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International Council for the
Exploration of the Sea

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Demersal Fish Committee

REPORT OF THE NORTH SEA FLATFISH WORKING GROUP

Charlottenlund, 14 - 18 May 1979

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REPORT OF THE NORTH SEA FLATFISH WORKING GROUP

1. INTRODUCTION

1.1 Participants

The ICES North Sea Flatfish Working Group met in Charlottenlund from 14-18 May 1979 with the following participation:

D W Armstrong	U.K. (Scotland)
R C A Bannister	U.K. (England)
F A v. Beek	Netherlands
R De Clerck(Chairman)	Belgium
R G Houghton	U.K. (England)
T Jakobsen	Norway
G Lefranc	France
E Nielsen	Denmark
G Rauck	Germany, Fed.Rep.of
J F de Veen	Netherlands
W Weber	Germany, Fed.Rep.of

V Nikolaev attended the meeting as the ICES Statistician.

1.2 Terms of Reference

At the 1978 Statutory Meeting it was decided (C.Res.1978/2:48) that the North Sea Flatfish Working Group should meet with the following terms of reference:

"(a) assess TACs for sole and plaice in the North Sea and the Channel for 1980,

(b) advise on the desirability of extending the current prohibition on fishing for flatfish by larger vessels within 12 miles of the coast of Belgium, Netherlands, Federal Republic of Germany, and Denmark, beyond 12 miles or to other coastal areas,

(c) assess the effect of by-catch in the *Crangon* fishery on the exploitation of flatfishes".

In addition, ACFM asked that the Group should consider, when time permits, the following questions:

1. Can stocks of male and female plaice and sole be treated as a mixed fishery?
2. Should the results of pre-recruit surveys be presented in catch per unit effort rather than as ratios?
3. Do regressions of catch in numbers per unit effort on numbers in stock of plaice differ between fleets?
4. From a stock/recruitment curve on North Sea sole, can one estimate the stock which gives maximal recruitment?
5. Should there be a minimum mesh size differential between beam and otter trawl, and, if so, what should be the proportions?

6. Can one allow for migration between the two areas in assessments of Sub-area IV and Division VIId plaice?

7. Should trammel net mesh sizes in the Division VIId sole fishery be controlled?

8. Are there any sequential tagging experiment data available which should be re-examined with a view to estimating natural mortality rate, and to obtain a better insight into the terminal F problem?

9. What spawning stock biomass yields the maximal recruitment?

10. What are the present effective mesh sizes in use, as estimated from the age of recruitment in cohort analysis?

2. NORTH SEA SOLE

2.1 Catch Trends

Reported catches for the period 1968-78 are shown in Table 2.1, but these figures do not include the non-reported landings known to have been made since the introduction of the quota regime in 1975, and these are included at the foot of the table (see also Figure 2.1).

The Group included this quantity in the assessment and thus the 1978 TAC of 10 000 tonnes was probably exceeded by some 10 000 tonnes (100%). In 1978 no changes occurred in the major fleets fishing for North Sea sole.

2.2 Assessment of the Current Situation

The steadily growing amount of unreported landings further increases the uncertainty which the Group feels about the assessments. The reliability of the catch data has not been restored to its pre-1975 level and it cannot be expected to improve in the near future. The Working Group felt that the concept of management by means of catch quota, although universally accepted as the principal management tool, has, in the case of North Sea sole so far, failed in practice and unless the effective enforcement of national quotas could be achieved, the use of TACs should be reconsidered.

2.3 Age Composition and Weight-at-Age Data

2.3.1 Age composition

No amendments were made to the provisional age composition of the total 1977 catch. 1978 age composition data were available from Belgium, Denmark, the Federal Republic of Germany and the Netherlands accounting for 91% of the official landings figure of 10 589 tonnes. The total of the countries' age compositions was then raised to account for the unreported landings to the estimated total of 20 389 tonnes. The resulting age composition is given in Tables 2.2 and 2.5.

2.3.2 Weight at age

Using the average (1969-73) catch weight-at-age data the sum of products check on the total age composition is 90.1%.

Because of the increasing uncertainty in estimating the total catch, and since there is no substantial increase in weight at age in 1978 (de Veen, pers.comm.), the Group left the number in the age composition and the weight-at-age data unchanged and made the relevant adjustments to catch and stock biomasses in the prognosis. The weight-at-age data for catch and stock are given in Table 2.8.

2.4 Virtual Population Analysis

2.4.1 Choice of terminal F at age array and M

No change in effort has taken place in 1978 compared with 1977; thus the 1977 exploitation pattern from last year's VPA were used as input (Tables 2.3 and 2.6). Natural mortality was assumed to be 0.1 as in previous assessments.

2.4.2 The VPA

The steady decline in spawning stock biomass since the mid-1960s has halted, and since 1975 it has been stabilised. The 1978 stock biomass is of about the same level as that of 1977, thus leaving the biomass at a low level. The age composition of the stock is such that the strength of recruiting year classes (Figure 2.2) has a substantial effect. The good year classes 1975 and 1976 are being followed by a below-average 1977 year class which will fully recruit this year.

2.5 Natural Mortality

2.5.1 Variations in natural mortality

Normally, it is assumed that natural mortality is constant for all age groups and over all the years used for VPA and prognosis runs. This has been the procedure too for the previous assessment on North Sea sole. By its nature, sole in the North Sea is vulnerable to extreme winters and qualitative analysis of the after-effects, of e.g. the severe winter 1962/63, showed that a considerable increase in natural mortality, caused by very low temperatures, must have taken place (Woodhead, 1964a,b). In 1963 most mortality occurred in May and June when the temperature started to rise again. Rauck (1969) showed that soles demonstrating the effects of prolonged low temperatures as open wounds and death could also be observed in less severe winters. De Veen (1978a) showed by simulation runs with varying M values for 1963 that a VPA ignoring an increased M for 1963 resulted in too high F values and too low stock biomass for the years prior to 1963. Recently, Houghton (pers.comm.) pointed again to the discrepancy between the observed catch rates and the VPA stock biomass estimated from the Group's previous VPAs. Figure 2.3 demonstrates that both the United Kingdom and Dutch cpue show the same downward trend since the early 1950s (lower part of the Figure), whereas the VPA stock estimate did not show any higher stock level prior to 1963 (upper part of the Figure).

A number of trial VPAs were run based on the VPA in the Group's report in 1978. In these trials, M values for 1963 ranging from 0.1 to 1.0 were put leaving the M values for the periods 1957-62 and 1964-77 unchanged (M = 0.10).

Figure 2.4 shows in bold lines the VPA stock biomass (in which the observed weight-at-age data per year derived from Dutch sole growth studies (de Veen, 1976, 1978b) were used) for the 10 runs. As can be expected, VPA stock biomass prior to 1963 increases with increasing M_{1963}.

In order to compare the VPA stock estimates with the cpue series, both the United Kingdom and the Dutch cpue were scaled down to the VPA stock range 1964-73 in which the average VPA stock equals the average United Kingdom and the average Dutch cpue.

Comparison show that from 1964 onwards the VPA stock curve agrees well with both cpue curves. Prior to 1964 both cpue curves rise to a substantially higher level and especially in the years 1957-60 they are in very good agreement with each other. For the years 1961, 1962 and 1963 both cpue curves agree with VPA runs in which a high M for 1963 has been taken. This means that it is very likely that the natural mortality in 1963 was of the order of 0.8 - 1.0.

Before 1959 the VPA stock curves shown still do not agree with the cpue curves; however, another simulation on similar lines (Houghton, pers.comm.) suggests that this discrepancy can also be resolved, so cpue and VPA curves match for the whole series.

2.5.2 The effect of the severe winter of 1979 on the natural mortality

De Veen (1969) showed that the effects of a strong or severe winter can be estimated qualitatively by calculating for the North Sea the number of days in which the surface water temperature has been below 3½°C. Surface temperatures probably represent temperature at the bottom because in the area considered the water column is homogenous throughout the year.

Figure 2.5 shows the situation in 1963. As a result of the normal east-west migration of the North Sea sole the fish moved to the deepest and warmest parts of their range but were still overrun by cold temperatures. Thus, the Silverpit and the Deepwater Channel showed the highest mortality rate later in May-June 1963 (Woodhead, 1964b). The area with reported dead or dying soles roughly coincides with 60 or more days line. Figure 2.6 shows the situation in the 1979 winter. Very high catch rates were experienced in the Belgian and Dutch sole fishery during January-March 1979 in the western half of the central and southern North Sea. However, compared with the 1963 situation, the duration of the cold water regime in these deeper parts of the North Sea was much less than in 1963, so that natural mortality owing to the 1979 severe winter may have been considerably less than in 1963.

Figure 2.7 shows the surface temperatures on four selected positions in the North Sea in 1963, 1979 and the average situation. The Galloper lightvessel temperatures in 1979 were slightly below the average in contrast to the low temperatures in 1963. The Smith Knoll lightvessel data for 1979 were below the average, but higher than in 1963. The position 55°05' - 55°14'N, 2°03' - 2°14'E in the central North Sea in the western part showed 1979 temperatures well below average and slightly above the 1963 picture. To conclude, the Elbe I lightvessel data showed 1979 temperatures far below average but somewhat higher than the 1963 situation (Ellett, 1963, 1967; Ellett and Baxter, 1963; D.H.I., 1954-77). Figure 2.7 confirms the findings of Figure 2.6.

At the moment no information on the level of M for 1979 is available. For prognosis purposes a number of values for M_{1979} has been chosen, e.g. 0.1, 0.2, 0.3, 0.4, and 0.5.

2.6 Catch Predictions

2.6.1 Introduction

To assess the order of magnitude of an increased M on catch and stock in 1980 and hence on a range of possible management measures, prediction runs have been made assuming an array of M values between 0.1 and 0.5. (Table 2.9.) In addition, some assumptions on recruit strength have been made. In Option A average recruitment having the same natural mortality as the adults has been taken. In Options B and C the figure for the 1978 year class as taken from the latest 0-group survey has been used. In Option B, this year class had the same M as the adult soles. In Option C an extra 50% natural mortality was assumed for the 1978 year class.

In each of the three Options three levels of F have been taken. In the first run, it was assumed that $F_{80} = F_{78}$, in the second run $F_{80} = 0.80 F_{78}$, and in the third run $F_{80} = 0.5 F_{78}$. In all runs it was assumed that the TAC for 1979 will be exceeded, and that $F_{79}=F_{78}$.

The runs were carried out for males and females separately, and the resulting stock and catch biomasses added together. The input stock numbers per age groups at the beginning of 1979, the F at age array and the calculated catches for 1979 and for M_{79} = 0.1, 0.2, 0.3, 0.4 and 0.5 are given for both sexes in Tables 2.9 and 2.10. The weight-at-age data for catch and stock are given in Table 2.8.

2.6.2 Results of catch predictions

Table 2.11 gives the details of the predictions for total and spawning stock and catch biomasses for 1980. To correct for the discrepancies mentioned in para. 2.3.1 all the figures have been raised by 10%.

Table 2.12 is a summary of the resulting total stock biomasses at the beginning of 1981. In Section 2.7 the difficulty to define a long-term objective for management will be given.

In Section 9.4 the absence of a stock/recruitment relationship in the available data is indicated. It is obvious that the stock at the beginning of 1978 was such that the good year class 1978 was produced. A short-term objective might be to restore the sole stock to at least the level at the beginning of 1978, viz., 54 700 tonnes.

Tables 2.11 and 2.12 show for different values of M in 1979 the level of TACs needed to reach the stock of 54 700 tonnes, i.e. the 1978 level, at the beginning of 1981. This will depend on the magnitude of M_{79} of the adult soles and the M_{79} of the year class recruiting in 1980.

2.7 Management Options

2.7.1 The present impossibility of giving an advice on a TAC for 1980

Owing to the effects of the severe winter of this year the level of the stock and the 1978 recruitment are unknown at present.

In 1962 a good year class was born, but it nearly disappeared after the 1963 winter. At the moment the situation is roughly the same. The fate of the good 1978 year class which has to recruit in 1980 is unknown. The international spring 0-group survey this year failed to show the 1978 year class, but this may be the result of retarded migration from deeper water which has happened also after the 1963 winter. Thus, in the months to come more information will become available on the strength of the 1978 year class at present. Another uncertainty is that the level of increased natural mortality on the adult soles is unknown at present.

It is therefore difficult to give any positive advice on a TAC for 1980 in this report. It is imperative to postpone any advice on management until more information on the after-effects of this severe winter become available.

Two possible short-term management options were discussed by the Working Group and are presented below:

(1) that the 1980 TAC should be chosen to return the total stock biomass in 1981 to 54 700 tonnes, which was that observed in 1978;

(2) the 1980 TAC should be chosen to make the 1981 spawning stock biomass equal to the average level of 1970-78, i.e. 46 000 tonnes.

TACs corresponding to these options for a range of values of M are given in the text tables below.

Text Table 1. TACs for North Sea sole for 1980 (in tonnes) to achieve a stock biomass in 1981 = 1978.

M_{79}	Option 1 (Average recruitment)	Option 2 (1978 recruit strength)	Option 3 (0.5 x 1978 recruit strength)
0.1	18 200	(23 000)	14 000
0.2	16 200	20 800	12 200
0.3	14 500	19 100	10 300
0.4	13 200	17 100	(8 900)
0.5	11 600	15 400	(7 000)

Text Table 2. TACs for North Sea sole for 1980 (in tonnes) to achieve a spawning stock biomass in 1981 = average 1970-78.

M_{79}	Option 1 (Average recruitment)	Option 2 (1978 recruit strength)	Option 3 (0.5 x 1978 recruit strength)
0.1	18 900	(23 500)	15 000
0.2	17 100	(21 800)	13 100
0.3	15 500	20 000	11 200
0.4	13 900	18 100	(9 800)
0.5	12 500	16 400	(8 000)

(NB. Figures within brackets are less accurate because of extrapolation on the curves.)

Whatever the effects of the 1979 winter on the stock, management should be aimed at restoring the present stock level immediately to the 1978 level. This short-term objective will certainly mean a reduction in the catch possibilities in 1980. It is necessary to know what the catch possibilities will be in 1980 and this can only be assessed after the missing information has been collected. There is a chance that a sensible assessment can be carried out in October-November this year, not earlier.

2.7.2 <u>The present impossibility of defining long-term management objectives for North Sea sole</u>

De Veen (1976, 1978b) has shown that growth is not constant in the North Sea sole, but that a dependency on the fishery exists. Another possibility is that the observed change in growth rate is linked with stock biomass. In both cases a constant parameter yield per recruit curve as given in last year's report, based on constant growth, with a defined F_{max} and $F_{0.1}$ position, is wrong.

In the long term, the effects of the fishery or of density-dependent growth on stock biomass will be significant.

In the case of the 1963 winter an increase in M from 0.1 to 0.9 has been deduced, but even in less severe winters an increase in M may occur (Rauck, 1969), and it is clearly not possible to estimate with any desired accuracy the variations in the future years.

2.7.3 Problems to be solved this year

In order to be able to assess the sole fishery in late autumn, the following problems should be tackled:

(1) Estimation of what is left of the 1978 year class through continuous pre-recruit surveys in the main sole nurseries.

(2) Assessing the relative abundance of the adult stock by following constantly the cpue and the age structure of the catch.

(3) Analysing the reports on dead soles collected presently in the Netherlands.

(4) Define a long-term objective taking into account dependent growth, varying M and recruitment and the probability of severe winters with large M values undoing any effect of management measures.

(5) When results of the current mesh selection experiments become available, mesh assessments should be carried out.

2.7.4 Recommendations

In the light of the conclusion arrived at the Working Group feels not to be in a position at the moment to give any advice on a 1980 TAC and recommends to be reconvened later in the year, but not earlier than October-November, provided the missing information on the effect of the 1979 severe winter is available.

3. NORTH SEA PLAICE

3.1 Catch Trend

Table 3.1 and Figure 3.1.A show the recent trend in total catch based on data submitted to Bulletin Statistique, where available, but with estimates of unreported landings where indicated. The 1978 catch was 112 000 tonnes, 5% down, on both the 1978 TAC and the catch in the previous year, but at the same level as the 1976 catch. Effort data (see Section 3.3) show that because of a reported decline in Dutch beam trawl effort in the last three years, total effort may have declined slightly. In the English fleet there was also some switch of interest from plaice to cod in 1978.

3.2 Age Composition

The 1977 age composition has been amended by adjusting last year's provisional figures to the final landings. However, the Danish age composition was re-calculated from the percentage age composition of the 1975 and 1976 Danish landings.

Provisional 1978 age composition data were available from Belgium, Denmark, England, the Federal Republic of Germany and the Netherlands, accounting for 95% of the total landings and the sum of these was raised to the total. The resulting age composition is added to the series in Tables 3.2 and 3.5.

Discarding almost certainly takes place in the beam trawl fleets, though not the otter trawl and seine fleets. However, no data were presented and no objective correction could be made for this effect. This could be an important source of bias in the age composition leading to an underestimate of the mortality on ages 1 to 3.

The total number of fish landed is estimated at 281.8 millions, equivalent to an average weight per individual of 397 g whole weight.

The sum of products using English mean weight at age is 2% higher than the observed total landing.

3.3 Virtual Population Analysis

Figure 3.2 summarises the results of several trial VPAs based on a range of values on either side of last year's input (run 1). The resulting mean F values, which converge for the years 1973-76, were correlated with the sum of the available English, Belgian and Dutch effort presented in Figure 3.3 and Table 3.8, with the results shown in Table 3.9. Only one of these correlations is significant (for which r = 0.707 for 6 degrees of freedom at the 5% level). The terminal F input was therefore kept the same as last year. The respective arrays are superimposed on Figure 3.2.B. As in previous years M = 0.1 for females and 0.15 for males. The VPA results are in Tables 3.3 and 3.4 (males) and Tables 3.6 and 3.7 (females).

For total spawning stock biomass the output from the VPA is based on the 1978 stock weight array applied to each year. This assumes no change in growth rate. The resulting trend is in Figure 3.1.A showing a steady decline. For the female spawning stock, this trend has been checked by applying unpublished 1st quarter Lowestoft otter trawl mean weight at age (Bannister, pers.comm.) for the individual years. The results of this calculation are compared with the VPA output in Figure 3.4.A. The difference between the two estimates of female spawning stock biomass cannot be explained at present.

In recent years the Netherlands beam trawl catch per effort (Figure 3.4.B) follows the likely trend in spawning biomass, but for reasons which are unknown at present the Lowestoft otter trawl data do not (Figure 3.4.C).

3.4 Recruitment

The trend in number of recruits at age 2 for the 1945-76 year classes is shown in Figure 3.8, and the frequency distribution in Table 3.1. The means are 199 x 10^6 for males and 179 x 10^6 for females. Modal recruitment is 150 x 10^6 per sex.

Because of the variable catch of one year olds, and the uncertainty of estimating one year old fishing mortality, recruitment in the prognosis has been set at age two. The 1977 year class has been estimated on the basis of 1-group pre-recruit surveys carried out in spring by RV "Tridens". The results from these surveys are positively correlated with the VPA with a value of r = 0.831 for n = 8. The data are in Table 3.11 and Figure 3.5. From the regression and the latest "Tridens" 1-group estimate (de Veen, pers.comm.) for the 1977 year class abundance, the expected value at age 2 is 344 x 10^6, which comprises 181 x 10^6 males and 163 x 10^6 females if the sex ratio is that shown by the means of the post-war VPA series. The strength of the 1978 and 1979 year classes is not known. The long-term mean of the 1945-76 year classes has therefore been used for these two year classes.

3.5 Weight at Age

For 1978 weight-at-age data were available from England and the Netherlands. The English data were the weighted mean of the Grimsby and Lowestoft samples, both quarterly and as a weighted mean across the quarters. The Netherlands data were the first quarter data for different parts of the North Sea. For the stock biomass the English and Netherlands first quarter data were compared and averaged by means of a representative line fitted by eye. For the catch prognosis only the weighted mean of the English quarterly data could be used. The two sets of data are included in Table 3.12 at columns 4, 5, 8 and 9. These are gutted weights.

In the catch forecast the weight at age was input as gutted weight, but the final total catch and stock weights were raised to whole weight using a factor of 1.06. This replaces the former factor of 1.125, for which no objective basis exists.

The subject of changes in plaice growth rate is currently under investigation.

3.6 Yield per Recruit

Figure 3.7 shows the relation between fishing mortality and both yield per recruit and stock biomass per recruit, based on the input data included in Table 3.12. The abscissa is the maximal value of F in the exploitation pattern. The 1978 position is indicated by arrows and shows that, as before, (Anon., 1976) the fishery is at the maximum on the female curve, and only a little below the asymptote on the male curve. On this basis, the stock could be described as fully exploited.

In this presentation the 1978 catch weight-at-age data are used, both for yield and stock biomass, and it is assumed that growth rate, natural mortality and exploitation pattern are constant.

3.7 Catch Predictions

A catch forecast up to 1981 was made using the data in Table 3.12, and assuming that fishing mortality in 1979 would be at the same level as that in 1978.

Figure 3.1.C shows the expected 1980 catch and 1981 spawning stock for different values of fishing mortality expressed in multiples of the present level, i.e. F is F_{80}/F_{78}. The data for these options, in the range of 0.6 to 1.4 of the present F, are shown in Table 3.14, whilst Table 3.13 shows the results for just two options, Option 1 in which the present F is maintained unchanged, and Option 2 in which $F_{80} = 0.8 \; F_{78}$.

The mesh sizes used in the English trawl and seine fleets are already above 80 mm, and are about 80-90 mm in the Danish seine fleet and gill net fleet. The proposed mesh changes will have no effect on the catches of these fleets. The beam trawl fleets generally use 75 mm meshes and will be affected by the proposed mesh change. However, the effect here will be to reduce the level of discarding. As already stated, discarding has not been taken into account in compiling the age composition, and so no change in the catch forecast has to be made. However, it should be noted that the position with relation to discarding is not satisfactory, and will require to be treated properly in future years.

3.8 Management Objectives

For both the catch option forecast in Table 3.13, the spawning stock does not change appreciably in the short term because of the level of recruitment, and the yield per recruit curve suggests that the present maximum value of F in the exploitation pattern corresponds to the diagnosis of full exploitation made in previous years.

For the years 1963-76, two year old recruits and the female stock biomass based on the English growth data, are plotted in Figure 3.6. No fit has been made to these data, but the plot suggests that recent year classes are larger, though more variable, than hitherto. On this basis the present management objective should be to maintain present spawning stock levels, and to prevent any further increase in fishing mortality. This would be achieved by adopting a TAC of 112 000 tonnes for 1980.

4. SOLE IN DIVISION VIId

4.1 Catch Trends

Total international landings have risen continuously from 840 tonnes in 1975 to 1 350 tonnes in 1978 (Table 4.1, Figure 4.1.A).

4.2 Age Composition

The 1977 age composition data were updated (Tables4.3 and 4.7). For 1978, Belgium, France and the United Kingdom (England) provided age composition data which accounted for 100% of the reported landings.

It is believed that perhaps 40% of the English landings and an unknown but probably significant proportion of the French landings are unreported in this area. At present, no data are available which could be used to correct for this, and for this reason age compositions have been revised to represent only the reported weights.

No data are available on discards and by-catch.

4.3 Weight at Age

Values of weight at age used in estimation of spawning stock biomass and for predicting catches are shown in Table 4.4. These values are unaltered from those used last year. The sum of products of mean weight at age with numbers caught was 6% below the reported 1978 landings.

4.4 Virtual Population Analysis

It was assumed that M = 0.1 for both sexes at all ages.

Data on fishing effort in the Belgian and United Kingdom (England) fisheries are shown in Table 4.2. Only four years' data are available for Division VIId for English vessels and only seven years' data were available for the Belgian fishery. It proved impossible to find a set of input F at age, for either males or females, such that F in years before 1978 was well correlated with either measure of fishing effort. On this basis, the input F at age for 1978 was based on the mean value for the period 1973-75. This procedure resulted in sets of input F at age which closely resembled those chosen by the Group last year (Tables 4.5 and 4.8).

Values of stock in numbers from VPA are given in Tables 4.6 and 4.9. Historical spawning stock biomasses are shown in Figure 4.1.A. Spawning stock levels declined between 1971 and 1976; the estimated level for 1978 is, however, in excess of that estimated for 1971.

4.5 Recruitment

The 1975 year class is thought to be of above average strength and in accordance with last year's procedure values of 11 x 10^6 male fish and 6.7 x 10^6 female fish at age 1 estimated from VPA were accepted. The average recruitment values for the period 1972-75 are 1.7 x 10^6 for males and 2.6 x 10^6 for females. The 1976 year class is also thought to be of above average magnitude but less than the 1975 year class. Accordingly, a value of 0.8 x the strength of the 1975 year class at age 1 was adopted for this year class and input F in 1978 at age 2 was adjusted to produce this result. The 1977 year class was assumed to be of average strength and input F at age 1 in 1978 was correspondingly adjusted.

The historical trend in recruitment is shown in Figure 4.1.B. There are not yet sufficient data to allow investigation of stock and recruitment relationships.

4.6 Yield per Recruit and Spawning Stock Biomass per Recruit

The yield and stock biomass per recruit curves were calculated on the basis of the 1978 F at age array (Tables 4.5 and 4.8), and the mean weights given in Table 4.4.

Combined male and female yield per recruit and spawning stock biomass per recruit curves (Figures 4.1.C and 4.1.D) were calculated by the method described in the Annex. The yield per recruit curve has a value of F_{max} at about 0.8 times the level of F in evidence in 1978.

4.7 Catch Predictions

Input data for catch predictions are shown in Table 4.10. In last year's report a TAC for 1979 of 2 200 tonnes was recommended. On the basis of this year's assessment, it appears that fishing effort would have to increase by 60% to 70% to take this catch. The Working Group felt that this cannot be achieved and that fishing effort in 1979 is likely to be of the same order of magnitude as that in 1978. For this reason the catch predictions made for 1980 are all based on the assumption that $F_{79} = F_{78}$ for both males and females. On this basis the predicted 1979 catch is about 1 450 tonnes.

All feasible catches for 1980 are shown in Figure 4.1.C and selected values from this figure are shown in Table 4.11.

4.8 Management Options

On the basis of the yield per recruit curve the level of F is slightly in excess of F_{max}. It is, therefore, probably advisable that F should not be allowed to increase in 1980. On this basis the maximum TAC which can be permitted is 1 380 tonnes. The corresponding predicted spawning stock biomass at the start of 1981 is 5 600 tonnes which is in excess of that estimated for the stock of 1978.

The TAC to achieve F_{max} in 1980 is 1 250 tonnes. If adopted, this will lead to a spawning stock biomass at the start of 1981 of about 6 000 tonnes.

Having made these points, however, it should be stressed that, because of the unreported landings referred to in Section 4.2, little reliance can be put on the assessments or on any TAC option.

5. SOLE IN DIVISION VIIe

5.1 Catch Trends (Table 4.1 and Figure 5.1.A)

Catches have risen from 491 tonnes in 1975 to 750 tonnes in 1978. Non-reporting of catches is not known to be a problem for this Division.

5.2 Age Composition

The 1977 age composition was updated to take account of small changes in the catch figures for that year (Tables 5.2 and 5.6). For 1978, only United Kingdom (England) provided age composition data, accounting for 60% of the total landings.

5.3 Weight at Age

Weight-at-age data used in the estimation of spawning stock biomass and for predicting catches are given in Table 5.3. These values are unaltered from those used by the Working Group at last year's meeting. The sum of products of mean weight at age with estimated numbers caught at age was 5% lower than the reported catch in 1978.

5.4 Virtual Population Analysis

It was assumed that M = 0.1 for both sexes at all ages. Data on fishing effort were submitted for the period 1969 to 1978 by United Kingdom (England) (Table 5.1). These data refer to the United Kingdom fleet only. It appears that United Kingdom fishing effort in 1978 is about 30% higher than the average level in the period 1973-75. On this basis, the fishing mortality ratios generated by the English fleet in 1978 are probably higher than those for the period 1973-75. French fishing effort over the same period has probably not decreased. On this basis, an attempt was made to find input F at age values for 1978 which produced somewhat lower values for the period 1973-75. This procedure was not entirely successful, but given the rather poor quality of the data set with which the Group currently has to work, it was felt that the input F arrays used this year were the best which can be obtained at present.

The input F at age sets for males and females now resemble each other much more closely than was the case last year (Tables 5.4 and 5.7).

Historical trends in spawning stock biomasses are shown in Figure 5.1.A. Spawning stock levels were fairly stable over the period 1969-78.

5.5 Recruitment

Average recruitment for the period 1972-75 was 1.1×10^6 for males and 1.4×10^6 for females. The 1975 year class is thought to be of above average strength, and the Group decided to adjust the terminal F at age 3 in 1978 to produce a number of recruits in the sea at age 2 in 1977 about double the average value.

The 1976 year class is also thought to be of above average size, but less than the 1975 year class. Input F values at age 2 in 1978 were therefore adjusted to give a value for the 1978 year class equal to 90% of that adopted for the 1975 year class.

The historical trend in recruitment is shown in Figure 5.1.B. There are insufficient data at present to allow presentation of a useful stock and recruitment scatter diagram.

5.6 Yield per Recruit and Spawning Stock Biomass per Recruit

Combined male and female yield per recruit and spawning stock biomass per recruit curves (Figures 5.1.C and 5.1.D) were calculated by the method described in the Annex. The yield per recruit curve is essentially flat-topped. $F_{0.1}$ is approximately at a value of F which is 80% of the F currently being generated by the fishery.

5.7 Catch Predictions

Input data for the catch predictions are given in Table 5.9. In last year's report a TAC of 500 tonnes was recommended for Division VIIe sole in 1979. If taken exactly, this will generate a reduction of about 35% in fishing effort and will result in a level of F less than $F_{0.1}$. On the basis of previous years, however, the recommended TAC has always been exceeded (see Table 5.1), and there appears to be no valid reason to believe that this will not occur in 1979.

On this basis the Working Group assumed that F_{79} will be the same as F_{78}. The predicted catch for 1979 on this assumption is 730 tonnes.

All feasible catches for 1980 are shown in Figure 5.1.C, and selected values from this figure are given in Table 4.11.

5.8 Management Options

On the basis of the yield per recruit curve, F in 1978 is in excess of $F_{0.1}$. It is therefore inadvisable that F in 1980 should be allowed to increase beyond current levels. The TAC to stabilise F at the 1978 level is 770 tonnes. The corresponding predicted spawning stock biomass at the start of 1981 is 4 100 tonnes, which is slightly in excess of that estimated for the start of 1980.

The TAC to achieve $F_{0.1}$ is 640 tonnes. If adopted and enforced, this will lead to a spawning stock biomass at the start of 1981 of about 4 200 tonnes.

6. ENGLISH CHANNEL PLAICE (Divisions VIId and VIIe)

6.1 General

In previous years, separate assessments have been made for Divisions VIId and VIIe plaice. This year a single assessment covering the combined populations of Divisions VIId and VIIe has been made, and it is proposed that this should be adopted as normal practice. The reasons for this change are as follows: an exchange of fish takes place between the two areas of up to 20% per annum (Houghton, 1976); the year class strengths and stock biomasses given by the separate assessments have shown similar trends (1978 report) and both populations receive mature fish from the North Sea at spawning time (Houghton and Harding, 1976).

However, the fleets which exploit the plaice in the two areas are different and so some problems will be encountered in analyses involving fishing effort, and the weights at age are slightly different. (Plaice aged less than 8 or 9 years in Division VIIe are, on average, 10% heavier than those in Division VIId and the older plaice are smaller.)

6.2 Catch Trends and Fleet Changes

Reported landings are given in Table 6.1 and Figure 6.1.A, those in 1978 were a few tonnes more than the landings in 1977. There was an increase over the landings of 1976 (the lowest recorded) and landings in 1978 were 91% of the average level since 1962 (3 176 tonnes). No fleet changes have been noted and the catch is still taken by Belgian and United Kingdom beam trawlers, Belgian, United Kingdom and French otter trawlers and by French and United Kingdom trammel netters. It is thought that a small quantity of plaice is landed and not reported by small beach boats of the United Kingdom and France using, respectively, trammel nets and small otter trawls in Division VIId. Since this is a fishery directed at sole, the extent of underreporting is probably not high and has been ignored. The effort data that are available are given in Table 6.2.

6.3 Age Composition

A new matrix of catch numbers at age for the years 1971 to 1977 was prepared by adding the matrices for Divisions VIId and VIIe used by the 1978 Working Group. The data for 1975 in Division VIId, found to be incorrect,were therefore amended.

The Division VIIe age compositions were prepared by raising United Kingdom trawl data to the total landings, those of Division VIId by summing United Kingdom trawl, trammel and Belgian trawl and raising to the total landings (Tables 6.3 and 6.6). As in previous years the French landings, which represented 66.7% of the total reported landings, were not sampled and have been assumed to have the same age composition as the combined United Kingdom and Belgian landings. Some improvements in sampling have taken place since 1975 following the introduction of United Kingdom sampling in Division VIId, but the basic data are still poor.

Discarding does take place in all fisheries but this has not been estimated and has been ignored.

6.4 Virtual Population Analysis

Natural mortality (M) was assumed to be 0.15 for males and 0.1 for females, as in previous assessments on the Channel plaice.

The terminal F chosen for the final VPA reproduces a pattern of fishing mortality for 1975-78 which is similar to the trend in effort for the same period (Table 6.2). The input F on age 1 in 1978 was, however, adjusted to give a stock of 1 year olds which equalled the average number of 1 year olds in 1971 to 1974.

Tables 6.4, 6.5, 6.7 and 6.8 give the fishing mortalities and stock numbers of the final VPA.

There is some correspondence between the level of recruitment in males to that of females during each year of the VPA which is at least a consistent feature.

6.5 Recruitment

The only estimates of recruitment available to the Working Group were those from the VPA. Systematic pre-recruit surveys were only started in 1977 by France and do not form a sufficient series.

The VPA estimates at age 1 have been plotted in Figure 6.1.B for year classes 1970 to 1977. For the 1970 to 1973 year classes, the average recruitment was 6.6 x 10^6 and this figure was used in the catch predictions and yield curves.

The unknown strengths of the 1977 and 1978 year classes will influence the catch forecast for 1980.

No trend in recruitment is apparent from Figure 6.1.B. In the period 1970-77 the 1974 year class was about half average strength and the 1975 year class was twice average strength.

It is estimated that 56% of the spawners in the Channel are fish that migrate into the area from the North Sea (Houghton and Harding, 1976). A stock and recruitment relationship cannot be drawn for this reason and also because the data are very poor. One can say that as long as the North Sea spawning stock is healthy then the recruitment of plaice to the English Channel will probably be maintained.

6.6 Weight at Age

Weights at age for Division VIId plus Division VIIe were estimated from the mean of the VIId and VIIe stocks weights used in the 1978 Working Group. These were derived from United Kingdom and Belgian data for various periods. The 1978 catch weights at age were not available to the present Working Group. Combined catch weights at age were obtained by interpolation from the stock weights at age. Weights for the 13 year olds and older were roughly estimated from the growth curve. The estimated combined weights at age are given in Table 6.9.

Sums of products between these catch weights at age and the new matrix of catch numbers at age (ages 1 to 13+) were calculated for each year between 1971 and 1978. The percentage discrepancies were respectively for each year in this period: +9.9, +8.6, +8.6, +14.7, -3.8, +2.0, +3.0, -13.8. This decline probably reflects an increase in the growth rate of plaice, which is demonstrable in the United Kingdom data for Division VIIe. Reasonable agreement for the period 1975 to 1977 is to be expected since the basic data were derived from samples taken in these years but the discrepancy in 1978 is rather large. No other alternative was open to the Group than to use the data set of Table 6.9 and to raise the forecasted yields and the estimated stock biomasses from the VPA by the ratios of actual landings divided by sums of products for each year (i.e., 0.91, 0.92, 0.92, 0.87, 1.04, 0.98, 0.97, 1.16 for the period 1971 to 1978).

6.7 Yield and Spawning Stock Biomass Curves

The long-term yield based on the 1978 exploitation patterns and contoured for the two sexes is shown in Figure 6.1.C. Average recruitment at age 1 for the year classes 1970-73 (6 600 000 female recruitment equals male recruitment equals 3 300 000) was applied to the average yield per recruit values for females and males to produce the yield curve. As F on the age group subject to maximum exploitation in 1978 was different for females and males (Tables 6.4 and 6.7) these two values were used as units in the respective yield per recruit calculations to arrive at corresponding values for the two sexes.

The yield curve is flat-topped with $F_{max} = 0.8 \times F_{78}$. For both F_{max} and F_{78} the long-term yield is about 2 200 tonnes which is nearly 700 tonnes below the present level of landings. The difference is caused chiefly by the strong 1975 year class which in 1978 accounted for about 40% of the landings.

Figure 6.1.C also shows the long-term spawning stock biomass as a function of F.

6.8 Catch Predictions

The input data were as in Table 6.10. A factor of 1.16 was applied to all forecasted yields and stock biomasses since this was the discrepancy in the sums of products for 1978.

It was assumed that $F_{79} = F_{78}$ in all forecasts which reflects the probability that the TAC for 1979 of 2 920 tonnes will not be taken.

Catch and stock predictions were made for 1980, assuming the same relative F at age as in 1978, for a range of values of F up to twice that of 1978 and 1979. The results (multiplied by 1.16) have been plotted in Figure 6.1.C and are given (for two options) in Table 6.11.

The projected spawning stock biomasses have been plotted in Figure 6.1.A along with those taken from the VPA and with the actual and projected landings.

6.9 Management Options

The stock is lightly overexploited at the present levels of fishing mortality (weighted mean F of 3 year olds and older of 0.97 for males and 0.71 for females) according to the yield curve (Figure 6.1.C). The theoretical maximum long-term yield would be obtained at an F which is 80% of the present level and this would be achieved by a TAC for 1980 of 1 995 tonnes (Option 2).

As was pointed out in Section 6.5, an objective related to the preservation of the spawning stock biomass in the English Channel is not very meaningful and so this option is not regarded as a useful one, even though the VPA has given a rather sharp decline in spawning stock in the area since 1971.

Maintaining the existing levels of F would imply a TAC for 1980 of 2 350 tonnes (Option 1).

7. ADVICE on Desirability of Extending the Current Prohibition on Fishing for Flatfish by Larger Vessels within 12 Miles of the Coast of Belgium, the Netherlands, the Federal Republic of Germany, and Denmark beyond 12 Miles or to Other Coastal Areas

The Working Group felt that to advise on the desirability of extending the current prohibition on fishing for flatfish by larger vessels within 12 miles of the coast of Belgium, the Netherlands, the Federal Republic of Germany, and Denmark beyond 12 miles or to other coastal areas could not be satisfactorily dealt with at this meeting.

Considerable amounts of data will have to be compiled if a reasonable answer is to be given to this problem. Since there is a proposal in this report that the Group should be reconvened in October-November, it is suggested that the question can be answered at that meeting.

8. THE EFFECT OF BY-CATCH IN THE CRANGON FISHERY ON THE EXPLOITATION OF FLATFISH

Considerable quantities of undersized protected fish are caught and destroyed by the shrimp fisheries. The North Sea Flatfish Working Group dealt with this subject several times (Report of the Flatfish Working Group, 1972, 1973 and 1974).

Undersized flatfish (plaice, sole, flounder and dab) are regularly caught in the Wadden Sea of the southern North Sea by the crangonid shrimp fisheries of Denmark, the Federal Republic of Germany, the Netherlands and Belgium. The United Kingdom and France also contribute to a destruction of undersized flatfish, but to a much lesser extent and in other areas. The gear in use for catching crangonids in the North Sea is mainly the beam trawl, but the otter trawl is used in the Channel by France. Regarding the mesh size all the shrimp gears can be broadly classified as unselective for most of the flatfish species.

In some countries up to the 1950s a lot of fish by-catch consisting partly of undersized flatfish was landed besides fodder and consumption shrimps. All the shrimp fishing countries have by now abandoned this practice, since the whole fish by-catch is discarded after a sieving process on board.

8.1 Mesh Size of Shrimp Trawls (Report of the Working Group on Crangonid Shrimps, (Doc. C.M.1979/K:7))

In offshore areas of the EEC zone a minimum mesh size of 16 mm (stretched) exists. In most fisheries mesh sizes of 20-23 mm are commonly used and in Denmark even mesh sizes of 20-28 mm in the cod end are applied.

Federal Republic of Germany

Schleswig-Holstein:

Mesh size: by law (Schleswig-Holsteinische Fischereiordnung) 8 mm (bar length)

in practice, 9 mm and (mostly) 10 mm (bar length)

Niedersachsen:

Mesh size: by law (Seefischerei-Vertragsgesetz) 16 mm (stretched)

in practice, 9 mm and (mostly) 10 mm (bar length).

Due to the small mesh size of shrimp nets and the occurrence of consumption shrimps in the nursery areas of several fish species, the by-catch of undersized protected fish in the shrimp fisheries is unavoidable.

A long series of relative data are available in the Federal Republic of Germany (Tiews, 1979) (Table 8.1). For the Netherlands, figures exist for 1963, 1964 and 1972 and will be available for 1979 as well. For Belgium by-catch figures of 0-group flatfish discarded by the shrimp fleets for 1949-64 are available.

The figures for 1963 of caught juvenile flatfish, comparable for the three countries mentioned, are, for plaice: Federal Republic of Germany: 310 millions of individuals, Netherlands more than 1 000 millions of individuals, Belgium, 11 millions of individuals. For sole: Federal Republic of Germany: 20 millions, Netherlands 100 millions, Belgium, 4 millions. In these figures, year class strength in the different areas plays an important role. The number of soles caught by the Federal Republic of Germany shrimp fleet, for example, reached a peak in 1962 with 112 millions of fish.

Reasons for mortalities of undersized flatfish due to shrimp fishing are:

1. meshing in the net
2. trawling for extended periods, especially with large catches

3. effect of the stay on deck, during which especially the temperature of the air plays a major role
4. effects of the sorting of the shrimp catch. Especially the shaking sieve has been reported to cause lethal brain damage.

After 1963, developments leading to a reduction of this problem took place in several countries.

8.2 Selective Trawls (Figure 8.1)

Experiments comparing the normal beam trawl with several new types of selective beam trawls have been conducted in 1962 and 1963 by Bohl and Konra. 1978 by Morh and Rauck, and in 1976 by Albrechtsen. It appears that the amount of flatfishes is reduced by about 80-100% in the selective trawl catches (Table 8.2), the total reduction being by about 80%.

In general, these results indicate that the selective beam trawl reduces the amount of by-catch efficiently while at the same time losses in the shrimp catches are negligible and the sorting of the catch is made easier.

Selective trawls in use

Selective trawls with separating panels strongly reducing the by-catch are now in use in: Denmark: the whole fleet uses this type of net. Landings of marketable fish from shrimp boats are forbidden; the Federal Republic of Germany: the use of such a net, especially in offshore areas with large by-catches of fish increased very considerably in recent years; the Netherlands: in use in the northern parts of the country. Not in use in the Zealand district, due to the importance of by-catch of marketable fish to the shrimp fleet and the frequent clogging of the separating panel by seaweeds and hydroids in the area. Belgium: no use of this net due to the importance of marketable by-catch and the frequent clogging of the separating panel by seaweeds and hydroids in the area. United Kingdom: no use of selective trawl. France: selective trawl invented and in use in Division VIId (Brabant, 1974).

Recent Danish research demonstrated that up to about 85% of the flatfishes caught escape from a selective trawl. These findings are in line with earlier research in other countries (Boddeke, 1965; Van den Broucke and Van Middelem, 1973; Mohr and Rauck, 1978).

8.3 Rotating Sieves

The rotating sieve, developed in the Netherlands in the period 1968-72, works at a slow revolving speed (12-16 turns per minute) and the sorting process uses large amounts of water. The by-catch is washed overboard using water transport. A recent development is an automatic catch transporter in which the catch is stored in water-filled basins immediately.

Rotating shrimp sieves are in use by 60% of the Dutch fleet, one vessel in Denmark and a part of the Belgian fleet. The use is limited to larger shrimp boats (of minimum size 17 metres). Further requirements may include a large capacity water pump to generate the sieving process.

8.4 General Conclusions

From the 1972 assessment until present insufficient progress has been made in quantifying natural mortality of 0- and 1-group plaice and sole in such a way that the Group could be able to estimate the proportion of the 0- and 1-group total population caught by the shrimp fisheries. Thus, the effect of by-catch in the Crangon fishery on the survival of 0- and 1-group plaice and sole cannot be quantified at present.

In general it can be stated that the amount of undersized flatfish has been steadily reduced by the introduction of the various methods described above. It seems unlikely that for the future a further improvement of the survival rate of undersized flatfish is possible. However, it should be mentioned that the selective trawl, separating by-catch from shrimps under water, is the most efficient method, giving the highest survival rate for flatfish.

Beside the information on discarded or destructed flatfish in the shrimp fishery given in Table 8.3 for the most recent years, there is at present no further information on other countries available.

9. SCIENTIFIC QUESTIONS BY THE ACFM

9.1 Can Stocks of Male and Female Plaice and Sole be treated as a Mixed Fishery?

Male and female flatfish populations show sexual differences in growth rates, and sometimes in exploitation pattern. The practice of treating them separately should be retained for the present.

9.2 Should the Results of Pre-recruit Surveys be presented in Catch per Unit Effort rather than as Ratios?

In previous reports, the pre-recruit survey data for North Sea plaice and sole were expressed as anomalies from a mean value. The use of absolute density units is desirable and density indices are now available (Anon., 1979).

In fact, however, if the basic purpose of a pre-recruit survey is to give an estimate of the strength of recruiting year classes, results from such surveys should be well correlated with corresponding VPA results.

9.3 Do Regressions of Catch in Numbers per Unit Effort on Numbers in Stock of Plaice differ between Fleets?

This report contains data for the catch per effort by weight of the Belgian and Netherlands beam trawl fleets, and the English otter trawl fleet. The beam trawl and otter trawl trends differ. Catch numbers per effort regressions have not been calculated but will be produced for the next Working Group meeting.

9.4 From a Stock/Recruitment Curve on North Sea Sole, can one estimate the Stock which gives Maximal Recruitment?

The plot of recruitment against spawning stock biomass was shown in Figure 9.4.1. Over a wide range of spawning stock biomass no trend modulation of recruitment can be detected. The two good year classes are thought to have been the results of cold winters. A stock level giving maximal recruitment cannot be defined.

9.5 Should there be a Minimum Mesh Size Differential between Beam- and Otter Trawl, and, if so, what should be the Proportion?

To answer this question, see para. 2.7.3 (5).

9.6 Can one allow for Migration between the two Areas in Assessments of Sub-area IV and Division VIId Plaice?

The Working Group discussed this and concluded that although this could be allowed for in the assessments, it was not necessary to do so. The reason is that the migratory fish did not appear to contribute a significant amount to the landings in Divisions VIId and VIIe, according to the VPA results and the estimates of the numbers of fish migrating into the area.

9.7 Should Trammel Net Mesh Sizes in the Division VIId Sole Fishery be controlled?

There is no case at present for controlling the mesh size of trammel netters in the Division VIId sole fishery for two reasons. Firstly, the exploitation pattern is less severe than for the present trawl fishery (70 mm mesh). Secondly, commercial trammel netters use large meshes of 4" for practical and economic reasons. Non-commercial netters use smaller meshes but do not at present capture significant numbers of fish below the minimum landing size.

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Table 2.1 Nominal catch (tonnes) of SOLE in Sub-area IV, 1968-1978.
(Data for 1968-1977 from Bulletin Statistique)

Country	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978*)
Belgium	3 874	2 703	1 880	2 227	1 834	1 485	1 130	1 383	1 456	1 669	1 629
Denmark	1 590	842	525	1 149	671	957	705	682	574	323	443
France	273	364	265	403	206	250	195	297	598	337	294
Germany, Fed.Rep. of	1 138	692	318	600	258	336	173	233	192	310	467
Netherlands	25 175	22 032	16 024	18 776	17 662	15 883	15 343	15 242	11 044	11 106	7 100
Poland	-	-	-	-	-	-	-	-	5	-	
Sweden[a)]	...	-	13	12	13	13	12	+	-	-	
U.K. (Engl.+Wales)	1 129	927	660	485	449	387	340	426	455	491	556
U.K. (Scotland)	-	-	1	2	+	1	...	-	2	...	
Total	33 179	27 560	19 686	23 654	21 093	19 312	17 898	18 263	14 326	14 236	
Unreported landings								2 500	3 000	4 000	9 900
Grand Total								20 763	17 326	18 236	20 389

*) Preliminary data

a) Figures include catches made in Division IIIa. The 1968 catch was included in 148 tonnes of Various Pleuronectiforms.

Table 2.2 North Sea SOLE

Age composition of total catch (thousands) (males)

AGE	1969	1970	1971	1972	1973	1974
1	0	557	331	0	113	267
2	12637	3015	17671	3411	5840	9328
3	10291	13170	6692	23672	6500	15834
4	2918	3936	6709	3739	7643	3404
5	5631	769	2462	2544	1419	3447
6	8780	1290	438	1116	1160	1232
7	0	5523	694	162	344	821
8	66	44	2647	464	285	421
9	278	32	64	2269	610	194
10	3	240	45	51	1268	211
11	862	65	162	13	33	808
12	3	1022	48	288	194	18
13	236	98	660	22	161	16
14	32	220	160	420	27	167

AGE	1975	1976	1977	1978
1	233	394	817	27
2	10141	1435	9776	11428
3	14917	11512	5544	13879
4	5319	7077	8202	3042
5	913	2808	4304	3634
6	1709	669	1078	2323
7	230	1101	212	1103
8	284	246	557	360
9	171	227	121	284
10	115	102	92	136
11	57	137	23	92
12	697	59	53	44
13	6	592	55	48
14	27	29	402	4

Table 2.3 North Sea SOLE

Fishing Mortalities (males)

AGE	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
1	.000	.008	.015	.000	.002	.006	.014	.008	.013	.010
2	.324	.146	.308	.183	.149	.217	.265	.102	.253	.220
3	.627	.579	.484	.757	.549	.654	.557	.478	.614	.600
4	.527	.461	.583	.485	.519	.550	.421	.495	.659	.720
5	.801	.226	.518	.404	.304	.415	.246	.364	.563	.610
6	.306	.374	.174	.416	.289	.416	.331	.256	.207	.600
7	.000	.286	.315	.081	.194	.304	.113	.328	.108	.300
8	.082	.072	.193	.319	.179	.341	.146	.152	.245	.240
9	.087	.047	.128	.225	.785	.160	.201	.149	.094	.170
10	.007	.090	.077	.128	.170	.609	.120	.160	.075	.130
11	.134	.174	.073	.326	.103	.140	.288	.185	.044	.090
12	.002	.208	.169	.162	.567	.067	.154	.477	.091	.100
13	.127	.074	.181	.098	.115	.072	.026	.170	1.001	.100
14	.150	.150	.150	.150	.150	.150	.150	.150	.150	.150

MEAN F FOR AGES >= 3 AND <= 14 (WEIGHTED BY STOCK IN NUMBERS)

	.423	.393	.380	.544	.413	.503	.424	.413	.482	.543

continued....

Table 2.3 (continued)

AGE-NATURAL MORTALITY

1	2	3	4	5	6	7	8	9	10	11
.100	.100	.100	.100	.100	.100	.100	.100	.100	.100	.100

12	13	14
.100	.100	.100

Table 2.4 North Sea SOLE
Stock in numbers (thousands) (males)

AGE	1969	1970	1971	1972	1973	197.
1	25803	77902	23968	48886	55579	50732
2	47862	23347	69959	21372	44234	50183
3	23092	31324	18262	46542	16100	34478
4	7454	11161	15880	10187	19745	8416
5	10664	3982	6370	8021	5677	10630
6	34913	4330	2873	3433	4846	3791
7	735	23263	2695	2184	2049	3285
8	882	665	15811	1781	1822	1527
9	3513	736	560	11793	1171	1378
10	475	2914	635	446	8518	483
11	7207	427	2409	532	355	6503
12	1589	5703	324	2026	469	290
13	2080	1435	4190	248	1560	241
14	241	1658	1206	3165	203	1258

AGE	1975	1976	1977	1978
1	17347	51029	67941	2851
2	45650	15475	45799	60699
3	35554	31685	12639	32165
4	16223	18957	17768	6191
5	4393	9640	10452	8320
6	6352	3109	6061	5384
7	2262	4127	2178	4461
8	2194	1829	2691	1769
9	983	1716	1421	1906
10	1063	727	1337	1171
11	238	853	561	1122
12	5117	161	641	485
13	245	3968	91	530
14	203	216	3029	30

Table 2.5 North Sea SOLE
Age composition of total catch (thousands) (females)

AGE	1969	1970	1971	1972	1973	1974
1	265	649	185	0	610	410
2	13812	4068	20731	533	7376	10207
3	10086	13946	7214	19772	5470	12729
4	2174	4953	6298	3795	8795	2969
5	5083	1042	1703	2905	2503	3199
6	13408	1677	584	856	1208	814
7	243	7832	914	282	748	571
8	115	168	4266	567	565	208
9	537	56	79	3059	684	235
10	193	479	47	47	2002	206
11	1544	74	219	24	188	1200
12	154	1542	0	186	116	48
13	291	85	1094	26	207	4
14	96	303	72	658	46	101

AGE	1975	1976	1977	1978
1	51	405	1109	2
2	14391	1594	15036	14016
3	15292	10817	7975	15818
4	6153	8116	9114	3118
5	1083	3075	4305	3075
6	2014	751	1135	1975
7	400	1480	180	657
8	467	461	724	242
9	229	444	199	369
10	104	275	158	61
11	176	170	88	142
12	1307	141	88	80
13	21	1563	70	62
14	62	40	551	56

Table 2.6 North Sea SOLE
Fishing mortalities (females)

AGE	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
1	.010	.009	.012	.000	.011	.008	.003	.007	.017	.010
2	.344	.189	.371	.038	.216	.235	.375	.092	.348	.280
3	.585	.610	.521	.640	.571	.612	.574	.475	.750	.660
4	.347	.565	.545	.506	.582	.620	.600	.606	.830	.660
5	.578	.248	.341	.461	.654	.382	.426	.606	.669	.660
6	.332	.337	.192	.256	.314	.404	.391	.521	.416	.660
7	.198	.293	.276	.120	.331	.214	.315	.492	.201	.400
8	.128	.183	.230	.246	.331	.129	.243	.638	.421	.400
9	.191	.076	.110	.229	.465	.199	.183	.341	.555	.350
10	.275	.232	.076	.080	.206	.220	.114	.309	.175	.290
11	.152	.144	.142	.046	.457	.165	.264	.245	.137	.210
12	.192	.200	.000	.154	.287	.179	.242	.310	.174	.160
13	.114	.139	.190	.069	.230	.013	.098	.449	.223	.160
14	.150	.150	.150	.150	.150	.150	.250	.250	.250	.250

MEAN F FOR AGES >= 3 AND <= 14 (WEIGHTED BY STOCK IN NUMBERS)

.378	.405	.358	.458	.467	.454	.493	.515	.661	.622

continued....

Table 2.6 (continued)

AGE-NATURAL MORTALITY

1	2	3	4	5	6	7	8	9	10	11	12	13	14
.100	.100	.100	.100	.100	.100	.100	.100	.100	.100	.100	.100	.100	.100

Table 2.7 North Sea SOLE.
Stock in numbers (thousands) (females)

AGE	1969	1970	1971	1972	1973	1974
1	27706	78082	16870	44049	57216	53684
2	49747	24817	70034	15088	39858	51191
3	23814	31917	18593	43719	13146	29064
4	7768	12004	15687	9994	20858	6718
5	12105	4967	6174	8232	5450	10550
6	49736	6143	3506	3972	4697	2564
7	1419	32290	3968	2618	2782	3105
8	1007	1053	21788	2723	2101	1808
9	3241	802	793	15666	1926	1365
10	842	2423	673	643	11272	1095
11	11503	579	1738	564	537	8299
12	923	8942	454	1365	488	308
13	2829	689	6627	410	1058	331
14	723	2283	542	4958	347	761

AGE	1975	1976	1977	1978
1	21181	59630	67662	211
2	48185	19117	53570	60169
3	36634	29959	15783	34217
4	14256	18677	16863	6745
5	3271	7078	9220	6652
6	6514	1933	3495	4272
7	1549	3985	1038	2087
8	2267	1022	2205	769
9	1438	1609	489	1309
10	1012	1084	1035	254
11	795	817	720	786
12	6370	553	579	568
13	233	4523	367	440
14	256	191	2612	265

Table 2.8 North Sea SOLE

Nominal weight (g) at age for stock and catch (average 1969-1973)

Age	Males		Females	
	Biomass	Catch	Biomass	Catch
1	10		10	
2	39	90	62	124
3	146	203	199	257
4	231	259	316	377
5	283	302	425	473
6	316	326	507	540
7	339	351	566	585
8	361	371	605	622
9	377	383	639	654
10	387	392	671	684
11	395	395	694	703
12	401	403	713	723
13	404	406	729	735
14	406	407	739	745
15	410	410	742	750
16	410	410	748	750
17	410	410	752	750
18	410	410	758	750
19	410	410	760	750
20	410	410	760	750

Table 2.9 North Sea SOLE

Input data for catch predictions. Assumed catch in 1979

Stock (female)		Catch Natural Mortality				
1979	F	.1	.2	.3	.4	.5
43 000	.01	407.2	387.9	369.7	352.8	336.8
39 421	.28	9 182.9	8 766.3	8 375.5	8 008.7	7 664.2
41 174	.66	19 034.3	18 227.3	17 468.5	16 754.7	16 082.7
16 024	.66	7 407.7	7 093.7	6 798.4	6 520.6	6 259.0
3 159	.66	1 460.4	1 398.5	1 340.2	1 285.5	1 233.9
3 115	.66	1 440.0	1 379.0	1 321.6	1 267.6	1 216.7
2 001	.40	629.9	601.9	575.6	551.0	527.8
1 256	.40	395.4	377.8	361.3	395.8	331.3
463	.35	130.5	124.7	119.2	114.0	109.2
835	.29	200.5	191.4	182.9	174.9	167.4
176	.21	31.8	30.3	29.0	27.7	26.5
573	.16	80.7	77.0	73.5	70.2	67.1
443	.16	62.4	59.5	56.8	54.3	51.9
343	.16	48.3	46.1	44.0	42.0	40.2
310	.16	43.7	41.7	39.8	38.0	36.3
2 075	.16	292.4	278.8	266.1	254.2	243.0
89	.16	12.5	12.0	11.4	10.9	10.4
33	.16	4.7	4.4	4.2	4.0	3.9
127	.16	17.9	17.1	16.3	15.6	14.9
77	.25	16.2	15.5	14.8	14.2	13.5

Table 2.10 North Sea SOLE

Input data for catch predictions. Assumed catch 1979

Stock (male)		Catch Natural Mortality				
1979	F	.1	.2	.3	.4	.5
42 000	.01	397.7	378.8	361.1	344.6	329.0
37 622	.22	7 083.2	6 758.5	6 454.0	6 168.3	5 900.1
44 001	.60	18 986.4	18 172.6	17 407.7	16 688.4	16 011.5
16 058	.72	7 889.8	7 558.9	7 247.7	6 954.8	6 679.0
2 731	.61	1 192.8	1 141.8	1 093.8	1 048.7	1 006.2
4 073	.60	1 757.5	1 682.2	1 611.4	1 544.8	1 482.1
2 731	.30	675.3	644.7	616.1	589.2	564.0
2 963	.24	602.8	575.3	549.5	525.2	502.5
1 274	.17	189.8	181.0	172.8	165.1	157.8
1 430	.13	166.1	158.3	151.1	144.3	137.9
934	.09	76.6	73.0	69.6	66.5	63.5
891	.10	80.8	77.0	73.4	70.1	67.0
394	.10	35.7	34.0	32.5	31.0	29.6
430	.10	39.0	37.2	35.4	33.8	32.3
36	.10	3.3	3.1	3.0	2.8	2.7
1 478	.10	134.0	127.7	121.8	116.3	111.1
125	.10	11.3	10.8	10.3	9.8	9.4
394	.10	35.7	34.0	32.5	31.0	29.6
143	.10	13.0	12.4	11.8	11.3	10.8
18	.15	2.4	2.3	2.2	2.1	2.0

Table 2.11 North Sea SOLE. Catch predictions for 1980 (in tonnes)

	Option A			Option B			Option C		
	Mean Recruitment			Recruitment Females 73 400 Males 71 200			Recruitment Females 1/2 = 73 400 Males 1/2 = 71 200		
	Run I	Run II	Run III	Run I	Run II	Run III	Run I	Run II	Run III
M = .1 in 1979									
Total stock biomass	56 232	56 232	56 232	64 317	64 317	64 317	56 034	56 034	56 034
Spawning stock	46 321	46 321	46 321	46 321	46 321	46 321	46 321	46 321	46 321
Catch	20 240	17 116	11 781	21 967	18 777	12 738	20 141	17 160	11 726
M = .2 in 1979									
Total stock biomass	54 197	54 197	54 197	60 654	60 654	60 654	52 932	52 932	52 932
Spawning stock	44 275	44 275	44 275	44 275	44 275	44 275	44 275	44 275	44 275
Catch	19 437	16 445	11 275	20 823	17 578	12 078	19 173	16 214	11 165
M = .3 in 1979									
Total stock biomass	52 272	52 272	52 272	57 264	57 264	57 264	50 285	50 285	50 285
Spawing stock	42 360	42 360	42 360	42 350	42 450	42 350	42 350	42 350	42 350
Catch	18 690	15 010	10 875	19 754	15 760	11 462	18 254	15 444	10 639
M = .4 in 1979									
Total stock biomass	50 479	50 479	50 479	54 131	54 131	54 131	54 131	54 131	54 131
Spawning stock	40 557	40 557	40 557	40 557	40 557	40 557	40 557	40 557	40 557
Catch	17 974	15 543	10 461	18 766	15 851	10 890	17 402	14 729	10 153
M = .5 in 1979									
Total stock biomass	48 785	48 785	48 785	51 238	51 238	51 238	45 518	45 518	45 518
Spawning stock	38 863	38 868	38 863	38 863	38 863	38 863	38 863	38 863	38 863
Catch	17 314	14 641	10 076	17 842	15 070	11 022	16 661	14 058	10 021

Table 2.12 North Sea SOLE. Stock size in tonnes in 1981

	Mean Recruitment			Recruitment Females 73 400 Males 71 200			Recruitment Females 36 700 Males 35 600		
	Run I	Run II	Run III	Run I	Run II	Run III	Run I	Run II	Run III
M = .1									
Total stock	52 448	56 364	63 030	56 265	60 423	67 331	47 575	51 271	57 519
Spawners	44 811	48 727	55 393	48 628	52 786	59 694	39 938	43 634	49 882
M = .2									
Total stock	51 161	54 934	61 358	54 978	58 993	65 659	46 299	49 852	55 847
Spawners	43 524	47 297	53 721	47 341	51 356	58 022	38 662	42 215	48 210
M = .3									
Total stock	49 958	53 601	59 795	53 844	57 662	64 086	45 093	48 512	54 284
Spawners	42 321	45 964	52 158	46 207	50 025	56 449	37 456	40 875	46 647
M = .4									
Total stock	48 829	52 338	58 322	52 646	56 408	62 623	43 956	47 256	52 822
Spawners	41 192	44 701	50 685	45 009	48 771	54 986	36 319	39 619	45 185
M = .5									
Total stock	47 762	51 161	56 947	52 272	55 220	61 237	41 052	46 079	51 436
Spawners	40 125	43 524	49 310	44 635	47 583	53 600	33 415	38 442	43 799

Table 3.1 North Sea PLAICE

Nominal catch (tonnes) in Sub-area IV, 1968-1978 (from Bulletin Statistique)

Country	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978*)
Belgium	5 576	4 476	4 360	5 073	5 531	6 133	6 202	6 154	4 574	6 547	3 817
Denmark	30 369	35 227	32 807	22 278	24 494	23 266	19 814	22 731	23 724	20 900	20 800
Faroe Islands	-	-	-	-	-	1	-	1	-	1	-
France	1 310	1 330	1 406	1 380	1 062	1 355	519	536	497	598	587
Germany, Fed.Rep.of	5 250	5 071	5 519	3 296	4 318	5 451	3 233	4 040	3 654	5 423	4 599
Netherlands	33 236	39 420	46 080	44 502	52 048	57 948	54 438	51 293	46 630	42 307	29 250
Norway	38	26	22	18	19	15	13	13	20	16	12
Poland	-	-	-	-	-	1	-	153	40	-	-
Sweden[a]	776	772	608	588	626	432	431	35	26	-	30
UK (England & Wales)	29 569	30 349	34 839	32 576	31 642	30 400	23 854	20 290	23 789	27 623	27 624
UK (Scotland)	5 810	4 981	4 703	4 210	3 410	4 815	4 002	3 266	3 310	3 623	3 877
USSR	-	-	-	-	-	397	39	-	-	-	-
Total	111 934	121 652	130 344	113 921	123 150	130 214	112 545	108 512	106 264	107 038	
Unreported landings[b]									5 000	11 384	21 150
Grand Total									111 264	118 422	111 746

*) preliminary

a) 1968-74 includes Division IIIa

b) estimated by the Working Group

Table 3.2 North Sea PLAICE

Age composition of total catch in 1969-1978 (thousands) (males)

AGE	1969	1970	1971	1972	1973	1974
1	280	1401	428	1084	437	890
2	8941	13245	18836	14557	13037	9832
3	25842	27962	27438	22094	35623	30891
4	18546	31668	16385	23947	46290	36116
5	19726	23087	11357	10059	21150	19987
6	50365	18237	10351	7461	5635	8467
7	3967	37039	6189	5963	2789	3085
8	1913	2346	10683	3204	3331	1904
9	4041	1155	1408	5720	1764	1807
10	1084	1336	1189	1213	4290	1009
11	939	528	781	856	155	2356
12	686	663	374	736	379	247
13	209	307	487	300	276	392
14	217	120	183	345	261	162
15+	371	362	449	477	524	340

AGE	1975	1976	1977	1978
1	981	3027	1719	859
2	21743	19178	27651	32224
3	59986	51915	40316	26795
4	15709	79941	48351	29309
5	11399	19126	34451	33183
6	7457	5353	3667	22052
7	4166	3744	2159	3142
8	2037	2351	1577	1265
9	1430	1225	1233	727
10	866	723	519	792
11	264	579	271	294
12	892	143	220	92
13	181	574	107	120
14	110	98	295	100
15+	258	391	211	470

Table 3.3 North Sea PLAICE

Fishing mortality 1969-1978 (M = 0.15) (males)

AGE	969	1970	1971	1972	1973	1974	1975	1976	1977	1978
1	.00	.01	.00	.01	.00	.00	.01	.02	.01	.01
2	.08	.09	.12	.11	.11	.03	.09	.13	.23	.12
3	.28	.38	.26	.19	.38	.38	.23	.28	.41	.34
4	.25	.61	.38	.35	.68	.77	.32	.53	.44	.55
5	.38	.52	.43	.41	.57	.67	.55	.77	.42	.57
6	.46	.68	.43	.52	.39	.44	.53	.52	.30	.50
7	.36	.68	.48	.45	.35	.37	.38	.53	.38	.43
8	.22	.35	.40	.46	.46	.41	.42	.36	.42	.38
9	.53	.19	.35	.37	.47	.46	.58	.45	.31	.33
10	.29	.33	.28	.54	.48	.52	.39	.62	.32	.32
11	.24	.21	.30	.32	.11	.51	.23	.47	.47	.29
12	.32	.25	.21	.48	.21	.25	.34	.18	.31	.27
13	.17	.22	.27	.25	.31	.33	.27	.36	.19	.26
14	.27	.13	.18	.30	.34	.29	.14	.22	.31	.25
15	.20	.20	.20	.20	.20	.20	.20	.20	.20	.24

MEAN F FOR AGES >= 2 AND <= 15 (NOT WEIGHTED BY STOCK IN NUMBERS)

.29	.35	.31	.35	36	.40	.33	.40	.34	.35

Table 3.4 North Sea PLAICE

Stock in numbers (thousands) 1969-1978 (males)

AGE	1969	1970	1971	1972	1973	1974
1	191824	214339	182897	157758	428062	333357
2	118847	164845	183185	157024	134779	368932
3	114307	94014	129621	140189	121677	103938
4	91203	74516	55125	86215	100231	71865
5	67209	61362	35003	32332	52108	43724
6	146824	39650	31553	19657	18552	25334
7	14118	79955	17364	17615	10048	10770
8	10521	8491	34731	9243	9661	6075
9	10447	7288	5143	20040	5003	5245
10	4639	5271	5204	3127	11971	2681
11	4792	2992	3248	3390	1575	6351
12	2693	3257	2087	2075	2127	1212
13	1435	1685	2191	1450	1107	1480
14	969	1042	1166	1436	971	698
15	649	634	786	835	917	595

AGE	1975	1976	1977	1978
1	199531	172320	357854	92955
2	286098	170829	145512	306415
3	307658	226115	129287	99688
4	60965	209367	146670	74099
5	28695	37971	106590	81667
6	19261	14205	15122	59980
7	14044	9712	7297	9630
8	6424	8244	4912	4289
9	3473	3651	4927	2774
10	2849	1673	2013	3102
11	1378	1654	775	1253
12	3297	942	890	417
13	815	2014	679	563
14	912	534	1204	485
15	452	684	369	764

Table 3.5 North Sea PLAICE

Age composition of total catch in 1969-1978 (thousands) (females)

AGE	1969	1970	1971	1972	1973	1974
1	8	770	481	765	723	728
2	9241	9311	19676	12888	12608	10456
3.	25934	27086	25283	25198	33328	29127
4	18834	28301	15825	21076	41452	24431
5	13499	16990	11499	12836	19349	20248
6	39605	13838	10296	10898	7816	10270
7	5050	34679	7023	11437	6171	4359
8	3091	4509	13864	11773	6375	4450
9	4672	2747	3210	18503	5694	3341
10	1868	3772	2471	4892	12955	3152
11	3174	1522	2303	4635	2665	9661
12	933	2102	1536	5654	2099	1654
13	990	752	1424	2687	1945	1659
14	362	721	627	2733	2836	1321
15	687	320	742	1183	1150	1258
16	348	373	346	1475	705	709
17	481	291	826	2459	901	1209
18	179	173	307	618	413	136
19	202	95	176	368	289	54
20	173	99	88	202	328	42

AGE	1975	1976	1977	1978
1	269	1076	1149	307
2	18210	14735	26743	26508
3	46396	36246	27656	24350
4	18884	51867	31604	22854
5	14398	8750	25898	25167
6	13806	6677	4276	18243
7	7270	6753	2762	3053
8	3993	4518	2452	2093
9	6223	2498	1896	1707
10	3024	2145	1018	1953
11	1593	2025	783	846
12	8071	909	843	509
13	1017	7374	273	554
14	1374	372	1490	210
15	1435	559	166	1120
16	1166	552	217	114
17	431	674	158	146
18	1166	272	146	127
19	132	310	111	174
20	25	44	102	79

Table 3.6 North Sea PLAICE

Fishing mortality 1969-1978 (M = 0.10) (females)

AGE	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
1	.00	.00	.00	.01	.00	.00	.00	.01	.01	.01
2	.08	.07	.12	.11	.13	.04	.09	.12	.21	.14
3	.24	.33	.23	.20	.40	.45	.25	.24	.29	.26
4	.22	.38	.29	.28	.52	.50	.52	.42	.31	.37
5	.20	.27	.24	.35	.41	.46	.55	.42	.34	.38
6	.23	.29	.24	.33	.34	.34	.57	.47	.34	.38
7	.18	.28	.21	.40	.28	.32	.38	.55	.32	.38
8	.12	.21	.15	.57	.36	.30	.42	.38	.34	.38
9	.17	.14	.21	.28	.53	.35	.76	.45	.25	.38
10	.10	.18	.16	.49	.29	.56	.43	.56	.30	.38
11	.22	.09	.15	.45	.47	.32	.54	.51	.36	.38
12	.09	.20	.12	.56	.33	.53	.44	.60	.36	.38
13	.16	.09	.18	.28	.34	.42	.65	.80	.32	.38
14	.07	.15	.09	.55	.46	.36	.65	.47	.32	.38
15	.21	.08	.20	.22	.41	.34	.72	.53	.35	.38
16	.11	.15	.10	.67	.18	.43	.53	.60	.35	.38
17	.22	.11	.52	1.59	1.04	.46	.44	.59	.30	.38
18	.23	.11	.15	.83	1.31	.37	.96	.49	.22	.38
19	.29	.16	.13	.23	1.11	.50	.64	.64	.34	.38
20	.10	.20	.20	.20	.30	.40	.40	.40	.40	.38

MEAN F FOR AGES >= 2 AND <= 20 (NOT WEIGHTED BY STOCK IN NUMBERS)

	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
	.17	.18	.19	.45	.48	.39	.52	.49	.32	.36

Table 3.7 North Sea PLAICE

Stock in numbers (thousands) 1969-1978 (females)

AGE	1969	1970	1971	1972	1973	1974
1	165688	200532	146605	118837	285788	237443
2	122262	149913	180716	132196	106801	257904
3	129783	101847	126799	144829	107373	84663
4	102091	92822	66471	90739	107128	65002
5	77434	74500	57165	45134	62111	57638
6	206134	57251	51292	40813	28670	37236
7	32602	148930	38677	36641	26595	18531
8	27786	24705	101860	28331	22315	18210
9	30831	22205	18074	79001	14493	14148
10	21503	23461	17483	13307	53931	7724
11	16769	17632	17647	13473	7408	36511
12	11118	12161	14553	13781	7800	4179
13	7075	9173	9008	11709	7118	5068
14	5518	5462	7586	6799	3046	4597
15	3748	4649	4257	6268	3565	4534
16	3597	2740	3902	3148	4544	2136
17	2509	2924	2125	3202	1453	3442
18	920	1814	2369	1141	589	466
19	845	663	1477	1852	448	144
20	1909	573	509	1169	1327	133

AGE	1975	1976	1977	1978
1	157289	168347	236578	32419
2	214155	142065	151304	12972
3	223423	176475	114549	11521
4	49014	158136	125287	77416
5	35683	26470	93943	83391
6	33019	18659	15661	60448
7	24010	16812	10559	10116
8	12159	14834	8820	6935
9	12257	7219	9140	5656
10	9065	5210	4165	6471
11	4005	5337	2684	2803
12	23875	2116	2912	1687
13	2216	13957	1055	1836
14	3013	1043	5663	696
15	2907	1427	591	3711
16	2964	1274	762	378
17	1261	1578	631	484
18	1970	733	790	421
19	292	682	406	577
20	79	140	324	262

Table 3.8 North Sea PLAICE. Fishing Effort Data 1971-1978

	1971	1972	1973	1974	1975	1976	1977	1978
Lowestoft trawl (hours)	272 878	270 929	261 466	242 949	191 437	215 941	211 207	217 428
Grimsby trawl (hours)	170 909	177 233	148 417	124 889	87 523	88 575	93 406	136 521
Grimsby seine (hours)	140 755	150 501	159 449	140 981	133 146	142 327	140 896	162 267
Belgian beam-trawl (horse power corrected)	129 000	139 473	137 737	147 342	181 940	209 345	224 370	226 947
Netherlands beam-trawl (horse power corrected)	1 092 716	1 100 905	1 296 297	1 338 173	1 443 481	1 407 797	1 302 814	1 102 458
Total	1 806 258	1 839 041	2 003 366	1 994 334	2 037 527	2 063 985	1 972 747	1 845 621

Table 3.9 North Sea PLAICE. Mean F values in 10 VPA for different trial runs and the correlation with the trend in fishing effort.

Year	Hours fishing (thousands)	Mean F ages (4-10)					Mean F ages (4-10)				
		Run 1	Run 2	Run 3	Run 4	Run 5	Run 1	Run 2	Run 3	Run 4	Run 5
1971	1 806.3	0.391	0.391	0.390	0.394	0.399	0.213	0.212	0.217	0.217	0.218
1972	1 839.0	0.437	0.439	0.438	0.443	0.443	0.385	0.379	0.393	0.394	0.396
1973	2 003.4	0.480	0.484	0.486	0.492	0.490	0.388	0.380	0.401	0.405	0.406
1974	1 994.3	0.506	0.519	0.516	0.526	0.524	0.402	0.390	0.419	0.424	0.430
1975	2 037.5	0.455	0.470	0.477	0.477	0.475	0.518	0.490	0.550	0.553	0.578
1976	2 064.0	0.539	0.558	0.569	0.566	0.585	0.465	0.429	0.509	0.523	0.564
1977	1 972.7	0.372	0.386	0.422	0.421	0.393	0.313	0.276	0.356	0.384	0.425
1978	1 845.6	0.440	0.456	0.500	0.516	0.440	0.380	0.320	0.464	0.520	0.626
Correlation coefficient		0.615	0.656	0.649	0.586	0.705	0.757	0.703	0.651	0.583	0.455

Table 3.10 North Sea PLAICE

Frequency distribution of recruitment at age 2 from VPA (millions)

	Male	Female
100-119	3	2
120-139	3	4
140-159	7	11
160-179	6	4
180-199	5	4
200-219	-	2
220-239	1	2
240-259	1	2
260-279	-	-
280-299	3	-
300-219	1	-
320-339	-	-
340-359	-	-
360-379	1	-
>380	1	1

Table 3.11 North Sea PLAICE

VPA and I-group spring survey data 1968-1977

Year	I-group Tridens Abundance Index (relative units)	VPA recruits at age 2 (x 10^6)
1968	2 876	314.7
1969	9 670	363.9
1970	-	289.2
1971	2 746	241.6
1972	18 625	625.9
1973	6 017	500.3
1974	4 004	312.9
1975	1 713	296.8
1976	7 729	519.4
1977	4 503	

Table 3.12 North Sea PLAICE

Input data used for catch forecast

Age	Males				Females			
	Relative F	Catch in number 1978 (000)	Stock weight averages kg*	Catch weight at age kg*	Relative F	Catch in number 1978 (000)	Stock weight averages kg*	Catch weight at age kg*
2	0.210	32 224	0.220	0.274	0.368	26 508	0.200	0.310
3	0.596	26 795	0.260	0.303	0.684	24 350	0.300	0.365
4	0.965	29 309	0.310	0.334	0.974	22 854	0.400	0.415
5	1.000	33 183	0.350	0.355	1.000	25 167	0.500	0.470
6	0.877	22 052	0.410	0.380	1.000	18 243	0.590	0.525
7	0.754	3 142	0.450	0.410	1.000	3 053	0.680	0.575
8	0.667	1 265	0.500	0.430	1.000	2 093	0.770	0.620
9	0.579	727	0.550	0.460	1.000	1 707	0.840	0.670
10	0.561	792	0.600	0.480	1.000	1 953	0.900	0.720
11	0.509	294	0.650	0.510	1.000	846	0.960	0.765
12	0.474	92	0.690	0.530	1.000	509	1.000	0.815
13	0.456	120	0.720	0.550	1.000	554	1.100	0.860
14	0.439	100	0.740	0.570	1.000	210	1.130	0.900
15	0.421	470	0.760	0.590	1.000	1 120	1.150	0.940
16					1.000	114	1.180	0.980
17					1.000	146	1.200	1.020
18					1.000	127	1.200	1.060
19					1.000	174	1.200	1.100
20					1.000	79	1.200	1.135
Column 1	2	3	4	5	6	7	8	9

*) kilogrammes gutted weight

	Males	Females
R_{1979}	181.8×10^6	162.4×10^6
R_{1980}	199.0×10^6	178.7×10^6
R_{1981}	199.0×10^6	178.7×10^6
F_{1978}	0.57	0.38

Table 3.13 North Sea PLAICE

Catch and spawning stock biomass predictions (sexes combined). Whole weight (in thousand tonnes)

Year	Option 1			Option 2		
	F	Catch	Stock	F	Catch	Stock
1978	F_{78}	113.5	276.3	F_{78}	113.5	276.3
1979	F_{78}	112.0	282.0	F_{78}	112.0	282.0
1980	F_{78}	112.0	281.3	$F=0.8\ F_{78}$	92.6	281.3
1981	F_{78}	108.8	270.9	$F=0.8\ F_{78}$	95.3	290.1

Table 3.14 North Sea PLAICE

Catch in 1980. Spawning stock in 1981

1980 F as multiple of 1978 F	Catch (1980) (tonnes)	Spawning Stock (1981) (tonnes)
0.6	72 000	313 000
0.7	83 000	302 000
0.8	93 000	290 000
0.9	103 000	282 000
1.0	112 000	271 000
1.1	121 000	263 000
1.2	130 000	255 000
1.3	139 000	246 000
1.4	147 000	238 000

Table 4.1 English Channel SOLE

Nominal catch (tonnes) in Divisions VIId and VIIe, 1968-1978

YEAR	BELGIUM		FRANCE		NETHERLANDS 3)		U.K.		TOTAL	
	VIId	VIIe	VIId	VIIe	VIId	VIIe	VIId	VIIe	VIId	VIIe
1968	30		520		-		133	114	797	
1969	10	8	606		-		177	138	939	
1970	127	10	753		1		228	125	1 244	
1971	157	3	816		1		254	152	1 383	
1972	147	6	676		8		322	201	1 360	
1973	126	2	775		-		360	194 2)	1 457	
1974	159	6	706		3		309	181	1 364	
1975	132	3	464	271	1		244	217	841	491
1976	203	4	599	352	-		404	260	1 206	616
1977	225	3	737	331	-		315	272	1 277	606
1978 1)	226.4	2	761.5	291.8	-		366	453	1 353.9	746.8

1) Preliminary figures
2) Figures amended from 1976 Working Group Report
3) Mainly Division VIId

Note: Catches for Divisions VIId and VIIe combined were taken from Bulletin Statistique as were the separate catches in 1975-77.
The VIId and VIIe separate catches for previous years were obtained from national statistics.

Table 4.2 SOLE in Division VIId

Fishing effort and catch per unit.
Fishing effort for Belgium and the United Kingdom

Year	Total Catch (tonnes)	Belgium Landings (tonnes)	Belgium CPUE (kg/h) Beam-trawl	Belgium Fishing Effort (hours)	United Kingdom Landings (tonnes)	United Kingdom CPUE (t/1 000 h)	United Kingdom Fishing Effort (hours)
1972		147	8.1	18 148	322		
1973		126	8.2	15 366	360		
1974		159	9.5	16 737	309		
1975	841	132	7.9	16 709	244	4.220	57 820
1976	1 206	203	11.3	17 965	404	4.878	82 821
1977	1 277	225	9.8	22 959	315	2.320	135 776
1978	1 353.9	226.4	9.4	24 085	366	3.963	92 354

Table 4.3 Division VIId SOLE (males)

Age composition of total catch (thousands)

AGE	1971	1972	1973	1974	1975	1976
1	.0	.0	.0	.0	.0	.0
2	91.0	34.7	147.6	186.1	4.7	306.7
3	222.2	215.8	189.1	187.3	291.1	456.2
4	11.0	185.4	389.4	191.3	223.8	263.7
5	.0	.0	137.5	213.5	78.7	73.8
6	15.3	45.3	14.8	32.0	226.4	12.1
7	63.5	.0	30.5	11.4	73.8	76.4
8	447.5	45.3	12.5	.0	33.8	17.2
9	15.3	510.5	100.8	30.2	9.3	17.1
10	21.4	41.0	130.5	9.7	18.2	4.2
11	51.9	28.5	38.3	47.4	10.0	44.0
12	34.8	.0	24.2	45.1	95.6	235.4
13	108.1	162.5	52.3	.0	9.1	52.1
14+	220.4	28.5	76.6	22.3	105.3	50.2

AGE	1977	1978
1	.0	307.8
2	900.0	986.4
3	357.1	1414.0
4	356.6	338.3
5	125.5	222.4
6	35.6	158.3
7	35.7	36.0
8	52.9	33.8
9	8.9	18.7
10	33.0	19.5
11	20.7	16.8
12	30.1	11.0
13	16.4	5.5
14+	125.8	75.4

Table 4.4 Division VIId SOLE

Stock weight at age

Males

1	2	3	4	5	6
.027	.097	.178	.221	.270	.302
7	8	9	10	11	12
.335	.362	.378	.400	.416	.427
13	14+				
.437	.443				

Females

1	2	3	4	5	6
.027	.135	.243	.346	.410	.475
7	8	9	10	11	12
.524	.567	.594	.621	.648	.670
13	14	15	16	17	18
.680	.680	.700	.704	.708	.712
19	20	21+			
.713	.713	.713			

Table 4.5 Division VIId SOLE (males)
Fishing mortalities (M = 0.10)

AGE	1971	1972	1973	1974	1975	1976	1977	1978
1	.00	.00	.00	.00	.00	.00	.00	.18
2	.05	.03	.13	.08	.00	.16	.10	.14
3	.23	.14	.22	.22	.16	.25	.25	.20
4	.03	.27	.35	.32	.40	.20	.28	.35
5	.00	.00	.30	.30	.19	.20	.12	.25
6	.05	.18	.04	.09	.52	.04	.12	.20
7	.07	.00	.16	.04	.29	.30	.13	.16
8	.28	.06	.05	.00	.14	.09	.30	.15
9	.05	.52	.17	.16	.07	.09	.06	.15
10	.07	.17	.22	.02	.12	.03	.22	.15
11	.38	.11	.20	.10	.02	.43	.21	.15
12	.10	.00	.11	.35	.28	.89	.52	.15
13	1.15	.79	.85	.00	.10	.21	.12	.15
14	.15	.15	.15	.15	.15	.15	.15	.15

MEAN F FOR AGES >= 3 AND <= 10 (WEIGHTED BY STOCK IN NUMBERS)

.16	.22	.23	.19	.25	.20	.21	.22

Table 4.6 Division VIId SOLE (males)
Stock in numbers (thousands)

AGE	1971	1972	1973	1974	1975	1976
1	1278	1370	2670	2667	2433	11040
2	2017	1157	1240	2416	2414	2202
3	1127	1738	1014	982	2009	2179
4	447	809	1368	738	711	1541
5	320	394	556	868	486	431
6	320	289	357	373	583	365
7	967	275	219	309	307	313
8	1915	815	249	169	268	208
9	329	1309	634	213	153	211
10	348	283	701	532	164	130
11	171	295	217	510	473	131
12	380	106	240	160	417	418
13	165	311	96	194	102	286
14	367	47	128	37	175	84

AGE	1977	1978
1	6817	1981
2	9989	7978
3	1701	8183
4	1539	1200
5	1144	1054
6	320	916
7	319	256
8	211	255
9	172	141
10	175	147
11	113	127
12	77	83
13	156	41
14	210	126

Table 4.7 Division VIId SOLE (females)
Age composition of total catch (thousands)

AGE	1971	1972	1973	1974	1975	1976
1	.0	.0	.0	.0	.0	.0
2	.0	.0	339.8	354.6	16.9	388.8
3	249.1	294.6	128.9	364.8	484.9	793.1
4	42.7	28.5	367.2	127.3	205.2	476.1
5	45.2	.0	120.3	270.6	60.7	183.2
6	.0	.0	30.5	43.4	209.1	59.7
7	21.4	.0	46.9	87.9	23.3	201.5
8	327.9	.0	50.0	10.3	12.3	34.2
9	20.8	310.7	71.1	10.8	9.0	19.2
10	.0	226.4	152.3	46.2	4.9	8.2
11	47.0	.0	28.1	111.3	16.7	3.7
12	70.2	.0	58.6	.0	70.7	4.7
13	48.8	24.8	63.3	8.6	7.6	140.4
14	73.3	57.7	18.0	41.1	6.0	1.0
15	.0	.0	26.6	21.1	9.0	11.3
16	28.7	39.1	21.1	6.3	11.1	22.0
17	.0	.0	.0	36.0	43.3	10.2
18	.0	9.3	.0	25.7	9.4	21.5
19	.0	.0	.0	9.7	25.6	14.0
20	97.1	8.1	.0	17.1	7.1	5.0
21	26.3	38.5	14.1	30.8	8.9	26.3

AGE	1977	1978
1	.0	54.8
2	1202.8	793.1
3	596.1	913.7
4	688.8	205.1
5	168.0	92.3
6	95.9	137.5
7	22.3	53.6
8	64.4	19.9
9	47.4	38.7
10	10.3	14.8
11	6.3	10.6
12	4.9	7.0
13	23.1	6.7
14	53.0	25.6
15	14.4	22.6
16	.6	1.0
17	5.9	12.2
18	13.5	1.9
19	56.4	3.4
20	5.9	11.4
21	.1	5.0

Table 4.8 Division VIId SOLE (females)
Fishing mortalities (M = 0.10)

AGE	1971	1972	1973	1974	1975	1976	1977	1978
1	.00	.00	.00	.00	.00	.00	.00	.02
2	.00	.00	.21	.15	.01	.20	.23	.19
3	.37	.16	.24	.33	.27	.49	.46	.25
4	.13	.06	.26	.35	.28	.41	.91	.25
5	.23	.00	.33	.28	.25	.38	.22	.25
6	.00	.00	.12	.17	.33	.37	.31	.25
7	.05	.00	.40	.54	.12	.53	.20	.25
8	.22	.00	.48	.13	.12	.23	.29	.25
9	.06	.30	.21	.16	.14	.24	.49	.25
10	.00	1.39	.21	.18	.09	.17	.18	.25
11	.20	.00	.54	.21	.08	.08	.17	.25
12	.35	.00	.39	.00	.18	.03	.14	.25
13	.11	.18	.46	.08	.27	.57	.17	.25
14	.43	.17	.17	.54	.07	.05	.38	.25
15	.00	.00	.10	.28	.19	.15	1.35	.25
16	.30	.43	.21	.03	.21	.83	.01	.25
17	.00	.00	.00	.58	.24	.26	.48	.25
18	.00	.23	.00	.56	.26	.16	.58	.25
19	.00	.00	.00	.18	1.71	.67	.69	.26
20	.59	.33	.00	.83	.17	3.53	.59	.25
21	.25	.25	.25	.25	.25	.25	.25	.25

MEAN F FOR AGES >= 3 AND <= 16 (WEIGHTED BY STOCK IN NUMBERS)

	1971	1972	1973	1974	1975	1976	1977	1978
	.20	.20	.26	.27	.25	.42	.47	.25

Table 4.9 Division VIId SOLE (females)
Stock in numbers (thousands)

AGE	1971	1972	1973	1974	1975	1976
1	776	2066	3043	2656	2525	6685
2	2362	702	1870	2753	2403	2285
3	837	2137	635	1369	2155	2159
4	381	521	1654	452	893	1490
5	229	305	444	1148	289	613
6	167	164	276	288	782	204
7	502	151	149	220	219	510
8	1726	434	136	90	116	176
9	368	1251	392	76	72	93
10	234	313	837	288	59	56
11	270	211	71	613	216	48
12	248	199	191	37	449	180
13	482	158	180	118	34	339
14	219	390	129	103	98	23
15	130	129	298	91	55	83
16	116	117	116	245	62	41
17	53	77	69	85	215	46
18	58	48	70	63	43	154
19	33	53	35	63	32	30
20	161	30	48	32	48	5
21	37	54	20	43	12	37

AGE	1977	1978
1	5314	2532
2	6049	4809
3	1699	4332
4	1202	972
5	897	438
6	381	652
7	128	254
8	270	94
9	127	183
10	66	70
11	43	50
12	40	33
13	158	32
14	174	121
15	20	107
16	65	5
17	16	58
18	32	9
19	119	16
20	14	54
21	0	7

Table 4.10 SOLE in Division VIId

Input data for estimation of yield per recruit curves and for catch predictions

Age	Males (M = 0.1)			Females (M = 0.1)		
	F_t	Relative F_t	$\bar{w}_t$	F_t	Relative F_t	$\bar{w}_t$
1	.178	0.51	.027	.023	.09	.027
2	.139	0.40		.19	.76	.135
3	.20	0.57	.178	.25	1.00	.243
4	.35	1.00	.221	.25	1.00	.346
5	.25	0.71	.270	.25	1.00	.410
6	.20	0.57	.302	.25	1.00	.475
7	.16	0.46	.335	.25	1.00	.524
8	.15	0.43	.362	.25	1.00	.567
9	.15	0.43	.378	.25	1.00	.594
10	.15	0.43	.400	.25	1.00	.621
11	.15	0.43	.416	.25	1.00	.648
12	.15	0.43	.427	.25	1.00	.670
13	.15	0.43	.437	.25	1.00	.680
14	.15	0.43	.443	.25	1.00	.680
15				.25	1.00	.700
16				.25	1.00	.704
17				.25	1.00	.708
18				.25	1.00	.712
19				.25	1.00	.713
20				.25	1.00	.713
21				.25	1.00	.713

Recruits at age 1

1978 : 1 981
1979 : 1 996
1980 : 1 996

Recruits at age 2

1978 : 2 532
1979 : 2 573
1980 : 2 573

Table 4.11 SOLE in Divisions VIId and VIIe

Selected catch predictions

	Div. VIId		Div. VIIe	
Spawning stock biomass 1978 (tonnes x 10^{-3})	5.5		3.8	
Catch 1978 (tonnes x 10^{-2})	13.5		7.5	
Spawning stock biomass 1979	3.4		3.8	
Catch 1979	14.5		7.3	
Spawning stock biomass 1980	6.1		4.0	
F_{80}/F_{78}	Males Catch 1980	Females Spawning Stock Biomass	Males Catch 1980	Females Spawning Stock Biomass
0	0	7.1	0	4.7
0.1	1.6	7.9	0.8	4.6
0.2	3.0	6.7	1.7	4.4
0.4	5.9	6.5	3.3	4.3
0.6	8.5	6.1	4.8	4.2
0.8	11.3	5.9	6.3	4.1
1.0	13.8	5.6	7.8	4.0
1.5	19.4	4.9	11.0	3.7
2.0	24.4	4.4		

Table 5.1 SOLE in Division VIIe

Fishing effort and catch per unit effort
(United Kingdom)

Year	Total Catch (tonnes)	U.K. Landings (tonnes)	U.K. CPUE tonnes/ 1 000 hours	U.K. Fishing Effort (hours)
1969	(369)*	138	1.93	71 503
1970	(413)*	125	1.24	100 806
1971	(457)*	152	1.02	149 020
1972	(461)*	201	1.30	154 615
1973	(482)*	194	0.95	204 211
1974	(449)*	181	1.14	158 772
1975	491	217	1.41	153 900
1976	616	260	1.57	165 605
1977	606	272	1.28	212 500
1978	746.8	453	2.09	216 746

*) Working Group estimate for assessment purposes

Table 5.2 Division VIIe SOLE (males)

Age composition of total catch (thousands)

AGE	1969	1970	1971	1972	1973	1974
2	44.5	10.8	24.2	58.3	58.7	46.5
3	63.8	102.5	100.4	140.6	136.8	134.1
4	30.1	130.4	77.1	91.5	167.0	90.2
5	36.5	27.8	28.6	32.8	50.3	43.4
6	52.6	31.5	14.0	17.5	29.2	17.8
7	.0	21.5	34.5	.0	8.6	19.0
8	15.2	6.2	39.3	6.1	23.0	19.5
9	16.5	30.0	6.8	79.3	8.6	17.0
10	.0	13.7	.0	22.2	.0	7.0
11	.0	10.9	35.7	16.6	.0	23.8
12	2.7	5.0	2.0	7.9	8.6	7.1
13	6.7	6.2	7.8	11.0	11.3	10.6
14	2.7	.1	6.8	3.1	.0	6.6
15	.1	.1	.1	.1	20.6	2.8
16	.1	.1	.1	.1	3.1	3.3
17	.1	.1	.1	.1	.1	.7
18	.1	3.8	.1	.1	.1	.1
19	.1	1.2	.1	3.1	.1	1.8
20	.1	.1	2.0	.1	.1	.7
21+	.1	1.3	5.1	25.8	1.6	6.6

AGE	1975	1976	1977	1978
2	50.3	67.6	197.7	139.3
3	236.0	185.5	181.2	533.3
4	56.7	163.7	143.1	172.2
5	91.2	59.9	92.2	45.5
6	69.1	78.6	43.7	51.0
7	17.5	35.1	40.6	65.8
8	38.8	24.4	31.6	33.7
9	6.1	37.9	2.7	18.7
10	5.2	34.5	12.0	16.7
11	17.8	3.6	14.4	10.6
12	17.2	14.5	4.8	5.5
13	3.6	21.0	5.5	5.6
14	6.1	9.1	20.2	2.0
15	.1	3.7	3.2	9.7
16	6.1	4.3	5.2	3.1
17	.1	22.5	4.4	5.3
18	6.4	17.9	8.5	.3
19	5.7	1.2	.0	10.7
20	.1	.0	.0	2.5
21+	9.5	13.4	4.6	10.2

Table 5.3 Division VIIe SOLE

Stock weight at age data (kg)

(Males)

2	3	4	5	6	7
.168	.199	.230	.268	.287	.316
8	9	10	11	12	13
.341	.364	.381	.405	.427	.438
14	15	16	17	18	19
.454	.473	.489	.501	.513	.526
20	21+				
.543	.601				

(Females)

2	3	4	5	6	7
.182	.244	.302	.364	.420	.465
8	9	10	11	12	13
.513	.552	.588	.625	.659	.683
14	15	16	17	18	19
.708	.735	.757	.778	.801	.817
20	21+				
.834	.923				

Table 5.4 Division VIIe SOLE (males)

Fishing mortalities (M = 0.10)

AGE	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
2	.06	.02	.03	.06	.05	.04	.06	.06	.09	.08
3	.13	.18	.18	.19	.16	.14	.26	.32	.20	.35
4	.12	.38	.18	.23	.32	.14	.07	.26	.38	.26
5	.15	.14	.12	.10	.17	.11	.18	.09	.21	.18
6	.10	.17	.09	.09	.11	.07	.24	.21	.08	.15
7	.00	.05	.26	.00	.05	.08	.09	.16	.14	.15
8	.07	.05	.10	.06	.20	.14	.22	.15	.19	.15
9	.13	.17	.06	.28	.10	.20	.05	.30	.02	.15
10	.00	.13	.00	.27	.00	.10	.08	.43	.13	.15
11	.00	.04	.53	.14	.00	.15	.35	.06	.28	.15
12	.04	.04	.01	.19	.09	.13	.11	.48	.10	.15
13	.22	.10	.08	.05	.40	.13	.08	.18	.30	.15
14	.06	.00	.13	.04	.00	.38	.09	.26	.23	.15
15	.00	.00	.00	.00	.31	.02	.01	.07	.12	.15
16	.00	.00	.00	.01	.08	.07	.04	.45	.12	.15
17	.01	.01	.00	.00	.01	.02	.00	.20	1.04	.15
18	.00	.71	.01	.00	.00	.01	.24	.60	.10	.15
19	.01	.02	.03	.22	.01	.07	.49	.06	.00	.15
20	.04	.01	.04	.04	.01	.04	.00	.00	.00	.15
21	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15

MEAN F FOR AGES >= 3 AND <= 16 (WEIGHTED BY STOCK IN NUMBERS)

.09	.15	.14	.16	.16	.12	.17	.22	.19	.25

Table 5.5 Division VIIe SOLE (males)
Stock in numbers (thousands)

AGE	1969	1970	1971	1972	1973	1974
2	768	707	977	1121	1261	1236
3	547	653	629	861	959	1085
4	280	434	493	474	645	737
5	268	225	269	373	342	426
6	597	208	177	216	307	262
7	151	490	158	147	179	250
8	236	136	423	110	133	154
9	144	199	117	345	94	98
10	313	115	152	100	237	77
11	142	283	91	137	69	215
12	82	129	246	48	108	63
13	36	71	112	221	36	90
14	52	26	59	94	189	22
15	31	44	23	47	82	171
16	23	28	40	21	42	55
17	9	21	25	36	19	35
18	52	8	19	22	32	17
19	11	56	3	17	20	29
20	2	9	50	3	12	18
21	0	2	8	43	3	11

AGE	1975	1976	1977	1978
2	842	1244	2299	1974
3	1074	714	1062	1892
4	854	748	470	789
5	582	719	521	290
6	344	440	594	384
7	220	246	323	496
8	208	182	189	254
9	121	151	142	141
10	73	103	101	126
11	63	61	61	80
12	167	40	52	41
13	50	135	22	42
14	71	42	102	15
15	14	59	29	73
16	152	12	50	23
17	46	132	7	40
18	31	42	98	2
19	15	22	21	81
20	25	8	19	19
21	16	22	8	17

Table 5.6 Division VIIe SOLE (females)
Age composition of total catch (thousands)

AGE	1969	1970	1971	1972	1973	1974
2	46.8	25.4	20.8	55.8	43.0	43.2
3	235.2	133.6	111.5	245.0	202.7	212.3
4	66.3	174.7	157.6	84.0	281.0	111.2
5	107.8	46.0	147.5	116.5	74.5	114.7
6	164.9	82.9	45.6	94.4	70.7	53.7
7	16.4	99.7	47.4	20.2	119.5	28.5
8	32.8	14.2	141.2	18.6	2.6	32.0
9	9.4	16.5	7.4	60.4	21.8	22.2
10	16.8	34.1	31.5	19.3	31.6	21.5
11	13.5	16.0	18.2	29.0	5.8	16.3
12	6.7	11.0	20.2	13.1	19.0	13.5
13	1.5	17.4	13.7	3.1	6.9	10.7
14	14.9	8.3	13.7	2.7	4.4	7.3
15	5.2	15.8	7.7	13.5	4.6	9.5
16	4.6	4.5	4.8	7.2	3.3	6.3
17	7.9	.0	2.1	2.9	.5	3.0
18	1.2	.9	2.3	5.1	12.3	7.1
19	3.1	3.0	8.8	1.5	.5	6.5
20	.2	1.8	3.7	2.7	1.1	2.6
21	5.6	15.8	14.3	8.7	13.2	14.6

AGE	1975	1976	1977	1978
2	19.1	66.6	99.5	65.3
3	267.4	164.3	190.3	455.5
4	121.5	275.1	219.8	166.5
5	122.5	88.9	128.2	138.8
6	50.8	93.1	62.5	124.3
7	10.0	60.4	49.7	25.0
8	36.4	10.7	63.7	42.2
9	20.1	23.9	7.9	45.9
10	18.5	22.3	16.1	16.2
11	10.7	9.4	20.7	12.3
12	19.7	3.2	8.1	11.3
13	14.1	44.4	12.1	4.7
14	16.6	8.5	21.4	8.0
15	8.3	11.7	3.4	26.2
16	5.5	12.1	13.2	11.6
17	9.9	14.8	9.4	6.2
18	11.6	4.5	5.7	5.1
19	2.7	15.1	2.7	5.4
20	2.5	3.7	8.9	5.2
21	13.3	23.3	21.6	26.3

Table 5.7 Division VIIe SOLE (females)
Fishing mortalities (M = 0.10)

AGE	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
2	.05	.03	.01	.04	.05	.03	.02	.06	.04	.03
3	.20	.16	.19	.17	.19	.34	.19	.16	.21	.22
4	.18	.20	.25	.19	.27	.14	.29	.28	.30	.26
5	.22	.17	.23	.26	.23	.15	.19	.32	.18	.28
6	.14	.24	.22	.21	.23	.23	.08	.20	.34	.24
7	.05	.11	.18	.13	.38	.12	.05	.12	.14	.20
8	.09	.05	.20	.09	.02	.15	.20	.07	.16	.15
9	.04	.06	.03	.11	.13	.21	.12	.17	.06	.15
10	.07	.16	.13	.09	.07	.17	.25	.17	.15	.15
11	.07	.09	.11	.15	.03	.04	.11	.17	.21	.15
12	.03	.07	.13	.10	.13	.08	.06	.04	.20	.15
13	.01	.08	.11	.02	.06	.09	.11	.16	.17	.15
14	.10	.07	.08	.03	.04	.08	.17	.08	.10	.15
15	.09	.14	.08	.09	.05	.10	.11	.16	.04	.15
16	.10	.09	.05	.09	.03	.08	.07	.20	.24	.15
17	.16	.00	.05	.04	.01	.03	.16	.24	.21	.15
18	.04	.02	.06	.15	.19	.12	.13	.09	.12	.15
19	.10	.13	.27	.05	.02	.13	.06	.22	.06	.15
20	.01	.07	.22	.11	.04	.11	.06	.09	.18	.15
21	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15

MEAN F FOR AGES >= 3 AND <= 16 (WEIGHTED BY STOCK IN NUMBERS)

.14	.14	.18	.16	.19	.17	.16	.19	.20	.22

Table 5.9 Division VIIe SOLE

Input data for estimation of yield per recruit curves and for catch predictions

Age	Males (M = 0.1)			Females (M = 0.1)		
	F_t	Relative F_t	$\bar{w}_t$	F_t	Relative F_t	$\bar{w}_t$
1	-	-	-	-	-	-
2	.08	.23	.168	.03	.11	.182
3	.35	1.00	.199	.22	.79	.244
4	.26	.74	.230	.26	.93	.302
5	.18	.51	.268	.28	1.00	.364
6	.15	.43	.287	.24	.86	.420
7	.15	.43	.316	.20	.71	.465
8	.15	.43	.341	.15	.54	.513
9	.15	.43	.364	.15	.54	.552
10	.15	.43	.381	.15	.54	.588
11	.15	.43	.405	.15	.54	.625
12	.15	.43	.427	.15	.54	.659
13	.15	.43	.438	.15	.54	.683
14	.15	.43	.454	.15	.54	.708
15	.15	.43	.473	.15	.54	.735
16	.15	.43	.489	.15	.54	.757
17	.15	.43	.501	.15	.54	.778
18	.15	.43	.513	.15	.54	.801
19	.15	.43	.526	.15	.54	.817
20	.15	.43	.543	.15	.54	.834
21	.15	.43	.601	.15	.54	.923

Recruits at age 2

1978 : 2 485

1979 : 1 357

1980 : 1 357

Recruits at age 2

1978 : 1 974

1979 : 1 115

1980 : 1 115

Table 6.1 English Channel PLAICE

Nominal catch (tonnes) in Divisions VIId and VIIe, 1962-1978

Year	Belgium		France		Nether-lands		U.K. (England & Wales)		Total	
	VIId	VIIe	VIId	VIIe	VIId	VIIe	VIId	VIIe	VIId	VIIe
1962	24		874		-		545	373	1 816	
1963	32		1 162		-		472	506	2 172	
1964	28		1 393		-		616	422	2 459	
1965	33		2 130		-		841	445	3 449	
1966	25		2 700[1)]		-		1 067	681	4 473	
1967	11		2 905		-		976	829	4 721	
1968	30		1 920		-		713	641	3 304	
1969	18	12	1 681		-		521	508	2 740	
1970	170	13	2 161		6		1 126	391	3 867	
1971	175	4	2 635		-		1 025	440	4 279	
1972	163	14	1 866		17		855	327	3 242	
1973	139	5	1 735		-		889	367	3 135	
1974	148	4	2 180		13		564	248	3 157	
1975	153	8	1 802	288	-		293	279	2 248	575
1976	146	5	1 349	388	-		378	306	1 873	699
1977	148	23	1 714	336	-		304	363	2 166	722
1978*	151	-	1 640	291	-		349	465	2 140	756

*) preliminary figures as reported

1) Figure from Révue des Travaux de l'Institut des Pêches maritimes raised to round fresh weight

NB. All combined VIId,e figures and the 1975-77 data are from Bulletin Statistique. All others are from national statistics.

Table 6.2 English Channel PLAICE. Catch per effort data and estimated effective effort

Year	CPUE				Effective f				
	Tonnes landed	U.K. CPUE VIIe	U.K. CPUE VIId	Belgian CPUE VIId	U.K. VIIe		U.K. VIId	Belgian VIId	
1971	4 279	4.25	-	-	1 007		-	-	
1972	3 242	3.59	-	3.5	903		-	926	
1973	3 135	3.06	-	6.9	1 025	1 007	-	454	518
1974	3 157	2.90	-	8.3	1 089		-	380	
1975	2 823	2.79	3.21	9.0	1 012		879	314	
1976	2 572	2.80	5.09	8.2	919		505	314	
1977	2 888	2.45	3.22	6.1	1 179		897	473	
1978	2 896	3.22	4.96	6.4	899		584	452	

Table 6.3 Division VIId and VIIe PLAICE

Age composition of total catch in 1971-1978 (thousands) (males)

AGE	1971	1972	1973	1974	1975	1976
1	.4	20.9	3.0	29.0	2.9	324.3
2	465.2	347.9	132.5	80.7	1444.9	451.8
3	2211.2	1918.8	844.4	324.3	1047.9	1016.4
4	872.2	720.5	2501.2	381.9	536.9	287.7
5	531.5	314.9	782.0	150.3	301.6	129.0
6	361.7	443.4	164.7	36.9	65.6	68.2
7	228.1	172.9	98.6	35.4	33.9	71.8
8	205.3	27.6	7.5	18.2	37.7	25.4
9	156.5	57.2	4.5	3.0	17.6	17.2
10	8.1	6.3	40.0	.7	45.9	13.7
11	1.4	28.4	2.5	40.5	24.9	14.1
12	12.5	1.8	.1	.4	22.2	10.8
13 +	4.4	9.4	14.0	.5	4.4	36.0

AGE	1977	1978
1	46.0	122.7
2	2057.0	1271.2
3	520.8	1697.1
4	363.4	127.1
5	119.1	69.5
6	112.2	43.7
7	37.3	39.5
8	52.7	14.7
9	12.4	12.9
10	24.7	1.2
11	17.3	2.8
12	4.1	9.2
13 +	49.2	8.6

Table 6.4 Division VIId and VIIe PLAICE

Fishing mortality 1971-1978 (M = 0.15) (males)

AGE	1971	1972	1973	1974	1975	1976	1977	1978
1	.000	.010	.001	.008	.002	.054	.012	.040
2	.072	.145	.076	.041	.572	.413	.516	.500
3	.721	.440	.574	.255	.971	.988	1.137	1.030
4	.712	.512	1.735	.524	.810	.744	1.200	.920
5	.454	.572	1.782	.402	.991	.430	.757	.730
6	.669	.810	.633	.322	.290	.593	.779	.660
7	.557	.752	.391	.250	.519	.554	.720	.660
8	.462	.111	.059	.109	.433	.892	.990	.660
9	1.987	.212	.023	.029	.138	.339	1.658	.660
10	.217	.356	.213	.004	.713	.144	1.100	.660
11	.042	3.163	.220	.326	.187	.466	.257	.310
12	.530	.066	.101	.047	.282	.110	.225	.200
13	.200	.200	.200	.200	.200	.200	.200	.200

MEAN F FOR AGES >= 3 AND <= 13 (WEIGHTED BY STOCK IN NUMBERS)

.669	.494	1.179	.320	.788	.754	.982	.966

Table 6.5 Division VIId and VIIe PLAICE

Stock in numbers (thousands) 1971-1978 (males)

AGE	1971	1972	1973	1974	1975	1976
1	3224.2	2275.7	2526.9	4151.6	1665.0	6694.8
2	7212.8	2774.8	1939.3	2172.1	3546.5	1430.4
3	4594.1	5777.3	2066.4	1546.5	1794.8	1722.7
4	1828.7	1922.8	3203.8	1001.4	1031.5	585.0
5	1558.8	772.7	991.4	486.4	510,3	395.1
6	791.6	851.8	375.2	143.6	280.0	163.0
7	571.3	348.9	326.3	171.5	89.5	180.4
8	594.1	281.7	141.5	189.9	114.9	45.8
9	190.8	322.1	216.9	114.9	146.6	64.1
10	44.6	22.5	224.4	182.5	96.1	109.9
11	36.8	30.9	13.6	156.2	156.5	40.5
12	32.5	30.4	1.1	9.4	97.0	111.6
13	7.7	16.5	24.5	.9	7.7	63.0

AGE	1977	1978
1	4066.7	3368.1
2	5461.9	3457.6
3	814.5	2806.7
4	552.0	225.0
5	239.3	143.2
6	221.1	96.6
7	77.6	87.3
8	89.2	32.5
9	16.2	28.5
10	39.3	2.7
11	81.9	11.3
12	21.9	54.5
13	86.1	15.1

Table 6.6 Division VIId and VIIe PLAICE

Age composition of total catch in 1971-1978 (thousands) (females)

AGE	1971	1972	1973	1974	1975	1976
1	0	2	1	9	1	196
2	198	253	68	476	983	355
3	851	717	679	1716	994	1040
4	330	400	861	794	402	475
5	344	215	498	1324	316	286
6	316	340	203	336	235	185
7	309	51	74	223	86	188
8	574	221	17	65	66	70
9	153	134	111	99	33	30
10	280	85	102	183	38	42
11	142	35	12	106	18	17
12	142	105	24	88	85	24
13+	180	273	12	90	105	211

AGE	1977	1978
1	51	34
2	1964	588
3	616	1412
4	584	142
5	271	169
6	81	53
7	47	57
8	83	61
9	52	32
10	23	17
11	26	22
12	12	6
13+	100	106

Table 6.7 Division VIId and VIIe PLAICE

Fishing mortality 1971-1978 (M = 0.10) (females)

AGE	1971	1972	1973	1974	1975	1976	1977	1978
1	.00	.00	.00	.00	.00	.04	.03	.01
2	.04	.09	.02	.19	.36	.30	.53	.40
3	.36	.19	.31	.91	.67	.69	1.11	.82
4	.25	.25	.32	.62	.49	.70	.96	.73
5	.37	.23	.51	1.01	.48	.69	1.01	.73
6	.43	.67	.32	.68	.42	.50	.37	.47
7	.29	.10	.26	.60	.32	.61	.20	.43
8	.46	.31	.04	.35	.32	.41	.53	.39
9	.31	.16	.22	.30	.26	.21	.54	.35
10	.81	.25	.16	.60	.16	.55	.22	.31
11	.72	.19	.05	.22	.09	.09	.69	.30
12	.31	1.98	.17	.46	.25	.16	.08	.30
13	.30	.30	.30	.30	.30	.30	.30	.30

MEAN F FOR AGES >= 3 AND <= 13 (WEIGHTED BY STOCK IN NUMBERS)

.38	.26	.30	.74	.47	.59	.78	.71

Table 5.8 Division VIIe SOLE (females)
Stock in numbers (thousands)

AGE	1969	1970	1971	1972	1973	1974
2	1116	779	1831	1421	909	1801
3	1357	966	681	1637	1233	781
4	414	1005	747	510	1248	923
5	571	311	743	526	382	863
6	1300	415	238	533	366	275
7	371	1020	297	172	392	264
8	386	320	828	223	137	242
9	273	318	276	615	184	121
10	245	238	272	243	499	146
11	198	206	183	216	201	422
12	257	166	171	148	168	177
13	137	226	140	136	122	134
14	158	123	188	113	120	103
15	66	129	103	157	100	104
16	52	55	101	86	129	86
17	57	42	46	87	71	114
18	29	44	38	39	76	64
19	34	25	39	33	31	57
20	29	28	20	27	28	27
21	9	26	24	14	22	24

AGE	1975	1976	1977	1978
2	1296	1222	2776	2485
3	1588	1155	1042	2419
4	506	1183	889	763
5	729	342	610	596
6	672	544	225	611
7	198	560	404	145
8	212	169	449	318
9	188	157	143	346
10	88	151	119	122
11	112	63	116	93
12	366	91	48	85
13	147	313	79	35
14	111	120	241	60
15	87	85	100	197
16	85	71	65	87
17	72	72	52	47
18	100	56	51	38
19	51	80	46	41
20	46	44	58	39
21	22	39	36	44

Table 6.8 Division VIId and VIIe PLAICE
Stock in numbers (thousands), 1971-1978 (females)

AGE	1971	1972	1973	1974	1975	1976
1	3586	3733	3154	3805	1582	5694
2	5078	3245	3375	2853	3434	1431
3	2957	4407	2695	2989	2130	2175
4	1550	1868	3307	1795	1085	987
5	1161	1090	1311	2176	873	601
6	948	724	782	715	720	491
7	1292	559	334	515	329	429
8	1634	876	457	232	255	217
9	607	935	583	397	149	168
10	525	404	719	422	266	104
11	288	211	285	554	209	204
12	550	126	158	247	401	172
13	240	363	16	120	140	282

AGE	1977	1978
1	2118	3275
2	4965	1868
3	958	2633
4	985	286
5	444	341
6	274	147
7	269	171
8	211	199
9	130	112
10	124	68
11	54	90
12	169	25
13	133	142

Table 6.9 English Channel VIIe and VIId PLAICE

Weight at age data (derived from the mean of the VIId and VIIe stock weights used in the 1978 Report; catch weights by interpolation (kg).

Age	Male		Female	
	Catch	Stock	Catch	Stock
1	0.218	0.180	0.248	0.200
2	0.290	0.255	0.342	0.295
3	0.355	0.325	0.435	0.390
4	0.408	0.385	0.522	0.480
5	0.450	0.430	0.605	0.565
6	0.485	0.470	0.685	0.645
7	0.515	0.500	0.762	0.725
8	0.540	0.530	0.836	0.800
9	0.560	0.550	0.907	0.872
10	0.579	0.570	0.976	0.942
11	0.595	0.588	1.041	1.010
12	0.620	0.602	1.104	1.072
13+	0.650	0.637	1.300	1.137

N.B. The value for 13+ year olds was estimated on the basis of the extended growth curves and the abundance in recent catches.

Table 6.10 English Channel PLAICE

Data used for catch prognosis and yield curves

Age	Males (M = 0.15)				Females (M = 0.1)			
	Prop. F	N_{78}	Stock weight at age a)	Catch weight b)	Prop. F	N_{78}	Stock weight at age a)	Catch weight b)
1	0.039	3 300*	0.180	0.218	0.013	3 300*	0.200	0.248
2	0.485	3 458	0.255	0.290	0.488	1 868	0.295	0.342
3	1.000	2 807	0.325	0.355	1.000	2 633	0.390	0.435
4	0.893	225	0.385	0.408	0.890	286	0.480	0.522
5	0.709	143	0.430	0.450	0.890	341	0.565	0.605
6	0.641	97	0.470	0.485	0.573	147	0.645	0.685
7	0.641	87	0.500	0.515	0.524	171	0.725	0.762
8	0.641	32	0.530	0.540	0.476	199	0.800	0.836
9	0.641	29	0.550	0.560	0.427	112	0.872	0.907
10	0.641	3	0.570	0.579	0.378	68	0.942	0.976
11	0.301	11	0.588	0.595	0.366	90	1.010	1.041
12	0.194	55	0.602	0.620	0.366	25	1.072	1.104
13+	0.194	51	0.637	0.650	0.366	421	1.137	1.300

*) average recruitment year classes 1970-1973

a) Stock weight used in prediction of spawning stock biomass

b) Catch weight used in prediction of catch

Table 6.11 English Channel PLAICE

Prediction of catch and spawning stock biomass. Sexes combined

Year	Option 1			Option 2		
	F	Catch	Spawning Stock Biomass	F	Catch	Spawning Stock Biomass
1978	F_{78}	2 894	3 167	F_{78}	2 896	2 731
1979	F_{78}	2 467	2 935	F_{78}	2 491	2 921
1980	F_{78}	2 350	2 311	$F_{max}=0.8F_{78}$	1 995	2 297
1981			2 119			2 403

Table 8.1 By-catches of undersized protected fish in Federal Republic of Germany shrimp fishery (in millions of fish). (The figures do not take survived discards into account).

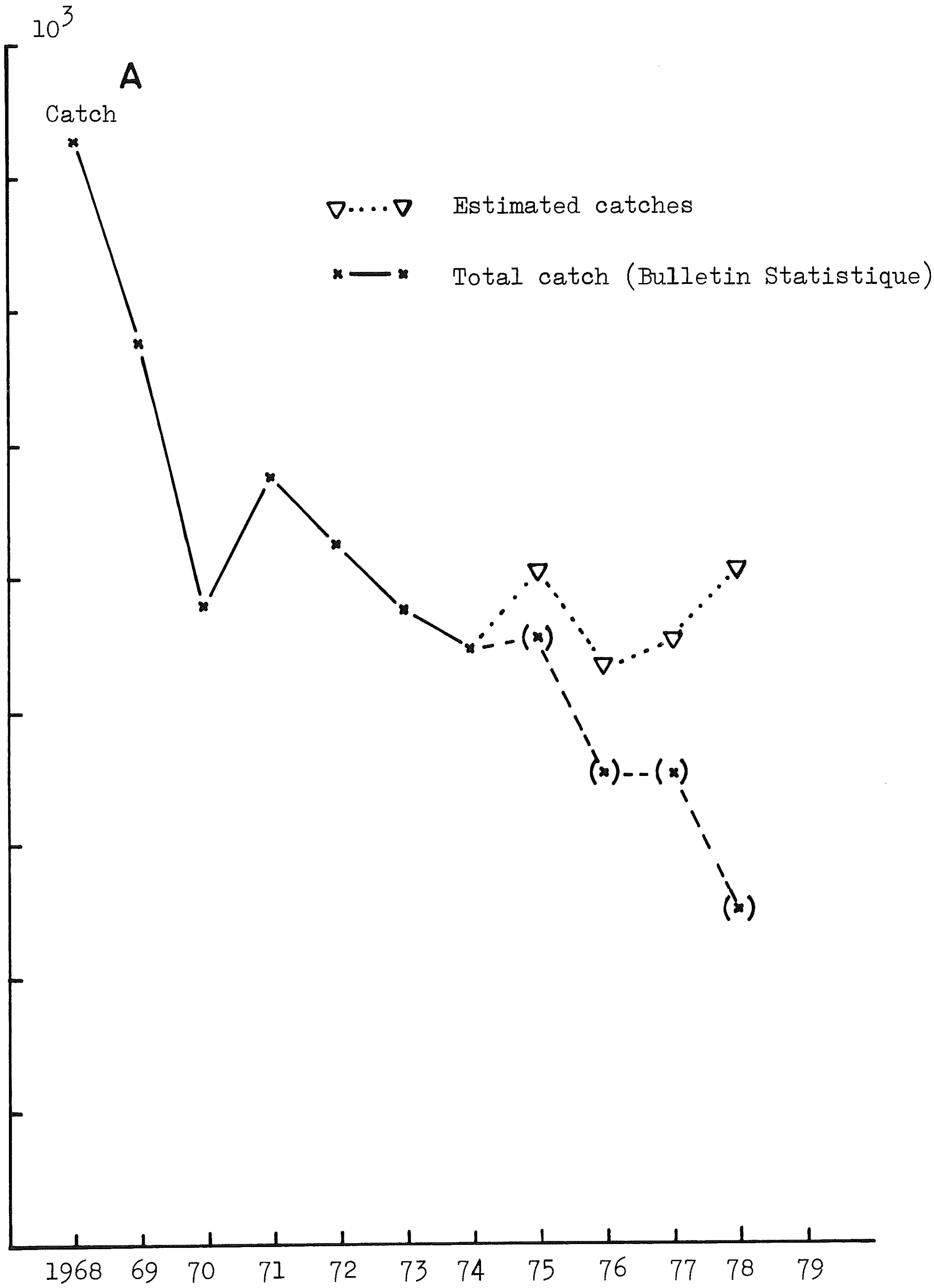
Year	Plaice	Sole	Dab	Whiting	Cod
1954	274	88	60	3	1
1955	136	69	35	4	1
1956	138	53	39	9	1
1957	247	47	39	23	14
1958	259	94	37	9	5
1959	281	77	54	109	9
1960	172	66	67	32	4
1961	140	45	96	40	6
1962	160	112	27	12	1
1963	310	20	74	22	11
1964	137	53	113	26	10
1965	154	52	64	22	3
1966	164	50	103	12	21
1967	144	98	88	26	2
1968	119	106	150	7	5
1969	163	51	78	14	30
1970	133	37	84	11	97
1971	76	40	97	2	2
1972	97	22	93	6	2
1973	112	34	172	9	1
1974	155	19	145	28	6
1975	67	19	136	2	2
1976	230	11	201	44	26
1977	235	43	172	36	40
1978	437	41	269	16	34
Average 1954-1978	181	53	99	21	13

Table 8.2 Comparison of normal beam trawl with a selective one. Catch in grammes/hour (see Anon. 1979)

	Normal Beam Trawl	Selective Beam Trawl	
Species	Average of 8 hauls (grams)	Average of 9 hauls (grams)	Loss in %
Shrimps	102 021	97 006	5
Plaice	2 427	70	98
Sole	291	54	81
Flounder	1 389	-	100
Dab	10 673	214	98

Table 8.3 Estimated number of flatfish caught by the Danish and German (Federal Republic of) *Crangon* boats (in millions)

Year	Plaice		Sole		Dab	
	Denmark	Germany, F.R.	Denmark	Germany, F.R.	Denmark	Germany, F.R.
1975	4	67	-	19	63	136
1976	4	230	-	11	93	201
1977	6	235	-	43	22	172
1978	-	437	-	41	-	269



<u>Figure 2.1</u> North Sea SOLE

Total catch per year in the period 1968-1978

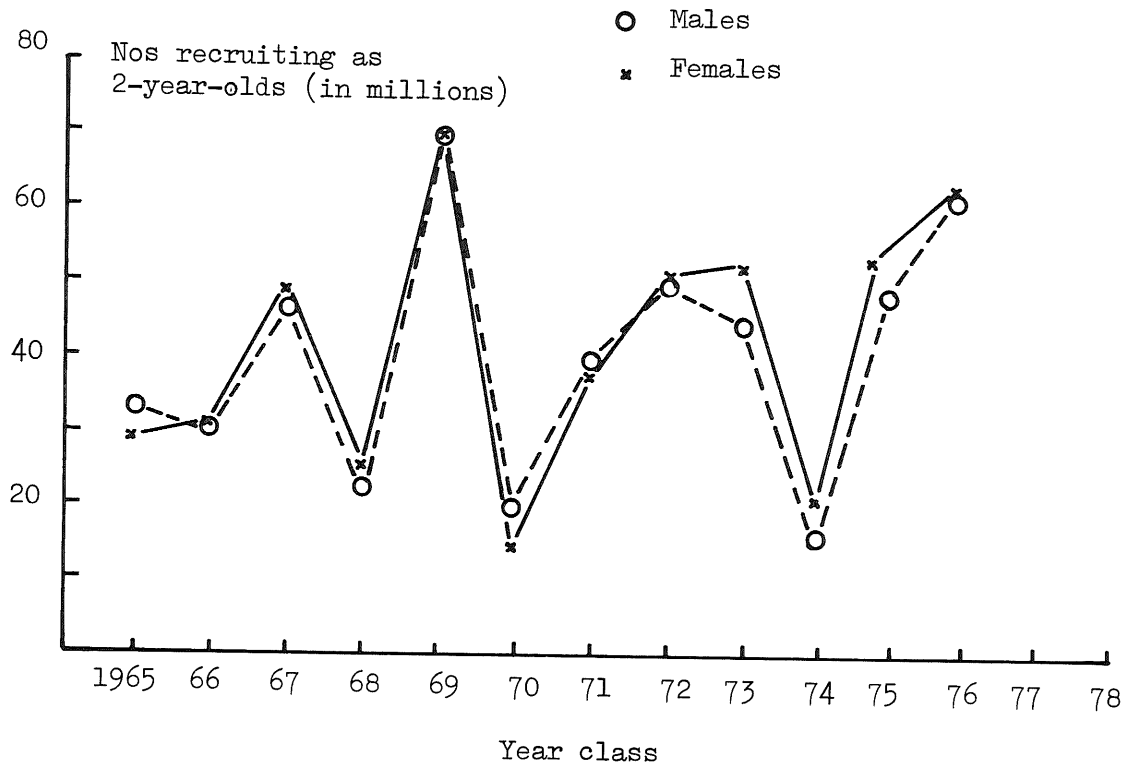
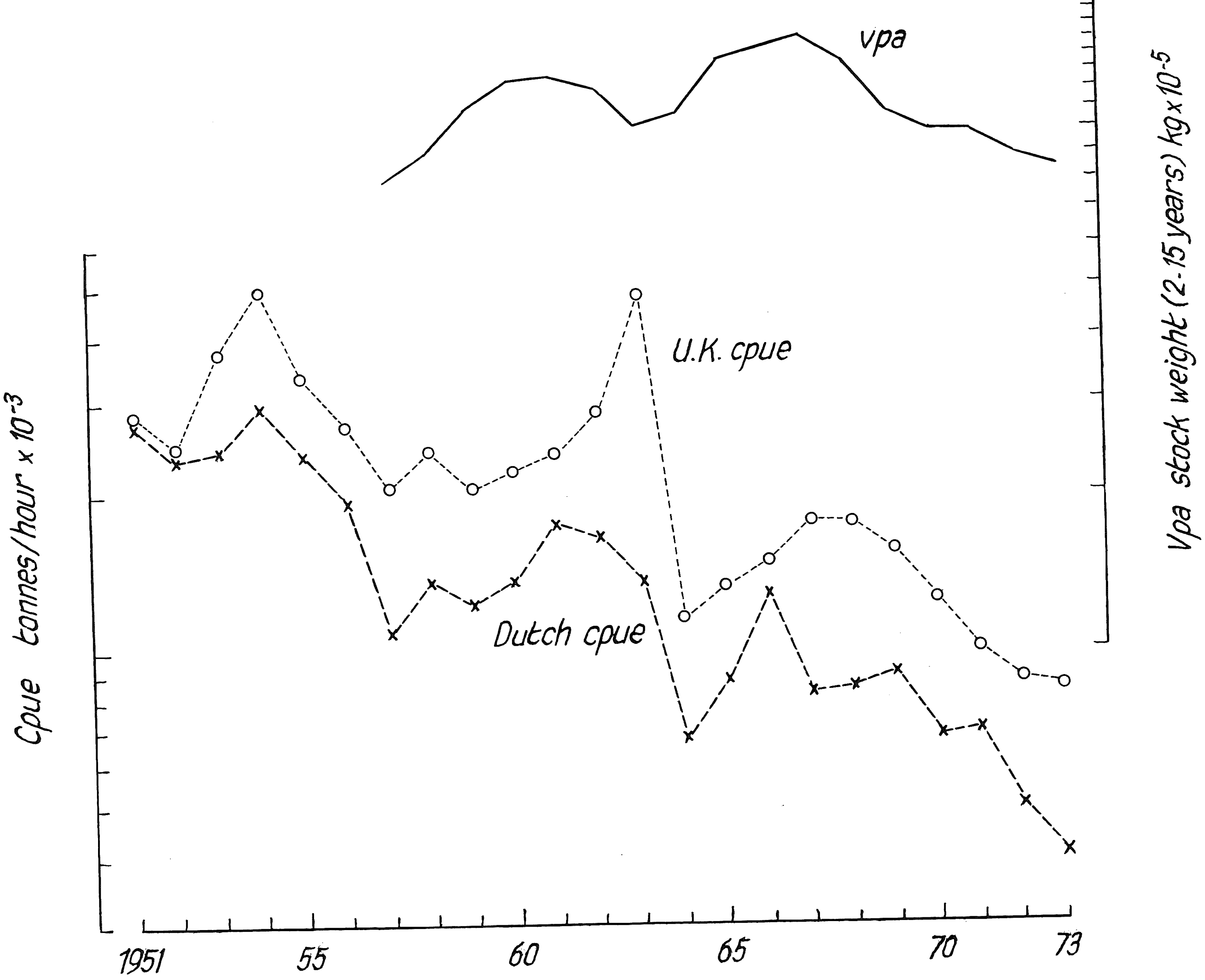


Figure 2.2 North Sea SOLE

Recruitment 1967-1977

Figure 2.3 North Sea SOLE

CPUE and Stock Trends



<u>Figure 2.4</u> North Sea SOLE

Stock biomass for different values of M for 1963

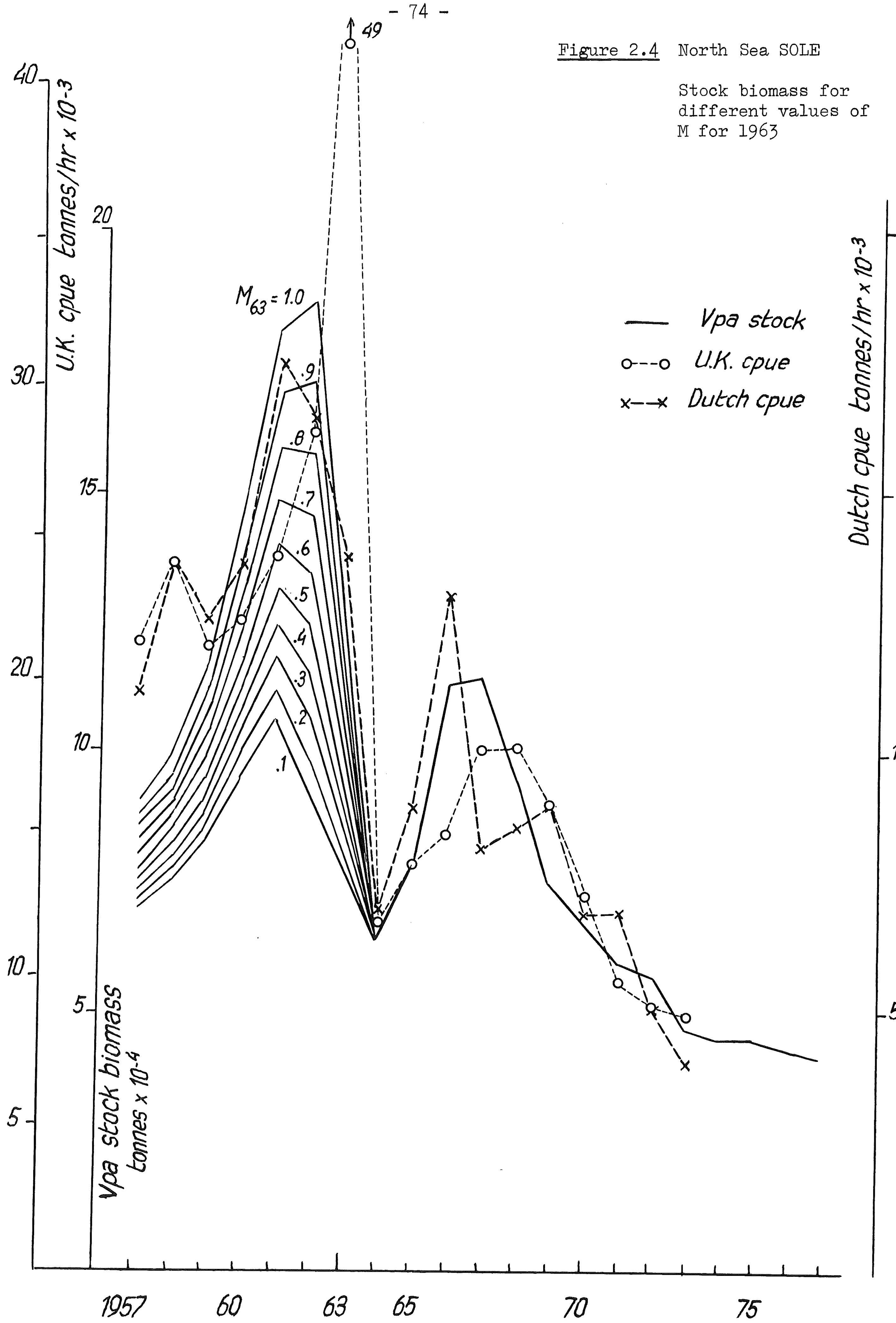
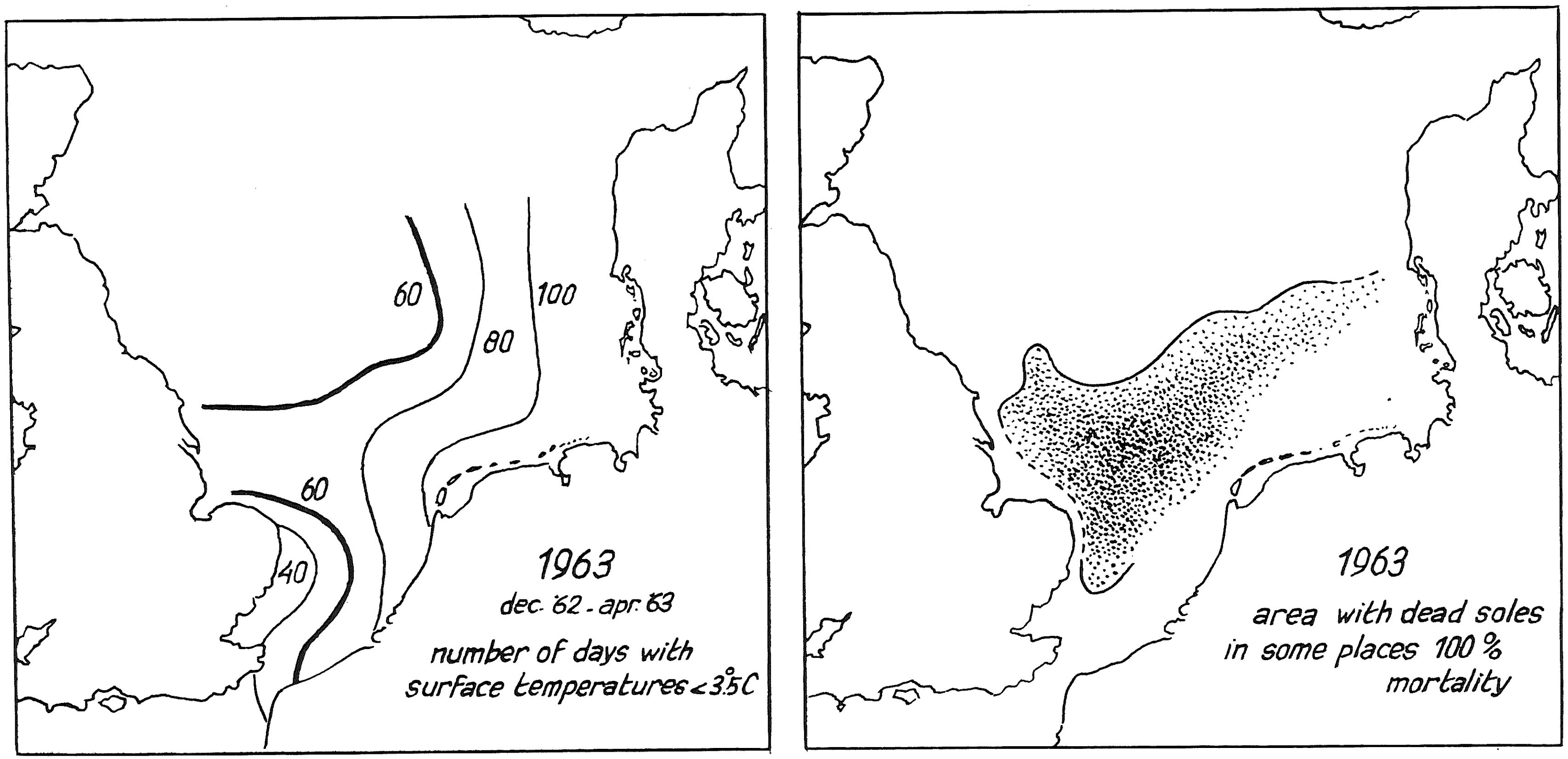


Figure 2.5 North Sea SOLE



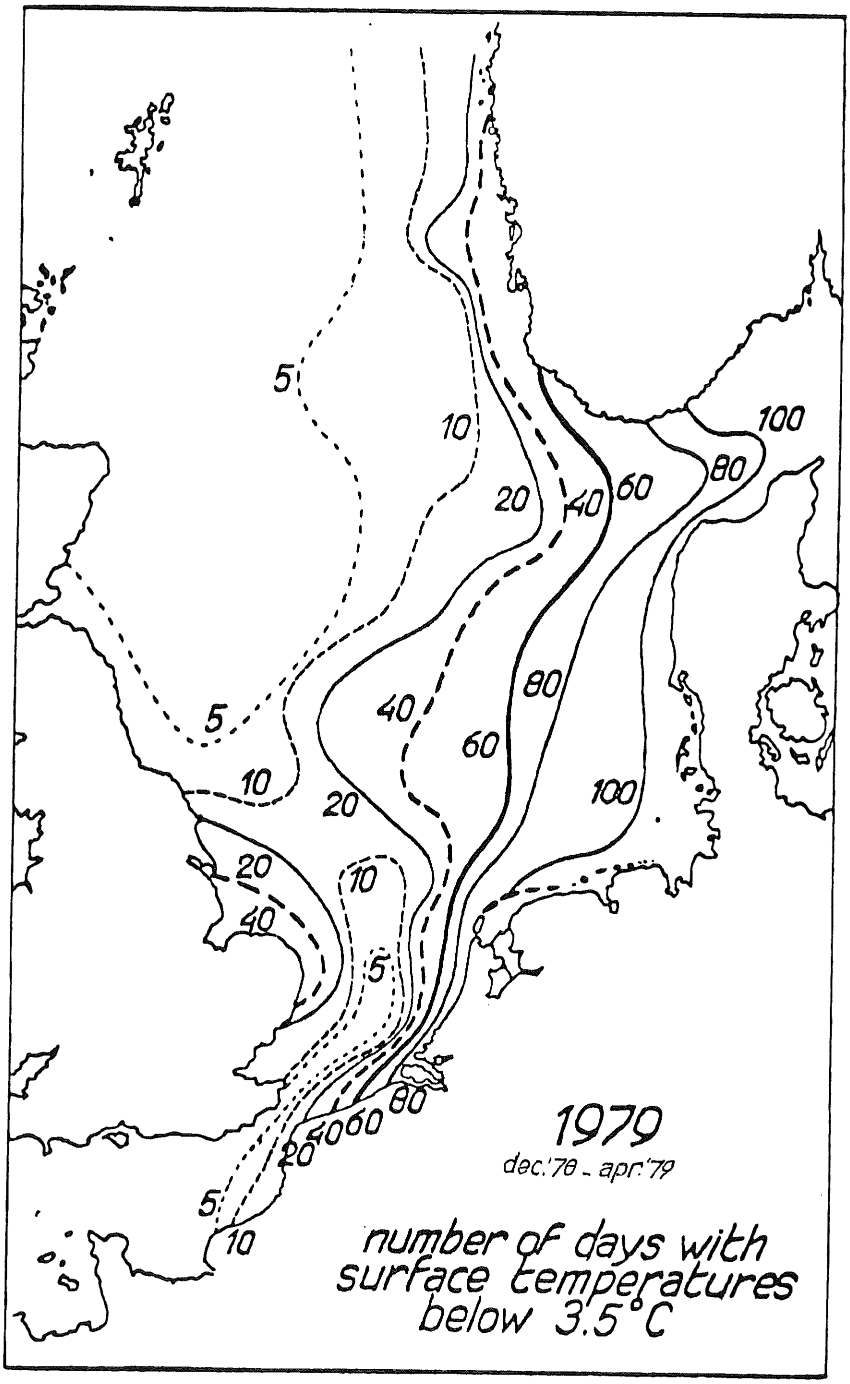
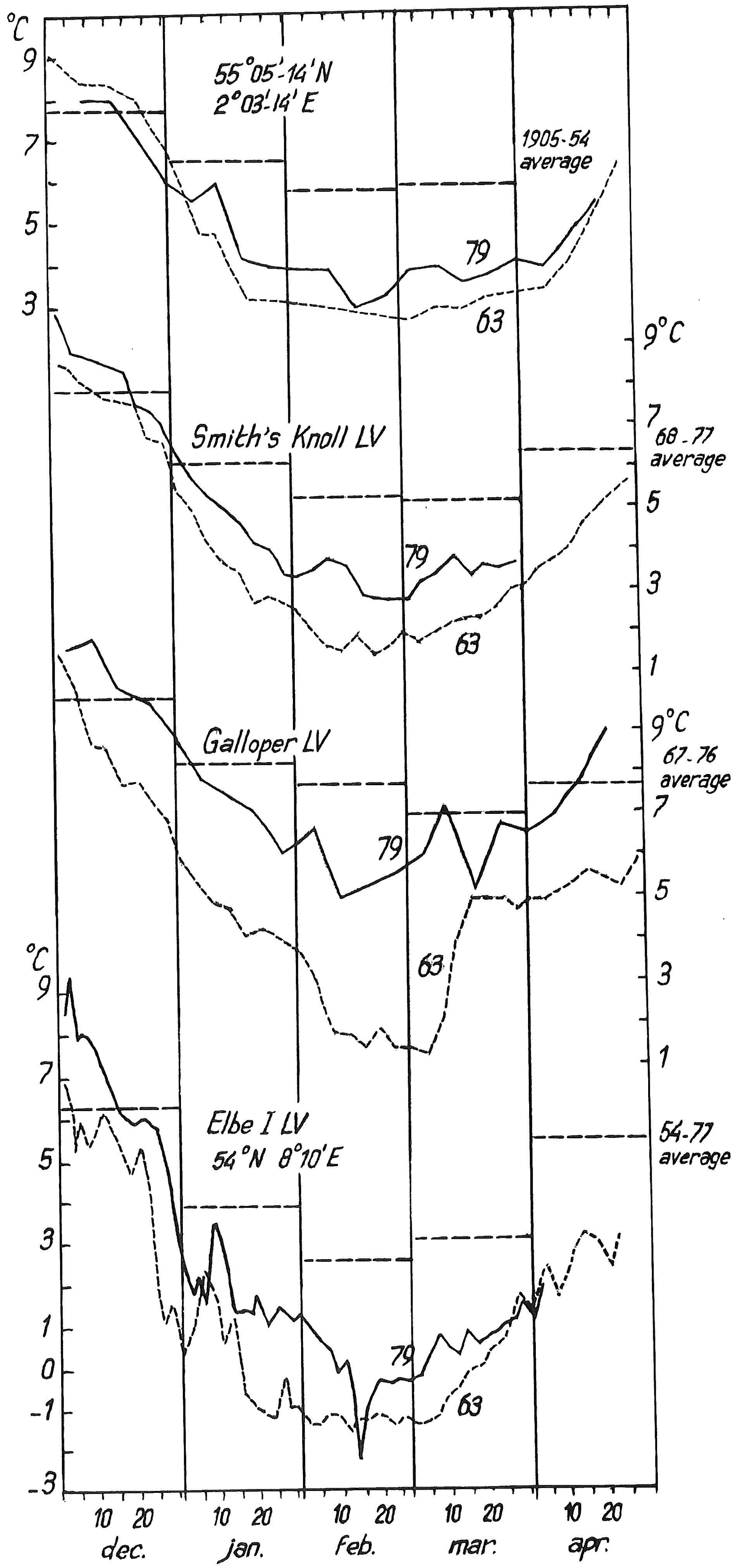


Figure 2.6 North Sea SOLE

Figure 2.7


°C
9
7
5
3
55°05'-14'N
2°03'-14'E
1905-54
average
79
63
9°C
7
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average
5
3
1
Smith's Knoll LV
79
63
9°C
67-76
average
7
5
3
1
Galloper LV
79
63
°C
9
7
5
3
1
0
-1
-3
Elbe I LV
54°N 8°10'E
54-77
average
79
63
10 20
dec.
10 20
jan.
10 20
feb.
10 20
mar.
10 20
apr.

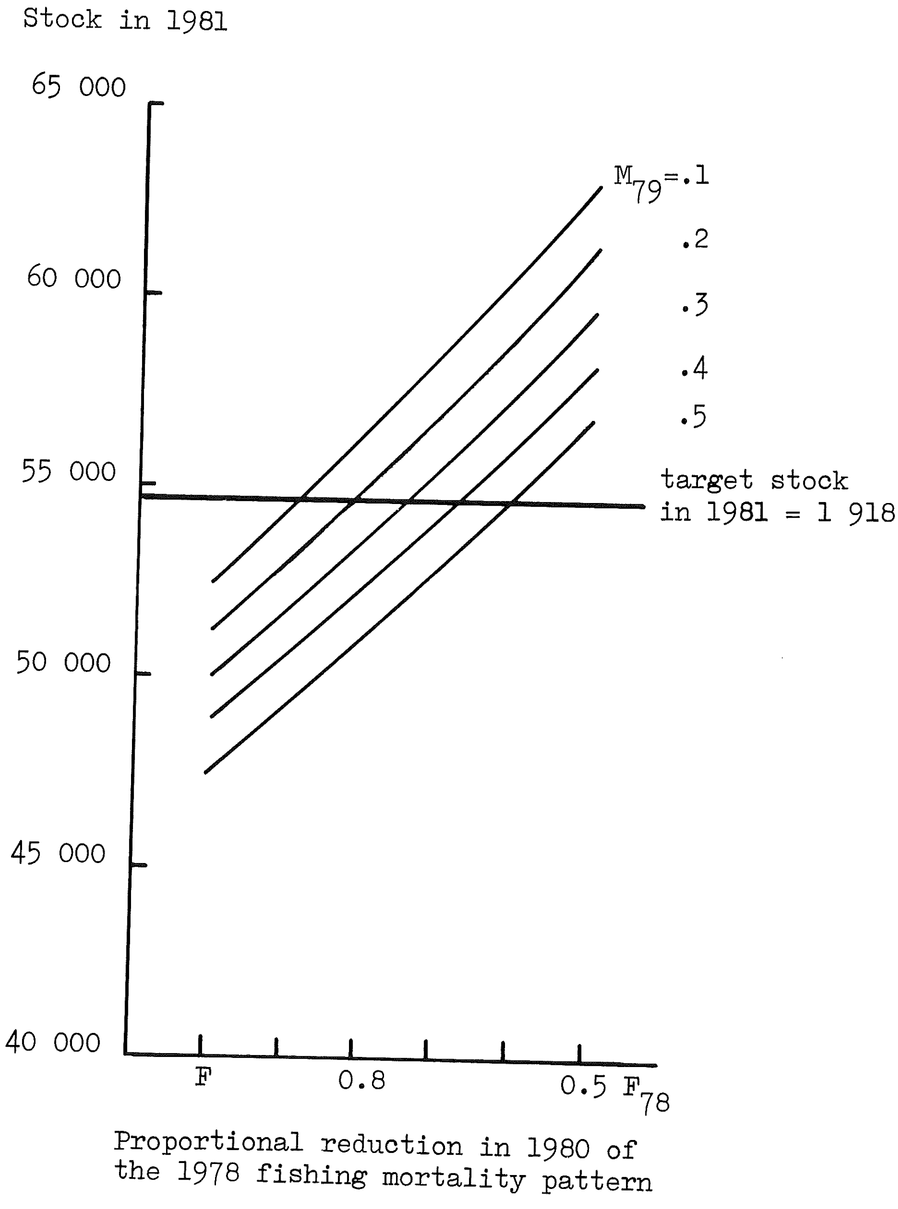


Figure 2.8 North Sea SOLE

Stock size prediction for different values of F and M

Figure 3.1 North Sea plaice

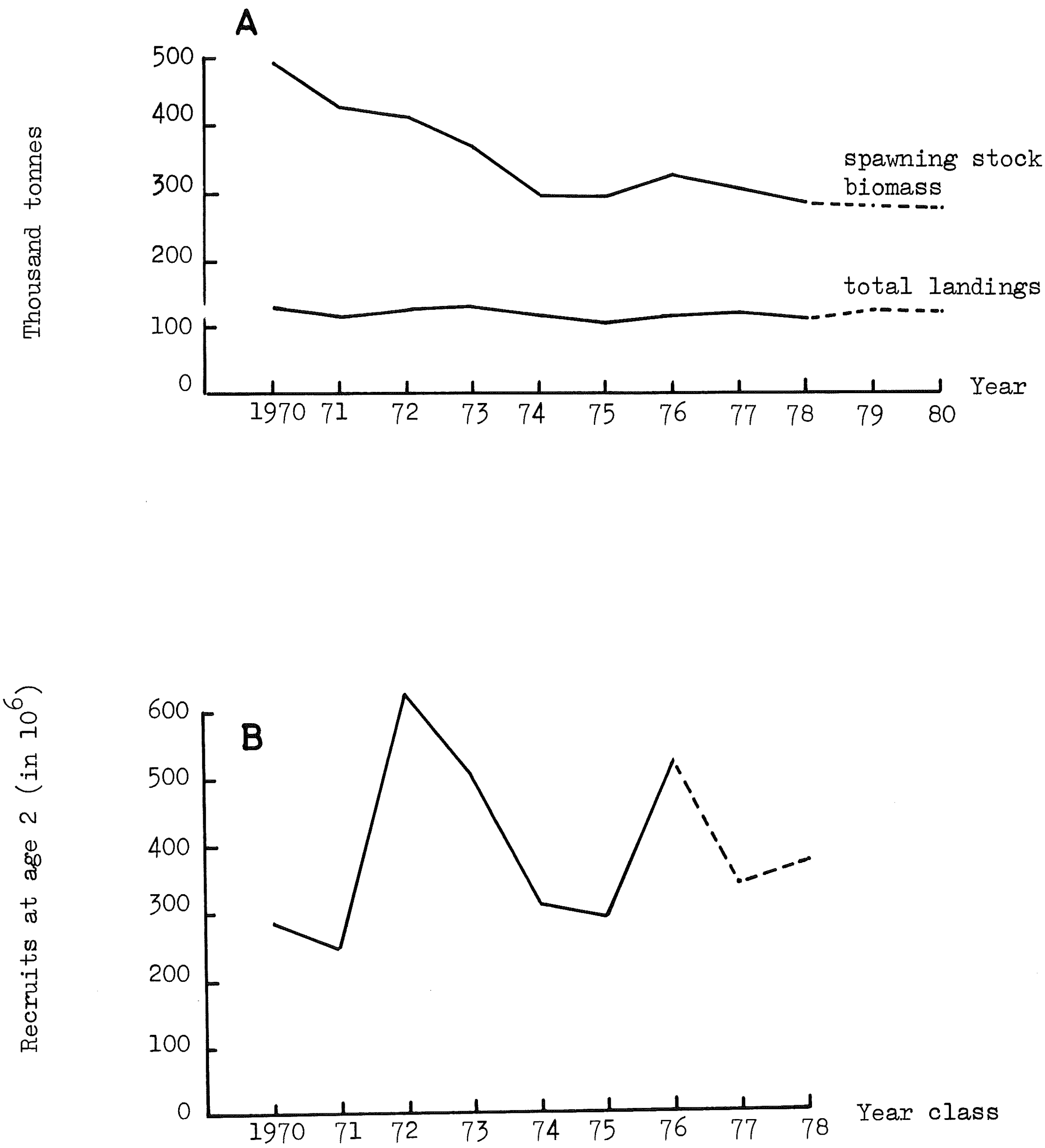


Figure 3.1 (continued)

Data for Equilibrium
Yield Curve

F	(Thousand tonnes whole weight)
0.1	46.746
0.2	70.290
0.3	83.564
0.4	91.648
0.5	96.853
0.6	100.363
0.7	102.829
0.8	104.591
0.9	105.869
1.0	106.864
1.1	107.615
1.2	108.204
1.3	108.668
1.4	109.052
1.5	109.332
1.6	109.592
1.7	109.771
1.8	109.987
1.9	110.122
2.0	110.257

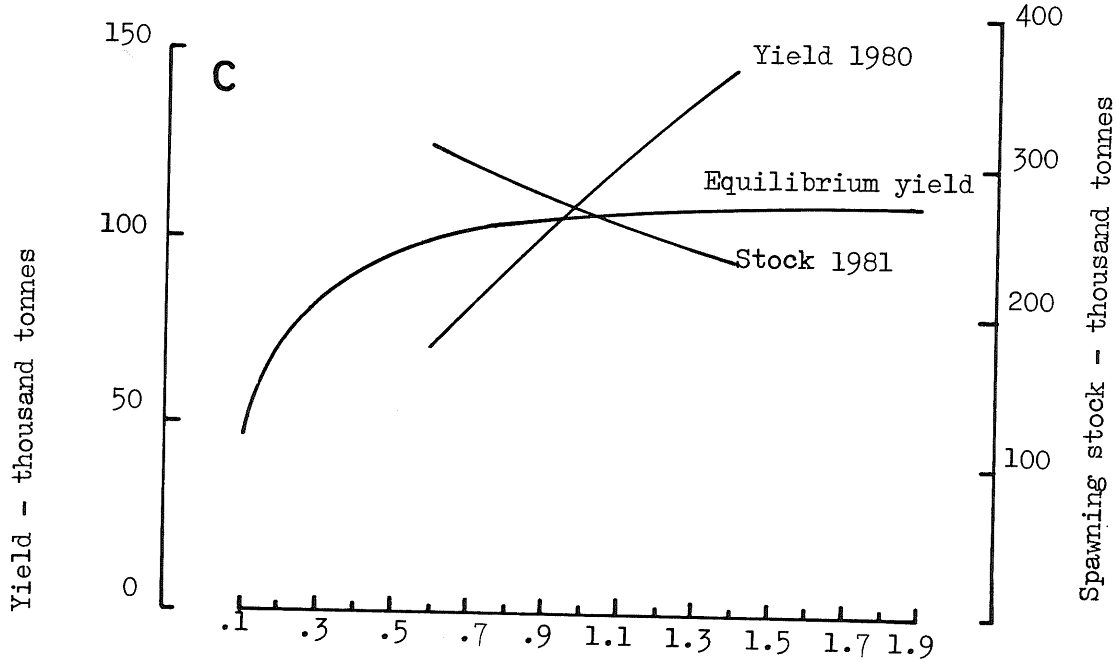
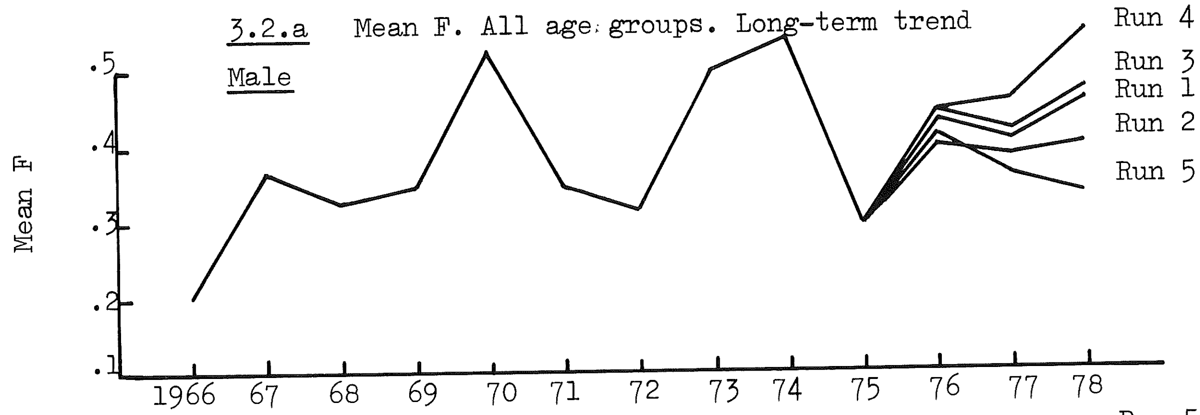
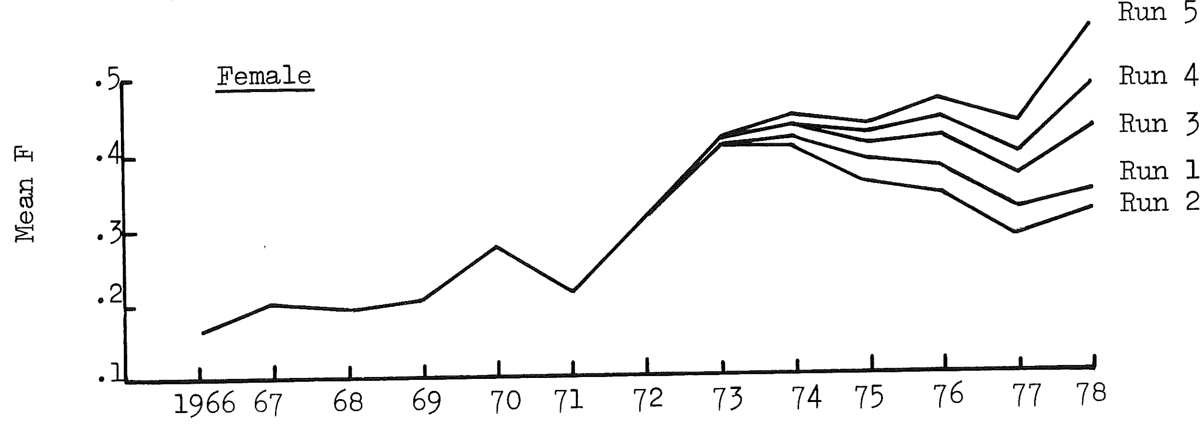


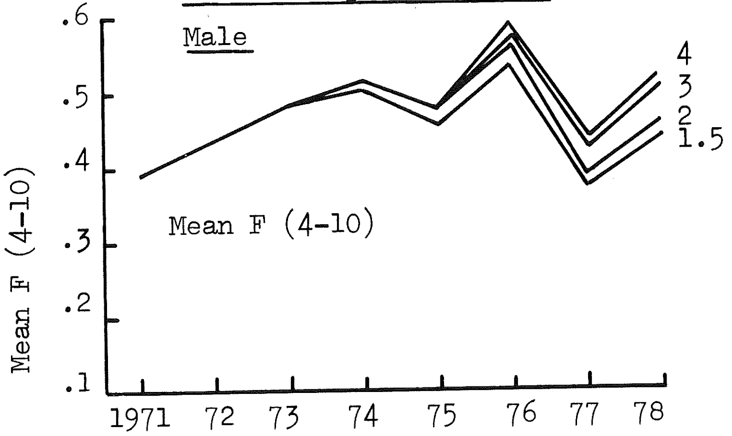
Figure 3.2 North Sea PLAICE. Results of trial VPA runs

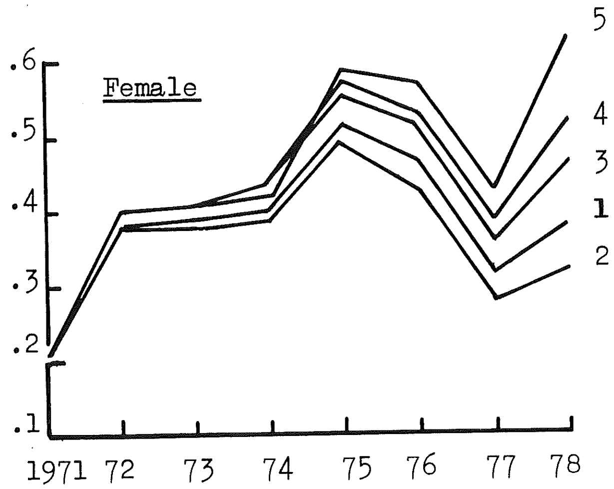
3.2.a Mean F. All age groups. Long-term trend



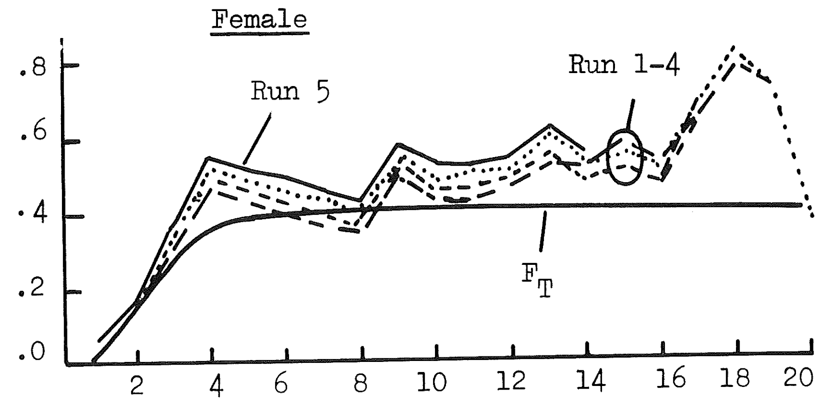


Mean F. Ages 4-10 only





3.2.b Exploitation patterns. Mean F at age for 1973-76. Forecast run



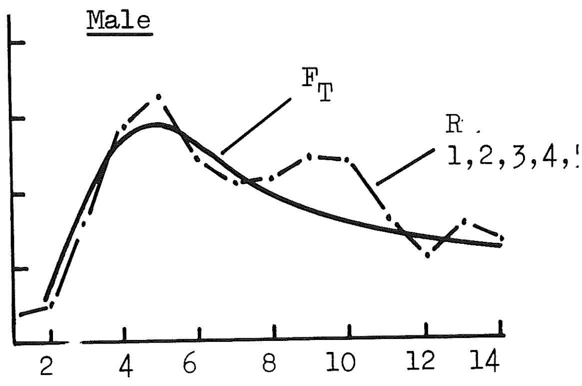


Figure 3.3 North Sea PLAICE

Trend in Fishing Effort 1971-1978

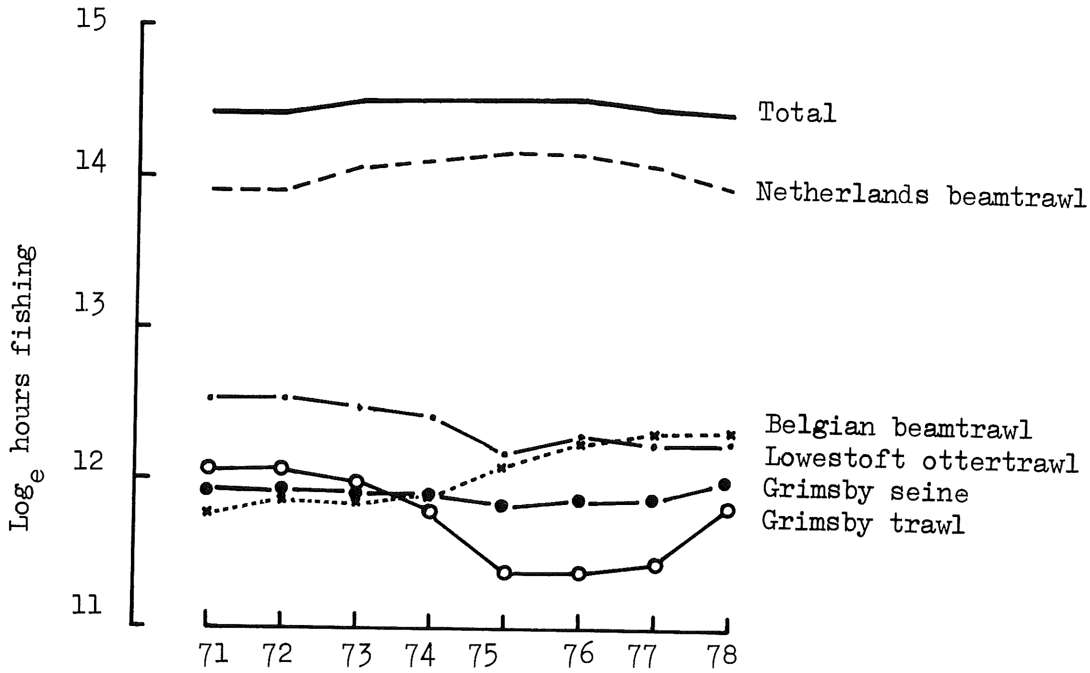


Figure 3.4 North Sea PLAICE

Trends in spawning stock biomass and catch per effort

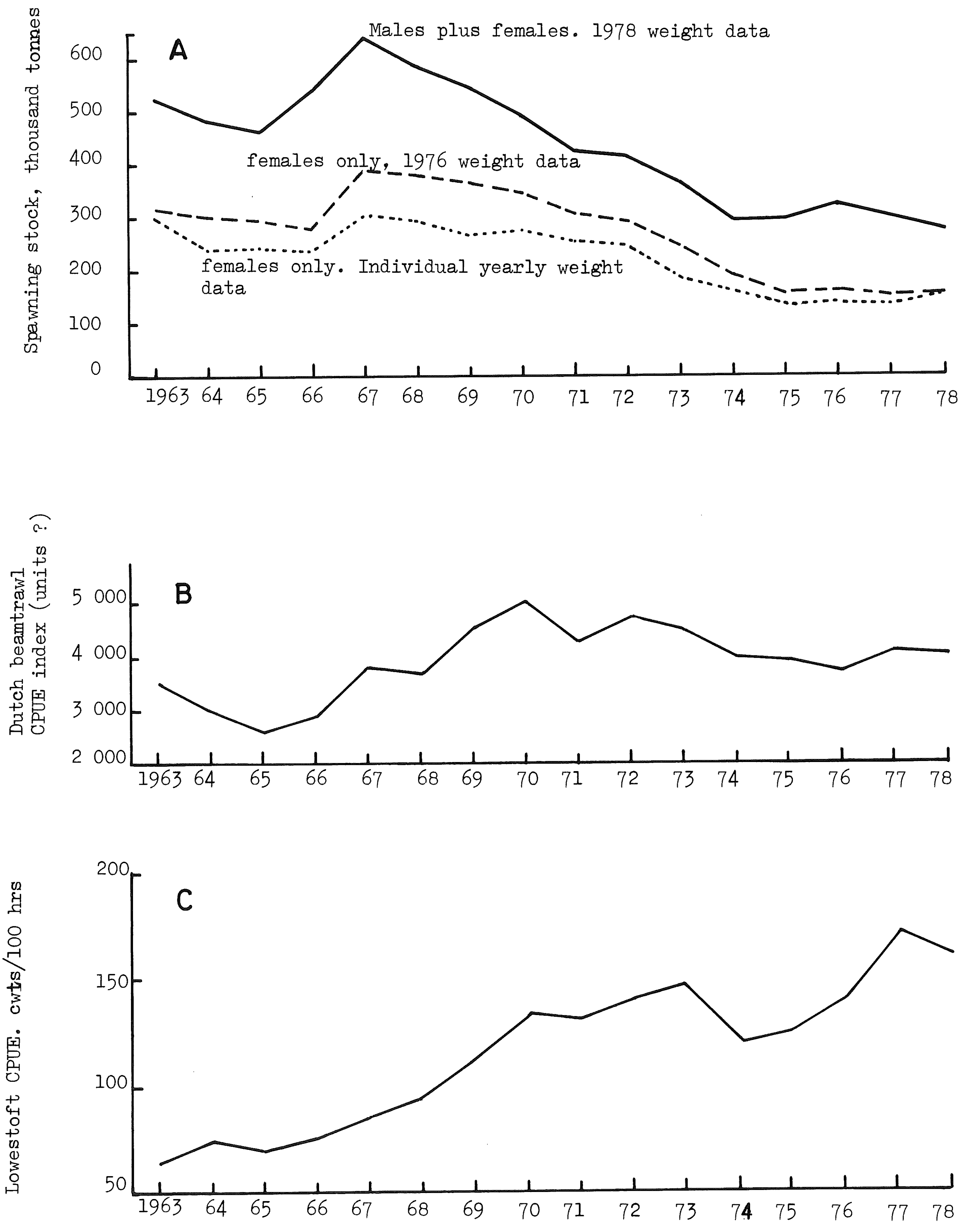
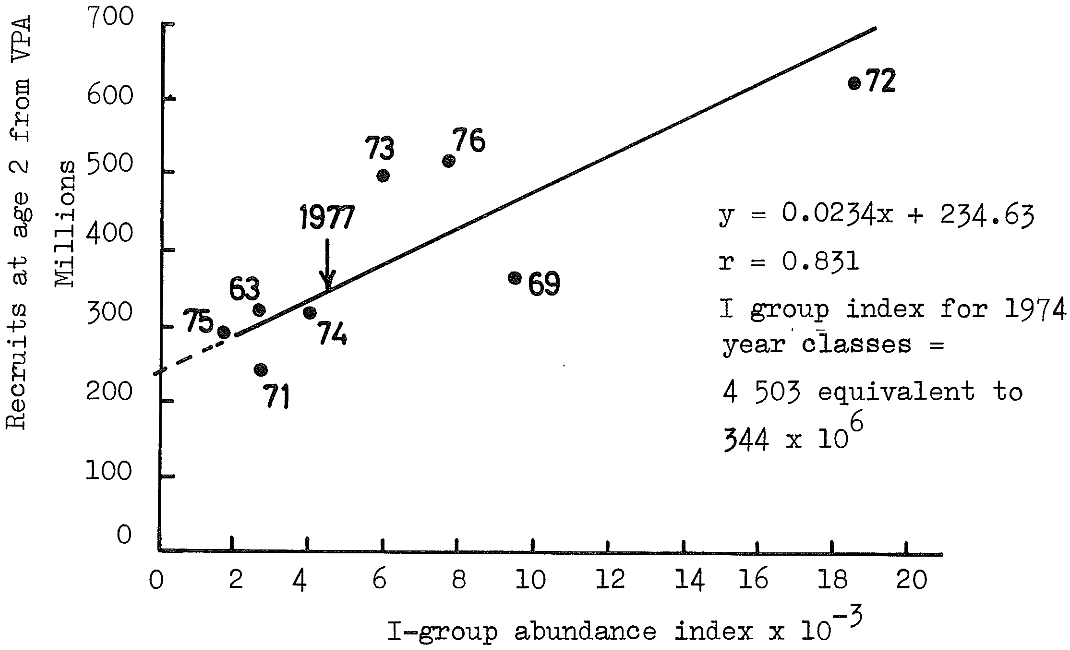


Figure 3.5 North Sea PLAICE

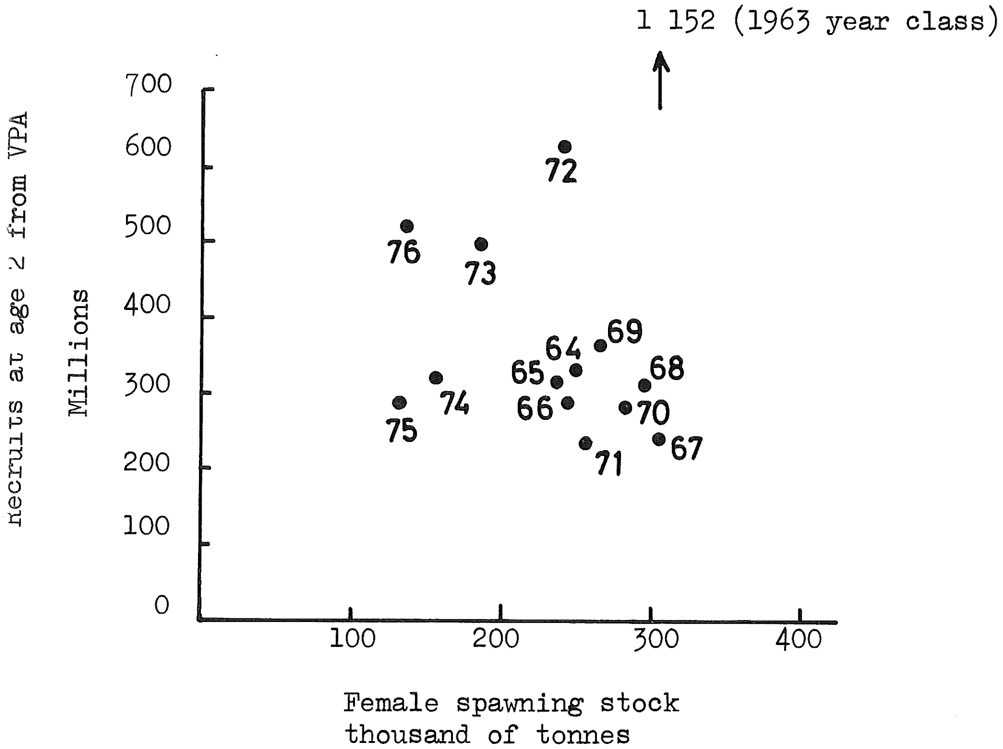
Relation between VPA and 1 Group pre-recruit survey estimates



Data for plotting		
Year	I-group	Recruit
1976	7 709	519
1975	1 713	297
1974	4 004	313
1973	6 017	509
1972	18 625	626
1971	2 746	242
1970	-	-
1969	9 670	364
1968	2 876	315

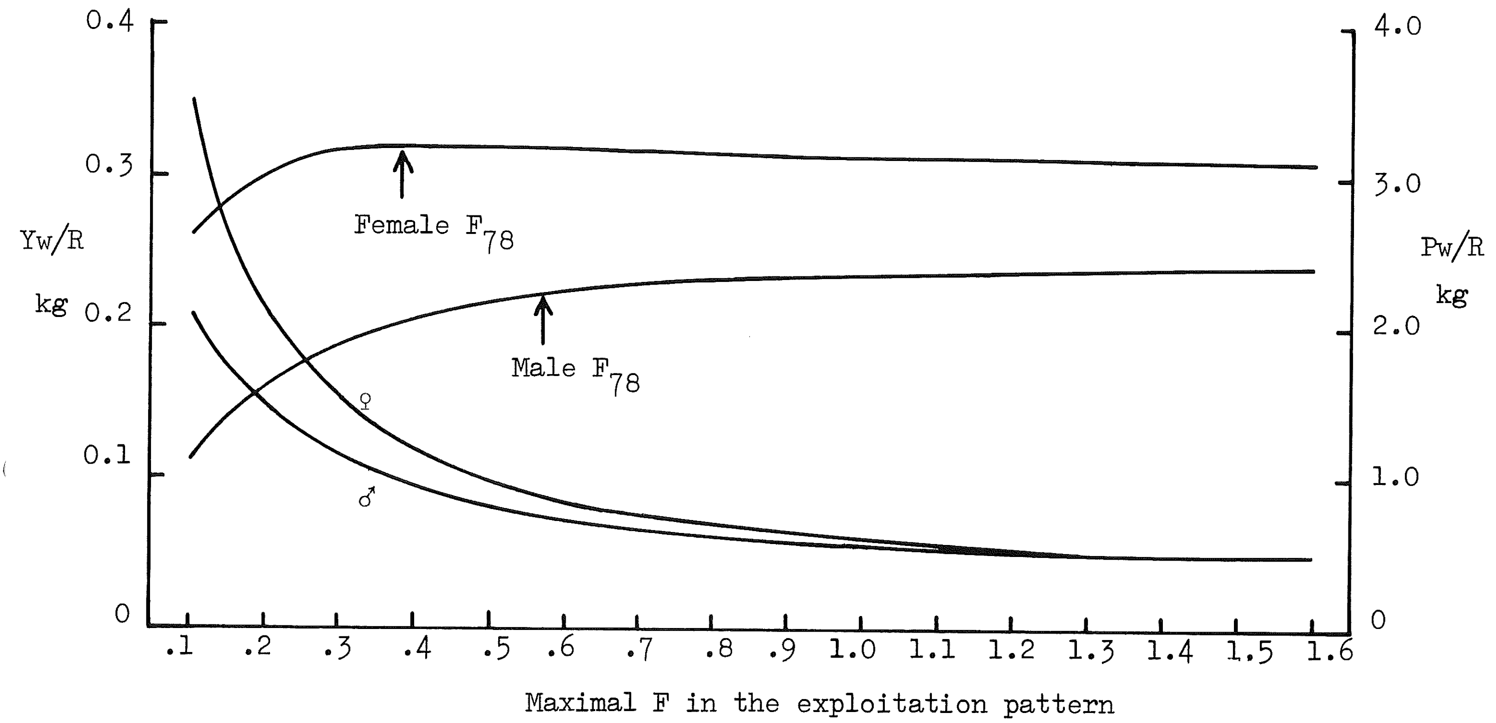
Figure 3.6 North Sea PLAICE

Relation between VPA recruits at age 2 and female spawning stock biomass. 1963-1976



Data for plotting		
Year	Spawning stock	Recruit
1963	303	1 152
1964	250	332
1965	242	318
1966	239	291
1967	308	242
1968	298	315
1969	268	364
1970	279	289
1971	259	242
1972	249	626
1973	185	500
1974	163	313
1975	140	297
1976	135	519

Figure 3.7 North Sea PLAICE
Yield per recruit curves



Data for Figure 3.7

F	Yw/Recruit (kg)		Pw/Recruit (kg)	
	Males	Females	Males	Females
0.1	0.111	0.262	2.075	3.439
0.2	0.163	0.305	1.482	2.102
0.3	0.189	0.316	1.155	1.514
0.4	0.206	0.319	0.959	1.196
0.5	0.216	0.319	0.832	0.999
0.6	0.222	0.318	0.745	0.367
0.7	0.227	0.317	0.682	0.773
0.8	0.231	0.316	0.634	0.702
0.9	0.234	0.315	0.597	0.646
1.0	0.236	0.314	0.567	0.602
1.1	0.238	0.314	0.542	0.566
1.2	0.239	0.313	0.521	0.535
1.3	0.240	0.312	0.502	0.509
1.4	0.242	0.311	0.486	0.487
1.5	0.243	0.311	0.472	0.467

N.B.
Not the same F values -
1st set is absolute F,
2nd set is F_{80}/F_{78}

Figure 3.8 North Sea PLAICE
Trend in Recruitment

North Sea Plaice Recruitment
Age 2, millions

Year class	Males	Females
1945	185.1	192.1
1946	163.6	179.7
1947	182.7	131.5
1948	139.9	145.9
1949	153.7	160.2
1950	146.8	155.2
1951	119.2	121.4
1952	135.6	154.2
1953	143.1	154.3
1954	171.9	180.9
1955	110.9	108.6
1956	154.4	145.9
1957	252.3	245.5
1958	280.6	231.8
1959	287.4	230.3
1960	236.5	184.6
1961	188.1	158.6
1962	186.4	168.4
1963	619.9	532.3
1964	170.4	161.8
1965	164.0	154.3
1966	140.6	150.8
1967	118.8	122.3
1968	164.8	149.9
1969	183.2	180.7
1970	157.0	132.2
1971	134.8	106.8
1972	368.0	257.8
1973	286.1	214.2
1974	170.8	142.1
1975	145.5	151.3
1976	306.4	213.0

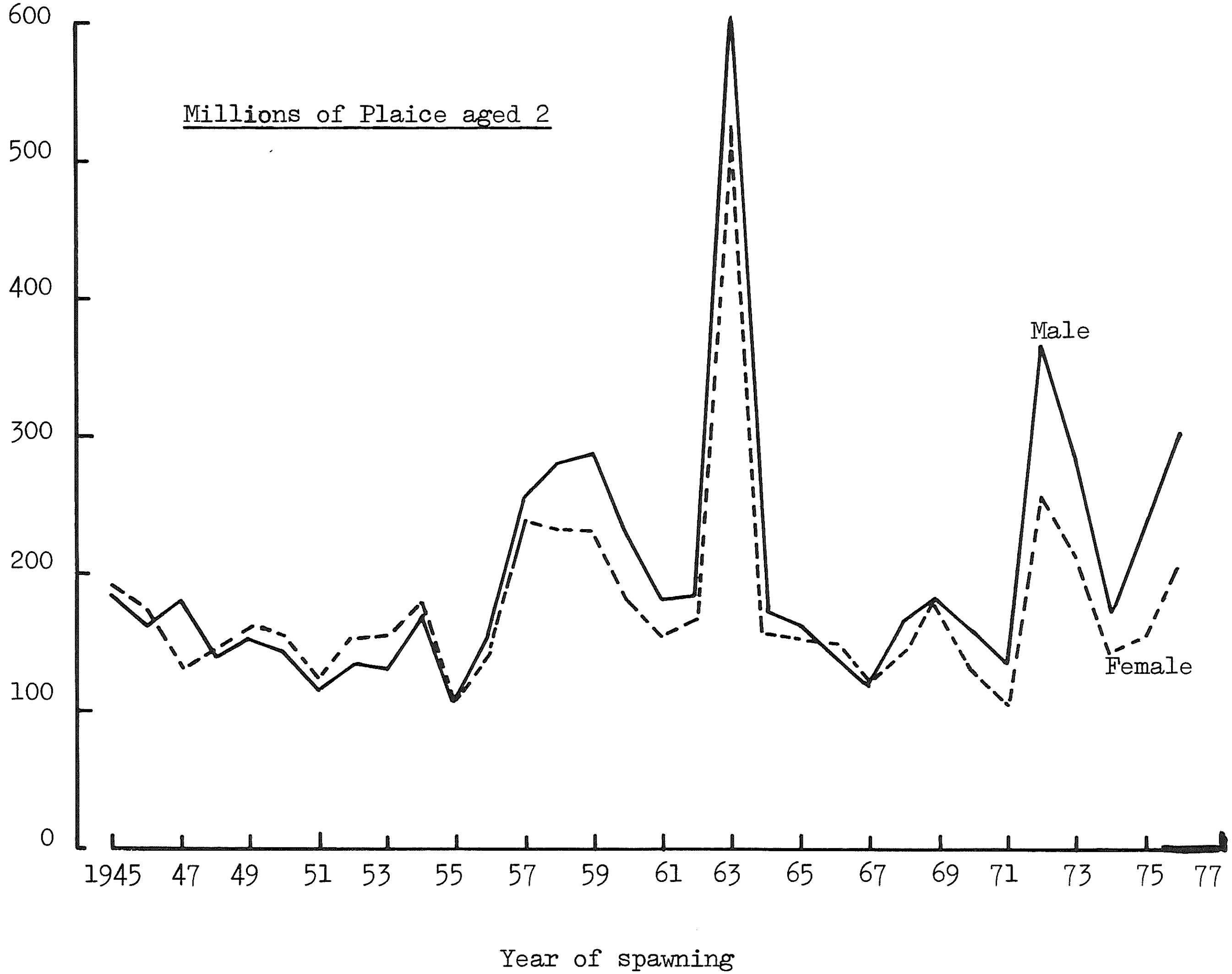


Figure 4.1 SOLE in Division VIId

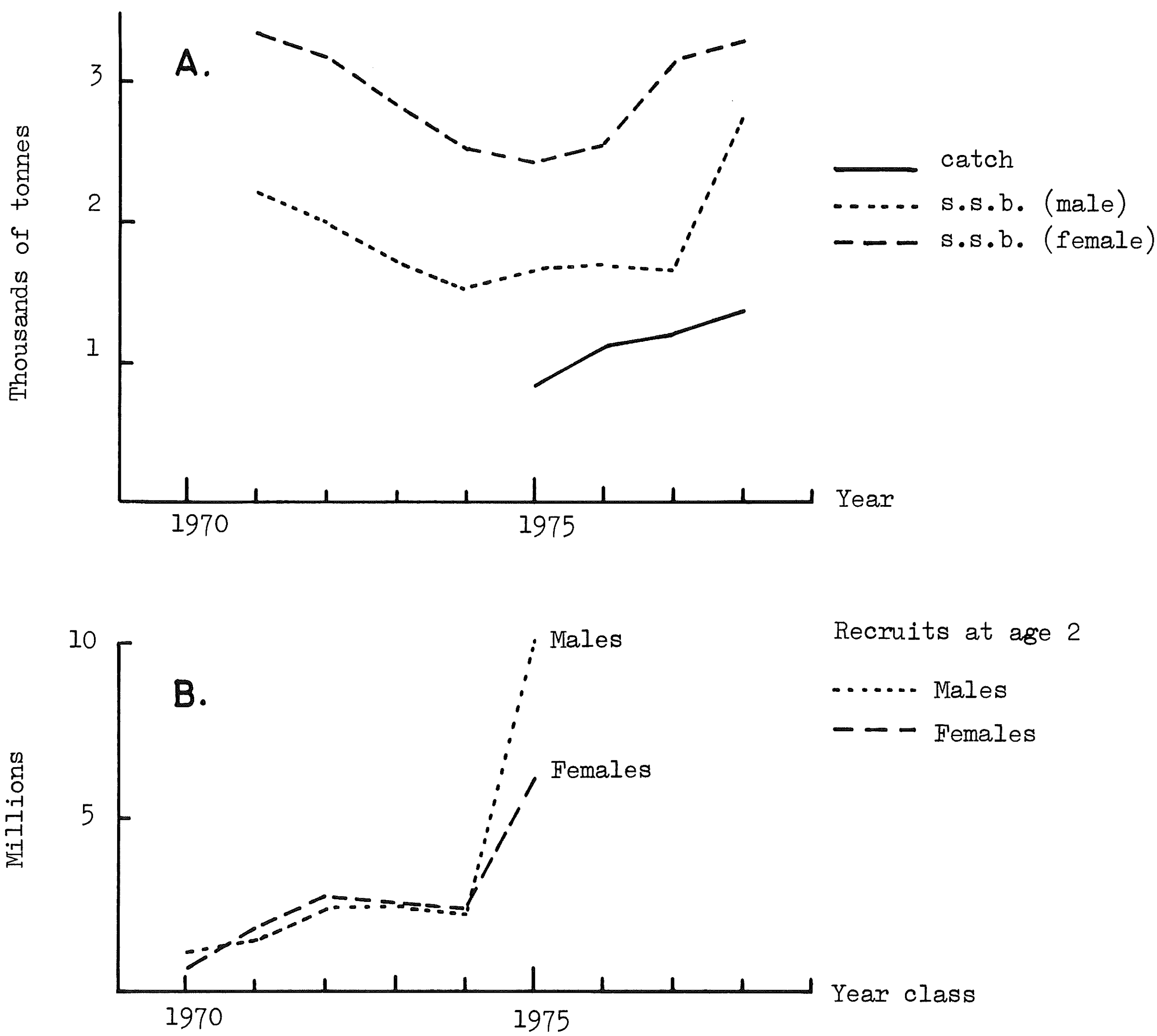
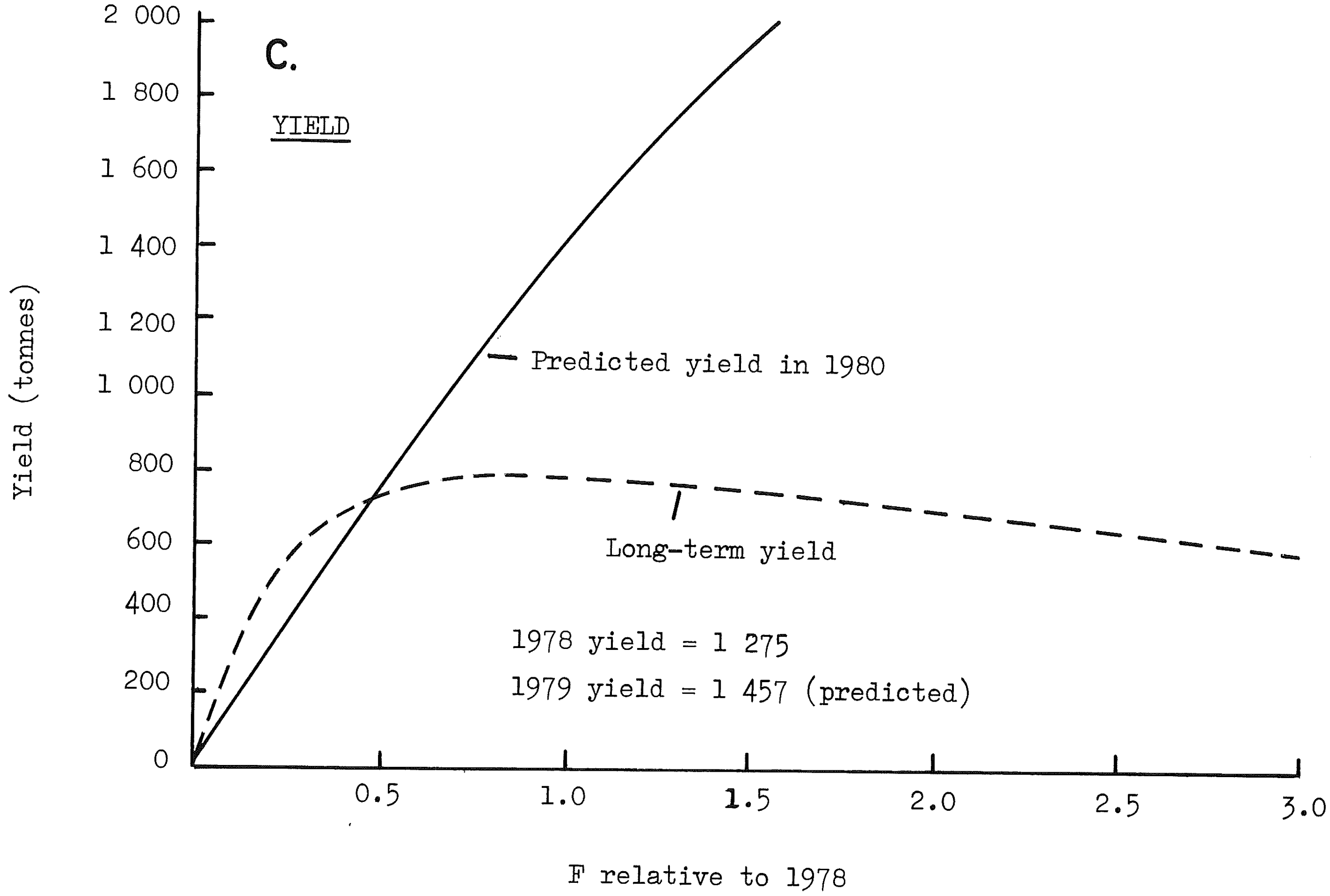


Figure 4.1 (continued)



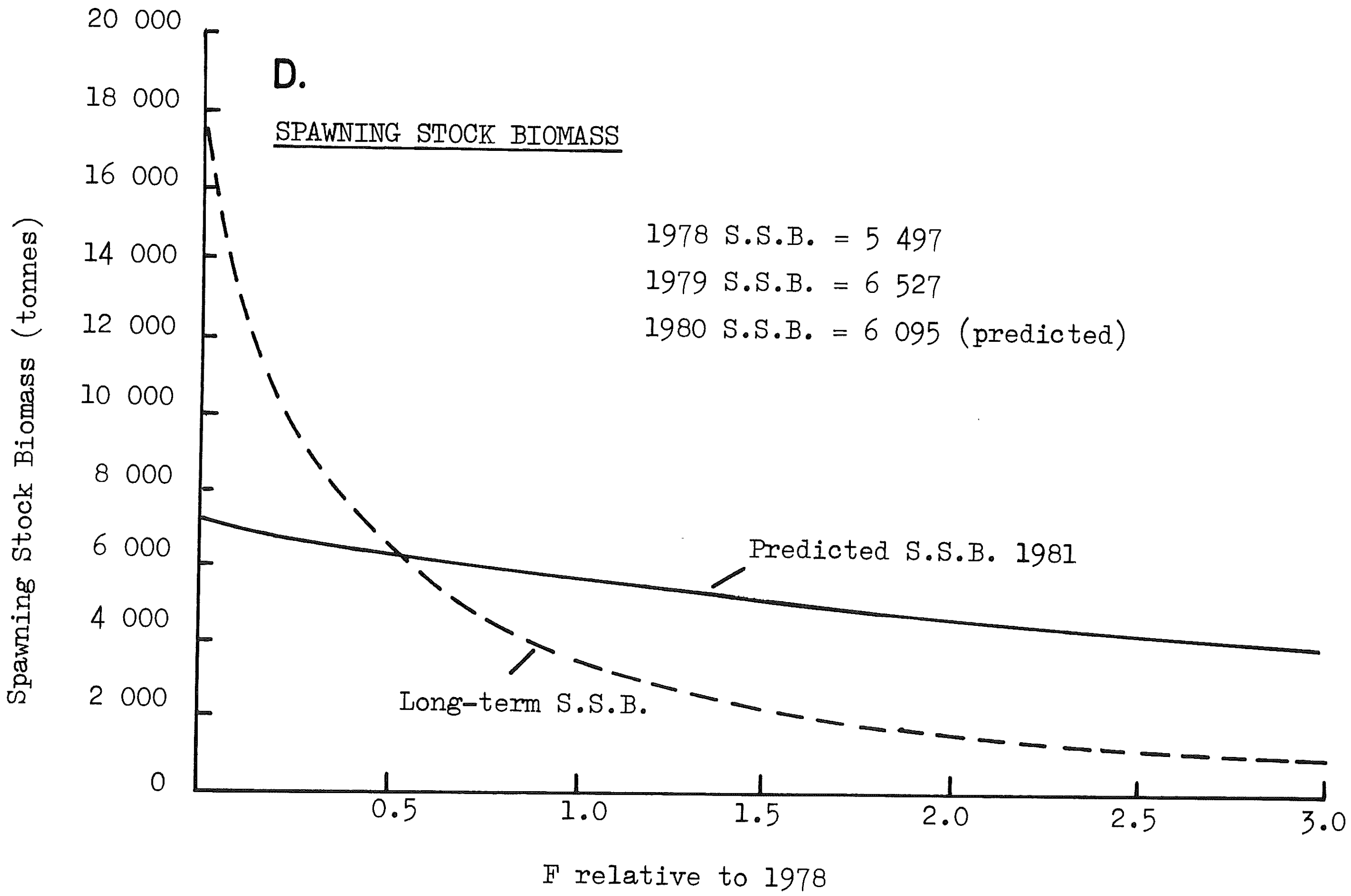


Figure 5.1 SOLE in Division VIIe

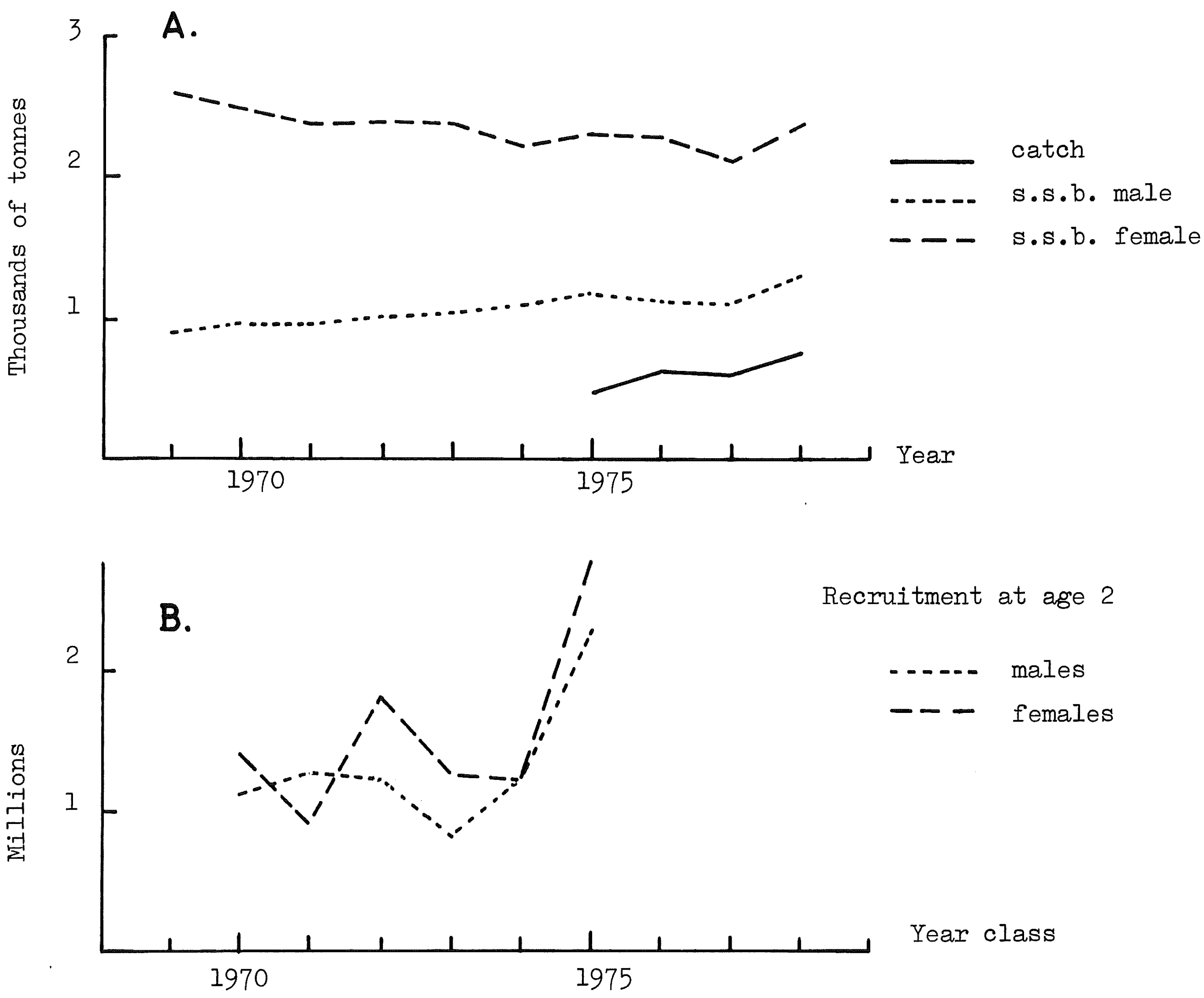
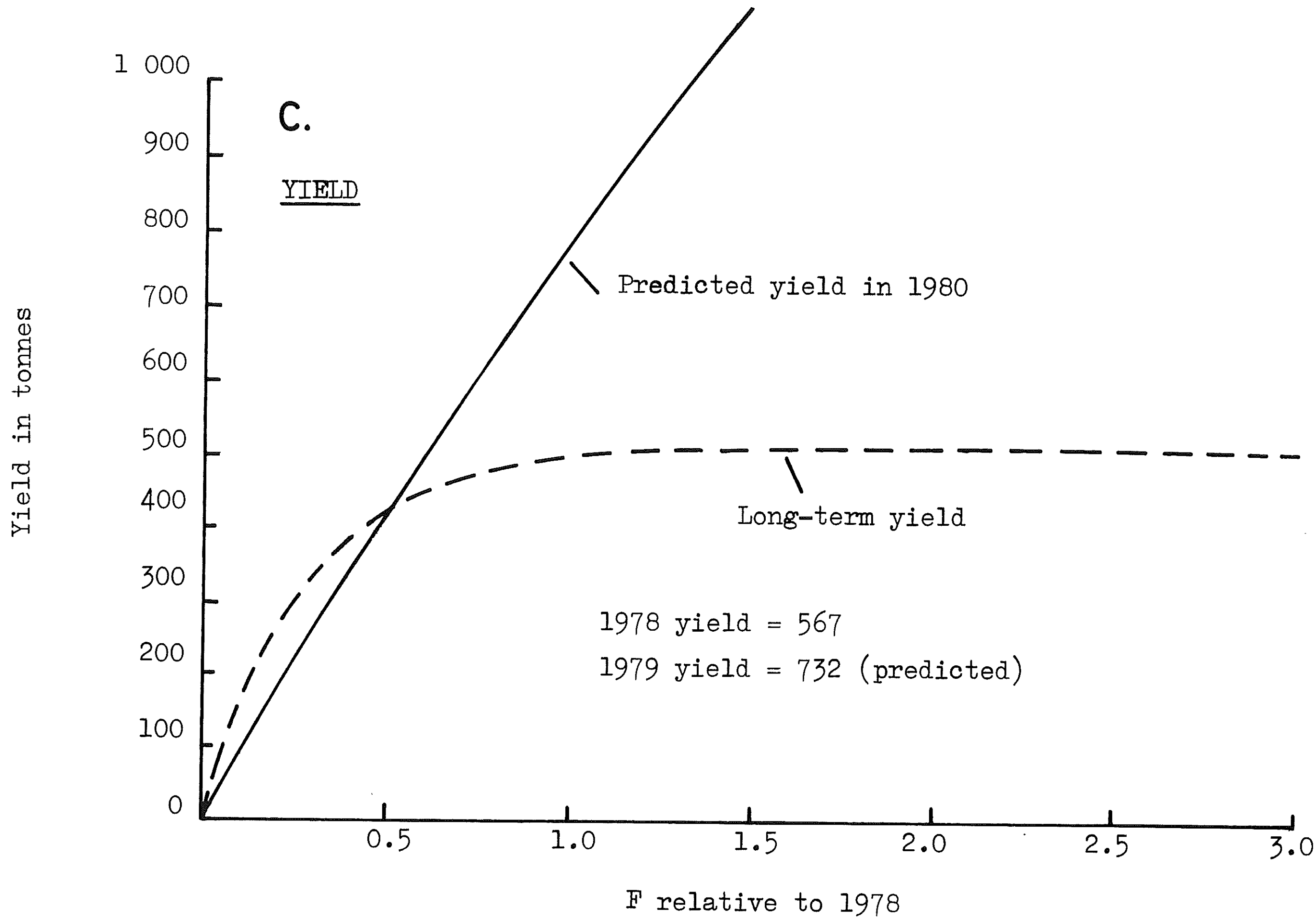


Figure 5.1 (continued)



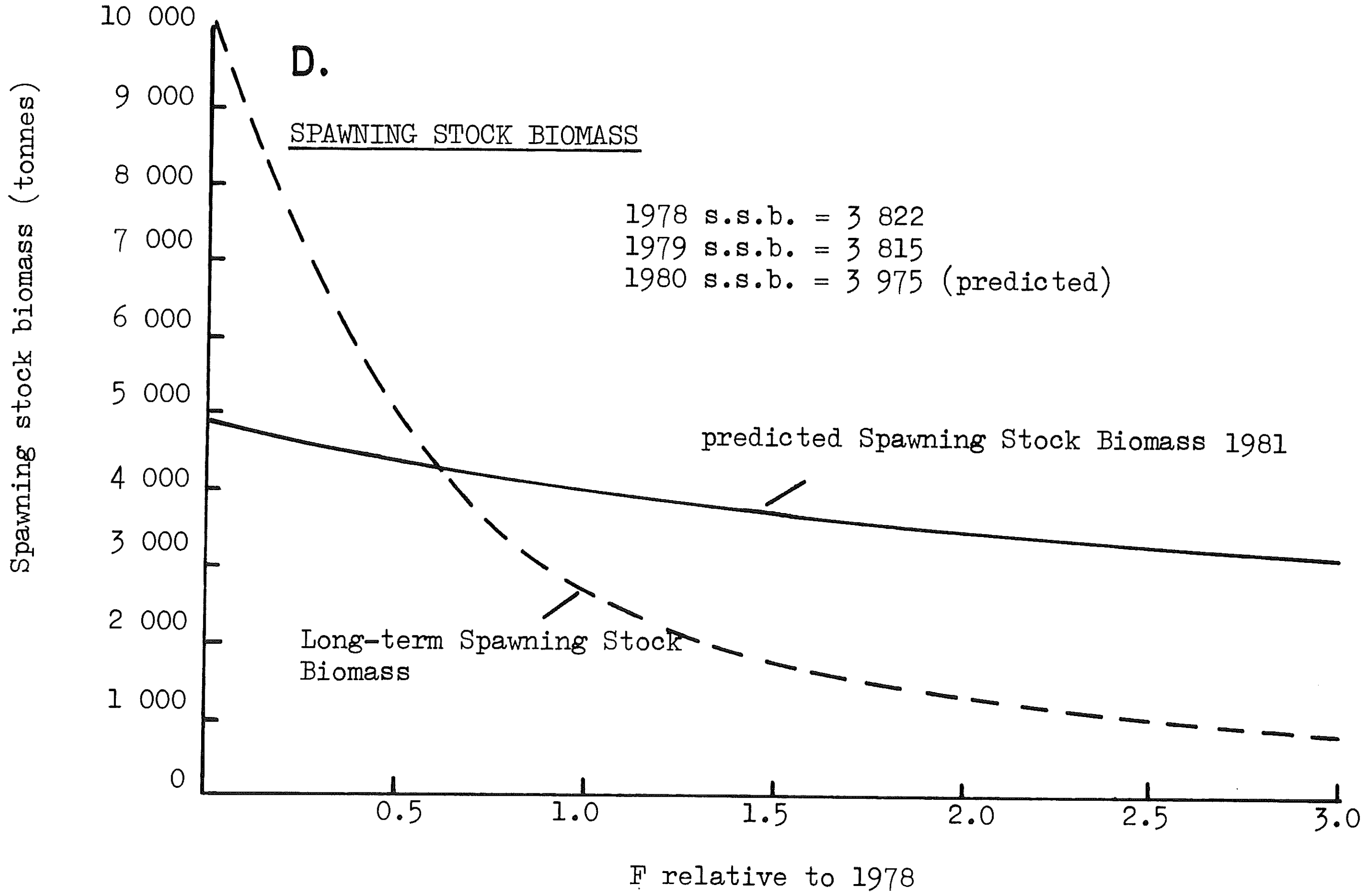
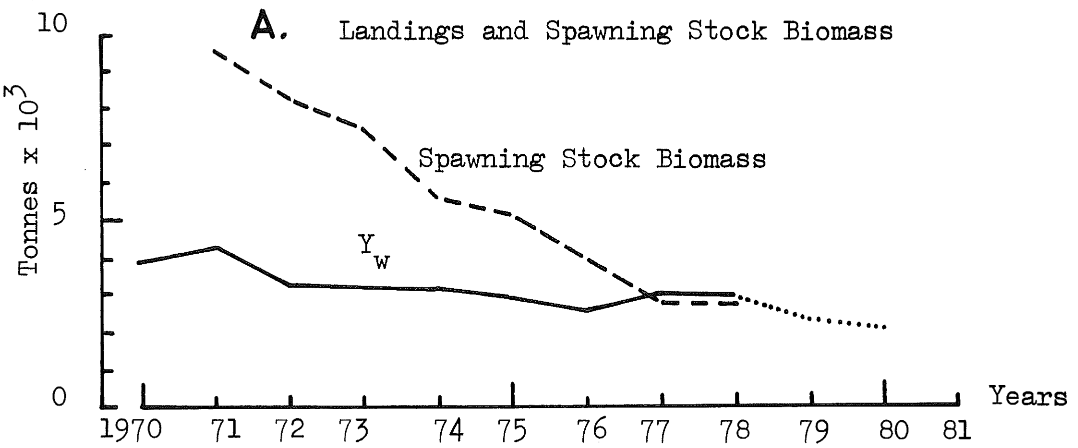
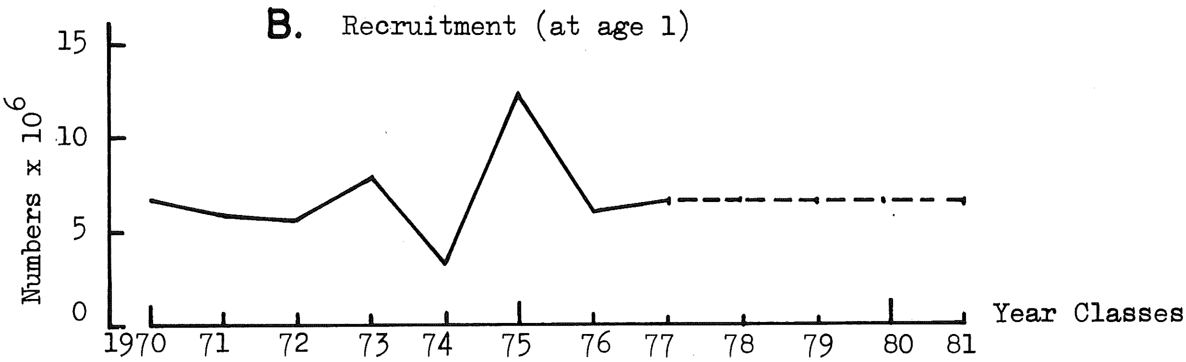


Figure 6.1 English Channel Plaice (sexes combined)





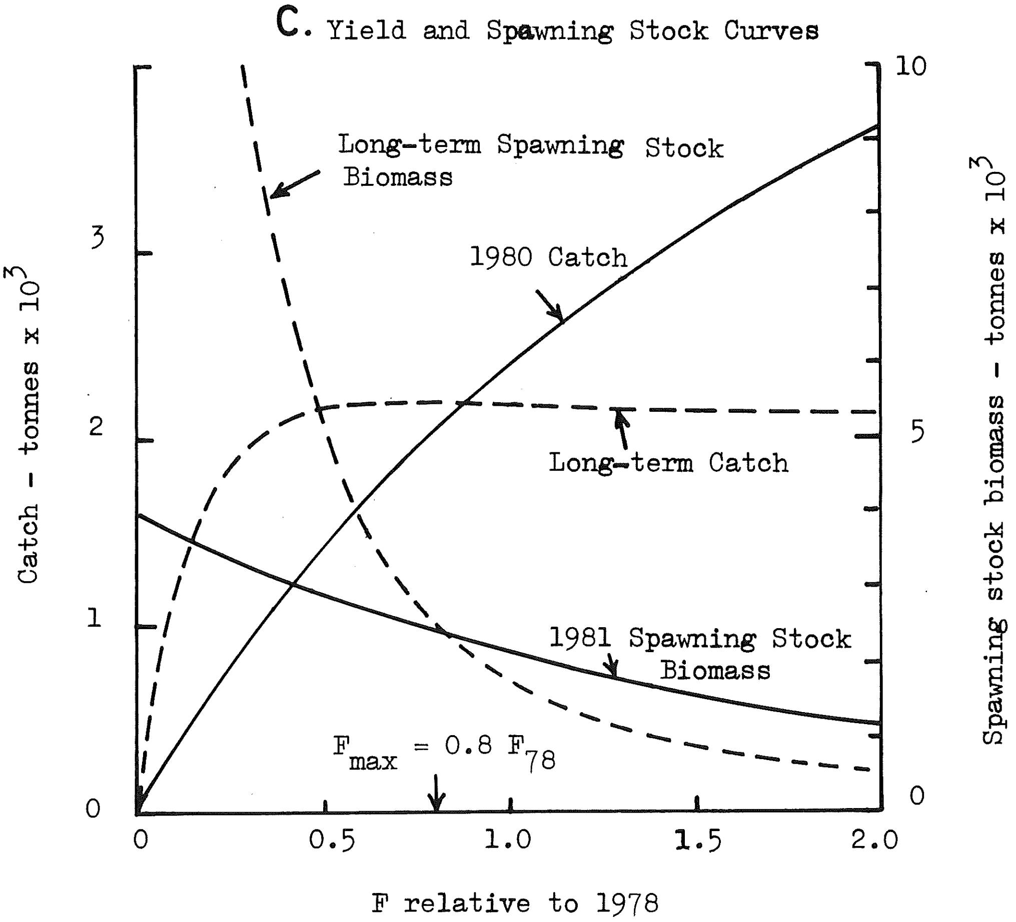


Figure 8.1 One type of selective shrimp net for separating shrimps from the rest of the catch

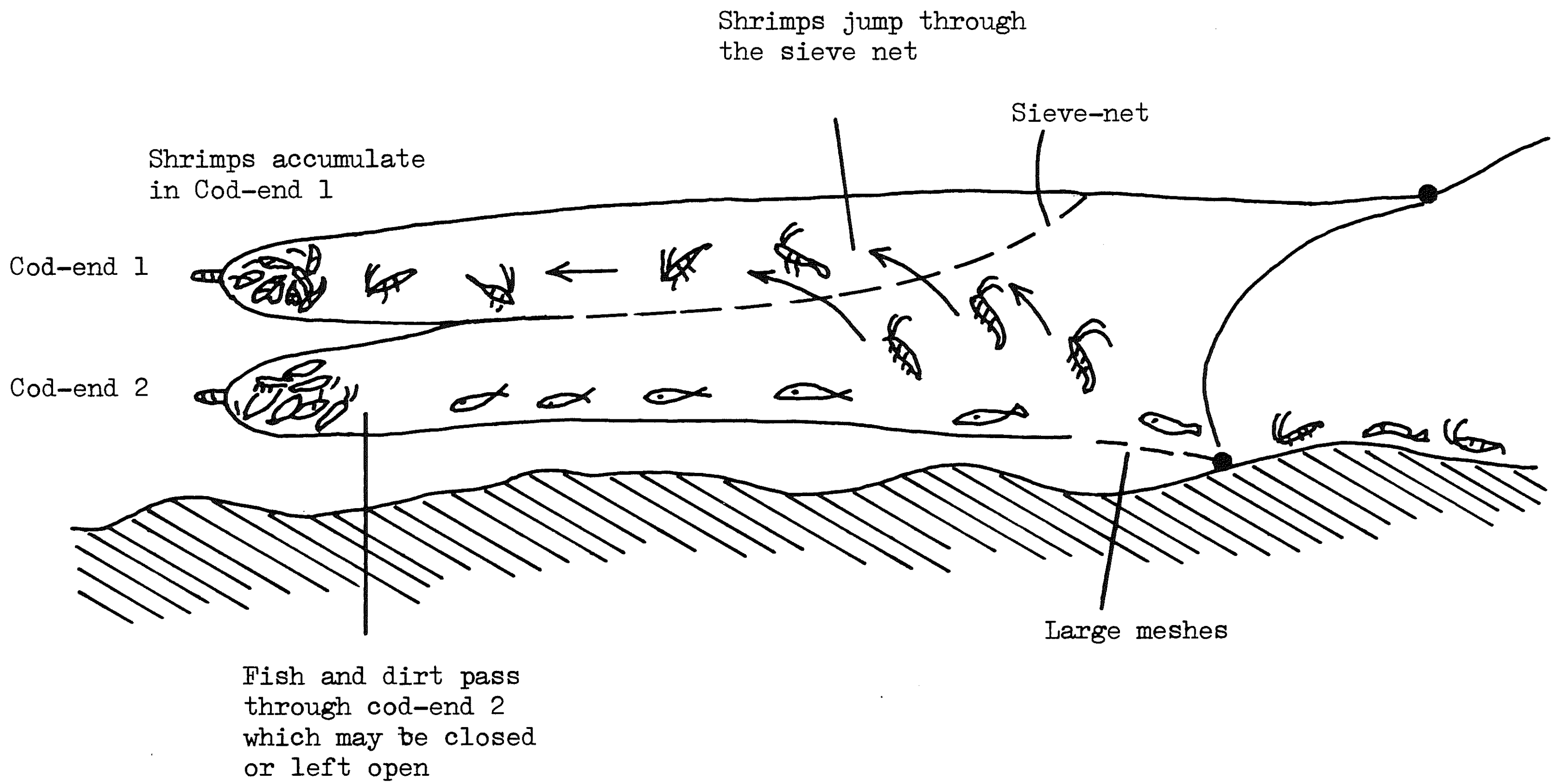
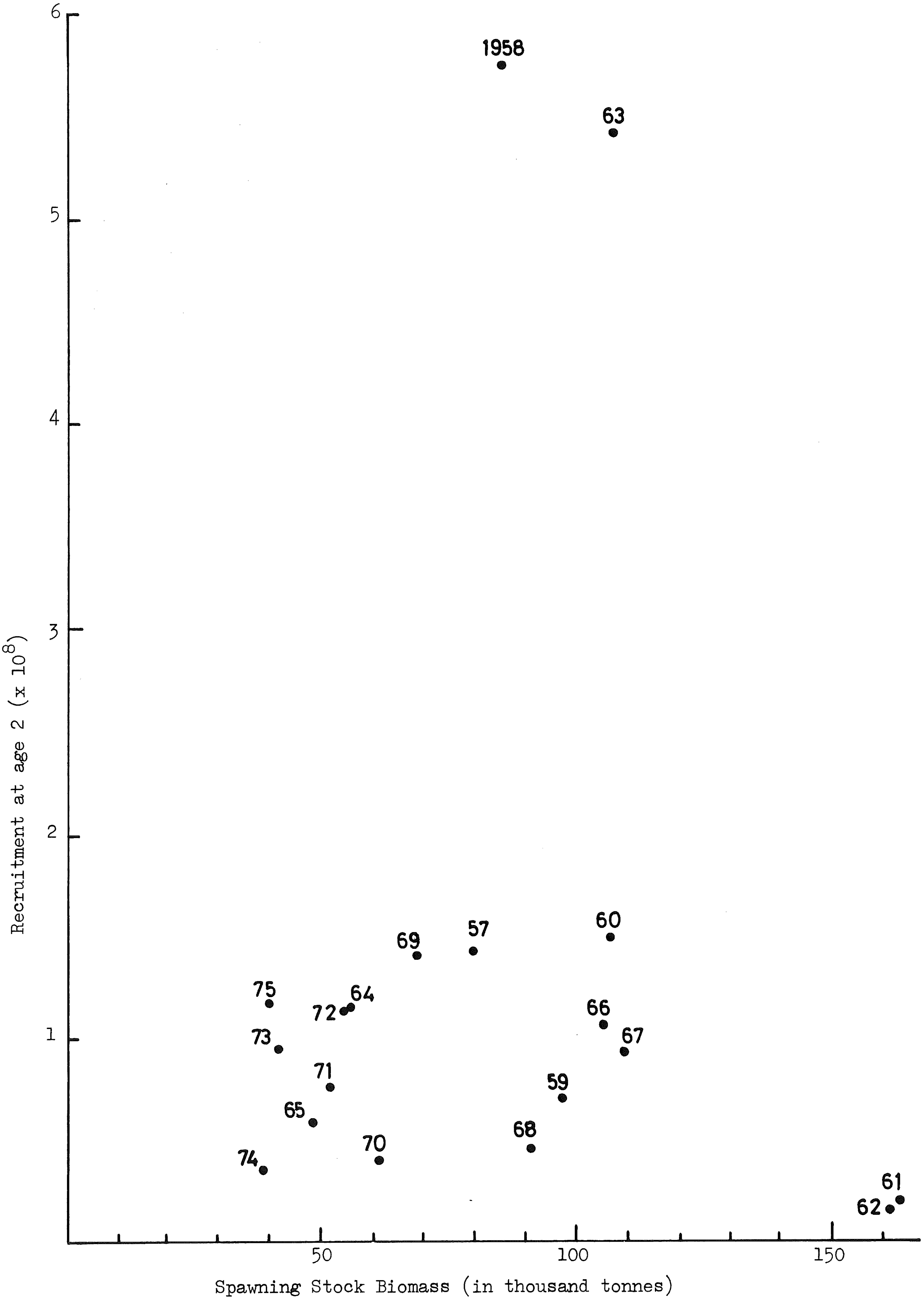


Figure 9.4.1 North Sea SOLE
Spawning Stock Recruitment Plot



ANNEX

COMBINATION OF MALES AND FEMALES YIELD PER RECRUIT CURVES

For flatfish stocks VPAs are carried out for each sex separately. This results in an estimated set of F at age for the last year for which input catch data are available for males and females, respectively. These sets of F at age are different as are the values of mean weight at age, and in the case of plaice, the assumed values of M at age. The differences in F at age mean that if yield per recruit values for males and females respectively are conventionally plotted against F, the male and female curves will be on different scales. To get round this problem the male and female curves are plotted on a scale of F relative to F in the year from which the exploitation pattern has been derived (in our case, 1978). Values of yield per recruit for any value of F relative to F in 1978 are the read off from the respective male and female curves and combined to give a yield per recruit value for males + females by use of the following relationship:

$$y/r = (rm \times ym + rf \times yf)/(rm + rf)$$

where y/r = male + female yield per recruit

rm = average male recruitment

rf = average female recruitment

ym = yield per recruit of males

yf = yield per recruit of females.

Obviously, biomass per recruit curves for males and females can be considered by use of analogous methods.

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