International Council for the Exploration of the Sea
C.Ni。1976/H:2

Pelagic Fish (Northern) Committee

# REPORT OF THE HERRING ASSESSMENT WORKING GROUP FOR THE AREA SOUTH OF $62^{\circ} \mathrm{N}$ <br> Charlottenlund, 26 February - 6 March 1976 

x) General Secretary,
ICBS, Charlottenlund Slot, DK-2920 Charlottenlund, Denmark。

1. Introduction and Participation ..... 1
2. North Sea ..... 2
2.1 The fishery in 1975 ..... 2
2.2 Fishing mortality in 1975 ..... 3
2.3 Results from VPA ..... 3
2.4 Recruitment ..... 4
2.4.1 Methods for estimating recruitment ..... 4
2.4.2 Year class 1972 ..... 5
2.4 .3 Year class 1973 ..... 5
2.4.4 Year class 1974 ..... 5
2.5 Estimates of relative spawning stock biomass from herring larval surveys ..... 5
2.5.2 Northern North Sea ..... 5
2.5.3 Central North Sea ..... 6
2.5.4 Southern North Sea/Eastern Channel ..... 6
2.5.5 Decrease in size of the spawning stock. ..... 6
2.6 TACs for 1976 and 1977 ..... 6
3. Celtic Sea ..... 8
3.1 Catch data ..... 8
3.2 Racial composition of the Celtic Sea herring stock ..... 8
3.3 . Catch in numbers per year class ..... 9
3.4 Mean weight at age ..... 9
3.5 Estimates of fishing mortality in the 1975/76 season ..... 9
3.6 Estimates of fishing mortalities in previous seasons ..... 9
3.7 Recruitment ..... 10
3.8 TAC for 1977/78 ..... 10
3.9 Additional conservation measures ..... 11
4. Herring in Division VIa ..... -11
4.1 Total catches and fisheries in Division VIa ..... 11
4.2 Catoh in numbers in Division VIa ..... 11
4.3 Stock and mortality estimates ..... 12
4.4 Catch prognosis for 1976 and 1977 ..... 12
4.5 Advice on TAC ..... 14
5. Irish Sea Herring (Division VIIa) ..... 15
5.1 Introduction ..... 15
5.2 Catch and effort ..... 15
5.3 Age composition of the stock ..... 15
5.4 Management ..... 16
5.5 TAC for 1977 ..... 17

## Page

6. Sprat Assessment for the North Sea and Skagerak ..... 17
6.1 Introduction ..... 17
6.2 North Sea sprat ..... 18
6.2.1 The North Sea fishery in 1975 ..... 18
6.2.2 Biological parameters of the North Sea sprat ..... 18
6.2.3 Fishing mortality and stock size ..... 19
6.2.4 The effect of fishing mortality on yield per recruit and stock size ..... 20
6.2.5 Calculation of TAC for 1977 ..... 21
6.2.6 Protection of 0/1-group sprat ..... 21
6.3 Sprat in Division IIIa and the Norwegian fjords ..... 22
6.3.1 The sprat fishery ..... 22
6.3.2 Biological data ..... 22
6.3.3 Stock assessment ..... 23
7. Minimum Landing Size for North Sea Herring ..... 23
8. Application of the ICES "FISHDAT" System ..... 23
9. Summary ..... 24
10. References ..... 25
Tables 2.1-2.12 ..... 27
Tables 3.1-3.8 ..... 35
Tables 4.1 - 4.5 ..... 39
Tables 5.2.1 - 5.3.3 ..... 42
Tables 6.1 - 6.12 ..... 48
Figures l-9 ..... 58

## 1．Introduction and Participation

1．l The Herring Assessment Working Group for the Area South of $62^{\circ} \mathrm{N}$ met at Char－ lottenlund in the period 26 th February－6th March 1976 to report to the Liaison Committee meeting in April 1976 on the following subjects：
（a）reassessment of the state of，and appropriate levels of TAC for，North Sea and Skagerak herring in 1976 and 1977；
（b）the TAC level for Celtic Sea herring in the period 1 April 1977－31 March 1978；
（c）the appropriate level of TAC for Division VIa herring in 1977；
（d）assessment of the herring population in the Northern Irish Sea（Division VIIa），and the provision of advice on the TAC level，if required；
（e）reassessment of North Sea sprat，and the appropriate TAC level for 1977；
（f）assessment of the state of the sprat stock in Division IIIa and advice on the need for regulatory action．

The Working Group was also asked to provide further advice on a minimum landing size for North Sea herring。

I．2 Member countries were represented by the following scientists：

| Dr H Ackefors | Sweden |
| :---: | :---: |
| Dr R S Bailey | U．K．（Scotland） |
| Mr A Bowers | U．K．（England） |
| Mr E Bakken | Norway |
| Mr A Corten | Netherlands |
| Dr S Fedorov | U．S．S．R． |
| Mr J Jakobsson | Iceland |
| Dr A Lindquist | Sweden |
| Mr M Liwoch | Poland |
| Dr A Malkov | U．S．S．R． |
| M A Maucorps | France |
| Mr J Molloy | Ireland |
| Mrs E Nielsen | Denmark |
| Mr K Popp Madsen | Denmark |
| Mr K H Postuma | Netherlands |
| Mr A Saville（Chairman） | UoK。（Scotland） |
| Dr A Schumacher | Federal Republic of Germany |
| Mre G Speiser | Federal Republic of Germany |
| Mr $\emptyset$ Ulltang | Norway |
| Mr K Vickers | UoKo（Northern Ireland） |
| Mr R J Wood | UoK。（England） |
| Mr 0 J Østvedt | Norway。 |

1．3 During the course of the meeting the Working Group had the opportunity to discuss with the Chairman of the ICES ADP Working Group，and with members of the Danish Institute for Fisheries and Marine Research concerned with the development of the ADP system，recent refinements in the programme for handling herring data．Comments on this system are given in Section 8．

2．1．l In Table 2.1 catch data for the years 1966－75 are given（preliminary for 1975）。 The total North Sea catch in 1975，excluding Skagerak，amounted to 302567 tons which is about 27000 tons higher than in 1974o Thus，the catches of the two last years are the lowest on record，with the exception of the war years 1915－17 and 1941－42．

2．1．2 In previous years the preliminary estimates have increased by about $10 \%$ when the final catch data have become available。 It is，however，expected that for 1975 the change will be considerably less but even with such an increase the catch for 1975 will be less than 340000 tons The Skagerak catch decreased from 55512 tons in 1974 to 52129 tons in 1975 （Table 2．2）．

2．1．3 Tables 2．3－2．7 give the catch data for the sub－divisions of the area used in the previous reports．In area IVaE the catches in 1975 decreased to 9014 from 15377 tons in 1974．In area IVaW the catch in 1975 increased to 99679 tons from the very low 1974 catch of 84174 tons．In Division IVb the total catch in 1975 was 177810 tons which is about 10000 tons higher than in 1974。 The socalled adult fishery（for human consumption） decreased from 116000 tons in 1974 to about 88000 tons in 1975 （Table 2．5） whereas there was a corresponding increase in the young herring fisheries （for industrial purposes including by－catohes）from about 52000 tons in 1974 to about 90000 tons in 1975．In Division IVc and Division VIId the catch in 1975 increased to about 23000 tons from 7383 tons in 1974 ．

2．1．4 The numbers of herring at each age in the catches in each area are given in Table 2.8 and those for the total North Sea are summarised in the text table below Annual catches in numbers per age group in each of the last ten years are goiven in Table 2．10。

Millions of herwing caught per age group（winter rings）

| Year Age | 0 | 1 | 2 | 3 | 4 | 5 and older | Total |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1971 | 684 | 4378 | 1147 | 622 | 208 | 97 | 7177 |
| 1972 | 750 | 3 | 341 | 1 | 441 | 344 | 131 |
| 1973 | 289 | 2368 | 1344 | 659 | 150 | 40 | 66 |
| 1974 | 992 | 838 | 718 | 327 | 114 | 79 | 4906 |
| 1975 | 261 | 2436 | 528 | 254 | 139 | 88 | 3069 |

2．1．5 The catches of 0－group herring in 1975 have decreased sharply from the very high 1974 level，whereas the catches of the l－group have almost trebled．Catches of 2 －ringers，and older were at an even lower level than in 1974。

2．1．6 The eatoh in numbers was caloulated for the skagerak catches for the second year running（Table 2．9）and the 1974 figures were updated according to the final catch figures．In 1975 there was a sharp decrease in 0－group catches as compared with 1974，whereas the catch in numbers of older age groups increased．

2．2 Fishing mortality in 1975
2．2．1 Fishing mortality on adults（year class 1972 and older）
Few direct estimates for $F$ adults 1975 were available The total mortality rate calculated from Dutch catch per unit effort data in the central North Sea was l．89。 This is probably an overestimate，due to fluotuations in availability．The mean figure of 0.92 for the last three years may be a more reliable estimate。

In the absence of any other direct information on the $\mathrm{F}_{\mathrm{adul}}$ ts 1975，a value of 0.90 was used as the estimate for Fadults 1975 ．The catch prediction and the VPA have been based on this figure．

2．2．2 Fishing mortality on l－ringers（year class 1973）
No direct estimate for $\mathrm{F}_{\mathrm{l}}$ ringers 1975 was availeble．However，there is an estimate of the stock of l－ringers at the beginning of 1975 dexived from the Young Herring Survey．This year class was estimated at $409 \times 109$（para： 2.4 .3 ）．The catch of $2436 \times 10^{6}$ l－ringers in 1975 then corresponds to an $\mathrm{F}_{\text {1－ringers }} 1975=0.73$ 。
As the stock estimate from YHS may not be very accurate，it was considered unwise to base the $F_{\text {I－ringers }} 1975$ exclusively on the YHS estimate．A second estimate，derived irom catch per unit effort data from the young herring fisheries in the central North Sea，indicated a year olass strength of the 1973 year class as 0 group of $6.3 \times 1.9$ and corresponding to $4.76 \times 109$ l－group in 1975．This estimate is very close to that obtained from the Young Herring Survey and would indicate an for l－ringers in 1975 of 0.80 A third indication of $F_{1 \text {－ringers }} 1975$ was based on the results of the VPA（Section 2．3），The mean value for Fl－ringers over the period 1967－70 was about 0．5，but it increased to about 0.95 in 1971－73 and has probably remained about this level in subsequent years．
In the light of the above information a value of 0.90 was used as the best estimate for $F_{1-r i n g e r s ~} 1975^{\circ}$

## 2．2．3 Fishing mortality on 0－group（year elass 1974）

No direct estimate for $\mathrm{F}_{0 \text { ogroup }} 1975$ was available Preliminary data from the YHS in 1976 indicate a year class strength of $2051 \times 10^{6}$ as l－ringers in thr beginning of 1976 （Section 2.404 ）．A catch of $261 \times 100$－group in 1975 would then have corresponded to an $F_{0-g r o u p}=0.11$ ．
In view of the possible erroxs in the YHS estimates，the Working Gxoup decided to base its estimate of Fo－group 1975 on VPA results for the period 1971－73．Values of $F_{0-g r o u p ~ o v e r ~ t h i s ~ p e r i o d ~ r a n g e d ~ f r o m ~}^{0.11}$ to 0.17 with a mean of 0．14。

A third indication of $F_{0-g r o u p} 1975$ may be derived from the development of the sprat fishery in the central North Seao As most of the 0－group herring are caught as by－catch in this fishery，a change in the effort will affect Fo－group in herringo The average effort in 1971－73 of 42.7 thousand hours increased in 1975 to 55.9 thousands hours or by $30 \%$ Applying this increase to the avexage $F_{0-g r o u p}$ in 1971－73 of 0.14 ，as stated above one arrives at an $F_{0-g r o u p ~} 1975$ of 8.18 。
In the light of the above information，a figure of 0.18 was used as the estimate for $\mathrm{F}_{0 \text {－group }} 1975^{\circ}$
2.3 Results from VPA

2．3．1 Calculated fishing mortalities and stock sizes for the period 1966－74 are given in Tables 2.11 and 2．12．It should be noted that the estimates of fishing mortality and stock size for 1974 are highly dependent on the input Fis for 1975 and too much reliance should not be placed on them．

2．3．2 The VPA results presented in the previous report（Doc。C．M．1975／H：2） indicated that fishing mortality on l－ringers in 1971 had increased sharply from about 0.5 to about 0.95 ．The VPA results presented in Table 2.11 conm firm that in 1971 the fishing mortality on l－ringers was in fact at this high level．The table further indicates that this high fishing mortality on l－ringers has been continued in later yearso
2.3 .3 The fishing mortalities on adult fish in the period 1968－73 has remained at a level of about $l_{0} 0$ which is more than twice the level giving the maximum yield per recruit．

2．3．4 It should be noted that the changes in fishing mortalities in 1972 and 1971 due to the new input data for 1975 are very small giving only slightly lower mortalities in 1971－72 than in the previous assessment。Calculated stock size biomass for 1971 and 1972 are slightly higher than those given in the previous report（CoMo1975／H：2）。

2．3．5 The year class 1972 has now been estimated for the first time from VPA。 The figure of $2.42 \times 109$ still depends to some extent on the input of $F$ in 1975 but it would indicate that the 1.972 year class is about $31 \%$ of the long－term mean（1962－69（CoMol972／H：13，pol3））．The year classes 1970 and 1971 are now estimated at $7.2 \times 10^{9}$ and $5.1 \times 10^{9}$ as 0 －group respectively．

## 2．4 Recruitment <br> 2．4．1 Methods for estimating recruitment

The first estimate of a new year class is normally based on two sources of information．One of them is the results of the ICES Young Herring Survey， which in recent years have been available at the time of the Working Group meeting．The YHS gives an estimate of the stock of l－ringers at the beginning of the year．From the number of 0 －group caught during the previous year and the assumed natural mortality rate one can estimate the initial year class strength。
The other estimate of year class strength is obtained from catches of 0－group， and an assumption of $F_{0-g r o u p ~ i n ~ t h e ~ p r e v i o u s ~ y e a r . ~}^{\text {anogroup }}$ is estimated from past estimates from VPA，and from information on subsequent developments of fishing effort。

One year later，a second estimate of the same year class is derived from the catch of l－ringers and an assumption of $\mathrm{F}_{\text {I－ringers }}$ Each subsequent year the estimate of that year class becomes more precise．

The first estimate of a year class may contain considerable errors，as is evident from the table below，giving estimated values from earlier reports from the Working Group．

Estimates of year class strength as 0－group in No＇s x $10^{-9}$

| Year <br> class | First estimate <br> made by Working <br> Group | Second Working <br> Group estimate | Third Working <br> Group estimate <br> based on catch <br> laringers | Most recent <br> estimate <br> from VPA |
| :--- | :---: | :---: | :---: | :---: |
| 1970 | 11.8 | 11.8 | - | 7.2 |
| 1971 | 7.922 | $\left.7.9^{2}\right)$ | 6.2 | 5.1 |
| 1972 | $7.92)$ | $5.61)$ | 2.8 | 2.4 |
| 1973 | 6.0 | 6.0 | 5.8 | - |
| 1974 | 2.5 | 1.7 | - | - |

1）Not available during Working Group meeting 1974.
2）For 1971 year class these estimates were based on indications from these sources that this year class was of average strength for the 1972 year class no data were available and the year class was assumed to be average。

The year classes 1970 and 1971 are now estimated at $7.2 \times 10^{9}$ and $5.1 \times 10^{9}$ respectively. This means that they were originally overestimated by some $60 \%$ 。
2.4.2 Year class 1972

The best estimate for year class 1972 now available is $2.4 \times 10^{9}$ 。 It should be noted that this year class was overestimated in the Young Herring Survey by $175 \%$. A much more accurate estimate of this year class was given in February 1975, when both the catches of 0 - and l-ringers were taken into account. The serious overestimation of this year class was one of the main causes of the overoptimistic assessment of the North Sea stock during the Working Group meeting in 1974.

## 2.4 .3 Year class 1973

A first estimate of year class 1973 was available for the YHS in 1975. The regression of VPA stock size on YHS estimates, given in C.M.1975/H:9 was recalculated, inserting the updated estimate for the 1971 year class and the preliminary estimate for the 1972 year class (Table 2.12). The new regression formula calculated is $Y=0.00238 \mathrm{x}$ l.34. This gives an estimate of 4.9 x 109 l-ringers in 1975, and consequently an initial year class strength of $6.0 \times 10^{9}$ as 0 -group.
A second estimate for year class 1973 was derived from VPA, assuming $F_{1-x i n g e r s ~} 1975$ to have been 0.90 (Section 2.2.2). This corresponds to a yearclass of $5.8 \times 10^{9}$ as 0 -group. This figure was accepted as the best estimate for year class 1.973 available, but is not completely independent.

### 2.4.4 Year class 1974

A first estimate on year class 1974 was available from preliminary data on the YHS in 1976. Using the regression formula given in 2.2 .3 , this year class would be estimated at $2.1 \times 10^{9}$ 1-xingers in 1976 . A catch of $261 \times 10^{6} 0$-group would then correspond to a stock of $2.5 \times 1090$-group at the beginning of 1975.
A second estimate for year class 1974 was derived from VPA, assuming an Fo-group 1975 of 0.18 (Section 2.2.3) . This corresponds to a year class of $1.7 \times 109$ as 0 -group. This figure was accepted as the best available estimate for the year class 1974.
2.5 Estimates of relative spawning stock biomass from herring larval surveys
5.1 Provisional abundance estimates were calculated for the $1975 / 76$ spawning season from the data obtained during the international surveys of herring larvae in the North Sea and adjacent waters. A comparison was made of the abundance estimates for herring larvae $<10 \mathrm{~mm}$ in length, and total herring larvae, between surveys made in 1975/76 and comparable surveys carried out during 1974/75. The results are given in Table 2.5 .1 , together with the percentage decrease or increase between the 1974 and 1975 estimates. The estimates were adjusted, where necessary, to take account of any significant differences in the distribution of sampling stations between the two years.

## North Sea

2.5.2 There was a good coverage of the Orkney/Shetland area during the period 3-25 September 1975. Compared with roughly the same period in 1974 there was a decrease of over $60 \%$ in both the abundance estimate of the smallest larvae ( $<10 \mathrm{~mm}$ ), and of total larvae of all length groups. The survey between 20-25 September 1975 showed a reduction of $88 \%$ in larvae $<.10 \mathrm{~mm}$ compared with a survey in 1974 covering a Jonger time period, but the total
number of all sizes of larvae showed a reduction of only $24 \%$ These surveys，which covered the major spawning alea in the northern North Sea suggest an overall decrease in herring larval production in 1975 of approximately 50\％。

## 2.5 .3 Central North Sea

Three extensive surveys were made in 1975 and abundance estimates for all of these were low compered with those of recent years．Due to the very poor coverage of this area in 1974 it was only possible to make one com－ parison between that survey and the corresponding one in 1975．Because the survey in 1975 was made a few days later than the one in 1974，it is more reasonable to compare the abundance estimates for all sizes of larvae rather than the estimates for only the smallest ones．A decrease of $52 \%$ is indicated for 2975 。

2．5．4 Southern North Sea／Eastern Channel
Two surveys can be compared in this area，one in December and the other in January．The abundance estimates for both are extremely low，although low production has been a feature of this area for several years．Discounting the estimate for larvae＜l0 mm in the December survey，an overall decrease in production in 1975 of the order of $50 \%$ is indicated．

2．5．5 Decrease in the size of the spawning stock
There was a decrease in herring larval production in all spawning areas of the North Sea in 1975／76 of roughly $50 \%$ compared with 1974 a In the southern North Sea，an area which has contributed only an insignificant pro－ portion of the total North Sea larval production in recent years，there was a substantial increase in the herring catch during the spawning season， probably indicating an increase in the number of herring in the area．The very low numbers of larvae subsequently caught，however，may indicate that a high proportion of these herring were caught before they were able to spawn．The total population of adult North Sea， 3 years and older，from the stock prognosis shows a reduotion，both in the number of potential spawners， and in stock biomess of $45 \%$ in 1975 from the 1974 levelso This estimate of the reduction in the size of the atock of spawning herring in the Noxth Sea in 1975 is therefore in very close agreement with that deduced indepen＝ dently from the reduction in larval production，estimated from the inter－ national survey of herring larvae．

### 2.6 TACs for 1976 and 1977

In the report of the Liaison Committee in October 1975 the Working Group advised that，in the light of the evidence of the very low spawning stock size for North Sea herring and the dangers in this situation of continued low recruitment，it was imperative that action should be taken to rebuild the stock as quickly as possible。 Accordingly，it advised a complete pro－ hibition of a directed fishery for North Sea herring and more rigid restrictions on byocatch of herring in the mixed fisheries．With the new data available to the 1976 meeting the spawning stock size as at 1 September 1976 was estimated at 249000 tons。 This is 100000 tons greater than the estimated spawning stock for 1975，due to the recruitment of the 1973 year class，which appears to be appreciably stronger than that of 1972．This estimate was based on the assumption that the TAC of 87000 tons agreed by NEAFC for the period 1 January $=30$ June 1976 would be taken，and that there would be no fishing after 30 June 1976.
However，a spawning stock of 249000 tons is much less than that required to ensure optimal recruitment．In Figure 1 the relationship between spawning stock size，and the recruitment which that spawning stock pro－ duced over the period 1952－74，is shown。 This suggests that there is a relationship between stock size and recruitment at stock sizes below about

800000 tons．The low spawning stook sizes in the period 1968 to 1974 have produced，on average，recruitments well below the long－term mean． The value of about 800000 tons is about $30 \%$ of the spawning stock biomass in the late 1940s，when this stook was only lightly exploitedo

The relation between the lightly exploited spawning stock size and that at which recruitment failed was examined for other herring stocks in the ICES area．In the Atlanto－Scandian herring it is rather difficult，because of the wide annual variations in recruitment to judge at what spawning stock size the sustained decline in recruitment occurred；but this would appear to have been at a level of $\frac{1}{2}-\frac{1}{4}$ of the lightly exploited stock （Dragesund and Ulltang，1975）。 Similarly for Icelandic spring and summer spawners the data presented by Jakobsson（1973）would suggest that in these stocks the recruitment decline started at a spawning stock biomass of about $1 / 3$ and $1 / 2$ of the lightly exploited stock respectively。 The relative consistency of these values might suggest that when no stock／ recruitment relationship can be demonstrated，a value of about $1 / 3$ of the lightly exploited stock might be taken as being a realistic value at which to take measures to rebuild the spawning stock for herring．
In this situation the Working Group can only reiterate their advice that it is imperative to rebuild the spawning stock as quickly as possible。 In the light of the stock／recruitment relationship shown in Figuxe l，it was decided that the initial objective should be to attain a spawning stock size of about 800000 tons as quickly as possible．A prognosis was carried out of the time which will be necessary to achieve this on the assumption of （i）a complete ban on a directed herring fishery；（ii）with two options of exploitation resulting from the by－catch in other Recommendation 2 fisheries，and（iii）recruitment estimated from the stock／recruitment relationship given in Figure 1 。 One of these options（F for l－group $=0.8$ ， F for $0-g r o u p=0.15)$ is at approximately the level of the fishing mortality rates on these age groups in recent years．The alternative option is at half these fishing mortality rates to give a measure of the likely effect of restrictions on the fisheries which produce these by－catches．The results are shown in the text table below．

| Mixed fishery <br> Fls |  | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\mathrm{~F}_{\text {0－group }}=0.15$ | A | 146 | 249 | 351 | 494 | 696 | 930 |
| $\mathrm{~F}_{\text {1－group }}=0.80$ | B | 3 | 4.4 | 5.3 | 6.5 | 7.4 | 8.0 |
| $\mathrm{~F}_{\text {0－group }}=0.075$ | A | 146 | 249 | 381 | 599 | 922 | - |
| $\mathrm{F}_{\text {I－group }}=0.40$ | B | 3 | 4.4 | 5.6 | 7.2 | 7.9 | - |

$A=$ spawning stock biomass in thousand ton units．
$B=$ recruitment produced by that spawning stock as 0－group $x 10^{-9}$（from Figure 1）。

This shows that even with a complete ban on directed fisheries for herring after 30 June 1976，the stock will not reach the requisite level of 800000 tons until September 1980，if the current level of exploitation of juvenile herring continues．If the current level of exploitation of juvenile herring in the mixed fisheries is halved，this stock level will be reached one year earlier，in September 1979。

It must be stressed that these results are highly dependent on the estimates of recruitment for the 1975 and subsequent year classes which were obtained from Figure $l_{0}$ As there is considerable variability of the annual values about this line，the requisite stock level could be obtained somewhat earlier or somewhat later．As the estimate of the current stock level， however，is very close to the origin of the stock／recruitment curve，there is a considerable risk that two successive years of below average recruit－ ment for these stock levels could reduce the stock to the point where recovery might be very much retarded or may not take place。 In these circumstances further restriction of by－catches of those year classes which are already in the stock is highly desirable。
The low level of recruitment，estimated from Figure l，from the spawning stock size in 1975，is supported by the low abundance of large herring larvae found in surveys carried out in February 1976 in the Dutch coastal area and in the Skagerak．The Working Group must stress that the current situation of this stock is so serious that no further directed fishery should be considered in 1976 and 1977 and that every effort should be made to reduce the by－catch in the mixed fisheries．The spawning stock in 1977 is very dependent on the estimated strength of the 1973 year class in that year．This estimate is largely controlled by the assumption that there will be no directed fishery after l．July 1976。 If a TAC is agreed for the whole of 1976 higher than that at present set for the first six months of 1976 ，the spawning stock in 1977 will have been overestimated and the recovery of the stock thereafter will be very much slower and might never take place。 This situation will be reviewed in 1977，but on present data it seems highly unlikely that any relaxation of these restrictions can be advocated before 1979．Attainment of a spawning stock size of about 800000 tons must be con－ sidered as only an initial objective，which must be reached as quickly as possible if the future of this herring stock is to be assured．In the longer term，although some fishing may be permissible，this should be restricted， to permit a further increase in spawning stock size，with the aim of ultimately attaining a value of about 1.5 million tons，corresponding to a total stock biomass of about 2 million tons．Such a stock level will give a better prospect of optimal recruitment，will give more stable annual catehes and will give a major increase in catch per unit effort．
3．Geltic Sea

3．1 Catch data
The catch data for the period 1965－75 from the Celtic Sea are given in Table 3．1．The figures for 1975 are provisional and the 1974 figures，which had been estimated in the previous report（ $C . M_{0} 1975 / \mathrm{H}: 2$ ），have been revised and slightly altered．The total catch of 16000 tons in 1975 is the lowest recorded since 1965．The decline is particularly noticeable in the catches by the Irish fleet．
In previous reports，stock assessment of Celtic Sea herring was based on a fishing season extending from 1 March－ 28 February。 Howeverg the NEAFC quota system was based on a period 1 April－ 31 Marcho It was，therefore， decided to rearrange the Working Group data according to the NEAFC quota season and the catches by countries per season on this basis are given in Table 3．2．For both the $1974 / 75$ and $1975 / 76$ seasons the total recorded catches were much lower than the TAC set by NEAFW of 32000 and 25000 tons respectively．

### 3.2 Racial composition of the Celtic Sea herring stock

The Celtic Sea herring stock has been considered by previous Working Groups to be a selfwontained winter spawning stock．The existence of an autumn spawning stock in the area had been noticed（Wood and Foster，1966）in the late fifties，but since this stock did not constitute an important part of
the total landings，it was ignored in any stock assessments made at that time．During the 1974／75 season，herring identified by their maturity stages and low vertebral counts as autumn spawners constituted about $5 \%$ by weight of the total Irish catch．During $1975 / 76$ these autumn spawners constituted over $35 \%$ of the total weight of the Irish catch．It is not known whether these herring represent an influx of a new component into the Celtic Sea or whether they are the result of a change in the spawning time of the main winter spawning race。 For the purpose of stock assessment in this report，they have been considered to belong to the Celtic Sea stock． However，it must be pointed out that if they are a separate stock，then the total size of the Celtic Sea stock will be overestimated．

## 3．3 Catch in numbers per year class

The age composition of the total catch in $1975 / 76$ was calculated from Irish and Dutch age data using the same procedure adopted in previous reports． There is，however，a scarcity of age composition data for the catches for the early part of the season and only two samples（ 100 otoliths）were available to cover the period 1 April to 31 August when $30 \%$ of the total catch was taken．Because of the revised catches for $1974 / 75$ and the change to the new season（i．e．starting from 1 April），some slight changes were made in the previously calculated age compositions of the catches．The new age com－ positions of the total catches from $1965 / 66-1975 / 76$ are shown in Table 3．3．
3.4 Mean weight at age

3．4．1 At the previous Working Group meeting，no accurate data were available of mean weight at age for Celtic Sea herringo In order to make a catch prognosis， mean weights at age in previous assessments were estimated from the von Bertalanffy parameters for Celtic Sea，herring。

3．4．2 During the $1975 / 76$ season，mean weights at age were measured from Irish catches．These mean weights are somewhat higher than those estimated during the previous meeting（Table 3．4）。 The figures derived from the Irish catches $1975 / 76$ are now considered to be the best data on mean weight at age。 Consequently，these mean weights have been used in the following prognosis of catch and stock size in 1976／77．The new values used have increased the estimated stock biomasses by approximately lo 0

### 3.5 Estimates of fishing mortality in the 1975／76 season

The only direct mortality estimates for Celtic Sea herring are derived from Irish catch／effort data Using these data the total mortality rate for 1975／76 was estimated at 1.29 ．When the values from catch per effort data are compared with those obtained from VPA it can be seen that those from copoe data vary considerably in the last 3 years（Table 3．5）e However，as the effort in the last three seasons has been very constant，it was decided that the mean value of $Z$ for this period from Irish copoe．data would be the best estimate of total mortality for 1975／76。 Assuming a natural mortality of 0.10 this resulted in a value of $F=0.82$ and this value was subsequently used in the calculation of stock size in 1976 and as an input value for VPA．
3.6 Estimates of fishing mortalities in previous seasons

Fishing mortalities and stock sizes in previous seasons have been cal culated by VPA using the catch compositions in Table 3.3 and assuming an Fadult of 0.82 in the season $1975 / 76$ ．The results of this analysis are presented in Tables 3.6 and 3.7.
Fishing mortality on l－ringers has in the past only been a small fraction of the adult fishing mortality。 Over the period 1970－74，FI－ringers have been on average $15 \%$ of $F$ adults．

The 1972／73 year class，which recruited to the fishery in 1975／76，appears to be of very low strength．Assuming an $F$ adults of 0.82 over the last fishing season，the strength of this year class as l－mingers is estimated at 32 million（Table 3.7 ）。 The modal value for year class strength in the Celtic Sea stock is 100 million l－ringers（Doco CoMol975／H：2）．

The 1973／74 year class seems to be better than the preceding one，although only a preliminary estimate can be made of this year class，based on the catch of l－ringers in the $1975 / 76$ season。 If an Fl－ringer of 0 ol2 is assumed（ $=15 \%$ Fadults which is the same proportion as in the five previous years），the stock size at the beginning of the season is estimated at 109 million l－ringers．

An industrial fishery exists in the Irish Sea which exploits quantities of O－and l－group herring．Molloy and Corten（1975）concluded that some recruits to the Celtic sea may come from that part of the Irish Sea where this fishery takes place．It may therefore have some effect on the recruit－ ment level to the Celtic Sea stock although the extent is not yet known （see para． 5.2 of this report dealing with the Irish Sea stock）。

### 3.8 TAC for 1977／78

The stock size at 1 April 1976 was calculated from the catoh composition
in the season $1975 / 76$ ，using the following assumptions：
$M=0.10$
$F_{\text {adults }} 1975 / 76=0.82$（see above）
$F_{1 \text {－ringers }} 1975 / 76=0.12$（see above）．
Recruitment of year class 1974 will be of modal strength（ 100 million of 1－ringers）。

Estimated stock size at 1 April 1976

| $\begin{aligned} & \text { Age } \\ & \text { in ring's } \end{aligned}$ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | $8+$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Numbers <br> $\times 10-3$ | 100000 | 87441 | 9958 | 11962 | 5253 | 4601 | 2476 | 966 | 734 |

For the 1976／77 fishing season，NEAFC has agreed a TAC of 16800 tons for the Celtic Sea．In order to take this TAC，a fishing mortality of 0.87 will have to be applied to the adult stock（Table 3.8 ）．This will leave an adult stock of only 10200 tons by the end of this fishing season．This is a dangerously low spawning stock level being about $17 \%$ of the spawning stock in the period 1965－70（Figure 2）。 Furthermore，it should be stressed that the figure of 10200 tons depends to a large extent on the assumption of $\mathrm{F}_{1 \text {－ringers }} 1975=0.12$ If fishing mortality on l－ringers in 1975 has been more than 0．l2，the year class $1973 / 74$ will be weaker than estimated，and the stock of adults left by the end of the $1976 / 77$ season will be even lower．
There is no information available at present on the contribution that year class 1974／75 will make to the adult stock in 1977。 In this situation，the Working Group can only recommend a closure of the entire fishery from lst April 1977，until the spawning stock has recovered to a sufficiently high
level．The Working Group considers this level to be at least $1 / 3$ of the stock size in a period of light exploitation（see para．2．5）．The estimated stock during the period of light exploitation is about 120000 ； therefore，the minimum spawning stock should be set at 40000 tons （Figure 2）．

Provided year classes 1974，and 1975 are of modal strength，a closure of the fishery during two seasons would be sufficient to bring the spawning stock to the requisite level。

3．9 Additional conservation measures
In paragraph 3.8 it is estimated that the spawning stock in 1976／77 will be at a very low level，if the TAC for the season is taken in full．This situation is largely due to the TAC for $1976 / 77$ having been set at a level which will require a fishing mortality rate about twice that giving the maximum yield per recruit（para。3．8）and about 50\％above the level recommended for this stock in the last report of the Working Group．

As an appreciable part of the annual catch is taken on the spawning grounds， which are entirely within Irish fishery jurisdiction，a considerable con－ tribution to improving the size of the spawning stock in 1976／77，and to improving the prospects for recovery of this stock in subsequent years，could be made if the spawning grounds were closed to fishing in December 1976 and January 1977，when the main part of the catch in this area is normally taken。

4．Herring in Division VIa
4．1 Potal catches and the fisheries in Division VIa
The total catch reported by each country in Division VIa for each of the years 1966－74 is given in Table 401 together with preliminary estimates of the catches taken in 1975．Estimates of the weight of herring taken in each year in the Moray Firth young herring and sprat fisheries are also given． The final figure of total catch in Division VIa in 1974 shows an increase of about 4000 tons over the preliminary figure for that year in the last report of the Working Group．The preliminary 1975 figure of 128240 tons shows a decrease of about 81000 tons（ $40 \%$ ）compared with the final 1974 figure and a decrease of about 119000 tons（ $48 \%$ ）compared with 1973．The provisional catch figures for 1975 indicate that only $83 \%$ of the TAC of 155200 tons have been taken．This decrease in total catch is partly a result of a quota regulation introduced by NEAFC for 1975 and partly low abundance in the area mainly fished by purse seiners．
The catches by Norway，Faroes and Iceland show a drastic decline from a total for these countries of 41155 tons in 1974 to only 3152 tons in 1975． In spite of considerable time spent for searching for herring in the area north of Scotland and west of the Hebrides normally fished by purse seiners，few schools of herring were found in 1975．In contrast，countries fishing with trawls further south in Division VIa were able to maintain their catch at about the same level as in 1974 （Netherlands，Ireland）or even to increase their catch（France）．

## 4．2 Catch in numbers in Division VIa

4．2．1 Estimates of the numbers of autumn spawning herring per age group caught in Division VIa in each of the years 1966－75 are given in Table 4．2，and in the Moray Firth in Table 4．3．The estimates for the period 1966－72 are taken from Saville and Morrison（1973），and from unpublished Scottish data on the catch in number in the Moray Firth fishery．

4．2．2 Estimates of the numbers of autumn spawning herring caught in 1974 have been corrected according to the revised catch figures．The numbers per age group for 1975 are compiled from national reports．Catches in number per age group for countries for which no age composition data were avail－ able were raised by using age data from other countries，taking into account the seasonality of the fisheries．

4．2．3 As in the preceding 5 years，the 1969 year class provided a considerable component of the fishery，accounting in 1975 for $26 \%$ of the numbers caught in Division VIa and contributing in 1975 to the fishery in about the same proportion as the recruiting year class 1972 （29\％）。

4．3 Stock and mortality estimates
4．3．1 The estimated fishing mortalities，and stock in numbers per age group in the pericd 1965－73，calculated by VPA，are given in Tables 4.4 and 4.5 ． The result of this type of analysis is critically dependent on the estimated fishing mortality in the most recent year。 In the previous report fishing mortality was estimated on the basis of catch per unit effort data of the Scottish Minch fishery．Since national and international regulations have been introduced in this fishery，catch per unit effort data for 1975 do not provide an estimate of $F$ in this year．Calculation of $F$ from stock sizes obtained from VPA for the beginning of 1975 and corresponding catches in 1975 resulted in an estimated $F$ of about $30 \%$ lower than in the previous year as outlined above（ 0.7 ）giving an $F$ of 0.5 for 1975 ．

4．3．2 The stock in number data（Table 4．5）confirm the estimate of the strength of the 1970 year class given in the previous report．The number of l－ringers from this year class（ $1186 \times 10^{6}$ ）is of the same order as the long－term average over the period 1957－73，i．e． $1054 \times 10^{6}$ ，but only $75 \%$ of the 1965－73 average，i。e． $1568 \times 106$ ．The 1971 year class（ $537 \times 106$ ）， however，is very much weaker being only $45 \%$ of the strength of the 1970 year class．The sizes of the 1972 and 1973 year classes（ $1546 \times 10^{6}$ and $1600 \times 10^{6}$ respectively）are estimated from Scottish catch per landing data， using a regression presented in the 1974 report of this Group（CoMo1974／H：4）。 It should be noted，however，that in 1975 the landing of small herring in Scottish ports was restricted by national and international regulations and therefore the estimate of the 1973 year class has to be considered as a minimal estimate。

4．4 Catch prognosis for 1976 and 1977
4．4．1 A prediction has been made of the catch which could be taken in 1977。 The basic age composition at 1 January 1975 was calculated from the catch in numbers per age group in 1975 by using the $F=0.5$ in 1975 given in param graph 4．3．1．

4．4．2 The mean weights per age group calculated for 1975 are not very different from those calculated for 1974.

Mean weights per age in grammes

| Age <br> in rings | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | $\geq 9$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1974 | 88 | 124 | 163 | 171 | 190 | 212 | 218 | 220 | 220 |
| 1975 | 91 | 118 | 152 | 179 | 182 | 199 | 217 | 228 | 228 |

This shows that the relatively low weights of the 4 －ringers in 1974 and of the 5 －ringers in 1975 belonged to the 1969 year class，which is the largest year class which has ever been observed in the stock．For the catch pre－ diction and estimation of biomass the mean of 1974 and 1975 weights wexe used．
4.4.3 As in the calculation of the 1976 TAC the recruiting year classes (1974 and 1975) for which no information is available were taken as equal to the most frequent recruitment in the period $1957-73$ ( $650 \times 10^{6}$ )。 This level is about $40 \%$ below the average over the same period and will therefore reduce the probability of overestimating the stock sizes, and the corresponding catches calculated on this basis.
4.4.4 The number of 2-ringed herring recruiting to the fishery in Division VIa is affected by the Moray Firth sprat and herring fisheries on l-ringers. In order to account for these catches in estimating the number of 2-ringers in the following year an $F$ of 0.13 was applied. This value corresponds to the 1969-73 average Fo The catch of l-ringers in Division VIa was calculated by using an $F$ which is $10 \%$ of the $F$ applied to the older age groups. As in the previous assessments the $F$ applied to the $2-r i n g e r s$ was taken as $50 \%$ of the $F$ for 3 -ringers and older.
4.4.5 The basic parameters used to calculaterithe TAC for 1977 are given below:

| Age <br> (rings $)$ | Number per age group <br> at I Jan.1977 (x 10-6 $)$ | Average weight per age group <br> in grammes |
| :--- | :---: | :---: |
| 1 | 650.0 | 90 |
| 2 | 516.4 | 121 |
| 3 | 891.4 | 158 |
| 4 | 423.4 | 175 |
| 5 | 74.7 | 186 |
| 6 | 59.7 | 206 |
| 7 | 166.3 | 218 |
| 8 | 28.6 | 224 |
| 9 | 48.7 | 224 |

4.4.6 The stock size at the beginning of 1977 was calculated on the assumption that in 1976 the TAC of 136000 tons will be taken, which implies a fishing mortality of 0.51 on adults (3-ringers and older) in that year. The remaining biomass will be at about the same level as in the beginning of 1975 and slightly below that of 1976 (Figure 3).

Predicted catch figures together with the corresponding values for $F$ and the biomass of the adult component of the stock are given in the table below (weight in 1000 tons):

| $\begin{aligned} & 1975 \\ & \text { Bioma:s } \end{aligned}$ | 1976 |  |  | 1977 |  |  | $1978$ <br> Biomass |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Biomass | F | Catch | Biomass | F | Catch |  |
| 368 | 416 | 0.51 | 136 | 357 | $\begin{gathered} 0.18 \\ \left(\mathrm{~F}_{0.1}\right) \end{gathered}$ | 52 | 370 |
|  |  |  |  |  | 0.30 | 83 | 339 |
|  |  |  |  |  | $\left(\begin{array}{c}0.60 \\ \left(\mathrm{~F}_{\text {max }}\right)\end{array}\right.$ | 146 | 275 |


| 4 | Advice on TAC |
| :---: | :---: |
|  | In advising on the TAC the Working Group followed the guidelines worked out at the ICES＂Ad hoc Meeting on the Provision of Advice on the Biological Basis for Fisheries Management＂（Doc．C．M．1976／Gens3）． |
| 4.5 .1 | The TAC for 1977 corresponding to $\mathrm{F}_{0.1}=0.18$ was calculated as 52000 tons． |
| 4.5 .2 | This result was then considered in relation to minimum stock size levelso The level of stock size which would produce the most desirable level of recruitment for the herring stock in Division VIa cannot at present be defined from a stock／recruitment curve。 Therefore，estimates of the relevant adult stock size have to be made on the basis of the history of the stock and the fishery． |
| $4 \cdot 5 \cdot 3$ | In the period prior to 1965 the size of the stock was at an average level of 205000 tons，with only minor fluctuations，supporting a rela－ tively stable fishery of about 60000 tons per year（Figure 3）。 The average recruitment during this period was about $440 \times 10^{6} 1$－ringers． After 1965 the level of recruitment increased considerably，the average over the 1965－72 period being about $1700 \times 10^{6}$ l－ringers and， excluding the two outstanding year classes 1963 and 1969，about $1100 \times 10^{6}$ l－ringed herring．This leads to the conclusion that a stock size of 200－250 000 tons will be sufficient to prevent recruitment failure due to low spawning potential and that an annual catch of about $30 \%$ of the fishable biomass does not reduce the stock below the required minimum level． |
| 4.5 .4 | At the level of stock size estimated for the beginning of 1977，fishing at $\mathrm{F}_{0} 1$ would allow a catch of only $15 \%$ of the stock．This would result in an increase in stock size of only $4 \%$ by January 1978，but would require a reduction of about $62 \%$ from the 1976 TAC level。 Since fishing at $\mathrm{F}_{\mathrm{O}_{\mathrm{O}}} 1$ is intended to serve as a long－term objective rather than an immediate ${ }^{0}$ step，this sharp reduction in TAC seems to be an unnecessary rigid measure in the present situation． |
| 4.5 .5 | Fishing at $F_{\max }$ ，however，would increase the TAC for 1977 above that for 1976 by $7 \%$ ，but would decrease the size of the stock by $23 \%$ ．This is undesirable particularly as fishing at this level would remove $41 \%$ of the stock present at the beginning of 1977. |
| 4.5 .6 | The flat top of the yield per recruit curve（Figure 4）begins at $F=0.3$ ． In the range between $F=0.3$ and $F_{\max }=0.6$ the increase in yieId per recruit is only $4 \%$ ．Considering thex points set out in 4.504 it seems advisable to apply an $F=0.3$ as an intermediate step in the light of the actual fishing situation．This gives a TAC of 83000 tons in 1977 and would result in a biomass of 339000 tons at the beginning of 1978．This level is only $5 \%$ below that of 1975 but about $50 \%$ above the minimum stock size suggested in paragraph 4.5 .3 ．The TAC for 1977 would be $23 \%$ of the biomass at the beginning of 1977 ． |
| 4.5 .7 | It should also be borne in mind that in Division VIa steps have been taken to optimise the exploitation pattern．A minimum landing size of 20 cm has been introduced for herring in this area and the $10 \%$ herring by－catch regulation enforced since 1 February 1976 in the Moray Firth sprat fishery should reduce the exploitation of 0 －and l－group recruits to this stock considerably． |

5. Irish Sea Herring (Division VIIa)
5.1 Introduction
5.l.l Herring fishing in the North Irish Sea is supported by two autumn spawning stocks called the Mourne stock and the Manx stock. They have distinct spawning grounds which are shown in Figure 6 but for management purposes they may be considered together. The need for management was appreciated following a considerable increase in catch, effort and estimated $F$ on the Manx stock from 1970 onwards. Since most of the herring were taken in the area of United Kingdom fisheries jurisdiction first steps in management were taken on a national basis.
5.l.2 In 1972 a Working Party of United Kingdom fishery scientists recommended a prohibition from 1 October to 17 November in each year from 1973 of fishing for herring within 12 miles of the Isle of Man and a shorter prohibition within 12 miles of the coast of Northern Ireland, South of $54^{\circ} 10^{\circ} \mathrm{N}$ to a line SE from Haulbowline Rock. The prohibition was expected to reduce effort at a time when the shoals of herring were concentrated for spawning. In fact, there was a decrease of $F$ on the Manx stock from 0.62 in 1972 to 0.47 in 1973. A closure of the Mourne fishery for 2 weeks in October 1973 was not followed by a decrease in the estimated $F$ from the 1972 level of $=0.80$.
5.1.3 In 1974 effort and catch rose sharply despite the continuation of the prohibition of fishing mentioned in 5.l.2. Consequently the United Kingdom Working Party recommended a TAC of about 12000 tons for 1975 for the Manx stock. The basis for this recommendation was reported to ICES (Doc. C.M. 1975/H:40). The TAC was in fact set at 18000 tons for $U 0$. $\mathrm{K}_{0}$ fishermen. The actual catch by $U_{0} K$. vessels was 15408 tons, and by those of other nations 3727 tons, giving a total of 19135 tons. No TAC was set for the Mourne herring but a $3 \frac{1}{2}$ day fishing week was introduced. The prohibitions of fishing for herring of both stocks remained in force in the periods mentioned above。
5.2 Catch and effort

Annual catch data from 1964 to 1975 are given in Tables 5.2.1 and 5.2.2. Most of the catch until 1974, other than that taken by Ireland, was taken in the months of May to October inclusive with more than half the annual catch taken in September.

In 1974 and 1975 there was some catch in each month of the year, but most was of pre-spawning or spawning herring in July and October. The Irish catch on the Mourne stock from 1969 included an industrial fishery on 0 - and $1-$ ring herring (Table 5.3.1 (b))
Most of the herring is caught by trawling. Available statistics on effort (expressed as trawler landings, ioe. one day's fishing) are given in Table 5.2.3. The very large increase in effort in 1974 was in part due to the catches made in winter and spring but was mainly the result of the deployment of a larger number of boats.

### 5.3 Age composition of the stock

5.3.1 Total catches of Manx herring were converted to catches in numbers using data from samples taken of landings in the Isle of Man, England, NoIreland and Ireland supplemented in 1974 and 1975 by French and Dutch samples.
Catches of Mourne herring were similarly treated, though available sampling data were more limited. Most of the data are from Irish samplingo
From Tables $5.3 .1(a)$ and (b) it can be seen that 2 - and 3-ring fish are the most numerous age groups in the catches of Manx stock, and 0-and l-ring fish in those of the Mourne stock.
5.3 .2 Tables $5.3 .2(a)$ and（b）show annual stock sizes at 1 January each year estimated by VPA with input values of $M=0.1, F=0.7$ for both stocks． It should be noted that l－ring fish are only partially recruited to the fishery on Manx stock．Full recruitment takes place as $2-\mathrm{group}$ fish． Recruitment was high in 1969，71， 72 and 74。 All available evidence suggests that it was average in 1975。
Stock estimates of the Mourne herring show that the stock size has decreased considerably since 1971．

## 5．3．3 Industrial fishery

Since 1969 an industrial fishery has been carried out in the northern part of the Irish Sea。Sampling of the catches has enabled estimates of the weight of young herring landed to be made．These were as follows：

| Year | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Tons | 2210 | 3796 | 2715 | 2251 | 1913 | 2190 | 1573 |

Examination of otoliths has shown that 0 －group herring are first taken during June／July when they are approximately 10 cm long．These young herring remain in the catches for approximately one year until they migrate offshore as l－group，at which time they are approximately $18-20 \mathrm{~cm}$ long． They appear to be most abundant during the winter months The total catch of herring in this fishery expressed as numbers per age class is shown in Table 5.3 .3 for the period 1969 to 1975 ．During this period the average annual number per age group taken was as follows：

| Age group | 0 | 1 | 2 | 3 | Total |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Numbers $\left(10^{-6}\right)$ | 73.9 | 24.5 | 6.9 | 0.7 | 106.0 |

Catches of this size must have some effect on the level of recruitment to the adult stock to which they would have recruited．The appearance of the strong 1969 year class as l－ring fish in the Mourne stock was preceded by high catches of 0 －group fish in the industrial fishery and in general catches of O－group herring in the industrial fishery would seem to give an index of the recruitment level to the Mourne fishery．In addition， there is a very strong similarity between the vertebral counts of the Mourne stock and of the herring taken in the industrial fishery．

## 5．4 Management

Predictions of the stocks in 1977 were caloulated and are given in the table below：

| Stocks | Biomass <br> 1975 | 1976 |  |  |  |
| :--- | :--- | :--- | :--- | :--- | :--- |
|  | 42951 | 36736 | 0.4 | 11573 | 39148 |
|  | 14196 | 13166 | 0.74 | 6594 | 14924 |

5．4．1 For the Manx stock a value of $M=0.1$ was used throughout．$F=0.65$ for 1975 was estimated from the regression of $F$ on effort for a long series of data．Recruitment of 83 x 106 2－ring fish was assumed for 1976 and 1977； this is the average value from VPA for the years 1964－73．It is likely that the 1976 catoh estimated at 11000 tons in the light of U．Ko national restrictions will generate an $F$ of 0.4 in that year．This value has been used for 1976 in the calculations but it must be stressed that it will be
unrealistic if there is a major diversion of fishing effort to this area by other countries．The yield per recruit curve for this stock is shown in Figure 7；it can be seen that values of $F=0.4$ in 1976 and $F=0.3$ in 1977 represent progressive steps from the 1975 value of $F=0.65$ towards the $F_{0.1}=0.16$ ，in accordance with the recommendation given by the ICES＂Ad hoc Meeting on the Provision of Advice on the Biological Basis for Fisheries Management＂（Doc．CoM．1976／Gen：3）．Estimates of recent recruitment to the Manx stock indicate that there is no need a．t present for concern about the level of spawning stock size。 On these considerations an $F=0.3$ was taken as the appropriate level for 1977．This would entail a TAC for 1977 of 10000 tons for the Manx stock．
5．4．2 For the Mourne stock a value of $M=0.1$ was also used．Mean $F$ on the
0 －group for the years 1969－73 from VPA was $F=0.74$ ．The spawning stock biomass
has shown a considerable decrease over the years for which estimates are
available。 It was considered that $F$ on adults in 1.975 was at much the same
level as in the preceding 2 years．$F$ on the l－ring and older fish from VPA
in 1973 was $F=0.77$ and in 1974 for Northern Ireland trawl cop．e。data
was $F=0.80$ ．It was decided to use a value of $F=0.74$ on all age groups
in both 1975 and 1976 in the calculation of stock sizes．Recruitment of 0－
group fish for 1976 and 1977 was estimated at $75 \%$ of the mean recruitment
1969－73（from VPA）to allow for the possibility that some of the 0－group fish
taken in the industrial catch could have been from some stock other than the
Mourne one．The Mourne $0-$ group recruitment value used was therefore
$128 \times 10^{6}$ fish．In calculating the TAC for this stock in 1977 an $F=0.3$ was
used as in the Manx stock．This would allow a build up of the stock and
would produce a yield for 1977 of 3000 tons．This TAC is calculated on the
assumption that the recommendation regarding a minimum landing size in para－
graph 5.4 .4 is implemented in 1977．

5．5．TAC for 1977 in Division VIIa
As discussed in paragraphs 5.4 .1 and 5.4 .2 fishing at an $F$ of 0.3 would appear to be an allowable intermediate step in approaching the $\mathbb{F}_{0.1}$ value for these stocks．This gives a TAC for the whole North Irish Sea area of 13000 tons in 1977．

5．5．1 Minimum landing size
In Section 7 it is explained that the introduction of a minimum landing size of 20 cm would result in an appreciable increase in the yield per recruit for North Sea herring．Advice on this topic given to the November 1975 meeting of NEAFC also stressed that this measure would result in a considerable increase in spawning stock biomass．

This measure would have similar effects in other areas where herring have similar growth curves and where there is exploitation of fish below this size。 Although a detailed comparison between the growth curves between Irish Sea and North Sea herring was not made，it was possible to show that the average weight／age was very similar for adult fish but that the Irish Sea stocks appeared to grow slightly faster in the younger age groups．This would indi－ cate that the introduction of a minimum landing size of 20 cm would have a similar beneficial effect on the yield／recruit and spawning stock biomass for Irish Sea herring。

6．Sprat Assessment for the North Sea and Skagerak
6．1 Introduction
At its meeting in 1975 the Working Group considered the recent increase in catches of sprat in the North Sea．In the absence of adequate biological data the Working Group was unable to do more than advise a precautionary TAC，which it was suggested should be at the level of catch in 1974，ioe． 300000 tons．With a further sharp increase in catches in 1975 in both the North Sea and Skagerak，the Working Group asked for more detailed information for its 1976 meeting．

Since the populations of sprat in the North Sea and Skagerak appear to be more or less distinct, the Group decided that the two stocks should be treated separately for assessment purposes. The catches from the Norwegian fjords (ICES Division IVa East) are considered to be from, and were included in, the Skagerak stock.
Owing to some confusion in the past, the Group agreed on a set of definitions for the age of sprat. Peak spawning in the North Sea and Skagerak occurs from about May-July. Fish born in this period are termed 0-group until 31 December of that year, and then for the whole of the next year they are l-group. Over the winter period sprat in their first year of life are termed 0/l-group, and similarly for the older age groups.

### 6.2 North Sea sprat

6.2.1 The North Sea fishery in 1975

In Table 6ol catch data for the years 1966-74 and preliminary catch data for 1975 are given for each sub-division of the North Sea. The total North Sea catch in 1975, excluding the Norwegian fjord catch, amounted to 635300 tons, the highest catch on record and more than double that taken in 1974. The increased catch in 1975 came almost exclusively from ICES Division IVb and was taken by two countries, Denmark and Norway. In Division IVb the catch of Denmark increased from 159400 tons in 1974 to 321800 tons in 1975, and the catch of Norway from 9500 tons in 1974 to 145700 tons in 1975.
The annual age compositions for Sub-divisions IVb east and IVb west which were included in the previous report were updated (Table 6.2). Although Danish and Norwegian data exist for Sub-divison IVb west for 1974 and 1975, to prodide an age composition for the 1974-75 season which is comparable with the earlier ones, the percentage age compositions given in Table 6.2 are based only on English data from the North Shields winter fishery, this being the only available source of data prior to 1974. Those for Sub-division IVb east are based on Danish data from the summer fishery.
The catch in number per age group was calculated by the Working Group from the national data for age compositions of catches in 1974 and 1975. These are given for each region in Table 6.3. It is clear that the high catches in both 1974 and 1975 were due to the strength of the 1973 year class which made the major contribution to the catches as l-year old fish in 1974 and as 2 -year old fish in 1975. The 1974 year class appears to be much weaker than the 1973 year class in the North Sea sprat population.

## 6.2 .2 Biological parameters of the North Sea sprat

The weight at age of sprat in the North Sea landings was estimated from data provided from both the inshore and offshore fisheries. Only the larger members of the 0-group are taken in the winter fisheries and so for this age group the mean weight in the catches is probably higher than that for the population in sea. Values for all age groups are given for January 1974 and for January and July 1975 in the text table below. The values were rather different in 1974 and 1975, so the means of the two sets of estimates have been used in the assessment of North Sea sprat.

Mean weight (g)

| Age | January |  |  | Mean |
| :---: | :---: | :---: | :---: | :---: |
|  | 1974 | 1975 |  |  |
| 0 | - | - | - | 0 |
| 1 | 2.3 | 3.1 | 2.7 | 4.6 |
| 2 | 9.0 | 10.4 | 9.7 | 14.1 |
| 3 | 15.3 | 17.3 | 16.3 | 20.0 |
| 4 | 19.9 | 25.6 | 22.7 | 29.0 |
| 5 | 28.4 | 29.8 | 29.1 | - |

The estimate of natural mortality（M）of North Sea sprat used is that of 0.8 made by Johnson（1970）。 The only other available estimate of the natural mortality rate is that of 1.05 for the Gullmar Fjord in the Skagerak area made by Lindquist（1974）。
Sprat first spawn at an age of about 2 years．The spawning stock is there－ fore considered to consist of the 2－group fish and older．

## 6．2．3 Fishing mortality and stock size

The recent increase in the total annual catches of sprat from the North Sea is very large．To understand its effect on the stock，estimates of fishing mortality or stock size are required．The Working Group considered a number of methods of obtaining such estimates．
a）Virtial Population Analysis
VPA is of doubtful validity for short－lived species like sprat because the estimates of $F$ and stock size obtained are highly dependent on the accuracy of the values of $M$ and the fishing mortality assumed for the oldest age groups and in the last year of the analysis．With this reservation in mind， the Working Group carried out VPAs on two sets of data：

1．the annual catch in numbers of each age group for the whole North Sea from 1967－75 on a fishing season basis（ioe．July－June）．The estimates of catch com－ position up to 1973－74 had been prepared prior to the meeting using samples from the English and Scottish commercial landings for the inshore fisheries，research vessel samples taken mainly during the International Young Herring Surveys for the offshore fisheries and all other available age data．The data for 1974－75 were calculated by the Working Group．The input data are given in Table 6．4．
2o the quarterly catch in numbers per age group for the whole North Sea from January 1974 －December 1975, estimated by the Working Group from catch and age com－ position data supplied by participants．The input data are given in Table 6．5．

The VPAs were carried out using a natural mortality coefficient of 0.8 and input values of the final fishing mortalities given in Tables 6.6 and 6．7． To give reasonable input values it was assumed that $F$ had been at a rather low level in the period 1967－73 and that it doubled in 1974 and again in 1975．In the quarterly VPA it was assumed that $M$ is evenly distributed throughout the year．
The values of fishing mortality estimated from the VPAs are given in Tables 6.6 and 6.7 ，and the estimated stock size and recruitment on 1 July of each year in Table 6．8。

The stock size appears to have fluctuated considerably as a result of an increase in recruitment from 1972－75 and in stock size in 1974（Table 6．8）。 The increased catches taken from 1974－75 may therefore in part be due to an increase in stock．The fishing mortality appears to have been low up to 1971－72 and to have increased since then．
This analysis suggests that the catches of sprat taken in 1974 and 1975 represent a considerable proportion of the average total stock in the North Sea and that catches at this level may only be sustainable at the higher level of recruitment from 1972 to 1975.
The level of recruitment in 1975 cannot yet be measured quantitatively but age compositions in that year（Tables 6.2 and 6.3 ）suggest that it was not as high as in 1974．The poor catches in the British coastal fisheries in
the last three months of 1975, moreover, indicate that the 1975 year class may be substantially weaker than either of the two preceding ones. It can only be assumed, therefore, that there will be a return to the earlier recruitment levels and that this is likely to result in a considerable decrease in catch in 1976, if fishing effort remains at the same level as in 1975.
b) Catch per unit effort

The VPA indicates rather low levels of F prior to 1972 and an increase to about 0.2 by 1974 (Tables 6.6 and 6.7) 。 Independent estimates of total mortality (Z) between late 1974 and late 1975 were made from catch-perw unit effort data supplied by the Soviet Union and by Denmark for the offshore fisheries (Table 6.9). The two estimates of $Z$ obtained (1.20 and 1.32 ) indicate values of $F$ in that year of about $0.4-0.5$. As these are estimates of fishing mortality rate in 1975, and the catch in that year was about twice that of 1974, these estimates are in reasonable agreement with that from VPA.
c) Estimates independent of catch and effort data

In addition to the above estimates of fishing mortality, the Working Group considered other ways of obtaining estimates of the stock size in the North Sea. Egg and larval surveys carried out in 1972 by Johnson and Dawson (1975) indicate a stock of about 0.5 million tons in that part of the North Sea south of $57^{\circ} \mathrm{N}$ 。 Although this cannot be taken as a precise estimate it was calculated making conservative assumptions and so is probably not unreasonable as a minimum estimate, since spawning also occurs to the northeast of Scotland. The stock size calculated by this means is of the same order as that from VPA.

The estimates from these different methods are therefore in some agreement but, in view of the reservations about their accuracy, the Working Group considers it essential that other methods for estimating stock size and recruitment estimates be investigated. In particular, the possibility of carrying out coordinated acoustic surveys and egg and larval surveys should be considered.
6.2.4 The effect of fishing mortality on yield per recruit and stock size

Yield per recruit curves were prepared using an $M$ of 0.8 and weight at age values given above (Figure 8). Three patterns of exploitation were considered:
a) $F$ in the first year of life ( $F_{o}$ ) at about the present level, ioed about $1 / 6$ of the $F$ on the older age group ( $F_{\text {adult }}$ );
b) $F_{0}=F_{\text {adult }}$;
c) $F_{o}=$ zero.

All three yield per recruit curves rise steeply with increase in $F$ up to a level of fishing mortality of about 0.6. With the same level of exploitation in the first year as in older fish; the curve then reaches an asymptote, but the yield per recruit continues to rise with low or zero exploitation in the first year. These curves are typical of those for short-lived, fast-growing species of fish, and suggest that with yield as the only criterion, the most efficient form of exploitation is to catch the fish when they are young. At the present estimated levels of
fishing mortality，there is also little likelihood that selective restriction of 0 －group exploitation would result in any significant gain in yield per recruit。
Although no gain in yield per recruit is likely to accrue from reducing fishing mortality，heavy exploitation would seriously depress the spawning stock size．The effects of different patterns of exploitation，and of in－ creasing values of $F$ ，on the spawning stock were also considered（Figure 9）． Reduction of the spawning stock to about $1 / 3$ of the unexploited level is estimated to ocour with an $F$ of about 0.54 ．Reduction of the current rate of exploitation in the first year would have only a marginal effect on the spawning stock size．On the other hand，if the exploitation rate in the first year increased disproportionately，a considerable reduction in spawning stock would occur．Any regulation that prevents an increase of exploitation on the 0－group is therefore desirable。

## 6.2 .5 Calculation of TAC for 1977

Although the output of the VPA must be treated with reserve，the Working Group decided that the absence of more reliable estimates the results should be used to calculater a Total Allowable Catoh for 1977．The following basis was used for the calculation：
a）Since there are indications that the strength of the 1975 is below those of the three preceding year classes and since there is no way of predicting the strength of the 1976 year class in 1977，it was assumed that recruitment of these year classes will be at the mean for the years 1967－74 of $181 \times 109$ fish（Table 6．8）。
b）In the absence of information on the relationship between stock and recruitment，it was decided that it would be undesirable to reduce the spawning stock below $1 / 3$ of the unexploited level as had been done for herring（paragraph 2.6 ）．With the present exploitation pattern，this would occur with a fishing mortality of 0.57 ，that is about the same level as in 1974－75．At this $F$ the spawning stock per recruit is 2.19 g （Figure 8）。

The predicted long－term annual catch calculated on this basis is 396000 tons． Thus it is estimated that a fishing mortality not substantially different from that in 1975 will result in a catch in 1977 considerably lower than that taken in 1975．This situation is the result of a lower level of recruitment and it must be borne in mind that，with a short life－span species such as sprat，there will inevitably be major fluctuations in annual catch due to recruitment variation。
A rather cautious approach is also necessary because，if recruitment in 1977 is below average and the TAC is，as a result，set at too high a level，then the $F$ generated will be much higher than 0.57 and concentrated on the older age groups．The spawning stock will then be reduced to a level much lower than that advocated，greatly increasing the risk of reaching the level at which a stock／recruitment relationship occurs．It must also be borne in mind that any increase in $F$ in the sprat fishery will result in a heavier fishing mortality rate of immature herring caught as bymcatch in the sprat fishery．

Taking all the above factors into considerationg the Working Group recommends that the TAC for sprat in the North Sea for 1977 should be set no higher than 400000 tons．

## 6．2．6 Protection of $0 / 1$－group sprat

In paragraph 6．2．4 attention was drawn to the desirability of protecting
 of the Working Group experiments were discussed which gave selection factors
for sprat from which it was deduced that a 20 mm mesh size in sprat trawls would be the appropriate size to give almost complete protection to
 of this mesn sfze, NEAFC introduced a 16 mm mesh size for sprat trawls at its mid-texm meeting in November 1975.
Further experiments have been carried out on the problems of meshing and selection, using Scottish commercial sprat trawlers fishing by normal commercial practice for the Scottish fleet, but using trawls of 16 mm and 20 mm mesh sizes. A total of 27 trawl hauls were carried out in which catches up to 10 tons were taken, and covering a sprat population with a size range from 3.5 to 13.5 cm 。
These results suggested that, under the conditions of these experiments, meshing was not a problem with either 16 mm or 20 mm mesh sizes. They also gave selection factors somewhat lower than those stated in the previous report - suggesting $50 \%$ selection lengths of 5.7 cm for a 16 mm mesh size, and 703 cm for a 20 mm mesh size. In view of the differences between these new results and those previously reported, and the possibility that selection by sprat trawls may vary appreciably from one national fishery to another, depending on factors such as towing speed and net design, it is recommended that further experiments be done under the normal commercial practice of national fleets fishing North Sea sprato
In the western North Sea 0/l-group sprat may be largely confined to areas close to the coast This age group can form a major proportion of the catches of the $U_{0} K$ fishery in coastal areas, but does not contribute appreciably to the catches of other fisheries further oftshore. The differences in the age composition of the stocks in coastal and more offshore waters may also be a factor in influencing the applicability of the selection experiments mentioned above to fleets of other countries, as these experiments were carried out in a coastal area.
6.3 Sprat in Division IIIa and the Norwegian Fjords

The sprat population in areas III and IVa east (the Norwegian west coast fjords) can be considered as a single stock which is largely independent of the population in othex areas of the North Sea. This population spawns in a well-defined area between Denmark and Sweden from May to Augusto From the spawning area the larvae drift either to the Skagerak and Kattegat coastal areas or to the Norwegian coastal areas. As in the North Sea, most Skagerak sprat become sexually mature at an age of 2 years, with a small proportion spawning at an age of one year.
6.3.1 The sprat fishery

The fishery for sprat has the following structure: in the coastal areas of Norway and Sweden there have been purse-seine fisheries for more than a century, with little annual fluctuations in the yieldo The catch is used for human consumption only. In addition, there are trawl fisheries for sprat by Denmark and Sweden, the greatest landings being taken from summer to early winter. The Danish landings remained at a constant level until 1972。 There was a major increase in these landings from 1973 onwards. The total landings from these trawl fisheries in 1975 were at a level of about 100000 tons. Catches in this area for the period 1966-75 are given in Table 6.10.

## 6.3 .2 Biological data

Biological observations on the sprat in Divs. IIIa/IVa east exist for a considerable time. The percentage age compositions, excluding the $0 / 1$ group, and the mean age in samples from the purse-seine catches from the coastal area, and in trawl samples from the open sea, are given in Table 6.11. These do not show any long-term trends.

The percentage in numbers of $0 / 1$－group sprat in Swedish samples for the period 1966－75 does not show any significant trend（Table 6．12）．It is apparent，however，that the proportion of 0／1－group sprat in the trawl catches is consistently higher than in the purse－seine catches．
There are no effort data available which would permit an evaluation of stock size changes from catch per unit effort in Division IIIa。 Since， however，the fishing effort has not changed in the Norwegian and Swedish coastal fisheries，and since the catches have not increased appreciably，it would appear that there has not been any major increase in stock abundance in Division IIIa．The large increase in total catch from the open sea fishery therefore must have at least largely been due to an increase in fishing effort．

## 6.3 .3 stock assessment

The features of the population dynamics of North Sea sprat described in the report of the Working Group last year（Doc． CoM ． $1975 / \mathrm{H}: 2$ ）apply also to the sprat in Division IIIa。
No age data are available in a suitable form to carry out a VPA for the Skagerak stock。 The Working Group was，therefore，not able to estimate a．．． TAC on any precise basis．Any further increase of the fishing effort，how－ ever，might have the effect of reducing recruitment，and of bringing about a collapse of the stocks and the fisheries，before appropriate conservation action could be taken．Moreover，with regulation of sprat and herring fisheries in the North Sea，there is likely to be a major diversion of fishing effort to Skagerak sprat unless some control is introduced in that area．In 1977 the landings should therefore not be allowed to exceed the level of 1975. This would mean a total allowable catch for Division IIIa and the Norwegian fjords of 100000 tons．
To improve the ability to advise on regulation of Division IIIa sprat， methods are required to measure the strength of the recruiting year classes． Such methods may include 0 －group surveys．

## 7．Minimum Landing Size for North Sea Herring

7．1 In a previous report（Doc。CoMo1975／H：2）selection experiments for sprat indicated that the selection factor was in the range $3.5-4.5$ ．Information now available from Scottish selection experiments carried out on commercial pair trawlers suggest roughly similar values（para。6．2．6）o According to these results，the $50 \%$ retention length of sprat，corresponding to the 16 mm minimum mesh size introduced by NEAFC is between 5.5 and 7.2 cm ，or close to the mean length of the 0－group sprat．

7．2 No mesh selection experiments were available for that size range of herring but the Working Group considered it unlikely that selection factors for herring would differ appreciably from those found for sprat．Setting a minimum landing size for North Sea herring corresponding to $50 \%$ retention length of the 16 mm mesh（ioe．minimum landing size of about 6 cm ）would be absurd as it would achieve nothing and would be unenforcable。As explained in the report of the Liaison Committee（Doc。C．Mo1975／Li：9）prepared at the Montreal Meeting in October 1975，a 20 cm minimum landing size for North Sea herring has been introduced in Division VIa and the yield per recruit curves for herring in the two areas are very similar．It would therefore be appropriate to have uniformity in minimum landing sizes between the two areas and any other areas where similar conditions apply．

8．Application of the ICES＂FISHDAT＂System
During the present meeting Working Group members were introduced to recent developments in the ICES data processing system for North Sea herring．

A trial run using input data from the 1972 herring fisheries was already made in 1974 and reported on by the ADP Working Group (Doc. CoM. 1975/D:2). The output was in general agreement with the results obtained by the Herring Assessment Working Group using the same data but slightly different assumptions on eog. allocation of unallocated catch data.

Since then further development has taken place and handling made much easier for the user by the introduction of a direct data-base management system.
The present Working Group endorsed that the "FISHDAT" System contains important assets to the assessment work:
(i) It will almost completely cut out the very appreciable time hitherto spent on tedious oalculations and preparation of basic tables thus giving the Group more time for their main object, which should be the scientific appraisal of the material and of the conclusions based thereon.
(ii) It necessitates a steady inflow of data in a uniform format from the laboratories involved. At present, Working Groups are frequently presented with untreated data in a more or less suitable form for processing.
(iii) Working the ADP System requires a higher degree of explicit and consistent assumptions than are perhaps applied at present by Working Groups, especially on a year-to-year basis.

The Working Group recommends that steps be taken to bring the ADP System into full operation.

| 9. | Summary |
| :---: | :---: |
| 9 | The new data available for North Sea herring suggest that there will be some increase in the size of the adult stock in 1976, due to the recruitment in that year of the 1973 year class. However, the spawning stock in 1976 will still be at a very low level of about l/lo of that in the immediate post-war years. There is now some evidence that, at a spawning stock biomass below 800000 tons, recruitment becomes dependent on spawning stock biomass for this population. It is therefore imperative that firm action be taken to rebuild the stock to this level as quickly as possible。 |
| 9.2 | In the light of this position it is strongly recommended that directed fisheries on North Sea herring should be prohibited from 1 July 1976, and every attempt should be made to further restrict the by-catches of herring in the mixed fisheries, until the spawning stock recovers to 800000 tons. It is difficult to predict with any precision how long this will take, but with the best assumptions which can be made, this may not be achieved before 1980 with the present exploitation rate in the mixed fisheries or before 1979 if some further restrictions are introduced on these。 |
| 9.3 | The rapid decline in the Celtic Sea herring stock has continued. It is estimated that if the agreed 1976/77 TAC is taken in full, the adult stock biomass at the end of that season will be below $10 \%$ of the level under conditions of light exploitation. It is considered essential to rebuild this adult stock to a level of 40000 tons as quickly as possible. |
| 9.4 | It is therefore recommended that there should be no fishery on this stock in 1977/78 and that consideration should be given to closing the fishery within Irish fishing jurisdiction, on the spawning grounds in DecemberJanuary 1976/77. If these measures are implemented and recruitment is not below average some fishing might be permissible in 1979/80. |

9.5 The state of the herring stock in Division VIa is not as serious as in the
stocks mentioned above. If the agreed TAC for 1976 is taken in full, the
remaining stock biomass will be about the same level in 1977 as in 1975
and 1976 . There are indications of recruitment of a 1973 year class con-
siderably above the modal value used in forecasting recruitment when no
indications are available. There is no evidence of the stock biomass in
this population being at the level where recruitment will be affected. The 1977
TAC recommended for this stock is 83000 tons.
9.6 An assessment has been made of the herring stock in Division VIIa. In this area there would appear to be two distinct spawning stocks - one in the area around the Isle of Man and one in the Mourne area. However, there is probably some mixing of them during part of the year, and for practical reasons it would be advisable to treat them as a single management unit. There is clear evidence of a rapid increase in exploitation of these stocks in recent years which has been partially controlled by unilateral regulatory action by the United Kingdom. International control now appears highly desirable and it is recommended that a TAC of 13000 tons be brought in force in 1977.
There is a considerable fishery in the northern part of Division VIIa of juvenile herring used for industrial purposes. It is recommended that in Division VIIa, a minimum landing size for herring of 20 cm be introduced, in conformity with that currently in force in Division VIa.
9.7 Advances have been made in the assessment of North Sea sprat which have permitted the recommendation of a TAC for this species, in that area, on a firmer basis. It is recommended that in 1977 the TAC for North Sea sprat, excluding the Norwegian fjords, should be set at a level not higher than 400000 tons.
9.8 Few data are available to permit the calculation of a permissible catch level for the sprat stock in Division IIIa and in the Norwegian fjords. However, catches in this area have been increasing very rapidly in recent years and this can be expected to continue as a result of more stringent restrictions on both sprat and herring fishing in the North Sea. It is therefore recommended that in these areas the catch of sprat in 1977 shall not be allowed to exceed the catch level in 1975. This would entail a. TAC of 100000 tons.

## 10. References

Dragesund, 0. and Ulltang, $\varnothing$., 1975. Stock size fluctuations and rate of exploitation of the Norwegian spring-spawning herring, 1950-1974. C.M.1975/H:47 (mimeo).

Jakobsson, Ja, 1973. Population studies on the Icelandic herring stocks. C.M.1973/H:4 (mimeo).

Johnson, P. O., 1970. The Wash sprat fishery。 FishoInvesto SernII, 26(4):77。

Johnson, P. O. and Dawson, W.A., 1975. The distribution of eggs and larvae of some pelagic fish species in the central and southern North Sea during June 1972. CoM.1975/H:13 (mimeo).

Lindquist，$A_{0}$ ，1974o Some sprat stock data：Skagerak and Kattegato ICES，CoM．1974／H：I2（mimeo）．

Molloy，Jo and Corten，$A_{0}$ ，1975．Young Herring Surveys in the Irish Sea。 ICES，C．Mol975／Hஃll（mimeo）．

Wood，$R_{0} J_{0}$ and Foster，Me，1966。 Studies on the Dunmore herring stock． 2．The otoliths of the Dunmore herring。 JoCons．intoExploro Mer，30（2）：222－236．
Table 2.1. Herring. Catch in tons 1966-1975.
North Sea (Sub-area IV and Divisions VIId and e) by country.

| Country <br> Year | 1966 | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Belgium | 391 | 410 | 134 | 468 | 1200 | 681 | 1337 | 2160 | 603 | 2361 |
| Denmark | 105900 | 135000 | 163100 | 180260 | 133331 | 185393 | 213738 | $174254{ }^{\text {a }}$ | 61728 | 113411 |
| Faroe Isl. | 1491 | 35993 | 49995 | 40640 | 58365 | 45524 | 48444 | $54935{ }^{\text {b }}$ | 26161 b | 29384 |
| France | 10711 | 11478 | 12852 | 15307 | 11482 | 11408 | 12901 | 22235 | 12548 | 19710 |
| Germany, D.R. | - | - | - | - | 290 | 475 | 127 | 1728 | 3268 | 2607 |
| Germany, For. | 54157 | 32312 | 21216 | 12798 | 7150 | 3570 | 3065 | $10634{ }^{\text {c }}$ | 12470 | 5738 |
| Iceland | 1047 | 5684 | 44489 | 19997 | 22951 | 37171 | 31998 | $23742^{\text {d }}$ | 29017 | 16289 |
| Netherlands | 56668 | 37270 | 22306 | 29769 | 46218 | 32479 | 24829 | 34070 | 35106 | 35938 |
| Norway | 424462 | 240032 | 211904 | 114938 | 193102 | 125842 | 117501 | 99739 | 40975 | 30714 |
| Poland | 74071 | 37816 | 11954 | 9221 | 5057 | 2031 | 2235 | 5738 | 9850 | 7069 |
| Sweden | 121970 | 121591 | 88061 | 33109 | 34670 | 36880 | 7366 | $4222^{\text {e }}$ | 3561 | 3500 |
|  | f) 10716 | 8215 | 5128 | 6666 | 9702 | 4113 | 394 | 2268 | 5699 | 6475 |
| U.K. (Scotland) | I) 17557 | 18138 | 16477 | 22053 | 21885 | 25073 | 17227 | 16012 | 15034 | 8862 |
| USSR | 16442 | 11660 | $70 \quad 029$ | 61.549 | 18078 | 9500 | 16386 | 30735 | 18096 | 20509 |
| Total N. Sea | 895583 | 695599 | 717645 | 546775 | 563481 | 520140 | 497548 | 484012 | 275116 | 302567 |
| Skagerak | 144655 | 279744 | 280036 | 113279 | 71071 | 61570 | 67021 | 84566 | 55.512 | 52129 |
| Grand Total | 1040238 | 975343 | 997681 | 660054 | 634552 | 581710 | 564569 | 568578 | 330628 | 354696 |

Footnotes: a) Total includes 2107 tons for human consumption unspecified to area. b) Supplied by Fiskirannsóknarstovan.
c) From Federal Republic of Germany national statistics compiled by Federal Research Board of Fisheries, Hamburg.
Total catch in tons.
Skagerak (Division IIIa excl. Kattegat).

| Year | Denmark | Faroe Islands | Germany Fed.Rep. | Iceland | $\begin{gathered} \text { Nether- } \\ \text { lands } \end{gathered}$ | Norway | Poland | Sweden | U.S.S.R. | Total |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1966 | 75200 | - | 432 | - | 74 | 30438 | 511 | 38000 | - | 144655 |
| 1967 | 100400 | - | 466 | 2151 | - | 95039 | 127 | 66000 | 15561 | 279744 |
| 1968 | 143600 | - | 2 | 695 | 36 | 71865 | 42 | 45000 | 18796 | 280036 |
| 1969 | 57965 | - | - | - | - | 13957 | - | 41357 | - | 113279 |
| 1970 | 30107 | - | - | 6453 | - | 7581 | - | 26930 | - | 71071 |
| 1971 | 26985 | 5636 | - | 3066 | - | 6120 | - | 19763 | - | 61570 |
| 1972 | 34900 | 4115 | - | 7317 | - | 1045 | - | 19644 | - | 67021 |
| 1973 | 42098 | $5265^{\text {a) }}$ | - | $15938^{\text {a }}$ | - | 836 | - | $20429^{\text {a }}$ | - | 84566 |
| 1974 | 35732 | 7132 | 36 | 231 | - | 698 | - | 11683 | - | 55512 |
| 1975 ${ }^{\text {² }}$ | 29944 | 8342 | 108 | 1209 | - | 196 | - | 12348 | - | 52129 |

ㅍ) Preliminary figures. a) See Table 2.1 footnote under relevant country.
Table 2.3. Herring. Total catch in tons.

| Year | Belgium | Denmark | Faroe <br> Islands | France | $\begin{gathered} \text { German } \\ \text { Dem.Rep. } \end{gathered}$ | Germany <br> Fed.Rep. | Iceland | Netherlands | Norway | Poland | $\begin{gathered} \text { U.K. } \\ \text { Scotland } \end{gathered}$ | Sweden | U.S.S.R. | Total |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1971 | - | 6219 | 239 | - | - | - | - | 167 | 10720 | - | - | - | - | 17345 |
| 1972 | - | 19711 | 979 | - | - | 9 | 1943 | 40 | 50 | - | - | - | - | 22732 |
| 1973 | - | 686 | $12776^{\text {a }}$ | - | 637 | - | - | 331 | 236 | - | - | - | - | 14666 |
| 1974 | - | 12284 | 532 | - | 55 | - | 2460 | 46 | - | - | - | - | - | 15377 |
| 1975 | - | 7436 | - | - | - | - | 1502 | 24 | 52 | - | - | - | - | 9014 |

a) See Table 2.1. footnote under relevant country.


| Year | Denmark | $\begin{aligned} & \text { Faroe } \\ & \text { Islands } \end{aligned}$ | $\begin{aligned} & \text { Fin- } \\ & \text { land } \end{aligned}$ | France | $\begin{gathered} \text { German } \\ \text { Dem.Rep. } \end{gathered}$ | $\begin{aligned} & \text { Germany } \\ & \text { Fed. Rep. } \end{aligned}$ | Iceland | $\left.\begin{array}{\|c} \text { Nether- } \\ \text { lands } \end{array} \right\rvert\,$ | Norway | Poland | U.K. <br> England | $\begin{gathered} \text { U.K. } \\ \text { Scotiand } \end{gathered}$ | Sweden | USSR | Total |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1971 | 44500 | 45095 | - | 514 | - | 389 | 36992 | 5755 | 115108 | 1288 | - | 24711 | 4954 | 9500 | 288806 |
| 1972 | 29711 | 37004 | - | 888 | - | 100 | 29721 | I 967 | 100408 | 1620 | 74 | 17227 | - | 16386 | 235106 |
| 1973 | 41341 | $42159^{\text {a }}$ | 1540 | 209 | 1057 | 2624 | 23742 | 4615 | 62749 | 5547 | - | 15430 | 4222 | 30735 | 247697 |
| 1974 | 3475 | 16676 | - | 414 | 40 | 1431 | 22421 | 2139 | 14393 | 9187 | - | 10473 | - | 3525 | 84174 |
| 1975 | 12982 | 19722 | - | 595 | - | 1459 | 7679 | 2238 | 23497 | 6310 | - | 6633 | - | 11562 | 99679 |

${ }^{\text {a) }}$ See footnote under relevant country.
Herring. Total catch in tons.
North Sea central (Division IVB). Adult herring fisheries.
Table 2.5.

| Year | Denmark | Faroe Islands | France | German Dem.Rep. | Germany <br> Fed.Rep. | Iceland | Netherlands | Norway | Poland | $\begin{gathered} \text { U.K. } \\ \text { England } \end{gathered}$ | $\left\|\begin{array}{c} \text { U.K. } \\ \text { Scotland } \end{array}\right\|$ | Sweden | USSR | Total |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1971 ${ }^{\text {a }}$ | 2488 | 429 | 4734 | - | - | 179 | 10172 | 14 | 743 | 4113 | 362 | 1926 | - | 25168 |
| 1972 | 1589 | 10460 | 2014 | - | 21 | 334 | 11372 | 17043 | 615 | 271 | - | 4068 | - | 47787 |
| 1973 | - | - | 8259 | 34 | 115 | - | 17370 | 29027 | 191 | 2175 | 582 | - | - | 57753 |
| 1974 | 2067 | 8953 | 8561 | 3173 | 3832 | 4136 | 31229 | 26582 | 662 | 5658 | 41 | 2416 | 14566 | 116396 |
| 1975 | 4348 | 9662 | 4958 | 2607 | 2104 | 7108 | 28267 | 7215 | 759 | 6403 | 2229 | 3500 | 8822 | 87980 |

Table 2.5.1. Provisional Estimates of the abundance of herring larvae in the North Sea in 1975/76, and comparable estimates for 1974/75.

| Area and date of survey | Numbers of larvae $<10 \mathrm{~mm} \times 10^{-9}$ | \% Reduction <br> $1974 \rightarrow 1975$ | Numbers of larvae of all size groups | \% Reduction $1974 \rightarrow 1975$ |
| :---: | :---: | :---: | :---: | :---: |
| Orkney Shetland Area |  |  |  |  |
| 7-19/9/74 | 1164 |  | 2147 |  |
| 3-25/9/75 | 425 | 63\% | 744 | 65\% |
| 23/9-2/10/74 | 225 |  | 996 |  |
| 20-25/9/75 | 26 | 88\% | 761 | 24\% |
| Central North Sea |  |  |  |  |
| 2-9/10/74 | 1271 |  | 1699 |  |
| 8-14/10/75 | 79 | 94\% | 822 | 52\% |
| Southern North Sea/ Eastern Channel |  |  |  |  |
| 9-16/12/74 | 1 |  | 11 |  |
| 8-19/12/75 | 3 |  | 8 | 27\% |
| $7-16 / 1 / 75$ | 15 |  | 22 |  |
| 7-19/1/76 | 3 | 80\% | 9 | 69\% |

Table 2.6. Herring. Total catch in tons.

| Year | Young herring fisheries |  |  |  | Total young and adult fisheries <br> (Tables 2.5 and 2.6) |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Denmark | Germany, Fed.Rep. | Sweden | Total | 190209 |
|  | 132161 | 3055 | 30000 | 165216 | 216579 |
| 1972 | 162671 | 2823 | 3298 | 168792 | 193379 |
| 1973 | 129988 | 5638 | - | 135626 | 168168 |
| 1974 | 43866 | 6761 | 145 | 51772 | 177810 |
| 1975 | 87661 | 2169 | - | 89830 |  |

Table 2.7. Herring. Total catch in tons.

| Year | Belgium | Denmark | France | Germany <br> Fed.Rep. | Netherlands | Poland | U.K. <br> England | USSR | Total |
| :---: | :---: | :---: | ---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1971 | 673 | 25 | 6160 | 126 | 16385 | - | 82 | - | 23451 |
| 1972 | 1337 | 57 | 9999 | 112 | 11450 | - | 49 | - | 23004 |
| 1973 | 2160 | 132 | 13767 | 2257 | 11754 | - | 93 | - | 30163 |
| 1974 | 603 | 36 | 4573 | 432 | 1692 | 1 | 41 | 5 | 7383 |
| 1975 | 2361 | 984 | 14157 | 6 | 5411 | - | 72 | 125 | 23116 |

Table 2．8．North Sea catch in millions of fish by age．

|  |  | ，nomin －$\dot{\circ} \dot{\operatorname{con}} \dot{\mathrm{m}}$ <br>  $\rightarrow$ $+$ |  |  | $\begin{aligned} & 0 \\ & \dot{0} \\ & \dot{\circ} \\ & \sigma \\ & \dot{\alpha} \end{aligned}$ | $r-1$ | $\begin{aligned} & n \\ & \dot{0} \\ & \infty \\ & \cdots \\ & m \end{aligned}$ |  | n $\stackrel{1}{\circ}$ $\sim$ $n$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\stackrel{\infty}{\wedge}$ | $\underset{0}{+}$ | $\stackrel{+}{\circ}$ | 0， 11110 | $0$ | $\begin{array}{rrr} 0 \\ \dot{r} & 1 & \dot{0} \end{array}$ | $\begin{array}{r} r \\ -i \end{array}$ | $\underset{\sim}{-1} 0$ | $\stackrel{+}{+}$ |
|  | $\infty$ |  | $\stackrel{H}{i}$ |  | $\underset{\sim}{\forall}$ |  | $\stackrel{\dot{v}}{ }$ | $\left\lvert\, \begin{array}{ll} 0 & 0 \\ \dot{m} & \dot{0} \end{array}\right.$ | $\stackrel{\sim}{n}$ |
|  | $\sim$ | 11 1  <br> 0 1 1 | $\begin{gathered} \text { ソ } \\ 0 \end{gathered}$ |  | $\stackrel{r}{\dot{n}}$ | $\left\|\begin{array}{lll} \dot{n} & M & \tilde{\sim} \\ \dot{\sim} & 0 & 0 \\ 0 & 0 \end{array}\right\|$ | 운 |  | $\cdots$ |
|  | 6 | 'r. | $\stackrel{0}{\circ}$ |  | $\begin{aligned} & 0 \\ & \dot{R} \\ & \dot{n} \end{aligned}$ | $\left\|\begin{array}{ccc} 0 & 6 & \Gamma \\ \dot{\infty} & 1 & \dot{m} \\ \dot{1} & \dot{0} \end{array}\right\|$ | $\begin{aligned} & \underset{\sim}{\tilde{N}} \end{aligned}$ |  | 9 <br>  <br> $\vdots$ <br> -1 |
|  | in | Mー下 vo <br>  | $\begin{aligned} & \sigma \\ & \dot{\sim} \end{aligned}$ |  | $\begin{aligned} & \text { m } \\ & \dot{n} \end{aligned}$ | $\begin{array}{ccc} 0 & 0 & \tilde{0} \\ \dot{0} & 1 & 0 \\ m & \ddots & \dot{1} \\ \hline \end{array}$ | $\begin{aligned} & -1 \\ & \stackrel{0}{\circ} \\ & \hline \end{aligned}$ |  | $\begin{aligned} & \dot{-1} \\ & i \\ & i \end{aligned}$ |
|  | $\checkmark$ |  | $\begin{aligned} & 6 \\ & \dot{\sim} \\ & \underset{r}{2} \end{aligned}$ |  | $\begin{aligned} & \sim \\ & \vdots \\ & \dot{\sim} \\ & \sim \end{aligned}$ | $\left\|\begin{array}{ccc} \because & 0 & + \\ \dot{-} \dot{\sigma} & \dot{\sigma} & \dot{\infty} \end{array}\right\|$ | $\left\lvert\, \begin{aligned} & 0 \\ & \dot{0} \\ & \underset{\sim}{n} \end{aligned}\right.$ | $\begin{aligned} & 0 \sim \dot{\sim} \dot{0} \\ & \dot{\sim} \dot{\sim} \dot{\sim} \dot{\sim} \dot{\sim} \dot{\sim} \end{aligned}$ | 0 <br> $\vdots$ <br>  <br> $\sim$ <br> $\sim$ |
|  | m | $\begin{aligned} & \infty \infty \infty \infty r r \\ & \dot{\infty} \stackrel{\infty}{\dot{\circ}} \dot{\sim} \dot{\sim} \dot{\sim} \dot{\sim} \dot{\sim} \dot{\sim} \end{aligned}$ | $\begin{aligned} & \infty \\ & \underset{\sim}{\dot{m}} \end{aligned}$ |  | $\begin{gathered} \underset{y}{0} \\ \underset{\sim}{6} \end{gathered}$ |  | $\left.\begin{gathered} 0 \\ \dot{j} \\ \underset{n}{n} \end{gathered} \right\rvert\,$ |  | $\stackrel{\sim}{\sim}$ |
|  | $\sim$ |  | $\begin{aligned} & \text { n } \\ & \dot{O} \\ & \text { H } \\ & H \end{aligned}$ |  | $\begin{aligned} & \text { N} \\ & \dot{j} \\ & \underset{\sim}{2} \\ & -1 \end{aligned}$ |  | $\begin{aligned} & \bullet \\ & \dot{\sim} \\ & \underset{\sim}{*} \end{aligned}$ |  | － |
|  | － |  | $\begin{aligned} & 0 \\ & \dot{0} \\ & \dot{+} \\ & m \\ & m \end{aligned}$ |  | $\begin{aligned} & 0 \\ & \dot{0} \\ & 0 \\ & m \\ & \infty \\ & \sim \end{aligned}$ |  | $\begin{aligned} & - \\ & \dot{0} \\ & \dot{\infty} \end{aligned}$ |  | 0 0 $\dot{0}$ $\sim$ $\sim$ $\sim$ |
|  | － | 11. | $\begin{aligned} & \text { + } \\ & \stackrel{\circ}{n} \end{aligned}$ |  | $\begin{aligned} & + \\ & \stackrel{\circ}{\infty} \\ & \underset{\sim}{2} \end{aligned}$ |  | $\begin{aligned} & -1 \\ & \dot{\circ} \\ & \dot{\sigma} \end{aligned}$ | $\begin{array}{ll} -1 & 9 \\ \dot{\circ} \dot{0} \\ \stackrel{0}{0} \end{array}$ | － |
|  |  |  |  |  |  |  |  |  |  |
|  |  | $\begin{aligned} & N \\ & \underset{\sim}{N} \end{aligned}$ |  | $\stackrel{\text { N }}{\stackrel{\sim}{\sim}}$ |  | $\underset{\substack{\text { ¢ } \\ \text {－}}}{\text { d }}$ |  | $\stackrel{n}{\sim}$ |  |

Table 2.9. Skagerak catch in millions of fish by age.

| Age in winter rings | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | $>8$ | Total |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1974 | 632.2 | 292.3 | 92.1 | 46.4 | 14.5 | 5.8 | 1.1 | 0.8 | - | - | 1.085 .2 |
| 1975 | 76.2 | 380.7 | 38.0 | 36.2 | 49.1 | 13.3 | 5.4 | 0.6 | 0.6 | - | 600.1 |

Table 2.10. Millions of herring caught annually per age group (winter rings)

| Year <br> Winter rings | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | $>8$ | Total |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1966 | 374.5 | 1383.1 | 2569.1 | 741.2 | 450.1 | 889.8 | 45.3 | 64.8 | 35.5 | 236.3 | 6850.3 |
| 1967 | 645.4 | 1674.3 | 1171.5 | 1364.7 | 371.5 | 297.8 | 393.1 | 67.9 | 81.6 | 172.8 | 6240.6 |
| 1968 | 839.3 | 2425.0 | 1795.2 | 1494.3 | 621.4 | 157.1 | 145.0 | 163.4 | 13.7 | 91.8 | 7746.2 |
| 1969 | 112.0 | 2503.3 | 1883.0 | 296.3 | 133.1 | 190.8 | 49.9 | 42.7 | 27.4 | 25.1 | 5263.6 |
| 1970 | 898.1 | 1196.2 | 2002.8 | 883.6 | 125.2 | 50.3 | 61.0 | 7.9 | 12.0 | 12.2 | 5249.3 |
| 1971 | 684.0 | 4378.5 | 1146.8 | 662.5 | 208.3 | 26.9 | 30.5 | 26.8 | - | 12.4 | 7176.7 |
| 1972 | 750.4 | 3340.6 | 1440.5 | 343.8 | 130.6 | 32.9 | 5.0 | 0.2 | 1.1 | 0.4 | 6045.5 |
| 1973 | 289:4 | 2368.0 | 1344.2 | 659.2 | 150.2 | 59.3 | 30.6 | 3.7 | 1.4 | 0.6 | 4906.6 |
| 1974 | 996.1 | 846.1 | 772.6 | 362.0 | 126.0 | 56.1 | 22.3 | 5.0 | 2.0 | 1.1 | 3189.3 |
| 1975 | 261.0 | 2436.0 | 527.6 | 253.7 | 139.0 | 58.1 | 16.3 | 9.3 | 3.5 | 1.4 | 3705.9 |


| Winter <br> rings <br> Years | 1966 | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 ${ }^{\text {1) }}$ | 1975 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 0 | 0.08 | 0.09 | 0.12 | 0.03 | 0.11 | 0.11 | 0.17 | 0.13 | 0.20 | ? |
| 1 | 0.34 | 0.50 | 0.52 | 0.56 | 0.47 | 0.96 | 0.91 | 1.00 | 0.63 | $0.9{ }^{\text {³ }}$ ) |
| 2 | 0.68 | 0.47 | 1.47 | 0.88 | 1.08 | 0.99 | 0.89 | 1.09 | 1.00 | $0.9{ }^{\text {³ }}$ ) |
| 3 | 0.71 | 0.84 | 1.92 | 0.94 | 1.30 | 1.24 | 0.82 | 1.27 | 0.88 | 0.9 픞) |
| 4 | 0.56 | 0.84 | 1.07 | 0.86 | 1.29 | 1.20 | 0.77 | 0.95 | 0.78 | 0.9 푸) |
| 5 | 0.82 | 0.80 | 0.96 | 1.05 | 0.84 | 0.98 | 0.52 | 0.86 | 1.05 | $0.9{ }^{\text {73 }}$ ) |
| 6 | 0.37 | 0.90 | 1.06 | 0.83 | 1.07 | 2.10 | 0.42 | 1.22 | 0.79 | $0.9{ }^{\text {* }}$ ( |
| 7 | 0.36 | 1.30 | 1.31 | 0.96 | 0.26 | 2.48 | 0.06 | 0.55 | 0.57 | $0.9{ }^{\text {F }}$ |
| 8 | 0.69 | 0.90 | 0.90 | 0.70 | 0.70 | 0.70 | 0.70 | 0.55 | 0.57 | $0.9{ }^{\text {F }}$ ) |
| $\overline{\mathrm{F}}_{\mathrm{W}} \geq 2$ | 0.68 | 0.70 | 1.50 | 0.89 | 1.13 | 1.11 | 0.86 | 1.12 | 0.94 |  |

1) Inefficient estimates. $\quad$ ) Assumed values.
Table 2.12. Total North Sea. Calculated stock in numbers $x 10^{-9}$ and stock biomass.

Table 3.1. Annual Celtic Sea Herring Catcines 1965-1975

| Year | Bulgaria | France | Germany D.R. | Germany F.R. | Ireland | Netherlands | Poland | U.K. | U.S.S.R | Total |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1965 | - | 1742 | - | 353 | 3980 | 7198 | - | 1054 | - | 14327 |
| 1966 | - | 5506 | - | 1143 | 6891 | 16605 | 112 | 197 | - | 31454 |
| 1967 | - | 3825 | - | 910 | 11133 | 13184 | 300 | 398 | - | 29750 |
| 1968 | - | 2637 | - | 1662 | 9480 | 15679 | 130 | 598 | - | 30186 |
| 1969 | - | 7038 | - | 5906 | 18712 | 16256 | 252 | - | - | 48164 |
| 1970 | - | 3529 | - | 1481 | 24702 | 7015 | 1191 | 220 | - | 38236 |
| 1971 | - | 3393 | - | 974 | 12602 | 9672 | 881 | 65 | - | 27587 |
| 1972 | - | 7327 | - | 393 | 20109 | 6758 | 751 | - | 618 | 35956 |
| 1973 | 123 | 5553 | 7 | 294 | 13105 | 5834 | 1125 | - | 334 | 26375 |
| 1974 | - | 2261 | - | 433 | 13991 | 2105 | 954 | - | , | 19744 |
| 1975+ | - | 1920 | - | 399 | 8430 | 2646 | 512 | - | 2139 | 16046 |


| Season | Bulgaria | France | Germany, D.R. | Germany, F.R. | Ireland | Netherlands | Poland | U.K. | U.S.S.R. | Total |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1965/6 | - | 1742 | - | 353 | 3482 | 13071 | - | 1054 | - | 19702 |
| 1966/7 | - | 5506 | - | 1143 | 8061 | 11459 | 112 | 197 | - | 26478 |
| 1967/8 | - | 3825 | - | 910 | 10736 | 10204 | 425 | 398 | - | 26498 |
| 1968/9 | - | 2637 | - | 1662 | 11996 | 12191 | 130 | 598 | - | 29214 |
| 1969/70 | - | 7038 | - | 5906 | 16712 | 13111 | 261 | 400 | - | 43428 |
| 1970/1 | - | 3627 | - | 1481 | 19106 | 4667 | 778 | 220 | - | 29879 |
| 1971/2 | - | 3383 | - | 974 | 13757 | 10600 | 880 | 65 | - | 29659 |
| 1972/3 | - | 7327 | - | 393 | 18846 | 6852 | 751 |  | 618 | 34878 |
| 1973/4 | 123 | 4143 | 7 | 294 | 11317 | 5834 | 1139 | - | 334 | 23191 |
| 1974/5 | - | 2150 | - | 435 | 11683 | 2462 | 954 | - | - | 17684 |
| 1975/6+ | - | . 1882 | - | 399 | 6474 | 2401 | 512 | - | 2139 | 13807 |

Table 3.3. Celtic Sea. Catch in number per age group $\times 10^{-3}$

|  | Age in rings |  |  |  |  |  |  |  |  | Total |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | 1 |  |  |  | 5 | 6 | 7 | 8 | 8+ |  |
| 1965-66 | 58 | 70937 | 9456 | 15911 | 3433 | 4584 | 12241 | 1391 | 7566 | 125576 |
| 1966-67 | 6337 | 19146 | 58633 | 9827 | 13193 | 5585 | 3581 | 8472 | 3839 | 128614 |
| 1967-68 | 6921 | 36168 | 19486 | 47837 | 8954 | 9334 | 3894 | 6462 | 6684 | 145741 |
| 1968-69 | 11699 | 53028 | 38421 | 11207 | 22286 | 4538 | 3965 | 1251 | 4608 | 151003 |
| 1969-70 | 7787 | 91994 | 54473 | 32318 | 11881 | 17265 | 4612 | 2130 | 3418 | 225878 |
| 1970-71 | 640 | 31540 | 48706 | 25937 | 18270 | 7095 | 5751 | 1925 | 3194 | 143058 |
| 1971-72 | 10262 | 22451 | 34382 | 40536 | 18449 | 9807 | 3779 | 4846 | 2143 | 146655 |
| 1972-73 | 7279 | 124357 | 16922 | 13817 | 13674 | 4331 | 2654 | 2103 | 749 | 185886 |
| 1973-74 | 22171 | 34122 | 45162 | 6269 | 8251 | 4655 | 3209 | 1966 | 714 | 126519 |
| 1974-75 | 4516 | 38285 | 15427 | 19865 | 3782 | 3311 | 2668 | 806 | 742 | 89402 |
| 1975-76 | 11737 | 13402 | 16100 | 7070 | 6192 | 3333 | 1300 | 988 | 1047 | 61169 |


| Season | Z from Irish catch/effort | $\begin{aligned} & \text { F adult from VPA } \\ & \text { assuming } \\ & \text { F } 1975 / 76=0.82 \end{aligned}$ |
| :---: | :---: | :---: |
| 1967-68 | 0.52 | 0.50 |
| 1968-69 | 0.42 | 0.40 |
| 1969-70 | 0.60 | 0.60 |
| 1970-71 | 0.44 | 0.55 |
| 1971-72 | 0.92 | 0.82 |
| 1972-73 | 0.75 | 0.65 |
| 1973-74 | 0.92 | 0.76 |
| 1974-75 | 0.54 | 0.80 |
| 1975-76 | 1.29 |  |


Table 3.6. Fisning mortalities from VPA and weignteq mean values of. F.

| Season | 1965/66 | 1966/67 | 1967/68 | 1968/69 | 1969/70 | 1970/71 | 1971/72 | 1972/73 | 1973/74 | $1974 / 75^{+}$ | 1975/76 ${ }^{+}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| W. rings |  |  |  |  |  |  |  |  |  |  |  |
| 1 | 0.00 | 0.03 | 0.03 | 0.05 | 0.06 | 0.01 | 0.04 | 0.09 | 0.25 | 0.16 | 0.10 |
| 2 | 0.30 | 0.23 | 0.24 | 0.34 | 0.52 | 0.35 | 0.44 | 0.87 | 0.72 | 0.79 | 0.82 |
| 3 | 0.21 | 0.38 | 0.34 | 0.39 | 0.61 | 0.50 | 0.71 | 0.62 | 0.82 | 0.74 | 0.82 |
| 4 | 0.35 | 0.31 | 0.53 | 0.29 | 0.58 | 0.59 | 0.92 | 0.61 | 0.44 | 0.96 | 0.82 |
| 5 | 0.22 | 0.49 | 0.45 | 0.45 | 0.51 | 0.67 | 0.99 | 0.82 | 0.82 | 0.46 | 0.82 |
| 6 | 0.21 | 0.57 | 0.68 | 0.38 | 0.67 | 0.57 | 0.82 | 0.58 | 0.65 | 0.83 | 0.82 |
| 7 | 0.51 | 0.23 | 0.88 | 0.61 | 0.74 | 0.43 | 0.60 | 0.48 | 1.03 | 0.86 | 0.82 |
| 8 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.82 |
| $\begin{aligned} & \text { Weignted } F \\ & \text { (adults) } \end{aligned}$ | 0.31 | 0.40 | 0.50 | 0.40 | 0.60 | 0.55 | 0.82 | 0.65 | 0.76 | 0.80 | 0.82 |

Table 3.7. Calculated stock size in numbers $\left(x 10^{-6}\right)$ by age and year ( $M=0.1$ ) at I April

| Season | 1965 | 1966 | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | $1974{ }^{+}$ | $1975{ }^{+}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| W. rings |  |  |  |  |  |  |  |  |  |  |  |
| 1 | 109.8 | 202.0 | 220.5 | 276.1 | 131.0 | 73.3 | 256.9 | 84.5 | 104.1 | 32.4 | 129.5 |
| 2 | 290.0 | 99.3 | 176.8 | 192.9 | 238.7 | 111.2 | 65.7 | 222.7 | 69.6 | 73.2 | 25.0 |
| 3 | 52.9 | 195.1 | 71.7 | 125.6 | 124.3 | 128.9 | 70.7 | 38.2 | 84.1 | 30.7 | 30.0 |
| 4 | 56.0 | 38.9 | 121.0 | 46.4 | 77.2 | 60.9 | 70.5 | 31.5 | 18.5 | 33.5 | 13.2 |
| 5 | 18.5 | 35.6 | 25.9 | 64.2 | 31.4 | 39.3 | 30.6 | 25.3 | 15.4 | 10.8 | 11.6 |
| 6 | 25.3 | 13.5 | 19.7 | 15.0 | 37.0 | 17.1 | 18.3 | 10.3 | 10.2 | 6.1 | 6.2 |
| 7 | 32.2 | 18.6 | 6.9 | 9.0 | 9.2 | 17.1 | 8.8 | 7.3 | 5.2 | 4.8 | 2.4 |
| 8 | 2.9 | 17.6 | 13.4 | 2.6 | 4.4 | 4.0 | 10.1 | 4.4 | 4.1 | 1.7 | 1.8 |
| Adult stock in numbers | 477.8 | 418.6 | 435.4 | 455.7 | 522.2 | 378.5 | 274.7 | 339.7 | 207.1 | 160.8 | 90.2 |
| Adult stock | 71732 | 61269 | 60450 | 65373 | 61333 | 49045 | 28020 | 30679 | 20503 | 15095 | 8935 |

Table 3.8. Catch prognosis. Celtic Sea

| Age in rings | $\begin{aligned} & \text { Mean } \\ & \text { weigint (g) } \end{aligned}$ | $\begin{aligned} & \text { Catch } \\ & 1975-76 \times 10^{-3} \end{aligned}$ | $\begin{aligned} & \text { Stock size }\left(x 10^{-3}\right) \\ & \text { I April } 1976 \end{aligned}$ | Catch <br> 1976-77 | Stock size <br> 1 April 1977 |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 1 | 137.6 | 11737 | 100000 | 11600 | 100000 |
| 2 | 198.9 | 13402 | 87441 | 48705 | 79500 |
| 3 | 238.8 | 16100 | 9958 | 5547 | 33140 |
| 4 | 264.5 | 7070 | 11962 | 6663 | 3774 |
| 5 | 268.6 | 6192 | 5253 | 2926 | 4534 |
| 6 | 290.6 | 3333 | 4601 | 2563 | 1991 |
| 7 | 294.3 | 1300 | 2476 | 1379 | 1744 |
| 8 | 301.8 | 988 | 966 | 538 | 938 |
| $8+$ | 317.6 | 1047 | 734 | 409 | 366 |
| $\begin{aligned} & \text { Weigint in } \\ & \text { tons } \end{aligned}$ |  | ```Calculated 13640 Actual 13807``` | ```8}68 Adults \geq2 rings Weights previous season``` | 16599 | 10120 <br> Adults $\geq 2$ rings Weigints previous season |
| Source of data and assumptions made | Irisn data 1975-76 season | Data reported to WG meeting | Assumptions: $\begin{aligned} & \mathrm{F}_{\mathrm{ad}} 1975 / 76=0.82 \\ & \mathrm{~F}_{\text {juv }} 1975 / 76=0.12 \\ & \text { Year class } 1974= \\ & \text { loo million } \\ & \text { l-ringers } \end{aligned}$ | Assumptions: <br> NEAFC quota of 16800 t will be approx. taken $\begin{aligned} & \left(F_{a d}=0.87\right. \\ & \left.\bar{F}_{\text {juv }}=0.13\right) \end{aligned}$ | $\begin{aligned} & \text { Assumptions: } \\ & \text { year class } 1975= \\ & 100 \text { mill. l-ringers } \end{aligned}$ |

Table 4.I. Total catches of herring (metric tons) in Division VIa, 1966-1975.

| Country | 1966 | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 ${ }^{\text {² }}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Belgium | 23 | - | - | - | - | - | - | - | - | - |
| U.K. England | 1 | - | 7 | 3 | 1 | - | - | - | 45 | - |
| Faroe Islands ${ }^{\text {a }}$ | - | - | - | - | 15100 | 8100 | 8.094 | 10003 | 5371 | 10 |
| France | 1 | 379 | 1124 | 966 | I 293 | 2055 | 680 | 2441 | 547 | 2720 |
| German Dem.Rep. | 412 | 177 | 3 | 416 | 207 | 330 | 935 | 2507 | 2037 | $1994{ }^{\text {c }}$ ) |
| Germany, Fed.Rep. | 14634 | 17318 | 14874 | 15805 | 16548 | 7700 | 4108 | 17443 | 14354 | 4283 |
| Iceland | - | - | - | - | 5595 | 5416 | 2066 | 2532 | 9566 | 2633 |
| Ireland ${ }^{\text {b }}$ | 7759 | 12290 | 13390 | 11895 | 11716 | 12161 | 17308 | 14668 | 12557 | 10417 |
| Netherlands | 251 | 4576 | 2957 | 1514 | 1102 | 9252 | 23370 | 32715 | 19635 | 19305 |
| Norway | - | - | - | - | 20199 | 76720 | 17400 | 36302 | 26218 | 509 |
| Poland | - | 727 | 2791 | 3188 | 3709 | - | - | 5685 | 6368 | 2934 |
| J.K. Scotland | 69363 | 67404 | 65180 | 90222 | 103530 | 99537 | 107638 | 120800 | 107475 | 80468 |
| USSR | - | - | - | - | 3 | - | ? | 2052 | 5388 | 2967 |
| Total | 92444 | 102871 | 100326 | 124009 | 179003 | 221271 | 174873 | 247148 | 209561 | 128240 |
| Scottish juvenile herring and sprat fisheries in Moray Firth | $20 \quad 734$ | 6507 | 4985 | 3100 | 1385 | 5666 | 10242 | 7219 | 13003 | 2454 |

*) Preliminary figures.
a)
a) Figures supplied by Fiskirannsóknarsotvan.
b) Catches mainly taken in Division VIIb and
b) Catches mainly taken in Division VIIb and landed in VIa.
c) Reported to NEAFC.
Herring autumn spawners．Catch in number $x 10^{-3}$ ，Division VIa．

| Year <br> Age（rings） | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | ＞ 10 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1966 | － | 6299 | 251086 | 33526 | 70449 | 38471 | 22691 | 12656 | 20790 | 17005 | 7418 | 8752 |
| 1967 | － | 30944 | 22374 | 263880 | 49150 | 48320 | 36143 | 15226 | 10397 | 15068 | 10962 | 7937 |
| 1968 | － | 58215 | 90027 | 26031 | 243304 | 19679 | 28436 | 17699 | 7275 | 4493 | 5326 | 4570 |
| 1969 | － | 14077 | 106022 | 84565 | 27604 | 264558 | 25795 | 45908 | 27932 | 11003 | 5197 | 13058 |
| 1970 | － | 158085 | 107037 | 272693 | 124498 | 42623 | 185380 | 24821 | 29920 | 14276 | 5156 | 6903 |
| 1971 | － | 53113 | 283962 | 346206 | 261891 | 94206 | 25876 | 166165 | 16425 | 16286 | 8038 | 5578 |
| 1972 | 147 | 35047 | 647919 | 208367 | 72885 | 83361 | 37428 | 13445 | 94577 | 8154 | 5855 | 5377 |
| 1973 | － | 17654 | 271166 | 990183 | 155828 | 66476 | 68522 | 26512 | 8037 | $53767^{1)}$ | － | － |
| 1974 | － | 61641 | 143585 | 205806 | 553627 | 90584 | 45144 | 43069 | 18504 | $45393^{1}$ | － | － |
| 1975 | 20 | 99018 | 232698 | 93827 | 75178 | 209646 | 36051 | 14500 | 18988 | $27851^{1}$ ） | － | － |

Table 4．3．Catch in numbers $x 10^{-3}$ ，Moray Firth．

|  | ＊ | サ |
| :---: | :---: | :---: |
|  | m |  |
|  | $\sim$ |  MNN <br>  |
|  | $\checkmark$ |  <br>  <br>  우N N |
|  | $\bigcirc$ |  |
|  |  | ○ Noon ふのののふのふのふの <br>  |

Table 4.4.

| Age (rings) | 1965 | 1966 | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | $1974^{\text {\# }}$ | $1975^{*)}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 0 | 0.08 | 0.19 | 0.11 | 0.07 | 0.13 | 0.00 | 0.15 | 0.04 | 0.15 | 0.29 |  |
| 1 | 0.11 | 0.57 | 0.26 | 0.17 | 0.04 | 0.20 | 0.05 | 0.33 | 0.10 | 0.24 | 0.13 |
| 2 | 0.08 | 0.24 | 0.12 | 0.18 | 0.10 | 0.15 | 0.35 | 0.26 | 0.47 | 0.46 | 0.25 |
| 3 | 0.19 | 0.19 | 0.17 | 0.14 | 0.20 | 0.36 | 0.81 | 0.42 | 0.58 | 0.68 | 0.50 |
| 4 | 0.29 | 0.26 | 0.29 | 0.20 | 0.19 | 0.44 | 0.62 | 0.34 | 0.55 | 0.67 | 0.50 |
| 5 | 0.25 | 0.23 | 0.25 | 0.16 | 0.32 | 0.45 | 0.62 | 0.36 | 0.53 | 0.64 | 0.50 |
| 6 | 0.14 | 0.34 | 0.32 | 0.20 | 0.29 | 0.34 | 0.48 | 0.47 | 0.50 | 0.75 | 0.50 |
| 7 | 0.42 | 0.34 | 0.36 | 0.23 | 0.51 | 0.45 | 0.51 | 0.44 | 0.63 | 0.59 | 0.50 |
| 8 | 0.39 | 0.53 | 0.47 | 0.26 | 0.58 | 0.66 | 0.53 | 0.54 | 0.46 | 1.14 | 0.50 |
| 9 | 0.38 | 0.54 | 0.83 | 0.33 | 0.68 | 0.59 | 0.82 | 0.48 | 0.45 | 0.51 | 0.50 |
| Mean $\mathrm{F}_{\mathrm{w}} \geq 2$ | 0.22 | 0.25 | 0.20 | 0.19 | 0.23 | 0.32 | 0.55 | 0.31 | 0.55 | 0.93 | - |

Table 4.5. Herring in Division VIa (Moray Firth included). Stock in number $x 10^{-6}$ and biomass of the adult stock at beginning

| Age (rings) | 1965 | 1966 | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 ${ }^{\text {* }}$ | 1975 ${ }^{\text {\% }}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 0 | 615 | 1267 | 1865 | 1144 | 1719 | 4400 | 1533 | 620 | 1991 | 2264 |  |
| 1 | 3143 | 510 | 945 | 1509 | 969 | 1371 | 3942 | 1186 | 537 | 1546 | 1539 |
| 2 | 328 | 2554 | 262 | 658 | 1156 | 837 | 1013 | 3397 | 768 | 437 | 1106 |
| 3 | 438 | 275 | 1827 | 210 | 495 | 943 | 651 | 645 | 2353 | 435 | 250 |
| 4 | 286 | 328 | 205 | 1389 | 165 | 367 | 593 | 263 | 384 | 1191 | 200 |
| 5 | 117 | 194 | 230 | 139 | 1026 | 123 | 214 | 290 | 169 | 201 | 558 |
| 6 | 58 | 82 | 139 | 162 | 107 | 677 | 71 | 105 | 183 | 89 | 96 |
| 7 | 88 | 46 | 53 | 92 | 120 | 72 | 436 | 39 | 59 | 101 | 39 |
| 8 | 70 | 53 | 29 | 33 | 66 | 65 | 42 | 237 | 23 | 28 | 51 |
| 9 | 25 | 43 | 28 | 17 | 23 | 33 | 30 | 22 | 125 | 13 | 8 |
| 10 | 24 | 15 | 23 | 11 | 11 | 11 | 17 | 12 | 12 | 73 | 7 |
| Total $\geq 2$ | 1434 | 3590 | 2796 | 2711 | 3169 | 3128 | 3067 | 5010 | 4076 | 2568 | 2315 |
| Biomass $\geq 2$ <br> in 1000 tons | 238 | 498 | 457 | 449 | 508 | 517 | 499 | 704 | 650 | 433 | 368 |

Table 5.2.1. Herring. Total catches in Division VIIa (North Irish Sea),

| Country | 1964 | 1965 | 1966 | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 | 1975*) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| France | - | - | - | - | - | - | 558 | 1815 | 1224 | 254 | 3194 | 789 |
| Ireland | 85 | 52 | 18 | 118 | 68 | 2328 | 3933 | 3131 | 2529 | 3614 | 5894 | 4790 |
| Netherlands | - | - | - | - | - | - | - | - | - | 143 | 1116 | 532 |
| U.K. | 1849 | 5617 | 3178 | 7145 | $8 \quad 389$ | 9821 | 17912 | 21861 | $23 \quad 337$ | $18 \quad 587$ | 27489 | $18 \quad 244$ |
| Total | 1934 | 5669 | 3196 | 7263 | 8457 | 12149 | 22403 | 26807 | 27090 | 22598 | 37693 | 24355 |




1. Manx stock. 2. Mourne stock. ¥) Preliminary.
Table 5．2．3．Effort and mortality on Manx stock．

| $\begin{gathered} \text { R } \\ \stackrel{1}{S} \\ \text { 品 } \\ \circ \\ \stackrel{4}{4} \\ \text { 4 } \end{gathered}$ | $\begin{aligned} & \alpha \\ & \vdots \\ & 0 \end{aligned}$ | $\begin{aligned} & \underset{\sim}{4} \\ & \dot{\circ} \end{aligned}$ | $\begin{aligned} & \dot{N} \\ & \dot{0} \end{aligned}$ | $\begin{aligned} & \text { O} \\ & M \\ & \dot{0} \end{aligned}$ | $\begin{aligned} & N \\ & M \\ & \dot{O} \end{aligned}$ | $\begin{aligned} & 0 \\ & \underset{~}{0} \\ & 0 \end{aligned}$ | $\begin{aligned} & \infty \\ & + \\ & \dot{0} \end{aligned}$ | $\stackrel{+}{\square}$ | $\begin{aligned} & \tilde{0} \\ & 0 \end{aligned}$ | $\stackrel{\Im}{+}$ | $\begin{aligned} & \stackrel{\rightharpoonup}{\infty} \\ & \dot{0} \end{aligned}$ | $\begin{aligned} & \text { た⿵ } \\ & \stackrel{0}{0} \\ & \dot{e} \end{aligned}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\begin{aligned} & \text { J } \\ & \text { H } \end{aligned}$ | $\stackrel{N}{N}$ | $\begin{array}{r} -1 \\ \omega_{0} \end{array}$ | $\begin{aligned} & \text { in } \\ & \infty \end{aligned}$ | $\begin{aligned} & \text { in } \\ & \text { N } \\ & \text { H } \end{aligned}$ | $\begin{aligned} & \stackrel{-}{n} \\ & \stackrel{1}{-1} \\ & \text { H} \end{aligned}$ | $\stackrel{i n}{\stackrel{i n}{f}}$ | $\begin{aligned} & \sigma \\ & \hat{0} \\ & \stackrel{0}{0} \end{aligned}$ | $\begin{aligned} & + \\ & \text { M } \\ & \underset{\sim}{2} \end{aligned}$ | $\begin{aligned} & \mathbb{N} \\ & M \\ & \sim \end{aligned}$ | $\begin{aligned} & \text { N } \\ & \underset{\sim}{n} \\ & m \end{aligned}$ | $\begin{aligned} & \stackrel{\sim}{ナ} \\ & \sim \end{aligned}$ |
| $\begin{gathered} H \\ 0 \\ 0 \\ 0 \end{gathered}$ | $\begin{aligned} & \text { J } \\ & \text { O } \\ & \underset{1}{2} \end{aligned}$ | $\begin{aligned} & \text { in } \\ & \stackrel{\circ}{\circ} \\ & \underset{\sim}{2} \end{aligned}$ | $\begin{aligned} & 0 \\ & \stackrel{0}{\alpha} \\ & \underset{\sim}{1} \end{aligned}$ | $\begin{aligned} & \underset{o}{0} \\ & \underset{\sim}{7} \end{aligned}$ | $\begin{aligned} & \infty \\ & \dot{\circ} \\ & \stackrel{\rightharpoonup}{\circ} \\ & r-1 \end{aligned}$ | $\begin{aligned} & \text { oे } \\ & \text { on } \\ & \end{aligned}$ | $\begin{aligned} & \stackrel{O}{\gtrless} \\ & \stackrel{\rightharpoonup}{r} \end{aligned}$ | $\underset{\sim}{\underset{\sim}{H}}$ | $\stackrel{N}{N}$ | $\begin{aligned} & m \\ & \stackrel{m}{\sigma} \\ & \underset{\sim}{2} \end{aligned}$ | $\begin{aligned} & \pm \\ & \underset{\sim}{\lambda} \end{aligned}$ | $\begin{aligned} & \stackrel{\sim}{\rightleftharpoons} \\ & \underset{\sim}{\prime} \end{aligned}$ |

Table 5.3.1(a). Catch in number $\times 10^{-6}$ Manx stock.

| Rings | 1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| :---: | ---: | ---: | ---: | ---: | :---: | :---: | :---: | :---: | :---: |
| Year |  |  |  |  |  |  | $8+$ |  |  |
| 1964 | 0.01 | 2.58 | 0.37 | 0.13 | 0.22 | 0.24 | 0.25 | 0.03 | 0.07 |
| 1965 | 0.31 | 20.78 | 6.78 | 1.03 | 0.46 | 0.63 | 0.41 | 0.31 | 0.08 |
| 1966 | 0.18 | 3.89 | 7.91 | 1.88 | 0.33 | 0.27 | 0.18 | 0.04 | 0.03 |
| 1967 | 1.02 | 17.82 | 4.79 | 7.61 | 1.80 | 0.38 | 0.20 | 0.20 | 0.20 |
| 1968 | 0.44 | 24.46 | 11.29 | 2.68 | 4.33 | 0.70 | 0.06 | 0.00 | 0.29 |
| 1969 | 0.19 | 22.84 | 14.25 | 6.24 | 2.47 | 1.97 | 0.42 | 0.02 | 0.00 |
| 1970 | 0.75 | 25.24 | 27.89 | 13.24 | 9.42 | 2.88 | 2.66 | 0.31 | 0.00 |
| 1971 | 4.98 | 54.36 | 21.91 | 18.68 | 9.67 | 3.41 | 1.74 | 1.04 | 0.12 |
| 1972 | 3.59 | 41.24 | 25.72 | 11.14 | 12.99 | 6.38 | 1.94 | 1.25 | 0.00 |
| 1973 | 1.71 | 18.32 | 22.23 | 10.45 | 5.40 | 3.98 | 2.04 | 1.01 | 0.36 |
| 1974 | 12.55 | 92.99 | 31.55 | 18.81 | 9.35 | 3.96 | 4.41 | 1.00 | 0.00 |
| 1975 | 5.59 | 38.64 | 36.33 | 9.37 | 6.12 | 4.08 | 1.88 | 0.95 | 0.38 |


| Table 5.3.I(b). Catch in number $\times 10^{-6}$ Mourne stock. |
| :--- |
| Year | | Rings | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | $8+$ |
| :---: | ---: | ---: | ---: | ---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1969 | 48.1 | 18.2 | 7.7 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 1970 | 161.5 | 23.7 | 3.6 | 1.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 1971 | 100.3 | 47.4 | 33.1 | 12.9 | 1.1 | 0.4 | 0.5 | 0.2 | 0.2 | 0.03 |
| 1972 | 78.4 | 37.0 | 14.9 | 0.9 | 1.9 | 0.6 | 0.3 | 0.7 | 0.1 | 0.3 |
| 1973 | 50.2 | 40.4 | 14.0 | 15.5 | 0.8 | 1.4 | 1.0 | 0.5 | 1.0 | 0.2 |
| 1974 | 57.9 | 30.3 | 13.6 | 7.2 | 5.1 | 1.0 | 0.9 | 0.6 | 0.2 | 0.4 |
| 1975 | 20.3 | 27.7 | 9.3 | 2.8 | 1.4 | 1.7 | 0.1 | 0.2 | 0.2 | 0.1 |

Table 5.3.2(a). Manx herring Division VIIa.

| Age (rings) | 1965 | 1966 | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 ${ }^{\text {\# }}$ ) | 1975 ${ }^{\text {\# }}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1 | 32 | 73 | 100 | 128 | 96 | 140 | 127 | 91 | 201 | 102 | 32 |
| 2 | 58 | 29 | 66 | 90 | 116 | 86 | 126 | 110 | 79 | 180 | 80 |
| 3 | 14 | 33 | 22 | 42 | 58 | 83 | 54 | 62 | 60 | 54 | 75 |
| 4 | 2 | 6 | 22 | 16 | 28 | 39 | 49 | 28 | 32 | 34 | 19 |
| 5 | 1 | 1 | 4 | 13 | 12 | 19 | 23 | 26 | 15 | 19 | 13 |
| 6 | 1 | 1 | 1 | 2 | 8 | 8 | 8 | 12 | 12 | 8 | 8 |
| 7 | 1 | 1 | 0 | 0 | 1 | 5 | 5 | 4 | 4 | 7 | 4 |
| 8 | 1 | 0 | 0 | 0 | 0 | 1 | 2 | 3 | 2 | 2 | 2 |
| Stock in number $(2-8)$ | 78 | 71 | 115 | 163 | 223 | 241 | 267 | 245 | 204 | 304 | 201 |
| Stock biomass $(2-8)$ | 14734 | 13937 | 22092 | 31518 | 43526 | 48820 | 63254 | 49266 | 41393 | 58998 | 42750 |
| Fishing mortalities by year and age. |  |  |  |  |  |  |  |  |  |  |  |
| Age (rings) |  |  |  |  |  |  |  |  |  |  |  |
| 1 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.04 | 0.04 | 0.01 | 0.14 |  |
| 2 | 0.47 | 0.15 | 0.34 | 0.34 | 0.23 | 0.37 | 0.60 | 0.50 | 0.28 | 0.77 |  |
| 3 | 0.69 | 0.29 | 0.25 | 0.33 | 0.30 | 0.43 | 0.55 | 0.56 | 0.49 | 0.93 |  |
| 4 | 0.73 | 0.36 | 0.44 | 0.20 | 0.27 | 0.44 | 0.51 | 0.53 | 0.42 | 0.87 |  |
| 5 | 0.59 | 0.47 | 0.61 | 0.42 | 0.25 | 0.72 | 0.58 | 0.72 | 0.47 | 0.71 |  |
| 6 | 0.65 | 0.75 | 1.46 | 0.46 | 0.31 | 0.46 | 0.56 | 0.86 | 0.44 | 0.67 |  |
| 7 | 0.73 | 0.34 | 2.30 | 0.86 | 0.48 | 0.77 | 0.49 | 0.63 | 0.66 | 0.13 |  |
| 8 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 |  |
| Mean | 0.71 | 0.71 | 0.39 | 0.32 | 0.29 | 0.48 | 0.54 | 0.62 | 0.47 | 0.87 |  |

※) Inefficient estimates.
Table 5.3.2(b). Mourne herring Division VIIa.

| Age (ring: <br> Year | 1969 | 1970 | 1971 | 1972 | 1973 | $1974{ }^{\text { }}$ ) | $1975^{\text {7 }}$ ) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 0 | 125 | 280 | 181 | 154 | 112 | 124 | ? |
| 1 | ? | 68 | 100 | 68 | 65 | 53 | 57 |
| 2 | ? | ? | 39 | 45 | 27 | 21 | 19 |
| 3 | ? | ? | 19 | 3 | 27 | 11 | 6 |
| 4 | ? | ? | 4 | 5 | 2 | 9 | 3 |
| 5 | ? | ? | 2 | 3 | 3 | 1 | 4 |
| 6 | ? | ? | 4 | 1 | 2 | 1 | 0 |
| 7 | ? | ? | 1 | 3 | 1 | 1 | 0 |
| 8 | ? | ? | 1 | 1 | 2 | 0 | 0 |
| Total stock in numbers (0-8) | ? | ? | 351 | 283 | 241 | 221 | ? |
| Total stock biomass (1-8) | ? | ? | 28535 | 20313 | 20927 | 15457 | (12 980) |
| Fishing mortalities by year and age. |  |  |  |  |  |  | $\cdot$ |
| Age (rings) |  |  |  |  |  |  |  |
| 0 | 0.52 | 0.93 | 0.87 | 0.76 | 0.64 | 0.67 |  |
| 1 | ? | 0.46 | 0.69 | 0.84 | 1.05 | 0.91 |  |
| 2 | ? | ? | 2.34 | 0.43 | 0.80 | 1.17 |  |
| 3 | ? | ? | 1.22 | 0.33 | 0.95 | 1.19 |  |
| 4 | ? | ? | 0.28 | 0.48 | 0.49 | 0.85 |  |
| 5 | ? | ? | 0.22 | 0.24 | 0.71 | 1.90 |  |
| 6 | ? | ? | 0.16 | 0.25 | 0.67 | 1.25 |  |
| 7 | ? | ? | 0.23 | 0.28 | 0.75 | 1.00 |  |
| 8 | ? | ? | 0.34 | 0.09 | 0.71 | 0.87 |  |
| Mean | ? | ? | 0.70 | 0.41 | 0.75 | 1.09 |  |

※) Inefficient estimates.
Table 5.3.3. North Irish Sea industrial fisbery.


| Country | 1966 | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 ${ }^{\text {a) }}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | IVa West |  |  |  |  |  |  |  |  |  |
| Denmark | - | - | - | - | - | - | - | - | 5.3 | 0.5 |
| Faroe Islands | - | - | - | - | - | - | - | - | 0.2 | 12.9 |
| France | - | + | - | - | - | - | - | - | - | - |
| Germany, Federal | - | + | - | - | - | - | - | + | - | - |
| Republic of |  | - | + | + | + | + | + | + | + | - |
| Norway | - | - | - | - | - | 0.9 | 2.2 | - | - | 1.5 |
| Poland | - | + | - | - | - | - | - | + | - | 3.3 |
| Sweden | - | - | - | - | - | - | - | 1.0 | 2.2 | 10.0 |
| U.K. (England) | $+$ | - | - | - | - | + | - | 0.2 | - | - |
| U.K. (Scotland) | 65.1 | 19.1 | 13.0 | 12.4 | 3.8 | 15.0 | 29.8 | 49.4 | 41.2 | 9.4 |
| Total | 65.1 | 19.1 | 13.0 | 12.4 | 3.8 | 15.9 | 32.0 | 50.6 | 48.7 | 37.5 |
|  | IVb West |  |  |  |  |  |  |  |  |  |
| Denmark | $\ldots$ | . ${ }^{\circ}$ | -•• | $\ldots$ | 8.6 | 9.9 | 14.4 | 47.0 | 55.4 | 106.6 |
| Faroe Islands | - | - | - | - | - | - | - | - | 4.0 | 30.0 |
| France | - | - | 1.0 | - | - | - | - | - | - |  |
| German Democratic | $+$ | + | - | - | - | - | - | - | 1.7 | $1.7{ }^{\text {b }}$ |
| Republic | $+$ | $+$ | $+$ |  |  |  |  |  |  |  |
| Netherlands | + | + | + | 2.0 | + | + | $+$ |  |  |  |
| Norway | - | - | - | - | - | - | 4.1 | 3.4 | 9.5 | 145.7 6.1 |
| Poland | $+$ | + | + | 3.3 | -17 |  | ${ }_{27}^{+} 8$ | 34.6 |  |  |
| U.K. (England) | 0.9 | 11.9 | 2.6 | 3.3 | 11.2 | 25.5 7.2 | 11.8 3.6 | 34.6 2.9 | 25.5 8.6 | 32.5 4.9 |
| U.K. (Scotland) U.S.S.R. | 6.0 | $7 \cdot 4$ | 13.4 | 22.0 | 9.5 | 7.2 1.2 | 3.6 0.8 | 2.9 17.9 | 8.6 32.9 | 4.9 47.5 |
| Total | 6.9 | 19.3 | 17.0 | 27.3 | 29.3 | 43.8 | 44.7 | 105.8 | 137.7 | 375.1 |

Table 6.1 (ctd). a at catches in the North Sea ( 00 netric tons)

| Country | 1966 | 1967. | 1968 | 1969 | 1970 | 1971 | 1972 | $1973$ | 1974 | $1975^{\text {a }}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| IVb East |  |  |  |  |  |  |  |  |  |  |
| Denmark | 24.5 | 17.4 | 18.1 | 18.5 | 16.2 | 19.9 | 28.8 | 93.9 | 104.0 | 215.2 |
| Germany, Federal Republic of | 8.5 | 11.5 | 16.7 | 6.3 | 7.6 | 5.1 | 1.7 | 11.0 | 17.5 | 0.4 |
| Total | 33.0 | 28.9 | 34.8 | 24.8 | 23.8 | 25.0 | 30.5 | 104.9 | 121.5 | 215.6 |
|  | IVC |  |  |  |  |  |  |  |  |  |
| Belgium | 1.4 | 0.4 | 0.4 | 0.4 | 0.6 | 0.1 | 0.1 | 0.2 | + | + |
| Denmark |  | - | - | - | - | - | - | - | 0.9 | 3.9 |
| France | $+$ | - | $+$ | 0.1 | + | + | - | + | 0.3 | 0.1 |
| Germany, Federal Republic of | - | - | - | - | + | - | + | - | - | - |
| Netherlands | 1.5 | 0.2 | 1.0 | 1.6 | 1.5 | 1.0 | 0.4 | + | + | 0.2 |
| U.K. (England) | 5.7 | 3.2 | 6.2 | 4.2 | 3.9 | 0.2 | + | 0.8 | 3.4 | 2.9 |
| Total | 8.6 | 3.8 | 7.6 | 6.3 | 6.0 | 1.3 | 0.5 | 1.0 | 4.6 | 7.1 |
| Total North Sea |  |  |  |  |  |  |  |  |  |  |
| Belgium | 1.4 | 0.4 | 0.4 | 0.4 | 0.6 | 0.1 | 0.1 | 0.2 | + | + |
| Denmark | 24.5 | 17.4 | 18.1 | 18.5 | 24.8 | 29.8 | 43.2 | 140.9 | 165.6 | 326.2 |
| Faroe Islands | - | - | - | - | - | - | - | - | 4.2 | 42.9 |
| France | + | + | 1.0 | 0.1 | + | $+$ | - | $+$ | 0.3 | 0.1 |
| German Democratic | + | $+$ | - | - | _ | - | - | - | 1.7 | $1.7{ }^{\text {b }}$ |
| Republic <br> Germany, Federal |  |  |  |  |  |  |  |  |  |  |
| Republic of | 8.5 | 11.5 | 16.7 | 6.3 | 7.6 | 5.1 | 1.7 | 11.0 | 17.5 | 0.4 |
| Netherlands | 1.5 | 0.2 | 1.0 | 3.6 | 1.5 | 1.0 | 0.4 | + | + | 0.2 |
| Norway | - | - | - | - | - | 0.9 | 6.3 | 3.4 | 9.5 | 147.2 |
| Poland | + | + | + | - | - | - | $+$ | + | - | 9.4 |
| Sweden | - | - | - | - | - | - | - | 1.0 | 2.2 | 10.0 |
| U.K. (England) | 6.6 | 15.1 | 8.8 | 7.5 | 15.1 | 25.7 | 21.8 | 35.6 | 28.9 | 35.4 |
| U.K. (Scotland) | 71.1 | 26.5 | 26.4 | 34.4 | 13.3 | 22.2 | 33.4 | 52.3 | 49.8 | 14.3 |
| U.S.S.R. | - | - | - | - | , | 1.2 | 0.8 | 17.9 | 32.9 | 47.5 |
| Total | 113.6 | 71.1 | 72.4 | 70.8 | 62.9 | 86.0 | 107.7 | 262.3 | 312.5 | 635.3 |

Table 6.2 Percentage age compositions of landings 1967-1975. Division IVb - west of $3^{\circ}$ E (English data from North Shields fishery)

| Fishing <br> Season | $0 / 1$ | $1 / 2$ | $2 / 3$ | $3 / 4$ | $4 / 5$ | $5 / 6$ |
| :--- | ---: | ---: | ---: | ---: | ---: | :---: |
| $1967-68$ | 17.1 | 53.8 | 16.9 | 11.1 | 1.2 |  |
| $1968-69$ | 3.0 | 37.5 | 43.1 | 11.7 | 4.3 | 0.3 |
| $1969-70$ | 89.5 | 4.9 | 2.2 | 2.9 | 0.5 | 0.1 |
| $1970-71$ | 40.9 | 25.3 | 22.8 | 8.3 | 2.8 |  |
| $1971-72$ | 8.8 | 77.9 | 8.6 | 4.2 | 0.4 |  |
| $1972-73$ | 33.7 | 44.2 | 17.9 | 2.9 | 1.1 | 0.2 |
| $1973-74$ | 58.5 | 39.3 | 1.7 | 0.6 |  |  |
| $1974-75$ | 15.7 | 59.9 | 22.0 | 2.2 | 0.2 |  |

Division IVb - east of 30 E (Danish data)

| Fishing | Age Group |  |  |  |  |  |
| :--- | ---: | ---: | ---: | :---: | :---: | :---: |
| Season | 0 | 1 | 2 | 3 | $>3$ |  |
| 1967 |  | 10 | 76 | 14 |  |  |
| 1968 |  | 9 | 57 | 27 | 5 |  |
| 1969 |  | 1 | 41 | 39 | 20 |  |
| 1970 | 0.3 | 33 | 33 | 22 | 12 |  |
| 1971 | 4 | 23 | 40 | 20 | 17 |  |
| 1972 | 15 | 69 | 76 | 16 | 2 |  |
| 1973 |  | 65 | 35 | 4 | 1 |  |
| 1974 |  | 59 | 1 | 40 | 0.8 |  |
| 1975 |  |  |  |  |  |  |

Table 6.3 Total North Sea sprat catch 1974 and 1975. Numbers caught per age group x $10^{-6}$.

| Area | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| IVa (W) | 1974 | 901. ${ }^{\text {, } 6}$ | 2963.11 | 693.01 | 111.98 | 12.23 |  | 20.68 |
|  | 1975 | 267.15 | 2011.08 | 1025.43 | 363.59 | 11.07 | 2.24 |  |
| $\operatorname{IVb}(E)$ | 1974 | 3.34 | 8486.67 | 4727.88 | 116.51 | 1.73 | 3.91 |  |
|  | 1975 | 9.80 | 13169.04 | 9281.97 | 149.50 | 6.26 |  |  |
| $\operatorname{IVb}(\mathrm{W})$ | 1974 | $\begin{aligned} & 609.38 \\ & 665.42 \end{aligned}$ | $\begin{array}{ll} 6 & 848.08 \\ 5 & 110.00 \end{array}$ | 6033.40 | 1095.59 | 220.80 | 49.52 |  |
|  | 1975 |  |  | 17287.01 | 4.395 .97 | 282.70 | 16.99 |  |
| IVc | 1974 | 21.73 | 766.15 | 620.77 | 28.59 | 1.83 | 3.34 |  |
|  | 1975 |  | 1182.43 | 499.09 | 45.84 | 1.76 |  |  |

Table 6.4. North Sea sprat catch 1967-75.
Numbers caught per age group $\mathrm{x} 10^{-6}$ in the period 1 July - 30 June.


| Age Group |  |  |  |
| :---: | :---: | :---: | :---: |
|  | $2 / 3$ | $3 / 4$ | $4 / 5$ |
| 2176 | 472 | 11 |  |
| 1956 | 721 | 137 |  |
| 1100 | 730 | 300 |  |
| 1564 | 828 | 385 |  |
| 1534 | 775 | 438 |  |
| 3615 | 752 | 214 |  |
| 2912 | 885 | 255 |  |
| 6648 | 351 | 26 |  |

Table 6.5. Total North Sea sprat catch 1974 and 1975. Numbers caught per age group x $10^{-6}$.

Table 6.6. Estimates of $F$ in North Sea sprat from 1967-1974 from annual VPA.


[^0]Table 6.8. Stock biomass and annual recruitment of North Sea sprat, as estimated from Virtual Population Analyses.

|  | Total stock in 000' tons at l July | Numbers of 0recruits at 1 |
| :---: | :---: | :---: |
| 1967 | 874 | 192 |
| 1968 | 1154 | 113 |
| 1969 | 1170 | 129 |
| 1970 | 1040 | 68 |
| 1971 | 820 | 75 |
| 1972 | 445 | 257 * |
| 1973 | (801)* | (381)* |
| 1974 | 1624 | 236 |
| Mean $1967-74$ | 991 | 181 |

* The values in parentheses are extremely uncertain.

Table 6.9. Total mortality rate (Z) of North Sea sprat calculated from catch/effort data.

Table 6.10. Sprat catches in the Skagerak and Kattegat
('000 metric tons) 1966-75.

| Country | 1966 | 1967 | 1968 | 1969 | $\begin{aligned} & 1970 \\ & \text { IIIa } \\ & \hline \end{aligned}$ | 1971 | 1972 | 1973 | 1974 | 1975 ${ }^{\text {a) }}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Denmark | 3.4 | 5.3 | 3.1 | 1.6 | 4.2 | 2.2 | 2.1 | 54.4 | 48.9 | 75.7 |
| Norway ${ }_{\text {b }}$ | 1.1 | 3.3 | 2.1 | 1.7 | 2.4 | 2.9 | 2.4 | 3.2 | 1.4 | 1.8 |
| Sweden ${ }^{\text {b }}$ | 4.3 | 3.9 | 4.6 | 3.5 | 8.4 | 12.0 | 21.2 | 18.7 | 20.5 | 23.0 |
| Total | 8.8 | 12.5 | 9.8 | 6.8 | 15.0 | 17.1 | 25.7 | 76.3 | 70.8 | 100.5 |
| IVa East (Norwegian west coast fjords) |  |  |  |  |  |  |  |  |  |  |
| Norway | 10.7 | 10.2 | 6.3 | 11.8 | 6.4 | 4.4 | 6.9 | 8.8 | 3.3 | 2.4 |

a) Preliminary figures as reported.
b) $1966-69$ not complete.
Percentage distribution of year classes and mean age from I-group onwards in Swedish sprat samples taken from September to March.

## Table 6.11.

 Purse seines and land seines within $\quad$ Trawl fishery in Skagerak and Kattegatthe archipelago Mean
age
2.53
2.50
2.37
2.17
2.39
2.59
2.29
2.50
1.93
2.77
2.37
2.29
2.32
2.32
2.29 N
$\vdots$
$\vdots$





Table 6.12. Percentage of 0/l-group sprat in samples from the Swedish sprat fishery during September to March.

| Season | Purse seines and land seines within the archipelago | Trawls in Skagerak and Kattegat |
| :---: | :---: | :---: |
| 1966/67 |  | 16.2 |
| 1967/68 | 6.7 | 9.0 |
| 1968/69 | 9.0 | 35.8 |
| 1969/70 | 1.5 | 8.4 |
| 1970/71 | 4.9 | 9.9 |
| 1971/72 | 1.6 | 30.4 |
| 1.972/73 | 2.3 | 29.7 |
| 1973/74 | 8.3 | 19.8 |
| 1974/75 | 3.8 | 19.5 |

Figure 1. biomass of the spawning stock which produced that



Figure 2. Celtic Sea spawning stock.

Figure 4. VIa herring.
 and yield in 1000 tons (solid line)




Figure 5. VIa herring. Stock size per recruit in grams (broken line) and corresponding stock size in 1000 tons (solid line) assuming constant modal recruitment ( $650 \mathrm{x} 10^{6}$ l-ringers) and equilibrium situation for different values of $F$.


Figure 7. Yield per recruit curve for Manx herring stock.




[^0]:    1) Inefficient estimate.
