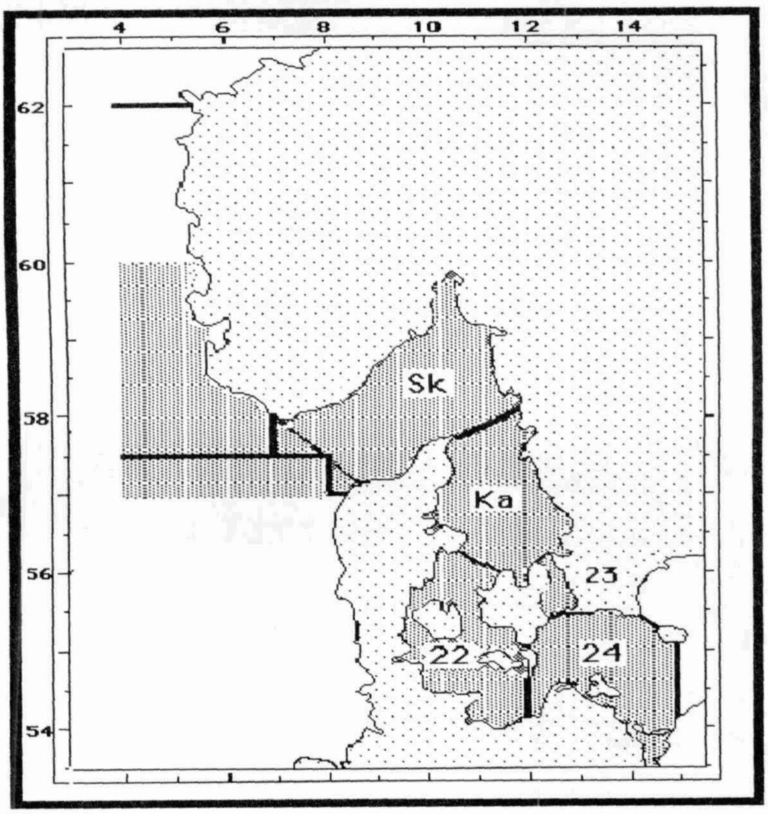
Resource Management Committee

ICES CM 1998/D:1
Ref. H

REPORT OF THE

STUDY GROUP ON THE STOCK STRUCTURE OF THE BALTIC SPRING-SPAWNING HERRING

Lysekil, Sweden
12–16 January 1998



This report is not to be quoted without prior consultation with the General Secretary. The document is a report of an expert group under the auspices of the International Council for the Exploration of the Sea and does not necessarily represent the views of the Council.

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

Palægade 2–4 DK-1261 Copenhagen K Denmark

Table of Contents

1 Introduction

1.1 Terms of reference

During the ICES 1997 Annual Science Conference (85th Statutory Meeting) in Baltimore, USA, it was decided (C. Res. 1997/2:34), that a Study Group on the Stock Structure of the Baltic Spring Spawning Herring (SGSSBH) should meet at the Institute for Marine Research, Lysekil, Sweden from 12 to 16 January 1998 to:

a) formulate a migration model of Western Baltic spring-spawning herring that is consistent with present knowledge and which can be used on a routine basis for assessment purposes. The model should be linked to the results of an evaluation of the methodology on separation of stocks;

b) compare the methodologies for stock discrimination by vertebrae counts or otolith analyses and start to update the historical split between spring and autumn-spawning components in Division IIIa;

c) review and update catch at age and mean weight at age data for all fishing fleets that catch herring in Division IIIa and Sub-divisions 22-24. The task should include the possibility of a revised sampling regime of affected fleets;

d) review and test consistency among existing results from research survey and adapt future sampling to the requirements for validating the migration model.

1.2 Participation

The meeting was attended by:

Fredrik Arrhenius	Sweden
Jorgen Dalskov (Chairman)	Denmark
Joachim Gröger	Germany
Tomas Gröhsler	Germany
Georgs Kornilovs	Latvia
Johan Modin	Sweden
Henrik Mosegaard	Denmark
Bengt Sjöstrand	Sweden

1.3 Background

Herring caught in Division IIIa is a mixture of North Sea autumn spawners and Baltic spring spawners. In assessment, all spring spawners caught in the eastern part of the North Sea, Skagerrak and Kattegat and Sub-division 22, 23 and 24 are considered to be one stock with spawning grounds round the island Rügen in the Western Baltic area.

Since 1993, the Herring Assessment Working Group for the Area South of 62° N (HAWG) has encountered severe problems in assessing the status of the spring spawning stock in Division IIIa and Sub-division 22, 23 and 24. These problems have repeatedly been described over the past years by the HAWG. The problems originate from two sources.

Firstly, year and age trends are in conflict between survey indices and the commercial catch data. Some of the indices are internally inconsistent, often demonstrating negative mortality. Furthermore, tuning of the catch data by individual surveys has resulted in conflicting estimates of SSB and fishing mortalities.

The second cause for concern is the estimate of the proportion of North Sea autumn spawners in the total landings in the Sub-division 22-24 and Division IIIa. This proportion varies significantly between years.

In view of the important consequences of applying the present splitting method when classifying the mixed stocks into North Sea autumn spawners and Western Baltic spring spawners, the method had to be reviewed and optionally replaced by other methods.

At the HAWG meeting in 1997 (ICES CM1997/Assess:8) the problems listed above were addressed and it was recommended, that a Study Group should initiate inter-sessionally work on the above issues.

2. Stock components of Western Baltic herring

2.1 General knowledge

Herring in the Kattegat, Skagerrak and Western Baltic can be separated into several autumn and spring-spawning stocks. The identification of spawning components have been based on morphometric and meristic characters observed from samples at different spawning sites and seasons (e.g. Heinke, 1898; Jensen, 1957). Rosenberg and Palmén (1981) used vertebrae counts (VS), numbers of keeled scales and the 1st winter ring (1st WR) on otoliths to identify seven spawning components in the Kattegat, Skagerrak and Western Baltic. They further used length distributions obtained during the IBTS survey in 1980 to quantify the three main components of herring stocks in the Skagerrak and Kattegat: North Sea autumn spawners (NSAS), coastal Kattegat Winter spawners (KWS) and spring spawners. The latter could be further subdivided into Skagerrak spring spawners (SSS) and Baltic spring spawners (WBSS).

The herring in the western Baltic have been separated into three spring spawning and one autumn spawning components (Aro, 1989). The Baltic Fisheries Assessment WG has taken a more holistic approach and recognises at present only one spring spawning component in Sub-divisions 22 and 24; the WBSS stock.

Knowledge of migration patterns and spatial distributions are schematic. The NSAS enters Skagerrak and Kattegat as larvae (Johannessen & Moksness 1991) and migrates before maturation back to the North Sea at an age of 2-3 years (Rosenberg & Palmén, 1982). The WBSS spawns around the Baltic islands Rügen and is mixed with other Baltic spring spawners present in the SW Baltic (Aro 1989). Tag recaptures demonstrate that spent and some immature WBSS migrates northwards after spawning to the Sound, the Belt Sea, the Kattegat, the Skagerrak and the North Sea (Biester, 1979). An unknown proportion of the adult herring remains in the SW Baltic. A return migration starting in the 3rd quarter back to the spawning areas around Rügen can be inferred from tagging experiments in the Kattegat (Ackefors, 1978). A southward migration can also be inferred from hydro-acoustic surveys in the Sound during 1995 to 1996, which revealed large quantities of herring in the Sound from September to April.

Cross-fertilisation experiments between NSAS and WBSS suggest that meristic characters like VS correlate inversely with prevailing temperatures of prehatched larvae (Hempel & Blaxter 1961). The experimental results also indicate that this response to temperature might be inherited. However, genetic studies by various techniques have not confirmed genetic isolation between herring stocks (Ryman et al., 1984; Dahle & Eriksen, 1990).

2.2 Stock separation methods

Herring stocks in the Division IIIa and the western Baltic have traditionally been separated by average vertebrae (VS) counts (e.g. Jensen, 1957). Linear regression techniques and discriminant analysis have been applied in order to estimate fractions of spring and autumn spawners in Division IIIa (Gröger & Gröhsler, 1995, 1996). It was assumed that the NSAS had a mean of 56.53 equal to the observed VS, while the WBBS was represented by a lower mean number of 55.62. However, one local spring-spawning herring, the SSS are represented by a higher mean VS, 57.0 (Rosenberg & Palmén, 1981). Therefore, the estimate of the NSAS fraction will be influenced to an unknown extent by the SSS stock component.

Johannessen and Jorgensen (1992) used 15 morphometric and 4 meristic characters in a multivariate analysis to separate stocks in the North Sea, Division IIIa and the western Baltic. Their study showed a classification success of 90-95 %. Although the results are encouraging the approach would require a too large sampling for routine monitoring of the different stocks.

An ICES study group in 1992 (ICES 1992/H:5) evaluated the applicability of separation methods. The group concluded that a simple modal length analysis of the 2+ age groups might be precise enough for routine assessment purposes. In practice, modal length analysis has proved to be an imprecise measure requiring a large sampling effort. Experience within the HAWG showed that the separation procedure often failed. Instead, the method has been supplemented by linear regression techniques on VS counts. However, the amounts of herring catches that was allocated to the NSAS stock have varied between 30 to 50% of total annual landings during the last 10 years. Errors in the estimate of this withdrawal will clearly affect the quality of the assessment of the WBSS stock.

A potent separation method is based on the observation, that the diameter of the first Winter ring (annuli), on the otoliths of autumn spawners, is significantly larger than for spring spawners (Rosenberg & Palmén, 1982). The analysis of otolith annuli has however not been applied on a routine basis in the Kattegat-Skagerrak area. New image analysis systems have improved the possibility for fast and reliable analyses.

Microstructural otolith analysis have, also been tested to separate spring and autumn spawners (Moksness & Fossum, 1991). Larval otolith growth, which can be inferred from primary increment widths on otoliths of adults, is significantly slower for autumn spawners. Mosegaard & Popp-Madsen (1996) showed that the processing speed of the analysis can be accelerated by image analysis and training. The disadvantage of a lower number measurements compared with the present sampling of VS are outweighed by a higher precision.

Stock separation of herring in the Division IIIa and neighbouring seas by genetic analysis (enzymes or mitochondrial DNA) have not been successful (Ryman et al., 1984; Dahle & Eriksen, 1990) or at least not conclusive (Naevdal et al., 1997).

Lipid compositions in the heart tissues have been used to separate North Sea and Baltic herring with some success (Grahl-Nielsen & Ulvlund, 1990). The approach seems to offer a potential for individual discrimination (ICES 1992/H:5) but have not yet been developed as a routine tool.

2.3 Failure of the analysis of modal length – VS count method

A workshop on methods to separate autumn and spring spawners was conducted (ICES1992/H:5) after a series of failures using modal length analysis on 0- and 1-groups in Division IIIa. The 1992 workshop recommended the use of discriminant analysis on morphometric characters, continuation of VS counts until further development of other methods, development of otolith microstructure analysis especially on adult fish and evaluating discrimination by fatty acid analysis.

2.4 Herring stocks as perceived by the HAWG

Catches of herring in the Division IIIa (the Kattegat and the Skagerrak) have in assessment relations been assigned to two main components:

- The Baltic/Division IIIa spring spawners
- The North Sea autumn spawners

Recent assessments of herring in Div IIIa and SV Baltic have been based on the assumption that the influence of local stocks on the herring dynamics has minor importance.

2.5 A revised discrimination based on Swedish and Danish herring samples using VS counts.

In order to analyse the differences of two mixed herring populations in Div. IIIa and to be able to separate them two learning samples of vertebrae counts were taken in 1995. Theory, models, data and results were presented in Gröger & Gröhsler (1995a,b, 1996).

Regression approach

The regression approach was performed as described in Gröger & Gröhsler (1995a, b, 1996) and can be written in matrix algebra as:

$$vc = [1\ area]\begin{bmatrix} a \\ b \end{bmatrix} + u$$

$$= \quad X \quad \beta \ + u$$

where the design matrix X consists of a dummy coded variable, area (= area code) and a vector of ones. The estimation of the regression coefficients $\hat{\beta} = (X\_X)^{-1} X\_VS$ was done by the ordinary least squares technique (OLS) where the vector $\hat{\beta}$ contains the two regression coefficients â and ^b. VS means vertebra counts. The hats on $\hat{\beta}$, â and b,^ indicate that these are estimators and not the associated unknown exact values. For statistical and mathematical details see Dhrymes 1985, Fahmeir et al. 1984, Hartung et al. 1989, Lütkepohl 1992, Neter et al. 1985.

The identification of the above linear herring regression model was based on 396 observations from the North Sea and 353 observations from the Baltic (two learning samples from 1995). The estimated OLS parameters of the model are a = 56.53 for the intercept and b = 0.91 for the slope which corresponds to a North Sea sample mean of 56.53 and a Baltic sample mean of 55.62. These values inserted into the above equation gives

$$VS\,(area) = 56.53 - 0.91\; x\; area$$

or inverted

$$\hat{area}\,(VS_{new}) = \frac{56.53 - VS_{new}}{0.91}$$

which forms the basis for all calculations carried out here in order to split given herring samples into a Baltic and a North Sea component. This was done by inserting the sample mean VS into the above equation leading to the corresponding proportion of Baltic herring individuals of the underlying sample. It is complement gives the proportion of North Sea herring.

The herring samples, which were analysed during the study group meeting, are based on two time series, one from Sweden (of the years 1991 to 1997) and one from Denmark (of the years 1984 to 1995). The calculation units were hauls defined by year, quarter, area (either on the basis of ICES rectangles or on the basis of the three areas Skagerrak, Kattegat and Sound) and age class. Additionally the Swedish data on herring proportions were multiplied with associated catch weights leading to results on proportions in catch per unit effort terms, CPUE, here given as weight in kg. Due to a model artefact in some cases the calculations gave negative fractions and probabilities, respectively (see Gröger & Gröhsler 1995a,b, 1996). Hence the following range correction was applied

$$Prop\;(Baltic\;)^{corr.} = \left[\frac{Prop(Baltic) - \text{Min}\;(Prop(Baltic))}{\text{Max}\;(Prop(Baltic)) - \text{Min}\;(Prop(Baltic))}\right]$$

$$Prop\;(N.S.\;)^{corr.} = \left[\frac{Prop(N.S.) - \text{Min}\;(Prop(N.S.))}{\text{Max}\;(Prop(N.S.)) - \text{Min}\;(Prop(Baltic))}\right]$$

or

$$Prop\;(N.S.\;)^{corr.} = 1 - Prop\;(Baltic\;)^{corr}$$

which shifts the values linearly into the [0,1] interval without changing the underlying shape of the distribution (see Burkhart et al. 1974). The whole output is given in Appendix 1.

Discriminant analysis

The linear approach has some disadvantages. One is the fact that negative fractions may result. The other is that the variability in the learning samples are neglected.

This is the reason why the calculation of herring proportions based on discriminant decision rules are of a better statistical nature. The decision rules used here are expressed as Maximum Likelihood (ML) distance functions with heterogeneous (non-pooled) group variances, one function for the Baltic herring population, and another for the North Sea herring population (see eq. (4)). They measure the (average) number of vertebra of later routinely sampled herring (VS_{new}) as a difference from the mean vertebra count of either the Baltic ($\overline{VS_{Baltic}}$) or the North Sea herring population ($\overline{VS_{N.S.}}$)

$$d_{Baltic}(VS_{new}) = -\frac{1}{2}(VS_{new} - 55.62)^T\, 0.69^{-1}(VS_{new} - 55.62) - \frac{1}{2}\ln|0.69|$$
$$= -(VS_{new} - 55.62)^2 \times 0.725 + 0.186$$

$$d_{N.S.}(VS_{new}) = -\frac{1}{2}(VS_{new} - 56.53)^T\, 0.50^{-1}(VS_{new} - 56.53) - \frac{1}{2}\ln|0.50|$$
$$= -(VS_{new} - 56.53)^2 + 0.347$$

It can easily be seen that these distance functions contain the uncertainty of the learning samples. Simply spoken they are standardised through the inclusion of the associated inverse sample variances 0.69^{-1} for the Baltic and 0.50^{-1} for the North Sea (the ^{T}s mean that the associated column vectors are transposed to row vectors and the ||-sign means that this is the determinant of the variance-covariance matrix).

The decision rules (= distance functions) were then used to calculate so called posterior probabilities as expressed in the following equation.

$$Prop\,(Baltic\,|\,\overline{VS_{new}}) = \frac{e^{(d_{Baltic}(\overline{VS_{new}}))}}{e^{(d_{Baltic}(\overline{VS_{new}}))} + e^{(d_{N.S.}(\overline{VS_{new}}))}}$$

$$Prop\,(N.S.\,|\,\overline{VS_{new}}) = 1 - P(Baltic\,|\,\overline{VS_{new}})$$

The basic idea of these posterior probabilities is to allocate a single herring into that group for which this single herring receives the highest probability, i.e. for which the difference between average and individual vertebra number is smallest and for which the (underlying) distance function is largest, respectively.

In order to be comparable with historic procedures, sample means (not individual values) of the above defined calculation units were inserted into the equation. The results can then be interpreted as the herring proportion with "Baltic membership". Its complement gives the fraction of North Sea herring individuals.

The relatively good discriminatory power of the decision rules was checked earlier by calculating nonparametric misclassification and error rates, respectively, through jack-knifing (for reclassification purposes exactly one single herring from the calculation of the decision rules was left out) and bootstrapping (which excludes not only one but by random a larger subset of herring data from the calculation of the decision rules for any reclassification). For further statistical and mathematical details see Dhrymes 1985, Fahmeir et al. 1984, Hartung et al. 1989, Lütkepohl 1992, Neter et al. 1985.

Comparison of both methods

Both methods were compared by calculating the VS for the above mentioned calculation units on the basis of ICES rectangles. A regression analysis was performed to identify the relationship between the linear and the corrected linear model, between the linear and the discriminant model, and between the corrected linear and the discriminant model. In all three cases the fit was highly significant (p=0.0001) and was close to a R^2 of 1 which means that only a small amount of unexplained variation was left. The following 3 linear relationships were determined:

$$Lin.Balt.Prop. = 1.018871 + 3.137306 \times Discrim.Balt.Prop.$$

$$Corr.Lin.Balt.Prop. = 0.167243 + 0.878739 \times Discrim.Balt.Prop.$$

$$Lin.Balt.Prop. = 1.614577 + 3.567794 \times Corr.Lin.Balt.Prop.$$

where the first and the second fit each received an explained variation of about 98% (R^2=0.9794 and R^2=0.9786) and the third fit of nearly 100% (R^2=0.9994). Various F tests whether the deviations are significant or not (i.e. whether in all three cases the null hypotheses: intercept=0 or slope=1, can be rejected or not) lead to the conclusion that the deviations in each of the three cases were significant (p=0.0001).

Obviously the bias (deviation) between the splitting results of the corrected linear model and the discriminant function model is smallest since with 0.17 the intercept is much closer to 0 and with 0.90 the slope is much closer to 1 than in each of the two other cases. The reason is that this type of correction can be seen as the inclusion of an uncertainty and variation factor, respectively, which is standardizing the splitting values by its range. This is to some degree equivalent to a standardization through the variance. In case of the relationship between the uncorrected and the corrected linear model the variance is smallest since the corrected herring proportions are nothing else than a linear transformation (linear shift) of the uncorrected values. I.e., this type of transformation does not change the underlying distribution of the uncorrected values.

Appendix 1 shows the calculated proportion, using the Discriminant Model, of Western Baltic Spring spawners and North Sea autumn spawners in Swedish samples collected in Skagerrak, Kattegat and the Sound for 1991-1997 . Appendix 2 shows the result from Danish samples is shown for the years 1989 to 1995 also where the Discriminant has been used.

2.6 Comparisons using VS counts between Swedish and Danish samples

In order to compare the Danish and Swedish splitting results for the two separation rules (linear and discriminant) only a subset of 16 data points could be used due to a small geographical overlap of the corresponding calculation units between the two national surveys. The two different types of discrimination rules (plus the linear correction) were computed and their results were then compared and statistically tested by means of ANOVA and regression techniques.

A comparison of the national splitting results on the basis of the discriminant model by means of the regression technique lead to an insignificant relationship between the two national data sets ($p=0.0750$). This is also indicated by only 21% of explained variation ($R^2=0.2090$). Furthermore, the estimated intercept was highly insignificant, i.e. not significantly different from zero ($p=0.1288$). Therefore, a second regression without intercept was performed, i.e. the regression line is expected to go through the origin. This type of regression line is highly significant ($p=0.0001$) with about 91% of explained variation ($R^2=0.9104$). The slope of 1.0732 is significantly different from 0 (t test, $p=0.0001$) but not from 1 (F test, $p=0.7091$). This means that the splitting results of the two different national data sets on the basis of the discriminant model are free of any systematic deviation and can therefore be considered as approximately equal.

A comparison of the national splitting results on the basis of the corrected linear splitting model by means of the regression technique lead to an insignificant linear relationship ($p=0.0803$). This is further indicated by a high amount of about 80% of unexplained variation ($p=0.2024$). Therefore, also in this case a second type of regression without intercept was performed, i.e. the regression line is again expected to go through the origin. This type of regression is highly significant ($p=0.0001$) with about 90% of explained variation ($R^2=0.9104$). But in this case, the slope of 1.2331 is not only strongly significant from 0 (t test, $p=0.0001$) but also slightly different from 1 (F test, $p=0.0430$). This means that the splitting results of the two different national data sets on the basis of the corrected linear splitting model is not (like in case of the discriminant rules) purely free of any systematic deviation between the countries. Obviously, these differ slightly by a factor of 1.23.

2.7 Comparison between proportions using VS counts and otolith microstructure.

Analysis of otolith microstructure (OM) may distinguish between the hatching time on an individual level (Mosegaard & Popp-Madsen 1996). Therefore this method does readily separate the Rügen herring from any autumn or winter spawning populations but not necessarily from other local spring spawners in Div.IIIa. Until now the HAWG has applied the same mean weight at age for the NSAS and the WBSS in Div.IIIa. The OM method allows for using individual weight at age at the major stock level.

The Danish acoustic 1996 survey in the NS and Division IIIa was analysed using OM to separate Spring spawners from Autumn/Winter spawners. The results were calculated as the proportion Spring spawners per ICES rectangle and age class (age classes = winter ringers (WR) pooling >3 WR into a plus group). These OM results were compared to the results of a discriminant analysis of VS counts from the Swedish surveys in quarter III 1996 (see section 2.5), only samples where more than 7 individuals had been analysed were employed. A plot of OM identified proportions versus VS proportions exhibited a reasonable agreement applying a logistic transformation of the VS discriminant-proportions (fig. 2.7). The logistic transformation was applied to ensure a robust extrapolation where predicted proportions will be in the range from 0 to 1 over the entire range of possible proportions from the VS discriminant analysis.

3.0 Assessment data of the Western Baltic spring spawning herring stock

3.1 Catch at age data

As described in section 1.3, the HAWG has not succeeded in conducting a proper analytical assessment since 1993. Catch data have been produced yearly and in 1992 a general radical revision was conducted (ICES 1992/H:5). Despite these changes or revisions, total catch in numbers and mean weight, including all stocks in the area, still gives an unacceptable assessment.

3.2 Review on sampling levels in each country for the period 1991-1996

Denmark, Sweden, Germany, Poland and Norway carry out herring fishery in Division IIIA and Sub-Divisions 22-24. Sweden and Denmark carry out herring fishery in Skagerrak, Kattegat and Sub-Divisions 22-24, while Germany and Poland only have herring fishery in Sub-Divisions 22-24 and Norway only in Skagerrak.

The review of sampling levels in each country is made taking into account that the recommended level is one sample per 1000 t landed per quarter (Anon, 1997). Tables 3.2.1-3.2.7 show the calculated number of samples and the calculated number of fish aged per 1000 t of landings. Landings smaller than 1000 t were also taken into consideration when the level of sampling was calculated.

Table 3.2.1 shows the number of samples and number of fish aged per 1000 t of commercial catches in Sweden. The sampling of catches in Kattegat is on a high level. In comparison with previous years, the sampling level from commercial catches in Skagerrak in 1995-1996 has increased and is on an acceptable level, but it has considerably decreased in Sub-Divisions 22-24 and covers now only one quarter.

Table 3.2.2 shows the sampling intensity of herring landings in Denmark. The sampling level is high in Skagerrak. In Kattegat the samples are taken unevenly and the number of samples taken has decreased in the last years. In Sub-Divisions 22-24 the sampling has not reached the recommended level and in some quarters no samples are taken.

Table 3.2.3 shows the sampling of herring landings in Germany. Herring fishery is performed only in Sub-Divisions 22-24 and mainly in the first and the second quarters. The sampling level is acceptable and follows the fishing intensity in Germany.

Table 3.2.4 shows the sampling of Polish herring landings in Sub-Divisions 22-24. In general the sampling level is acceptable and corresponds to landing levels by quarter. No information was available on sampling in 1996.

Table 3.2.5 shows the sampling intensity of herring landings in Norway. The fishery is performed and samples are taken in Skagerrak. The sampling level is low and irregular.

Tables 3.2.6 and 3.2.7 shows the number of samples and number of fish aged per 1000 t of commercial catches by all the countries. The highest sampling level is in Kattegat. In Skagerrak it has substantially improved and reached the acceptable level. In Sub-Divisions 22-24 the sampling level in some quarters is still rather low. Considering that 100 fish aged could comprise one sample the herring ageing should be increased in Skagerrak and Sub-Divisions 22-24.

3.3 Comparisons on the age readings

Age readings on herring are conducted by counting dark winter rings in the Sagitta otoliths using reflected light. In the first half of the year the age is determined by the number of winter rings plus the edge and in the second half by the number of winter rings. The age determination of WBSS from Sub-division 24 has been found to produce a high degree of disagreement among readers (ICES 1997/J:5).

3.4 Geographical distribution of commercial catches

As can be seen in section 3.2, the number of samples collected from commercial landings has in some years been at an inadequate low level which has caused, that for some countries not all quarters have been covered by samples from commercial landings. Therefore, samples from other countries or other quarters had to be used when calculating landings in numbers and mean weight. The Study Group found that it was necessary to further analyse the geographical distribution of commercial catches, especially in Sub-division 22-24.

Only data from Sweden and Denmark were available on a rectangle basis at the meeting. Table 3.4.1 shows that the geographical distribution of the Danish and Swedish catches in Sub-division 24 are almost identical and almost all these catches are taken by trawlers using a mesh size of >=32mm. By-catches of herring in the small meshed (mesh-sizes below 32mm) fishery for sprat taken in the same rectangles are only minor.

The German total landihgs of herring caught in Sub-division 22 and 24 dropped in 1991 from a level around 55,000 tons to a level around 12,000 tons. A change in fishing pattern took place. In the years prior to 1991 trawlers were responsible for most of the catches (trawlers from the former GDR). From 1991 and onwards the fishery has been dominated by gill-net- and trap-net-catches exclusively located to the coastal regions of Germany.

No information on the geographical distribution of the Polish herring catches was available to the Study Group.

Only Denmark and Germany conduct herring fishery in Sub-division 22. In this area Danish catches are taken by gill-nets, trap-nets and trawls. Trawlers take the predominant part of the catches in the Great Belt and in the area to the North of the Danish island Fyn. Therefore, there is only an insignificant overlap in the geographical distribution of the Danish and the German catches in Sub-division 22.

As the fishing pattern is different from county to county, it is essential that all commercial fisheries are sampled adequately, since it is not possible to calculate numbers caught and mean weight using samples from other countries. In section 3.8 some guidelines to compile catch data for assessment purposes are listed.

3.5 Mean weight at age in the catches

Mean weight at age in the herring catches, show a very large variability. The largest differences in mean weight appear between herring caught in the Western Baltic and in Division IIIa (Table 3.5.1) with the herring in the Western Baltic having much lower weight at age. The weight of Western Baltic herring is app. 50% of the Division IIIa herring for 2-3 ringed fish and 70-80% for older herring. The present weights used by the HAWG for the total stock, are averages weighted by catches at age in the two areas. Figure 3.1 shows averages over 1991-96 for the weight at age in the two areas, and the weighted means used by the HAWG. The increasing proportion of Western Baltic herring older than 4-rings is clearly illustrated.

The mean weights for younger herring in Division IIIa are overestimating the weight for spring spawners since the weights are not adjusted when these age groups are split between autumn and spring spawners. Thus they reflect the weight of the autumn spawners since these constitute the dominant component.

The weights at age from the IBTS in February (average over 1991-96) are also presented in Figure 3.1. Their values lay between the weights from Western Baltic and Division IIIa. The values are closer to the Western Baltic for younger herring but approaches the values from Division IIIa catches for older fish.

The heavier older herring (≥ 4 WR) caught in Division IIIa are most likely not of Rügen origin. The fish that are going to spawn in the Western Baltic are, at the time of the IBTS, aggregated in the Sound or approaching their spawning areas. Neither are there any indications that they are North Sea autumn spawners. Their size at age and high number of vertebrae, make it probable that they are local Skagerrak Spring Spawners.

3.6 Summary of the identified problems on the catch at age data

The fishery for industrial purposes has decreased during recent years. The sampling scheme of catch at age for these purposes has generally been acceptable. However, there have been difficulties in getting samples in the directed herring consumption fishery in different areas (Anon. 1997/Assess: 8). Although the overall sampling meets the recommended level of one sample per 1000 t landed per quarter the distribution of the different fisheries by areas and seasons is not sampled adequately.

By using the vertebra counts in herring from surveys versus the same character from the fisheries by SD, year, quarter and age class, a difference was noted towards a higher mean VS in herring sampled from landings (Anon. 1997/Assess:8).

From 1987 and onwards the stocks have been split into spring and autumn spawners in Division IIIa and Subarea IVa. However in the light of the problems with the splitting methodology (stock separation, catch at age) it should be emphasised that the basis for this assessment of the stock relies on questionable catch data.

3.7 Survey data

3.7.1 Trawl surveys

The following trawl surveys are conducted every year:

- German bottom trawl survey (GBTS) in Sub-divisions 22 and 24 in November/December since 1979,
- German bottom trawl survey (GBTS) in Sub-division 24 in January/February since 1979,
- International bottom trawl survey (IBTS) in Division IIIa in quarter 1 (since 1974), quarter 3 (since 1990) and quarter 4 (1990-1996)

The main purpose of GBTS (gear: HG 20/25 with a net opening of about 4 m) is to estimate recruitment indices for cod stocks. IBTS is designed for herring (gear: GOV with a net opening of 5.5 m).

The actual survey design is creating the following problems:

- Since the German trawl type used was selected for catching pre-recruit cod and flatfishes it may not be optimal for catching herring.
- Most parts of Sub-division 22, some parts of Sub-division 24 and the Kattegat are dominated by shallow waters that are generally inaccessible below 10 m for research vessels.

3.7.2 Acoustic surveys

The following two acoustic surveys are carried out every year:

- Danish summer survey in Division IIIa in July/August since 1986,
- German/Danish survey in Sub-divisions 21-24 in September/October since 1987.

In addition a Danish/Swedish monitoring programme was carried out in Sub-division 23 in autumn/spring from 1993 to 1997.

The acoustic surveys are conducted every year to supply the HAWG with an index value for the stock size of herring in the Western Baltic area.
The main purpose of the acoustic monitoring in Sub-division 23 was to provide information for the evaluation of possible environmental impacts of the construction of the Sound bridge between Denmark and Sweden.

The following problems are not yet solved for the hydro-acoustic surveys (Anon. 1997/J:4):

- in some years the spatial coverage of the acoustic survey has varied due to national allocation of survey timing/ship time of the research vessel and due to failures of the vessels during the survey,

- incomplete spatial coverage during the survey in Sub-divisions 22, 23 and in some parts of 24, due to shallow water areas. These areas are inaccessible for the German RV 'Solea', and the Danish RV 'Dana',

- the actual TS constants used since 1983 represent in reality the North Sea herring properties, this may influence the results to a high degree, ,

- inconsistency of year-class estimates. In Sub-division 22 and 24 the 92, 93 and 94 year classes follow an expected decreasing trend with age. The 0-group had the highest estimated abundance and the age-classes decreased with age in a predictable way. This pattern was different in Sub-division 23 for the 93 and 94 year classes. The abundance estimates were increasing with age.

3.7.3 Larval survey

One German larval survey is carried out every year since 1977 from March/April to June on the main spawning grounds of the Western Baltic spring spawning herring in the Greifswalder Bodden and adjacent waters. To get the index for the estimation of the year-class strength used by the HAWG, the number of larvae which will reach the length of TL = 30 mm (larvae after metamorphosis) are calculated taking into consideration growth and mortality (Klenz 1993; Mueller & Klenz 1994).

Figure 3.7.3.1. show a plot of the larval index (0 group) and the estimated age 1 from the hydro-acoustic survey next year in SD 24. The expected trend that should show similar year class estimates in both series cannot be seen. Values estimated by the hydro-acoustic are always higher than the larval index, except for 1994-yearclass.

3.7.4 Summary on survey data

The problem of incomplete spatial coverage due to shallow water areas or administrative/economic constraints will remain in future acoustic surveys. A possible solution to this problem could be to identify those ICES rectangles within a Sub-division which are significantly correlated with the estimated stock number of the whole Sub-division (Anon. 1997/J:4). Another solution could be to use smaller research vessels.

The consistency of year class estimates should be checked for every survey. Following one year-class it is expected that the estimated numbers are decreasing. In the case of increasing numbers with age by year class (=negative mortalities), the 0 and 1 group of herring should not be used for assessment purposes until a better survey design is found to solve this problem.

Investigations should be carried out to find and verify a new TS conversion formula adequately reflecting the properties of the WBSS population. .

The following reasons could explain the unexpected differences in comparing the larval index values with the corresponding ones from the hydro-acoustic survey:

- Underestimating of the 0 group by the larval index which can be caused by survey design, calculation method etc.,
- Overestimating of the 0 group by the hydro-acoustic survey which can be caused by biological sampling method, TS-relationship, etc.,
- Assuming correct calculations in both series, additional local spawning stock components in SD 24 could explain the unexpected higher hydro-acoustic value for age 1.

The results of the Danish summer acoustic survey in Division IIIa and the German/Danish acoustic survey in Sub-divisions 21-24 are summarised in two different reports. In some cases the results are different from the HAWG report (e.g. Anon. 1997/Assess:8; Anon. 1997/H:11). The reason for this is that autumn and spring spawners are not split in a consistent way. Therefore, it t is recommended by the study group members to use, in both cases, the same splitting factor.

Existing fishery-independent surveys have not been adequately designed to give an independent estimate of stock size and migration patterns. Thus changes in migration pattern and timing between years may violate the validity of the time-series.
This problem has been described at the HAWG. Year and age trends are in conflict between survey indices and the commercial catch data.

3.8 Review on assessment data

As described in section 3.4 certain guidelines when compiling catch at age data for assessment purposes has to be used. A high level of fluctuation was noticed in the old catch at age data as well as the calculated mean weights (Section 3.1, 3.2 and 3.5). The Study Group therefore agreed, that more effort has to be directed into recalculation and recompiling old catch at age data in numbers and mean weight for the period 1990 to 1996.

The agreed guideline to be used, when compiling catch at age data for Sub-division 22-24:

- Swedish samples may be used on Danish catches and visa versa.
- Polish samples may be used on German catches and visa versa.

The opinion of the Study Group was that it was essential that the old catch data should be revised and updated prior to the 1998 HAWG meeting. Each county should revise their catch data for all quarters where samples were taken, if lack of samples in certain quarters were detected sampling data from other countries should be used.

As described in section 3.7.2 different splitting factors has been used in the acoustic surveys in Division IIIa and the North Sea and on the commercial catch data. These differences cause a significant inconsistency in the data sets as the acoustic data are used as biomass indexes in the assessment. It was not possible for the Study Group to recalculate the estimates from the acoustic surveys, as data were not available to the Group.

The Study Group recommends that each country, which conducts acoustic surveys in the areas where Western Baltic spring spawners mix with other spawning stocks, recalculate estimates of the different stocks using the splitting procedure adopted by the HAWG.

4 Migration model

4.1 Outline

The SG felt that the formulation of a migration model for the Western Baltic herring would be useful both as a conceptual aid and for stock assessment if quantitatively expressed. A simplified conceptual migration model of the WBSS herring should account for I) the spawning area, II) the nursery area for larval and juvenile growth, III) the feeding area for large juvenile and adult herring and IV) the wintering area for predominantly maturing individuals. The SG decided to explore the concept of an age structured dynamic box model.

Box1: The spawning occurs in **coastal areas of the Western Baltic Sea** where the **Rügen area** may be considered a well studied location with a high spawning concentration but only representative for the timing and age structure of the box. Box1 begins to fill in March with age groups 3+ and is again empty in May. There is a continuous turnover of the box.

Box2: Larvae and early juveniles occupy shallow areas of **Sub-division 22 and 24**. The box is being populated 10 days after reproduction. This box also acts as a retention area for some part of the adult population.

Box3: After spawning, adult individuals migrate to **the Kattegat, the Skagarrak and parts of the Eastern North Sea areas**. The box starts to fill in May and the outflow of the mature individuals starts in August. Some part of the immature population (2wr) also migrates out of the box together with the mature individuals.

Box4: The Sound area functions as a wintering area for maturing individuals before spawning and as a transport path for herring migrating to the North after spawning. The box could be subdivided according to the direction of differential flows based on the maturity index of migrating individuals. Box4 is filled from Box3 from August to October and emptied to box2 and further to box 1 from March to May.

From April to June there is a rapid flow through from Box1 and Box2 through Box4 to Box3.

4.2 Hypotheses

A model for estimation of natural mortality, stock size, and fraction of stock emigrating between the Western Baltic and the Kattegat/Skagerrak has earlier been presented by Sparholt (1989).
This model uses half-yearly catch at age data (ages 3-6), February IYFS in the Skagarrak Kattegat for age classes 2 and 3 (IYFS-2 and IYFS-3), the November-December German trawl survey in the Western Baltic for age-1 (GDR-1), the August-September acoustic survey in the Skagarrak Kattegat for ages 2-6 (DK-acoustic), and the October acoustic survey in the Western Baltic for ages 2-6 (G-acoustic).
Some of the underlying hypotheses are that:

- There are two stock components, a stationary Kattegat/Skagarrak (A), and migrant W Baltic stock (B),
- F's differ by areas and half year but are constant over ages 3-6 and over years,
- The natural mortality is constant over time, area and for ages 3-6,
- The migration takes place momentarily at January 1st from Box I to Box IV, and back again at July 1st,
- The fraction emigrating is constant over time and for ages 3-6,
- All 2-group W Baltic herring have migrated to the Skagarrak Kattegat by February with the same rate as older herring by July 1st,
- The GDR-1 index is proportional to the 3-group migrant W Baltic stock at January 1st,
- The DK-acoustic gives only an absolute estimate of age 2 but increasing underestimation of older ages.

The SG did not feel that the above mentioned model fully correspond with the present consensus about the fisheries and the migration pattern of the Western Baltic herring. There was no decision on an alternative explicit model formulation but it could in principle be solved with a traditional VPA approach with separate F's for the four boxes I, II, III, and IV. The cohort numbers could then be linked by instantaneous migrations of age groups between boxes. The tuning of the VPA should then be conducted with the appropriate fleets for the different age groups, boxes, and periods.

The SG felt that a number of hypotheses should be formulated specifically relating to a new migration model, and the recent development of the fishery:

- The fishing mortality and fishing pattern has changed considerably during the last three years and therefore cannot be regarded as constant over years.
- Catches in Skagarrak/Kattegat of the Western Baltic stock may be separated from catches of North Sea and local autumn/winter spawning herring on the basis of otolith micro structure.

- The precision of this split should be included in a maximum likelyhood function for estimation of stock size.
- All mature individuals from stock (B) in Box III (the Kattegat/Skagarrak area) migrate to Box IV (the Sound area) at September 1st.
- A constant fraction of all mature individuals from stock (B) in Box I (The Rügen Spawning area) migrate to Box III (the Kattegat/Skagarrak area) at June 1st, the rest migrate to Box II at the same date.
- Commercial catches in Box I (The Rügen Spawning area) from March to May represent the mature individuals of stock component (B).
- Commercial catches in Box III (the Kattegat/Skagarrak area) of age groups 3 and older from October to May, represent only stock (A).
- Catches in Box III (the Kattegat/Skagarrak area) of age group 2 at all times of the year represent a mixture of stock (A) and stock (B).
- Catches in Box III (the Kattegat/Skagarrak area) of age groups 0 and 1 at all times of the year represent only stock (A).
- Catches in Box II (Subdivisions 22 and 24) of age groups 0 and 1 at all times of the year represent only stock (B).

Data for the analysis.

Box 1: Relative in- and outflow may be obtained from CPUE on the spawning population. Abundance of small herring larvae in box1 and box2 during the hatching period may give an index of spawning stock biomass.

Box 2: Indices of the 2 youngest year-classes may be obtained from GBTS in Nov/Dec and GBTS in Jan/Feb in Sub-division 22 and 24. Indications of selective migration of large 1-group herring to Box3 may be derived from comparisons between frequencies of otolith size at 1st. WR. Remaining juvenile and adult herring may be estimated from the German/Danish Hydro-acoustic surveys in Sub-division 21-24 (Sept./Oct.).

Box 3: Changes in the age composition 2WR/3+WR in the Kattegat commercial fisheries (>32mm) from July to September could provide estimates of southward migrations of mature individuals. The Danish acoustic survey in Division IIIa in July/August may provide a fishery independent estimate of the absolute abundances by age-class of WBSS.

Box 4: The flow rates between box4 and box1 could be estimated by comparing differential changes in the age composition of herring caught with similar gear. German commercial gillnet catches of spawning herring could be compared to experimental gillnet catches from the Danish monitoring programme as well as to commercial gillnet catches in the Sound.

Problems to be looked at:

The general concept is that the Western Baltic herring spawning in the Rügen area and along the Northern German coastline spend the larval and early juvenile stages in shallow waters of the Western

Baltic.During the spring period juveniles at age two start feeding migrations to the North through the Danish Great Belt and the Sound to be found in the Kattegat, Skagarrak and the Eastern part of the North Sea outside Skagarrak. Only the adult (2-ringers and older) Division IIIa/Baltic spring spawners are considered to migrate into the North Sea (ICES CM 1992/H:2 p.3). However additional age one spring spawners are identified in the area (Working paper HAWG 1997) The exact timing and the proportion of age 2 herring leaving the Western Baltic for their first feeding migration are therefore rather uncertain.

In late July and August mature herring migrate southwards through the Kattegat. During the period August to March large numbers of more than 20 cm herring are found in the Sound (Stæhr 1997). The wintering population is dominated by 3-ringers or older (number of winter rings before Jan. 1) but occasionally relatively high numbers of 2-ringers are found especially in the northern part of this area (Nielsen 1996). The highest abundances are found in the first surveys each year either in September or in October depending on when the investigations start. It is unclear to what extent changes in absolute or relative abundance during the winter period in the Sound can be used to estimate mortality. There may be potential mixing with other stocks in large parts of the geographical distribution. In Division IIIa both NS autumn and winter spawners as well as local spring and winter spawners add to the complexity. In Sub-division 24 there may be a mix with Eastern Baltic herring in the Bornholm area.

5 Conclusions

5.1 Tasks before the HAWG 1998 meeting

As described in section 3.8, the Study Group agreed, that it was necessary to recalculate and recompile old catch at age data in numbers and mean weight for the period 1990 to 1996 for areas Division IIIa and Sub-division 22-24.

5.2 Future work

The close agreement between proportions of spring spawners estimated by otolith microstructure (OM) analysis and transformed discriminant analysis on VS counts encourage further work to calibrate the methods on an individual level.

- Swedish historical material on VS counts should be compared with the corresponding OM at the individual level to intercalibrate the two methods.
- Efforts should be made to increase the amount of pure stock material (learning samples), form the NSAS and the local SSS and KSS.
- Additional analysis of the variation in VS count and WR size frequency analysis should be conducted on the Swedish historical material to indicate to what extent SSS and KSS mix with the WBSS after identification of the spring spawning component in Division IIIa.
- A multivariate discriminant function should be developed relating vertebral counts, geographical area of sampling, time of year, age, size and maturity to OM identified proportion of WBSS of the total mix of WBSS, NSSS and inference of local SSS and KSS.

- A revision of the split for the years 1991 to 1997 should be conducted on both Danish and Swedish data from both commercial and survey samples utilising the canonical discriminant function on VS counts, geographical area of sampling, time of year, age, size, and maturity.
- A revision of the mean weight at age should be conducted according to the revised split of the spawning stocks.

5.3 Ideas and suggestions for revision of sampling schemes

For management purposes, the HAWG in several years has been asked to produce forecasts for the fleets that exploit the herring stocks in the North Sea and in Division IIIa. As the fleets definitions used in HAWG are based on fishing areas and mesh-sizes, it is essential that all fleets in all countries and in all quarter is sampled adequately.

Research programmes have shown that The Sound (Sub-division 23) is an important part of the WBSS's migration route (se section 2.1 and Nielsen, 1996). Therefore, the Study Group encourage, the countries which fishing fleets carry out fishing in this area, to collect samples from these commercial fisheries and even to co-ordinate their sampling schemes.

As described in section 3.7-3.7.4 several surveys are carried out in the areas where WBSS are caught. The Study Group found it unfortunate, that herring caught on these surveys, not as standard, is worked up with special reference to collect information on the distribution of stock components.

Herring samples from surveys and commercial catches should be worked up according to the requirements, of a precise identification of the WBSS, with an optimal allocation of resources for different procedures. Otolith microstructure analysis should be the future basis for the discrimination between autumn/winter spawners and spring spawners. In the NE North Sea and Division IIIa all age groups should be selected for OM analysis. In the Sub-division 22, 23 and 24 OM analysis may be restricted to immature individual.

For a more detailed split between various local stocks of spring spawners and WBSS in Division IIIa meristic and morphometric characters should be applied. The detailed procedures should be subject to a continuo evaluation depending on fluctuations in the abundance and distribution of the local stocks.
SSS may primarily differ from WBSS in mean VS counts so this method should be supplement the OM analysis on specific age-groups in areas and periods where the two types mix. Herring in the Northern Skagerrak and along the Norwegian South coast should be considered regarding mature individuals during the summer period and for 1 and 2 WR all year round.
KSS have a high overlap with WBSS in mean VS counts whereas growth rates may differ to some degree. For herring in the Kattegat OM analysis should combined with analysis of length and weight frequencies or otolith size at formation of WR1, 2 and 3.

The study group suggests a revision of the prevailing sampling scheme for detailed OM analysis, VS counts and morphometrics. Compared with today the sample frequency for advanced analyses should be increased on the expense of reduced sample sizes.

The spatial and temporal distribution of fishing effort may be used as an indication of the migration of the WBSS herring. It has been known that the commercial fisheries in Division IIIa move from the western Skagerrak in early summer towards east and south until autumn. This fishing pattern can also be related to the traditional herring fishery in Kattegat during autumn.

It is therefore suggested that catch data should if possible be disaggregated on a ICES rectangles. This would together with adequate splitting procedures enable more profound investigations on the spatial distribution of the spring and autumn spawning components in Division IIIa.

5.4 Scientific plans for the EU founded herring project

An EU funded research project on the discrimination of herring stocks in the Kattegat and Skagerrak started in February 1997. The objectives are to evaluate the use of vertebrae counts, otolith macrostructure analysis (annuli) and microstructure analysis (primary increment units) for the separation into spring- and autumn spawning stock components. The task includes an revision of the separation in commercial and survey samples for the period 1993-1997. Participants belong to the Danish, German and Swedish national fishery labs. The first part of the project includes an assessment of various discrimination methods for the analysis of VS numbers. After an evaluation of variances of these results during spring 1998 analysis of annuli will start from a selected set of sub-samples of the otoliths gathered in the Swedish national sampling programs. Microstructural analysis of the same individuals will start in late 1998.

6 Suggestions, conclusions and recommendations

The Study Group therefore recommend, that in each country which conduct acoustic survey in the areas where it is known mixture of Western Baltic spring spawners and other spawning stocks occur, to recalculate stock estimates on the different stocks using the same splitting factor as used by HAWG.

The study group suggests a revision of the prevailing sampling scheme for detailed OM analysis, VS counts and morphometrics. Compared with today the sample frequency for advanced analyses should be increased on the expense of reduced sample sizes.

It is therefore suggested that catch data should if possible be disaggregated on a ICES rectangles. This would together with adequate splitting procedures enable more profound investigations on the spatial distribution of the spring and autumn spawning components in Division IIIa.

7 Acknowledgement

The Study group participants thank the Swedish Institute for Marine Research, Lysekil for the invitation to meet in Lysekil and for providing excellent working facilities and service, together with a beautiful view over the Gullmarsfjorden.

8 References

Ackefors, H., 1978. Swedish herring tagging experiments, 1968-1970 in the Kattegat. Medd. Havsfiskelab., Lysekil 241:1-10

Aro, E., 1989. A review of fish migration patterns in the Baltic. Rapp. P.-v. Réun. Cons. int. Explor. Mer. 190:72-96

Biester, E. 1979. Der Frühjahrshering Rügens. Doctoral Thesis. Wilhelm-Pieck Universität Rostock

Burkhart, H. E. and Strub, M. R. 1974: A model for simulation of planted loblolly pine stands.Vol. 30: Growth Models for Tree and Stand Simulation (Ed. J. Fries). Royal College of Forestry, Sweden. 128-135.

Dahle & Eriksen, 1990. Spring and autumn spawners of herring (Clupea harengus L.) in the North Sea, Skagerrak and Kattegat. Population genetic analysis. Fish. Res. 9:131-141

Dhrymes, J.P. 1985. Introductory Econometrics. Springer, New York.

Fahmeir, L.; Hamerle, A. 1984. Multivariate Statistische Verfahren. Walter de Gruyter, Berlin.

Grahl-Nielsen O., and K.A. Ulvund, Distinguishing populations of herring by chemometry of fatty acids. A.m. Fish. Soc. Symp. 7:566-571

Gröger, J., Gröhsler, T. (1995). On the Discrimination of Herring Stocks in Division IIIa. ICES C.M. 1995/J:22.

Gröger, J., Gröhsler, T. (1995). Statistical Separation of Herring Stocks in Division IIIa (delivered to Archive of Fisheries and Marine Sciences in October 1995).

Gröger, J., Gröhsler, T. (1996). Information Updated Discrimination of Herring Stocks in Baltic Division IIIa. ICES C.M. 1996 / J:10

Hartung, J.; Elpelt, B. 1989. Multivariate Statistik. R. Oldenbourg, München.

Heinke, F., 1898. Naturgeschichte des Herings. Teil 1. Deutscher Seefischerei-Verein. Band II.

Hempel, G. and J.H.S. Blaxter, 1961. The experimental modification of meristic characters in herring (Clupea harengus L.). ICES Journal du Conseil 26:339-346

ICES 1992. Workshop on methods of forecasting herring catches in the Division IIIa and the North Sea. ICES C.M. 1992/H:5

ICES 1997.1996 ICES coordinated acoustic survey of ICES divisions IIIa, IVa, IVb, and VIa. ICES CM 1997/H:11.

ICES. 1997. Report of the Baltic International Fish Survey Working Group. ICES CM 1997/J:4.

ICES 1997. Report of the Herring Assessment Working Group for the Area South of 62°N. ICES, C.M. 1997/Assess:8

Jensen, A.J.C., 1957. Danish herring investigations in the Skagerrak, Kattegat, Belts and Baltic. Ann. Biol. 14:191-194.

Johannessen, A., and T. Jorgensen, 1991. Stock structure and classification of herring (Clupea harengus L.) in the North Sea, Skagerrak/Kattegat and western Baltic based on a multivariate analysis of morphometric and meristic characters. Proc. Int. Herring Symposium. Alaska Sea Grant program report 91-01:223-244

Johannessen, E. and E. Moksness, 1991. Herring larvae (Clupea harengus) in the Skagerrak area from December 1987 to April 1988. Fish. Res. 11:155-170

Klenz, B.1993. Quantitative Larvenanalyse des Ruegenschen Fruehjahrsherings in den Laichsaisaisons 1991 and 1992. Infn. Fischw., 40(3): 118-124.

Lütkepohl, H. 1992. Multivariate Statistische Verfahren, Wintersemester 1991/92. Unveröffentlichtes Vorlesungsskript. Institut für Statistik und Ökonometrie. Christian-Albrechts-Universität zu Kiel.

Neter, J., Wasserman, W., Kutner, M.H. 1985. Applied Linear Statistical Models. Richard D. Irwin, Illinois.

Moksness, E. & P. Fossum, 1991. Distinguishing spring and autumn spawned herring larvae (Clupea harengus L.) by otolith microstructure. ICES J. Mar. Sci. 48:61-66.

Mosegaard, H. and K. Popp-Madsen, 1996. Racial discrimination of herring stocks, comparing vertebral counts and otolith

Mueller, H. & Klenz, B. 1994.Quantitative Analysis of Ruegen Spring Spawning herring larval Surveys with Regard to the Recruitment of the Western Baltic and Division IIIa Stock. ICES CM 1994/L:30.

Nielsen, R., 1996. Acoustic monitoring of herring related to the establishment of a fixed link acros the Sound between Copenhagen and Malmö. DFU-report no. 11-96.

Rosenberg, R. & L.-E. Palmén, 1982. Composition of herring stocks in the Skagerrak-Kattegatt and the relations of these stocks with those of the North Sea and adjacent waters. Fish. Res. 1:83-104.

Ryman, N., U. Lagercrantz, L. Andersson, R. Chakraborty and R. Rosenberg, 1984. Lack of correspondence between genetic and morphologic variability patterns in Atlantic herring (Clupea harengus). Heredity 53:687-704

Sparholt, H., 1989. A model for estimating natural mortality rate, stock size and emigration of the Skagerrak-Kattekat and western Baltic herring stocks, based on catch-at age, acoustic and young fish survey data. Rapp. P.-v. Réun. Cons. int. Explor. Mer. 190-261-270.

Staehr, K.-J., 1998. Summary of the environmental impact monitoring on herring in the Sound autumn 1995 to autumn 1997. Working paper to the Planning Group for Herring Surveys, Bergen, January 1998.

Table 3.2.1.
Sampling of commercial catches of herring in Sweden by quarter in Skagerrak, Kattegat and Sub-Divisions 22-24 in 1993-1996

Year	Quarter	Area	Number of samples per 1000t of landings	Number of fish aged per 1000t of landings	Area	Number of samples per 1000t of landings	Number of fish aged per 1000t of landings	Area	Number of samples per 1000t of landings	Number of fish aged per 1000t of landings
1993	1	Skagerrak	0.5	59	Kattegat	2.7	224	SD 22-24	0.9	60
	2		0.3	30		15.7	424		1.2	82
	3		0.4	38		17.5	745		3.3	181
	4		1.0	53		4.6	90		2.2	116
1994	1		1.2	76		2.0	128		3.3	176
	2		0.1	10		4.6	309		0	0
	3		1.3	17		6.7	374		3.8	207
	4		1.4	53		5.6	115		2.0	70
1995	1		2.0	66		4.8	150		0	0
	2		1.7	97		8.4	330		0	0
	3		1.4	25		1.5	28		0	0
	4		1.9	90		1.0	17		12.1	177
1996	1		1.9	103		13.6	221		0	0
	2		1.7	94		5.6	401		0	0
	3		0.7	28		2.0	98		1.5	101
	4		1.2	69		1.8	109		0	0

Table 3.2.2.
Sampling of commercial catches of herring in Denmark by quarter in Skagerrak, Kattegat and Subdivisions 22-24 in 1993-1996

Year	Quarter	Area	Number of samples per 1000t of landings	Number of fish aged per 1000t of landings	Area	Number of samples per 1000t of landings	Number of fish aged per 1000t of landings	Area	Number of samples per 1000t of landings	Number of fish aged per 1000t of landings
1993	1	Skagerrak	1.6	147	Kattegat	1.0	153	SD 22-24	0.1	7
	2		0.9	11		2.3	152		1.0	95
	3		0.7	46		2.5	283		0.5	48
	4		1.2	83		1.4	178		0	0
1994	1		6.1	4		45.0	790		0.2	10
	2		0.8	28		4.4	108		0.4	25
	3		0.6	41		1.8	153		0.3	28
	4		2.1	80		1.8	83		0.8	138
1995	1		4.6	328		0.7	88		0.1	12
	2		4.8	123		1.3	148		0.2	36
	3		0.9	66		1.7	221		0	0
	4		3.1	149		1.4	160		0.3	37
1996	1		2.1	241		1.7	200		0.4	0.3
	2		7.7	125		1.5	177		0.4	33
	3		1.3	21		0.7	100		0.1	16
	4		1.5	111		0.2	23		0	0

Table 3.2.3.
Sampling of commercial catches of herring in Germany by quarter in Sub-Divisions 22-24 in 1993-1995

Year	Quarter	Number of samples per 1000t of landings	Number of fish aged per 1000t of landings
1993	1	2.6	118
	2	4.9	334
	3	0	0
	4	>30	1500
1994	1	7.0	263
	2	2.4	117
	3	0	0
	4	13.3	642
1995	1	3.5	161
	2	3.6	228
	3	0	0
	4	20	500
1996	1	80	6940
	2	3.7	203
	3	0	0
	4	25	1250

Table 3.2.4.
Sampling of commercial catches of herring in Poland by quarter in Sub-Divisions 22-24 in 1993-1996

Year	Quarter	Number of samples per 1000t of landings	Number of fish aged per 1000t of landings
1993	1	0.8	54
	2	1.5	134
	3	6.7	667
	4	0	0
1994	1	7.5	697
	2	2.6	205
	3	>10	>990
	4	10	850
1995	1	1.3	161
	2	1.9	228
	3	>10	>980
	4	>10	>780

No information available for 1996

Table 3.2.5.
Sampling of commercial catches of herring in Norway by quarter in Skagerrak in 1993-1996

Year	Quarter	Number of samples per 1000t of landings	Number of fish aged per 1000t of landings
1993	1	0	0
	2	1.5	131
	3	0.1	11
	4	0.8	28
1994	no sampling		
1995	1	0	0
	2	0.4	38
	3	0.1	15
	4	0	0
1996	1	0	0
	2	1.4	5.3
	3	0	0
	4	27.3	0

Table 3.2.6.
Number of samples per 1000t of commercial landings of herring by quarter in Division IIIA and Sub-Divisions 22-24 by all the countries

Year	Quarter	Skagerrak	Kattegat	SD 22-24
1993	1	1.0	1.6	0.6
	2	0.7	10.2	1.9
	3	0.6	4.6	1.5
	4	1.0	2.7	0.8
1994	1	2.5	3.7	1.5
	2	0.5	4.7	1.4
	3	0.8	2.8	1.0
	4	1.7	3.9	1.8
1995	1	2.8	2.3	1.0
	2	2.1	6.6	1.1
	3	1.0	1.5	0.1
	4	1.7	1.2	4.7
1996	1	2.0	5.3	1.1
	2	2.2	3.8	1.2
	3	0.9	1.9	0.6
	4	3.4	1.2	0.4

Table 3.2.7.
Number of fish aged per 1000t of commercial landings of herring by quarter in Division IIIA and Sub-Divisions 22-24 by all the countries

Year	Quarter	Skagerrak	Kattegat	SD 22-24
1993	1	101	178	59
	2	31	312	143
	3	40	347	112
	4	60	140	42
1994	1	56	154	75
	2	18	269	86
	3	23	197	77
	4	56	101	157
1995	1	145	112	58
	2	92	282	96
	3	44	57	13
	4	81	72	96
1996	1	191	207	75
	2	78	301	73
	3	23	98	43
	4	82	78	17

Table 3.4.1
Geographical distribution of herring catches (tons) in Sub-division 24
Comparisons between Danish and Swedish catches

		1. Quarter		2. Quarter		3. Quarter		4. Quarter		Total	
		Denmark	Sweden	Denmark	Sweden	Denmark	Sweden	Denmark	Sweden	Denmark	Sweden
1994	37G2	227		34						261	
	37G3	276		5						281	
	37G4	187								187	
	38G2	5794	15	4539		17		334		10684	15
	38G3	5493		1066		53		809	20	7421	20
	38G4	182		367	12			91		640	12
	39G2	1637	66	1902	40	21	7	606	230	4166	343
	39G3	1773	1266	48	879		791	25	1707	1846	4643
	39G4	270	135	0	1202	165	531	324	507	759	2375
	Total	15839	1482	7961	2133	256	1329	2189	2464	26245	7408
1995	37G2	12		237						249	
	37G3	170								170	
	37G4	41								41	
	38G2	3010		3613		10		824		7457	
	38G3	2231	34	701	13				6	2932	53
	38G4	304	44	49	2			48	45	401	91
	39G2	991	11	1050	65		263	536	154	2577	493
	39G3	74	3251	9	3482		5353		2627	83	14713
	39G4		280	146	1584	110	825	99	297	355	2986
	Total	6833	3620	5805	5146	120	6441	1507	3129	14265	18336
1996	37G2	802		214				502		1518	
	37G3			77						77	
	37G4							29		29	
	38G2	1530		1345	20	95		357		3327	20
	38G3	789		1666	107			75		2530	107
	38G4	10		182		60				252	0
	39G2	354		363	48	135	162	1510	241	2362	451
	39G3		1645	375	574	11	2714		2159	386	7092
	39G4		319	82	432	51	374	131	182	264	1307
	Total	3485	1964	4304	1181	352	3250	2604	2582	10745	8977

Table 3.4.2
Geographical distribution of Danish herring catches (tons) in Sub-division 22 by quarter 1994 - 1996

		1. Quarter	2. Quarter	3. Quarter	4. Quarter	Total
1994	37G1	12	0	0	12	23
	38G0	112	491	50	367	1.020
	38G1	654	418	0	0	1.072
	38G2	0	15	0	0	15
	39E9	0	12	13	189	213
	39G0	423	256	567	445	1.692
	39G1	0	6	78	0	84
	40G0	1.020	326	2.211	1.764	5.321
	40G1	0	0	35	83	118
	41G0	48	0	279	2.030	2.356
	41G1	0	0	1.211	178	1.389
	Total	2.268	1.524	4.443	5.068	13.303
1995	37G0	148	0	0	0	148
	37G1	1.800	285	0	228	2.313
	38G0	733	1.972	0	815	3.520
	38G1	216	99	0	65	380
	39E9	25	396	0	116	537
	39G0	387	667	180	1.272	2.505
	39G1	97	3	0	0	100
	40E9	0	8	0	0	8
	40G0	2.603	2.771	1.553	2.519	9.446
	40G1	13	52	208	67	340
	41G0	337	727	721	919	2.704
	41G1	0	143	191	209	543
	Total	6.360	7.122	2.853	6.210	22.545
1996	37G0	0	0	1	0	1
	37G1	374	19	68	271	732
	38E9	23	13	0	0	36
	38G0	637	1.612	123	394	2.766
	38G1	58	239	3	174	473
	38G2	0	0	0	34	34
	39E9	0	877	43	570	1.489
	39G0	469	578	202	580	1.830
	39G1	20	0	0	56	76
	40E9	0	27	0	0	27
	40G0	2.096	1.901	1.200	1.092	6.289
	40G1	0	429	456	91	976
	41G0	1.021	760	541	338	2.661
	41G1	0	277	295	88	661
	Total	4.698	6.731	2.933	3.689	18.050

Table 3.5.1 Mean weights at age in landings from Div. IIIa and Sub-div 22-24. (from ICES 1997/Assess:8)

		Age								
Year	Area	0	1	2	3	4	5	6	7	8+
87	22-24	11,7	15,7	34,8	76,7	98,4	121,9	141,4	151,4	163,4
	IIIa			57	85	105,6	145,3	154,6	201,2	280,4
88	22-24	11	16,9	29,1	83,8	108,5	124,8	142,2	143,7	135,8
	IIIa			47,3	77	138,3	156	166	149	209
89	22-24	13,5	17,5	43,6	70,5	105,9	122	125,5	137,8	131,5
	IIIa			56,5	79,9	125,5	151,6	167,3	189,2	204,8
90	22-24	13,8	24,2	44,5	75,5	95,9	121,1	142,6	138,7	145,8
	IIIa		56,6	65	84,6	102,4	111,1	109,3	141	84,3
91	22-24	11,5	31,5	58,5	78,8	98,5	120,9	138,6	152,2	179
	IIIa	33,7	60,5	77,4	101,7	127,5	148,6	165,4	182,5	194,9
92	22-24	19,1	23,3	44,8	77,4	99,2	123,3	152,9	166,2	184,2
	IIIa		53,4	96,2	115,2	138,6	172,9	184	201,7	201,3
93	22-24	16,2	24,5	44,5	73,6	94,1	122,4	149,4	168,5	169,1
	IIIa		60,4	88,6	121,5	147,2	160,3	182,9	195,6	218,2
94	22-24	12,9	28,2	54,2	76,4	95	117,7	133,6	154,3	173,9
	IIIa			127,2	120,1	148,6	165,3	190,6	204,1	216,5
95	22-24	9,3	16,3	42,8	68,3	88,9	125,4	150,4	193,3	207,4
	IIIa	17,5	37,8	101,2	148,3	165,5	188,7	213	233,1	232,2
96	22-24	12,1	22,9	45,3	73,6	91,2	115,3	119,4	137,8	181,3
	IIIa	7,3	22,9	74,1	127	172	182,8	200,9	197,7	212,3

Table 3.5.2 Mean weights at age averaged over 1991-96

		Age								
	Source	0	1	2	3	4	5	6	7	=8
mean	SD 22-24	13,52	24,45	48,35	74,68	94,43	120,83	140,72	162,05	182,48
mean	DN, IIIa	19,50	47,00	94,12	122,30	149,90	169,77	189,47	202,45	212,57
	std dev 22-24	3,54	5,18	6,40	3,75	4,02	3,74	12,86	18,87	13,34
	std dev IIIa	13,31	16,34	19,29	15,35	16,55	14,80	16,36	16,79	13,20
	CV 22-24	0,26	0,21	0,13	0,05	0,04	0,03	0,09	0,12	0,07
	CV IIIa	0,68	0,35	0,20	0,13	0,11	0,09	0,09	0,08	0,06
WBal as % of IIIa		69,32	52,02	51,37	61,07	63,03	71,18	74,27	80,04	85,85
	IYFS mean		21,38	61,01	100,81	134,27	161,61	166,39	208,26	213,90
	HAWG mean	15,85	26,82	74,57	98,70	118,03	139,63	155,88	174,03	190,82

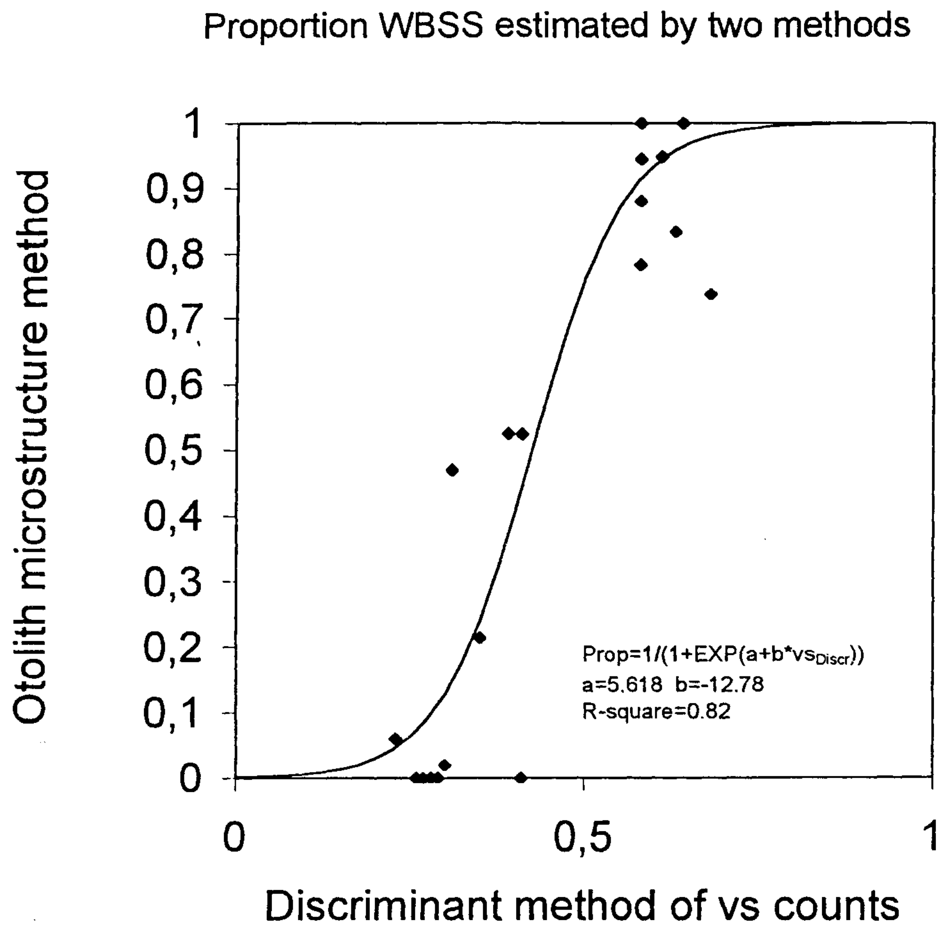


Figure 2.7 Proportion spring spawning herring by age-class, ICES rectangle, from quarter 3 1996 in Skagarrak and Kattegat. Herring from the Danish acoustic survey samples were estimated by the otolith microstructure method. Herring from the Swedish surveys were estimated by Discriminant analysis of VS counts.

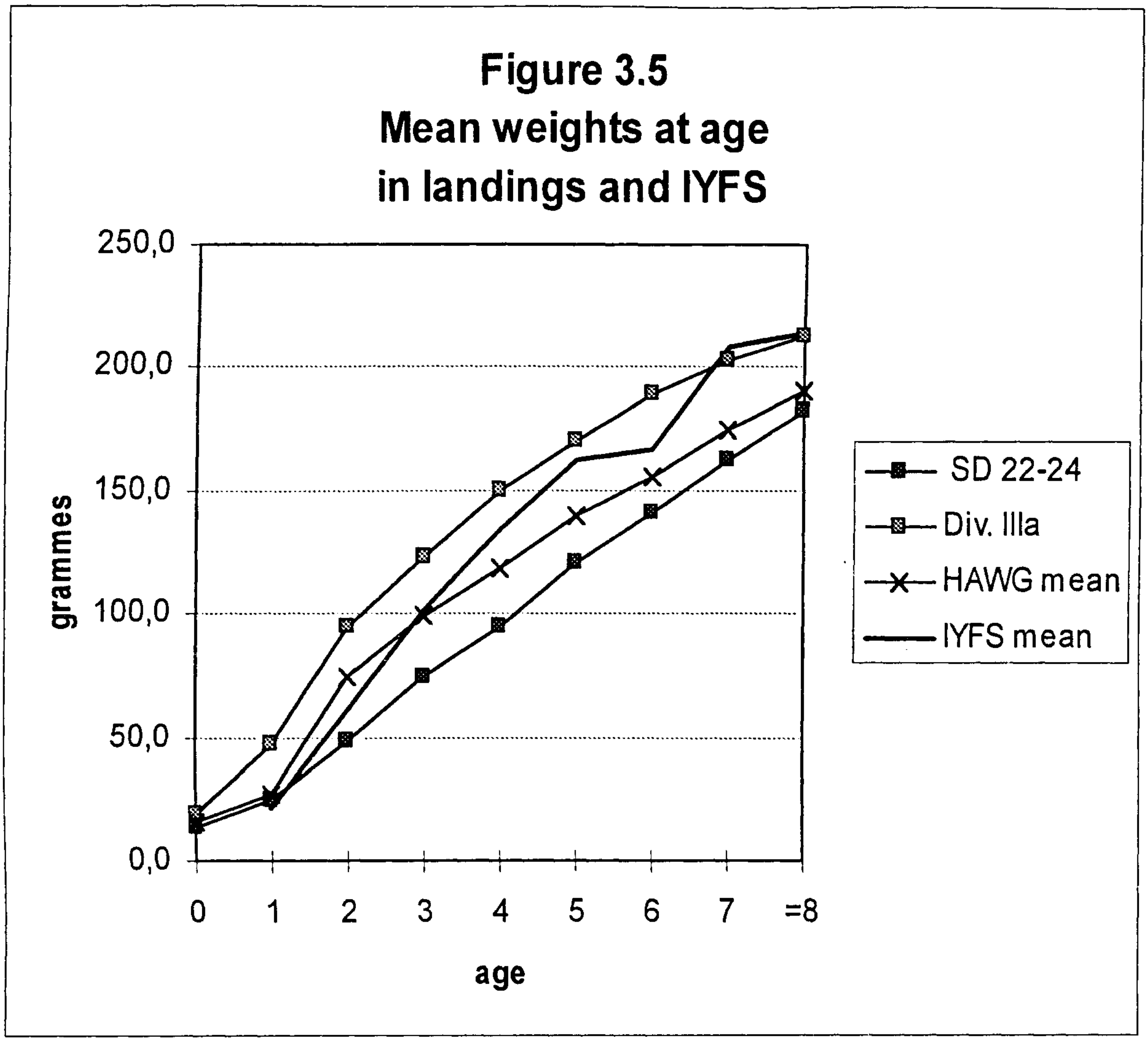


Figure 3.5
Mean weights at age
in landings and IYFS
250,0
200,0
150,0
100,0
50,0
0,0
grammes
0
1
2
3
4
5
6
7
=8
age
SD 22-24
Div. IIIa
HAWG mean
IYFS mean

APPENDIX 1

Results of DISCRIMINANT MODEL analysis based on Swedish data 1991-1997

Average Proportions of Baltic Herring and North Sea Herring.

(by YEAR, QUARTER, AGE, SkaKat)

Year=91

		Averages							
		Prop. of Baltic Herr.				Prop. of NS Herr.			
		Area (SkaKat)				Area (SkaKat)			
		Skagerrak	Kattegat	Sound	ALL	Skagerrak	Kattegat	Sound	ALL
Quarter	Age								
1	1	0.33	0.42	0.51	0.42	0.67	0.58	0.49	0.58
	2	0.34	0.42	0.45	0.40	0.66	0.58	0.55	0.60
	3	0.50	0.62	0.52	0.55	0.50	0.38	0.48	0.45
	4	0.29	0.54	0.54	0.46	0.71	0.46	0.46	0.54
	ALL	0.37	0.50	0.51	0.46	0.64	0.50	0.50	0.54
2	Age								
	1	0.30	0.33	0.45	0.36	0.70	0.67	0.55	0.64
	2	0.37	0.50	0.43	0.43	0.63	0.50	0.57	0.57
	3	0.42	0.59	0.61	0.54	0.58	0.41	0.39	0.46
	4	0.43	0.62	0.48	0.51	0.57	0.38	0.52	0.49
	ALL	0.38	0.51	0.49	0.46	0.62	0.49	0.51	0.54
3	Age								
	0	0.39	0.35	0.50	0.41	0.61	0.65	0.50	0.59
	1	0.43	0.37	0.50	0.43	0.57	0.63	0.50	0.57
	2	0.50	0.56	0.77	0.61	0.50	0.44	0.23	0.39
	3	0.33	0.50	0.60	0.48	0.67	0.50	0.40	0.52
	4	0.75	0.61	0.65	0.67	0.25	0.39	0.35	0.33
	ALL	0.48	0.48	0.60	0.52	0.52	0.52	0.40	0.48

Swedish data

Year=92

		Averages							
		Prop. of Baltic Herr.				Prop. of NS Herr.			
		Area (SkaKat)			ALL	Area (SkaKat)			ALL
		Skag-errak	Katt-egat	Sound		Skag-errak	Katt-egat	Sound	
Quarter	Age								
1	1	0.35	0.41	.	0.38	0.65	0.59	.	0.62
	2	0.40	0.44	.	0.42	0.60	0.56	.	0.58
	3	0.42	0.46	.	0.44	0.58	0.54	.	0.56
	4	0.36	0.56	.	0.46	0.64	0.44	.	0.54
	ALL	0.38	0.47	.	0.43	0.62	0.53	.	0.58
3	Age								
	0	0.35	0.34	0.45	0.38	0.65	0.66	0.55	0.62
	1	0.43	0.50	0.51	0.48	0.57	0.50	0.49	0.52
	2	0.50	0.59	0.62	0.57	0.50	0.41	0.38	0.43
	3	0.50	0.56	0.63	0.56	0.50	0.44	0.37	0.44
	4	0.56	0.62	0.63	0.60	0.44	0.38	0.37	0.40
	ALL	0.47	0.52	0.57	0.52	0.53	0.48	0.43	0.48

Swedish data

Year=93

		Averages							
		Prop. of Baltic Herr.				Prop. of NS Herr.			
		Area (SkaKat)			ALL	Area (SkaKat)			ALL
		Skag-errak	Katt-egat	Sound		Skag-errak	Katt-egat	Sound	
Quarter	Age								
1	0	.	.	0.21	0.21	.	.	0.79	0.79
	1	0.35	0.31	0.44	0.37	0.65	0.69	0.56	0.63
	2	0.31	0.47	0.43	0.40	0.69	0.53	0.57	0.60
	3	0.26	0.48	0.60	0.45	0.74	0.52	0.40	0.55
	4	0.33	0.55	0.55	0.48	0.67	0.45	0.45	0.52
	ALL	0.31	0.45	0.45	0.41	0.69	0.55	0.55	0.59
2	Age								
	1	0.33	0.38	0.35	0.35	0.67	0.62	0.65	0.65
	2	0.42	0.57	0.62	0.54	0.58	0.43	0.38	0.46
	3	0.43	0.58	0.59	0.53	0.57	0.42	0.41	0.47
	4	0.60	0.60	0.55	0.58	0.40	0.40	0.45	0.42
	ALL	0.45	0.53	0.53	0.50	0.56	0.47	0.47	0.50
3	Age								
	0	0.34	0.46	0.50	0.43	0.66	0.54	0.50	0.57
	1	0.37	0.42	0.47	0.42	0.63	0.58	0.53	0.58
	2	0.56	0.58	0.56	0.57	0.44	0.42	0.44	0.43
	3	0.71	0.53	0.65	0.63	0.29	0.47	0.35	0.37
	4	0.33	0.59	0.57	0.50	0.67	0.41	0.43	0.50
	ALL	0.46	0.52	0.55	0.51	0.54	0.48	0.45	0.49

Swedish data

Year=94

		Averages							
		Prop. of Baltic Herr.				Prop. of NS Herr.			
		Area (SkaKat)			ALL	Area (SkaKat)			ALL
		Skag-errak	Katt-egat	Sound		Skag-errak	Katt-egat	Sound	
Quarter	Age								
1	1	0.35	0.41	0.47	0.41	0.65	0.59	0.53	0.59
	2	0.38	0.37	0.47	0.41	0.62	0.63	0.53	0.59
	3	0.57	0.52	0.53	0.54	0.43	0.48	0.47	0.46
	4	0.56	0.54	0.56	0.55	0.44	0.46	0.44	0.45
	ALL	0.47	0.46	0.51	0.48	0.54	0.54	0.49	0.52
2	Age								
	1	0.36	0.40	0.40	0.39	0.64	0.60	0.60	0.61
	2	0.33	0.45	0.48	0.42	0.67	0.55	0.52	0.58
	3	0.34	0.60	0.73	0.56	0.66	0.40	0.27	0.44
	4	0.55	0.50	0.55	0.53	0.45	0.50	0.45	0.47
	ALL	0.40	0.49	0.54	0.47	0.61	0.51	0.46	0.53
3	Age								
	0	0.32	0.36	0.60	0.43	0.68	0.64	0.40	0.57
	1	0.33	0.40	0.47	0.40	0.67	0.60	0.53	0.60
	2	0.50	0.47	0.44	0.47	0.50	0.53	0.56	0.53
	3	0.61	0.61	0.50	0.57	0.39	0.39	0.50	0.43
	4	0.64	0.57	0.61	0.61	0.36	0.43	0.39	0.39
	ALL	0.48	0.48	0.52	0.50	0.52	0.52	0.48	0.50

Swedish data

Year=95

		Averages							
		Prop. of Baltic Herr.				Prop. of NS Herr.			
		Area (SkaKat)			ALL	Area (SkaKat)			ALL
		Skag-errak	Katt-egat	Sound		Skag-errak	Katt-egat	Sound	
Quarter	Age								
1	1	0.37	0.45	0.46	0.43	0.63	0.55	0.54	0.57
	2	0.34	0.47	0.53	0.45	0.66	0.53	0.47	0.55
	3	0.33	0.32	0.45	0.37	0.67	0.68	0.55	0.63
	4	0.66	0.43	0.58	0.56	0.34	0.57	0.42	0.44
	ALL	0.43	0.42	0.51	0.45	0.58	0.58	0.50	0.55
2	Age								
	1	0.34	0.44	0.49	0.42	0.66	0.56	0.51	0.58
	2	0.38	0.44	0.50	0.44	0.62	0.56	0.50	0.56
	3	0.47	0.50	0.50	0.49	0.53	0.50	0.50	0.51
	4	0.56	0.60	0.52	0.56	0.44	0.40	0.48	0.44
	ALL	0.44	0.50	0.50	0.48	0.56	0.51	0.50	0.52
3	Age								
	0	0.38	0.34	.	0.36	0.62	0.66	.	0.64
	1	0.36	0.42	0.62	0.47	0.64	0.58	0.38	0.53
	2	0.34	0.48	0.48	0.43	0.66	0.52	0.52	0.57
	3	0.57	0.60	0.68	0.62	0.43	0.40	0.32	0.38
	4	0.54	0.59	0.64	0.59	0.46	0.41	0.36	0.41
	ALL	0.44	0.49	0.61	0.50	0.56	0.51	0.40	0.50

Swedish

Year=96

		Averages							
		Prop. of Baltic Herr.				Prop. of NS Herr.			
		Area (SkaKat)			ALL	Area (SkaKat)			ALL
		Skag-errak	Katt-egat	Sound		Skag-errak	Katt-egat	Sound	
Quarter	Age								
1	1	0.36	0.34	0.50	0.40	0.64	0.66	0.50	0.60
	2	0.41	0.50	0.61	0.51	0.59	0.50	0.39	0.49
	3	0.40	0.40	0.55	0.45	0.60	0.60	0.45	0.55
	4	0.49	0.45	0.63	0.52	0.51	0.55	0.37	0.48
	ALL	0.42	0.42	0.57	0.47	0.59	0.58	0.43	0.53
3	Age								
	0	0.42	0.36	.	0.39	0.58	0.64	.	0.61
	1	0.32	0.40	0.61	0.44	0.68	0.60	0.39	0.56
	2	0.58	0.61	0.61	0.60	0.42	0.39	0.39	0.40
	3	0.49	0.50	0.50	0.50	0.51	0.50	0.50	0.50
	4	0.54	0.40	0.57	0.50	0.46	0.60	0.43	0.50
	ALL	0.47	0.45	0.57	0.49	0.53	0.55	0.43	0.51

Swedish data

Year=97

		Averages							
		Prop. of Baltic Herr.				Prop. of NS Herr.			
		Area (SkaKat)			ALL	Area (SkaKat)			ALL
		Skag-errak	Katt-egat	Sound		Skag-errak	Katt-egat	Sound	
Quarter	Age								
1	1	0.34	0.36	0.49	0.40	0.66	0.64	0.51	0.60
	2	0.27	0.36	0.56	0.40	0.73	0.64	0.44	0.60
	3	0.46	0.58	0.60	0.55	0.54	0.42	0.40	0.45
	4	0.51	0.53	0.60	0.55	0.49	0.47	0.40	0.45
	ALL	0.40	0.46	0.56	0.47	0.61	0.54	0.44	0.53

APPENDIX 2

Results of DISCRIMINANT MODEL analysis based on Danish data 1984-1995

Average Proportions of Baltic Herring and North Sea Herring.
(by YEAR, QUARTER, AGE, SkaKat)

Year=84		Averages							
		Prop. of Baltic Herr.				Prop. of NS Herr.			
		Area (SkaKat)				Area (SkaKat)			
		Skag-errak	Katt-egat	Sound	ALL	Skag-errak	Katt-egat	Sound	ALL
Quarter	Age								
1	1	.	0.50	.	0.50	.	0.50	.	0.50
	2	.	0.48	.	0.48	.	0.52	.	0.52
	3	.	0.59	0.55	0.57	.	0.41	0.45	0.43
	4	.	0.42	0.58	0.50	.	0.58	0.42	0.50
	ALL	.	0.50	0.57	0.52	.	0.50	0.44	0.48
2	1	.	0.57	.	0.57	.	0.43	.	0.43
	2	.	0.66	.	0.66	.	0.34	.	0.34
	3	.	0.38	.	0.38	.	0.62	.	0.62
	ALL	.	0.54	.	0.54	.	0.46	.	0.46
3	1	0.37	0.44	.	0.41	0.63	0.56	.	0.60
	2	0.53	0.63	.	0.58	0.47	0.37	.	0.42
	3	0.62	0.69	.	0.66	0.38	0.31	.	0.35
	4	0.54	0.50	.	0.52	0.46	0.50	.	0.48
	ALL	0.52	0.57	.	0.54	0.49	0.44	.	0.46
4	Age								
	1	.	.	0.21	0.21	.	.	0.79	0.79
	2	.	.	0.52	0.52	.	.	0.48	0.48
	3	.	.	0.64	0.64	.	.	0.36	0.36
	4	.	.	0.58	0.58	.	.	0.42	0.42
	ALL	.	.	0.49	0.49	.	.	0.51	0.51

Danish data
Year=85

		Averages					
		Prop. of Baltic Herr.			Prop. of NS Herr.		
		Area (SkaKat)			Area (SkaKat)		
		Skag-errak	Katt-egat	ALL	Skag-errak	Katt-egat	ALL
Quarter	Age						
1	1	.	0.50	0.50	.	0.50	0.50
	2	.	0.36	0.36	.	0.64	0.64
	3	.	0.58	0.58	.	0.42	0.42
	4	.	0.30	0.30	.	0.70	0.70
	ALL	.	0.44	0.44	.	0.57	0.57
2	Age						
	1	0.50	.	0.50	0.50	.	0.50
	2	0.48	.	0.48	0.52	.	0.52
	3	0.59	.	0.59	0.41	.	0.41
	4	0.58	.	0.58	0.42	.	0.42
	ALL	0.54	.	0.54	0.46	.	0.46
3	Age						
	1	0.35	.	0.35	0.65	.	0.65
	2	0.43	.	0.43	0.57	.	0.57
	3	0.63	.	0.63	0.37	.	0.37
	4	0.66	.	0.66	0.34	.	0.34
	ALL	0.52	.	0.52	0.48	.	0.48

Danish data
Year=86

		Averages							
		Prop. of Baltic Herr.				Prop. of NS Herr.			
		Area (SkaKat)			ALL	Area (SkaKat)			ALL
		Skag-errak	Katt-egat	Sound	ALL	Skag-errak	Katt-egat	Sound	ALL
Quarter	Age								
2	1	.	0.29	.	0.29	.	0.71	.	0.71
	2	0.16	0.41	.	0.29	0.84	0.59	.	0.72
	3	0.62	0.63	.	0.63	0.38	0.37	.	0.38
	4	0.61	0.62	.	0.62	0.39	0.38	.	0.39
	ALL	0.46	0.49	.	0.48	0.54	0.51	.	0.52
3	Age								
	0	0.50	.	.	0.50	0.50	.	.	0.50
	1	0.36	.	.	0.36	0.64	.	.	0.64
	2	0.55	.	.	0.55	0.45	.	.	0.45
	3	0.62	.	.	0.62	0.38	.	.	0.38
	4	0.67	.	.	0.67	0.33	.	.	0.33
	ALL	0.54	.	.	0.54	0.46	.	.	0.46
4	Age								
	1	0.38	.	.	0.38	0.62	.	.	0.62
	2	0.57	.	0.45	0.51	0.43	.	0.55	0.49
	3	0.65	.	0.58	0.62	0.35	.	0.42	0.39
	4	0.53	.	0.61	0.57	0.47	.	0.39	0.43
	ALL	0.53	.	0.55	0.54	0.47	.	0.45	0.46

Danish data
Year=87

		Averages					
		Prop. of Baltic Herr.			Prop. of NS Herr.		
		Area (SkaKat)			Area (SkaKat)		
		Katt-egat	Sound	ALL	Katt-egat	Sound	ALL
Quarter	Age						
1	1	0.47	.	0.47	0.53	.	0.53
	2	0.47	.	0.47	0.53	.	0.53
	3	0.57	.	0.57	0.43	.	0.43
	4	0.63	.	0.63	0.37	.	0.37
	ALL	0.54	.	0.54	0.47	.	0.47
2	1	0.41	.	0.41	0.59	.	0.59
	2	0.31	.	0.31	0.69	.	0.69
	3	0.57	.	0.57	0.43	.	0.43
	4	0.58	.	0.58	0.42	.	0.42
	ALL	0.47	.	0.47	0.53	.	0.53
3	0	0.38	.	0.38	0.62	.	0.62
	1	0.38	.	0.38	0.62	.	0.62
	2	0.56	.	0.56	0.44	.	0.44
	3	0.87	.	0.87	0.13	.	0.13
	ALL	0.55	.	0.55	0.45	.	0.45
4	Age						
	1	.	0.50	0.50	.	0.50	0.50
	2	.	0.50	0.50	.	0.50	0.50
	3	.	0.68	0.68	.	0.32	0.32

Danish data

Year=87		Averages					
		Prop. of Baltic Herr.			Prop. of NS Herr.		
		Area (SkaKat)		ALL	Area (SkaKat)		ALL
		Katt-egat	Sound		Katt-egat	Sound	
Quarter	Age						
4	4	.	0.61	0.61	.	0.39	0.39
	ALL	.	0.57	0.57	.	0.43	0.43

Danish data

Year=88

		Averages					
		Prop. of Baltic Herr.			Prop. of NS Herr.		
		Area (SkaKat)		ALL	Area (SkaKat)		ALL
		Skag-errak	Katt-egat		Skag-errak	Katt-egat	
Quarter	Age						
2	1	0.29	0.33	0.31	0.71	0.67	0.69
	2	0.41	0.50	0.46	0.59	0.50	0.55
	3	0.54	0.21	0.38	0.46	0.79	0.63
	4	0.72	0.50	0.61	0.28	0.50	0.39
	ALL	0.49	0.39	0.44	0.51	0.62	0.56
3	Age						
	1	0.37	.	0.37	0.63	.	0.63
	2	0.42	.	0.42	0.58	.	0.58
	3	0.54	.	0.54	0.46	.	0.46
	ALL	0.44	.	0.44	0.56	.	0.56

Danish data

Year=89		Averages			
		Prop. of Baltic Herr.		Prop. of NS Herr.	
		Area (Ska-Kat)		Area (Ska-Kat)	
		Skagerrak	ALL	Skagerrak	ALL
Quarter	Age				
3	1	0.40	0.40	0.60	0.60
	2	0.41	0.41	0.59	0.59
	3	0.49	0.49	0.51	0.51
	4	0.55	0.55	0.45	0.45
	ALL	0.46	0.46	0.54	0.54

Danish data
Year=90

		Averages			
		Prop. of Baltic Herr.		Prop. of NS Herr.	
		Area (Ska-Kat)		Area (Ska-Kat)	
		Skagerrak	ALL	Skagerrak	ALL
Quarter	Age				
3	1	0.33	0.33	0.67	0.67
	2	0.46	0.46	0.54	0.54
	3	0.55	0.55	0.45	0.45
	4	0.56	0.56	0.44	0.44
	ALL	0.48	0.48	0.53	0.53

Danish data
Year=91

		Averages					
		Prop. of Baltic Herr.			Prop. of NS Herr.		
		Area (SkaKat)		ALL	Area (SkaKat)		ALL
		Skag-errak	Katt-egat		Skag-errak	Katt-egat	
Quarter	Age						
2	1	0.31	.	0.31	0.69	.	0.69
	2	0.31	.	0.31	0.69	.	0.69
	3	0.52	.	0.52	0.48	.	0.48
	4	0.53	.	0.53	0.47	.	0.47
	ALL	0.42	.	0.42	0.58	.	0.58
3	Age						
	0	.	0.38	0.38	.	0.62	0.62
	1	0.32	0.35	0.34	0.68	0.65	0.67
	2	0.52	0.59	0.56	0.48	0.41	0.45
	3	0.56	0.60	0.58	0.44	0.40	0.42
	4	0.58	0.54	0.56	0.42	0.46	0.44
	ALL	0.50	0.49	0.49	0.51	0.51	0.51
4	Age						
	0	0.41	0.45	0.43	0.59	0.55	0.57
	1	0.21	0.30	0.26	0.79	0.70	0.75
	2	.	0.54	0.54	.	0.46	0.46
	3	.	0.50	0.50	.	0.50	0.50
	4	.	0.50	0.50	.	0.50	0.50
	ALL	0.31	0.46	0.42	0.69	0.54	0.58

Danish data

Year=92

		Averages					
		Prop. of Baltic Herr.			Prop. of NS Herr.		
		Area (SkaKat)			Area (SkaKat)		
		Skag-errak	Katt-egat	ALL	Skag-errak	Katt-egat	ALL
Quarter	Age						
3	0	0.50	0.21	0.36	0.50	0.79	0.65
	1	0.31	0.45	0.38	0.69	0.55	0.62
	2	0.46	0.57	0.52	0.54	0.43	0.49
	3	0.57	0.64	0.61	0.43	0.36	0.40
	4	0.58	0.76	0.67	0.42	0.24	0.33
	ALL	0.48	0.53	0.51	0.52	0.47	0.50

Danish data
Year=93

		Averages					
		Prop. of Baltic Herr.			Prop. of NS Herr.		
		Area (SkaKat)		ALL	Area (SkaKat)		ALL
		Skag-errak	Katt-egat		Skag-errak	Katt-egat	
Quarter	Age						
2	1	.	0.50	0.50	.	0.50	0.50
	2	.	0.60	0.60	.	0.40	0.40
	3	.	0.53	0.53	.	0.47	0.47
	4	.	0.77	0.77	.	0.23	0.23
	ALL	.	0.60	0.60	.	0.40	0.40
3	Age						
	0	.	0.50	0.50	.	0.50	0.50
	1	0.30	0.37	0.34	0.70	0.63	0.67
	2	0.43	0.63	0.53	0.57	0.37	0.47
	3	0.37	0.66	0.52	0.63	0.34	0.49
	4	0.62	0.65	0.64	0.38	0.35	0.37
	ALL	0.43	0.56	0.50	0.57	0.44	0.50
4	Age						
	0	0.31	0.26	0.29	0.69	0.74	0.72
	1	0.27	0.28	0.28	0.73	0.72	0.73
	2	0.52	0.45	0.49	0.48	0.55	0.52
	3	0.38	0.62	0.50	0.62	0.38	0.50
	4	0.35	0.66	0.51	0.65	0.34	0.50
	ALL	0.37	0.45	0.41	0.63	0.55	0.59

Danish data
Year=94

		Averages							
		Prop. of Baltic Herr.				Prop. of NS Herr.			
		Area (SkaKat)			ALL	Area (SkaKat)			ALL
		Skag-errak	Katt-egat	Sound		Skag-errak	Katt-egat	Sound	
Quarter	Age								
1	3	.	.	0.50	0.50	.	.	0.50	0.50
	4	.	.	0.52	0.52	.	.	0.48	0.48
	ALL	.	.	0.51	0.51	.	.	0.49	0.49
3	Age								
	0	.	0.50	.	0.50	.	0.50	.	0.50
	1	0.35	0.38	.	0.37	0.65	0.62	.	0.64
	2	0.45	0.54	.	0.50	0.55	0.46	.	0.51
	3	0.62	0.61	.	0.62	0.38	0.39	.	0.39
	4	0.60	0.68	.	0.64	0.40	0.32	.	0.36
	ALL	0.51	0.54	.	0.53	0.50	0.46	.	0.47
4	Age								
	1	.	.	0.42	0.42	.	.	0.58	0.58
	2	.	.	0.48	0.48	.	.	0.52	0.52
	3	.	.	0.53	0.53	.	.	0.47	0.47
	4	.	.	0.60	0.60	.	.	0.40	0.40
	ALL	.	.	0.51	0.51	.	.	0.49	0.49

Danish data

Year=95

		Averages							
		Prop. of Baltic Herr.				Prop. of NS Herr.			
		Area (SkaKat)			ALL	Area (SkaKat)			ALL
		Skag-errak	Katt-egat	Sound	ALL	Skag-errak	Katt-egat	Sound	ALL
Quarter	Age								
2	2	0.36	.	.	0.36	0.64	.	.	0.64
	3	0.37	.	.	0.37	0.63	.	.	0.63
	4	0.56	.	.	0.56	0.44	.	.	0.44
	ALL	0.43	.	.	0.43	0.57	.	.	0.57
3	Age								
	1	0.41	.	.	0.41	0.59	.	.	0.59
	2	0.37	.	.	0.37	0.63	.	.	0.63
	3	0.48	.	.	0.48	0.52	.	.	0.52
	4	0.53	.	.	0.53	0.47	.	.	0.47
	ALL	0.45	.	.	0.45	0.55	.	.	0.55
4	Age								
	0	.	0.39	0.40	0.40	.	0.61	0.60	0.61
	1	0.34	0.68	0.52	0.51	0.66	0.32	0.48	0.49
	2	0.46	0.56	0.49	0.50	0.54	0.44	0.51	0.50
	3	0.52	0.61	0.48	0.54	0.48	0.39	0.52	0.46
	4	0.74	0.64	0.65	0.68	0.26	0.36	0.35	0.32
	ALL	0.52	0.58	0.51	0.53	0.49	0.42	0.49	0.47

Comparisons between Danish and Swedish data

A N A L Y S I S   O F   V E R T E B R A   C O U N T S
Comparison of Swedish and Danish Data per Rectangle

ANOVA/GLM: Comp. of Danish and Swedish Data (Linear Model)

General Linear Models Procedure
Class Level Information

Class	Levels	Values
COUNTRY	2	Denmark Sweden
YEAR	5	91 92 93 94 95
QUARTER	4	1 2 3 4
RECT	39	4057 4061 4155 4156 4157 4158 4161 4250 4251 4252 4256 4257 4258 4261 4351 4352 4353 4355 4356 4357 4358 4369 4450 4453 4454 4455 4456 4458 4466 4469 4472 4554 4555 4556 4569 4572 4655 4656 4672
AGE	5	0 1 2 3 4

General Linear Models Procedure

Dependent Variable: PROBBALT   Prop.of Baltic Herring

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	50	39.76275569	0.79525511	14.69	0.0001
Error	876	47.42552587	0.05413873		
Corrected Total	926	87.18828155			

R-Square	C.V.	Root MSE	PROBBALT Mean
0.456056	49.45473	0.2326773	0.4704854

Source	DF	Type I SS	Mean Square	F Value	Pr > F
COUNTRY	1	2.37130751	2.37130751	43.80	0.0001
YEAR	4	0.32814032	0.08203508	1.52	0.1957
QUARTER	3	2.62440391	0.87480130	16.16	0.0001
RECT	38	9.60280193	0.25270531	4.67	0.0001
AGE	4	24.83610203	6.20902551	114.69	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
COUNTRY	1	0.03531594	0.03531594	0.65	0.4195
YEAR	4	0.30877232	0.07719308	1.43	0.2234
QUARTER	3	3.29046260	1.09682087	20.26	0.0001
RECT	38	7.19777462	0.18941512	3.50	0.0001
AGE	4	24.83610203	6.20902551	114.69	0.0001

Parameter		Estimate		T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT		0.5878809168	B	5.11	0.0001	0.11495191
COUNTRY	Denmark	0.0434595741	B	0.81	0.4195	0.05380890
	Sweden	0.0000000000	B	.	.	.
YEAR	91	-.0229776012	B	-0.90	0.3705	0.02564348
	92	0.0395013566	B	1.34	0.1806	0.02947758
	93	-.0137628747	B	-0.54	0.5919	0.02566392
	94	-.0102481970	B	-0.42	0.6742	0.02437051
	95	0.0000000000	B	.	.	.
QUARTER	1	-.1302963803	B	-2.23	0.0257	0.05832261
	2	-.0714266294	B	-1.22	0.2230	0.05857828
	3	0.0393217342	B	0.73	0.4658	0.05389061
	4	0.0000000000	B	.	.	.
RECT	4057	0.2953169819	B	2.88	0.0041	0.10253517
	4061	0.1506826399	B	1.29	0.1981	0.11700555
	4155	0.2648885515	B	2.52	0.0120	0.10526381
	4156	0.2098590639	B	2.04	0.0416	0.10284024
	4157	0.1555859217	B	1.53	0.1269	0.10183131
	4158	0.2404944458	B	2.05	0.0407	0.11733037
	4161	0.2160592927	B	2.16	0.0313	0.10019174
	4250	0.1598447127	B	0.83	0.4075	0.19286894
	4251	-.0001552873	B	-0.00	0.9994	0.19286894
	4252	0.0167615753	B	0.07	0.9473	0.25374073
	4256	0.1073116171	B	1.04	0.2964	0.10270016
	4257	0.1631889438	B	1.59	0.1115	0.10242750
	4258	0.0829390424	B	0.62	0.5345	0.13348397
	4261	0.1206476353	B	1.18	0.2388	0.10235199
	4351	-.1108885287	B	-0.66	0.5087	0.16773022
	4352	0.1767615753	B	0.70	0.4862	0.25374073
	4353	0.0554961327	B	0.50	0.6180	0.11124123
	4355	0.1179316927	B	1.06	0.2884	0.11100619
	4356	0.1261780823	B	1.23	0.2177	0.10229497
	4357	0.1689489641	B	1.64	0.1017	0.10312218
	4358	0.0526723054	B	0.44	0.6633	0.12095737
	4369	0.0634286124	B	0.54	0.5898	0.11760890
	4450	0.0124448047	B	0.07	0.9409	0.16773022
	4453	-.0489475132	B	-0.47	0.6414	0.10505065
	4454	0.0275713365	B	0.27	0.7906	0.10378538
	4455	0.0795261426	B	0.83	0.4084	0.09615100
	4456	0.0534277375	B	0.52	0.6022	0.10247202
	4458	0.1328367614	B	1.32	0.1883	0.10089385
	4466	0.1025347270	B	0.96	0.3357	0.10645714
	4469	-.1219791883	B	-1.14	0.2555	0.10719200
	4472	0.0652484089	B	0.64	0.5192	0.10117375
	4554	0.0257079590	B	0.22	0.8289	0.11895019
	4555	0.0350988784	B	0.36	0.7222	0.09870238
	4556	-.0037783749	B	-0.04	0.9708	0.10317992
	4569	0.1371894888	B	1.03	0.3042	0.13343800
	4572	0.1691321157	B	1.44	0.1493	0.11719764
	4655	0.0879883231	B	0.86	0.3896	0.10221710
	4656	0.0132309201	B	0.09	0.9269	0.14415949
	4672	0.0000000000	B	.	.	.
AGE	0	-.4856101331	B	-14.70	0.0001	0.03302580
	1	-.3813685106	B	-16.40	0.0001	0.02325395
	2	-.1975347853	B	-8.41	0.0001	0.02348828
	3	-.0422519238	B	-1.74	0.0822	0.02428408
	4	0.0000000000	B	.	.	.

ANOVA/GLM: Comp. of Danish and Swedish Data (Discriminant Rules)

General Linear Models Procedure
Class Level Information

Class	Levels	Values
COUNTRY	2	Denmark Sweden
YEAR	5	91 92 93 94 95
QUARTER	4	1 2 3 4
RECT	39	4057 4061 4155 4156 4157 4158 4161 4250 4251 4252 4256 4257 4258 4261 4351 4352 4353 4355 4356 4357 4358 4369 4450 4453 4454 4455 4456 4458 4466 4469 4472 4554 4555 4556 4569 4572 4655 4656 4672
AGE	5	0 1 2 3 4

Number of observations in data set = 935

General Linear Models Procedure

Dependent Variable: PROBBALT   Prop.of Baltic Herring

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	50	7.49870520	0.14997410	10.48	0.0001
Error	876	12.53352802	0.01430768		
Corrected Total	926	20.03223323			

R-Square	C.V.	Root MSE	PROBBALT Mean
0.374332	25.38933	0.1196147	0.4711219

Source	DF	Type I SS	Mean Square	F Value	Pr > F
COUNTRY	1	0.42035533	0.42035533	29.38	0.0001
YEAR	4	0.06414782	0.01603696	1.12	0.3453
QUARTER	3	0.68767186	0.22922395	16.02	0.0001
RECT	38	1.72190096	0.04531318	3.17	0.0001
AGE	4	4.60462923	1.15115731	80.46	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
COUNTRY	1	0.00006374	0.00006374	0.00	0.9468
YEAR	4	0.04445512	0.01111378	0.78	0.5404
QUARTER	3	0.86037705	0.28679235	20.04	0.0001
RECT	38	1.26381626	0.03325832	2.32	0.0001
AGE	4	4.60462923	1.15115731	80.46	0.0001

Parameter		Estimate		T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT		0.4833942311	B	8.18	0.0001	0.05909446
COUNTRY	Denmark	-.0018463545	B	-0.07	0.9468	0.02766207
	Sweden	0.0000000000	B	.	.	.
YEAR	91	-.0036713905	B	-0.28	0.7807	0.01318280
	92	0.0156227099	B	1.03	0.3029	0.01515383
	93	-.0083850500	B	-0.64	0.5252	0.01319330
	94	0.0038083048	B	0.30	0.7612	0.01252839
	95	0.0000000000	B	.	.	.
QUARTER	1	-.0304176391	B	-1.01	0.3106	0.02998248
	2	0.0017798355	B	0.06	0.9529	0.03011391
	3	0.0542674938	B	1.96	0.0504	0.02770408
	4	0.0000000000	B	.	.	.
RECT	4057	0.1287853734	B	2.44	0.0148	0.05271127
	4061	0.1042589947	B	1.73	0.0834	0.06015020
	4155	0.0875536163	B	1.62	0.1060	0.05411400
	4156	0.0970570895	B	1.84	0.0667	0.05286810
	4157	0.0657690803	B	1.26	0.2093	0.05234942
	4158	0.1355185808	B	2.25	0.0249	0.06031718
	4161	0.1212190528	B	2.35	0.0188	0.05150655
	4250	0.0825836657	B	0.83	0.4051	0.09915004
	4251	-.0524163343	B	-0.53	0.5972	0.09915004
	4252	0.0546641394	B	0.42	0.6753	0.13044300
	4256	0.0598229013	B	1.13	0.2575	0.05279608
	4257	0.0720260308	B	1.37	0.1717	0.05265592
	4258	0.0554604943	B	0.81	0.4192	0.06862142
	4261	0.1029046134	B	1.96	0.0508	0.05261709
	4351	-.0052640312	B	-0.06	0.9513	0.08622673
	4352	-.0553358606	B	-0.42	0.6715	0.13044300
	4353	0.0449038019	B	0.79	0.4325	0.05718688
	4355	0.0675925824	B	1.18	0.2366	0.05706604
	4356	0.0583534680	B	1.11	0.2675	0.05258779
	4357	0.0934456376	B	1.76	0.0783	0.05301304
	4358	0.1282654233	B	2.06	0.0394	0.06218175
	4369	0.0645286634	B	1.07	0.2861	0.06046036
	4450	-.0685973645	B	-0.80	0.4265	0.08622673
	4453	-.0048528166	B	-0.09	0.9284	0.05400442
	4454	0.0285045036	B	0.53	0.5933	0.05335397
	4455	0.0670659998	B	1.36	0.1752	0.04942929
	4456	0.0419398285	B	0.80	0.4262	0.05267880
	4458	0.1063917979	B	2.05	0.0405	0.05186750
	4466	0.0511289659	B	0.93	0.3504	0.05472747
	4469	-.0304895324	B	-0.55	0.5802	0.05510525
	4472	0.0522468638	B	1.00	0.3154	0.05201139
	4554	0.0482465342	B	0.79	0.4303	0.06114990
	4555	0.0268168439	B	0.53	0.5973	0.05074090
	4556	0.0004387583	B	0.01	0.9934	0.05304272
	4569	0.0596460892	B	0.87	0.3848	0.06859779
	4572	0.0707538799	B	1.17	0.2406	0.06024895
	4655	0.0290762074	B	0.55	0.5802	0.05254775
	4656	0.0472251417	B	0.64	0.5241	0.07410949
	4672	0.0000000000	B	.	.	.
AGE	0	-.2232973365	B	-13.15	0.0001	0.01697790
	1	-.1639693409	B	-13.72	0.0001	0.01195439
	2	-.0898083934	B	-7.44	0.0001	0.01207485
	3	-.0283457767	B	-2.27	0.0234	0.01248395
	4	0.0000000000	B	.	.	.

Abs. Deviations: Comp. of Danish and Swedish Data (Linear Models)

YEAR	QUARTER	N Obs	Variable	Sum
91	3	3	DIF	0.86
			ABSDIF	0.86
			COUNT	3.00
92	3	1	DIF	-0.50
			ABSDIF	0.50
			COUNT	1.00
94	3	12	DIF	0.97
			ABSDIF	1.87
			COUNT	12.00

Regression: Comp. of Danish and Swedish Data (Linear Model)

Model: MODEL1
NOTE: No intercept in model. R-square is redefined.
Dependent Variable: BASWELIN

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	5.57753	5.57753	78.974	0.0001
Error	15	1.05937	0.07062		
U Total	16	6.63690			

Root MSE	0.26575	R-square	0.8404
Dep Mean	0.56188	Adj R-sq	0.8297
C.V.	47.29755		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
BADENLIN	1	1.045872	0.11768899	8.887	0.0001

Abs. Deviations: Comp. of Danish and Swedish Data (Discriminant Rules)

YEAR	QUARTER	N Obs	Variable	Sum
91	3	3	DIF	0.69
			ABSDIF	0.69
			COUNT	3.00
92	3	1	DIF	-0.16
			ABSDIF	0.16
			COUNT	1.00
94	3	12	DIF	0.34
			ABSDIF	1.20
			COUNT	10.00

Regression: Comp. of Danish and Swedish Data (Discriminant Rules)

Model: MODEL1
NOTE: No intercept in model. R-square is redefined.
Dependent Variable: BASWEDIS

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	4.82736	4.82736	152.429	0.0001
Error	15	0.47504	0.03167		
U Total	16	5.30240			

Root MSE	0.17796	R-square	0.9104
Dep Mean	0.54750	Adj R-sq	0.9044
C.V.	32.50397		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
BADENDIS	1	1.073199	0.08692530	12.346	0.0001