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Report of the Study Group on Redfish Stocks (SGRS)

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

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Executive Summary

1. **Review of the survey design of the international trawl- acoustic surveys in the Irminger Sea and adjacent waters.** The methods of hydroacoustic and trawl estimation of abundance and biomass of pelagic redfish in the Irminger (and partly Labrador) Sea were reviewed under consideration of past experience, recent knowledge on the biology of the species and technological developments. Recommendations for the upcoming survey in June/July 2005 and for future work were developed by the Group. Especially the signal-to-noise ratios and target strength models applied within the hydroacoustic measurements require further experimental work. The use of a lower transducer frequency (18 kHz) was also considered as a possibility for the estimation of redfish density below the "deep-scattering layer" (DSL).
2. **Planning of the international trawl/acoustic survey of redfish in the Irminger Sea and adjacent waters in June/July 2005.** Based on past experience and the suggested improvements that can already be implemented during the next survey in June/July 2005, the detailed survey plan for this survey was set up. Three vessels from Germany, Iceland and Russia will participate in the survey and operate within an area of around 400 000 NM^2 in the Irminger and Labrador Sea to estimate the abundance and biomass of pelagic redfish. In the depth zone that can be surveyed by hydroacoustic measurements, i.e. shallower than the DSL (down to about 350 m), hydroacoustic measurements and identification trawls will be carried out, whereas within and below the DSL (down to about 1000 m), redfish abundance can currently only be estimated by trawls. The Group decided that the trawling duration of the deeper hauls will be expanded to at least 3 hours to increase the catch rates for a more precise abundance estimation. As in the past surveys, biological data will be collected from the redfish caught by the pelagic nets employed, and hydrographic measurements will be taken on regular stations on the survey tracks.
3. **Required frequency, number of vessels needed and timing of future surveys.** Although an annual survey would certainly allow an improved estimation of interannual changes in distribution and abundance, the Group felt that the continuation of bi-annual surveys would be more realistic, considering limitations in national budgets for survey time. The Group recommends that at least four vessels should participate to allow a sufficiently dense coverage of the survey area. The efforts directed at involving other nations in the survey should be continued. Since the most recent survey in May-June 2003 was carried out about 3 weeks earlier than previous surveys and pointed to considerable seasonal effects, the Group recommends to keep the timing of the survey from (mid-)June to (mid- to late) July.

1 Introduction

1.1 Terms of reference

At the 92th ICES Statutory Meeting it was decided (C.Res.2004/2D01) that:

"The Study Group on Redfish Stocks [SGRS] (Chair: Christoph Stransky, Germany) will meet for 3 days in January 2005 (and for 3 days in late July 2005) at ICES Headquarters to:

a. review the survey design of the international trawl- acoustic surveys in the Irminger Sea and adjacent waters (January meeting);
b. to advise on the required frequency, number of vessels needed and the timing of the future surveys (January and July meeting);
c. plan the international trawl/acoustic survey of redfish to be carried out in the Irminger Sea and adjacent waters in June/July 2005 (January);
d. prepare the report on the outcome of the 2005 survey (July).

SGRS will report by 15 March 2005 (January meeting) and 15 August 2005 (July meeting) for the attention of the Resource Management Committee, North Western Working Group, and ACFM."

1.2 Participants

Eckhard Bethke	BFA Fi, Germany
John Dalen	IMR, Norway
Robert Kieser (by communication)	DFO, Canada
Kristján Kristinsson	MRI, Iceland
Victor Mamylov (by communication)	PINRO, Russia
Andrey Pedchenko	PINRO, Russia
Michael Pennington	IMR, Norway
Christoph Stransky (Chair)	BFA Fi, Germany

Detailed contact information of the participants is given in Annex 1.

2 Review of the survey design of the international trawl-acoustic surveys in the Irminger Sea and adjacent waters

2.1 Historical development, horizontal and vertical coverage

From the onset of the commercial fishery on oceanic redfish in 1982, the former Soviet Union (later Russia) conducted acoustic surveys in the Irminger Sea. Iceland started with a pilot acoustic survey in 1991 (Magnússon *et al*. 1992a) and conducted a survey in 1992, which was intended to be carried out in cooperation with Russia in 1992 but finally presented as separate surveys (Magnússon *et al*. 1992b). The 1992 surveys proved the need for a wider area coverage (ICES, 1994), thus Iceland and Norway carried out a survey in 1994 (Magnússon *et al*. 1994), followed by surveys in 1996 (Magnússon *et al*. 1996) and 1999 (Sigurdsson *et al*. 1999) with participation of Iceland, Russia and Germany. Beside these international surveys, Russia conducted surveys in 1993 (Shibanov *et al*. 1994), in 1995 (Shibanov *et al*. 1996, Pedchenko *et al*. 1997) and 1997 (Melnikov *et al*. 1998). Within the latter two surveys, experimental work aimed at estimating redfish density below 500 m by both acoustic and trawl methods. Icelandic scientists also conducted a survey in 1998 to map the deeper layer redfish distribution patterns below 500 m depth (Sigurdsson and Reynisson 1998). During all the surveys until 1999, oceanic redfish was only measured by acoustics down to approximately 500 m depth. The attempts undertaken to measure below that depth did not essentially succeed in obtaining any stock size estimate. The reasons are reduced signal-to-noise ratios (SNR) at depth and interference from the “deep scattering layer (DSL)”, which is a mixture of many vertebrate and invertebrate species, mingled with redfish (Magnússon 1996). The international hydro-acoustic survey in June/July 1999 provided an expanded vertical coverage of the survey area, i.e. redfish below 500 m depth were assessed by an experimental trawl-acoustic method proposed by Russian scientists. Details of the survey settings and methods are given in ICES (1999b) and Sigurdsson *et al*. (1999). In 2001, a trawl-acoustic survey was carried out by Germany, Iceland, Russia and Norway. Approximately 420 000 NM^2 were covered (ICES, 2002).

The basic area coverage of the most recent international survey in May-June 2003 was extended from what has previously been used and was defined in ICES (1995). As the results from the surveys in 1999 and 2001 indicated that the covered area did not reach the boundary of the distribution area of pelagic redfish in the acoustic layer, the Planning Group on Redfish Stocks (PGRS) in 2003 (ICES, 2003a) felt it was necessary to expand the area both to the south and west. As the fishery has also changed towards greater depths in later years, it was also considered important to continue the expansion of the vertical coverage to assess the stock within the DSL and below. The results of the 2003 survey were presented in ICES (2003b).

2.2 Seasonal effects

It has been observed that the redfish distribution in spring and summer and the areas where dense redfish concentrations are found vary from year to year and partly depend on oceanographic conditions (Shibanov *et al.* 1995, Pedchenko *et al.* 1996, Pedchenko 2004). During recent years, two main areas of the pelagic redfish fishery have been observed (ICES, 2004a): During April-June, the fishery concentrates in the NE Irminger Sea in deeper waters (usually below 500 m), whereas during July-August, the fishery shifts southwestwards into shallower waters (usually above 500 m) in the Labrador Sea (NAFO Regulatory Area).

The unusually low biomass estimates within the acoustic layer above the DSL, derived from the 2003 survey (ICES, 2003b), were very likely affected by high seasonal variation in redfish distribution. The survey was carried out during May-June 2003 and showed only minor amounts of redfish in the southwestern survey area, whereas a successful commercial fishery was taking place in this area a few weeks later (ICES, 2004a). The results of the survey in May-June 2003 also showed a high percentage of post-spawning redfish in the area, indicating a considerable influence of seasonal effects on the distribution redfish in the Irminger Sea. The current knowledge on redfish biology, on the spatial distribution during the life span and on habitat conditions has to be considered when interpreting the survey results.

2.3 Improvements of the survey design to be implemented in the survey in June/July 2005

We have to distinguish between short-term and long-term changes in survey design. For the next survey, only the implementation of short-term improvements is possible. We have to use the available equipment and the available software systems for data acquisition, scrutinization and evaluation. Changes in equipment and software systems will require significant experimental work.

2.3.1 Hydroacoustic measurements

Environmental and system noise as well as reverberation from unwanted targets in the water column interfere with echo integration of deeper redfish distributions. The SNR can be defined as the ratio between the echo energy from the target and the total noise at the receiver output (Kieser *et al.,* 2005). To maximize the SNR, it is necessary to choose long pulse lengths in combination with a narrow bandwidth to maximize the target echo energy. That reduces the range resolution of the sounder. The echo integration (EI) method does not require a high range resolution. But the mean distance between the targets is large enough, so that this should not cause problems for echo counting.

The standard sphere calibration is a key procedure that contributes to the accuracy of the survey results in a fundamental way and is essential on each vessel. The procedures must be carried out at the start of a survey and repeated if there are any doubts on the achieved success (e.g. long term track record shows larger changes, unexpected fish TS and density measurements).

The calibration of the sounder needs special care due to a bug in the sounder EK500. The calibration is usually carried out at a small range between the calibration sphere and the transducer, but at those distances a filter delay causes a time variant gain (TVG) error and wrong calibration results. A work around will be developed by the German participant until the summer survey and distributed to the partners. The calibration should be carried out at the largest possible range, preferable a range larger than 25 m.

For the calibration, the lobe program (or a similar program) has to be used. To provide appropriate settings for echo counting, it is necessary to adjust the angle sensitivity to the environmental conditions (Bodholt 2002) before starting the calibration. For these procedures, the results of the calibration tank experiments delivered by Simrad with the transducer are needed. This ensures to be able to compensate the beam function of the transducer applied within the recorded data.

The SNR is a function of the frequency, because the attenuation, the geometrical dimensions and directivity of the transducer, as well as the environmental noise level are functions of the frequency. It could be possible that the use of a lower frequency (18 kHz) results in an improved SNR and therefore to lower errors in the results of echo integration. This will be evaluated until the summer survey by the German participant. If it is useful to apply a lower frequency, this would be possible on the German and the Icelandic vessel.

All participating vessels will use the EK500 and BI500 or a comparable evaluation system. The BI500 stores sample data (data of the Q telegrams), which will be appropriate for possible target strength analyses and should be sufficient from relevant quality arguments. For additional studies, Sample Data should be stored if possible.

For thresholding, the method derived in Bethke (2004), with modifications on the comparable evaluation system, should be used:

- Measure or calculate S_{vMax} for the smallest target (zoom function of the BI500 or Bethke 2004, Equation 9, $G_{env} = 1$)
- Calculate the maximum threshold value by subtracting 13 dB.
- Obtain the maximum range for the desired measurement accuracy (±10%) at that range where the noise and reverberation level is larger than the S_v threshold – 4dB. The maximum range has to be considered as the starting depth of the DSL.

The range dependency of the signal and noise can make it necessary to carry out the evaluation in several layers and in several steps. It is expected that when only applying EI data down to the upper limit of the DSL (night/day: ≈ 250/400 m), the applied EI threshold (-80 to -84 dB/m^3) should be sufficiently low. When having low densities and mainly smaller fish, one should have a more dynamic attitude of using a lower threshold.

To collect experimental data on redfish echoes within and below the DSL, a pulse length of 3 ms and narrow bandwidth will be applied during night time as an alternative to the standard setting of 1 ms and wide bandwidth.

To provide data collection for the development of echo counting the TS settings of the sounder should be the same on each vessel. At the moment, no professional echo counter is available. The BI500 stores single fish data which can be applied for echo counting analyses and development work.

2.3.2 Abundance estimation by trawls

The Group decided to apply only two trawl types during the upcoming survey: firstly, trawls shallower than the DSL, secondly, trawls within and deeper than the DSL (see Section 3.6 for details). Furthermore, the trawling duration of the deeper hauls will be expanded to at least three hours to increase the catch rates for a more precise abundance estimation. This also increases the relative contribution of the pure trawling time to the whole time effort spent on each trawling track, considering the time-consuming shooting and hauling procedures. For abundance estimation of redfish within and below the DSL, the Group recommends keeping both methods that have been used in the past, i.e. direct trawl estimates and s_A values calculated from the regression between trawl abundance and s_A values in the hydroacoustic layer above the DSL (see Section 3.5).

2.3.3 Biological sampling

Since the biological sampling procedures were repeatedly refined and adjusted according to practical experience during the past redfish surveys, recent knowledge on growth, maturation, parasitology and other fields of redfish research, the Group felt no need to change the basic methodology and forms used on the 2003 survey (ICES, 2003a).

However, the collection of biological data for roundnose grenadier (*Coryphaenoides rupestris*) during the next survey was considered (WD3 and WD4), and it was advised that all participating nations should record detailed biological data and scales (and otoliths if possible) from this species (see Section 3.8).

2.3.4 Error estimation

The error estimation for abundance and biomass estimates of the survey was not addressed in detail by this group, since these will have to be considered after the outcome of the next ICES "Workshop on Survey Design and Data Analysis" (WKSAD) in May 2005 and after the availability of the survey data at the end of July 2005. As a general recommendation of the WKSAD in June 2004 (ICES, 2004b, see Section 2.4), survey precision should be given as relative standard error.

2.4 Future experimental work

2.4.1 Developments in hydroacoustic techniques

Longer term research projects, outside the survey frame work, are needed to implement a professional echo counting software into the evaluation software. For this theoretical and experimental work is still necessary addressing signal to noise measurements, model development and software implementation of the effects of SNR on echo integration (EI) and echo counting on biomass estimates. Detection and measurement of redfish below the DSL may be possible with a lowered transducer (Dalen *et al*., 2003) as individual redfish will gain in echo strength as the beam foot print at range gets smaller and individual redfish hence fill a larger portion of the sample volume. Near stationary experimental measurements with a lowered transducer or observations at low speed in calm seas with a lowered transducer might be considered as a first step allow target tracking and verification of results to obtain better information in the long term. The aim should be to develop a verification method of acoustical results using echo counting and echo integration. The background noise and reverberation information needed to be processed to increase the accuracy of the survey results.

The Institute of Marine Research (IMR) in Bergen, Norway, is presently running a research and development project where one of the goals is to provide an improved deep-towed vehicle having a four-frequency acoustic system. Analyses are presently taking place at the IMR on target strength acquired during the 2001 cruise data using a deep-towed vehicle (Dalen *et al.* 2003) to possibly develop a depth dependent target strength model for the deep-water *S. mentella*. The current target strength models for redfish are summarised in Annex 3.

2.4.2 Survey design and analysis

The recommendations of the most recent ICES "Workshop on Survey Design and Analysis" (WKSAD; ICES 2004b) were presented, and where relevant for the redfish surveys, were discussed:

1. Inclusion of systematic sampling (with stratification) or stratified random sampling should be considered in the designing of a fish survey. In the presence of positive local autocorrelation, a more precise estimate of the population mean will usually be obtained by systematic sampling or stratified random sampling than by simple random sampling. The optimal sampling design will depend on the population under study and the relative importance attached to getting the most precise estimate of the population mean and to getting a good estimate of that precision. A wide range of real and simulated examples suggest that systematic sampling will often be optimal if getting the most precise estimate of the sample mean is the dominant objective. However, stratified random sampling will often be preferable if getting a good estimate of the precision is also important.
2. Information from the commercial fishing industry should be considered, where appropriate, to provide guidance on survey design (e.g., in the definition of strata).
3. Efforts should be made to maximize the number of samples taken, if survey precision needs to be enhanced. This may be achieved by shortening towing times or by using instruments in as efficient a manner as possible. Consideration should be given to the effect of shortened tow times to establish if this is a practical and effective course of action.
4. Information additional to that of fish density should be collected on surveys, particularly when that information is related (covariate) and can be collected more extensively. Incorporation of appropriate covariates (habitat, environment) can lead to improved precision of the abundance estimate, provided that a good relationship exists, and that the covariate is known at more sample locations than the fish density. Ideally, the covariate should be known at all locations where the fish density is interpolated to (i.e., the whole survey area).
5. Means to provide direct estimates of abundance from surveys should be investigated. Calibrating a survey time series using historical catch data may generate more robust abundance estimates (in recent time periods) than a catch-at-age analysis due to problems associated with the accuracy of catch data.
6. All publicly funded surveys should include a description of their estimation procedures in their reports, particularly those benefiting from EC funding and those carried out under the auspices of ICES. Survey reporting practices vary considerably and, in some cases, the methods used to estimate abundance or population characteristics, such as age and length distributions, are not adequately described.
7. The design effect and the effective sample size should be reported whenever possible to give a measure of the efficiency of a survey design, and the sampling unit over which the data were gathered (the 'support') should be explicitly stated. The design effect is a measure of the efficiency of a survey. It is calculated as the ratio of the variance of the estimated mean for the actual design (and variance estimator employed) and the expected variance obtained under simple random sampling. The effective sample size is the number of samples selected by simple random sampling that would be required to achieve the same precision obtained with n samples under the actual complex sampling design.

8. Survey precision should be reported as the relative standard error (100% * standard error / estimate). The term coefficient of variation (CV) is ambiguous and should be avoided.

The trawl-acoustic survey for redfish is a stratified systematic survey in accordance with recommendation 1. Based on the fishing patterns of the commercial fleet, the spacing of transects will be denser in the northeastern than in the remaining survey area in 2005 (rec. 2). Presently, it has not been determined what is the optimal tow time that will maximize the precision of estimates of length distributions or fish densities (rec. 3). Due to the reduced work schedule on the German vessel, however, there is only limited potential to increase the number of trawl stations. The relation between water temperature measured during the surveys and density has helped to determine the best time of year to conduct the surveys (rec. 4). At present there is no reliable independent estimate of absolute abundance to calibrate the redfish surveys (rec. 5). In the next survey report, a description of all estimation procedures will be reported (rec. 6). In particular, the effective sample size for estimating length distributions, and hence the precision of the length distributions, will be reported (rec. 7). Estimating the precision of systematic surveys is not straightforward (it is a major topic for the May 2005 Workshop on Survey Design and Analysis), but the estimates of the precision of the length distributors will provide a measure of the variability caused by this factor (rec. 8).

3 Planning of the international trawl/acoustic survey of redfish in the Irminger Sea and adjacent waters in June/July 2005

3.1 Vessels, timing and survey strategy

The main objective of this survey will be a trawl-acoustic assessment of the pelagic redfish stock in the Irminger Sea and adjacent waters, in June/July 2005. The basic area coverage was determined to be extended from what has previously been used and was defined in ICES (1995). As the results of the survey in 1999 indicated, the area covered did not reach the boundary of the distribution area of pelagic redfish in the acoustic layer. Therefore, the group felt it necessary to continue to cover the southern area to 52°N and the western boundary to 51°W. As the fishery has also changed towards greater depths in recent years, it is also considered important to continue expansion of the vertical coverage to assess the stock which is below the acoustic layer (within and below the DSL; see Sections 3.5–3.6).

The following research vessels will participate in the survey:

Name of the vessel	Country	Period	Approx. date of arrival to field	Days in field
Árni Friðriksson	Iceland	27 June – 22 July	29 June	20
Vilnius	Russia	1 June – 30 July	20 June	20
Walther Herwig III	Germany	10 June – 13 July	16 June	20

The vessels will communicate daily via e-mail or telex, and by radio communication starting at 09:00 UTC. Information on the communication among vessels is given in Annex 4.

In Figure 1 and Table 2, the planned survey tracks are shown for each participating vessel. Based on experience from the past surveys, fisheries information and expected hydrographic conditions (WD1), the distribution of survey tracks within the distribution area of pelagic redfish was planned.

"Árni Friðriksson" will cover the southwestern part of the survey area; "Vilnius" will cover the northeastern area and the central part south to 53°N and "Walther Herwig III" the northern part of the area. The total length of the planned survey tracks is 9036 nautical miles (NM), divided between the vessels as follows:

"Vilnius" 3017 NM, "Walther Herwig III" 2981 NM and "Árni Friðriksson" 3038 NM.

In the 1994 and 1996 international surveys, the survey tracks ran parallel to lines of latitude with 45 NM distance between the tracks except for the area of an assumed denser distribution of oceanic redfish, i.e. the so-called "box" where the distance between the tracks was 30 NM. In WD4 to the planning of the 1999 survey (ICES, 1999), calculations were made on the consequences using only every second track. These results show that a larger distance than 30 NM may be used between the cruise tracks, without affecting the acoustic estimate significantly. Recalculation of the mean acoustic density over the whole survey area covered in the 1994 survey using alternatively the data from every second track, results in estimates, which differ by less than 5% from the one obtained using the whole data set. Based on this information it was decided to run the 1999 survey with 45 NM between all cruise tracks, as there was only a limited number of vessels participating and the group felt an urgent need for trawling within and below the DSL. The group decided to do so again in the planned survey 2005, except in the northeastern area where the distance will be 30 NM.

For evaluating the data, the boundaries of sub-areas A-G as used in the 1994 and 1996 (Magnússon *et al*. 1994 and 1996) surveys will be shifted according to ICES and NAFO regulatory area borders (Annex 6).

3.2 Data exchange during the survey

The daily reporting on the data among the vessels will be performed in the sheet given in Annex 5. In addition, the range of the acoustic values between the positions of the stations of the most recent day shall be reported. Information about the data exchange after the survey is given in **chapter 3.10.**

3.3 Instrumental settings, target strength, calibration

All participating vessels will use a 38 kHz Simrad EK500 split beam echo sounder and a BI500 post-processor for echo integration.

The standardisation of the setting of instruments was discussed and it was agreed to use an integration threshold of –80 to –84 dB//m^3, depending on the pulse length used and the system noise level according to the method derived in Bethke (2004). To collect experimental data on redfish echoes within and below the DSL, a pulse length of 3 ms and narrow bandwidth will be applied during night time as an alternative to the standard setting of 1 ms and wide bandwidth.

It was also agreed that the acoustic data should be stored down to at least 750 m depth. In Table 1, the settings of instruments are given for each vessel.

As the observed length range of the redfish in the 1999 acoustic survey has increased from previous years, a length based target strength model of TS=20 lgL-71.3 dB will be used for the estimation of the number of pelagic redfish in the survey area. This is the same TS model as was used in 2001 and 2003.

At the beginning of each national part of the survey, the calibration of the acoustic equipment on board each vessel will be carried out using a standard sphere calibration (Foote *et al*., 1987) or equivalent method, and applying both pulse length and bandwidth settings (1 ms wide, 3 ms narrow). The participating vessels will aim at a common inter-ship calibration. Thus, the inter-ship calibration will, if possible within one working day, be carried out between vessels in their overlapping area, preferably also involving trawling.

3.4 Acoustic estimation

Acoustic data obtained when the mixing of the target fish with the components of the DSL is greatest (during the night) should be discarded in the biomass estimation. On sections along the survey tracks, where the available acoustic data are not satisfactory due to mixing, the integrator values will be estimated by interpolation (from values in the nearest vicinity).

The acoustic survey data will be divided into statistical rectangles, which are one degree in latitude and two degrees in longitude. A mean value of the area backscattering strength in each rectangle is estimated and subsequently, the number of fish. Values in rectangles which have not been covered, but are within the surveyed area, are estimated by interpolation from values obtained within rectangles in the nearest vicinity. The total number of fish is then obtained by summation of individual rectangles.

Acoustic data for redfish within and below the DSL shall be stored separately. This shall be done by scrutinizing the acoustic data in each depth category as a separate unit in the BI-500 post-processing system or equivalent equipment (on "Vilnius").

In order to measure the noise from the environment and vessel, participants integrate in passive mode in depth channels (25 m) from 250 m down to at least 750 m for at least 5 NM with a resolution of 1 NM. This could be done during night, using both bandwidths (wide and narrow), pulse lengths (1 and 3 ms) and thresholds used during the survey.

To be able to make a comparable "detailed report" in the post-processing, the height of the layers should be set to 25 m, and the registrations should be scrutinized and presented for every 5 NM. The data should, however, be stored for every 1 NM. In the acoustic report table (see Annex 7a), a column for including the upper depth limit of the DSL is added.

An effort should be made to estimate the effect of different thresholds at different depths on the integrator values from the acoustic equipment used on the three vessels. This is especially important for the low scattering values expected, as the threshold effect will vary with the pulse length, noise and depth used and may as well be dependent on the resolution of the S_v-values stored by the BI500 system (or equivalent equipment on "Vilnius") (stored depth interval/number of stored values per ping).

3.5 Abundance estimation below the acoustic layer

The estimation of the redfish abundance within and below the DSL is based on catches. The stock size above the DSL is acoustically measured. The numbers from the measuring system (BI500) are the nautical area backscattering coefficient (NASC), expressed as s_A values, which are converted by means of the length distribution from the catches to an area fish density. It is assumed that the acoustically measured fish density values are more precise than estimated fish density from the trawling (swept area method), since relatively little is known about the catchability and effective area of the trawls. To get a correlation between catches and s_A values (calibration), echo integration are done at the same time and depth as trawling above the DSL. A problem with this data acquisition is that in some areas, the redfish occurs above DSL in very low densities and is frequently mixed with species of the DSL. Here, the challenge is to exclude these species from echo integration by means of the integration threshold.

As in 1999, 2001 and 2003, the assessment of the redfish abundance inside and below the DSL will be attempted by two methods providing an absolute estimate (based on the acoustic data) and a survey trawl index. The catches in number per standardised tow will be converted to expected s_A values using regression analysis between s_A values (dependent variable) and catches in standardised haul performed (independent variable) above the DSL. This requires the sufficient coverage of the variation in s_A values and catches between minimum and maximum values. Thereafter, the estimated s_A values for the depth layer will be converted to absolute fish numbers and fish biomass (WD 5). The stored s_A values derived from the deep layer below 500 m will be analysed for their applicability for direct conversion to fish numbers by changing the BI500 threshold settings according to the method derived in Bethke (2004).

In order to study the relation between catch and acoustically measured values (calibration of trawls) better, additional measurements and calculations based on the echo counting method will be done. The results of echo counting can be converted into equivalent s_A-values, with the advantage that small single targets can be excluded more reliable from the echo integration. These computations must be done to a large extent manually. The German participant will do this after the survey. The other participants supply the catch data, trawl data and hydroacoustic data needed for this procedure. The settings for the EK500 will be specified before the survey.

An improved regression analysis, including the standard errors and the confidence intervals of the parameter estimates, as described in WD3 of ICES (2003a), will be used to predict the s_A values below the DSL. This work will be carried out by the Icelandic participants.

3.6 Trawling

The net used on “Árni Friðriksson” will be a new Gloria type #1024, with a vertical opening of approximately 45 m. The net employed on “Walther Herwig III” will also be a Gloria type #1024, with a vertical opening of approximately 45 m. On Vilnius, a Russian pelagic trawl (design 75/448) with a circumference of 448 m and a vertical opening of 47–50 m will be used.

Each vessel should identify the acoustic redfish records by trawl catches in two different types. The identification hauls should exclusively cover:

1. The depth zones shallower than the DSL, in which redfish could be acoustically identified. For abundance estimation in the areas in or below the DSL, it is essential to integrate the s_A-value over the trawled distance in the trawled depth zones above the DSL and to report those s_A-values in the specified format (Annex 7b and 11). Trawling distance should be 4 NM.
2. The depth zones within and below the DSL. These trawls should cover the following four depth layers (headline): 350–500 m, 500–650 m, 650–800 m, 800–950 m. Trawling distance at each depth layer should be 3 NM calculated with GPS, excluding the setting and hauling of the net.

Both types of identification hauls should be evenly distributed in the survey area (about three hauls per day). Station data as well as total redfish catch in numbers and weight should be reported in accordance with Annex 7b. Changes of course shall also be registered in the sailing diary sheet (Annex 5).

3.7 Hydrography

All participants of the international survey will carry out hydrographic observations using CTD down to 1000 m depth. The CTD stations should be taken at the corners of each transect and at each trawl station. The CTD station should be divided evenly throughout the survey area.

The hydrographical data at depths of 0, 10, 20, 30, 50, 100, 200, 300, 400, 500, 600, 700, 800, 900 and 1000 m from each CTD station shall be included in daily report for exchange between the participants during the survey.

After the survey, when the data have been calibrated, the whole set of obtained information on pressure, temperature and salinity will be exchanged to each of the participating countries in CTD standard files (Annex 8).

The long-term hydrographical Russian 3K section (nine standard stations) in the Irminger Sea will be included in the joint survey programme and carried out by the Russian vessel.

3.8 Biological sampling

It was agreed to follow a similar procedure as used during the surveys since 1994 (described in ICES C.M. 1993/G:6, ICES CM 1994/G:4, ICES CM 1999/G:9 and ICES CM 2002/D:08). The biological data mentioned below shall be exchanged by e-mail, using the database format given in Annex 7a-c (Excel spreadsheet).

Biological sampling should be conducted as follows:

1. In the case of sub-sampling, the ratio of the sub-sample to the total catch should be noted as “conversion factor” in the data recording sheet.
2. Individual data: The total length (cm below), individual weight, sex and stage of maturity should be measured on at least 300 redfish from each haul. The maturity scale given in Annex 9 will be used for data exchange. The Russian participants will use the maturity scale given in Annex 10 that will be converted to the one given in Annex 9.
3. Otolith sampling: A minimum of one otolith pair per cm group and sex should be collected at each station. The otolith envelope should carry at least the station no. and fish ID no. given in the database to allow for allocation to the individual biological data.
4. Stomach content and parasite information: Observations on the stomach fullness, the location and size of skin/muscular pigments as well as infestation of *Sphyrion lumpi* and its remnants should be investigated on at least 50 randomly sampled fish from the sub-sample of each haul, according to the details given in Annex 7c (see also WD 2 in ICES 1999). Registration of melanin shall also be recorded on a scale 1–4 (1= nothing, 2= little; 3= medium; 4= much).
5. Biological data as well as scales (and otoliths if possible) of roundnose grenadier (*Coryphaenoides rupestris*) should be collected by all participating nations according to WD3. It was noted, however, that fish weight can only be recorded with a precision of 1 g on “Árni Friðriksson” and “Walther Herwig III”, and that Russia should provide detailed maturity staging guidelines well in advance of the survey.

Sampling of stomachs for subsequent laboratory analysis is optional. Plankton sampling is also optional.

3.9 Further issues

3.9.1 Exchange of experts

Germany, Iceland and Russia invited other participants to join their part of the survey. Russia accepted the invitation from Germany and will send a specialist with “Walther Herwig III”. Furthermore, Russia decided to send a specialist with “Árni Friðriksson”. Iceland announced that there would be space for up to two guest scientists on the Icelandic vessel. Due to staff limitations, the Icelandic and German cruise partners will not be able to send guest scientists from their labs to other vessels.

3.9.2 MAR-ECO sampling

It was noted that Germany and Russia will be participating in a large-scale project on the ecosystem along the Reykjanes Ridge from Iceland to the Azores, called “MAR-ECO: Patterns and processes of the ecosystems of the northern mid-Atlantic” (http://www.mar-eco.no). The German vessel will conduct sampling at the end of the redfish survey on 60°N 19–39°W, whereas the Russian vessel will carry out their MAR-ECO sampling on the Reykjanes Ridge from about 53°–62°N.

3.10 Time schedule for the survey report

The final reporting will take place during the next SGRS meeting at ICES Headquarters in Copenhagen from 25–27 July 2005. To finalise the work during 3 days, the following plan will be followed:

As soon as the vessel has finished scrutinising the acoustic data – after the survey tracks are finished, the data (according to Annex 5) must be sent to other participants. Not later than 23 July, all data shall be sent via email to all cruise leaders. The data shall be sent in the format described in Annex 7a-c, 8 and 11 all participants shall have a copy in an electronic format.

Russia will calculate the abundance estimation of the redfish within and below the DSL, including writing of the material and methods, results and discussion.

Russia will work up the environmental data, including the drawing of pictures, writing of the material and methods, results and discussion.

Iceland will calculate and finalise the acoustic data, including writing of the material and methods, results and discussion. Iceland will also draw the cruise tracks and information on stations.

Germany will be responsible for writing about biological results, including writing of the material and methods, results and discussion. In addition, Germany will be responsible for the experimental work described in chapter 3.5.

All drafts must be sent to the SGRS chair before 24 July 2005 who will compile the data. A draft report will be distributed to the cruise and meeting participants during the SGRS meeting in Copenhagen 25–27 July 2005.

4 Required frequency, number of vessels needed and timing of future surveys

The Group discussed the required frequency, the number of vessels needed and timing of future surveys, but noted that the given recommendations shall be reconsidered after the survey in June/July 2005.

Although an annual survey would certainly allow an improved estimation of interannual changes in distribution and abundance, the Group felt that the continuation of bi-annual surveys would be more realistic, considering limitations in national budgets for survey time.

As for Germany, the European Commission is financing 50% of the survey within the Data Collection Regulation (DCR, Council Regulation 1639/2001), since it is listed as a Priority 1 survey. Regarding the participation of other vessels in future surveys, this EU co-financing would also be eligible for countries like Spain or Portugal, but the national research vessels would have to be equipped with the appropriate gear and technology to participate, whereas other non-EU countries participating in the pelagic redfish fishery, such as Canada, Norway and the Faroe Islands, cannot receive DCR funding. Ideally, additional vessels should take part in the survey, and the Group recommends that at least four vessels should participate to allow a sufficiently dense coverage of the survey area. Thus, the efforts directed at involving other nations in the survey should be continued.

Since the most recent survey in May-June 2003 was carried out about 3 weeks earlier than previous surveys and pointed to considerable seasonal effects (see Section 2.2), the Group recommends to keep the timing of the survey from (mid-)June to (mid- to late) July.

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Table 1. Instrument settings of the acoustic equipment settings onboard the participating vessels. On "Vilnius" and "Árni Friðriksson", the transducers used are hull-mounted, but on "Walther Herwig III", a towed body will be used (towed at about 20 m depth) in rough weather conditions, and a hull-mounted transducer in calm weather. The sound speed setting used in the EK500 will be set in the beginning of the survey. The alternative pulse length and bandwidth settings given in parentheses will be applied during night time to collect experimental data on redfish echoes within and below the DSL.

	Árni Friðriksson	Vilnius	Walther Herwig III
Echo sounder/ integrator	Simrad EK500 /BI500	Simrad EK500 / FAMAS (analogue to BI500)	Simrad EK500 /BI500
Frequency	38 kHz	38 kHz	38kHz
Transmission power	2000 W	2000 W	2000 W
Absorption coef-ficient	10 dB/km	10 dB/km	10 dB/km
Pulse length	1.0 ms (3.0 ms)	1.0 ms (3.0 ms)	1.0 ms (3.0 ms)
Bandwidth	Wide (Narrow)	Wide (Narrow)	Wide (Narrow)
Transducer type	ES38-B	ES38-B	ES38-B
Integration threshold	-80 dB/m^3	-80 dB/m^3	-80 dB/m^3

Table 2. Agreed cruise tracks for the international survey for redfish in June/July 2005.

Vilnius			Walther Herwig III			Árni Friðriksson		
Lat	Long	Distance	Lat	Long	Distance	Lat	Long	Distance
-26.25	59.60	Start	-23.00	63.00	Start	-33.00	58.50	Start
-33.00	62.25	253	-26.00	63.00	82	-45.50	58.50	391
-34.00	63.25	66	-28.50	64.50	112	-48.00	57.00	120
-28.00	63.25	162	-28.50	65.50	60	-42.00	57.00	196
-27.00	62.75	41	-31.00	65.00	70	-42.00	56.25	45
-32.00	62.75	137	-32.25	65.50	43	-50.00	56.25	267
-31.00	62.25	41	-35.00	64.50	92	-50.00	55.50	45
-26.00	62.25	140	-29.50	64.50	142	-42.00	55.50	272
-26.00	61.75	30	-28.50	63.75	52	-42.00	54.75	45
-30.00	61.75	114	-37.00	63.75	225	-51.00	54.75	311
-28.50	61.00	62	-35.00	63.00	70	-50.50	54.00	48
-31.00	59.25	129	-40.00	63.00	136	-42.00	54.00	300
-42.00	59.25	337	-40.00	62.25	45	-42.00	53.25	45
-37.00	57.00	208	-34.50	62.25	154	-50.00	53.25	287
-41.00	57.00	131	-33.00	61.50	62	-50.00	52.50	45
-41.00	56.25	45	-41.00	61.50	229	-48.00	52.50	73
-36.50	56.25	150	-42.00	60.75	54	-48.00	51.75	45
-36.50	55.50	45	-31.00	60.75	322	-46.50	51.75	56
-41.00	55.50	153	-35.00	57.75	218	-46.50	52.50	45
-41.00	54.75	45	-45.00	57.75	320	-45.00	52.50	55
-37.50	54.75	121	-42.00	60.00	164	-45.00	51.75	45
-38.50	54.00	57	-31.00	60.00	330	-43.50	51.75	56
-41.00	54.00	88				-43.50	52.50	45
-41.00	53.25	45				-38.00	52.50	201
-38.00	53.25	108						
-35.00	55.50	171						
-35.00	57.00	90						
-33.50	57.00	49						
Total sailing (NM)		3017			2981			3038
Days in the field		20			20			20
Average sailing/day		151			149			152

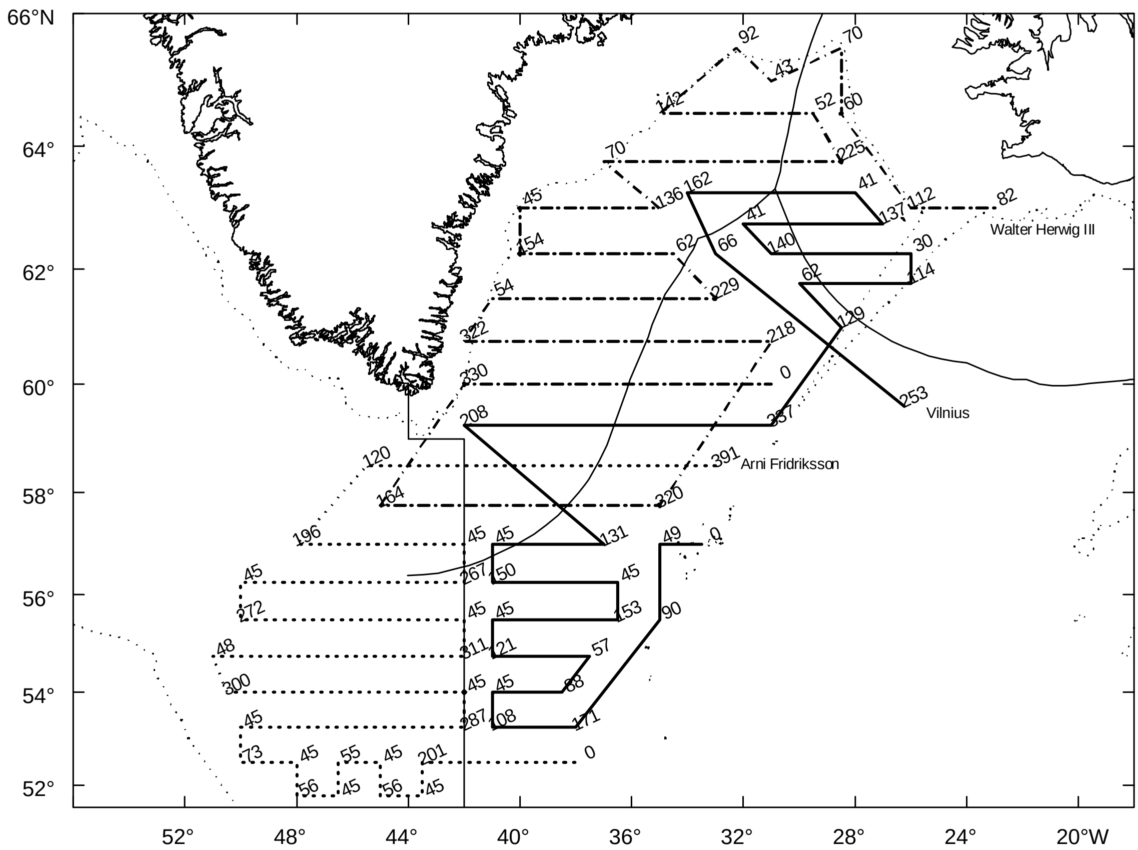

Figure 1. Preliminary cruise tracks of the international survey for redfish in June/July 2005.

Annex 1: List of participants

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Annex 2: List of Working Documents

WD1. Pedchenko, A.P.: On International Trawl-Acoustic Survey for Redfish in the Irminger Sea in June-July 2005.

WD2. Pedchenko, A.P.: The role of interannual environmental variations in geographic range of spawning and feeding concentrations of redfish *Sebastes mentella* in the Irminger Sea.

WD3. Pedchenko, A.P.: Recommendations on biological sampling procedure for roundnose grenadier.

WD4. Vinnichenko, V.I. and V. N. Khlivnoy: Distribution and biological characteristics of young roundnose grenadier (*Coryphaenoides rupestris*) in the Northeast Atlantic (by data of Russian investigations in 2003).

WD5. Mamylov, V.S.: Methodical aspects of trawl-acoustic surveys on redfish stock in the Irminger Sea.

Annex 3: Current target strength (TS) model applied in the international trawl-acoustic survey in the Irminger Sea and adjacent waters and models from the literature

Target strength: Eq.1: <TS> = a log L + b1, or Eq.2: <TS> = 20 log L + b2. Measured *in situ (average)*: <TS>, estimated: <*TS*>

Origin/species	Length range [cm]	Depth [m]	<TS> [dB] Eq.1	<*TS*> [dB] Eq.2	a	b1 [dB]	b2 [dB]	Remarks	L=25 cm	L=45 cm
Applied - surveys										
S. mentella	all (based on L = 37 cm)	all		-40.0	20		-71.3		-43.3	-38.2
Foote 1987										
S. marinus	19.7 ± 8.7	165-225	-40.6					*in situ*		
	19.7			-41.5	20		-67.5	- " -	-39.5	-34.4
Reynisson 1992										
S. mentella	all, L = 37 cm (aver.)		-40.0					*in situ*		
Gauthier & Rose 2001 & 2002										
S. mentella/fasciatus	24.5 - 30				19.0	-66.5		encaged	-39.9	(-35.1)
- " -					20		-68.1	- " -	-40.1	(-35.0)
" - " - "	16.9 - 32.3	134-387			17.1	-64.9		*in situ*	-41.0	(-36.6)
" - " - "					20		-68,7	- " -	-40.7	(-35.6)
Mamylov 2004										
S. mentella	? 19				17.1	-70.9		*in situ*	(-47.0)	
- " -	> 19				30.9	-88.9		- " -	-45.7	-37.8
S. marinus & viviparus	? 20				17.7	-71.3		- " -	(-46.6)	
- " -	> 20				29.6	-86.7		- " -	-45.3	-37.8

Annex 4: Information on communication between vessels

The missing information regarding “Vilnius” will be sent to other participants well in advance of the survey.

R/V Vilnius (Russia)
Call sign: UFJN
Telephone:
Telefax:
Inmarsat C: 427300228; 427311390
Email:
Data:

R/V Árni Friðriksson RE 200 (Iceland)
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Telefax: +354 8540532
Inmarsat C: 581 425150710
Inmarsat B (Tel.): 00874 325150710
Fax: 00874 325150711
Data: 00874 325150712
Iridium (Tel.): 881-631426272
e-mail: arnif.bru@sjopostur.is

R/V Walther Herwig III (Germany)
Call sign: DBFR
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00870 600365043
Data 00870 600365042
Inmarsat C (Telex): +581 421121550
e-mail: fahrtleiter@wh3.bfa-fisch.de

Annex 5: Sheet used for daily reporting of data among the vessels

This example also shows the format of the data. The data should be sent as ASCII text with semicolon (;) as a separator.

INTERNATIONAL TRAWL-ACOUSTIC REDFISH SURVEY.

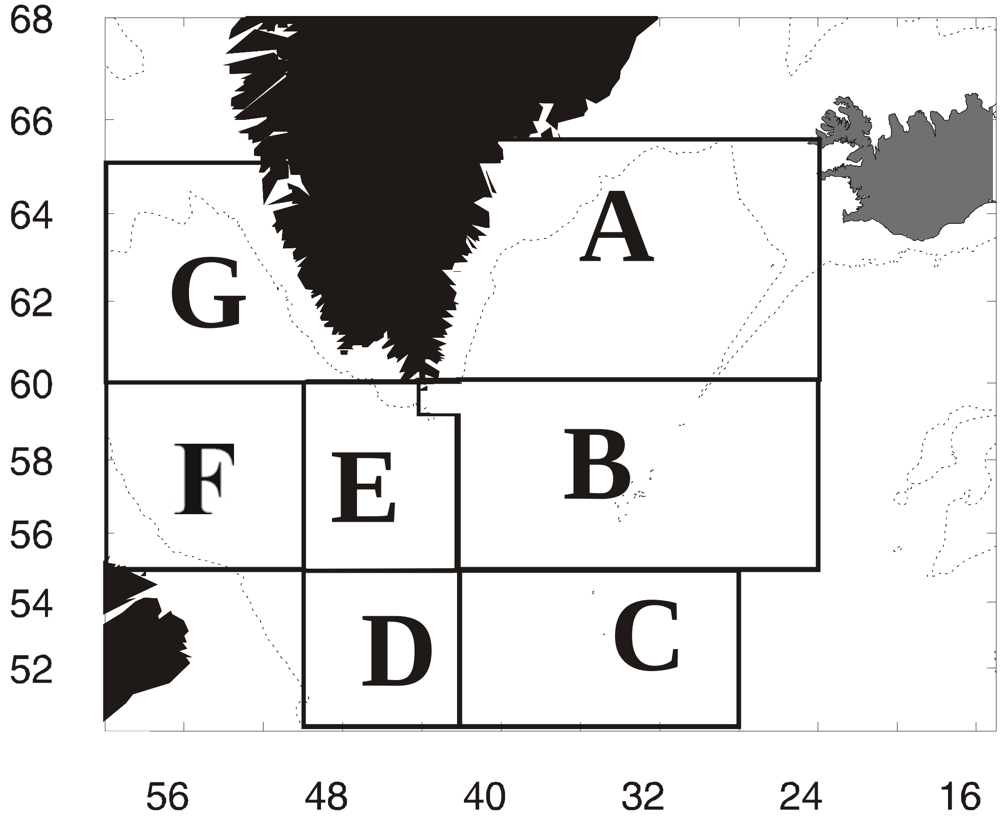
Daily reporting of data

Vessel: vessel name

sent	N	Station number	Type of station	Log	Date	Position Lat	Position Lon	Time (GMT)	Catch (kg)	Sa range min	from last max	TEMPERATURE AT DUFFERENT DEPTHS T0	T10	T20	T30	T50	T100	T200	T300	T400	T500	T600	T700	T800	T900	T1000
+	1		ch.course	160	22.06	6250	2710	1300		0	0															
+	2	273	ctd	180	22.06	6238	2742	1650		0	0	8.90	8.90	8.73	8.58	8.44	7.66	7.31	7.25	7.1	6.57	6.37	5.86	5.45	5.01	4.59
+	3		ch.course	184	22.06	6235	2748	1752		0	0															
+	4		ch.course	197	22.06	6226	2805	1907		0	0															
+	5	274	3	215	22.06	6219	2808	2130	103	0	0															
+	6	275	3	299	23.06	6230	2806	2300	186	0	0															
+	7	276	ctd	318	24.06	6233	2752	0316		0	0	9.30	9.29	9.94	8.60	8.46	7.47	7.15	6.89	7.05	6.85	6.56	6.23	5.58	5.02	4.64
+	8	277	1	369	24.06	6231	2600	0925	0	0	0															
+	9	278	3	416	24.06	6230	2440	1515	6	0	0															
+	10	279	ctd	436	24.06	6231	2427	1810		0	0	9.00	8.96	8.73	8.44	8.09	7.79	7.57	7.37	7.19	6.94	6.61	6.21	5.68	5.1	4.63
+	11	280	3	487	25.06	6230	2214	0145	6	0	0															
+	12	281	ctd	491	25.06	6230	2208	0340		0	0	9.70	9.66	9.64	9.30	8.49	7.96	7.71	7.47	7.28	7.07	6.87	6.23	5.6	5.1	4.7
+	13	282	ctd	548	25.06	6230	2011	0955		0	0	10.10	10.10	9.94	9.55	9.03	8.52	8.21	7.94	7.81	7.7	7.51	7.21	6.85	6.27	5.63
+	14	283	3	560	25.06	6218	2013	1200	0	0	0															
+	15	284	ctd	607	25.06	6130	2012	1847		0	0	10.60	10.55	10.25	9.74	9.31	8.6	8.28	8.1	7.91	7.75	7.57	7.32	6.85	6.27	5.6
+	16	285	3	625	25.06	6129	2046	2105	2	0	0															
+	17	286	2	636	26.06	6129	2108	0040	1	0	0															
+	18	287	3	723	26.06	6130	2407	0942	8	0	0															
+	19	288	ctd	729	26.06	6130	2415	1215		0	0	9.80	9.78	9.43	9.09	8.49	8.16	7.83	7.66	7.53	7.37	7.14	6.8	6.28	5.63	5.13
+	20	289	ctd	800	26.06	6130	2647	1925		0	0	9.80	9.70	9.30	9.10	8.46	7.82	7.37	7.21	7.03	6.95	6.69	6.31	5.86	5.54	
+	21	290	3	802	26.06	6130	2646	2000	4	0	0															
+	22	291	3	860	27.06	6130	2834	0323	14	0	0															
+	23	292	ctd	868	27.06	6130	2847	0610		0	0	9.80	9.82	8.70	8.09	7.26	6.5	6.05	5.71	5.17	4.93	4.83	4.55	4.44	4.17	3.98
+	24	293	3	948	27.06	6032	3027	1420	20	0	0															
+	25	294	ctd	958	27.06	6031	3018	1835		0	0	10.90	10.87	10.36	9.39	8.39	7.59	7.37	7.21	6.94	6.32	6.54	5.33	5.24	4.6	4.43
+	26	295	2	994	27.06	6030	2857	2228	0	0	0															
+	27	296	3	1016	28.06	6030	2815	0155	5	0	0															
+	28	297	ctd	1024	28.06	6030	2758	0457		0	0	10.90	10.89	10.67	9.69	8.86	8.03	7.58	7.47	7.35	7.22	6.9	6.57	5.97	5.47	4.83
+	29		ch.course	1064	28.06	6031	2630	0902		0	0															
+	30	298	3	1097	28.06	6004	2718	1210	6.2	0	0															
+	31	299	ctd	1107	28.06	5958	2735	1558		0	0	11.90	11.86	11.84	10.84	9.7	9.2	8.96	8.03	7.53	7.36	7.18	6.9	6.06	5.57	5
+	32	300	2	1213	29.06	5839	2950	0200	0	0	0															
+	33	301	ctd	1268	29.06	5800	3101	0800		0	0	11.10	11.12	10.81	9.69	8.63	7.95	7.61	7.51	7.35	7.01	6.69	6.7	6.11	5.44	5.03
+	34	302	3	1303	29.06	5800	3206	1155	8.5	0	0															
+	35	303	1	1390	29.06	5800	3449	2202	4.9	0	7															
+	36	304	3	1404	30.06	5800	3512	0215	8	7	20															
+	37	305	ctd	1409	30.06	5800	3518	0349				11.00	10.94	10.94	10.77	8.29	7.38	7.35	6.59	6.2	6.01	5.48	4.9	4.43	4.09	3.92

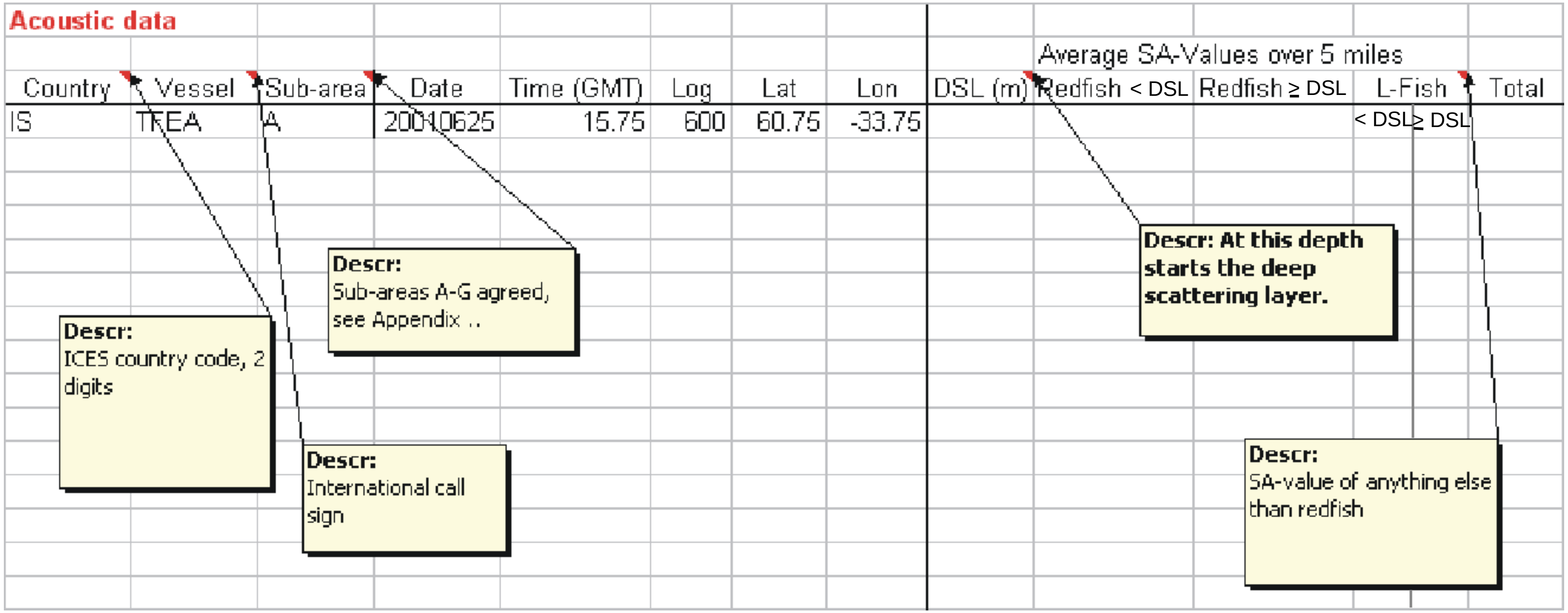
IRMINGER SEA June-July 2005

Annex 6: Sub-areas A-G, agreed to be used in international survey in June/July 2005 for redfish in the Irminger Sea and adjacent waters



Annex 7: Various Sheets used for Observations

Annex 7a: Sheet used for exchange of acoustical observations



Acoustic data													
									Average SA-Values over 5 miles				
Country	Vessel	Sub-area	Date	Time (GMT)	Log	Lat	Lon	DSL (m)	Redfish < DSL	Redfish ≥ DSL	L-Fish < DSL	L-Fish ≥ DSL	Total
IS	TFEA	A	20010625	15.75	600	60.75	-33.75						

Annex 7b. Sheet used for exchange of station information and sailing diary

Empty cells: no data recorded

					Redfish Catch			Start							End						
Country	Vessel	Station	Sub-area	StType	Weight (kg)	No	SA-Value	Date	Time (GMT)	Lat	Lon	Log	Bottom depth	Headrope depth	Date	Time (UTC)	Lat	Lon	Log	Bottom depth	Headrope depth
IS	TFEA	22	A	1				20010625	15.75	60.75	-33.75		2500	250	20010625	15.75	60.75	-33.75		2500	500

Descr:
ICES country code, 2 digits

Descr:
Sub-areas A-G agreed, see Appendix ..

Descr:
SA-Value integrated for depth interval in front of the trawl

Descr:
1= above the DSL
2= within and below the DSL

Descr:
International call sign

Descr:
National station number

Annex 7c: Sheet used for exchange of biological observations

Empty cells: no data recorded
All fish are to be sampled randomly !

Depth range of trawl | Muscular pigment | Melanin Content in muscles | Parasitation Number in Fillet

Country	Vessel	Station	Sub-area	StType	Date	Time (UTC)	Lat	Lon	Bottom depth	min	max	Fish no	ConvFactor	Length	Weight	Sex	Maturation	StomFullness	StomachWt	Locality	square cm	Melanin content in muscles	F-AP	F-U	F-OC
IS	TFEA	22	A	1	20010625	15.75	60.75	-33.75	2500	250	350	1	0.76	35.5	520	M	3	1		F		1			

Descr:
ICES country code, 2 digits

Descr:
International call sign

Descr:
National station number

Descr:
Sub-areas A-G agreed, see Appendix ..

Descr:
Depth range (m) of the trawl during trawling, measured as depth of the **headrope**

Descr:
1= above the DSL
2= within and below the DSL

Descr: No. of fish at this station
1 to number of fish measured at that station

Descr:
ratio of subsample/total catch, value between 0 and 1

Descr:
"cm below" with one decimal (dot as decimal sign)

Descr:
F=fillet
V=ventral part
H=head
A=anal part

Descr:
Stomach fullness, visual scale (ICES s
1 = everted
2= empty
3= little content
4= medium
5= full stomach

Descr:
Empty = not sexed
M= Males
F= females
U = not possible to determine sex

Annex 8: Sheet used for exchange of hydrographic observations

Form for hydrographic data exchange.
Vessel:
Station no:
Date:
Time:
Lat:
Lon:
Bottom depth:

Pressure	Temp	Salinity
db	**ITS-90**	**PSS-78**
5.000	2.5595	32.5555

Annex 9: Maturity scale agreed to be used in the international survey in June/July 2005 for redfish in the Irminger Sea and adjacent waters

MATURITY STAGES OF FEMALE REDFISH

Stage	Code	Ovaries description
Immature	1	Ovaries tubular, thin and small. Ovarian wall whitish and delicate. Without conspicuous blood vessels. If visible eggs occur, they are very small, whitish or pale yellowish. Pigmented eye larvae are never observed in the ovary.
Maturing/ Mature	2	The ovary has increased in size considerably and it is easy to distinguish in the body cavity. The ovary wall and eggs inside the ovary are clearly visible. Eggs are yellow and opaque.
Mature/ Fertilized	3	Ovaries are considerably bigger and occupy most of the body cavity. Colour is bright yellow. Many eggs are transparent (approx. 50%) because of yolk re-absorption the eye pigment of the larvae becomes visible.
Parturition	4	Ovary occupy practically the whole body cavity, it is delicate and the wall transparent and thin. The colour shift to a green-yellowish due to larval developing, the eyes are evident and there is little yolk. Larvae are easily released from the ovary when it is manipulated.
Post spawning	5	Ovary is flaccid, but still big. No visible larvae inside or just a remainder of them. The colour is purple or blackish, sometimes confused with the body cavity wall (peritoneum).
Recovery	6	Size is reduced to stage 3 or smaller, but no visible eggs, colour yellow to purple.

MATURITY STAGES OF MALE REDFISH

Stage	Code	Testes and genital papilla description
Immature	1	Testes are translucent, very thin and sometimes even difficult to detect, because it is confused with the mesentery. Width less than 1 mm. The penis is difficult to distinguish and easy to confuse with female genital papilla.
Maturing/ Mature	2	The testes are more easily distinguishable because of increasing size. They are white. Width more than 1,1–1,5 mm. There is no running sperm when the testes are cut. Penis is visible, and it is easy to identify sex externally.
Mature/ Fertilized	3	Testes are bright white. The sperm is observed inside the testes, but only when they are cut, i.e. sperm doesn't run out of the testes when they are pressed. Penis is thick, but no sperm is observed on it.
Parturition	4	Testes are big and with a cream colour. The sperm run out of the fish when belly is pressed. Penis is very conspicuous, with a purple tip and there are remains of sperm on it.
Post spawning	5	Testes are flaccid. The colour is still cream but with obvious dark (brown) patches. Practically no sperm inside the testes.
Recovery	6	Size of the testes has been reduced to stage 3, but the sperm is not visible. The colour is whitish.

Annex 10: Maturity scale used by Russia in the international survey in June/July 2005 for redfish in the Irminger Sea and adjacent waters

	MALES
Juvenile stage	Gonads are poorly developed, sex is indistinguishable. Specimens at this stage occur throughout a year.
Stage 1	Sex is distinguishable. Testicles are as thin long colourless bends and occur throughout a year.
Stage 2	Testicles are as thick long bends, on a cross section they are of irregular triangular shape of brownish colouring. Remnants of non-extruded sperm are available in repetitive-maturing specimens. December-March.
Stage 3	Testicles are large, elastic, coloured brown, in some cases they are of violet shade. Along a cross section they are of triangular shape with smoothed angles. March-June.
Stage 4	Testicles are large, of light-brown colouring, with a white colour being irregular in some areas. At the end of the stage the testicles are white due to the sperm formed. Along the cross section the sperm does not run. June-September.
Stage 5	Mating period. Testicles are of milky-white colour. When dissecting the external sides flow down and drops of sperm are released from spermatic duct. September-November.
Stage 6	Extrusion (after mating). Testicles are of brownish colour with white patches. Two zones are visible along a cross section, i.e. brown marginal and white middle zones. October-December.
	FEMALES
Juvenile stage	Gonads are poorly developed, sex is indistinguishable. Specimens at this stage occur all the year round.
Stage 1	Ovaries are poorly developed, of light-yellowish colour, eggs are indistinguishable during a whole year.
Stage 2	(for repetitive-spawning fish - stage 9–2). Eggs are with 0.2–0.5mm diameter. In immature fish a membrane of ovaries is transparent, in repetitive-spawning specimens it is covered with black pigment. May-August.
Stage 3	Ovaries are bright-orange, egg diameter is about 1mm. August-September.
Stage 4	Ovaries occupy above a half of the body cavity, egg diameter is up to 1.5mm. September-December.
Stage 5	Ovaries are muddy-greenish, eggs are transparent. December-March.
Stage 6	Ovary membrane is strongly prolonged. The stage lasts from the moment of cleavage to the beginning of eye pigmentation in embryo. December-March.
Stage 7	Eye pigmentation begins in embryos owing to which ovaries gradually acquire black colouring. February-March.
Stage 8	Eyes acquire bright metallic shade. Embryos are well developed and mobile. The stage lasts until larvae extrusion.
Stage 9	Ovaries have fallen off, of bloody colouring. Single unextruded larvae occur. April-June.

Annex 11: Sheet used for registration of acoustic values of redfish during trawling at depths above the DSL

			S_A values for redfish at the same location as the trawl haul							
Station No.	Depth of trawl (m)	Vertical opening	Inside the trawl opening	0-150 m	150-300 m	300-450 m	450-600 m	600-750 m	> 750 m	Comments