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PART 1

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REPORT OF THE WORKING GROUP ON ASSESSMENT OF PELAGIC STOCKS IN THE BALTIC

COPENHAGEN, 17-27 APRIL 1990

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1 INTRODUCTION

1.1 Participants

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1.2 Terms of Reference

The terms of reference (C.Res.1989/2:4:13) were as follows:

The Working Group on Assessment of Pelagic Stocks in the Baltic (Chairman: Mr B. Sjöstrand) will meet at ICES Headquarters from 17-27 April 1990 to:

a) consider the Report of the Working Group on Multispecies Assessments of Baltic Fish;

b) compile fishing effort and catch-per-unit-effort data for possible use in assessments;

c) evaluate the validity of the present stock unit definitions for assessment and management purposes for herring and sprat in the Baltic and in Division IIIa;

d) assess the status of and provide catch options for 1991 within safe biological limits for the herring and sprat stocks in the Baltic, including the combined stock of spring-spawning herring in Division IIIa and Sub-divisions 22-24;

e) provide quarterly catch-at-age and catch and stock mean weight-at-age data by sub-division for Baltic herring and sprat for 1989 as input to the multispecies VPA;

f) review the changes in growth of Baltic herring stocks, consider to what extent these are density-dependent or due to environmental factors, and discuss the implications for management;

g) evaluate the consequences of maintaining the present IBSFC quota allocation system, with particular reference to the risk of overexploitation of individual stocks;

h) produce a report for ACMP at its 1990 session on the effect of hypoxia in particular, and other forms of pollution, on the relevant Baltic fish stocks based on a review to be produced by Ms E. Nielsen and Dr O. Bagge.

2 GENERAL CONSIDERATIONS

2.1 Results from Acoustic Surveys 1989

2.1.1 The International Hydroacoustic Survey 1989

The 1989 survey was performed in the same way as in previous years, i.e., with the same target strength regression and way of determining the area covered. An intercalibration between R/V "Argos" and R/V "Eisbär" gave a regression that was used to convert the acoustic signals from "Eisbär" to "Argos" units. All the acoustic data from both vessels could thus be used in the calculation of fish density.

The total numbers of herring in Sub-divisions 24-29S have increased about 25%, mostly (40%) due to the strong year classes 1986 and 1988. The total biomass in Sub-divisions 24-29S has increased about 15%.

It was discovered during the disucssion in the Planning Group for Hydroacoustic Surveys in the Baltic that the age composition of the sprat differed between the Swedish and German samples. Therefore, a re-run was made, using only the Swedish age data which were more in line with the USSR data.

The sprat estimate indicates a very strong 1989 year class, and the numbers in Sub-divisions 26 and 28 have, due to the strong 1986, 1988, and 1989 year classes, increased by 586%.

The results are given in the report of the Planning Group for Hydroacoustic Surveys in the Baltic (Anon., 1990b), together with an explanation of the problems with the age-reading of the sprat.

2.1.2 Joint Danish-German hydroacoustic survey in the Western Baltic

The second hydroacoustic survey in the Western Baltic in November 1989 covered very well ICES Sub-divisions 22 and 23 and, to a minor extent, Sub-division 24. The fishery showed the occurrence of younger herring of age groups 0 and 1 in the Belt Sea and Western Baltic, whereas older fish were absent. They were found in limited numbers in Sub-division 24 only.

The results were taken together with the results from the other two acoustic surveys in Division IIIa to tune the VPA for the combined stock of Division IIIa and Sub-divisions 22-24 and they showed a surprisingly good fit. In Sub-division 24, the hydroacoustic data were pooled with the international hydroacoustic survey results of Sweden, German Democratic Republic, and Poland for that Sub-division. Details are given in Section 3.2.6.1.

2.1.3 The USSR hydroacoustic survey 1989

The latest hydroacoustic survey, which was conducted from 25 September up to 30 October 1989, covered Sub-divisions 26, 28, 29, and 32. It included the economic zones of Poland, Sweden, and Finland.

The major tracks were passing through from east to west, starting from 20-30 m depth off the Soviet coast and finishing off the border of the 12-mile Swedish and Finnish zones.

The abundance of 1-year-old and older fish was the highest for the period 1983-1989. On the whole, the biomass of sprat (age 1 and older) was 453,000 t in Sub-divisions 26 and 28, and 171,000 t in Sub-divisions 29 and 32. Biomass of herring was 324,800 t in Sub-division 26, 655,200 t in Sub-divisions 28 and 29S, and 265,200 t in Sub-division 32.

2.2 Multispecies Assessments

The report of the Working Group on Multispecies Assessments of Baltic Fish (Anon., 1990a) was presented to this Working Group. Since last year, the work was concentrated on improving the data bases for the MSVPA programs.

The catch-at-age and mean weight-at-age data by quarter for 1977-1979 and for 1988 have been added to the previous data for 1980-1987 for both the Western Baltic MSVPA and the Central Baltic MSVPA.

The recompilation of the stomach data was not finished and this, together with adding new stomach data to the old set, is the main task at present for the Baltic Multispecies Working Group.

Estimates of the geographical distribution of cod in the Baltic by quarter (based on the bottom trawl surveys) have improved considerably since the meeting reported in Anon. (1990). According to a working document presented to this Working Group by Sparholt, Aro, and Modin, the weighting of the stomach data from the various sub-divisions against each other can now be done on a firm basis.

A thorough examination of the available knowledge on the fish consumption by sea mammals and sea birds was carried out by the Baltic Multispecies Working Group. It was concluded that the predation effects from these sources are small compared to the predation by cod and that they can, therefore, be dealt with as a part of the residual mortality, as is done at present.

The Baltic Multispecies Working Group felt that the estimates of natural mortality are still not sufficiently reliable to replace the values used at present by this Working Group in the single species assessments. For the Western Baltic MSVPA, the sprat terminal Fs were the main problem, and for the Central MSVPA, the uncertainties about the precision in the stomach data were the main problem. However, this Working Group ran into problems when trying to apply constant natural mortalities over the years 1974-1989 in the sprat VPAs. Therefore, this Working Group used mean predation mortalities over ages 1 to 3 for the sprat stock in Sub-divisions 26 and 28 as estimated by the MSVPA.

Year	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
M	.36	.49	.52	.58	.51	.52	.49	.38	.32	.27	.25	.27

Thus, the M values used (for 1977-1988) were those from the MSVPA, variable by year, for 1974-1976 the value M = .40 was used, and for 1989 the value M = .27. These M values were considered as conservative estimates, because the residual mortalities were not included and because the values were taken from the sprat stock with the lowest predation mortality according to the MSVPAs. Time did not allow the Working Group to apply these M values to all the sprat assessments but only to the combined assessment for Sub-divisions 22-32.

The Multispecies Working Group asked this Working Group for advice on how to get sensible input Fs for sprat in the MSVPA models. As the F level on sprat is low in the Baltic and the number of age groups is small in the stock, the VPA does not converge very well. The present Working Group recommends that acoustic stock estimates for sprat could be used. These are available for 1987 and 1989 for Sub-division 22, and for 1977 to 1989 for Sub-divisions 24-29. The relative distribution between Sub-divisions 22 and 24 has not changed significantly in the period 1977-1989 and, therefore, the mean for 1987 and 1989 could be used to get the relative distribution, and this could make up for the lacking data for Sub-division 22 for the years before 1987. Also, sprat catch rates in the German Democratic Republic bottom trawl survey could be considered in this context, but these data were not available to this Working Group.

The quarterly catch-at-age and mean weight-at-age data for 1989 were made available to the Baltic Multispecies Working Group by this Working Group for herring and sprat and by the Baltic Demersal Working Group for cod.

3 <u>HERRING</u>

3.1 <u>Assessment Units and Growth</u>

3.1.1 <u>Assessment units for Baltic herring</u>

The Working Group was asked to evaluate the validity of the present stock unit definitions for assessment and management purposes for herring in the Baltic.

Three stocks/assessment units in the marginal area could easily be distinguished:

1) Spring-spawning herring in Sub-divisions 22, 23, and 24 together with spring spawners in Division IIIa

These are separated from other Baltic herring by their migratory habits. They migrate from spawning places in southwest Baltic to Division IIIa and even into the northeastern parts of the North Sea. They get infested by the parasitic nematode <u>Anisakis</u>, most probably from eating krill (euphausiids) containing the parasite. Krill species do not occur in the Baltic, and the <u>Anisakis</u> can, therefore, serve as a natural tag showing that the infested animal has spent some time in a more marine environment than the southwestern Baltic. Tagging experiments (Biester, 1979; Jönsson, 1981) have also provided many recaptures from the Skagerrak but very few from areas east of Bornholm.

2) Herring in Sub-division 30, the Bothnian Sea

Tagging experiments (Otterlind, 1966 and 1976; Parmanna and Sjöblom , 1982 and 1986) show that the vast majority of fish tagged in this area is also recaptured there. Only taggings close to the southern border have given some recaptures from the Baltic proper.

3) Herring in Sub-division 31, the Bothnian Bay

Similarly, these herring stay in the Bothnian Bay all year round, and few tagged fish are recaptured outside the area.

The splitting (in 1980) of these two areas into eastern and western parts was based on the distribution of fishing areas and on management considerations. The herring spawn and are fished along both the eastern and western coasts, but move after spawning to the deeper waters in the middle of these areas.

The situation is more complicated concerning stocks and assessment units in the Baltic proper and the Gulf of Finland (Sub-divisions 25-29 and 32).

<u>Spawning</u>

Herring spawn (Anon., 1979) all along the Swedish and Finnish coasts, particularly in the archipelagos. On the sandy, open coasts of the southern and southeastern Baltic, spawning occurs along parts of the Polish and USSR coastlines. Large spawning grounds are also situated in the Gulf of Riga and in adjacent Estonian waters continuing in the Gulf of Finland.

Spawning occurs more or less all year round, with the main season for spring spawners from March to July and for autumn spawners from August to November.

<u>Stocks</u>

Herring from different spawning places in the Baltic show differences. This is most obvious when comparing lengths at age. The largest herring spawn in the south, and length decreases gradually towards the north. There are also more abrupt differences between herring spawning in some bays and gulfs and those spawning outside along the coast of the open sea. The Gulf spawners are shorter at age than the sea-coast spawners.

Also size and form of the otoliths differ between spawning areas and are used to allocate herring to different stocks (Ojaveer <u>et al</u>., 1981; Anon., 1986).

Other morphometric and meristic characters have not been of great help when separating Baltic herring into stocks. The amount of genetic differentiation seems, however, to be small between "stocks" of herring, not only in the Baltic. Ryman <u>et al</u>. (1984) studied allele frequencies for polymorphic loci of various enzymes on herring from 17 localities in Scandinavian waters. More than 99% of the total gene diversity was found within populations.

It is pointed out by Smith and Jamieson (1986) that a rather moderate gene flow between neighbouring spawning aggregations would be sufficient to prevent genetic differentiation.

Migrations

Herring make spawning, feeding, and winter migrations between the coasts and the open sea (Anon., 1979; Aro, 1989). Tagging has demonstrated that, for instance, herring along the Swedish coast spend the second half of the year in the waters east and south-east of Bornholm, and that fish from the northern parts of the Baltic proper can move to Gdansk Bay and the Bornholm area. Also, tagged herring from the Gulf of Finland (at least from the western parts) have been recaptured in the Baltic proper. The migrations have been shown to vary from time to time in both frequency and in range, probably in response to changing environmental conditions.

The above-mentioned feeding migrations result in an extensive mixing of herring of different origin during most of the third and fourth quarters of the year. A demonstration of the mixing is given in Figure 3.1.3. which presents the length frequency distriibutions for 2-year-old herring in October-November as measured during the 1983-1986 acoustic surveys and presented by sub-division. The length range is from 12.5 to 25.5 cm. It is seen that the proportions of "small" and "large" herring vary not only between areas, but also between years.

Assessment units

The analytical assessments of Baltic herring have for a long period been calibrated by the results of acoustic surveys covering Sub-divisions 24 to 29. These surveys have been conducted in October-November, i.e., during a time when the mixing of herring is maximal.

The herring in the Baltic proper have been separated into five assessment units: Sub-divisions 25-27, 28-29S, Gulf of Riga, 29N-30 and Sub-divison 32. This split was done mainly to reflect spawning areas, fishing areas, and management areas, but does not take the mixing and the distribution pattern during summer/autumn into account.

One result of this procedure has been the creation of a very big and lightly fished "stock" in Sub-division 28-29S (total biomass = 700,000 t, average F = 0.1). The reason is that the acoustic surveys in these areas do register large amounts of fish emanating from other areas (such as Sub-division 29N, parts of Sub-division 32, and from the Gulf of Riga).

One way of coping with this type of phenomenon could be to enlarge the assessment unit to the whole are within which the migration takes place, in other words, the whole of Sub-divisions 25 to 29 and Sub-division 32. The Working Group adopted this course of action for its 1990 assessments.

A consequence of this "all herring in one bag" approach is that separate entities cannot be monitored, and that one or the other of these could get lost through over-exploitation and/or recruitment failure.

The tentative solution for this year was, in addition to the whole area assessment, to continue to assess separately the entities Gulf of Finland herring, Gulf of Riga herring, and the herring spawning along the Polish and USSR coasts in Sub-division 26.

The comparison (see Section 3.3.6 and Figure 3.2.2) made between the sum of separate assessments (taken from the 1989 report and from Anon., 1987 appendix for the assessment of Sub-division 29N) and the assessment for the total area give very similar results of the dynamics of recruitment and spawning stock biomass.

Status quo catch levels for 1990 and 1991 were calculated for the separate assessments for Sub-division 32 and for the Gulf of Riga. These values were almost identical to the catch figures obtained by splitting the SQC for the total assessment into smaller areas according to catches in number and mean weights in these smaller areas.

In future years, more effort should be made to analyze basic catch data, such as length at age (length frequency distribution) in order to identify and follow components with different growth rates. Also, the results from the acoustic surveys should be studied for distributions of length groups according to areas and to depth. Such studies can give an insight into migration and mixing rates on which detailed data are now missing. The results should be compared with the data from the otolith classification.

It would also be valuable to apply some method for monitoring spawning herring on spawning grounds at spawning time.

The Working Group recommends that the question of stock identification and allocation should also be discussed at the next meeting.

The amount of workload for the relevant institutes for this Working Group and for ACFM should be taken into account, when the number of assessment units are discussed.

3.1.2 Growth

3.1.2.1 Changes in growth of herring

The Working Group initially intended to perform an analysis of growth changes for herring at its 1990 meeting, but due to lack of time it was decided to postpone the analysis to the 1991 meeting. However, the Federal Republic of Germany presented data on estimated length of 1- and 2-year-old herring, obtained by back-calculation from otoliths of herring collected in the western Baltic (Sub-division 22) in the first quarter of 1989. A total of 134 otoliths was sampled.

The back-calculated lengths at age showed a decreasing trend from the 1981 to the 1986 year classes, and, thereafter, increasing lengths at age again (Figure 3.1.1). The ranking of the year classes according to length at age was basically the same at age 2 as at age 1, indicating that differences in length at age between year classes were already established at age 1.

Surface water temperature in the third quarter of the year as 0-group seemed to be highly correlated with length at age 1 of a year class (Figure 3.1.2).

3.1.2.2 Length frequency distributions

Length-at-age data collected during the acoustic surveys in October showed bimodal and, sometimes, polymodal length distributiuons (Figure 3.1.3), suggesting a mixture of herring from different stocks. The length distributions were split into normally distributed components, using the Mix program. Mean length and proportion of each component are given in Table 3.1.2. The number of components and the relative contribution of each were highly variable between years. Moreover, mean length at age of the various components differed by 2-5 cm.

These results demonstrate the difficulties involved in studying growth changes, and the importance of establishing time series based on data from the same biological stock unit. It is, therefore, suggested, that analyses should be based on data collected on spawning grounds, and back-calculations used to study growth of juveniles.

3.2 Herring in Sub-divisions 22, 23, and 24 and in Division IIIa

3.2.1 Introduction

As in previous years, two assessments were made, one for herring in Sub-divisions 22 and 24, and one for herring in the combined Division IIIa and Sub-divisions 22 to 24. Due to the considerable migration of herring from the western Baltic into Division IIIa, the latter assessment seems to be the more appropriate approach from a biological point of view. Both assessments were made on an annual basis.

The catch-at-age data used for the combined assessment included transfers of spring spawners from the North Sea. Details on the method used for separation of spring and autumn spawners are given in Anon. (1990c).

3.2.2 Catch data

Reported landings for 1989 are shown by countries in Tables 3.2.1 -3.2.3 for Sub-divisions 22 and 24, Sub-division 23, and Division IIIa, respectively.

The landings in Sub-divisions 22 and 24 in 1989 were 92,954 t, which is at approximately the same level as in the previous years (6,000 t less than the landings in 1988). The major change was in the Danish catches, which were reduced by 10,000 t.

The landings in Sub-division 23 amounted to 1,630 t in 1989, compared with 219 t in 1988.

In Division IIIa the estimated catch in 1989 was 172,043 t, a reduction of 50% compared with 1988. The 1989 landings were the lowest since 1982. Approximately 70% of the total catch was taken in the human consumption fishery, the rest in the small-meshed clupeoid fishery. Danish industrial landings of herring from Division IIIa were reduced by approximately 135,000 t from 1988 to 1989, partly due to change in fishing effort from small clupeoids to *Nephrops*. Swedish landings in 1989 were 60,000 t lower than in 1988.

The catch of spring spawners from Division IIIa and Sub-divisions

22-24 in the North Sea in 1989 was estimated at 19,869 t, compared with 23,306 t in 1988.

The total catch of 2-year-old and older spring-spawning herring in Division IIIa (including transfers from the North Sea) and Sub-divisions 22-24 by half-year are presented in Table 3.2.4. The catch in 1989 was estimated at 170,543 t, approximately 60,000 t less than the 1988 landings. Catches in Division IIIa and Sub-divisions 22-24 were approximately equal.

3.2.3 Catch in numbers at age

The half-yearly catch in numbers-at-age for Sub-divisions 22-24, Division IIIa, and the combined area are shown in Table 3.2.5.

Age-composition data by quarter were available from all countries fishing in Sub-divisions 22 and 24, except for the third quarter in Sub-division 24, where Polish samples were used to separate the catches from the German Democratic Republic and Sweden.

In Sub-division 23, the catch was distributed according to the quarterly age composition for the total catch in Sub-divisions 22 and 24.

Half-yearly catch in numbers at age of spring spawners in Division IIIa (including transfers from the North Sea) were calculated from data given by the Herring Assessment Working Group for the Area South of 62^{0}N (Anon. 1990c).

3.2.4 Mean weights at age

For each half-year, weighted average mean weights-at-age in the catch in Sub-divisions 22 to 24, in the catch of spring spawners in Division IIIa (including transfers from the North Sea), and for the combined management area are presented in Table 3.2.5. Mean weights-at-age in the catch were also used in the VPA as estimates for mean weights-at-age in the stock.

3.2.5 Herring in Sub-divisions 22 and 24 assessed as a unit stock

In order to make use of the long-time series of 0-and 1-group catch data for the western Baltic, not available in the same amount for Division IIIa, the Working Group decided to continue in running a VPA for a unit stock in Sub-divisions 22 and 24.

Following the procedure in previous years, the natural mortality was chosen as 0.3, accounting for emigration from the area into Division IIIa. For the separable VPA, age 3 was chosen as reference age for the combined assessment, in order to get as comparable results as possible. Trial runs showed the terminal S =2.00 to best reflect the selection pattern for older ages (Table 3.2.5.4).

Recruitment data from the International Young Fish Surveys in Division IIIa and from the German Democratic Republic Young Fish Surveys in Sub-divisions 22 and 24 were analyzed by using the RCRTINX2 program (Table 3.2.5.3 and Figure 3.2.5). The predicted year-class strength for the 1988 and 1987 year classes gave the basis for calibrating the final VPA (Tables 3.2.5.5 and 3.2.5.6). The estimate of age 1 in 1987 from separable VPA is very close to the strength predicted by RCRTINX2 for this year class. Catch in numbers and mean weights at age are given in Tables 3.2.5.1 and 3.2.5.2.

From the data presented to the Working Group, the conclusion can be drawn that the fishing pressure on young herring (ages 0 and 1) was high in 1987 and 1988, and decreased slightly in 1989. The fishing mortality of age group 1, however, was still by 30% above the average in 1989.

3.2.6 Herring in Division IIIa and Sub-divisions 22, 23, and 24

3.2.6.1 Fishery-independent stock estimates

Three acoustic surveys were carried out during 1989 on this stock:

1) A Swedish/Danish/Norwegian survey in Division IIIa and the eastern part of the North Sea during August.

2) A Swedish/GDR survey in Sub-divisions 23 and 24 in October.

3) A Danish/Federal Republic of Germany survey in Sub-divisions 22-24 in October.

As in 1987 and 1988, the coverage of the area was good in 1989. The area below depths of 20 m in Sub-division 24 was covered by both surveys 2 and 3, and a mean estimate for these two surveys was calculated and used in combination with survey 1 and 3 as indicated in Table 3.2.6.1. The coverage of survey 2 for Sub-division 24 was 3,085 nm^2 and this was raised to 3,210 nm^2, which is the area of the depth stratum with depth below 20 m.

3.2.6.2 VPA

Catch in number and mean weight-at-age data are shown in Tables 3.2.6.2 and 3.2.6.3.

The data available to tune the VPA were the acoustic estimate of absolute stock numbers from the Division IIIa Survey, the Danish-Federal Republic of Germany Joint Sub-divisions 22-24 Survey, and the International Survey in Sub-division 24. The data from bottom-trawl surveys were considered too uncertain to be of use in the tuning. Table 3.2.6.4 gives the RCRTINX2 results for the indices when regressed against the final VPA, which is described in the following.

The acoustic estimates from 1987-1989 were used and corrected to account for the variable amount of the catch taken before the survey, i.e., from 1 January to the time for the acoustic surveys, and for the numbers dead due to natural courses. This correction was done as follows:

1) all catches taken in the first two quarters of the year were definitely taken before the survey.

2) For Division IIIa, half of the catch taken in the third quarter of the year was assumed to be taken before the survey in Division IIIa, which is conducted in August/September.

3) All the catch taken in the three first quarters of the year in Sub-divisions 22-24 was assumed to be taken before the survey.

4) All the catch taken before the survey was assumed to be taken at the mid-date between 1 January and 1 October.

5) The natural mortality was assumed to be 0.075 between 1 January and the mid-date as well as between the mid date and 1 October.

The catches taken before the surveys are given in Table 3.2.6.5, and the corrected acoustic estimates are shown in Table 3.2.6.6.

The ICES/ACFM tuning procedure was used regarding the acoustic data as effort data. The input diagnostics and results are shown in Tables 3.2.6.7, 3.2.6.8, and 3.2.6.9. A run with no weighing instead of a tri-cubic weighing put on the regression gave almost identical results. The reliability of this tuning was questioned on the same grounds as for the North Sea herring assessment (Anon., 1990c).

Therefore, an _ad hoc_ tuning was also done using the acoustic estimates of 2+ ringers. As the proportions of the catches taken before the survey were found to be 82%, 73%, and 82%, respectively, for 1987, 1988, and 1989, it was assumed that the percentage of numbers dying before the survey were the same as the percentage of the catch taken before the survey. First a separable VPA was done, and the diagnostics are given in Table 3.2.6.10. A VPA using the terminal population size from the SVPA was then made. The level of F was chosen to give the last sum of squared residuals (ssq) for all three years. The ssq's for various levels of F (F_3 is the age of unit selection) are given in Table 3.2.6.11. The final VPA results are given in Tables 3.2.6.12 and 3.2.6.13 and in Figures 3.2.6A and B.

The estimates of the VPA F_{2-6} in 1989 differed only slightly between the two tuning methods (Tables 3.2.6.9 and 3.2.6.12). As can be seen from Tables 3.2.6.8 and 3.2.6.11, the acoustic data seem surprisingly precise, although it must be taken into account that the time series is very short.

3.2.6.3 Yield per recruit

The input data are given in Table 3.2.6.14. Yield-per-recruit callculations (Figure 3.2.6C) show that $F_{0.1}$ = 0.188 and F_{max} = 0.345. Thus, the 1989 fishing level was about twice Fmax.

3.2.6.4 Catch predictions

The recruitment figure for the 1988 year class as 2-ringers 1 January 1990 was obtained by RCRTINX2 of VPA 2-ringers compared to GDR0, GDR1, and IYFS2 indices (Table 3.2.6.4). The recruitment figure for the 1989 year class as 1-ringers 1 January 1990 was obtained by RCRTINX2 of VPA 1-ringers compared to the GDR0 index (Table 3.2.6.15). The recruitment figure for the 1990 year class as 0-ringers 1 January 1990 was taken as the mean from the VPA over the period 1974-1987 (Table 3.2.6.13). The fishing mortality pattern was taken as the mean for 1982-1987. Fishing mortality in 1990 was assumed to be at the same level as in 1989. The weight at age from the catches in 1989 were adopted for 1990-1992. The results of the prediction are given in Tables 3.2.6.16 and

3.2.6.17 and Figure 3.2.6D.

3.2.6.5 Separation of the catch projections

The projected catch at age in numbers for 1991, assuming the same fishing level in 1991 as in 1989, was separated into half-yearly catches by area. Due to differences in the seasonality in the fisheries between Division IIIa and Sub-divisions 22-24, a half-yearly separation is preferable to a yearly separation. The separation was done using the proportion of the catches by half year and area found in the 1989 data. Mean weights by half year and area were applied to give the catch in tonnes (see Table 3.2.6.17).

The catch in 1991 in Division IIIa will be 101,761 t, of which 16,060 t will come from the catch of 0- and 1-ringers. The catch in 1991 in Sub-divisions 22-24 will be 97,373 t, of which 23,622 t will come from the catch of 0- and 1-ringers (Table 3.2.6.18).

3.2.6.6 Reliability of F estimates for the Western Baltic herring

In last year's report we discussed the reliability of the high F level for this herring stock and concluded that the only possibility for an over-estimation of the level of F (being about 0.8) was a use of a too high S value. However, we have no firm evidence of S being too high, neither from the fishery nor from the acoustic surveys or other surveys.

3.3 Herring in Sub-divisions 25-29 (including Gulf of Riga and Sub-division 32

3.3.1 Catches

Catches have been remarkably stable in this area since the beginning of the 1970s. They have varied between 325,000 and 250,000 t. In 1989, about 292,000 t were caught.

3.3.2 Catch in numbers at age (Table 3.3.1)

For the period 1974-1988, catch-at-age data were combined for the assessment unit of Sub-divisions 25-29, Sub-division 32, and Gulf of Riga. The 1989 data on catch-at-age were disaggregated by quarters for Sub-divisions 25, 26, 27, 28 (and Gulf of Riga) and 29. Annual data from Gulf of Riga and Sub-division 32 were taken from the separate assessment for those areas and added. About 85% of the catches were sampled for age composition. The remaining catches were distributed on ages according to quarter and sub-division.

3.3.3 Mean weights at age (Table 3.3.2)

Mean weights from Sub-divisions 25-29, 32, and the Gulf of Riga were weighted together by catches in numbers for 1974-1988. The weights for 1989 were weighted together by sub-division and quarters.

3.3.4 Assessment

Tuning data. The results from the International Acoustic Surveys of 1982-1989 were used to tune the VPA. They covered Sub-divisions 25-29S. The stock estimates in number at age from the acoustic surveys were treated as input CPUE values to the *ad hoc* tuning program. Effort was put as 1.0 in all years.

The acoustic estimates obtained in October-November each year were regarded as indices of the average stock size that year. The proportion of the catch taken before and after the survey are fairly stable, only during 1985-1989 did the proportion of the catch taken in the fourth quarter (for Sub-divisions 25-29S for which quarterly data were easily available) vary between 18 and 25%. Therefore, no correction was made for pre-survey catches nor for natural mortality.

Table 3.3.3 gives the input data for the tuning, and Table 3.3.4 the output. Log-transformated catchabilities (q) were used. The 1989 q-values were estimated as the 1982-1988 means. These means were rather similar for age groups 3-8, but lower for the 2-group and more so for the 1-group, thus indicating that the young herring are not well covered by the surveys (Figure 3.3.1).

Fishing mortalities 1989

The fishing mortalities in Table 3.3.5 are the output from the tuning procedure. The reference F (average for ages 3-8) shows a slow increase from about 0.22 in 1974 to 0.32 around 1984-1986 and then a slight decrease. The separable VPA with reference age = 4, terminal selection value = 1.0 and a F of 0.29 for the 4-group in 1989 are given as Table 3.3.7. This was used for the final VPA (using terminal populations to determine terminal F values). Table 3.3.8 and Figure 3.3.3A give fishing mortality, and Table 3.3.9 and Figure 3.3.3B stock sizes.

According to this assessment, both the exploitation level (0.25-0.32) and spawning stock size (898,000-1,220,000 t) have been very stable since 1974. The observed variations are without a trend.

Recruitment

As has been stated in earlier reports, the recruitment data for herring are poor in the Baltic. The available data from young fish surveys (Gdansk Bay in Sub-division 26 and the Gulf of Riga) were not thought to be representative for the whole area. Consequently, it was the long-term (1974-1987) mean (14.4×10^9) which was used for both the 1989 and 1990 year classes.

3.3.5 Prediction for 1990-1992 (Tables 3.3.9-3.3.11 and Figure 3.3.3D)

Input fishing mortalities were from the 1987-1989 average pattern, scaled to give a level of 0.29 for the reference F. Mean weights at age for the catch and stock were taken as the 1987-1989 average. *Status quo* catches are predicted for 295,000 t in 1990 and 293,000 t in 1991. This will be accompanied by a slight drop in spawning stock from 1,106 in 1990 to 1,087 in 1992.

3.3.6 Allocations of catches on areas

In order to give a picture of the likely allocation of predicted catches by areas, the following procedure was adopted: the predicted catches in number at age for 1990 and 1991 were distributed among areas as the 1987-1989 average of catch in numbers at age and multiplied with the mean weight at age for each area (Table 3.3.12).

Comparison between this assessment and assessments on smaller areas

Figure 3.3.2 shows the recruitment and spawning stock biomass for the "single area" assessments, their sum, and the assessment of the total area. It should be noted that the assessment for Sub-division 29N only covers the period 1977-1986. The correspondence is indeed very good, both for recruitment and biomass.

3.3.7 Separation of herring stocks in Sub-divisions 25-27

As in previous years, the Working Group separated the total catches in the area into the two main stocks present, i.e., the fast-growing, short-lived coastal herring spawning along the southern coast in Sub-divisions 25-26 (from Hanø Bay to Gdansk Bay) and the slow-growing, long-lived open-sea herring spawning along the coast in Sub-division 27.

It should be noted that the coastal herring includes autumn spawners which make up 4-8% of the total catch in Sub-divisions 25 and 26. It was decided, however, not to perform independent assessment of the open-sea herring - which was the case in previous years - because data for tuning of VPA for that population are missing.

3.3.8 Separation procedure

As in previous years, the Polish (Sub-divisions 25-26) and USSR (Sub-division 26) catches, presented as numbers at age, were separated on the basis of otolith types into coastal and open-sea components. The Polish catches in the Swedish zone (Sub-divisions 25, 26, and 27) were separated on the same basis. This method is still not adopted in the Swedish and Danish laboratories, and these countries presented catch as numbers at age for each quarter of the year. Total catches of the German Democratic Republic and USSR in the Swedish zone of Sub-division 25 were separated into population and age components according to population and age composition of Polish catches in that zone, as the seasons and fishing grounds of the German Democratic Republic and USSR fisheries overlap with those of the Polish fishery.

All Swedish catches in Sub-division 25 in the first half-year and 33% of the second half-year catches were assumed to be coastal herring, while 67% of the second half-year catches were allotted to the sea stock. The same rule was applied for the separation of Danish catches in Sub-division 25. All catches in Sub-division 27 were assumed to be open-sea herring.

3.3.9 Catch trends

In 1989, estimated catch of the coastal herring was about 73,000 t showing a slight decrease (3%) when compared with 1988 catch. Estimated open-sea herring catch increased by 16% from about 69,000 t to 80,000 t (Table 3.3.13).

3.3.10 Mean weight at age

For both the coastal and open-sea herring stocks, data on mean weight at age were supplied by Poland (Sub-divisions 25-26) and the USSR (Sub-divisions 26).

It was assumed that the German Democratic Republic and USSR weights at age in Sub-division 25 were the same as those in the Polish catches in the Swedish fishery zone.

Sweden supplied the data on a quarterly basis for Sub-divisions 25 and 27, and Denmark supplied similar data for Sub-division 25. Swedish and Danish data from the first half of the year from Sub-division 25 were assumed to represent only the coastal stock, while the data from the second half year were assumed to represent both stocks.

3.3.11 VPA for coastal herring

Natural mortality was assumed at a level of 0.3 for all years and age groups.

The CPUEs of Polish state-owned cutters in the first and second quarters were used for tuning. These data were standardized by GLM for the 1976-1989 period (Table 3.3.17). As coastal herring constitutes almost 100% of Polish catches in the first quarter, and over 90% in the second quarter, the CPUE series is believed to represent coastal herring stock. Fishing effort was calculated as the ratio of total catch to arithmetic mean CPUE in the first and second quarters. As catchability estimates in age groups did not show any time trend, the Laurec-Shepherd tuning method was applied. Standard error of predicted catchability is less than 0.3 or slightly higher than 0.3 for most age groups, except age 1 where it equals 0.4 (Table 3.3.18). Separable VPA with reference age of 3 and terminal selection equal 1 was then run (Table 3.3.20), to obtain terminal populations for the final VPA (Tables 3.3.21 and 3.3.22 and Figure 3.3.4A and B). Mean Fs for ages 2-6 from tuning module and from final VPA are the same.

3.3.12 Recruitment and catch prediction

Recruitment data from Polish young fish survey in Gulf of Gdansk and VPA estimates of year-class strength were analysed using program RCRTINX2 (Table 3.3.13 and 3.3.14). The analysis showed poor quality of recruitment data and indicated that 1988 and 1989 year-class strength is slightly (2-3%) below the average, and so average values were assumed. Weight at age in the catch and in the stock were taken to be means from the period 1985-1989. The fishing pattern was determined as the averages of the 1975-1987 fishing mortalities. Input parameters for the projection are given in Table 3.3.24, and the results are shown in Table 3.3.15 and Figure 3.3.4.D.

If the fishing mortality in 1990 and 1991 is at the same level as in 1989, the spawning stock biomass will remain at a level of about 170,000 t in these years. Catches at 1990 and 1991 are projected to be at a level of about 77,000 t.

F_{med} and F_{high} estimates are estimated as 0.28 and 0.60, respec-tively, and $F_{0.1}$ as 0.31.

3.4 Gulf of Riga

3.4.1 Catches

As compared with the 1982-1988 period, in 1989 total catches in the Gulf of Riga increased. That was due to a greater amount of open-sea herring caught in that Gulf in 1989, whereas the Gulf herring landings remained on the 1988 level. In the Gulf of Riga, herring is fished only by the USSR.

Catches in tonnes

Category	1976	1977	1978	1979	1980	1981	1982
Total catch	31,975	25,544	23,056	21,758	20,702	22,646	17,431
Gulf of Riga herring	27,422	24,186	16,728	17,142,	14,998	16,769	12,777
Open-sea herring	4,553	2,358	6,328	4,717	5,704	5,877	4,654

Category	1983	1984	1985	1986	1987	1988	1989
Total catch	20,318	19,679	20,187	18,180	17,676	19,779	22,676
Gulf of Riga herring	15,541	15,843	15,575	16,927,	12,884	16,791	16,783
Open-sea herring	4,777	3,836	4,612	1,253	4,792	2,988	5,893

3.4.2 Catch in numbers at age

Age compositions were available for trapnet and trawl catches (Table 3.4.1).

3.4.3 Mean weight at age

The mean weight of age groups for the total stock was calculated from corresponding data on trapnet and trawl herring. The SOP check showed that in 1989 nominal catches constituted 102% of the calculated catches.

Excluding the 0- and 1-group fish, in 1989 average weight of the Gulf of Riga herring by age groups was less than in previous years, and in several age groups the lowest on record for the period 1970-1989 (Table 3.4.2).

3.4.4 VPA

Natural mortality was taken equal to that assumed previously (0.2). For determination of the level of input Fs for 1989, the same method as last year was used. As the series of acoustic estimates were considered to be too short for tuning the VPA, the input Fs were calculated on the basis of the total numbers (millions) of the 3-7-year-old herring in 1989 and the 2-6-year-old herring in 1988 found in the Gulf of Riga during the acoustic survey in November 1988 and January 1990.

	Age					
Year	2	3	4	5	6	7
1988	323	3,446	1,215	754	231	-
1989	-	252	2,142	504	252	38

Z for the age groups 2-6 in 1989 was estimated as 0.63 and F = 0.43 (M = 0.20). Input Fs for the age groups were derived from the separable VPA (Table 3.4.3), with age group 4 as the reference age and the selections factor 1.3 for age 7. The average unweighted F for the 4-7-year-old herring in 1989 (0.43) equals the average F for age groups 2-6. This is considerably higher than $F_{0.1}$ (0.26). The VPA results are given in Table 3.4.4 and Figures 3.4.1A and B.

3.4.5 Recruitment and catch prediction

As in recent years, the abundance of 1- and 2-group herring for the prediction was estimated on the basis of a regression of year class abundance from the VPA on the average number of 0-group fish per haul with the experimental bottom trawl given in the text table below:

	Year						
	1975	1976	1977	1978	1979	1980	1981
Abundance of 0-group herring per haul	4,565	2,493	798	697	296	586	1,310
1-group (millions) from VPA	3,464	797	1,007	967	1,123	939	1,691

	1982	1983	1984	1985	1986	1987	1988	1989
Abundance of 0-group herring per haul	768	1,694	806	454	3,315	358	1,601	2,228
1-group (millions) from VPA	1,306	2,065	1,028	899	2,807	303	1,707	-

The corresponding equation is $y = 616 + 0.582\,x$; $r = 0.86$. Both abundance of 0-group herring from the 1988 survey and the abundance of 1-group fish in 1989 from the VPA ($1,707 \times 10^6$ fish) indicate that the 1988 year claass is above the average ($1,453 \times 10^6$ fish at age 1) of the year classes of 1975-1987. The average 0-group herring numbers in experimental trawl catches in 1989 were still higher than in 1988. Consequently, it can be presumed that the 1989 herring year class in the Gulf of Riga is well above the average too. To avoid possible overestimation, its abundance was assumed equal to that of the 1988 year class ($1,707 \times 10^6$ fish at age 1). The prediction was made using the average of the exploitation patterns for 1988-1989 (Table 3.4.6). The 1991 and 1992 year classes were assumed to be of average strength (1,453 x 10^6 fish at age 1). Mean weights at age were taken as the averages for 1988-1989.

Input parameters for the projection are listed in Table 3.4.6 and the results in Tables 3.4.7 and 3.4.8 and Figure 3.4.1D.

3.5 Herring in Sub-division 30

The herring in this area are treated as one unit. At the meeting, no age and weight data from the western part of this area were available. The assessment is, therefore, based on data from the former unit Sub-division 30E.

3.5.1 Landings, effort and CPUE trends

According to the preliminary figures, the landings in the eastern part of the sub-division (26,989 t) increased by 10% from the previous year. In the autumn of 1989 there were some discards of small herring due to marketing problems. Of the annual catch, 54% is taken with pelagic trawls and 33% by trap nets.

3.5.2 Age compositions and weight at age

Quarterly age compositions were available for bottom trawl, pelagic trawl, and trap net fisheries. Quarterly numbers at age were summed, and VPA was made on an annual basis. The SOP check for 1989 was 100%. Catch weight at age was assumed for weight at age for the stock. Tables 3.5.1 and 3.5.2 give catch numbers and weights at age.

3.5.3 Estimation of fishing mortality

Catch numbers in age groups 1-10 and associated effort data for bottom trawl, pelagic trawl, and trap net were available for the period 1974-1989 for Sub-divisions 29N and 30 combined (Table 3.5.3), but not split for the two Sub-divisions. Therefore, the tuning was based on the combined data. The catch taken in Sub-division 30 is about 40% of the combined catch. In most age groups, the SIGMA (overall) values were around 0.2 (Table 3.5.4). In the tuned VPA, F on the oldest age group (age 10) was set to the mean of the five previous age groups (Table 3.5.5).

3.5.4 Virtual population analysis

The natural mortality of M = 0.20 was used for all years and age groups.

Catch numbers and mean weights in age groups 1-10+ for the period 1974-1989 in Sub-division 30 were used as input to the VPA. For the separable VPA, terminal F of 0.16 on age 3 and terminal S of 0.8 were applied (Table 3.5.6). This resulted in a lower fishing mortality in Sub-division 30 in 1989 (F_{2-6} = 0.153) than in the tuned VPA (F_{2-6} = 0.202), based on the combined CPUE data for Sub-divisions 29N and 30, which was considered to be acceptable taking into account the smaller catches and wider area in Sub-division 30 compared to Sub-division 29N. Fishing mortalities, stock size, and biomass estimates generated by the separable VPA are shown in Tables 3.5.7 and 3.5.8 and Figure 3.5.1A and B.

3.5.5 Recruitment

According to the VPA, the year class 1987 is poor and the 1988 year class is strong. Due to the uncertainty in the size of the 1988 year class, it was reduced from 5654 to 4296 million fish as 1-group (2 x mean for 1974-1987). Year class 1989 was predicted to be above average by RCRTINX2 based on zooplankton data. Due to the low correlations, the year classes of 1989 and 1990 were, however, assumed to be average.

3.5.6 Yield per recruit and catch forecast

The slightly smoothed 1989 exploitation pattern was used for the yield-per-recruit analysis and prediction. The inputs to these analyses are summarised in Table 3.5.9 The yield per recruit curve derived is shown in Figure 3.5.1C and has a maximum with F = 0.632.

A catch forecast was run using the same input values as for the yield-per-recruit analyses (Table 3.5.9). Fishing mortality in 1990 was assumed equal to that in 1989, resulting in predicted landings in 1990 of 32,000 t (Table 3.5.10). Table 3.5.11 and Figure 3.5.1D give the catch options for 1991 and SSB in 1992 with F_{89}, 1.2 x F_{89}, $F_{0.1}$ and F_{med}. The predicted catches and biomass are given in Table 3.5.12 by age groups for the option $F_{89} = F_{90} = F_{91}$.

With F_{91} = 1.2 x F_{89}, the SSB in 1992 is equal to SSB in 1989.

Catches taken in the western part of the Sub-division are less than 10% of the total catch (Table 3.5.13). In order to account for that part of the catch not included in the assessment, an increase of a TAC based on this assessment could be justified.

3.6 Herring in Sub-division 31

Herring in this area is treated as one unit. At the meeting no age and weight data from the western part of the area were available. The assessmnt is, therefore, based on data from the former unit Sub-division 31E.

3.6.1 Landings, effort and CPUE trends

According to preliminary figures, the landings in the eastern part of the Sub-division (3,571 t) decreased by 58% from the previous year. The reasons for the small catches are marketing problems and low CPUE, which may be connected to the unusual herring distribution caused by the exceptionally high water temperature in 1989.

3.6.2 Age compositions and weight at age

Quarterly age compositions were available for bottom trawl, pelagic trawl, and trap net fisheries. Quarterly numbers at age were summed, and a VPA was made on an annual basis. The SOP check for 1989 was 100%. Catch weight at age was assumed for weight at age for the stock. Tables 3.6.1 and 3.6.2 give catch numbers and weights at age.

3.6.3 Estimation of fishing mortality

Catch numbers in age groups 1-10 and associated effort data for bottom trawl, pelagic trawl, and trap net were available for the period 1974-1989 (Table 3.6.3) and were used for the VPA tuning. In most age groups, the Sigma (overall) values were around 0.3 (Table 3.6.4). In the tuned VPA, F on the oldest age group (age 10) was set to the mean of the five previous age groups (Table 3.6.5).

3.6.4 Virtual population analysis

The natural mortality of M = 0.15 was used for all years and age groups. The assumption of a low M was based on the low amount of cod in the northernmost Baltic Sub-division.

Catch in numbers and mean weights for age groups 1-10+ for the period 1974-1989 were used as input to the VPA. For the separable VPA, terminal F of 0.10 on age 3 and terminal S of 0.7 were applied (Table 3.6.6) This resulted in a slightly lower fishing mortality in 1989 (F_{2-6} = 0.101) than in the tuned VPA (0.104), which was considered to be acceptable. Fishing mortality, stock size, and biomass estimates generated by the separable VPA are shown in Tables 3.6.7 and 3.6.8 and Figures 3.6.1A and B.

3.6.5 Recruitment

According to the VPA, the year class of 1987 is poor and that of 1988 is slightly above average. Year class 1989 was predicted to be close to the average by the RCRTINX2 program using zooplankton data. Both year classes 1989 and 1990 were assumed to be average.

3.6.6 Yield per recruit and catch forecast

The smoothed 1989 exploitation pattern was used for the yield-per recruit analysis and prediction. The inputs to these analyses are summarized in Table 3.6.9. The mean weights at age were from the 1989 catch data.

The yield per recruit curve derived is shown in Figure 3.6.1C and has a maximum at F = 0.467. F_{89} (0.096) is lower than $F_{0.1}$ (0.218).

A catch forecast was run using the same input values as for the yield-per-recruit analysis (Table 3.6.9). Fishing mortality in 1990 was assumed equal to that in 1989, resulting in predicted landings in 1990 of 4,000 t (Table 3.6.10). Table 3.6.11 gives catch options for 1991 and SSB for 1992 with F_{88}, F_{89}, $F_{0.1}$, and F_{med}. The predicted catches and biomass are given in Table 3.6.12 and Figure 3.6.1D y age groups for the options $F_{89} = F_{90} = F_{91}$.

With all predicted catch options, the spawning stock will be increasing in 1991 and 1992 from the present low level.

Catches taken in the western part of the Sub-division are less than 10% of the total catch (Table 3.5.13). In order to account for that part of the catch not included in the assessment, an increase in the TAC based on this assessment could be justified.

3.7 Herring in Sub-division 32 (Gulf of Finland) Catches

3.7.1 Landings

Compared with the previous year, the 1989 herring catches in the Gulf of Finland decreased.

Country	1974	1975	1976	1977	1978	1979	1980	1981
Finland	11,579	8,321	12,525	12,317	13,791	10,929	10,207	12,781
USSR	37,085	27,111	34,490	34,745	34,005	29,124	28,673	28,019
Total	48,664	35,432	47,015	47,062	47,796	40,053	38,880	40,800

Country	1982	1983	1984	1985	1986	1987	1988	1989[1]
Finland	16,272	22,470	20,695	19,290	16,533	17,080	19,135	17,871
USSR	23,589	27,795	24,692	24,899	25,520	21,462	23,140	18,384
Total	39,861	50,265	45,387	44,189	42,053	38,542	42,275	36,255

[1] Preliminary.
Weights in t.

3.7.2 Catch in numbers at age

Both Finland and the USSR supplied catch in numbers data by age groups in 1989 (Table 3.7.1).

3.7.3 Weight at age

On the basis of the average weights at age on the USSR and Finnish catches, an average weighted by catches in numbers was calculated (Table 3.7.2). The nominal catch constituted 102% of the calculated SOP in 1989. With the exception of younger herring (age groups 1 and 2) in 1989, the mean weights at ages were less than in 1987-1988. Mean weights in the catches and on the stock were taken equal.

3.7.4 VPA

The same constant natural mortality rate (M = 0.2) for all age groups as at 1988 was applied. The F level was estimated by tuning VPA against the yearly effort and catch values in four fisheries (the USSR pelagic trawl fishery, Finnish pelagic trawl, bottom trawl and trapnet fishery) in 1982-1989 (Table 3.7.3). The terminal F for the oldest age group in 1989 was calculated as the average for the 4 oldest age groups. Input fishing mortalities for the age groups in 1989 were estimated from a separable VPA. The version having the reference F_3 = 0.23 and S = 0.8 for age group 9 was thought to best represent the fishing pattern in 1989 (Table 3.7.4). The resulting average F for the age groups 2-5 of 0.218 is higher than $F_{0.1}$ (= 0.179). The VPA results are presented in Tables 3.7.5 and 3.7.6. and Figures 3.7.1A and B.

3.7.5 Catch prediction

The 1989 year class was well represented in 1989 catches as 0-group (Table 3.7.1). Information on catch composition in the first quarter of 1990 confirms a rather high abundance of that year class in both the USSR and Finnish fishery. On account of the high proportion of young herring in the catches, the USSR trawl fishery for pelagic species was closed for period in some areas in the Gulf of Finland and the northeast Baltic. Therefore, its abundance (3200×10^6 fish at age 1) was taken as being above the average for 1970-1987 (3066×10^6 fish at age 1). The 1990-1992 year classes were assumed to be equal to the average for the 1970-1987 period. The prediction was run with a somewhat smoothed average (1988-1989) exploitation pattern. M was taken equal to the 1989 values (0.2). The average for 1988-1989 weights at age were applied. Input data are shown in Table 3.7.7.

The results indicate that from 1989 to 1992 the spawning stock biomass of the Gulf of Finland herring will probably increase (Tables 3.7.8 and 3.7.9 and Figure 3.7.1D.

4 SPRAT

4.1 Introduction

4.1.1 Assessment units

The Working Group found it difficult on biological grounds to justify a splitting of Baltic sprat into three stocks. It was pointed out that certain practical advantages may arise from the splitting, i.e., from the point of view of national management.

The Working Group, therefore, continued to assess the Baltic sprat as one unit. The assessment was based on acoustic survey results. These surveys are now covering a very large part of the sprat distribution area.

An assessment was also made for Sub-divisions 26 and 28, based on estimates of natural mortality during the years 1977-1988 obtained in a different way. It could be regarded as a way of comparing the general result.

Catches at age and mean weight are presented according to the former assessment units Sub-divisions 22-25, and 27-29, and 32.

4.1.2 Catches

The total catch of sprat in the Baltic amounted to 85,818 t in 1989 (Table 4.1). This is an increase by 6.8% as compared to the year before. The catch mainly increased in Sub-divisions 28, 25, and 22 and diminished in Sub-divisions 24, 26, and 27.

4.2 Sprat in Sub-divisions 22, 24, and 25

4.2.1 Catches

Country	1977	1978	1979	1980	1981	1982	1983
Denmark	7,167	10,815	5,549	4,738	8,359	6,787	6,202
German Dem.Rep.	2,214	1,090	924	114	78	1,022	2,692
Germany,Fed.Rep.	766	784	691	541	564	632	619
Poland	19,984	8,281	5,735	6,217	4,300	4,439	2,786
Sweden	173	569	1,336	1,185	747	1,460	1,659
USSR	6,000	360	135	-	2	3	-
Total	36,304	21,899	14,370	12,795	14,050	14,343	13,958

Country	1984	1985	1986	1987	1988	1989
Denmark	2,957	4,148	5,954	2,593	1,972	5,239
German Dem.Rep.	2,761	1,950	2,514	1,307	1,234	1,166
Germany,Fed.Rep.	663	879	473	1,125	330	565
Poland	1,639	5,460	12,057	15,488	10,932	11,902
Sweden	3,232	3,391	2,153	723	1,230	1,993
USSR	-	-	-	-	-	-
Total	11,252	15,828	23,151	21,236	15,698	20,865

Weights in t.

The total catch from the assessment unit increased by 33% in 1989 as compared with 1988. The major increase appeared in the catch of Denmark, but slight increases of catches also appeared for the other countries fishing in the area except for the catch of the German Democratic Republic. Swedish catches were used mainly for industrial purposes.

4.2.2 Catch in number by age and year

The Federal Republic of Germany, the German Democratic Republic, and Poland provided their total catches in numbers by age groups. Danish catches by age were given as percentages of the catch and were calculated according to mean weight per age group in samples taken by Danish scientists and according to the catches of Denmark. Swedish catches were raised according to the age composition of the catches of Poland in the same sub-division at the same time. Catch numbers are given in Table 4.2.1.

4.2.3 Mean weight at age

The countries providing catches in numbers also supplied mean weights at age in their landings. Weighted mean weights in catch (Table 4.2.2) were calculated on the bais of the catch in number taken country by country.

The SOP of catches in number is in accordance with the nominal catch taken from the assessment unit in 1989. Mean weights at age in the stock estimated in 1988 were also used in this year's assessment.

4.2.4 VPA

No separate assessment was made.

4.3 Sprat in Sub-divisions 26 and 28

4.3.1 Catch trends

Country	1977	1978	1979	1980	1981	1982	1983
German Dep.Rep.	14,725	12,619	3,057	15	-	-	-
Poland	18,758	16,411	6,660	6,518	4,591	9,770	4,302
Sweden	28	35	65	66	87	120	274
USSR	51,544	43,700	22,067	18,990	13,093	13,618	8,919
Total	85,055	72,765	31,849	25,529	17,770	23,508	13,495

Country	1984	1985	1986	1987	1988	1989
Finland	-	-	-	21	11	2
Poland	7,615	13,023	11,596	16,515	11,304	6,749
Sweden	4,180	2,395	1,010	2,684	3,921	735
USSR	19,354	27,560	29,356	37,426	36,573	50,258
Total	31,149	42,978	41,962	56,646	51,809	57,744

Weights in tonnes.

The total catch from the assessment unit increased by 11.5% in 1989 as compared with 1988. The major increase appeared in the USSR landings. Polish and Swedish catches in 1989 decreased. Fishing effort and catch per unit effort in the USSR and Polish sprat fishery are given in the following text table:

		USSR		Poland	
Year	Sub-division	Trawling hours	CPUE,t	Standardized effort	CPUE,t
1985	26	11,182	1.66	3,258	4.67
	28	7,779	1.16		
	Total	18,961	1.45		
1986	26	8,466	1.18	3,711	3.68
	28	16,234	1.19		
	Total	24,700	1.19		
1987	26	22,263	1.15	3,727	4.80
	28	10,948	1.08		
	Total	33,211	1.12		
1988	26	21,975	1.10	3,440	3.81
	28	12,750	1.00		
	Total	34,725	1.05		
1989	26	10,566	1.2	2,291	3.14
	28	23,374	1.3		
	Total	33,940	1.3		

4.3.2 Catch in number

Poland and the USSR supplied catches in numbers by age. The catches taken by Sweden and Finland were raised by the age composition of the USSR (Table 4.3.1).

4.3.3 Mean weight at age

Mean weights used were supplied by Poland and the USSR. These mean weights at age were weighted by catches in numbers of these countries in Sub-divisions 26 and 28, and the resulting mean weights at age were used as the average weights in the catches. The average weight at age in the stock was taken equal to the weight of fish of the same age group in the first quarter of the year based on the USSR and Polish data (Tables 4.3.2 and 4.3.3). The SOP based on weighted mean weights at age in 1989 was in very good agreement with the nominal catch (Table 4.3.4).

4.3.4 VPA

In the first run of VPA, the natural mortality was assumed to be equal to 0.5 for all ages in all years. However, the resulting stock biomass appeared to be unrealistically high. So, the next assessment was based on variable M in years (but constant at age) natural mortality (Table 4.3.5). This mortality was assumed to consist of two components: a cod predation component and a residual component.

$$M = M_{cod} + M_{res}.$$

For M_{cod} values, the estimates of Baltic Multispecies Working Group (Anon., 1990a) were assumed.

The M_{res} was estimated using the following procedure:

a) total mortality (Z) estimates were obtained from USSR acoustic data as $Z = \ln(N_y/N_{y+1})$ for years (y) 1984-1988.

b) The $Z-M_{cod}$ values were regressed against effort data

$$Z-M_{cod} = M_{res} + q \text{ Effort}$$

resulting in $M_{res} = 0.12$.

In the tuning module, the USSR acoustic surveys were used as CPUE input (Table 4.3.6). The log catchabilities (Table 4.3.7) did not vary with clear trend and sigma values were less than 0.3 for ages 1-3 and higher (0.5-0.9) for other age groups. The separable VPA with reference age of 3 and terminal S equal to 1.6 was run to estimate terminal populations for the final VPA (Tables 4.3.10-4.3.12 and Figures 4.3.1A and B), which indicated that spawning stock in 1988-1989 was at a level of about 280,000 t.

4.3.5 Recruitment and catch prediction

Year classes older than 1988 were taken from VPA. The 1988 and 1989 year classes were estimated from the USSR 0-group data from a pelagic trawl and Isaacs-Kidd trawl surveys in September-October (Tables 4.3.13 and 4.3.14). The 1990-1991 year classes were set at the average level for 1980-1987 (Tables 4.3.9 and 4.3.12). A natural mortality level of 1989 was applied for all years. All input data are given in Table 4.3.15. The results of the predictions are given in Tables 4.3.16-4.3.17 and Figures 4.3.1C and 4.3.1D. Taking into account the IBSFC TACs for sprat in the Baltic Sea in 1990, it can be expected that the sprat catch in Sub-divisions 26 and 28 in that year will be about 65,000 t. In 1991, continuation of the increase in the sprat stock is expected.

The status quo catch in 1991 is estimated at a level of about 80,000 t.

4.4 Sprat in Sub-divisions 27, 29-32

4.4.1 Catches

Country	1978	1979	1980	1981	1982	1983
Finland	6,373	7,125	6,311	8,580	4,550	3,355
German, Dem.Rep.	1	37	12	-	-	-
Poland	-	-	-	-	-	-
Sweden	196	825	1,133	716	1,170	783
USSR	31,469	22,860	14,429	10,787	5,245	4,803
Total	38,039	30,847	19,885	17,353	10,965	8,944

Country	1984	1985	1986	1987	1988	1989
Finland	2,415	2,923	3,246	2,796	3,025	2,752
Sweden	985	1,325	67	46	2,194	694
USSR	6,537	6,443	7,128	7,462	7,608	13,939
Total	9,937	10,691	10,441	10,204	12,827	17,385

Weights in tonnes.

Compared to 1988, in 1989 Swedish catches decreased by 1,500 t, Finnish catches remained at the previous level, and USSR catches increased by 83%. The total catch increased by 36%. The catches were mainly taken in the mixed herring-sprat fishery as herring by-catch.

4.4.2 Catch in numbers by age and year

The USSR and Finland presented catches in millions by age groups. The Swedish catch was raised to the age composition of the combined USSR and Finnish landings (Table 4.4.1).

4.4.3 Mean weight at age

Weighted mean weight-at-age data from the USSR and Finnish fisheries were applied for 1989. Weights at age in the catch and in the stock were taken as being equal (Table 4.4.2). The nominal catch constituted 100% of the calculated one.

4.4.4 VPA

No separate assessment was made.

4.5 Sprat in the Total Baltic (Sub-Divisions 22-32)

4.5.1 Catches

The catches (Table 4.1) increased from 80,300 t in 1988 to 85,000 t in 1989.

4.5.2 Catch in numbers at age

Catch in numbers at age were summed from the existing files covering the stocks in Sub-divisions 22-25, Sub-divisions 26 and 28, and Sub-divisions 27, 29-32 (Table 4.5.1).

4.5.3 Mean weight at age and maturity data

Mean weight in the catches were obtained by weighting the means from the three units by catches in numbers (Table 4.5.2).

A maturity ogive was calculated as an average of the three ogives used.

4.5.4 VPA

Preliminary trial assessments, using constant values of natural mortality over the period 1977-1989, resulted in quite unrealistic levels of F and stock size. It was, therefore, decided to apply the yearly average values as given by the Working Group on Multispecies Assessment of Baltic Fish and calculated as an average over ages 1-3 (Figure 4.5.1).

Results from the International Acoustic Survey in Sub-divisions 24-29S in October and from the USSR Acoustic Surveys in Sub-divisions 26 and 28 in September-October were used for tuning the VPA. The values of the estimated stock in numbers at age were treated as CPUE data and accompanied by an effort level of 1.0 for all years. Survey data from 1983-1989 were taken as indices of the stock for the corresponding years. Tuning data are shown in Table 4.5.3. Catchability estimates (logged) at age are given in Table 4.5.4. Sigma values for age groups 1-3 are around 0.2 but for age groups 4-6 between 0.5-0.8.

Results from the VPA based on the tuning are given in Table 4.5.5. A separable VPA with a terminal selection value of 1.3, a terminal F of 0.085, and a reference age of 3 was performed. The resulting fishing mortalities show high values (about 0.45) up to 1980 and were thereafter at a level of about 0.15 (Table 4.5.7).

Spawning stock biomass declined to just below 100,000 t in 1981 but then increased and appears now to have reached its former level of 600,000 t. Terminal populations were used for determining the fishing mortalities shown in Table 4.5.7 and Figure 4.5.2A; stock sizes are given in Table 4.5.8 and Figure 4.5.2B.

4.5.5 Recruitment and catch prediction

Both the 1988 and 1989 year classes are thought to be above average. The value for the 1988 year class in the VPA was, however, regarded as too high, and the mean level of the good year classes 1982 and 1986 (56×10^9) was used for both year classes in the prediction. The long-term average (27.1×10^9) was used for the 1991 year class.

The prediction was made with a continuation of the 1989 exploitation pattern in 1990 and with mean weights taken as the 1984-1989 average (Tables 4.5.9- 4.5.11). The status quo catches are 82,000 t in 1990 and 99,000 t in 1991.

The predicted status quo catches for 1990 and 1991 were distributed on sub-areas according to catch in numbers and mean weights in these areas (Tables 4.5.12 and Figure 4.5.2D).

5 EFFORT AND CPUE

Effort and CPUE data from the herring fisheries have been partly revised for 1988 (Table 5.1), and collected for 1989 (Table 5.2).

Polish CPUE data were standardized using GLM model, where type of cutter, gear, month, year, and area effects were taken into account. The model explained 75-80% of the CPUE variation.

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Table 3.1.1 HERRING catches in the Baltic Sea by countries and sub-divisions, 1987 and 1988 (t). By-catch of sprat in directed herring fisheries excluded and by-catch of herring in sprat fisheries included. (Data as reported to the Working Group.)

Year and country	Total catch	Sub-divisions											
		22	23	24	25	26	27	28	29S	29N	30	31	32
1988													
Denmark	43,971	23,987	102	9,088	10,794	-	-	-	-	-	-	-	-
Finland	91,122	-	-	-	-	-	115	1,869	1,600	35,424	24,478	8,501	19,135
German Dem. Rep	53,456	-	-	49,488	3,866	102	-	-	-	-	-	-	-
Germany, Fed. Rep.	5,188	4,937	-	251	-	-	-	-	-	-	-	-	-
Poland	63,746	-	-	6,590	36,777	20,379	-	-	-	-	-	-	-
Sweden	41,540	-	117	4,586	16,941	24	14,366	1,319	100	648	3,172	267	-
USSR	122,849	-	-	-	9,051	26,767	4,795	36,673	22,423	-	-	-	23,140
Total	421,872	28,924	219	70,003	77,429	47,272	19,276	39,861	24,123	36,072	27,650	8,768	42,275
1989													
Denmark	30,571	15,419	1,528	6,311	7,313	-	-	-	-	-	-	-	-
Finland	83,170	-	-	-	-	-	450	1,586	1,692	30,799	26,989	3,783	17,871
German Dem. Rep	54,827	366	-	50,841	2,302	357	96	865	-	-	-	-	-
Germany, Fed. Rep.	5,166	4,943	-	223	-	-	-	-	-	-	-	-	-
Poland	60,278	-	-	8,524	33,602	18,152	-	-	-	-	-	-	-
Sweden	66,499	-	102	6,327	10,676	146	35,552	1,263	84	675	3,242	432	-
USSR	121,784	-	-	-	8,756	21,495	5,858	40,164	27,127	-	-	-	18,384
Total	422,295	20,728	1,630	72,226	70,649	40,150	41,956	43,878	28,903	31,474	30,231	4,215	36,255

Table 3.1.2 Separation of length distributions of HERRING (age 2) from acoustic survey into mean lengths and proportions in total distribution by Sub-division.

Sub-division	1983	1984	1985	1986
24a	18.0, 22.5	22	21 , 24	16 , 20 , 23
24b	0.07, 0.93	1.00	0.43, 0.07	0.02, 0.80, 0.1?
25a	18.5 , 21.5	18 , 22	17 , 20 , 23.5	17.5, 20
25b	0.14, 0.86	0.40, 0.59	0.18, 0.76, 0.06	0.47, 0.53
26a	17 , 19 , 21	16 , 20	14 , 17 , 19.5, 23	16 , 19
26b	0.40, 0.10, 0.50	0,24, 0.76	0.16, 0.54, 0.28, 0.02	0.14, 0.86
27a	-	17 , 22	16.5, 18	16.5, 18.5
27b	-	0.97, 0.03	0.86, 0.14	0.96, 0.04
28a	15.5, 18	15 , 16.5, 21	14 , 16 , 18	16.5, 18.5
28b	0.58, 0.42	0.52, 0.44, 0.04	0.31, 0.63, 0.06	0.67, 0.33
29a	15 , 17.5	15.5	15 , 16 , 20	16.5
29b	0.21, 0.79	0.91	0.61, 0.38, 0.01	1.00

a - mean length.
b - proportions in total distribution.

Table 3.2.1 HERRING, catch in tonnes in Sub-divisions 22 and 24, as reported to the Working Group.

Country	1978	1979	1980	1981	1982	1983
Denmark	12,383	9,659	7,221	8,098	4,583	4,583
German Democratic Republic	40,678	46,749	58,501	54,501	50,739	50,739
Germany, Fed. Rep.	6,849	6,672	9,323	8,300	8,300	8,300
Poland	6,335	10,276	13,605	13,366	16,868	16,868
Sweden	6,550	10,151	12,010	7,660	6,536	6,536
Total	72,795	85,543	100,337	90,159	107,519	108,103

Country	1984	1985	1986	1987	1988	1989
Denmark	23,762	15,942	14,046	32,462	33,075	21,730
German Democratic Republic	49,022	46,749	51,180	47,267	49,488	51,207
Germany, Fed. Rep.	7,085	7,888	8,850	5,806	5,188	5,166
Poland	14,250	16,721	12,344	7,997	6,590	8,524
Sweden	7,689	11,373	5,946	7,814	4,586	6,327
Total	101,808	101,870	92,066	101,346	98,927	92,954

Table 3.2.2 HERRING, catch in tonnes in Sub-division 23, as reported to the Working Group.

Country	1978	1979	1980	1981	1982	1983
Denmark	4,090	8,817	6,313	8,098	7,139	4,583
Sweden	1,000	1,860	2,400	2,000	2,460	2,416
Total	5,091	10,677	8,713	10,098	9,599	6,999

Country	1984	1985	1986	1987	1988	1989
Denmark	6,935	6,849	1,490	754	102	1,528
Sweden	800	1,113	1,365	172	117	102
Total	7,735	7,962	2,855	926	219	1,630

Table 3.2.3 HERRING, catch in tonnes in Division IIIa (data from Anon., 1990c).

Country	1978	1979	1980	1981	1982	1983
			Skagerrak			
Denmark	7,753	8,729	22,811	45,525	43,328	54,102
Faroe Islands	1,041	817	526	900	715	1,980
Germany, Fed. Rep.	28	181	-	199	43	40
Norway	4,131	4,719	4,145	7,230	11,700	3,334
Sweden	11,551	8,140	10,701	30,274	24,859	35,176
Sub-total	25,504	22,586	38,183	83,876	80,645	94,632
			Kattegat			
Denmark	29,241	21,337	25,380	48,922	38,609	62,901
Sweden	35,193	25,272	18,260	38,871	38,892	40,463
Sub-total	64,434	46,609	43,640	87,833	77,501	103,364
Division IIIa total	88,938	69,195	81,823	171,601	158,146	197,996

Country	1974	1975	1986	1987	1988	1989
			Skagerrak			
Denmark	64,421	88,192	94,014	105,017	144,421	47,393
Faroe Islands	891	455	520	-	-	-
Germany, Fed. Rep.	-	-	11	-	-	-
Norway	1,494	4,425	1,537	1,209	5,674	1,605
Sweden	59,195	40,349	42,996	51,184	57,159	39,756
Sub-total	126,201	133,421	139,078	157,410	207,254	88,754
			Kattegat			
Denmark	71,359	69,235	37,419	46,603	76,175	57,130
Sweden	35,027	39,829	35,852	29,844	49,653	26,159
Sub-total	106,386	109,064	73,271	76,447	125,828	83,289
Division IIIa total	232,587	242,485	212,349	233,931	333,082	172,043

Table 3.2.4 HERRING. Catch by half-year and total annual catch of 2 years and older spring spawning herring in Sub-divisions 22-24 and Division IIIa.

Year	1st half-year	2nd half-year	Total
1975	58,593	31,433	106,219
1976	56,426	26,974	85,567
1977	56,426	32,248	88,841
1978	84,678	39,510	124,196
1979	77,442	46,085	123,527
1980	87,487	55,173	142,660
1981	91,930	66,047	157,977
1982	82,233	68,442	150,675
1983	95,586	56,245	151,831
1984	104,931	86,361	191,292
1985	136,856	73,913	210,769
1986	116,299	47,588	163,887
1987	102,910	41,242	144,152
1988	120,851	108,617	230,223
1989	113,104	68,970	182,074

Table 3.2.5 HERRING. Estimated catch at age (millions) and mean weight at age (g) of spring spawners in Sub-divisions 22-24 and Division IIIa in 1989. Transfers from the North Sea are included.

Age	Sub-divisions 22-24		Division IIIa		Total	
	N	W	N	W	N	W
			1st half-year			
0	-	-	-	-	-	-
1	549.8	14.2	-	-	549.8	14.2
2	253.9	42.1	230.3	41.4	484.2	41.8
3	351.0	70.9	317.3	73.5	668.3	71.6
4	227.1	107.8	52.1	102.4	279.2	106.8
5	53.3	128.3	11.5	124.5	64.8	127.6
6	28.1	136.1	3.9	158.0	32.0	138.8
7	9.2	151.7	1.4	194.6	10.6	154.9
8+	2.3	159.2	0.3	195.1	2.6	163.4
			2nd half-year			
0	129.7	13.5	-	-	129.7	13.5
1	155.7	26.4	447.8	36.4	603.5	33.8
2	31.6	65.4	267.4	69.5	299.0	69.0
3	31.2	84.1	186.4	92.8	217.6	91.5
4	12.3	102.6	63.1	144.7	75.4	137.9
5	3.8	93.7	18.5	168.0	22.3	155.4
6	3.4	85.4	9.8	170.5	13.2	148.6
7	1.2	100.7	4.0	186.8	5.2	167.0
8+	1.6	106.3	2.0	209.3	3.6	163.5

Table 3.2.5.1 SUM OF PRODUCTS CHECK.

HERRING IN FISHING AREAS 22 AND 24
CATEGORY: TOTAL

CATCH IN NUMBERS UNIT: millions

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	14	23	19	25	31	91	256	89	60	204	84	40
1	176	175	299	165	340	466	438	1310	703	239	253	110
2	270	135	50	44	62	150	258	156	426	447	197	302
3	238	122	161	152	244	185	201	228	231	332	625	279
4	67	78	168	227	227	200	105	128	59	87	115	211
5	40	50	124	119	65	123	52	43	17	8	23	52
6	18	68	41	37	13	45	26	18	7	4	7	17
7	5	57	8	24	3	18	11	6	4	3	2	4
8+	2	19	3	4	2	2	4	4	5	1	1	4
TOTAL	829	726	872	797	987	1279	1349	1981	1512	1325	1305	1018

	1982	1983	1984	1985	1986	1987	1988	1989
0	99	100	58	159	313	771	611	179
1	391	475	335	243	280	1090	861	682
2	245	334	334	312	131	221	364	285
3	496	361	292	416	404	220	363	386
4	124	290	182	218	280	311	142	244
5	70	35	144	97	94	97	119	59
6	15	12	22	25	21	28	34	34
7	4	2	7	4	6	8	10	11
8+	3	3	2	5	3	4	6	4
TOTAL	1447	1612	1376	1479	1532	2750	2510	1884

Table 3.2.5.2 SUM OF PRODUCTS CHECK.

HERRING IN FISHING AREAS 22 AND 24
CATEGORY: TOTAL

MEAN WEIGHT AT AGE IN THE CATCH UNIT: gram

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	13.40	13.40
1	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	25.80	25.80
2	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	62.30	62.30
3	95.00	95.00	95.00	95.00	95.00	95.00	95.00	95.00	95.00	95.00	90.50	90.50
4	125.00	125.00	125.00	125.00	125.00	125.00	125.00	125.00	125.00	125.00	135.80	135.80
5	155.00	155.00	155.00	155.00	155.00	155.00	155.00	155.00	155.00	155.00	156.50	156.50
6	187.00	187.00	187.00	187.00	187.00	187.00	187.00	187.00	187.00	187.00	187.00	187.00
7	210.00	210.00	210.00	210.00	210.00	210.00	210.00	210.00	210.00	210.00	214.60	214.60
8+	223.00	223.00	223.00	223.00	223.00	223.00	223.00	223.00	223.00	223.00	236.70	226.20

	1982	1983	1984	1985	1986	1987	1988	1989
0	12.30	13.50	12.20	15.00	9.10	11.70	11.00	14.15
1	27.20	22.50	33.70	30.00	17.60	15.70	16.90	17.52
2	62.60	65.00	56.00	47.00	44.10	34.80	29.10	43.62
3	93.20	95.40	93.50	88.00	68.20	76.70	83.80	70.53
4	127.60	121.10	120.30	119.00	110.80	98.40	108.50	105.85
5	149.30	154.10	143.20	137.00	143.80	121.90	124.80	122.00
6	177.60	176.30	165.10	159.00	172.20	141.40	142.20	125.46
7	199.20	197.90	211.20	181.00	177.30	151.40	143.70	137.80
8+	212.50	265.80	251.50	133.00	184.40	163.40	135.80	131.52

Table 3.2.5.3

Analysis by RCRTINX2 of data from file RECRUIT-1
SD'22&24, 1-GROUP RECRUITING POST 1977

Data for 3 surveys over 13 years
REGRESSION TYPE = C
TAPERED TIME WEIGHTING APPLIED
POWER = 3 OVER 20 YEARS
PRIOR WEIGHTING NOT APPLIED
FINAL ESTIMATES SHRUNK TOWARDS MEAN
ESTIMATES WITH S.E.'S GREATER THAN THAT OF MEAN INCLUDED
MINIMUM S.E. FOR ANY SURVEY TAKEN AS .20
MINIMUM OF 5 POINTS USED FOR REGRESSION

Yearclass = 1983

Survey/ Series	Index Value	Slope	Inter- cept	Rsquare	No. Pts	Predicted Value	Sigma	Standard Error	Weight
IYFS 2	7.5326	.415	5.161	.9694	5	8.2874	.05686	.07305	.60467
GDRYF0	5.3149	-.600	9.804	.0875	6	6.6131	1.02061	1.28211	.01471
GDRYF1	1.3584	1.463	6.165	.2740	6	8.1526	.51437	.56194	.07659
MEAN						7.9655	.28206	.28206	.30402

Yearclass = 1984

Survey/ Series	Index Value	Slope	Inter- cept	Rsquare	No. Pts	Predicted Value	Sigma	Standard Error	Weight
IYFS 2	7.3544	.395	5.285	.9686	6	8.1891	.05556	.06336	.59036
GDRYF0	4.6298	-2.788	17.486	.0034	7	4.5808	5.11421	5.69129	.00073
GDRYF1	1.2613	1.504	6.123	.2860	7	8.0204	.47364	.50714	.09182
MEAN						8.0015	.27290	.27290	.31709

Yearclass = 1985

Survey/ Series	Index Value	Slope	Inter- cept	Rsquare	No. Pts	Predicted Value	Sigma	Standard Error	Weight
IYFS 2	7.9800	.640	3.515	.4342	7	8.6214	.35914	.45452	.25015
GDRYF0	4.9273	-1.025	11.618	.0314	8	6.5674	1.74285	1.93787	.01376
GDRYF1	1.3056	2.038	5.403	.2065	8	8.0636	.61555	.65559	.12024
MEAN						7.9502	.28968	.28968	.61585

Yearclass = 1986

Survey/ Series	Index Value	Slope	Inter- cept	Rsquare	No. Pts	Predicted Value	Sigma	Standard Error	Weight
IYFS 2	8.9664	.548	4.097	.4645	8	9.0073	.32114	.47186	.23703
GDRYF0	5.2101	-1.998	15.480	.0081	9	5.0707	3.28550	3.65195	.00396
GDRYF1	2.0744	2.106	5.327	.2041	9	9.6948	.58716	.86415	.07067
MEAN						7.9717	.27689	.27689	.68834

cont'd.

Table 3.2.5.3 cont'd.

Yearclass = 1987

Survey/ Series	Index Value	Slope	Inter- cept	Rsquare	No. Pts	Predicted Value	Sigma	Standard Error	Weight
IYFS 2									
GDRYF0	4.5506	6.517	-17.691	.0008	10	11.9648	10.39318	11.03659	.00047
GDRYF1	1.3218	1.364	6.168	.2760	10	7.9706	.47243	.49731	.23215
MEAN						8.0009	.27353	.27353	.76738

Yearclass = 1988

Survey/ Series	Index Value	Slope	Inter- cept	Rsquare	No. Pts	Predicted Value	Sigma	Standard Error	Weight
IYFS 2	8.0687	.413	4.973	.4882	9	8.3085	.30301	.33394	.32914
GDRYF0	4.7883	19.701	-71.584	.0001	11	22.7519	29.16316	31.03771	.00004
GDRYF1	1.1939	1.431	6.058	.2629	11	7.7669	.47074	.49815	.14791
MEAN						7.9823	.26494	.26494	.52291

Yearclass = 1989

Survey/ Series	Index Value	Slope	Inter- cept	Rsquare	No. Pts	Predicted Value	Sigma	Standard Error	Weight
IYFS 2									
GDRYF0	5.2553	******	381.333	.0000	12	-91.4885	123.93578	134.07904	.00000
GDRYF1									
MEAN						7.9705	.25330	.25330	1.00000

Yearclass	Weighted Average Prediction		Internal Standard Error	External Standard Error	Virtual Population Analysis		Ext.SE/ Int.SE
1983	8.15	3479.23	.16	.14	8.21	3682.00	.88
1984	8.11	3332.49	.15	.08	7.60	1999.00	.49
1985	8.11	3336.60	.23	.20	8.14	3413.00	.86
1986	8.33	4136.07	.23	.35	8.24	3786.00	1.53
1987	8.00	2968.35	.24	.06	7.80	2444.00	.26
1988	8.06	3160.18	.19	.12	7.85	2560.00	.64
1989	7.97	2893.14	.25	.19			.74

Table 3.2.5.4 HERRING in Sub-divisions 22 and 24. 70-89 onages 1 to 7 with Terminal F of .500 on age 3 and Terminal S of 2.000.

Matrix of Residuals

Years / Ages	70/71	71/72	72/73	73/74	74/75	75/76	76/77	77/78	78/79
1/ 2	-.060	.915	1.539	.193	.743	-.100	.515	.063	-.573
2/ 3	1.450	.457	-.548	-1.551	-.278	-.082	.478	-.526	.187
3/ 4	1.174	-.308	-.457	-.902	.305	-.036	-.043	.361	.180
4/ 5	-.022	-.845	-.203	.286	.247	.183	-.195	.375	.645
5/ 6	-1.157	-.517	.298	.858	-.345	-.027	-.432	-.234	-.350
6/ 7	-1.693	1.477	-.298	1.145	-.923	-.092	-.019	-.420	-.750
	.000	.000	.000	.000	.000	.000	.000	.000	.000
WTS	.100	.100	.100	.100	.100	.100	.100	.100	.100

Years / Ages	79/80	80/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88	88/89		WTS
1/ 2	-.444	-.586	-1.353	-.706	-.127	-.555	-.086	-.295	.499	.435	.000	.497
2/ 3	-.013	.180	-.119	-.294	.594	.094	-.014	-.116	-.163	.205	.000	.568
3/ 4	.707	.926	.460	-.089	.448	-.113	-.073	-.047	.039	-.079	.000	.688
4/ 5	.543	.179	.260	.144	-.002	-.265	-.113	.273	.060	-.114	.000	1.000
5/ 6	-.930	-.661	.043	.248	-.600	.477	.194	.056	-.237	-.109	.000	.679
6/ 7	-.363	-.379	.285	.568	-.370	.515	.176	-.143	-.174	-.192	.000	.469
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	-1.226	
WTS	.100	.100	.100	.100	.100	1.000	1.000	1.000	1.000	1.000		

Fishing Mortalities (F)

	70	71	72	73	74	75	76	77	78	79
F-values	.2237	.2762	.3499	.4327	.3592	.6282	.6375	.7963	.5771	.3956

	80	81	82	83	84	85	86	87	88	89
F-values	.3806	.4669	.5113	.4063	.4678	.4723	.4390	.4852	.5098	.5000

Selection-at-age (S)

	1	2	3	4	5	6	7
S-values	.4563	.3992	1.0000	1.6115	2.0366	1.9490	2.0000

Table 3.2.5.5 VIRTUAL POPULATION ANALYSIS.

HERRING IN FISHING AREAS 22 AND 24

FISHING MORTALITY COEFFICIENT UNIT: Year-1 NATURAL MORTALITY COEFFICIENT = .30

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	.110	.114	.213	.176	.301	.386	.355	.562	.241	.166	.091	.056
2	.262	.127	.048	.048	.102	.234	.434	.231	.405	.265	.224	.167
3	.416	.202	.246	.224	.462	.560	.643	1.016	.718	.734	.833	.644
4	.258	.262	.529	.745	.689	1.021	.853	1.431	.950	.756	.708	.898
5	.266	.355	.987	1.071	.562	1.259	.965	1.322	.880	.361	.512	.982
6	.143	1.156	.628	1.154	.348	1.187	1.238	1.343	.861	.652	.622	1.060
7	.444	1.014	.444	1.177	.317	1.313	1.374	1.642	1.528	1.368	.922	1.168
8+	.444	1.014	.444	1.177	.317	1.313	1.374	1.642	1.528	1.368	.922	1.168
(1- 6)U	.242	.369	.442	.570	.411	.775	.748	.984	.676	.489	.498	.635
(2- 6)U	.269	.421	.488	.649	.433	.852	.826	1.068	.763	.554	.580	.750

	1982	1983	1984	1985	1986	1987	1988	1989	1980-87
1	.176	.177	.125	.182	.134	.347	.401	.290	.161
2	.190	.251	.203	.182	.157	.165	.208	.250	.192
3	.509	.532	.409	.472	.427	.484	.503	.399	.539
4	.780	.737	.647	.703	.787	.797	.771	.885	.757
5	1.046	.601	1.275	1.046	.894	.818	.985	1.055	.897
6	1.009	.566	1.172	.940	.783	.865	.911	1.015	.877
7	.956	.393	.807	.803	.709	.989	1.085	1.097	.843
8+	.956	.393	.807	.803	.709	.989	1.085	1.097	.843
(1- 6)U	.618	.477	.639	.588	.530	.579	.630	.649	
(2- 6)U	.707	.537	.741	.669	.610	.626	.675	.721	

Table 3.2.5.6 VIRTUAL POPULATION ANALYSIS.

HERRING IN FISHING AREAS 22 AND 24

STOCK SIZE IN NUMBERS UNIT: millions

BIOMASS TOTALS UNIT: tonnes

ALL VALUES, EXCEPT THOSE REFERRING TO THE SPAWNING STOCK ARE GIVEN FOR 1 JANUARY; THE SPAWNING STOCK DATA REFLECT THE STOCK SITUATION AT SPAWNING TIME, WHEREBY THE FOLLOWING VALUES ARE USED: PROPORTION OF ANNUAL F BEFORE SPAWNING: .100
PROPORTION OF ANNUAL M BEFORE SPAWNING: .250

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	1958	1874	1788	1181	1501	1669	1680	3476	3786	1799	3349	2330
2	1349	1300	1239	1070	734	823	841	873	1468	2205	1129	2265
3	800	769	848	874	756	491	482	403	513	725	1253	668
4	338	391	466	492	518	353	208	188	108	185	258	403
5	195	193	223	203	173	193	94	66	33	31	64	94
6	157	111	100	61	52	73	41	27	13	10	16	29
7	16	101	26	40	14	27	16	9	5	4	4	6
8+	5	33	8	6	8	4	5	5	8	1	3	7
TOTAL NO	4819	4772	4698	3927	3755	3632	3367	5046	5934	4962	6075	5802
SPS NO	1635	1696	1707	1629	1393	1130	903	792	987	1450	1489	1734
TOT.BIOM	294654	309148	302341	280213	245796	216751	175874	187954	221304	261019	319682	339488
SPS BIOM	172561	186026	180123	171533	150763	122720	89954	74752	81902	117179	138101	155485

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1980-87
1	2787	3370	3296	1681	2580	4267	2988	3113	0	2957
2	1632	1731	2091	2156	1038	1672	2235	1483	1726	1714
3	1420	1000	998	1264	1331	657	1050	1345	855	1074
4	260	632	435	491	584	643	300	470	669	463
5	122	88	224	169	180	197	215	103	144	142
6	26	32	36	46	44	55	64	59	27	35
7	7	7	13	8	13	15	17	19	16	9
8+	5	11	5	10	7	7	10	8	7	7
TOTAL NO	6260	6870	7098	5826	5777	7512	6879	6600		
SPS NO	1912	1942	2044	2256	1959	1815	2047	1995		
TOT.BIOM	356217	382050	378687	314274	229580	268622	275843	287495		
SPS BIOM	164042	173430	172127	183342	135840	141329	142496	146960		

Table 3.2.6.1 Acoustic estimates of HERRING number (in millions) at age in August-October 1989.

Age group	A Spring spawn.herring Division IIIa + eastern part of Sub-division IV	B[1] Sub-divisions 23-24. Swedish & German Dem.Rep. survey	C Sub-divisions 22-24. Germany, Fed.Rep. & Denmark survey. For Sub-divs. 23-24 only depth <20 included	D Sub-divisions 23-24. Germany, Fed.Rep. & Denmark survey. Depth > 20 m	E = Mean of B and D	Total Western Baltic Division IIIa herring stock A + C + E
0	-	614	7,715	6,676	3,645	11,360
1	-	279	2,535	1,002	641	3,176
2	1,105	188	80	203	196	1,381
3	714	155	10	148	152	876
4	317	105.3	0	33	69	386
5	81	23.4	0	0	12	93
6	54	4.4	0	0	2.2	56.2
7	16	3.1	0	0	1.6	17.6
8+	4.2	0.6	0	0	0.3	4.5
Total 2+	2,289					2,814
Biomass (t)	255,500					

[1] Figures raised by 3210/3085 because the estimate was considered to represent depths below 20 m (area = 3210 nm^2) and the area of the covered part of the Sub-division 24 was only 3085 nm^2.

Table 3.2.6.2 VIRTUAL POPULATION ANALYSIS.

HERRING IN THE WESTERN BALTIC AND KATTEGAT. 1980-1989 includes estimated numbers of spring spawners 0- and 1-groups in Division IIIa.

CATCH IN NUMBERS UNIT: millions

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
0	31	91	256	89	60	204	296	2033	1032	1709	555	1173
1	340	466	438	1310	703	239	636	651	1101	1777	2101	1035
2	438	301	585	488	931	1074	494	1005	572	850	1207	849
3	379	242	229	291	586	440	908	467	779	485	521	844
4	274	257	110	140	70	105	143	277	150	348	235	353
5	91	138	55	50	19	13	25	58	84	39	162	100
6	22	51	27	21	8	4	7	18	18	14	24	35
7	6	19	11	7	4	3	2	4	4	2	8	7
8+	3	2	4	4	5	1	2	4	3	3	2	6
TOTAL	1584	1567	1715	2400	2386	2083	2513	4517	3743	5227	4815	4410

	1986	1987	1988	1989
0	1053	771	611	130
1	1020	1440	861	1153
2	468	988	2443	783
3	611	388	928	886
4	390	394	205	355
5	123	125	152	87
6	28	37	41	45
7	10	10	11	16
8+	3	4	6	6
TOTAL	3706	4156	5258	3461

Table 3.2.6.3 VIRTUAL POPULATION ANALYSIS.

HERRING IN THE WESTERN BALTIC AND KATTEGAT

MEAN WEIGHT AT AGE OF THE STOCK   UNIT: gram

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
0	9.000	9.000	9.000	9.000	9.000	9.000	13.400	13.400	12.000	12.000	12.000	12.000
1	16.000	16.000	16.000	16.000	16.000	16.000	25.800	25.800	29.000	29.000	29.000	14.000
2	76.300	59.080	59.570	61.240	58.430	61.720	63.190	64.010	63.310	60.390	63.370	62.860
3	111.000	94.190	93.380	96.320	94.050	92.290	96.620	96.320	100.610	97.030	106.680	108.410
4	137.200	127.190	126.650	126.710	126.580	126.500	126.630	127.190	127.500	128.400	131.890	136.390
5	172.900	146.850	146.620	148.090	146.350	147.070	145.980	146.830	149.420	147.070	147.590	153.730
6	209.000	167.950	166.890	168.720	169.140	169.140	170.380	168.170	172.030	167.900	172.410	173.030
7	236.200	190.620	190.440	191.090	190.840	191.390	189.290	190.870	190.870	192.440	204.490	200.140
8+	240.800	192.610	183.870	183.870	185.620	192.610	192.610	183.870	180.960	180.960	197.210	194.720

	1986	1987	1988	1989
0	9.170	11.780	11.000	13.500
1	13.000	12.800	16.900	24.500
2	72.560	51.990	45.200	52.200
3	91.260	80.290	71.700	76.500
4	120.690	99.910	101.000	113.400
5	152.000	127.070	124.800	134.700
6	177.390	144.620	144.400	141.700
7	184.100	157.800	145.700	160.000
8+	199.780	166.420	135.800	163.700

Table 3.2.6.4 Analysis by RCRTINX2 of data from file RECBAL:SYMB.

WESTERN BALTIC AND DIV IIIA HERRING RECRUITMENT INDICES.

```
Data for     4 surveys over    13 years
REGRESSION TYPE = C
TAPERED TIME WEIGHTING APPLIED
POWER =     1 OVER  20 YEARS
PRIOR WEIGHTING NOT APPLIED
FINAL ESTIMATES SHRUNK TOWARDS MEAN
ESTIMATES WITH S.E.'S GREATER THAN THAT OF MEAN    INCLUDED
MINIMUM S.E. FOR ANY SURVEY TAKEN AS        .20
MINIMUM OF    5 POINTS USED FOR REGRESSION
```

Yearclass = 1986

Survey/ Series	Index Value	Slope	Inter- cept	Rsquare	No. Pts	Predicted Value	Sigma	Standard Error	Weight
IYFS 2	8.9664	.707	2.817	.3850	8	9.1578	.45130	.68737	.14263
GDR 0	5.2101	1.617	1.022	.0524	8	9.4461	1.51763	1.78727	.02110
GDR 1	2.0744	2.773	4.357	.1614	9	10.1101	.78060	1.23467	.04421
ACOUST	7.3218	1.793	-4.749	.1857	9	8.3766	.71701	.79400	.10689
MEAN						7.8409	.31361	.31361	.68518

Yearclass = 1987

Survey/ Series	Index Value	Slope	Inter- cept	Rsquare	No. Pts	Predicted Value	Sigma	Standard Error	Weight
IYFS 2	.6931	.523	4.090	.6504	9	4.4522	.32907	.96769	.07286
GDR 0	4.5506	1.060	3.320	.1913	9	8.1429	.92280	.98837	.06984
GDR 1	1.3218	1.436	5.982	.4911	10	7.8798	.43556	.46313	.31808
ACOUST	7.0085	2.082	-6.767	.2363	10	7.8234	.76931	.81849	.10184
MEAN						7.9372	.39494	.39494	.43739

Yearclass = 1988

Survey/ Series	Index Value	Slope	Inter- cept	Rsquare	No. Pts	Predicted Value	Sigma	Standard Error	Weight
IYFS 2	8.0687	.320	5.823	.2279	10	8.4060	.77954	.84862	.09820
GDR 0	4.7883	1.167	2.789	.1648	10	8.3779	.95353	1.02926	.06675
GDR 1	1.1939	1.489	5.888	.4799	11	7.6654	.42445	.45495	.34166
ACOUST									
MEAN						7.9101	.37859	.37859	.49339

Yearclass = 1989

Survey/ Series	Index Value	Slope	Inter- cept	Rsquare	No. Pts	Predicted Value	Sigma	Standard Error	Weight
IYFS 2									
GDR 0	5.2553	1.178	2.735	.1630	10	8.9266	.97269	1.11504	.10465
GDR 1									
ACOUST									
MEAN						7.9114	.38122	.38122	.89535

Yearclass		Weighted Average Prediction	Internal Standard Error	External Standard Error	Virtual Population Analysis		Ext.SE/ Int.SE
1986	8.22	3715.10	.26	.32	8.58	5348.00	1.24
1987	7.67	2138.37	.26	.45	7.70	2210.00	1.73
1988	7.91	2714.65	.27	.14			.53
1989	.02	3034.12	.36	.31			.86

Table 3.2.6.5 The catch (millions) of HERRING in Division IIIa and Sub-divisions 22-24 taken before the acoustic survey.

Year	Area	Age							
		2	3	4	5	6	7	8	9+
1987	Sub-divisions 22-24	203	227	322	105	29.6	9.3	4.2	-
1987	Division IIIa	519	131	60	19	6.8	0.7	0.0	-
Total		722	358	382	124	36.4	10.0	4.2	-
1988	Sub-divisions 22-24	323	329	130	109	30.4	8.7	4.6	-
1988	Division IIIa	1283	421	48	23	6.0	1.0	0.0	
Total		1606	750	178	132	36.4	9.7	4.6	-
1989	Sub-divisions 22-24	254	352	229	54	29.1	9.8	2.1	0.6
1989	Division IIIa	328	377	77	19	8.4	3.3	2.1	0.1
Total		582	729	306	73	37.5	13.1	4.2	0.7

Table 3.2.6.6 The corrected acoustic estimates (in millions) arrived at by assuming that the acoustic survey is conducted at 1 October, that the catches taken before the survey (see Table 3.2.6.3) are taken at the mid-date between 1 January and 1 October, that M=0.075 from 1 January to this mid-date, and also from the mid-date to 1 October.

	Age							
Year	2	3	4	5	6	7	8	9+
1987	2,824	1,476	813	278	92	18.8	-	-
1988	4,925	2,371	477	309	95	39.8	-	-
1989	2,232	1,803	778	187	106	34.6	10.5	-

Table 3.2.6.7 Tuning file for Herring in Division IIIa and Sub-divisions 22-24.

```
HERRING DIV IIIA + 22-24, SPARHOLT 1989
101
ACOUS. EST. DIV IIIA
1987, 1989
1,1
2, 7
1,2824,1476,813,278.4,91.5,18.8
1,4925,2371,477,309,95,39.8
1,2232,1803,778,187,106,34.6,10.5
```

Table 3.2.6.8 Tuning results for herring in Division IIIa and Sub-divisions 22-24.

DISAGGREGATED Qs
LOG TRANSFORMATION
NO explanatory variate (Mean used)
Fleet 1 ,ACOUS. EST. DIV IIIA, has terminal q estimated as the mean
FLEETS COMBINED BY ** VARIANCE **

Regression weights
, .348, .893, 1.000,
Oldest age F = 1.000*average of 3 younger ages. Fleets combined by variance of predictions
Fishing mortalities

Age,	87,	88,	89,
2,	.389,	.895,	.553,
3,	.603,	.780,	1.020,
4,	.830,	.760,	.802,
5,	.857,	.938,	.889,
6,	.935,	.785,	.828,
7,	.874,	.828,	.840,

Log catchability estimates

Age 2

Fleet,	87,	88,	89
1 ,	.11,	.59,	.46

SUMMARY STATISTICS

Fleet ,	Pred. q ,	SE(q),	Partial, F ,	Raised, F ,	SLOPE ,	SE Slope ,	INTRCPT,	SE Intrcpt
1 ,	.45 ,	.206,	1.5758 ,	.5528,	.000E+00,	.000E+00,	.455,	.115

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.553	.206	0.000	.206	0.000

Age 3

Fleet,	87,	88,	89
1 ,	.83,	.69,	.73

cont'd.

Table 3.2.6.8 cont'd.

SUMMARY STATISTICS

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	.73	.060	2.0741	1.0192	.000E+00	.000E+00	.730	.033

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
1.019	.600E-01	0.000	.600E-01	0.000

Age 4

Fleet	87	88	89
1	.54	.57	.56

SUMMARY STATISTICS

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	.56	.014	1.7548	.8007	.000E+00	.000E+00	.562	.008

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.801	.137E-01	0.000	.137E-01	0.000

Age 5

Fleet	87	88	89
1	.65	.65	.65

SUMMARY STATISTICS

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	.65	.001	1.9092	.8882	.000E+00	.000E+00	.647	.001

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.888	.144E-02	0.000	.144E-02	0.000

Age 6

Fleet	87	88	89
1	.84	.60	.67

cont'd.

Table 3.2.6.8 cont'd.

SUMMARY STATISTICS

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	.67	.102	1.9483	.8271	.000E+00	.000E+00	.667	.057

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.827	.102	0.000	.102	0.000

Table 3.2.6.9 VIRTUAL POPULATION ANALYSIS from tuning.

HERRING IN THE WESTERN BALTIC AND KATTEGAT

FISHING MORTALITY COEFFICIENT   UNIT: Year-1   NATURAL MORTALITY COEFFICIENT = .20

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
2	.561	.445	.762	.411	.708	.484	.422	.429	.380	.445	.473	.390
3	.616	.706	.730	1.169	1.325	.898	1.014	.918	.703	.647	.544	.721
4	.799	1.200	.841	1.572	1.059	.936	.863	1.062	.894	.810	.770	.902
5	.712	1.370	.939	1.297	1.017	.564	.603	1.125	1.201	.617	1.222	1.044
6	.524	1.221	1.216	1.282	.743	.610	.687	1.276	1.533	.648	1.015	1.005
7	.678	1.264	.999	1.384	.940	.703	.718	1.154	1.209	.692	1.002	.987
8+	.678	1.264	.999	1.384	.940	.703	.718	1.154	1.209	.692	1.002	.987
(2- 6)U	.642	.988	.897	1.146	.970	.698	.718	.962	.942	.634	.805	.813
(2- 5)U	.672	.930	.818	1.112	1.027	.720	.725	.884	.794	.630	.752	.765

	1986	1987	1988	1989
2	.371	.388	.894	.553
3	.542	.603	.779	1.019
4	.904	.830	.760	.801
5	.975	.857	.937	.888
6	.878	.935	.785	.827
7	.929	.874	.828	.840
8+	.929	.874	.828	.840
(2- 6)U	.734	.723	.831	.818
(2- 5)U	.698	.670	.843	.815

Table 3.2.6.10 HERRING in the western Baltic and Kattegat.

from 74 to 89 on ages 2 to 7
with Terminal F of .710 on age 3 and Terminal S of 1.300

Initial sum of squared residuals was 21.314 and
final sum of squared residuals is 7.867 after 66 iterations

Matrix of Residuals

Years / Ages	74/75	75/76	76/77	77/78	78/79
2/ 3	.610	-.371	.447	-1.004	-.067
3/ 4	.098	-.212	-.122	.196	.556
4/ 5	.112	.204	-.154	.386	.185
5/ 6	-.189	.064	-.189	-.025	-.177
6/ 7	-.532	.077	.303	-.073	-.643
	.000	.000	.000	.000	.000
WTS	.010	.010	.010	.010	.010

Years / Ages	79/80	80/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88	88/89		WTS
2/ 3	-.222	-.072	-.258	-.607	.361	.000	-.135	-.174	-.258	.579	.000	.445
3/ 4	.441	.750	.276	-.285	.312	-.278	-.003	-.226	.007	.205	.000	.617
4/ 5	.469	.176	.007	-.055	.081	-.185	-.019	.184	.027	-.204	.000	1.000
5/ 6	-.558	-.599	-.238	.160	-.398	.358	.061	.037	-.020	-.060	.000	.751
6/ 7	-.392	-.275	.203	.668	-.237	.154	.061	.010	.173	-.237	.000	.569
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	-.753	
WTS	.010	.010	.010	.010	.010	.010	1.000	1.000	1.000	1.000		

Fishing Mortalities (F)

	74	75	76	77	78	79
F-values	.5566	.8726	.7616	1.0706	.8966	.6289

	80	81	82	83	84	85	86	87	88	89
F-values	.6019	.8082	.7966	.5400	.6668	.6965	.6478	.6578	.7167	.7100

Selection-at-age (S)

	2	3	4	5	6	7
S-values	.6949	1.0000	1.2861	1.4339	1.3340	1.3000

Table 3.2.6.11 HERRING in Division IIIa and Sub-divisions 22-24. Estimated stock size at the time of the acoustic survey.

Stock size

Year	Acoustic estimate	F_3 0.60	0.65	0.70	0.71	0.72
1987	3,216	3,392	3,138	3,084	3,073	3,063
1988	4,551	4,846	4,634	4,450	4,418	4,385
1989	2,814	3,556	3,248	2,985	2,938	2,890

ssqs

Year	F_3 0.65	0.70	0.71	0.72
1987	6	17	20	23
1988	7	10	18	27
1989	188	29	15	6
Sum	201	56	53	56

Table 3.2.6.12 VPA

HERRING IN THE WESTERN BALTIC AND KATTEGAT

FISHING MORTALITY COEFFICIENT   UNIT: Year-1   NATURAL MORTALITY COEFFICIENT = .20

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
0	.014	.033	.058	.018	.024	.040	.082	.349	.139	.235	.149	.186
1	.288	.301	.222	.461	.187	.128	.167	.258	.324	.376	.506	.453
2	.564	.446	.763	.410	.705	.483	.421	.428	.379	.445	.474	.394
3	.618	.715	.734	1.174	1.320	.891	1.009	.916	.701	.646	.544	.726
4	.794	1.210	.862	1.601	1.071	.926	.846	1.047	.887	.805	.767	.903
5	.711	1.347	.962	1.401	1.082	.577	.590	1.070	1.152	.607	1.200	1.035
6	.528	1.215	1.146	1.382	.922	.703	.719	1.206	1.285	.589	.979	.953
7	.716	1.290	.985	1.139	1.192	1.173	.968	1.302	1.013	.446	.815	.899
8+	.716	1.290	.985	1.139	1.192	1.173	.968	1.302	1.013	.446	.815	.899
(2- 6)U	.643	.987	.893	1.194	1.020	.716	.717	.933	.881	.618	.793	.802

	1986	1987	1988	1989	1982-87	
0	.111	.174	.122	.166	.166	.018
1	.245	.217	.300	.353	.353	.373
2	.381	.397	.690	.491	.412	.436
3	.550	.629	.809	.582	.632	.669
4	.916	.854	.829	.872	.855	.905
5	.976	.884	1.006	1.098	.976	1.033
6	.860	.938	.843	.988	.934	.988
7	.814	.832	.833	.992	.803	.850
8+	.814	.832	.833	.992	.803	.800
(2- 6)U	.736	.740	.836	.806		

Table 3.2.6.13

HERRING IN THE WESTERN BALTIC AND KATTEGAT

STOCK SIZE IN NUMBERS   UNIT: millions

BIOMASS TOTALS   UNIT: tonnes

ALL VALUES, EXCEPT THOSE REFERRING TO THE SPAWNING STOCK ARE GIVEN FOR 1 JANUARY; THE SPAWNING STOCK DATA REFLECT THE STOCK SITUATION AT SPAWNING TIME, WHEREBY THE FOLLOWING VALUES ARE USED: PROPORTION OF ANNUAL F BEFORE SPAWNING: .100
PROPORTION OF ANNUAL M BEFORE SPAWNING: .250

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
0	2441	3060	5027	5622	2737	5796	4164	7569	8737	8952	4414	7593
1	1492	1970	2423	3885	4522	2187	4561	3142	4371	6223	5792	3114
2	1110	916	1194	1590	2006	3070	1575	3161	1987	2590	3500	2860
3	898	517	480	456	864	811	1551	846	1687	1113	1358	1783
4	[illegible]	396	207	189	115	189	273	463	277	685	478	645
5	[illegible]	261	97	72	31	32	61	96	133	94	251	182
6	59	76	43	30	14	9	15	28	27	34	42	62
7	13	28	19	11	6	5	4	6	7	6	16	[illegible]
8+	6	3	7	6	8	2	4	6	5	4	4	[illegible]
TOTAL NO	6758	7171	9497	11861	10305	12100	12206	15317	17231	19707	15654	16262
SPS NO	1475	1070	634	816	1035	1275	1576	1599	1849	1866	2196	2441
TOT.BIOM	355421	260968	252454	296945	319700	382814	470158	546191	589186	662660	698808	639206
SPS BIOM	186097	121077	85400	78877	91041	108451	153358	153158	186253	190278	229032	267337

	1986	1987	1988	1989	1990	1974-87
0	11067	5298	5866	935	0	5891
1	5160	8112	3643	4252	649	4068
2	1621	3307	5345	2209	2446	2178
3	1580	907	1821	2194	1107	1061
4	707	746	396	664	1004	423
5	214	232	260	141	227	135
6	53	66	78	78	39	40
7	20	18	21	28	24	12
8+	6	8	12	10	12	6
TOTAL NO	20427	18693	17442	10511		
SPS NO	2169	2081	2780	2618		
TOT.BIOM	562367	528697	586665	511414		
SPS BIOM	[illegible]	[illegible]	[illegible]	[illegible]		

Table 3.2.6.14

List of input variables for the ICES prediction program.

HERRING IN DIV IIIA AND 22-24
The reference F is the mean F for the age group range from 2 to 6

The number of recruits per year is as follows:

Year	Recruitment
1990	5891.0
1991	5891.0
1992	5891.0

Proportion of F (fishing mortality) effective before spawning: .1000
Proportion of M (natural mortality) effective before spawning: .2500

Data are printed in the following units:

Number of fish:	millions
Weight by age group in the catch:	gram
Weight by age group in the stock:	gram
Stock biomass:	tonnes
Catch weight:	tonnes

age	stock size	fishing pattern	natural mortality	maturity ogive	weight in the catch	weight in the stock
0	5891.0	.18	.20	.00	13.500	13.500
1	4973.0	.37	.20	.00	24.500	24.500
2	2715.0	.44	.20	.20	52.200	52.200
3	1107.0	.67	.20	.75	76.500	76.500
4	1004.0	.91	.20	.90	113.400	113.400
5	227.0	1.03	.20	1.00	134.700	134.700
6	39.0	.99	.20	1.00	141.700	141.700
7	24.0	.85	.20	1.00	160.000	160.000
8+	12.0	.85	.20	1.00	163.700	163.700

Table 3.2.6.15 HERRING in Division IIIa and Sub-divisions 22-24.
Analysis by RCRTINX2 data. VPA - 1 ringers.

Data for 2 surveys over 11 years
REGRESSION TYPE = C
TAPERED TIME WEIGHTING APPLIED
POWER = 3 OVER 20 YEARS
PRIOR WEIGHTING NOT APPLIED
FINAL ESTIMATES SHRUNK TOWARDS MEAN
ESTIMATES WITH S.E.'S GREATER THAN THAT OF MEAN INCLUDED
MINIMUM S.E. FOR ANY SURVEY TAKEN AS .20
MINIMUM OF 5 POINTS USED FOR REGRESSION

Yearclass = 1986

Survey/ Series	Index Value	Slope	Inter- cept	Rsquare	No. Pts	Predicted Value	Sigma	Standard Error	Weight
GDR0	9.8098	2.681	-15.373	.0148	7	10.9250	2.47283	2.88057	.00904
GDR1	6.5468	4.563	-16.974	.0230	7	12.8986	1.97902	2.92560	.00876
MEAN						8.4095	.27628	.27628	.98221

Yearclass = 1987

Survey/ Series	Index Value	Slope	Inter- cept	Rsquare	No. Pts	Predicted Value	Sigma	Standard Error	Weight
GDR0	9.1453	1.163	-1.978	.1127	8	8.6594	1.01163	1.07734	.06876
GDR1	5.6204	1.237	1.451	.2791	8	8.4029	.57942	.61656	.20993
MEAN						8.4870	.33262	.33262	.72131

Yearclass = 1988

Survey/ Series	Index Value	Slope	Inter- cept	Rsquare	No. Pts	Predicted Value	Sigma	Standard Error	Weight
GDR0	9.3852	1.370	-3.902	.0898	9	8.9538	1.11720	1.19537	.05496
GDR1	5.4424	1.316	.981	.2741	9	8.1420	.57100	.61253	.20932
MEAN						8.4560	.32672	.32672	.73571

Yearclass = 1989

Survey/ Series	Index Value	Slope	Inter- cept	Rsquare	No. Pts	Predicted Value	Sigma	Standard Error	Weight
GDR0	9.8552	1.486	-5.034	.0764	10	9.6143	1.15012	1.27982	.05550
GDR1									
MEAN						8.4471	.31023	.31023	.94450

Yearclass	Weighted Average Prediction		Internal Standard Error	External Standard Error	Virtual Population Analysis		Ext.SE/ Int.SE
1986	8.47	4777.09	.27	.34	9.00	8113.00	1.24
1987	8.48	4823.33	.28	.04	8.20	3644.00	.15
1988	8.42	4526.04	.28	.13	8.36	4253.00	.46
1989	8.51	4973.34	.30	.27	6.48	650.00	.89

Table 3.2.6.16

Effects of different levels of fishing mortality on catch, stock biomass and spawning stock biomass.

HERRING DIV IIIA AND 22-24

Year 1990					Year 1991					Year 1992	
factor	ref. F	stock biomass	sp.stock biomass	catch	factor	ref. F	stock biomass	sp.stock biomass	catch	stock biomass	sp.stock biomass
1.0	.81	584	207	217	.0	.00	545	206	0	780	369
					.1	.08		205	26	747	343
					.2	.16		203	50	715	320
					.4	.32		200	95	657	277
					.6	.48		197	134	605	241
					.8	.65		194	168	559	211
					1.0	.81		191	199	518	184
					1.2	.97		188	227	481	161
					1.4	1.13		185	251	448	141
					1.6	1.29		182	274	418	124
					1.8	1.45		179	293	391	109
					2.0	1.62		176	311	367	96

The data unit of the biomass and the catch is 1000 tonnes.
The spawning stock biomass is given for the time of spawning.
The spawning stock biomass for 1992 has been calculated with the same fishing mortality as for 1991.
The reference F is the mean F for the age group range from 2 to 6

Table 3.2.6.17 Detailed prediction for HERRING in Division IIIa and Sub-divisions 22-24.

```
*******************************************************
* Year 1990. F-factor   1.000 and reference F    .8080 *
*******************************************************
```

age	absolute F	catch in numbers	catch in weight	stock size	stock biomass	at 1 January sp.stock size	at 1 January sp.stock biomass	at spawning time sp.stock size	at spawning time sp.stock biomass
0	.1800	882.18	11909	5891.0	79528	.00	0	.00	0
1	.3700	1402.52	34361	4973.0	121838	.00	0	.00	0
2	.4400	882.34	46058	2715.0	141723	543.00	28344	494.28	25801
3	.6700	495.35	37894	1107.0	84685	830.25	63514	738.58	56501
4	.9100	551.84	62578	1004.0	113853	903.60	102468	784.77	88992
5	1.0300	134.53	18120	227.0	30576	227.00	30576	194.80	26238
6	.9900	22.57	3198	39.0	5526	39.00	5526	33.60	4761
7	.8500	12.63	2020	24.0	3840	24.00	3840	20.97	3355
8+	.8500	6.31	1033	12.0	1964	12.00	1964	10.48	1716
Total		4390.28	217176	15992.0	583536	2578.85	236234	2277.48	207366

```
*******************************************************
* Year 1991. F-factor   1.000 and reference F    .8080 *
*******************************************************
```

age	absolute F	catch in numbers	catch in weight	stock size	stock biomass	at 1 January sp.stock size	at 1 January sp.stock biomass	at spawning time sp.stock size	at spawning time sp.stock biomass
0	.1800	882.18	11909	5891.0	79528	.00	0	.00	0
1	.3700	1136.18	27836	4028.6	98701	.00	0	.00	0
2	.4400	913.98	47709	2812.4	146805	562.47	29361	512.01	26726
3	.6700	640.60	49006	1431.6	109517	1073.70	82137	955.15	73068
4	.9100	254.91	28907	463.8	52592	417.40	47333	362.51	41108
5	1.0300	196.09	26413	330.9	44569	330.88	44569	283.94	38246
6	.9900	38.41	5442	66.4	9401	66.35	9401	57.17	8100
7	.8500	6.24	998	11.9	1898	11.86	1898	10.37	1658
8+	.8500	6.63	1085	12.6	2062	12.60	2062	11.01	1801
Total		4075.22	199308	15049.1	545076	2475.26	216763	2192.14	190710

```
*******************************************************
* Year 1992. F-factor   1.000 and reference F    .8080 *
*******************************************************
```

age	absolute F	catch in numbers	catch in weight	stock size	stock biomass	at 1 January sp.stock size	at 1 January sp.stock biomass	at spawning time sp.stock size	at spawning time sp.stock biomass
0	.1800	882.18	11909	5891.0	79528	.00	0	.00	0
1	.3700	1136.18	27836	4028.6	98701	.00	0	.00	0
2	.4400	740.41	38649	2278.3	118926	455.66	23785	414.78	21651
3	.6700	663.58	50763	1482.9	113444	1112.20	85083	989.40	75688
4	.9100	329.66	37383	599.8	68014	539.79	61212	468.81	53162
5	1.0300	90.58	12201	152.8	20587	152.84	20587	131.16	17667
6	.9900	55.98	7932	96.7	13704	96.71	13704	83.32	11807
7	.8500	10.62	1699	20.2	3229	20.19	3229	17.64	2821
8+	.8500	4.50	737	8.6	1401	8.56	1401	7.48	1224
Total		3913.70	189112	14558.9	517538	2385.95	209004	2112.58	184023

Table 3.2.6.18 HERRING. The prediction of catch at age in 1991 by area and half-year. N=catch in numbers (millions), w=mean weight at age (grams), C=catch (tonnes).

Age	Sub-divisions 22-24			Division IIIa		
	N	w	C	N	w	C
1st half-year						
0	-	-	-	-	-	
1	541.7	14.2	7,692	-	-	
2	296.4	42.1	12,478	268.8	41.4	11,128
3	353.9	70.9	18,002	229.6	73.5	16,876
4	163.1	107.8	17,852	37.4	102.4	3,830
5	120.1	128.3	15,409	25.9	124.5	3,225
6	23.7	136.1	3,226	3.3	158.0	521
7	3.5	151.7	531	0.5	194.6	97
8+	2.7	159.2	430	0.4	195.1	78
Σ			74,920			35,755
2nd half-year						
0	880.0	13.5	11,880	-	-	
1	153.4	26.4	4,050	441.2	36.4	16,060
2	36.9	65.4	2,413	312.1	69.5	21,691
3	22.6	84.1	1,901	134.9	92.8	12,519
4	8.8	102.6	903	45.3	144.7	6,555
5	8.6	93.7	806	41.7	168.0	7,005
6	2.9	85.4	248	8.3	170.5	1,415
7	0.5	100.7	50	1.5	186.8	280
8+	1.9	106.3	202	2.3	209.3	481
Σ			22,453			66,006
Total catch			97,373			101,761
Predicted total catch in Sub-div. 22-24 + Div. IIIa:						199,134

Table 3.3.1 SUM OF PRODUCTS CHECK

HERRING IN THE AREAS 25-29 AND 32 PLUS GULF OF RIGA
CATEGORY: TOTAL

CATCH IN NUMBERS   UNIT: millions

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
0	27	56	21	20	86	51	81	68	66	31	60	30
1	2739	1974	2519	1328	1156	482	1138	1388	947	794	866	1261
2	1857	1792	1352	2711	1396	1372	1033	1696	2373	1924	1330	2408
3	1390	1694	1398	915	1979	977	1077	792	927	2014	1538	1280
4	1674	987	1067	718	476	1502	580	698	403	703	1242	989
5	521	1032	536	657	391	361	788	395	355	272	431	739
6	352	379	639	381	380	298	193	508	218	269	198	264
7	632	277	250	300	190	288	213	154	275	178	181	139
8	99	374	140	218	238	182	226	132	97	185	137	118
9	88	78	262	122	117	170	104	157	96	79	119	76
10+	102	99	98	206	129	132	223	242	231	179	177	159
TOTAL	9481	8742	8282	7576	6538	5815	5656	6230	5988	6628	6279	7463

	1986	1987	1988	1989
0	44	10	38	123
1	530	990	480	854
2	1808	775	2289	588
3	2089	1555	859	2481
4	2014	1442	1122	723
5	735	682	994	917
6	369	493	393	749
7	134	243	282	273
8	87	91	115	206
9	61	36	45	81
10+	86	69	56	55
TOTAL	7957	6386	6673	7050

Table 3.3.2

SUM OF PRODUCTS CHECK

HERRING IN THE AREAS 25-29 AND 32 PLUS GULF OF RIGA
CATEGORY: TOTAL

MEAN WEIGHT AT AGE IN THE CATCH UNIT: gram

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
0	7.100	6.400	6.200	5.900	5.400	5.400	7.300	6.800	6.100	6.500	7.000	5.900
1	27.500	29.200	21.400	27.600	24.500	21.700	22.600	25.400	20.500	18.400	16.200	15.600
2	32.100	28.700	35.000	25.800	41.800	38.900	34.500	33.700	38.200	30.000	27.800	21.600
3	39.000	46.700	35.900	46.100	38.500	55.200	51.200	50.200	49.600	53.900	41.500	39.200
4	43.300	49.100	55.000	53.400	53.600	47.300	65.000	65.900	60.000	56.500	61.600	53.900
5	69.200	51.200	55.100	67.000	58.900	64.000	59.200	73.700	70.100	71.500	62.800	66.400
6	77.500	77.200	54.900	60.100	71.800	70.400	75.400	71.900	78.700	83.900	75.100	72.600
7	82.400	77.500	78.900	69.700	72.000	76.300	79.000	83.600	77.300	88.100	85.800	83.300
8	74.300	82.300	70.700	88.600	69.300	82.500	86.900	87.500	89.700	89.200	89.100	93.000
9	73.300	69.600	89.900	91.100	95.100	79.700	93.500	97.900	99.000	104.700	95.300	99.700
10+	78.100	74.600	67.500	93.300	89.400	95.600	101.900	107.400	106.000	115.400	111.600	107.800

	1986	1987	1988	1989
0	6.200	5.700	6.400	7.450
1	18.300	14.900	19.600	22.300
2	25.300	32.300	24.600	33.700
3	32.400	37.100	43.600	33.100
4	48.900	42.200	48.600	45.900
5	61.000	55.700	50.900	53.800
6	67.700	62.400	62.800	56.900
7	78.200	70.300	69.900	66.000
8	93.000	82.400	84.500	74.600
9	96.200	93.800	87.800	84.400
10+	104.100	102.500	98.300	103.800

Table 3.3.3

```
HERRING 25-29S TUNING DATA:Acoustic estimates ARGOS and/or EISBAR
101
Internartional Acoustic Surveys 1982-89
1982, 1989
1, 1
1, 9
1, 4594, 6383, 2316, 1334, 1300, 994, 580, 379, 251
1, 3023, 4862, 4986, 2175, 1392, 1211, 1063, 670, 411
1, 5341, 4932, 5042, 4024, 1365, 844, 576, 376, 189
1, 2897, 6526, 3542, 2987, 1021, 470, 360, 202, 129
1, 3305, 7493, 8223, 3737, 2611, 830, 342, 205, 102
1, 5287, 2099, 4412, 4555, 1736, 1013, 321, 101, 32
1, 1172, 3753, 1875, 4168, 3506, 1435, 720, 210, 84
1, 4786, 2256, 6270, 2537, 3795, 2209, 897, 311, 69
```

Table 3.3.4 HERRING in Sub-divisions 25-29S and 32 plus Gulf of Riga. Tuning analysis.

DISAGGREGATED Qs
LOG TRANSFORMATION
No explanatory variate (Mean used)
Fleet 1 ,International Acous, has terminal q estimated as the mean
FLEETS COMBINED BY ** VARIANCE **

Regression weights
, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000,
Oldest age F = 1.000*average of 5 younger ages. Fleets combined by variance of predictions
Fishing mortalities

Age,	82,	83,	84,	85,	86,	87,	88,	89,
1,	.073,	.056,	.045,	.071,	.061,	.049,	.070,	.044,
2,	.239,	.208,	.125,	.171,	.137,	.118,	.152,	.115,
3,	.255,	.328,	.255,	.171,	.220,	.167,	.186,	.244,
4,	.245,	.313,	.345,	.259,	.440,	.233,	.175,	.236,
5,	.246,	.260,	.322,	.356,	.312,	.261,	.250,	.211,
6,	.217,	.299,	.307,	.335,	.303,	.357,	.235,	.302,
7,	.280,	.276,	.337,	.367,	.283,	.335,	.356,	.255,
8,	.227,	.308,	.355,	.384,	.414,	.317,	.261,	.479,
9,	.243,	.291,	.333,	.340,	.350,	.300,	.255,	.297,

Log catchability estimates

Age 1

Fleet,	82,	83,	84,	85,	86,	87,	88,	89
1 ,	-1.04,	-1.54,	-1.27,	-1.32,	-.97,	-1.35,	-1.76,	-1.39

SUMMARY STATISTICS

Fleet ,	Pred. q ,	SE(q),	Partial F ,	Raised F ,	SLOPE ,	SE Slope ,	INTRCPT,	SE Intrcpt
1 ,	-1.39 ,	.326,	.2483 ,	.0443,	.000E+00,	.000E+00,	-1.393,	.109

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.044	.326	0.000	.326	0.000

Age 2

Fleet,	82,	83,	84,	85,	86,	87,	88,	89
1 ,	-.44,	-.64,	-.77,	-.77,	-.57,	-1.14,	-1.39,	-.82

cont'd.

Table 3.3.4 cont'd.

SUMMARY STATISTICS

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-.82	.328	.4421	.1152	.000E+00	.000E+00	-.816	.109

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.115	.328	0.000	.328	0.000

Age 3

Fleet	82	83	84	85	86	87	88	89
1	-.45	-.21	-.18	-.75	-.14	-.75	-.90	-.48

SUMMARY STATISTICS

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-.48	.310	.6175	.2443	.000E+00	.000E+00	-.492	.103

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.244	.310	0.000	.310	0.000

Age 4

Fleet	82	83	84	85	86	87	88	89
1	-.21	-.03	.11	-.25	-.20	-.31	-.43	-.19

SUMMARY STATISTICS

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-.19	.176	.9290	.2363	.000E+00	.000E+00	-.187	.059

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.236	.176	0.000	.176	0.000

Age 5

Fleet	82	83	84	85	86	87	88	89
1	-.10	.29	.02	-.71	.10	-.41	-.13	-.13

cont'd.

Table 3.3.4 cont'd.

SUMMARY STATISTICS

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-.13	.327	.8745	.2113	.000E+00	.000E+00	-.134	.109

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.211	.327	0.000	.327	0.000

Age 6

Fleet	82	83	84	85	86	87	88	89
1	-.01	.30	.27	-.52	-.38	-.31	-.15	-.12

SUMMARY STATISTICS

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-.12	.311	.8906	.3020	.000E+00	.000E+00	-.116	.104

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.302	.311	0.000	.311	0.000

Age 7

Fleet	82	83	84	85	86	87	88	89
1	-.53	.50	.07	-.05	-.32	-.82	-.10	-.18

SUMMARY STATISTICS

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-.18	.420	.8371	.2548	.000E+00	.000E+00	-.178	.140

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.255	.420	0.000	.420	0.000

Age 8

Fleet	82	83	84	85	86	87	88	89
1	-.12	.11	-.03	-.42	-.03	-1.05	-.74	-.32

cont'd.

Table 3.3.4 cont'd.

SUMMARY STATISTICS

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-.322	.422	.7231	.4790	.000E+00	.000E+00	-.324	.141

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.479	.422	0.000	.422	0.000

Table 3.3.5 VPA from tuning.

HERRING IN THE AREAS 25-29 AND 32 PLUS GULF OF RIGA

FISHING MORTALITY COEFFICIENT UNIT: Year-1 NATURAL MORTALITY COEFFICIENT = .20

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	.228	.229	.148	.151	.133	.080	.130	.097	.073	.056	.045	.071
2	.171	.229	.243	.234	.235	.230	.244	.291	.239	.208	.125	.171
3	.236	.233	.280	.257	.268	.257	.284	.300	.255	.328	.255	.171
4	.271	.262	.225	.227	.207	.335	.239	.301	.245	.315	.345	.259
5	.177	.268	.221	.211	.186	.239	.294	.254	.246	.260	.322	.356
6	.192	.189	.264	.242	.181	.211	.194	.314	.217	.299	.307	.335
7	.226	.228	.183	.190	.183	.203	.230	.234	.280	.276	.337	.367
8	.193	.202	.172	.241	.227	.267	.243	.217	.227	.308	.355	.384
9	.212	.230	.213	.222	.197	.252	.241	.265	.243	.291	.333	.340
10+	.212	.230	.213	.222	.197	.252	.241	.265	.243	.291	.333	.340
(3- 8)U	.216	.230	.224	.228	.209	.252	.247	.270	.245	.297	.320	.312

	1986	1987	1988	1989	1974-87
1	.061	.049	.070	.044	.111
2	.137	.118	.152	.115	.205
3	.220	.167	.186	.244	.251
4	.440	.233	.175	.236	.279
5	.312	.261	.250	.211	.258
6	.303	.357	.235	.302	.257
7	.283	.335	.356	.255	.254
8	.414	.317	.261	.479	.269
9	.350	.300	.255	.297	.264
10+	.350	.300	.255	.297	.264
(3- 8)U	.329	.278	.244	.288	

Table 3.3.6 VPA from tuning.

HERRING IN THE AREAS 25-29 AND 32 PLUS GULF OF RIGA

STOCK SIZE IN NUMBERS UNIT: millions

BIOMASS TOTALS UNIT: tonnes

ALL VALUES, EXCEPT THOSE REFERRING TO THE SPAWNING STOCK ARE GIVEN FOR 1 JANUARY; THE SPAWNING STOCK DATA REFLECT THE STOCK SITUATION AT SPAWNING TIME, WHEREBY THE FOLLOWING VALUES ARE USED: PROPORTION OF ANNUAL F BEFORE SPAWNING: .350
PROPORTION OF ANNUAL M BEFORE SPAWNING: .300

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	14781	10592	20207	10406	10251	6925	10273	16512	14823	16053	21510	20402
2	12998	9637	6896	14274	7323	7351	5235	7385	12267	11282	12427	16830
3	7276	8969	6277	4429	9248	4739	4784	3356	4522	7908	7505	8975
4	7737	4707	5819	3882	2803	5791	3002	2948	2036	2868	4665	4761
5	3531	4829	2966	3804	2532	1867	3392	1936	1786	1304	1717	2704
6	2214	2421	3025	1946	2523	1721	1203	2069	1229	1143	823	1018
7	3435	1496	1641	1902	1250	1724	1141	812	1238	810	694	496
8	619	2244	975	1119	1287	853	1152	742	526	766	503	406
9	506	418	1500	672	720	840	534	740	489	343	461	289
10+	587	530	561	1135	794	652	1146	1140	1177	778	685	605
TOTAL NO	53685	45843	49869	43571	38731	32462	31861	37640	40093	43256	50991	56485
SPS NO	29942	27286	23363	24708	22058	19647	16822	15837	18275	19698	21652	26303
TOT.BIOM	2270471	2039238	1919928	1837702	1712474	1543520	1501294	1650160	1656888	1676722	1687213	1716783
SPS BIOM	1494198	1393446	1209453	1234578	1163619	1102718	1025947	972723	1028725	1053624	1030301	1082425

	1986	1987	1988	1989	1990	1974-87
1	9916	22929	7795	21728	0	14684
2	15566	7641	17879	5949	17018	10508
3	11610	11115	5557	12576	4341	7194
4	6195	7625	7699	3776	8064	4631
5	3008	3266	4945	5293	2441	2760
6	1550	1802	2061	3155	3508	1764
7	596	938	1033	1334	1910	1298
8	281	368	549	593	846	846
9	226	152	219	346	300	564
10+	319	292	273	235	354	743
TOTAL NO	49269	56128	48011	54984		
SPS NO	28938	26115	30220	26243		
TOT.BIOM	1670648	1757410	1754933	1924715		
SPS BIOM	1137943	1133179	1267924	1158821		

Table 3.3.7 HERRING in Sub-divisions 25-29S and 32 plus Gulf of Riga.

from 74 to 89 on ages 1 to 9
with Terminal F of .290 on age 4 and Terminal S of 1.000

Initial sum of squared residuals was 18.631 and
final sum of squared residuals is 7.882 after 108 iterations

Matrix of Residuals

Years	74/75	75/76	76/77	77/78	78/79
Ages					
1/ 2	1.039	.859	.466	.373	.497
2/ 3	.107	.127	.333	.145	.437
3/ 4	.204	.188	.459	.339	.212
4/ 5	.024	.012	-.044	-.028	-.102
5/ 6	-.129	-.108	-.175	-.075	-.095
6/ 7	-.200	-.163	.248	.082	-.080
7/ 8	.089	.108	-.366	-.376	-.308
8/ 9	-.360	-.384	-.530	-.152	-.178
	.000	.000	.000	.000	.000
WTS	.010	.010	.010	.010	.010

Years	79/80	80/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88	88/89		WTS
Ages												
1/ 2	-.242	.192	-.134	-.028	.081	-.435	.184	.063	-.327	.485	.000	.247
2/ 3	.170	.265	.417	.261	.230	.032	.091	.003	-.175	.024	.000	.632
3/ 4	.303	.287	.347	.234	.345	.288	-.652	.079	.117	.138	.000	.409
4/ 5	.107	-.080	.028	.038	.033	.047	-.222	.472	-.152	-.145	.000	.655
5/ 6	.101	-.013	-.041	-.066	-.126	.030	.188	-.199	.040	-.051	.000	1.000
6/ 7	-.181	-.218	-.012	-.131	-.039	-.097	.180	-.172	.057	.039	.000	.729
7/ 8	-.268	.041	-.157	.070	-.167	-.018	-.024	-.196	.254	-.004	.000	.546
8/ 9	-.116	-.237	-.468	-.285	-.152	-.020	.003	.133	.044	-.131	.000	.546
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	2.855	
WTS	.010	.010	.010	.010	.010	1.000	1.000	1.000	1.000	1.000		

Fishing Mortalities (F)

	74	75	76	77	78	79
F-values	.3210	.3440	.3213	.3174	.2760	.3078

	80	81	82	83	84	85	86	87	88	89
F-values	.2962	.3062	.2593	.2911	.3022	.3119	.3084	.2730	.2567	.2900

Selection-at-age (S)

	1	2	3	4	5	6	7	8	9
S-values	.2215	.5280	.7544	1.0000	1.0035	1.0226	1.0600	1.1217	1.0000

Table 3.3.8 VIRTUAL POPULATION ANALYSIS

HERRING IN THE AREAS 25-29 AND 32 PLUS GULF OF RIGA

FISHING MORTALITY COEFFICIENT UNIT: Year-1 NATURAL MORTALITY COEFFICIENT = .20

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	.241	.238	.146	.150	.131	.078	.130	.097	.069	.058	.046	.084
2	.188	.245	.255	.231	.232	.226	.240	.291	.237	.196	.129	.175
3	.260	.262	.307	.275	.263	.253	.278	.292	.256	.325	.238	.176
4	.305	.298	.262	.256	.224	.327	.234	.293	.237	.314	.341	.237
5	.232	.313	.261	.255	.216	.265	.285	.248	.237	.249	.323	.350
6	.265	.264	.326	.300	.230	.253	.221	.301	.210	.285	.290	.336
7	.321	.344	.279	.250	.240	.273	.290	.276	.264	.265	.316	.340
8	.294	.320	.293	.418	.322	.381	.357	.294	.280	.285	.336	.350
9	.320	.398	.388	.449	.415	.401	.391	.452	.361	.388	.300	.315
10+	.320	.398	.388	.449	.415	.401	.391	.452	.361	.388	.300	.315
(3- 8)U	.280	.300	.288	.292	.249	.292	.278	.284	.247	.287	.307	.298

	1986	1987	1988	1989	1974-87
1	.068	.046	.078	.064	.113
2	.165	.133	.144	.130	.210
3	.226	.209	.214	.229	.259
4	.461	.241	.229	.281	.288
5	.277	.278	.260	.297	.271
6	.296	.303	.256	.319	.277
7	.285	.324	.284	.284	.290
8	.370	.319	.250	.347	.330
9	.308	.257	.257	.280	.367
10+	.308	.257	.257	.280	.367
(3- 8)U	.319	.279	.249	.293	

Table 3.3.9 HERRING in Sub-divisions 25-29 and 32 plus Gulf of Riga.

STOCK SIZE IN NUMBERS UNIT: millions

BIOMASS TOTALS UNIT: tonnes

ALL VALUES, EXCEPT THOSE REFERRING TO THE SPAWNING STOCK ARE GIVEN FOR 1 JANUARY; THE SPAWNING STOCK DATA REFLECT THE STOCK SITUATION AT SPAWNING TIME, WHEREBY THE FOLLOWING VALUES ARE
USED: PROPORTION OF ANNUAL F BEFORE SPAWNING: .350
PROPORTION OF ANNUAL M BEFORE SPAWNING: .300

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	14075	10224	20422	10503	10383	7037	10265	16600	15551	15650	21118	17343
2	11909	9059	6595	14450	7403	7459	5326	7379	12339	11878	12096	16508
3	6669	8078	5805	4183	9391	4805	4872	3431	4516	7967	7992	8705
4	6982	4210	5090	3496	2602	5909	3055	3021	2097	2864	4714	5160
5	2766	4212	2560	3208	2216	1702	3488	1979	1846	1355	1713	2743
6	1661	1795	2521	1613	2035	1463	1069	2148	1265	1192	864	1015
7	2527	1043	1129	1490	979	1324	930	701	1302	840	734	530
8	427	1501	605	700	950	630	825	570	436	818	527	438
9	352	260	893	370	377	564	353	473	348	270	504	309
10+	408	330	334	624	416	438	756	729	837	611	749	646
TOTAL NO	47775	40713	45953	40637	36753	31330	30939	37030	40536	43443	51011	53396
SPS NO	25377	23016	19574	21804	20021	18428	15919	15166	17983	20081	22094	26394
TOT.BIOM	1949468	1743868	1670303	1611884	1550899	1439316	1406047	1574926	1631753	1678026	1714470	1687563
SPS BIOM	1220509	1132032	972845	1017301	1005885	999883	934237	898576	989842	1056383	1062997	1103079

	1986	1987	1988	1989	1990	1974-87
1	8946	24032	7011	15134	0	14439
2	13062	6846	18782	5307	11620	10165
3	11347	9065	4907	13315	3815	6916
4	5974	7410	6022	3244	8668	4470
5	3334	3086	4769	3921	2006	2586
6	1582	2069	1913	3011	2386	1592
7	594	964	1251	1213	1792	1073
8	309	366	571	771	747	650
9	253	175	218	364	446	393
10+	356	335	271	247	378	541
TOTAL NO	45757	54347	45715	46526		
SPS NO	27271	23810	28594	24591		
TOT.BIOM	1601046	1677834	1650420	1682113		
SPS BIOM	1107756	1057031	1180008	1072206		

Table 3.3.10
List of input variables for the ICES prediction program.

HERRING IN AREAS 25-29 AND 32
The reference F is the mean F for the age group range from 3 to 8

The number of recruits per year is as follows:

Year	Recruitment
1990	14439.0
1991	14439.0
1992	14439.0

Proportion of F (fishing mortality) effective before spawning: .3500
Proportion of M (natural mortality) effective before spawning: .3000

Data are printed in the following units:

Number of fish: millions
Weight by age group in the catch: gram
Weight by age group in the stock: gram
Stock biomass: tonnes
Catch weight: tonnes

age	stock size	fishing pattern	natural mortality	maturity ogive	weight in the catch	weight in the stock
1	14439.0	.07	.20	.00	18.933	18.933
2	11620.0	.15	.20	.70	30.200	30.200
3	3815.0	.23	.20	.90	37.933	37.933
4	8668.0	.27	.20	1.00	45.567	45.567
5	2006.0	.30	.20	1.00	53.467	53.467
6	2386.0	.31	.20	1.00	60.700	60.700
7	1792.0	.32	.20	1.00	68.733	68.733
8	747.0	.33	.20	1.00	80.500	80.500
9	446.0	.28	.20	1.00	88.667	88.667
10+	378.0	.28	.20	1.00	101.533	101.533

Table 3.3.11

Effects of different levels of fishing mortality on catch, stock biomass and spawning stock biomass.

HERRING IN AREAS 25-29

Year 1990					Year 1991					Year 1992	
factor	ref. F	stock biomass	sp.stock biomass	catch	factor	ref. F	stock biomass	sp.stock biomass	catch	stock biomass	sp.stock biomass
1.0	.29	1677	1106	295	.0	.00	1671	1192	0	1978	1472
					.1	.03		1182	33	1943	1427
					.2	.06		1171	65	1908	1384
					.4	.12		1150	126	1843	1302
					.6	.18		1130	184	1780	1225
					.8	.23		1110	240	1720	1153
					1.0	.29		1090	293	1664	1087
					1.2	.35		1071	344	1610	1024
					1.4	.41		1052	392	1558	966
					1.6	.47		1034	438	1509	911
					1.8	.53		1015	482	1462	860
					2.0	.59		998	524	1418	812

The data unit of the biomass and the catch is 1000 tonnes.
The spawning stock biomass is given for the time of spawning.
The spawning stock biomass for 1992 has been calculated with the same fishing mortality as for 1991.
The reference F is the mean F for the age group range from 3 to 8

Table 3.3.12 Herring in Sub-divisions 25-29 and 32 and Gulf of Riga. Catches by area for 1987-1989 and distribution of predicted catches.

1987-89 average catch and mean weight at age

MEAN	25-27		28+29S		GoRi		29N		32		TOTAL
AGE	N	W	N	W	N	W	N	W	N	W	N
1	296,0	26,4	103,0	16,8	45,7	11,3	72,3	12,9	265,7	13,4	782,7
2	368,0	46,5	176,3	26,2	98,0	16,3	111,0	21,8	442,0	18,9	1195,3
3	490,3	56,6	315,0	39,5	238,7	19,1	193,3	28,3	366,7	24,5	1604,0
4	412,7	65,0	174,0	40,1	153,3	24,4	169,0	35,8	176,7	31,0	1085,7
5	343,3	71,9	173,3	48,3	98,7	30,0	141,0	41,8	113,7	38,4	870,0
6	217,7	76,6	134,3	55,9	41,7	37,6	83,0	48,1	69,7	47,1	546,3
7	106,0	81,0	61,3	62,0	13,2	46,6	43,0	59,3	41,0	59,0	264,5
8	58,0	95,1	34,7	76,1	3,3	45,2	22,7	67,1	20,3	71,0	139,0
9	22,3	99,4	10,7	82,5	1,1	99,3	9,3	78,0	11,0	78,2	54,4
10	20,7	110,6	10,7	93,8	0,2	53,8	19,0	94,7	6,7	102,2	57,2
SUM	2335,0		1193,3		693,8		863,7		1513,3		6599,1

Distribution of SQC 1990 and 1991 on subunits

	25-27		28+29S		GoRi		29N		32		TOTAL Catch N:o	
AGE	SQC 90	SQC 91	SQC 90	SQC 91	SQC 90	SQC 91	SQC 90	SQC 91	SQC 90	SQC 91	SQC 90	SQC 91
1	8833	8833	1958	1958	582	582	1056	1056	4029	4029	885,8	885,8
2	21069	19985	5677	5385	1961	1860	2973	2820	10278	9749	1470,7	1395,0
3	12340	26485	5532	11874	2027	4350	2433	5221	3989	8561	713,2	1530,7
4	46135	13209	12011	3439	6435	1842	10396	2977	9420	2697	1867,3	534,6
5	13444	36307	4557	12308	1613	4356	3208	8664	2376	6417	473,6	1279,0
6	17682	9017	7968	4063	1661	847	4231	2158	3477	1773	579,4	295,5
7	14523	11610	6429	5140	1038	830	4314	3449	4090	3270	447,2	357,5
8	7594	10833	3631	5179	208	296	2094	2988	1987	2834	191,3	272,9
9	4049	3992	1605	1582	193	190	1328	1309	1568	1545	99,2	97,8
10	3359	4528	1471	1983	18	25	2643	3563	1001	1350	84,1	113,4
TOTAL	149028		50841		15737		34676		42215		292497	
ton		144798		52912		15180		34204		42226		289320

Table 3.3.13 Catch (tonnes) of coastal and open-sea HERRING in Southern Baltic (Sub-divisions 25-27) in 1972-1989.

Year	Coastal	Open Sea	Compiled catch	Official catch
1972	56,865	50,523	107,388	118,272
1973	57,288	81,217	138,505	148,078
1974	81,292	77,324	158,618	159,197
1975	109,239	69,846	179,085	172,617
1976	93,635	82,471	176,106	174,388
1977	83,946	103,399	187,345	187,138
1978	88,853	88,510	177,363	174,007
1979	99,407	90,499	189,906	189,989
1980	103,218	71,794	175,012	174,662
1981	77,406	80,864	158,270	164,598
1982	97,748	68,394	166,142	179,624
1983	100,150	74,044	174,194	174,194
1984	79,456	67,222	146,678	146,678
1985	82,249	71,322	153,571	153,803
1986	76,871	61,872	138,743	138,743
1987	66,114	55,644	121,758	121,779
1988	74,995	68,948	143,943	143,977
1989	72,866	79,937	152,803	152,755

Table 3.3.14 Coastal spring spawners herring year class strength in the Gulf of Gdansk in 1976-1989 according to Polish young fish surveys.

Year class	IV Quarter 0-group	I Quarter 1-group
1976	6001(9)	13025(16)
1977	1174(9)	333(16)
1978	1401(30)	644(6)
1979	1521(17)	5221(20)
1980	3339(13) (y)	6745(18)
1981	27(4) (y)	3131
1982	735(13)	9254(11)
1983	3274(17)	8649(10)
1984	11714(16)	1266(12)
1985	941(13)	3633(7)
1986	no data	no data
1987	556(13)	2241(27)
1988	1670(14)	6538(28)
1989	2981(15)	4866(14)

Note: No of of hauls are given in brackets, (y) - non representative value.

Table 3.3.15: SOP check.

HERRING IN THE COASTAL AREAS 25, 26 AND 27
CATEGORY: TOTAL

CATCH IN NUMBERS UNIT: millions

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
0	352	320	52	20	73	123	49	36	86	71	21	39
1	782	651	703	304	96	421	388	173	80	166	229	250
2	393	543	440	786	522	369	387	783	306	213	219	342
3	318	247	216	261	491	384	203	233	644	272	272	259
4	121	129	71	83	187	180	164	72	113	316	240	207
5	66	27	42	32	59	91	71	55	42	48	193	137
6	25	7	8	27	23	26	31	26	32	22	38	37
7	10	8	6	7	11	13	14	16	14	10	15	8
8	2	3	4	5	4	4	6	9	6	8	7	9
9+	17	7	35	12	7	11	23	17	8	1	7	4
TOTAL	2086	1942	1575	1536	1474	1622	1337	1420	1331	1126	1241	1291

	1987	1988	1989
0	7	29	14
1	158	223	189
2	291	388	191
3	382	291	282
4	191	230	175
5	92	82	133
6	33	49	56
7	7	10	21
8	3	5	16
9+	1	2	9
TOTAL	1165	1308	1087

Table 3.3.16 SOP check.

HERRING IN THE COASTAL AREAS 25, 26 AND 27
CATEGORY: TOTAL

MEAN WEIGHT AT AGE IN THE CATCH   UNIT: gram

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
0	12.300	12.300	12.300	12.300	12.300	12.300	12.300	12.300	9.600	8.100	11.870	12.570
1	18.400	18.400	18.400	18.400	18.400	18.400	18.400	18.400	32.600	19.640	19.660	17.700
2	66.400	66.400	66.400	66.400	66.400	66.400	66.400	66.400	59.500	50.550	45.160	39.970
3	98.600	98.600	98.600	98.600	98.600	98.600	98.600	98.600	85.000	77.880	67.810	59.030
4	121.600	121.600	121.600	121.600	121.600	121.600	121.600	121.600	104.400	100.320	84.230	79.850
5	155.400	155.400	155.400	155.400	155.400	155.400	155.400	155.400	130.700	120.200	98.940	99.470
6	153.400	153.400	153.400	153.400	153.400	153.400	153.400	153.400	158.400	137.310	115.700	100.360
7	171.400	171.400	171.400	171.400	171.400	171.400	171.400	171.400	146.200	145.330	128.770	115.490
8	169.100	169.100	169.100	169.100	169.100	169.100	169.100	169.100	150.500	154.990	134.070	131.960
9+	183.300	183.300	183.300	183.300	183.300	183.300	183.300	183.300	157.700	172.590	155.760	122.890

	1987	1988	1989
0	9.300	26.200	12.500
1	26.600	20.200	33.300
2	42.800	48.000	53.600
3	57.700	65.000	68.400
4	74.100	78.000	81.300
5	92.400	92.600	90.900
6	105.500	102.200	100.500
7	113.600	104.300	101.300
8	119.600	122.400	105.300
9+	122.500	131.100	114.100

Table 3.3.17 Tuning data.

```
HERRING CU 25-27, TUNING ACC. TO POLISH MEAN CPUE IN 1 AND 2 QUARTER
101
CPUE 1 AND 2 QUARTER
1975,1989
1,1
1,8
59,782,393,318,121,66,25,10,2
55,651,543,247,129,27,7,8,3
46,703,440,216,71,42,8,6,4
43,304,786,261,83,32,27,7,5
63,96,522,491,187,59,23,11,4
51,421,369,384,180,91,26,13,4
40,388,387,203,164,71,31,14,6
38,173,783,233,72,55,26,16,9
39,80,306,644,113,42,32,14,6
32,166,213,272,316,48,22,10,8
32,229,219,272,240,193,38,15,7
36,250,342,259,207,137,37,8,9
31,158,291,382,191,92,33,7,3
37,223,388,291,230,82,49,10,5
44,189,191,282,175,133,56,21,16
```

Table 3.3.18

DISAGGREGATED Qs
LOG TRANSFORMATION
NO explanatory variate (Mean used)
Fleet 1 ,CPUE 1 AND 2 QUARTER, has terminal q estimated as the mean
FLEETS COMBINED BY ** VARIANCE **

Regression weights
, .007, .043, .116, .222, .348, .482, .610, .725, .820, .893, .944, .976, .993, .999, 1.000,
Oldest age F = 1.000*average of 5 younger ages. Fleets combined by variance of predictions
Fishing mortalities

Age,	75,	76,	77,	78,	79,	80,	81,	82,	83,	84,	85,	86,	87,	88,	89,
1,	.341,	.261,	.210,	.124,	.060,	.225,	.094,	.068,	.036,	.076,	.081,	.121,	.079,	.191,	.110,
2,	.413,	.477,	.316,	.432,	.364,	.387,	.375,	.310,	.183,	.142,	.152,	.185,	.226,	.318,	.279,
3,	.582,	.567,	.398,	.353,	.604,	.567,	.432,	.459,	.514,	.274,	.304,	.304,	.366,	.417,	.458,
4,	.768,	.569,	.355,	.293,	.524,	.531,	.581,	.299,	.479,	.587,	.468,	.451,	.433,	.443,	.542,
5,	.738,	.431,	.412,	.296,	.397,	.597,	.469,	.445,	.323,	.434,	1.052,	.611,	.423,	.378,	.570,
6,	.551,	.183,	.240,	.569,	.406,	.347,	.473,	.352,	.583,	.316,	.873,	.672,	.322,	.475,	.544,
7,	.656,	.373,	.224,	.412,	.579,	.466,	.347,	.558,	.349,	.398,	.399,	.521,	.304,	.169,	.439,
8,	.659,	.424,	.326,	.384,	.502,	.502,	.461,	.422,	.449,	.402,	.619,	.512,	.370,	.376,	.510,

Log catchability estimates

Age 1

Fleet,	75,	76,	77,	78,	79,	80,	81,	82,	83,	84,	85,	86,	87,	88,	89
1 ,	-5.15,	-5.35,	-5.39,	-5.85,	-6.95,	-5.42,	-6.06,	-6.33,	-6.98,	-6.04,	-5.98,	-5.69,	-5.96,	-5.26,	-5.99

SUMMARY STATISTICS

Fleet ,	Pred. q ,	SE(q),	Partial F ,	Raised F ,	SLOPE ,	SE Slope ,	INTRCPT,	SE Intrcpt
1 ,	-5.99 ,	.403,	.1100 ,	.1101,	.000E+00,	.000E+00,	-5.992,	.126

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.110	.403	0.000	.403	0.000

Age 2

Fleet,	75,	76,	77,	78,	79,	80,	81,	82,	83,	84,	85,	86,	87,	88,	89
1 ,	-4.96,	-4.75,	-4.98,	-4.60,	-5.16,	-4.88,	-4.67,	-4.81,	-5.36,	-5.42,	-5.35,	-5.27,	-4.92,	-4.75,	-5.06

cont'd.

Table 3.3.18 cont'd.

SUMMARY STATISTICS

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-5.06	.223	.2792	.2793	.000E+00	.000E+00	-5.060	.070

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.279	.223	0.000	.223	0.000

Age 3

Fleet	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89
1	-4.62	-4.57	-4.75	-4.80	-4.65	-4.50	-4.53	-4.42	-4.33	-4.76	-4.66	-4.78	-4.44	-4.49	-4.57

SUMMARY STATISTICS

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-4.57	.123	.4573	.4580	.000E+00	.000E+00	-4.567	.038

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.458	.123	0.000	.123	0.000

Age 4

Fleet	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89
1	-4.34	-4.57	-4.87	-4.99	-4.79	-4.57	-4.23	-4.84	-4.40	-4.00	-4.22	-4.38	-4.27	-4.42	-4.40

SUMMARY STATISTICS

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-4.40	.202	.5419	.5415	.000E+00	.000E+00	-4.397	.063

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.542	.202	0.000	.202	0.000

Age 5

Fleet	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89
1	-4.39	-4.85	-4.72	-4.97	-5.07	-4.44	-4.45	-4.45	-4.80	-4.30	-3.42	-4.07	-4.30	-4.58	-4.35

SUMMARY STATISTICS

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-4.35	.337	.5690	.5699	.000E+00	.000E+00	-4.348	.106

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.570	.337	0.000	.337	0.000

cont'd

Table 3.3.18 cont'd.

Age 6

Fleet	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89
1	-4.69	-5.76	-5.24	-4.31	-5.04	-5.00	-4.43	-4.69	-4.22	-4.63	-3.61	-3.99	-4.56	-4.36	-4.39

SUMMARY STATISTICS

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-4.39	.332	.5466	.5436	.000E+00	.000E+00	-4.388	.104

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.544	.332	0.000	.332	0.000

Age 7

Fleet	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89
1	-4.52	-4.98	-5.24	-4.69	-4.72	-4.66	-4.73	-4.23	-4.68	-4.38	-4.36	-4.26	-4.69	-5.38	-4.62

SUMMARY STATISTICS

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-4.62	.281	.4329	.4390	.000E+00	.000E+00	-4.622	.088

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.439	.281	0.000	.281	0.000

Table 3.3.19 Tuned VPA.

HERRING IN THE COASTAL AREAS 25, 26 AND 27

FISHING MORTALITY COEFFICIENT   UNIT: Year-1   NATURAL MORTALITY COEFFICIENT = .30

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	.341	.261	.210	.124	.060	.225	.094	.068	.036	.076	.081	.121
2	.413	.477	.316	.432	.364	.387	.375	.310	.183	.142	.152	.185
3	.582	.567	.398	.353	.604	.567	.432	.459	.514	.274	.304	.304
4	.768	.569	.355	.293	.524	.531	.581	.299	.479	.587	.468	.451
5	.738	.431	.412	.296	.397	.597	.469	.445	.323	.434	1.052	.611
6	.551	.183	.240	.569	.406	.347	.473	.352	.583	.316	.873	.672
7	.656	.373	.224	.412	.579	.466	.347	.558	.349	.398	.399	.521
8	.659	.424	.326	.384	.502	.502	.461	.422	.449	.402	.619	.512
9+	.659	.424	.326	.384	.502	.502	.461	.422	.449	.402	.619	.512
(2- 6)U	.611	.445	.344	.388	.459	.486	.466	.373	.416	.350	.570	.445
(2- 8)U	.624	.432	.324	.391	.482	.485	.448	.406	.411	.365	.553	.465

	1987	1988	1989	1975-87
1	.079	.191	.110	.137
2	.226	.318	.279	.305
3	.366	.417	.458	.440
4	.433	.443	.542	.488
5	.423	.378	.570	.510
6	.322	.475	.544	.453
7	.304	.169	.439	.430
8	.370	.376	.510	.464
9+	.370	.376	.510	.464
(2- 6)U	.354	.406	.478	
(2- 8)U	.349	.368	.477	

Table 3.3.20

Title : HERRING IN THE COASTAL AREAS 25, 26 AND 27
At 08.57.44 25 APRIL 1990
from 75 to 89 on ages 1 to 8
with Terminal F of .450 on age 3 and Terminal S of 1.000

Initial sum of squared residuals was 38.345 and
final sum of squared residuals is 12.667 after 106 iterations

Matrix of Residuals

Years / Ages	75/76	76/77	77/78	78/79
1/ 2	.291	.418	.268	.052
2/ 3	-.237	.395	.383	.529
3/ 4	-.321	.262	.405	-.028
4/ 5	.046	-.060	.070	-.213
5/ 6	.613	-.077	-.401	-.331
6/ 7	-.491	-1.118	-.898	.085
7/ 8	.153	-.146	-.465	.232
	.000	.000	.000	.000
WTS	.100	.100	.100	.100

Years / Ages	79/80	80/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88	88/89		WTS
1/ 2	-.935	.283	-.516	-.160	-.637	.400	.019	.104	-.474	.715	.000	.252
2/ 3	.169	.247	.174	.101	-.039	-.076	-.282	-.382	-.093	.347	.000	.423
3/ 4	.421	.055	.288	.230	.158	-.106	-.261	-.385	.008	.122	.000	.459
4/ 5	-.055	-.065	.145	-.143	.124	.082	-.161	-.078	.161	-.029	.000	1.000
5/ 6	-.084	-.036	-.059	-.258	-.211	-.305	.806	.426	-.174	-.303	.000	.318
6/ 7	-.402	-.574	-.540	-.261	.201	-.226	.589	.487	.275	.039	.000	.234
7/ 8	.458	.029	-.237	.559	.002	.150	.003	.442	-.047	-.836	.000	.318
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	-1.194	
WTS	.100	.750	.750	.750	.750	1.000	1.000	1.000	1.000	1.000		

Fishing Mortalities (F)

	75	76	77	78	79
F-values	.7838	.5419	.3817	.3745	.4656

	80	81	82	83	84	85	86	87	88	89
F-values	.4960	.4180	.3356	.3331	.3069	.4052	.4205	.3659	.3750	.4500

Selection-at-age (S)

	1	2	3	4	5	6	7	8
S-values	.2623	.6201	1.0000	1.1916	1.2371	1.1342	.8625	1.0000

Table 3.3.21 VIRTUAL POPULATION ANALYSIS Final VPA resulting from separable VPA.

HERRING IN THE COASTAL AREAS 25, 26 AND 27

FISHING MORTALITY COEFFICIENT UNIT: Year-1 NATURAL MORTALITY COEFFICIENT = .30

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	.343	.255	.208	.121	.060	.218	.091	.069	.037	.079	.082	.118
2	.416	.482	.307	.428	.350	.388	.358	.297	.185	.144	.158	.188
3	.578	.572	.404	.339	.596	.534	.434	.429	.481	.279	.309	.319
4	.805	.563	.361	.299	.493	.518	.525	.301	.431	.526	.481	.463
5	.887	.469	.404	.302	.409	.539	.451	.378	.326	.370	.835	.639
6	.636	.247	.271	.553	.418	.362	.401	.331	.451	.320	.656	.420
7	.728	.471	.329	.488	.550	.489	.370	.428	.321	.270	.406	.315
8	.769	.509	.463	.678	.667	.460	.497	.464	.300	.356	.348	.527
9+	.769	.509	.463	.678	.667	.460	.497	.464	.300	.356	.348	.527
(2- 6)U	.664	.467	.349	.384	.453	.468	.434	.347	.375	.328	.488	.406
(2- 8)U	.688	.473	.363	.441	.498	.470	.434	.375	.356	.323	.456	.410

	1987	1988	1989	1975-87
1	.075	.154	.118	.135
2	.219	.299	.213	.302
3	.373	.401	.419	.435
4	.465	.455	.509	.479
5	.440	.421	.597	.496
6	.346	.507	.649	.416
7	.154	.185	.486	.409
8	.183	.159	.582	.479
9+	.183	.159	.582	.479
(2- 6)U	.369	.417	.477	
(2- 8)U	.311	.347	.494	

Table 3.3.22 Final VPA with age 1 in 1989 adopted as the average of 1975-1987 values.

HERRING IN THE COASTAL AREAS 25, 26 AND 27

STOCK SIZE IN NUMBERS UNIT: millions

BIOMASS TOTALS UNIT: tonnes

ALL VALUES, EXCEPT THOSE REFERRING TO THE SPAWNING STOCK ARE GIVEN FOR 1 JANUARY; THE SPAWNING STOCK DATA REFLECT THE STOCK SITUATION AT SPAWNING TIME, WHEREBY THE FOLLOWING VALUES ARE USED: PROPORTION OF ANNUAL F BEFORE SPAWNING: .350
PROPORTION OF ANNUAL M BEFORE SPAWNING: .300

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	3088	3326	4299	3088	1886	2477	5180	3016	2560	2519	3364	2581
2	1322	1623	1909	2585	2028	1315	1476	3505	2086	1828	1725	2296
3	825	646	743	1040	1249	1058	661	764	1930	1284	1173	1091
4	249	343	270	367	549	510	459	317	369	884	720	638
5	128	83	145	140	202	248	225	201	174	177	387	330
6	61	39	38	72	76	99	107	106	102	93	91	124
7	22	24	23	22	30	37	51	53	57	48	50	35
8	4	8	11	12	10	13	17	26	26	30	27	25
9+	36	20	108	28	17	34	68	51	35	2	29	11
TOTAL NO	5737	6112	7545	7354	6047	5792	8244	8041	7338	6867	7564	7130
SPS NO	1903	2005	2474	3192	3087	2468	2306	3810	3707	3451	3275	3550
TOT.BIOM	296741	302299	365784	419247	412284	367877	389911	472696	466743	442226	347540	306716
SPS BIOM	172108	175815	220869	275686	282123	242007	223978	319783	298328	286200	218111	203527

	1987	1988	1989	1990	1975-87
1	2505	1805	[illegible]	0	-
2	1699	1721	1147	2109	1954
3	1409	1010	945	687	1067
4	587	719	501	460	482
5	297	273	338	223	210
6	129	142	133	138	88
7	60	68	63	51	39
8	19	38	42	29	18
9+	7	12	24	27	34
TOTAL NO	6714	5788	6259		
SPS NO	3293	3063	2450		
TOT.BIOM	315290	293931	326579		
SPS BIOM	195606	199554	171877		

Table 3.3.23 RCRTINX2 analysis for herring in Sub-divisions 25-27 coastal stock.
CO HERRING, POLISH YOUNG FISH SURVEY - 0 AND 1 AGE GROUPS

Data for 2 surveys over 14 years
REGRESSION TYPE = C
TAPERED TIME WEIGHTING NOT APPLIED
PRIOR WEIGHTING NOT APPLIED
FINAL ESTIMATES SHRUNK TOWARDS MEAN
ESTIMATES WITH S.E.'S GREATER THAN THAT OF MEAN INCLUDED
MINIMUM S.E. FOR ANY SURVEY TAKEN AS .00
MINIMUM OF 5 POINTS USED FOR REGRESSION

Yearclass = 1988

Survey/ Series	Index Value	Slope	Inter- cept	Rsquare	No. Pts	Predicted Value	Sigma	Standard Error	Weight
QUART4	7.4212	.607	3.594	.1091	11	8.0968	.95120	.99453	.07892
QUART1	8.7855	.838	1.218	.1050	11	8.5775	.97227	1.03444	.07294
MEAN						7.9423	.30336	.30336	.84814

Yearclass = 1989

Survey/ Series	Index Value	Slope	Inter- cept	Rsquare	No. Pts	Predicted Value	Sigma	Standard Error	Weight
QUART4	8.0003	.607	3.594	.1091	11	8.4482	.95120	1.00565	.07718
QUART1	8.4902	.838	1.218	.1050	11	8.3302	.97227	1.02245	.07466
MEAN						7.9423	.30336	.30336	.84815

Yearclass		Weighted Average Prediction	Internal Standard Error	External Standard Error	Virtual Population Analysis	Ext.SE/ Int.SE
1988	8.00	2983.46	.28	.12		.42
1989	8.01	3011.86	.28	.11		.41

Table 3.3.24
List of input variables for the ICES prediction program.

HERRING IN SUB-DIVISIONS 25-27 COASTAL STOCK
The reference F is the mean F for the age group range from 2 to 6

The number of recruits per year is as follows:

Year	Recruitment
1990	3068.0
1991	3068.0
1992	3068.0

Proportion of F (fishing mortality) effective before spawning: .3500
Proportion of M (natural mortality) effective before spawning: .3000

Data are printed in the following units:

Number of fish:	millions
Weight by age group in the catch:	gram
Weight by age group in the stock:	gram
Stock biomass:	tonnes
Catch weight:	tonnes

age	stock size	fishing pattern	natural mortality	maturity ogive	weight in the catch	weight in the stock
1	3068.0	.13	.30	.00	23.492	23.492
2	2109.0	.30	.30	.90	45.906	45.906
3	687.0	.44	.30	1.00	63.588	63.588
4	460.0	.48	.30	1.00	79.496	79.496
5	223.0	.50	.30	1.00	94.862	94.862
6	138.0	.42	.30	1.00	104.852	104.852
7	51.0	.41	.30	1.00	112.692	112.692
8	29.0	.48	.30	1.00	122.666	122.666
9+	17.0	.48	.30	1.00	129.270	129.270

Table 3.3.25 Status quo catch.

Effects of different levels of fishing mortality on catch, stock biomass and spawning stock biomass.

HERRING IN SUB-DIVISIONS 25-27 COASTAL STOCK

Year 1990					Year 1991					Year 1992	
fac-tor	ref. F	stock biomass	sp.stock biomass	catch	fac-tor	ref. F	stock biomass	sp.stock biomass	catch	stock biomass	sp.stock biomass
1.1	.47	298	170	77	.0	.00	301	201	0	391	282
					.1	.04		198	8	381	270
					.2	.09		195	17	372	258
					.4	.17		190	32	355	236
					.6	.26		185	46	339	216
					.8	.34		180	60	324	198
					1.0	.43		175	72	309	182
					1.2	.51		170	84	296	167
					1.4	.60		166	95	284	153
					1.6	.68		161	105	273	141
					1.8	.77		157	114	262	130
					2.0	.85		152	123	252	120

The data unit of the biomass and the catch is 1000 tonnes.
The spawning stock biomass is given for the time of spawning.
The spawning stock biomass for 1992 has been calculated with the same fishing mortality as for 1991.
The reference F is the mean F for the age group range from 2 to 6

Table 3.4.1 SUM OF PRODUCTS CHECK

HERRING IN THE GULF OF RIGA
CATEGORY: TOTAL

CATCH IN NUMBERS UNIT: millions

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	77	4	2	0	4	32	10	1	8	15	19	11
1	546	795	105	87	303	112	426	70	112	77	101	63
2	383	628	770	294	303	563	237	885	97	177	126	173
3	410	131	154	578	299	288	364	141	404	104	100	112
4	149	114	54	60	326	157	160	110	39	343	55	83
5	49	36	35	17	38	161	59	35	36	22	133	51
6	45	13	13	17	9	15	81	16	9	19	11	72
7	2	15	7	2	13	2	4	16	3	7	9	7
8	1	0	5	1	3	2	4	1	5	3	2	3
9	2	0	1	1	1	2	2	0	0	2	1	0
10+	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	1662	1737	1147	1057	1298	1335	1346	1274	714	769	555	575

	1982	1983	1984	1985	1986	1987	1988	1989
0	1	3	2	4	1	1	1	15
1	80	50	44	23	9	70	6	61
2	96	225	152	284	107	49	198	47
3	117	138	255	204	247	110	113	493
4	69	78	96	122	111	205	112	143
5	43	39	57	32	67	75	145	76
6	30	23	33	24	20	32	39	54
7	25	16	15	8	8	5	28	7
8	2	9	10	4	4	1	4	5
9	1	1	2	2	2	1	2	0
10+	1	0	1	1	1	0	0	0
TOTAL	464	581	665	707	574	549	647	901

Table 3.4.2 SUM OF PRODUCTS CHECK

HERRING IN THE GULF OF RIGA
CATEGORY: TOTAL

MEAN WEIGHT AT AGE IN THE CATCH   UNIT: gram

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	6.1	4.5	7.0	7.0	6.1	5.8	5.8	2.9	5.3	6.3	7.1	7.6
1	12.7	12.2	15.4	16.3	13.8	14.2	12.2	13.2	9.8	12.2	14.5	12.1
2	19.2	19.2	21.0	21.3	18.3	17.3	18.5	16.0	17.7	16.2	20.1	21.6
3	24.3	26.5	31.4	28.0	26.0	22.5	24.1	22.7	21.9	23.4	24.1	28.8
4	29.2	34.8	40.9	34.9	32.3	32.2	29.2	26.9	27.3	27.6	32.1	33.4
5	33.0	42.9	46.2	42.4	37.7	33.8	30.5	29.5	31.1	29.8	39.3	39.0
6	46.0	64.6	40.0	45.8	41.3	39.1	39.3	31.2	30.4	34.0	45.6	43.9
7	45.0	45.0	68.2	45.0	54.3	47.3	38.3	29.4	38.1	36.8	53.3	49.9
8	50.0	50.0	54.4	50.0	66.6	43.2	39.7	50.0	50.0	36.3	70.3	55.3
9	55.0	55.0	60.3	55.0	50.5	55.0	65.8	55.0	55.0	35.6	72.3	83.4
10+	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	90.0

	1982	1983	1984	1985	1986	1987	1988	1989
0	5.4	5.7	5.4	6.0	6.0	6.0	6.6	6.7
1	14.1	13.8	10.0	12.9	12.6	10.1	11.7	12.0
2	21.4	19.3	15.0	17.2	19.8	15.4	18.6	14.8
3	28.7	27.6	21.5	20.8	25.6	19.7	21.0	16.6
4	35.7	37.9	28.1	27.8	31.4	26.3	27.3	19.6
5	37.2	41.6	34.3	35.8	40.2	30.3	36.8	23.0
6	45.1	50.9	39.1	48.7	46.2	37.9	43.4	31.5
7	50.3	61.0	49.1	53.1	63.9	43.1	58.6	38.2
8	62.4	93.6	51.2	59.1	65.3	40.6	61.1	34.0
9	84.5	57.3	73.4	75.8	77.7	140.3	100.1	57.7
10+	143.0	.0	84.9	85.0	85.0	.0	100.1	61.4

Table 3.4.3

Title : HERRING IN THE GULF OF RIGA
At 11.42.02 25 APRIL 1990
from 70 to 89 on ages 1 to 7
with Terminal F of .450 on age 4 and Terminal S of 1.300

Initial sum of squared residuals was 83.327 and
final sum of squared residuals is 18.550 after 112 iterations

Matrix of Residuals

Years	70/71	71/72	72/73	73/74	74/75	75/76	76/77	77/78	78/79
Ages									
1/ 2	.753	.973	-.071	.153	.630	.525	.118	.308	.807
2/ 3	.682	1.127	.088	.237	.101	.462	.123	.299	.132
3/ 4	.148	-.048	.143	.246	.065	-.055	.112	.206	-.149
4/ 5	-.078	-.072	.076	-.123	-.169	.008	.085	-.220	.055
5/ 6	-.464	-.470	-.558	-.066	-.155	-.510	-.346	-.181	-.026
6/ 7	-1.078	-1.195	.113	-.759	-.046	-.075	-.424	-.260	-.612
	.000	.000	.000	.000	.000	.000	.000	.000	.000
WTS	.100	.100	.100	.100	.100	.100	.100	.100	.100

Years	79/80	80/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88	88/89		WTS
Ages												
1/ 2	.379	.810	.582	.149	.250	-.943	-.483	-.503	.350	-.669	.000	.248
2/ 3	.395	.420	.353	-.218	.189	-.422	.167	.138	-.450	-.542	.000	.337
3/ 4	-.056	-.003	-.047	.070	.176	.106	.169	-.099	-.094	-.340	.000	.909
4/ 5	.061	-.298	-.071	.046	-.066	.276	-.012	-.058	.113	.109	.000	1.000
5/ 6	-.262	.133	-.306	-.023	-.322	-.082	-.231	.176	.335	.604	.000	.441
6/ 7	-.489	-.404	-.057	-.252	-.312	.158	.096	.564	-.447	1.137	.000	.248
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.531	
WTS	.100	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000		

Fishing Mortalities (F)

	70	71	72	73	74	75	76	77	78	79
F-values	1.3361	1.0909	.8894	.7038	.6980	1.0123	1.2200	.7190	.5153	.5545

	80	81	82	83	84	85	86	87	88	89
F-values	.4167	.5066	.4374	.4482	.5502	.4120	.3415	.3186	.3735	.4500

Selection-at-age (S)

	1	2	3	4	5	6	7
S-values	.0895	.4076	.7622	1.0000	1.2003	1.4103	1.3000

Table 3.4.4 VIRTUAL POPULATION ANALYSIS

HERRING IN THE GULF OF RIGA

FISHING MORTALITY COEFFICIENT   UNIT: Year-1   VARIABLE NATURAL MORTALITY COEFFICIENT

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	.392	.259	.089	.076	.188	.163	.142	.099	.127	.094	.107	.078
2	.278	1.014	.404	.356	.387	.587	.566	.456	.184	.301	.231	.283
3	1.008	.813	.700	.568	.700	.734	.912	.747	.366	.304	.293	.352
4	1.167	.833	.913	.613	.695	.956	1.181	.759	.445	.605	.279	.452
5	1.051	1.027	.625	.799	.964	.856	1.201	.873	.539	.485	.537	.481
6	1.140	.882	1.406	.693	1.225	1.359	1.512	1.258	.559	.627	.476	.674
7	1.651	1.817	1.978	1.073	1.935	1.286	1.525	1.687	.913	1.074	.690	.796
8+	1.651	1.817	1.978	1.073	1.935	1.286	1.525	1.687	.913	1.074	.690	.796
(4- 7)U	1.260	1.140	1.230	.794	1.205	1.114	1.355	1.139	.614	.697	.495	.601
(2- 6)U	1.053	.914	.810	.606	.794	.899	1.075	.815	.419	.464	.363	.448

	1982	1983	1984	1985	1986	1987	1988	1989
1	.055	.044	.024	.025	.011	.028	.022	.040
2	.174	.227	.189	.210	.154	.077	.103	.241
3	.335	.431	.448	.413	.284	.236	.254	.396
4	.404	.414	.633	.400	.414	.404	.402	.591
5	.478	.447	.532	.443	.398	.551	.559	.526
6	.61[illegible]	.554	.985	.598	.542	.339	.622	.418
7	.550	.852	.878	.563	.414	.255	.556	.196
8+	.550	.852	.878	.563	.414	.255	.556	.196
(4- 7)U	.512	.562	.757	.501	.442	.387	.535	.433
(2- 6)U	.401	.415	.557	.413	.359	.322	.388	.435

Table 3.4.5 VIRTUAL POPULATION ANALYSIS

HERRING IN THE GULF OF RIGA

STOCK SIZE IN NUMBERS UNIT: millions

BIOMASS TOTALS UNIT: tonnes

ALL VALUES, EXCEPT THOSE REFERRING TO THE SPAWNING STOCK ARE GIVEN FOR 1 JANUARY; THE SPAWNING STOCK DATA REFLECT THE STOCK SITUATION AT SPAWNING TIME, WHEREBY THE FOLLOWING VALUES ARE USED: PROPORTION OF ANNUAL F BEFORE SPAWNING: .100
PROPORTION OF ANNUAL M BEFORE SPAWNING: .300

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	1802	3737	1337	1270	1899	802	3464	797	1007	967	1123	939
2	629	1048	2481	1053	1013	1354	537	2589	621	763	686	786
3	686	250	527	1426	535	592	643	287	1411	445	440	424
4	227	216	95	140	695	272	245	224	117	842	255	256
5	80	60	81	33	65	293	90	65	92	63	358	151
6	62	24	18	37	13	21	100	23	23	45	31	163
7	3	19	9	4	16	3	5	21	6	11	19	15
8+	3	1	8	3	5	6	8	1	10	9	6	7
TOTAL NO	3569	5353	4556	3966	4541	3350	5155	4005	3288	3149	2913	2740
SPS NO	1472	1332	2587	2357	2112	2170	1427	2736	2040	1867	1557	1547
TOT.BIOM	65702	34835	92335	91358	87881	63242	83390	67735	59267	62069	65783	63257
SPS BIOM	55773	32624	61544	61916	53420	48596	34667	49877	44244	43126	43097	44745

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1975-87
1	1691	1306	2065	1028	899	2807	505	1707	0	1453
2	677	1247	974	1651	821	728	2235	243	1343	1037
3	451	443	774	660	1096	576	552	1651	156	635
4	232	257	224	405	357	675	372	350	910	335
5	127	121	132	97	222	193	369	204	159	155
6	73	61	60	57	51	122	91	173	99	65
7	65	30	27	20	26	24	71	40	93	21
8+	9	13	22	15	19	10	15	33	49	11
TOTAL NO	3335	3484	4278	3934	3491	5135	4002	4402		
SPS NO	1421	1864	1925	2530	2294	2065	3250	2383		
TOT.BIOM	71623	75801	67543	74913	81050	80640	89504	71157		
SPS BIOM	41503	49709	40855	53888	61913	46514	75610	44952		

Table 3.4.6
List of input variables for the ICES prediction program.

HERRING-RIGA PREDICTION
The reference F is the mean F for the age group range from 4 to 7

The number of recruits per year is as follows:

Year	Recruitment
1990	1707.0
1991	1453.0
1992	1453.0

Proportion of F (fishing mortality) effective before spawning: .1000
Proportion of M (natural mortality) effective before spawning: .3000

Data are printed in the following units:

Number of fish: millions
Weight by age group in the catch: gram
Weight by age group in the stock: gram
Stock biomass: tonnes
Catch weight: tonnes

age	stock size	fishing pattern	natural mortality	maturity ogive	weight in the catch	weight in the stock
1	1707.0	.03	.20	.00	11.850	11.850
2	1343.0	.17	.20	.93	16.700	16.700
3	156.0	.32	.20	.98	18.800	18.800
4	910.0	.50	.20	.98	23.450	23.450
5	159.0	.54	.20	1.00	29.900	29.900
6	99.0	.52	.20	1.00	37.450	37.450
7	93.0	.38	.20	1.00	48.400	48.400
8+	49.0	.38	.20	1.00	47.550	47.550

Table 3.4.7

Effects of different levels of fishing mortality on catch, stock biomass and spawning stock biomass.

HERRING-RIGA PREDICTION

Year 1990					Year 1991					Year 1992	
factor	ref. F	stock biomass	sp.stock biomass	catch	factor	ref. F	stock biomass	sp.stock biomass	catch	stock biomass	sp.stock biomass
1.0	.49	82	54	17	.0	.00	82	59	0	100	76
					.1	.05		59	2	98	74
					.2	.10		59	4	96	71
					.4	.19		58	7	92	67
					.6	.29		58	11	88	63
					.8	.39		58	14	85	60
					1.0	.49		57	17	82	57
					1.2	.58		57	19	79	54
					1.4	.68		56	22	76	51
					1.6	.78		56	24	74	49
					1.8	.87		56	27	71	46
					2.0	.97		55	29	69	44

The data unit of the biomass and the catch is 1000 tonnes.
The spawning stock biomass is given for the time of spawning.
The spawning stock biomass for 1992 has been calculated with the same fishing mortality as for 1991.
The reference F is the mean F for the age group range from 4 to 7

Table 3.4.8

11.58.25 25 APRIL 1990
HERRING-RIGA PREDICTION

****
* Year 1990. F-factor 1.000 and reference F .4850 *
****

age	absolute F	catch in numbers	catch in weight	stock size	stock biomass	at 1 January sp.stock size	at 1 January sp.stock biomass	at spawning time sp.stock size	at spawning time sp.stock biomass
1	.0300	45.748	542.1	1707.00	20227.9	.00	.0	.00	.0
2	.1700	190.834	3186.9	1343.00	22428.1	1248.99	20858.1	1156.43	19312.3
3	.3200	38.926	731.8	156.00	2932.8	152.88	2874.1	139.44	2621.5
4	.5000	327.219	7673.3	910.00	21339.5	891.80	20912.7	798.90	18734.3
5	.5400	60.669	1814.0	159.00	4754.1	159.00	4754.1	141.87	4241.9
6	.5200	36.697	1374.3	99.00	3707.5	99.00	3707.5	88.51	3314.7
7	.3800	26.816	1297.9	93.00	4501.2	93.00	4501.2	84.32	4081.0
8+	.3800	14.129	671.8	49.00	2330.0	49.00	2330.0	44.43	2112.4
Total		741.037	17292.2	4516.00	82221.1	2693.67	59937.8	2453.90	54418.2

****
* Year 1991. F-factor 1.000 and reference F .4850 *
****

age	absolute F	catch in numbers	catch in weight	stock size	stock biomass	at 1 January sp.stock size	at 1 January sp.stock biomass	at spawning time sp.stock size	at spawning time sp.stock biomass
1	.0300	38.940	461.4	1453.00	17218.1	.00	.0	.00	.0
2	.1700	192.719	3218.4	1356.27	22649.7	1261.33	21064.2	1167.85	19503.1
3	.3200	231.474	4351.7	927.66	17439.9	909.10	17091.1	829.20	15588.9
4	.5000	33.349	782.0	92.75	2174.9	90.89	2131.4	81.42	1909.4
5	.5400	172.427	5155.6	451.89	13511.6	451.89	13511.6	403.20	12055.8
6	.5200	28.120	1053.1	75.86	2841.0	75.86	2841.0	67.82	2540.0
7	.3800	13.895	672.5	48.19	2332.3	48.19	2332.3	43.69	2114.6
8+	.3800	22.925	1090.1	79.51	3780.5	79.51	3780.5	72.08	3427.6
Total		733.849	16784.8	4485.12	81948.0	2916.77	62752.1	2665.27	57139.4

cont'd.

Table 3.4.8 cont'd.

****
* Year 1992. F-factor 1.000 and reference F .4850 *
****

						at 1 January		at spawning time	
age	absolute F	catch in numbers	catch in weight	stock size	stock biomass	sp.stock size	sp.stock biomass	sp.stock size	sp.stock biomass
1	.0300	38.940	461.4	1453.00	17218.1	.00	.0	.00	.0
2	.1700	164.043	2739.5	1154.46	19279.4	1073.65	17929.9	994.08	16601.1
3	.3200	233.761	4394.7	936.82	17612.2	918.09	17260.0	837.39	15742.9
4	.5000	198.313	4650.4	551.51	12932.9	540.48	12674.3	484.18	11354.0
5	.5400	17.573	525.4	46.06	1377.1	46.06	1377.1	41.09	1228.7
6	.5200	79.920	2993.0	215.60	8074.4	215.60	8074.4	192.76	7218.9
7	.3800	10.647	515.3	36.93	1787.2	36.93	1787.2	33.48	1620.4
8+	.3800	20.615	980.3	71.50	3399.6	71.50	3399.6	64.82	3082.3
Total		763.813	17260.1	4465.87	81680.9	2902.29	62502.4	2647.80	56848.2