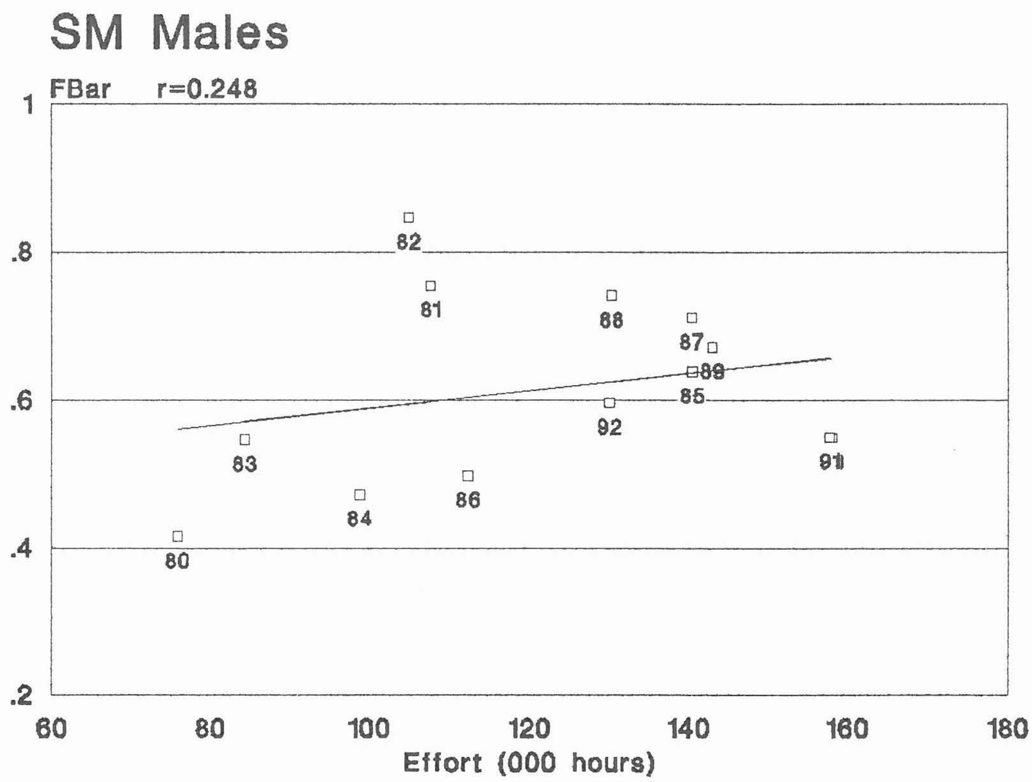


Figure 5.4.10 Functional Unit : South Minch (12)
Relationships between Fbar from VPA and fishing effort for male and female Nephrops



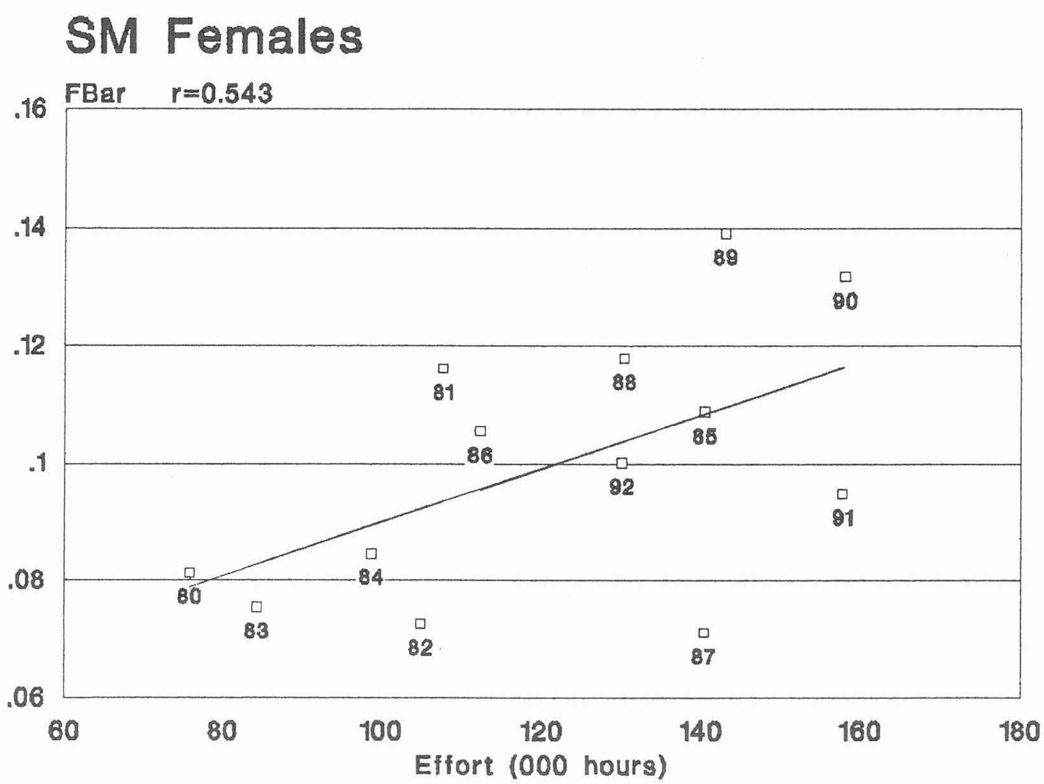


Figure 5.4.11 FU: South Minch (12)
Relationship between LPUE and combined male and female TSB

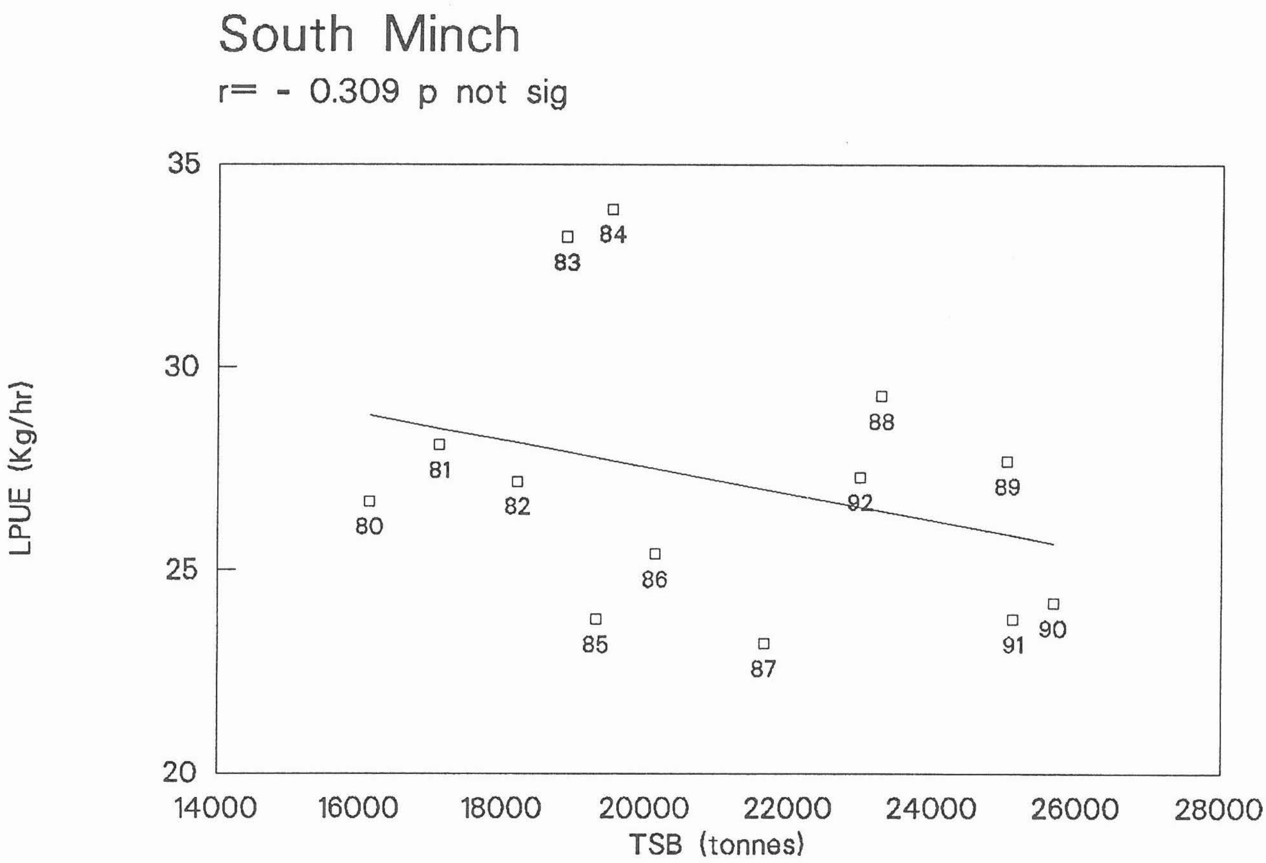


Figure 5.4.12 Functional Unit : South Minch (12)
Relationships between Landings(t) and Effort(t)
Least Squares linear regression line shown.

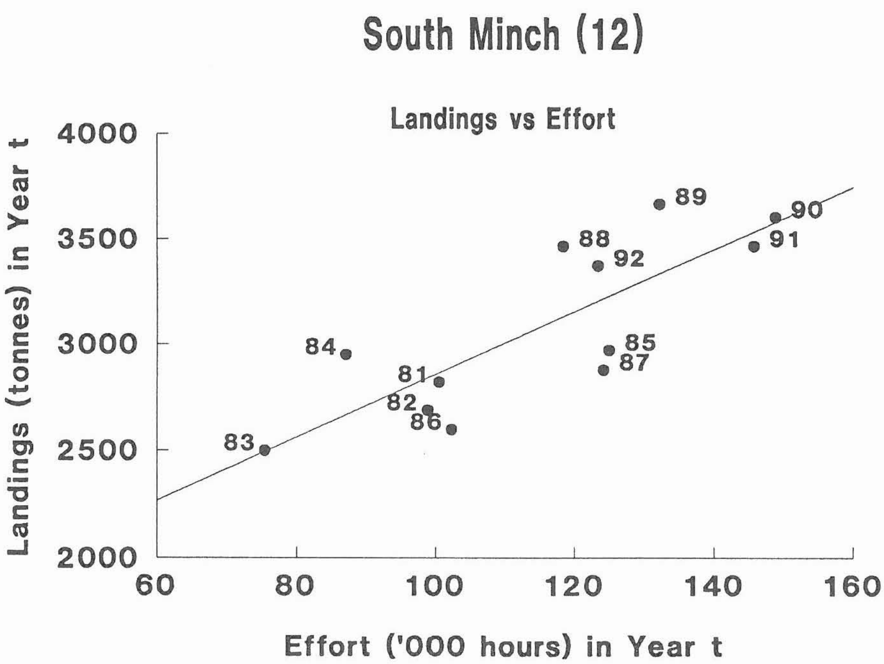


Figure 5.4.13 Functional Unit : Firth of Clyde (13)
Percentage changes in long term landings and stock biomass and in short term landings following various percentage changes in fishing effort. Separate plots shown for males and females.

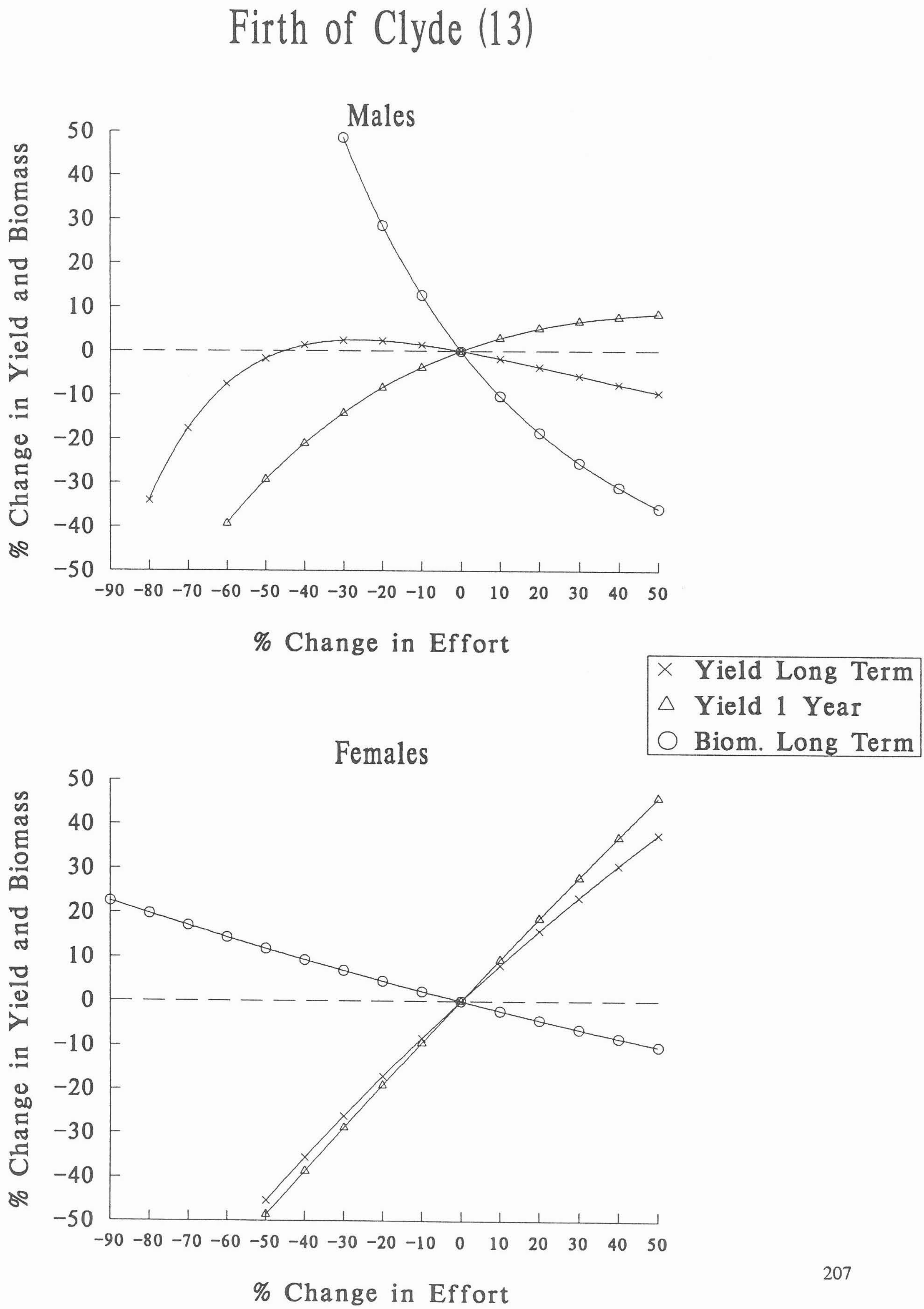
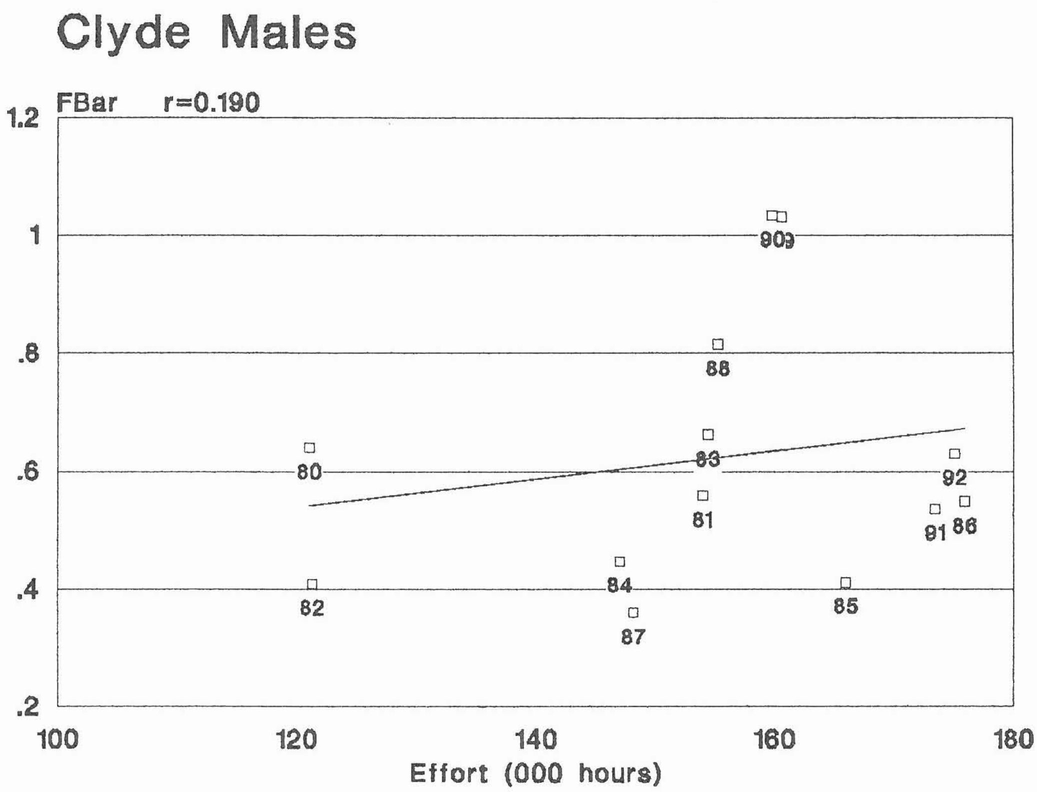


Figure 5.4.14 Functional Unit : Firth of Clyde (13)
Relationships between Fbar from VPA and fishing effort for male and female Nephrops



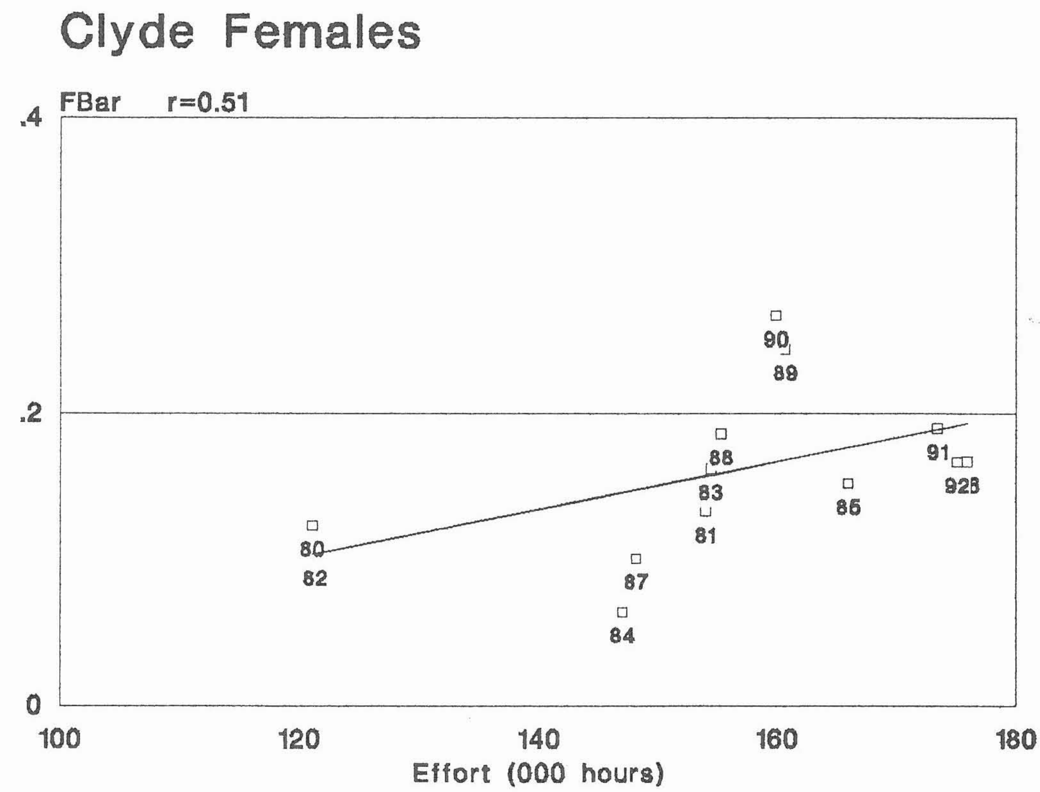


Figure 5.4.15 FU: Firth of Clyde (13)
Relationship between LPUE and combined male and female TSB

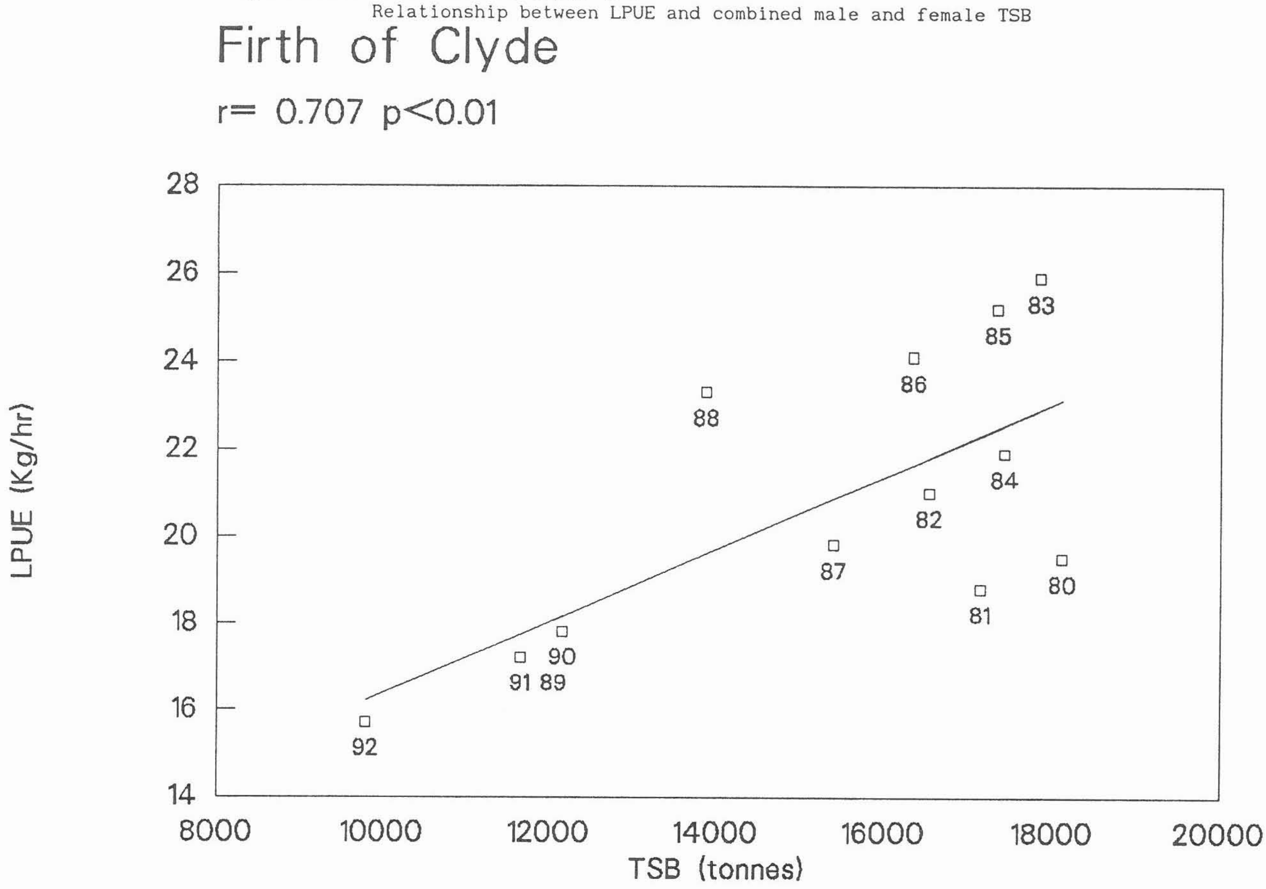


Figure 5.4.16 Functional Unit : Firth of Clyde (13)
Relationships between Landings(t) and Effort(t)
Least Squares linear regression line shown.

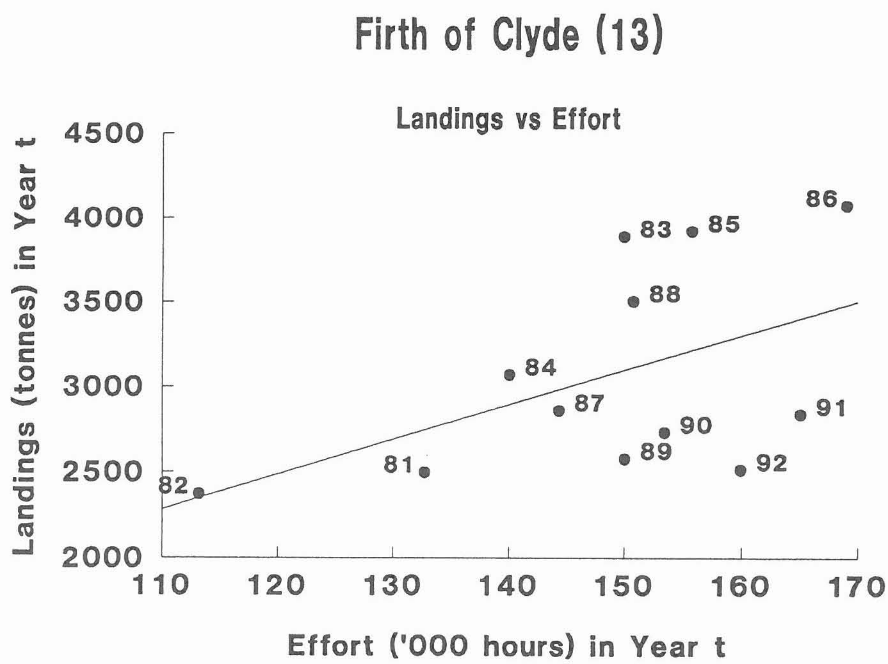


Figure 5.6.1 Skagerrak and Kattegat (3 & 4): Total landings (tonnes) 1960-1992

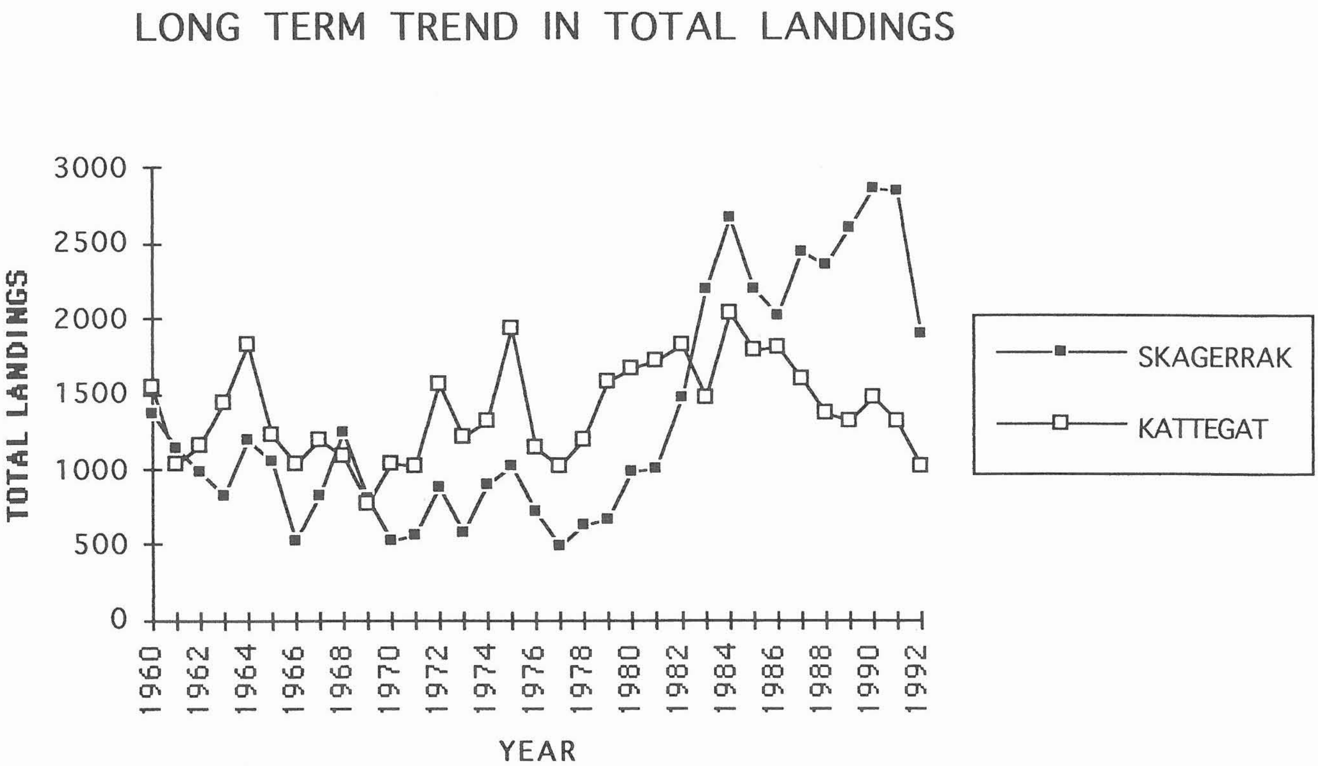


Figure 5.6.2 Skagerrak and Kattegat(3 & 4): Standardised Swedish Nephrops trawl effort (hours) and Danish effort (days).

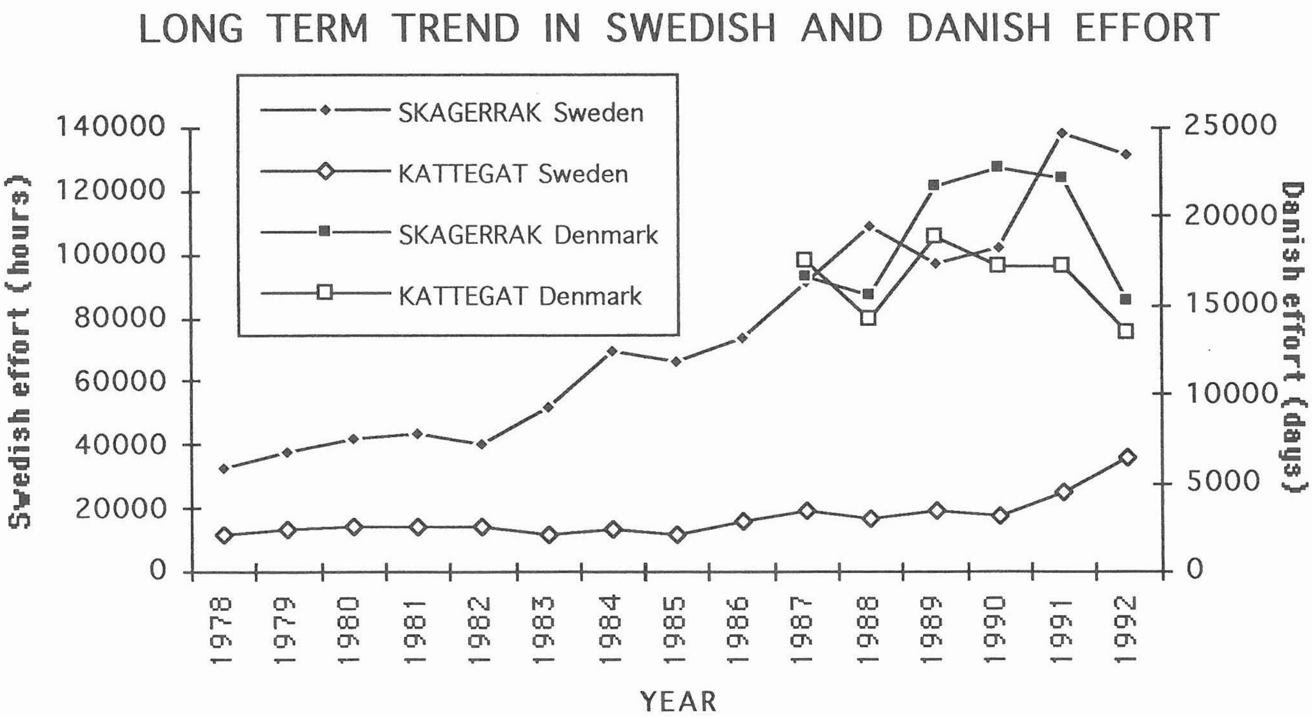


Figure 5.6.3 Skagerrak and Kattegat (3 & 4): LPUE (kg/hr) in Swedish trawls 1968-1992.

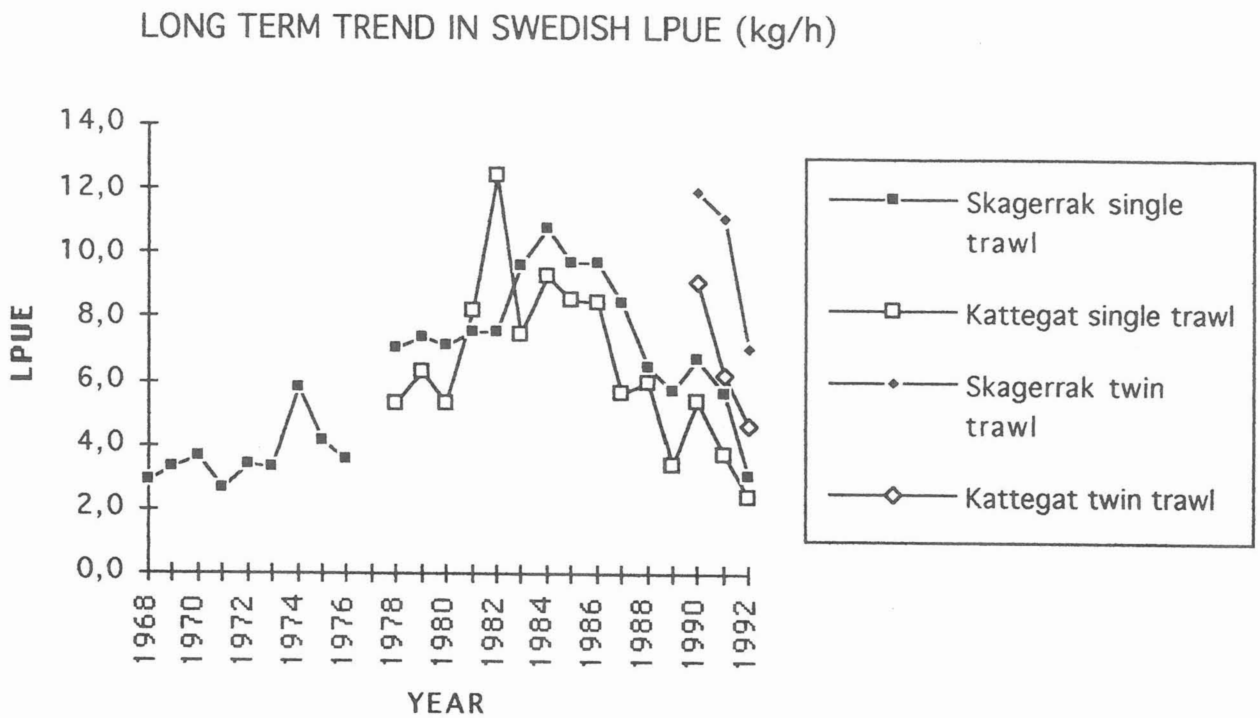


Figure 5.6.4 Skagerrak and Kattegat (3 & 4) Denmark and Sweden combined LPUE.

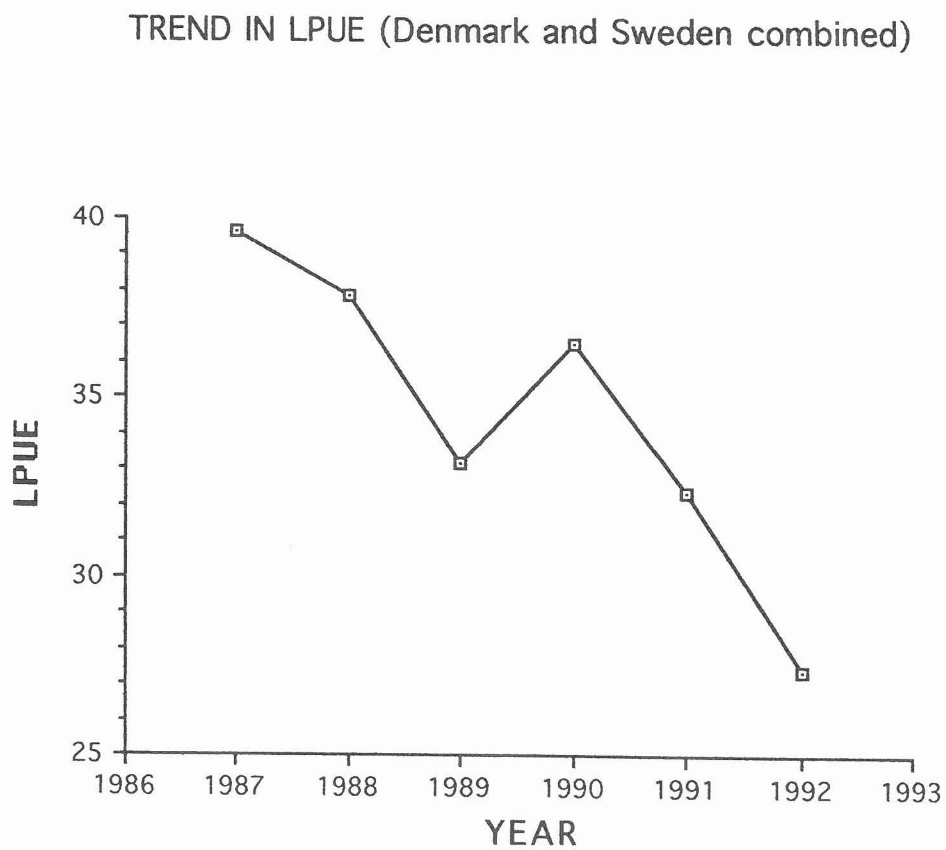


Figure 5.6.5 Skagerrak and Kattegat (3 & 4) combined.
Length frequency distributions for males and females in the discards and landings from Danish, Swedish and Norwegian samples.

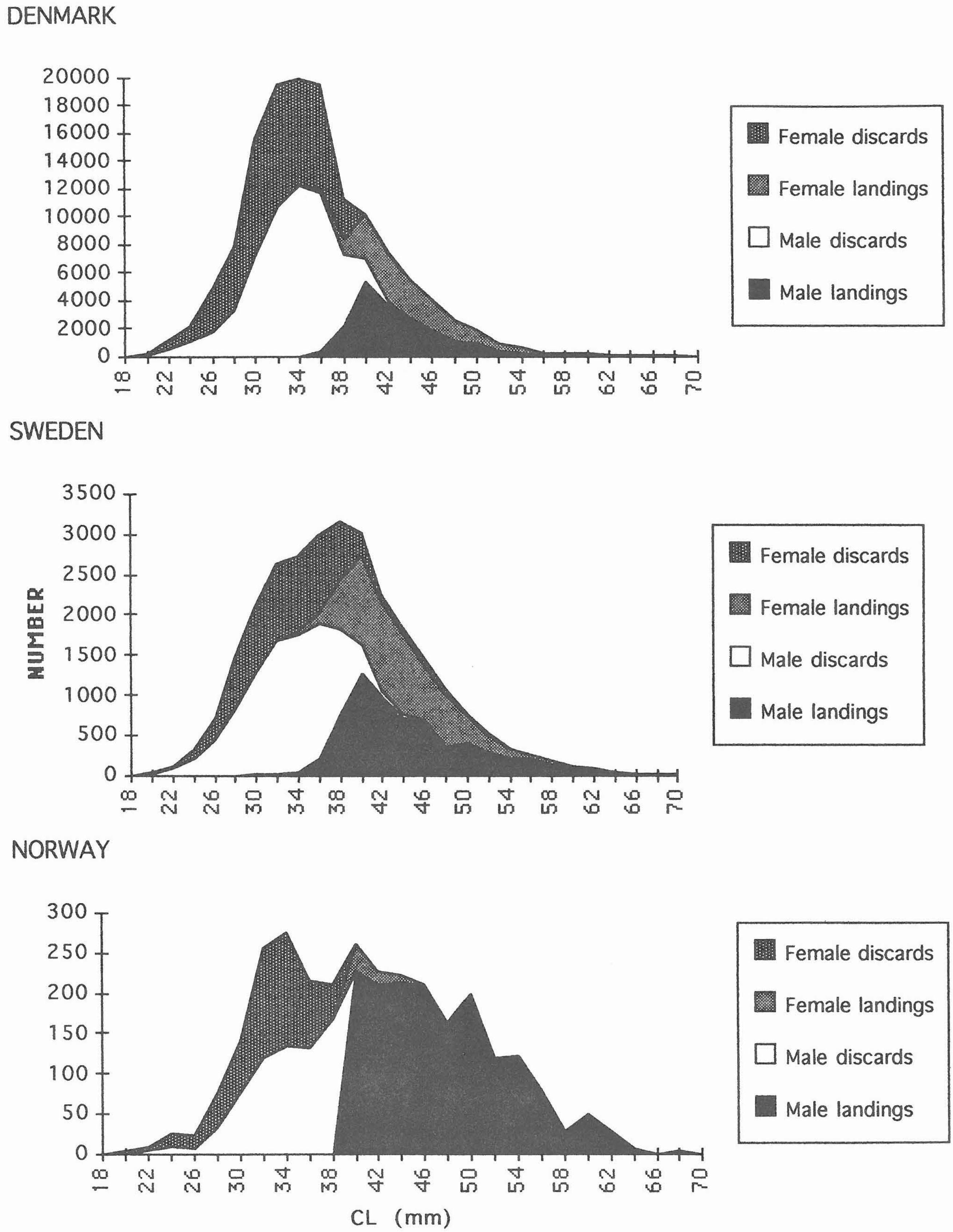


Figure 5.6.6 Functional Unit : Skagerrak and Kattegat (3 & 4)
Percentage changes in long term landings and stock biomass and in short term landings following various percentage changes in fishing effort. Separate plots shown for males and females.

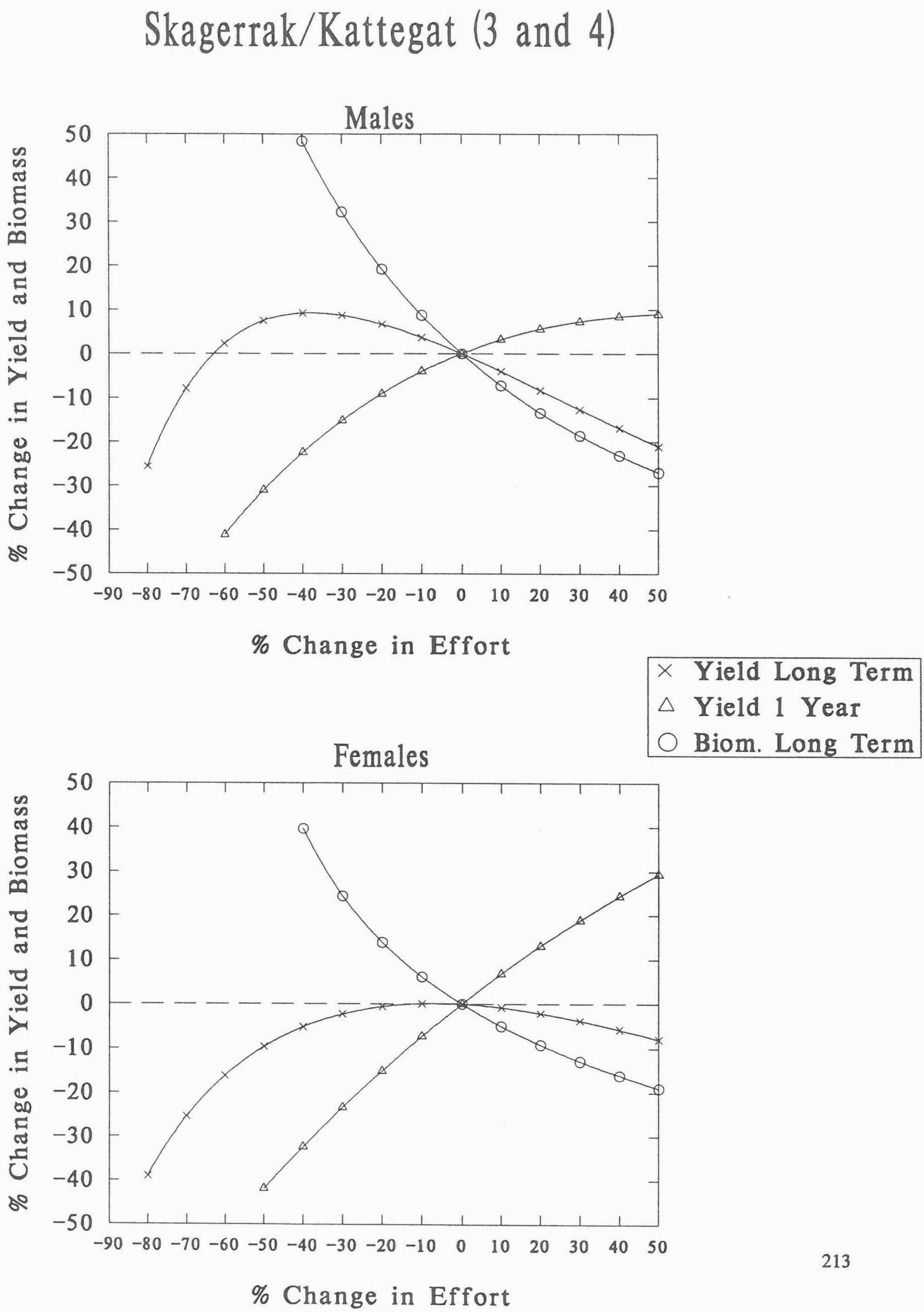


Figure 5.6.7 FU: Skagerrak and Kattegat (3 & 4) Swedish landings vs effort

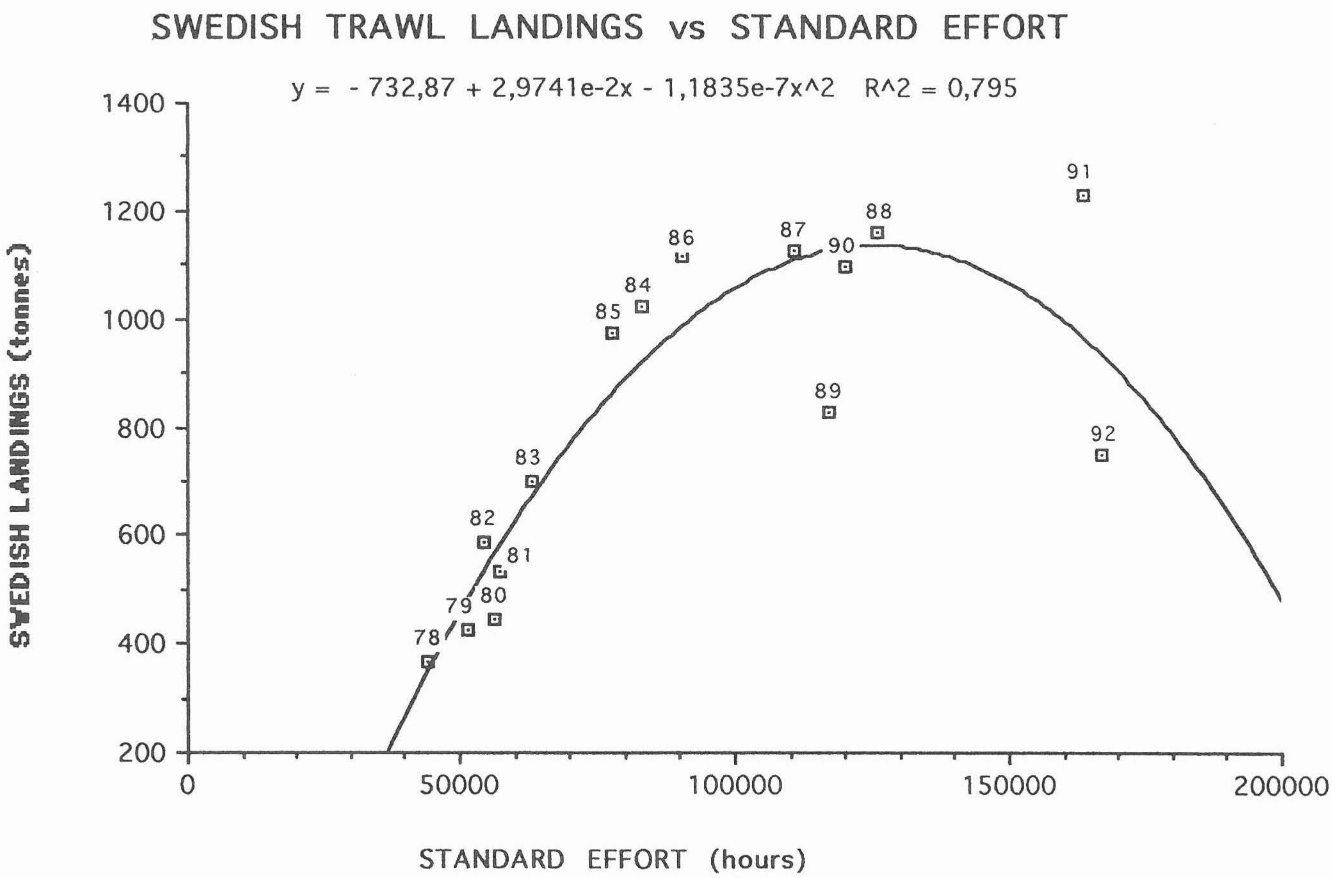


Figure 5.6.8 FU: Skagerrak and Kattegat (3 & 4) Total landings vs raised effort.

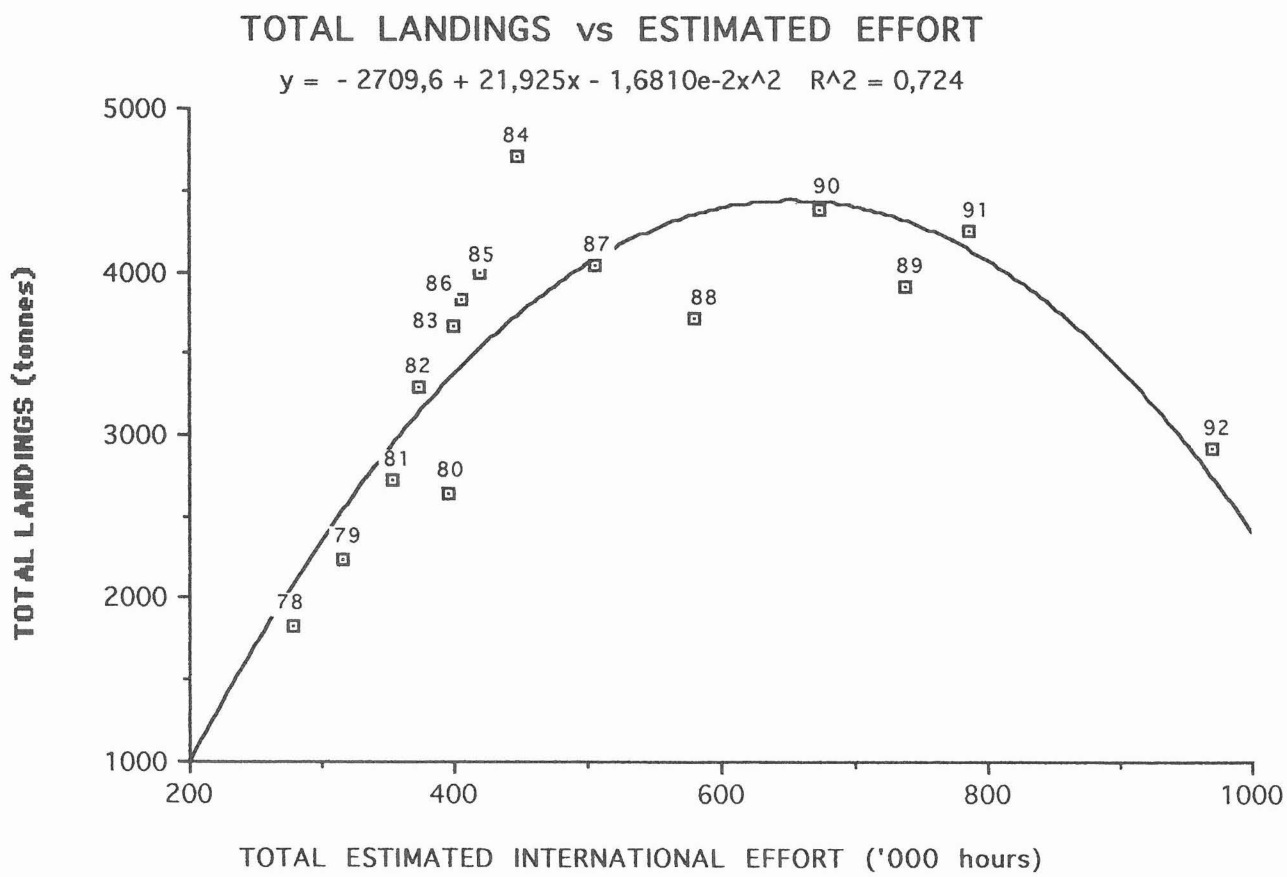


Figure 5.7.1 Functional Unit : Moray Firth (9)
Percentage changes in long term landings and stock biomass and in short term landings following various percentage changes in fishing effort. Separate plots shown for males and females.

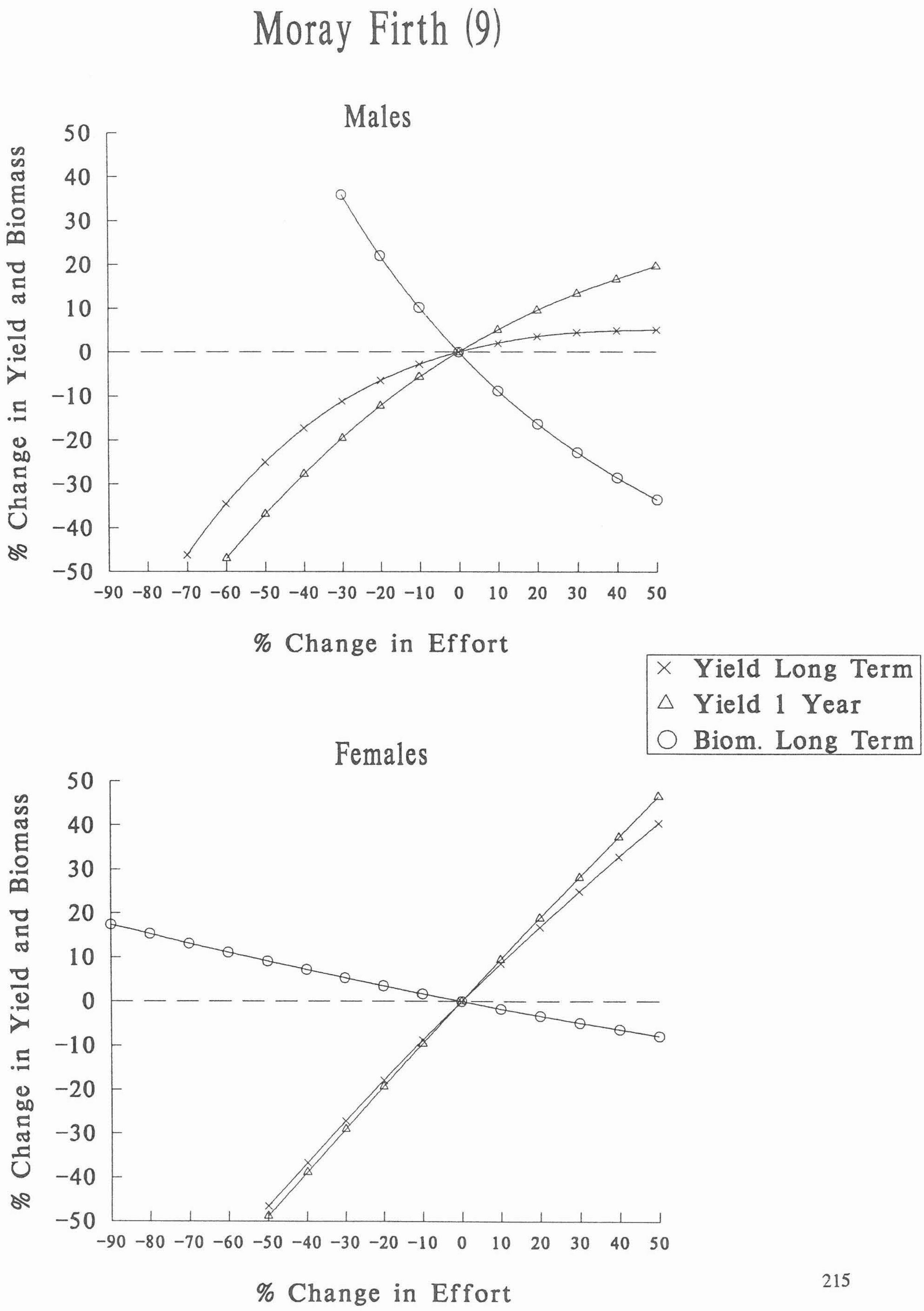
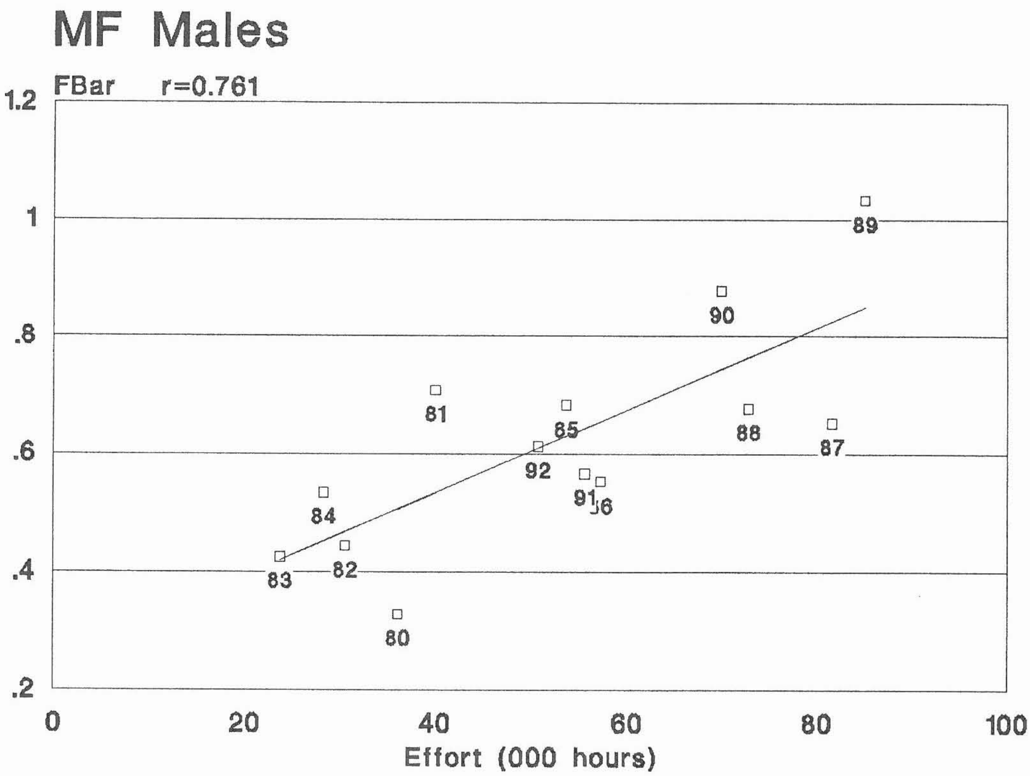


Figure 5.7.2 Functional Unit : Moray Firth (9)
Relationships between Fbar from VPA and fishing effort for male and female Nephrops



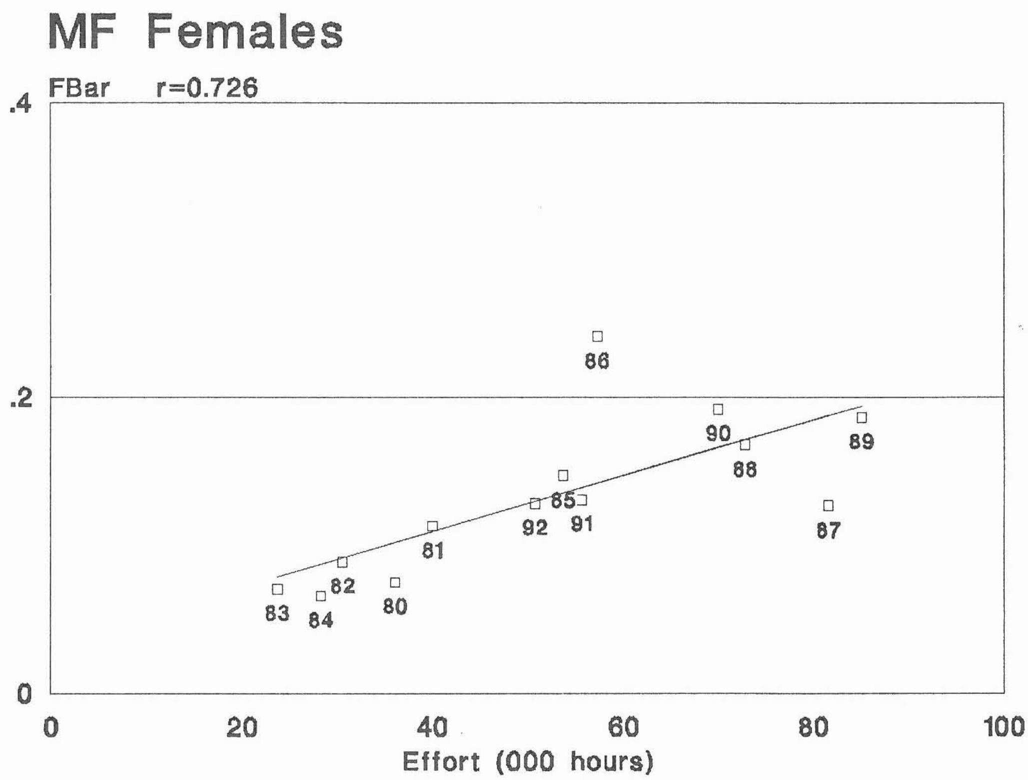


Figure 5.7.3 FU: Moray Firth (9)
Relationship between LPUE and combined male and female TSB

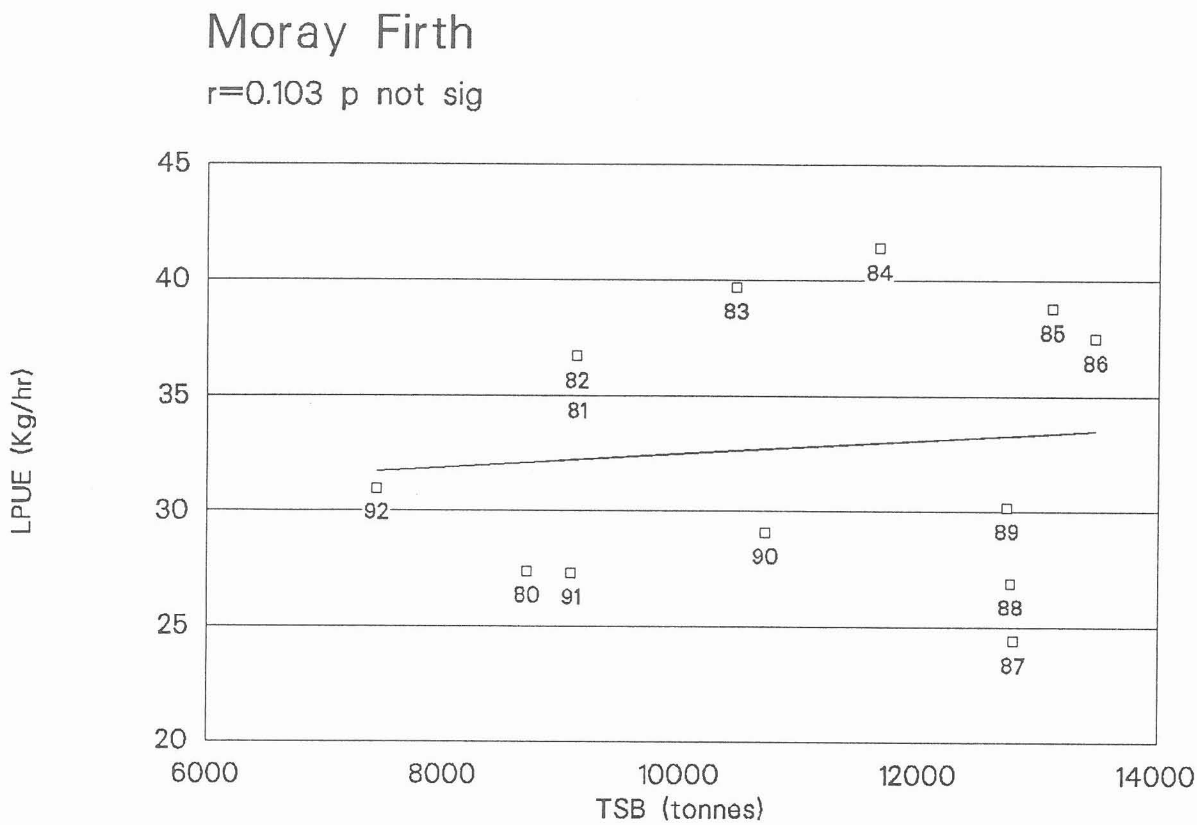


Figure 5.7.4 Functional Unit : Moray Firth (9)
Relationships between Landings(t) and Effort(t)
Least Squares linear regression line shown.

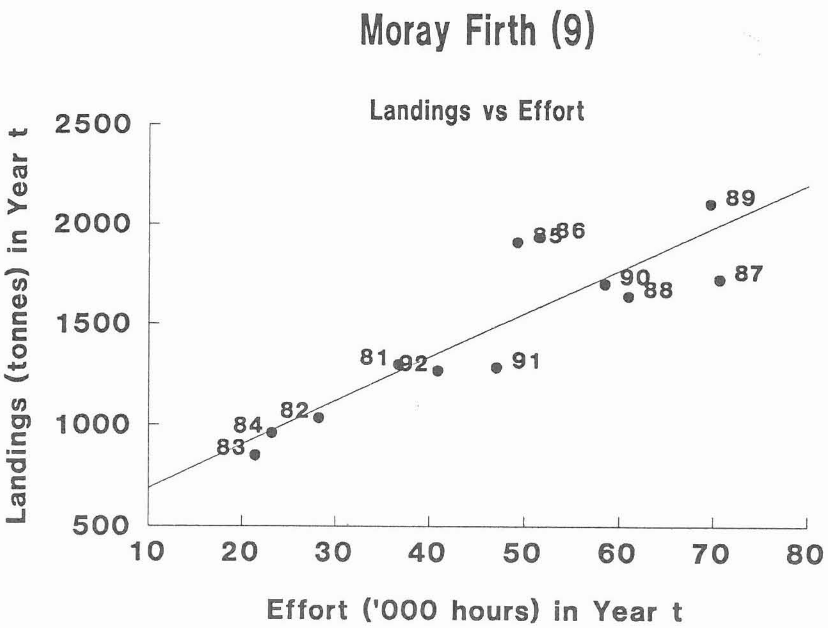


Figure 5.7.5 Functional Unit : Noup (10)
Relationships between Landings(t) and Effort(t)
Least Squares linear regression line shown.

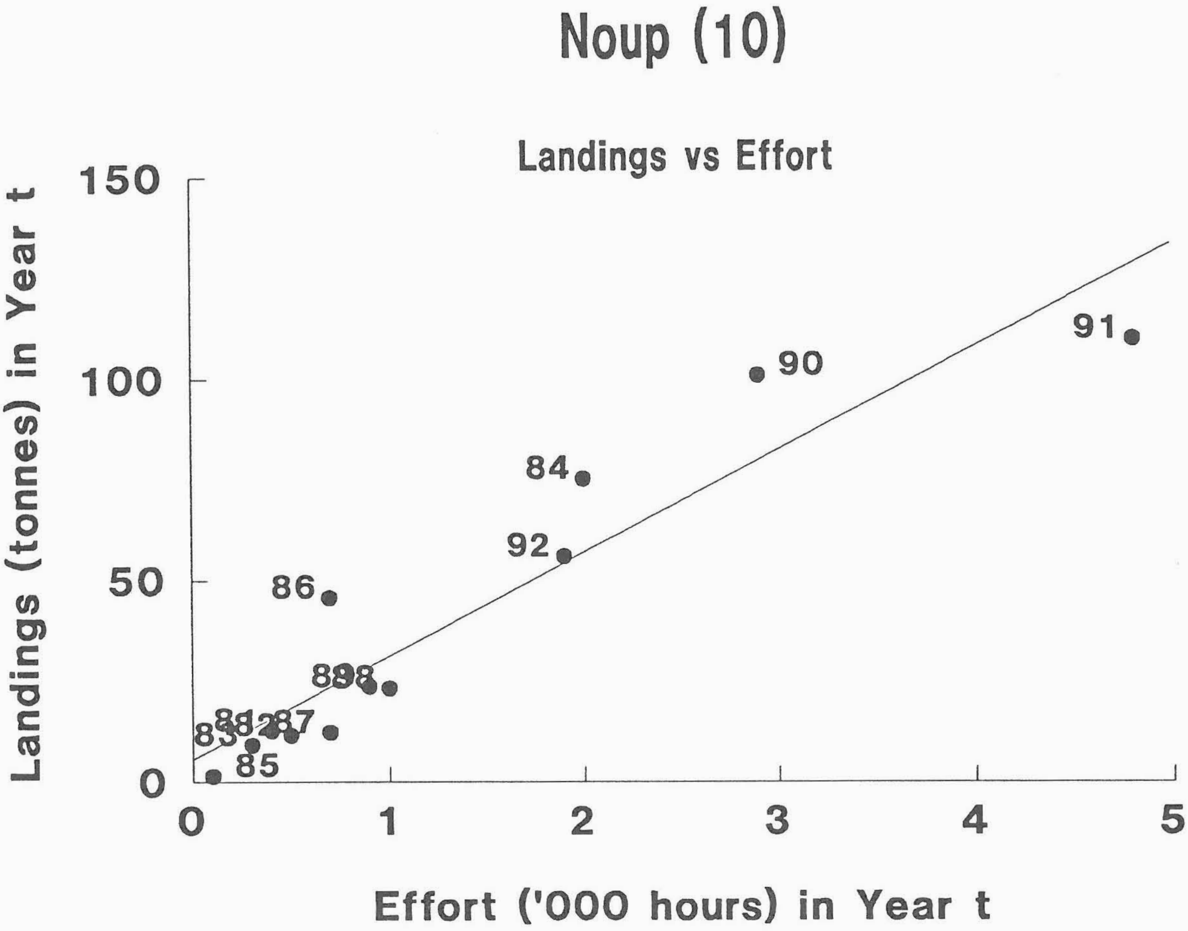


Figure 5.8.1 Functional Unit : Fladen Ground (7)
Relationships between Landings(t) and Effort(t)
Least Squares linear regression line shown.

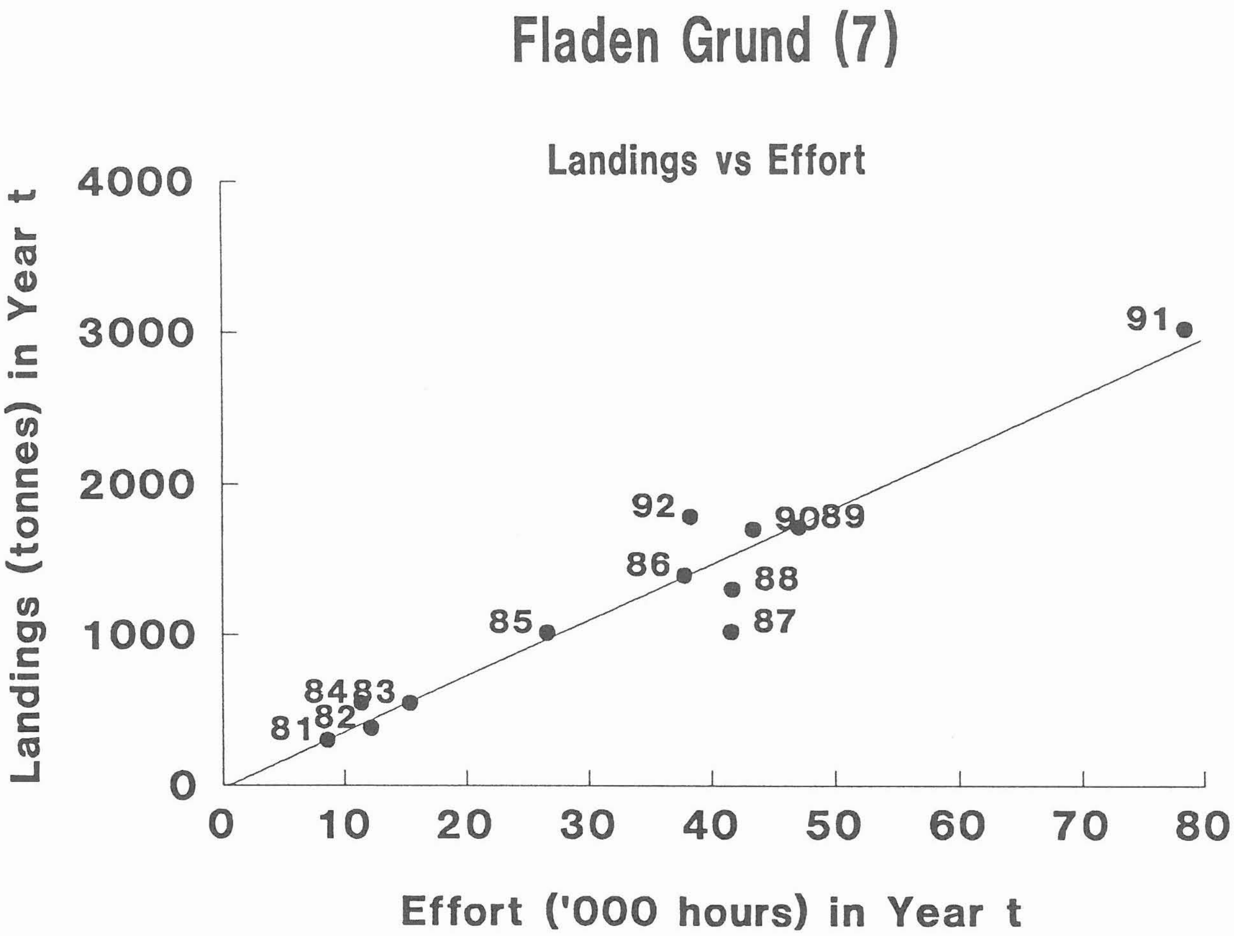


Figure 5.9.1 Nephrops : North Sea (mainly IVb + IVc)
Belgian Nephrops trawlers
Landings, by sex (1986-92)

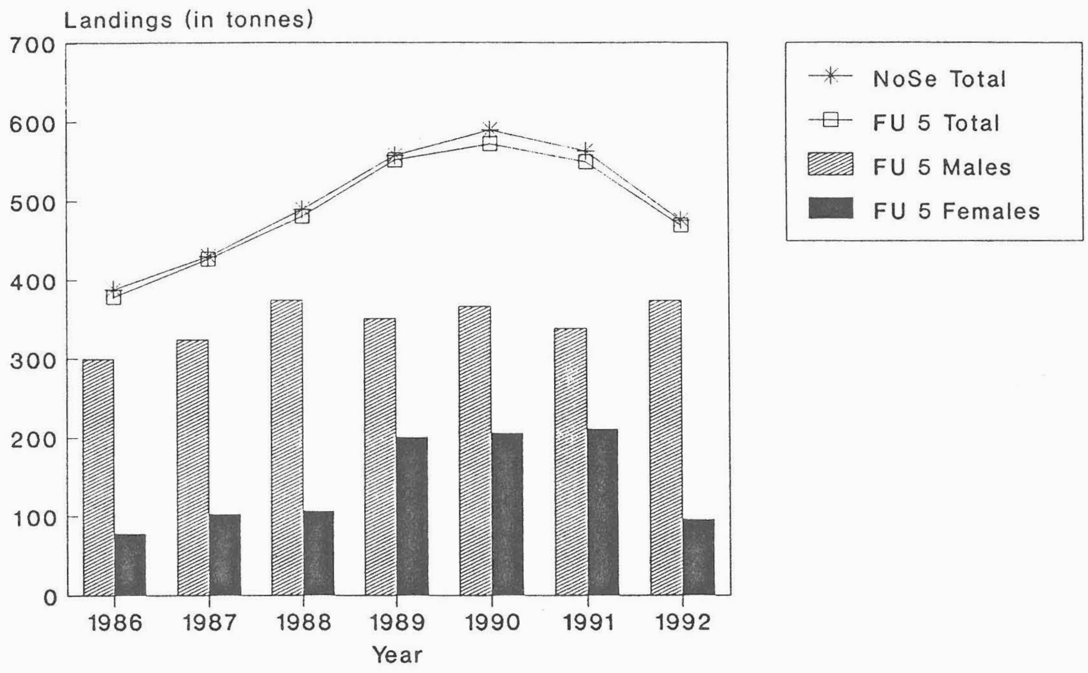


Figure 5.9.2 Nephrops : North Sea (mainly IVb + IVc)
Belgian Nephrops trawlers
Annual LPUEs, by sex (1986-92)

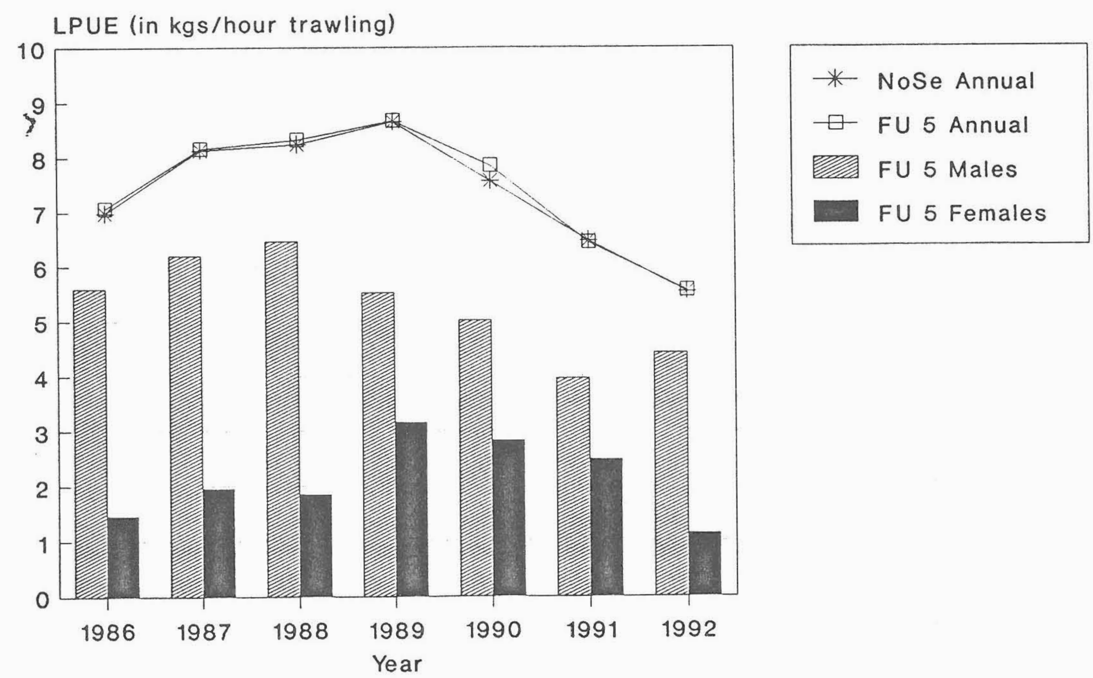


Figure 5.9.3 Nephrops : Botney Gut - Silver Pit
Sex ratio of "Medium + Large" landings
All size classes pooled : 1986-92

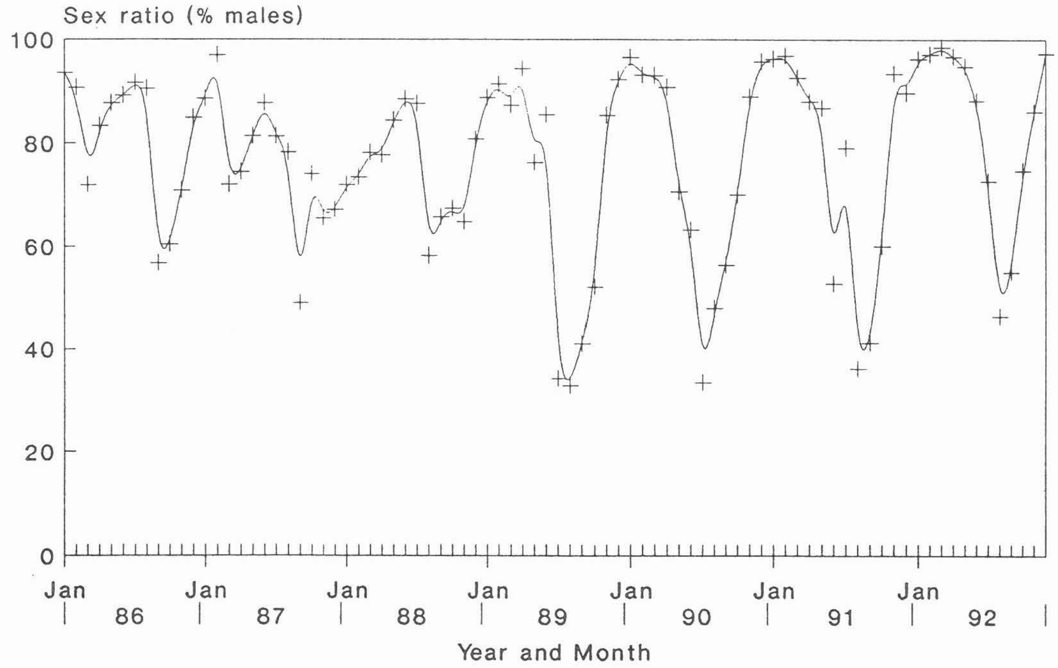


Figure 5.9.4 Nephrops : North Sea (mainly IVb + IVc)
Belgian Nephrops trawlers
Effort, by year and quarter (1986-92)

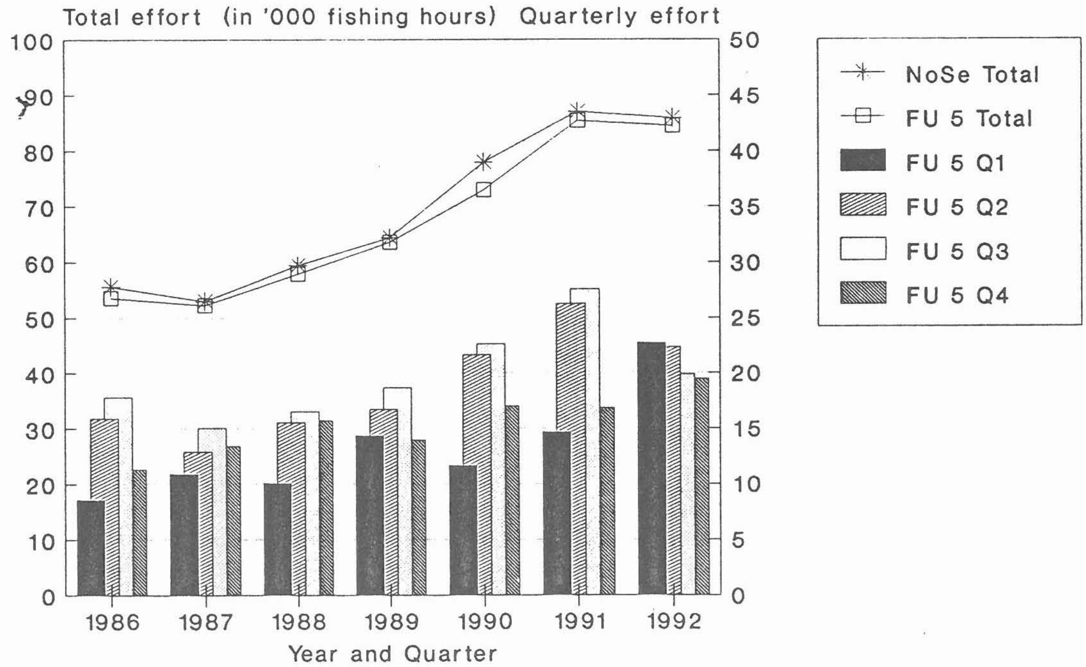
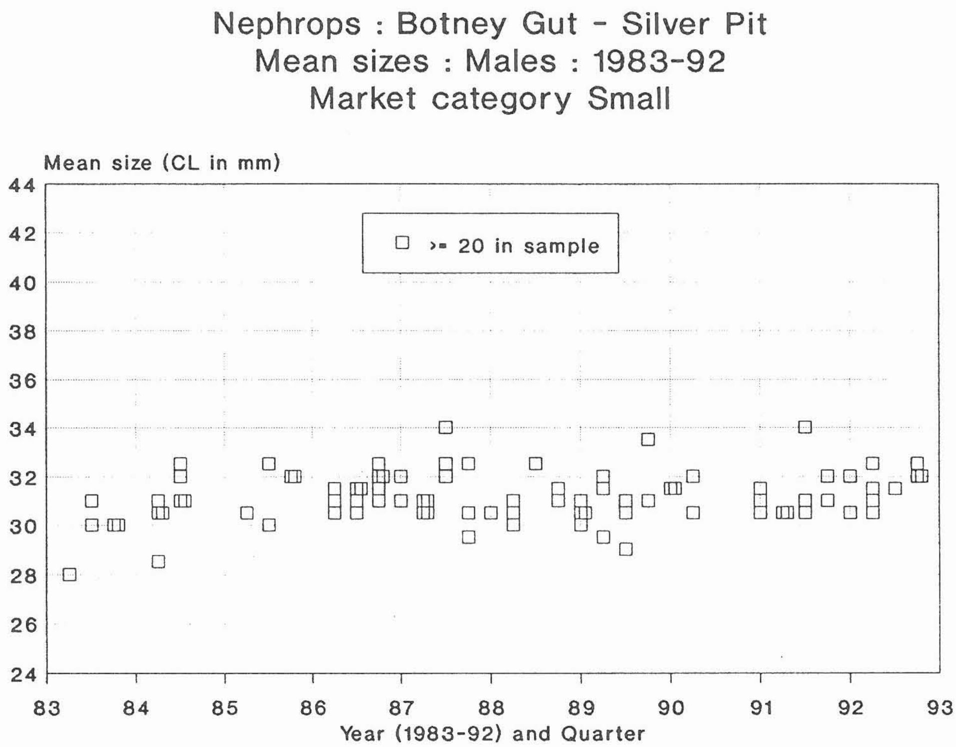


Figure 5.9.5 Botney Gut and Siver Pit (5): Mean size (CL mm) of male and female Nephrops in the small market classes, 1983-1992.



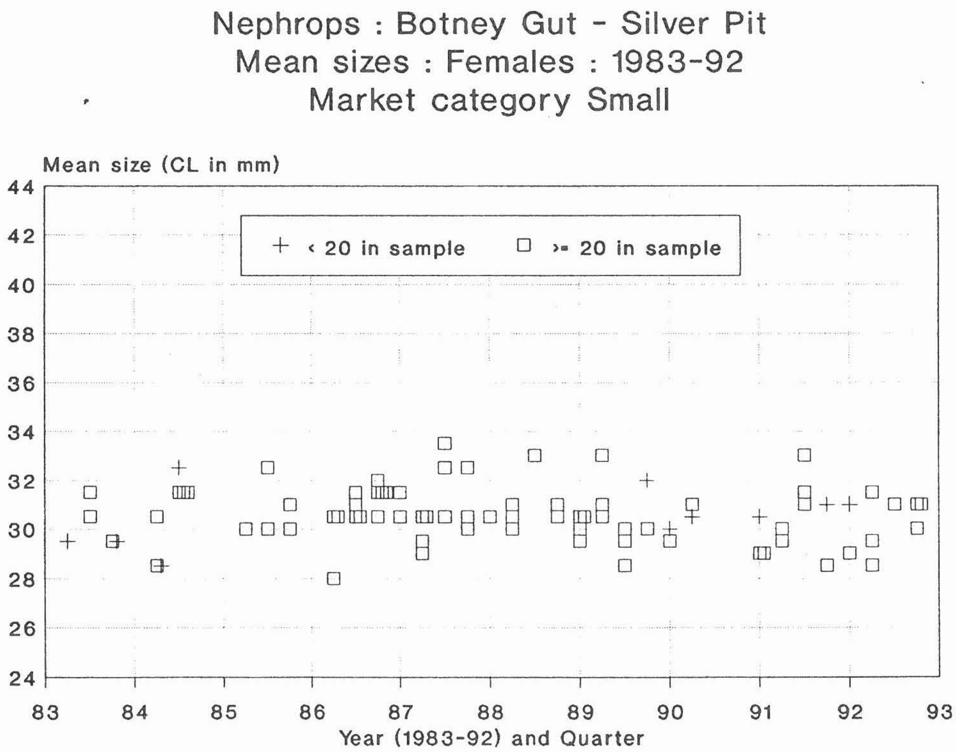
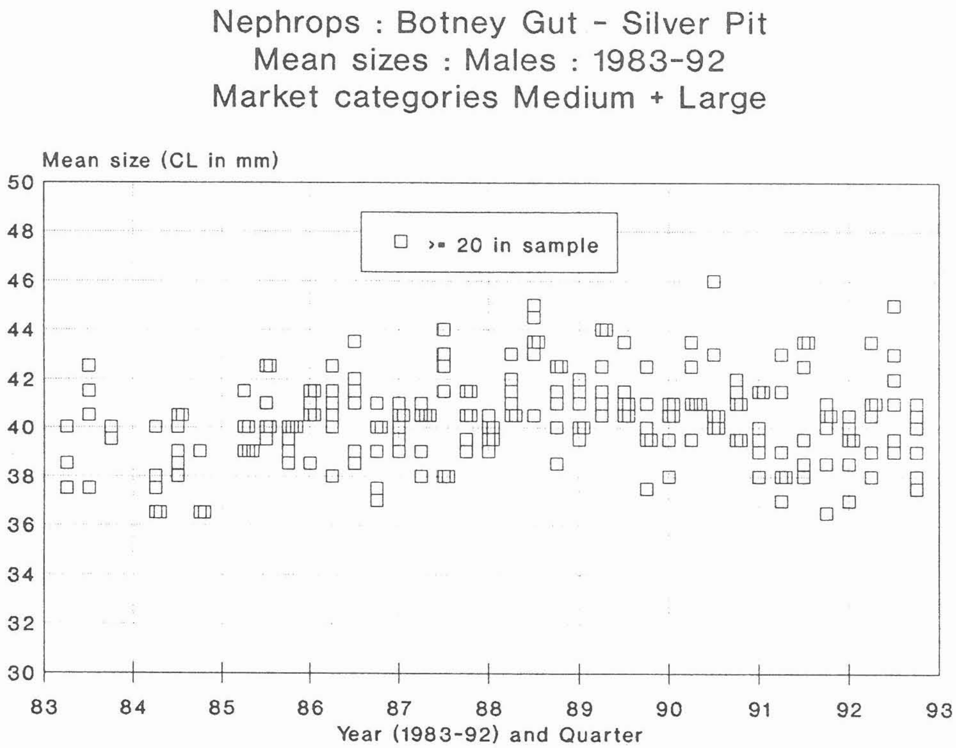


Figure 5.9.6 Botney Gut and Siver Pit (5): Mean size (CL mm) of male and female Nephrops in the medium + large market classes, 1980-1991.



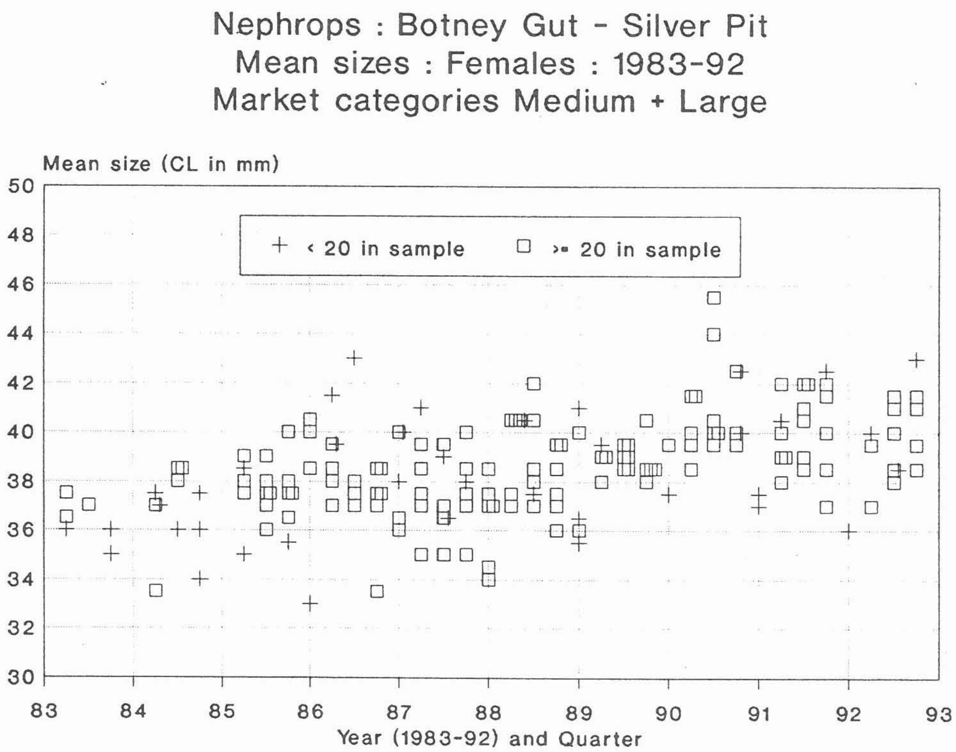


Figure 5.9.7 Functional Unit : Botney Gut and Silver Pit (5)
Percentage changes in long term landings and stock biomass and in short term landings following various percentage changes in fishing effort. Separate plots shown for males and females.

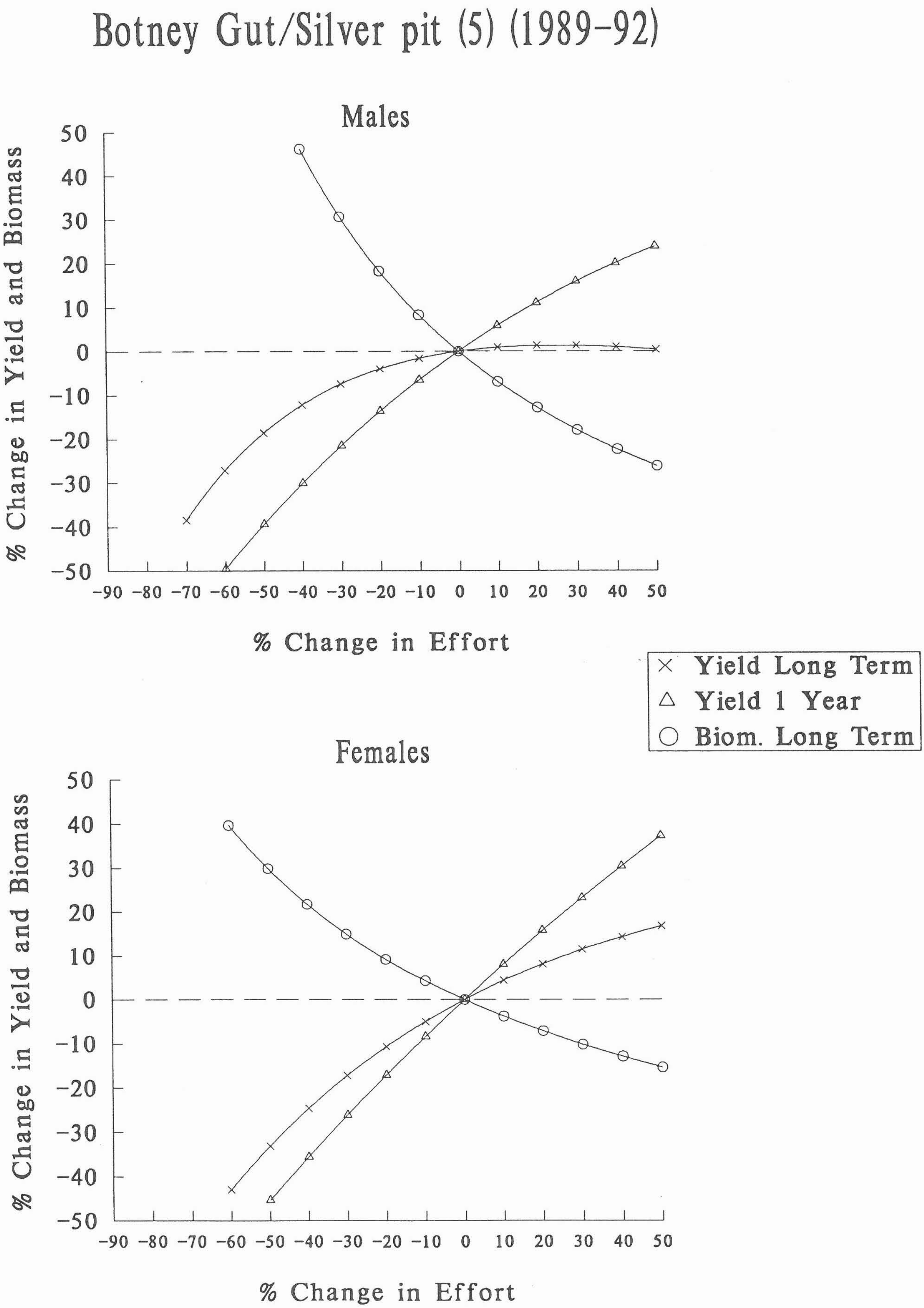
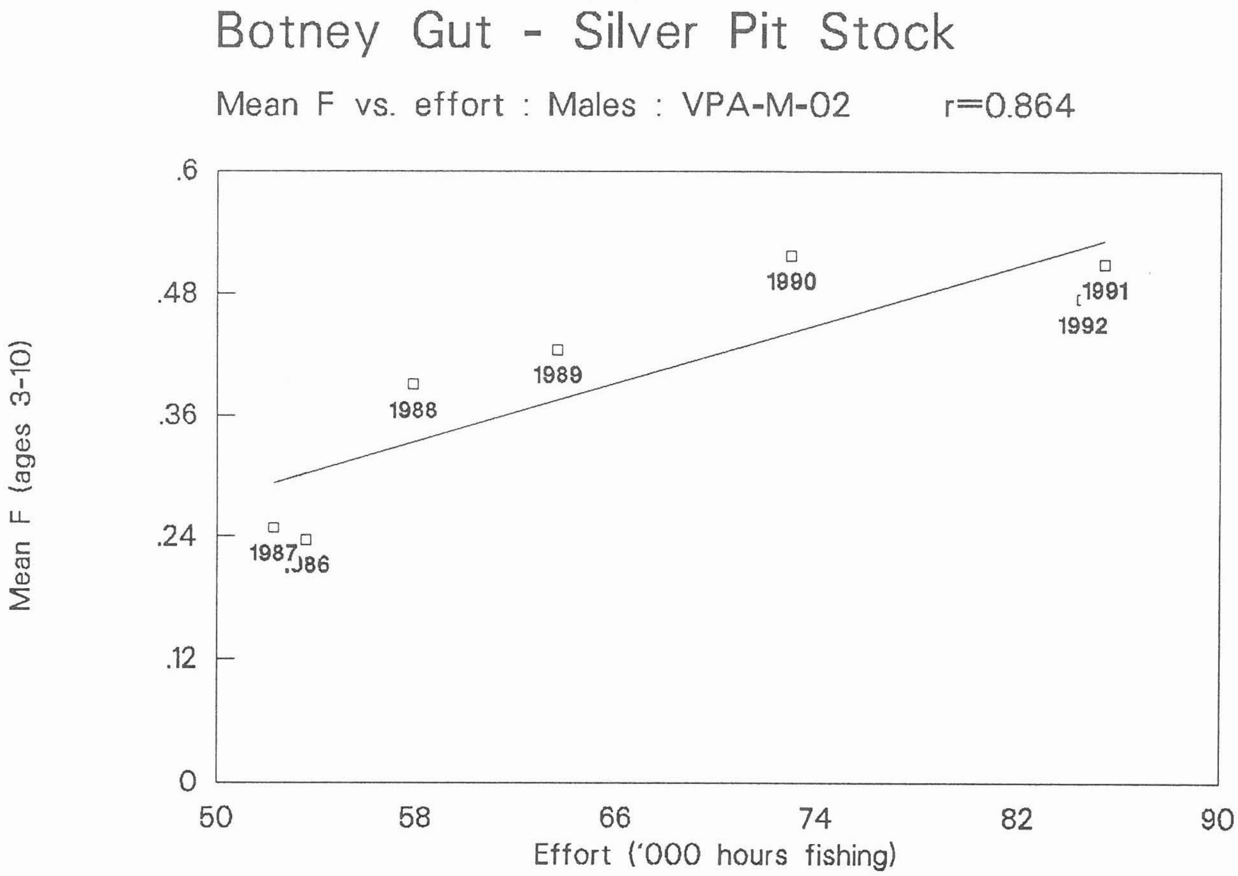


Figure 5.9.8 Functional Unit : Botney Gut and Silver Pit (5)
Relationships between Fbar from VPA and fishing effort for male and female Nephrops



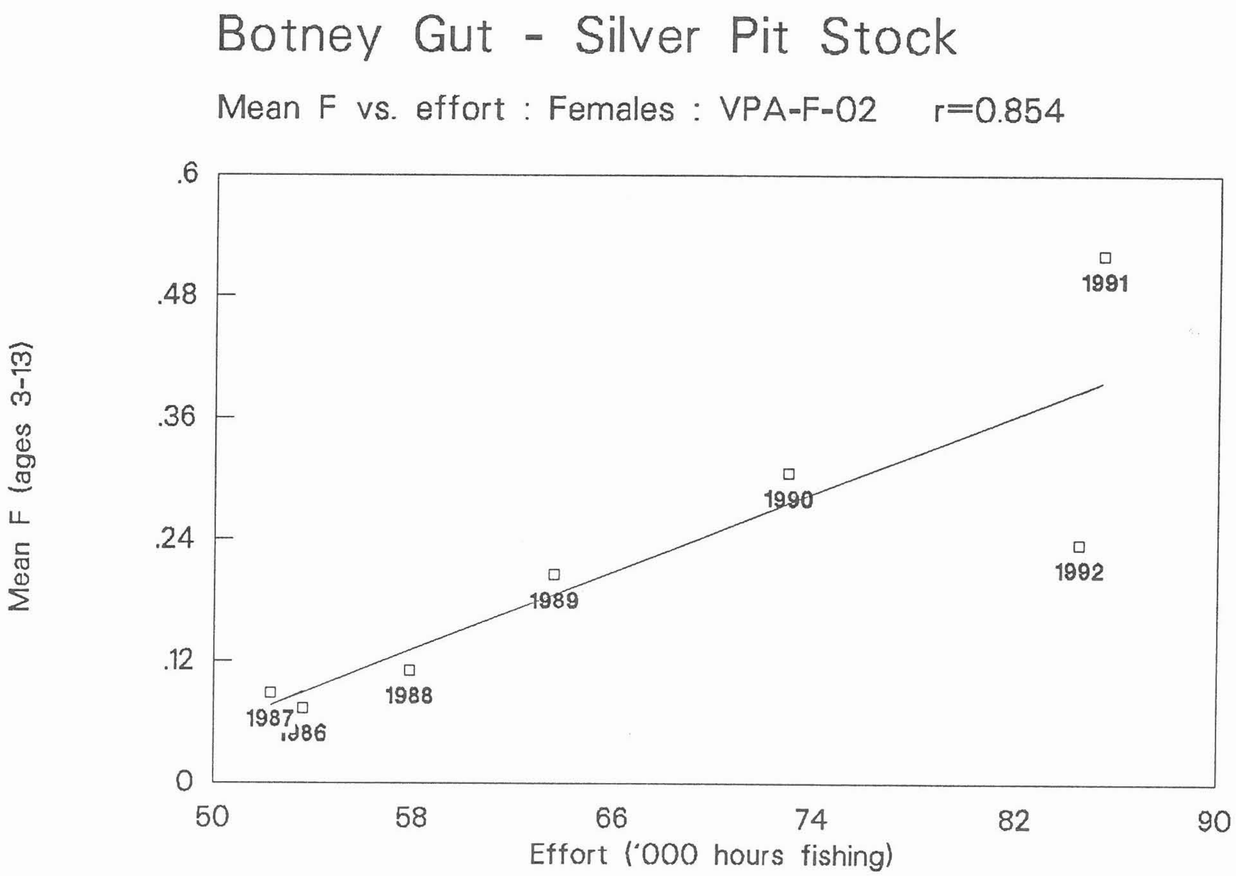


Figure 5.9.9 Functional Unit : Botney Gut and Silver Pit (5)
Relationships between Total Landings(t) and Effort
Least Squares linear regression line shown.

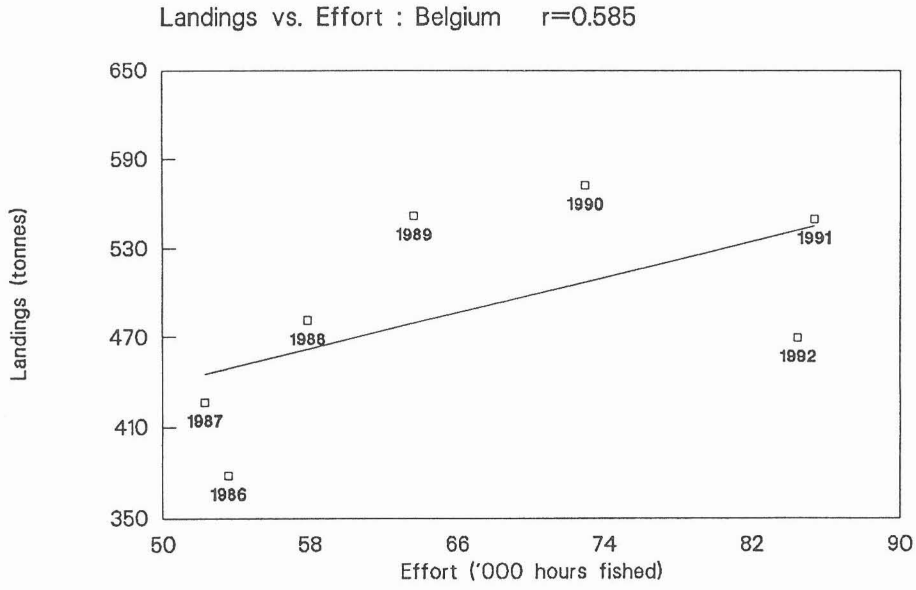


Figure 5.9.10 Functional Unit : Botney Gut and Silver Pit (5)
Relationships between Male Landings(t) and Effort
Least Squares linear regression line shown.

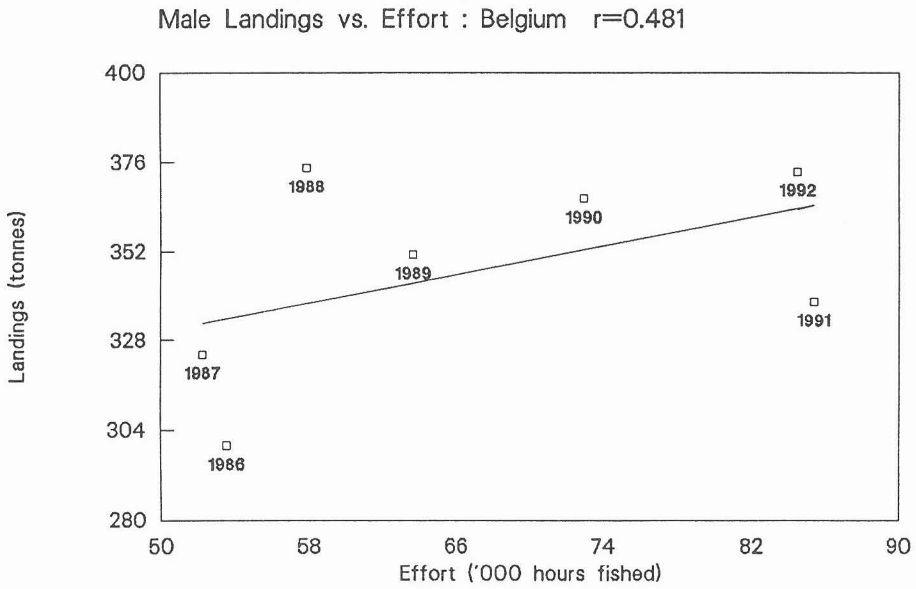


Figure 5.9.11 Functional Unit : Botney Gut and Silver Pit (5)
Relationships between Female Landings(t) and Effort
Least Squares linear regression line shown.

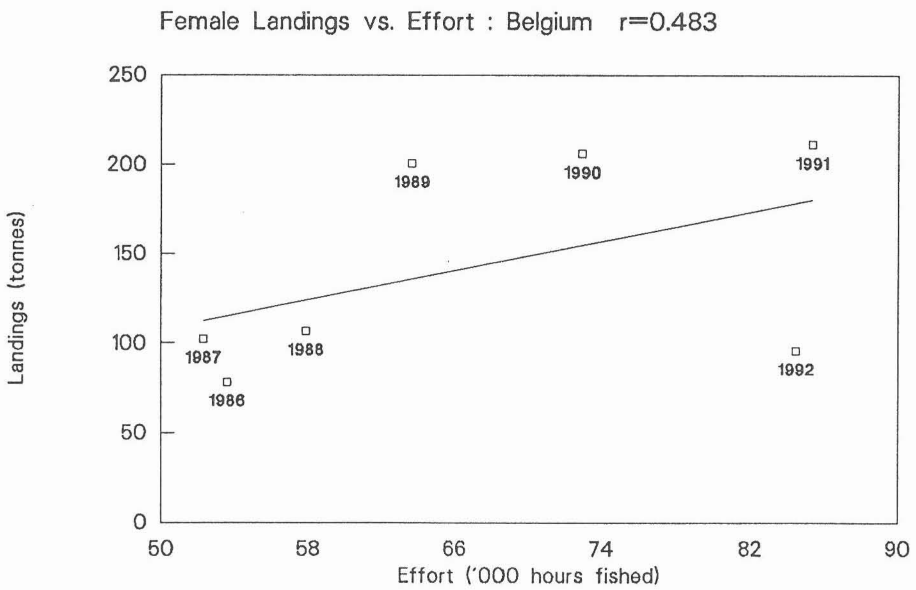


Figure 5.10.1 Farn Deeps(6): Mean GRT and HP of vessels in the Farn Deeps fishery.

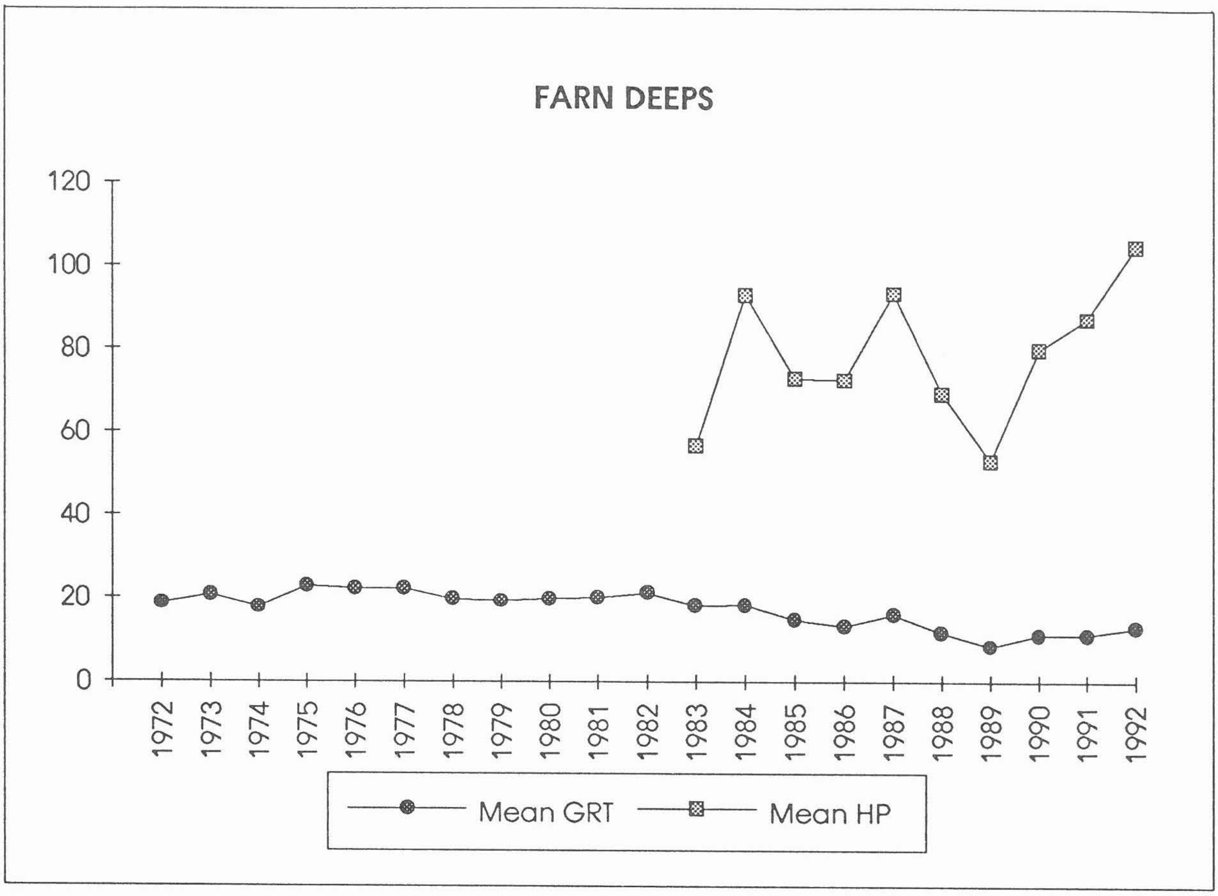


Figure 5.10.2 Farn Deeps(6): LPUE trends of directed effort vessels compared with all vessels.

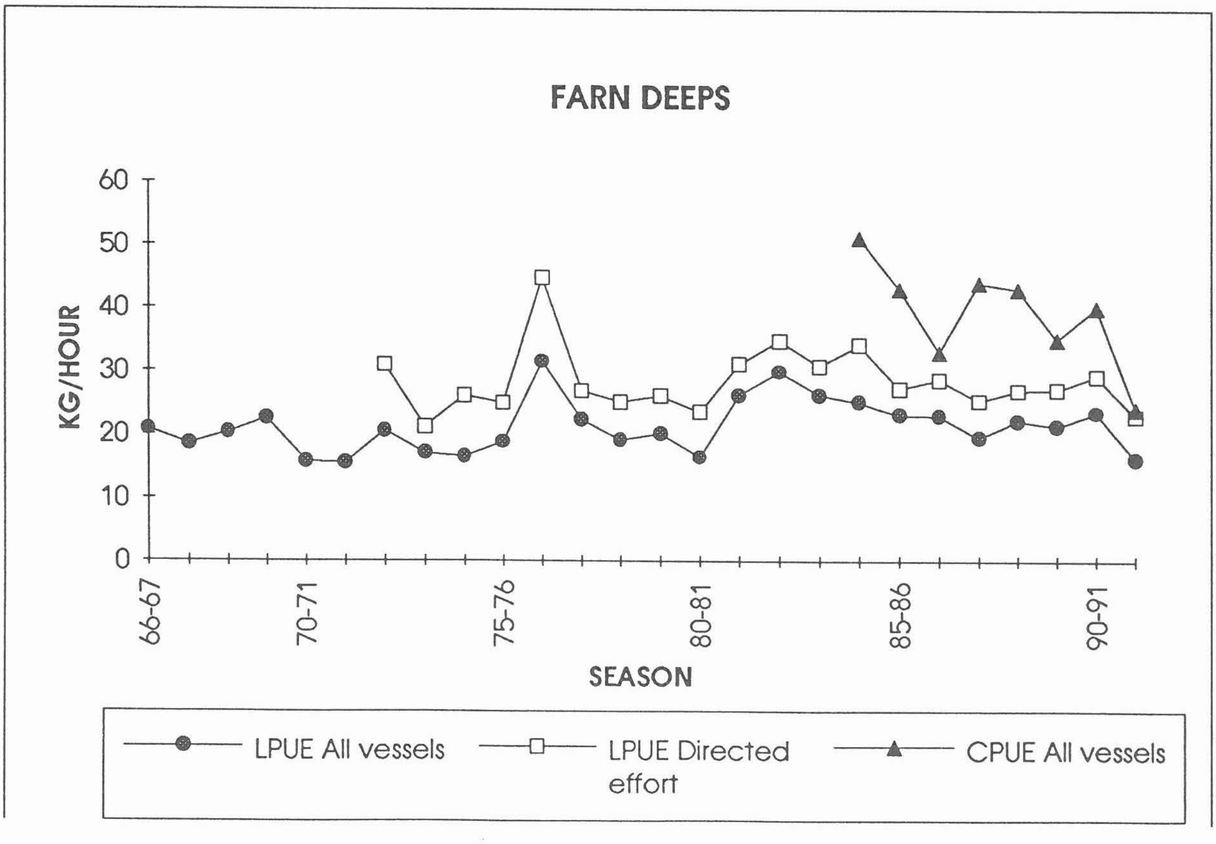


Figure 5.10.3 Farn Deeps(6): Landings (tonnes) 1966/67 to 1991/92.

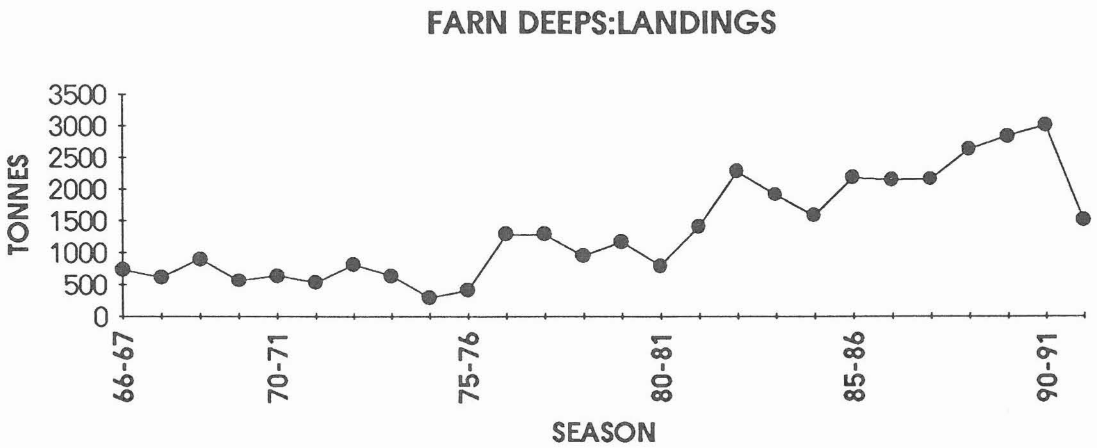


Figure 5.10.4 Farn Deeps (6): Effort (hours fished) 1966/67 to 1991/92

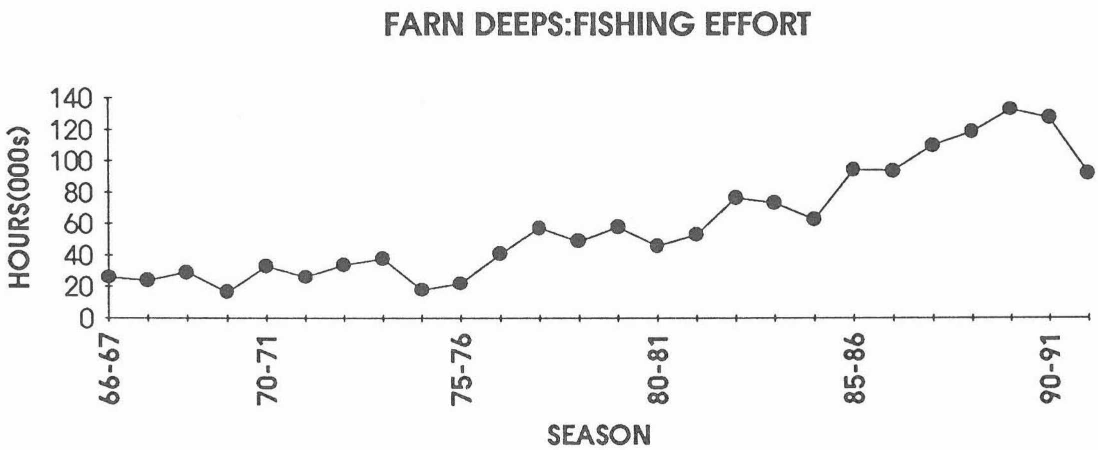


Figure 5.10.5 Farn Deeps (6): LPUE (Kg/hour) 1966/67 to 1991/92

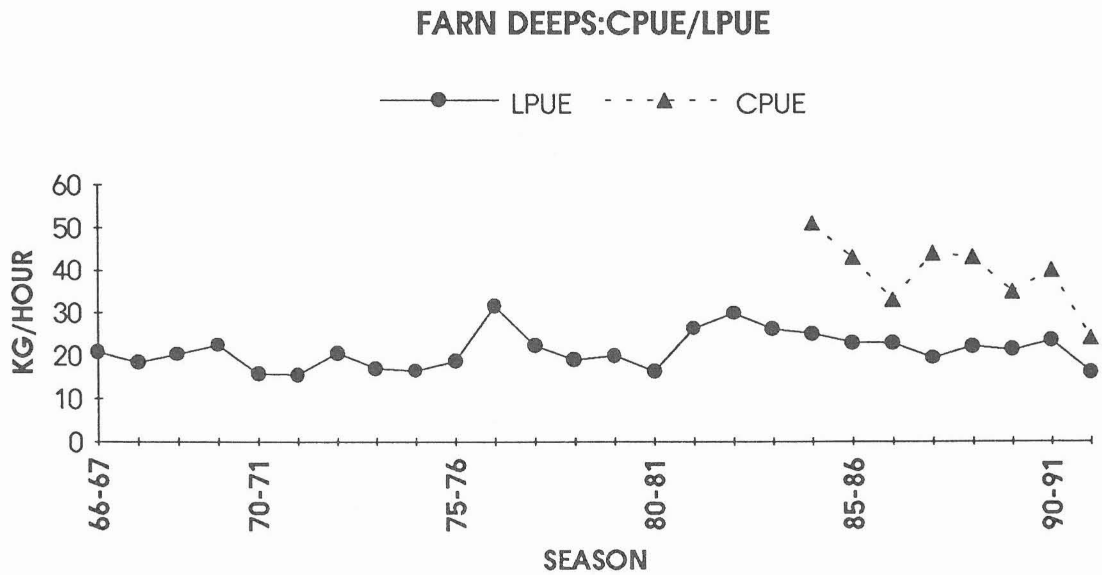
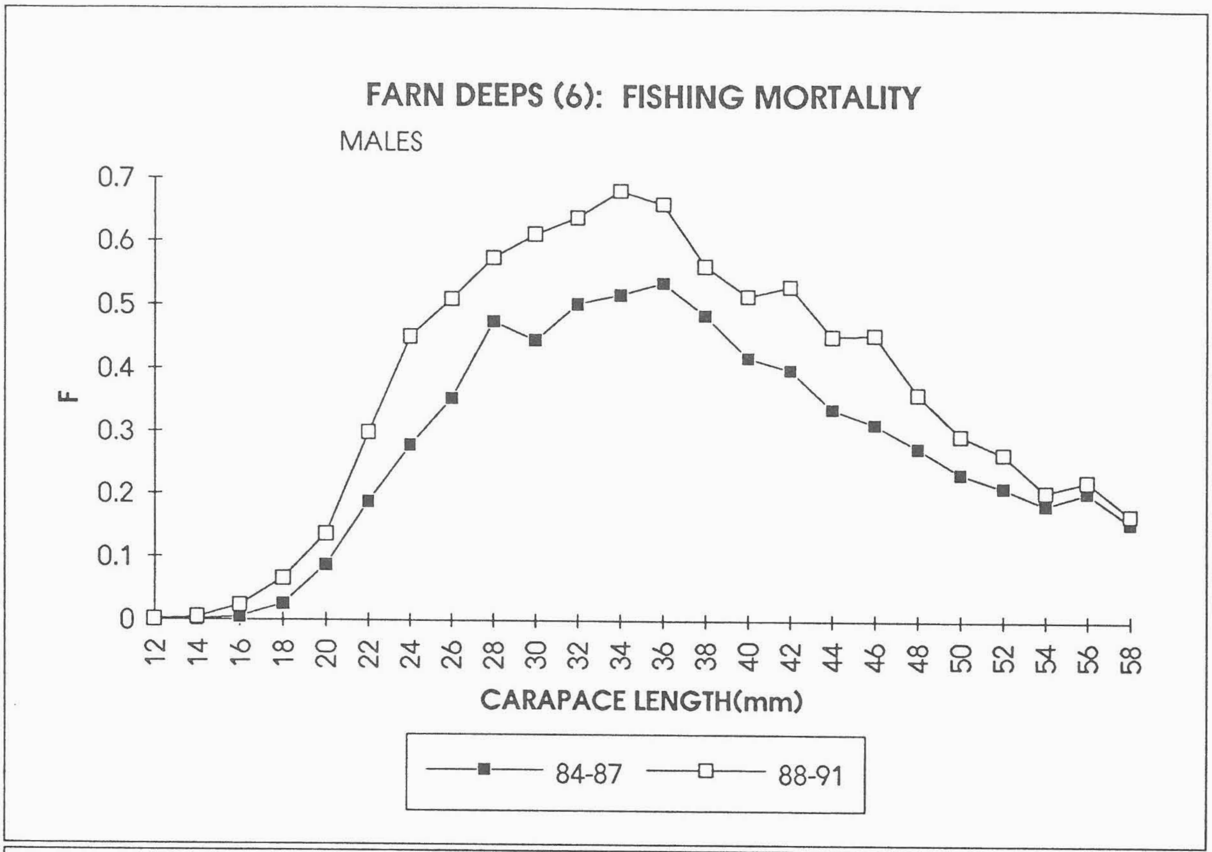


Figure 5.10.6 Farn Deeps (6): LCA annualised fishing mortalities by length for two different time periods, 1984-87 and 1988-91. Males and females shown separately.



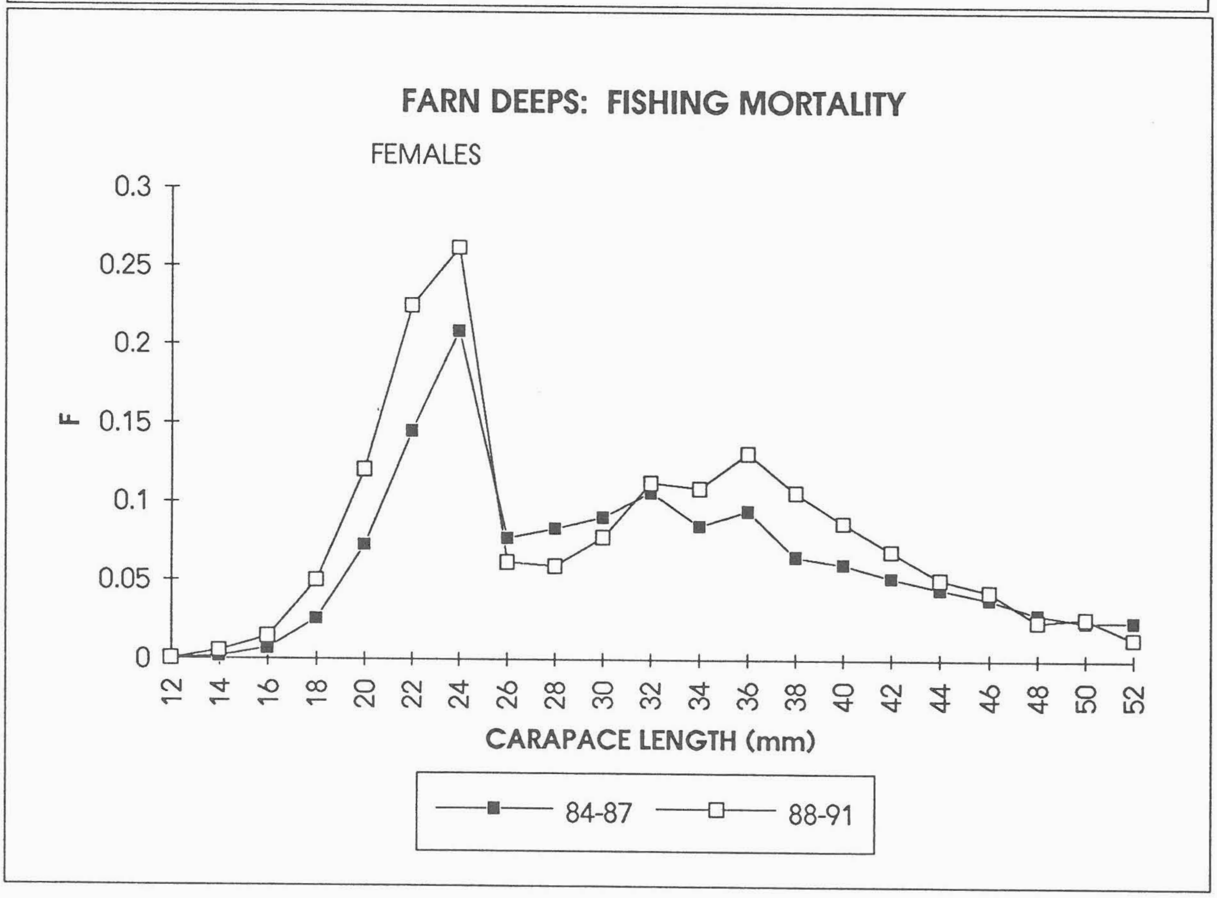
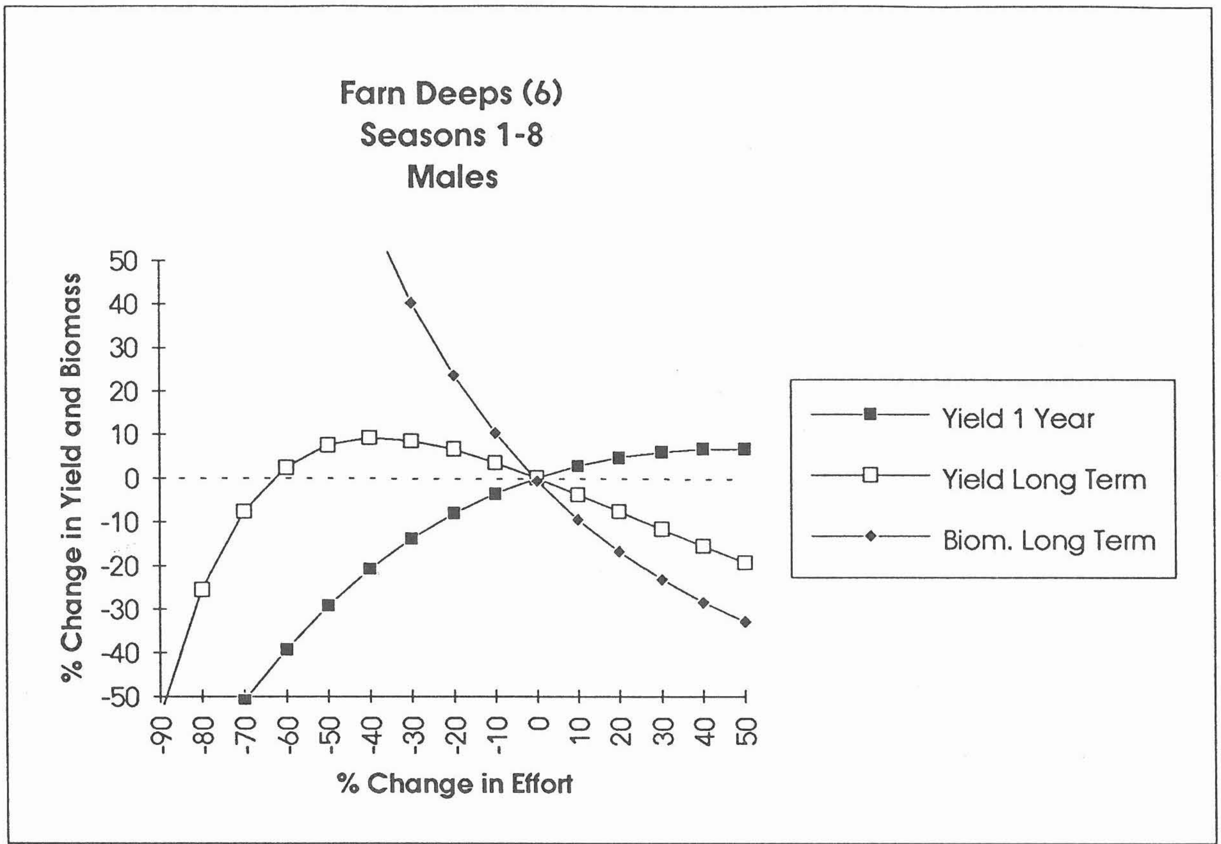


Figure 5.10.7 Functional Unit : Farn Deeps (6) 1984-91
Percentage changes in long term landings and stock biomass and in short term landings following various percentage changes in fishing effort. Separate plots shown for males and females.



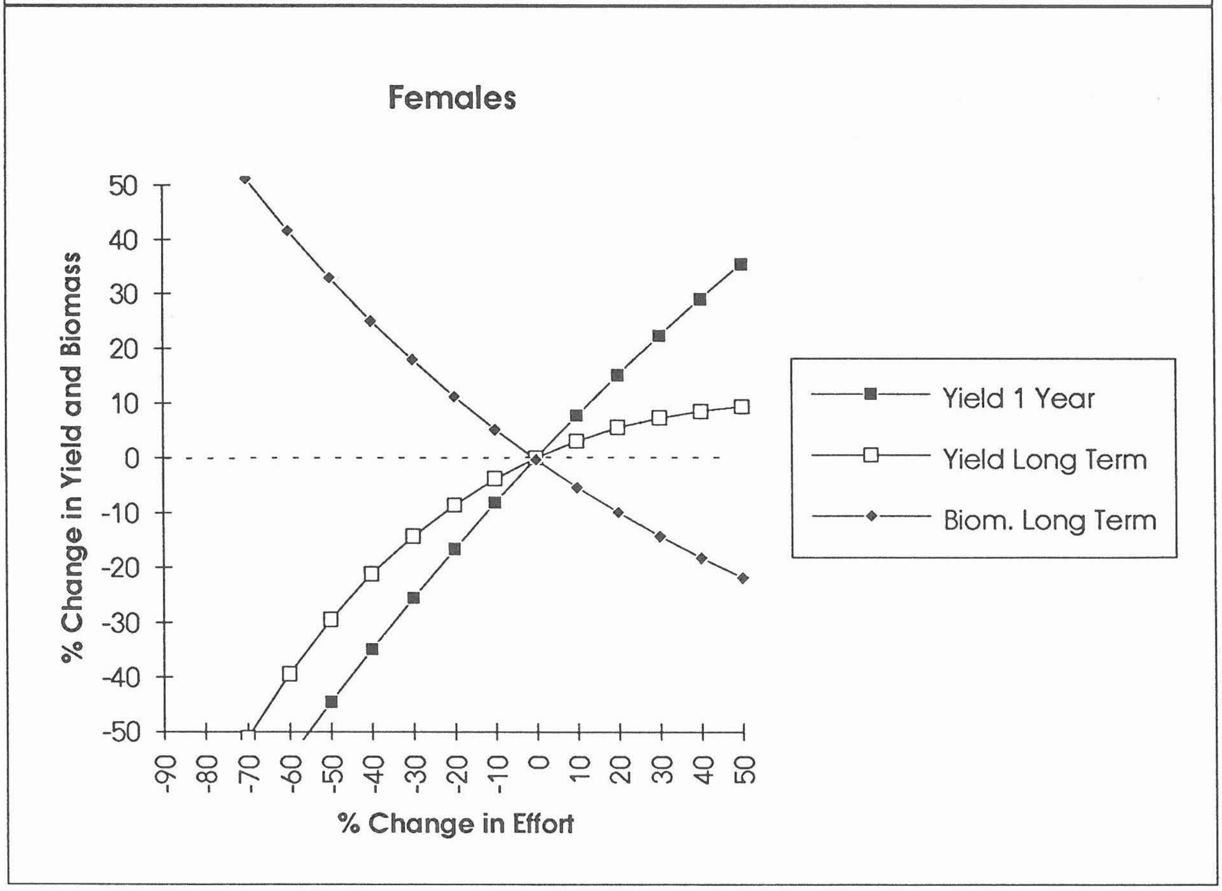


Figure 5.10.8 Functional Unit : Farn Deeps (6) 1984-87
Percentage changes in long term landings and stock biomass and in short term landings following various percentage changes in fishing effort. Separate plots shown for males and females.

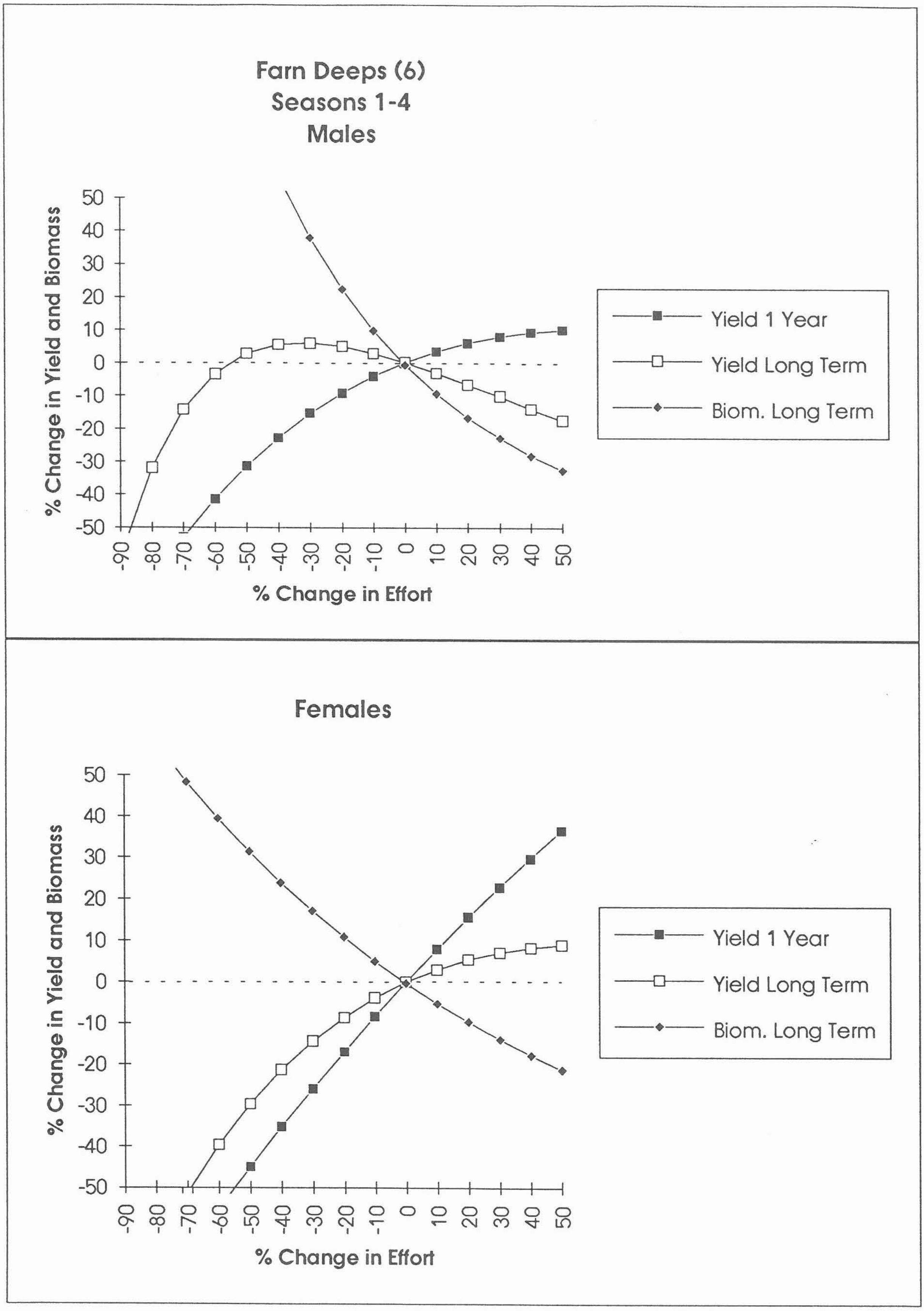


Figure 5.10.9 Functional Unit : Farn Deeps (6) 1988-91
Percentage changes in long term landings and stock biomass and in short term landings following various percentage changes in fishing effort. Separate plots shown for males and females.

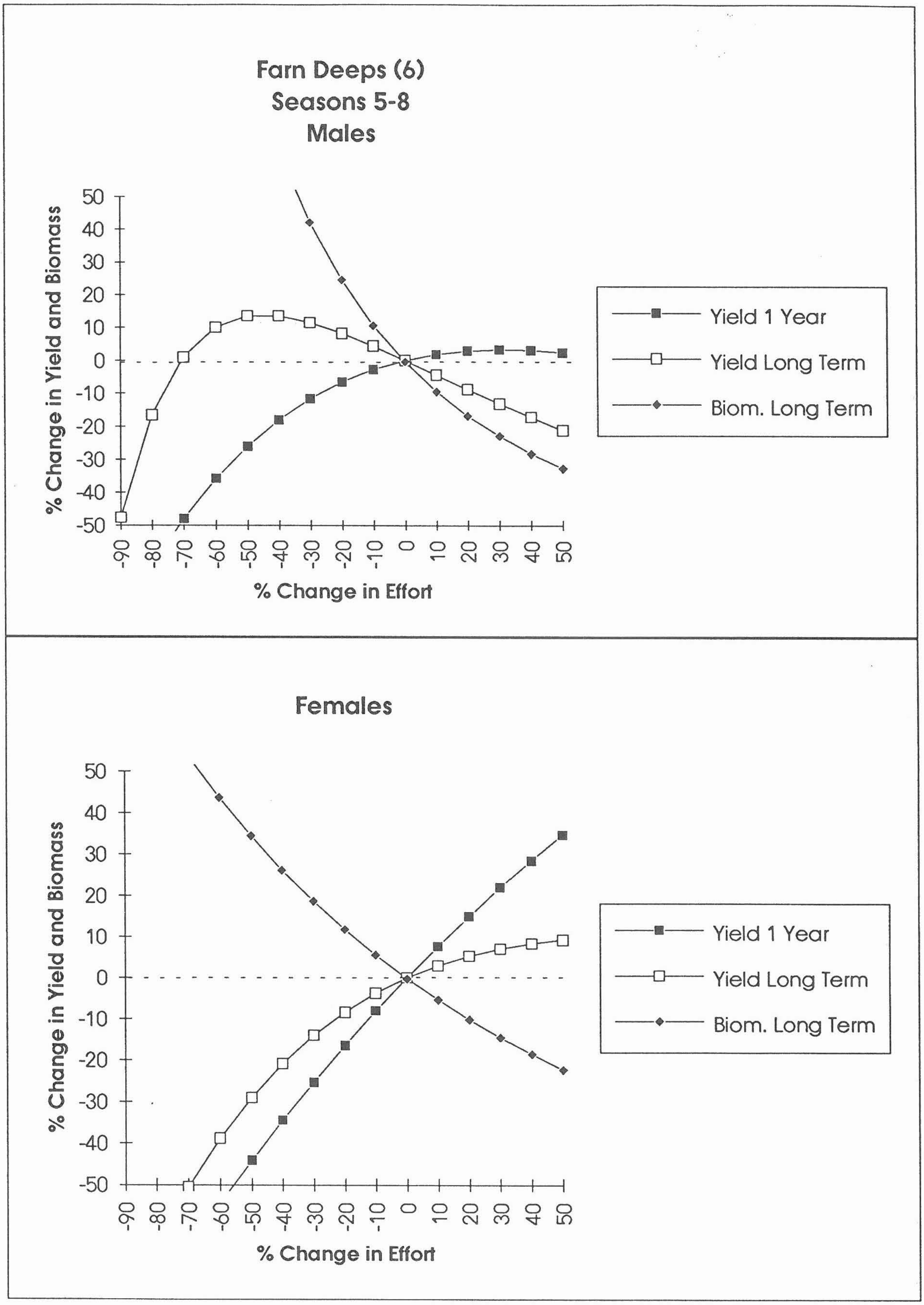
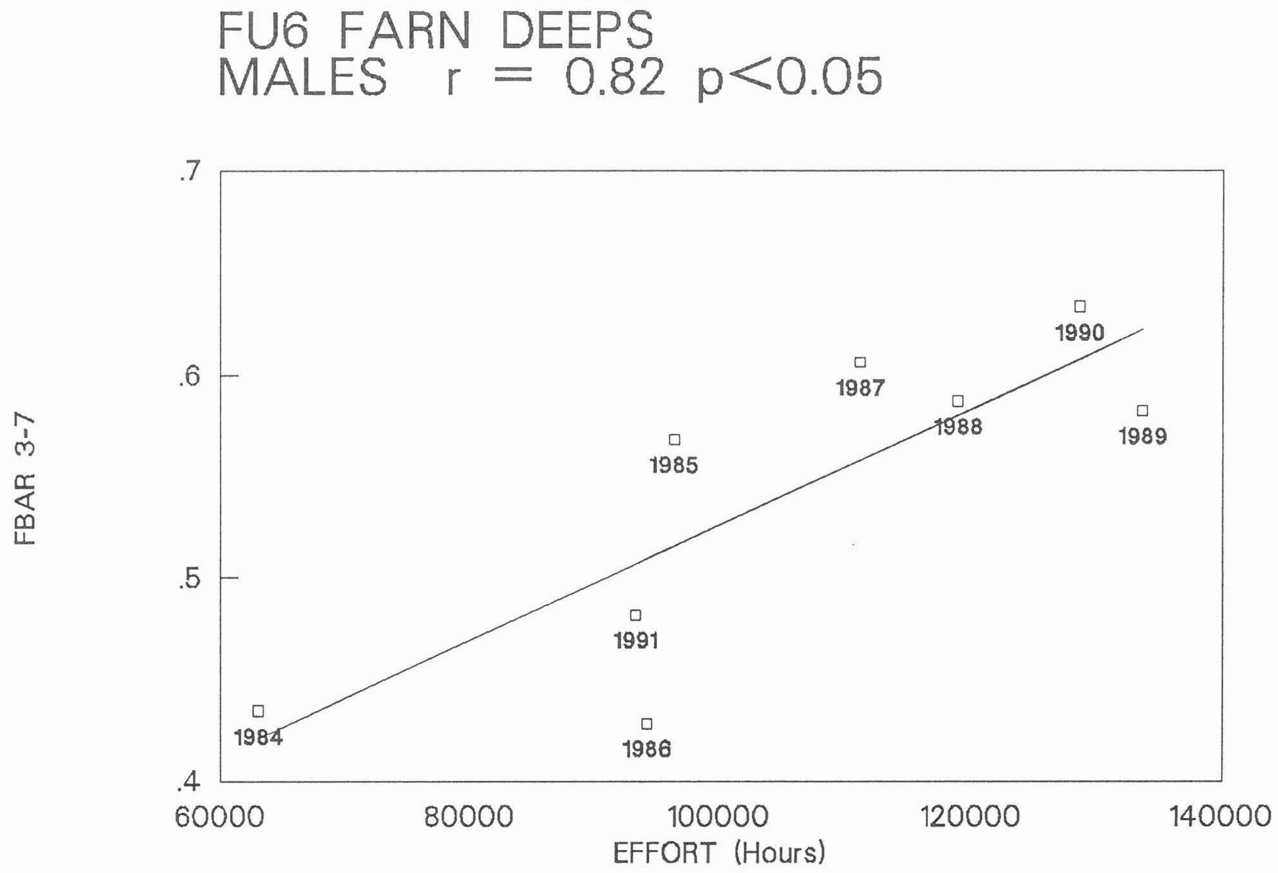


Figure 5.10.10 Functional Unit : Farn Deeps (6)
Relationships between Fbar from VPA and fishing effort for male and female Nephrops



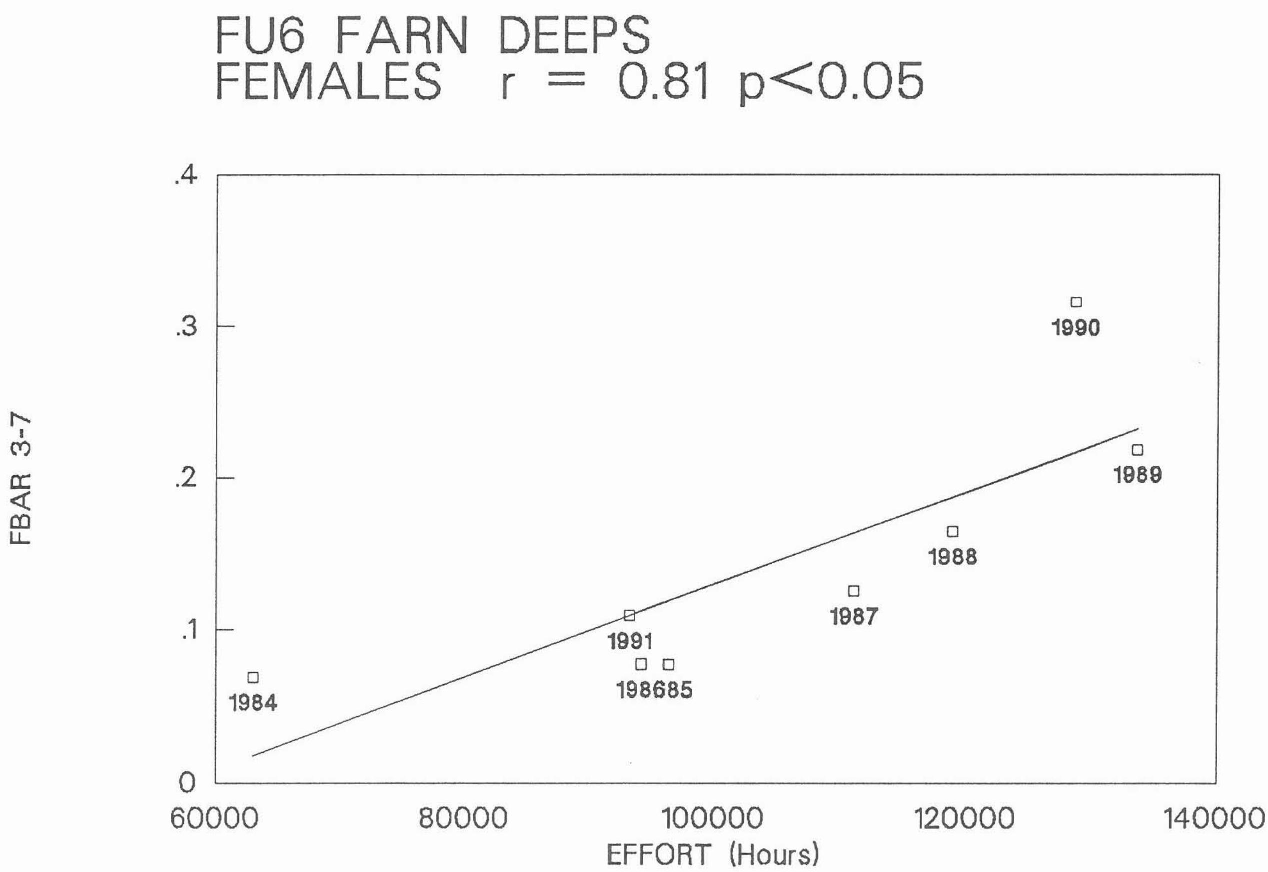


Figure 5.10.11 FU: Farn Deeps (6)
Relationship between LPUE and combined male and female TSB

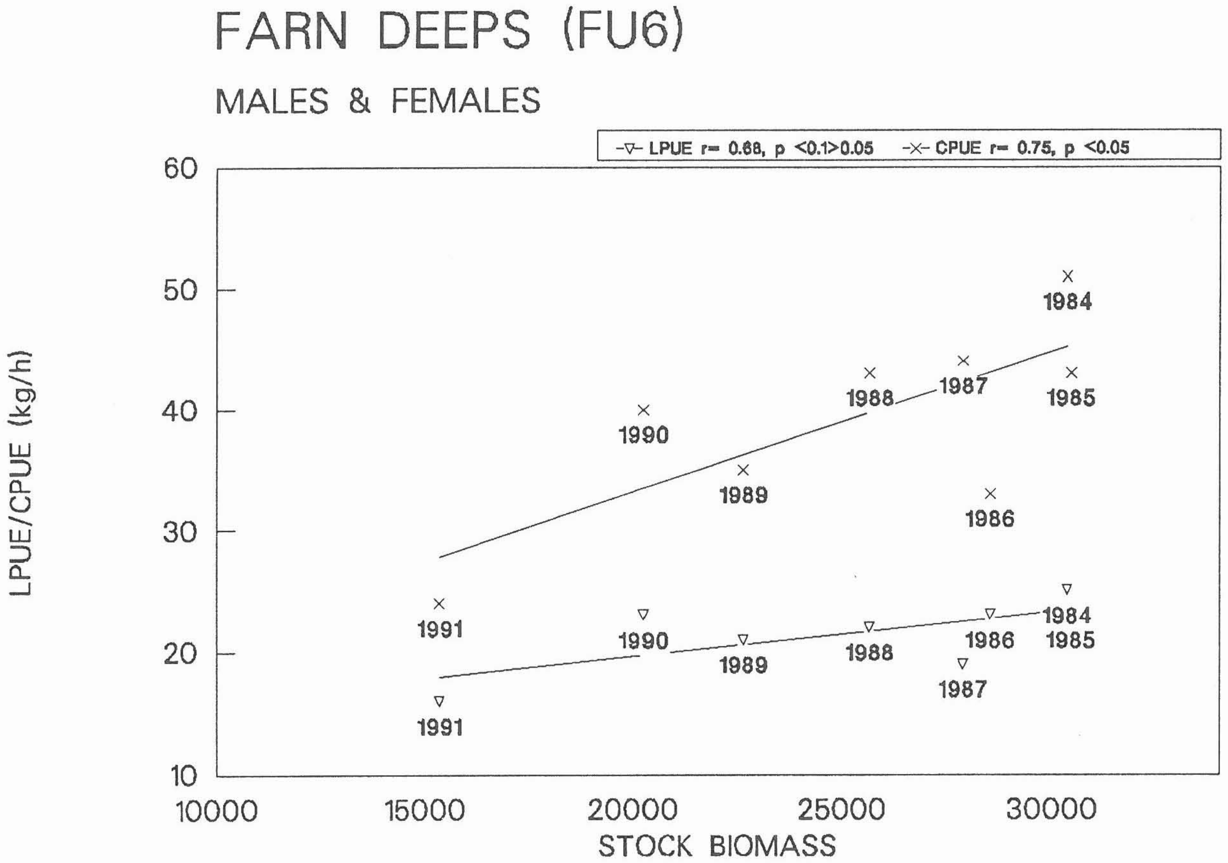


Figure 5.10.12 Functional Unit : Farn Deeps (6)
Relationships between Landings(t) and Effort(t)
Least Squares linear regression line shown.

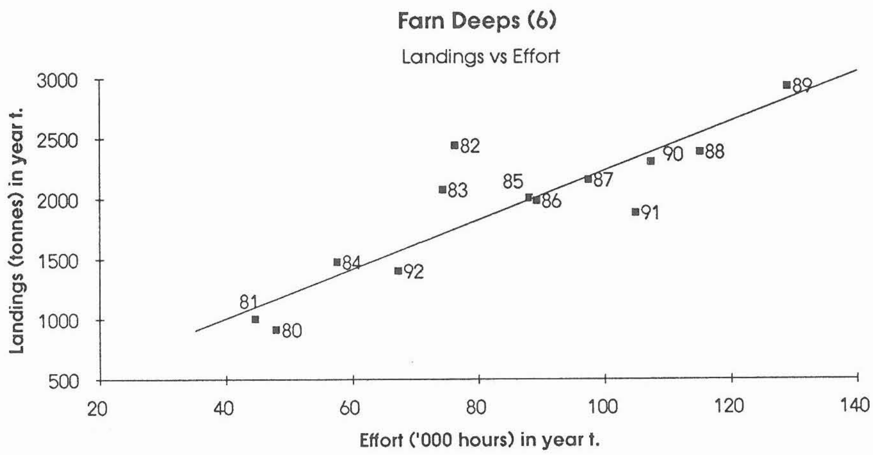


Figure 5.10.13 Functional Unit : Firth of Forth (8)
Percentage changes in long term landings and stock biomass and in short term landings following various percentage changes in fishing effort. Separate plots shown for males and females.

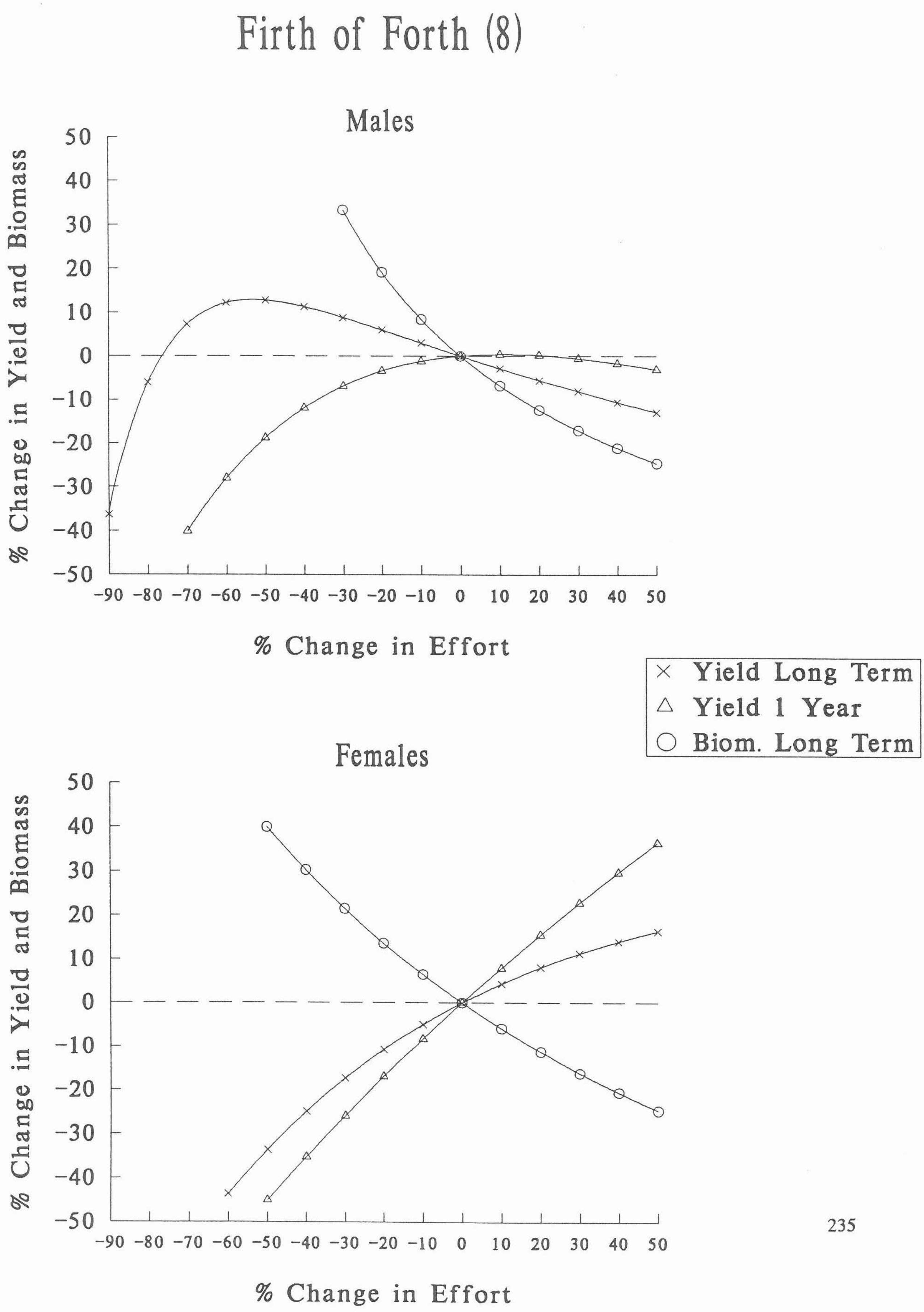
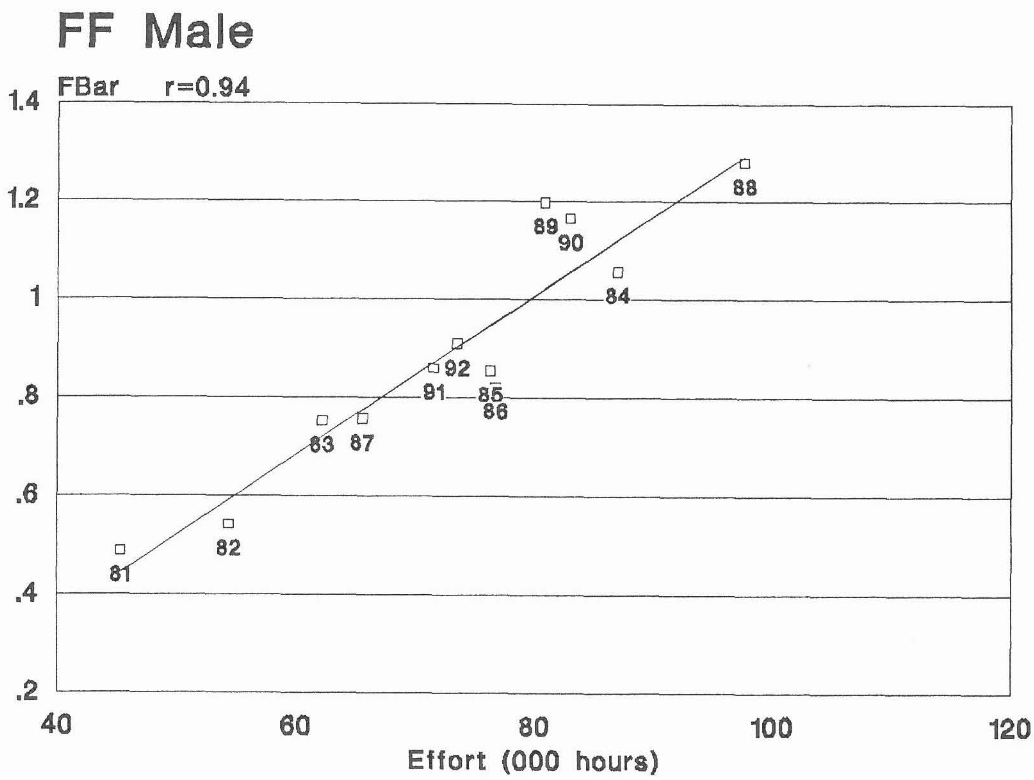


Figure 5.10.14 Functional Unit : Firth of Forth (8)
Relationships between Fbar from VPA and fishing effort for male and female Nephrops



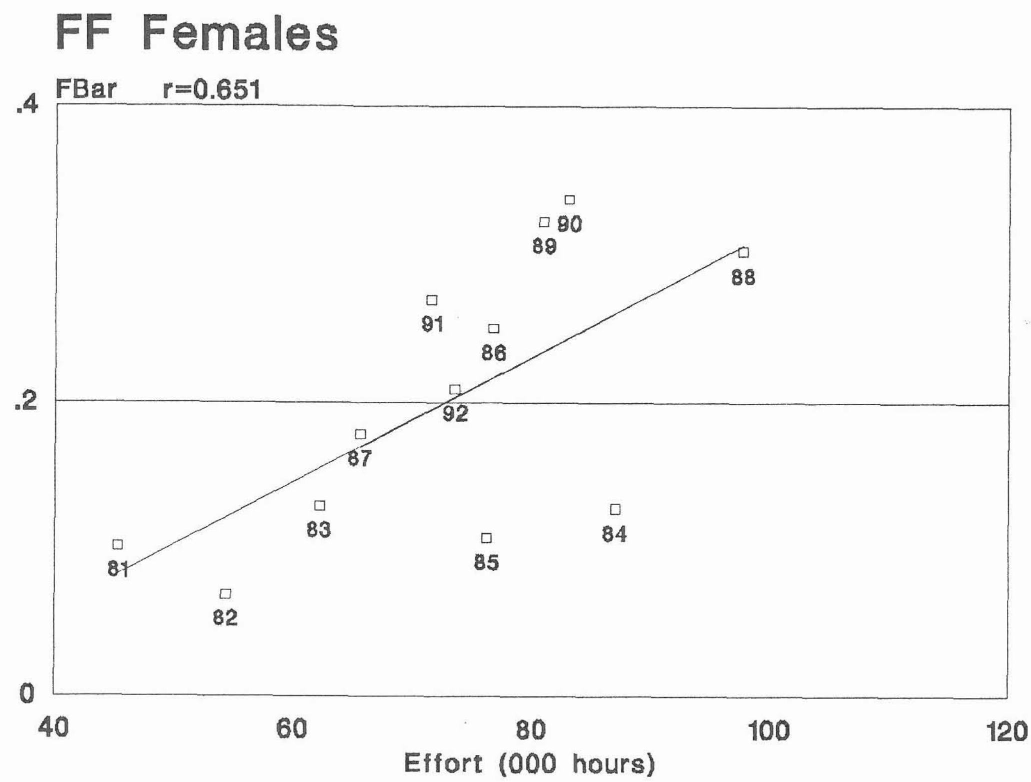


Figure 5.10.15 FU: Firth of Forth (8)
Relationship between LPUE and combined male and female TSB

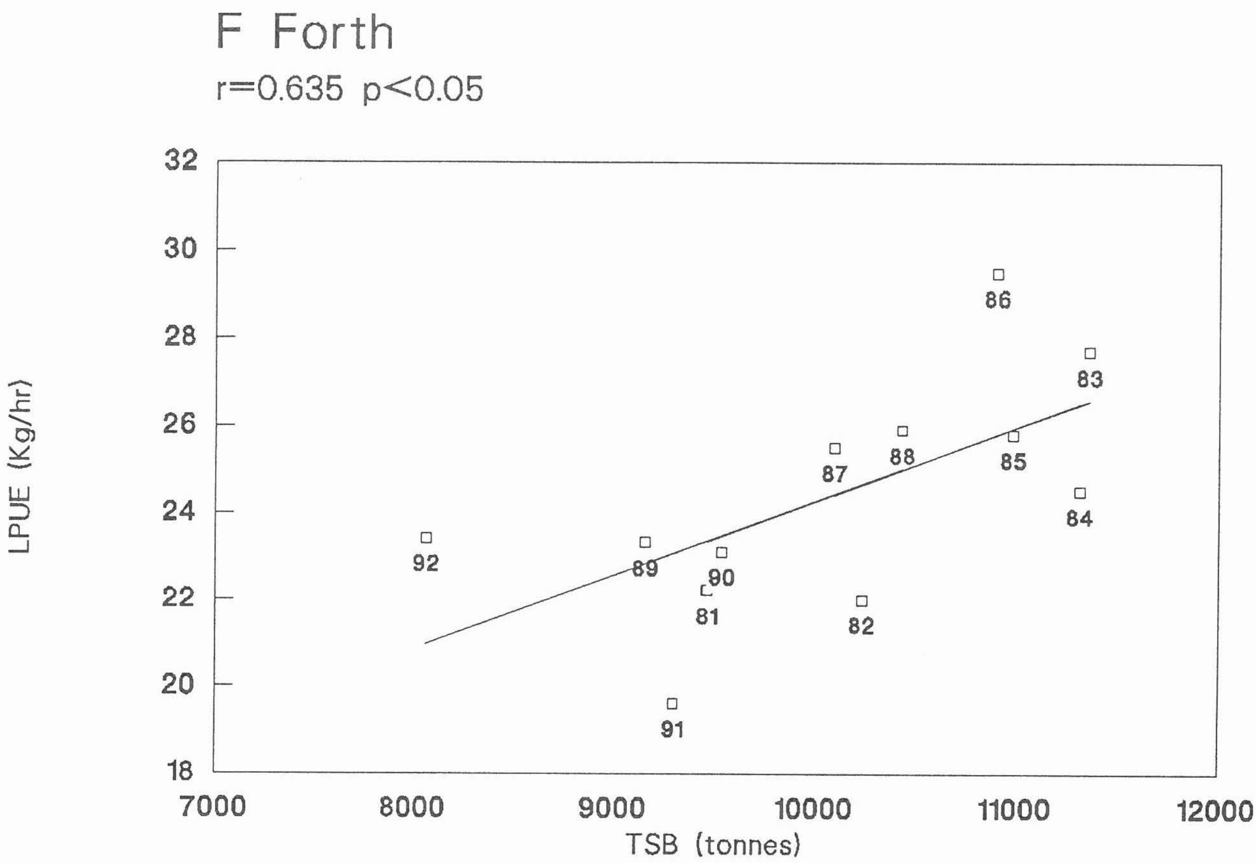


Figure 5.10.16 Functional Unit : Firth of Forth (8)
Relationships between Landings(t) and Effort(t)
Least Squares linear regression line shown.

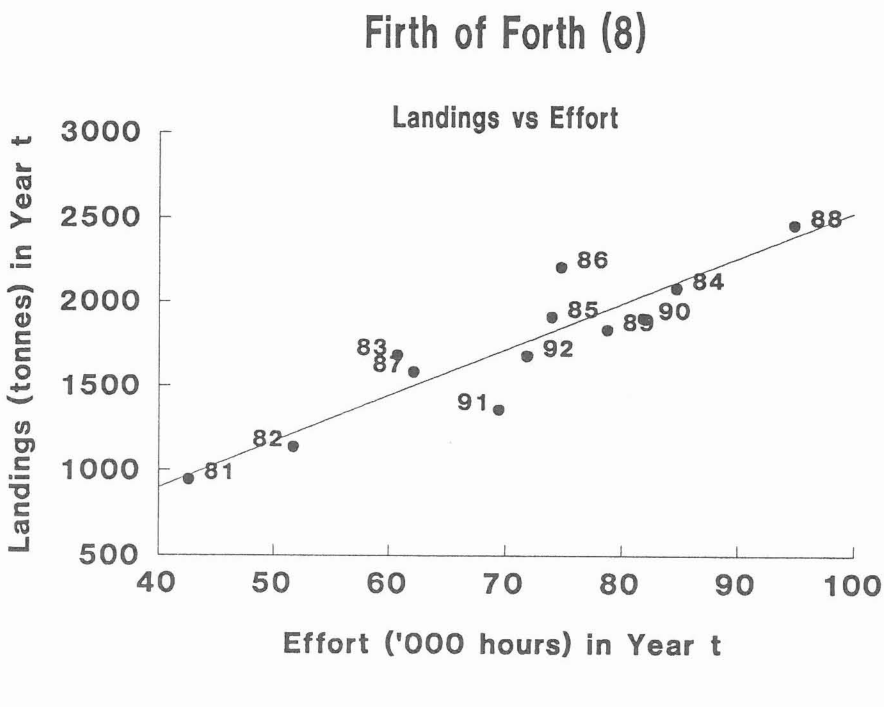
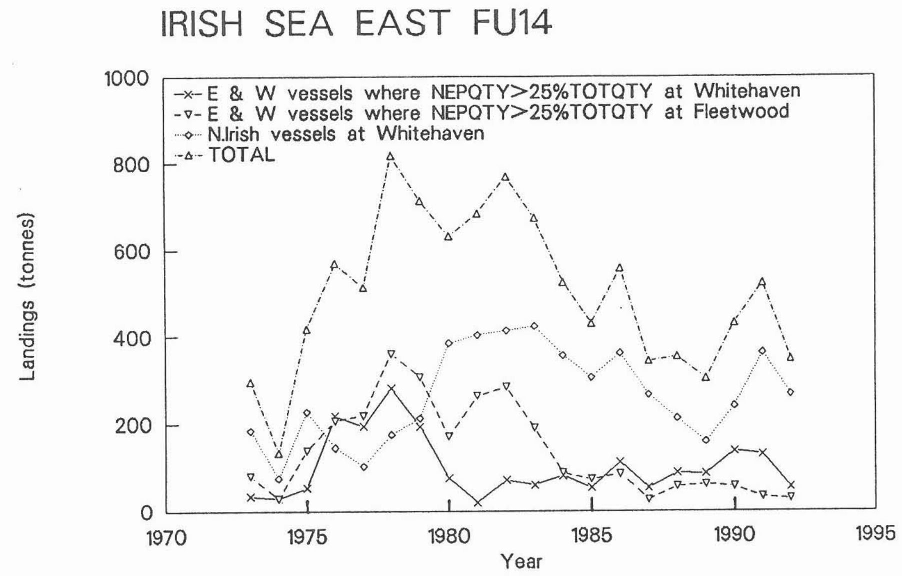
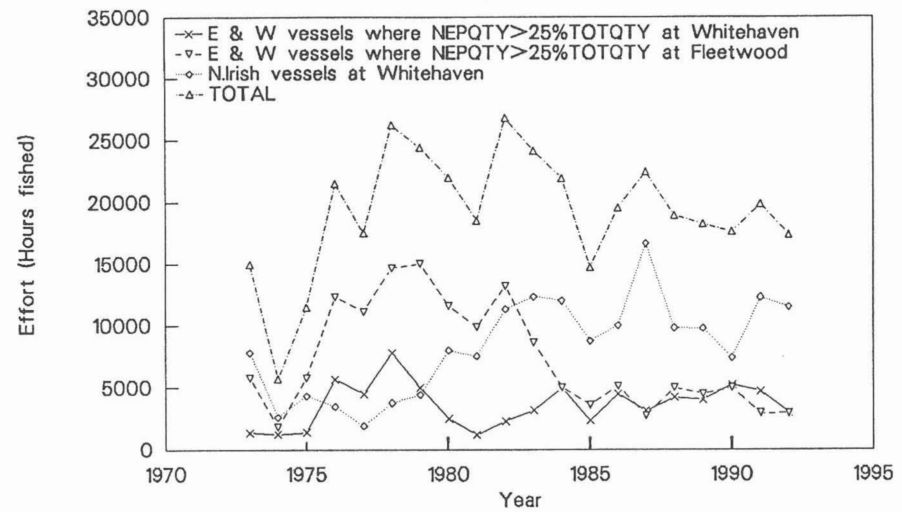


Figure 5.11.1 Irish Sea East(14) : A. Landings (tonnes) B. Effort (hours fished) C. LPUE (kg/hour) for various categories of vessel 1973-1992.

A



B



C

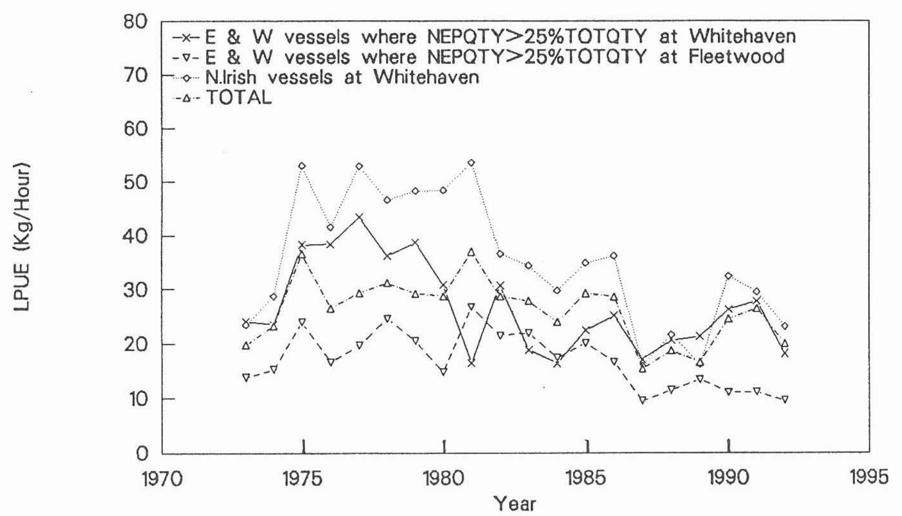


Figure 5.11.2 Functional Unit : Irish Sea East (14) 1985-88
Percentage changes in long term landings and stock biomass and in short term landings following various percentage changes in fishing effort. Separate plots shown for males and females.

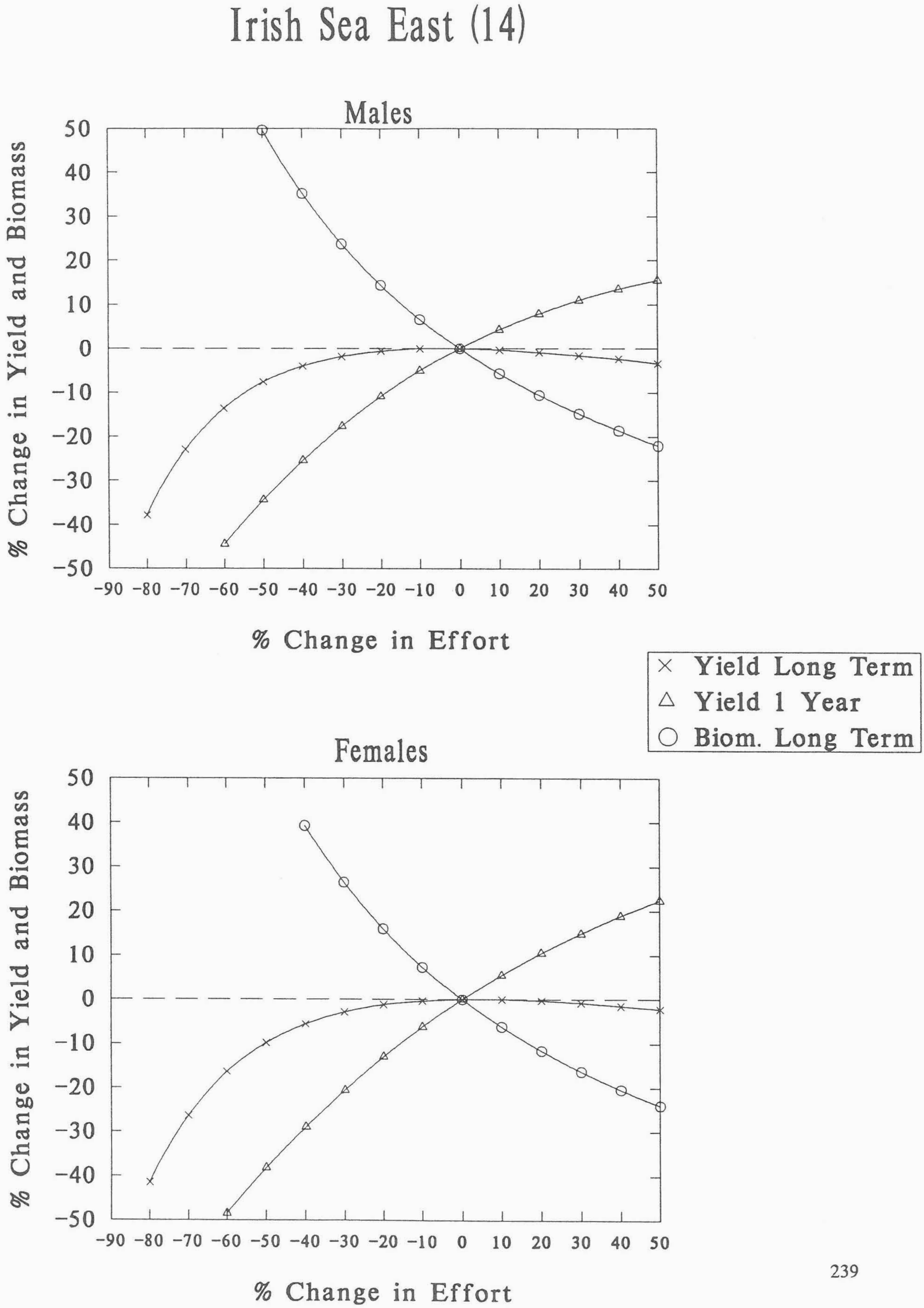


Figure 5.11.3 Functional Unit : Irish Sea East (14)
Relationships between Landings(t) and Effort(t)
Least Squares linear regression line shown.

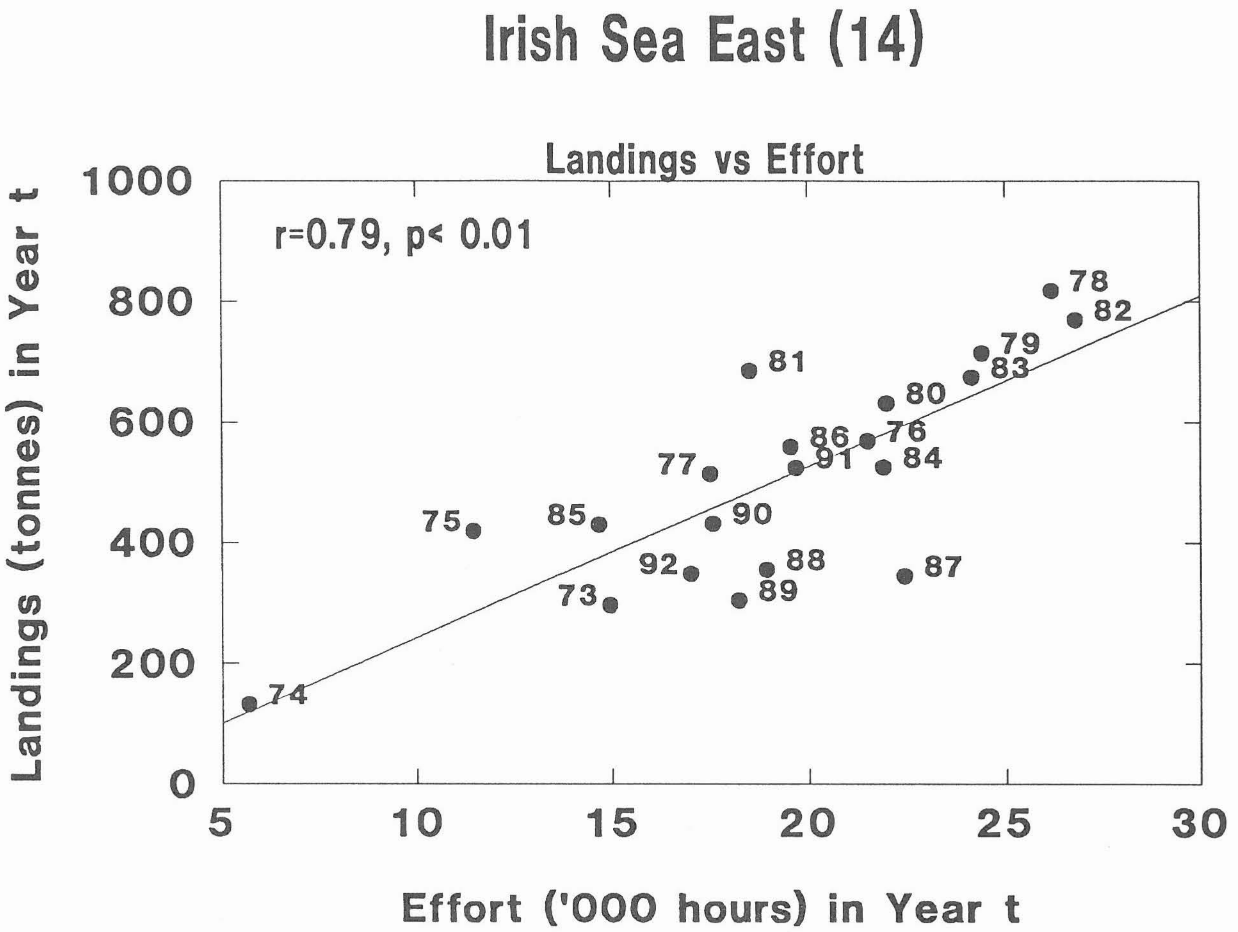


Figure 5.11.4 Irish Sea West(15) : Total landings by Northern Ireland 1954-1991

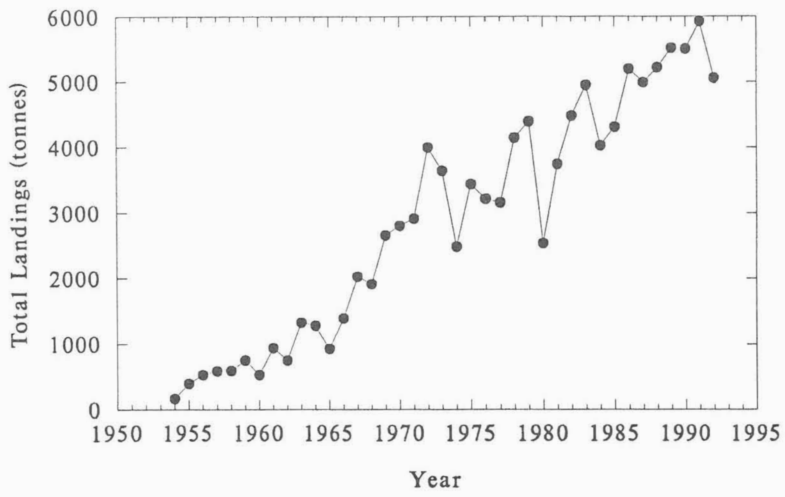
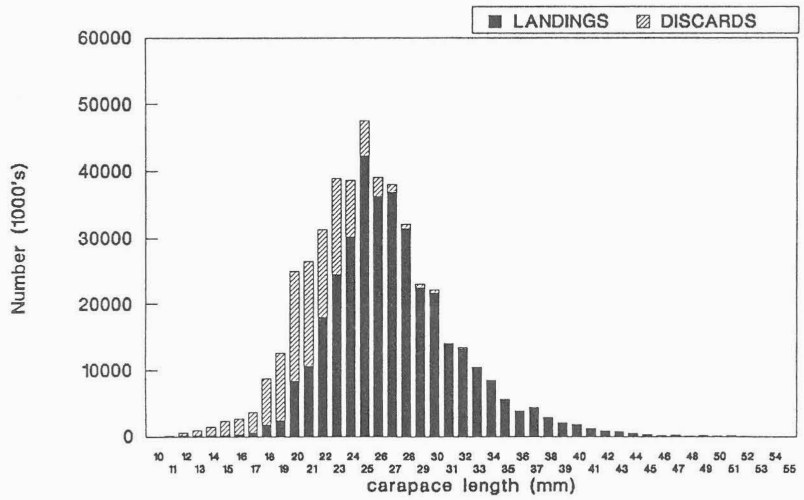


Figure 5.11.5 Irish Sea West (15): Length compositions from Northern Ireland and Republic of Ireland (1992).

NORTHERN IRELAND
1992 Size Composition



IRELAND
1992 Size Composition

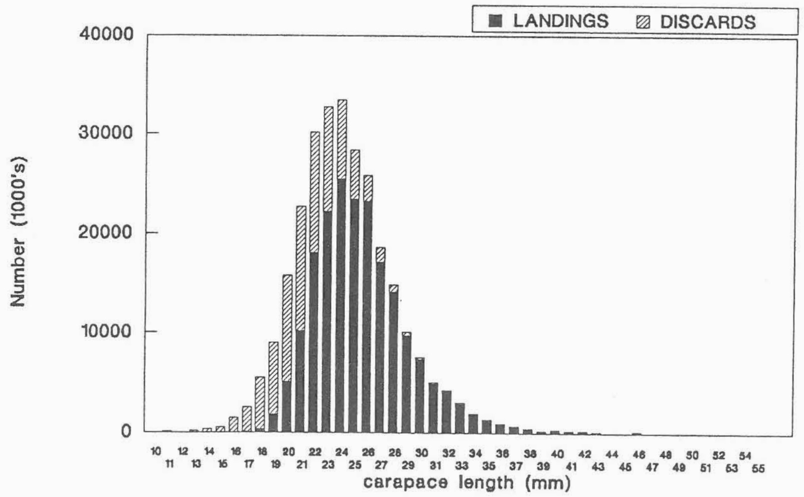
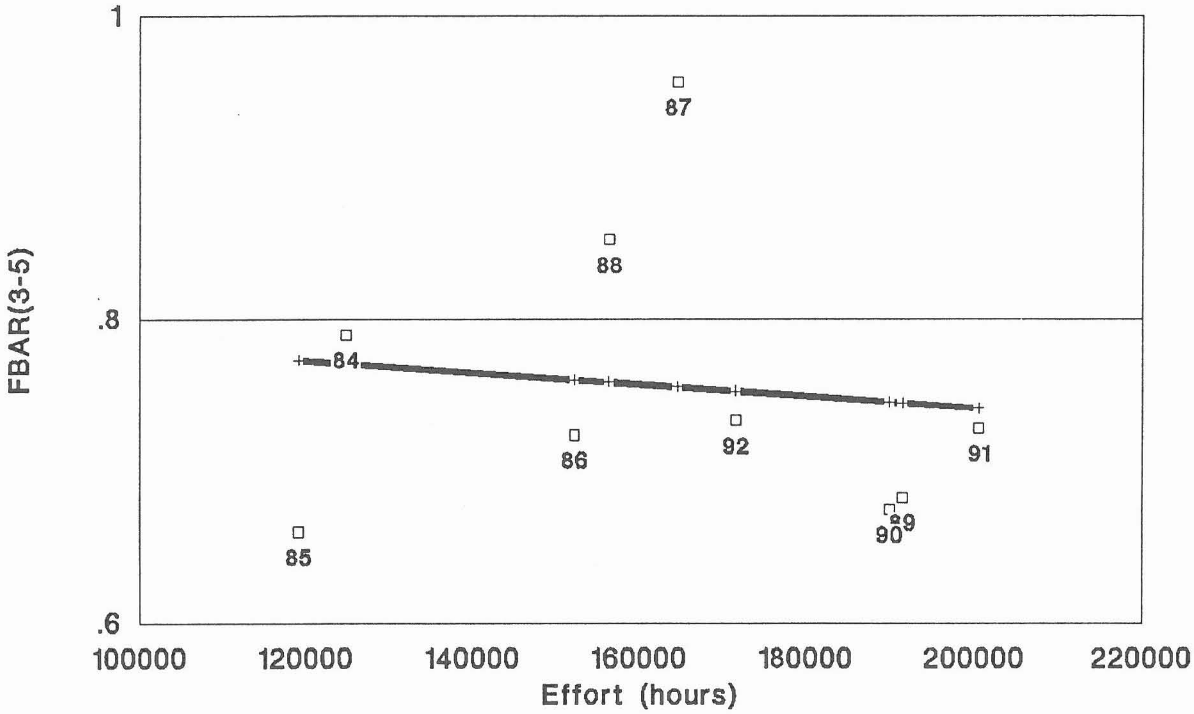


Figure 5.11.6 Functional Unit : Irish Sea West (15)
Relationships between Fbar from VPA and fishing effort for male and female Nephrops

FU 15 - IRISH SEA MALES

FBAR(3-5) vs Effort R=-0.11



FU 15 - IRISH SEA FEMALES

FBAR(3-5) vs Effort R=0.749

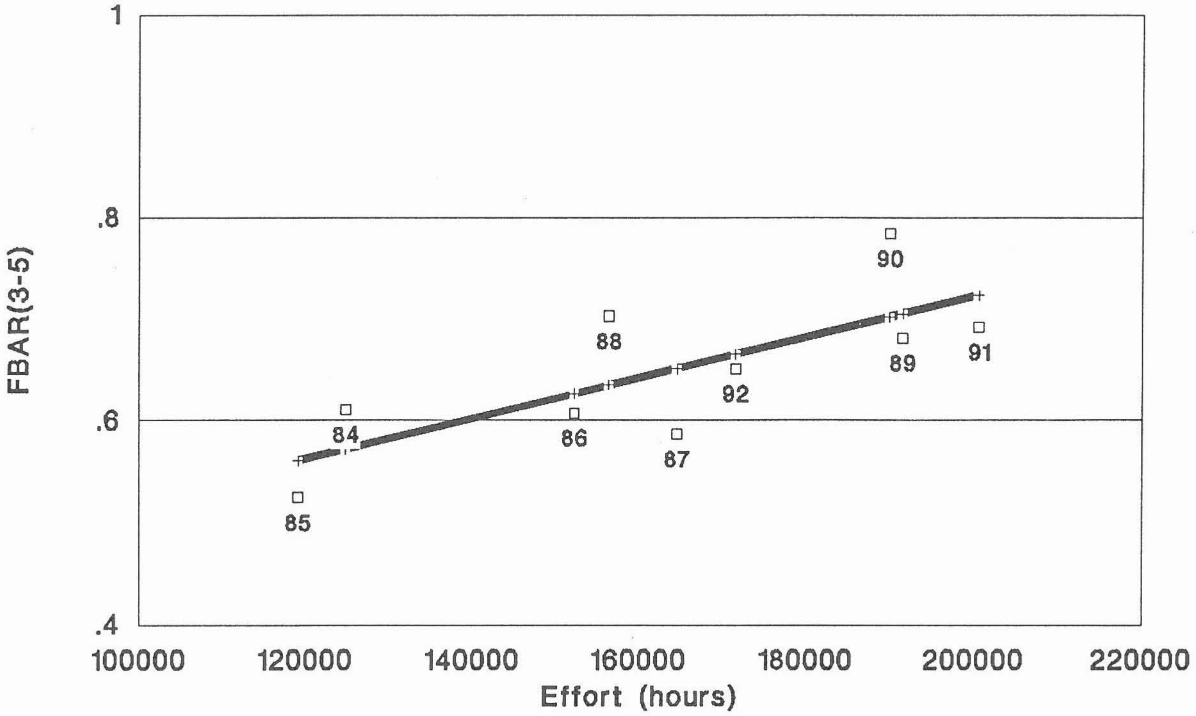


Figure 5.11.7 Functional Unit : Irish Sea West (15)
Relationships between Landings(t) and Effort(t)
Least Squares linear regression line shown.

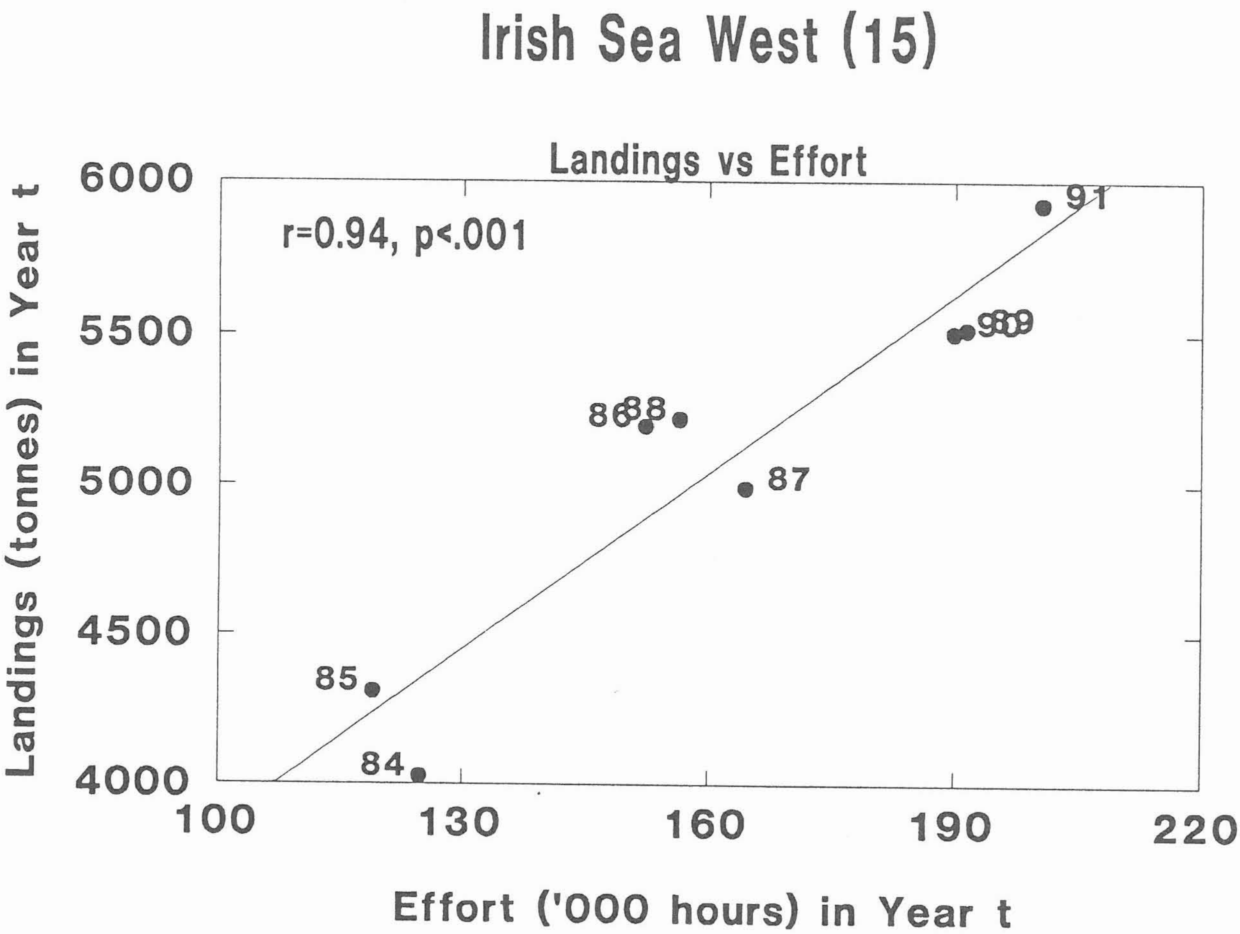


Figure 5.13.1 Porcupine Bank (16) : A. Total landings (tonnes) by Spanish fleet B. Spanish effort (effort index) C. CPUE (kg/effort index) all figures 1971-1992

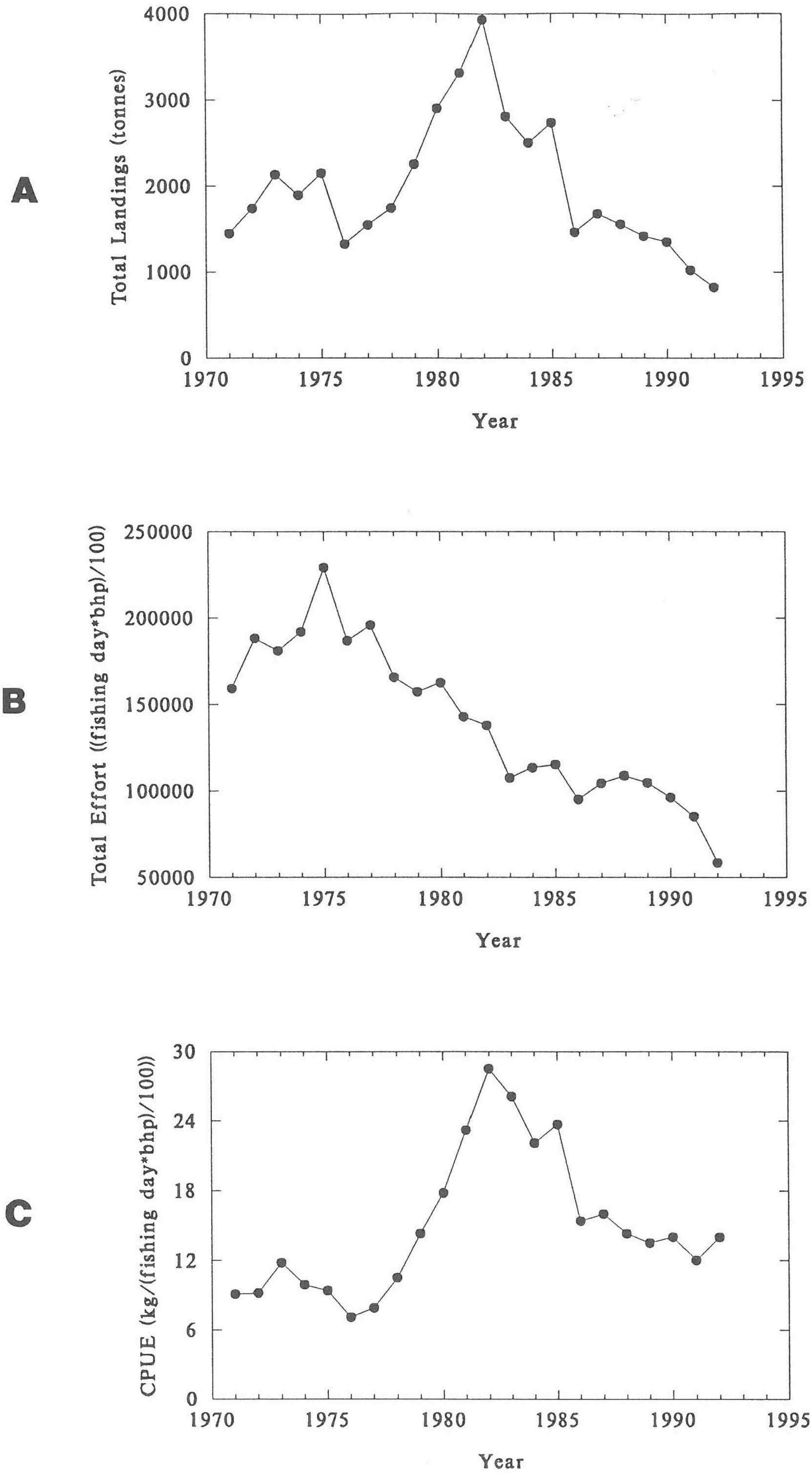


Figure 5.13.2 Functional Unit : Porcupine Bank (16) 1988-92
Percentage changes in long term landings and stock biomass and in short term landings following various percentage changes in fishing effort. Separate plots shown for males and females.

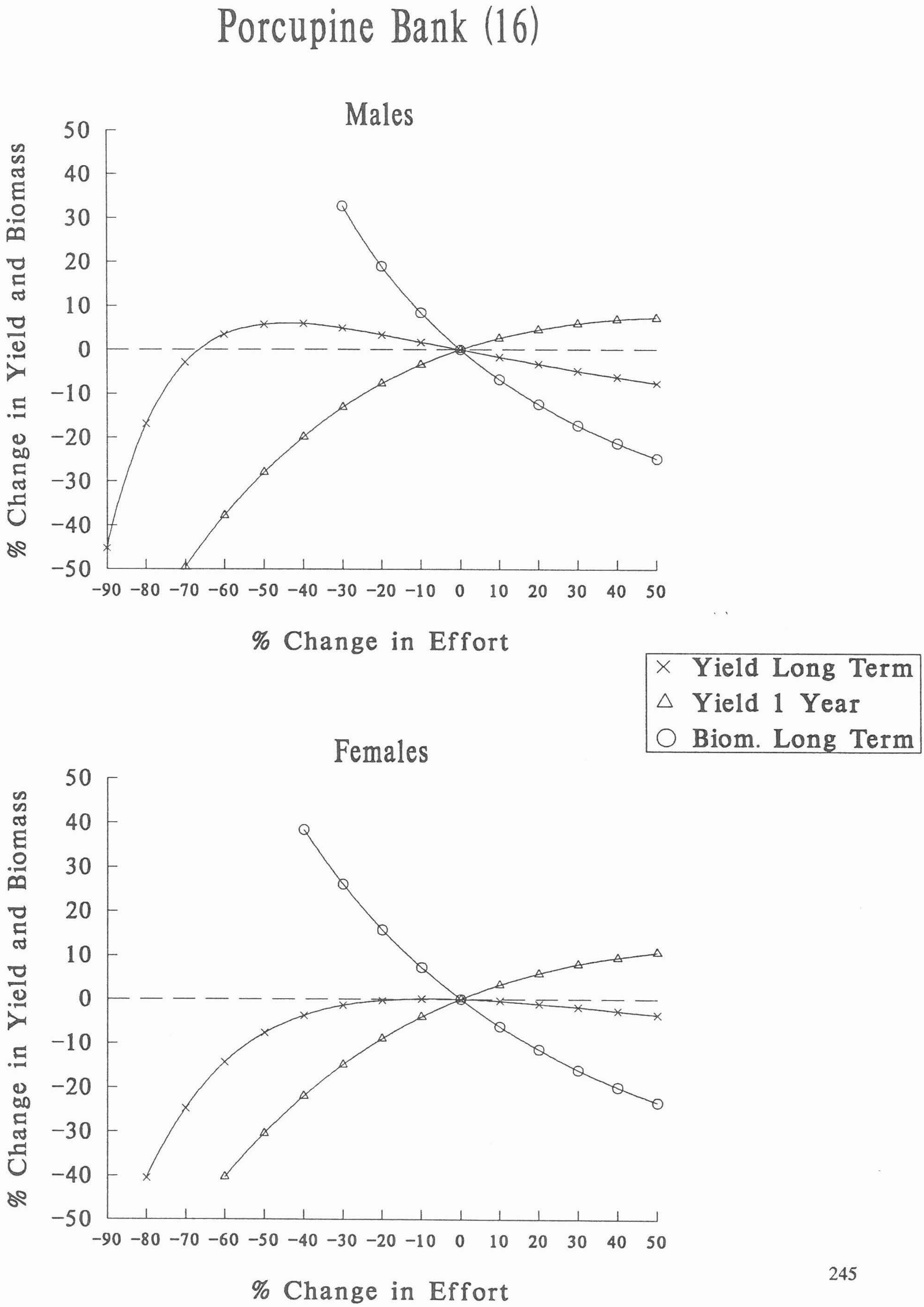
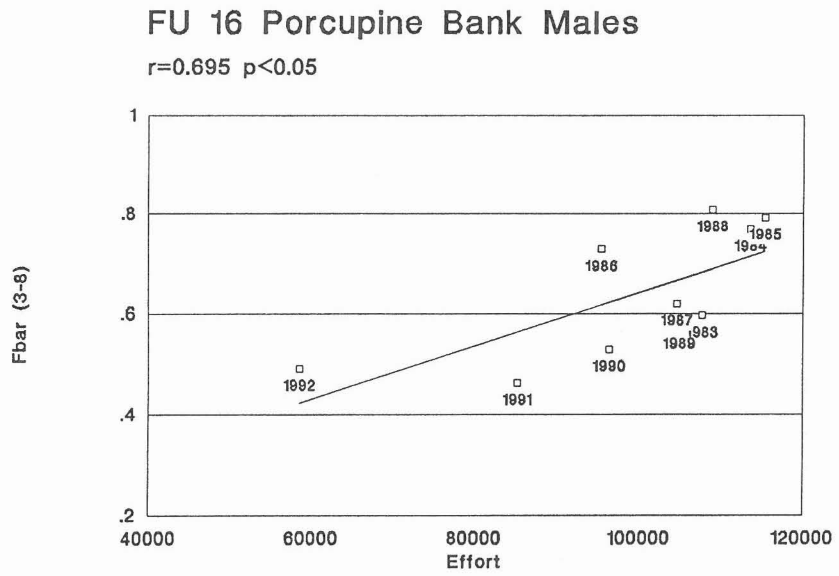


Figure 5.13.3 Functional Unit : Porcupine Bank (16)
Relationships between Fbar from VPA and fishing effort for male and female Nephrops



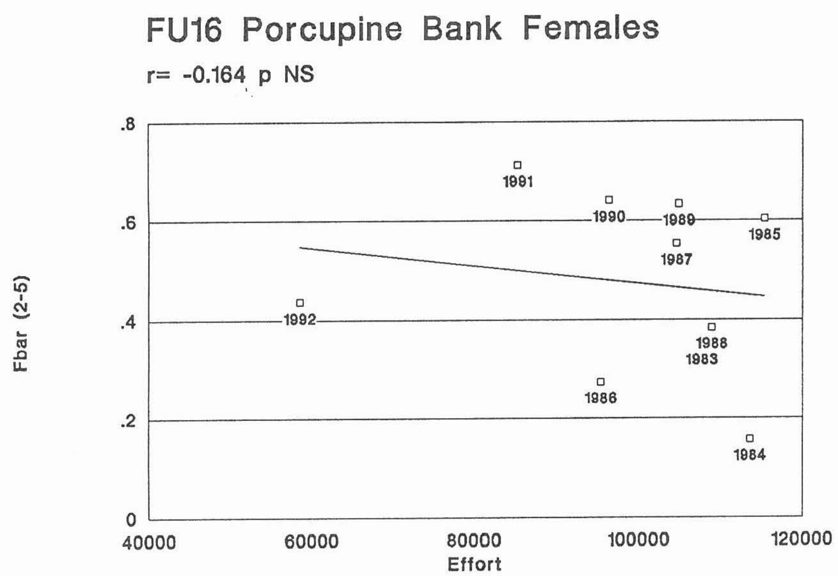


Figure 5.13.4 Functional Unit : Porcupine Bank (16) Finfish Trawl
Relationships between Landings(t) and Effort(t)
Least Squares linear regression line shown.

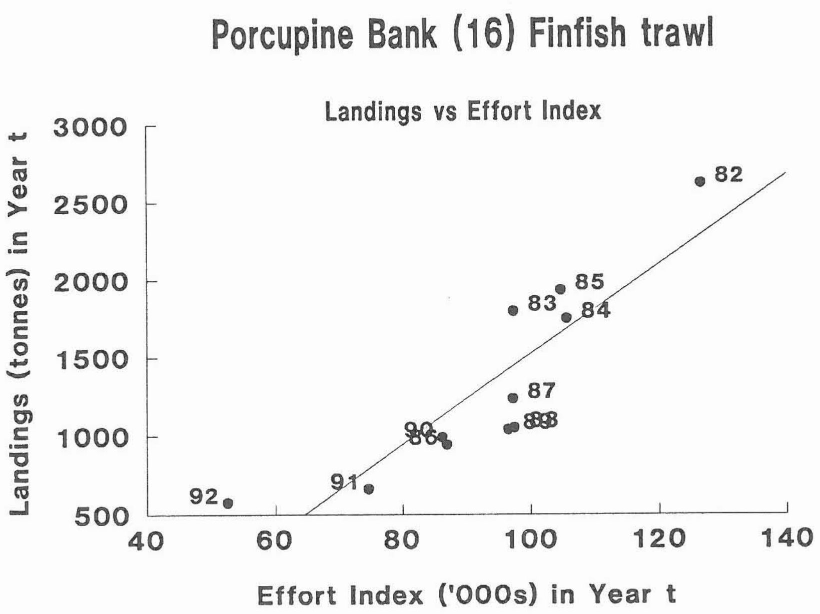


Figure 5.14.1 Celtic Sea (20-22) : A. Total landings (tonnes) and landings by French fleet B. French effort (hours) C. LPUE (kg/hour) 1982-92

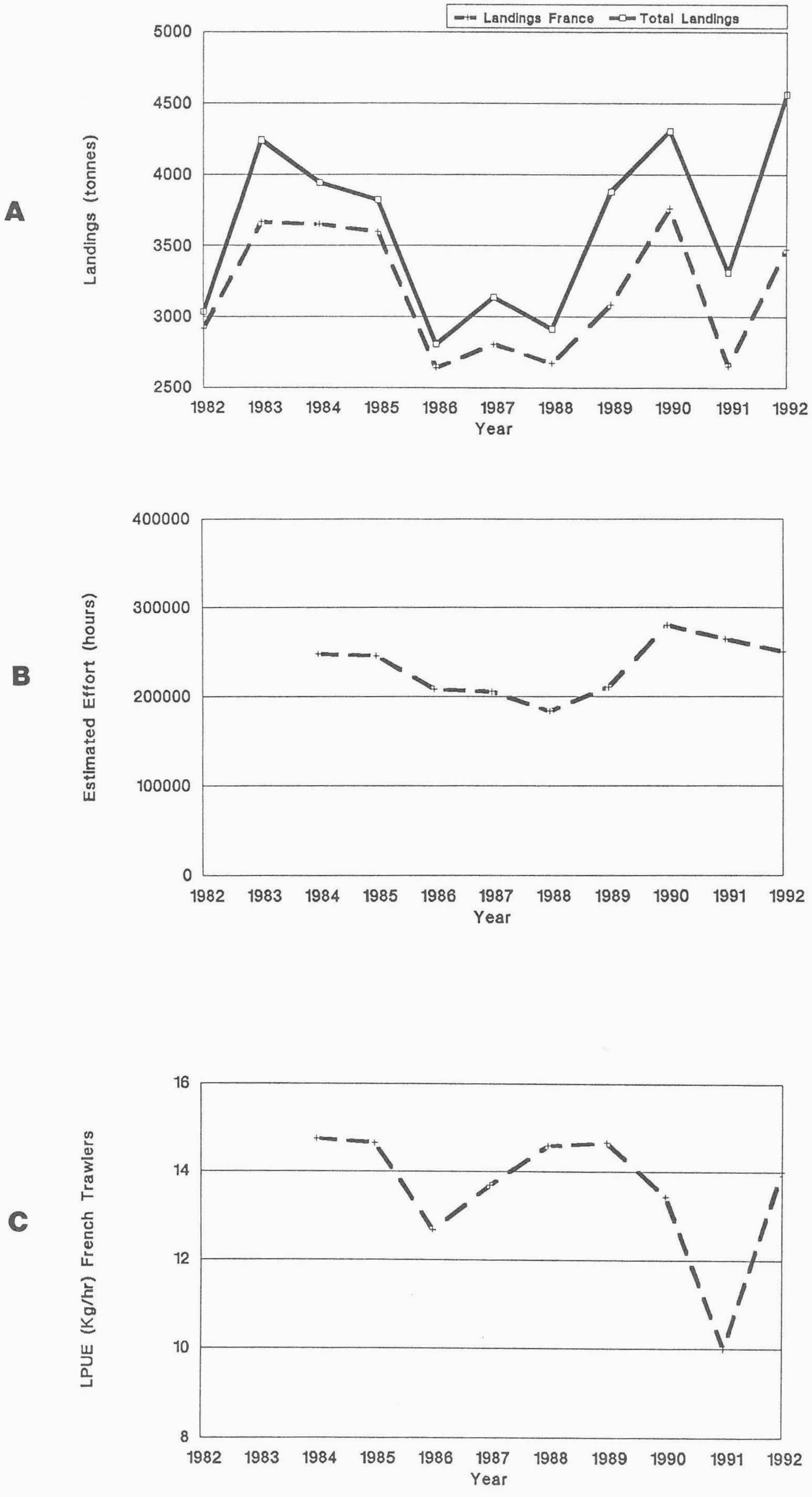


Figure 5.14.2 Functional Unit : Celtic Sea (20-22)
Relationship between Fbar from VPA and fishing effort for male Nephrops

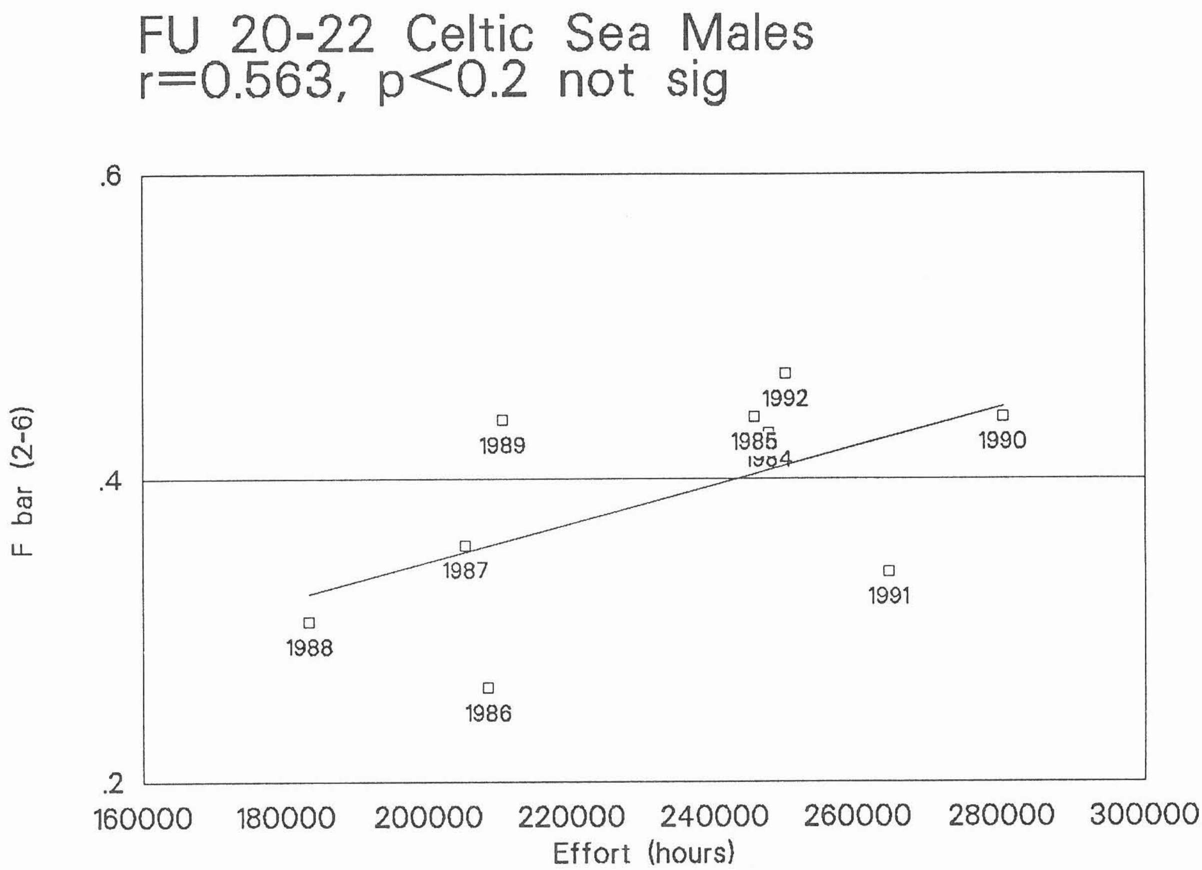


Figure 5.14.3 Functional Unit : Celtic Sea (20-22)
Relationships between Landings(t) and Effort(t)
Least Squares linear regression line shown.

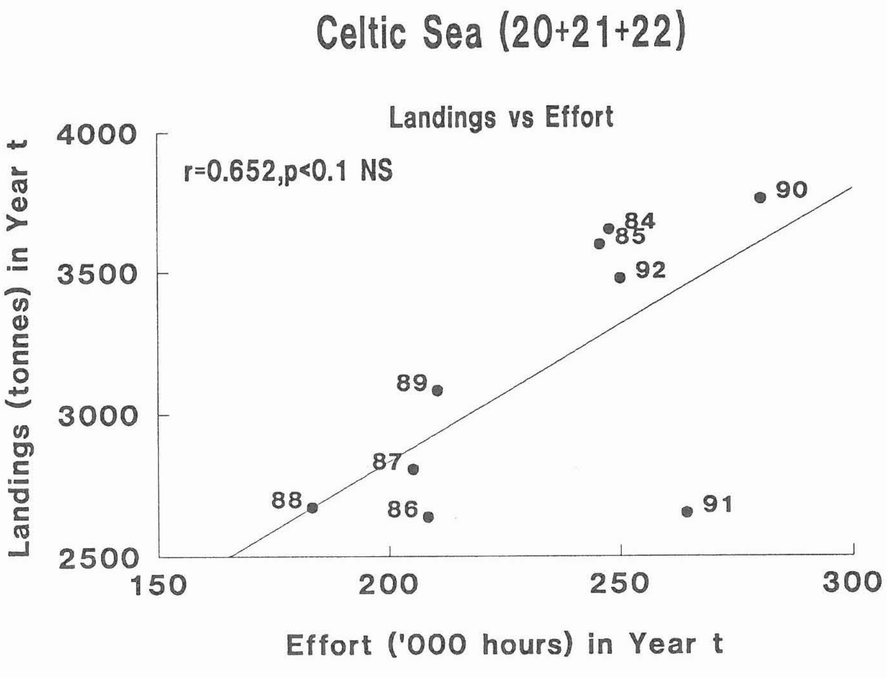


Figure 5.15.1 Bay of Biscay (23 & 24) : A. Total landings (tonnes) French fleet B. French effort (hours) C. LPUE (kg/hour) 1984-92

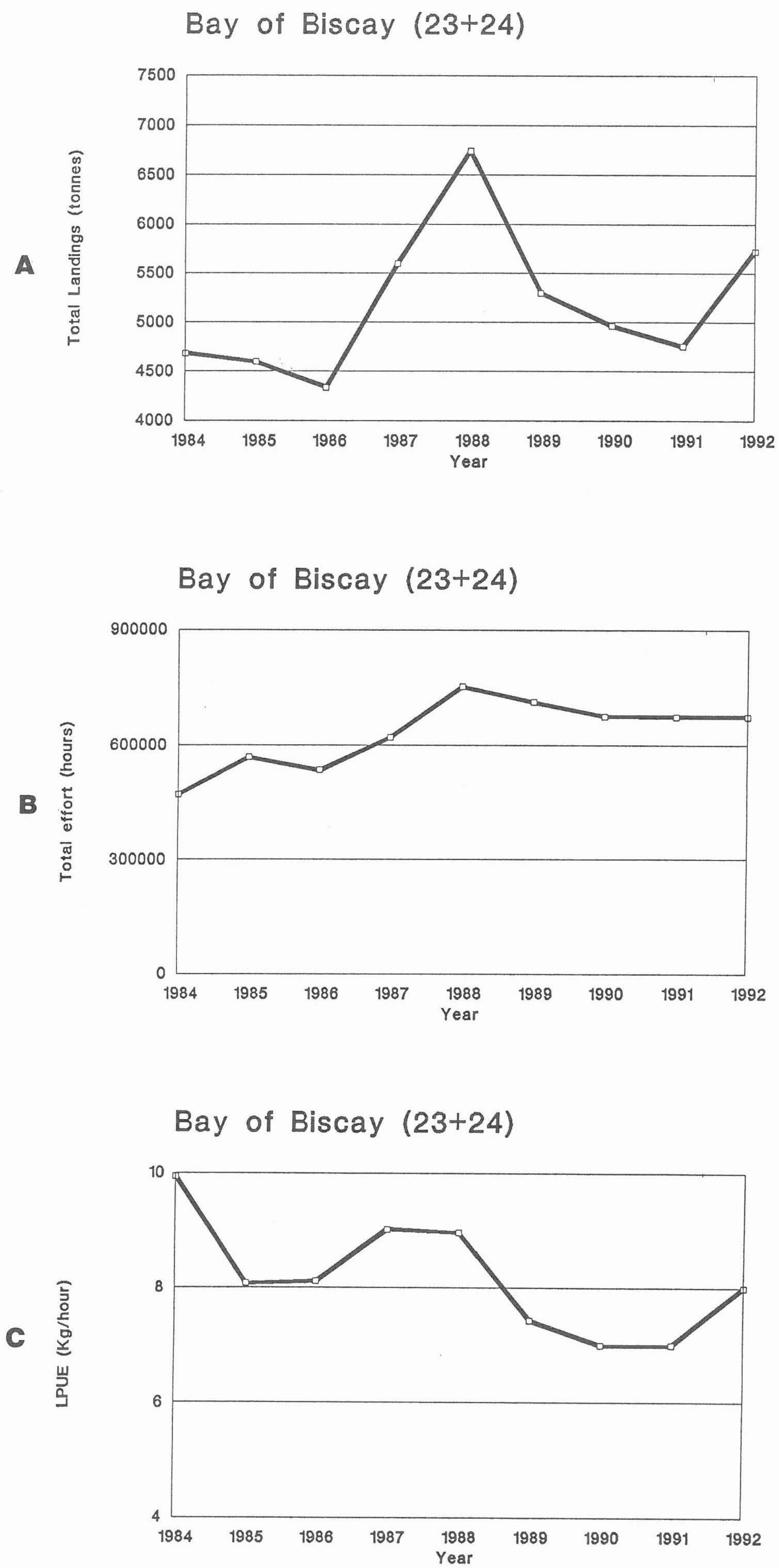
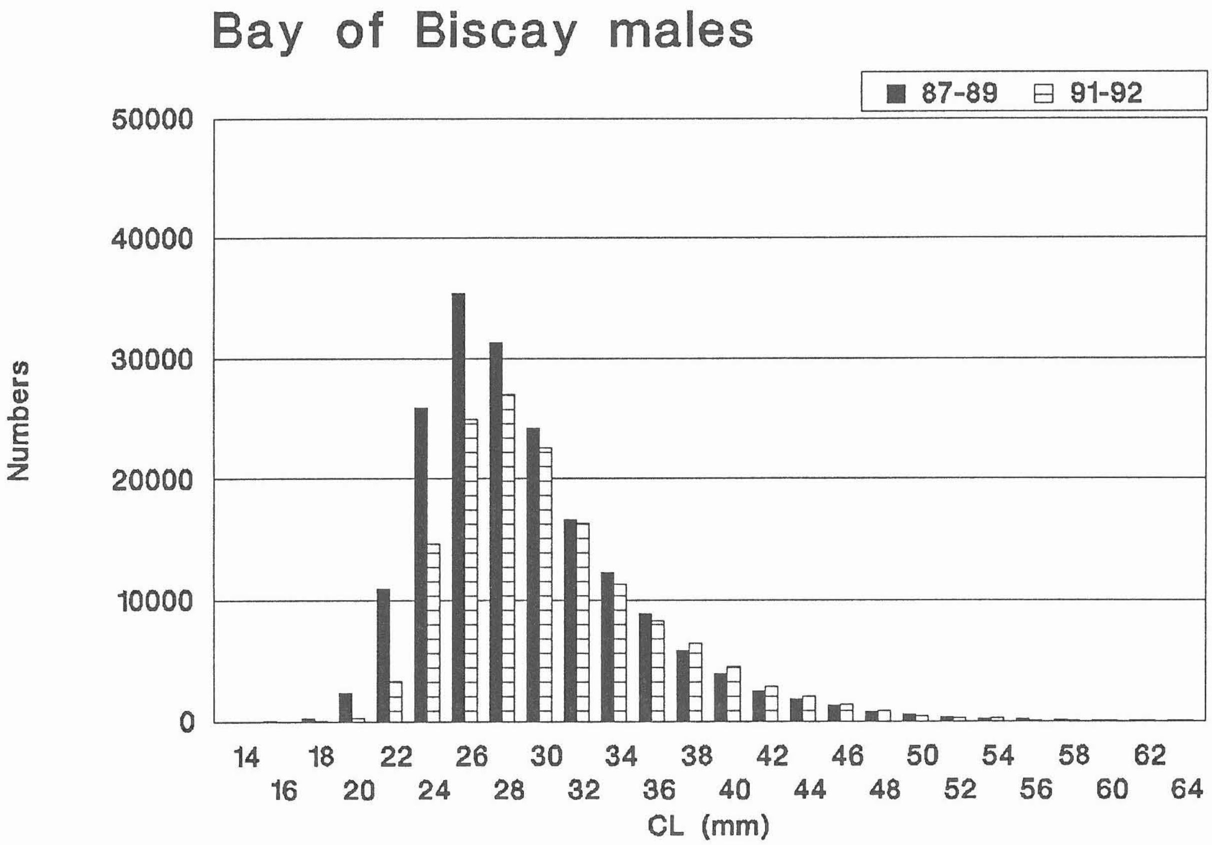


Figure 5.15.2 Bay of Biscay (23 & 24): Average length compositions for the periods 1987-89 and 1991-92. Sexes shown separately.



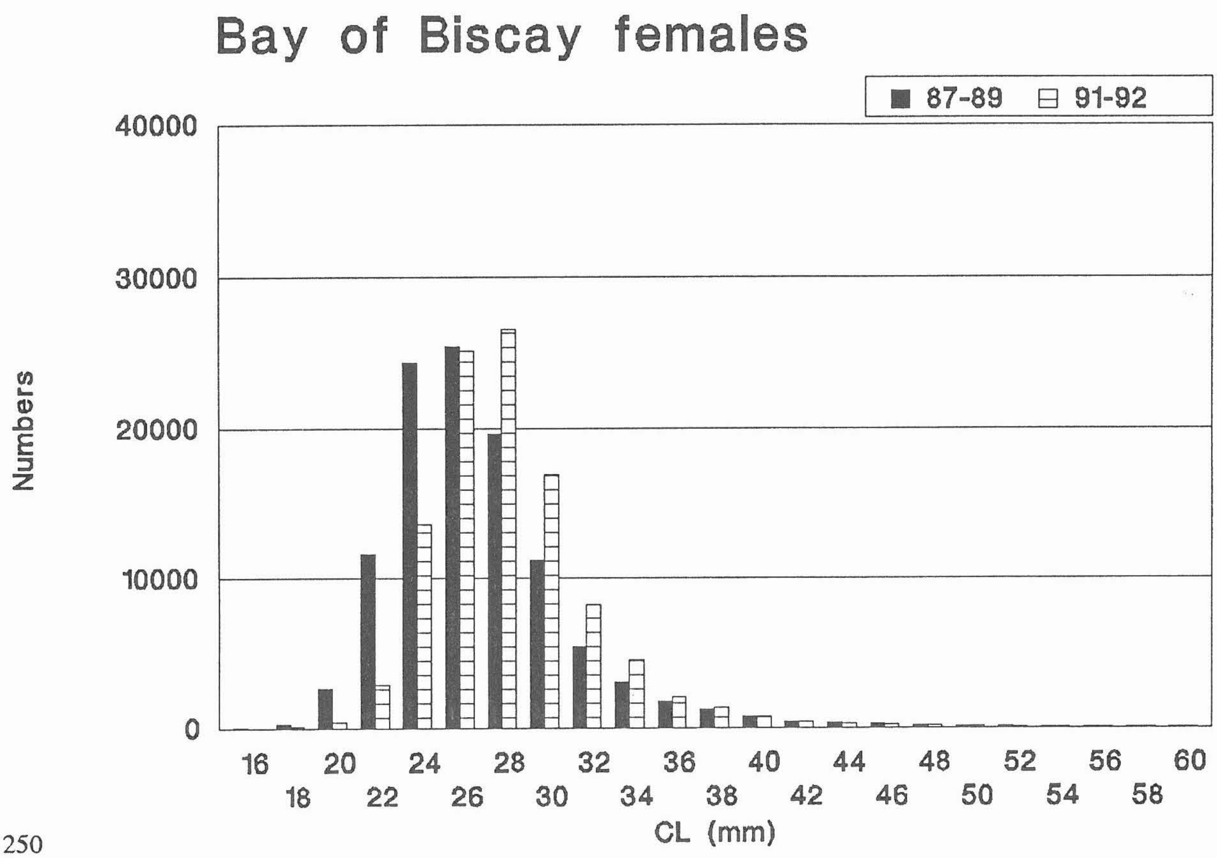


Figure 5.15.3 Functional Unit : Bay of Biscay (23 & 24) 1987-89
Percentage changes in long term landings and stock biomass and in short term landings following various percentage changes in fishing effort. Separate plots shown for males and females.

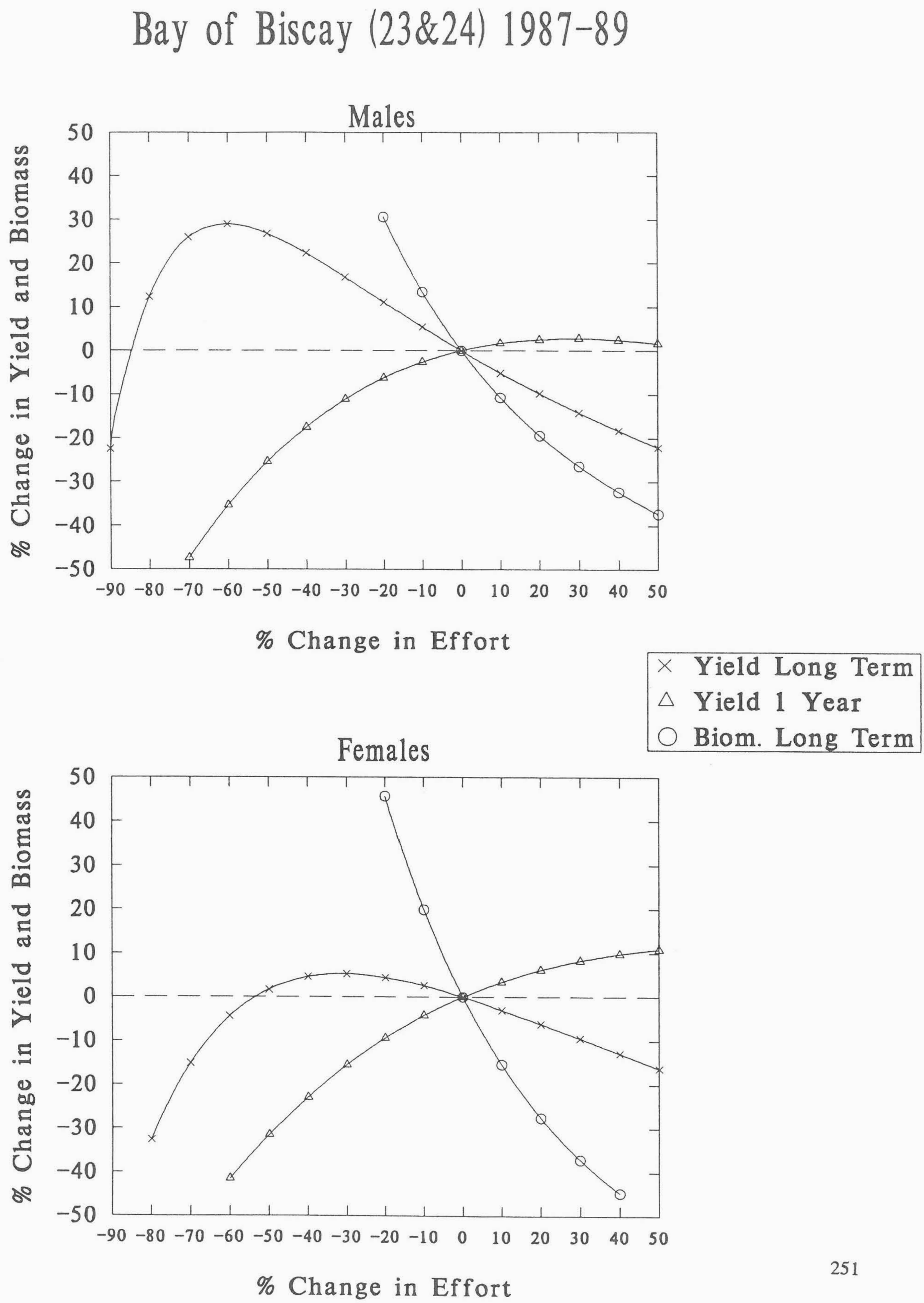


Figure 5.15.4 Functional Unit : Bay of Biscay (23 & 24) 1991-92
Percentage changes in long term landings and stock biomass and in short term landings following various percentage changes in fishing effort. Separate plots shown for males and females.

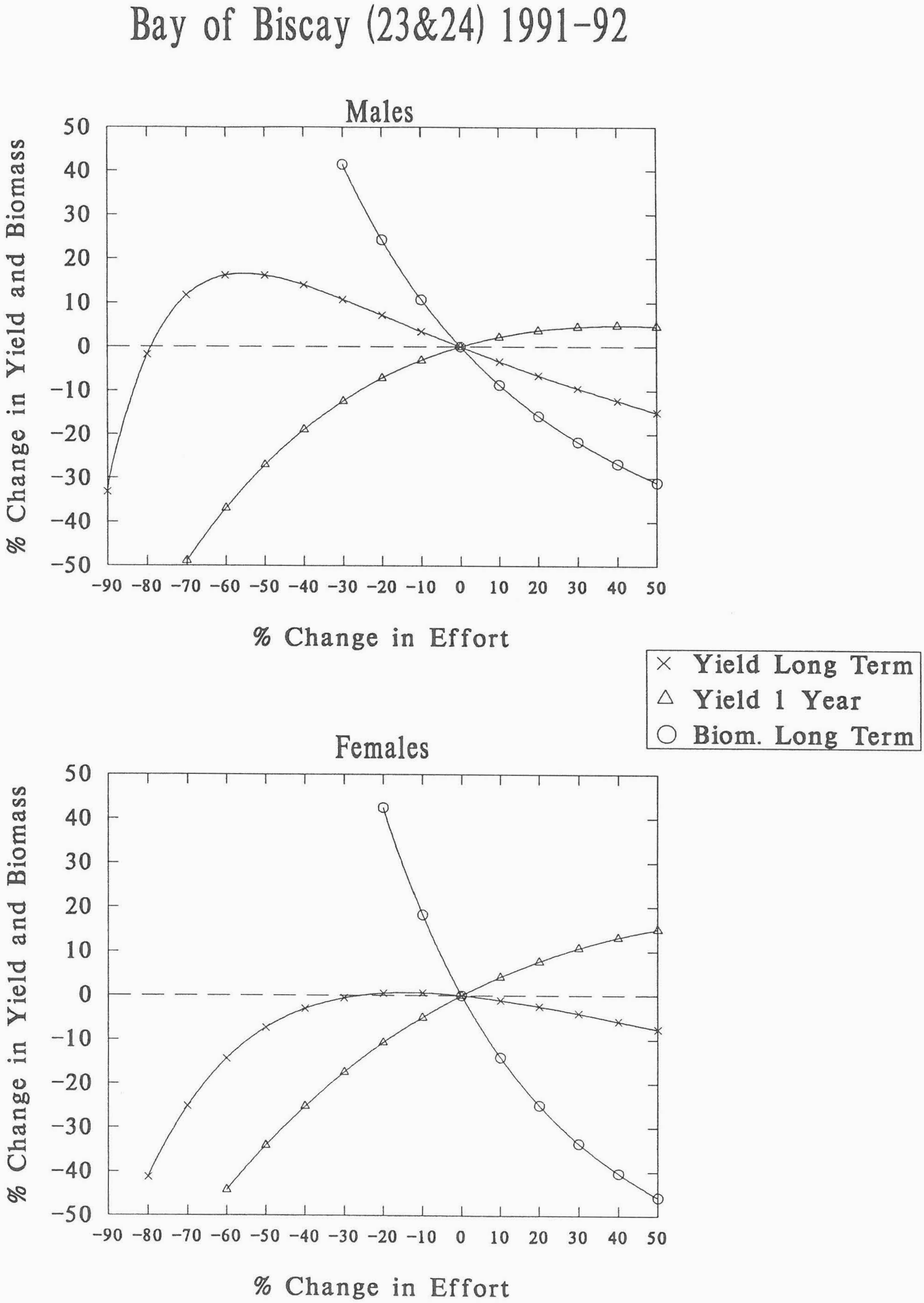


Figure 5.15.5 Functional Unit : Bay of Biscay (23 & 24)
Relationships between Landings(t) and Effort(t)
Least Squares linear regression line shown.

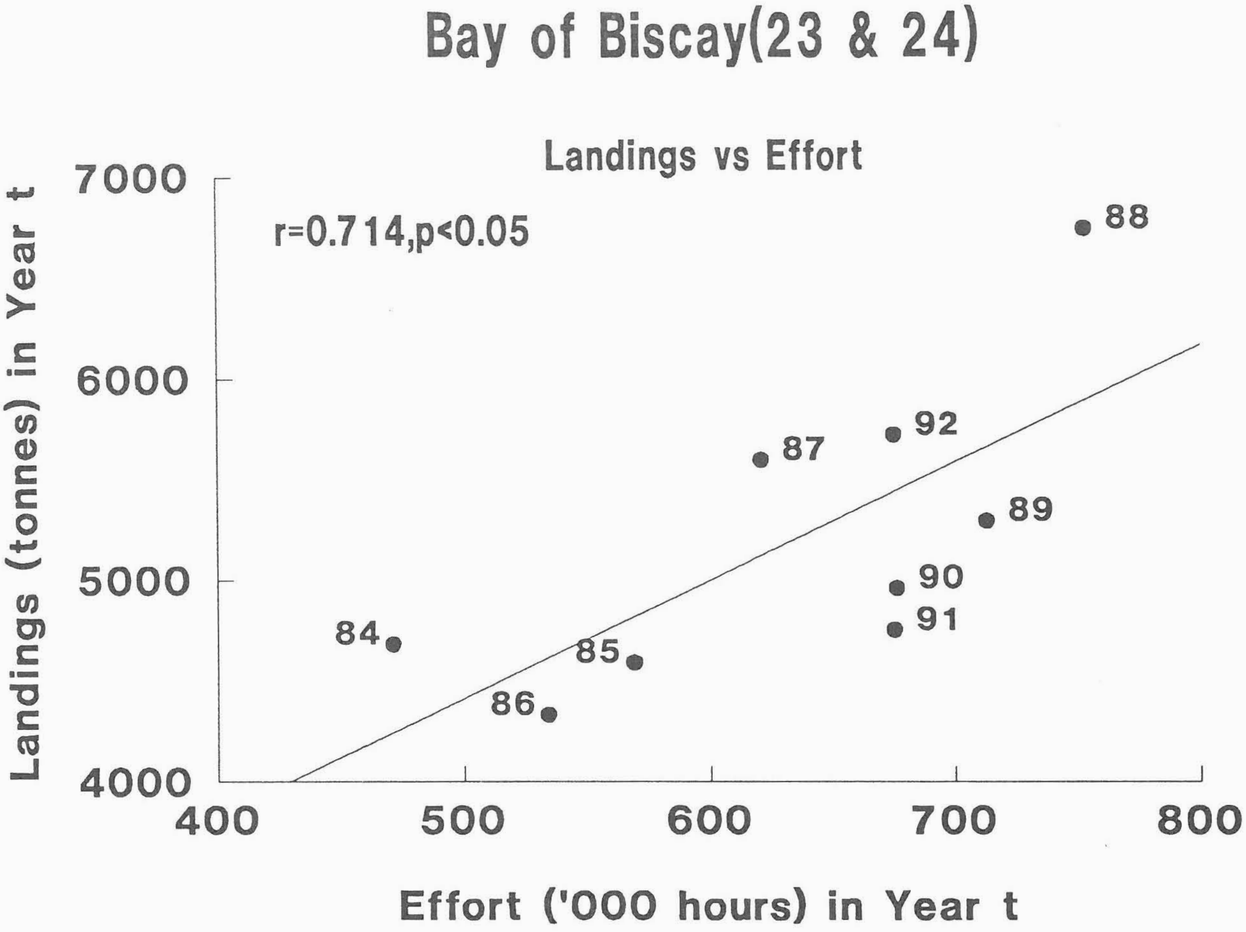


Figure 5.16.1 North Galicia (25) : A. Total landings (tonnes) B. Effort (number of trips) C. CPUE (kg/effort index) all figures 1975-1992 for Spanish Bacas - homeport La Coruna.

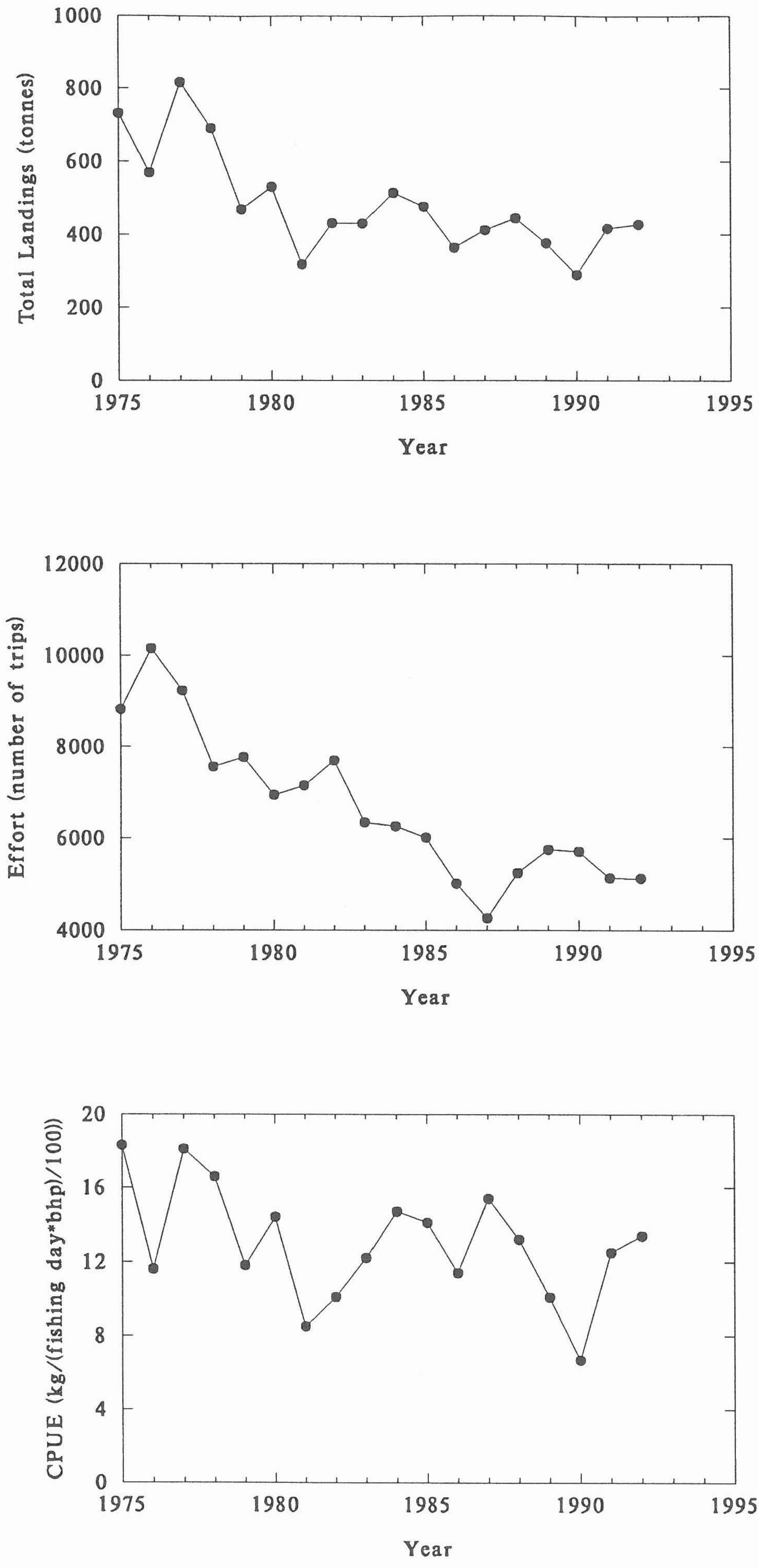


Figure 5.16.2 Functional Unit : North Galicia (25)
Relationships between Fbar from VPA and fishing effort for male and female Nephrops

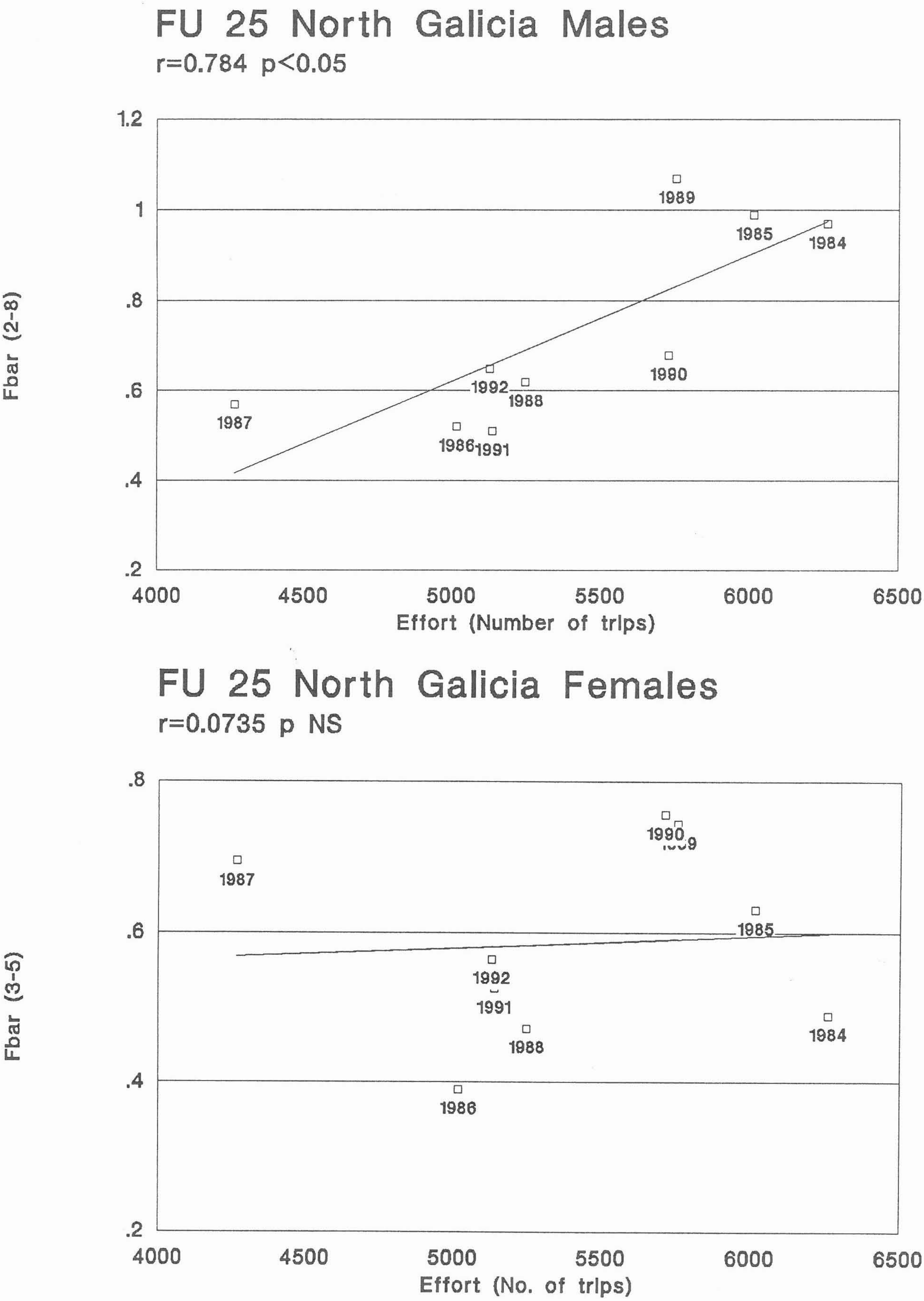


Figure 5.16.3 Functional Unit : North Galicia (25)
Relationships between Landings(t) and Effort(t) and between Landings(t) and Landings per unit effort(LPUE) (t-1).
Least Squares linear regression line shown.

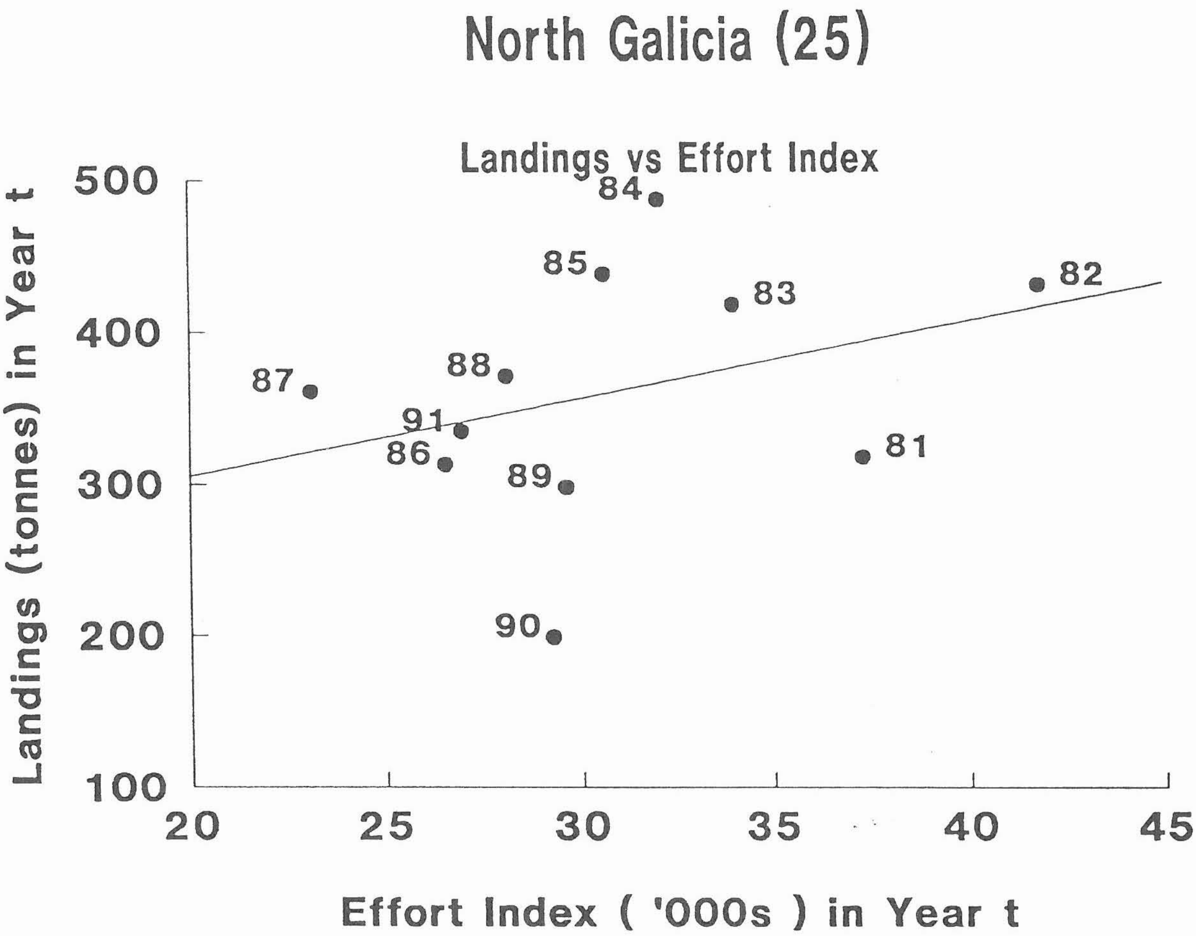


Figure 5.18.1 West Galicia (26) : A. Total landings (tonnes) 1975-1992

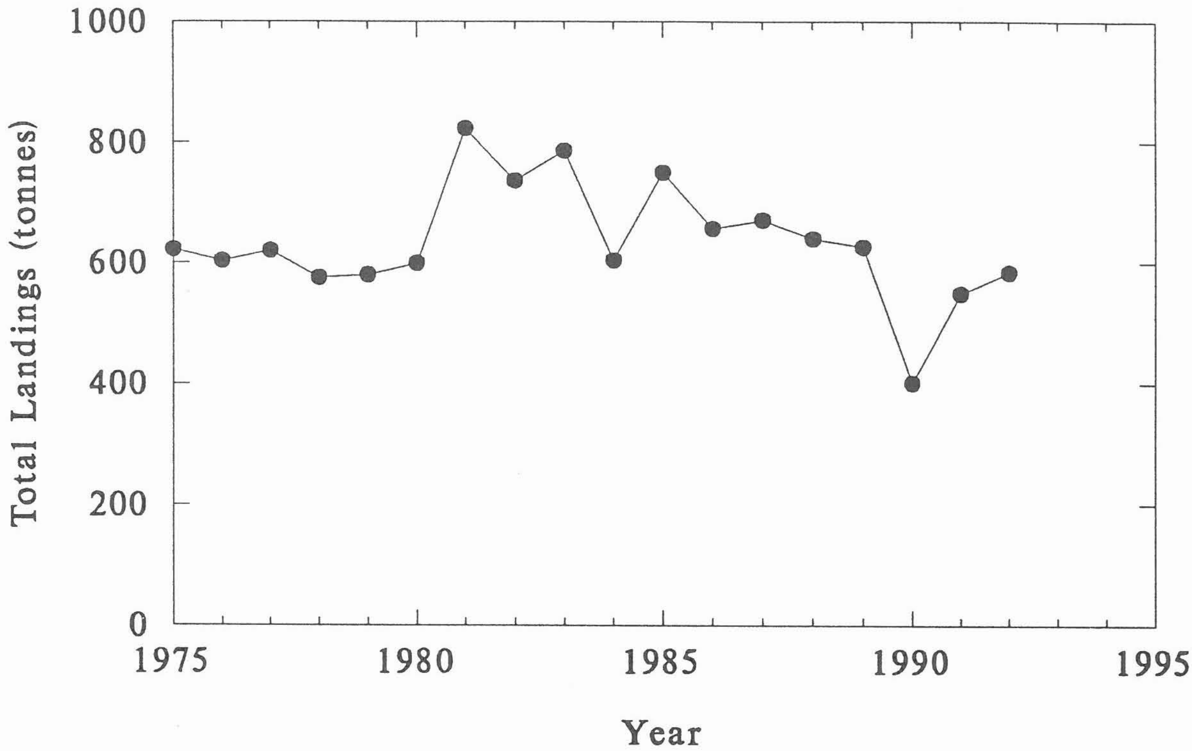


Figure 5.18.2 Functional Unit : West Galicia (26) 1991-92
Percentage changes in long term landings and stock biomass and in short term landings following various percentage changes in fishing effort. Separate plots shown for males and females.

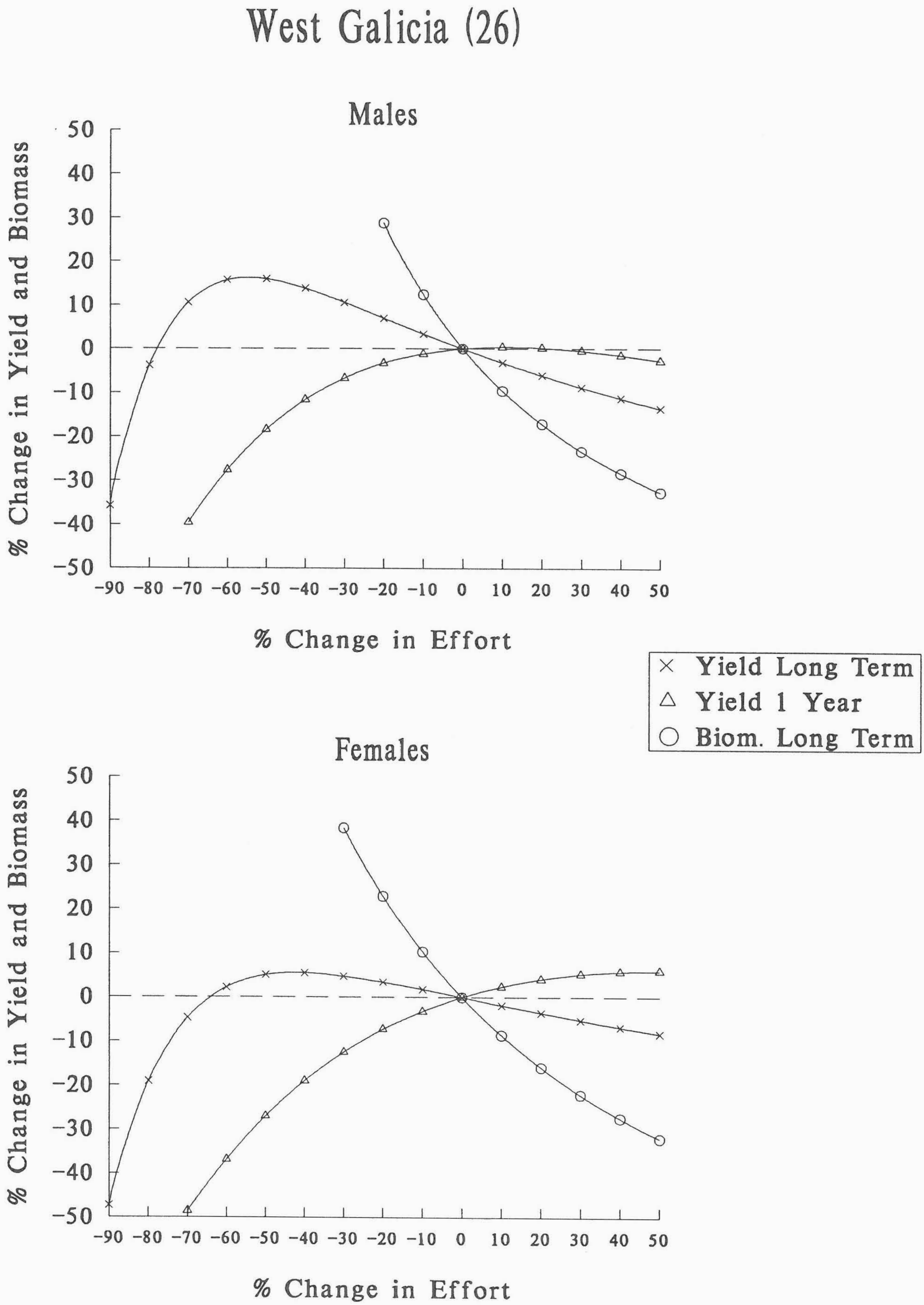
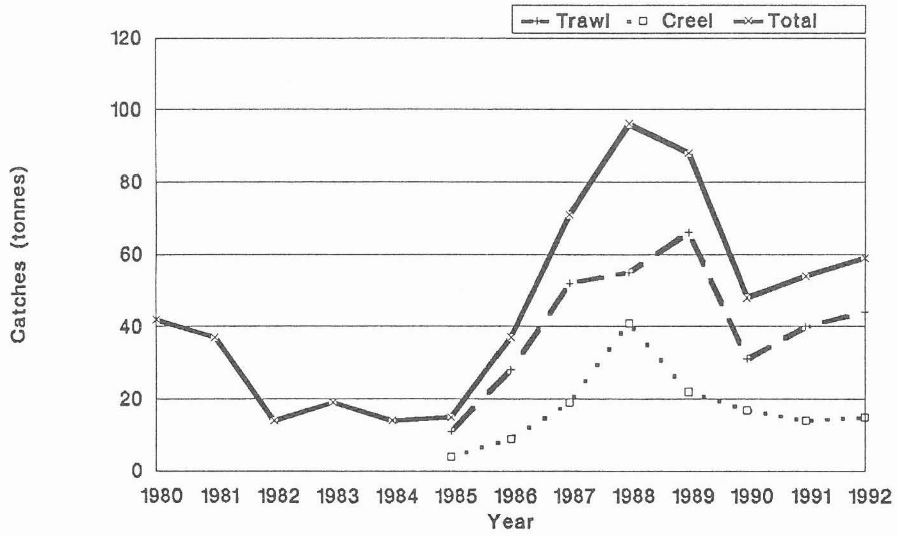
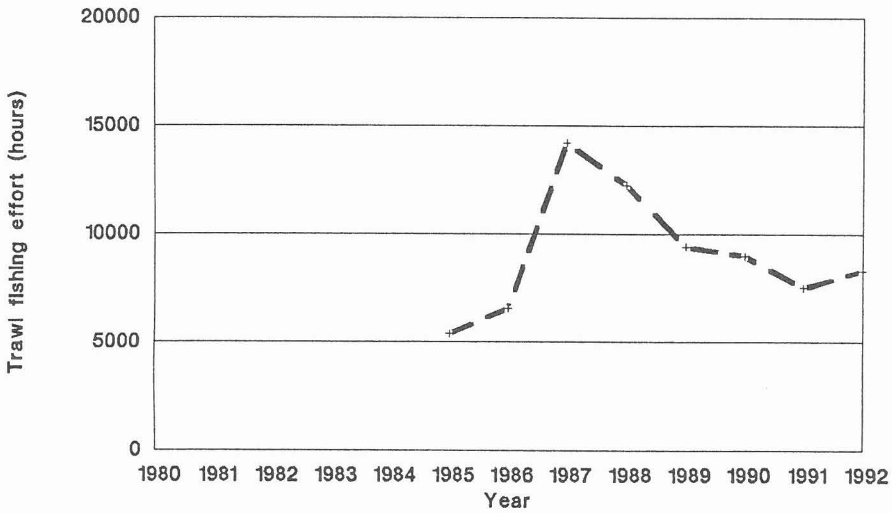


Figure 5.18.3 North Portugal (27) : A. Total catches and by gear(tonnes)
B. Trawling effort (hours) C. CPUE (kg/hour) 1980-92

A



B



C

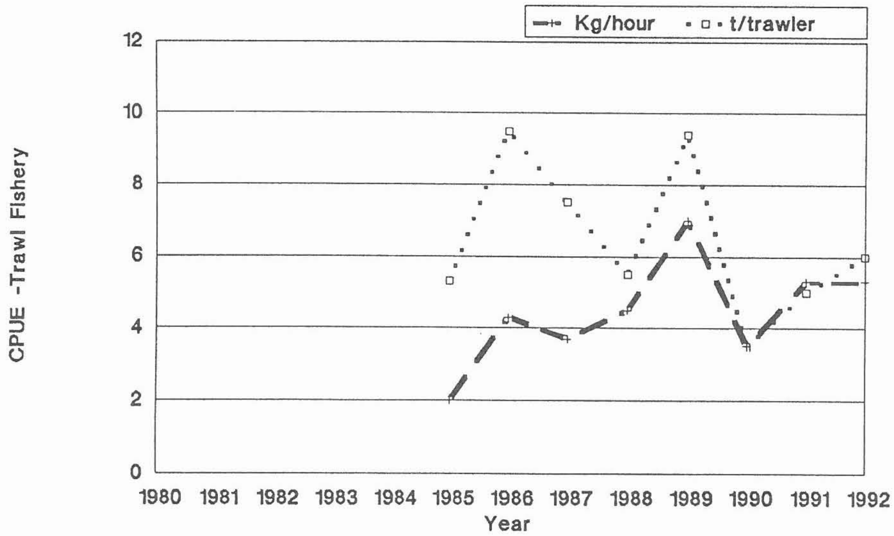
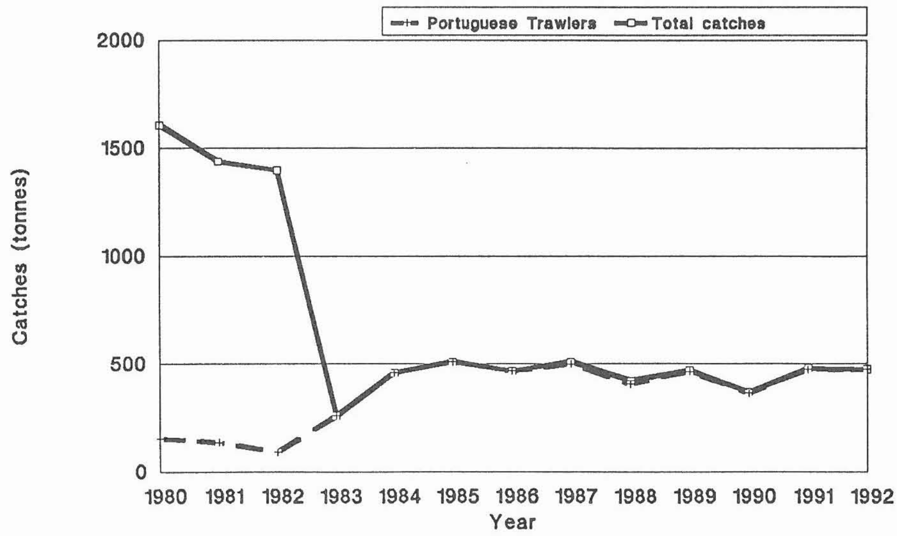
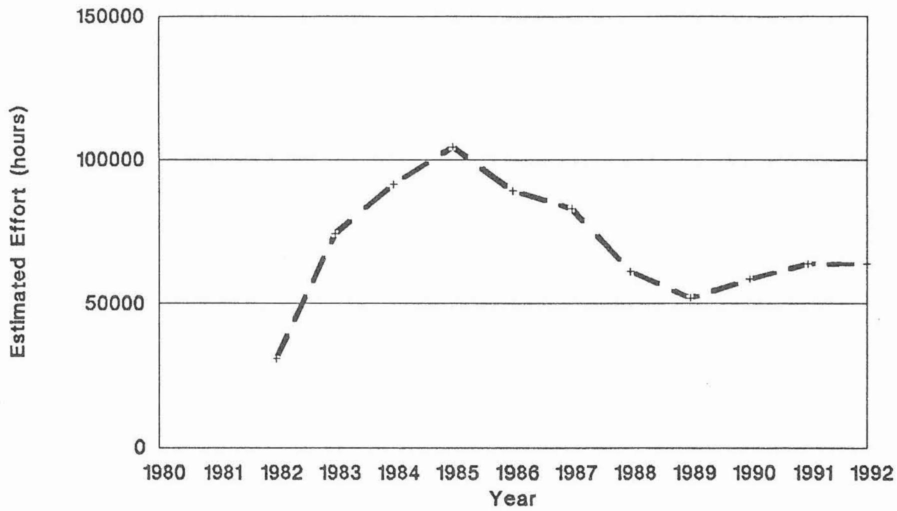


Figure 5.18.4 SW and S Portugal (28 & 29) : A Total catches (tonnes) 1980-1992 and by Portuguese trawlers. B Effort (hours) C CPUE (Kg/hour)





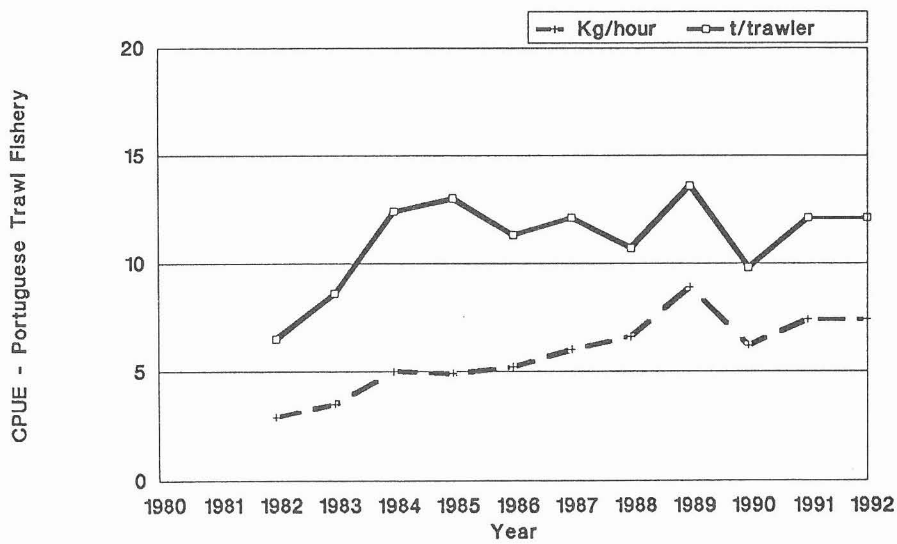


Figure 5.18.5 Functional Unit : South West and South Portugal (28-29) 1988-92
Percentage changes in long term landings and stock biomass short term landings following various percentage changes in fishing effort. Separate plots shown for males and females.

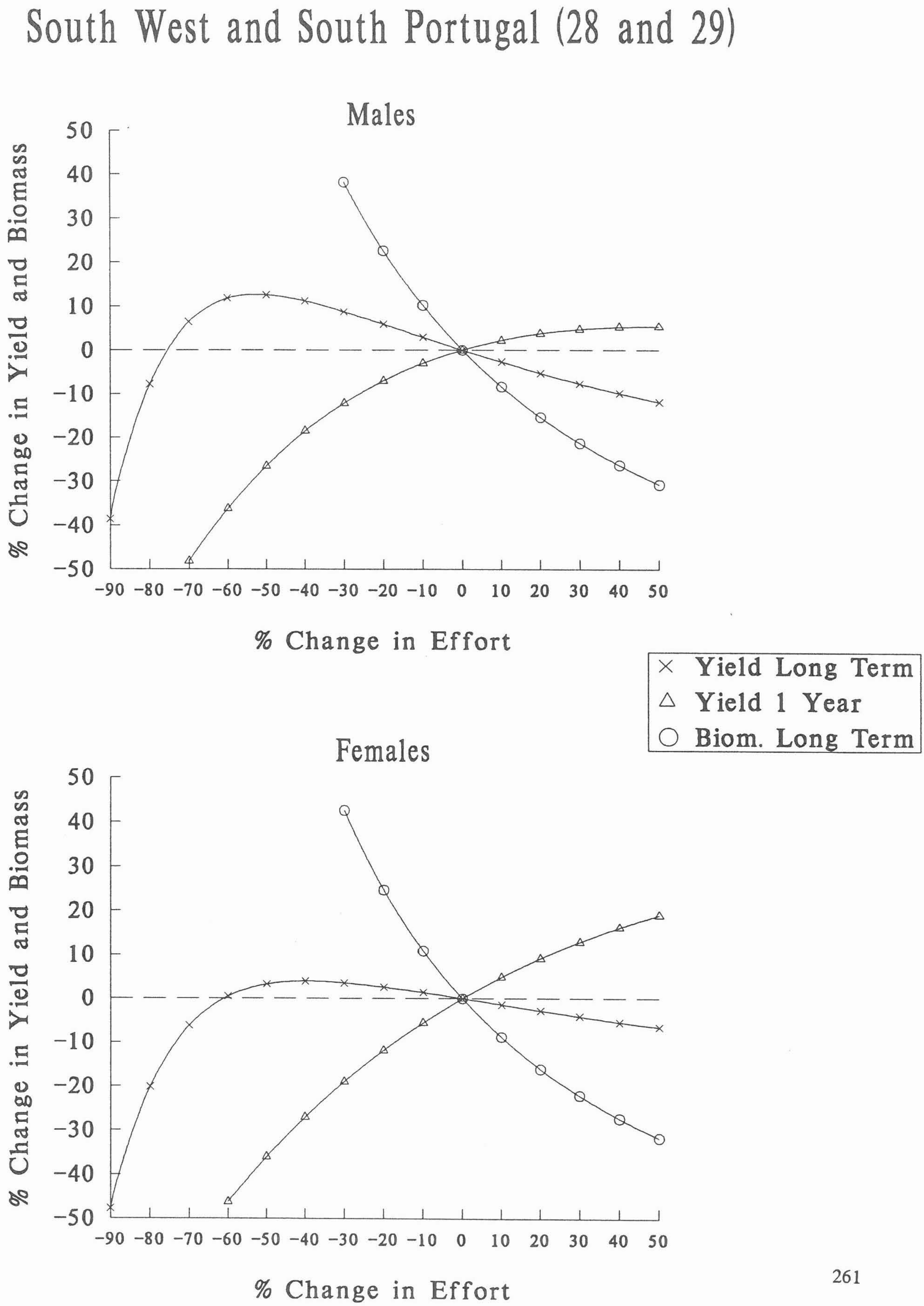
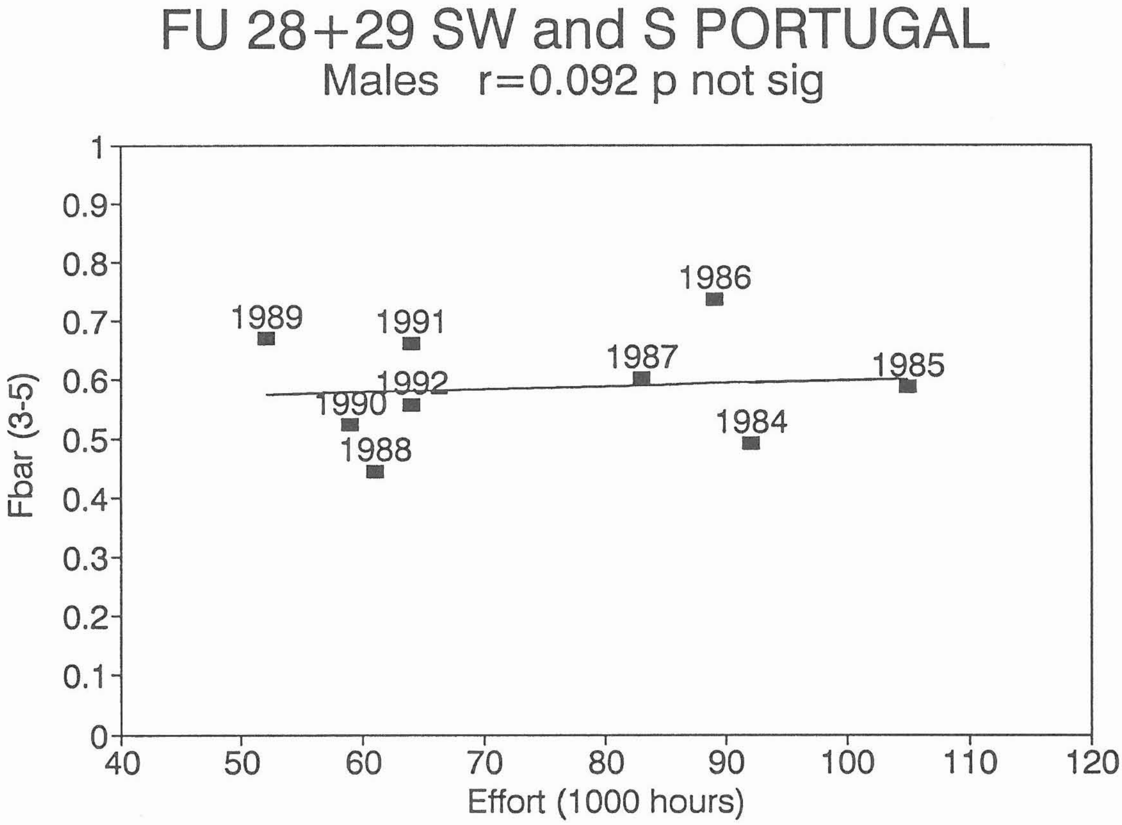
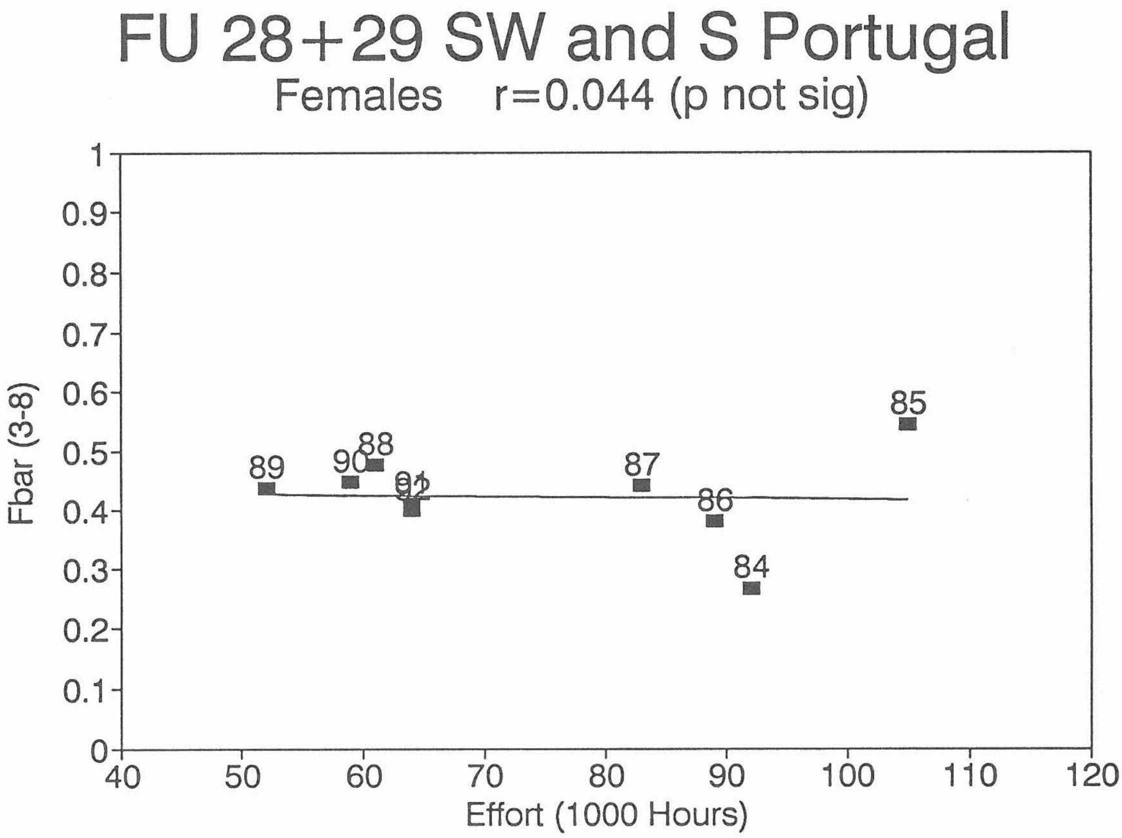


Figure 5.18.6 Functional Unit : SW and S Portugal (28 & 29)
Relationships between Fbar from VPA and fishing effort for male and female Nephrops





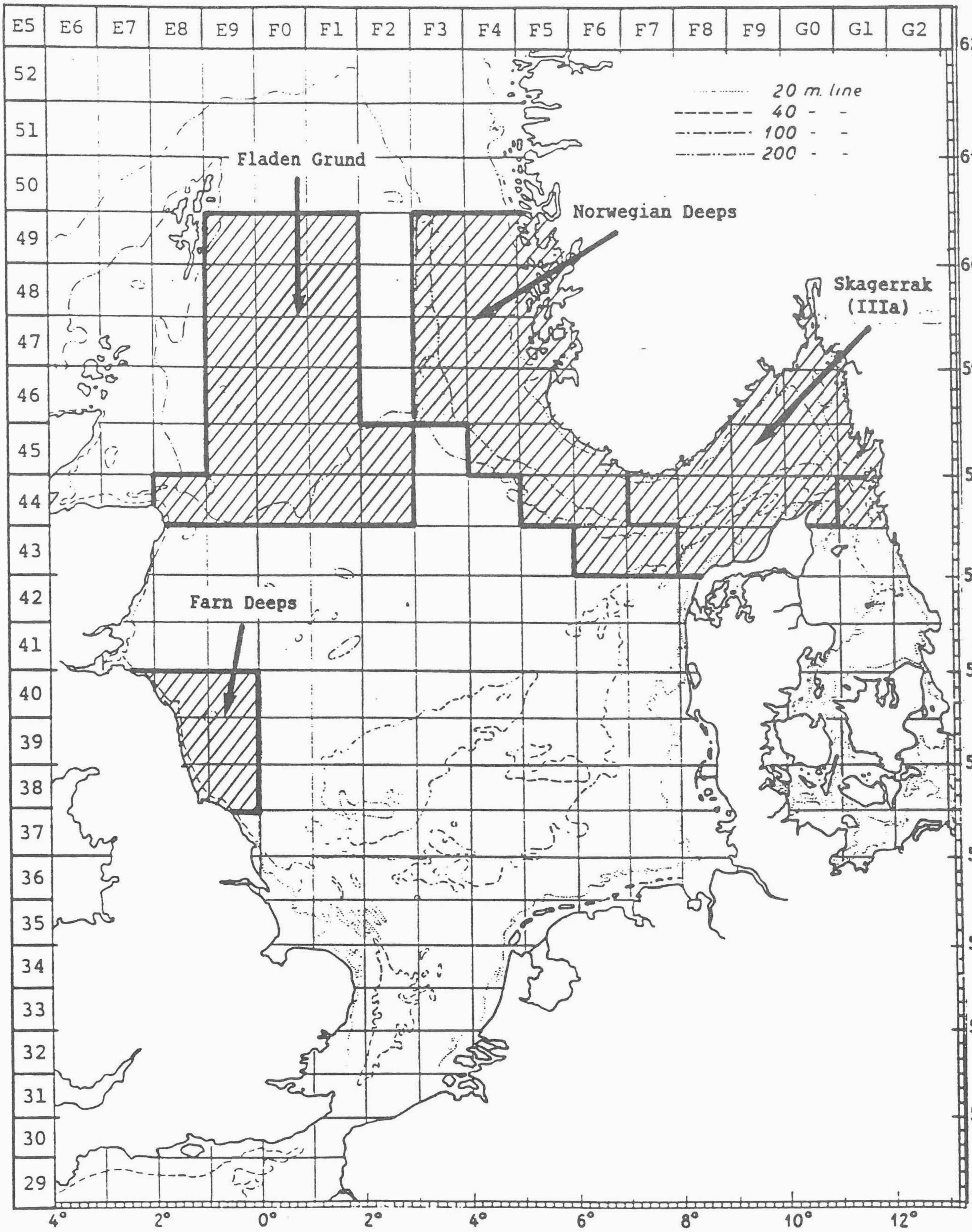


Figure 6.1.1 The management units of Pandalus in ICES Sub-area IV and Division IIIa as defined by statistical squares according to the Working Group.

Figure 6.3.1 Mean carapace length (mm) at age (quarters) for year classes 1980-91 in years 1984-92

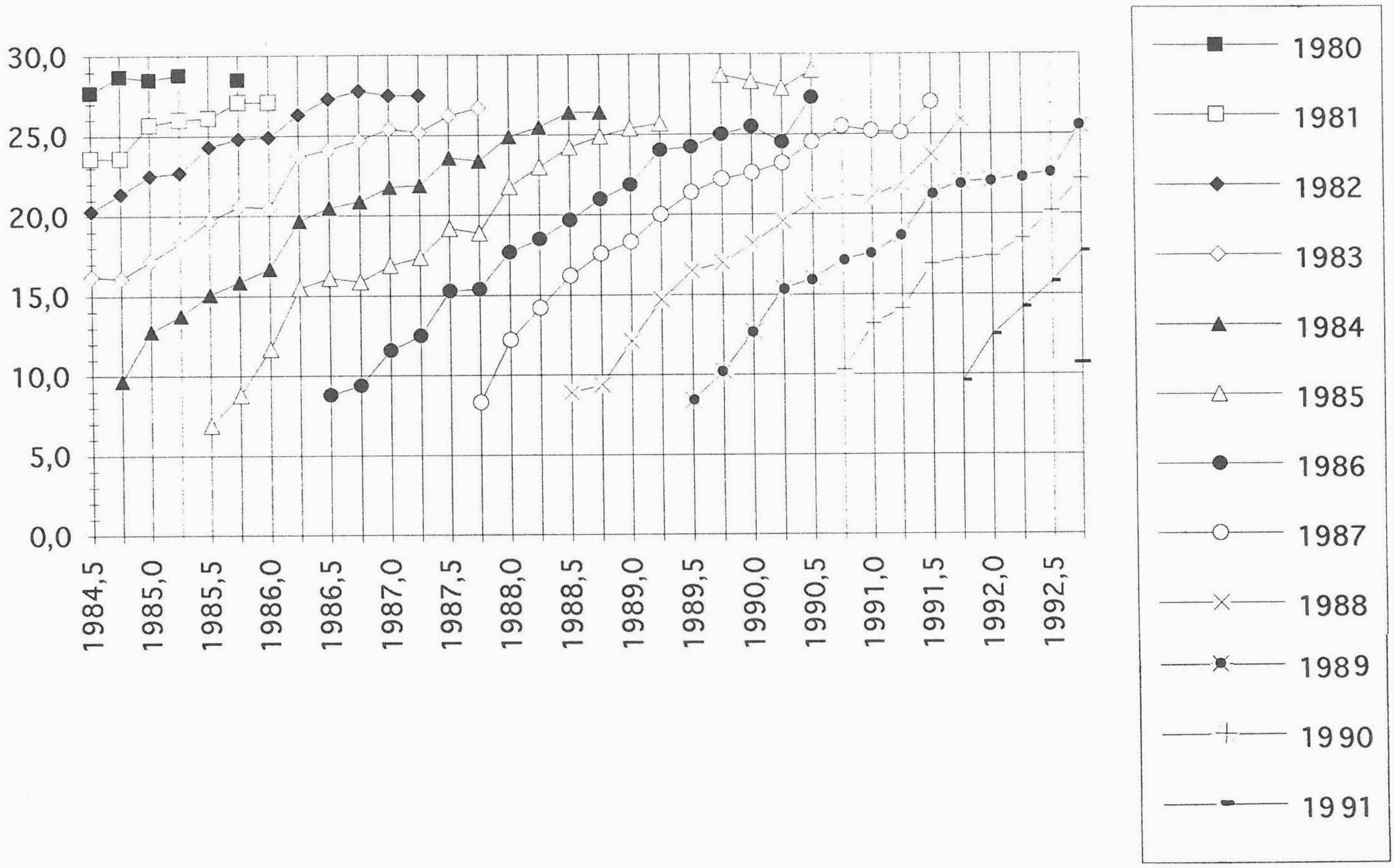
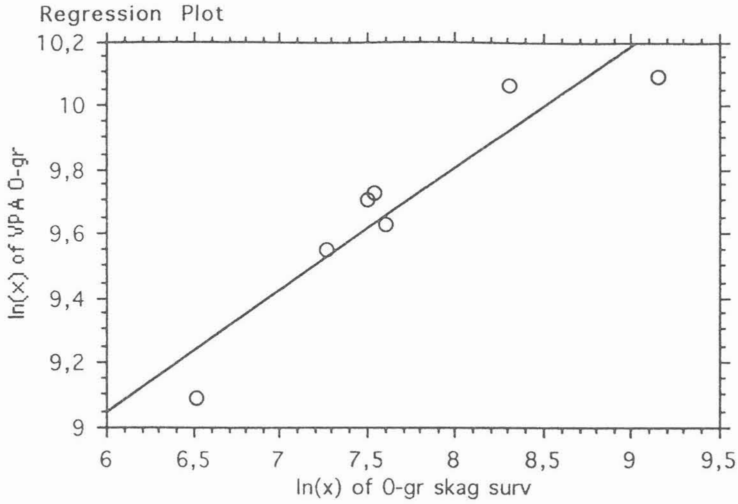


Figure 6.3.2 Pandalus 0-group VPA (IIIa and IVa E) on 0-group indices (IIIa and IVa survey). Regression of ln values.

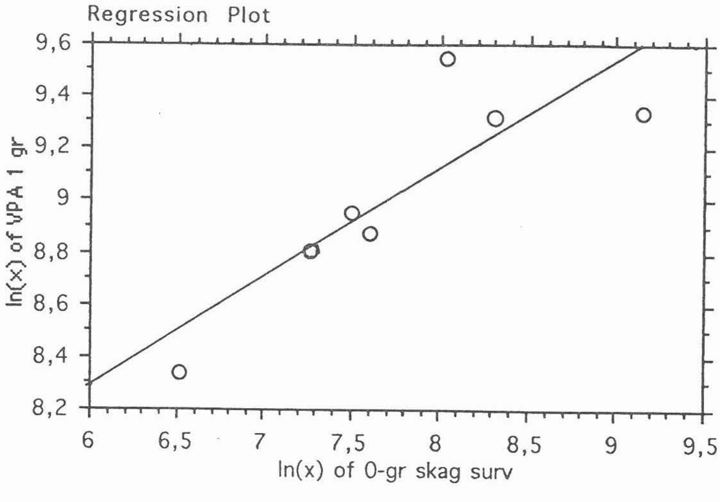


Y = 6,769 + ,38 * X; R^2 = ,877

Regression Coefficients
ln(x) of VPA 0-gr vs. ln(x) of 0-gr skag surv

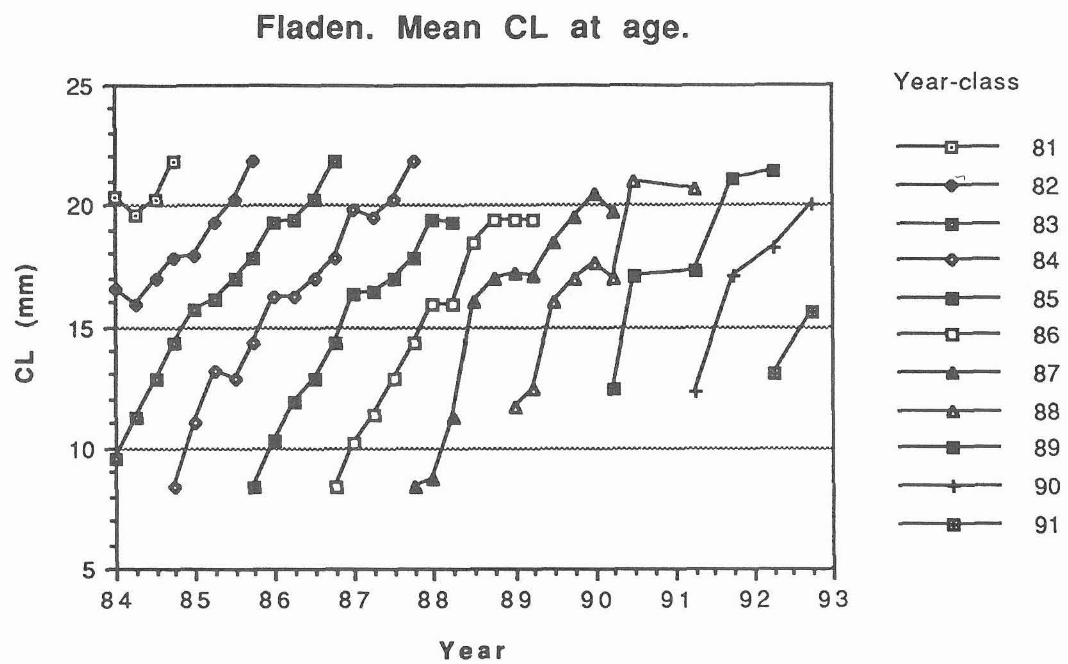
	Coefficient	Std. Error	Std. Coeff.	t-Value	P-Value
Intercept	6,769	,492	6,769	13,761	<,0001
ln(x) of 0-gr skag surv	,380	,064	,937	5,982	,0019

Figure 6.3.3 Pandalus 1-group VPA (IIIa and IVa E) on 0-group indices (IIIa and IVa survey). Regression of ln values.



$Y = 5.806 + .414 * X;\ r^2 = 0.72$

Figure 6.4.1 Mean carapace length (mm) at age (quarters) for year classes 1981-90 in years 1984-91



Appendix 1: Working Paper

Splitting of male monthly length-frequency data by Normal Curve fitting to estimate age composition using Irish Sea (Republic of Ireland) data by

Paul Hillis, Dublin, Ireland

Introduction

The program MIX (MacDonald and Pitcher, 1979) which fits a series of normal curves to a polymodal length frequency distribution by maximising likelihood, is a potentially valuable tool for 'ageing' *Nephrops*, which, owing to their moulting, cannot be aged by normal means. This method has been previously used on research vessel data where the shortness of hauls reduces variation in length at age resulting from small scale effects (Tully et al 1989) and it is applied here to examine its potential for ageing commercial catches for routine stock assessment purposes.

Materials and Methods

The material analysed consisted of the monthly aggregate sample length distributions of male *Nephrops* for 1991 and 1992 (Note there were no samples for January or December of either year). The program requests as input,length frequency and for each postulated cohort, parameters of proportion, mean length, and sigma. Visual inspection of the data provides starting input values to meet this requirement. Initially, a number of the parameters are held fixed but with subsequent runs the constraints are gradually relaxed;all the time a value of Chi squared monitors the fit between the observed and expected length distributions. Usually the last constraint to be withdrawn was the sigma of the oldest component present, except where the value of mean length was very clear from its mode (other parameters could then be allowed to depend on it).

Results

The mean lengths estimated from curve-fitting appear in Table 1, and the numbers at age in Table 2. Figure 1 illustrates the nature of the length distributions over a four month period in 1992 and the underlying fitted curves are shown. The ages ascribed to these modes are those of Hillis (1979) and others and are generally accepted for the dense, western Irish Sea population with January (minimum moulting season) values of 18-20mm CL for the partially recruited age-group 2 and 23-26mm Cl for age-group 3. These show that while the method is rather approximate, nonetheless, monthly commercial samples from this area are amenable to splitting. It has been shown that research vessel samples give even better results (Tully *et al.*, 1989).

Usually the number of age-groups identified by the method was three or four, and in fact the method becomes very cumbersome in the presence of more than about five groups. The standard deviation (sigma) values were usually in the region of 1.0-2.5 and increased markedly in seasons of maximum moulting. The oldest group identified often had a higher sigma value than the others, perhaps indicating that the group was in fact a plus group. Very low sigmas occurred in the youngest group and, combined with low numbers, indicated only partial recruitment. However, the distribution of length of age groups is only approximately normal and departures from normality could produce spurious 'additional' age groups with low sigma values.

Males were often found to recruit to the fishery starting in Autumn at age 1 and completing the process the following summer when they provided the mainstay of the catch. The method implies that numbers of males older than age-group 4 are extremely scarce.

Theoretically it is possible to calculate mortality rates (Z) from changes in the numbers at age in catch samples providing that effort is taken into account; effectively then calculating Z for an age-group based on changes in its catch per unit effort through time. This was not possible here but Table 3 gives some estimates of Z derived from the numbers calculated (quarterly and annual values are included). These figures can only be regarded as illustrative and more work is required before anything can be read into the values. Note that due to the short life after recruitment, the majority age group during the period, that of 1989, shows net recruitment during the first quarter which lowers the Z value for the whole year.

Discussion

For this stock at least the process looks a promising way of generating age distributions for assessment. The estimates of proportions in each age could be applied to the raised numbers caught by the fleet as used in the assessments (in a way analogous to that used for *Pandalus* - see Section 6).

It would be interesting to compare the results from this type of splitting with those obtained after 'slicing'. This is a job suitable for the Study group.

At present it is too early to place any emphasis on the estimates of Z obtained. Following a more rigorous approach it may be possible to say whether the levels of Z are generally higher than was earlier thought.

References

Hillis, J.P. (1979). Growth studies on the prawn *Nephrops norvegicus*. Rapp. P.-V Reun., Cons.int.Explor.Mer, 175:170-175 .

MacDonald, P.D.M. and Pitcher, T.J.(1979). Age groups from size frequency data: a versatile and efficient method of analysing distribution mixtures. J. Fish. Res. Bd. Can., 36:987-1001.

Tully, O., Hillis, J.P. and McMullen, D. (1989).Fitting normal curves to polymodal length frequencies to assess growth in *Nephrops*. ICES, Doc. C.M.1989/K:32.

Table 1 Mean lengths of male Nephrops estimated by MIX, monthly for 1991 and 1992

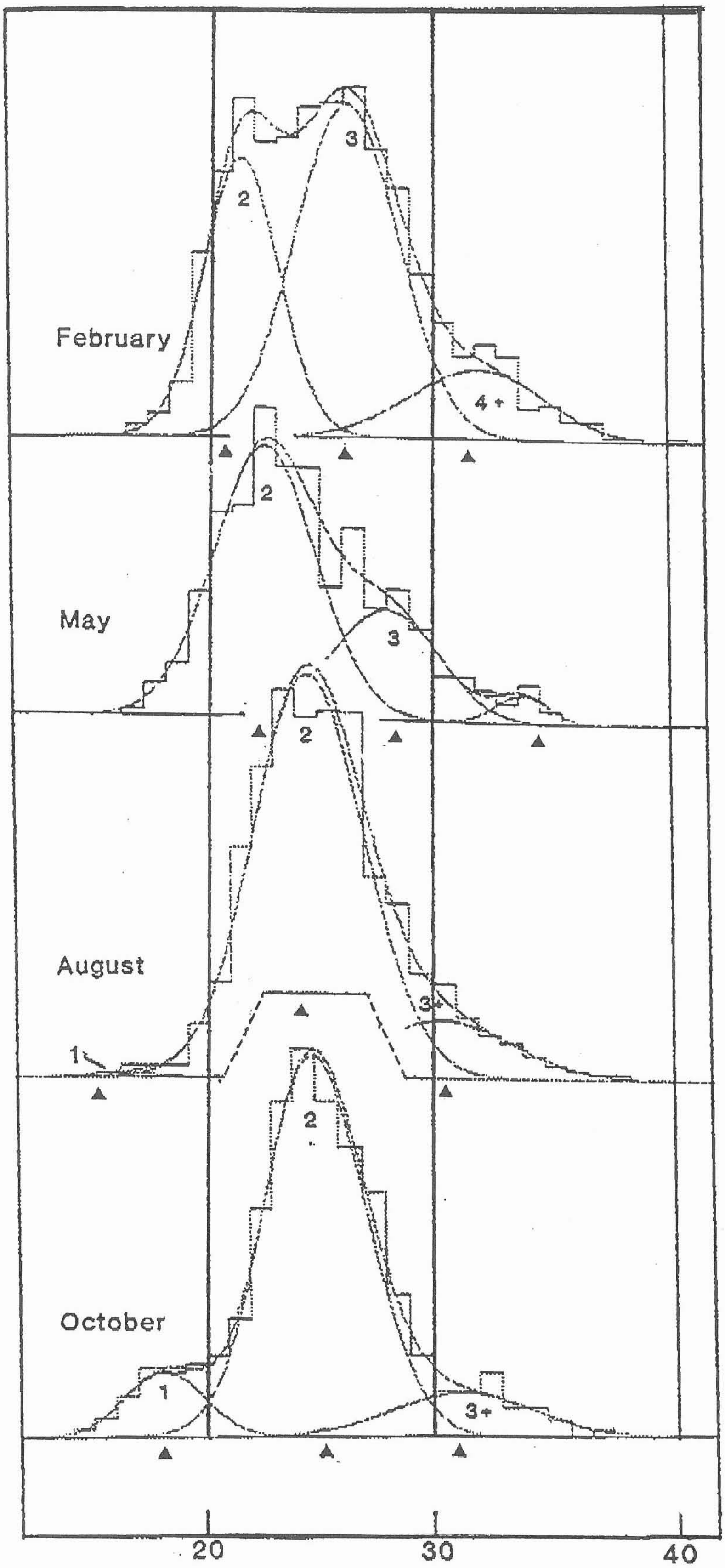
Year class		1991	1990	1989	1988	1987
Year	Month					
1991	Jan			19.4	25.2	32.1
	Feb			19.4	25.2	32.1
	Mar			21.9	27.1	36.2
	Apr			18.6	26.8	35.3
	May			20.6	25.1	29.8
	Jun			21.7	27.1	33.6
	Jul			21	26.2	27.9
	Aug		17.6	24.7	31.6	36.3
	Sep		18.8	24.4	27.4	
	Oct		18.8	24.5	28	
	Nov		18.8	24.5	28	
	Dec		18.8	24.5	28	
1992	Jan		18.8	24.5	28	
	Feb		18.8	24.5	28	
	Mar		23.8	27.6	30	
	Apr	(21.1)	23.1	26.8	30.7	
	May		23.8	28.8	34.3	
	Jun		23.5	27.3	31.4	
	Jul		23.7	27.1	31.9	
	Aug	16.3	24.3	28.2		
	Sep	17.8	24.3	29.9	31.5	
	Oct	18.1	24.9	31.3		
	Nov	18.4	23.3	30.1	32.1	
	Dec	18.4	23.3	30.1	32.1	

Table 2 Numbers of male Nephrops caught estimated by MIX, monthly for 1991 and 1992

Year class		1991	1990	1989	1988	1987
Year	Month					
1991	Jan			5	58	7
	Feb			2	20	2
	Mar			33	62	6
	Apr			3	23	5
	May			23	88	27
	Jun			130	81	11
	Jul			23	162	48
	Aug		28	228	19	8
	Sep		12	96	73	
	Oct		24	136	56	
	Nov		13	183	11	
	Dec		7	97	6	
1992	Jan		12	68	28	
	Feb		11	60	25	
	Mar		59	14	12	
	Apr	20	15	38	19	
	May		56	35	10	
	Jun		67	16	9	
	Jul		68	65	13	
	Aug	1	95	39		
	Sep	8	124	5	18	
	Oct	16	116	19		
	Nov	6	89	22	9	
	Dec	5	76	19	8	

Table 3 Total Mortality values (Z) quarterly and annually, 1991 and 1992 for male Nephrops. Derived from ageing by normal curve fitting.

Quarter	Year Clas	1990	1989	1988
1			-1.27	0.76
2			0.56	1.62
3		-1.97	1.16	2.49
4		-1.85	1.94	
Year		-2.26	0.87	1.67



Appendix Figure..1... Demonstration of fitting of normal curves to length frequency histograms for male *Nephrops* from commercial samples of unsorted catch from the Western Irish Sea to illustrate a potential method of ageing, February, May, August, and October 1992.

Appendix 2: Working Paper

Growth Sensitivity of Length Slicing and VPA

by

David B. Bennett, Fisheries Laboratory, Lowestoft, England

Approach

To test the sensitivity of the length slicing and VPA program to growth input parameters the Farn Deeps (FU6) males were taken as a test data set (Anon, 1992). The K and L_{inf} values of the von Bertalanffy growth equation were varied independently by plus or minus 25% to give values of:-

Run no.	1	2	3	4	5
K	0.16	0.16	0.16	0.12	0.20
L_{inf}	66.0	49.50	82.50	66.0	66.0

All other inputs were kept as in Table 5.1.3 and 5.1.4 of the 1992 Working Group Report (Anon., 1992), except that, to keep the largest length below the lowest L_{inf} value used (49.5mm CL), the length composition for run 2 was truncated into a plus group at 48mm CL.

The effects of changing the growth parameters, assuming t(0) = 0, are shown in Figure 1. The low L_{inf} and the high L_{inf} curves (runs 2 and 3) show the lower and upper limits of the variation in length at age tested. Runs 4 and 5 show low and high growth towards the same L_{inf}. The growth curves tested encompass all but one (Cantabrian (FU31)) of the male growth inputs used last year (Anon., 1992). Figure 2 shows examples of the range of growth curves used for the various Functional Units, together with the growth curves for Farn Deeps (FU6) and runs 2 and 3.

Results

The impact of the different growth inputs on the length slicing programme are shown in Figure 3. Taking run 1 as the "standard", increasing the L_{inf} and K by 25% (runs 3 and 5) gave age compositions with more *Nephrops* allocated to the younger ages. Conversely, reducing the L_{inf} and K by 25% (runs 2 and 4) put more *Nephrops* into the older age classes. For run 2 the influence of the large plus group, necessary to keep the largest length group below L_{inf}, is shown at age 11.

The sensitivity of the length slicing and VPA was further assessed by examining the VPA outputs for yield, mean fishing mortality (Fbar, ages 3-7), stock biomass, and recruitment. Taking means across the years (1984-1990) Figure 4 shows percentage changes in the VPA outputs with reference to the "standard" run (1). There was virtually no variation in yield. F(bar) increased by 66% and 38% in runs 2 and 4 - lower growth - and decreased by 127% and 27% in runs 3 and 5 - higher growth. Stock biomass and recruitment changed in the opposite directions with decreases of 159% and 64% respectively in run 2 and 55% and 22% in run 4 - lower growth - and increases of 33% and 9% in run 3 and 20% and 5% in run 5 - higher growth.

The sensitivity to the growth inputs of the VPA outputs over the time period (1984 - 1990) used in the 1992 Working Group report (Anon., 1992) for the Farn Deeps (FU6) are shown in Figures 5 - 8. While there were annual fluctuations in yield, there was little variation due to the growth inputs (Figure 5). Run 1, the Farn Deeps (FU6) output last year, shows an increasing trend in fishing mortality (F(bar)) with a dip in 1986 (Figure 6). The other runs show similar trends, albeit at different magnitudes, except for the last year (1990) when F(bar) tends to increase more with the higher growth runs (3 and 5) and level off or decrease for runs 2 and 4 - lower growth. The annual trends in stock biomass were maintained with different growth inputs, although again at different levels (Figure 7), with the exception of the last year (1990) which showed some divergence from the "standard" run. Recruitment trends (Figure 8) followed the other outputs, mirroring an increasing trend over time, except for the last year (1990) when the values were inverted.

Conclusions

The variations in growth inputs tested encompass nearly all the growth curves used for the Functional Units assessed in last year's report (Anon., 1992). The output from the length slicing programme showed the expected response with faster growth allocating more *Nephrops* to the younger age classes, and vice versa for the slower growth inputs.

Some of the outputs from the VPA - fishing mortality, stock biomass, and recruitment - showed considerable sensitivity to the growth inputs. As one would expect, the yield was not sensitive to the growth inputs. With higher growth, lower estimates (with respect to the "standard" run for Farn Deeps (FU6)) were obtained for F(bar), while for stock biomass and recruitment the estimates were larger. Conversely, with lower growth inputs, the estimates of F(bar) increased, while the estimates for stock biomass and recruitment decreased. The variations ranged from +66 to -159, with respect to the "standard" values. Despite the sensitivity of the magnitudes of the VPA outputs to the growth inputs, the overall time trends remained broadly similar to the "standard" output. There was some variation in the last year, but that is expected with a VPA due to a lack of convergence.

Growth data for many of the *Nephrops* Functional Units are poor or non-existent. Some assessments were made using growth parameters from other Functional Units. The tentative conclusion from this initial sensitivity analysis of the length slicing and VPA is that while the size of the estimates are sensitive to the growth inputs, the trends observed remain the same, excepting the last year of the time series. There is considerable scope for extending and improving such a sensitivity analysis. This could be a suitable task for a meeting of the ICES *Nephrops* Study Group, who would have more time to explore this approach.

References

Anon. (1992). Report of the Working Group on *Nephrops* and *Pandalus* stocks. ICES, Doc. C.M.1992 Assess:8

Figure 1 Calculated von Bertalanffy growth curves , assuming to=0, used in the five runs of the sensitivity analysis

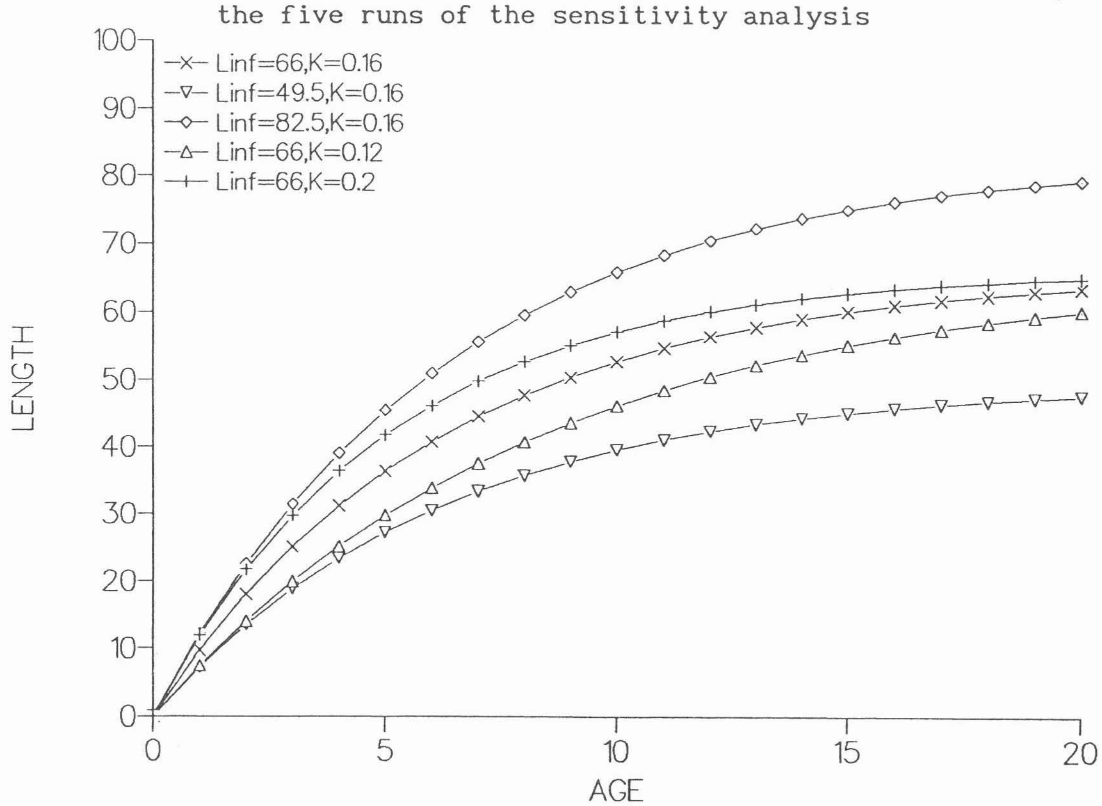


Figure 2 Comparison of the standard run (Farn Deeps (FU6)), the maximum (run 3) and minimum (run 2) growth curves with a selection of the range of growth curves used for assessment in the 1992 Nephrops Working Group Report (Anon,1992)

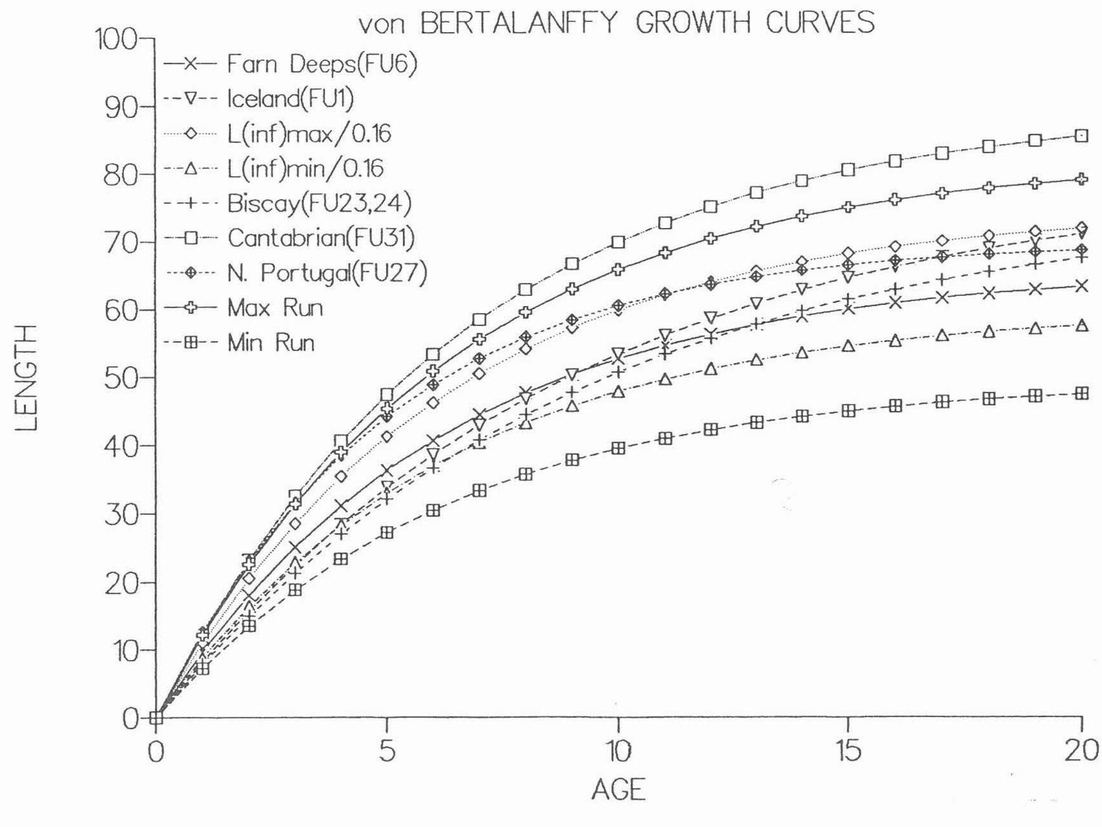


Figure 3 Outputs of the mean numbers at age (arbitrary) from the length slicing programme for various growth inputs.

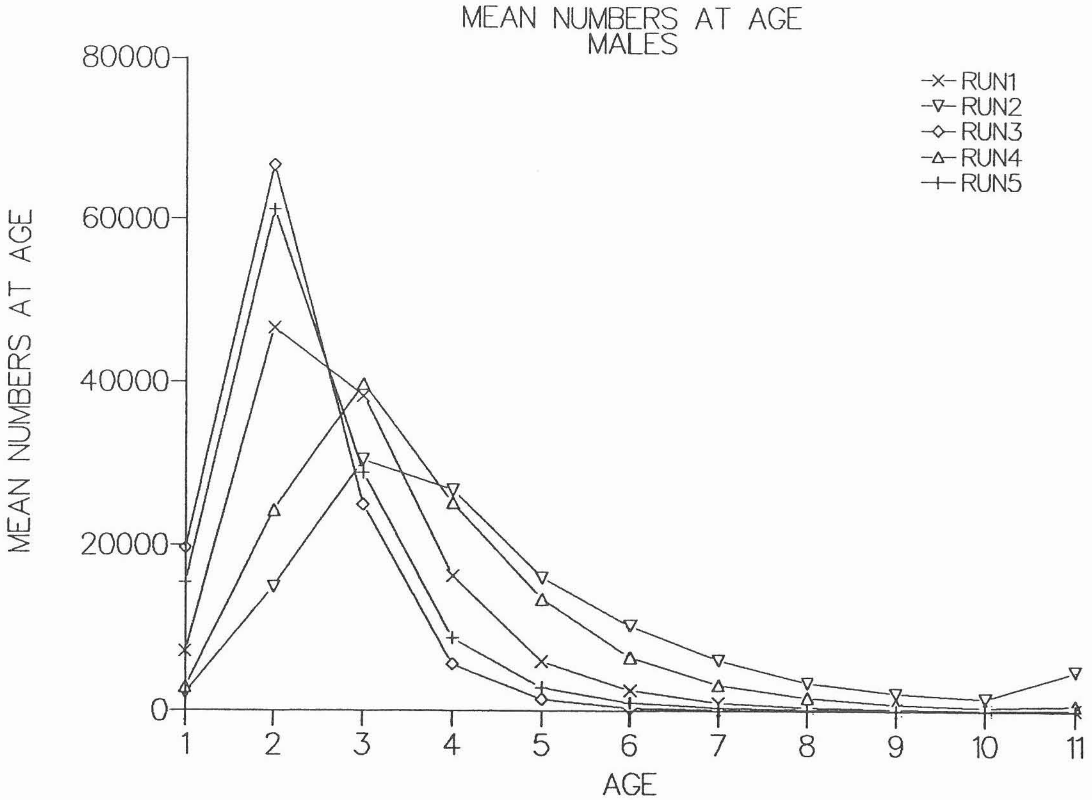


Figure 4 Mean (across years) outputs of yield, fishing mortality, stock biomass, and recruitment expressed as a percentage change compared with the "standard" run (Farn deeps (FU6)).

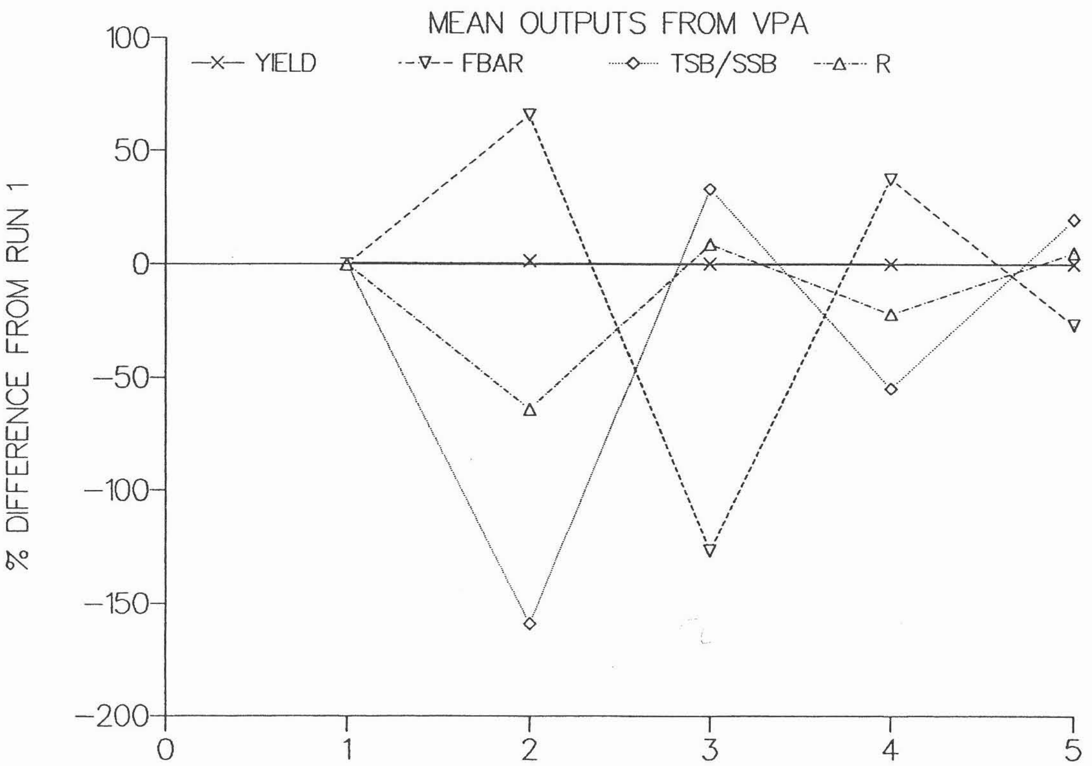


Figure 5 Annual trends in yield for a range of growth inputs (runs 1-5).

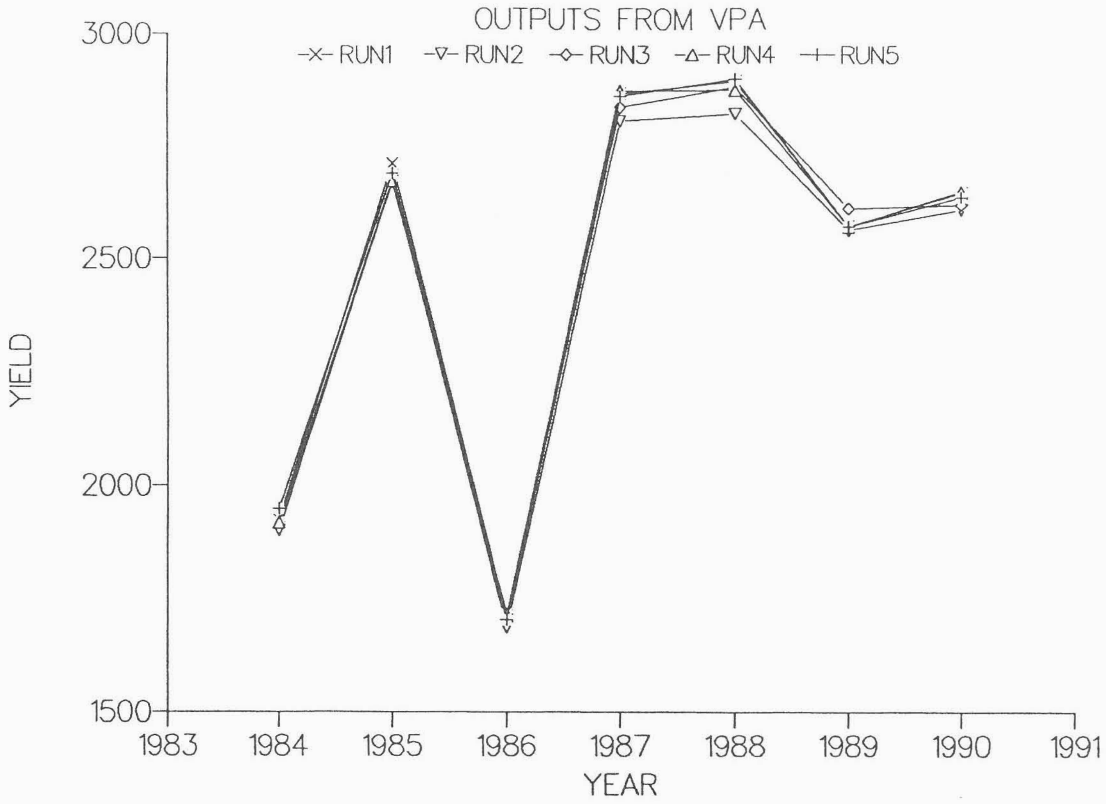


Figure 6 Annual trends in Fbar for a range of growth inputs (runs 1-5).

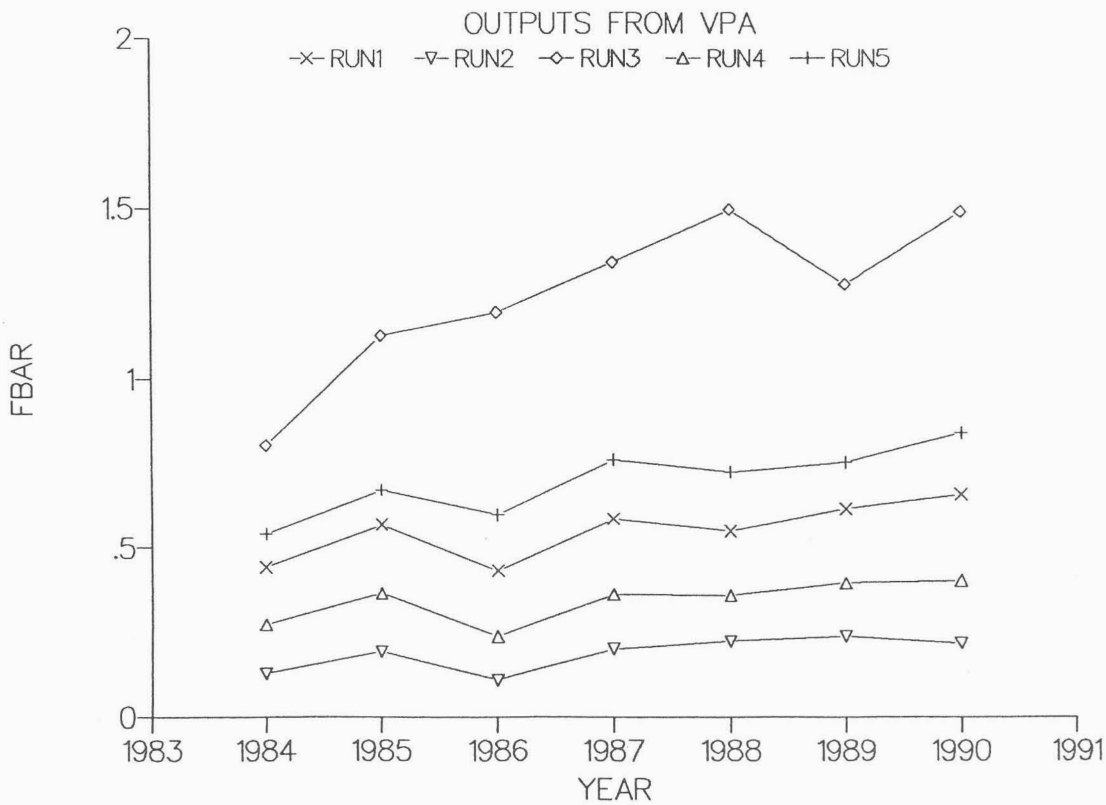


Figure 7 Annual trends in stock biomass for a range of growth inputs (1-5)

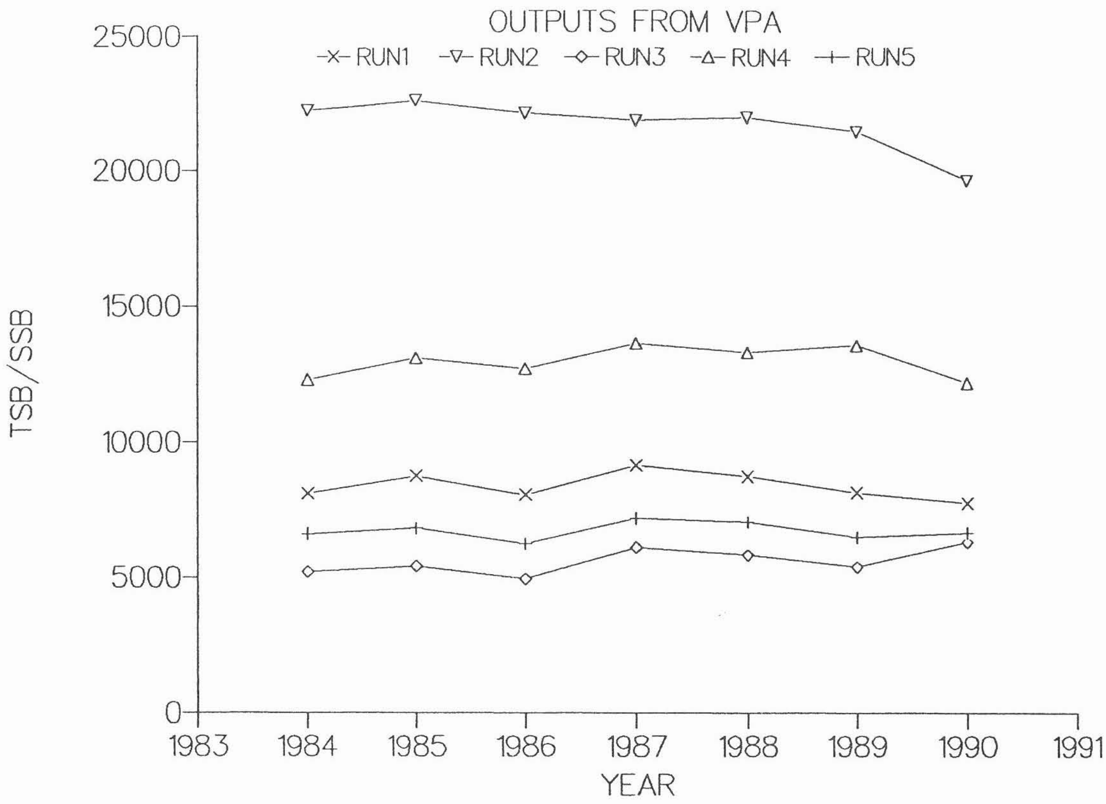
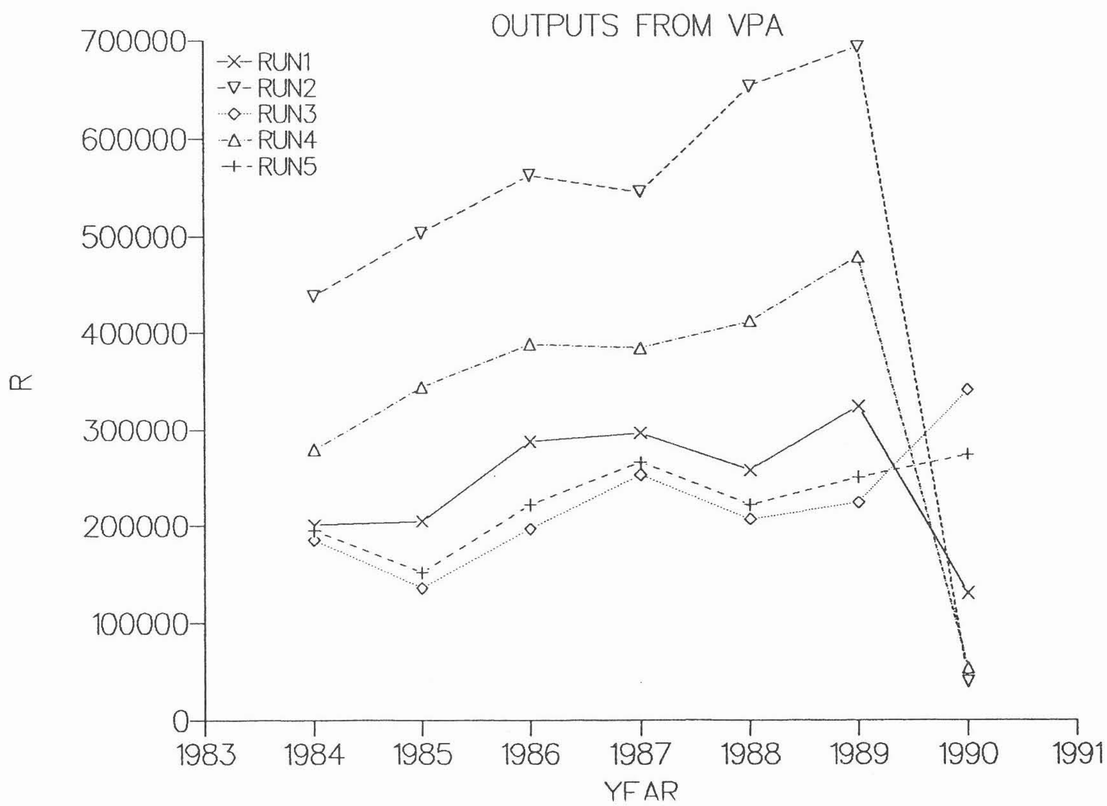


Figure 8 Annual trends in recruitment for a range of growth inputs (runs 1-5).



Appendix 3: Working Paper

Recovery of Population Data from Simulated Population and Catch data using the 'Knife edged Slicing and VPA method'

by

N Bailey and M Afonso Dias, SOAFD Aberdeen

Introduction

At recent *Nephrops* Working Groups (Anon.,1991,1992) a pseudo 'age-based' approach was introduced for the assessment of *Nephrops*. This consists of a 'knife edged' slicing method which makes use of the von Bertalanffy growth curve to divide catch length distributions into a series of catches at nominal ages. The slicing is then followed by a regular tuned VPA method (based on the Laurec/Shepherd approach). Ostensibly reasonable results were obtained for a number of stocks although the reliability of these remains to be fully tested and there is scope for the application of a variety of validation methods. The need for such validation is not unique to this method and the reliability of many of the more regularly used length-based methods also require more investigation (Hillborn and Walters, 1992).

Of the two stages in the process, most reservations relate to the growth model implied by the slicing technique. The rather crude method takes no account of the likely variation of length for each age in the mixture of ages in the population; assuming a mixture of normal distributions this variation could be expressed by the standard deviation. Rather less concern attaches to the subsequent VPA method, the properties of which have been widely investigated and are better understood.

There is of course scope for the application of a number of alternative methods for deconvolution of the length distribution but to perform tolerably well these frequently require fairly strong signals (visible modes) in the length distribution. *Nephrops* length distributions collected from commercial samples are most often categorised by an absence of such signals. Furthermore, deconvolution methods of this type (for example Multifan (Otter Software 1988) and MIX (MacDonald and Pitcher 1979)) are rather time consuming and it is considered more worthwhile at this stage to further investigate the more simple approach.

The application of the method to sets of catch at length data from simulated age structured populations in which recruitment, mortality and growth processes are all known, offers one way of testing the reliability. In this paper, a preliminary study is presented which could form the basis of a more detailed investigation.

Methods

a) Simulation of population, fishing mortality (F), and catch at age

Population numbers were generated for a period of 20 years. Input vectors of recruitment values at the youngest age and population numbers at each of 10 ages in the first year provided a starting point. An input exploitation pattern (F at age) typical of males was applied to the first year with input scaling factors for each subsequent year to allow for variation in the overall level of F through time. Natural mortality (M) was held constant at 0.3; again in line with values used in male assessments. To generate population numbers down each cohort, the recruitment numbers were rolled forward using the exponential decay equation and applying the appropriate total mortality (F+M). Note that in this study the population was started from '1' group and that for the 1 and 2 year olds F was set at an extremely low value.

Applying the standard catch equation to the resultant matrix of numbers at age yielded the catch at age data. For each year, the proportion of catch in each age was also calculated (see below). This method provided the opportunity to vary various parameters in order to generate populations with different characteristics. In this study the approach was deliberately selective and three types of population were set up as follows;

Trial 1:	fixed scaling factor, recruitment increasing steadily.
Trial 2:	fixed scaling factor, recruitment variable.
Trial 3:	variable scaling factor, variable recruitment.

Figure 1 illustrates the population characteristics.

b) Conversion of age data to length data

In order to make this conversion, it was assumed that the distribution of lengths at each age was described by a normal distribution. It was also assumed that the mean lengths of each of these distributions present in the population in any year followed a growth curve of the von Bertalanffy type (other models could be tried). In addition to input growth parameters (again typical of male *Nephrops* viz. Linf= 65, K=0.16, to=-0.05), a vector of standard deviations (SD) (one for each age) was also input. The magnitude of this parameter, or the pattern of SD with increasing age, probably has an important effect on the performance of the slicing method which of course ignores such variation. For the three trials listed above, SD was increased with increasing age (and mean length at age) in addition a fourth trial was made (see Figure 1);

Trial 4: SD was first increased but then decreased again at the largest sizes.

Armed with these inputs and a starting length and length grouping interval the simulation of lengths could begin, dealing with each year in turn. For each age the proportion of the normal distribution present in each length class was calculated by making use of the Fortran NAG Library routine S15ABF which calculates values for the cumulative Normal distribution function. A description of this function can be found in Abramowitz and Stegun (1968). The proportion of the overall length distribution present in this age at this length is then obtained by multiplying by the proportion that this age represents in the overall distribution. (see under a) above). Number at that age and length is then obtained by multiplying by the overall catch number. As each age is dealt with the numbers at length in the mixture is the obtained by summing across ages. The resultant series of length compositions, one for each year, was then examined and the slicing/VPA applied.

Note that in order to accommodate the inclusion of '1' group *Nephrops* the starting length was set low (at 5mm) and that this is a size rather lower than that usually observed in commercial samples.

c) Application of slicing and VPA

The procedure was that used in the routine assessments. For slicing the four sets of data, the input growth curve used was the same as that employed in the simulation; 9 ages and a plus group were selected.

Input F values for the margins of the VPA table were supplied and tuning, in the absence of effort data, was carried out by using 'historic F' ie mean F across years (with no trend). F on the oldest age was calculated as the average of the preceding three ages. Note that only the last ten years of simulated data were used in the analysis (ie 1983-1992).

d) Comparison of output with simulated data

There are undoubtedly many ways in which the performance of the slicing method could be assessed, two rather simple approaches are presented here for illustrative purposes. Firstly, for the catches, Fs and numbers at age 'i' in year 'j' the estimates from each trial were compared with the simulations from each trial as follows:

Percentage difference(i,j) = ((VPA(i,j)-Trial(i,j)) /Trial(i,j)) * 100

These % differences were first examined graphically by both age and year. In some trials the pattern in successive years was similar so to simplify presentation, mean 'differences' and the standarad deviations of these were calculated across years.

Secondly, key indicators from a standard assessment ie Fbar (across the ages) and recruitment at the youngest age were calculated from the time series of VPA estimates and plotted alongside the same indicators calculated from the time series of simulated data. These were also, for the present, compared graphically.

Results

a) The simulated age based data sets

For brevity, full details of each of the trial populations simulated are not included. Table 1 however, illustrates catch at age generated in Trial 1. Note that the way the population was set up generated smaller catches at age 2 than age 1, this has implications later.

b) The length compositions generated

An example of a simulated length distribution is shown in Figure 2 for Trial 1 (first year, 1983). The effect of the catch at age data at the youngest ages described above is illustrated. Examination of the length composition illustrates a perhaps unfortunate feature of the simulations and one which makes the data unlike most *Nephrops* fishery length compositions. Inclusion of the 1 group resulted in a recognisable mode at small size. Otherwise the length composition obtained is rather similar to that usually seen ie characterised by being unimodal.

c) Comparison of the VPA outputs with the simulated data

In addition to the simulated catch at age data, Table 1 shows the results of the slicing (labelled VPA) to produce catch at age and also the % difference (Comparison) of these two. Similar comparisons were made for each trial and for catch, F and population number; these are not shown here.

There is always a danger in using the percentage method to express differences since this can give the appearance of wide deviations when in fact, owing to the low numbers involved, the differences are likely to be of little consequence. This has particular relevance to the older ages (see below). Bearing this in mind some comments can be made.

Considering the pattern of deviations it is first worth mentioning the problem of the 'age group 2' already alluded to. Table 1 shows that large deviations attach to this group, an observation throughout all trials and outputs except for the estimates of N at age which were unaffected. Since the problem has been discussed as something of an artifact and since the absolute numbers involved were relatively small, it is suggested that more attention is paid to ages above this.

Figure 3 shows the pattern of deviations down the ages and for each year (only the first 6 years shown for clarity), there was similarity in pattern across years for Trial 1 and also Trial 4 - (not shown) but in the trials characterised by very variable recruitment pattern, Trials 2 and 3 (latter not shown) the pattern was more variable and large deviations could be seen to 'track' through successive years and ages. The exception to this was in deviations associated with F at age which appeared to be relatively unaffected.

In order to summarise this information, mean deviations across years were calculated (together with standard deviation to give an idea of year to year variability); an example is included in Table 1. The results are presented for each trial in Figures 4, 5 and 6 which deal with deviations between simulated data and slicing/VPA output for catch, F and Number at age respectively.

Percentage deviations (labelled 'variation' in Figure 4) in catch at age from age 3 onwards showed a general increase in all trials. In Trial 1, deviations were mostly below 100% and SD was low while in Trial 2 (with variable recruitment) and Trial 3 (with variable scaling of F in addition), deviations and SD were bigger. Trial 4 with the different pattern of standard deviations about mean length, showed a drop in percentage deviation at the oldest age.

For 'age group' 3 and above, percentage deviations in F at age (Figure 5) were generally small in all trials, with negative deviations in the younger ages changing to an upward trend of positive deviations at the older ages. Standard deviations were also quite small. Note in this figure that the most recent year has been excluded because the F for the untuned age 1 in the most recent year (ie 'input F') was inappropriately large and produced some spurious results.

The pattern of mean percentage deviations in the Numbers at age (Figure 6) is particularly interesting. In all trials the large values at 'age group 1' are a result of the inappropriate input F described above and can be ignored. Above this 'age', mean deviations increased up to age 7 in all trials, smallest values being obtained in Trial 1. Above this age, deviations continued to rise in Trial 1 but levelled off in 2 and 3 and began to fall in Trial 4. Interestingly, the deviations dropped as low as 10% in this last trial (one with variable standard deviation at mean length in the simulation) suggesting that the degree of spread of length at age has a bearing on the reliability of the application of the slicing/VPA method.

Throughout the presentations of the previous 3 paragraphs, the importance of the 'large' % deviations is hard to judge because these were often associated with low absolute numbers.

A more immediately useful consideration is how the trends in the results of the slicing/VPA compare with the same trends in the simulated populations. Figure 7 illustrates trends in Fbar (ages 3-8). In Trials 1, 2 and 4 the exploitation pattern and the scaling were held constant so there is no evidence of trend in the simulated Fbar . This is fairly well matched in the VPA results for Trials 1 and 2. In Trial 3 the simulated Fbar first rises and then declines, a pattern evident in the slicing/VPA results thus the latter would in this case allow the correct conclusions to be drawn about the stock.

It is noticeable that there is a consistent downward bias in the VPA estimates. This is probably explained by the slicing technique which, between every 'age', truncates the length at age distribution forcing some 'younger' animals into 'age classes' above. This has the effect of artificially increasing survival rate (hence lower F).

Figure 8 illustrates the trends in recruitment generated by the simulation and the slicing VPA. Here, Trials 1 and 4 simulated steadily increasing recruitment which (apart from in the most recent VPA year) is well matched by the slicing/VPA. Similarly useful results seem to be obtained where the simulations involved variable recruitment (Trials 2 and 3). To some extent, the VPA results 'smoothed' the recruitment series but the general trends could be picked up and again appropriate conclusions would be drawn about the state of the stock.

Discussion

It would be premature at this stage to offer a full discussion of the implications of the findings of this study. There are many other things which could be examined Other underlying distributions than the normal one could be tried, this is relevant particularly in relation to the nature of the annual length samples used. For the youngest ages at least, growth during the year implies some progression of the normal distribution through time. Depending on the seasonal pattern of catches, this will at best produce a rather 'flattened' normal distribution. Different growth models in the trial populations could also be investigated to see how well the slicing method subsequently performed. In widening the study to present more 'awkward' populations one might, for example, vary the exploitation pattern through time. M might reasonably be varied also.

In addition one would probably wish to be more careful in setting up the trials than the somewhat selective approach used here. It would probably have been better to change only one feature of the trial population at a time (here there were some combinations of factors (see Figure 1). In retrospect it may have been better to use the known F's (ie those used in simulating the data) at the oldest age and final year, and to have dispensed with tuning altogether. This might have allowed a rather better indication of the performance of the slicing growth model - without the added complication of noise from the tuning process. It would also have avoided the artifact described above where an exceptionally high value of F was accidently applied to the youngest age (an age not included in the tuning process) which led to some unrepresentative results in the most recent year

At present the study is only telling us something about the performance of the slicing VPA against a population simulated in a particular way. There is no evidence as yet to say how the population should be set up and so the relevance of the results is more difficult to judge. Nevertheless, some comments are possible.

In the first place, the rather large discrepancies produced because of the use of a length distribution in which a distinct mode was inadvertently simulated, suggest a weakness in the slicing. In practise, however, a distribution showing modes would probably not be considered for 'slicing' anyway. Leaving aside this rather dramatic discrepancy, it is too early to say whether or not the detailed differences observed between estimated and simulated data constitute major flaws in the method. It is also too early to say whether the method gives a particular bias. It is probably more worthwhile at this stage concentrating on the more general picture.

One of the key requirements of the type of assessment being considered is that it can at least give a reliable picture of overall trends in the main indicators of the state of the stock; one would not for example wish to overlook an increasing trend in Fbar or a decline in recruitment. In this study, Fbar and recruitment were examined and the slicing VPA method appeared to be able to return estimates of these which broadly matched the trends in the simulated data. The particulary encouraging sign was that this was so even when both the recruitment trend and fishing mortality were varied simultaneously (Trial 3).

The approach looks to be a promising way of evaluating the slicing/VPA method for assessing *Nephrops*. At the very least it offers one way of understanding the bias introduced by the method, a desirable precursor to the use of any method (Hillborn and Walters, 1992)

There is clearly scope for a more detailed study employing more rigorous and established simulation techniques such as 'Monte-Carlo' simulation. It is hoped that this will be taken up at the *Nephrops* Study Group with some input from the expertise of the Methods Working Group.

References

Abramowitz, M. and Stegun, I.A. (1968) Handbook of Mathmatical Functions. Dover publications.

Anon. (1991). Report of the Working Group on the Assessment of *Nephrops* Stocks ICES, Doc. C.M.1991/Assess:11 (mimeo).

Anon. (1992). Report of the Working Group on the Assessment of *Nephrops* and *Pandalus* Stocks. ICES, Doc. C.M.1992/Assess:8 (mimeo).

Hilborn, R. and Walters, C.J. (1992). Quantitative Fisheries Stock Assessment- choice, dynamics and uncertainty. Chapman and Hall. 570pp.

Table 1 Example to show simulated catch at age data, corresponding catch at age from slicing/VPA and the % deviations of the latter compared to the former.

CATCH AT AGE

Trial

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	64.6	66.8	69.0	71.1	73.3	75.4	77.6	79.7	81.9	84.0
2	46.1	47.6	49.2	50.8	52.4	54.0	55.6	57.2	58.8	60.4
3	1716.1	1777.4	1838.7	1899.9	1961.2	2022.5	2083.8	2145.1	2206.4	2267.7
4	1781.3	1847.3	1913.2	1979.2	2045.2	2111.2	2177.1	2243.1	2309.1	2375.1
5	564.2	585.9	607.6	629.3	651.0	672.7	694.4	716.1	737.8	759.5
6	220.6	229.4	238.2	247.0	255.9	264.7	273.5	282.3	291.1	300.0
7	86.1	89.7	93.3	96.8	100.4	104.0	107.6	111.2	114.8	118.4
8	29.2	30.4	31.7	33.0	34.3	35.5	36.8	38.1	39.3	40.6
9	10.5	11.0	11.4	11.9	12.4	12.9	13.3	13.8	14.3	14.8
10	5.0	5.2	5.4	5.7	5.9	6.2	6.4	6.6	6.9	7.1

VPA

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	63	65	67	69	71	73	75	77	80	82
2	188	194	201	208	214	221	228	234	241	248
3	1602	1660	1717	1775	1833	1890	1948	2005	2063	2121
4	1467	1521	1575	1630	1684	1738	1792	1846	1900	1954
5	734	762	790	818	845	873	901	929	957	984
6	281	292	303	314	325	336	347	358	369	380
7	114	119	123	128	132	137	142	146	151	155
8	44	46	48	50	52	53	55	57	59	61
9	19	19	20	21	22	23	23	24	25	26
10	12	12	13	13	14	14	15	15	16	16

Comparison

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	Mean	SD
1	-3	-3	-3	-3	-3	-3	-3	-3	-2	-2	-3	0.4
2	308	307	308	309	308	309	310	309	310	311	309	1.1
3	-7	-7	-7	-7	-7	-7	-7	-7	-6	-6	-7	0.1
4	-18	-18	-18	-18	-18	-18	-18	-18	-18	-18	-18	0.0
5	30	30	30	30	30	30	30	30	30	30	30	0.2
6	27	27	27	27	27	27	27	27	27	27	27	0.2
7	32	33	32	32	31	32	32	31	32	31	32	0.5
8	51	51	51	52	52	49	49	50	50	50	51	0.9
9	81	73	75	76	78	79	72	74	75	76	76	2.7
10	142	131	139	129	137	128	135	126	133	125	132	5.5

Figure 1 Diagram to show the patterns of recruitment, F scaling and standard deviation at age in the 4 simulated populations.(Trials 1-4)

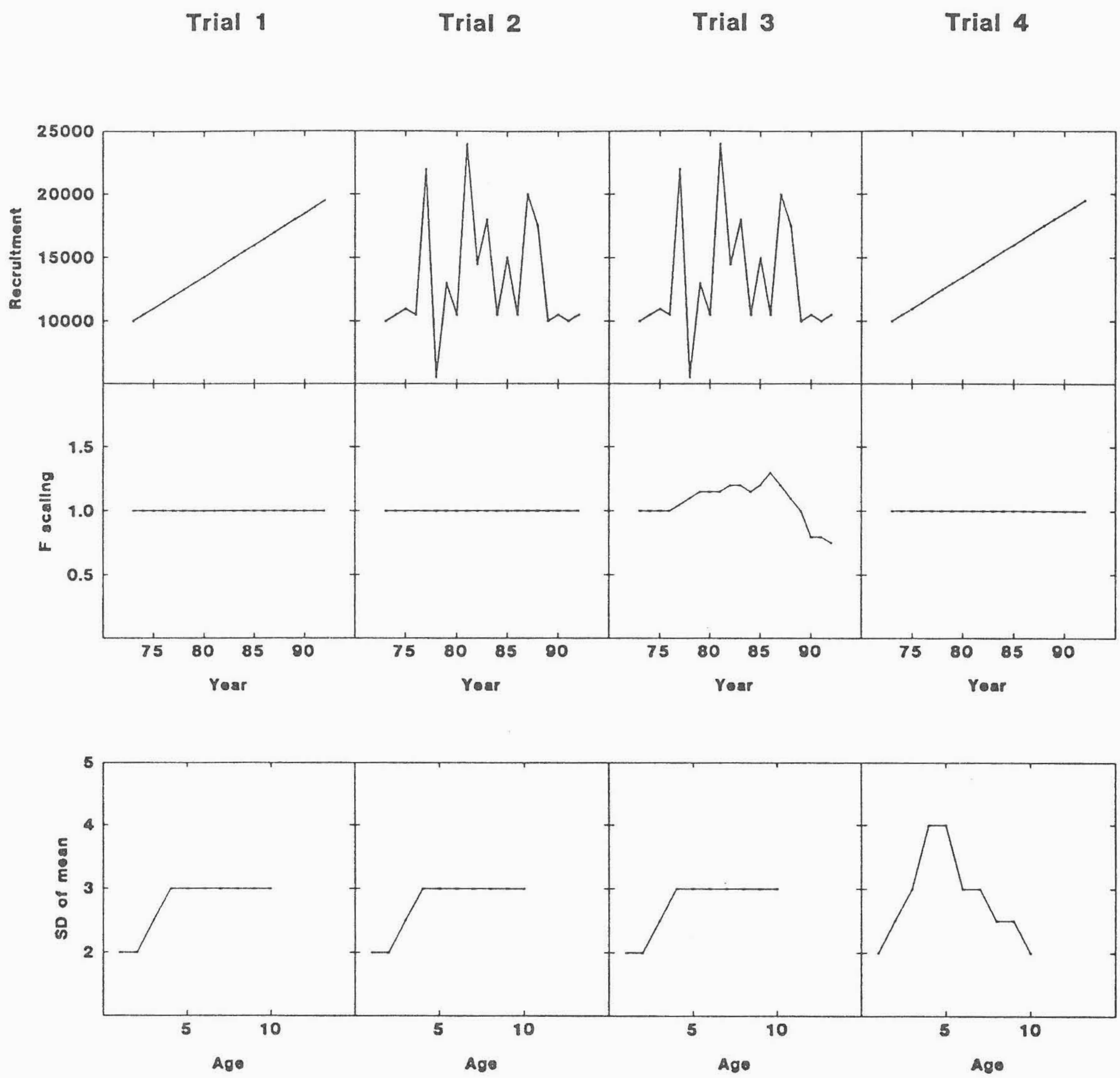


Figure 2 Example simulated length distribution (Trial 1 1983) prior to slicing

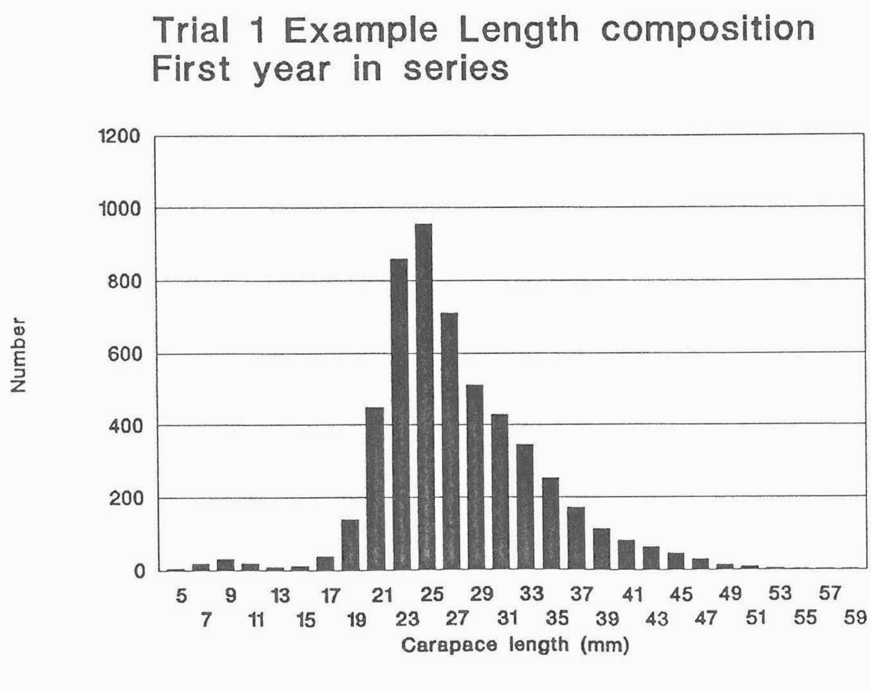


Figure 3 Patterns of % deviation ('variation %') by age for each year (first six years of analysis) for catch, F and number at age in Trials 1 & 2

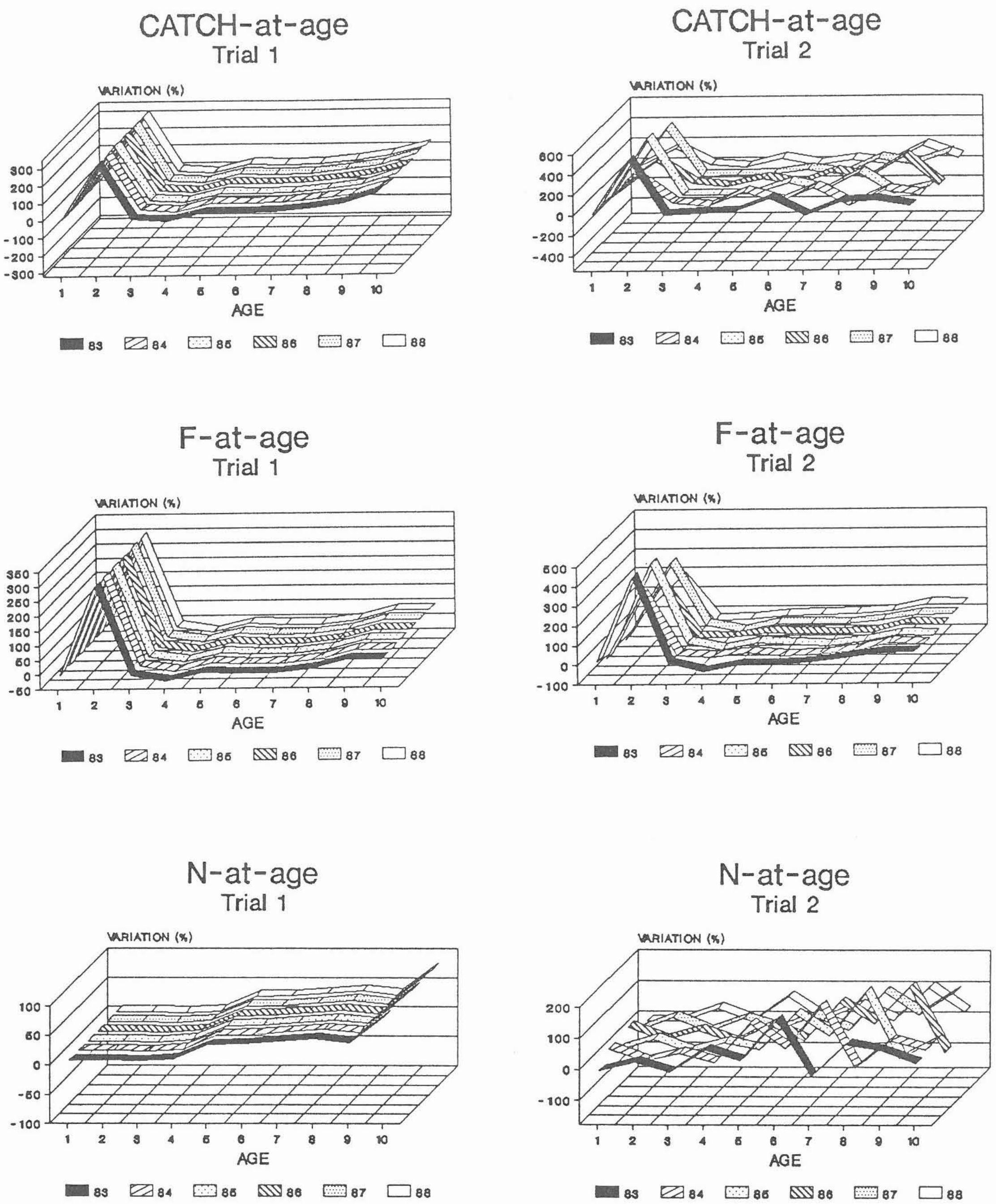


Figure 4 Mean % deviation (across years) between slicing/VPA catch at age and simulated catch at age in Trials 1-4. Standard deviation also shown to illustrate year to year variability.

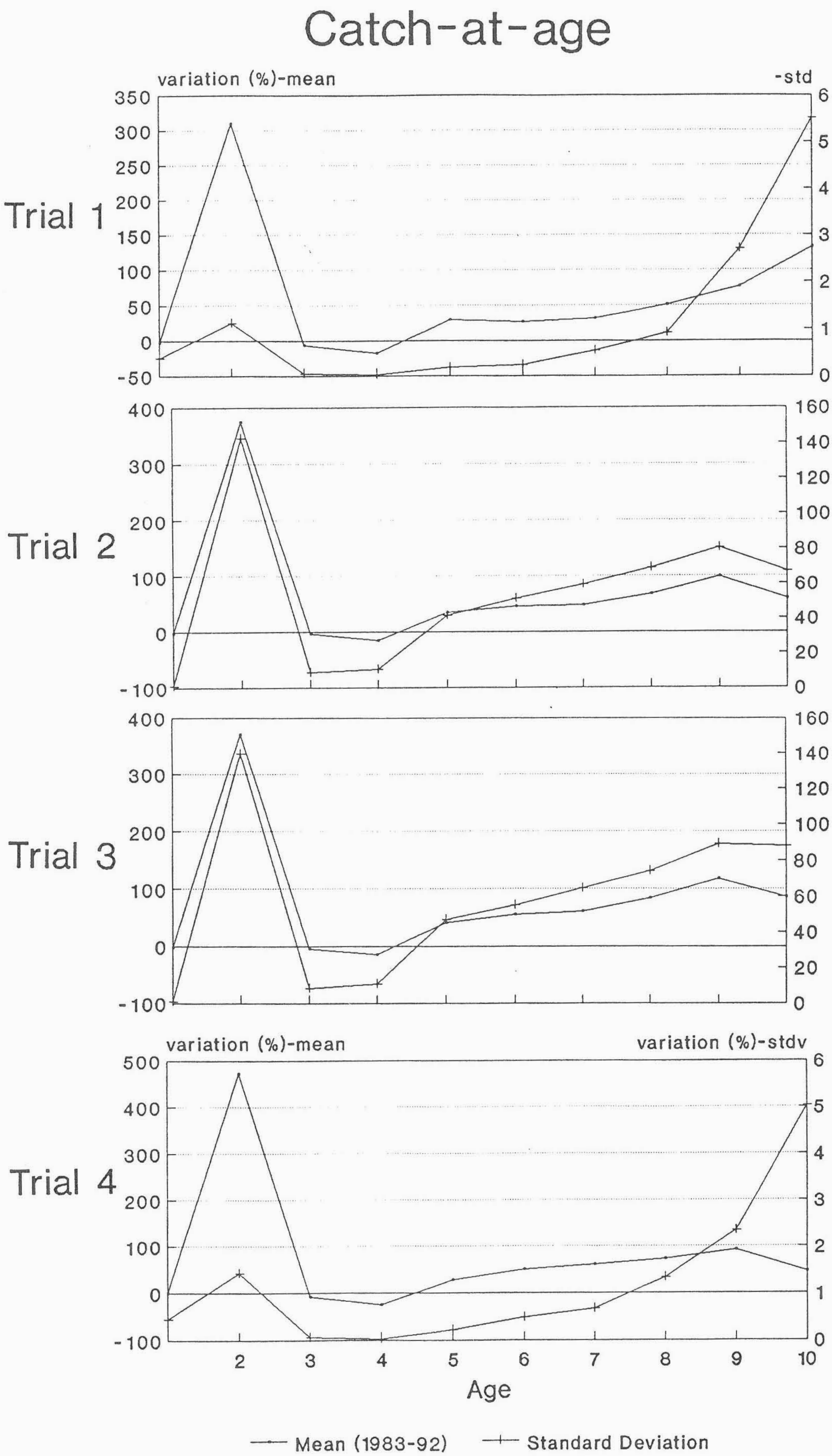


Figure 5 Mean % deviation (across years) between slicing/VPA F at age and simulated F at age in Trials 1-4. Standard deviation also shown to illustrate year to year variability.

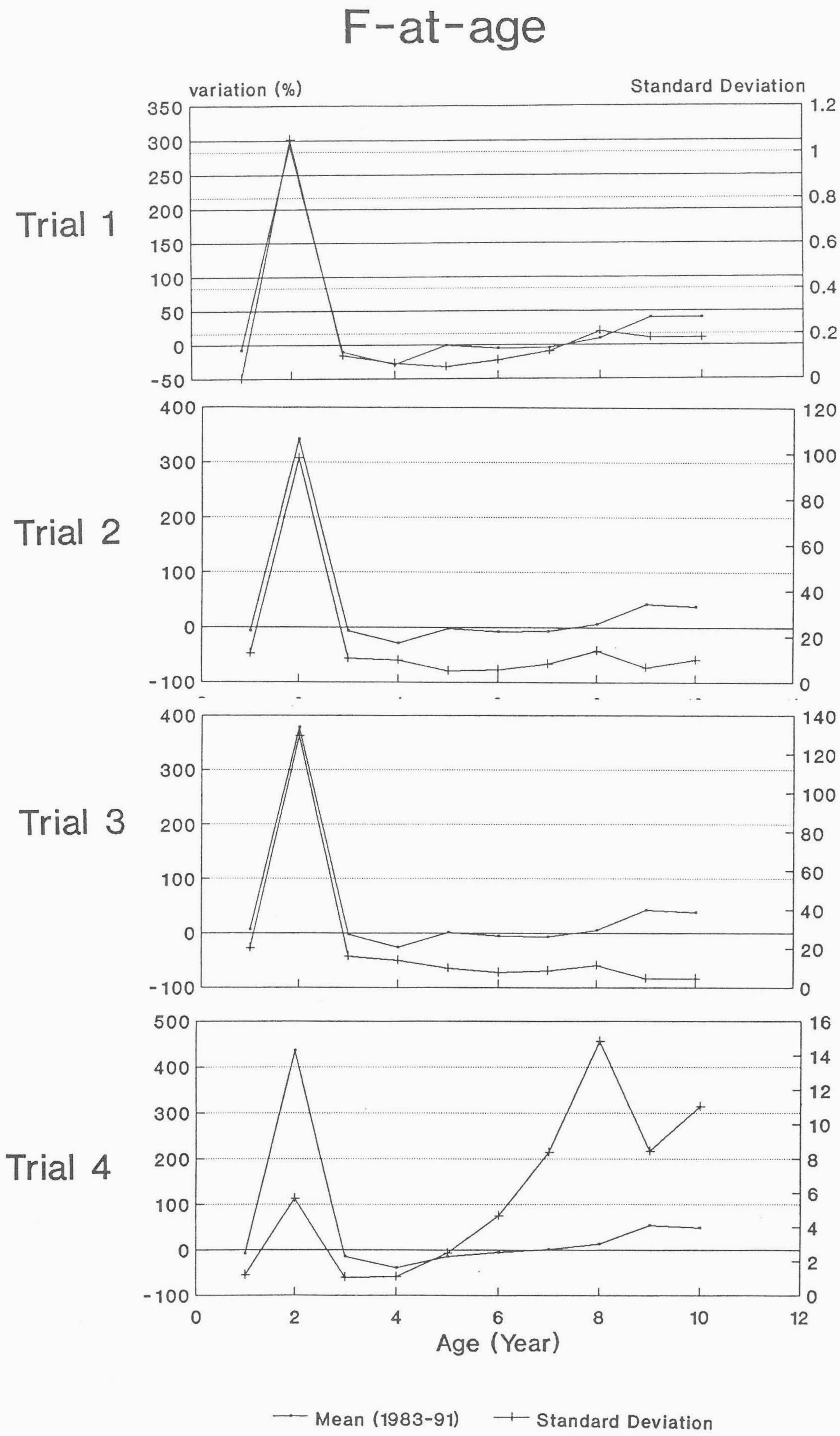


Figure 6 Mean % deviation (across years) between slicing/VPA number at age and simulated number at age in Trials 1-4. Standard deviation also shown to illustrate year to year variability.

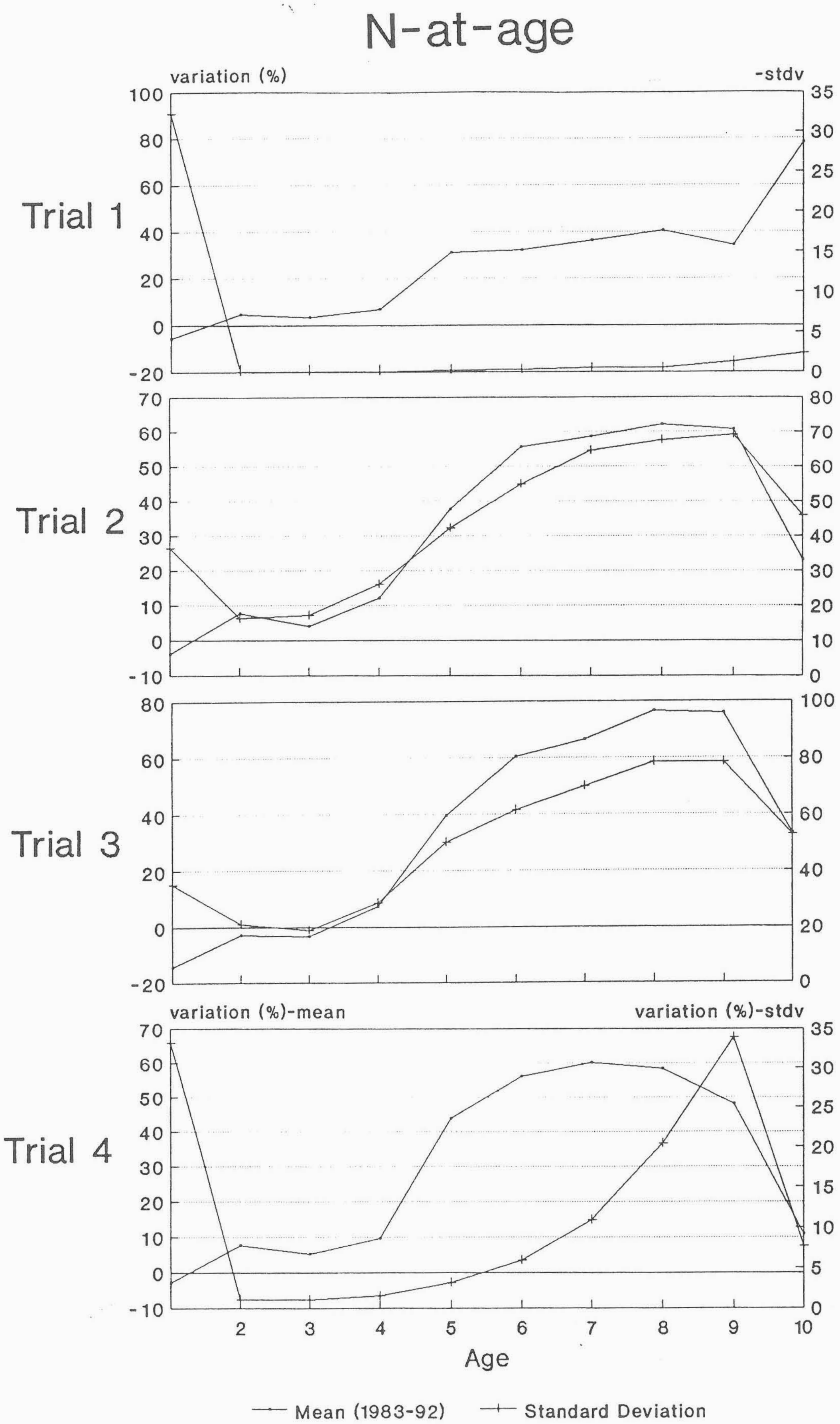


Figure 7 Comparison of trends in Fbar from simulated data with trends in the estimated Fbar from slicing/VPA.

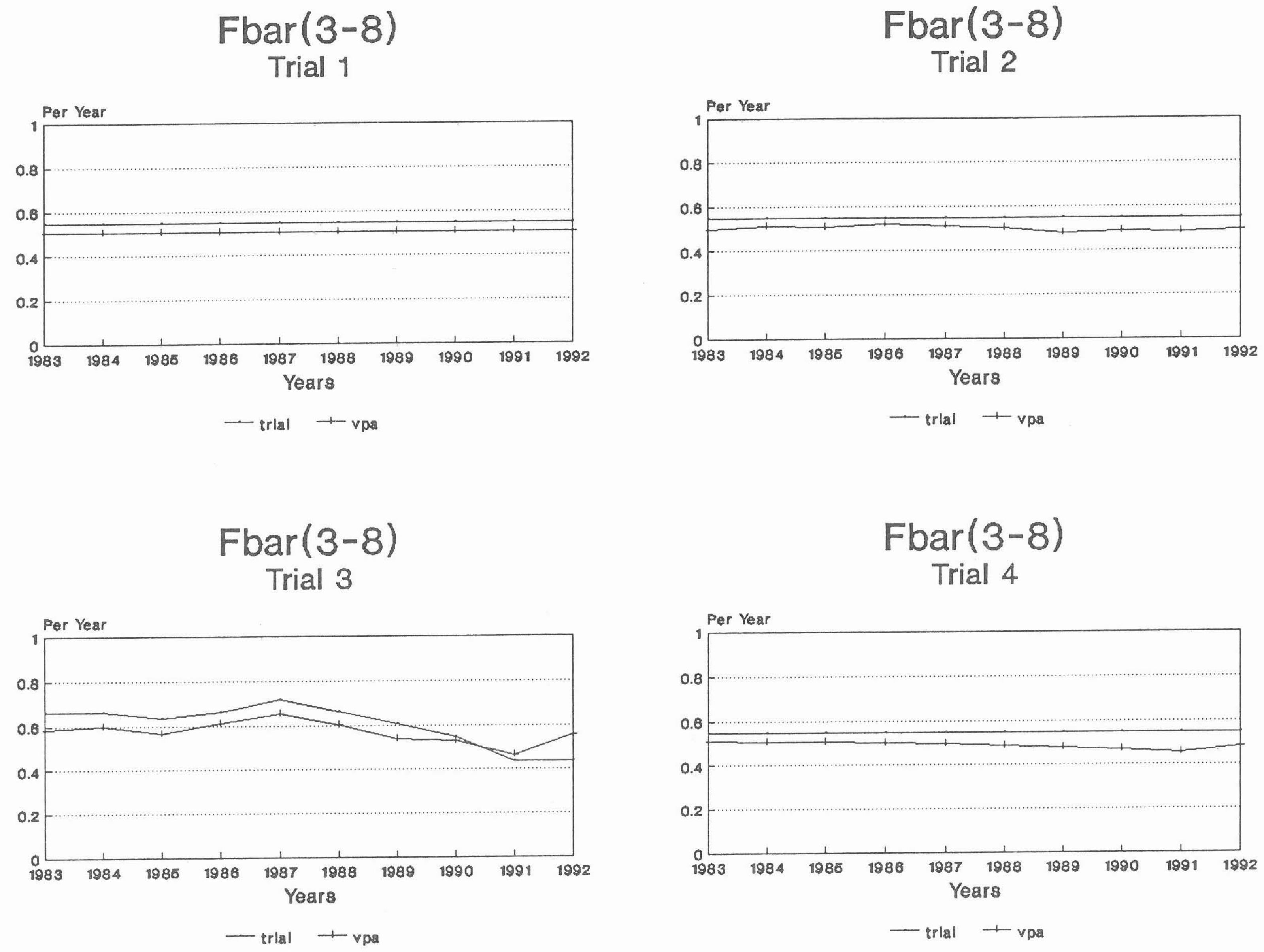


Figure 8 Comparison of trends in recruitment from simulated data with trends in the estimated recruitment from slicing/VPA.

Appendix 4: Working Paper

Estimation of *Nephrops* stock biomass on the Fladen Ground by TV survey

by

C Chapman, N Bailey, J Kinnear, D Bova, SOAFD, Aberdeen

Introduction

In previous Working Group reports (Anon., 1991; 1992) we drew attention to the problem of assessing the Fladen stock by conventional modelling, given its likely widespread distribution and the difficulties of achieving an adequate level of catch sampling (Table 5.8.1). As an alternative approach we have looked at the feasibility of surveying the Fladen stock by means of underwater TV. This method has been applied previously in Scottish inshore waters (Bailey and Chapman, 1983; Chapman, 1985) In June/July, 1992 the RV Scotia carried out a combined TV and trawling survey of the Fladen ground. The densities of *Nephrops* burrows were estimated and this information has been used to calculate stock abundance and biomass over different parts of the ground. The results should be regarded as preliminary since analysis was carried out on only about half the available video tape for each station.

Methods

A colour TV camera (Osprey type 1360 CCD) was mounted on an epibenthic sledge (Shand and Priestley, 1993, in preparation) towed by RV Scotia. The camera was arranged to view obliquely forwards between the runners of the sledge. Lighting for the camera was provided by four 500 watt quartz-iodide lamps (Hydro--Products). The video signal was combined with a digital date/time signal and recorded on a video cassette recorder and monitor (Sony U-matic). Also mounted on the sledge was a photographic camera (Hasselblad), with associated flash unit, and an ultrasonic range finder (Micro Ranger, Remote Marine Systems). The latter was mounted vertically on the sledge to provide information on the height of the cameras above the sea bed and the degree of sinking of the sledge runners into the mud sediment. These data, together with the camera lens angle specifications were used to estimate the dimensions of the camera field of view. The distances covered by the sledge were estimated throughout the tow by timing the passage of conspicuous objects on the sea bed as they passed from top to bottom of the screen (see Chapman, 1985 for details).

The survey was largely restricted to areas of sea bed known to be composed of muddy sediment (from charts published by the British Geological Survey (BGS)), within the statistical squares making up the Fladen ground, as defined by the *Nephrops* Working Group (Figure 1). The overall survey area was divided into 11 strata (see Table 2) within which two to eight randomly chosen stations were investigated. A stratified sampling regime was used such that the number of stations depended on the relative area of muddy sediment within each stratum, given by the BGS charts. The TV sledge was deployed for about 20 mins at each of 69 stations in total (Figure 1 and Table 1).

A 50 mm mesh *Nephrops* trawl (Scotnet, 54 m headline) was deployed at 22 stations throughout the survey area (Table 1). Hauls were 30 mins duration. Sediment samples for particle size analysis were taken at each trawl station using a Day grab.

Results and Dicussion

Initially, analysis of some of the video tapes was performed by three or four people to provide a measure of the variability in *Nephrops* burrow recognition by different observers. Also, the 20 min recordings were initially divided into four 5 min sections in order to check for small-scale geographical variations in burrow density. This approach revealed that density estimates were reasonably consistent between observers and small-scale spatial variation was small. Therefore, for most of the stations two 5 min sections of video tape were analysed, usually by two observers, occasionally by one. A fuller analysis of the tapes will be undertaken at a later date.

Results showed that *Nephrops* were distributed over most of the survey area, though three stations to the East (numbers 10-12 in Figure 1) were shown to have a hard substrate unsuited to *Nephrops* (Table 1). Emergent *Nephrops* were observed at 47 stations, although counts were generally low (Table 1). No attempt was made to reduce the disturbance effect of the camera lights on *Nephrops* by use of red filters (see Chapman, 1985). Also, it was not practical to plan the TV runs to coincide with the expected burrow emergence times of *Nephrops* at each station. Therefore counts of burrows are likely to provide a better stock estimate than counts of *Nephrops*. The burrows of *Nephrops* were readily distinguished by their deep crater-like, crescent shaped entrances leading into horizontal tunnels. Also seen were small funnel-shaped openings, leading into vertical shafts, which were attributed to the Thalassinid, Calocaris macandreae (Nash et al., 1984).

The results (Table 1) reveal that *Nephrops* burrow density varied considerably over the survey area, from 0.006 to 0.312 burrows/m2 (stations 39 and 26 respectively). The highest densities were recorded on sandy--mud sediments in the SE sector of the ground, in strata D, E, F and G (Figure 2 and Table 2). In order to estimate the abundance of the stock, station density determinations within strata were combined to give an overall figure. The product of overall density and the area of suitable sediment (calculated by digitizing the relevant BGS sediment charts) provided an estimate of the abundance of *Nephrops* burrows for each stratum and for the Fladen ground as a whole (Table 2).

To estimate the biomass of the stock the original intention was to use the trawl catches within strata to obtain separate estimates of *Nephrops* mean CL and hence, average weight. However, the trawl catch rates were generally low and highly variable (Table 1), though at the time they were of similar magnitude to those of commercial vessels working in the same locations. To convert abundance to an estimate of biomass we have therefore chosen to use the overall average *Nephrops* weight obtained from all trawl hauls combined (23.47g). Estimates of biomass for each stratum and overall are given in Table 2. This suggests a total stock biomass in the range 110-120,000 tonnes. These figures may be over-estimates because a proportion of burrows were likely to be unoccupied. This proportion is not accurately known, though the video analysis could probably be refined to measure this (based on the grey colour of the mud at the burrow entrance, compared to the brown colour of undisturbed mud). A rough calculation shows that the total removals from the stock by fishing in 1991 (the peak year), doubled to allow for natural mortality, amounts to only 10% of the burrow abundance estimates in Table 2 On this basis the proportion of unoccupied burrows is probably fairly small. From the BGS charts the area of muddy sediments on the Fladen Ground is estimated to be over 29,000 Km2. This estimate does not include small areas of muddy sediment (amounting to about 3700 Km2) within the Fladen FU but outside the survey strata, but does include muddy-sand sediments, in which the silt/clay fraction may be as low as 10%, possibly making the sediments in parts of the ground too coarse to support *Nephrops* burrows. On the other hand, *Nephrops* have been found on such coarse sediments in the Irish Sea (Anon., 1988). In the future it should be possible to relate the station density data to the local sediment characteristics (Figure 2) in more detail in order to improve the accuracy of the area and biomass predictions.

References

Anon. (1988).Report of Study Group on *Nephrops*. ICES Doc. C.M.1988/K:29.

Anon. (1991). Report of Working Group on *Nephrops* stocks. ICES, Doc. C.M.1991/Assess:11.

Anon. (1992) Report of Working Group on *Nephrops* stocks. ICES, Doc. C.M.1992/Assess:8.

Bailey, N. and Chapman, C.J. (1983). A comparison of density, length composition and growth of two populations off the West coast of Scotland. ICES, Doc. C.M.1983/K:42.

Chapman, C.J. (1985). Observing Norway lobster, *Nephrops norvegicus* (L) by towed sledge fitted with photographic and telivision cameras. In: Underwater photography and television for scientists. J.D.George, G.I. Lythgoe, J.N. Lythgoe (Eds), Chapter 10. Clarendon Press, Oxford. pp 100-108. Nash, R.D.M., Chapman, C.J., Atkinson, R.J.A. and Morgan, P.J. (1984).Observations on the burrows and burrowing behaviour of *Calocaris macandreae* (Crustacea: Decapoda: Thalassinoidea). J. Zool., Lond. 202:425-439.

Shand, C.W. and Priestley, R. (1993). Sea bed sledge system for benthic observations (In preparation).

Table 1 Fladen Ground survey (Scotia Cruise - 0892S) results, showing for each station : range of burrow density, Nephrops counts and trawl catch rates (kg/hr and numbers N), mean carapace length (mm) and sex ratio (% females). See Figure 1 for station locations.

	TV counts			Trawl Samples (30 mins)						
Station	Burrows low m^{-2}	high	Nephrops	Haul No.	Catch rate	Male N	Male Mean	Female N	Female Mean	Sex ratio
					kg/hr		Size		Size	
1	NA		NA							
2	0.186	0.270	3	217	1.7	47	28.0	26	23.7	35.6
3	0.184	0.233	12							
4	0.249	0.302	3							
5	0.191	0.240	4							
6	0.195	0.219	10	218	48.0	748	33.0	281	27.4	27.3
7	0.193	0.205	1							
8	0.161	0.194	7							
9	0.122	0.151	10	219	17.6	257	33.9	60	28.5	18.9
10	0.000	0.000	0							
11	0.000	0.000	0							
12	0.000	0.000	0							
13	0.197	0.232	3							
14	0.262	0.262	0							
15	0.196	0.230	4							
16	0.169	0.173	1							
17	0.223	0.263	28	220	41.8	723	32.3	187	27.0	20.6
18	0.275	0.301	3							
19	0.257	0.276	0							
20	0.260	0.266	2							
21	0.212	0.235	1	221	6.0	96	31.4	49	27.2	33.8
22	0.195	0.195	3							
23	0.279	0.279	2							
24	0.255	0.293	2							
25	0.294	0.315	11							
26	0.312	0.312	6	222	34.0	492	34.7	53	27.0	9.7
27	0.218	0.228	1							
28	0.133	0.136	0							
29	0.271	0.305	1	223	1.4	17	37.8	2	32.5	10.5
30	0.271	0.294	1	224	5.6	64	36.2	12	28.8	15.8
31	0.109	0.114	5							
32	0.267	0.299	2							
33	0.132	0.132	0	225	0	0		0		
34	0.273	0.285	5	226	+	1	45.5	0		0
35	0.060	0.060	0							
36	0.062	0.062	3	227	0.48	5	35.3	0		0
37	0.052	0.052	0							
38	0.027	0.027	0	228	0.79	4	46.5	2	31.0	33.3
39	0.006	0.066	0							
40	0.084	0.098	0							
41	0.039	0.033	0							
42	0.281	0.307	3							
43	0.047	0.051	0	229	2.24	15	43.3	3	27.8	16.7
44	0.111	0.122	4							
45	0.112	0.115	0							
46	0.149	0.149	4							
47	0.257	0.307	5	230	11.2	156	35.1	29	25.9	15.7
48	0.133	0.141	2							
49	0.125	0.134	6							
50	0.156	0.165	3							
51	0.123	0.137	0	231	0.28	6	30.8	1	27.5	14.3
52	0.160	0.168	0							
53	0.086	0.089	1	232	8.0	67	36.1	44	33.2	39.6
54	0.137	0.156	3							
55	0.122	0.126	5							
56	0.076	0.094	5	233	58.0	518	33.3	478	33.7	48.0
57	0.206	0.206	8							
58	0.098	0.098	2							
59	0.100	0.126	0							
60	0.127	0.148	3	234	2.48	24	35.2	17	36.1	41.5
61	0.133	0.226	4							
62	0.032	0.034	0							
63	0.208	0.240	29	235	44.0	815	30.5	240	27.7	22.7
64	0.110	0.137	2	236	0.86	16	31.1	7	26.8	30.4
65	0.204	0.232	0							
66	0.294	0.294	3							
67	0.113	0.113	6	237	26.0	482	30.1	124	26.1	20.5
68	0.156	0.156	2	238	0.72	10	32.3	5	32.7	33.3
69	0.113	0.113	0							

Table 2 Estimates of sediment area (Km2), Nephrops density (burrows/m2) abundance (numbers in Millions) and biomass (tonnes) for each stratum and overall on the Fladen ground.

		Density		Abundance(million)		Biomass	(mt)
Stratum	Area(km2)	Low	High	Low	High	Low	High
A	2665.9	.121	.141	322.5739	375.8919	7570.809	8822.183
B	3074.7	.153	.163	470.4291	501.1761	11040.97	11762.60
C	4007	.156	.165	625.092	661.155	14670.91	15517.31
D	3064	.24	.256	735.36	784.384	17258.90	18409.49
E	3207.6	.222	.245	712.0872	785.862	16712.69	18444.18
F	2461.6	.199	.263	489.8584	647.4008	11496.98	15194.50
G	2558.9	.2078	.226	531.7394	578.3114	12479.92	13572.97
H	2002	.134	.146	268.268	292.292	6296.250	6860.093
I	2864.2	.139	.144	398.1238	412.4448	9343.966	9680.079
J	2245.7	.0395	.0395	88.70515	88.70515	2081.910	2081.910
K	1100.4	.061	.061	67.1244	67.1244	1575.410	1575.410
Totals	29252			4709.361	5194.748	110528.7	121920.7

Notes 1 Low and High estimates based on min. and max. burrow counts respectively, by different observers

Notes 2 Strata stat. squares are: A (E845-46);B (E946);C (E944-45);D (F046) E (F045);F (F0-F144);G (F145-46);H (E947);I (F047);J (F048);K (F149)

Figure 1: Chart showing ICES statistical squares (shaded) making up the Fladen Ground Functional Unit (FU 7) and station positions sampled by TV camera sledge during RV Scotia cruise, 26 June - 9 July, 1992. Some stations were also sampled by trawl (see Table 1).

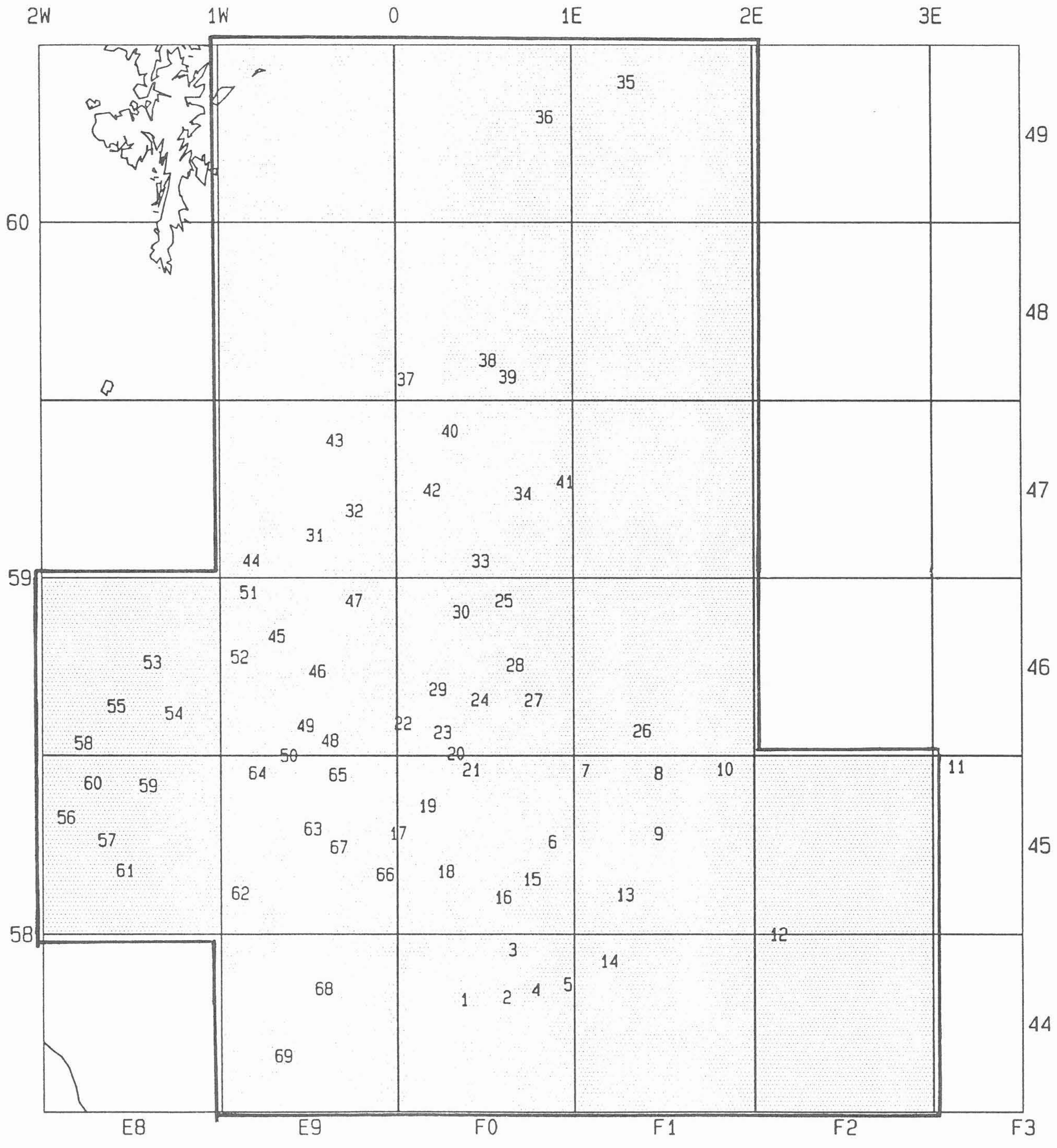


Figure 2: Chart of Fladen Ground showing boundaries of different sediment strata (Mud -dotted line; Sandy Mud -broken lines; Muddy Sand -solid lines) and mean burrow densities (no./100m2) at each position.