ADDENDUM 2: WGBIFS BIAS MANUAL 2011

MANUAL FOR THE BALTIC INTERNATIONAL ACOUSTIC SURVEY (BIAS)

Version 0.82

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KALININGRAD, RUSSIA

ICES International Council for the Exploration of the Sea
CIEM Conseil International pour l'Exploration de la Mer

International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer

H. C. Andersens Boulevard 44–46
DK-1553 Copenhagen V
Denmark
Telephone (+45) 33 38 67 00
Telefax (+45) 33 93 42 15
www.ices.dk
info@ices.dk

Contents

1 Introduction

Hydroacoustic surveys have been conducted in the Baltic Sea internationally, since 1978. The starting point was the cooperation between Sweden and the German Democratic Republic in October 1978, which produced the first acoustic estimates of total biomass of herring and sprat in the Baltic Proper (Håkansson *et al.,* 1979). Since then there has been at least one annual hydroacoustic survey for herring and sprat stocks mainly for assessment purposes and results have been reported to ICES to be used for stock assessment (ICES, 1994a, 1995a, 1995b; Hagström *et al.*, 1991).

At the ICES Annual Science Conference in September 1997, the Baltic Fish Committee decided, that a manual for the Baltic International Acoustic Surveys should be elaborated. The structure of the manual follows that of the Baltic International Trawl Surveys (BITS). In order to obtain standardization for all ICES acoustic surveys some demands from the Manual for Herring Acoustic Surveys in ICES Divisions III, IV and VI (ICES, 1994b) are adopted.

The objective of the Baltic International Acoustic Surveys (BIAS) program is to standardize survey design, acoustic measurements, fishing method and data analysis throughout all national surveys where data are used as indices for assessment purposes.

2 Survey design

2.1 Area of observation

The acoustic surveys should cover the total area of ICES Division III. The border by subdivision is given in Figure 2.1 and Table 2.1. The area is limited by the 10 m depth line.

Information about any changes in the planned acoustic transects pattern for given survey (vessel) as well as any difficulties concern the acoustic survey realization should by immediately transferred to the acoustic surveys coordinators within the WGBIFS, i.e. Niklas Larson, Lysekil – Sweden (niklas.larson@fiskeriverket.se) and Uwe Boettcher, Rostock – Germany (uwe.boettcher@vti.bund.de), with copy to the WGBIFS chair.

2.2 Stratification

The stratification is based on ICES statistical rectangles with a range of 0.5 degrees in latitude and 1 degree in longitude.

The areas of all strata limited by the 10 m depth line are given in Table 2.2

2.3 Transects

Parallel transects are spaced on regular rectangle basis at a maximum distance of 15 nautical miles.

The transect density should be about 60 NM per area of 1000 NM^2.

In the vicinity of islands and in sounds the strategy of parallel transects leads to an unsuitable coverage of the survey area. In this case a zigzag course should be used to achieve a regular covering. The length of the survey track per 1000 NM^2 track should be the same as when using parallel transects.

2.4 Observation time

The Baltic International Acoustic Survey is carried out in September/October. It is assumed that during this time of the year there is little or no emigration or immigration in the main part of the Baltic Sea so that the estimates are representing a good 'snapshot' of the herring, sprat and cod resources.

In the shallow water areas of the western Baltic a great part of the fish concentrations are close to the bottom during daytime and therefore not visible for the echosounder. This leads to an underestimation of fish. Therefore it is recommended that shallow water areas in the western Baltic should be surveyed only during night-time.

3 Acoustic measurements

3.1 Equipment

The standard equipment used for the survey is the echosounder Simrad EK/EY-60 or Simrad EK/EY-500.

The standard frequency used for the survey is 38 kHz.

3.2 Instrument settings

Some instrument settings will influence the acoustic measurements to a high degree. Particularly the following calibration settings in the ***Transceiver Menu*** are essential to the correct function of the acoustic device:

Max. Power

2-Way Beam Angle

Sv Transd. Gain

TS Transd. Gain

Additional in the split-beam case:

Angle Sens.Along

Angle Sens.Athw.

3dB Beamw.Along

3dB Beamw.Athw.

Alongship Offset

Athw.ship Offset

The following settings are recommended:

Pulse rate the high ping rate, i.e. of 3–4 pings per second (optional)

Absorption coef.	3 dBkm
Pulse Length	1 msec.
Bandwidth	Wide

and in the ***Layer Menu***:

Threshold	-60 dB
Bottom margin	0.5 m

It is recommended to record this setting regularly to have a log about the main function of the acoustic measuring system.

It is also recommended that each year the same settings (Min Sv = -60dB) are used for the printer in order to facilitate comparison of echograms.

3.3 Sampling unit

The Elementary Sampling Distance Unit (ESDU) is the length of cruise track, where acoustic measurements are averaged to give one sample. It is recommended to use as averaging unit 1 nautical mile.

3.4 Calibration

A calibration of the transducer must be conducted at least once during the survey with the same ping rate as mentioned in the Section 3.2. If possible, the transducer should be calibrated both at the beginning and the end of the survey. Calibration procedures are described in Annex 2. Full details are described in "*Simrad ER60 Scientific echo sounder reference manual. Release 2.2.0; 11 January 2008*".

3.5 Intercalibration

When more than one ship is engaged in the same area the performance of the equipment should be compared by means of an intercalibration. Preferably the vessels should start and finish the intercalibration with fishery hauls. A survey track should be chosen in areas with high density scattering layers. The settings of the acoustic equipment should be kept constant during the whole survey.

During the intercalibration one leading vessel should steam 0.5 nautical miles ahead of the other. The lateral distance between the survey tracks should be 0.3 nautical miles. The intercalibration track should be at least 40 nautical miles. It is emphasized that the vessels have to change their position at least once during the operation.

4 Fishery

4.1 Gear

Trawling is done with different pelagic gear in the midwater as well as in the near bottom. The collection of the trawl gears used in surveys is given in Table 4.1.

The stretched mesh size in the codend of the pelagic trawl used in the ICES Subdivisions 22–24 and 25–32 should be 20 and 12 mm, respectively.

4.2 Method

The collection of biological samples is done to determine the species composition and length, age and weight distributions of target species detected by the echosounder system.

It is recommended to sample a minimum of 2 hauls per the ICES rectangle.

Standard fishing speed is 3.0 - 3.5 knots.

The standard trawling time is 30 minutes.

It has to be secured that all type of fish concentration is sampled for species recognition. In situations with fish vertically distributed over the whole water column, specifically in shallow waters, the whole depth range should be sampled by the trawl haul. In the case of two or more layers in one area (Figure 4.2.1), it is recommended to sample all layers by separate hauls. If shoals and scattering layers are present (Figure 4.2.2), both should be sampled by separate trawl hauls.

4.3 Samples

4.3.1 Species composition

It should be achieved to sort the total catch into **all species** (Table 4.3.1). The corresponding weight per species should be registered.

In case of homogenous large catches of clupeids a sub-sample of at least 50 kg should be taken and sorted for the identification of the species. The weight of the sub-sample and the total weight per species in the sub-sample should be registered.

In case of heterogeneous large catches consisting of a mixture of clupeids and few larger species the total catch should be partitioned into the part of larger species and that of the mixture of clupeids. From the mixture of clupeids, a sub-sample of at least 50 kg should be taken. The total weight per species for the part of the larger species and the total weight of the sub-sample of mixed clupeids should be registered.

Certain related species that are hard to identify down to species level may be grouped by genus levels or larger taxonomic units.

4.3.2 Length distribution

Length distribution is recorded for all caught fish species. Length is defined as total length (measured from tip of snout to tip of caudal fin). Length is measured to 0.5 cm below for herring and sprat, and to 1 cm below for all other species.

In case of large catches of clupeids with a narrow length spectrum, a sub-sample should be taken containing at least 200 specimens per species to get a reasonable length distribution. For other species at least 50 specimens should be measured, if possible.

In case of large herring/sprat catches with a wide length spectrum, the sub-samples should contain at least 400 specimens.

4.3.3 Weight distribution

Herring and sprat should be sorted into 0.5 cm length groups and weighed. Taking into account the available manpower two methods are possible:

Maximum effort method. The mean weight per length group for herring and sprat is to be measured for each control-haul**.**

Minimum effort method. The mean weight per length group for herring and sprat is to be measured for each the ICES Subdivision**.** It is recommended to cover the whole subdivision homogeneously.

The maximum effort method should be preferred.

4.3.4 Age distribution

Taking into account the available manpower two methods are possible:

Maximum effort method: The otoliths samples are collected for herring, sprat and cod per each trawl haul**.**

Minimum effort method: The otoliths samples are collected for herring, sprat and cod per each the ICES Subdivision**.** It is recommended to cover the whole Sub-division homogeneously.

The maximum effort method should be preferred.

If otoliths samples are to be taken of the 3 target species (herring, sprat, cod) the number of otoliths per length-class are not fixed by a constant figure. The following minimum sampling levels should be maintained for herring, sprat and cod per the ICES Subdivision and per 0.5 cm length-class:

- 5 otoliths for length <10 cm
- 10 otoliths for length >=10 cm.

For the smallest size groups, that presumably contain only one age group, the number of otoliths per length class may be reduced.

4.4 Environmental data

Temperature, salinity and oxygen content should be measured with a CTD probe after each haul, and recorded at least in 1-m intervals.

5 Data analysis

5.1 Species composition

Trawl catches within each the ICES rectangle are combined to give an average species composition of the catch. Each trawl catch is given equal weight, unless it is decided that a trawl catch is not representative for the fish concentrations sampled. In this case, the particular trawl catch is not used. The species frequency f_i of species i can be estimated by

$$f_i = \frac{1}{M}\sum_{k=1}^{M}\frac{n_{ik}}{N_k} \qquad (5.1)$$

where: n_{ik} the fish number of species i in the haul, N_k the total fish number in this haul and M is the number of hauls in the ICES rectangle.

It is allowed to exclude a species from further total species frequency calculation if the overall mean contribution to all sampled hauls is lower than one per cent.

Data about the share of cod and clupeids in samples as well as their abundance per the ICES rectangle should be delivered in at least two decimals rounding format, to the acoustic surveys data coordinators (for names see the Section 2.1), for a final calculation of fish stocks resources.

5.2 Length distribution

It is assumed that catch rates are poorly related to abundance. In this case each trawl catch is given equal weight. The length frequency f_{ij} in the length class j is calculated as the mean of all M_i trawl catches containing species i

$$f_{ij} = \frac{1}{M_i}\sum_{k=1}^{M_i}\frac{n_{ijk}}{N_{ik}} \qquad (5.2)$$

where: n_{ijk} the number of fish within the length class j and N_{ik} the total number of species i in the haul k.

5.3 Age distribution

Minimum effort method: All sampled otoliths within each the ICES Subdivision are assumed to be representative for the species age distribution within this area. The age–length-key in this ICES Subdivision can be expressed as frequencies f_{aj} or as relative quantities (fractions) q_{aj} associated with age a in length class j. The combination of the age length key q_{aj} for the whole Sub-division with the length distribution f_j from a specific ICES rectangle results in the age distribution f_a for this ICES rectangle, i.e.

$$f_a = \sum_j q_{aj} \cdot f_j \qquad (5.3.1)$$

Maximum effort method: The age distribution for each rectangle is estimated as unweighted mean of all samples, i.e.

$$f_a = \frac{1}{M} \sum_k f_{ak} \qquad (5.3.2)$$

5.4 Weight distribution

Minimum effort method: For the calculation of the weight distribution per age group W_a we use also the normalized age–length-key q_{aj} (see Section 5.3) and the mean weight per length group W_j.

$$W_a = \sum_j q_{aj} \cdot f_j \cdot W_j \qquad (5.4.1)$$

Maximum effort method: The weight distribution for each rectangle is estimated as unweighted mean of all samples.

$$w_a = \frac{1}{M} \sum_k w_{ak} \qquad (5.4.2)$$

5.5 Lack of sample hauls

In the case of lack of sample hauls within an individual ICES rectangle (as a result of small bottom depth, bad weather conditions or other limitations) a mean of all available neighbouring rectangles should be taken.

5.6 Allocation of records

During the survey herring and sprat normally cannot be distinguished from other species by visual inspection of the echogram. Both herring and sprat tend to be distributed in scattering layers or in pelagic layers of small schools, and it is not possible to ascribe values to typical herring schools.

Species allocation is then based entirely upon trawl catch composition. The estimates of total fish density are then allocated to species and age groups according to the trawl catch composition in the corresponding ICES rectangle.

5.7 Target strength of an individual fish

The mean cross section σ of an individual fish of species i should be derived from a function which describes the length-dependence of the target-strength.

$$TS = a_i + b_i \cdot \log L \qquad (5.7.1)$$

a_i and b_i are constants for the i'th species and L is the length of the individual fish in cm.

The equivalent formula for the cross section is:

$$\sigma_{ij} = 4\pi \cdot 10^{a_i/10} \cdot L_j^{b_i/10} \qquad (5.7.2)$$

Normally we assume a quadratic relationship that means b_i is 20. We get the formula:

$$\sigma_{ij} = d_i \cdot L_j^{\,2} \qquad (5.7.3)$$

The parameters a, b and d are listed in Table 5.7 for different species.

5.8 Estimation of the mean cross section in the ICES rectangle

The basis for the estimation of total fish density F from the measured area scattering cross section S_a is the conversion factor c.

$$F = S_a \cdot c = \frac{S_a}{<\sigma>} \qquad (5.8.1)$$

The mean cross section $<\sigma>$ in the ICES rectangle is dependent from the species composition and the length distributions of all species. From formula 5.7.3 we get the corresponding cross section $<\sigma_i>$

$$<\sigma_i> = \sum_j f_{ij} \cdot d_i \cdot L_j^2 \qquad (5.8.2)$$

where: L_j is the midpoint of the j-th length class and f_{ij} the respective frequency.

It follows that the mean cross section in the ICES rectangle can be estimated as the weighted mean of all species related cross sections $<\sigma_i>$:

$$<\sigma> = \sum f_i \sigma_i = \sum_i f_i \sum_j f_{ij} d_i L_j^2 \qquad (5.8.3)$$

5.9 Abundance estimation

The total number of fish in the ICES rectangle has to be estimated as:

$$N = F \cdot A = \frac{S_a}{<\sigma>} \cdot A \qquad (5.9.1)$$

This total abundance is split into species classes N_i by

$$N_i = N \cdot f_i \qquad (5.9.2)$$

especially in abundance of herring N_h, sprat N_s and cod N_c.

The abundance of the species i is divided into age-classes, $N_{a,j}$ according to the age distribution $f_{i,a}$ in each ICES rectangle:

$$N_{ia} = N_i \cdot f_{ia} \qquad (5.9.3)$$

Biomass estimation

The biomass Q_{ia} for the species i and the age group a is calculated from the abundance N_{ia} and the mean weight per age group:

$$Q_{ai} = N_{ai} \cdot W_a \quad (5.10.1)$$

6 Data exchange and database

6.1 Exchange of survey results

The main results of the recently conducted the BIAS survey should be summarized and reported to the Baltic International Acoustic Surveys coordinators, i.e. Niklas Larson, Lysekil – Sweden (niklas.larson@fiskeriverket.se) and Uwe Boettcher, Rostock – Germany (uwe.boettcher@vti.bund.de), not later than end of February of the next year. Data should be submitted in the BAD1 format using the Excel spreadsheet. Name of the file, e.g. BAD1POL2008.xls should contain the abbreviation of the database i.e. BAD1, three letters code of the country delivered (e.g.: POL – for Poland, SWE – for Sweden, etc.) and year of survey realization. Results of survey are indispensable for the Baltic clupeids and cod stocks size assessment yearly verification, realized by the ICES WGBFAS, and should contain the following documents:

- results in the BAD1 format (as described below in Section 6.2),
- a map reflected the echo integration track and the location of fish catch stations,
- a short description of the survey,
- a table contains the basic values needed for the fish stocks abundance estimation (survey statistics),
- tables contain the data on herring, sprat and cod stocks abundance per age groups,
- tables contain the mean weights of herring, sprat and cod per age groups.

The new standard exchange format, which is described in the Table 6.1, is recommended for the next BIAS surveys documents preparation.

6.2 BAD1

The database BAD1 is the collection of results from the Baltic International Acoustic Surveys (BIAS) and the Baltic Acoustic Spring Surveys (BASS). The sampling unit is the ICES rectangle (see Section 2.2). The contents of the database are similar to the standard data exchange format (6.1) for the BIAS. The database BAD-1 consists of the following six tables:

- AH Abundance (in millions) of herring per age group,
- AS Abundance (in millions) of sprat per age group,
- AC Abundance (in millions) of cod per age group,
- ST Basic values for the computation of the abundance,
- SU Description of the different surveys,
- WH Mean weights of herring per age group,
- WS Mean weights of sprat per age group,
- WC Mean weights of cod per age group.

The inner structure of the tables is summarized in the Table 6.2.

7 References

Håkansson, N., Kollberg, S., Falk, U., Götze, E., Rechlin, O. 1979. A hydroacoustic and trawl survey of herring and sprat stocks of the Baltic proper in October 1978. Fischerei-Forschung, Wissenschaftliche Schriftenreihe 17(2): 7–23.

Hagström, O., Palmen, L.-E., Hakansson, N., Kästner, D., Rothbart, H. Götze, E., Grygiel, W., Wyszynski, M. 1991. Acoustic estimates of the herring and sprat stocks in the Baltic proper, October 1990. ICES CM 1991/J:34.

ICES. 1994a. Report of the Planning Group for Hydroacoustic Surveys in the Baltic. ICES CM 1994/J:4, 18pp.

ICES. 1994b. Report of the Planning Group for Herring Surveys. ICES CM 1994/H:3, 26 pp.

ICES. 1995a. Report of the Study Group on Data Preparation for the Assessment of Demersal and Pelagic Stocks in the Baltic. ICES CM 1995/Assess:17, 104 pp.

ICES. 1995b. Report of the Study Group on Assessment-related Research-Activities relevant to the Baltic Fish Resources. ICES CM 1995/J:1, 59 pp.

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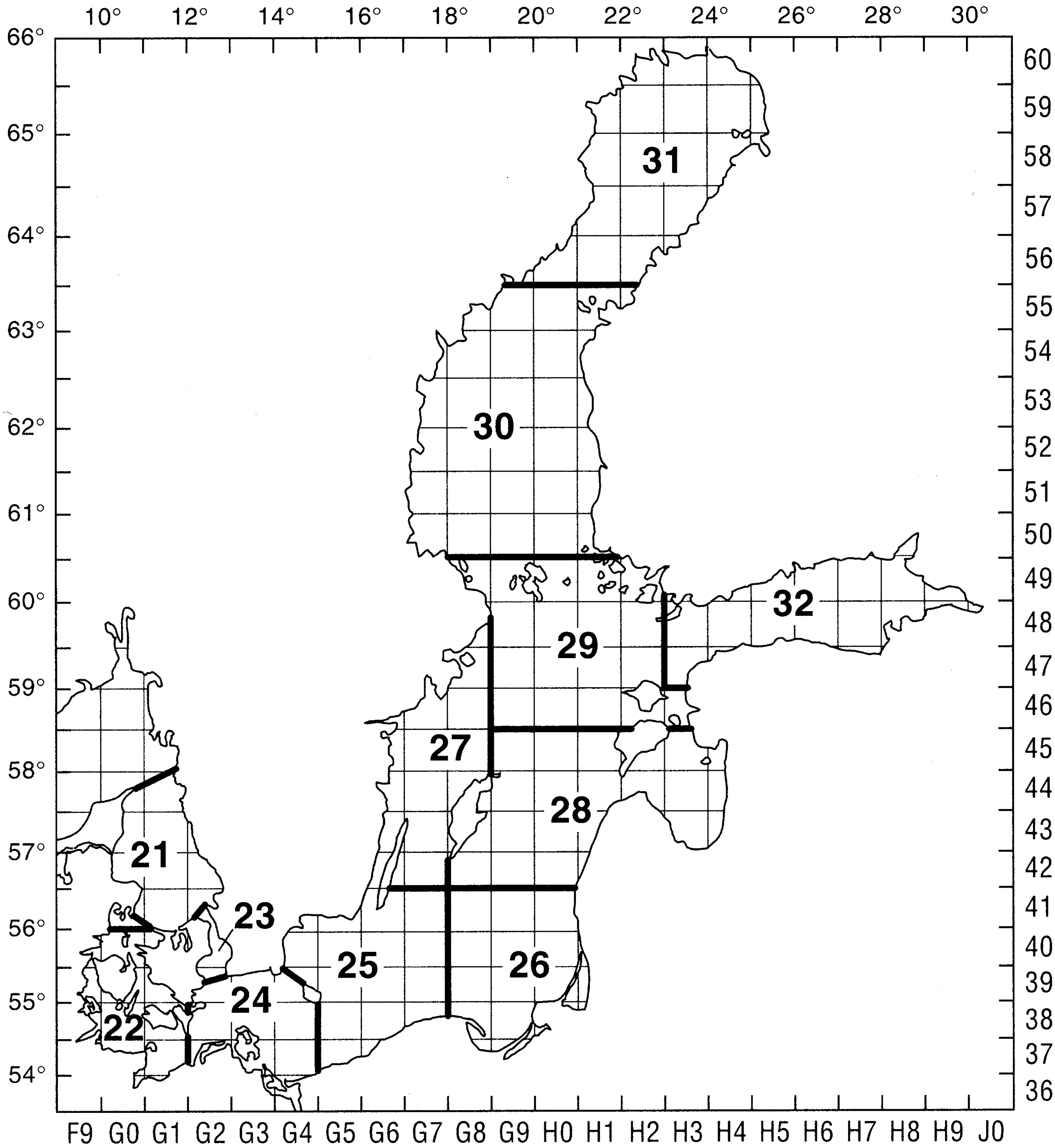

Figure 2.1. ICES Sub-division borders and rectangles codes.

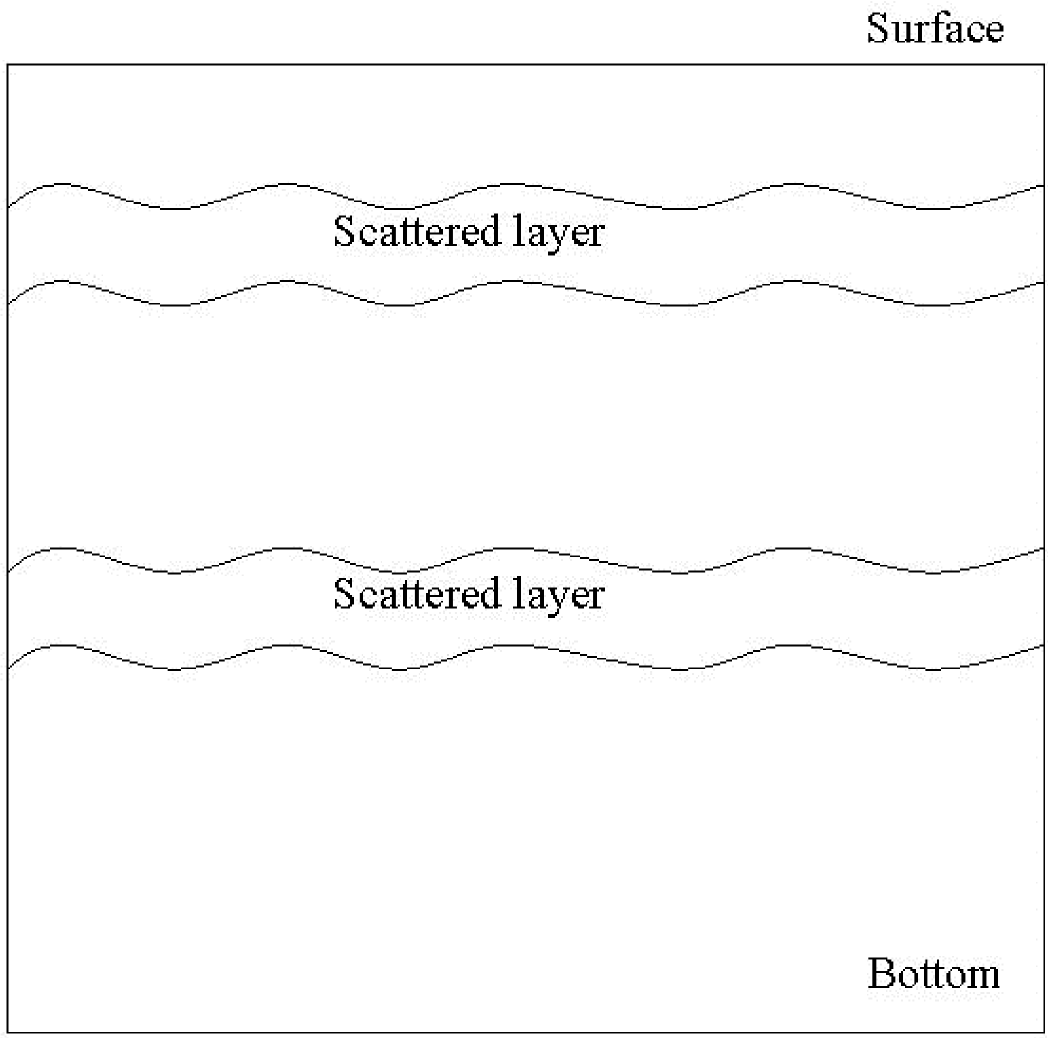

Figure 4.2.1. Multiple scattering fish layers.

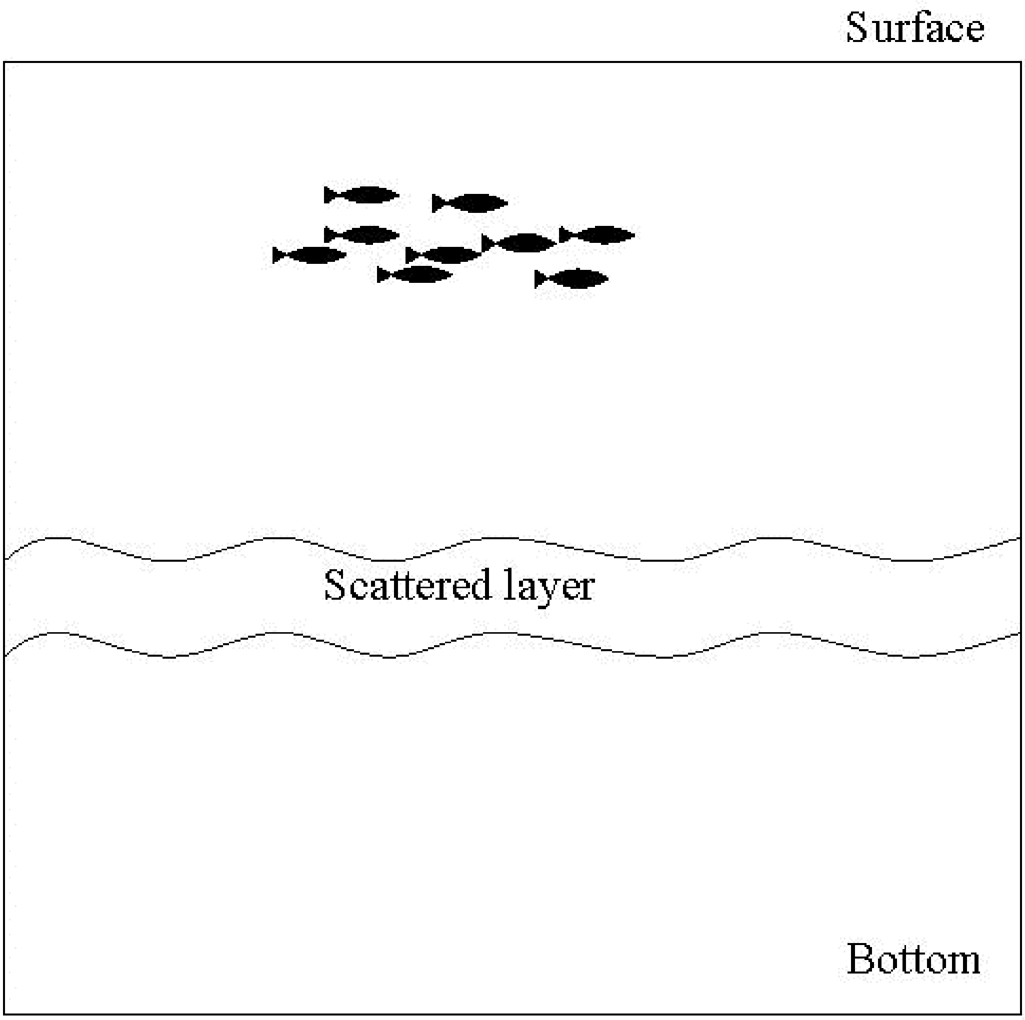

Figure 4.2.2. Shoals and scattering fish layers.

Table 2.1. The boundaries of the ICES Sub-divisions of the Baltic Sea and the Belts (IBSFC Fishery Rules).

SUBDIVISION 22	
Northern boundary:	a line from Hasenore head to Gniben Point
Eastern boundary:	a line at longitude 12° East due South from Zealand to Falster, then along the East coast of the Island of Falster to Gedser Odde (54°34′N, 11°58′E), then due South to the coast of the Federal Republic of Germany.
SUBDIVISION 23	
Northern boundary:	a line from Gilbjerg Head to the Kullen.
Southern boundary:	a line from Falsterbo Light on the Swedish coast to Stevns Light on the Danish coast.
SUBDIVISION 24	
The western boundaries coincide with the eastern boundary of the ICES Subdivision 22 and the southern boundary of the ICES Subdivision 23. The eastern boundary runs along the line from Sandhammeren Light to Hammerode Light and south of the Bornholm further along 15°E.	
SUBDIVISION 25	
Northern boundary:	the latitude 56°30′N.
Eastern boundary:	the longitude 18°E.
Western boundary:	coincides with the eastern boundary of the ICES Subdivision 24
SUBDIVISION 26	
Northern boundary:	the latitude 56°30′N.
Eastern boundary:	the longitude 18° E.
SUBDIVISION 27	
Eastern boundary:	the longitude 19° E from 59°41′N to the Isle of Gotland and from the Isle of Gotland along 57° N to 18° E and further to the south along the longitude 18° E.
Western boundary:	the latitude 56°30′N.
SUBDIVISION 28	
Northern boundary:	the latitude 58°30′N.
	the latitude 56°30′N.
Western boundary:	north of Gotland, the latitude 19° E and south of Gotland along 57° N to the longitude 18° E, and further south along the longitude 18o E.
SUBDIVISION 29	
Northern boundary:	the latitude 60°30′N.
Eastern boundary:	the longitude 23° E to 59° N and further along 59° N to the southeastern boundary: the latitude 58°30′N.
Western boundary:	from 59°41′N, along the longitude 19° E to the south.
SUBDIVISION 30	
Northern boundary:	the latitude 63°30′N.
Southern boundary:	the latitude 60°30′N.
SUBDIVISION 31	
Southern boundary:	the latitude 63°30′N.
SUBDIVISION 32	
Western boundary:	coincides with the eastern boundary of the ICES Subdivision 29

Table 2.2. Area of strata (values of the areas of standard rectangles in nautical square miles below 10 m depth).

Estimated w ith a dataset from Seifert & Kayser (Seifert. T.; Kayser. B.: 1995. A high resolution spherical grid topography of the Baltic Sea. Meeresw iss. Berichte (Marine Science Reports) Inst. Ostseeforschung Warnemünde. Nr. 9. 1995. S. 72 - 88.).

SD21	41G0	41G1	41G2	42G1	42G2	43G1	43G2
	108.1	946.8	432.3	884.2	606.8	699.0	107.0

SD22	37G0	37G1	38F9	38G0	38G1	39F9	39G0	39G1	40F9	40G0	40G1	41G0	41G1
	209.9	723.3	51.9	735.3	173.2	159.3	201.7	250.0	51.3	538.1	174.5	173.1	18.0

SD23	39G2	40G2	41G2
	130.9	164.0	72.3

SD24	37G2	37G3	37G4	38G2	38G3	38G4	39G2	39G3	39G4
	192.4	167.7	875.1	832.9	865.7	1034.8	406.1	765.0	524.8

SD25	37G5	37G6	38G5	38G6	38G7	39G4	39G5	39G6	39G7	40G4	40G5	40G6	40G7	41G4	41G5	41G6	41G7
	642.2	130.7	1035.7	940.2	471.7	287.3	979.0	1026.0	1026.0	677.2	1012.9	1013.0	1013.0	59.4	190.2	764.4	1000.0

SD26	37G8	37G9	38G8	38G9	38H0	39G8	39G9	39H0	39H1	40G8	40G9	40H0	40H1	41G8	41G9	41H0	41H1
	86.0	151.6	624.6	918.2	37.8	1026.0	1026.0	881.6	12.8	1013.0	1013.0	1012.1	56.3	1000.0	1000.0	953.3	16.6

SD27	42G6	42G7	43G6	43G7	43G8	44G6	44G7	44G8	45G6	45G7	45G8	46G6	46G7	46G8	47G8	48G8
	266.0	986.9	269.8	913.8	106.1	200.9	960.5	456.6	72.9	908.7	947.2	38.9	452.6	884.8	264.3	53.8

SD28	42g8	42g9	42h0	42h1	43g8	43g9	43h0	43h1	43h3	43h4	44g8	44g9	44h0	44h1	44h2	44h3	44h4	45g9	45h0	45h1	45h2	45h3	45h4
	945.4	986.9	968.5	75.0	296.2	973.7	973.7	412.7	744.3	261.9	68.1	876.6	960.5	824.6	627.3	936.1	290.6	924.5	947.2	827.1	209.9	638.2	96.5

SD29	46g9	46h0	46h1	46h2	46h3	47g9	47h0	47h1	47h2	48g9	48h0	48h1	48h2	49g8	49g9	49h0	49h1	49h2
	933.8	933.8	921.5	258.0	13.2	876.2	920.3	920.3	793.9	772.8	730.3	544.0	597.0	196.0	564.2	85.3	65.2	28.4

SD30	50G7	50G8	50G9	50H0	50H1	51G7	51G8	51G9	51H0	51H1	52G7	52G8	52G9	52H0	52H1	53G7	53G8	59G9
	403.1	833.4	879.5	795.1	41.6	614.5	863.7	865.8	865.7	237.3	482.6	852.0	852.0	852.0	263.9	354.5	838.1	838.1

SD30	53H0	53H1	54G7	54G8	54G9	54H0	55G8	55G9	55H0	55H1
cont.	838.1	126.6	13.2	642.2	824.2	727.9	103.6	625.6	688.6	86.7

SD31	56G9	56H0	56H1	56H2	56H3	57H1	57H2	57H3	57H4	58H1	58H2	58H3	58H4	59H1	59H2	59H3	59H4	60H2	60H3	60H4
	8.1	269.2	789.7	414.3	13.2	558.1	782.0	518.9	9.0	486.0	767.8	766.1	256.6	105.8	603.1	752.5	409.0	49.2	181.2	58.0

SD32	47H3	47H4	47H7	48H3	48H4	48H5	48H6	48H7	48H8	49H4	49H5	49H6	49H7	49H8	49H9	50H8
	536.2	90.9	90.0	615.7	835.1	767.2	776.1	851.4	308.5	64.8	306.9	586.5	754.6	665.1	205.2	43.0

Table 4.1. Trawl gears specification.

A	B	C	D	E	F	G	H	J	K	L	M	N2/N3												O	P
Country	Vessel	Power	Code	Name	Type	Panels	Headl	Groundr	Sweeps	Length	Circum	Mesh size												Height	Spread
		kW			B/P	2/4	m	m	m	m	m	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	m	m
GFR	WAH3	2900	GOV	GOV	B	2	36.0	52.8	110.0	51.7	76.0	200	160	120	80	50								4	23
GFR	WAH3	2900	PS205	PSN205	P	4	50.4	55.4	99.5	84.3	205.0	400	200	160	80	50								12	28
GFR	WAH3	2900	1600#	1600# Engelnetz	P	4	70.0	78.0	69.5	118.5	315.0	200	100	50										19	36
GFR	SOL	588	BLACK	Blacksprutte 854#	P	4	39.2	39.2	105.0	60.4	156.0	8/200	4/200	200	160	120								11	22
GFR	SOL	588	PS388	Krake	P	4	42.0	42.0	63.5	59.8	142.4	400	200	80										9	21
GFR	SOL	588	H20	HG20/25	B	2	25.7	39.8	63.5	41.9	51.0	120	80	40										3	15
GFR	SOL	588	AAL	Aalhopser	B	2	31.0	29.7	63.5	57.5	119.0	160	120	80	40									6	19
GFR	SOL	588	KAB	Kabeljaubomber	P	2	53.2	53.2	63.5	73.5	129.6	200	160	120										11	30
POL	BAL	1030	P20	P20/25	B	2	28.0	42.4	100.0	53.4		120	40											4	11
POL	BAL	1030	TV3	TV-3 930#	B	4	71.7	78.8			74.4	200	40											6.5	
POL	BAL	1030	WP53	WP53/64x4	P	4	53.0	53.0	88.0	86.0	217.6	800	100											22	32
RUS	MON		RTM	RTM33S	P																				
RUS	ATL	1764	RTA	70/300 project0495	P	4	70.0	70.0	75.0	101.3	300.0	7000	5000	4000	2000	800	400	200	100	80	60	45	37	28	41
FIN	JUL	750	1600'	Finflyder combi	P	4	86.0	86.0	60.0	160.3	467.2	3200	1600	800	290	120	80	40						23	38
SWE	ARG	1324	FOTOE	Fotö 3.2	P	4	60.2	60.2	108.0	98.0	260.0	6400	3200	1600	800	400	200	100	40					16	90
SWE	ARG	1324	MACRO	Macro 5A:1	P	4	86.0	86.0	108.0	98.0	205.0	6400	3200	1600	800	400	200	100	40					19	105

Table 4.3. Species list.

NODC	Scientific name	English name
3734030201	*AURELIA AURITA*	COMMON JELLYFISH
5704020401	*SEPIETTA OWENIANA*	
5706010401	*ALLOTEUTHIS SUBULATA*	
6188030110	*CANCER PAGURUS*	EDIBLE CRAB
8603010000	*PETROMYZINIDAE*	LAMPREYS
8603010217	*LAMPETRA FLUVIATILIS*	RIVER LAMPREY
8603010301	*PETROMYZON MARINUS*	SEA LAMPREY
8606010201	*MYXINE GLUTINOSA*	HAGFISH
8710010201	*SQUALUS ACANTHIAS*	SPURDOG / SPINY DOGFISH
8713040134	*RAJA RADIATA*	STARRY RAY
8741010102	*ANGUILLA ANGUILLA*	EEL
8747010000	*CLUPEIDAE*	HERRINGS
8747010109	*ALOSA FALLAX*	TWAITE SHAD
8747010201	*CLUPEA HARENGUS*	HERRING
8747011701	*SPRATTUS SPRATTUS*	SPRAT
8747012201	*SARDINA PILCHARDUS*	PILCHARD, SARDINE
8747020104	*ENGRAULIS ENCRASICOLUS*	ANCHOVY
8755010115	*COREGONUS OXYRINCHUS / C. LAVARETUS*	WHITEFISH / HOUTING / POWAN
8755010305	*SALMO SALAR*	SALMON
8755010306	*SALMO TRUTTA*	TROUT
8755030301	*OSMERUS EPELANUS*	SMELT
8756010237	*ARGENTINA SPYRAENA*	LESSER SILVERSMELT
8759010501	*MAUROLICUS MUELLERI*	PEARLSIDE
8776014401	*RUTILUS RUTILUS*	ROACH
8791030402	*GADUS MORRHUA*	COD
8791030901	*POLLACHIUS VIRENS*	SAITHE
8791031301	*MELANOGRAMMUS AEGLEFINUS*	HADDOCK
8791031501	*RHINONEMUS CIMBRIUS*	FOUR BEARDED ROCKLING
8791031701	*TRISOPTERUS MINUTUS*	POOR COD
8791031703	*TRISOPTERUS ESMARKI*	NORWAY POUT
8791031801	*MERLANGIUS MERLANGIUS*	WHITING
8791032201	*MICROMESTISTIUS POTASSOU*	BLUE WHITING
8791040105	*MERLUCCIUS MERLUCCIUS*	HAKE
8793010000	*ZOARCIDAE*	EEL-POUTS
8793010724	*LYCODES VAHLII*	VAHL'S EELPOUT
8793012001	*ZOARCES VIVIPARUS*	EELPOUT
8803020502	*BELONE BELONE*	GARFISH
8818010101	*GASTEROSTEUS ACULEATUS*	THREE-SPINED STICKLEBACK
8818010201	*SPINACHIA SPINACHIA*	SEA STICKLEBACK
8820020000	*SYNGNATHIDAE*	PIPE FISHES
8820020119	*SYNGNATUS ROSTELLATUS*	NILSSON'S PIPEFISH
8820020120	*SYNGNATUS ACUS*	GREAT PIPEFISH
8820020123	*SYNGNATUS TYPHLE*	DEEP-SNOUTED PIPEFISH

Table 4.3 continued.

NODC	Scientific name	English name
8820022101	*ENTELURUS AEQUOREUS*	SNAKE PIPEFISH
8826020601	*EUTRIGLA GURNARDUS*	GREY GURNARD
8831020825	*COTTUS GOBIO*	BULLHEAD
8831022205	*MYOXOCEPHALUS QUADRICORNIS*	FOUR SPINED SCULPIN
8831022207	*MYOXOCEPHALUS SCORPIUS*	BULL ROUT
8831024601	*TAURULUS BUBALIS*	SEA SCORPION
8831080803	*AGONUS CATAPHRACTUS*	POGGE
8831090828	*LIPARIS LIPARIS*	SEA SNAIL
8831091501	*CYCLOPTERUS LUMPUS*	LUMPFISH
8835020101	*DICETRARCHUS LABRAX*	BASS
8835200202	*PERCA FLUVIATILIS*	PERCH
NODC	*Scientific name*	English name
8835200403	*STIZOSTEDION LUCIOPERCA*	ZANDER (PIKEPERCH)
8835280103	*TRACHURUS TRACHURUS*	HORSE MACKEREL
8835450202	*MULLUS SURMULETUS*	RED MULLET
8839013501	*CTENOLABRUS RUPESTRIS*	GOLD SINNY
8840060102	*TRACHINUS DRACO*	GREATER WEEVER
8842120905	*LUMPENUS LAMPRETAEFORMIS*	SNAKE BLENNY
8842130209	*PHOLIS GUNELLUS*	BUTTERFISH
8845010000	*AMMODYTIDAE*	SANDEELS
8845010105	*AMMODYTES TOBIANUS (LANCEA)*	SAND EEL
8845010301	*HYPEROPLUS LANCEOLATUS*	GREATER SANDEEL
8846010106	*CALLIONYMUS LYRA*	SPOTTED DRAGONET
8846010107	*CALLIONYMUS MACULATUS*	DRAGONET
8847010000	*GOBIIDAE*	GOBIES
8847015101	*POMATOSCHISTUS MINUTUS*	SAND GOBY
8847015103	*POMATOSCHISTUS MICROPS*	COMMON GOBY
8847016701	*LESUEURIGOBIUS FRIESSII*	FRIESES' GOBY
8850030302	*SCOMBER SCOMBRUS*	MACKEREL
8857030402	*SCOPHTHALMUS MAXIMUS*	TURBOT
8857030403	*SCOPHTHALMUS RHOMBUS*	BRILL
8857031702	*ARNOGLOSSUS LATERNA*	SCALDFISH
8857040603	*HIPPOGLOSSOIDES PLATESSOIDES*	LONG ROUGH DAB
8857040904	*LIMANDA LIMANDA*	DAB
8857041202	*MICROSTOMUS KITT*	LEMON SOLE
8857041402	*PLATICHTHYS FLESUS*	FLOUNDER
8857041502	*PLEURONECTES PLATESSA*	PLAICE
8858010601	*SOLEA SOLEA*	SOLE
8858010801	*BUGLOSSIDIUM LUTEUM*	SOLENETTE

Table 5.7. Target strength parameters.

Species	A	B	D
Clupea harengus	-71.2	20	9.533E-07
Sprattus sprattus	-71.2	20	9.533E-07
Gadus morhua	-67.5	20	2.235E-06
Trachurus trachurus	-73.0	20	6.298E-07
Scomber scombrus	-84.9	20	4.066E-08

Until new TS parameters are agreed the following is suggested:

- Gadoids should be treated as cod,
- Salmonids and three-spined stickleback should be treated as herring,
- fish without swim-bladder should be treated as mackerel,
- other fish species should be treated as cod.

Recently calculated the values of the TS parameter for *Trachurus trachurus* and *Scomber scombrus* (Table 5.7) is recommended to use for preparation of the standard data set from the BIAS and BASS surveys.

Table 6.1. Data exchange format.

Structure of table SURV

Field	Type	Length	Decimals	Description
CCODE	String	10		Survey code
SHIP	String	20		Name of ship
YEAR	Int	4		Year of survey
COUNTRY	String	20		responsible country

Structure of table STAT

Field	Type	Length	Decimals	Description
CCODE	String	10		Survey code
SD	String	4		ICES Subdivision
RECT	String	5		ICES rectangle
FLAG	Dec	6	4	Treatment for multiple coverage (1)
SA	Dec	10	1	NASC per ESDU
SIGMA	Dec	10	1	Acoustic cross section of mean target
NTOT	Dec	10	2	Total number of targets
HH	Dec	6	2	Proportion of herring
HS	Dec	6	2	Proportion of sprat
HC	Dec	6	2	Proportion of cod
Remarks	String	50		

Structure of table NHER (abundance of herring)

Field	Type	Length	Decimals	Description
CCODE	String	10		Survey code
SD	String	4		ICES Subdivision
RECT	String	5		ICES rectangle
N	Dec	10	2	Number (millions)
AGE	Int	1		Age group (1 – 8)

Structure of table NSPR (abundance of sprat)

Field	Type	Length	Decimals	Description
CCODE	String	10		Survey code
SD	String	4		ICES Subdivision
RECT	String	5		ICES rectangle
N	Dec	10	2	Number (millions)
AGE	Int	1		Age group (1 – 8)

Structure of table NCOD (abundance of cod)

Field	Type	Length	Decimals	Description
CCODE	String	10		Survey code
SD	String	4		ICES Subdivision
RECT	String	5		ICES rectangle
N	Dec	10	2	Number (millions)
AGE	Int	1		Age group (1 – 8)

Structure of table WHER (Mean weight of herring)

Field	Type	Length	Decimals	Description
CCODE	String	10		Survey code
SD	String	4		ICES Subdivision
RECT	String	5		ICES rectangle
N	Dec	10	2	Mean weight (gram)
AGE	Int	1		Age group (1 – 8)

Structure of table WSPR (Mean weight of sprat)

Field	Type	Length	Decimals	Description
CCODE	String	10		Survey code
SD	String	4		ICES Subdivision
RECT	String	5		ICES rectangle
N	Dec	10	2	Mean weight (gram)
AGE	Int	1		Age group (1 – 8)

Structure of table WCOD (Mean weight of cod)

Field	Type	Length	Decimals	Description
CCODE	String	10		Survey code
SD	String	4		ICES Subdivision
RECT	String	5		ICES rectangle
N	Dec	10	2	Mean weight (gram)
AGE	Int	1		Age group (1 – 8)

Table 6.2. Structure of BAD-1 database.

Structure of table AH

FIELD	TYPE	LENGTH	DECIMALS	DESCRIPTION
CCODE	C	7		Survey code
SD	C	4		ICES Subdivision
RECT	C	5		ICES rectangle
NHTOT	N	8	2	Total herring abundance (millions)
NH0	N	8	2	Abundance of herring age group 0 (millions)
NH1	N	8	2	Abundance of herring age group 1 (millions)
NH2	N	8	2	Abundance of herring age group 2 (millions)
NH3	N	8	2	Abundance of herring age group 3 (millions)
NH4	N	8	2	Abundance of herring age group 4 (millions)
NH5	N	8	2	Abundance of herring age group 5 (millions)
NH6	N	8	2	Abundance of herring age group 6 (millions)
NH7	N	8	2	Abundance of herring age group 7 (millions)
NH8	N	8	2	Abundance of herring age group 8+ (millions)

Structure of table AS

FIELD	TYPE	LENGTH	DECIMALS	DESCRIPTION
CCODE	C	7		Survey code
SD	C	4		ICES Subdivision
RECT	C	5		ICES rectangle
NSTOT	N	8	2	Total sprat abundance (millions)
NS0	N	8	2	Abundance of sprat age group 0 (millions)
NS1	N	8	2	Abundance of sprat age group 1 (millions)
NS2	N	8	2	Abundance of sprat age group 2 (millions)
NS3	N	8	2	Abundance of sprat age group 3 (millions)
NS4	N	8	2	Abundance of sprat age group 4 (millions)
NS5	N	8	2	Abundance of sprat age group 5 (millions)
NS6	N	8	2	Abundance of sprat age group 6 (millions)
NS7	N	8	2	Abundance of sprat age group 7 (millions)
NS8	N	8	2	Abundance of sprat age group 8+ (millions)

Structure of table AC

Field	Type	Length	Decimals	Description
CCODE	C	7		Survey code
SD	C	4		ICES Subdivision
RECT	C	5		ICES rectangle
NCTOT	N	8	2	Total cod abundance (millions)
NC0	N	8	2	Abundance of cod age group 0 (millions)
NC1	N	8	2	Abundance of cod age group 1 (millions)
NC2	N	8	2	Abundance of cod age group 2 (millions)
NC3	N	8	2	Abundance of cod age group 3 (millions)
NC4	N	8	2	Abundance of cod age group 4 (millions)
NC5	N	8	2	Abundance of cod age group 5 (millions)
NC6	N	8	2	Abundance of cod age group 6 (millions)
NC7	N	8	2	Abundance of cod age group 7 (millions)
NC8	N	8	2	Abundance of cod age group 8+ (millions)

Structure of table WH

Field	Type	Length	Decimals	Description
CCODE	C	7		Survey code
SD	C	4		ICES Subdivision
RECT	C	5		ICES rectangle
WHTOT	N	7	2	Total mean weight of herring (gram)
WH0	N	7	2	Mean weight of herring age group 0 (gram)
WH1	N	7	2	Mean weight of herring age group 1 (gram)
WH2	N	7	2	Mean weight of herring age group 2 (gram)
WH3	N	7	2	Mean weight of herring age group 3 (gram)
WH4	N	7	2	Mean weight of herring age group 4 (gram)
WH5	N	7	2	Mean weight of herring age group 5 (gram)
WH6	N	7	2	Mean weight of herring age group 6 (gram)
WH7	N	7	2	Mean weight of herring age group 7 (gram)
WH8	N	7	2	Mean weight of herring age group 8+ (gram)

Structure of table WS

FIELD	TYPE	LENGTH	DECIMALS	DESCRIPTION
CCODE	C	7		Survey code
SD	C	4		ICES Subdivision
RECT	C	5		ICES rectangle
WSTOT	N	7	2	Total mean weight of sprat (gram)
WS0	N	7	2	Abundance of sprat age group 0 (gram)
WS1	N	7	2	Abundance of sprat age group 1 (gram)
WS2	N	7	2	Abundance of sprat age group 2 (gram)
WS3	N	7	2	Abundance of sprat age group 3 (gram)
WS4	N	7	2	Abundance of sprat age group 4 (gram)
WS5	N	7	2	Abundance of sprat age group 5 (gram)
WS6	N	7	2	Abundance of sprat age group 6 (gram)
WS7	N	7	2	Abundance of sprat age group 7 (gram)
WS8	N	7	2	Abundance of sprat age group 8+ (gram)

Structure of table WC

FIELD	TYPE	LENGTH	DECIMALS	DESCRIPTION
CCODE	C	7		Survey code
SD	C	4		ICES Subdivision
RECT	C	5		ICES rectangle
WCTOT	N	7	2	Total mean weight of cod (gram)
WC0	N	7	2	Mean weight of cod age group 0 (gram)
WC1	N	7	2	Mean weight of cod age group 1 (gram)
WC2	N	7	2	Mean weight of cod age group 2 (gram)
WC3	N	7	2	Mean weight of cod age group 3 (gram)
WC4	N	7	2	Mean weight of cod age group 4 (gram)
WC5	N	7	2	Mean weight of cod age group 5 (gram)
WC6	N	7	2	Mean weight of cod age group 6 (gram)
WC7	N	7	2	Mean weight of cod age group 7 (gram)
WC8	N	7	2	Mean weight of cod age group 8+ (gram)

Structure of table ST

FIELD	TYPE	LENGTH	DECIMALS	DESCRIPTION
CCODE	C	7		Survey code
SD	C	4		ICES Subdivision
RECT	C	5		ICES rectangle
AREA	N	7	1	Area [NM^2] see
SA	N	7	1	Mean Sa [m^2/NM^2]
SIGMA	N	7	3	Mean ⊚ [cm^2] see formula (5.8.3)
NTOT	N	8	2	Total number of fish (millions) see formula (5.9.1)
HH	N	7	2	Percentage of herring
HS	N	7	2	Percentage of sprat
HC	N	7	3	Percentage of cod

Structure of table SU

Field	Type	Length	Decimals	Description
CCODE	C	7		Survey code
SHIP	C	20		Name of the vessel
YEAR	C	5		Survey year

Annex 1: List of symbols

a	age group
i	species
j	length class
k	haul
a_i, b_i, d_i	parameter of the TS-length relation for species i
f_i	frequency of species i
f_a	frequency of age group a
f_j	frequency of length j
f_{ij}	frequency of length class j for species i
f_{ia}	frequency of age group a for species i
n_{ik}	fish number of species i in haul k
n_{ijk}	fish number of species i and length class j in haul k
q_{ai}	normalized age–length-key
A	Area of the ICES rectangle
F	fish density
L_j	length in class j
M	number of hauls in the ICES rectangle
M_i	number of hauls containing species i
N_k	total fish number in haul k
N_{ik}	fish number of species i in haul k
N_i	abundance of species i
N_{ia}	abundance of age group a for species i
N	total abundance
S_a	area scattering cross section
W_j	mean weight in length class j
W_a	mean weight of age group a
Q_{ai}	biomass of age group a for species i
$\langle\sigma\rangle$	mean cross section
$\langle\sigma_i\rangle$	mean cross section of species i

Annex 2: Calibration procedures

Centering of the split-beam

The purpose of this operation is to move the immersed, suspended sphere onto the acoustic axis of the transducer. First the echosounder should be set so that the echo from sphere is visible on the display.

Select the Transceiver menu and set:

Mode:	Active
Pulse length:	Medium
Bandwidth:	Wide
Transducer depth:	0.0 m

Select the Operation menu and set:

Ping mode:	Normal
Ping interval:	1.0 sec.
Noise margin:	0 dB

Select the Display/Echogram menu and set

Range:	Select a range from the sea surface well below the sphere
Range start:	0.0 m
Auto range:	Off
Bot. Range Pres.:	Off
Presentation:	Normal
Layer lines:	On
Integration lines:	10 000
TVG:	40 log R
TS colour min.:	-50 dB

Select the Log menu and set

Mode:	Ping
Ping interval:	100

Select the Layer menu and set

Super layer:	1

Select the Layer menu/Layer-1 menu and set

Type:	Surface
Range:	
and Range start:	The range must be wide enough to cover the sphere echo during the movements in the centering operation. Otherwise it should be as narrow as possible, in order to exclude disturbing fish echoes. Be sure that also the bottom echo as well as the trailing edge of the transmitter pulse and the echo from the additional weight are outside the layer.
Margin:	0.0 m
Sv Threshold:	-80 dB
No. of sublayers:	1

The rest of the sub-layers should be turned off.

Select the TS-detection menu and set

Min. value:	-50 dB
Min. echo length:	0.8
Max. echo length:	1.8
Max. gain comp.:	6.0 dB
Max. phase dev.:	2.0

The best value for the sound velocity should be set in the sound velocity menu in order to keep the accuracy as high as possible for the calibration exercise.

If the sphere is in the beam an echo will now be seen as a steady line in the echogram. If the sphere furthermore is inside the -6 dB limit of the beam, the echo will show up as a dot on the TS-detection window on the left side of the screen. The horizontal projection makes it easy to see which way the sphere must be moved to reach the beam center. Movement of the sphere occurs by turning various winches, always one winch at a time and on specific command by the director of this procedure, who is guided by constant observation of the echo on the screen.

SA - measurement

A test and if necessary, a calibration of the s_A -calculation may be carried out according to the following procedure.

Check the cable connections to colour printer-1.

Switch on colour printer-1.

Select the printer menu and set

Integration tables:	Number of the transceiver in use (if EK 500)
Echogram:	Slave

The echogram recording will then be similar to the one on display. Read the measured s_A - value, the red number in the integrator table after each log interval. Calculate the theoretical s_A - value as follows:

TS sphere = target strength of the sphere

σ_{bs} = backscattering cross section of the sphere

$\sigma_{bs} = 10^{TS\ sphere/10}$

r = distance between the transducer and the sphere

(read from display screen, underneath the horizontal projection window).

If the recommended minimum of 15 m between the transducer and the calibration sphere for 38 kHz frequency cannot be attained, the absolute minimum distance to attain the theoretical accuracy of $\pm$0.1 dB for the S_A-calibration is 10 m (transducer type ES38B, max. TX power 2000 W).

The measured distance to the calibration sphere in the TS Detection menu will always be larger than the correct distance. The measured distance has to be reduced by the distance given in the table below and used when calculating the theoretical s_A - value. The given data are based on medium TX pulse with Wide Bandwidth and long TX pulse with Narrow Bandwidth (frequency 38 kHz).

Reduce distance r by 0.30 m when using Wide Bandwidth and 0.9 m when using Narrow Bandwidth.

ψ = equivalent 2-way beam angle (from the measurement data delivered with the transducer).

$\psi = 10^{dB\text{–}value/10}$

s_A (theory) = $(4\Pi r_0^2)\ \sigma_{bs}\ (1852m/nm)^2 / \psi\ r^2$

where: r_0 = 1 meter is the standard reference distance for backscattering

If the measured s_A -value differs from the theoretical value, this can be corrected by changing the S_V Transducer Gain in the Transceiver menu. Calculate a new transducer gain:

New trans. gain = Old trans. gain + 10 log(s_A(measured)/ s_A(theory))/2

Enter the S_V Transducer Gain in the Transducer menu, and the measured s_A -value will be correct.

The calibration conditions and results are recorder in a calibration report.