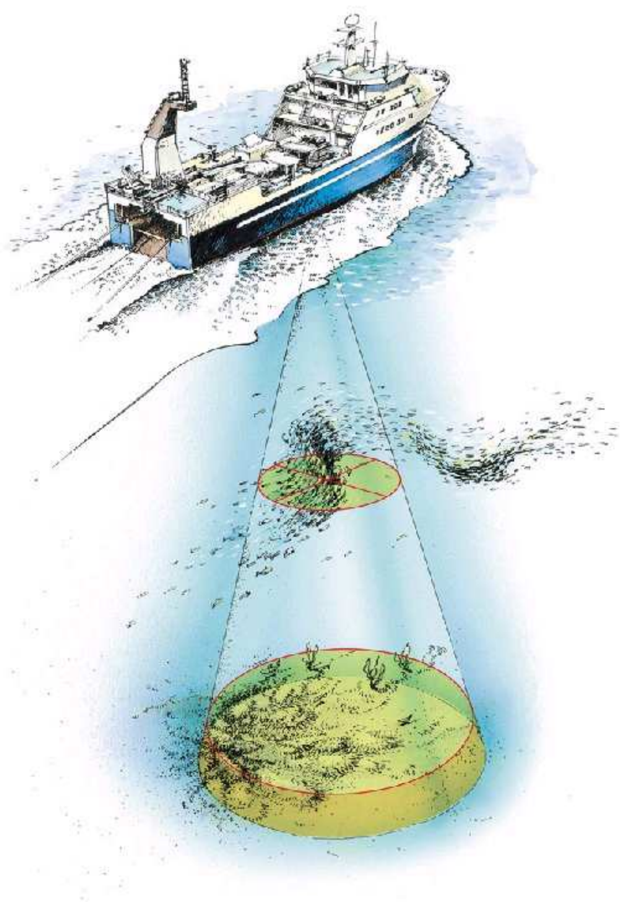
ICES Planning Group on Northeast Atlantic Pelagic Ecosystem Surveys (PGNAPES)
ICES Planning Group of Temperate International Pelagic Surveys (PGTIPS)

MANUAL FOR HYDRO ACOUSTIC SURVEYING IN THE NORTHEAST ATLANTIC

!!!!!!! DRAFT ONLY till PGNAPES 2008 !!!!!!



Version 2.1
May 2008

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

Table of Contents

1 Introduction

This manual was developed through the ICES Planning Groups on Northeast Atlantic Pelagic Ecosystem Surveys (PGNAPES) and the Planning Group of Herring surveys (PGTIPS) as a guide to the methodologies that should be adhered to during the planning, execution and analysis phases of ICES coordinated survey programs.

The results of the surveys discussed in this document are provided in area and time based management units in an attempt to move towards an ecosystem approach in the group. The surveys described here are the following:

PGNAPES surveys
The first survey within this group is termed the **"International blue whiting spawning stock survey", for the time being and only in this document, further referred to as IBSSS,** and aimed at assessing the spawning stock biomass of blue whiting during the spawning season in March-April as well as to determine the spatial distribution at this time of year. This estimate is used as a tuning index by ICES to determine the size of the population. The spawning areas of blue whiting west of the British Isles have most actively been surveyed by Norway and Russia. Some coordination of these survey activities took place over a number of years, until the Russian spawning stock survey was discontinued in 1996. Russia resumed the blue whiting spawning stock survey in 2001. There was, however, no further coordination between Norwegian and Russian surveys.

In the Norwegian Sea and Barents Sea the joint survey in late spring (late April-early June) is termed the **"International ecosystem survey in the Nordic Seas", for the time being and only in this document, further referred to as IESNS,** aimed at observing the pelagic ecosystem in the area, with particular focus on Norwegian Spring Spawning herring, blue whiting, zooplankton and hydrography.

In 2003 ACFM recommended that a coordinated survey be organised covering the main spawning grounds of blue whiting. Other countries than those presently taking part in these surveys were invited to take part. The coordination of blue whiting surveys is taken care of by an extended ICES Planning Group on Northeast Atlantic Pelagic Ecosystem Surveys (PGNAPES), including also the blue whiting spawning survey during spring.

PGTIPS surveys

The survey targeting the largest stock within this group is the **North Sea Hydro Acoustic Survey for Herring and Sprat (HERAS)** in July. It traditionally delivers indexes for North Sea autumn- and springspawners spawners and sprat to the ICES Herring Assesment Working Group (HAWG).

Closely connected to HERAS is the **West of Scotland Herring Survey, which deals with autumnspawners west of Scotland** (ICES area VIA) during the same period.

Listed in the table below are the contributions since 2004 by country to the surveys coordinated through ICES led PGNAPES and PGTIPS planning groups.

Table 1.1. Survey contributions.

	Survey		
Country	**IBSSS**	**IESNS**	**HERAS**
Denmark	Expertise	Vessel	Vessel
Faeroe Islands	Vessel	Vessel	-
Germany	Expertise	Expertise	Vessel
Iceland	Vessel	Vessel	-
Ireland	Vessel	-	
Norway	Vessel & Expertise	Vessel	Vessel
Russia	Vessel	Vessel	-
The Netherlands	Vessel	Expertise	Vessel
France	Funding	-	-
Spain	Funding	-	-
Scotland	Expertise	Expertise	Vessel
England	Expertise	Expertise	-

For all surveys mentioned above at least the following research methods are being applied:

- Hydro acoustic sampling
- Trawl sampling
- Plankton sampling
- Hydrographic sampling

For a more detailed description of the work carried out by the planning groups and to review current reports please refer:

PGTIPS (former PGHERS): http://www.ices.dk/iceswork/wgdetailacfm.asp?wg=PGHERS
PGNAPES: http://www.ices.dk/iceswork/wgdetailacfm.asp?wg=PGNAPES

2 Survey coordination

2.1 Survey planning

The main forum for survey planning are the PGNAPES/PGTIPS meetings the year before the survey. Planning will usually start before the meeting, and continue until the time of the survey.

By the time of the meeting, participating countries must decide the resources that they can offer for a survey at the level of detail that allows the group to effectively plan the survey. Details about the resources include:

- Vessel(s)
- Vessel time (effective survey days)
- Possible/impossible dates and areas of operation
- Possibilities for sharing expertise through exchange of personnel

Based on the available resources for the survey, allocation of survey effort in terms of areas and dates is decided during the PGNAPES and PGTIPS meetings.

2.2 Survey coordinator

Survey coordinator should be appointed for each coordinated survey, preferably during the PGNAPES meeting the year before the survey. Survey coordinator then has the responsibility to carry planning further, for example to update the survey plan as more detailed information on commitments becomes available. Survey coordinator is the main contact person for information exchange before, during and after the survey, until finishing the survey report; similarly, survey coordinator must keep other participants updated about the planning. It is also the responsibility of the survey coordinator to find suitable dates and venue for post-survey meeting, if such meeting is arranged. Contact details for survey vessels involved are given in Appendix A.

2.3 Coordinating vessel

During the survey, one vessel will act as the coordinating vessel. Usually this will be the vessel where the survey coordinator is. Coordinating vessels is the hub for information exchange during the survey. Contact details for a number of vessels can be found in the table below. A coordinating vessel will be chosen during the survey planning phase. Contact details for survey vessels involved are given in Appendix A.

2.4 Information exchange

PGNAPES
Data exchange during and after the survey is relatively smooth due to improved adherence to the PGNAPES data exchange format. Further improvements to the data exchange and database format were discussed. It was agreed that proposed changes of data formats will be sent in before the start of the survey in order for all vessels to use the most up to date format for data exchange. An important change in the database format was to switch from common PGNAPES species naming to the use of the standard three-letter species code used by ICES. All 2006 data will be imported into the database shortly and made available for the survey participants on the web.

PGTIPS
The North Sea – and the West of Scotland survey are coordinated by PGTIPS. Aggregated data survey data are uploaded in the Fishframe database at least a month before the meeting date (normally end of January). During the meeting the joined estimates and the survey report are prepared for the HAWG.
The groups is trying to develop a database containing raw international survey data. However regional differences in survey methods, induced by the highly variable circumstances by area, causes the

process of raising the data to aggregated level to be different. Thus the data collected in the different national areas are not compatible and the national participants do not give a high priority to the upload of raw data (which is complicated anyway), knowing that they will have to be dealt with separately anyway.
At PGTIPS the coverage for the July surveys are planned. During the surveys there is daily radio contact between the national vessels.

2.5 Cruise plan

An annual cruise plan requires at least the following items:

- Expertise needed during the survey
  - Scrutiny
  - Fish taxonomist
  - Oceanographer (technical, interpretation)
  - Acoustic technician (calibration, operation)
  - IT technician (Unix, windows, Ingres, network)
- Trajectories to be survey
- Stations to be sampled (CTD, Plankton)
- Additional sampling requirements
- Coordination between vessels
- Deadlines for (partial) data results and reports

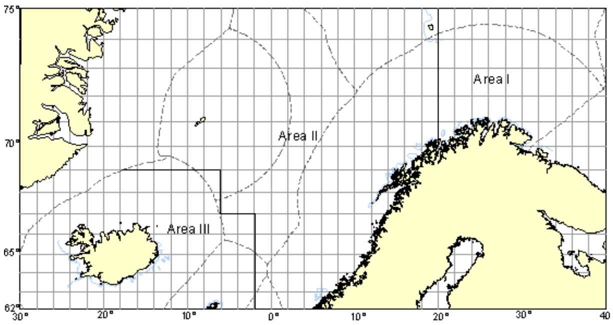
3 Survey design

3.1 Survey area

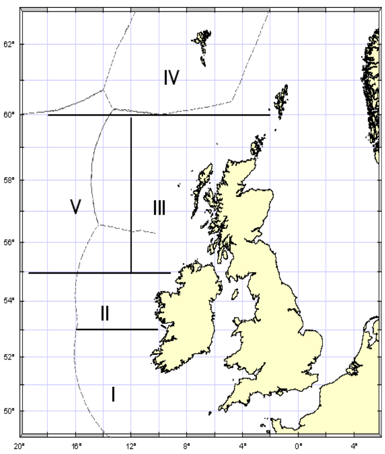
PGNAPES

IESNS (to be updated by PGNAPES members)

IBSSS
In 2004–2005, PGNAPES produced a plan for achieving the optimum coverage that could be achieved for the spawning area blue whiting surveys. This plan was followed in the surveys in spring 2005 and 2006. Based on experiences gained, the overall timing of the survey (from mid-March to mid-April) appears appropriate, although a further review of coordinated survey timing is undertaken each year. The spatial confines of the survey, although not fixed, are defined as core spawning areas and secondary target areas as suggested in 2005 (Figure 3.1). Every year the target areas will be allocated to ships, but the highest priority will always be target area 1 (this area has usually hosted about half of blue whiting biomass in the survey area). The survey must follow the standardised survey protocol given in this report.



I. Barent Sea
II. Central Norwegian Sea
III. Icelandic Zone

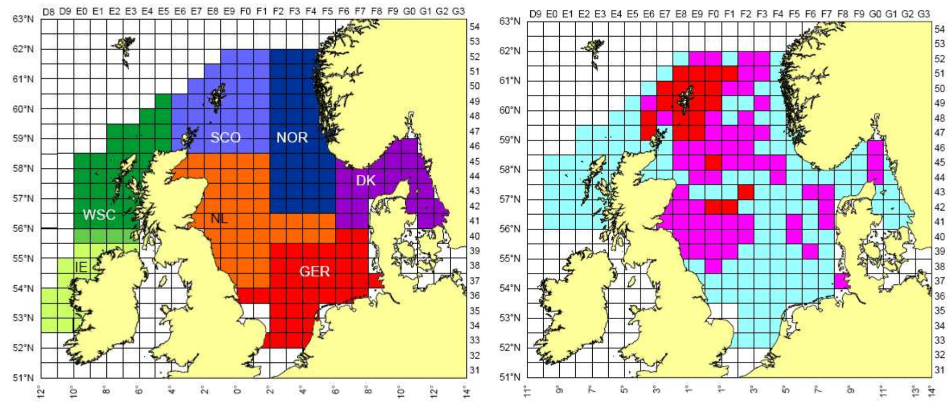


I. South Porcupine
II. North Porcupine
III. Hebrides
IV. Southern Faroese
V. Rockall and Hatton Banks

Figure 3.1. Survey sub-areas used in the IESNS and IBSS

PHTIPS

The international area of the North Sea Hydro Acoustic survey is every year the same, based on where herring and sprat have been found historically. The survey is roughly divided in 5 national areas (see figure below). These areas may be different from year to year for logistic reasons, but also to get to know each others border area, sometimes overlap and inter calibrations.
The survey effort is basically two east-west transect through each ICES rectangle, However high density area are covered with a double intensity at the cost of areas with low concentrations (see figure 3.2).



A B

Figure 3.2. A: Survey area layouts for all participating vessel in the 2008 acoustic survey of the North Sea and adjacent area's. (IE = Celtic Explorer; WSC = West of Scotland charter; SCO = Scotia; NOR = Johan Hjort; DK = Dana; NL = Tridens; GER = Solea). B: Figure … Survey effort in the 2008 acoustic survey of the North Sea and adjacent areas. (Red = 7.5 nautical miles spacing; Magenta 15 n. mi.; Cyan = 30 n. mi.).

3.2 Survey implementation

Transect design

Area coverage
Pre-agreed target area coverage is designed to maximise survey effort and avoid duplication. It is dependent on the pre-agreed survey areas as assigned during the survey planning phase and should be adhered to wherever possible.
Agreement: Variations from pre-agreed target areas should only be undertaken after consultation with the assigned survey coordinator.

Orientation
This is specific to the type of survey being undertaken. Two aspects should be considered in choosing the direction of transects. Transects should preferably run perpendicular to the greatest gradients in fish density, which are often related to gradients in bottom topography and hydrography. This means that transects will normally run perpendicular to the coast. The second aspect considers the direction in which the fish are migrating. If there is evidence of rapid displacement of the fish throughout the area, it is advisable to run transects parallel to the direction of migration. This survey design will minimise the bias caused by double counting.

> *PGNAPES note: For IBSSS: The survey direction is historically from south to north which is NOT in opposition to the known migration patterns. Since inter-vessel time gaps can be as much as several weeks either survey direction would lead to a bias in the stock distribution and stock estimate and therefore it was decided to continue the historical approach. However, a strong effort has been made in 2007 to compress the overall survey time window to avoid double counting.*

PGTIPS note: For HERAS: The northern North Sea is survey in a south-north direction while the centre and southern North Sea are surveyed in a north-south direction. A detailed simulation study of the effects of motion on the survey design of North Sea herring is available in Rivoirard et al. (2000).

Design

PGNAPES: Due to the extent of geographical coverage carried out during the IBSSS, a parallel transect design has been adopted during this survey. Based on a review carried out by Rivoirard *et al.,* (2000), as referred to by Simmonds and MacLennan (2005), in instances where transect length is twice that of transect spacing a parallel design should be used as the best means of reducing variance.

Spacing

- PGNAPES - Transect spacing as agreed during the PGNAPES survey planning phase should be no less than 30nmi or no greater than 40nmi where possible to maintain the integrity of the international time series.
- PGTIPS - Transects are spaced at a maximum distance of 30 nautical miles and a maximum distance of 7.5nautical miles.

Survey progression in time

It should be carried out as determined during the survey planning phase (PGNAPES, PGTIPS) and adhered to wherever possible. **Live communication with the survey coordinator is essential.** Contact details for survey vessels involved are given in Appendix A.

Ship's speed

During the survey speed should be maintained at 10–12 knots where possible. At higher speeds, problems are encountered with engine noise or propeller cavitation. These problems, however, depend on the vessel and the positioning of acoustic transducers. In rough weather, the ship's speed may be reduced as required in order to avoid problems with air bubbles under the ship and resultant loss of signal, although this problem is somewhat alleviated by the use of a dropped keel mounted transducers.

Acoustic recording depth

PGNAPES: Is set to 750 meters. No blue whiting or herring is expected to be at greater depths.
PGTIPS: Is set to the bottom for North Sea surveys. To be updated by PGTIPS members.

Day/night operations

It is recommended – if time permits during the survey – to study the diurnal behaviour of fish schools, in order to determine at what time during the 24hr period the fish may not be available to the echosounder. Listed below is the current survey operand:

- PGNAPES - 24 hour operations
- PGTIPS - During North Sea West of Scotland and Irish herring surveys operations are conducted during the hours of daylight in the areas covered by the German, Dutch, Scottish and Irish vessels. Surveys in the Danish and Norwegian areas are executed according to a 24 hours scheme.

4 Acoustic sampling

4.1 Mounting acoustic equipment

Transducer

The standard transducer used in fisheries acoustics is the 38kHz ES38B from Kongsberg Simrad. In order of preference, it is advisable to mount the transducer in a dropped keel, a towed body or on the hull of the vessel. Steps should be taken to ensure that the flight of the towed body is stable and level, this should ideally be achieved with the aid of a motion sensor.

Drop keel mounting
Modern research and certain commercially chartered vessels are now equipped with a retractable drop keel on which acoustic sensors may be mounted (Figure 4.1).

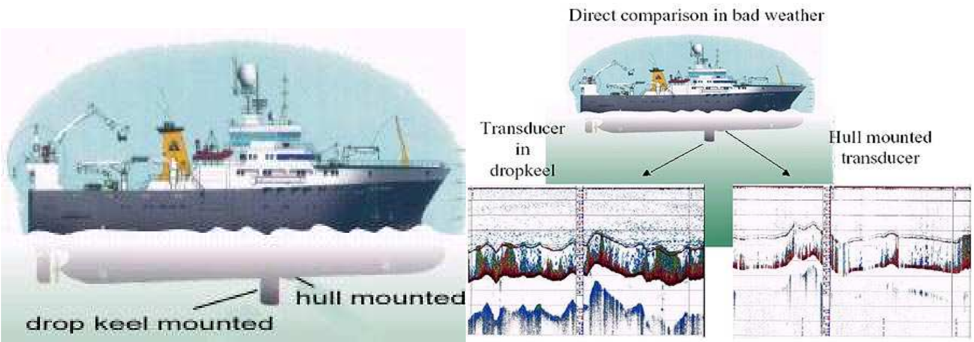


Figure 4.1. Drop keel mounting (left panel) and difference in performance with hull mounting (right panel). Source: http://www.uib.no/gosars/english/background/special_features/dropkeel_more.html

Towed body mounting
A tow body is an independent towed unit suspended from the main survey platform with a mounted transducer (Fig. 4.2). As the unit is towed alongside the vessel the survey depth is a function of cable length and vessel speed.


Figure 4.2. Towed body as used by FRS Aberdeen and IMARES (left panel) and image of a typical towing depth (right panel).
Source:http://www.acoustics.washington.edu/~gauthier/Research/Sitka/towfish1.jpg

4.2 Calibration

There are a number of transducer parameters that require knowledge of the sound speed in water. The theoretical context is given in Bodholt 2002. It is essential that a CTD cast is used to determine the temperature and salinity of the water so that sound speed can be calculated (see Appendix 2 and MacLennan & Simmonds 2005 for equations) and entered into the EK500 or the EK/ER60.

Calibration of the transducer should be conducted at least once during the survey. Calibration procedures are described in the Simrad EK500 manual, the EK/ER60 manuals and by Foote *et al.*

(1987). Ideally, the procedure as described in the Simrad manual should be followed with certain exceptions (see below). Minimum target range for the calibration of a split beam 38 kHz echosounder is 10 metres, although greater distances are recommended (about 20 m), because centering of the target below the transducer is facilitated if the target is suspended at a greater depth. An average integrated value for the sphere, taken when it is centrally located, should be taken as the measured NASC. The calculations should be then performed a number of times (two or three) in an iterative procedure such that the values of measured NASC and theoretical NASC should converge, as described in the Simrad manual. A choice is then made as to whether the S_v Transducer gain should be changed, rendering absolute NASC, or alternatively, the S_v Transducer gain can be unaltered and a correction factor applied to the NASC. Only one strategy should be applied during a cruise, such that for example, the latter option is to be employed when calibration is only possible after the cruise has started. If possible, the transducer should be calibrated both at the beginning and the end of the survey; with a mean correction factor applied to the data. If a new calibration differs less than 0.2 dB, the sounder system functions acceptably. If it differs more than 0.2 dB, the system should be thoroughly inspected.

There are a number of parameters which require knowledge of the speed of sound in water. It is therefore recommended that appropriate apparatus be used to determine the temperature and salinity of the water so that sound speed can be calculated (see MacLennan & Simmonds 1992 for equations) and entered into the EK500 or the EK/ER60.

A number of calibration parameters and results (tabulated in the table below) should be included as a minimum in the final survey report. Some of these parameters not included in the Simrad operators manual and are defined below and will be specific to certain operating systems only.

4.2.1 Calibration procedure for Simrad EK/ER60 echosounder

The calibrating procedure for the Simrad EK and ER60 are clearly laid out in the users manual and should be followed as such.

The determination of sound speed for the ER60 is calculated automatically in the environment dialogue box, when the parameters of temperature and salinity are inputted from CTD casts. During the actual calibration itself, Simrad recommend no less than 150 data points from the standard target sphere per frequency. Outlying points above or below the target reference TS value can be removed as required to further refine the accuracy of the result before final acceptance of the data set. Updating the beam pattern is the final stage of the calibration procedure and will result in an alteration of the beam pattern parameters. The Simrad ER60 allows the beam pattern to be adjusted by loading the results of previous calibrations if erroneous values are entered by mistake. A calibration report for all survey calibrations should be included in the final cruise report.

Caution! Before starting a calibration make sure that the transducer has been given time to adjust its temperature to the surrounding water temperature.

The absorption coefficient on the EK/ER60 can be set to 1 decimal place. Calculations using Temperature of 10.5 degrees, salinity of 34.5 ppt depth of 60m, ph 7.5 gives an absorption of 9.8dB/km at 38kHz (from Echoview calculator using Francois and Garrison (1982) formula). The angle sensitivity can be found in Install/Transceiver installation/Transducer parameters. The LOBE program or a similar program should be used for calibration. Calculations concerning angle sensitivity can be found in **Appendix B**.

The transducer settings of the EK/ER60 can be found in Install/Transceiver installation/Transducer parameters.

To get the calibration report from EK/ER60 :

Open the calibration program:
C:\Program Files\Simrad\Scientific\EK/ER60 \Bin\Calibration.exe

Open the file created with the calibration of your primary transducer and

Print as .PDF gives you the possibility to have the first part of the file, containing calibration settings and results as an image in stead of a table. The format is fixed and it can be used in reports easily.

4.2.2 Calibration procedure for Simrad EK500 echosounder

It is evident that all versions of the EK500 up to and including version 5.* do not take account of the receiver delay in the calculation of target range (see Fernandes & Simmonds 1996). This is particularly important when calibrating at short range (10 m) as it can lead to a systematic underestimate of biomass of 3%. The correct range to the target should therefore be applied in calibration (see below). The equivalent two way beam angle (ψ) should also be corrected for sound speed according to Bodholt (1999).

Receiver delay, Δt: This is very specific mainly to the echosounder band-pass filters and to a lesser extent to the transducer bandwidth, the standard target and the pulse duration which may affect the peak value. Target, bandwidth and pulse duration specific values for the Simrad EK400 are given in Foote *et al.* (1987, their Table 1). Values for the EK500 can be measured. Bethke (2007) provided a result for the narrow bandwidth. For the wide bandwidth (3.8 kHz) Simrad recommends using 3 sample distances (10 cm). This equates to a value:

Δt = 1.07 ms for narrow bandwidth (Δr = 0.8 m)
Δt = 0.39 ms for wide bandwidth (Δr = 0.3 m)

The range to half peak amplitude, r_m: This is the measured range between the start of the transmit pulse and the point on the leading edge of the echo at which the amplitude has risen to half the peak value (m). This is usually determined from experience with the readings from an oscilloscope display. For example, for a 38.1 mm tungsten carbide standard target insonified at 38 kHz at a colour Threshold setting of -70 dB (S_v colour min.), it is measured as from the top of the transmit pulse to the leading edge of the pink colour on the target sphere echo.

However, range to sphere = $\mathbf{r_{sph}}$ may then be calculated to verify the measured results:

$$r_{sph} = r_m - \Delta r$$
$$= r_m - \frac{c \times \Delta t}{2}$$

Note that in the firmware version 5.2 and 5.3 a correction of 3 samples is already included. A simple check can be carried out. Two calibrations at the same environmental conditions but at different ranges have to show the same results.

Correction factor for pre-calibration NASC's on EK500: $$K = \frac{1}{10^{\frac{\Delta G}{5}}}$$

Where: ΔG = Calibrated S_v Transducer Gain – Default S_v Transducer gain

Correction factor for pre-calibration S_v's on EK: $$K = 10\log_{10}\left(s_A correction\ factor\right)$$

A calibration report as shown in Tale 4.1 should be completed at the end of each calibration .

Calibration report	
Frequency (kHz)	
Transducer serial no.	
Vessel	
Date	
Place	
Latitude	
Longitude	
Bottom depth (m)	
Temperature (℃)	
Salinity (ppt)	
Speed of sound (m.s-1)	
TS of sphere (dB)	
Pulse duration (s)	
Equivalent 2-way beam angle (dB)	
Receiver delay (s)*	
Default S_v transducer gain	

Iteration no.	1	2	3
Time			
Range to half peak amplitude (m)*			
Range to sphere (m)			
Theoretical NASC (m2.nmile-2)			
Measured NASC (m2.nmile-2)			

Calibated S_v transducer gain			
DeltaG = New gain - Old gain			
Correction factor for pre-calibration NASC's on EK			
Correction factor for pre-calibration S_v's			

Default TS transducer gain			
Iteration no.	1	2	3
Time			
Measured TS			
Calibrated TS gain			

Table 4.1: Calibration report sheet used with EK500 calibration

Note:* All parameters may not be necessary when using the Simrad EK/ER60 echosounder.

4.3 Inter-ship comparison ('Intercalibration')

The advantage of inter-ship comparison is that it will demonstrate any gross difference in acoustic performance. The inter-ship comparison is NOT an absolute calibration, but it is a useful means of checking that there is no great difference in the respective measurement capabilities, which might occur for instance if one vessel suffered more fish avoidance due to having a worse noise signature, and thus consistently indicated a lower abundance for the same fish ensemble. If the comparison nevertheless reveals a large difference, the equipment on both ships should be recalibrated as soon as possible, in accordance with the procedures described in section 4.2.

The inter-ship comparison works best when:

- It is done in an area where there are substantial quantities of fish in layers, or dispersed aggregations of varying density.
- Moving in formation (figure 4.3),
    - keeping around a 400m offset astern
    - not being in each others wake
    - not detecting the other vessels' echosounder
    - taking the lead in turns in case one ship is more sensitive to weather or avoidance behaviour than the other.
- Covering a time window of 2-6 hours depending on the spatial distribution and density of fish in that area
- Keeping constant radio contact to ensure satisfactory cooperation

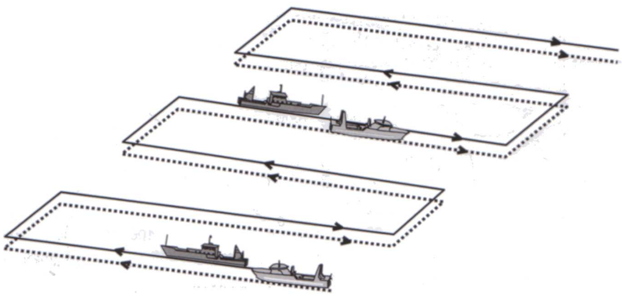


Figure 4.3. Typical inter-vessel comparison track lines where both vessels take the lead position in turns.

Integration periods need to be synchronized so that they relate to the same portion s of the cruise track. Thus the following ship must record the echo-integrals over time periods which are delayed relative to those of the leader. Keeping track of the log counter of the default way to do this.

Treatment of results

Standard Ricker regression techniques are used in data analysis (see the figure below). These procedures are available within PGNPES as R codes. If the 95% confidence limits do not include unity, as in the example below this suggests that one ship is producing biased results and the reason for this discrepancy should be investigated.

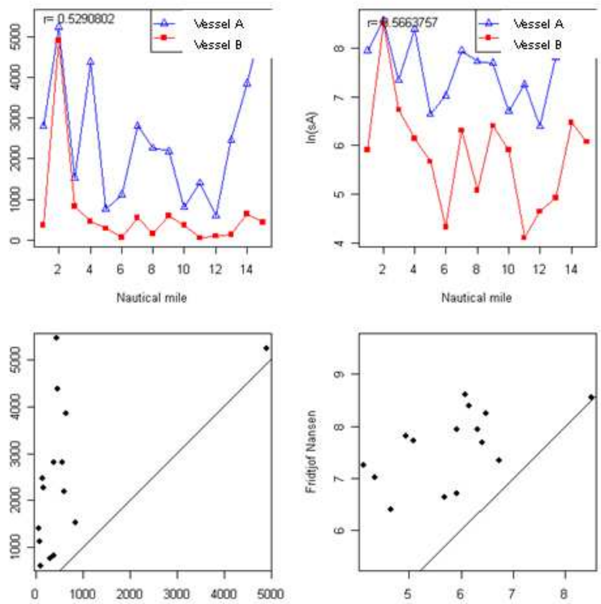


Figure 4.4 Results from an inter-vessel comparison 'vessel A' against 'vessel B'. The regression slope is 0.56 showing a significant difference between the vessels. The upper panels show sequential data along the cruise track, the lower panels are scatter plots comparing concurrent measurements on the two vessels. (The left panels show original values whereas the right panels show these same values on a log scale.

4.4 Echosounder operation

There are a number of settings that are made during calibration that have a direct influence on the fundamental operation for echo-integration and target strength measurement and therefore affect logged data. Once set according to the particular transducer these should NOT be changed during the survey. It is recommended that each year the same settings be used for the survey in order to facilitate comparison across years.

4.3.1 Operation procedure for Simrad EK500

Apart from the settings obtained during the calibration for most settings the default values from the manufacturer may be used, or alternatively the operator can choose his own settings depending on the circumstances. It is recommended that each year the same settings be used for the printer in order to facilitate comparison of echograms.

The settings changed by the calibration have a direct influence on the fundamental operation for echo-integration and target strength measurement and therefore affect logged data at stable environmental conditions. Once set according to the particular transducer, these should NOT be changed during the survey. These important settings are listed in Table 4.2.

The minimum detection level on the bottom detection menu depends on the water depth and bottom type. At depths less than 100 m and hard bottoms, the Threshold level may be set at –30 dB: this will enable the instrument to detect dense schools close to the bottom. At depths greater than 100 m or soft bottoms, the Threshold has to be lowered (-60 dB), otherwise the upper layer of the bottom will be counted as fish as well. However, misinterpretation can be repaired by the operator during the scrutinising procedure.

In the operation menu it is recommended to use as short a regular ping interval as possible. It is not advisable to use a ping rate of 0.0 seconds (variable interval according to depth) as this brings about irregular sample (ping) numbers per equivalent distance sampling unit which may bias the analysis with the EchoView program. A bottom margin of the order of 0.5 m is recommended for the layer menus. In shallow areas (<100 m) this can be somewhat reduced. The S_v minimum for echo integration and presentation of the echogram should be set at –70 dB. Increasing the S_v minimum will reduce the integration values if the herring occur in scattering layers or in loose aggregations. This setting is less important when the data is collected by a post processing package such as Simrad's BI500 or Sonardata's EchoView software as the Threshold can be determined in post processing.

Users were asked to compile a list of variables that must be held constant to maintain comparable survey conditions.

Table 4.2. Important calibration and survey settings for the EK500, which should not be changed during the survey. Those marked * indicate settings that are specific to the transducer / transceiver.

/OPERATION MENU/Ping Mode
/OPERATION MENU/Ping Interval
/OPERATION MENU/Transmit Power
/OPERATION MENU/Noise Margin
/TRANSCEIVER MENU/Transceiver-1 Menu
/TRANSCEIVER MENU/Transceiver-1 Menu/Transducer Type*
/TRANSCEIVER MENU/Transceiver-1 Menu/Transducer Depth
/TRANSCEIVER MENU/Transceiver-1 Menu/Absorption Coef.
/TRANSCEIVER MENU/Transceiver-1 Menu/Pulse Length
/TRANSCEIVER MENU/TRANSCEIVER-1 MENU/BANDWIDTH
/TRANSCEIVER MENU/TRANSCEIVER-1 MENU/MAX. POWER*
/TRANSCEIVER MENU/TRANSCEIVER-1 MENU/2-WAY BEAM ANGLE*
/TRANSCEIVER MENU/TRANSCEIVER-1 MENU/SV TRANSD. GAIN*
/TRANSCEIVER MENU/TRANSCEIVER-1 MENU/TS TRANSD. GAIN*
/TRANSCEIVER MENU/TRANSCEIVER-1 MENU/ABSORPTION COEF.*
/SOUND-VELOCITY MENU/PROFILE TYPE
/SOUND-VELOCITY MENU/VELOCITY MIN
/SOUND-VELOCITY MENU/ VELOCITY MAX
/TRANSCEIVER MENU/Transceiver-1 Menu/3 dB Beamw.Along*
/TRANSCEIVER MENU/Transceiver-1 Menu/3 dB Beamw.Athw.*
/TRANSCEIVER MENU/TRANSCEIVER-1 MENU/ANGLE SENS.ALONG*
/TRANSCEIVER MENU/TRANSCEIVER-1 MENU/ANGLE SENS.ATHW.*
/TRANSCEIVER MENU/TRANSCEIVER-1 MENU/ALONGSHIP OFFSET*
/TRANSCEIVER MENU/TRANSCEIVER-1 MENU/ATHW.SHIP OFFSET*

Table 4.3. Settings for the EK500, which could be changed (*if the environmental condition change)

/OPERATION MENU/Noise Margin
/TRANSCEIVER MENU/Transceiver-1 Menu/Transducer Depth
/TRANSCEIVER MENU/Transceiver-1 Menu/Absorption Coef.*
/TRANSCEIVER MENU/TRANSCEIVER-1 MENU/2-WAY BEAM ANGLE*
/TRANSCEIVER MENU/TRANSCEIVER-1 MENU/SV TRANSD. GAIN*
/TRANSCEIVER MENU/TRANSCEIVER-1 MENU/TS TRANSD. GAIN*
/TRANSCEIVER MENU/TRANSCEIVER-1 MENU/ABSORPTION COEF.*
/SOUND-VELOCITY MENU/VELOCITY MIN*
/SOUND-VELOCITY MENU/ VELOCITY MAX*
/TRANSCEIVER MENU/Transceiver-1 Menu/3 dB Beamw.Along*
/TRANSCEIVER MENU/Transceiver-1 Menu/3 dB Beamw.Athw.*
/TRANSCEIVER MENU/TRANSCEIVER-1 MENU/ANGLE SENS.ALONG*
/TRANSCEIVER MENU/TRANSCEIVER-1 MENU/ANGLE SENS.ATHW.*
/TRANSCEIVER MENU/TRANSCEIVER-1 MENU/ALONGSHIP OFFSET*
/TRANSCEIVER MENU/TRANSCEIVER-1 MENU/ATHW.SHIP OFFSET*

4.3.2 Operation procedure for Simrad EK/ER60

The following steps should be checked:

Settings in header menu:

Install

/Transceiver

1. Check if all frequency channels appear in green text. If not, choose correct transducer in “transducer/selection”.

/Navigation

1. Select serial port of GPS device. If nothing present or other, check “port management” in Install – port control.
2. Select serial port of speed information (probably GPS)

3. Select distance calculation method (probably from speed). This box is also used to set the starting number of the overall distance of the survey.

/Environment

1. Set the temperature and salinity of the calibration site

Output file

1. Directory: enter data recording directory
2. Raw data/file size: decide on the length of individual datafiles (based on distance or file length)

Operation normal

2. Mode: active
3. Set pulse duration, sample interval bandwidth combination. This pulse duration should be equal to the one used in the calibration file.
4. Choose power which to use
5. Set depth of transducer from surface level

Operation ping control

Choose a ping interval which does not give an error or warning.

<u>Input of calibration data</u>

After completing the above steps you should now be able to view correct echograms of the installed frequencies.

Right click on the single echo window which opens the single target detection dialog. Then click “calibration”. In the calibration window, open the calibration file made during calibration. Click “update beam data” to upload calibration data into the echosounder.

The echosounder should then be ready for use.

4.4 Interpretation of acoustic images - ”Scrutiny”

The process of echogram scrutinisation is a largely subjective process that should be at the very least carried out in the presence of someone who is experienced **not only with the process but also with the survey area and the target species**. Species aggregation tactics may vary greatly between species in addition to temporal and geographical variation.

As a result the allocation of NASC to species always needs support of trawl-information. However, it should be noted that catch composition is influenced by the fish behaviour in response to the gear. It is therefore necessary to judge whether the catch-composition is a true reflection of the real species composition of the logged school or layer data and whether the allocated percentage species composition needs to be further investigated.

An effort should be made to scrutinize to the species level, where possible, and adhering to ICES three-letter species codes for data submissions. Probability classifications are being used in the North Sea herring survey (“*definitely”, probably”” and “possibly” classes*). During mixed species analysis e.g. during coastal surveys, if it proves impossible to accurately determine mixed species aggregations to species level then mixed ‘codes’ should only be submitted to the group through prior agreement.

Methods of species allocation are often highly specific to the survey being undertaken. The method used depends largely upon the schooling behaviour of the target species, and the mixing with other species. For example: In the North Sea and Division VIa the species allocation is based mainly on the identification of individual schools on the echogram. In the Skagerrak-Kattegat and Baltic the identification is based on composition of trawl catches. A few typical target species echograms are shown below.

It is obvious that during the scrutinising process subjective decisions have to be made. However, joint sessions of scientists from participating countries who scrutinised each others data has shown that the deviation between the estimated quantities of herring are within the range of 10%, provided that trawl information of the recordings is available (Reid *et al.* 1998).

The scrutinizing is based on combination of visual clues in the echograms, information from single echoes, disappearance of echoes when changing lower integration Threshold, trawl catches, and possibly comparing echoes from different frequencies. This is an expert process prone to errors and subject to a large degree of subjectivity. Often it is useful to look observations over some tens of miles at time, as some continuity that facilitates scrutinizing can usually be expected.

Through a process of personnel exchange on surveys and dedicated workshops it is hoped to further develop the existing knowledge base within both PGNAPES and PGTIPS on fish behavior directly relating to echogram scrutinisation.

Echogram scrutinisation used to be done by measuring the increment of the integrator line on the printed paper output of the echogram. This was a simple and efficient way of scrutinising if one deals with single species schools and if there are no problems with bottom integration. More generally, computer based post-processing systems such as the Simrad BI60 or Sonardata Echoview systems are currently being used for scrutinising.

It is recommended that one depth-range be used for the whole area in the printer output and on post-processing systems. This will ensure that similar echo traces from all parts of the survey area will have the same appearance and hence are visually more comparable.

For all internationally coordinated surveys, a range of ICES three letter species codes have been applied through a common database to ease the flow of data between participant countries.

Use of trawl information

The allocation of echo-traces to species is governed by the results of trawl hauls. In many cases these are considered together with observations from the netsonde and the echogram during the haul. In some cases it is not possible to assign schools (echo traces) to species directly e.g. where the haul contains a mixture of species and no clear differentiation can be made between the observed schools. In such situations the integral is assigned to a species mixture category according to the trawl results. This is defined as percentage by number or weight taking into account the correct conversion to scattering length; post processing software is then used to apply weights and lengths. There are two main problems with using trawl data to define “acoustic” mixtures:

- Different species are known to have different catchabilities when encountering fishing gear, so the exact proportions in the trawl are unlikely to be an exact sample of the true mixture. For instance herring are likely to be faster swimmers than blue whiting.
  - PGTIPS: For instance herring are likely to be faster swimmers than Norway pout
- A target species may also be encountered within a multi-species mixed layer. In some instances the non-target species may be small enough to pass through the gear meshes, thus providing a bias in the trawl catch to the actual content of the school/layer. Mesh size calculations are given in **Appendix D**.
  - PGTIPS: Herring are often found in a mixture with “0” group pout, which are mostly lost through the meshes. This may also occur with other small gadoids. In this case the exact proportions are unavailable and the operator must make an informed guess

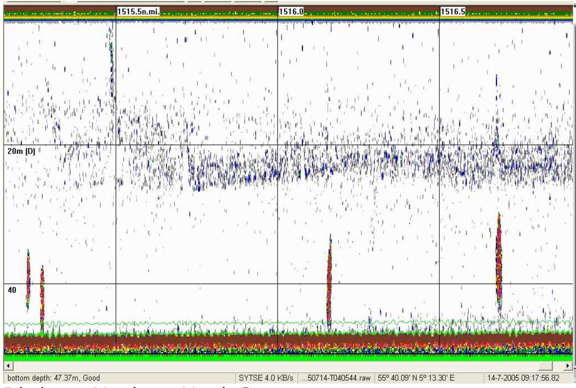
Target species specifications

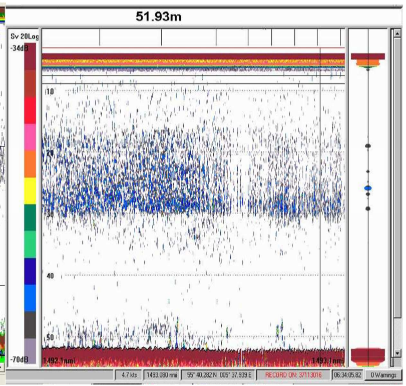
Herring (*Clupea harengus*) and Sprat (Sprattus sprattus)

Remarks:
In the western and northern part of the area covered by the survey, most of the herring occur in well-defined schools, often of a characteristic shape as pillar-shaped large dense schools or as layers of very small and dense school at the surface. In the northern and central part, schools of Norway pout and herring are difficult to distinguish from each other.
In low density areas of the western area mixed layers and aggregation of small schools consisting of gadoids and herring may occur. Sprat marks in the North Sea and VIa appear mostly as quite large, typical, pillar-shaped marks, usually slightly more diffuse than herring and usually in shallow water.

Examples of typical echograms:

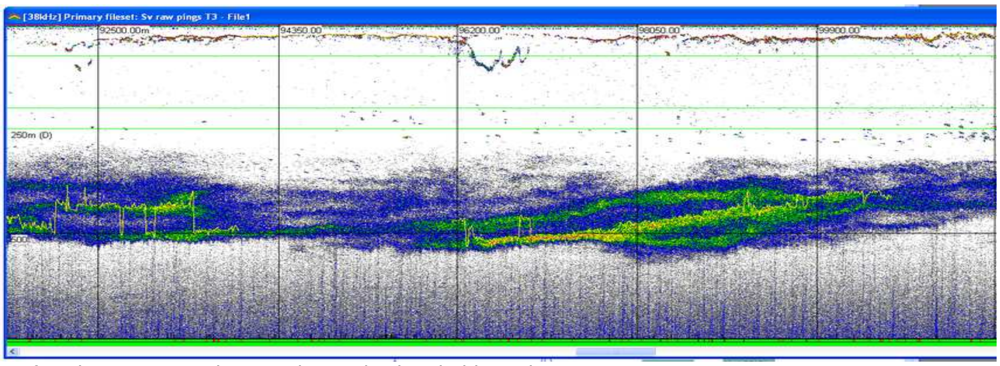
Comment [sy1]: We could decide to leave examples out.





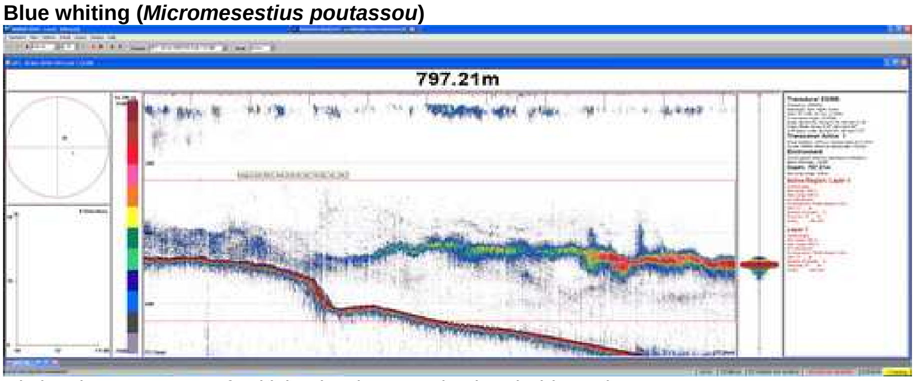
Distinct - Northern North Sea

Scattered and mixed - German Bight



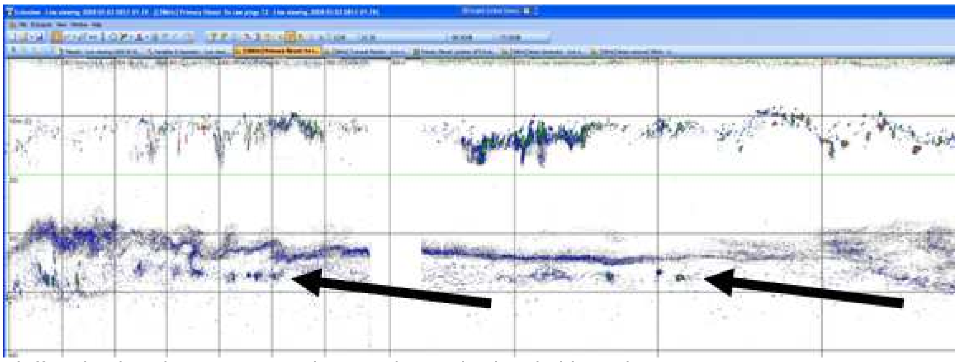
Surface layer - Norwegian Sea (IESNS). Threshold: -80dB.

Blue whiting (*Micromesestius poutassou*)



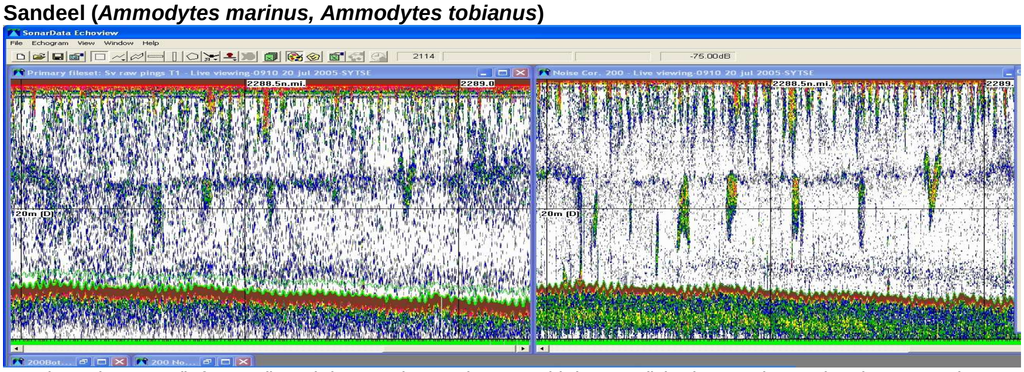
Distinct layers – West of British Isles (IBWSSS). Threshold: -70dB.

Remarks:



Fluffy schools to layers - Norwegian Sea (IESNS). Threshold: -70dB.

Sandeel (*Ammodytes marinus, Ammodytes tobianus*)



38 Khz echogram (left panel) and the 200 kHz echogram (right panel) in the North Sea herring spawning survey. Threshold: -70dB.

Meso-pelagics

Remarks:

Meso-pelagic fish species is a name often used for all unidentified backscatter layers in deeper waters (300m – 750m) not likely to be plankton. Examples of typical echograms:

Krill

Mackerel (*Scomber scombrus*)

Remarks:

Mackerel will hardly be detected by the 38kHz transducer but will lit up weak on the 200kHz.

Examples of typical echograms:

Horse mackerel *(Trachurus trachurus*)

Examples of typical echograms:

Description:

Pearlside (*Maurolicus müelleri*)

Examples of typical echograms:

Description:

Software post-processing procedures

Echoview software post-processing procedures

General checklist:

1. Put selected template in Echoview template folder.
2. Create new EV file selecting the correct template (if one may exist for this type of survey). All species names, virtual variables used and other settings will be copied from this template.
3. Add datafiles. Tip: create an Echoview file not containing too much raw data files (e.g. one day fileset). Tip: open cruisetrack for first check. Just check to see if cruise track is in the correct place and no files are missing. If not this might be due to freak start so add extra file at the beginning of file set.
4. Save as, using cruise and daily file name, into a logic directory structure.
5. Update calibration settings in all frequencies to be used. Check if this is set to automatically".
6. Block out bad data (define analysis area). Tip: open cruisetrack while blocking out bad data. Minor bottom integrations can cause a huge amount of unwanted biomass. Potential sections to block out:
   - Period with no daylight.
   - All trawling activity. The restart position can be estimated in the Cruise Track Window, where the track crosses start position on restarted survey.

   Any other periods not to be included such as extra stations, steaming periods or sections between transect.
7. Assign bottom and surface lines (below bottom and entire near field need to be blocked out). For a standard 38kHz near field is set to approximately 7m.
8. Scrutiny (see below)
9. Check export settings (if not already in the template) and export

LSSS software post-processing procedures

BI500/BI60 software post-processing procedures

Thresholding remove unwanted echoes and keep target species

An advantage of using a post-processing systems like BEI or EchoView is the ability to change the Threshold value of the received echoes. By changing the Threshold the non-target-species (plankton in particular) can be filtered out. The Threshold used may differ, depending on a variety of conditions, including the water depth (more care should be taken at greater depth) and the particular size of fish. Examples of conditions where certain Thresholds have been applied using the BEI and Echoview post processing systems are described below; they should not be used without verification.

Several institutes have developed or contributed to image processing systems for post processing of echograms. This can extract a range in school descriptors; energetic, morphometric and positional, which can be used to define the characteristics of schools of a particular species. These techniques are based on a license module called "**Virtual echogram**" often accompanied by the "**School detection**" module. In general such systems can differentiate most observed schools to species; however, these are usually the schools which an experienced survey operator can also discriminate by more traditional methods. These systems are likely to become more valuable in the future when they can be fed with multi-frequency data.

At the beginning of the survey it is advisable to experiment to find the right Thresholds specific to the conditions encountered during the survey. This can be achieved by isolating schools and changing the Threshold to leave only the target species. Notes should be made to track the action taken specific to each survey.

Thresholding using the BEI post processing system

The main principle has been to use as little threshhold as possible at any time, but experience show that for herring down to approximately 50 meters about -60db is suitable. However, at extremely high levels as experienced in coastal waters a Threshold of up to -54 db maybe required in order to remove unwanted plankton.

> When starting a new 5-mile, first a layer is entered which defines the lower depth of the vertical herring distribution. This depth is found by looking for herring schools as discrete jumps in the integrator line and include the lowest school. We then set the Threshold at a level where all the plankton is removed. This is done by varying the Threshold and looking for changes in the coloring of the upper level. Herring schools will often appear as very tiny red dots, size only a few pixels, hardly visible. Note that this Threshold applies only for the upper channel, down to approx 50 meters. A note is made of the NASC when the correct Threshold is found. This value

is noted and is given to herring after the Threshold has been reduced again to -85 db. The Threshold is lowered again to -85 db, herring is given the noted value and the rest, up to 100 % is given to plankton

In deeper waters (below 50m), the procedure for this depth is similar as for the upper layer: The Threshold is reduced until the plankton disappears from the screen, normally till about -69db, sometimes as low as -66db. That NASC is kept for blue whiting and mesopelagic fishes. Normally 20-30 percent is given to mesopelagics and the rest to blue whiting, depending on the ration in the nearest trawl hauls. The rest, up to 100 % is then given to plankton.

During blue whiting spawning stock surveys, plankton can filtered out using –82 dB as the reference Threshold level below which all increase in backscattering is assumed to come from targets of no interest. When increasing the Threshold, one expects plankton and mesopelagics to disappear, usually around –69/66/63 dB, unless these are very dense. As a rough rule of thumb, if one has a registration that contains blue whiting and that does not coincide with dense plankton / mesopelagics registrations, proportion of NASC that remains when the Threshold is increased to –66 dB can allocated to blue whiting. However, further adjustment may be applied if there is evidence that registrations contain further non-blue whiting echoes, especially in deeper layers where echoes may get cluttered. If small individuals of blue whiting are present, a lower Threshold may be appropriate.

Thresholding using the BI60 post processing system

PGTIPS

In stratified waters (mainly in the northern - and northeastern part of the survey area) there is often a layer of plankton in the upper 50 m. In this layer, very small, dense schools of herring may be found. Normally all the plankton is filtered out at –42 dB. The remaining NASC may be assigned to herring if clear schools are still visible and, of course, trawl information indicates that herring are present.

In the range of 30–60 m the same procedure may be used. Here NASC are normally assigned to schools of fish after filtering out plankton by putting the Threshold in the range of –48 to –51 dB.

In the layer below 60 m a Threshold of –54 to –60 dB may be applied. In the deeper parts of the area (>150m) a lower Threshold than –60 dB may be applied. At these depths, often close to the bottom, herring schools are normally, larger and easier to recognize.

After scrutinizing, the whole analysis area can be allocated to “plankton and fish” in order to define “plankton” after subtracting the individual regions (fish). Also this method will give you the opportunity to have all surveyed cells in your output files.

Multi-frequency use

The echosounder frequency routinely used for abundance estimation is 38 kHz. However, many vessels now operate multiple transducers with working frequencies of 18, 120 and 200 kHz. At present these data are used more for species recognition than for abundance estimation. For instance, herring and mackerel may have different target strengths at different frequencies. Mackerel is backscatter more strongly visible at 200 kHz than at 38 kHz (Fig. 4.5).

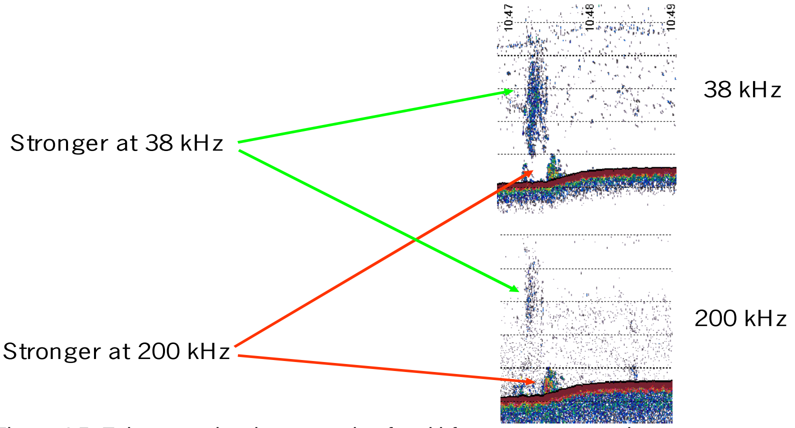


Figure 4.5. Echogram showing example of multi-frequency approach.

To process the data for extraction of schools the variable computation method available in Echo View is being used by many labs. The method has been used in 2001–2003 and was developed under the EU program SIMFAMI.
Previously when processing by hand (2000 and before) a small 'background' value for scattered fish was removed from integrator layers with many fish schools. It was noted that fish schools appear consistently on 38, 120 and 200kHz echograms while other features such as plankton may be strong on some frequencies and weak on others.

Use of single target TS distribution data

The SIMRAD EK500 or EK/ER60 used with a split-beam transducer allows the collection of TS values for all single targets detected in the beam. A TS distribution can then be produced for each EDSU. In some situations there may be two species present in an area with substantially different TS values, and this could be used to determine the species allocation. Again, this data must be used with caution. There are doubts about the precision of the TS detection algorithm, particularly in older firmware releases. By definition, single targets are unlikely to be detected from fish in schools. As schools are often the main subject for herring acoustic surveys, TS data may be unrepresentative for the population. However, where the survey encounters diffuse mixtures, there may be value in such data.

PGNAPES
During blue whiting spawning stock surveys, TS distribution is often useful in separating blue whiting from mesopelagics in the upper layers. If blue whiting is present, one usually expects to see a prominent peak somewhere around –35 dB.

Allocation to mixed layers or mixed schools

Sometimes fish occur mixed with other species in aggregations of smaller schools. In this case, species allocation is based on the composition of trawl catches. Those schools are separated from other fish using the standard scrutinising procedures (see above) and/or the allocation of the proportion of the different target species on the basis of catch composition.

Important! The weight-based catch composition does not always resembles the acoustic image of the schools/layers targeted. See an example below.

Table 4.3. Catch composition in kilograms converted to catch composition in sA values. The sA correction factors are taken from Simmonds and McLennan 2007.

	Catch composition **(kg)**	sA correction fctor (Simmonds &McLennan 2007)	sA	Catch composition **(sA)**
Whiting	10.0%	1	0.100	37.34%
Herring	40.0%	2.4	0.167	62.23%
Sandeel	50.0%	426.6	0.001	0.44%
Total	**90.0%**		**0.268**	**100.00%**

PGNAPES
This procedure is normally not applied during the PGNAPES surveys but can be used if necessary.

5 Biological sampling

5.1 Trawling

Proper species allocation of the acoustic records is not possible if no trawl information is available. The general rule is to make as many trawl hauls as possible, especially if echo traces are visible on the echosounder after a blank period. If surface schools are known to occur in the area it is often advisable to take occasional surface trawls even in the absence of any significant marks.

The principal objective is to obtain a sample from the school or the layer that appears as an echo trace on the sounder by means of directed trawling (figure 5.1). The type of trawling gear used is not important as long as it is suitable to catch a representative sample of the target-school or layer. Gear details for survey vessels involved are given in Appendix A.

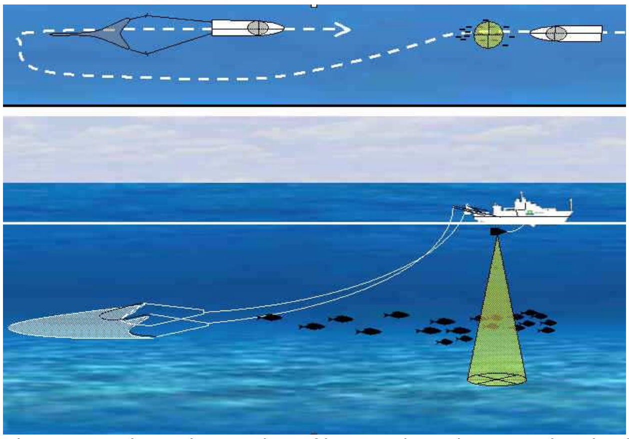


Figure 5.1 Schematic overview of how to shoot the gear when back trawling.

Information about the most important dimensions of the trawls used should be included in the survey report from each of the participating vessels.

During trawling it is important to take note of the traces on the echosounder and the netsonde in order to judge if the target-school entered the net or if some other traces contaminate the sample. It is recommended that notes be made on the appearance and behaviour of fish in the net during every haul. If a target is missed during a haul, the catch composition should not be used for species allocation.

5.2 Biological sampling procedure

The first step of trawl catch anaylsis is to determine species composition. This can be carried by breaking the total catch into species components by weight either by exhaustive sampling, sub-sampling (raising to the total catch) or by a combination of both. Second step is to record biological parameters of the target species within the catch (age, sex, sexual maturity and individual weight measurements).

Table 5.1. Sampling levels for all target species. O=otoliths, S=scales, L=length, M=maturity, G=gender.

	IBSSS	**IESNS**	**HERAS**	**West of Scotland herring survey**	**West of Scotland herring survey (Irish)**
	PGNAPES	**PGNAPES**	**PGTIPS**	**PGTIPS**	**PGTIPS**
Sprat	-	-	OLMG	OLMG	OLMG
Blue whiting	OLMG	OLMG	-	-	-
Herring	-	SLMG	OLMG	OLMG	OLMG
Dealfish	LMG	LMG	-	-	-
Mackerel	L	L	L	L	L
Horse mackerel	L	L	L	L	L
Snake pipefish	LG	LG	LG	LG	LG

5.2.1 *Total catch treatment*

The ***Condition*** and ***Quality*** of the catch should be recorded by the person in charge of the biological sampling in consultation with the officer in charge or the fishing master according to a standard classification (Table 5.2).

Condition: Inspecting the gear when it comes back on deck.
Quality: Observe how the fishing was carried out and how the gear performed.

Table 5.2. Condition and quality categories.

Condition	
Condition of the gear after the haul is finished	**Code**
Not inspected	blank
No damage or minor damage of the gear, nothing of consequence to selection and catch.	1
Gear is damaged. Some fish may have escaped the codend.	2
Trawl has long gashes, or large pieces of net are missing, codend intact. Codend torn, very little catch. Codend torned, very little catch. Gear completely destroyed or lost	3

Quality	
Indicates to what degree the catch represents the quantity of fish in the area, judged according to the manner in which the gear was used and the behaviour of the gear.	**Code**
Not observed	blank
The trawl has been set at a predetermined position, the trawl sensors have shown that the registrated schools have been hit.	1
The trawl has been set at a predetermined position; trawl sensors show problems with the gear, e.g. faulty door distance, or other indications of malfunction.	2
The trawl has been aimed at an acoustic registration; trawl sensors show problems with the traw, it has not been fishing properly due to technical problems, or the catch is not representative due to large quantities of corals, jellyfish or mud.	3

In general, the complete catch should be worked up with respect to species composition If the catch contains specimens which differ significantly from the main catch, e.g., by size or low abundance, these may be set aside from the total catch, before handling the remaining catch. Decisions regarding the further handling of the catch depend on whether it is possible to get a representative sample without sorting the total catch. The final sample amount of each species taken out is either the total amount or a representative subsample of that species in the catch. Since net sorting by size is known to occur it is advisable that subsamples are drawn from different parts of the catch.

The word *sample* should be understood as the number of specimens of a species extracted from a catch for closer examination, e.g., Individual sampling (or biological sampling) is a detailed study of each specimen where various biological parameters are measured; length, weight, sex, maturity and age.

The number of fish in the catch is found by dividing the total weight of this group by the mean weight. The mean weight is found by taking the weight of the sample divided by the number in the sample.

Catch_number = Catch_weight x (sample_number)/ (sample_weight).

For herring and blue whiting a representative number of individuals, 100 fish per species if possible should be examined for:

Comment [L2]: During surveys only 50 specimens are taken per species and haul onboard some vessels!

- Length (measured in ½ cm intervals)
- Weigth (measured in grammes)
- Sex
- Maturity (maturity key is given in section 5.5)
- Age (in winter rings) (herring using scale and blue whiting using otoliths)

5.2.2 Length measurements

Representative length measurements of between 150-250 individuals should be taken.

- Herring and sprat: are measured to the 0.5 cm below.
- All other species: to the whole cm below.

The length measured should be the **total length** of the fish, rounding down towards the nearest length interval.

.

5.2.3 Aging: Collection and reading of otoliths and scales

Collection

Scales in herring

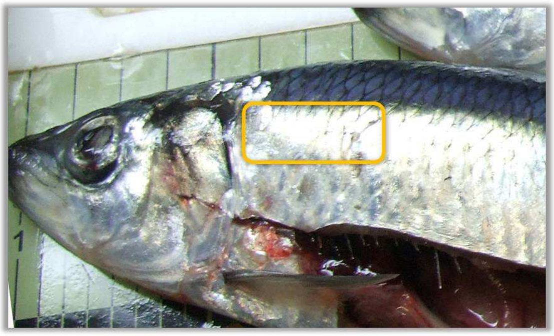


Figure 5.2. Picture with zone indication on herring where scales should be taken

A blotting paper within numbered squares is soaked in water and placed on a tray where the scales are temporarily deposited.. A sufficient number of scales should be taken from each herring to obtain about 4-5 good specimens for age reading. Before the scales are taken, submerge the herring in sea water and carefully stroke the body from front backwards to remove any loose scales that may have come from other fish.

After length, weight, sex and maturity of those fish had been determined the scales are mounted on microscope slides. Each slide will contain the scales of 2 individual fish. The slides must be numbered with permanent ink beforehand. The first and last slide should also contain information on cruise number, station and date. The scales are cleaned with water from any adhering tissue and dirt, placed on a microscope slide that had been prepared with a layer of gelatine (use tweezers). The scale is slightly curved and must be placed on the slide with the convex side upwards. If the scales cannot be prepared on slides immediately after sampling, they must be frozen immediately to prevent them from drying.

Otoliths

If possible 2 otoliths should be taken of each individual. If age determination of herring is done by scale reading a number of otoliths should also be taken for comparison (100-200 over different trawl hauls per cruise.

Otolith and scale reading

Otoliths and scales may be read onboard using standard procedures for otoltih reading of blue whiting or scale reading of herring or they may be examined at a later stage in the institute laboratories.

Reading

Herring otoliths and scales

Count the number of hyaline zones (winter zones; dark in reflected light) on the otoliths, number of zones on the scales. Figure 5.3 shows an example on a herring scale and how the number of winter ring can be read.

January 1 is the date on which the fish becomes one year older. If otoliths or scales from a fish caught in the autumn have started a new winter zone, this zone should not be counted (or measured). If otoliths or scales from a fish caught in the spring have not yet started the winter zone, this should be assigned a year more than the number of zones, i.e., the edge is counted (and measured) as a winter zone.

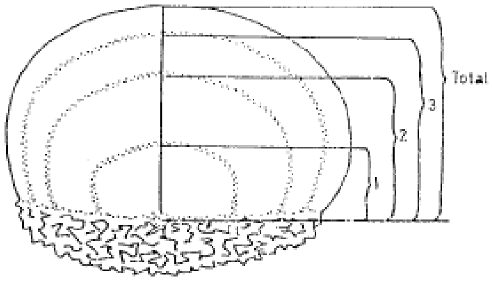


Figure 5.3. Herring scale

Blue whiting otoliths

It is difficult to give strict rules for the determination of zones, the width of rings and zones and the distance between them must be appraised continuously. In otoliths of young fish (<2 years) it may be difficult to distinguish between the first winter zone and «Bower's zone» («Bailey's zone») and other rings («checks»), particularly for I-group fish caught in the year's first quarter. The results of measurements of the first winter zone cover, on average, 53 measuring units at calibration 12 (12 marks per 2 mm). This may be used as a guide. In older fish the first zone that is counted is normally distinct. «Bower's zone» and other «checks» on the inside are distinguished from the other zones because they appear thinner and are often broken. Figure 5.4 shows an example on a blue whiting otolith and how the number of winter ring can be read.

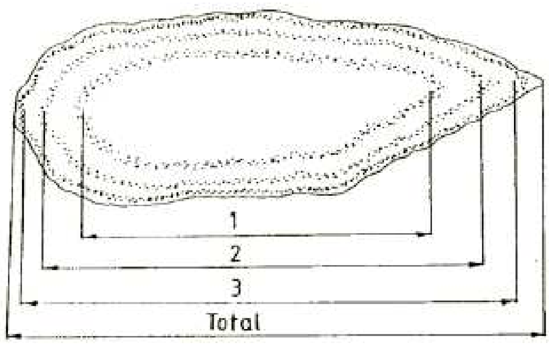


Figure 5.4. Blue whiting otolith

Comment [L3]: Scale and otolith reading is and should also be done by experienced people who are familiar with SOPs. Thus these paragraphs can be omitted.

5.2.4 Maturity stages

Maturity of herring and blue whiting should be determined according to fixed scales, although reporting of the data varies according to participants. See **Appendix C** for details. The 8 point scale is based on Bowers and Holliday (1961). A conversion between the 8 point scale and the 4 point scale is presented in **Appendix C.**

Detailed manual to determine gonad maturity of blue whiting is currently being compiled by the Marine Institute (Ireland) and will be available to the group by the year end 2007. Reference: Power et al. 2007, Manual to determine gonad maturity of blue whiting, Marine Institute publication. In press.

This chapter needs to be checked and updated.

- Propose to include color photographs of the different stages.
- It should be made absolutely clear whether we mean maturation of the fish of maturation of the gonad.

5.3 Deepsea species

A deep-sea species photo guide has been created during the blue whiting surveys of 2007 and 2008. This photo guide will be available as a stand alone document to all PGNAPES and PGTIPS coordinated surveys. A word of caution is appropriate here: All the determinations have been done on board aided by available literature and equipment. All identifications are based on Muus and Nielsen (1999) and the three volume compilation by Whitihead et al. (1986). If in doubt also http://www.fishbase.org (FishBase 2008) was consulted. Most if not all of the identification are, therefore, correct. However, due to the catch methods some of the species were not in a state that they could be identified immediately, and discriminating features had to be taken from various individuals of a group of specimens of which we were confident to represent one species. It is, thus, possible that inconsistencies might occur. The user of the guide is encouraged not to view it as a final version but as a product in development and help to expand and improve the list of know species of the investigation area. The following references have been used:

1. Froese, R. and D. Pauly. Editors. 2008. FishBase. http://www.fishbase.org version (01/2008). World Wide Web electronic publication.
2. Muus, B.J. and J.G. Nielsen, 1999. Sea fish. Scandinavian Fishing Year Book, Hedehusene, Denmark. 340 p.
3. Whitehead, P.J.P., M.-L. Bauchot, J.-C. Hureau, J. Nielsen and E. Tortonese (eds.), 1986. Fishes of the North-eastern Atlantic and the Mediterranean. UNESCO, Paris. Vols. I-III: 1473 p. (FNAM)

During each cruise it is recommended to compile a list of species which are regularly caught containing

- scientific names
- point specific features which discriminate them of other related species
- photographs

Also make sure to include instruction to identify all species to the exact species name and if this is not possible samples should be taken for later indentification ashore.

6 Plankton sampling

6.1 Sampling plankton

The standard equipment for zooplankton sampling is the WP2 net (Fig. 6.1), with 180 or 200 µm mesh size and 56 cm aperture. The net is hauled vertically from 200 m or the bottom to the surface at a speed of 0.5 m s^{-1}. It is important not to stop the haul or lower the speed until the net is above the sea surface.

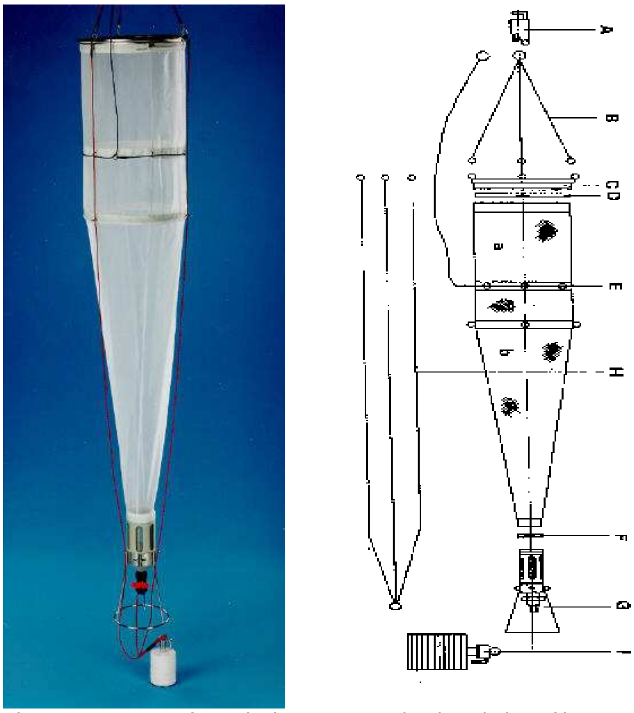


Figure 6.1. Image of a typical WP2 net and a description of its parts.

A. "Nansen release mechanism" (heavy duty version) for operating/closing plankton net by a 0.8 kg drop messenger (not used during the survey).
B. Three 6 mm Nylon lines with bridle and snap hook (length: 85 cm).
C. Ring of AISI 316 stainless steel tubing with 3 loops for bridle and weight lines, 2 loops for an optional digital counter located in the middle of the opening. I.D. □57 cm = area of 0.25 m2.
D. AISI 316 stainless steel clamping fixture.
E. Part a net: 180 - 200 micron Monodur Nytal (Nylon) net with 6 loops for the 6 mm (diameter) Nylon line closure rope. Cylindrical net length is 95 cm. Part b net is identical to a, but conically shaped. The length is 166 cm.
F. AISI 316 stainless steel clamping fixture.
G. Net bucket, based on the Hensen design. The bucket is made of a 160 mm (diameter) Polypropylene tubing with a plastic draining tap, 6 openings, (Total area of 315 cm2), covered by 180 - 200 micron net material of AISI 316 stainless steel, 1 round supporting rack bucket and 3 loops for lead weights.
H. 3 Nylon lines for the weight with bridle and snap hook.
I. Lead weight of 25 kg

The WP-2 plankton net can be equipped with a digital flow meter (Optional) to determine the amount of water passing through the plankton net.

After each haul the contents of the net are gently washed with seawater into the net bucket which is subsequently emptied and rinsed into a sieve with a suitable mesh width of 180 – 200 µm depending on the mesh in the plankton sampler.

6.2 Processing plankton samples

At each station two plankton samples are taken. The first sample size fractioned into 2000, 1000 and 180 µm fractions which are oven dried at 70° C and subsequently weighed . The weighing must be done in a laboratory on land, but samples must be dried onboard and frozen for storage and transportation. Before weighing, samples must be dried again for at least 6 hours. The second sample is fixed in 4% formaldehyde-seawater solution buffered with sodium tetraborate to a pH of approximately 8 for later analyses (species determination).

Comment [L4]: The old manual mention no specific buffer. However, it is advisable that the working group agrees on a standard buffering agent that is used by each participant.

7 Hydrographical sampling

- Expand the hydrography section with instructions on how the CTD should be operated, discriminating between operations (speed, depth) and measurements (temperature, conductivity, fluorescence and oxygen)
- International coordinated spatial resolution?
- More coordinated approach within the group as to CTD coverage during coordinated surveys to be included in the meetings and manual

7.1 CTD operation

PGNAPES

At the Norwegian Sea survey a CTD profile should be taken every 60 nm at each plankton station. Temperature and salinity should be monitored from the surface layer and from the near-bottom or deepest layer regularly for calibration of the CTD sonde. It is important to select relatively homogenous layers to take the samples in to obtain good calibration accuracy. All countries agreed on performing hydrographic CTD downcasts down to a maximum depth of 1000m.

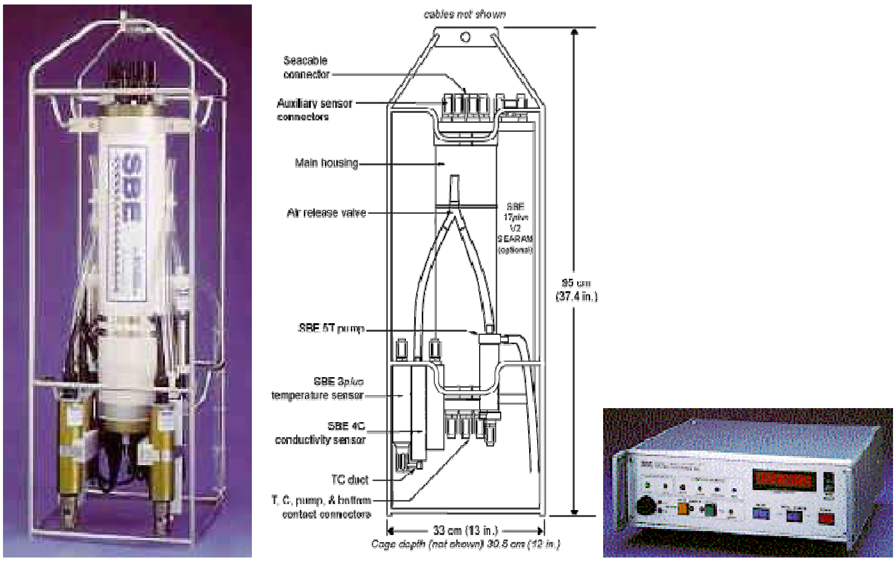


Figure 7.1. A SBE 9plus Underwater Unit with sensors for C, T, and P and a submersible pump optional auxiliary sensors (left panel) and and SBE 11plus V2 Deck Unit (right panel).

During the blue whiting survey at the spawning grounds CTD profiles should be taken at least every 60 nm. Temperature and conductivity/salinity shall be monitored from the surface to a maximum depth of 1000 m. Water samples for calibration of the CTD probe shall be taken regularly.

Comment [L5]: Hydrographers ! Please specify what regularly means!

Measured variables

- Temperature
- Depth / pressure
- Conductivity
- Oxygen
- Fluorescence

8 Data analysis

8.1 PGTIPS approach

To be updated

Theory

This section describes the calculation of numbers and biomass by species from the echo-integrator data and trawl data. Most of this section is taken from Simmonds *et al.* 1992.

The symbols used in this section are defined in the text but for completeness they are listed together below:

F_i	Estimated area density of species i
K	Equipment physical calibration factor
$<\sigma_i>$	Mean acoustic cross-section of species i
E_i	Partitioned echo-integral for species i
E_m	Echo-integral of a species mixture
c_i	Echo-integrator conversion factor for species i
TS	Target strength
TS_n	Target strength of one fish
TS_w	Target strength of unit weight of fish
a_i, b_i	Constants in the target strength to fish length formula
a_n, b_n	Constants in formula relating TS_n to fish length
a_w, b_w	Constants in formula relating TS_w to fish length
a_f, b_f	Constants in the fish weight-length formula
L	Fish length. Total length in ½ cm.
W	Weight in grams
L_j	Fish length at midpoint of size class j
f_{ij}	Relative length frequency for size class j of species i
w_i	Proportion of species i in trawl catches
A_k	Area of the elementary statistical sampling rectangle k
Q	Total biomass
Q_i	Total biomass for species i

The objective is to estimate the density of targets from the observed echo-integrals. This may be done using the following equation from Foote *et al.* (1987):

$$F_i = \left(\frac{K}{<\sigma_i>}\right)E_i \qquad \textbf{(1)}$$

The subscript i refer to one species or category or target. K is a calibration factor, $<\sigma_i>$ is the mean acoustic cross-section of species i, E_i is the mean echo-integral aalocated to the species in the judging prpcess and F_i is the estimated area density of species i. The quantity is the number or weight of species i, depending on whether σ_i is the mean cross-section per fish or unit weight. $c_i= (K/<\sigma_i>)$ is the integrator conversion factor, which may be different for each species. Furthermore, c_i depends upon the size-distribution of the insonified target, and if this differs over the whole surveyed area, the calculated conversion factors must take the regional variation into account.

K is determined from the physical calibration of the equipment, which is described in section 1 above. K does not depend upon the species or biological parameters. Several calibrations may be performed during a survey. The measured values of K or the settings of the EK500 may be different but they should be within 10% of one another.

Conversion factors for a single species

The mean cross-section $<\sigma_i>$ should be derived from a function which describes the length-dependence of the target-strength, normally expressed in the form:

$$TS = a_i + b_i Log_{10}(L) \qquad \textbf{(2)}$$

Where a_i and b_i are constants for the i'th species, the recommended target strength relationships for herring surveys in the Norwegian Sea and blue whiting surveys in the North east Atlantic area is given below.

Target Strength Equation Coefficients		
Species	**b_i**	**a_i**
Herring	20.0	-67.5
Blue whiting	21.8	-72.8
Mackerel	20	-84.9
Horse mackerel	20	-71.2
Physoclist species	20.0	-71.9

The equivalent formula for the cross-section is:

$$\sigma_i = 4\pi 10^{\left(\left(a_i + b_i Log(L)\right)/10\right)} \qquad \textbf{(3)}$$

The mean cross-section is calculated as the σ average over the size distribution of the insonified fish. Thus L_j is the mid-point of the j'th size class and f_{ij} is the corresponding frequency as deduced from the fishing samples by the method described earlier. The echo-integrator conversion factor is $c_i = K/<\sigma_i>$. The calculation may be repeated for any species with a target strength function.

$$<\sigma_i> = 4\pi \sum_j f_{ij} 10^{\left(\left(a_i + b_i Log(L_j)\right)/10\right)} \qquad \textbf{(4)}$$

Note that it is the cross-section that is averaged, not the target-strength. The arithmetic average of the target-strengths gives a geometric mean, which is incorrect. The term "mean target-strength" may be encountered in the literature, but this is normally the target-strength equivalent to $<\sigma_i>$, calculated as $10\log_{10}(<\sigma_i>/4\pi)$. Some authors refer to TS as 10 $\log(\sigma_{bs})$ the definition of σ is different from σ_{bs} and should not be confused.

Conversion factors for mixed species layers or categories

Sometimes several species are found in mixed concentrations such that the marks on the echogram due to each species cannot be distinguished. From inspection of the echogram, the echo-integrals can be partitioned to provide data for the mixture as one category, but not for the individual species. However, further partitioning to species level is possible by reference to the composition of the trawl catches (Nakken and Dommasnes, 1975).

Suppose E_m is the echo-integral of the mixture, and w_i is the proportion of the i'th species, calculated from fishing data. It is necessary to know the target-strength or the acoustic cross-section, which may be determined in the same manner as for single species above. The fish density contributed by each species is proportional to w_i. Thus the partitioned fish densities are:

$$F_i = \frac{w_i K}{\left(\sum_i w_i <\sigma_i>\right)} E_m \qquad \textbf{(5)}$$

The w_i may be expressed as the proportional number or weight of each species, according to the units used for $<\sigma_i>$ and c_i. Consistent units must be used throughout the analysis, but the principles are the same whether it is the number of individuals or the total weight that is to be estimated.

Using weight-length relationships

The abundance is expressed either as the total weight or the number of fish in the stock. When considering the structure of the stock, it is convenient to work with the numbers at each age. However, an assessment of the commercial fishing opportunities would normally be expressed as the weight of stock yield. Consistent units must be used throughout the analysis. Thus if the abundance is required as a weight while the target-strength function is given for individual fish, the latter must be converted to compatible units. This may be done by reference to the weight-length relationship for the species in question.

For a fish of length L, the weight W is variable but the mean relationship is given by an equation of the form:

$$W = a_f L^{b_f} \qquad \textbf{(6)}$$

Where a_f and b_f are taken as constants for one species. However, a_f and b_f could be considered as variables varying differently with stock and time of year as well as species. Suppose the target-strength of one fish is given as:

$$TS_n = a_n + b_n \log_{10}(L) \qquad \textbf{(7)}$$

The corresponding function TS_w, the target-strength of unit weight of fish has the same form with different constants:

$$TS_w = a_w + b_w \log_{10}(L) \qquad \textbf{(8)}$$

The number of individuals in a unit weight of fish is (1/W), so the constant coefficients are related to the formulae:

$$b_w = b_n - 10b_f \qquad \textbf{(9)}$$

$$a_w = a_n - 10\log_{10}(a_f) \qquad \textbf{(10)}$$

Abundance estimation

So far the analysis has produced an estimate of the mean density of the insonified fish, for each part of the area surveyed, and for each species considered. The next step is to determine the total abundance in the surveyed area. The abundance is calculated independently for each species or category of target for which data have been obtained by partitioning the echo-integrals. The calculations are the same for each category:

$$Q_i = \sum_{k=1}^{n} A_k F_i \qquad \textbf{(11)}$$

The total biomass for all species is:

$$Q = \sum_i Q_i \qquad \textbf{(12)}$$

The F_i are the mean densities and A_k are the elements of the area that have been selected for spatial averaging. The may be calculated from the shape of an area or measured, depending upon the complexity of the area. The presence of land should be taken into account, possibly by measuring the proportions of land and sea.

8.2 PGNAPES approach

In this section we describe how acoustic and trawl data are combined to yield age- and length-stratified stock abundance estimates for individual species. The methodology is in general terms described by Toresen et al. (1998) and in more technical terms and detail by Simmonds & MacLennan (2005).

Theory

The core of the analysis is the conversion of acoustic backscattering density estimates (expressed in units m^2/nm^2, and variously denoted as s_A or NASC) to estimates of fish density, relying on knowledge on average length of the fish and their length-dependent acoustic target strength.

Acoustic target strength of fish varies with fish size and various other characteristics of individual fish, but in practice only length dependence is taken in to account. This is expressed with the so-called target strength (TS) relationship

$$TS = a_i + b_i Log_{10}(L)\ . \qquad \textbf{(1)}$$

where L denotes length and a_i and b_i are regression coefficients for species i. Some canonical coefficients are in the table below; these values apply when length is expressed in centimetres:

Target Strength Equation Coefficients		
Species	**b_i**	**a_i**

Herring	20.0	-67.5
Blue whiting	21.8	-72.8
Mackerel	20	-84.9
Horse mackerel	20	-71.2
Physoclist species	20.0	-71.9

Acoustic cross-section of a single fish $\langle\sigma_i\rangle$ (units: metre squared) is given by the equation

$$\sigma_i = 4\pi 10^{\left(\left(a_i + b_i Log(L)\right)/10\right)} \qquad \textbf{(2)}$$

where the term in the exponent is the TS relationship. This can be simplified to $4\pi 10^{a/10} L^{b/10}$ (division by 10 is an anachronism coming from the conversion of length from centimetres to metres). For blue whiting and herring, the simplified equations resulting from the canonical TS coefficients are $\langle\sigma_{blue\ whiting}\rangle = 6.59 \cdot 10^{-7} L^{2.18}$ and $\langle\sigma_{herring}\rangle = 8.11 \cdot 10^{-7} L^{2.0}$. However, for blue whiting a slightly different equation is actually used: $\langle\sigma_{blue\ whiting}\rangle = 6.72 \cdot 10^{-7} L^{2.18}$. The origin of this discrepancy (implying a_i = -72.72 dB) is shrouded in mystery. All we can say is that using about 2% too high coefficient results in underestimation of blue whiting numbers by that amount relative to the “correct” coefficient.

Fish density ρ in numbers per square nautical mile is now obtained as

$$\rho = s_A / \langle\sigma\rangle \qquad \textbf{(3)}$$

Estimated numbers are converted to biomass estimate by multiplying them with mean individual weight. Age and length distributions are obtained by spreading total numbers to age and length classes using corresponding probability density distributions derived from trawl samples.

Implementation

Here we describe the practical implementation of the above calculations, also including how spatial dimension of the data is accounted for. In national surveys, details may differ, and corresponding cruise reports should be consulted for more information.

The acoustic data as well as the data from trawl hauls are analysed with a SAS based routine called “BEAM” (Totland and Godø 2001) to make estimates of total biomass and numbers of individuals by age and length in the whole survey area and within different sub-areas (i.e., the main areas in the terminology of BEAM). Strata of 1º latitude by 2º longitude were used. The area of a stratum are adjusted, when necessary, to correspond with the area representatively covered by the survey track. For blue whiting, this is particularly important in the shelf break zone where high densities of blue whiting quickly drop to zero at depths less than about 200 m.

To obtain an estimate of length distribution within each stratum, samples from the focal stratum are used. If the focal stratum was not sampled representatively, also samples from the adjacent strata are used. In such cases, only samples representing a similar kind of registration that dominated the focal stratum were included. Because this includes a degree of subjectivity, the sensitivity of the estimate with respect to the selected samples was crudely assessed by studying the influence of these samples on the length distribution in the stratum. No weighting of individual trawl samples was used because of differences in trawls and numbers of fish sampled and measurements. The number of fish in the stratum is then calculated from the total acoustic density and the length composition of fish.

Species-specific acoustic density (s_A, m^2/n.mile^2) for each stratum is estimated as the weighted mean of species-specific density estimates reported by all vessels from a certain stratum, with length of cruise track behind each value being used as the weighting factor. Splitting total acoustic densities to species-specific densities is at the responsibility of reporting vessels. Acoustic densities are nominally expressed at the spatial resolution of 5 nautical miles, but in practice there has been a deal of variation around this norm. In future surveys the standard spatial resolution is 1 nautical mile.

For conversion from acoustic density (s_A, m^2/n.mile^2) to fish density (ρ) the relationship $\rho = sA / \langle\sigma\rangle$, where $\langle\sigma\rangle$ is the average acoustic backscattering cross section (m^2). The total estimated abundance by stratum is redistributed into length classes using the length distribution estimated from trawl samples. Biomass estimates and age-specific estimates are calculated for main areas using age-length and length-weight keys that are obtained by using estimated numbers in each length class within strata as the weighting variable of individual data.

BEAM does not distinguish between mature and immature individuals, and calculations dealing with only mature fish are therefore carried out separately after the final BEAM run separately for each sub-area.

Proportions of mature individuals at length and age are estimated with logistic regression by weighting individual observations with estimated numbers within length class and stratum (variable 'popw' in the standard output dataset 'vgear' of BEAM). The estimates of spawning stock biomass and numbers of mature individuals by age and length were obtained by multiplying the numbers of individuals in each age and length class by estimated proportions of mature individuals. Spawning stock biomass is then obtained by multiplication of numbers at length by mean weight at length; this is valid assuming that immature and mature individuals have the same length-weight relationship.

9 Cruise reports

North Sea herring survey

- cruise reports should be produced following a standardised format
- cruise reports appear as appendix in the international report

Blue whiting survey

- Cruise reports aren't used internationally.
- Cruise reports are not included in the international report

The following can be included in the cruise report:

- Itinerary of the survey
- Map showing
    - Cruise track
    - Trawling station location
    - CTD station location
    - Plankton station location (if collected)
- Materials and methods
    - Acoustic data (A calibration report for all survey calibrations should be included in the final cruise report).
    - Hydrographical and zooplankton data
    - Biological data
- Results
    - Distribution and density of the acoustic data
    - Size and age distribution of the catches
    - Age-and size-stratified stock estimate(s)
    - Hydrographic conditions and zooplankton biomass
- Discussion
    - Acoustics
    - Scrutiny of the acoustic data
    - Trawling
    - Other relevant issues (e.g., weather)

9 Data Handling

Each individual country is responsible for working up its own survey data before entering these in the international database. It is imperative that the results are submitted in PGNAPES format to the "Faroese Fisheries Lab." (FFL) as quickly as possible after each survey. This to facilitate the processing of numbers for the combined survey report.

Submit data to Leon Smith ,e-mail: leonsmit@frs.fo

10.1 PGNAPES web based database

10.1.1 Overview and exchange format

At the PGSPFN meeting in Bergen 2001 the group agreed to set up a common database for the data collected in Norwegian Sea since 1996 by the different nations. This was due to the fact that the data handling was becoming more and more difficult, as the amount of data collected is huge. Already then a draft database design was made. In 2007 a database web server (Oracle 10g express edition) was set up at "Faroese Fisheries Lab." The PGNAPES group has committed itself to submit all relevant cruise data to this central database, to achieve easy access to the complete time series.

The PGNAPES data base was developed on an Microsoft Access platform, and the Access-version is very usefull during a survey, facilitating the collection and organisation of data and ensuring the quality and integrety of the dataset. Another great benefit is that the tableexports fits right into the central database on the internet.

Data files can be interchanged between the vessels in the *.csv format (comma-separated-values) with tables arranged as described by the PGNAPES database format.

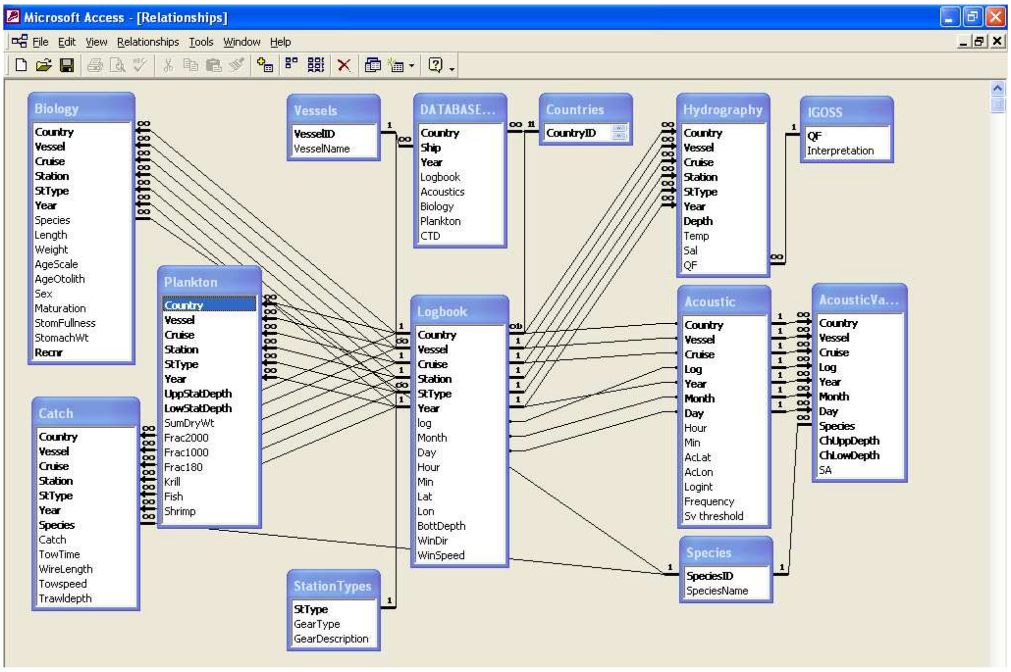
Data submission deadlines for all participant countries need to be established for uploading of herring and blue whiting acoustic data to the PGNAPES database.

At present not all countries submit data in the required format on a pre-agreed timescale. In some cases data from previous years is still outstanding.

It is therefore recommended that a deadline be determined with a person responsible in each country. It will then be the responsibility of this nominated person to submit the data in the agreed format on the pre-agreed timescale within 1 week of survey completion unless pre-agreed with PGNAPES database coordinator. After the deadline all responsible persons for the individual surveys will send an update of their data submission.

10.1.2 PGNAPES database table description

Tables and table constraints:



Appendix E lists all variables with the correct notation. Parameters in **bold** indicate primary key variables, and used together they form a unique key from the logbook to the other sheets, except to the acoustic table. The acoustic table can be linked to the logbook by the cruise identifier together with country, vessel, Cruise, log, year and month.

10.1.3 Example of data export from Access

As the PGNAPES participating nations have agreed on using the new database format it is recommended to use the PGNAPES database as a working tool while on a cruise. Using the database actively, putting all relevant cruise data into the base during the cruise will ensure data integrity, and that exports of data will come out right.

To make exports from the base will ensure that data exported are ready to import into the other participants databases.

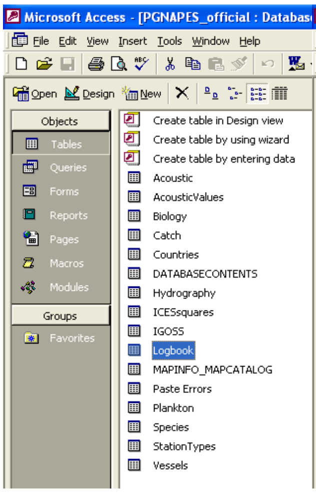
Exporting plankton, hydrography´, biology, or catch data always implies the export of the logbook table as it is the parent table of these underlying tables.

Exporting acoustic values always implies the export of the Acoustic tables as the acoustic table is a parent table of the acousticvalues table.

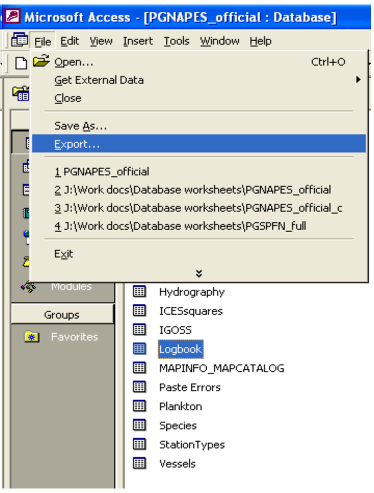
Is important to have the structure of the database in mind when exporting and supplying other participants with exported data.

Exporting data from access:

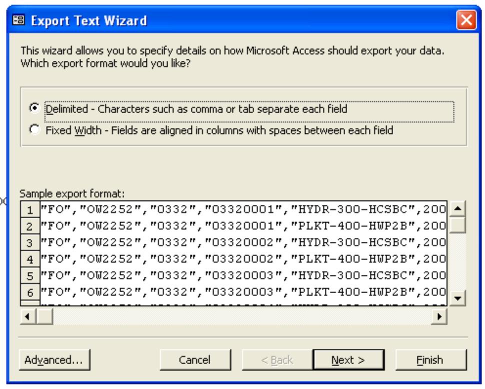
1. Mark the table you want to export (Figure A)
2. Go to File/export (Figure B)
3. Save as “TEXT format, supply file name
4. Save as delimited
5. Make sure it is comma delimited (Figure C), and include Fields Names on first row is tagged (Figure D)
6. Press finish



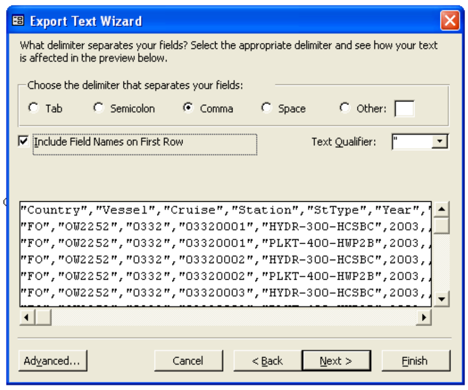
A



B



C



D

The fileformat is ordinary *ASCII*-format. The datavalues within the fileare arranged as Comma-Separated-Values (*.csv) as shown in the example below.

"Country","Vessel","Cruise","Station","StType","Year","log","Month","Day","Hour","Min","Lat","Lon","BottDepth","WinDir","WinSpeed"

"FO","OW2252","0332","03320001","HYDR-300-HCSBC",2003,,5,3,1,11,61.83,-7.00,77,45,15
"FO","OW2252","0332","03320001","PLKT-400-HWP2B",2003,,5,3,1,45,61.83,-7.00,77,45,15
"FO","OW2252","0332","03320002","HYDR-300-HCSBC",2003,,5,3,3,20,61.66,-7.30,130,45,15

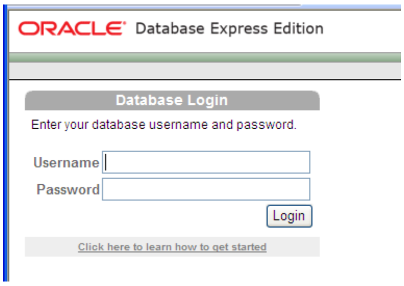
10.1.4 Internet access to PGNAPES database

Data are stored in an Oracle 10g Express edition database (freeware). The database server is based in the "Faroese Fisheries Lab." (FFL) Tórshavn Faroe Islands. By executing SQL queries through the Application Express web-interface, the user can extract data in any form.

URL: **http://oracle.frs.fo/apex**

Usernames and passwords are individual pr. nation. User access is limited to select data from the database. Insert , update and delete operations can only be performed by the schema owner (pgnapes_owner).

Log in on first page:



A

B

Select the SQL button (Figure .. A) and select the SQL Commands button (Figure… B). Then write or paste your SQL statement into the SQL text box and press the RUN button. Number of rows displayed are default 10, but can be changed in the Display drop down field.

Saving SQL-statements
It is possible to save your SQL statements, by pressing the "SAVE" button.. Retrieve your saved SQL's by pressing the "Saved SQL" button.

Its recommended to copy and paste the SQL statements on page 7 and onwards, to get a feel of the system.

Exporting from database
It is possible to download data from the database. After the SQL is executed the link ".csv export" pops up below the results pane. By clicking the CSV export link data will be downloaded to your computer. The user will be prompted, to choose to look at the data or to store the data locally.

Note that the format of the browser output and CSV file (decimal sign, thousands separator, text qualifier, etc.) depends on the language settings of your browser (Internet Explorer 'Internet options/language).

Standard Query Language
Writing SQL statements is relatively easy. Basically a select statement is divided into 3 parts.

- *Select clause:* What do you want to see.
- *From clause:* From which table(s) are you selecting data
- *Where clause:* Conditions on data selected.

Example codes are listed in **Appendix F.**

CAUTION:

Always remember to check the results. SQL returns exactly what you wrote in the SQL-statement. And that is not always the same as the results you wanted.....

Tutorials are easily found on the web
http://www.w3schools.com/sql/default.asp
http://www.sqlcourse.com/
http://www.1keydata.com/sql/sql.html
http://www.geocities.com/SiliconValley/Vista/2207/sql1.html

10.2 PGTIPS -Fishframe- webbased database

Survey data are checked and stored in the North Sea clone of the FishFrame system (www.Fishframe.org). Each country is responsible for uploading:

- Stage 3 data
    a. Abundance (AB files)
    b. Stock details (SD files)
- Stage 1 data
    a. Trawl information (AF files)
    b. Scrutinized NASC's (AA files)

After uploading the data, each country should double check the data through the data browser and reports. When the data are satisfactory, they should be "released". The joined estimate is then calculated by FishFrame and unsampled rectangles are interpolated. The FishFrame user manual (Jansen & Degel, 2007a) and Exchange format description (Degel & Jansen, 2006) contains the necessary information on data upload formats and how to upload, check, release, calculate, interpolate, tabulate, map and report in FishFrame. For documentation of the calculations please refer to Jansen & Degel (2007).

11 References

Bethke, E. 2007. Working paper - Filter Delay and Calibration Error.

Bethke, E.: A simple general approach to codend selectivity of trawls and its application to the data of Fiorentino et al. (1998) for Hake (Merlucius merlucius). Fisheries Research 70 (2004) 113-119

Bodholt, H., 2002. The effect of water temperature and salinity on echo sounder measurements. ICES Symposium on Acoustics in Fisheries, Montpellier June 2002 Paper No 123.

Bodholt, H. (1999). The effect of temperature and salinity on split-beam target strength measurement. Working Document presented to the FAST WG, St. Johns, Canada, 1999. Available from the author at helge.bodholt@simrad.no

Bowers, A. B. and Holliday, F. G. T. (1961). Histological changes in the gonad associated with the reproductive cycle of the herring (Clupea harengus L.). Marine Research Series 5(HMSO Edinburgh): 16.

Conti, S. G., Demer, D. A., Soule, M. A., Conti, J. H. E. 2005. An improved multiple-frequency method for measuring in situ target strengths. ICES Journal of Marine Science, 62: 1636 -1646

Degel, H and Jansen, T, (2006). FishFrame 4.3 Exchange Format Description. www.FishFrame.org, 22 December 2006.

Fernandes, P. G. and E. J. Simmonds (1996). Practical approaches to account for receiver delay and the TVG start time in the calibration of the Simrad EK500. ICES CM 1996/**B:**17, 8p.

Foote, K.G., H.P. Knudsen, G. Vestnes, D.N. MacLennan and E.J. Simmonds. 1987. Calibration of acoustic instruments for fish density estimation: a practical guide. ICES Coop. Res. Rep. 144, 57pp.

Francois, R. E. and G. R. Garrison (1982). "Sound absorption based on ocean measurements. Pt 1 Pure Water and Magnesium Sulphate contributions." J.Acoust.Soc.Am. 72(3).

Jansen, T, Degel, H (2007) and the users of FishFrame. FishFrame 4.3 User Manual. www.FishFrame.org, 28 January 2007.

MacLennan, D.N. and E.J. Simmonds. 2005 Fisheries Acoustics 2nd edition. Blackwell Science Ltd 2005, Oxford: 437pp.

MacLennan, D.N. and E.J. Simmonds. 1992 Fisheries Acoustics. Chapman and Hall, London and New York: 325pp.

MacLennan, D. N., Fernandes, P. G. and Dalen, J. (2001). A consistent approach to definitions and symbols in fisheries acoustics. ICES Journal of Marine Science,in press.

Nakken, O. and A. Dommasnes. 1975. The application of an echo integration system in investigations of the stock strength of the Barent Sea capelin 1971-1974. ICES CM 1975/B:25, 20pp.

Reid, D. G. and E. J. Simmonds (1993). "Image analysis techniques for the study of fish school structure from acoustic survey data." Can. J. Fish. Aqu. Sci.

Reid, D.G., P.G. Fernandes, E. Bethke, A. Couperus, E. Goetze, N. Hakansson, J. Pedersen, K.J. Staehr, E.J. Simmonds, R. Toresen and E. Torstensen. 1998. On visual scrutiny of echograms for acoustic stock estimation. ICES CM 1998/J:3, 6pp.

Rivoirard, J., Simmonds, E.J., Foote, K.F., Fernandes, P.G. and Bez, N. (2000). Geostatistics for estimating fish abundance. Blackwell Science Ltd., Oxford.

Simmonds, E.J, F Gerlotto, P G Fernandes, D N MacLennan, 2000. Observations and Extraction of three dimensional information on fish schools. Proceedings on the meeting of the annual Journal of Acoustical Society of America, Berlin June 2000

Simmonds, E.J., N.J. Williamson, F. Gerolotto and A. Aglen. 1992. Acoustic survey design and analysis procedures: a comprehensive review of current practice. ICES Coop. Res. Rep. 187: 130pp.

Wileman, D. 1991. Codend Selectivity: Updated review of available data. Study contract No. 1991/15 - Danish Institute for Fisheries Technology and Aquaculture.

ICES 2002, PGHERS Manual for Herring Acoustic Surveys in ICES Division III, IV and VIa.

Appendix A. Vessel details

Survey vessels and specifications of participants involved in surveys coordinated through PGNAPES and PGTIPS.

								
			Johan Hjort	**Bjarni Saemundsson**	**Atlantniro**	**Celtic Explorer**	**Fridtjof Nansen**	**Dana**
country			Norway	Iceland	Russia	Ireland	Russia	Denmark
callsign			LDGJ	TFEA		EIGB	UANA	OXBH
				55.8				
email			johan.hjort@imr.no	bsaem@sjopostur.is	762459747@marsatmail.com	celticexplorer@oceanpost.net	42730091@inmc.eik.com	togtleder@dana.dfu.min.dk
							pinro@gtel.ru	
bridge			+ 475 590 6400			+ 871 763 574328	+8-954-210-3640	+45 98944448 (in Hirtshals only)
bridge fax			+ 475 590 6401					+45 98945048 (in Hirtshals only)
general								
acoustic room								
gsm mobile				+354 8536847		087 967 8520		+45 40435479 or +45 30272529
gsm fax								+45 30250363
INMARSATA phone				+87761289064				+871 1610205
INMARSATA fax								+871 1610207
INMARSATB phone								+871 321938420
INMARSATC phone			+ 581 4257 13910				+581 4257 00913	
Iridium			+ 881 63141 3581					+881631450453
VSAT						+871 763 066 743		
DSC								219384000
Internet connection type			continuous	mail 2/day		continuous	continuous	mail 2/day
weblink contacts			web	web	web	web	web	web
weblink technical specs			web	web	web	web	web	web
Power (kW)			2900	1593		2550		2400
Equipment	acoustic	Echo sounder type	Simrad EK 60	Simrad EK60	Simrad EK 500	Simrad ER 60	Simrad EK 60	Simrad EK 60
		Primary Frequency (kHz)	38	38	38	38	38	38
		Primary transducer	ES 38B - SK	ES38B	ES38B	ES 38B - Serial	ES38B	ES 38B
		Other Frequencies (kHz)	18, 120, 200	18, 120	120	18, 120, 200	70	18, 120
		Transducer installation	dropped keel		Hull mounted	Drop keel	Hull mounted	towed body
		Post processing software	BEI		Sonardata Echoview	Sonardata Echoview	BI60	BI500 Echoview
		Log interval (nm)			1	1		1
		transducer depth	10		5	8.7	5	4
		upper integration limit	15		10	15	10	10
		Integration threshold (dB)			-80	-70		-70
		Using sonar systematically?			no	no		no
	hydrographics	CTD device	Seabird SBE 911 plus	Seabird SBE 911 plus		Seabird SBE 911 plus		Seabird SBE 911 plus
		Water sampler		SBE 32		Rosette sampler		yes
		Maximum sample depth (m)		1000	1000	1000		1000
		surface recorder		Seabird SBE21E				
Blue whiting survey	Fishing gear	Circumference (m)			716	768		
		Vertical opening (m)			50	48		
		Mesh size in codend (mm)			16	20		
		Typical towing speed (kn)			3.3-4.0	3.5-4.0		
NE Atlantic ecosystem survey	Fishing gear	type						
		nr of panels						
		Circumference (m)	313				716	397
		Vertical opening (m)	20				40	22
		Mesh size in codend (mm)	22				24	16
		Typical towing speed (kn)	3.0-4.0				3.3-3.9	3.0-4.5
Herring Surveys	Fishing gear	type	PSN205			Single pelagic trawl		Fotö trawl
		nr of panels	4			8		4
		doorspread	28			75		
		headline	50.4					
		groundrope	55.4					
		sweeps	99.5			40		
		length	84.3			70.6		
		Circumference (m)	205			330		
		Vertical opening (m)	15			11		
		mesh in panel 1	400			1600		
		mesh in panel 2	200			800		
		mesh in panel 3	160			400		
		mesh in panel 4	80			200		
		mesh in panel 5	50			100		
		mesh in panel 6				50		
		Mesh size in codend (mm)	10			20		16
		Typical towing speed (kn)	3.3-4.0			3.5-4.0		3.3-4.0

								
			Arni Frideriksson	**G.O. Sars**	**Magnus Heinason**	**Tridens**	**Solea**	**Scotia**
country			Iceland	Norway	Faeroer	Netherlands	Germany	Scotland
callsign			TFNA	LMEL	OW2252	PBVO	DBFI	MXHR6
			69.6					
email			arnifbru@sjopostur.is	g.o.sars@imr.no	423104110@inmc.eik.com	ms-tridens@minlnv.agro.nl	fahrtleiter@solea.bfa-fisch.de	scotia@marlab.ac.uk
bridge				+47 55906440	+ 871 623 104120			
bridge fax						+31 20 7178827		
general				+47 55906443				
acoustic room				+47 55906442				
gsm mobile			+354 8540535		+298 286092	+ 653 629 972	+49 160 977 296 14	+ 44 7775 83 5096
gsm fax					+298 286082			+ 44 7921 249 323
INMARSATA phone			+874325150710			+871 324 403 310	+871 761 651 777	+ 871 323 497 310
INMARSATA fax					+871 623104121	+871 324 403 315	+871 600 273 653	+ 871 323 497 311
INMARSATB phone								
INMARSATC phone							+ 581 4211 41759	
Iridium						+881621427705		
VSAT						+31 20 7178825		
DSC								
Internet connection type			mail 2/day	continuous	light mail 1/day	continuous		
weblink contacts			web	web	web	web	web	web
weblink technical specs			web	web		web		web
Power (kW)			4408	2940	1325	2940		
Equipment	acoustic	Echo sounder type	Simrad EK 500	Simrad EK 60	Simrad EK 500	Simrad EK 60		
		Primary Frequency (kHz)	38	38	38	38		
		Primary transducer	ES38B	ES 38B - SK	ES38B	ES 38B		
		Other Frequencies (kHz)	18, 120	18, 70, 120, 200		200		
		Transducer installation	drop keel	Drop keel	Hull mounted	Towed body		
		Post processing software	BI500	BEI	Sonardata Echoview	Sonardata Echoview		
		Log interval (nm)	1	1	5 (varying)	1		
		transducer depth	8.5	8	3	7		
		upper integration limit	11	15	7	12		
		Integration threshold (dB)	-70	-80	-70	-80		
		Using sonar systematically?	no	no	no	no		
	hydrographics	CTD device	Seabird SBE 911 plus	Seabird SBE 911 plus	Seabird SBE 911 plus	Seabird SBE 911 plus		
		Water sampler	SBE xx		SBE 12	SBE 12		
		Maximum sample depth (m)	1000	1000	750/1000	750		
		surface recorder	Seabird SBE21E					
Blue whiting survey	Fishing gear	Circumference (m)		586	640	1120		
		Vertical opening (m)		25-35	38-48	30-70		
		Mesh size in codend (mm)		22	40	±20		
		Typical towing speed (kn)		3.0-4.0	3.0-4.0	3.5-4.0		
NE Atlantic ecosystem survey	Fishing gear	type	Gloria					
		nr of panels						
		Circumference (m)	1024	586	640			
		Vertical opening (m)	55	25-35	38-48			
		Mesh size in codend (mm)	40	22	40			
		Typical towing speed (kn)	3.5-4.0	3.0-4.0	3.0-4.0			
North Sea herring survey	Fishing gear	type				2000 M Pel. Trawl		
		nr of panels		4		4		
		doorspread				45		
		headline		72		64		
		groundrope		72		72		
		sweeps		160		100		
		length		130		140		
		Circumference (m)		486		400		
		Vertical opening (m)		33		16		
		mesh in panel 1		3200		800		
		mesh in panel 2		1620		400		
		mesh in panel 3		400		200		
		mesh in panel 4		200		120		
		mesh in panel 5		100		80		
		mesh in panel 6		38				
		Mesh size in codend (mm)		10		20		
		Typical towing speed (kn)		3.3-4.0		3.3-4.0	3.3-4.0	3.3-4.0

Characteristics of trawl gear used in the **North Sea and Celtic Sea herring surveys**. “Mesh sizes in all panels” are listed for panels from the mouth of the net to the cod end; the number of entries is not an indication of the number of panels as adjacent panels may have the same mesh size.

This table has partly been integrated into the vessel details table (non-highlighted parts).

Country	Vessel	Power	Code	Name	Type	Panels	Headl	Groundr	Sweeps	Length	Circum	Mesh sizes in all panels						Codend	Height	Spread (wings)
		kW			B/P	2/4	m	m	m	m	m	mm	mm	mm	mm	mm	mm	**mm**	m	m
DEN	DAN2	3420		Fotø	P		60.4	66.4	121		397	3200	1600	800	400	200	100	**16**		
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		**10**	15	28
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	PS388	Krake	P	4	42.0	42.0	63.5	59.8	142.4	400	200	80				**10**	10	21
NED	TRI2	2940		2000 M Pel. Trawl	P	4	64.0	72.0	100.0	140.0	400	800	400	200	120	80		**20**	16	45
NOR	GOS	1700	3532	Akratral	P	4	72.0	72.0	160.0	130.0	486.4	3200	1620	400	200	100	38	**10**	33	
NOR	GOS	1700		[bottom trawl]	B															
SCO	SCO2	3000	PT160	Pel. Sampl. Trawl	P	4	38.0	38.0	70–115	87.0	256.0	800	600	400	200	100	38	**38**	12	32
IRE	CEX	3000	PMT	Pel. midwater trawl	P	4	58.0	58.0	55.0	40.0	330.0	3200	1600	400	200	100	50	**20**	15	45

Appendix B. Angle sensitivity

The angle sensitivity, beamwidth, transducer gain and the two-way beam angle are "pumping" according to changes of sound speed (see Bodholt 2002 for equations).

A key parameter is the angle sensitivity. This parameter is used to convert the measured electrical phase shift into the calculated and displayed angles of a target, which are used for TS compensation.

Data sheets giving measurements of Amplitude versus Phase for individual transducers can be obtained from Simrad on request.

.

From Figure 1? we can measure an electrical phase shift of 155.5° between the 3dB points. If the corresponding beamwidth of that transducer is 6.86°, the angle sensitivity is calculated as 155.5°/6.86° = 22.86 (instead of the default value of 21.9). The angle sensitivity of individual transducers can differ from the default value. Conti (et al. 2005) report values of 1 – 2.4 %, however, for the presented example the deviation was larger than 4 %. The use of an incorrect angle sensitivity has a significant influence on the TS compensation while the influence on the s_A value is relatively small. The s_A value depends on the square of the angle sensitivity. In this case, using the default value instead of the measured angle sensitivity introduces an error of about 10 % to the measurements. If the specific angle sensitivity is not known, the default value for the angle sensitivity and the given two-way beam angle should be used. These parameters have to be converted from the environmental conditions, given in the transducer sheet (obtained at a given temperature in a fresh-water container), into a parameter set for the instantaneous environmental conditions by the equations given in Bodholt 2002.

Angle sensitivity: $$n = \frac{c_0}{c}$$

The angle sensitivity has to be converted for EK 500 and EK 60 before the calibration is carried out.

Two-way beam angle: $$\psi = \psi_0 \frac{c^2}{c_0^{\,2}}$$

This two-way beam angle should be used even if the calibration results in a different value. If the specific angle sensitivity is known only this parameter has to be converted to changed environmental conditions. In this case the two-way beam angle should be calculated:

$$\psi[dB] = 10\log\left(\frac{\beta_1 \times \beta_2}{5800}\right)$$

Were β_1 and β_2 are the values measured by the calibration program.

If the environmental conditions of two calibrations differ or differ from the measurement conditions a conversion of angle sensitivity, beam width, transducer gain and two-way beam angle is needed. Now the index (e.g. c_0) means sound speed at calibration condition:

Beam width: $$u = u_0 \frac{c}{c_0}$$

Appendix C. Maturity classification for herring

Male herring

Netherlands & Germany	Norway	Scotland & Denmark*	Ireland
0= undefined	0= undecided / not checked		
1= virgin (**I**mmature) testes are long, very thin, translucent and transparent ribbons lying along an unbranched blood vessel; no sign of development; round end	1= immature (a) juvenile phase, gonads thread-like, thin, completely transperent and colourless; sex difficult to determine	1= Virgin herring gonads very small – threadlike; 2-3 mm broad; testes whitish or grey brown	1= Virgin individuals: small sexual organs close under vertebral column whitish or greyish brown in colour, knife shaped testes 2-3 cm long and 0.66 mm thick.
	2= immature (b) somewhat larger in volume; sex easier determined; still transparent with hint of colour	2= Virgin herring with small sexual organs height of testes is about 3-8 mm; testes a reddish grey colour	2= Maturing Virgins. Slightly larger than stage 1, still transparent colouration.
2= maturing (**M**) ribbons are already larger, reddish colour; smooth and transparent or development has clearly started, whitish/creamy colour of the gonades; gonads are more and more filling in the body cavity; sperm/milk still cannot be extruded using moderate pressure	3= maturing (a) opaque but developed in volume; distinct veins; testes white or with white spots, firm; can occupy half body cavity or more	3= maturing gonads occupy about half of the ventral cavity; breadth of the sexual organs is between 1 and 2 cm; testes reddish grey or greyish	3= Sexual Organs become more swollen, occupying about half of the ventral cavity
	4= maturing (b) gonads larger in volume; distinct veins; testes light grey or white; milt thick and slow-flowing	4= maturing gonads are almost as long as the body cavity; testes whitish	4= Gonads become more swollen, filling two thirds of ventral cavity, milt whitish
	5= maturing (c) testes are grey or white; The gonads are not yet running, however, a light pressure on the abdomen causes the milt to run	5= maturing gonads fill the body cavity; testes are milky white; sperm does not flow but can be extruded by pressure	5= Sexual Organs filling ventral cavity, milt is white in colour but not yet running
3= spawning (**R**unning) sperm/milk is flowing out or is extruded using moderate pressure to the fish body	6= spawning running gonads when light pressure is applied	6= spawning ripe gonads; testes white; sperm flow freely	6= milt running – Spawning
4= spent (**S**) gonads are shrunken, drained, transparent and reddish; residues of sperma/milk; showing no development	7= spent gonads loose; contain remaining milt	7= spent gonads baggy and bloodshot; testes may contain remains of sperm. The body cavity may contain bloody fluid. At this stage there can be difficulty in deciding sex; if the gonads are spread out it is easier to view the leading edge – sharp for male and rounded for female	7= Spents, testes slack, baggy and bloodshot
*Dutch Code (**I-M-R-S**) between brackets	8= resting gonads small; difficult to distinguish from stage 2-3	8= recovering testes are firm and larger than virgin herring in Stage 2. The walls of the gonads are striated laterally and blood vessels are prominent. Gonads are wine-red in colour. (This stage passes into Stage 3)	8= Recovering spents. Blood vessels showing.

Female herring

Netherlands & Germany	Norway	Scotland & Denmark*	Ireland
0= undefined	0= undecided / not checked		
1= virgin ovaries are thin, whitish, translucent and long ribbons; no sign of development; pointed end	1= immature (a) thread-like, thin, completely transperent and colourless; sex difficult to determine	1= Virgin herring gonads very small – threadlike; 2-3 mm broad; ovaries wine red	1= Virgin individuals: small sexual organs close under vertebral column Wine in colour, torpedo-shaped ovaries about 2-3 cm long and 0.66 mm thick
	2= immature (b) somewhat larger in volume; sex easier determined; still transparent with hint of colour	2= Virgin herring with small gonads the height of ovaries is about 3-8 mm; eggs not visible to the naked eye but can be seen with a magnifying glass; ovaries bright red colour	2= Maturing Virgins. Slightly larger than stage 1, still transparent.
2= maturing ribbons are already larger, reddish colour; lightly ribbed and milky or development has clearly started, eggs are becoming larger; ovaries are more and more filling in the body cavity; eggs still cannot be extruded using moderate pressure	3= maturing (a) opaque but developed in volume; distinct veins; ovaries with yellow/white eggs in lamellae; can occupy half body cavity or more	3= maturing gonads occupy about half of the ventral cavity; breadth of the sexual organs is between 1 and 2 cm; eggs are small but can be distinguished with the naked eye; the ovaries are organs	3= Sexual Organs become more swollen, occupying about half of the ventral cavity
	4= maturing (b) gonads larger in volume; distinct veins; ovaries yellowish or white, can occupy 2/3 or more of the body cavity depending on fish condition; Eggs distinct, feel like grain, becoming transparent in the front part of the gonad	4= maturing gonads are almost as long as the body cavity; eggs larger than in 3, varying in size and opaque; ovaries orange or pale yellow in colour	4= Ovaries become more swollen, filling two thirds of ventral cavity, eggs not transparent.
	5= maturing (c) ovaries fill the entire body cavity; most eggs transparent	5= maturing gonads fill the body cavity; eggs are large and round; some are transparent; ovaries are yellowish; eggs do not flow	5= Sexual Organs filling ventral cavity, ovaries with some large transparent eggs
3= spawning eggs are freely extruding or developed eggs are extruding using moderate pressure to the fish body	6= spawning running gonads when light pressure is applied	6= spawning ripe gonads; eggs transparent; eggs flow freely	6= Roe running – Spawning
4= spent gonads are shrunken, drained, not translucent, reddish, lightly ribbed; residues of eggs; showing no development	7= spent gonads loose; some remaining eggs	7= spent gonads baggy and bloodshot; ovaries are empty or only contain a few residual eggs; body cavity may contain bloody fluid. At this stage there can be difficulty in deciding sex; if the gonads are spread out it is easier to view the leading edge – sharp for male and rounded for female	7= Spents, ovaries slack with residual eggs, baggy and bloodshot
	8= resting gonads small; eggs not visible; difficult to distinguish from stage 2-3	8= recovering ovaries are firm and larger than virgin herring in Stage 2. Eggs are not visible to the naked eye. The walls of the gonads are striated vertically and blood vessels are prominent. Gonads are wine-red in colour. (This stage passes into Stage 3)	8= Recovering spents, no eggs visible. Blood vessels showing.

Maturity classification for blue whiting

Stage	Females	F	Males	F
blank	**Undecided/not checked**		**Undecided/not checked**	
1	**Immature** Ovaries transparent and white. No visible eggs.	<1/4	**Immature** Testes are thin and transparent. «Ribs» almost invisible.	<1/4
2	**Spent (new maturation) + First-time spawner** Ovaries transparent orange/red, somewhat spotted	1/3	**Spent (new maturation) + First-time spawner** Testes transparent pink/white, with some rolls or loops	1/2
3 - 4	**Maturing** Ovaries orange/pink. Opaque eggs barely visible.	1/2	**Maturing** Testes are in the process of becoming opaque pink/whit. Some blood vesssels with «bags». Curl when squeezed.	2/3
5	**Maturing** Ovaries harder orange/pink. Opaque eggs distinctly visible.	2/3	**Maturing** Testes opaque, white, plump.	3/4
6	**Maturing/mature** Ovaries orange/pink. Some hyaline eggs.	>3/4	**Maturing/mature** Testes opaque creme-white. Tightly curved bags or rolls.	1
7	**Spawning/running** Ovaries pink/white. Mainly hyaline eggs. Easy to squeeze out.	1	**Spawning/running** Testes opaque creme-white. Easy to squeeze out.	1
8	**Spent** Ovaries spotted pink/red, bloody. Some eggs remaining.	<1/2	**Spent** Testes yellow-white and bloody. Small crinkled band.	<3/4

F = Gonad length in relation to body cavity size.

Conversion from 8 to 4 stage key

8 point scale	4 point scale
1	I (**I**mmature)
2	
3	M (**M**ature)
4	
5	
6	R (**R**unning)
7	S (**S**pent and resting)
8	

Appendix D. Mesh size measurements

Measurements of herring selectivity with commercial vessels and midwater trawls gave for a mesh opening of 40 mm a selection length factor (S_L) in the range 3.9 to 4.4 with an average of 4.18 (Wileman 1991). The selection range was generally wider, from 34 to 51 mm, with an average of 40 mm. The selection range factor is therefore:

$$S_R = \frac{sr}{i}$$

The l_{50} value has to be sufficient below the smallest herring of age group 1 (length about 12 cm):

$$i = \frac{l_{50}}{S_L}$$

An un-weighted sample is needed also for the smallest fish length l_{min}:

$$l_{\min} = l_{50} - sr$$

Extrapolating these values we get for the mesh opening needed:

$$i = \frac{l_{\min}}{S_L + S_R}$$

Calculating the mesh opening to achieve a l_{50} value (the length were 50 % of the fish is retained in the trawl) sufficient below 12 cm a mesh opening i (inside measure of the stretched mesh between the knots) of smaller than 23 mm is needed. Details about the equations are given in Bethke (2004). Some dimensions of the trawls used by the participants are given in **Appendix A**.

Appendix E. PGNAPES database format

Logbook:

Country	Post code, 2 chars according to countries table
Vessel	Call sign, 2 or 6 digits acc. to Vessels table
Cruise	Cruise identifier
Station	National station number
StType	Geartype/activity: one line per activity at the same station: National definition of station type
Year	YYYY (4 digits)
Log	Value from the acoustic log (Nm)
Month	MM
Day	DD
Hour	HH, time GMT 0-24
Min	MM
Lat	Decimal degrees, negative latitude south 0°”0.0000 ”
Lon	Decimal degrees, negative longitude west of 0°“0.0 000”
BottDepth	Bottom depth (m)
WinDir	Compass degrees
WinSpeed	m/s

Acoustic:

Country	Post code, 2 chars according to countries table
Vessel	Call sign, 2 or 6 digits acc. to Vessels table
Cruise	Cruise identifier
Log	Min 4 digits (Nm)
Year	YYYY (4 digits)
Month	MM
Day	DD
Hour	HH, time GMT 0-24
Min	MM
AcLat	Decimal degrees, negative latitude south 0°“ 0.0000” The position refers to the beginning of the interval.
AcLon	Decimal degrees, negative longitude west of 0°“0.0000” The position refers to the beginning of the interval.
Logint	Nm, Log_end-Log start
Frequency	KHz
Sv.Threshold	DB

AcousticValues:

Country	Post code, 2 chars according to countries table
Vessel	Call sign, 2 or 6 digits acc. to Vessels table
Cruise	Cruise identifier
Log	Min 4 digits (Nm)
Year	YYYY (4 digits)
Month	MM
Day	DD
Species	Species code: HER, BLU,…
ChUppDepth	Upper channel depth (m) Rel. to surface
ChLowDepth	Lower channel depth (m) Rel. to surface
SA	Acoustic readings (m^2/nm^2)

Hydrography:

Country	Post code, 2 chars according to countries table
Vessel	Call sign, 2 or 6 digits acc. to Vessels table
Cruise	Cruise identifier
Station	National station numbers
StType	Geartype/activity: National definition of station type
Year	YYYY (4 digits)
Depth	Depth of measurement (m)
Temp	℃ (at least 2 decimals)
Sal	Salinity (psu, at least 3 decimals)
QF	Quality of salinity data: 0-5 (IGOSS quality flags)

Plankton:

Country	Post code, 2 chars according to countries table
Vessel	Call sign, 2 or 6 digits acc. to Vessels table
Cruise	Cruise identifier
Station	National station numbers
StType	Geartype/activity: National definition of station type
Year	YYYY (4 digits)
UppStatDepth	Upper station depth (m)
LowStatDepth	Lower station depth (m), if only one depth then same as upper
SumDryWt	Plankton mg dry weigth/m^2 in each interval
Frac2000	Size graded values, 2000 my sieve
Frac1000	1000 my sieve
Frac180	180 my sieve
Krill	From 2000 my sieve
Fish	-"-
Shrimp	-"-

Catch:

Country	Post code, 2 chars according to countries table
Vessel	Call sign, 2 or 6 digits acc. to Vessels table
Cruise	Cruise identifier
Station	National station numbers
StType	Geartype/activity: National definition of station type
Year	YYYY (4 digits)
Species	Species code: HER, BLU,…
Catch	Kg
Towtime	Minutes
Wirelength	(m)
TowSpeed	Knots
Trawldepth	(m)

Biology:

Country	Post code, 2 chars according to countries table
Vessel	Call sign, 2 or 6 digits acc. to Vessels table
Cruise	Cruise identifier
Station	National station numbers
StType	Geartype/activity: National definition of station type
Year	YYYY (4 digits)
Species	Species code: HER, BLU,…
Length	Cm with one decimal (dot as decimal sign)
Weight	G
AgeScale	Year from scale readings
AgeOtholit	Year from otolith
Sex	Empty means not sexed, 1= Female, 2= Male, 0= not possible to determine sex
Maturation	Maturation scale: Herring 1-8, Blue whiting 1-7
StomFullness	Stomach fullness, visual scale 1-5 (ICES)
StomachWt	Weight of stomach with content (g)
Recnr	Serial number identifying the fish

Support tables:

Countries:

CountryID	Postal code:FO,DE,NL,NO,IS,RU,SE,IE,DK
Countryname	Countryname

Values in Countries table:

CountryId	**Countryname**
FO	Faroe Islands
DE	Germany
NL	Netherlands
NO	Norway
IS	Iceland
RU	Russia
SE	Sweden
IE	Ireland
DK	Denmark

Vessels:

VesselID	Callsign
Vesselname	Vesselname

Values in Vesseltable:

VesselID	Vesselname
SEPI	Argos
TFJA	Arni Fridriksson (old)
TFNA	Arni Fridriksson
TFEA	Bjarni Sæmundsson
LLZG	G.O. Sars (old)
LDGJ	Johan Hjort
OW2252	Magnus Heinason
LHUW	Michael Sars
DBFR	Walter Herwig III
PBVO	Tridens
LMEL	G.O.Sars (new)
OXBH	Dana
UANA	Fridtjof Nansen
UHOB	Atlantniro
EIGB	Celtic Explorer

IGOSS:

QF	Quality Flag
Interpretation	Interpretation

Species:

SpeciesID	3 character code
SpeciesName	Species name in English
NODC	NODC-code
Scientific name	Scientific name latin
Name_NO	Norwegian Name

Gear:

STtype	Geartype/activity: National definition of station type
GearType	PLANKTON,CTD, or TRAWL (mandatory)
Geardescription	Informative desription of gear

Appendix F. PGNAPES database extraction codes

Copy and paste these selects into the SQL-query webinterface.

Planktonstations	**Trawlstations**	**CTDstations**
select l.* from logbook l,stationtypes s where l.sttype=s.sttype and s.geartype='PLANKTON'	select l.* from logbook l,stationtypes s where l.sttype=s.sttype and s.geartype='TRAWL'	select l.* from logbook l,stationtypes s where l.sttype=s.sttype and s.geartype='CTD'

Herring : SA sum pr acoustic log	**Herring: Average SA per statistical square**
Select a.country,a.vessel,a.cruise,a.log,a.year,a.month,a.day,a.Hour,a.min,a.aclat,a.aclon,nvl(sum(b.SA),0) "HER SA sum pr Acoustic log" from acoustic a,acousticvalues b where a.country=b.country(+) and a.vessel=b.vessel(+) and a.cruise=b.cruise(+) and a.log=b.log(+) and a.year=b.year(+) and a.month=b.month(+) and a.day=b.day(+) and b.species(+)='HER' group by a.country,a.vessel,a.cruise,a.log,a.year,a.month,a.day,a.Hour,a.min,a.aclat,a.aclon	SELECT b.Rect, b.lat, b.lon, b.Area_sqnmi, Sum((c.logint*a."WHB SAsum pr Acoustic log"))/(Sum(c.logint)) "SA_weighted by nmlog", Count(c.Logint) "CountOfLogint" FROM (select a.country,a.vessel,a.cruise,a.log,a.year,a.month,a.day,a.Hour,a.min,a.aclat,a.aclon,nvl(sum(b.SA),0) "WHB SAsum pr Acoustic log" from acoustic a,acousticvalues b where a.country=b.country(+) and a.vessel=b.vessel(+) and a.cruise=b.cruise(+) and a.log=b.log(+) and a.year=b.year(+) and a.month=b.month(+) and a.day=b.day(+) and b.species(+)='HER' group by a.country,a.vessel,a.cruise,a.log,a.year,a.month,a.day,a.Hour,a.min,a.aclat,a.aclon) a, ICESsquares b, Acoustic c WHERE a.country=c.country(+) and a.vessel=c.vessel(+) and a.cruise=c.cruise(+) and a.log=c.log(+) and a.year=c.year(+) and a.month=c.month(+) and a.day=c.day(+) and ((c.AcLat Between b.lat_min And b.lat_max) AND (c.AcLon Between b.lon_min And b.lon_max)) GROUP BY b.Rect, b.lat, b.lon, b.Area_sqnmi order by b.rect

Blue whiting : SA sum pr acoustic log	**Blue whiting: Avg SA pr statistical square**
select a.country,a.vessel,a.cruise,a.log,a.year,a.month,a.day,a.Hour,a.min,a.aclat,a.aclon,nvl(sum(b.SA),0) "WHB SAsum pr Acoustic log" from acoustic a,acousticvalues b where a.country=b.country(+) and a.vessel=b.vessel(+) and a.cruise=b.cruise(+) and a.log=b.log(+) and a.year=b.year(+) and a.month=b.month(+) and a.day=b.day(+) and b.species(+)='WHB' group by a.country,a.vessel,a.cruise,a.log,a.year,a.month,a.day,a.Hour,a.min,a.aclat,a.aclon	SELECT b.Rect, b.lat, b.lon, b.Area_sqnmi, Round(Sum((c.logint*a."WHB SAsum pr Acoustic log"))/(Sum(c.logint)),2) "SA_weighted by nmlog", Count(c.Logint) "CountOfLogint" FROM (select a.country,a.vessel,a.cruise,a.log,a.year,a.month,a.day,a.Hour,a.min,a.aclat,a.aclon,nvl(sum(b.SA),0) "WHB SAsum pr Acoustic log" from acoustic a,acousticvalues b where a.country=b.country(+) and a.vessel=b.vessel(+) and a.cruise=b.cruise(+) and a.log=b.log(+) and a.year=b.year(+) and a.month=b.month(+) and a.day=b.day(+) and b.species(+)='WHB' group by a.country,a.vessel,a.cruise,a.log,a.year,a.month,a.day,a.Hour,a.min,a.aclat,

	a.aclon) a, ICESsquares b, Acoustic c WHERE a.country=c.country(+) and a.vessel=c.vessel(+) and a.cruise=c.cruise(+) and a.log=c.log(+) and a.year=c.year(+) and a.month=c.month(+) and a.day=c.day(+) and ((c.AcLat Between b.lat_min And b.lat_max) AND (c.AcLon Between b.lon_min And b.lon_max)) GROUP BY b.Rect, b.lat, b.lon, b.Area_sqnmi order by b.rect

Select all data from a table	**Records in database, overview**
Select * from <tablename>	Select a.country,a.year,a.cruise,a.log,b.catch,c.bio,d.hydr,e.acoustic,f.acousticval,g.pl from (select country,year,cruise,count(station)LOG from logbook group by country,year,cruise order by country,year,cruise) a, (select country,year,cruise,count(station)catch from catch group by country,year,cruise order by country,year,cruise) b, (select country,year,cruise,count(station)bio from biology group by country,year,cruise)c, (select country,year,cruise,count(station)hydr from hydrography group by country,year,cruise)d, (select country,year,cruise,count(log) acoustic from acoustic group by country,year,cruise) e, (select country,year,cruise,count(log) acousticval from acousticvalues group by country,year,cruise) f, (select country,year,cruise,count(station) pl from plankton group by country,year,cruise) g where a.country=b.country (+)and a.year=b.year(+) and a.cruise=b.cruise(+) and a.country=c.country(+) and a.year=c.year(+) and a.cruise=c.cruise(+) and a.country=d.country(+) and a.year=d.year(+) and a.cruise=d.cruise(+) and a.country=e.country(+) and a.year=e.year(+) and a.cruise=e.cruise(+) and a.country=f.country(+) and a.year=f.year(+) and a.cruise=f.cruise(+) and a.country=g.country(+) and a.year=g.year(+) and a.cruise=g.cruise(+) order by a.country,a.year,a.cruise