# ICES PGHERS Report 2007

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# Report of the Planning Group for Herring Surveys (PGHERS)

22–26 January, 2007

Charlottenlund, Denmark

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

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# Contents

# Executive summary

### Highlights from PGHERS

- During the Planning Group for Herring Surveys (PGHERS) meeting in 2007 the stock estimates were done for the first time by the means of FishFrame, a software tool to calculate estimates derived from acoustic surveys. FishFrame performed satisfactorily and was used to combine the national data into the integrated survey result.
- The total combined estimate of North Sea spawning stock biomass (SSB) is 2.1 million t. This estimate is comparable to the 1.9 million t SSB in 2005 and the 2004 estimate of 2.6 million t. The stock is dominated by the 2000 year class. Growth of the 2000 year class still seems to be lower than average, individuals of this year class having almost the same size and weights than the one year younger fish of the 2001 year class. The West of Scotland estimate of SSB is 472,000 tonnes (190,000 in 2005). This is a substantial increase compared to last years estimate, and the SSB has more than doubled. The SSB is in the same order of magnitude that it had during the last ten years. The surveys are reported individually in Annex 2A-2F.
- The total sprat biomass was estimated as 452,000 t in the North Sea (down from 563,000 t in 2005). The biomass is dominated by mature sprat (98%). The total sprat in the Kattegat was estimated as 33,600 t, including 63% immature sprat (down from 59,800 t in 2005). There is no clear indication that the southern distribution has been reached. However, the highest concentration of sprat was observed off the coast of Scarborough, on the east coast of England.

**Review of larvae surveys in 2006/2007:** In total seven units and time periods out of ten were covered in the North Sea. The herring larvae sampling period was finished just prior to the PGHERS meeting, thus sample examination and larvae measurements have not yet been completed. The information necessary for the larvae abundance index calculation will be ready for and presented at the Herring Assessment Working Group (HAWG) meeting in March 2007.

**Coordination of larvae surveys for 2007/2008:** In the 2007/2008 period, the Netherlands and Germany will undertake seven larvae surveys in the North Sea. Outside the larval sampling programme some additional stations shall be sampled in the area of the Doggerbank to test anecdotal information of a recolonisation of the area and to obtain information about ongoing spawning activity. The Baltic Sea Fisheries Institute will continue with the larvae survey in the Greifswalder Bodden area in 2007, but the survey design will be altered and the N30 time series has to be recalculated to be assessable for the next benchmark assessment of the WBSS.

**North Sea acoustic surveys in 2006:** Six acoustic surveys were carried out during late June and July 2006 covering the North Sea and west of Scotland. The total combined estimate of North Sea spawning stock biomass (SSB) is 2.1 million t. This estimate is comparable to the 1.9 million t SSB in 2005 and the 2004 estimate of 2.6 million t. The stock is dominated by the 2000 year class. Growth of the 2000 year class seems still to be slower than average, individuals of this year class having almost the same size and weights than the one year younger fish of the 2001 year class. The West of Scotland estimate of SSB is 472,000 tonnes (190,000 in 2005). This is a substantial increase compared to last years estimate, and the SSB has more than doubled. The SSB is in the same order of magnitude that it had during the last ten years. The surveys are reported individually in Annex 2A-2F.

**Western Baltic acoustic surveys in 2006:** A joint German-Danish acoustic survey was carried out with RV "Solea" from 5 – 24 October in the Western Baltic. The estimate of

Western Baltic spring spawning herring is 214,000 t (compared to 198,000 in 2005). The sprat year class 2006 was overall exceptionally strong. In the Kattegat and the northern part of Subdivision 22 anchovy was observed in larger quantities. A full survey report is given in Annex 3.

**Manuals for acoustic and herring larvae surveys:** Several updates and improvements of the *manual for herring acoustic surveys in ICES Divisions III, IV, and VI*A have been suggested. The bibliography has been updated accordingly and the list of gears used by the different nations has been updated. The suggested changes are both very relevant and highly needed. However, the suggested text will need some reviewing which will be done by correspondence in cooperation between Germany, Denmark and Scotland. The revised text will be sent to all members of PGHERS before the next meeting by the Chair. No modifications were made in the *Manual for the International Herring Larvae Surveys south of 62° north*.

**Status and future of the FishFrame database:** All countries have uploaded survey data from 2006 for herring and sprat. The stage 3 dataset for 2003, 2004 and 2005 is completed as well. Testing of the data browser, reports, upload, data checking and interpolation for both in stage 1 and 3 was done during the meeting. Two bugs were found, corrected and testing was redone. FishFrame performed satisfactory and was therefore used to combine the national data into the integrated survey result. FishFrame will be used again for the 2007 survey period.

**Sprat:** Sprat data were available from RV “Walther Herwig III”, RV “Tridens” and RV “Dana”. The total sprat biomass was estimated as 452,000 t in the North Sea (down from 563,000 t in 2005). The biomass is dominated by mature sprat (98%). The total sprat in the Kattegat was estimated as 33,600 t, including 63% immature sprat (down from 59,800 t in 2005). There is no clear indication that the southern distribution has been reached. However, the highest concentration of sprat was observed off the coast of Scarborough, on the east coast of England.

**Coordination of acoustic surveys in 2007:** Six acoustic surveys will be carried out in the North Sea and west of Scotland in 2007 between 21 June and 25 July. Participants are referred to Figure 4.3.1.1 for indications of survey boundaries. “Tridens” and “Walther Herwig” will cover the area between 52º and 57º together with interlaced transects. A survey of the western Baltic and southern part of Kattegat will be carried out by a German research vessel in October.

**Investigation of bias introduced by change in gear in the larvae surveys:** In 2004, the Netherlands changed from a Gulf III plankton torpedo to a Gulf VII. However, nothing was known about differences in catchability between these two devices. To investigate the possible bias introduced by the change of gear, real-time fishing comparison trials were conducted in 2006, deploying both samplers in a single frame. Volume filtered by the Gulf VII was found to be significantly higher than in the Gulf III, but catchability was less. However, due to technical problems, no accurate calibration of flow meters could be performed and therefore numbers of larvae caught can not be converted by the volume filtered. During the 2007 mackerel and horse mackerel egg survey, ichthyoplankton hauls with both samplers are planned to compare the catchability of mackerel eggs.

**Recent studies on herring fat content and the accuracy of maturity staging:** Deborah Davidson from the Aberdeen University gave a presentation of her ongoing PhD study dealing with modern methods of measurements on herring fat content. Data obtained from the 2006 herring acoustic surveys indicate that, as herring length and weight increases, so too does fat content. When comparing fat and weight, fish of a heavier weight did not tend to have very low fat contents. A FATMAP (a visual representation of spatial variation in fat content of North Sea herring) was constructed for the immature herring in the “Scotia”, “Solea” and “Tridens” data. Initial analysis showed that there was a strong linear relationship between length and fat content of immature fish. Plotting the raw fat data showed a clear southeast to northwest trend in fat content.

In a second talk Lindsay McPherson from Aberdeen University presented her findings concerning the accuracy of macroscopic staging of North Sea herring. As the macroscopic maturity scale is based on a histological scale, histology is the most accurate means of assessing maturity stage in fish. New, unambiguous histology keys were formed in order to calculate the accuracy of macroscopic staging. Macroscopic staging on FRV “Scotia” in 2006 was 78.6% accurate for females and 83% accurate for males. Much of the error in female staging was due to maturing repeat spawners (stage 3) being assessed as recovering (stage 8). There were also difficulties in the sexing of virgin gonads, with examples of both sexes wrongly classified. While marked inaccuracies were found they are unlikely to impact upon the SSB as the number of fish assessed as immature (1-2) or mature (stages 3-8) were correct.

# 1 Terms of Reference

The **Planning Group for Herring Surveys** [PGHERS] (Chair: Norbert Rohlf, Germany) met at the Danish Institute for Fisheries Research, Charlottenlund, Denmark, from 22–26 January 2007 to:

a) combine the 2006 survey data to provide indices of abundance for the population within the area, by means of the FishFrameAcoustics database;
b) coordinate the timing, area and effort allocation and methodologies for acoustic and larvae surveys for herring and sprat in the North Sea, around Ireland, Division VIa and IIIa and the Western Baltic in 2007;
c) intensively test the in-year developments of the FishFrameAcoustics database, specifically verify the ability of the new system to calculate global survey estimates from raw acoustic and trawl data using 2005 and – if possible – 2006 survey data;
d) further harmonise the maturity readings of North Sea and Western Baltic herring conducted by different labs, specifically the definition of mature and immature fish;
e) report on the possible bias introduced by a change in gear in the Dutch herring larvae survey.

PGHERS will report by 5 February 2007 for the attention of the Living Resources, and the Resource Management Committees as well as to HAWG and ACFM.

# 2 Participants

| | |
|---|---|
| Norbert Rohlf (Chair) | Germany |
| Teunis Jansen (Host) | Denmark |
| Bram Couperus | Netherlands |
| Bjarne Stage | Denmark |
| Eberhard Götze | Germany |
| Jörn Schmidt | Germany |
| Paul Fernandes | UK |
| Bo Lundgren | Denmark |
| Else Torstensen | Norway |
| Karl-Johan Staehr | Denmark |
| Deborah Davidson | UK (part time) |
| Lindsay McPhersson | UK (part time) |
| Åge Fotland | Norway (part time) |

# 3 Herring larvae surveys

## 3.1 Review of Herring Larvae Surveys in 2006/2007

### 3.1.1 Review of the western Baltic larvae survey

The Rügen herring larvae survey (RHLS) is at present the only herring larvae survey in the Western Baltic. The survey is conducted by the German Institute for Baltic Sea Fisheries, Rostock, and its predecessor since 1977 in the Greifswalder Bodden and Strelasund. These waters, between Rügen Island and the mainland, are known to be the major spawning site of the Western Baltic spring spawning herring stock (WBSS). Sampling takes place with a Bongo-net on 35 fixed stations and is repeated weekly during most of the spawning season. Additional hydrographic parameters are recorded.

During the last decade, the RHLS was aimed at delivering a fishery independent recruitment estimate for the WBSS assessment conducted by the ICES Herring Assessment working group (HAWG). While the index calculated (the N30 index providing the extrapolated abundance of larvae at 30 mm length) has shown to predict very strong year classes reliably, it has failed to predict year classes of intermediate strength. The reasons for this disagreement are still under investigation.

The RHLS project was peer reviewed by two external reviewers in November 2006. The reviewers examined the existing data set thoroughly and discussed possibilities for amendments and future perspectives with all staff involved in the survey. They stated that the scientific value of the time series would be extremely valuable, but recommended to shift the main focus from the delivery of a recruitment index for the assessment towards basic ecology and early life history of commercially exploited fish stocks to utilise the results more effectively (Dickey-Collas and Nash 2006). A number of detailed recommendations were given, and some of them will already affect the survey work plan in 2007:

1) The weekly sampling will be continued, but sampling will start earlier in the year to cover more of the spawning season (will be extended by 4 weeks and start end of March), and the sampling of all 35 standard stations will take place in 2-3 days compared to 4-5 days in the previous setup. This should allow for a less “artificial” definition of cohorts.
2) The stratification of the survey area will be adjusted to allow for a complete coverage of a representative half of the stations during one day (aiming at a greater independence from unfavourable weather conditions), and to reduce the variability of the index. The time series will have to be recalculated following the re-stratification (see PGHERS WD Oeberst 2007).
3) The procedure for counting and measuring larvae will be amended: The total number of larvae counted will be reduced, and large larvae needed for the continued calculation of the N30 index will be targeted with a larger mesh in the outer bongo.
4) A number of basic assumptions will be tested during the next season, specifically the retention of larvae in the Greifswalder Bodden area (by regular sampling of additional stations outside the area), a possible net avoidance by the larvae (by a comparative sampling at night), the correlation between length and age (by otolith microincrement analysis) or the assumed high share of this specific area on the total spawning of WBSS (by a 3-vessel cooperative quasi-synoptic coverage of the whole spawning area to identify actual spawning sites.
5) An in-depth literature study has been started and will retrieve specifically the valuable grey literature (e.g. master’s theses in German) not utilized in the context of the RHLS so far.

In the medium term, ecosystem parameters will also be recorded, like the availability and extension of spawning substrate (macrophytes), food (nauplia) and predators or food competitors (namely the invasive ctenophore *Mnemiopsis*) in the area. National and international cooperation with different institutions and universities are in the phase of establishment. The N30 time series will be continued and available (after recalculation of the whole time series) for the next benchmark assessment of the WBSS, and results of the altered survey and the testing of basic assumptions will be presented to PGHERS in 2008. A second review of the RHLS is planned for 2009.

### 3.1.2 North Sea

In the reporting period, the Netherlands and Germany participated in the larvae surveys. In total seven units and time periods out of ten were covered in the North Sea (Table 3.1.2.1.).

**Table 3.1.2.1: Areas and time periods covered during the 2006/2007 herring larvae surveys:**

| **Area / Period** | **1–15 September** | **16–30 September** | **1–15 October** |
|---|---|---|---|
| Orkney / Shetland | Germany | Germany | |
| Buchan | -- | Netherlands | |
| Central North Sea | -- | Netherlands | -- |
| | | | |
| | 16–31 December | 1–15 January | 16–31 January |
| Southern North Sea | Netherlands | Germany | Netherlands |

The herring larvae sampling period was finished just prior to the PGHERS meeting. For most of the larvae surveys in the North Sea, sample examination and larvae measurements have not yet been completed; therefore, it is not yet possible to give an overview on the final larvae survey results. Distribution maps of larval abundance from individual surveys analysed so far are shown in Figures 3.1.2.1 – 3.1.2.4.

However, as in previous years, the information necessary for the larvae abundance index calculation will be ready for and presented at the Herring Assessment Working Group (HAWG) meeting in March 2007.

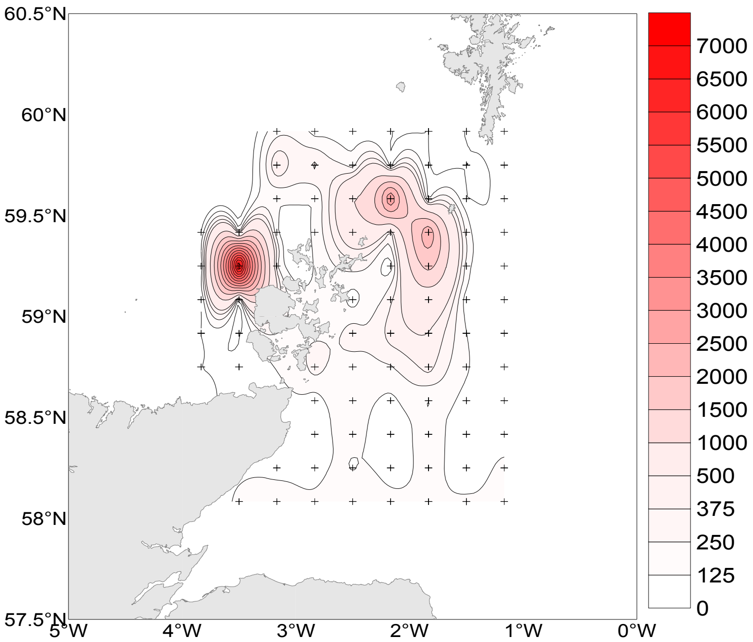


**Figure 3.1.2.1: Orkney/Shetlands 1 – 15 September 2006 (FRG), Larvae Abundance, all length classes (n/m²).**

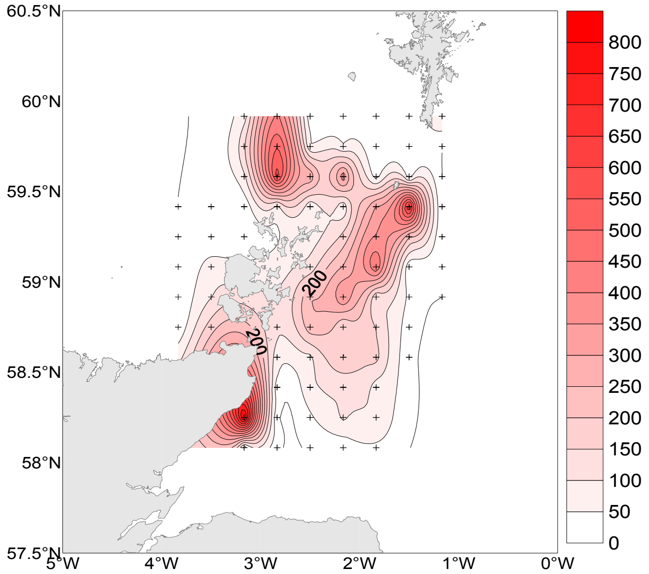


**Figure 3.1.2.2: Orkney/Shetlands 16 – 30 September 2006 (FRG), Larvae Abundance, all length classes (n/m²).**

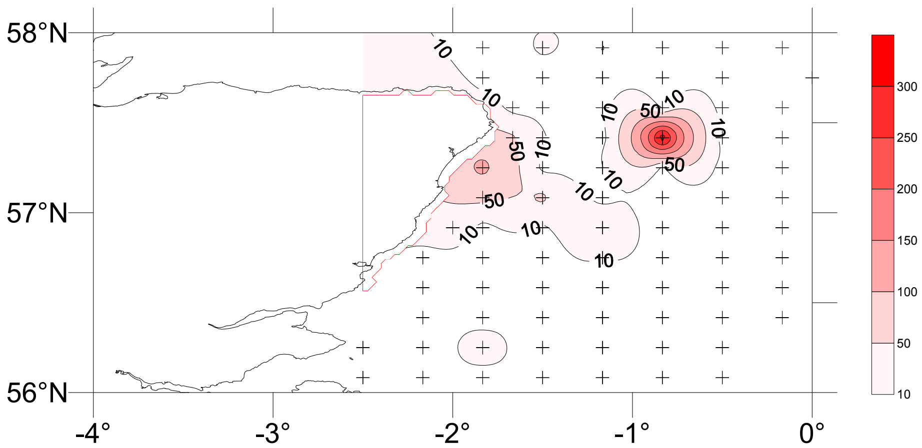


**Figure 3.1.2.3: Buchan 16 - 30 September 2006 (NL). Abundance of larvae < 10 mm (n/m²).**

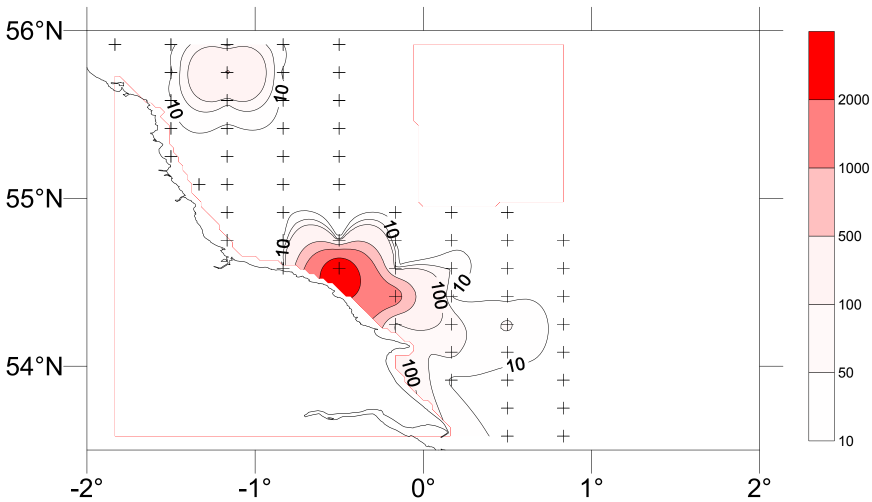


**Figure 3.1.2.4: Central North Sea 16 - 30 September 2006 (NL). Abundance of larvae < 10 mm (n/m²).**

## 3.2 Co-ordination of Larvae Surveys for 2007/2008

At present only the participation of the Netherlands and Germany is confirmed in the 2007/2008 period. Due to the ships time schedule, coverage of the first time window 1-15 September and the last time window 1-15 October will not be possible in any of the areas. In the second time window, ships from Germany and the Netherlands will share the area of the Central North Sea. Outside the larval sampling programme some additional stations shall be sampled in the area of the Doggerbank to test anecdotal information of a recolonisation of the area and to obtain information about ongoing spawning activity. No particular station grid has been designed by PGHERS because of the investigative nature of this sampling. The positioning of transect location should be the responsibility of the cruise leaders.

A preliminary timetable for the next sampling period is presented as follows:

**Table 3.2.1: Areas and time periods for the 2007/2008 herring larvae surveys:**

| Area / Period | 1–15 September | 16–30 September | 1–15 October |
|---|---|---|---|
| Orkney / Shetland | -- | Germany | |
| Buchan | -- | Netherlands | |
| Central North Sea | -- | Germany/Netherlands | -- |
| | | | |
| | **16–31 December** | **1–15 January** | **16–31 January** |
| Southern North Sea | Netherlands | Germany | Netherlands |

Survey results should be sent to Norbert Rohlf (Institut für Seefischerei, ISH, Hamburg), for inclusion into the IHLS database. ISH reports the summarised results and the updated series of MLAI-values to the HAWG.

## 3.3 Investigation of bias introduced by change of gear

### 3.3.1 Introduction

In 2004, the Netherlands changed from the use of a Gulf III plankton torpedo in the herring larvae surveys to the Gulf VII torpedo. However, nothing is known about differences in catchability of herring larvae between these two devices. The Gulf III is a heavy encased high-speed plankton torpedo with a blunt nose cone and one mechanical flow meter placed in the middle of the nose cone (Figure 3.3.1.1).

**Figure 3.3.1.1: The Gulf III plankton torpedo.**

The main differences between the Gulf VII and Gulf III is that the Gulf VII is an un-encased torpedo with a sharp nose cone and two electronic flow meters, one in the nose cone and one mounted externally (Figure 3.3.1.2).

**Figure 3.3.1.2: The Gulf VII plankton torpedo.**

To investigate the possible bias introduced by the change of gear, real-time fishing comparison trials were conducted during the September herring larvae survey in 2006.

### 3.3.2 Method

A frame was built on which both torpedo's could be mounted (Figure 3.3.2.1). In the frame, the torpedoes are placed approximately one metre apart. This frame was tested during a survey in May in the English Channel and Southern North Sea. The stability of the frame was tested with a heal-and-pitch sensor mounted on the frame. If the performance of the frame was good it would be used to conduct the whole larvae survey in September. The towing of the frame with both torpedoes was conducted as described in the manual for herring larvae surveys. The seabird CTD was not mounted on top of one of the torpedoes, but for stability it was mounted on the frame itself, in between the samplers. The frame was switched from the port to starboard winch and the torpedoes on the frame were switched from side to side.

**Figure 3.3.2.1: The frame, with both torpedoes mounted on top, as used for the comparing fishing trial.**

### 3.3.3 Results

***May survey***

The performance of the frame with both torpedoes in May was good. The frame was stable and showed less pitching and rolling compared to the torpedoes on their own (Table 3.3.3.1). It was therefore decided to use this setup for the September larvae survey.

**Table 3.3.3.1: Stability of the frame and separate torpedoes.**

| Position behind ship | Position on frame Gulf III | Gulf VII | Pitch | Roll |
|---|---|---|---|---|
| Starboard | Starboard | Portside | -0.16 | -0.14 |
| Starboard | Portside | Starboard | 0.00 | -0.57 |
| Portside | Portside | Starboard | -0.04 | -0.56 |
| Portside | Starboard | Portside | -0.19 | 0.54 |
| Portside | Separate | | 0.83 | -0.63 |
| Portside | | Separate | 1.05 | 1.03 |

***September survey***

During the September herring larvae survey 100 stations were sampled with both torpedoes. Three stations before the end of the survey, the mechanical flow meter of the Gulf III broke down and it was not possible to repair this on board the ship. It was, therefore, not possible to perform calibration tows with the frame. For the calculation of the flows it was decided to use the highest (1.85) and lowest (1.65) calibration value of the Gulf III flow meter that was found in the 2000 till 2003 herring larvae surveys which were conducted with this flow meter. Figure 3.3.3.1 shows the volume filtered by both torpedo's mounted on the frame.

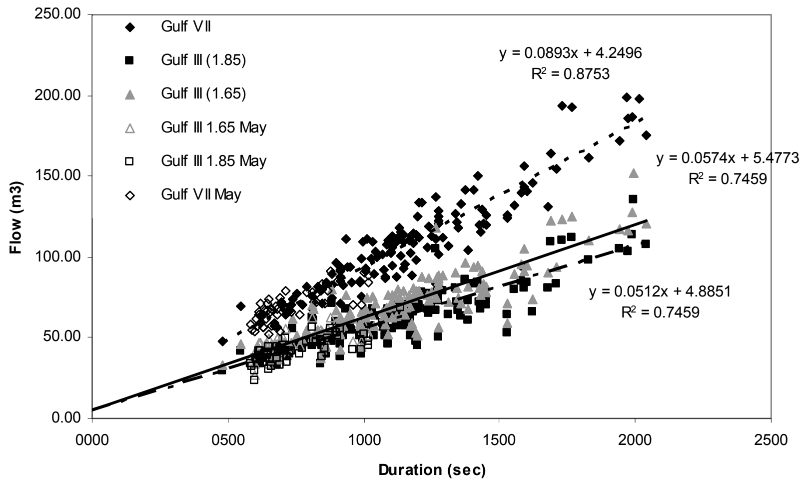


**Figure 3.3.3.1: Volume filtered by Gulf III and Gulf VII both mounted on the frame.**

Sea water volume filtered by the Gulf VII is significantly higher then the Gulf III. When comparing the flows from previous herring larvae surveys, where the torpedoes were towed separately, the volume filtered by the torpedoes is similar (Figure 3.3.3.2).

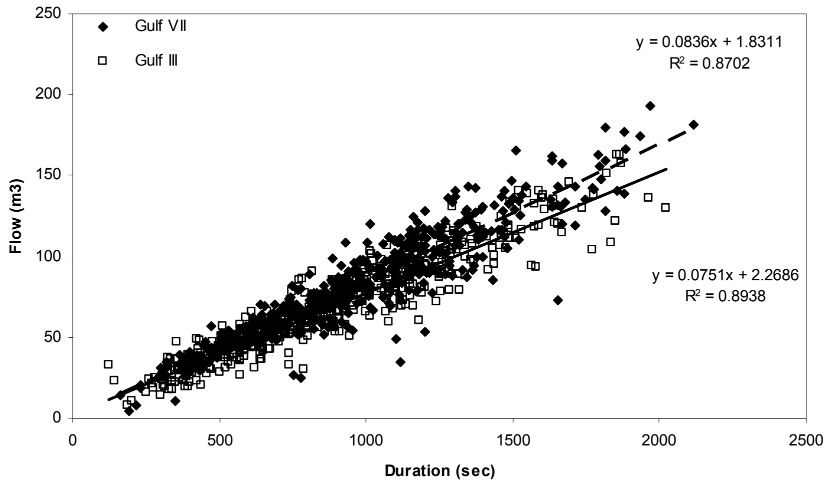


**Figure 3.3.3.2: Volume filtered by Gulf III and Gulf VII towed separately.**

Total numbers of larvae caught, corrected for the area of the nose cone, by the Gulf III were higher compared to the catches of the Gulf VII. For the length classes 7 to 10 mm the numbers of larvae caught by the Gulf III were significantly higher (Figure 3.3.3.3).

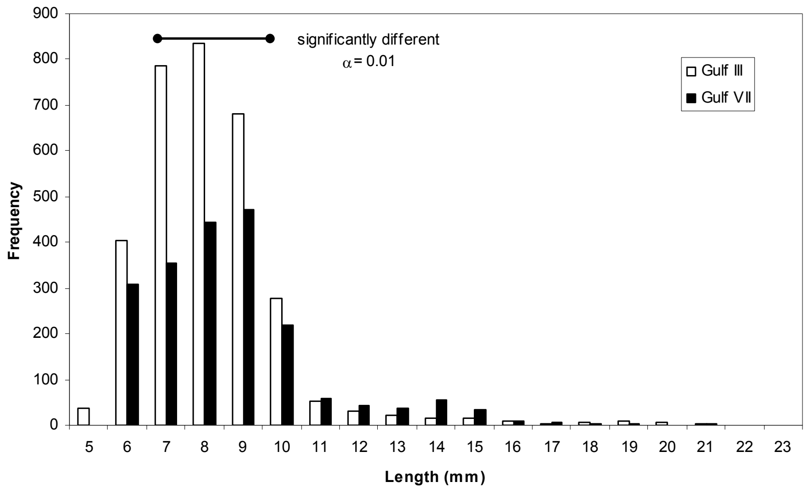


**Figure 3.3.3.3: Total number of larvae (frequency) caught by the Gulf III and Gulf VII while mounted on the frame. (Numbers are corrected for the 5% difference in area of the nose cone.).**

### 3.3.4 Discussion

With both torpedoes mounted on the frame the volume of sea water filtered by the Gulf VII is significantly higher. However no calibration of the flow meters was performed during the September survey. The calculated water volume filtered by the Gulf VII on the frame is the same compared to this torpedo being towed separately, while the volume filtered by the Gulf III is lower on the frame than towed separately. A new calibration will be performed with the three flow meters towed together over a known distance to check the calibration values.

The total number of larvae caught by the Gulf III is higher compared to the Gulf VII, but must be converted by the volume filtered to be comparable. Since the corrected flows can not be calculated this comparison cannot be made. If the number of larvae per filtered volume is still significantly higher in the catches of the Gulf III, correction factors will be calculated to estimate reliable Gulf VII catches.

During the 2007 mackerel and horse mackerel egg survey, ichthyoplankton hauls with both torpedoes are planned to compare the catchability of mackerel eggs.

## 3.4 Possible shift in spawning time of North Sea Herring

### 3.4.1 Larvae abundance

In 2006, herring larvae abundances in the Buchan area, the Central North Sea and Channel spawning grounds seem to have changed compared to the previous years. In 2005, the mean larvae abundance was higher in the Buchan and Central North Sea area compared to 2006 (Table 3.4.1.1) and the numbers of stations without any herring larvae was higher in 2006. The mean length of the herring larvae in 2006 was lower, and the number of yolk sac larvae found in the 2006 samples was 18% compared to 1% in 2005.

**Table 3.4.1.1: Larvae abundance in the Buchan area and the Central North Sea spawning grounds in 2005 and 2006.**

| | 2005 | 2006 |
|---|---|---|
| **Mean N Larvae/m3** | 3.31 | 0.81 |
| **StDev** | 9.66 | 5.25 |
| **Maximum N Larvae/m3** | 68.22 | 57.45 |
| **Total stations** | 160 | 143 |
| **% stations without larvae** | 32.5 | 44.8 |
| **Mean length (mm)** | 8.7 | 7.0 |
| **% yolk sac larvae** | 0.8 | 17.8 |

At the spawning grounds in the English Channel, larvae abundances in December 2004 were much higher compared to 2005, whereas the abundances in January 2005 were lower compared to 2006 (Table 3.4.1.2). This is interpreted as an indication that the peak in spawning was later in the period 2005/2006 compared to the previous year. Mean length of the herring was the same for both periods, but larvae minimum lengths (5 mm) were lower in 2005/2006, compared to 7 mm in 2004/2005. There is also a huge difference in the number of yolk-sac larvae: none were found in the samples in 2004/2005, while almost half the larvae in December 2005 and 8% in January 2006 still had a yolk sac.

**Table 3.4.1.2: Larvae abundance at the English Channel spawning grounds in December 2004 and 2005 and January 2005 and 2006.**

| | December | | January | |
|---|---|---|---|---|
| | 2004 | 2005 | 2005 | 2006 |
| **Mean N Larvae/m3** | 5.31 | 0.41 | 3.27 | 8.16 |
| **StDev** | 21.10 | 2.56 | 15.01 | 20.36 |
| **Maximum N Larvae/m3** | 307.10 | 22.17 | 137.97 | 121.09 |
| **Total stations** | 76 | 76 | 91 | 96 |
| **% stations without larvae** | 52.0 | 45.00 | 17.6 | 34.4 |
| **Mean length (mm)** | 9.1 | 9.4 | 10.3 | 10.3 |
| **% yolk sac larvae** | 0.0 | 47.0 | 0.0 | 8.0 |

Preliminary results of the sampling in the English Channel show that in December 2006 only 25% of the samples contained larvae of which only 1 sample contained over a hundred larvae. A lot of the larvae caught are reported to still have yolk sacs.

However, data collected in the Orkney/Shetland area during two coverages in the first and the second half of September show no indications of changes in the timing of peak spawning.

### 3.4.2 Data from other surveys and market sampling

In 2006 the ‘maatjes’ herring season was delayed by two weeks because of the low lipid content of the herring. The Dutch vessel “Tridens” sampled the Buchan and Central North Sea during the 2006 herring acoustic survey. Results from this survey show that, even though the herring were mature, low numbers of herring with developing gonads were found compared to previous years. The lipid content of caught herring showed also a high variance.

During the time of the larvae surveys in the Buchan area, the Central North Sea and the English Channel samples taken for the ‘market sampling’ at IMARES still had a high percentage of spawning herring. Also during the larvae surveys fishing vessels were seen in the area fishing for herring. Furthermore, fishermen have reported fishing on the ‘Doggerbank’ herring again, indicating a re-colonization of the Dogger Bank as spawning ground.

### 3.4.3 Future

The data presented may indicate a shift in the peak of spawning of North Sea herring in the Buchan area and the Central North Sea and English Channel spawning grounds. Whether this is yearly variation or a temporal shift can not be deduced from these data.

In order to prove that a shift is occurring, and to sample the peak of the spawning to detect the re-colonization of the Dogger Bank as spawning ground, some members of the group felt it necessary to extend the larvae survey in the Buchan into the first half of October and the survey in the English Channel into the first half of February.

However, other members of PGHERS are not convinced that the evidence presented to date indicates a shift in the timing of peak spawning. Unless strong indications for such a shift do occur, PGHERS found it more important to allow for the calculation of a robust estimate for the larvae index and therefore it is preferable for a more complete coverage of all survey areas contributing to the larvae index before any extension of the sampling period should be taken into account.

# 4 Acoustic surveys

## 4.1 Combined estimates of the acoustic survey

### 4.1.1 North Sea and West of Scotland acoustic survey

The surveys are reported individually in the Appendices of this report. A combined report has been prepared from the data from all surveys, attached as Annex 4. The combined survey results provide spatial distributions of herring abundance by number and biomass at age by statistical rectangle; and distributions of mean weight and fraction mature at age.

The estimates of North Sea autumn spawning herring SSB are reasonably consistent with previous years, at 2.1 million tonnes and 11,830 millions herring (Table 2). The survey again shows two well-above year classes of herring (1998 and 2000). Growth of the 2000 year class seems still to be slower than average, individuals of this year class have almost the same size and weights than the one year younger fish of the 2001 year class.

The estimates of Western Baltic spring spawning herring SSB are 336,500 tonnes and 4,026 million herring (Table 3), which is a strong increase following last years small decrease, but the Western Baltic survey is known to produce a rather noisy signal. The indications are that the stock might has recovered and is dominated by 1 and 2 ring fish.

Both the stock estimate as well as the SSB estimate for the herring in VIa(N) (West of Scotland) have significantly increased when compared to last years estimate. Given the known difficulties of quantifying young fish on this survey, the SSB estimate is likely to give the better index of change. The West of Scotland estimates of SSB are 472,000 tonnes and 2.6 billion herring. This is a substantial increase compared to last years estimate, and the SSB has more than doubled. The SSB is in the same order of magnitude that it had during the last ten years. The abundance by year class is consistent with previous years and also with results from the adjacent North Sea area. The 1998 year class is now depleted, but there were a significant number of 2 and 5 ring fish seen on the survey.

**Table 4.1.1.1. Total numbers (millions of fish) and biomass (thousands of tonnes) of North Sea autumn spawning herring in the area surveyed in the acoustic surveys July 2006, with mean weights and mean lengths by age ring.**

| Age ( ring) | Numbers | Biomass | Maturity | weight(g) | Length (cm) |
|---|---|---|---|---|---|
| 0 | 4621.8 | 42.1 | 0.00 | 9.1 | 10.65 |
| 1 | 6822.8 | 305.2 | 0.00 | 44.7 | 17.92 |
| 2 | 3772.3 | 477.8 | 0.66 | 126.7 | 24.22 |
| 3 | 1997.2 | 315.2 | 0.88 | 157.9 | 25.96 |
| 4 | 2097.5 | 394.3 | 0.98 | 188.0 | 27.19 |
| 5 | 4175.1 | 784.4 | 1.00 | 187.9 | 27.23 |
| 6 | 618.2 | 139.2 | 1.00 | 225.2 | 28.68 |
| 7 | 562.1 | 136.5 | 1.00 | 242.8 | 29.33 |
| 8 | 84.3 | 20.5 | 1.00 | 243.9 | 29.50 |
| 9+ | 70.4 | 18.6 | 1.00 | 265.0 | 30.19 |
| Immature | 12994.4 | 503.9 | | 38.8 | 15.92 |
| Mature | 11827.3 | 2129.9 | | 180.1 | 26.83 |
| Total | 24821.7 | 2633.8 | | 106.1 | 21.12 |

**Table 4.1.1.2. Total numbers (millions of fish) and biomass (thousands of tonnes) of Western Baltic spring spawning herring in the area surveyed in the acoustic surveys July 2006, with mean weights, mean length and fraction mature by age ring.**

| Age ( ring) | Numbers | Biomass | Maturity | weight(g) | Length (cm) |
|---|---|---|---|---|---|
| 0 | 5.4 | | | 5.9 | 10.19 |
| 1 | 2081.1 | 112.6 | 0.19 | 54.1 | 19.18 |
| 2 | 2217.0 | 160.4 | 0.67 | 72.4 | 21.23 |
| 3 | 1780.4 | 158.7 | 0.91 | 89.1 | 23.22 |
| 4 | 490.0 | 56.2 | 0.96 | 114.8 | 24.96 |
| 5 | 180.4 | 23.7 | 1 | 131.6 | 26.21 |
| 6 | 27.0 | 4.1 | 1 | 153.2 | 27.61 |
| 7 | 9.5 | 1.6 | 1 | 169.2 | 28.89 |
| 8 | 0.0 | 0.0 | | | |
| 9+ | 0.1 | 0.0 | 1 | 178.0 | 29.80 |
| Immature | 2764.2 | 180.9 | | 65.5 | 20.36 |
| Mature | 4026.7 | 336.5 | | 83.6 | 22.37 |
| Total | 6790.9 | 517.4 | | 76.2 | 21.55 |

**Table 4.1.1.3. Total numbers (millions of fish) and biomass (thousands of tonnes) of autumn spawning of West of Scotland herring in the area surveyed in the acoustic surveys July 2006, with mean weights, mean lengths and fraction mature by age ring.**

| Age ( ring) | Numbers | Biomass | Maturity | weight(g) | Length (cm) |
|---|---|---|---|---|---|
| 0 | | | | | |
| 1 | 112.3 | 8.4 | 0 | 74.99 | 20.57 |
| 2 | 835.2 | 112.5 | 0.808 | 134.52 | 24.66 |
| 3 | 387.9 | 64.3 | 0.965 | 165.72 | 26.33 |
| 4 | 284.5 | 52.8 | 1 | 185.42 | 27.29 |
| 5 | 582.2 | 112.2 | 1 | 192.48 | 27.60 |
| 6 | 414.7 | 84.8 | 1 | 204.13 | 28.11 |
| 7 | 227.0 | 48.0 | 1 | 211.22 | 28.39 |
| 8 | 21.7 | 4.8 | 1 | 224.04 | 29.92 |
| 9+ | 59.3 | 13.7 | 1 | 231.01 | 29.17 |
| Immature | 284.5 | 29.9 | | | |
| Mature | 2640.1 | 471.7 | | | |
| Total | 2924.6 | 501.5 | | | |

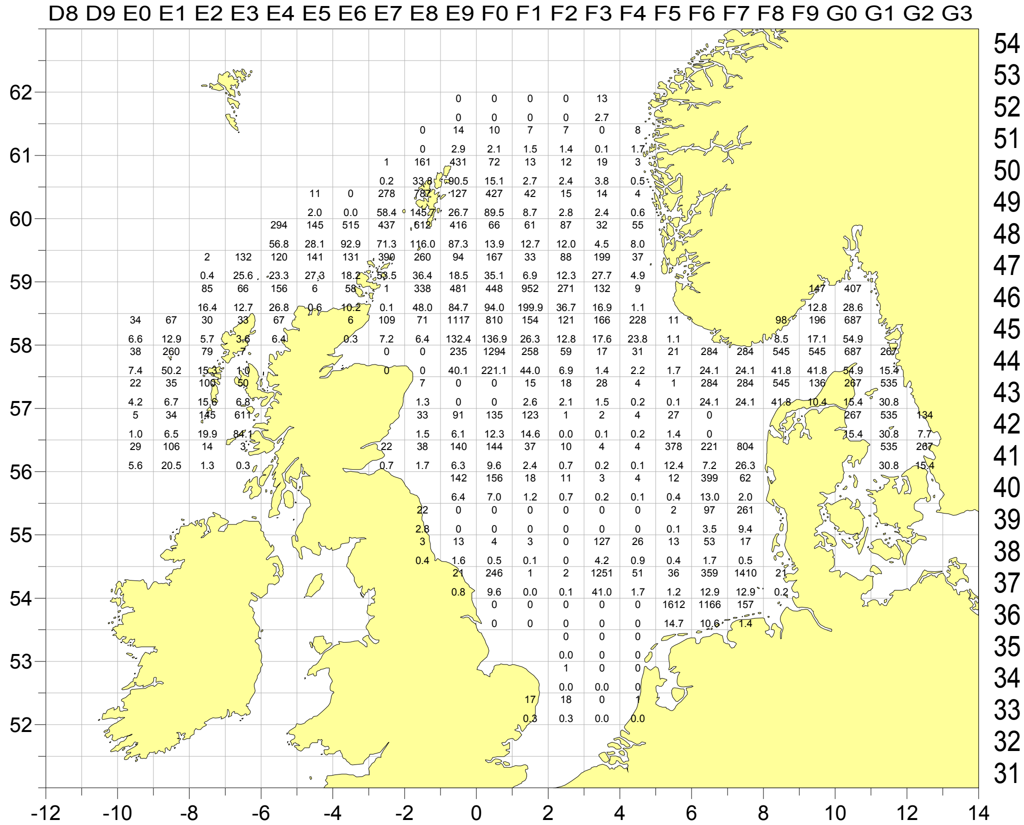

**Figure 4.1.1.1. Abundance of autumn spawning herring 1-9+ from combined acoustic survey July 2006. Numbers (millions) (upper figure) and biomass (thousands of tonnes) (lower figure).**

### 4.1.2 Western Baltic

A joint German-Danish acoustic survey was carried out with RV “Solea” from 5 – 24 October 2006 in the Western Baltic. This survey is conducted every year to supply ICES “Herring Assessment Working Group for the Area South of 62°N” (HAWG) and “Baltic Fisheries Assessment Working Group” (WGBFAS) with an index value for the stock size of herring and sprat in the Western Baltic area.

As in previous years, acoustic recordings were done only during the night. An EK60 echosounder with a hull mounted ES38B transducer and EchoView3 integrator software were used to collect and process acoustic data. The cruise track was 1,330 nautical miles long (area 13,788 n. mi.$^2$) and covered the ICES Subdivisions 21, 22, 23 and 24. To identify the target species and to determine the length and weight of fish, 54 trawl hauls were carried out. Samples of herring and sprat were frozen for subsequent analysis in the lab. After each haul hydrographic measurements were taken with a CTD-O2 probe.

The stock of Western Baltic spring spawning herring was estimated to be 5.7 x $10^9$ individual fishes or about 214x $10^3$ tonnes in Subdivisions 22–24. This is comparable to last year’s results. The estimated total sprat stock was found to 26.2 x $10^9$ fish or 158 x $10^3$ tonnes. This is the highest value ever observed. The abundance estimate of sprat is dominated by the most recent year-class. A survey report is provided in Annex 3

## 4.2 Sprat

Sprat data were available from RV “Walther Herwig III”, RV “Tridens” and RV “Dana”. RV “Scotia” and RV “Johan Hjort” reported no sprat in the northern areas. The distribution of sprat by numbers in millions and biomass in the North Sea is shown in Figure 4.2.1. The southern border of the survey area in 2006 was limited to 52° N. There was no clear indication that the southern distribution has been reached. The same situation is indicated in the north-eastern corner of the surveyed area. However, the highest concentration of sprat was observed off the coast of Scarborough, east coast of England.

In the North Sea no 0-group sprat was observed during the 2006 survey (Table 4.2.1). Here, the abundance was estimated to 44 179 mill individuals and the biomass 452 kt, which is a reduction compared to last year (ICES, 2006). The biomass was dominated by mature sprat (98%). The good year class of 2004, also shown to be very strong as 1 - group in 2005, was in 2006 the strongest 2 - group seen in the data (Table 4.2.2). The sprat is dominated by 1-and 2-group representing a total of 94 - 98% of the biomass.

In Division IIIa, sprat was observed in the ICES squares 41G1-G2, 42G1-G2 and 44G0-G1, all located in the Kattegat. The abundance and total biomass estimated to 2 242 million individuals (Table 4.2.3), a decrease from 4 570 million individuals in 2005. The biomass was estimated to 34 kt, of which immature fish made 63%. No sprat was measured in the IIIa-Skagerrak.

**Table 4.2.1. Sprat in the North Sea. Abundance, Biomass, mean weight and mean length by age and maturity, for the North Sea East and West of 3°E and for the total North Sea.**

| | 1I | 1M | 2I | 2M | 3I | 3M | 4M | TOTAL |
|---|---|---|---|---|---|---|---|---|
| | ABUNDANCE (MILL.) | | | | | | | |
| W of 3° E | 1044.803 | 8022.540 | 12.030 | 17097.600 | 0.297 | 763.976 | 10.009 | **26951.3** |
| E of 3° E | 382.494 | 13439.539 | 0.343 | 3370.138 | 0.008 | 34.657 | 0.285 | **17227.5** |
| Total North Sea | 1427.297 | 21462.079 | 12.373 | 20467.738 | 0.305 | 798.633 | 10.294 | **44178.7** |
| Immature total | | | | | | | | **1439.7** |
| Mature total | | | | | | | | **42728.4** |
| | **Biomass (kt)** | | | | | | | |
| W of 3° E | 5.67 | 60.76 | 0.12 | 228.03 | 0.00 | 11.96 | 0.17 | **306.7** |
| E of 3° E | 1.54 | 98.44 | 0.00 | 44.81 | 0.00 | 0.54 | 0.00 | **145.3** |
| Total North Sea | 7.21 | 159.19 | 0.12 | 272.84 | 0.00 | 12.50 | 0.17 | **452.0** |
| Immature total | | | | | | | | **7.3** |
| Mature total | | | | | | | | **444.7** |
| | **mean weight (g)** | | | | | | | |
| W of 3° E | 5.4 | 7.6 | 10.1 | 13.3 | 11.6 | 15.7 | 16.6 | |
| E of 3° E | 4.0 | 7.3 | 10.1 | 13.3 | 11.6 | 15.6 | 16.6 | |
| Total North Sea | 5.0 | 7.4 | 10.1 | 13.3 | 11.6 | 15.7 | 16. | |
| | **mean length (cm)** | | | | | | | |
| W of 3° E | 8.8 | 9.9 | 10.9 | 12.1 | 11.5 | 13.0 | 13.0 | |
| E of 3° E | 8.0 | 9.7 | 10.9 | 12.0 | 11.5 | 13.0 | 13.0 | |
| Total North Sea | 8.6 | 9.8 | 10.9 | 12.1 | 11.5 | 13.0 | 13.0 | |

**Table 4.2.2. Comparison of biomass and abundance of sprat as obtained by the summer North Sea acoustic survey. The survey area was increased over the years. Only figures for the last 4 years are roughly comparable.**

| | Biomass | | | | | Numbers | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3+ | Sum | 0 | 1 | 2 | 3+ | Sum |
| **2006** | **0.0** | **166.4** | **273.0** | **12.7** | **452.0** | **0** | **22889** | **20480** | **809** | **44179** |
| 2005 | 0.0 | 479.6 | 67.4 | 16.8 | 563.8 | 0 | 70175 | 5533 | 1106 | 76814 |
| 2004 | 19.4 | 266.6 | 71.5 | 2.1 | 359.6 | 17400 | 28940 | 5180 | 99 | 51620 |
| 2003 | 0.0 | 198.8 | 61.3 | 6.0 | 266.1 | 0 | 25292 | 3984 | 339 | 29616 |
| 2002 | 0.0 | 166.8 | 55.1 | 3.7 | 225.6 | 0 | 15769 | 3687 | 207 | 19664 |
| 2001 | 0.0 | 96.5 | 23.5 | 1.8 | 121.8 | 0 | 12639 | 1812 | 110 | 14561 |
| 2000 | 0.0 | 100.4 | 92.4 | 2.8 | 195.6 | 0 | 11569 | 6407 | 180 | 18156 |
| 1999 | 0.0 | 3.3 | 0.0 | 0.0 | 3.3 | 0 | 353 | 5 | 0 | 358 |
| 1998 | 0.1 | 48.2 | 14.1 | 0.8 | 63.2 | 17 | 5365 | 960 | 37 | 6379 |

**Table 4.2.3. Sprat in Division IIIa / Kattegat. Abundance, Biomass, mean weight and mean length by age and maturity.**

| | 0 | 1I | 1M | 2I | 2M | 3I | 3M | 4I | 4M | 5 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Abundance (mill.)** | | | | | | | | | | |
| IIIa-Kattegat | 86.006 | 43.261 | 18.025 | 1079.634 | 372.287 | 257.375 | 357.457 | 10.701 | 17.857 | 9.600 | **2242.2** |
| IIIa-Skagerrak | | | | | | | | | | | **0.0** |
| Total IIIa | 86.006 | 43.261 | 18.025 | 1079.634 | 372.287 | 257.375 | 357.457 | 10.701 | 17.857 | 9.600 | **2242.2** |
| Immature total | | | | | | | | | | | **1219.6** |
| Mature total | | | | | | | | | | | **765.2** |
| | **Biomass (kt)** | | | | | | | | | | |
| IIIa-Kattegat | 0.32 | 0.40 | 0.17 | 15.73 | 5.42 | 4.54 | 6.13 | 0.24 | 0.39 | 0.22 | **33.6** |
| IIIa-Skagerrak | | | | | | | | | | | **0.0** |
| Total IIIa | 0.32 | 0.40 | 0.17 | 15.73 | 5.42 | 4.54 | 6.13 | 0.24 | 0.39 | 0.22 | **33.6** |
| Immature total | | | | | | | | | | | **21.2** |
| Mature total | | | | | | | | | | | **12.3** |
| | **Mean length (g)*** | | | | | | | | | | |
| IIIa-Kattegat | 3.7 | 9.3 | 9.3 | 14.6 | 14.6 | 17.6 | 17.6 | 22.0 | 22.0 | 22.5 | |
| IIIa-Skagerrak | | | | | | | | | | | |
| Total IIIa | 3.7 | 9.3 | 9.3 | 14.6 | 14.6 | 17.6 | 17.6 | 22.0 | 22.0 | 22.5 | |
| | **Mean length (cm)*** | | | | | | | | | | |
| IIIa-Kattegat | 8.3 | 11.0 | 11.0 | 12.5 | 12.5 | 13.6 | 14.9 | 14.9 | 15.3 | | |
| IIIa-Skagerrak | | | | | | | | | | | |
| Total IIIa | 8.6 | 9.8 | 10.9 | 12.1 | 11.5 | 13.0 | 14.9 | 14.9 | 15.3 | | |

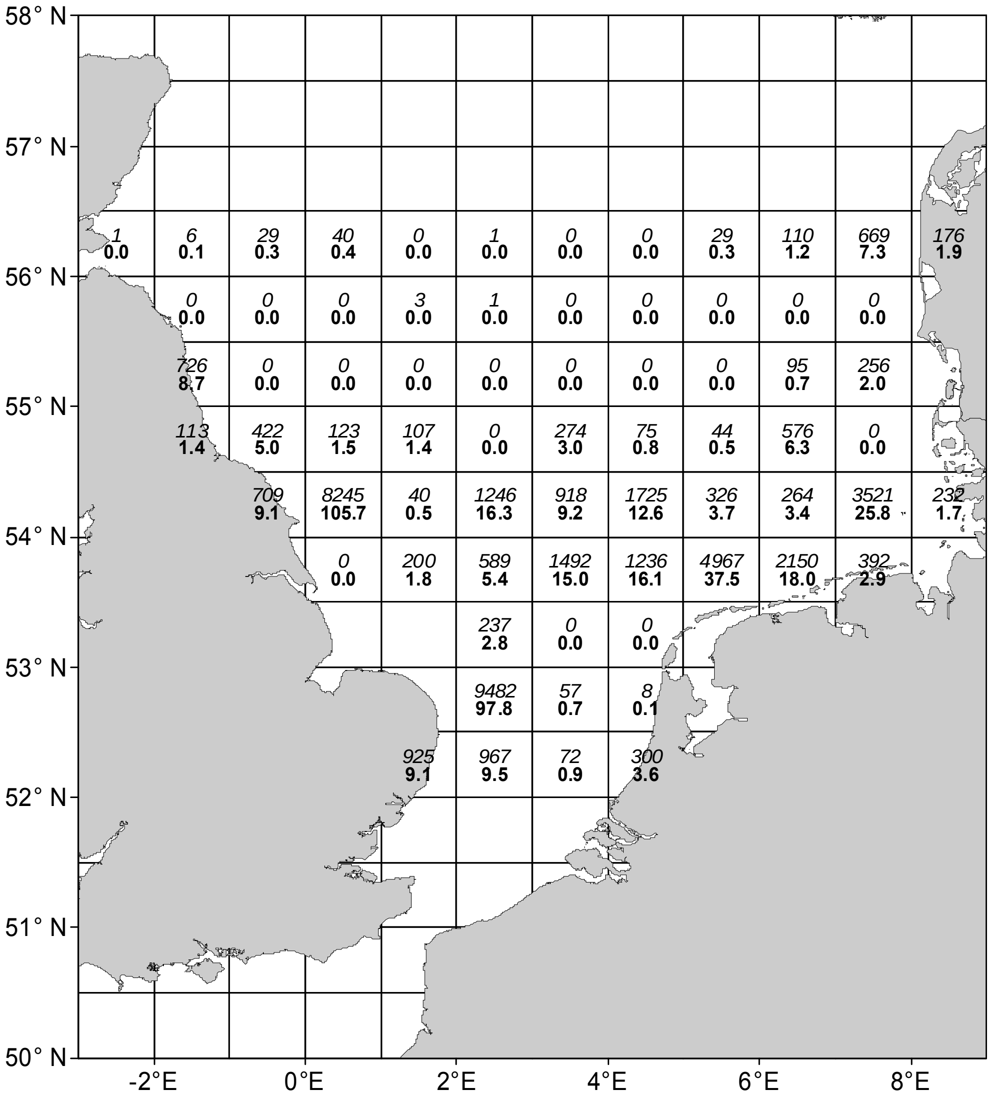


**Figure 4.2.1. North Sea sprat. Abundance (upper figure in italics, in million individuals) and biomass (lower figure in bold, in kt) per statistical rectangle as obtained by the herring acoustic survey 2006.**

## 4.3 Coordination of acoustic surveys in 2007

### 4.3.1 North Sea and West of Scotland

In 2004, the group re-allocated the survey effort applied to the International North Sea herring survey (see Section 5 of 2003 PGHERS report). In 2005, survey transects were interlaced for those vessels for which a good agreement of scrutiny procedures was demonstrated, and where fishing and interpretation of trawl haul information were comparable. The present layout is considered to be intermediate; it should facilitate further harmonisation of the methods without increasing the risk of losing continuity in the time series. In addition, the North Sea sprat stock should continue to be surveyed for reasons given in section 4 of 2005 report (ICES, 2005b). This requires that the southern boundary of the survey area be kept at 52°N.

In 2006, the group considered that interlacing survey transects would benefit the overall quality of the 2007 survey, but a higher level of coordination would be needed than in the past. To facilitate this, it was decided that tentative cruise tracks should be exchanged prior to the survey for further harmonisation. **Plans should be sent to Bram Couperus, IJmuiden, not later than 30 May 2007**; he will then contact individual cruise leaders if amendments are required.

Additionally, vessels should be in daily radio contact during the cruise at 1900 hrs UTC to exchange position and cruise track information as well as survey results (catch depth, species composition, mean length). Deviations from the original submitted cruise track should be communicated immediately, to enable the coordinator to adapt other nations cruise tracks and to avoid gaps. **Paul Fernandes and Bram Couperus have agreed to act as coordinators during the 2007 survey. They can be reached by email or phone between 25 June 25 and 1 July, and will initiate the radio communication from 1 July onwards**.

Acoustic surveys in the North Sea and west of Scotland in 2007 will be carried out in the periods and areas given in Table 4.3.1.1 and Figure 4.3.1.1.

**Table 4.3.1.1. Areas and Rectangles to be covered by the participants in the 2007 herring acoustic survey.**

| VESSEL | PERIOD | AREA | RECTANGLES |
|---|---|---|---|
| Charter west Sco (SCO) | 03 July – XX July (2 ½ weeks) | 56°- 60°30'N, 3° - 10° W | 41E0-E3, 42E0-E3, 43E0-E3, 44E0-E3, 45E0-E4, 46E1-E5, 47E2-E7, 48E3-E7, 49E4-E8, 50E5-E6 |
| Johan Hjort (NOR) | 21 June – 19 July | 56°30'- 62° N, 2° - 6° E | 42F2-F7, 43F2-F5, 44F2-F5, 45F2-F5, 46F2-F4, 47F2-F4, 48F2-F4, 49F2-F4, 50F2-F4, 51F2-F4, 52F2-F4, plus overlap area A, Overlap with Scotia Shetland between 60 – 61° N (49E8 - 50E9) |
| Scotia (SCO) | 29 June – 19 July | 57° - 62° N, 2/4° W - 2° E | 43E8-F1, 44E6-F1, 46E6-F1, 47E6-F1, 48E6-F1, 49E6-F1, 50E6-F1, 51E7-F1, 52E8-F1, 52E9-F1 Overlap with Johan Hjort North of 60 to 61 °N |
| Tridens (NED) PBVO | 25 June – 20 July | 53°30' – 58°30' N, Eng/ Sco to Den/Ger coasts | 36F0-F3, 38F2-F7, 40E8-F5, 41E7-F5, 42E7-F1, 45E6-F1 |
| Solea (GER) DBFH | 28 June – 17 July | 52° - 56° N, Eng to Den/Ger coasts | 33F1-F4, 34F2-F4, 35F2-F4, 36F4-F7, 37E9-F8, 38E9-F1, 39E8-F7, 40F6-F7 |
| Dana (DEN) OXBH | 01 July –12 July | Kattegat and North of 56° N, east of 6° E | 41 F6-F7, 41G1-G3, 42F6-F7, 42G0-G3, 43F6-G2, 44F6-G1, 45F8-G1, 46F9-G0 |

**Borders of survey areas between the west of Scotland charter vessel and RV "Scotia" can be moved if required. Overlapping areas** will be surveyed by (A) RV "Scotia" and RV "Johan Hjort" (mid of July, Rectangles 49E8-F0, 50E9-F0), (B) the charter vessel and RV "Scotia" (at dates to be defined, in Rectangles 47E6-E7, 48E6-E7. 49E6-E8), (C) RV "Johan Hjort" and RV "Dana" (around 10 July, Rectangles 42F6-7).

No **intercalibration** is planned for 2007.

The results from the national acoustic surveys in June-July 2007 will be collated and the results of the entire survey will be combined during the next PGHERS. It might be necessary to conduct a joint evaluation of those surveys where vessels are due to interlace during the cruise (NED, GER, SCO), preferably intersessionally. Individual or combined survey results for sprat and herring should be uploaded to FishFrame NorthSea module (FFN) no later than **30 November 2007**. The group agreed that if one or more parties deliver their *validated* data later than 15 December 2007, the latest institute will be given the responsibility for producing the combined survey data and report in 2007. Participants should also be prepared to additionally deliver their raw data to the stage 1 module of the database for the survey periods 2005 and 2006 no later than 30 October 2007.

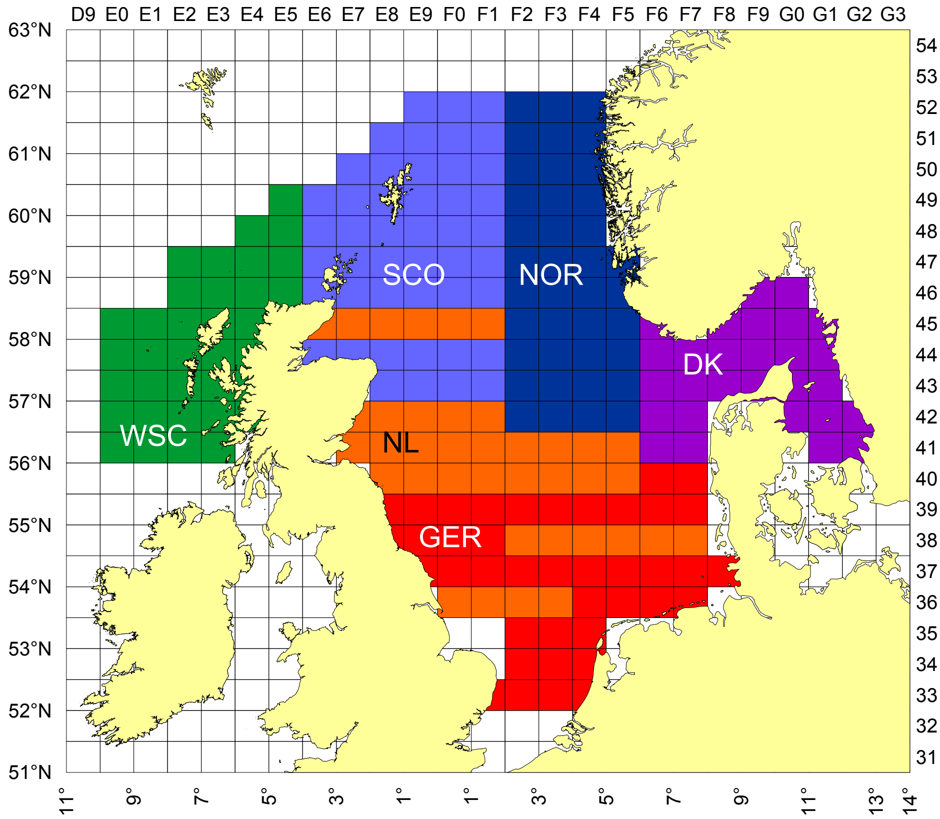


**Figure 4.3.1.1a. Survey area layouts for all participating vessel in the 2007 acoustic survey of the North Sea and adjacent areas. (WSC = West of Scotland charter; SCO = Scotia; NOR = Johan Hjort; DK = Dana; NL = Tridens; GER = Solea).**

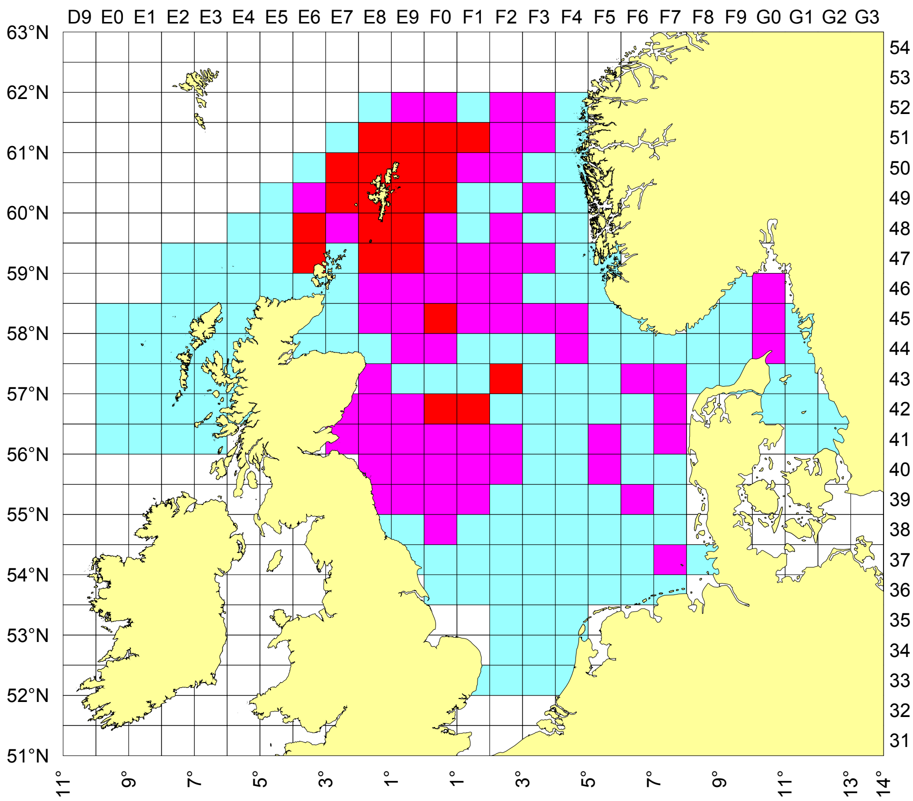


**Figure 4.3.1.1b. Survey effort in the 2007 acoustic survey of the North Sea and adjacent areas. (Red = 7.5 n. mi. spacing; Magenta = 15 n.mi.; Cyan = 30 n. mi.).**

### 4.4 Hydrographic data

According to one of last year's recommendation of PGHERS the hydrographic data from all participants of the acoustic survey in June / July were collated and stored in a common format. This collection contains now the period 2000–2005 in the Ocean Data View format completely. For the year 2006 only data from Scotland, the Netherlands and Germany are available. The missing datasets from the other participants will be delivered as soon as possible to update the database.

It is recommended also for future surveys, that hydrographic data should be collected and stored into the FishFrame database as an additional table to allow fast and easy access for all users. It is of special advantage that the hydrographic data are synchronous with the acoustic measurements.

The main aim of the database is to enable studies searching for possible linkages between the hydrographic environment and the distribution of fish. An appropriate analysis is only practicable if a sufficient amount of data records is present.

## 5 Review and update of PGHERS manuals

### 5.1 Acoustic manual

According to the recommendations of the 2006 PGHERS, several updates and improvements of the manual have been suggested by participants from Germany. These include: some reorganisation of the sequence of the sections in the manual; adding a section with special instructions for the calibration of EK60 complementing the ER60 manual; adding a section stressing the importance of measuring and compensating for the possible changes of environmental conditions between the calibration site and the survey areas and outlining the possible magnitudes of errors. The suggestions also include addition of guidelines for selecting a suitable mesh size for the sampling trawl and an extension of the section outlining the possibility of using multi-frequency algorithms to improve species recognition for the judging procedure. The bibliography has been updated accordingly and the list of gears used by the different nations has been updated. The suggested changes are both very relevant and highly needed.

However, the suggested text will need some reviewing which will be done by correspondence in cooperation between Germany, Denmark and Scotland. Also references to the now obsolete HERSUR database should be replaced with instructions on using the FishFrame database. The revised text will be sent to all members of PGHERS before the next meeting by the Chair.

In the EK60 calibration section it is suggested that the procedure in the ER60-manual is followed. PGHERS recommends that this must be complemented by the integration procedure on a centred calibration target as outlined in the second part of the Transducer and calibration section in order to determine a precise calibrated Sv-transducer gain.

PGHERS also recommends that the calibration procedure as outlined in the manual be evaluated by ICES WGFAST.

### 5.2 IHLS manual

This year no modifications were made with regard to the IHLS manual. Results obtained from the intercalibration exercise between Gulf III and Gulf VII sampler will be implemented in the manual as soon as they become available.

# 6 Biological Parameters

Doubts and difficulties in assessing the maturity of herring have been discussed in PGHERS since the end of the 1990s. The participants in the acoustic survey use either a four or an eight-point scale (which are compatible) for maturity classification. Last year in PGHERS, concerns were raised once again with regard to maturity staging of herring; especially about the classification of older herring (4+) in stage 2 and 8 (both on the eight-point scale). While herring in stage 2 are juveniles, fish in stage 8 are adults and could skip spawning for the recent period. Both stages can easily be mixed up and therefore a misclassification could result in an over- or underestimation of SSB.

With the aim to further harmonise the maturity staging of herring, PGHERS has investigated the impact of such a misclassification on SSB estimates.

One of the questions is: should herring in stage 8 be treated as being part of a spawning stock? The majority of North Sea herring are autumn spawners, but there are still spring-spawning herring in the North Sea. Most of these inhabit the Norwegian area and might be examined as being in stage 8 (after having spawned in spring) during the time of the acoustic surveys. On the other hand, PGHERS do not believe that stage 8 herring will contribute to the SSB of the autumn spawning stock in the given year, and thus they could be regarded as being outside the SSB of NSAS herring. However, whenever identified, herring in this stage are treated as mature fish by PGHERS and included in calculations of the SSB by the HAWG. It is also clear that once a fish has contributed to the spawning stock, it will always be an adult, because whenever herring passes through stage 8, they develop into stage 3 and can not go back to stage 2 (juveniles).

To evaluate the significance of this problem, PGHERS calculated the percentage of herring in each stage and for each of the acoustic survey in 2006, respectively (Table 6.1).

It is evident that the problem of misclassification of stages is not of equal importance in all of the areas surveyed. While both stages do occur in the Norwegian and Scottish area, they are seldom found in the southern parts of the North Sea, which is dominated by juvenile herring (survey area of Germany and the Netherlands). Herring in stage 8 do also occur in the Skagerrak / Kattegat area, but Denmark counts all 5-ringers as being 100% mature.

However, none of the surveyed areas in the North Sea contain a percentage of herring at stage 8 in excess of 11%. In most cases, it is the other stages are much better represented and not all fish in stage 8 can be regarded as misclassified. However, during the acoustic survey in the area West of Scotland almost 30% of herring were found to be in stage 8.

PGHERS concluded that misclassification of stages does occur, but should have only a minor effect for the calculation of SSB (see Section 8).

**Table 6.1. Percentage of the different maturity stages on the total numbers for each cruise in the different areas in 2006.**

| | STAGE 1 | STAGE 2 | STAGE 3 | STAGE 4 | STAGE 5 | STAGE 6 | STAGE 7 | STAGE 8 |
|---|---|---|---|---|---|---|---|---|
| Scotia (UK) | 1 | 8 | 57 | 22 | 0 | 0 | 0 | 11 |
| Johan Hjort (NOR) | 9 | 22 | 44 | 16 | 3 | -- | -- | 6 |
| Tridens (NL) | 77 | | 19 | | | 0 | | 4 |
| West of Scotland (UK) | 3 | 4 | 40 | 22 | - | - | - | 30 |
| Dana (DK) (only NS) | 78 | 21 | 1 | <1 | | | | |
| Solea (FRG) | > 99 | | <1 | | 0 | | 0 | |

# 7 FishFrame

## 7.1 History and objectives

At PGHERS 2004 and 2005 it was decided to initiate the development of a full system to store and process the data from the acoustic survey. The input data level should be scrutinized NASC values and complete information from trawl hauls. The output level should be global stock estimates. The system was regarded as consisting of three stages (Figure 7.1.1):

Stage I: Basic, disaggregated fisheries and acoustics data.

Stage II: Data manipulation and aggregation tools.

Stage III: Aggregated database and tools to derive global estimates from national, aggregated data.

A stepwise development and implementation approach was chosen. The first step was to:

- Evaluate current HerSur software and complete the dataset on that level.
- Develop and test stage III.
- Second step was to:
- Upgrade stage I (HerSur) to FishFrame technology.
- Develop and test stage II.

The first step was partly finished before PGHERS 2006. It was then decided to complete these tasks and begin on the second step.

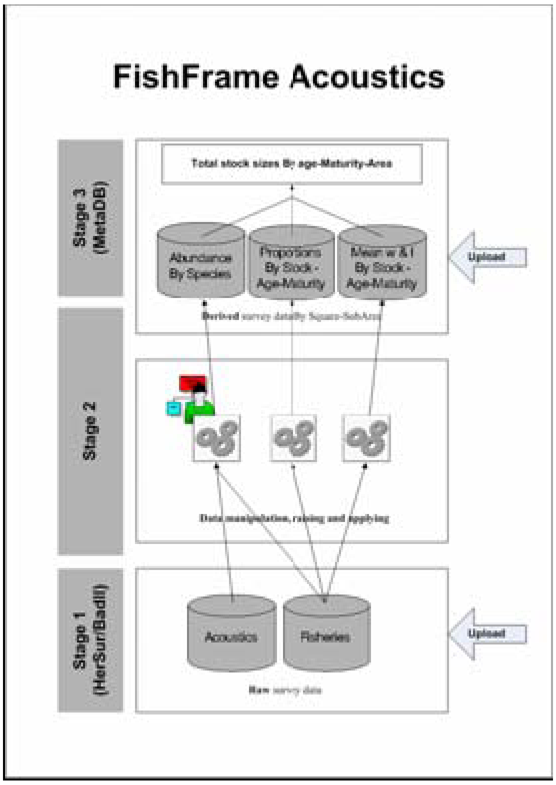


**Figure 7.1. Stages in handling of acoustic data in FishFrame.**

## 7.2 Status of FishFrame

Three new versions (4.1, 4.2 and 4.3) have been released since PGHERS 2006.

### 7.2.1 Development

The following tasks have been completed in 2006:

- General
  - FishFrameAcoustics 1.1 migration into FishFrame 4.3
  - Update documentation (user manual (Jansen and Degel, 2006a), test document (Jansen and Degel, 2006) and exchange format description (Degel and Jansen, 2006))
- Stage 3
  - Release step (data status tracking)
  - Interpolation of missing rectangles
  - Minor tasks: -Fraction with 9 decimal places. -Mileage with 1 decimal. -overwrite AB and SD per year, ship and species. –Position fields on pivot reports
- Stage 2
  - Planning/specification done during workshop in June
- Stage 1
  - Tree based data browser
  - Upload and validation
  - Release step (data status tracking)
  - Revise exchange format
  - Code reports

### 7.2.1 Data

***Stage 3 data***

All countries have uploaded survey data from 2006 for herring and sprat. Teunis Jansen completed the dataset for 2003, 2004 and 2005 by extracting the national input data from John Simmonds' combined excel sheets.

***Stage 1 data***

The upload for stage 1 data has only been open for 1 month, so there has not been much time to upload. Germany has uploaded the fisheries data (AF file) for 2006. The stage 1 data from 1995-2005 present in HerSur was migrated into FishFrame. The data quality was not satisfactory, especially in fields like date and position. This was handled whenever possible, but some data could not be migrated. Furthermore there was no stock identifier (like the spawning type field on the CA record). It is therefore recommended to check the data thoroughly or to re-upload them country by country.

### 7.2.2 Inter-session meeting

A FishFrameAcoustics workshop was held at DIFRES in Copenhagen on the 13-14 of June. The main purpose of the workshop was to analyze the differences between the various national raising and data handling procedures. Participants from the Netherlands, Germany, Scotland and Denmark represented the HERAS (North Sea) survey, while one participant from the Faroe Is. represented the two NAPES (North East Atlantic) surveys, and one representative from Germany represented the BIAS (Baltic Sea) survey.

Following topics were discussed: Combination of catches, Selection of homogeneous regions, Calculation of mean cross section $\sigma$, Estimation of unsampled strata, Stratification, Planning and prioritization of development tasks, Evaluation of Stage 1 exchange format, other software solutions (Beam, BEI2, Faroese Access base). Differences between the surveys (HERAS, BIAS and NAPES) were discussed as well.

The results can be seen in Degel and Jansen (2006a).

## 7.3 FishFrame Test

The structured acceptance test (Jansen and Degel, 2006b) was performed by several subgroups during the meeting.

### 7.3.1 Test results of calculation, aggregation and reporting procedures

Testing of the calculation, aggregation and reporting procedures in stage 3 was done on 2004 and 2005 data during the meeting by Paul Fernandes and Teunis Jansen. The outputs from FishFrame were compared with an updated version of John Simmonds' combined excel-sheets.

The test (Table 7.3.1.1) showed that the global estimate of herring was similar. The small difference (0.00–0.25%) is expected to be due to differences in precision during calculation. The complete testing in age maturity-rectangle details and on the mean weight and length showed similar satisfactory results. The complete test and results can be downloaded from FishFrame.

| | BALTIC SEA SPRING SPAWNERS | NORTH SEA AUTUMN SPAWNERS | TOTAL |
|---|---|---|---|
| 2004 | 0.00% | 0.25% | 0.23% |
| 2005 | 0.00% | 0.16% | 0.13% |

**Table 7.3.1.1. Results from comparison between John Simmonds' combined excel sheet and FishFrameAcoustics stage 3 after removing the interpolations and error regarding age 4 immature cells.**

### 7.3.2 Test results of remaining tests

Testing of the data browser, reports, upload, data checking and interpolation for both in stage 1 and 3 was done during the meeting by Bram Couperus and Jörn Schmidt. Two bugs (one in upload and one in interpolation) were found, corrected and the test was done again.

The final test only detected two known bugs that are not critical and will be dealt with in a later release. These two bugs are:

- Nonsense and corrupt xml upload-files are rejected with a general error message, not stating exactly what is wrong.
- Missing fields "Sounder" and "PostProcessor" is not detected even though they are mandatory.

## 7.4 Conclusion and planning

FishFrame performed satisfactory and was therefore used to combine the national data into the integrated survey result. FishFrame will be the used again for the 2007 survey period.

A list of prioritized tasks can be seen on FishFrame. Main items from this list are given below:

- Stage 1
  - Upload 2005 and 2006
  - Quality assure all historic data
- Stage 2
  - Develop and implement
- Stage 3
  - Possibility to upload data in CSV-files
- All stages:
  - Download data module
  - Standard reports for copy-paste into PGHERS report

### 7.4.1 Funding

So far DIFRES has paid nearly 100% of the development costs. An international group around FishFrame has applied EU for 200,000 Euro for the work in 2007. The outcome of this application is expected in March. Three man-months of work are dedicated to the acoustics component in this project proposal.

Later in 2008 and 2009 FishFrame needs either EU funding or funding by shared costs by the user countries. The latter option is to be explored during 2007.

### 7.4.2 Steering and ownership

FishFrame is *not* a DIFRES system. It is open source with shared ownership by the fisheries science community. It is the intention that many countries participate in development.

Development of this tool has, so far, been done by Teunis Jansen and Henrik Degel in collaboration with the users (primarily in WGBFAS and PGHERS); this is to be changed in 2007. A formal international group will be established which can take care of the future development, design and management. Some kind of collective management reflecting the bottom-up approach is the goal. The group should include representatives from as many institutes and user groups as possible, without compromising the ability to operate. At least one member of the group should represent the user group working with fisheries acoustics. Degel and Jansen (2006b) contains more information about steering, ownership etc.

## 8 Recent studies on herring fat content and the accuracy of maturity staging

Deborah Davidson from the Aberdeen University gave a presentation of her ongoing PhD study dealing with modern methods of measurements on herring fat content:

Organisms use stored lipids for a number of processes, such as growth, survival, and maturation. In the past morphometric condition indices such as Fulton's K condition index (calculated by: $K = (W/L^3)\cdot 100$) were used to estimate stored lipids. The Distell Fish Fatmeter is an example of a rapid, highly portable, and non-destructive means of measuring stored lipids in oily fish species. A previous study showed that the fat meter generates precise measures of fat content in North Sea herring, when compared with Soxhlet extraction analysis. During the 2006 herring acoustic survey, five members of the research team were onboard five of the ships involved: the MFV *Enterprise*, RV “Johan Hjort”, FRV “Scotia,” FFS “Solea”, and FRV “Tridens”. Preliminary investigations into the data indicate that, in general, as length and weight increases, so too does fat content. It was evident when comparing all of the data together, that fish of a larger length (from 200 mm) could have a fat content spanning from very low to very high (from 1% to 35% respectively), whereas smaller fish (from 90 mm) did not tend to have fat contents beyond a certain level (15%). When comparing fat and weight, fish of a heavier weight (around 120 g) did not tend to have very low fat contents (below 15%), although exceptions did occur. A preliminary FATMAP (a visual representation of spatial variation in fat content of North Sea herring) was constructed for the immature herring in the “Scotia”, “Solea” and “Tridens” data, by Christoph Konrad (Aberdeen University). Initial analysis showed that there was a strong linear relationship between length and fat content of immature fish. Plotting the raw fat data showed a clear southeast to northwest trend in fat content. To remove the effects of the relationship between length and fat, the residuals were plotted, and the southeast to northwest gradient in fat content was still evident. Finally, Fulton's K was calculated for all herring obtain from the different cruises, which was then compared with the corresponding fat contents. The relationship between the two was weak and positive for the “Enterprise” and “Solea” data ($r^2 = 0.119$, $n = 635$, $P < 0.0001$; and $r^2 = 0.265$, $n = 1964$, $P < 0.0001$, respectively), yet the correlation was non-significant in the *Scotia* data ($r^2 = 0.0008$, $n = 1873$, $P = 0.114$). However, in the “Tridens” data this relationship was stronger ($r^2$ = 0.522, n = 903, P < 0.0001). There was also a larger range of lengths present in the “Tridens” data (from 100 mm to 306 mm), compared to the other ships; with the “Solea” having sampled smaller fish (from 93 to 263 mm), and the “Enterprise”, “Johan Hjort” and “Scotia” having sampled larger (from 175 mm to 355 mm). This, perhaps, indicates that Fulton's K is only a good indicator of stored lipids in herring when there is a wider spectrum of lengths present, as was the case in the “Tridens” data.

Further work in this area includes: running the muscle tissue samples collected during the 2006 herring acoustic survey through Soxhlet extraction analyses for calibration of the fatmeters; continuing analysis of the 2006 data- including comparing fat content between sexes, maturity stages, and length classes; developing the FATMAP, in particular, including data from the “Enterprise” and “Johan Hjort”, looking at the spatial variation in fat content of mature herring, comparing spatial variation in fat content of male and female fish, and comparing that between maturity stages. It is also the intention to conduct the same study in the summer of 2007, if places were available on each of the ships involved. Also, it is hoped that the study will be continued at different times of the year, and perhaps for different stocks.

In a second talk Lindsay McPherson from Aberdeen University presented her findings concerning the accuracy of macroscopic staging of North Sea herring:

Accurate maturity staging is essential for the calculation of spawning stock biomass (SSB). There is concern that the macroscopic maturity staging of Atlantic herring (*Clupea harengus* L.) on research vessels taking part in HERAS is not accurate. As the macroscopic maturity scale is based on a histological scale, histology is the most accurate means of assessing maturity stage in fish. New, unambiguous histology keys were formed in order to calculate the accuracy of macroscopic staging. Macroscopic staging on FRV “Scotia” in 2006 was 78.6% accurate for females and 83% accurate for males. Much of the error in female staging was due to maturing repeat spawners (stage 3) being assessed as recovering (stage 8). There were also difficulties in the sexing of virgin gonads, with examples of both sexes wrongly classified. While marked inaccuracies were found they are unlikely to impact upon the SSB as the number of fish assessed as immature (1-2) or mature (stages 3-8) were correct. Due to its ease and inexpensive nature, macroscopic staging is unlikely to be replaced by a more accurate method; however, proxies could be introduced to increase the accuracy of macroscopic assessments. Gonadosomatic index (GSI) and oocyte diameter appear to be the best candidates as they are both simple to use at sea and are positively related to gonad maturation. It is hoped that in 2007 larger sample sizes from more than one vessel taking part in the herring acoustic surveys will allow comparison of accuracy between vessels and investigation into the accuracy of maturity staging in all maturity stages. The effect of fish length on macroscopic staging accuracy will also be considered.

# 9 Recommendations

## 9.1 Terms of Reference

The **Planning Group for Herring Surveys** [PGHERS] (Chair: Norbert Rohlf, Germany) will meet at the Netherlands Institute for Marine Research and Ecosystem Studies (IMARES), IJmuiden, The Netherlands, from 22 – 25 January 2008 to:

a ) combine the 2007 survey data to provide indices of abundance for the population of herring and sprat within the area, using the FishFrameAcoustics database;

b ) coordinate the timing, area and effort allocation and methodologies for acoustic and larvae surveys for herring and sprat in the North Sea, around Ireland, Division VIa and IIIa and the Western Baltic in 2008;

c ) examine the interpretation of echograms between the participants of the 2007 acoustic surveys to ensure quality control and proper exchange of experience;

d ) review histological studies to determine the accuracy of herring maturity reading;

e ) report on the possible bias introduced by a change in gear in the Dutch herring larvae survey.

PGHERS will report by 12 February 2008 for the attention of the Living Resources, and the Resource Management Committees as well as to HAWG.

### Supporting Information

| | |
|---|---|
| Priority | The International Acoustic and Larvae surveys provide essential data for the assessment of pelagic stocks in and around the North Sea (Divisions IV, VIa, IIIa, and Western Baltic). |
| Scientific Justification and relation to Action Plan: | The work of this Expert Group refers to items 1.2.1, 1.2.2, 1.13 (Strategy plan ICES)<br>Term of Reference a) and b)<br>Surveys for herring are currently carried out by five different countries, covering the whole of the North Sea, Western Baltic and the west coast of Scotland. Effective co-ordination and quality control for these surveys is essential and while data combination can be managed by mail, a meeting is required to ensure that the larvae database is being used correctly and that the acoustic surveys are being carried out and analysed on a consistent basis.<br>Term of Reference c)<br>Interpretation of echograms is subject to different national institutes. Exchange of experience is one of the vital interests of the PG to enable all involved participants a comparable background information and to reduces the risk of loss in information due to changing personnel.<br>Term of Reference d)<br>Modern approaches to determine the accuracy of herring maturity reading may be one source of information to be implemented in further developments of the sampling design in the herring surveys. A meeting is required to inform the participants about recent results with respect to maturity and fat content of herring and to discuss possible implications for the next survey period.<br>Term of Reference e)<br>The Dutch larvae survey has changed the sampling gear and the first results of comparison studies presented to PGHERS in 2007 shows a dramatic effect on larvae abundance and length frequencies. However, due to technical problems with flowmeters in this first approach, a further study shall be conducted. |
| Relation to Strategic Plan: | Directly relevant – it allows ICES to respond to requested advice on herring and sprat fisheries. |
| Resource Requirements: | No specific resource requirements beyond the need for members to prepare for and participate in the meeting |
| Participants | At least one scientist (preferably the cruise leader) from each survey; hence a minimum of 6 members. |
| Secretariat Facilities | None |
| Financial: | None |

| | |
|---|---|
| Linkages to Advisory Committees: | The survey data are prime inputs to the assessments which provide ACFM with information required for responding to requests for advice/information from NEAFC and EC DGXIV. |
| Linkages to other Committees or Groups: | Survey results are conveyed directly to the Herring Assessment Working Group for the Area South of 62°N (HAWG).<br>HAWG to see this report |
| Linkages to other Organisations: | None |
| Cost Share: | ICES 100% |

## 9.2 Further Recommendations

Note that the recommendations below are sorted so that recommendation 1 to 8 is addressed to parties outside the PGHERS group and recommendation 9 to 19 is addressed to the expert group members. Bold text refers to specific action required by PGHERS members.

| Recommendation | Action |
|---|---|
| 1. PGHERS recommends that the North Sea herring larvae survey should be considered for priority 1 EC funding, as it is international, it is used in the assessment of herring and could be used for additional species if required (e.g. plaice and cod eggs, sandeel larvae). | Appropriate expert group members to make a case to national DCR representatives. |
| 2. When using the 8 stage herring maturity scale, PGHERS recommends that particular attention be paid to the identification of stage 2 in older (4+) fish. Once a fish is (adult) mature and spawned it passes from stage 8 to stage 3 and so it is not possible to have a stage 2 "virgin" adult fish. The issue of "skipped spawners" and the proportion of "adults" which are immature needs to be clarified. **HAWG should comment on their needs to calculate a proportion of skipped spawners** (Stage 8) for the assessment. | HAWG and Expert Group Members |
| 3. PGHERS recommends that HAWG comment on what proportion of the total survey effort should be directed to the different survey indices contributed by PGHERS (adult herring / sprat / young herring). | HAWG |
| 4. PGHERS recommends that in the 2007 North Sea acoustic surveys, all participants take a student from Aberdeen University to make measurements of the fat content of herring. | Expert group members to note and Aberdeen university members to consult. |
| 5. PGHERS recommends a further study on the impact of bias introduced by the Dutch change in gear to the herring larvae survey. | IMARES |
| 6. PGHERS recommends that national institutes consider the long term funding of FishFrame after the EU FishFrame project. The latter is unlikely to have a complete acoustic survey analysis system completed, so in order for such a system to be available to participants, further funding will have to be sought. The FishFrame steering group should estimate how much funding will be required once the EU project is finished to complete the acoustic survey component and inform PGHERS members in 2008. PGHERS participants should prepare for funds to be made available in good time if possible. | FishFrame steering group and expert group members |
| 7. PGHERS recommends that Norway should return to give priority to the area assigned to the herring acoustic survey to ensure an adequate survey effort. | IMR Bergen |
| 8. PGHERS has recognised differences in the calibration results between Simrad EK500 and EK60 echosounders. PGHERS recommends ICES WGFAST to advise PGHERS and other acoustic survey planning groups (e.g. PGNAPES) on the implications of following the procedure in the EK60 manual for calibration of this new echosounder. | ICES WGFAST to consider reviewing EK60 calibration procedures. |
| 9. PGHERS recommends that all participants should upload stage 1 data from 2005 and 2006 into the FishFrame database up to 30 October 2007. | Expert group members |
| 10. PGHERS recommends that **all participants in the International North Sea Herring Acoustic Survey should exchange trawl data soon after the surveys have been completed (**age-readings when available**)**. In cases where trawl data are lacking in one particular area, trawl information from an adjacent area collected by a different participant, may be used. | Expert group members |

| | |
|---|---|
| 11. For the 2008 meeting, PGHERS recommends that all **participants should show echograms** from at least 10 Equivalent Distance Sampling Units corresponding to the 10 largest NASC's attributed to herring. | Expert group members |
| 12. **All participants in the 2007 North Sea herring acoustic survey should upload their survey estimates to the FishFrame database by 30 November 2007 for stage 3.** | Expert group members to note. |
| 13. **Participants in the 2007 North Sea herring acoustic survey should send their hydrographic data to Eberhard Goetze by 30 September 2007.** | Expert group members to note. |
| 14. PGHERS recommends **that cruise leaders participating in the International North Sea Herring Acoustic Survey should radio contact each other every day at 1900 UTC. Communication should be through medium frequency radio at 3333 kHz**, allowing all participants to listen to each other's conversation. Participants should observe radio operating protocols. | Expert group members to note. |
| 15. PGHERS recommends that survey cruise leaders should take all necessary steps to ensure that all ICES rectangles are surveyed as planned in the coordinated survey. Individual participants who, for whatever reason, are unable to survey any rectangle allocated to them, should make this known to other participants as soon as possible, this may allow for ad hoc adjustments to other surveys to fill any gaps (see recommendation 13 above). | Expert group members to note. |
| 16. PGHERS recommends that the four vessels covering the North Sea start their survey in the center of the combined survey area (NOR and SCO in the south, NED and GER in the north), to keep the quasi-synoptic character of the survey. This is considered specifically important for a survey targeting highly mobile fish like herring and sprat. | Expert group members to note. |
| 17. Germany should conduct a study on the implications of reduced survey effort (30 n.mi.versus 15 n.mi. density) on the abundance of herring and sprat in the southern part of the North Sea. | Expert group members to note. |
| 18. To determine possible shifts in spawning PGHERS recommends that all areas in the herring larvae surveys should be covered. | Expert group members to note. |
| 19. PGHERS recommends that in addition to the planned larvae surveys some sampling should take place in the area of the Dogger Bank at the end of the sampling period. | Expert group members to note. |

# 10 References


ICES. 2003. Report of the Planning Group for Herring Surveys. ICES CM 2003/G: 03, Appendix 4.

ICES. 2004. Report of the Planning Group for Herring Surveys. ICES CM 2004/G: 05, Ref. G, p. 5–7.

ICES. 2005a. Report of the Herring Assessment Working Group for the Area South of 62° N. (HAWG). 8-17 March 2005, ICES, Copenhagen, Part 1. ICES CM 2005/ACFM: 16, p. 227-228, 233.

ICES. 2005b. Report of the Planning Group for Herring Surveys. ICES CM 2005/G: 04, Ref. D, p. 1-16.

ICES. 2006. Report of the Planning Group for Herring Surveys. ICES CM 2006/LRC: 04. 235 pp.

Dickey-Collas, M., Nash, R.D.M. 2006. Review of Rügen herring larvae survey project. IMARES report C079/06 (Project No. 439.11000.02), 17 pp.

Oeberst, R. 2007. A new stratification of the Rügen herring larvae survey in the Greifswalder Bodden. WD to PGHERS Charlottenlund/DK, 22.-26.Jan. 2007, 8 pp.

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

Degel, H., Jansen, T. 2006b. FishFrame - Fisheries and stock assessment data framework. ICES CM 2006/M:02.

Jansen, T., Degel, H. 2006a. FishFrame 4.3 User Manual. www.FishFrame.org, 28 January 2006.

Jansen, T., and Degel, H., 2006b. FishFrame 4.3 Test Documentation. www.FishFrame.org, 26 January 2006.

Simmonds, J., MacLennan, S. 2005. Fisheries Acoustics – Theory and Practice. 2nd edition, Blackwell publishing. 437 p.

# Annex 1: List of participants

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# Annex 2: 2006 Acoustic Survey Reports

## Annex 2A: West of Scotland

Survey report for MFV *Enterprise*

3 July - 20 July 2006

Eric Armstrong, FRS Marine Laboratory, Aberdeen

## 1. Introduction

An acoustic survey for herring was carried out by the Marine Laboratory on the west coast of Scotland (ICES Division VIa(N)) from the 3–20 July 2006. The survey was conducted on the chartered fishing vessel MFV "Enterprise". The main objective of the survey was to provide an abundance estimate for herring in this area and to map the distribution of this species.

The survey was carried out as a part of the ICES coordinated herring acoustic survey of the North Sea and adjacent waters. The data from this survey were combined with other surveys in the North Sea to provide an age disaggregated abundance index for use in the assessment process. The assessment will be carried out by the ICES Herring Assessment Working Group (HAWG) to be held in March 2007.

This survey has been carried out every year, at this time, by the Marine Laboratory since 1992. With the exception of 1997 the survey has always been conducted using chartered commercial fishing vessels.

## 2. Personnel

| | |
|---|---|
| Eric Armstrong | Cruise Leader |
| Craig Davis | |
| Micheal Stewart | |
| Melanie Harding | |
| Colin Millar | (Part 1 3-11 July) |
| Morag Campbell | (Part 2 12-20 July) |
| Heather Pollock | Aberdeen University |

### 2.1 Narrative

Loading of the vessel and installation of a wet lab container and equipment was carried out on the 30$^{th}$ June. The vessel left Fraserburgh at 0300 on 3 July and proceeded to Loch Eriboll for a calibration. Survey work began at Cape Wrath at 1030hrs on the morning of the 4$^{th}$. The survey continued in generally good weather until 10$^{th}$ July when the vessel steamed to Loch Broom where a second calibration was carried out on the morning of the 11$^{th}$ prior to landing in Ullapool for a crew change. The survey continued from the 12$^{th}$ in poor weather for the first 12hrs covering the full survey area up to 60$^{o}$N 3$^{o}$W. This was successfully completed by mid afternoon on the 19$^{th}$. The vessel then steamed to Fraserburgh for off loading of personnel and equipment on the morning of the 20$^{th}$. No time was lost due to weather or mechanical breakdown and no damage occurred to net gear or acoustic equipment.

### 2.2 Survey design

The survey design (Figure IIA.1) was selected to cover the area in two levels of sampling intensity based on herring densities found in previous years. Areas with highest intensity sampling had a transect spacing of 7.5 nautical miles and lower intensity areas a transect spacing of 15 nautical miles. The track layout was systematic, with a random start point. Between track, data were discarded at the end of all transects. The survey area was within an area defined by 56 and 60° N, and the shelf break in the west to approx. 200m depth and the Scottish coast or the 4° W line in the east.

### 2.3 Calibration

Two good calibrations were carried out, at the beginning (3 July) in Loch Erribol and in the middle (11 July) in Loch Broom. All calibrations were carried out in ideal conditions, and the constants for the 38 kHz integrating frequency agreed well (Table IIA.1). All procedures were according to those defined in the survey manual.

### 2.4 Acoustic data collection

The survey was carried out using a Simrad EK60 38 kHz sounder echo-integrator, the system settings are given in Table IIA.1. Further data analysis was carried out using SonarData Echoview and Marine Laboratory Analysis systems. Data from the echo integrator were summed over quarter hour periods (2.5 n.mi. at 10 knots). The survey was generally restricted to hours of daylight between 0300h and 2300h UTC. A total of 2020 nautical miles of track were recorded. Echo integrator data were collected from 10 metres below the surface (transducer at 5.5 m depth) to 0.5 m above the seabed. Data were processed on a daily basis, then archived as Echoview files (*.ek5,*.evi) and stored on DVD and external hard drive.

### 2.5 Biological data - fishing trawls

33 trawl hauls (Figure IIA.1 and Tables IIA.2 and IIA.3) were carried out opportunistically during the survey on the denser echo traces. All trawls were carried out using a PT160 pelagic trawl with a 20 mm cod end liner. A scanning netsonde was mounted on the headline. Each haul was sampled for length, age, maturity and weight of individual herring. Up to 686 fish were measured at 0.5 cm intervals from each haul. Otoliths were collected with 1 per 0.5 cm class below 23 cm, 3 per 0.5 cm class from 23 to 27 cm and 10 per 0.5 cm class for 27.5 cm and above. Fish weights were collected at sea for all fish aged. An eight stage maturity scale was used. Immature fish were defined as stages 1 and 2.

### 2.6 Hydrographic data

A Minilogger temperature sensor was attached to the headline of the trawl for all hauls.

### 2.7 Data analysis

EDSUs were defined by 15 minute intervals which represented 2.5 n.mi. per EDSU, assuming a survey speed of 10 knots. The data were divided into three categories: "definitely herring traces"; "probably herring traces" and “possibly herring traces” (which were identified with enough uncertainty as to not be included in the estimate). Data were analysed using rectangles of 15’ by 15’.

Target strength to length relationships used were those recommended by the acoustic survey planning group (ICES, 1994).

For herring $TS = 20\log_{10}L-71.2$ dB per individual

For mackerel: $TS = 20\log_{10}L-84.9$ dB per individual

For gadoids: $TS = 20\log_{10}L-67.5$ dB per individual

For sprat: $TS = 20\log_{10}L-71.2$ dB per individual

The herring data from the trawl hauls were used to divide the area into three strata based on length distributions and geographic criteria. The three regions (Figure 2A.4) were:

- Inner Minch
- Outer Minch
- Area west of islands and north Scotland

Trawling in the Inner Minch area was again very difficult except in the most northerly and southerly parts. The length frequencies are presented in Table 2A.4. The overall age length key is presented in Table 2A.5.

# 3. RESULTS

## 3.1 Acoustic data

The geographical distribution of the NASC values assigned to herring are presented in Figure IIA.2. Large quantities of herring were detected to the south and north of the area in the middle of the shelf. The main areas of concentration were North of 58$^{o}$ 45’, and around 57$^{o}$ 00’N. There were also some good marks recorded at the Butt of Lewis. There were no major concentrations NW of Lewis at Gallan Head; little herring in the main part of the Minch; and no evidence of large quantities sometimes found at Barra Head.

## 3.2 Biological data

A total of 33 trawl hauls were carried out. Table 2A.2 gives the positions and characteristics of these trawl hauls and Table 2A.3 gives their species composition. 29 hauls contained sufficient herring to define the 3 survey sub areas (Figure 2A.4). Herring were present in 29 hauls and there was a good coverage of herring trawl hauls across the area with the exception of the Minch. All major concentrations were adequately characterised from these trawls. Other hauls were dominated by boarfish (haul 6), pipefish (haul 26), and two hauls catching nothing (hauls 14 and 31).

The weight of herring at length was determined from length stratified samples of each trawl haul. Length frequencies were recorded from a random sample and were measured in 0.5 cm intervals to the nearest 0.5 cm below. The resulting weight-length relationship for herring was:

$$W = 0.003414.^{3.28} \qquad \text{L measured in cm}$$

Samples of fish were aged in the laboratory by counting winter rings. These were then used to compile an age length key (Table IIA.5) to determine the proportion at age for each length class.

### 3.3 Biomass estimates

The total biomass estimates for the survey were:

| | | |
|---|---|---|
| **Total herring biomass** | **510,190 tonnes** | |
| Total herring numbers | 2,980 million | |

The results for ICES Subdivision VIa(N) alone were:

| | | |
|---|---|---|
| Definitely herring | 234,764 tonnes | 47% |
| Probably herring | 263,708 tonnes | 53% |
| **Total herring** | **498,472 tonnes** | |
| Spawning stock biomass | 433,671 tonnes | 87% |
| Immature | 64,801 tonnes | 13% |

Total abundance (numbers of fish) were:

| | | |
|---|---|---|
| Total herring | 2,935 million | |
| Spawning stock numbers | 2,664 million | 91% |
| Immature numbers | 271 million | 9% |

A breakdown of the estimates by age class is given in Table IIA.6. The survey included all of ICES Subdivision VIa(N) plus some of the area between 3° 30 and 4°W in Subdivision IV.

## 4 DISCUSSION

The stock estimate for VIa(N) is up substantially by approximately 95% from 2005 (from 254,906 to 498,472 tonnes). Given the known difficulties of quantifying young fish on this survey, the SSB estimate is likely to give a better index of change. This is up slightly less significantly, by 78% (243,588 to 433,671 tonnes) from 2005 to 2006. The abundance by year class is consistent with previous years and also with results from the adjacent North Sea area. The 1998 year class was no longer strong though there were a significant number of 2 and 5 ring fish seen on the survey (28% by number and 22% by weight for 2 ring, 20% by number and 22% by weight for 5 ring).

The distributions were broadly similar to previous years, with the bulk of the fish being found to the north of the survey area. The regular hot spot of smaller fish at Barra Head was not seen this year.

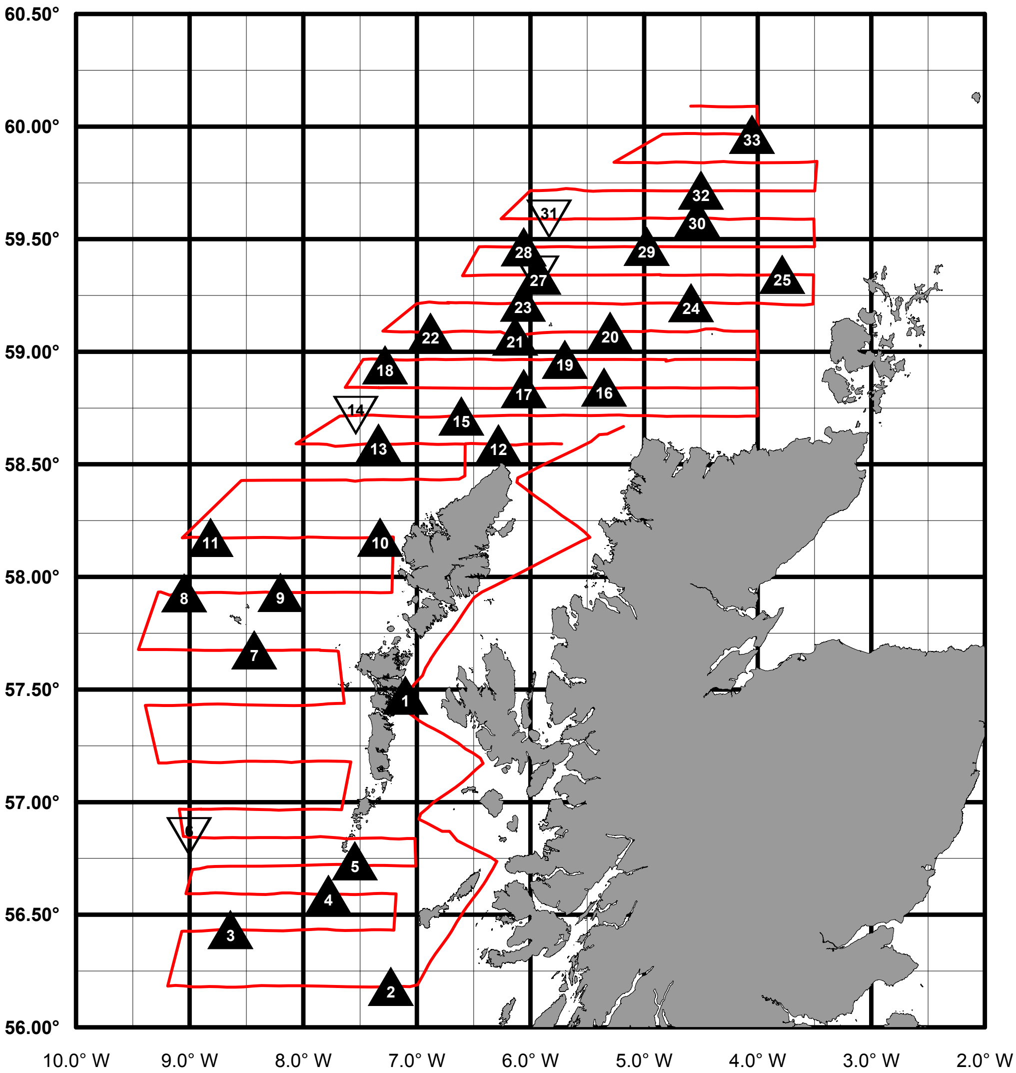


**Figure 2A.1: Map of the west of Scotland showing cruise track and positions of fishing trawls undertaken during the July 2006 west coast acoustic survey on MFV *Enterprise*. Filled triangles indicate trawls in which significant numbers of herring were caught, whilst open triangles indicate trawls with few or no herring. Haul 26, which is hidden by Haul 27, was fishing on a mid water layer that produced a clean haul of pipefish.**

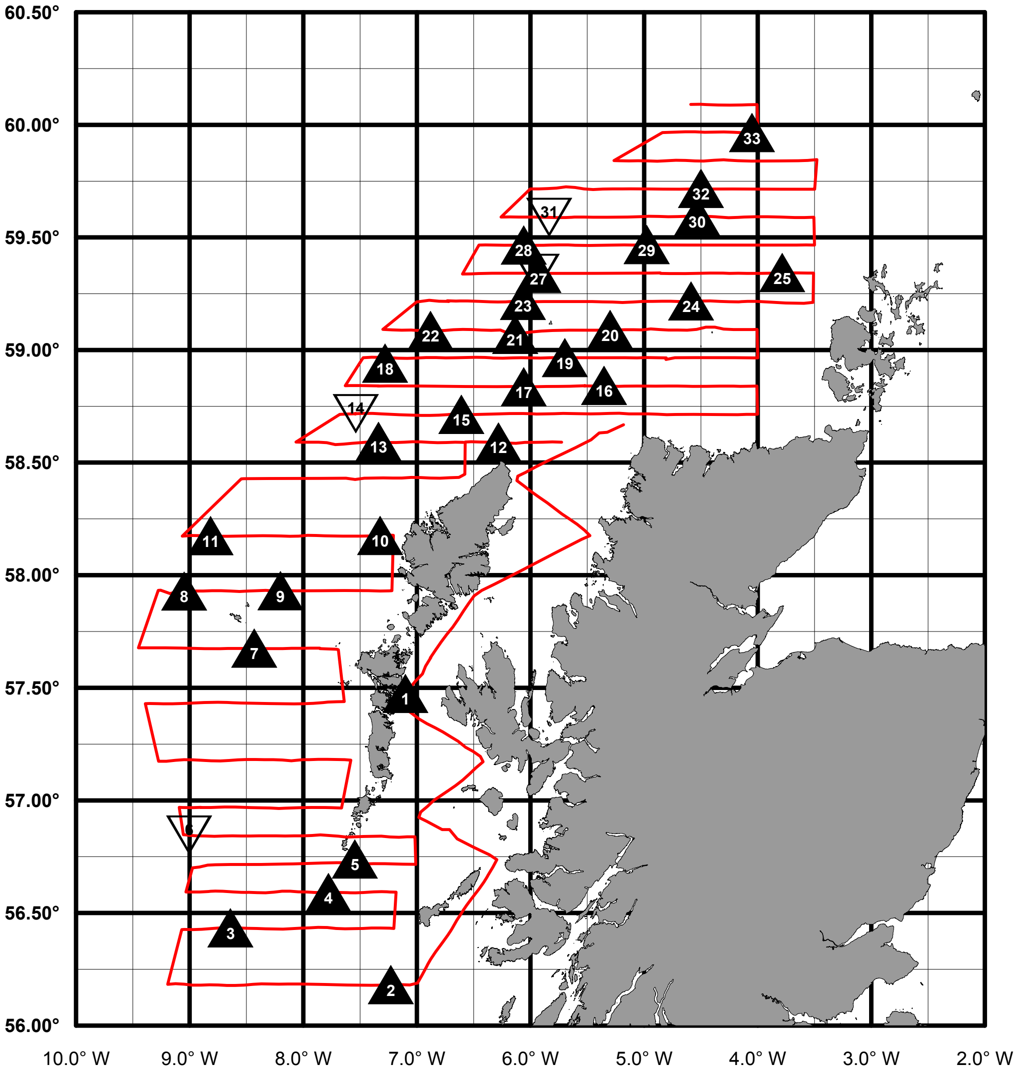


**Figure 2A.2: Map of the west of Scotland with a post plot showing the distribution of herring NASC values (on a proportional square root scale relative to a value of 8000) obtained during the July 2006 west coast acoustic survey on MFV "Enterprise".**

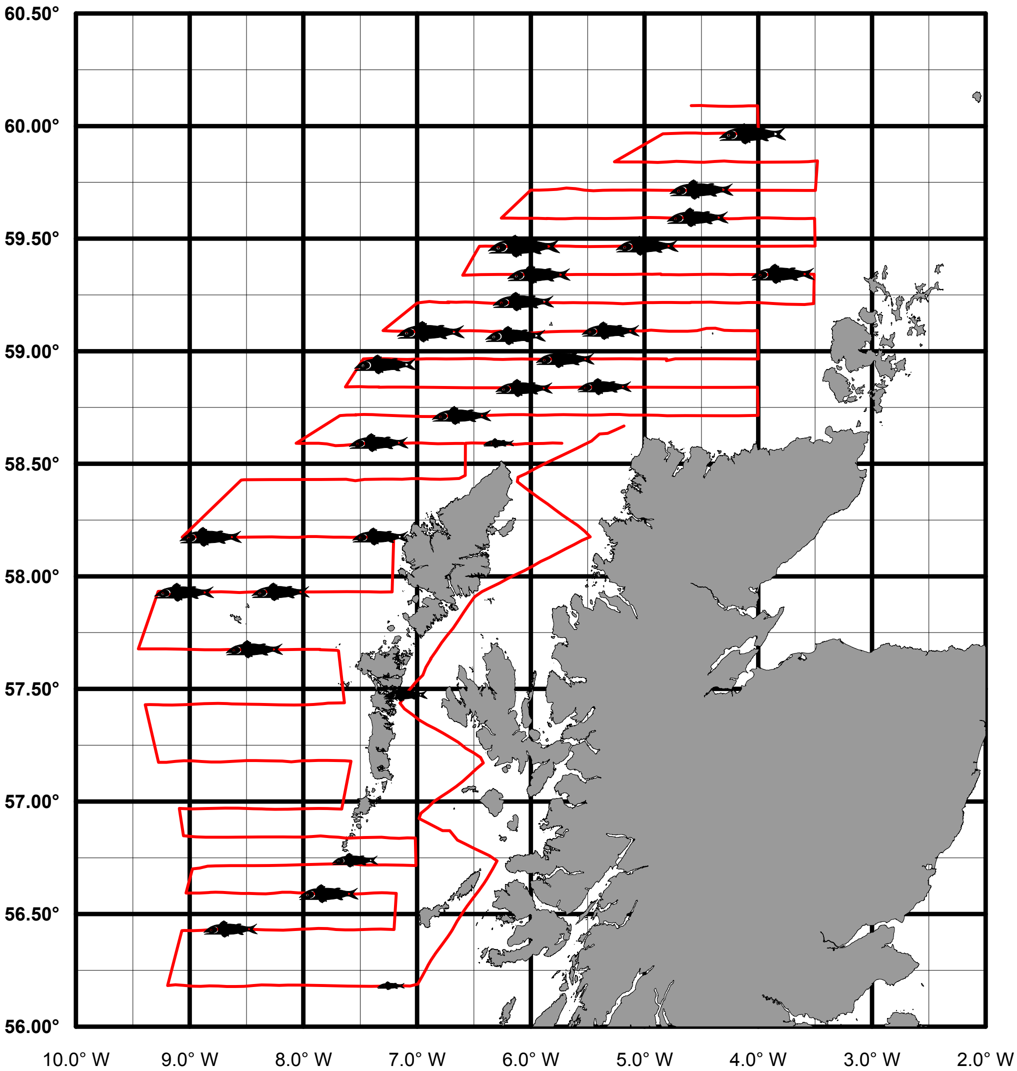


**Figure 2A.3: Map of the west of Scotland with a post plot showing the mean length of herring caught in the trawl hauls carried out during the July 2006 west coast acoustic survey on MFV "Enterprise".**

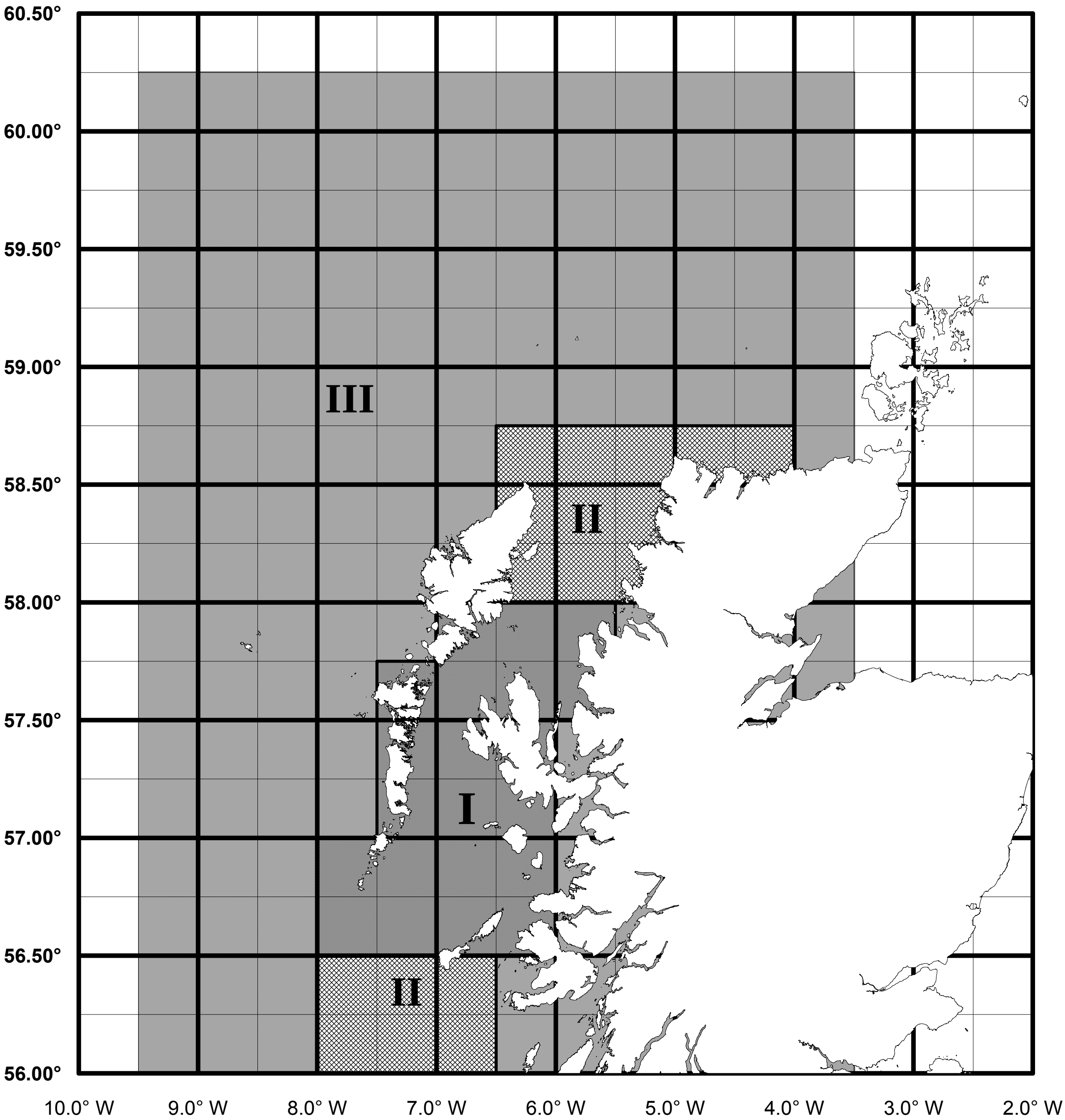


**Figure 2A.4: Map of the west of Scotland showing the area strata (indicated by shaded areas with roman numerals I-III used for combining data from the trawl hauls.**

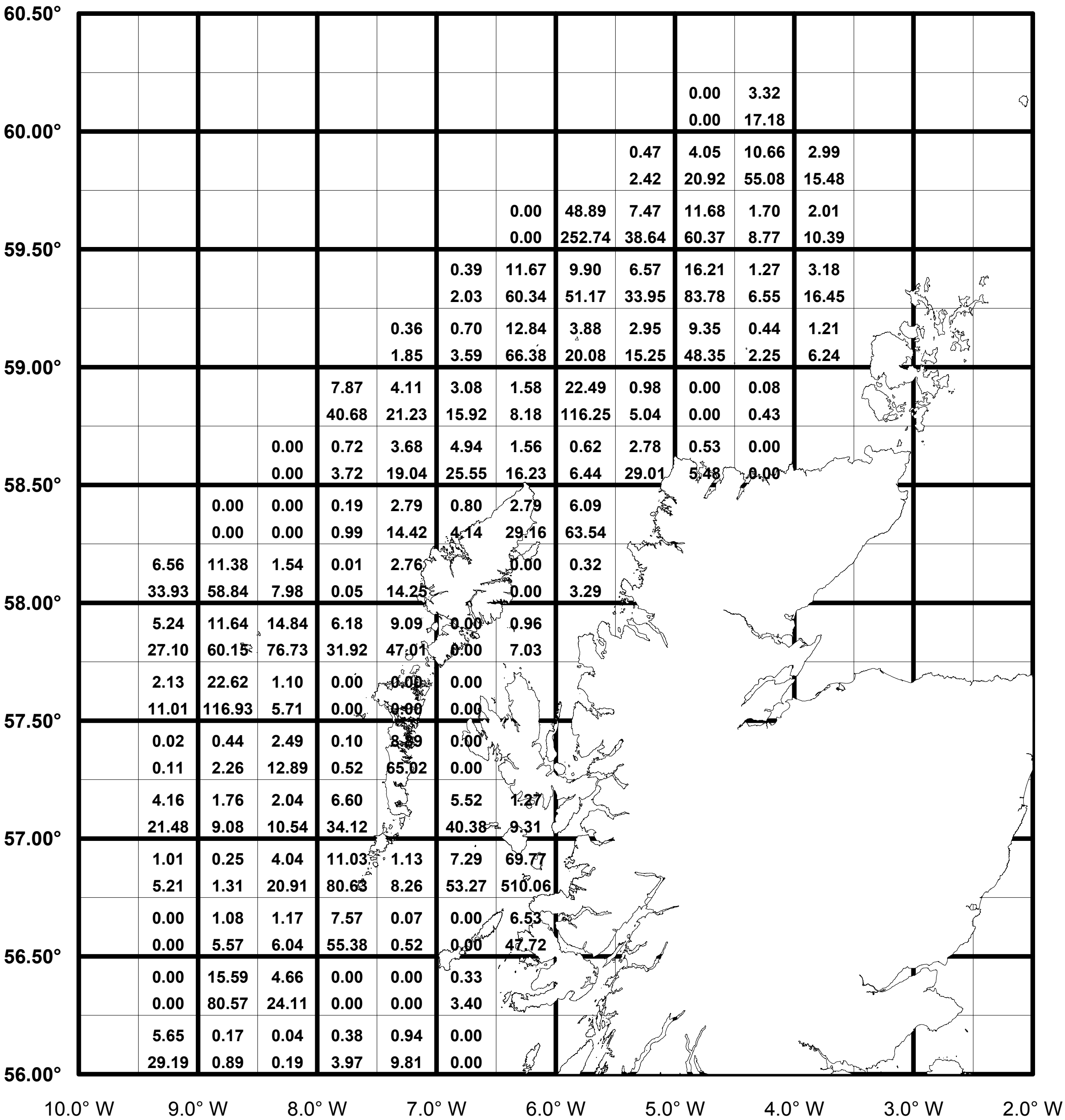


**Figure 2A.5: Map of the west of Scotland with a post plot showing the herring numbers in millions (bottom) and biomass in thousands of tonnes (top) by quarter ICES rectangle obtained during the July 2006 west coast acoustic survey on MFV “Enterprise”.**

**Table 2A.1: Simrad EK60 and analysis settings used on the July 2006 west coast of Scotland herring acoustic survey on MFV "Enterprise". Calibrations a) Loch Erribol 3 July; and b) Loch Broom 11 July. *Milap factor based on a Simrad factor of 1 because calibration settings were incorporated into the Echoview post processing package. Data from the calibration was lost due to computer problems. Fortunately the EK60 was being used for the first time and the settings had been left in their calibration settings, giving a calibration factor for NASCs of 1. Other relevant settings were taken from a screen dump of the transducer parameters taken immediately prior to use.**

| | |
|---|---|
| **TRANSCEIVER MENU** | |
| Frequency | 38 kHz |
| Sound speed | Not available, see above. |
| Max. Power | 2000 W |
| Equivalent two-way beam angle | -20.6 dB |
| Default Transducer Sv gain | 26.66 dB |
| 3 dB Beam width | 7.1° |
| **CALIBRATION DETAILS** | |
| TS of sphere | -42.4 dB |
| Range to sphere in calibration | Not available, see above. |
| Measured NASC value for calibration | Not available, see above. |
| Calibration factor for NASCs | 1 |
| Calibration constant for MILAP (optional)* | 1.1005 at -35 dB |
| **LOG MENU** | |
| Integration performed in Echoview post processing based on 15 minute EDSUs | |
| **OPERATION MENU** | |
| Ping interval | 1 s at 100 m range<br>1.5 s at 250 m range<br>2.5 at 500 m range |
| **ANALYSIS SETTINGS** | |
| Bottom margin (backstep) | 0.5 m |
| Integration start (absolute) depth | 11 m |
| Sv gain threshold | -70 dB |

**Table 2A.2: Details of the fishing trawls taken during the West Coast acoustic survey, July 2006; Trawl depth = depth (m) of headrope; Gear type P=pelagic; Duration of trawl (minutes); Total catch (number of baskets); Use H=used to qualify herring acoustic data, s= used to qualify sprat acoustic data (blank if neither).**

| Haul | Date | Latitude | Longitude | Time | Water Depth | Trawl Depth | Gear Type | Duration | Use | Baskets |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 5/7 | 58° 28.48 ' N | 7° 06.09 ' W | 03 : 43 | 65 | 57 | P | 16 | H | 12 |
| 2 | 5/7 | 56° 10.90 ' N | 7° 13.76 ' W | 17 : 47 | 85 | 77 | P | 37 | H | 1.5 |
| 3 | 6/7 | 56° 26.03 ' N | 8° 38.45 ' W | 08 : 52 | 130 | 122 | P | 30 | H | 6 |
| 4 | 6/7 | 56° 35.44 ' N | 7° 46.67 ' W | 17 : 43 | 105 | 97 | P | 22 | H | 10 |
| 5 | 7/7 | 56° 44.36 ' N | 7° 32.78 ' W | 09 : 02 | 85 | 77 | P | 25 | H | 40 |
| 6 | 7/7 | 56° 50.78 ' N | 9° 00.31 ' W | 19 : 25 | 115 | 107 | P | 20 | | 19 |
| 7 | 9/7 | 57° 40.58 ' N | 8° 25.89 ' W | 04 : 28 | 135 | 127 | P | 24 | H | 3 |
| 8 | 9/7 | 57° 55.76 ' N | 9° 02.90 ' W | 11 : 37 | 150 | 142 | P | 24 | H | 24 |
| 9 | 9/7 | 57° 55.87 ' N | 8° 12.02 ' W | 15 : 47 | 121 | 113 | P | 24 | H | 20 |
| 10 | 9/7 | 58° 10.60 ' N | 7° 19.39 ' W | 22 : 06 | 95 | 87 | P | 13 | H | 3 |
| 11 | 10/7 | 58° 10.52 ' N | 8° 48.94 ' W | 07 : 12 | 172 | 164 | P | 13 | H | 3 |
| 12 | 10/7 | 58° 35.50 ' N | 6° 16.95 ' W | 19 : 05 | 95 | 87 | P | 35 | H | 16 |
| 13 | 12/7 | 58° 35.64 ' N | 7° 20.28 ' W | 15 : 32 | 105 | 97 | P | 18 | H | 30 |
| 14 | 12/7 | 58° 43.04 ' N | 7° 32.26 ' W | 21 : 24 | 114 | 106 | P | 43 | | 0 |
| 15 | 13/7 | 58° 42.87 ' N | 6° 36.52 ' W | 05 : 26 | 125 | 117 | P | 46 | H | 8 |
| 16 | 13/7 | 58° 50.56 ' N | 5° 21.14 ' W | 20 : 30 | 98 | 90 | P | 20 | H | 1.25 |
| 17 | 14/7 | 58° 50.18 ' N | 6° 03.54 ' W | 04 : 03 | 108 | 100 | P | 32 | H | 16 |
| 18 | 14/7 | 58° 56.48 ' N | 7° 16.81 ' W | 09 : 37 | 110 | 102 | P | 27 | H | 60 |
| 19 | 14/7 | 58° 57.97 ' N | 5° 41.86 ' W | 18 : 32 | 100 | 92 | P | 20 | H | 18 |
| 20 | 15/7 | 59° 05.46 ' N | 5° 17.93 ' W | 09 : 54 | 115 | 107 | P | 30 | H | 12 |
| 21 | 15/7 | 59° 04.16 ' N | 6° 08.09 ' W | 14 : 04 | 60 | 52 | P | 18 | H | 18 |
| 22 | 15/7 | 59° 05.20 ' N | 6° 52.79 ' W | 17 : 43 | 180 | 172 | P | 20 | H | 2.75 |
| 23 | 16/7 | 59° 13.23 ' N | 6° 03.98 ' W | 04 : 34 | 108 | 100 | P | 18 | H | 4 |
| 24 | 16/7 | 59° 13.07 ' N | 4° 35.18 ' W | 10 : 07 | 80 | 72 | P | 78 | | 3 |
| 25 | 16/7 | 59° 20.62 ' N | 3° 47.02 ' W | 17 : 27 | 135 | 127 | P | 26 | H | 15 |
| 26 | 17/7 | 59° 20.41 ' N | 5° 56.69 ' W | 05 : 48 | 113 | 105 | P | 20 | | < 1 |
| 27 | 17/7 | 59° 20.43 ' N | 5° 55.76 ' W | 06 : 51 | 115 | 107 | P | 30 | H | 12 |
| 28 | 17/7 | 59° 27.98 ' N | 6° 03.59 ' W | 12 : 40 | 130 | 122 | P | 24 | H | 18 |
| 29 | 17/7 | 59° 28.08 ' N | 4° 58.65 ' W | 17 : 19 | 140 | 132 | P | 10 | H | 20 |
| 30 | 18/7 | 59° 35.66 ' N | 4° 31.99 ' W | 05 : 38 | 95 | 87 | P | 12 | H | 14 |
| 31 | 18/7 | 59° 35.33 ' N | 5° 50.12 ' W | 10 : 41 | 125 | 117 | P | 25 | | 0 |
| 32 | 18/7 | 59° 43.07 ' N | 4° 29.96 ' W | 19 : 16 | 105 | 97 | P | 8 | H | 11.75 |
| 33 | 19/7 | 59° 57.93 ' N | 4° 03.04 ' W | 11 : 42 | 140 | 132 | P | 26 | H | 2 |

**Table 2A.3: Catch composition by trawl haul on the west coast herring acoustic survey. MFV "Enterprise" (3 - 19 July 2006).**

| | HAUL | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Herring | *Clupea harengus* | 2944 | 544 | 1299 | 1760 | 10420 | 11 | 519 | 3960 | 4239 | 586 | 432 |
| Mackerel | *Scomber scombrus* | 38 | | | 30 | | 224 | | 48 | 10 | | |
| Haddock | *Melanogrammus aeglefinus* | | | | | | | | | | | |
| Whiting | *Merlangius merlangus* | | 2 | | 5 | | | | | | | |
| Cod | *Gadus morhua* | | | | | | | | | | | |
| Saithe | *Pollachius virens* | | | | 5 | | | | | | | |
| Norway Pout | *Trisopterus esmarki* | | 303 | | | | | | | | | |
| Poor Cod | *Trisopterus minutus* | | | | | | | | 12 | | | |
| Blue Whiting | *Micromesistius poutassou* | | | | | | | | 24 | | | |
| Lesser Argentine | *Argentina sphyraena* | | | | | | | | | | | |
| Lemon Sole | *Microstomus kitt* | | | | | | | | | | | |
| Grey Gurnard | *Eutrigla gurnardus* | | 2 | | | | | 3 | 12 | | 6 | |
| Hake | *Merluccius merluccius* | | | | | | | | | | | |
| Boar Fish | *Capros aper* | | | | | | 5880 | | 672 | | | |
| Horse Mackerel (Scad) | *Trachurus trachurus* | | | | | | 684 | 2 | 24 | | | |
| Monk fish (Angler) | *Lophius piscatorius* | | | | | | | | | | | |
| Pearlsides | *Maurolicus muelleri* | | | 18 | | | | | | | | |
| Blue-mouth | *Helicolenus dactylopterus* | | | | | | | | | | | |
| Snake Pipefish | *Entelurus aequoreus* | | | | | | | | 60 | | | 38 |
| Long Finned Squid | *Loligo* | | 307 | 18 | 10 | | 6564 | 5 | 804 | | 6 | 38 |

| | HAUL | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Herring | *Clupea harengus* | 5920 | 5085 | | 1496 | 202 | 3130 | 7699 | 3590 | 2266 | 3268 | 333 |
| Mackerel | *Scomber scombrus* | 152 | | | | | 32 | 4561 | | 30 | | 45 |
| Haddock | *Melanogrammus aeglefinus* | | | | 24 | 7 | | | | | | 1 |
| Whiting | *Merlangius merlangus* | | | | 24 | 1 | | | | | | 1 |
| Cod | *Gadus morhua* | | | | | 2 | | | | | | |
| Saithe | *Pollachius virens* | | | | | 1 | | | | | | 1 |
| Norway Pout | *Trisopterus esmarki* | | | | 384 | | | | | | | 93 |
| Poor Cod | *Trisopterus minutus* | | | | 12 | | | | | | | 4 |
| Blue Whiting | *Micromesistius poutassou* | | | | | | | | | | | 245 |
| Lesser Argentine | *Argentina sphyraena* | | | | 20 | | | | | | | 3 |
| Lemon Sole | *Microstomus kitt* | | | | | | | | | | | 1 |
| Grey Gurnard | *Eutrigla gurnardus* | | 15 | | 12 | 22 | | | | 6 | | 6 |
| Hake | *Merluccius merluccius* | | | | | | | | | | | 4 |
| Boar Fish | *Capros aper* | | | | | | | | | | | |
| Horse Mackerel (Scad) | *Trachurus trachurus* | | | | 4 | | | | | | | 28 |
| Monk fish (Angler) | *Lophius piscatorius* | | | | 8 | | | | | | | |
| Pearlsides | *Maurolicus muelleri* | | | | | | | | | | | |
| Blue-mouth | *Helicolenus dactylopterus* | | | | | | | | | | | 2 |
| Snake Pipefish | *Entelurus aequoreus* | | 360 | | 72 | | | | | 114 | | 169 |
| Long Finned Squid | *Loligo* | | 375 | | 560 | 33 | | | | 120 | | 558 |

**Table 2A.3 (cont.): Catch composition by trawl haul on the west coast herring acoustic survey. MFV "Enterprise" (3 - 19 July 2006).**

| | **Haul** | **23** | **24** | **25** | **26** | **27** | **28** | **29** | **30** | **31** | **32** | **33** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Herring | *Clupea harengus* | 612 | 40 | 2299 | | 1908 | 2322 | 3571 | 2368 | | 1903 | 279 |
| Mackerel | *Scomber scombrus* | | 1046 | | 1 | 36 | 346 | | 84 | | 222 | 11 |
| Haddock | *Melanogrammus aeglefinus* | | | | | | | | | | | |
| Whiting | *Merlangius merlangus* | | | 15 | | | | | | | | 4 |
| Cod | *Gadus morhua* | | | | | | | | | | | |
| Saithe | *Pollachius virens* | | | | | | | | | | | 1 |
| Norway Pout | *Trisopterus esmarki* | | | 62 | | | | | | | | |
| Poor Cod | *Trisopterus minutus* | | | | | | | | | | | |
| Blue Whiting | *Micromesistius poutassou* | | | | | | | | | | | |
| Lesser Argentine | *Argentina sphyraena* | | | | | | | | | | | |
| Lemon Sole | *Microstomus kitt* | | | | | | | | | | | |
| Grey Gurnard | *Eutrigla gurnardus* | | 13 | 15 | 1 | | | | | | | 7 |
| Hake | *Merluccius merluccius* | | | | | | | | | | | |
| Boar Fish | *Capros aper* | | | | | | | | | | | |
| Horse Mackerel (Scad) | *Trachurus trachurus* | | | | | | | | | | | |
| Monk fish (Angler) | *Lophius piscatorius* | | | | | | | | | | | |
| Pearlsides | *Maurolicus muelleri* | | | | | | | | | | | |
| Blue-mouth | *Helicolenus dactylopterus* | | | | | | | | | | | |
| Snake Pipefish | *Entelurus aequoreus* | | | | (n/a) | | | | | | | |
| Long Finned Squid | *Loligo* | | 13 | 92 | 1 | | | | | | | 12 |

**Table 2A.4: Herring length frequency proportion by trawl haul by sub-area for west coast acoustic survey MFV "Enterprise" (3 - 19 July 2006). Length in cm, weight in g, TS=target strength in dB.**

| L(CM) | I | | | II | | | III | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 5 | MEAN | 2 | 12 | MEAN | 3 | 4 | 7 | 8 | 9 |
| 18.5 | | | | | 0.3 | 0.3 | | | | | |
| 19.0 | | | | 2.8 | 1.1 | 1.3 | | | | | |
| 19.5 | 0.6 | | 0.1 | 4.8 | 6.3 | 6.2 | | | | | |
| 20.0 | 2.0 | | 0.4 | 8.5 | 18.3 | 17.5 | | | | | |
| 20.5 | 3.0 | | 0.7 | 11.5 | 17.7 | 17.2 | | | | | |
| 21.0 | 6.4 | | 1.4 | 21.0 | 18.0 | 18.2 | | | | | |
| 21.5 | 4.0 | | 0.9 | 18.2 | 7.1 | 8.1 | | | | | |
| 22.0 | 1.8 | | 0.4 | 16.3 | 0.6 | 1.9 | | | | | |
| 22.5 | 0.6 | | 0.1 | 6.3 | 0.9 | 1.3 | | | | | |
| 23.0 | 4.4 | 0.3 | 1.2 | 4.5 | 0.9 | 1.2 | | | | | |
| 23.5 | 6.2 | 6.1 | 6.1 | 1.7 | 2.4 | 2.3 | 0.5 | | | | |
| 24.0 | 12.6 | 24.9 | 22.2 | 2.2 | 4.5 | 4.3 | 3.5 | 2.6 | 0.4 | 0.3 | |
| 24.5 | 12.6 | 24.9 | 22.2 | 1.3 | 4.1 | 3.9 | 7.9 | 4.0 | 1.5 | | |
| 25.0 | 11.4 | 22.3 | 19.9 | 0.6 | 4.7 | 4.3 | 13.9 | 5.4 | 2.1 | | 0.4 |
| 25.5 | 6.8 | 7.7 | 7.5 | 0.4 | 2.8 | 2.6 | 10.2 | 2.8 | 4.4 | 0.9 | 2.6 |
| 26.0 | 7.8 | 4.5 | 5.2 | | 2.2 | 2.0 | 12.5 | 4.5 | 11.6 | 4.2 | 8.8 |
| 26.5 | 4.6 | 1.9 | 2.5 | | 0.9 | 0.9 | 10.4 | 5.4 | 18.5 | 10.3 | 16.5 |
| 27.0 | 6.4 | 1.9 | 2.9 | | 2.4 | 2.2 | 12.5 | 12.2 | 23.7 | 27.9 | 30.9 |
| 27.5 | 4.2 | 1.9 | 2.4 | | 1.8 | 1.7 | 12.2 | 15.9 | 18.5 | 22.4 | 22.1 |
| 28.0 | 3.6 | 2.9 | 3.0 | | 1.6 | 1.4 | 10.9 | 21.9 | 14.5 | 21.5 | 13.6 |
| 28.5 | 0.8 | 0.6 | 0.6 | | 0.9 | 0.9 | 3.5 | 11.6 | 4.4 | 9.7 | 5.1 |
| 29.0 | | 0.2 | 0.1 | | 0.5 | 0.4 | 1.2 | 8.2 | 0.4 | 2.4 | |
| 29.5 | | | | | | | 0.9 | 4.3 | | 0.3 | |
| 30.0 | | | | | 0.1 | 0.1 | | 1.1 | | | |
| 30.5 | | | | | | | 0.2 | | | | |
| 31.0 | | | | | | | | | | | |
| 31.5 | | | | | | | | | | | |
| 32.0 | | | | | | | | | | | |
| 32.5 | | | | | | | | | | | |
| 33.0 | | | | | | | | | | | |
| 33.5 | | | | | | | | | | | |
| 34.0 | | | | | | | | | | | |
| Number | 2994.0 | 10420.0 | | 539.0 | 5920.0 | | 1299.0 | 1760.0 | 519.0 | 3960.0 | 4239.0 |
| | | | | | | | | | | | |
| mean length | 24.9 | 25.3 | 25.3 | 21.9 | 22.5 | 22.4 | 26.9 | 27.9 | 27.4 | 27.9 | 27.6 |
| mean weight | 133.4 | 137.8 | 136.8 | 85.2 | 96.8 | 95.8 | 167.0 | 188.9 | 178.5 | 188.4 | 181.7 |
| TS/individual | -43.2 | -43.1 | -43.1 | -44.4 | -44.1 | -44.1 | -42.6 | -42.3 | -42.4 | -42.3 | -42.4 |
| TS/kilogramme | -34.5 | -34.5 | -34.5 | -33.7 | -34.0 | -34.0 | -34.8 | -35.0 | -34.9 | -35.0 | -35.0 |

**Table 2A.4 (cont.): Length frequency proportion by trawl haul by sub- area for west coast acoustic survey MFV "Enterprise" (3 - 19 July 2006). Length in cm, weight in g, TS=target strength in dB.**

| L(CM) | III | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10 | 11 | 13 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| 18.5 | | | | | | | | | | |
| 19.0 | | | | | | | | | | |
| 19.5 | | | | | | | | | | |
| 20.0 | | | | | | | | | | |
| 20.5 | | | | | | 0.3 | | | | |
| 21.0 | | | | | | 0.3 | | | | |
| 21.5 | | | | | | | | | | |
| 22.0 | | | | | | | | | | |
| 22.5 | | | | | | 0.3 | | | | |
| 23.0 | | | | | | | | | | |
| 23.5 | | | | | | | | | 0.4 | |
| 24.0 | 0.3 | | | | 1.5 | 0.9 | | | 1.1 | |
| 24.5 | | | | 0.5 | 5.0 | 1.7 | | 1.2 | 0.7 | |
| 25.0 | 2.4 | | 0.3 | | 16.3 | 1.7 | | 0.8 | 3.3 | |
| 25.5 | 5.6 | 0.7 | 0.6 | 2.2 | 9.9 | 3.5 | 0.4 | 2.4 | 6.2 | |
| 26.0 | 16.2 | 1.4 | 5.9 | 2.7 | 15.8 | 9.1 | 2.6 | 6.8 | 6.9 | |
| 26.5 | 20.5 | 6.0 | 13.9 | 16.4 | 11.9 | 16.5 | 7.7 | 20.0 | 17.8 | 6.0 |
| 27.0 | 27.8 | 10.9 | 26.8 | 22.3 | 16.8 | 28.2 | 12.5 | 23.6 | 17.8 | 21.2 |
| 27.5 | 16.9 | 22.0 | 22.4 | 24.5 | 11.9 | 20.4 | 24.9 | 22.8 | 22.9 | 39.1 |
| 28.0 | 8.0 | 31.7 | 19.8 | 21.2 | 8.9 | 9.5 | 21.2 | 14.0 | 13.5 | 24.5 |
| 28.5 | 1.0 | 16.4 | 6.5 | 8.1 | 1.0 | 6.9 | 16.1 | 4.4 | 5.8 | 7.1 |
| 29.0 | 0.3 | 7.6 | 3.2 | 1.1 | 0.5 | 0.9 | 8.1 | 0.8 | 1.8 | 1.1 |
| 29.5 | | 1.9 | | 0.8 | 0.5 | | 4.0 | 0.8 | 0.7 | 0.6 |
| 30.0 | 0.5 | 1.4 | | 0.3 | | | 0.6 | 0.5 | 0.5 | 0.6 |
| 30.5 | | | 0.3 | | | | 1.3 | 0.6 | | |
| 31.0 | 0.3 | | 0.3 | | | | 0.1 | 0.3 | | |
| 31.5 | | | | | | | | 0.3 | 0.3 | |
| 32.0 | | | | | | | 0.3 | 0.3 | 0.3 | |
| 32.5 | | | | | | | 0.1 | 0.3 | | |
| 33.0 | | | | | | | 0.1 | 0.1 | | |
| 33.5 | | | | | | | | | | |
| 34.0 | | | | | | | | | | |
| Number | 586.0 | 432.0 | 5085.0 | 1488.0 | 202.0 | 3185.0 | 7699.0 | 3590.0 | 2266.0 | 3250.0 |
| | | | | | | | | | | |
| mean length | 27.3 | 28.4 | 27.9 | 27.9 | 26.8 | 27.4 | 28.4 | 27.7 | 27.6 | 28.1 |
| mean weight | 175.6 | 198.6 | 187.1 | 187.1 | 166.0 | 178.8 | 199.1 | 184.2 | 181.1 | 191.7 |
| TS/individual | -42.5 | -42.1 | -42.3 | -42.3 | -42.6 | -42.4 | -42.1 | -42.3 | -42.4 | -42.2 |
| TS/kilogramme | -34.9 | -35.1 | -35.0 | -35.0 | -34.8 | -34.9 | -35.1 | -35.0 | -35.0 | -35.1 |

**Table 2A.4 (cont.): Length frequency proportion by trawl haul by sub- area for west coast acoustic survey MFV "Enterprise" (3 - 19 July 2006). Length in cm, weight in g, TS=target strength in dB.**

| L(CM) | III | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 22 | 23 | 25 | 27 | 28 | 29 | 30 | 32 | 33 | MEAN |
| 18.5 | | | | | | | | | | |
| 19.0 | | | | | | | | | | |
| 19.5 | | | | | | | | | | |
| 20.0 | | | | | | | | | | |
| 20.5 | | | | | | | | | | 0.0 |
| 21.0 | | | | | | | | | | 0.0 |
| 21.5 | | | | | | | | | | |
| 22.0 | | | | | | | | | | |
| 22.5 | | | | | | | | | | 0.0 |
| 23.0 | | | | | | | | | | |
| 23.5 | | | | | | | | | | 0.0 |
| 24.0 | | | | | | | | | | 0.3 |
| 24.5 | | | | | | | | | | 0.6 |
| 25.0 | | | 1.0 | | | 0.8 | | | | 1.0 |
| 25.5 | | | | | 0.3 | 0.4 | 0.4 | 0.5 | | 1.6 |
| 26.0 | | | 2.0 | | | 1.2 | 1.9 | 1.5 | 1.1 | 4.3 |
| 26.5 | 0.3 | 5.6 | 6.2 | 1.8 | 0.3 | 3.1 | 6.8 | 3.9 | | 10.1 |
| 27.0 | 2.1 | 18.0 | 16.3 | 9.4 | 1.6 | 12.0 | 18.8 | 8.4 | 1.4 | 18.9 |
| 27.5 | 14.7 | 31.4 | 16.0 | 35.9 | 6.2 | 23.6 | 21.5 | 17.7 | 7.9 | 22.5 |
| 28.0 | 17.7 | 27.5 | 18.9 | 21.2 | 11.4 | 25.6 | 27.1 | 30.0 | 23.3 | 19.2 |
| 28.5 | 17.4 | 12.4 | 13.0 | 15.9 | 6.7 | 21.3 | 13.6 | 17.2 | 24.4 | 10.4 |
| 29.0 | 15.3 | 4.2 | 8.8 | 7.0 | 11.4 | 5.4 | 7.9 | 10.8 | 19.4 | 4.6 |
| 29.5 | 12.6 | 1.0 | 6.5 | 4.7 | 9.0 | 2.3 | 1.5 | 4.4 | 9.7 | 2.2 |
| 30.0 | 7.8 | | 4.9 | 0.6 | 17.3 | 1.5 | 0.3 | 2.0 | 3.2 | 1.4 |
| 30.5 | 4.8 | | 2.3 | 1.3 | 12.9 | 1.5 | | 0.8 | 3.2 | 1.1 |
| 31.0 | 3.0 | | 2.3 | 0.6 | 8.5 | 0.4 | | 1.2 | 2.2 | 0.6 |
| 31.5 | 2.4 | | 1.7 | 0.9 | 7.0 | 0.4 | 0.3 | 0.6 | 1.8 | 0.5 |
| 32.0 | 0.6 | | | 0.3 | 4.7 | 0.4 | | | 1.8 | 0.3 |
| 32.5 | | | | | 1.6 | | | 0.3 | 0.4 | 0.1 |
| 33.0 | | | | | 0.5 | | | 0.3 | 0.4 | 0.1 |
| 33.5 | 0.0 | | | 0.3 | 0.5 | | | 0.6 | | 0.1 |
| 34.0 | 0.0 | | | | 0.3 | | | | | 0.0 |
| Number | 333.0 | 612.0 | 2299.0 | 1908.0 | 2322.0 | 3571.0 | 2368.0 | 1903.0 | 279.0 | |
| | | | | | | | | | | |
| mean length | 29.4 | 28.2 | 28.6 | 28.5 | 30.2 | 28.5 | 28.2 | 28.7 | 29.3 | 28.1 |
| mean weight | 223.6 | 194.7 | 205.7 | 203.1 | 245.9 | 201.2 | 195.9 | 206.2 | 220.6 | 193.4 |
| TS/individual | -41.8 | -42.2 | -42.1 | -42.1 | -41.6 | -42.1 | -42.2 | -42.0 | -41.9 | -42.2 |
| TS/kilogramme | -35.3 | -35.1 | -35.2 | -35.2 | -35.5 | -35.1 | -35.1 | -35.2 | -35.3 | -35.1 |

**Table 2A.5: Age/maturity-length key for herring (numbers of fish sampled MFV “Enterprise” (3–19 July 2006).**

| | NUMBER AT AGE / MATURITY | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LENGTH (CM) | 0 | 1 | 2I | 2M | 3I | 3M | 4 | 5 | 6 | 7 | 8 | 9+ | GRAND TOTAL |
| 18.5 | | 1 | | | | | | | | | | | 1 |
| 19 | | 2 | | | | | | | | | | | 2 |
| 19.5 | | 3 | | | | | | | | | | | 3 |
| 20 | | 3 | | | | | | | | | | | 3 |
| 20.5 | | 4 | 1 | | | | | | | | | | 5 |
| 21 | | 3 | | | | | | | | | | | 3 |
| 21.5 | | 3 | 1 | | | | | | | | | | 4 |
| 22 | | 2 | 1 | | | | | | | | | | 3 |
| 22.5 | | 4 | 5 | 2 | | | | | | | | | 11 |
| 23 | | | 8 | 8 | | | | | | | | | 16 |
| 23.5 | | | 10 | 13 | | | | | | | | | 23 |
| 24 | | | 5 | 37 | | 1 | | | | | | | 43 |
| 24.5 | | | 4 | 43 | | 2 | | | | | | | 49 |
| 25 | | | | 51 | | 10 | 1 | 1 | | | | | 63 |
| 25.5 | | | 3 | 57 | | 18 | 4 | | | | | | 82 |
| 26 | | | | 42 | | 41 | 8 | 9 | 1 | 1 | | | 102 |
| 26.5 | | | | 17 | | 44 | 22 | 35 | 3 | 2 | | | 123 |
| 27 | | | | 11 | | 26 | 32 | 55 | 10 | 4 | | | 138 |
| 27.5 | | | | 5 | | 25 | 48 | 97 | 72 | 26 | 1 | 3 | 277 |
| 28 | | | | 2 | | 13 | 27 | 78 | 99 | 47 | 3 | 7 | 276 |
| 28.5 | | | | | | 4 | 15 | 53 | 86 | 60 | 5 | 19 | 242 |
| 29 | | | | | | 1 | 5 | 34 | 56 | 42 | 15 | 18 | 171 |
| 29.5 | | | | | | | 3 | 26 | 37 | 20 | 5 | 17 | 108 |
| 30 | | | | | | 1 | 6 | 15 | 21 | 18 | 4 | 10 | 75 |
| 30.5 | | | | | | | 4 | 11 | 20 | 15 | 2 | 11 | 63 |
| 31 | | | | | | | 1 | 6 | 7 | 27 | 1 | 3 | 45 |
| 31.5 | | | | | | | | 7 | 8 | 12 | 3 | 8 | 38 |
| 32 | | | | | | | 1 | 1 | 5 | 6 | | 6 | 19 |
| 32.5 | | | | | | | | 3 | 1 | 3 | 1 | 7 | 15 |
| 33 | | | | | | | | | 1 | 2 | | 4 | 7 |
| 33.5 | | | | | | | | 1 | 1 | 4 | 1 | 4 | 11 |
| 34 | | | | | | | | | | 1 | | 1 | 2 |
| Grand Total | | 25 | 38 | 288 | | 186 | 177 | 432 | 428 | 290 | 41 | 118 | 2023 |

**Table 2A.6: Mean length, mean weight, biomass (thousands of tonnes) and numbers (millions) breakdown by age and maturity obtained during the MFV "Enterprise" 2006 herring acoustic survey.**

| TOTAL AREA | | | | | | |
|---|---|---|---|---|---|---|
| Age (ring) | Mean Length (cm) | Mean Weight (g) | Numbers (x $10^6$) | % | Biomass (x $10^3$ T) | % |
| 1 | 20.57 | 74.99 | 122 | 4 | 9.12 | 2 |
| 2i | 23.73 | 119.26 | 162 | 5 | 19.28 | 4 |
| 2m | 24.88 | 138.14 | 682 | 23 | 94.23 | 18 |
| 3i | 27.04 | 179.85 | 14 | 0 | 2.57 | 1 |
| 3m | 26.30 | 165.19 | 380 | 13 | 62.69 | 12 |
| 4 | 27.29 | 185.42 | 290 | 10 | 53.81 | 11 |
| 5 | 27.60 | 192.48 | 594 | 20 | 114.36 | 22 |
| 6 | 28.11 | 204.13 | 423 | 14 | 86.35 | 17 |
| 7 | 28.39 | 211.22 | 231 | 8 | 48.86 | 10 |
| 8 | 28.92 | 224.04 | 22 | 1 | 4.95 | 1 |
| 9+ | 29.17 | 231.01 | 61 | 2 | 13.99 | 3 |
| Mean | 56.46 | 171.18 | | | | |
| Total | | | 2980 | 100 | 510.19 | 100 |
| Immature | | | 297 | 10 | 30.96 | 6 |
| Mature | | | 2683 | 90 | 479.23 | 94 |

## Annex 2B: Denmark

### Acoustic Herring Survey report for RV "DANA"

23 June2006 – 6 July 2006

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## 1. Introduction

Since 1991 the Danish Institute for Fisheries Research (DIFRES) has participated in the ICES co-ordinated herring acoustic survey of the North Sea and adjacent waters with the responsibility for the surveying the Skagerrak and Kattegat area.

The actual 2006-survey with RV "DANA", covering the Skagerrak and Kattegat, was conducted in the period 25 June to 6 July 2006, while calibration was done during 23–25 June.

## 2. Survey

### 2.1 Personnel

***During calibration 23/6 – 25/6-2006***

| | |
|---|---|
| Bo Lundgren (cruise leader) | HFI |
| Torben Filt Jensen(assisting cruise leader) | ITT |
| Tommy Nielsen | ITT |
| Bo Tegen Nielsen | ITT |
| Martin Nielsen, technician trainee | |
| Jan Skriver, journalist | |

**During acoustic monitoring 25/6 - 6/7-2006**

| | |
|---|---|
| Bo Lundgren (cruise leader) | HFI |
| Karl-Johan Stæhr (assisting cruise leader) | HFI |
| Lotte Worsøe Clausen | HFI |
| Lise Sindahl | HFI |
| Helle Rasmussen | HFI |
| Sanne B. Ryle | HFI |
| Nina Fuglsang | HFI |
| Thyge Dyrnesli | ITT |

**HFI = Dept for Marine Fisheries, DIFRES, Denmark**

**ITT = Dept. of IT and Technical Support, DIFRES, Denmark**

**ADM = Administration Dept, DIFRES, Denmark**

### 2.2 Narrative

RV “Dana” left Hirtshals on 23 June 2006 at 12.00 to perform transducer calibration in the Danish part of Kattegat and not as normally at Bornø in the Gullmar Fjord in Sweden. This because a mail with the application to get a permission to enter Swedish waters due to unknown technical reasons did not reach the contact person responsible for sending the applications to the authorities.

RV “Dana” stopped outside Frederikshavn harbour on 25 July 2006 at 14.00 for exchange of scientific personnel and left again at 16.00 Danish local time (14.00 UTC) steaming towards the north-westerly corner of the survey area in the Skagerrak. The survey work (acoustic integration) started at the position 58º 08.15´ N 06º 14.99´ E in the north-western part of the Skagerrak. The western Skagerrak area was covered 26–30 June, eastern Skagerrak during 30 June – 3 July and Kattegat during 4–6 July. Short stops were made just outside Hirtshals on July 1 and just outside Skagen on July 3 to change a crew member. Totally the survey covered about 1800 nautical miles mainly using data from the 38 kHz paravane transducer running at depths of 4 – 6 m depending on the sea state and sailing direction relative to the waves. Simultaneously data from the 120 kHz and 18 kHz echosounders using the hull-mounted transducers were also recorded. The quality of the latter data is strongly dependent on the weather conditions, but this year the weather was calm so only about a days time of data were unusable. During trawling hull-mounted transducers were used for all three frequencies. The acoustic integration ended north of Skagen at 6 July, 06.30 UTC on the position 57º 35.66´ N 09º 57.59´ E. “Dana” went to harbour in Hirtshals on 11 July 2005 at 09.30 hour local time.

### 2.3 Survey design

The survey was carried out in the Kattegat and in the Skagerrak, east of 6° E and north of 56° N (Figure IIB.1). The area is split into 7 sub-areas surveyed by “Dana” and one overlap area to be surveyed also by the Norwegian and German survey partners. This year the survey was started in the eastern Kattegat and ended in the western Skagerrak in order to reach the overlap area on June 10$^{th}$ at the same time as the other partners. In principal the survey is designed with parallel survey tracks at right angles to the depth lines with a spacing of 10-15 nm in the area west of 10°E. Due to limited time periods and places for fishing (late morning, early afternoon and immediately before and after midnight; limited amount of fishable positions for bottom trawl hauls) this structure cannot not be kept strictly. Along the Swedish coast, the transects are planned as east-west transects with a spacing of 10 nm approximately at right angles to the coastline. In Kattegat the survey track was made in a zigzag way adapted to the depth curves and the relatively heavy ship traffic.

### 2.4 Calibration

The echo sounders were calibrated at two different locations in Kattegat during 24 - 25 June 2006. The calibration was performed according to the procedures established for EK60 with three frequencies (18, 38 and 120 kHz). This was the second calibration of the year, the previous one during a cruise to the Norwegian Sea in May. The calibration of the paravane split-beam transducer at 38 kHz was done against a 60 mm copper sphere at a position in Aalbæk Bugt (57° 36.77’N 10° 34.18’E). Calibration of the three hull-mounted split-beam transducers at 18, 38 and 120 kHz were carried out against 63mm, 60 mm and 23 mm copper spheres, respectively at a position just north of Læsø (57° 28.48’N 11° 03.72’E). The results were similar to the previous calibration earlier in the year, and for 38 kHz close to results from previous years. The calibration and setup data of the EK60 38 kHz used during the survey are shown in Table IIB.1.

### 2.5 Acoustic data collection

Acoustic data were collected using mainly the Simrad EK60 38kHz echosounder with the transducer (Type ES 38 7x7 degrees main lobe) in a towed body. The towed body runs at approx. 3 m depth in good weather and down to about 6–7 m as needed depending on the weather conditions, this year mostly at 4 – 5 m. The speed of the vessel during acoustic sampling was 9 – 11 knots. Also EK60 18 kHz and 120 kHz data were collected, but has not been directly used for the survey estimate but as an aid when distinguishing between fish and plankton. Acoustic data were recorded as raw data on hard disk all 24 hours also during fishing operations, but data taken during fishing periods (usually two daytime hauls and two night-time hauls (the latter immediately before and after local midnight)) are not used for the biomass estimate. The sampling unit (ESDU) was one nautical mile (nm). For the purpose of the later judging process raw data is also pre-integrated into 1 m meter samples for each ping. These samples stored in separate files one for each ESDU. Integration is conducted from 3 m below the transducer to 1 m above the bottom or to max 300 m depth. During trawl hauls the towed body is taken aboard and the EK60 38 kHz echosounder run on the hull transducer.

### 2.6 Biological data - fishing trawls

Trawl hauls were carried out during the survey for species identification. Pelagic hauls were carried out using a FOTÖ trawl (16 mm in the codend) while demersal hauls (Figure IIB.2) were carried out using an EXPO trawl (16 mm in the codend). Trawling was carried out in the time intervals 1000 to 1600 and 2200 to 0300 UTC (Table IIB.2), usually two day hauls (mostly demersal and two night hauls (mostly surface or midwater). The strategy was to cover most depth zones within each geographical stratum (see Figure IIB.2). In the deeper areas midwater hauls were made to help identify the largest depth at which herring would be expected. 1 hour hauls were used as a standard during the survey, but sometimes shortened if the catch indicators indicated very large catches.

The fish caught were sorted into species groups and length groups within each species. Number of individuals and weight for each length group for each species was recorded with emphasis on pelagic species. The clupeid fish were measured to the nearest 0.5 cm total length below, other fish to 1 cm, and the weight to the nearest 0.1g wet weight. In each trawl haul 10 (if available) herring per 0.5 cm length class were sampled for determination of age, race (North Sea autumn spawners or Baltic Sea spring spawners) and maturity. Micro-structure formed during the larval period was used for the discrimination of herring race. Maturity was determined according to an 8-stage scale as also used by Scotland (see Survey Manual App IV).

### 2.7 Hydrographic data

CTD profiles with a Seabird 911 were made immediately before or after each trawl haul. Salinity and temperature were measured continuously during the cruise at an intake at about 5 m depth. Data is stored together with position and weather data in the vessel's general information system. The distribution of CTD stations is shown in Figure IIB.2.

### 2.8 Data analysis

The raw data is preintegrated into 1m samples for each ping and divided into 1 mile datasets and stored on harddisk as files. Scrutiny of the acoustic data is done for a fixed set of layers (3–6 m, 6–10, 10–20 and so on) for each mile, using special judging software. It allows deleting layers and/or intervals with interference from wave- or ship wake-bubbles or rarely with bottom-integration. In areas with heavy abundance of jellyfish or zooplankton, usually krill, manually adjustable thresholds is applied separately to each layer to suppress background echoes

For each sub area the mean back scattering cross section was estimated for herring, sprat, gadoids and mackerel based on the TS-relationships given in the Manual for Herring Acoustic Surveys in ICES Division III, IV, and IVa (ICES 2000):

$$\text{Herring TS} = 20 \log L - 71.2 \text{ dB}$$

$$\text{Sprat TS} = 20 \log L - 71.2 \text{ dB}$$

$$\text{Gadoids TS} = 20 \log L - 67.5 \text{ dB}$$

$$\text{Mackerel TS} = 20 \log L - 84.9 \text{ dB}$$

where L is the total length in cm. The number of fish per species is assumed to be in proportion to the contribution of the given species in the trawl hauls. Therefore, the relative density of a given species is estimated by subarea using the species composition in the trawl hauls. The nearest trawl hauls are allocated to subareas with uniform depth strata. The length-race and length-age distributions for herring are assumed to be in accordance with the length-race and length-age distributions in the allocated trawl hauls.

Length-weight relationships by race for the herring were made based on the single fish sampled in each haul and frozen for later for micro-structure analysis of the otolith after the cruise.

# 3. Results & Discussion

## 3.1 Acoustic data

The total number of acoustic sample units of 1 nm (ESDU's) used in the stock size calculation is about 1300. Herring and sprat was not observed in mid-water trawl hauls at depths below 150 meters. Therefore, layers below 150 meter were excluded from the estimation.

## 3.2 Biological data

35 hauls were conducted (24 surface hauls, 2 mid water hauls, one of which was unsuccessful, and 10 bottom hauls (Figure IIB.2 and Tables IIB2 and IIB.3.). The total catch was 18 tons of which about 2.2 tons were jellyfish. Herring was present in 30 of the hauls and a total catch of about 2800 kg was taken during the survey. In only one haul herring was present below 150 m depths. Noticeable amounts of sprat were caught in two hauls in the southwestern Skagerrak and relatively large amounts in 8 hauls in Kattegat a total of 4100 kg for the whole survey. Mackerel was also present in many (24) of the hauls distributed over the survey area. Otherwise jellyfish and other invertebrates (krill, shrimp, and Norway lobster) were the most common among the remaining species.

Based on maturity analysis of frozen single fish samples from each haul, where micro-structure analysis of the otoliths was used to differentiate between North Sea herring and Western Baltic herring, the maturity by age key was made for both races is given in the text table below. North Sea autumn spawners at maturity stage 3 and up and spring-spawners at maturity state 2 and up have been considered as mature. The following constants have been used to split the catch.

*North Sea autumn spawners:*

| WR | 0 | 1i | 1m | 2i | 2m | 3i | 3m | 4i | 4m | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| % | 100 | 100 | 0 | 93 | 7 | 100 | 0 | - | - | 100 | 100 | 100 | 100 |

*Spring spawners:*

| WR | 0 | 1i | 1m | 2i | 2m | 3i | 3m | 4i | 4m | 5 | 6i | 7 | 8 | 9+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| % | 100 | 99 | 1 | 97 | 3 | 86 | 14 | 80 | 20 | 100 | 100 | 100 | 100 | 100 |

Figure IIB.4.a shows the length-weight relations for various age groups and the average for the two races based on the single fish data. The trendline estimates are based on the points of the average relations. Figure IIB.4.b shows the length-weight relations for sprat.

Table IIB.4.a shows the size distribution and total number of herring in each trawl haul based on the total catch for small catches or on subsamples raised to total catch for large samples. Table IIB.4.b shows the corresponding total catches.

### 3.3 Biomass estimates

The total herring biomass estimate for the survey is 567,000 tonnes of which 27.0% or 153,000 tonnes is North Sea autumn spawning herring and 73.0% or 414,000 tonnes is spring spawning herring.

The estimated total number of herring, mean weight and mean length per age and maturity group in each of the surveyed strata for the two herring stock components in the are given in Table IIB.5.a, b, and c. Stratum 560E06 is the overlap area and the others together is the standard Danish survey area.

Figures IIB.5.a and b show plots of the estimated number of either autumn spawning or spring spawning herring per stratum and and the total.

**STRATUM OVERVIEW ACOUSTIC HERRING SURVEY RV "DANA" CRUISE 042005 JULY 2005**

| STRATUM NR | STRATUM ID | AREA NM^2 | NUMBER OF LOGS | HAULS IN STRATUM | HAULS FROM NEIGHBOUR STRATA | TOTAL HAULS USED | MEAN SA | MEAN TS |
|---|---|---|---|---|---|---|---|---|
| 3 | 580E06 | 209 | 5 | 0 | 4 | 4 | 31.29948 | -47.3408 |
| 4 | 570E06 | 3600 | 303 | 7 | 3 | 10 | 192.0751 | -47.40157 |
| 5 | 580E08 | 1822 | 95 | 4 | 1 | 5 | 62.3704 | -43.64462 |
| 6 | 570E08 | 3406 | 320 | 3 | 5 | 8 | 115.337 | -44.97896 |
| 7 | C | 988 | 82 | 4 | 2 | 6 | 132.4637 | -41.16075 |
| 8 | D | 1837 | 184 | 4 | 6 | 10 | 186.8298 | -41.36337 |
| 9 | E | 5228 | 349 | 8 | 0 | 8 | 229.1694 | -48.22463 |
| 10 | 42F6 | 995 | 47 | 1 | 0 | 0 | 103.1449 | -47.65321 |

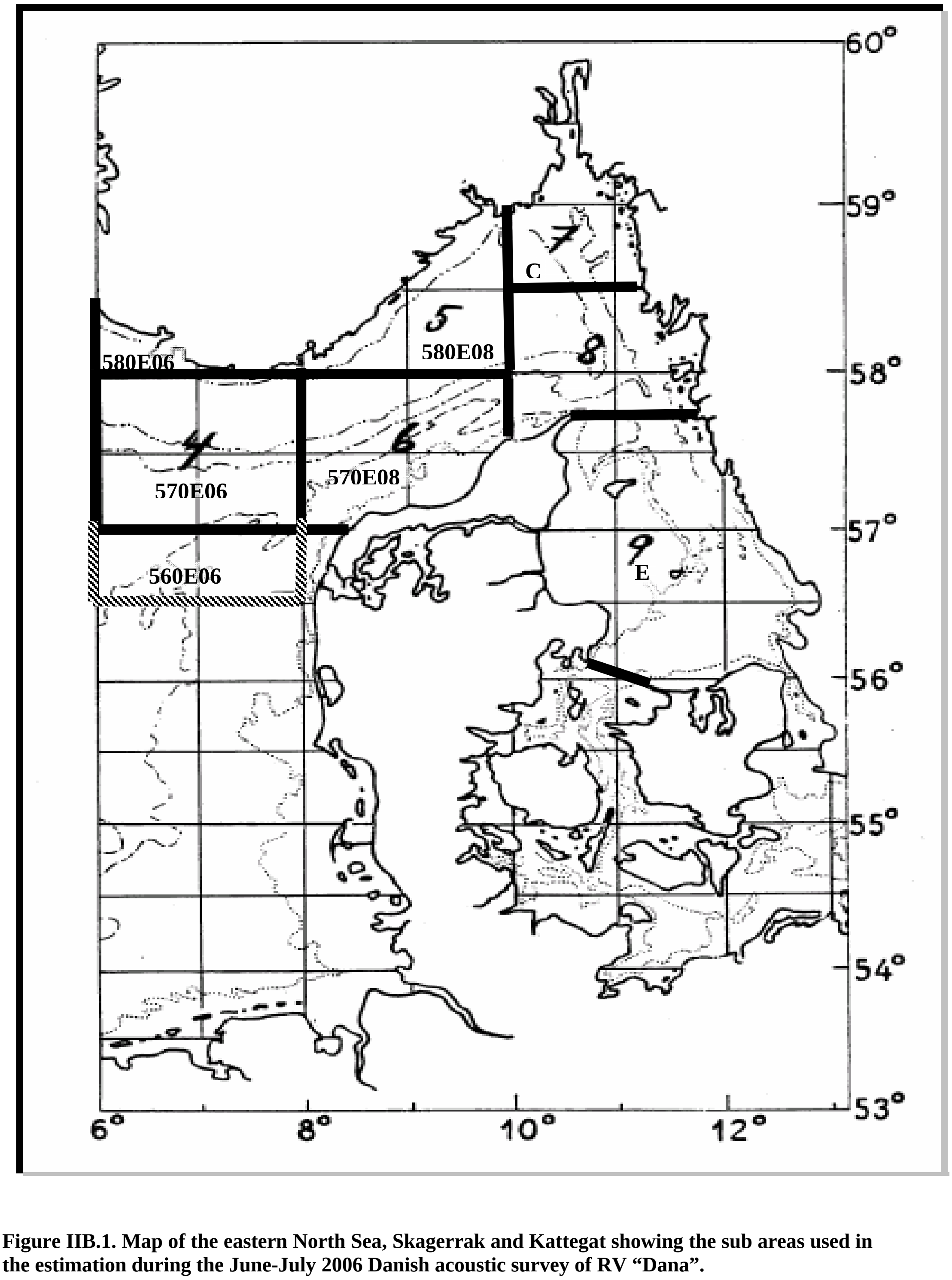



**Figure IIB.1. Map of the eastern North Sea, Skagerrak and Kattegat showing the sub areas used in the estimation during the June-July 2006 Danish acoustic survey of RV "Dana".**

# Cruise track and stations during the Acoustic Herring Survey RV "Dana" Cruise 052006 July 2006

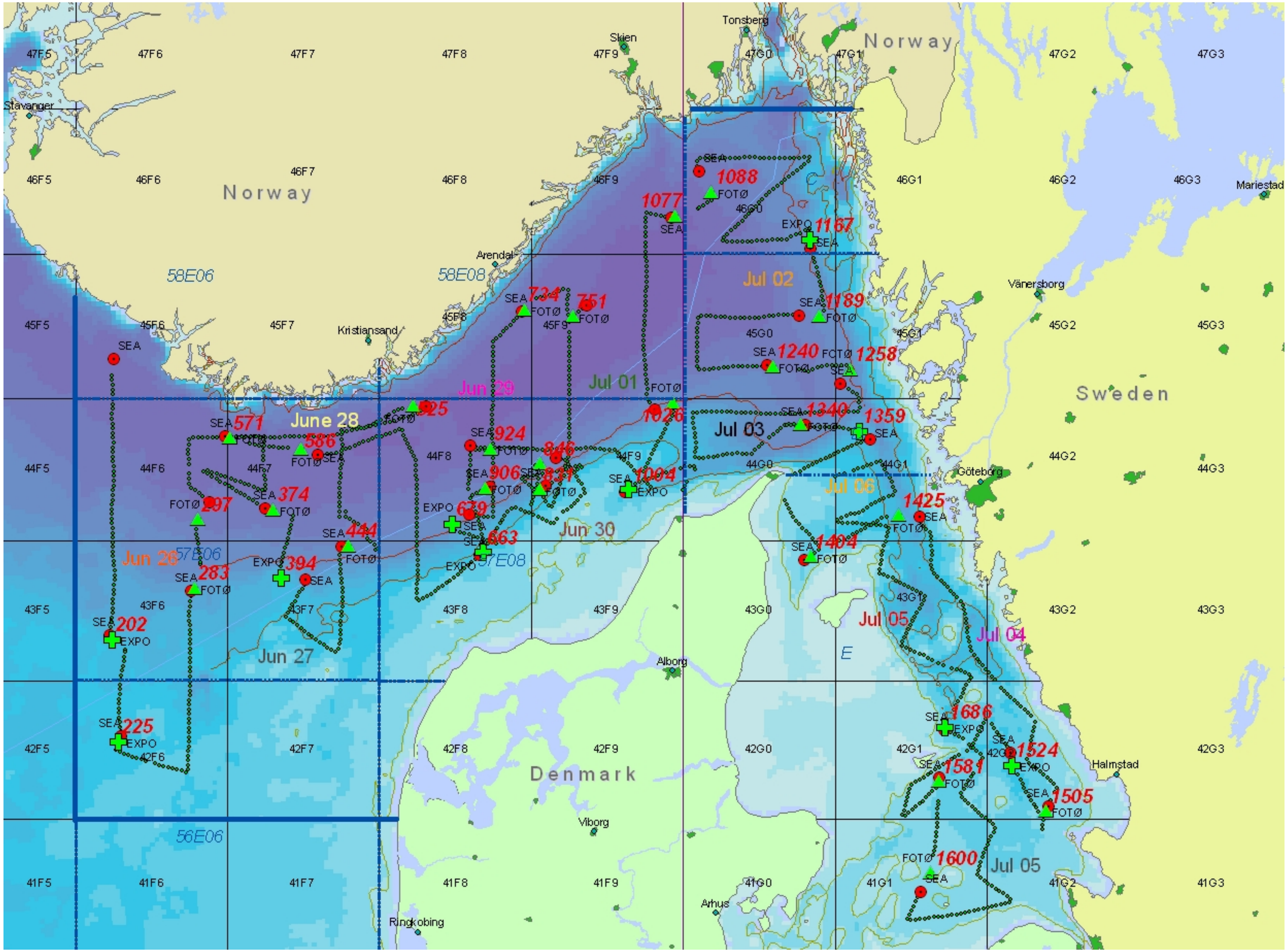



**Figure IIB.2. Map of the eastern North Sea, Skagerrak and Kattegat showing cruise track, the location of stations (trawl hauls and CTD stations) during the June - July Danish acoustic survey (Fotö hauls ▲ are pelagic and Expo hauls ╬ are generally demersal, Red numbers are haul IDs indicating cumulative sailed distance along the track in nm).**

**Bathymetry from: The MAST project DYNOCS MAST II contract No MAS2-CT94-0088**

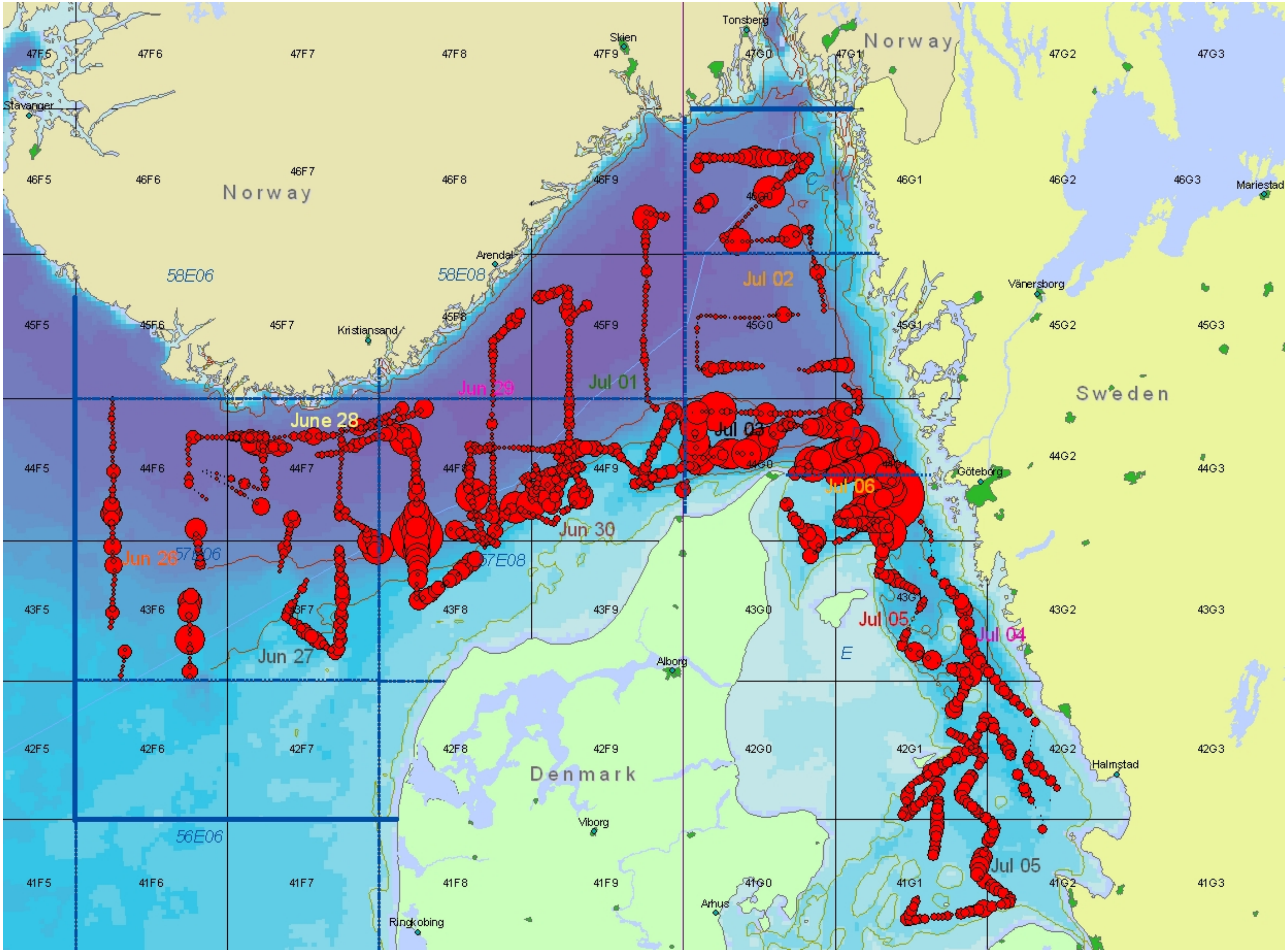
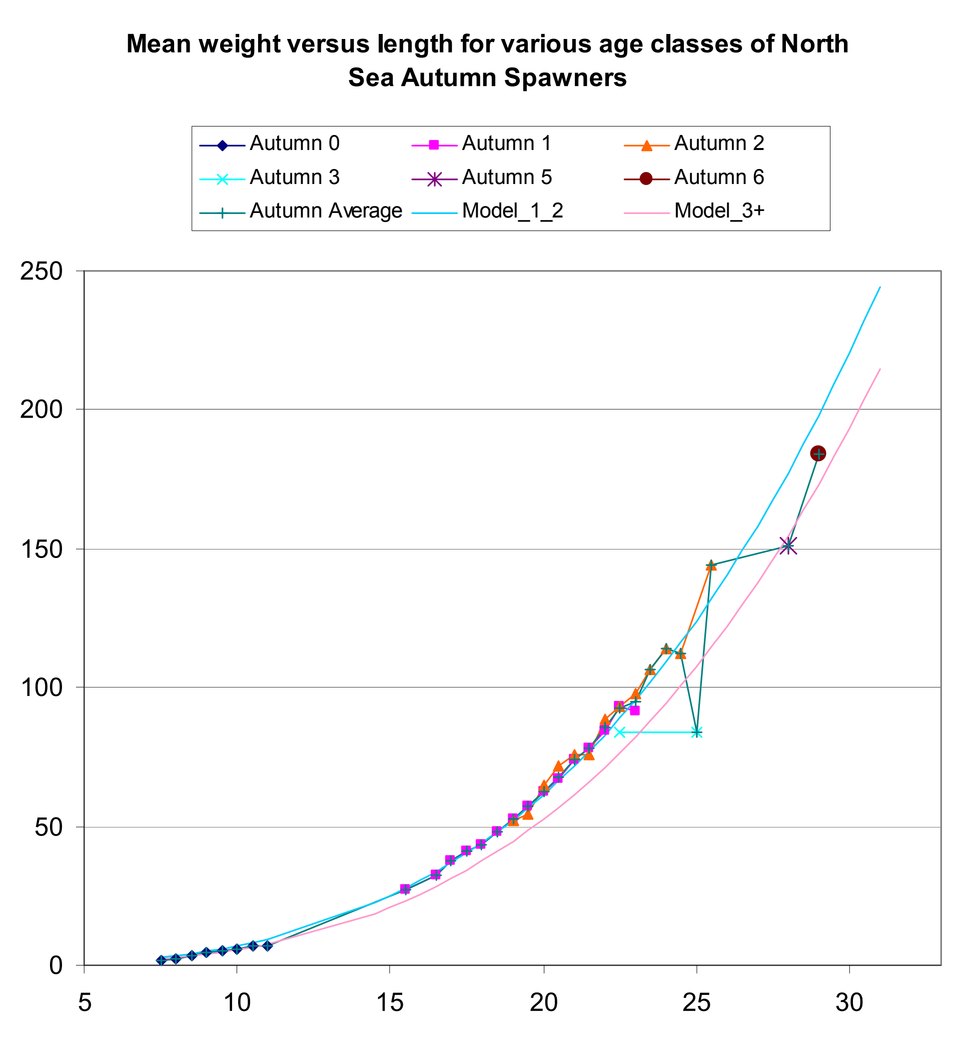



**Figure IIB.3.b. Relative herring density (in numbers per nm²) along the track of the June-July 2006 Danish acoustic survey in the eastern North Sea, Skagerrak and Kattegat. Red circles indicate relative density of herring per ESDU (1 nm).**



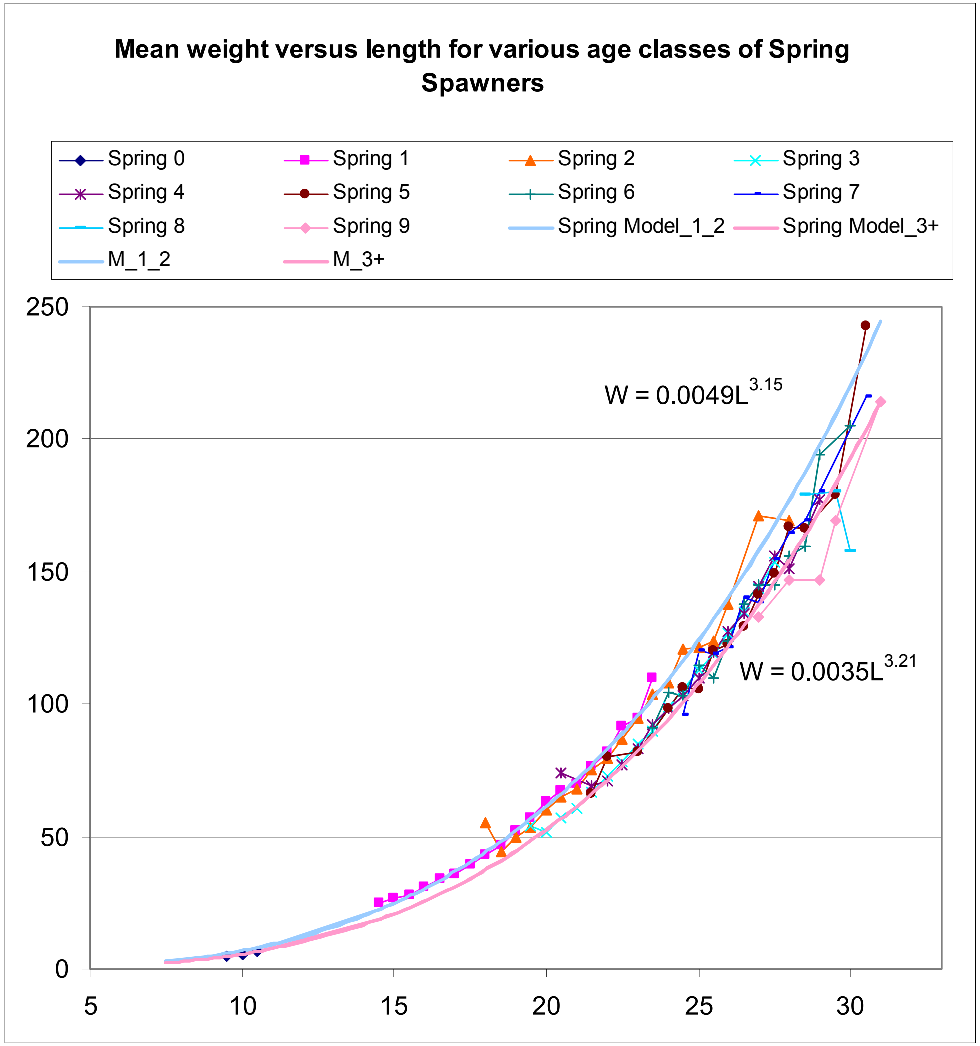




**Figure IIB.4.a. Length weight relationship by winter ring numbers for herring from the June - July 2006 Danish acoustic survey.**


**Figure IIB.4.b. Length weight relationship by winter ring numbers for sprat from the June - July 2006 Danish acoustic survey.**

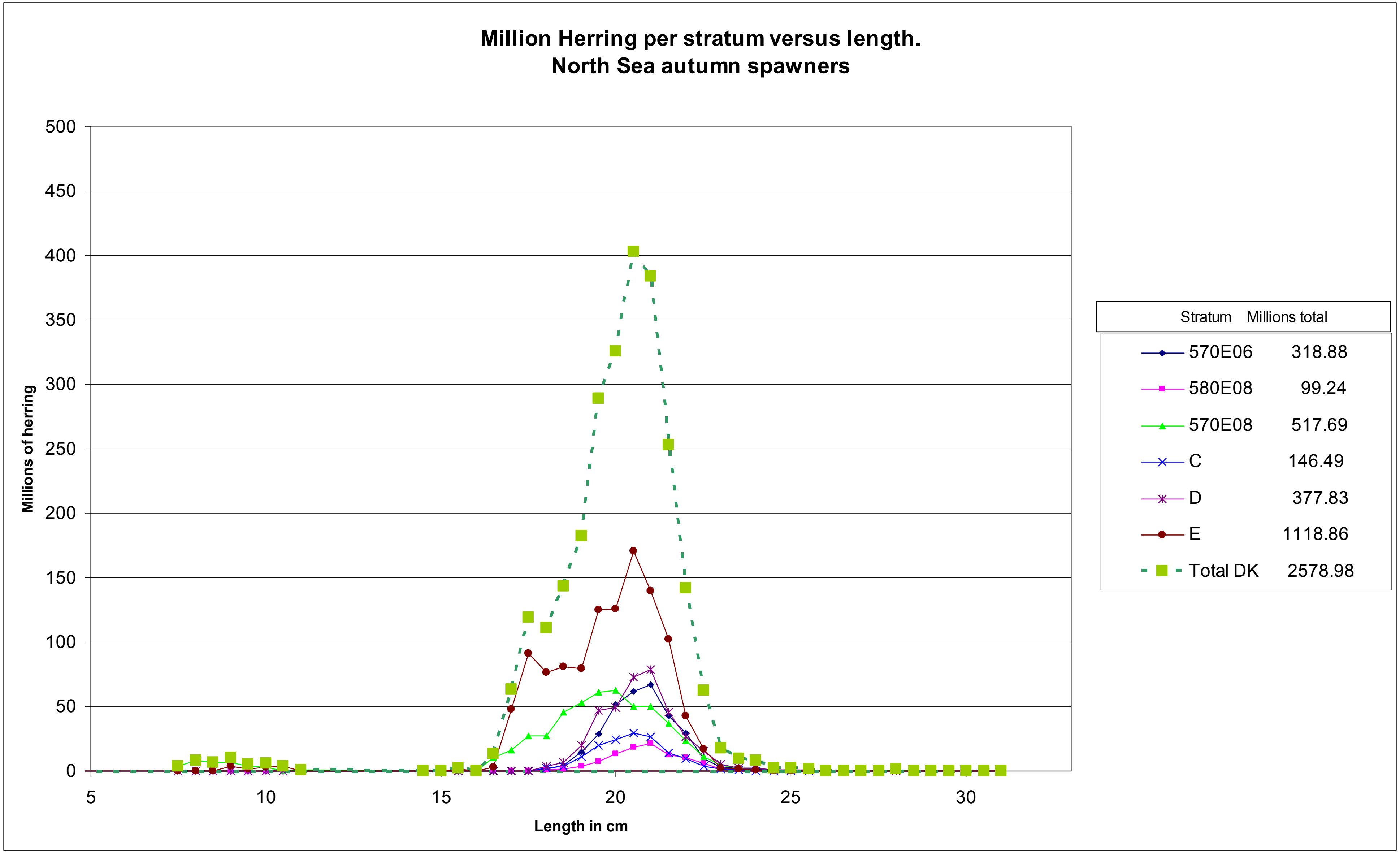



**Figure IIB.5.a. Estimated number of herring per length group in various strata from the July 2006 Danish acoustic survey.**

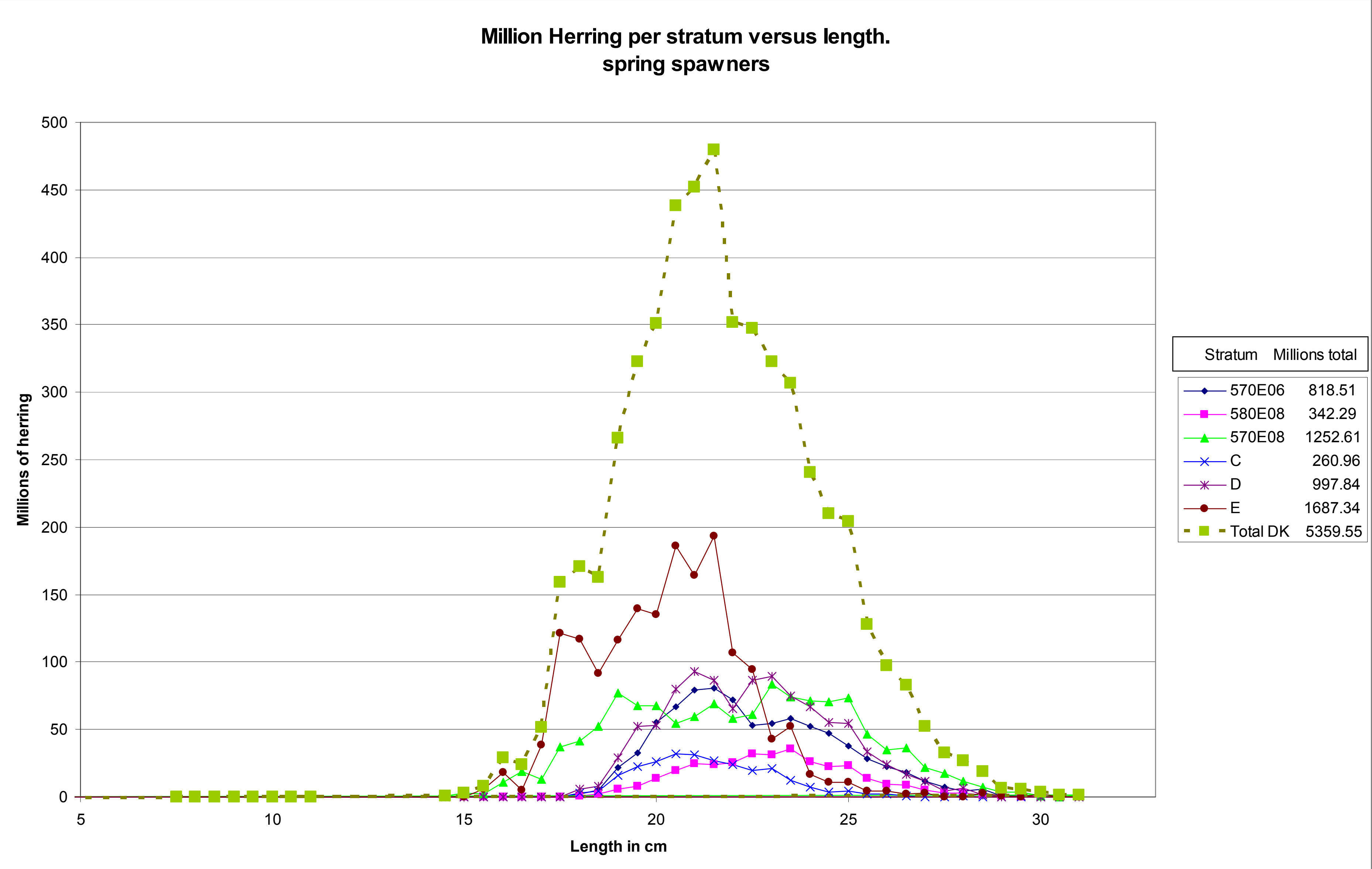



**Figure IIB.5.b. Estimated number of herring per length group in various strata from the June - July 2006 Danish acoustic survey.**

**Table IIB.1. Simrad EK60 and analysis settings used during the Acoustic Herring Survey RV "Dana" Cruise July 2006.**

| | |
|---|---|
| **Transceiver Menu** | |
| Frequency | 38 kHz |
| Sound speed | 1495 $m.s^{-1}$ |
| Max. Power | 2000 W |
| Equivalent two-way beam angle | -20.5 dB |
| Default Transducer Sv gain | 24.65 dB |
| 3 dB Beamwidth | 6.8° |
| **Calibration details** | |
| TS of sphere | -33.6 dB |
| Range to sphere in calibration | 9.20 m |
| Measured NASC value for calibration | 24941 $m^2/nmi^2$ |
| Calibration factor for NASCs | 1.00 |
| Absorption coeff | 9.872 dB/km |
| **Log Menu** | |
| Distance | 1,0 n.mi. using GPS-speed |
| Operation Menu | |
| Ping interval | 1 s external trig |
| **Analysis settings** | |
| Bottom margin (backstep) | 1.0 m |
| Integration start (absolute) depth | 7 - 9 m |
| Range of thresholds used | -70 dB |

**Table IIB.2. Trawl hauls during the Acoustic Herring Survey RV "Dana" Cruise June-July 2006.**

| Haul Nr | Haul ID | Date Time UTC | Sun Time | ICES Square | Lat N | Long E | Trawl Type | Bottom depth m | Wire Length m | Door distance m | Haul duration m | Catch weight kg | Herring weight kg | Raising ratio | Raised herring kg | Main species | Trawl speed kn | Trawl Dir deg | Wind Speed m/s | Wind Dir deg | Sea State Bf |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 202 | 01-02-06 10:54 | 11:19 | 43F6 | 57.07.179 | 006.19.057 | Expo | 67 | | | 60 | 75 | | | | Dab, Whiting | 3.2 | 127 | 6 | | 3 |
| 2 | 225 | 26-06-06 14:43 | 15:08 | 42F6 | 56.46.838 | 006.17.111 | Expo | 49 | | | 30 | 34 | | | | Cod, Large Medusa | 3 | 213 | 7 | | 3 |
| 3 | 283 | 26-06-06 21:39 | 22:06 | 43F6 | 57.19.936 | 006.47.205 | Fotö | 98 | | | 60 | 835 | | | | Herring, Mackerel | 4 | 14 | 5 | | 2 |
| 4 | 297 | 27-06-06 00:22 | 00:50 | 44F6 | 57.34.472 | 006.48.526 | Fotö | 268 | | | 60 | 882 | | | | Mackerel, Herring, Blue whiting | 4.1 | 26 | 6 | | 3 |
| 5 | 374 | 27-06-06 10:49 | 11:18 | 44F7 | 57.36.576 | 007.18.498 | Fotö | 296 | | | 60 | 12 | | | | Large Medusa, Saithe | 3.6 | 101 | 9 | | 3 |
| 6 | 394 | 27-06-06 13:51 | 14:21 | 43F7 | 57.21.965 | 007.21.468 | Expo | 80 | | | 73 | 20 | | | | Haddock, Saithe | 3.4 | 88 | 11 | | 4 |
| 7 | 444 | 27-06-06 21:05 | 21:36 | 43F7 | 57.28.848 | 007.48.015 | Fotö | 157 | | | 60 | 1930 | | | | Mackerel, Herring | 3.8 | 98 | 13 | | 5 |
| 8 | 525 | 28-06-06 14:24 | 14:57 | 44F8 | 57.58.403 | 008.13.650 | Fotö | 522 | | | 59 | 150 | | | | Herring, Mackerel, Large Medusa | 2.7 | 89 | 5 | | 4 |
| 9 | 571 | 28-06-06 21:12 | 21:40 | 44F7 | 57.51.729 | 007.01.001 | Fotö | 429 | | | 60 | 1776 | | | | Mackerel, Herring | 3 | 105 | 13 | | 6 |
| 10 | 586 | 29-06-06 00:19 | 00:49 | 44F7 | 57.49.302 | 007.29.353 | Fotö | 471 | | | 60 | 380 | | | | Mackerel, Herring, Large Medusa | 3.2 | 104 | 11 | | 5 |
| 11 | 663 | 29-06-06 10:24 | 10:59 | 43F8 | 57.27.455 | 008.41.240 | Expo | 38 | | | 54 | 92 | | | | Large Medusa | 3.4 | 57 | 7 | | 3 |
| 12 | 679 | 29-06-06 13:24 | 13:58 | 44F8 | 57.33.571 | 008.28.947 | Expo | 101 | | | 61 | 1565 | | | | Norway Pout, Saithe | 3.3 | 65 | 7 | | 3 |
| 13 | 734 | 29-06-06 21:11 | 21:47 | 45F9 | 58.18.560 | 008.57.445 | Fotö | 425 | | | 60 | 400 | | | | Mackerel, Herring, Large Medusa | 3.1 | 41 | 7 | | 3 |
| 14 | 751 | 30-06-06 00:17 | 00:54 | 45F9 | 58.17.172 | 009.16.681 | Fotö | 570 | | | 60 | 1219 | | | | Mackerel, Herring, Whiting | 3.5 | 52 | 5 | | 3 |
| 15 | 831 | 30-06-06 10:32 | 11:09 | 44F9 | 57.40.829 | 009.03.716 | Fotö | 66 | | | 60 | 60 | | | | Herring, Large Medusa | 3.6 | 213 | 4 | | 1 |
| 16 | 846 | 30-06-06 13:12 | 13:48 | 44F9 | 57.46.290 | 009.03.781 | Fotö | 110 | | | 59 | 0 | | | | 0 | 3.7 | 76 | 5 | | 1 |
| 17 | 906 | 30-06-06 21:09 | 21:44 | 44F8 | 57.41.159 | 008.42.181 | Fotö | 158 | | | 59 | 1135 | | | | Mackerel, Herring | 3.7 | 255 | 7 | | 2 |
| 18 | 924 | 01-07-06 00:13 | 00:48 | 44F8 | 57.49.407 | 008.44.287 | Fotö | 438 | | | 60 | 502 | | | | Mackerel, Herring, Large Medusa | 4 | 277 | 7 | | 2 |
| 19 | 1004 | 01-07-06 10:44 | 11:23 | 44F9 | 57.40.822 | 009.38.876 | Expo | 41 | | | 60 | 285 | | | | Herring | 2.9 | 48 | 4 | | 1 |
| 20 | 1026 | 01-07-06 14:08 | 14:47 | 44F9 | 57.59.137 | 009.56.254 | Fotö | 97 | | | 60 | 172 | | | | Herring, Large Medusa | 3.9 | 247 | 4 | | 1 |
| 21 | 1077 | 01-07-06 21:09 | 21:49 | 46F9 | 58.37.988 | 009.56.990 | Fotö | 449 | | | 59 | 445 | | | | Mackerel, Herring, Large Medusa | 3.7 | 77 | 3 | | 0 |
| 22 | 1088 | 02-07-06 00:15 | 00:55 | 46G0 | 58.42.865 | 010.11.533 | Fotö | 253 | | | 60 | 505 | | | | Mackerel, Herring, Large Medusa | 4.1 | 331 | 3 | | 1 |
| 23 | 1167 | 02-07-06 10:41 | 11:24 | 46G0 | 58.32.963 | 010.50.314 | Expo | 84 | | | 40 | 148 | | | | Invertebrates, Herring | 3 | 13 | 2 | | 0 |
| 24 | 1189 | 02-07-06 14:08 | 14:52 | 45G0 | 58.17.270 | 010.54.201 | Fotö | 146 | | | 60 | 236 | | | | Herring, Large Medusa, Mackerel | 3.7 | 269 | 2 | | 0 |
| 25 | 1240 | 02-07-06 21:15 | 21:57 | 45G0 | 58.06.753 | 010.35.690 | Fotö | 216 | | | 59 | 355 | | | | Mackerel, Large Medusa, Herring | 4 | 97 | 4 | | 0 |
| 26 | 1258 | 03-07-06 00:17 | 01:01 | 45G1 | 58.06.103 | 011.06.406 | Fotö | 126 | | | 59 | 666 | | | | Herring, Mackerel, Large Medusa | 3.6 | 216 | 5 | | 0 |
| 27 | 1340 | 03-07-06 10:34 | 11:17 | 44G0 | 57.54.525 | 010.46.863 | Fotö | 152 | | | 60 | 108 | | | | Large Medusa, Herring | 3.4 | 273 | 5 | | 1 |
| 28 | 1359 | 03-07-06 13:41 | 14:25 | 44G1 | 57.53.136 | 011.09.863 | Expo | 59 | | | 59 | 128 | | | | Herring, Whiting, Invertebrates | 2.6 | 134 | 3 | | 1 |
| 29 | 1404 | 03-07-06 21:10 | 21:53 | 43G0 | 57.26.577 | 010.50.663 | Fotö | 40 | | | 60 | 550 | | | | Large Medusa, Herring | 3.9 | 51 | 3 | | 0 |
| 30 | 1425 | 04-07-06 00:37 | 01:22 | 44G1 | 57.35.399 | 011.25.267 | Fotö | 68 | | | 60 | 924 | | | | Mackerel, Large Medusa, Herring | 4 | 102 | 4 | | 1 |
| 31 | 1505 | 04-07-06 10:31 | 11:20 | 42G2 | 56.31.739 | 012.23.709 | Fotö | 30 | | | 59 | 385 | | | | Large Medusa, Herring | 4 | 196 | 2 | | 1 |
| 32 | 1524 | 04-07-06 13:49 | 14:37 | 42G2 | 56.41.714 | 012.10.061 | Expo | 42 | | | 59 | 66 | | | | Invertebrates, Cod | 2.6 | 292 | 2 | | 1 |
| 33 | 1581 | 04-07-06 20:58 | 21:45 | 42G1 | 56.38.201 | 011.41.234 | Fotö | 32 | | | 60 | 306 | | | | Large Medusa, Sprat, Herring, Mackerel | 4 | 182 | 4 | | 0 |
| 34 | 1600 | 05-07-06 00:20 | 01:07 | 41G1 | 56.18.172 | 011.38.159 | Fotö | 27 | | | 60 | 225 | | | | Large Medusa, Mackerel | 4.5 | 208 | 7 | | 2 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | 1686 | 05-07-06 10:32 | 11:19 | 42G1 | 56.49.938 | 011.43.959 | Expo | 49 | 60 | 1698 | Sprat | 2.8 | 19 | 4 | 2 |

**Table IIB.3. Trawl hauls species composition in kg during the Acoustic Herring Survey RV "Dana" Cruise June-July 2006.**

| Station | 202 | 225 | 283 | 297 | 374 | 394 | 444 | 525 | 571 | 586 | 663 | 679 | 734 | 751 | 831 | 846 | 906 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ICES sq. | 43F6 | | 43F6 | 44F6 | 44F7 | 43F7 | 43F7 | 44F8 | 44F6 | 44F7 | 43f8 | 44F8 | 45F8 | 45F9 | 44F9 | 44F9 | 44F8 |
| Gear | Expo | Expo | Fotö | Fotö | Fotö | EXPO | Fotö | Fotö | Fotô | Fotô | EXPO | EXPO | Fotö | Fotô | Fotö | Fotö | Fotö |
| Fishing depth | Bottom | Bottom | Surface | Surface | 150-165 | Bottom | Surface | Surface | Surface | Surface | Bottom | Bottom | Surface | Surface | Surface | 60-70 | Surface |
| Total depth | 67 | 49 | 63 | 268 | 296 | 80 | 157 | 522 | 431 | 471 | 38 | 101 | 425 | 570 | 66 | 110 | 158 |
| Day/Night | D | D | N | N | D | D | N | D | N | N | D | D | N | N | D | D | N |
| Total catch | 75 | 34 | 835 | 882 | 12 | 20 | 1,930 | 150 | 1,776 | 380 | 92 | 1,565 | 400 | 1,219 | 60 | 0 | 1,135 |
| ***Scomber scombrus*** | | | 357.9 | 353 | 0.7 | | 1240.6 | 41.6 | 1267.8 | 225.3 | | | 261.9 | 812.7 | 4.3 | | 658.1 |
| ***Clupea harengus*** | | | 468.9 | 344.9 | | 0.2 | 633.4 | 82.6 | 465.2 | 85.5 | 0.1 | 0.9 | 96.6 | 363.2 | 30.2 | | 423.7 |
| ***Medusa*, spp.** | 0.5 | 4.8 | | 52.6 | 8.4 | | 28.9 | 22.9 | 36.9 | 54.6 | 91.1 | | 38.1 | 33.4 | 24.5 | | 46.5 |
| ***Sprattus sprattus*** | | | | | | | | | | | | | | | 0.1 | | |
| ***Trisopterus esmarki*** | 6.7 | 0.1 | | | | | | | | | | 1414.4 | | | | | |
| *Inv* | 0.3 | 0.3 | | | | 2.6 | | | | | | 17.7 | | | | | |
| ***Micromesistius poutassou*** | | | | 118.8 | | | | | | 14.7 | | | | | | | |
| ***Merlangius merlangus*** | 11.8 | 0.2 | | | | | | | 0.1 | | 0.2 | 16.5 | 0.1 | | 0.1 | | |
| ***Pollachius virens*** | 2.3 | | | | 3 | 2.8 | | | | | | 80.4 | | | | | 3.5 |
| *Limanda limanda* | 33 | 9.2 | | | | | | | | | | 9.9 | | | | | |
| ***Belone belone*** | | | 1.5 | 1.1 | | 3.8 | 15.5 | 2.5 | 5 | | | | 1.3 | 0.6 | 0.2 | | 2.4 |
| ***Cyclopterus lumpus*** | | | 1.3 | 11.5 | | 1.3 | 9.7 | 0.1 | 0.9 | | | 0.8 | 1.7 | 8.1 | | | |
| ***Gadus Morhua*** | 5.1 | 13.1 | | | | 0.7 | | | | | | 10.2 | | | | | |
| ***Melanogrammus aeglefinus*** | 3.5 | 0.4 | | | | 6.9 | | | | | 0.1 | 10.6 | | 0.1 | | | |
| *Trachinus draco* | | | | | | | | | | | | | | | | | |
| ***Merluccius merluccius*** | 3.4 | | | | | | | | | | | 0.2 | | | | | |
| *Hippoglosides plattessoides* | 1.6 | 0.5 | | | | | | | | | | | | | | | |
| *Entelurus aequoreus* | 0.7 | | 2.9 | 0.1 | 0.1 | | 1.9 | 0.3 | 0.2 | | | | 0.2 | 0.1 | 0.5 | | 0.8 |
| *Pleuronectes platessa* | 1.3 | 1.5 | | | | 0.6 | | | | | | 0.9 | | | | | |
| *Loligo* spp. | 2.6 | | 0.9 | | | 0.4 | | | | | 0.3 | | | 0.7 | | | |
| *Trigala* spp. | 1.3 | 1.5 | 1.5 | | | 0.2 | | | | | 0.3 | | | | 0.2 | | |
| ***Trachurus trachurus*** | | | | | | | | | | | | | | | | | |
| *Microstomus kitt* | 0.1 | 1.5 | | | | 0.5 | | | | | | 1 | | | | | |
| *Glyptocephalus cynoglossus* | | | | | | | | | | | | 1.6 | | | | | |
| *Hyperoplus lanceolatus* | | 0.7 | | | | | | | | | | | | | | | |
| *Pollachius pollachius* | | | | | | | | | | | | | | | | | |
| *Engraulis encrasicolus* | | | | | | | | | | | | | | | 0.1 | | |
| ***Ammodytes xx*** | | 0.2 | | | | | | | | | | | | | | | |
| *Oncorhynchus mykiss, Salmo gairdneri* | | | | | | | | | | | | | | | | | |

**Table IIB.3. Trawl haul species composition in kg during the Acoustic Herring Survey RV "Dana" Cruise June-July 2006 (continued).**

| Station | 924 | 1004 | 1026 | 1077 | 1088 | 1167 | 1189 | 1240 | 1258 | 1340 | 1359 | 1404 | 1425 | 1505 | 1524 | 1581 | 1600 | 1686 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ICES sq. | 44F8 | 44F9 | 44F9 | 46F9 | 46G0 | 46G0 | 45G0 | 45G0 | 45G1 | 44G0 | 44G1 | 43G0 | 44G1 | 41G2 | 42G2 | 42G1 | 41G1 | 42G1 | |
| Gear | Fotö | EXPO | Fotö | Fotö | Fotö | EXPO | Fotö | Fotö | Fotö | Fotö | EXPO | Fotö | Fotö | Fotö | Expo | Fotö | Fotö | Expo | |
| Fishing depth | Sur-face | Bottom | Surface | Surface | Surface | Bottom | Surface | Surface | Surface | Surface | Bottom | Surface | Surface | Surface | Bottom | Surface | Surface | Bottom | |
| Total depth | 438 | 41 | 97 | 449 | 253 | 84 | 146 | 216 | 126 | 152 | 59 | 40 | 68 | 30 | 42 | 32 | 27 | 49 | |
| Day/Night | N | D | D | N | N | D | D | N | N | D | D | N | N | D | D | N | N | D | |
| Total catch | 502 | 285 | 172 | 445 | 505 | 148 | 236 | 355 | 686 | 108 | 128 | 550 | 924 | 385 | 66 | 306 | 225 | 1,698 | 18284.6 |
| ***Scomber scombrus*** | 258.5 | | 7.8 | 226.7 | 223 | | 12.6 | 151.6 | 138.4 | 1.8 | | 8.4 | 772.1 | | | 32 | 58 | 1 | 7115.8 |
| ***Clupea harengus*** | 127.9 | 176.5 | 90.3 | 143.5 | 150.9 | 31.4 | 171.1 | 64.5 | 415.3 | 11.4 | 52.1 | 98 | 64.6 | 1.1 | | 46.6 | 5.6 | 28.1 | 4674.3 |
| ***Medusa, spp*** | 84.9 | | 71.8 | 67.6 | 128.5 | | 48 | 124.1 | 126.9 | 93.1 | | 426.1 | 68.5 | 383.4 | | 146.9 | 146.4 | 191.4 | 2550.8 |
| ***Sprattus sprattus*** | | | | | | 0.1 | | | | | | 0.3 | | | 0.3 | 64.2 | 1.8 | 1429.1 | 1495.9 |
| ***Trisopterus esmarki*** | | | | | | 5.3 | | | | | 1.5 | | | | | | | | 1428 |
| *Inv* | | 21.6 | | | | 90.8 | | | | | 15.3 | | | | 40.5 | | | | 189.1 |
| ***Micromesistius poutassou*** | 20 | | | | | | | | | | | | | | | | | | 153.5 |
| ***Merlangius merlangus*** | 0.1 | 30.8 | | 0.6 | | 5.7 | | | | 0.2 | 40.3 | 0.1 | | | 2.8 | | | 29.7 | 139.3 |
| ***Pollachius virens*** | | | | | | 0.2 | | 3.5 | | | 0.5 | | | | | | | | 96.2 |
| *Limanda limanda* | | 14.4 | | | | 0.5 | | | | | | | | | | | | 12.9 | 79.9 |
| ***Belone belone*** | 6.6 | | | 0.5 | 0.1 | | | 4.1 | 5 | 0.2 | | 9 | 17.1 | | | 0.2 | 0.3 | | 77 |
| ***Cyclopterus lumpus*** | 2.9 | | 1.8 | 5.8 | 2.6 | | 4 | 7.2 | 0.3 | 1 | 1.5 | | 0.2 | | 3.7 | 0.9 | 2.1 | 1.6 | 71 |
| ***Gadus Morhua*** | | 4.6 | | | | 2 | | | | | 7.3 | | | | 14.7 | | | 0.9 | 58.6 |
| ***Melanogrammus aeglefinus*** | | 18.3 | | 0.1 | | 1.5 | | | | | 1.4 | | | | 0.9 | | | | 43.8 |
| *Trachinus draco* | | | | | | | | | | | | 5 | | 0.5 | | 15.3 | 10.7 | 2.2 | 33.7 |
| ***Merluccius merluccius*** | | 14.8 | | | | | | | | | 2.2 | | | | 0.2 | | | | 20.8 |
| *Hippoglosides plattessoides* | | | | | | 5.1 | | | | | 4.3 | | | | 0.7 | | | | 12.2 |
| *Entelurus aequoreus* | 0.3 | | 0.3 | 0.3 | | | 0.3 | 0.1 | | 0.3 | | | | | | | | | 9.4 |
| *Pleuronectes platessa* | | 0.5 | | | | 0.2 | | | | | 0.9 | | | | 2.2 | | | 0.9 | 9 |
| *Loligo spp.* | 0.9 | 1 | | | | 0.5 | | | | | | | | | | | | | 7.3 |
| *Trigala spp.* | | 1.6 | | | | | | | | | | | | | 0.1 | 0.1 | | | 6.8 |
| ***Trachurus trachurus*** | | | | | | | | | | | | 3 | 1.4 | | | | | | 4.4 |
| *Microstomus kitt* | | 0.9 | | | | 0.1 | | | | | 0.2 | | | | | | | | 4.3 |
| *Glyptocephalus cynoglossus* | | | | | | | | | | | | | | | | | | | 1.6 |
| *Hyperoplus lanceolatus* | | | | | | | | | | | | 0.2 | | | | | | | 0.9 |
| *Pollachius pollachius* | | | | | | | | | | | 0.5 | | | | | | | | 0.5 |
| *Engraulis encrasicolus* | | | | | | | | | | | | | | 0.1 | | | | | 0.2 |
| ***Ammodytes xx*** | | | | | | | | | | | | | | | | | | | 0.2 |
| *Oncorhynchus mykiss, Salmo gairdneri* | | | | | | | | | | | | | | | | | 0.1 | | 0.1 |

**Table IIB.4.a. Raised length frequency composition by stratum and trawl station for the Acoustic Herring Survey RV "Dana" Cruise July 2006.**

| Stratum | 570E06 | | | | | | 570E08 | | | | | | | | 580E08 | | C | | | D | | | | | E | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Station | 283 | 297 | 394 | 444 | 571 | 586 | 525 | 663 | 679 | 831 | 906 | 924 | 1004 | 1026 | 734 | 751 | 1077 | 1088 | 1167 | 1189 | 1240 | 1258 | 1340 | 1359 | 1404 | 1425 | 1505 | 1581 | 1600 | 1686 | |
| ICES Sq | 43F6 | 44F6 | 43F7 | 43F7 | 44F7 | 44F7 | 44F8 | 43F8 | 44F8 | 44F9 | 44F8 | 44F8 | 44F9 | 44F9 | 45F8 | 45F9 | 46G0 | 46G0 | 46G0 | 45G0 | 45G0 | 45G1 | 44G0 | 44G1 | 43G0 | 44G1 | 41G2 | 42G1 | 41G1 | 42G1 | |
| length\Gear | Fotø | Fotø | Expo | Fotø | Fotø | Fotø | Fotø | Expo | Expo | Fotø | Fotø | Fotø | Expo | Fotø | Fotø | Fotø | Fotø | Fotø | Expo | Fotø | Fotø | Fotø | Fotø | Expo | Fotø | Fotø | Fotø | Fotø | Fotø | Expo | Total |
| 75 | | | | | | | | | | 10 | | | | | | | | | | | | | | | | | | | | | 10 |
| 80 | | | | | | | | | | 21 | | | | | | | | | | | | | | | | | | | | | 21 |
| 85 | | | | | | | | | | 17 | | | | | | | | | | | | | | | | | | | | | 17 |
| 90 | | | | | | | | | | 18 | | | | | | | | | | | | | | | 17 | | | | | | 35 |
| 95 | | | | | | | | | | 10 | | | | | | | | | | | | | | | 7 | | | | | | 17 |
| 100 | | | | | | | | | | 7 | | | | | | | | | | | | | | | 15 | | | | | | 22 |
| 105 | | | | | | | | | | | | | | | | | | | | | | | | | 20 | | | | | | 20 |
| 110 | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | 1 |
| 145 | | | | | | | | | | | | | 5 | | | | | | | | | | | | | | | | | | 5 |
| 150 | | | | | | | | | | | | | 26 | | | | | | | | | | | | | | | | | | 26 |
| 155 | | | | | | | | | | 3 | | | 21 | | | | | | | | | | | | | | | 2 | | 10 | 35 |
| 160 | | | | | | | | | | 3 | | | 98 | | | | | | | | | | | | | | | 2 | | 30 | 133 |
| 165 | | | | | | | | | | 44 | | | 124 | | | | | | | | | | | | 7 | | | 2 | | 10 | 187 |
| 170 | | | | | | | | | | 26 | | | 192 | | | | | | | | | | | | 23 | | | 6 | 4 | 111 | 362 |
| 175 | | | | 22 | | | | | | 62 | 15 | | 393 | | | | | 6 | | 6 | | | | | 149 | 2 | | 6 | 6 | 274 | 941 |
| 180 | | | | 109 | | | 6 | | | 102 | 29 | | 243 | | | | 28 | | 17 | | | 20 | | | 453 | | | 2 | 4 | 152 | 1164 |
| 185 | | | | 240 | 58 | | 12 | 1 | 19 | 120 | 87 | 11 | 362 | | 6 | | | 64 | 22 | 6 | | 20 | | 25 | 513 | 12 | | 7 | 5 | 51 | 1640 |
| 190 | 110 | | | 960 | 73 | 12 | 35 | | | 135 | 102 | 5 | 362 | | 12 | | 39 | 121 | 66 | 90 | | 99 | | 48 | 410 | 39 | | 28 | 12 | 20 | 2779 |
| 195 | 219 | 16 | | 1636 | 175 | 3 | 58 | | | 55 | 146 | 22 | 331 | | 18 | | 101 | 153 | 110 | 102 | 4 | 138 | 4 | 133 | 189 | 60 | 1 | 61 | 18 | 10 | 3763 |
| 200 | 904 | 33 | | 1353 | 570 | 59 | 75 | | | 16 | 394 | 103 | 207 | 7 | 55 | 56 | 180 | 223 | 99 | 152 | 2 | 335 | | 103 | 83 | 74 | 2 | 73 | 18 | | 5174 |
| 205 | 1096 | 33 | | 1134 | 906 | 108 | 69 | | | 13 | 277 | 103 | 124 | 3 | 42 | 160 | 315 | 338 | 66 | 254 | 7 | 730 | 9 | 180 | 46 | 97 | 2 | 171 | 16 | 10 | 6310 |
| 210 | 1287 | 99 | | 938 | 1111 | 86 | 118 | | | 5 | 262 | 124 | 5 | 34 | 52 | 272 | 247 | 344 | 39 | 412 | 4 | 1381 | 13 | 145 | 33 | 111 | 2 | 134 | 11 | 10 | 7281 |
| 215 | 876 | 280 | | 982 | 731 | 89 | 72 | | | 3 | 364 | 108 | | 51 | 52 | 240 | 186 | 217 | 22 | 321 | 11 | 1026 | 13 | 76 | 10 | 100 | 5 | 86 | 8 | 10 | 5939 |
| 220 | 630 | 247 | | 393 | 643 | 114 | 66 | | | | 364 | 87 | | 51 | 61 | 232 | 135 | 267 | | 293 | 18 | 474 | 15 | 23 | 13 | 79 | 2 | 81 | 1 | | 4289 |
| 225 | 219 | 198 | | 262 | 322 | 56 | 83 | | | | 248 | 65 | 5 | 51 | 100 | 384 | 96 | 127 | 11 | 197 | 51 | 474 | 22 | 19 | 3 | 100 | 1 | 33 | 3 | | 3129 |
| 230 | 82 | 132 | | 196 | 278 | 96 | 72 | | | 3 | 262 | 119 | | 82 | 70 | 184 | 146 | 108 | 6 | 164 | 75 | 335 | 12 | 7 | 10 | 51 | | 15 | 2 | | 2506 |
| 235 | 82 | 346 | | 65 | 161 | 62 | 89 | | | | 175 | 81 | | 85 | 115 | 272 | 107 | 51 | | 85 | 79 | 118 | 12 | 5 | | 30 | 1 | 15 | 1 | | 2038 |
| 240 | 55 | 429 | | 87 | 161 | 52 | 46 | | | 3 | 219 | 92 | | 92 | 118 | 136 | 56 | 19 | | 79 | 97 | 99 | 6 | 2 | | 32 | | 2 | | | 1881 |
| 245 | 55 | 313 | | 65 | 146 | 46 | 58 | | | | 335 | 70 | | 71 | 73 | 160 | 62 | 25 | | 23 | 99 | 79 | 5 | 2 | 3 | 14 | | 6 | | | 1711 |
| 250 | 55 | 313 | | 44 | 102 | 40 | 26 | | | 3 | 204 | 76 | | 129 | 67 | 96 | 51 | 6 | | 23 | 60 | 20 | 3 | 4 | 3 | 16 | | 2 | | | 1341 |
| 255 | | 214 | | 44 | 58 | 34 | 32 | | | | 175 | 59 | 5 | 51 | 33 | 112 | 22 | 6 | | 17 | 46 | | 5 | | | 9 | | | | | 924 |
| 260 | 27 | 148 | | 22 | 88 | 28 | 20 | | | | 146 | 54 | | 34 | 27 | 48 | 34 | | | 6 | 33 | | 3 | | | 7 | | 2 | | | 727 |
| 265 | 27 | 148 | | 87 | 15 | 19 | 12 | | | 3 | 146 | 49 | | 41 | 30 | 48 | 11 | | | | 11 | | 3 | | | 5 | | | | | 654 |
| 270 | 27 | 82 | | 22 | 15 | 9 | 14 | | | | 102 | 27 | | 20 | 12 | 32 | | | | | 11 | 20 | 2 | 4 | | 2 | | | | | 402 |
| 275 | | 49 | | 44 | 15 | 9 | 6 | | | 3 | 117 | 22 | | 10 | 21 | 8 | | | | 6 | 7 | | | | | | | | | | 315 |
| 280 | 27 | 33 | | 22 | | 3 | 3 | | | | 44 | 11 | | 20 | 9 | | 11 | 6 | | | 2 | | 1 | | | | | | | | 193 |
| 285 | | 66 | | | | 3 | 6 | | | 3 | 44 | 5 | | 3 | 3 | 16 | | | | | 2 | | | | | 7 | | | | | 158 |
| 290 | | | 1 | | | 3 | | | | | 15 | 16 | | | 6 | 8 | | | | | | | | | | 2 | | | | | 51 |
| 295 | 27 | | | | | | | | | | 29 | 5 | | 3 | | | | | | | | | | | | | | | | | 65 |
| 300 | | | | | | | | | | | | 5 | | | | | | 6 | | | | | | | | 5 | | | | | 16 |
| 305 | | 16 | | | | | | | | | | | | | 3 | | | | | | | | | | | | | | | | 20 |
| 310 | | | | | | | | | | | 29 | | | | | | | | | | | | | | | | | | | | 29 |
| Total | 5807 | 3198 | 1 | 8726 | 5627 | 932 | 976 | 1 | 19 | 686 | 4329 | 1320 | 2505 | 841 | 986 | 2464 | 1827 | 2089 | 457 | 2234 | 620 | 5366 | 128 | 774 | 2009 | 854 | 16 | 733 | 109 | 699 | 56333 |

**Table IIB.4.b. Raised catch weights of herring by trawl station for the Acoustic Herring Survey RV "Dana" Cruise July 2006.**

| Stratum | 570E06 | | | | | | 570E08 | | | | | | | | 580E08 | | C | | | D | | | | | E | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Station | 283 | 297 | 394 | 444 | 571 | 586 | 525 | 663 | 679 | 831 | 906 | 924 | 1004 | 1026 | 734 | 751 | 1077 | 1088 | 1167 | 1189 | 1240 | 1258 | 1340 | 1359 | 1404 | 1425 | 1505 | 1581 | 1600 | 1686 | |
| ICES Sq | 43F6 | 44F6 | 43F7 | 43F7 | 44F7 | 44F7 | 44F8 | 43F8 | 44F8 | 44F9 | 44F8 | 44F8 | 44F9 | 44F9 | 45F8 | 45F9 | 46G0 | 46G0 | 46G0 | 45G0 | 45G0 | 45G1 | 44G0 | 44G1 | 43G0 | 44G1 | 41G2 | 42G1 | 41G1 | 42G1 | |
| length\Gear | Fotø | Fotø | Expo | Fotø | Fotø | Fotø | Fotø | Expo | Expo | Fotø | Fotø | Fotø | Expo | Fotø | Fotø | Fotø | Fotø | Fotø | Expo | Fotø | Fotø | Fotø | Fotø | Expo | Fotø | Fotø | Fotø | Fotø | Fotø | Expo | Total |
| Total kg | 468.9 | 344.9 | 0.2 | 633.5 | 465.2 | 85.5 | 82.6 | 0.0 | 0.9 | 30.2 | 423.7 | 127.9 | 176.5 | 90.3 | 96.6 | 363.2 | 143.5 | 150.9 | 31.4 | 171.1 | 64.5 | 415.3 | 11.4 | 52.1 | 98.0 | 64.6 | 1.0 | 46.6 | 5.6 | 28.1 | 181.9 |

**Table IIB.5a. Numbers of herring by age, maturity, stock and sub area for the Acoustic Herring Survey RV "Dana" Cruise July 2005.**

| North Sea Autumn spawners. Abundance (millions) or proportions | North Sea Autumn spawners. Abundance (millions) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | - | - | - | - | - | - | - |
| | | | | | | | | - | - | - | - | - | - | - |
| 0 | 0 | 1I | 1M | 2I | 2M | 3I | 3M | 4I | 4M | 5 | 6 | 7 | 8 | 9+ |
| 580E06 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 570E06 | 0.000 | 313.225 | 0.000 | 72.161 | 5.660 | 1.311 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 580E08 | 0.000 | 72.471 | 0.000 | 5.200 | 0.408 | 0.000 | 0.000 | 0.000 | 0.000 | 0.281 | 0.000 | 0.000 | 0.000 | 0.000 |
| 570E08 | 30.989 | 425.099 | 0.000 | 37.470 | 2.939 | 2.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| C | 0.000 | 125.248 | 0.000 | 19.682 | 1.544 | 0.000 | 0.000 | 0.000 | 0.000 | 0.317 | 0.000 | 0.000 | 0.000 | 0.000 |
| D | 0.000 | 265.606 | 0.000 | 12.089 | 0.948 | 1.529 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| E | 6.566 | 107.840 | 0.000 | 17.390 | 0.000 | 1.233 | 0.000 | 0.000 | 0.000 | 0.000 | 1.086 | 0.000 | 0.000 | 0.000 |
| 560E06 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

| Western Baltic Spring Spawners Abundance (millions) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Stratum | 0.000 | 1I | 1M | 2I | 2M | 3I | 3M | 4I | 4M | 5 | 6 | 7 | 8 | 9+ |
| 580E06 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 570E06 | 0.000 | 113.511 | 29.151 | 86.723 | 188.002 | 14.881 | 191.226 | 2.099 | 71.022 | 27.547 | 11.874 | 7.075 | 0.000 | 1.919 |
| 580E08 | 0.000 | 44.570 | 11.446 | 34.222 | 74.188 | 9.718 | 124.882 | 1.277 | 43.218 | 9.647 | 6.134 | 2.206 | 0.881 | 0.775 |
| 570E08 | 0.000 | 299.951 | 77.030 | 119.150 | 258.298 | 22.292 | 286.455 | 3.714 | 125.654 | 43.740 | 21.711 | 7.284 | 1.773 | 4.749 |
| C | 0.000 | 48.478 | 12.450 | 35.472 | 76.897 | 5.112 | 65.691 | 0.401 | 13.552 | 0.654 | 0.436 | 0.508 | 0.311 | 0.439 |
| D | 0.000 | 199.938 | 51.346 | 119.725 | 259.543 | 24.221 | 311.244 | 2.747 | 92.928 | 20.297 | 9.042 | 1.653 | 0.696 | 0.802 |
| E | 5.385 | 904.479 | 206.535 | 302.416 | 591.085 | 53.684 | 522.202 | 2.244 | 56.100 | 13.492 | 10.324 | 4.140 | 0.000 | 0.000 |
| 560E06 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

**Table IIB.5b. Mean weight of herring by age, maturity, stock and subarea for the Acoustic Herring Survey RV "Dana" Cruise July 2006.**

| | North Sea Autumn spawners. | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean weight (g) | | | | | | | - | - | - | - | - | - | - |
| | | | | | | | | - | - | - | - | - | - | - |
| **Stratum** | **0** | **1i** | **1m** | **2i** | **2m** | **3i** | **3m** | **4i** | **4m** | **5** | **6** | **7** | **8** | **9+** |
| 580E06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 570E06 | 0.00 | 72.84 | 72.84 | 83.91 | 83.91 | 84.00 | 84.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 580E08 | 0.00 | 71.19 | 71.19 | 75.44 | 75.44 | 0.00 | 0.00 | 0.00 | 0.00 | 151.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 570E08 | 3.62 | 54.88 | 54.88 | 77.41 | 77.41 | 84.00 | 84.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| C | 0.00 | 66.14 | 66.14 | 72.15 | 72.15 | 0.00 | 0.00 | 0.00 | 0.00 | 151.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| D | 0.00 | 68.42 | 68.42 | 73.66 | 73.66 | 84.00 | 84.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| E | 5.12 | 58.42 | 58.42 | 69.36 | 69.36 | 84.00 | 84.00 | 0.00 | 0.00 | 0.00 | 184.00 | 0.00 | 0.00 | 0.00 |
| 560E06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

| | Spring Spawners | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean weight (g) | | | | | | | | | | | | | |
| **Stratum** | **0** | **1i** | **1m** | **2i** | **2m** | **3i** | **3m** | **4i** | **4m** | **5** | **6** | **7** | **8** | **9+** |
| 580E06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 570E06 | 0.00 | 67.08 | 67.08 | 80.57 | 80.57 | 99.33 | 99.33 | 112.48 | 112.48 | 121.59 | 145.94 | 156.28 | 0.00 | 152.69 |
| 580E08 | 0.00 | 66.29 | 66.29 | 81.51 | 81.51 | 94.76 | 94.76 | 108.79 | 108.79 | 132.27 | 129.70 | 143.25 | 173.99 | 142.25 |
| 570E08 | 0.00 | 55.53 | 55.53 | 81.30 | 81.30 | 101.35 | 101.35 | 114.55 | 114.55 | 132.64 | 151.53 | 164.45 | 173.57 | 176.44 |
| C | 0.00 | 57.73 | 57.73 | 69.64 | 69.64 | 81.70 | 81.70 | 97.29 | 97.29 | 104.44 | 116.00 | 112.00 | 158.00 | 147.00 |
| D | 0.00 | 61.62 | 61.62 | 78.05 | 78.05 | 91.15 | 91.15 | 111.45 | 111.45 | 127.29 | 132.98 | 134.30 | 180.00 | 147.00 |
| E | 5.85 | 47.89 | 47.89 | 60.34 | 60.34 | 66.19 | 66.19 | 87.84 | 87.84 | 90.96 | 145.56 | 126.34 | 0.00 | 0.00 |
| 560E06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

**Table IIB.5c. Mean length of herring by age, maturity, stock and subarea for the Acoustic Herring Survey RV “Dana” Cruise July 2006.**

| | NORTH SEA AUTUMN SPAWNERS. | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | - | - | - | - | - | - | - |
| | MEAN LENGTH (CM) | | | | | | | - | - | - | - | - | - | - |
| **STRATUM** | **0** | **1I** | **1M** | **2I** | **2M** | **3I** | **3M** | **4I** | **4M** | **5** | **6** | **7** | **8** | **9+** |
| 580E06 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 570E06 | 0.0 | 20.8 | 20.8 | 21.5 | 21.5 | 22.5 | 22.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 580E08 | 0.0 | 20.7 | 20.7 | 21.3 | 21.3 | 0.0 | 0.0 | 0.0 | 0.0 | 28.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 570E08 | 8.6 | 19.2 | 19.2 | 21.2 | 21.2 | 22.5 | 22.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| C | 0.0 | 20.4 | 20.4 | 21.0 | 21.0 | 0.0 | 0.0 | 0.0 | 0.0 | 28.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| D | 0.0 | 20.6 | 20.6 | 21.2 | 21.2 | 25.0 | 25.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| E | 9.5 | 19.8 | 19.8 | 20.6 | 20.6 | 25.0 | 25.0 | 0.0 | 0.0 | 0.0 | 29.0 | 0.0 | 0.0 | 0.0 |
| 560E06 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

| | SPRING SPAWNERS | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MEAN LENGTH (CM) | | | | | | | | | | | | | |
| **STRATUM** | **0** | **1I** | **1M** | **2I** | **2M** | **3I** | **3M** | **4I** | **4M** | **5** | **6** | **7** | **8** | **9+** |
| 580E06 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 570E06 | 0.0 | 20.3 | 20.3 | 21.6 | 21.6 | 23.9 | 23.9 | 25.0 | 25.0 | 25.7 | 27.0 | 27.5 | 0.0 | 28.4 |
| 580E08 | 0.0 | 20.3 | 20.3 | 21.9 | 21.9 | 23.6 | 23.6 | 24.8 | 24.8 | 26.3 | 26.4 | 27.0 | 29.2 | 28.0 |
| 570E08 | 0.0 | 19.1 | 19.1 | 21.7 | 21.7 | 24.1 | 24.1 | 25.0 | 25.0 | 26.3 | 27.7 | 28.1 | 29.6 | 29.4 |
| C | 0.0 | 19.6 | 19.6 | 20.9 | 20.9 | 22.8 | 22.8 | 24.1 | 24.1 | 25.3 | 26.0 | 26.0 | 30.0 | 28.0 |
| D | 0.0 | 20.0 | 20.0 | 21.7 | 21.7 | 23.5 | 23.5 | 24.9 | 24.9 | 26.1 | 26.7 | 27.0 | 29.5 | 28.0 |
| E | 10.2 | 18.6 | 18.6 | 20.5 | 20.5 | 21.7 | 21.7 | 23.3 | 23.3 | 23.3 | 26.6 | 25.9 | 0.0 | 0.0 |
| 560E06 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

## Annex 2C: Norway

**ICES coordinated acoustic survey**
**of Herring and Sprat in the North Sea**
**RV "Johan Hjort", 29 June – 27 July 2006**

**Else Torstensen, Institute of Marine Research, Flødevigen**

**N-4817 His, Norway**

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## 1. INTRODUCTION

In 2006, the Norwegian Institute of Marine Research carried out an Ecosystem survey in the North Sea from 29 June to 4 August. The survey was a joint survey combining the ICES coordinated herring acoustic survey for the North Sea and adjacent areas (ICES, 2006), the third quarter IBTS, the saithe acoustic survey and the acoustic survey for sandeel.

The herring acoustic survey is planned and coordinated by the Planning Group for Herring Surveys (ICES, 2006). Five countries cooperate in surveying the North Sea and Division IIIa for an acoustic abundance estimation of herring and sprat. The Norwegian herring acoustic area is between 57° and 65°N, 2° and 6°E. Data from the present survey will be combined with the other surveys to provide a combined age disaggregated abundance index for use in the assessment carried out by the ICES Herring Assessment Working Group (HAWG) to be held in March 2006.

Objectives for the survey with RV "Johan Hjort" were:

a ) To conduct an acoustic survey to estimate the abundance and distribution of herring and sprat in the eastern part of the North Sea, between 56°and 62° N, and between 2°and 6° E

b ) To conduct an acoustic survey to estimate the abundance and distribution of saithe in the northern North Sea, between 56°and 62° N

c ) To conduct an acoustic survey to estimate the abundance and distribution of sandeel in the northern North Sea, between 56°and 62° N

d ) To obtain biological samples(length, weight) of defined fish species; for target species length, weight, age, sex, maturity data were sampled and infection by Ichthyophonus in herring recorded

e ) To map the general hydrographical regime and monitor the standard profiles: Oksøy – Hanstholm, Hanstholm – Aberdeen, Utsira - Start Point

f ) To sample data on zooplankton and phytoplankton along the transects Utsira-Start Point and Hanstholm – Aberdeen

## 2. SURVEY DESCRIPTION AND METHODS

### 2.1 Personnel

| | |
|---|---|
| Else Torstensen | (Cruise leader, 29 June - 20 July) |
| Odd Smedstad | (Cruise leader, 20 - 27 July) |
| Tore Johannessen | (Cruise leader, 27 July - 4 August) |
| Jan Erik Nygård | (Acoustic expert, 29 June – 13 July) |
| Øyvind Torgersen | (Acoustic expert, 13 July – 4 August) |
| Ole Oskar Arnøy | (Technician, 13 – 27 July) |
| Knut Hansen | (Technician, 13 July – 4 August) |
| Inger Henriksen | (Technician, 13 – 27 July) |
| Anne-Liv Johnsen | (Technician, 29 June – 13 July) |
| Bjarte Kvinge | (Acoustic operator, 29 June – 13 July) |

| | |
|---|---|
| Jan de Lange | (Technician, 29 June – 13 July) |
| Harald Larsen | (Technician, 29 June – 13 July) |
| Svend Lemvig | (Technician, 13 – 27 July) |
| Elna Sælen Meland | (Technician, 27 July – 4 August) |
| Helén Løvdal Nilsen | (Technician, 13 – 27 July) |
| Are Salthaug | (Scientist, 29 June - 2 July) |
| Bente Skjold | (Technician, 29 June – 13 July) |
| Lisbeth Solbakken | (Technician, 29 June – 13 July) |
| Arne Storakre | (Technician, 29 June – 13 July |
| Bjørn Vidar Svendsen | (Technician, 13 – 27 July) |

### 2.3 Narrative

The RV "Johan Hjort" left Bergen at 1100 UTC on 29 June 2006 and set the course north-west to start with crossing south along the western part of the Norwegian trench for acoustic registration of saithe. A call was made in Kristiansand in the morning 2 July and the survey continued with the Oksøy-Hanstholm transect (58$^{o}$ 3'N and 8$^{o}$5' E) at 1355 UTC. We had a call in Hanstholm in the morning 3 July for service on the 3mm radar and started the Hanstholm-Aberdeen hydrographic transects in early afternoon. The survey continued with east-west transects from south to north. The vessel broke off the survey at N58° 26' and E4°45' and called Stavanger on the 12$^{th}$ at 1330 UTC for change of crews. "Johan Hjort" sailed again on 13 July at 1800 UTC. The survey recommenced at 2040 UTC. The Utsira-Start Point hydrographical transect started in the east (59° 17' N 4° 50'E) on the 14$^{th}$. The transect was finalized on the 17 July (1900 UTC) and we continued north to cover the east coast of Shetland. A call was made in Lerwick, Shetland on 20 July for change of cruise leader and a brake. "Johan Hjort" left the next day and continued the survey in the northern area. The 1$^{st}$ part of the survey finished 27 July at 0130 UTC in position 61°02'N and 04°15'E and the vessel proceeded to Bergen where "Johan Hjort" docked at 1500 UTC (see Figure 1). Figure 1 gives the cruise track and locations of trawl hauls and Figure 2 the locations of CTD-stations and plankton-stations, 29 June–27 July 2006. The weather conditions were extremely good during this year's summer survey.

The present report gives the results from the Norwegian herring target area.

### 2.3 Survey design

The first part of the survey was carried out in systematically parallel east-west transects progressing northwards from N 56° 30' to N 62° 00'. In principle, 15 nm and 30 nm were used as distance between the tracks according to the coordinated plan (ICES, 2006).

### 2.4 Calibration

Calibration was not performed as there was too much organic matter in the sea. The sounders were calibrated in April 2006, with only minor changes. The main settings for the 38 kHz transceiver are given in Table 1.

### 2.5 Acoustic data collection

The acoustic survey on RV "Johan Hjort" was carried out using a SIMRAD ER60 38 kHz sounder and transducer ES38B SK mounted on the drop keel. Acoustic data were collected 24 hours per day. Additional data were collected at 18, 120 and 200 kHz (ES120–7 transducer) but was not used in the present analysis. The mean volume back scattering values (Sv) were integrated over 1 nm intervals from 9–13 m (depending on weather conditions and the use of keel) below the surface to 0,5m above the seabed. The speed of the vessel during the acoustic sampling was 10–11 knots. The acoustic data were archived on tape. The acoustic recordings were scrutinized twice per day using the IMR BEI/SIMRAD BI500 Scientific Post Processing System (The Bergen Echo Integrator) (Foote *et al*., 1991). No paper records were available.

### 2.6 Biological data - fishing trawls

Trawling was carried out for supporting the species identifications of acoustic scatters and for biological sampling. For pelagic trawling Åkra and Harstad trawls were used. A GOV trawl, as standard for the IBTS-surveys and equipped with Balmoral Kite floats, was used for bottom trawling. The bottom trawl hauls were monitored using Scanmar TE40 (wide beam) and distance/depth sensor (A 4693) and Scanmar TE40-2 (PL) (narrow beam) and depth sensor D1200 were used to monitor pelagic trawl hauls.

The catches were sampled for species composition by weights. Biological samples (length, weight) of the most important species were taken according to the IMR fish-sampling manual (Fotland *et. al*., 2002). Herring were examined for sex, maturity (8 point scale), fat, stomach contents, vertebrae counts (east of 2°00'E) and macroscopic evidence of *Ichthyophonus* infection.

Otoliths were taken for age determinations (wr). If the catch of a target species contained less than 100 specimens, the total catch was sampled. If the catch contained more than 100 specimens, representative samples of about 100 specimens were randomly chosen.

### 2.7 Hydrographic data

CTD-stations were taken at each trawl station in addition to the four standard hydrographical profiles: Oksøy-Hanstholm, Hanstholm-Aberdeen, Utsira - Start Point and Fedje-Shetland.

### 2.8 Data analysis

Data from the echo integrator (sA) were averaged per 5 n.mi. The acoustic data were allocated to the following categories: herring, sprat, saithe, sandeel, pelagic fish, demersal fish and plankton. To calculate integrator conversion factors the target strengths of target species were estimated using the following TS/length relationship:

Herring and sprat: $TS = 20\log_{10}L - 71.2$ dB

Herring were separated from other recordings by using catch information and characteristics of the recordings. The abundance estimation (Toresen et al 1998) was made by ICES rectangles and summed up for the whole area. North Sea autumn spawners and Western Baltic spring spawners (WBSS) are mixed during summer in the area covered by RV "Johan Hjort" (east of 2°E). No system for workable stock discrimination on individual herring during the survey is available. The proportion of Baltic spring spawners and North Sea autumn spawners by age was calculated by applying the formula WBSS= ((56.5-VS (sample))/(56.5–55.8)) (ICES, 1999). All samples were worked up on board. The length-at age and weight-at age were assumed to be the same in the two stocks. The measured proportions of mature fish were applied equally to calculate the maturing part of each age group in both stocks.

## 3 RESULTS and DISCUSSION

The survey track showing the trawl hauls and the CTD stations are presented in Figure 1 and 2, respectively.

### 3.1 Acoustic data

#### *3.1. 1 Herring*

The distribution of NASC-values (sA) assigned to herring, are presented as mean values per 5 n.mi intervals in Figure 3. Herring were distributed in the whole surveyed area, with the highest mean densities (181 – 120) recorded in the ICES rectangles 46F2, 47F3 and 45F4. The overall highest values were measured outside the Norwegian PGHERS-area, in 46E9 and 46F1 with NASC- values of 496 and 316, respectively. Trawling was mainly based on random positions regularly chosen for trawling at the surface, i.e. not based on echo registration. In the "Norwegian" area herring tend to keep close to the surface and may thus be underestimated. More herring schools were observed than in the last years. Most of them were small and occurred scattered throughout the area, either close to the surface or near bottom.

#### 3.2.2 Sprat

No sprat was observed by RV "Johan Hjort". This is the same situation as has been seen the last years.

### 3.3 Biological data

A total of 104 valid trawl hauls were carried out, of which 62 (31 PT and 31 BT) were taken in the "herring"area (Figure 1, Table 2). In general 30 min hauls were made. Catch composition per haul is given in Table 3. Herring were present in 27 hauls of sample size >20 herring. The length distributions of herring are presented in Table 4. A total of 2 188 herring were length measured and 1 124 were aged (winter rings in otoliths). A low number of herring infected by Ichthyophonus was observed (<10 herring).

### 3.4 Abundance and Biomass estimates

#### 3.4.1 Herring

The abundance and biomass estimates presented, are confined to the Norwegian target area between 57° and 65°N, 2° and 6°E. The geographical distribution of the sA-values assigned to herring, are presented in Figure 3. The highest values were encountered in the central area, between 58°00'N and 59°30'N. Total number of herring was 1,744 million of which 78% was North Sea Autumn Spawners (NSAS). Total biomass of NSAS was estimated to 170,000 tonnes and the spawning stock biomass as 126,000 tonnes. These estimates are lower than the respective biomasses from the Norwegian area last year, 162,000t and 154,000t. The proportions of mature 2- and 3-ringers by numbers were estimated at 44% and 78%, respectively, comparable to the proportions estimated in 2005, 43 and 84% in 2005, respectively. Of the estimated numbers of 1-ringers 1% was classified as maturing. The number of the strong 2000-year class of the North Sea autumn spawners, 5-w-ringers in 2006, was still strong making 20% (numbers) and 25% (SSB).

Herring of the 2003-year-class made 33% of total number and 36% of the spawning stock biomass, with about 50% maturing fish. The 3 –and 4-ringers (2002 and 2001 year class) were represented by about 10% each of the total number and the biomass.

The total biomass of WBSS was 46,000 tonnes, a decline since last year.

Few good acoustic marks of herring schools were observed and the majority of the trawling positions were, however, regularly chosen for trawling at surface, i.e. not based on echo registration. Due to the tendency of staying near the surface during daytime, herring may have been underestimated.

Table 6 gives the mean length, mean weight, total numbers (millions) and biomass (thousands of tonnes) by age and maturity stage for the North Sea autumn spawners and the Western Baltic spring spawners in the Norwegian target area in June-July 2006.

### 3.5 Hydrography

A total of 121 CTD-stations were sampled (Figure 2). The horizontal distributions of temperature and salinity at 5m, 50m and at seabed, are shown in Figures 4a-c and 5a-c, respectively. The temperature at surface (5m depth) ranged from 13–15°C in the west to 13–17°C in the east, with the general highest temperature in the south eastern area. At 50 m depth, the highest temperatures were in the west, 10-12° in the Shetland area.

The hydrographical data are part of a monitoring program of a general monitoring program of IMR/ICES, and will be analysed and published separately.

## 4. References

Fotland, A. A., Borge, A., Gjøsæter, H. and Mjanger, H. 2002. Manual for sampling of fish and crustaceans. Ver. 3.14. Institute of Marine Research.

Foote, K. G., Knudsen, H. P., Korneliussen, R. J., Nordbø, P. E. and Røang, K. 1991. Post processing system for echo integrator data. J.Acoust. Soc. Am., 90, 37–47.

ICES. 1999. Report of the Herring Assessment Working Group for the Area South of 62°N. ICES CM 1999/ACFM: 12.

ICES. 2006. Report of the Planning Group on Herring Surveys. ICES CM 2006/LRC:04, Ref RMC, HAWG

Toresen, R., Gjøsæter, H., and de Barros, P. 1998. The acoustic method as used in the abundance estimation of capelin (*Mallotus villosus* Müller) and herring (*Clupea harengus* Linné) in the Barents Sea. Fisheries Research, 34: 27–37.

**Table 1. RV "Johan Hjort", survey 2006210. International acoustic survey on herring in the North Sea, 29 June – 27 July 2006. Simrad ER60 and analysis settings used.**

| **Tranceiver Menu** | **38 kHz** |
|---|---|
| Absorption coefficient | 10.0 dB/km |
| Pulse length | 1.024 ms |
| Bandwidth | 2.43 kHz |
| Max power | 2000 W |
| Two-way beam angle | -21.0 dB |
| 3 dB Beam width | 7.05/6.87 |
| **Calibration details** | |
| TS of sphere | -33.7 |
| Range to sphere in calibration | 16.00 m |
| Transducer gain | 26.94 |
| SaCorrection | -0,63 |
| **Log/Navigation Menu** | |
| Speed | Serial from ship's GPS |
| **Operation Menu** | |
| Ping interval | 0.0 - 08 sec |
| **Display/Printer Menu** | |
| Integration line | n/a |
| TS colour min. | -60 dB |
| Sv colour min. | -60 dB |

**Table 2. RV "Johan Hjort" 4–27 July 2005. Details of total trawl stations in the North Sea. PT = Pelagic Trawl, BT = Bottom Trawl.**

| Trawl haul no | Date | Lat | Lon | Time UTC | Water depth (m) | Trawl depth (m) | Duration (min) | | Total catch (kg) |
|---|---|---|---|---|---|---|---|---|---|
| BT281 | 29.jun | 60°35' | 3°04'E | 2358 | 154 | 155 | 35 | | 115,04 |
| BT282 | 30.jun | 60°14' | 3°07'E | 0402 | 127 | 130 | 31 | | 133,75 |
| BT283 | 30.jun | 59°48' | 3°07'E | 0755 | 131 | 132 | 28 | | 370,26 |
| BT284 | 30.jun | 59°17' | 3°09'E | 1208 | 138 | 139 | 30 | | 258,66 |
| BT285 | 30.jun | 58°51' | 3°07'E | 1640 | 109 | 110 | 30 | H | 105,24 |
| BT286 | 30.jun | 58°09' | 3°41'E | 2312 | 93 | 90 | 31 | | 119,53 |
| BT287 | 01.jul | 58°12' | 4°21'E | 0237 | 128 | 136 | 30 | | 265,83 |
| BT288 | 01.jul | 57°50' | 4°37'E | 0647 | 96 | 96 | 30 | | 78,58 |
| BT289 | 01.jul | 57°46' | 5°49'E | 1135 | 152 | 155 | 30 | | 304,29 |
| BT290 | 01.jul | 57°35' | 6°01'E | 1359 | 140 | 140 | 29 | | 12,16 |
| BT291 | 01.jul | 57°13' | 6°13*E | 1735 | 70 | 70 | 35 | | 69,64 |
| PT292 | 01.jul | 57°23' | 7°28' E | 2303 | 84 | 0 | 17 | H | 600,00 |
| BT293 | 02.jul | 57°25' | 7°39' E | 0057 | 111 | 113 | 30 | | 368,60 |
| PT294 | 02.jul | 57°28' | 8°27' E | 2134 | 62 | 0 | 28 | H | 89,90 |
| PT295 | 03.jul | 57°00' | 5°53' E | 2309 | 55 | 0 | 30 | h | 38,84 |
| BT296 | 04.jul | 56°40' | 5°42' E | 0231 | 56 | 55 | 30 | H | 143,82 |
| BT297 | 04.jul | 56°36' | 2°09' E | 1419 | 81 | 81 | 30 | | 62,85 |
| PT298 | 04.jul | 56°48' | 3°06' E | 1937 | 66 | 0 | 30 | | 28,28 |
| BT299 | 04.jul | 56°49' | 3°33' E | 2220 | 61 | 60 | 31 | | 260,56 |
| PT300 | 05.jul | 56°48' | 3°58' E | 0047 | 54 | 0 | 31 | h | 34,68 |
| BT301 | 05.jul | 56°45' | 4°37' E | 0352 | 57 | 57 | 30 | H | 358,18 |
| PT302 | 05.jul | 56°48' | 5°04' E | 0613 | 61 | 0 | 29 | | 14,93 |
| PT303 | 05.jul | 57°00' | 2°27' E | 2257 | 75 | 0 | 30 | | 10,85 |
| PT304 | 06.jul | 57°00' | 1°41' E | 0251 | 90 | 0 | 30 | | 6,10 |
| BT305 | 06.jul | 57°00' | 0°21'W | 1138 | 80 | 80 | 30 | | 329,71 |
| BT306 | 06.jul | 57°08' | 0°36' W | 2011 | 82 | 82 | 30 | h | 779,86 |
| BT307 | 07.jul | 57°13' | 0°29' E | 0039 | 85 | 85 | 31 | H | 183,01 |
| BT308 | 07.jul | 57°13' | 1°29' E | 0514 | 94 | 94 | 28 | H | 212,03 |
| BT309 | 07.jul | 57°16' | 2°37' E | 1230 | 80 | 80 | 30 | | 116,14 |
| PT310 | 07.jul | 57°23' | 2°34' E | 1710 | 75 | 0 | 31 | | 3,38 |
| BT311 | 07.jul | 57°24' | 3°27' E | 2036 | 63 | 63 | 29 | h | 479,53 |
| PT312 | 07.jul | 57°22' | 4°07' E | 2329 | 75 | 0 | 30 | H | 51,98 |
| BT313 | 08.jul | 57°20' | 4°13' E | 0054 | 65 | 65 | 30 | | 282,27 |
| PT314 | 08.jul | 57°23' | 5°04' E | 0438 | 70 | 0 | 29 | H | 19,26 |
| BT315 | 08.jul | 57°25' | 5°28' E | 0657 | 83 | 83 | 31 | | 144,70 |
| PT316 | 08.jul | 57°37' | 5°52' E | 1129 | 75 | 75 | 39 | | 0,00 |
| PT317 | 08.jul | 57°36' | 4°23' E | 1711 | 72 | 0 | 65 | H | 1500,00 |
| PT318 | 08.jul | 57°35' | 3°36' E | 2239 | 62 | 0 | 30 | h | 137,79 |
| BT319 | 09.jul | 57°36' | 3°31' E | 0014 | 75 | 75 | 31 | | 1181,48 |
| BT320 | 09.jul | 57°35' | 2°50' E | 0314 | 65 | 65 | 30 | | 316,35 |
| PT321 | 09.jul | 57°37' | 1°19' E | 0905 | 102 | 5 | 30 | H | 193,08 |
| BT322 | 09.jul | 57°54' | 0°20' E | 1521 | 139 | 132 | 33 | H | 181,66 |
| BT323 | 09.jul | 58°13' | 0°43' E | 2109 | 150 | 150 | 31 | H | 2017,54 |
| PT324 | 10.jul | 58°24' | 1°12' E | 0148 | 110 | 0 | 32 | H | 70,27 |
| BT325 | 10.jul | 58°19' | 1°32' E | 0455 | 109 | 109 | 31 | H | 121,63 |
| BT326 | 10.jul | 57°52' | 1°29' E | 0822 | 93 | 93 | 35 | H | 239,05 |
| PT327 | 10.jul | 57°55' | 3°11' E | 1511 | 68 | 10 | 36 | | 8,16 |
| PT328 | 10.jul | 57°53' | 4°06' E | 2012 | 92 | 0 | 31 | H | 759,97 |
| PT329 | 11.jul | 57°52' | 5°00' E | 0020 | 110 | 0 | 31 | H | 244,67 |
| PT330 | 11.jul | 58°06' | 5°45' E | 0441 | 306 | 0 | 30 | H | 170,75 |
| BT331 | 11.jul | 58°10' | 2°47'E | 1700 | 71 | 71 | 31 | | 210,12 |

**Table 2. Continued.**

| Trawl haul no | Date | Lat | Lon | Time UTC | Water depth (m) | Trawl depth (m) | Duration (min) | | Total catch (kg) |
|---|---|---|---|---|---|---|---|---|---|
| PT332 | 12.jul | 58°11' | 2°04'E | 2114 | 95 | 0 | 27 | H | 302,13 |
| PT333 | 12.jul | 58°25' | 2°58'E | 0201 | 100 | 0 | 35 | H | 175,02 |
| PT334 | 12.jul | 58°24' | 5°29' E | 2310 | 331 | 0 | 30 | h | 213,06 |
| PT335 | 14.jul | 58°26' | 4°26' E | 0358 | 270 | 0 | 31 | H | 230,19 |
| PT336 | 14.jul | 58°38' | 3°58' E | 0820 | 275 | 0 | 29 | | 4,88 |
| PT337 | 14.jul | 58°38' | 3°46' E | 1010 | 235 | 5 | 30 | H | 401,00 |
| BT338 | 14.jul | 58°38' | 2°52' E | 1442 | 113 | 113 | 30 | h | 133,65 |
| PT339 | 14.jul | 58°38' | 1°09' E | 2127 | 129 | 0 | 30 | H | 309,87 |
| BT340 | 15.jul | 58°45' | 0°35'E | 0049 | 133 | 133 | 26 | H | 684,35 |
| PT341 | 15.jul | 58°37' | 0°20'E | 0331 | 139 | 0 | 31 | h | 21,32 |
| BT342 | 15.jul | 58°38' | 0°20'E | 0656 | 130 | 130 | 25 | H | 221,47 |
| BT343 | 15.jul | 58°53' | 0°28'E | 1548 | 150 | 150 | 11 | H | 76,98 |
| BT344 | 15.jul | 58°53' | 1°21' E | 1933 | 121 | 120 | 30 | H | 173,45 |
| PT345 | 15.jul | 58°53' | 1°43'E | 2228 | 111 | 0 | 30 | H | 93,41 |
| PT346 | 16.jul | 58°53' | 2°04'E | 0028 | 109 | 15 | 30 | H | 1001,21 |
| PT347 | 16.jul | 59°04' | 3°35' E | 0845 | 247 | 0 | 30 | H | 54,45 |
| BT348 | 16.jul | 59°16' | 2°10' E | 1553 | 122 | 125 | 30 | H | 285,66 |
| PT349 | 16.jul | 59°17' | 3°05' E | 2139 | 133 | 20 | 31 | H | 54,69 |
| PT350 | 17.jul | 59°17' | 4°01' E | 0445 | 285 | 0 | 30 | h | 72,27 |
| PT351 | 17.jul | 59°33' | 3°16' E | 1734 | 162 | 0 | 30 | h | 29,05 |
| BT352 | 17.jul | 59°34' | 2°50' E | 2020 | 116 | 116 | 30 | | 199,31 |
| PT353 | 17.jul | 59°32' | 2°09' E | 2333 | 123 | 0 | 31 | H | 238,99 |
| PT354 | 18.jul | 59°17' | 1°55' E | 0250 | 119 | 0 | 30 | h | 41,97 |
| PT355 | 18.jul | 59°18' | 1°06' E | 0740 | 99 | 100 | 30 | h | 103,86 |
| PT356 | 18.jul | 59°18' | 0°30' E | 1203 | 131 | 129 | 30 | H | 134,20 |
| BT357 | 18.jul | 59°18' | 0°23' E | 1723 | 137 | 135 | 30 | H | 221,64 |
| BT358 | 19.jul | 59°45' | 0°27' E | 0756 | 141 | 137 | 31 | H | 281,86 |
| PT359 | 19.jul | 60°29' | 0°41' E | 1844 | 100 | 100 | 29 | | 4,88 |
| PT360 | 19.jul | 60°38' | 0°39' E | 2111 | 104 | 0 | 30 | h | 394,89 |
| PT361 | 19.jul | 60°48' | 0°36' E | 2338 | 107 | 80 | 30 | H | 36,38 |
| PT362 | 20.jul | 60°49' | 0°44' E | 0142 | 88 | 0 | 30 | H | 6,40 |
| BT363 | 20.jul | 60°30' | 0°51' E | 0633 | 101 | 100 | 29 | H | 302,54 |
| BT364 | 21.jul | 60°14' | 0°36' E | 1816 | 163 | 163 | 30 | H | 256,61 |
| BT365 | 21.jul | 60°14' | 0°12' E | 2140 | 122 | 120 | 30 | H | 181,32 |
| PT366 | 22.jul | 60°00' | 0°60' E | 0055 | 122 | 0 | 30 | H | 80,78 |
| BT367 | 22.jul | 59°51' | 0°29' E | 0343 | 135 | 135 | 30 | H | 117,53 |
| BT368 | 22.jul | 59°46' | 1°28' E | 0807 | 118 | 118 | 30 | H | 177,07 |
| PT369 | 22.jul | 60°04' | 4°09' E | 2336 | 290 | 0 | 30 | H | 157,41 |
| PT370 | 23.jul | 60°04' | 3°19' E | 0302 | 249 | 0 | 30 | H | 40,96 |
| BT371 | 23.jul | 60°16' | 2°36' E | 1022 | 105 | 105 | 27 | H | 75,19 |
| PT372 | 24.jul | 60°45' | 3°35' E | 0008 | 318 | 0 | 30 | H | 322,01 |
| BT373 | 24.jul | 60°44' | 2°36' E | 0531 | 125 | 125 | 30 | H | 178,39 |
| BT374 | 24.jul | 60°43' | 1°20' E | 1046 | 147 | 147 | 31 | H | 246,14 |
| BT375 | 24.jul | 60°46' | 0°34' E | 1440 | 145 | 145 | 30 | H | 125,46 |
| BT376 | 24.jul | 60°43' | 0°17' E | 1845 | 119 | 119 | 32 | | 0,00 |
| PT377 | 24.jul | 60°59' | 0°27' E | 2255 | 148 | 0 | 29 | H | 219,11 |
| BT378 | 25.jul | 61°13' | 0°16' E | 0113 | 165 | 165 | 30 | H | 160,19 |
| BT379 | 25.jul | 61°52' | 0°22' E | 0633 | 293 | 293 | 30 | | 367,28 |
| BT380 | 25.jul | 61°43' | 0°32' E | 1205 | 215 | 215 | 25 | H | 199,43 |
| BT381 | 25.jul | 61°14' | 0°30' E | 1551 | 167 | 167 | 30 | H | 332,63 |
| PT382 | 25.jul | 61°15' | 1°17' E | 2009 | 155 | 155 | 30 | | 122,26 |
| BT383 | 25.jul | 61°15' | 1°17' E | 2134 | 155 | 154 | 31 | H | 453,49 |
| PT384 | 26.jul | 61°28' | 1°20' E | 0025 | 177 | 0 | 30 | H | 75,65 |
| BT385 | 26.jul | 61°41' | 1°27' E | 0237 | 188 | 188 | 30 | h | 143,65 |

**Table 3: RV "Johan Hjort" 29 June - 27 July 2006. Catch compositions in the trawl hauls (kg) taken in the Norwegian herring acoustic area.**

| **Trawl station** | | BT281 | BT282 | BT283 | BT284 | BT285 | BT286 | BT287 | BT288 | BT289 | BT290 | BT291 | PT292 | BT293 | PT294 | PT295 | BT296 | BT297 | PT298 | BT299 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ICES rect** | | 50F3 | 49F3 | 48F3 | 47F3 | 46F3 | 45F3 | 45F3 | 44F4 | 44F5 | 44F6 | 43F6 | 43F7 | 43F7 | 42F5 | 42F5 | 43F3 | 43F5 | 43F5 | 44F4 |
| **Total catch (kg)** | | **115,09** | **133,75** | **370,26** | **258,66** | **105,24** | **119,53** | **265,83** | **75,85** | **304,29** | **12,16** | **68,47** | **600,00** | **337,48** | **89,37** | **38,84** | **143,30** | **67,53** | **28,28** | **260,56** |
| Herring | Clupea harengus | | | | | 7,89 | | | | | | | 276,00 | | 37,13 | 1,90 | 5,37 | | | |
| Sprat | Sprattus sprattus | | | | | | | | | | | | | | | | | | | |
| Mackerel | Scombrus scombrus | | | 1,08 | | | | | | 0,41 | | 10,38 | 324,00 | | 49,47 | 30,36 | | | 14,76 | |
| Horse mackerel | Tracurus tracurus | | | 0,64 | 1,21 | | | | | | | | | | 2,24 | | | | | |
| Norway pout | Trisopterus esmarkii | 24,04 | 20,83 | 45,50 | 164,33 | 5,68 | | 70,19 | 0,26 | 125,88 | 4,27 | 0,38 | | 224,38 | | | 0,14 | 0,58 | | |
| Haddock | Melanogrammus aeglefinus | | 0,14 | 8,95 | 0,03 | 34,25 | 72,03 | 11,97 | 31,04 | 0,07 | 0,02 | 1,20 | | 3,08 | 0,03 | 0,10 | | 13,27 | 0,00 | 4,08 |
| Whiting | Merlangius merlangus | 1,05 | 5,11 | 4,68 | 4,72 | 23,06 | 12,48 | | 1,96 | 0,29 | | | | 16,68 | 0,06 | 1,52 | 1,14 | 20,47 | 0,02 | 51,85 |
| Blue-whiting | Micromesistius poutassou | 0,66 | 0,69 | | | | | 5,35 | | | | | | | | | | | | |
| Saithe | Pollachius virens | 78,08 | 36,01 | 266,13 | 35,63 | 4,46 | | 90,25 | | 121,88 | 1,26 | | | 20,74 | | | | | | |
| Hake | Merluccius merluccius | | 0,16 | 3,19 | 36,15 | 0,35 | 1,95 | 2,65 | 4,49 | 36,41 | 5,43 | 2,23 | | 2,05 | | | 0,61 | | | |
| Pollack | Pollachius pollachius | | 4,39 | 3,48 | | | | 20,32 | | | | | | | | | | | | |
| Torsk | Brosme brosme | | | | | 4,10 | 1,80 | 4,68 | | | | | | | | | | | | |
| Cod | Gadus morhua | 2,69 | 11,14 | 14,36 | 5,44 | | | 25,46 | 8,00 | 13,33 | 0,00 | 6,05 | | 50,79 | | | 13,85 | 1,38 | | |
| Poor cod | Trisopterus minutus | | | | | | 0,05 | 3,46 | | 3,70 | | | | 1,67 | | | | | | |
| Silvery pout | Gadiculus argenteus | | | | | | | | | 0,09 | | | | | | | | | | |
| Ling | Molva molva | | | 6,29 | 1,15 | | | 7,83 | | | | | | | | | | | | |
| Blue ling | Molva diperygia | | | | | | | | | | | | | | | | | | | |
| Argentine | Argentina sphyraena | 0,42 | 0,16 | 0,48 | 0,27 | | 0,20 | 0,67 | 0,22 | | 0,07 | | | | | | | | | |
| Greater Argentines | Argentina silus | | | | | | | | | | | | | | | | | | | |
| Common dragonet | Callionymus lyra | 0,43 | 0,06 | | 0,02 | | | | 0,01 | | | | | | | | | | | |
| Spotted dragonet | Callionymus maculatus | | | | | | | | 0,01 | | | | | | | | | | | |
| Sandeels | Ammodytidae spp | | | | | | | | | | | | | | | | 0,25 | | | |
| Gurnard | Trigla spp | | 2,78 | | | 5,76 | | 0,58 | | | | 1,25 | | | | 3,17 | | | 9,15 | |
| Tub gunard | Trigla lucerna | | | 6,45 | 2,21 | | 3,13 | | 1,22 | | | | | | | | 4,50 | 3,78 | | 2,13 |
| Hook-nouse | Agonus cataphractus | | | | | | 0,02 | | | | | | | | | | | | | |
| Dab | Limanda limanda | | 0,14 | | | 5,76 | 19,97 | 0,38 | 8,86 | | | 36,59 | | 5,12 | | | 59,00 | 16,83 | | 186,00 |
| Sole | Solea solea | | | | | | | | | | | | | | | | | | | |
| Plaice | Pleuronectes platessa | | | | | 0,41 | 0,37 | | 2,00 | 0,48 | | 3,06 | | 0,29 | | | 2,86 | 1,01 | | 3,81 |
| Witch | Glyptocephalus cynoglossus | | | | 0,27 | | 0,14 | | | | | | | | | | | | | |
| Turbot | Scophthalmus maximus | | | | | 12,21 | | | 1,50 | | | | | | | | | | | |
| Lemon sole | Microstomus kitt | | 7,47 | 1,16 | 0,49 | | | | 1,01 | 0,43 | | | | 0,42 | | | 1,00 | 1,82 | | 2,51 |
| Long rough dab | Hippoglossoides platessoides | 5,98 | 39,51 | 6,64 | 0,23 | 1,32 | 1,98 | 3,43 | 0,96 | 0,29 | 0,66 | 0,91 | | 5,29 | | | 52,62 | 3,71 | | 8,29 |
| Megrim | Lepidorhombus whiffiagoni | | | | 0,91 | | | | | | | | | | | | | | | |
| Atlantic halibut | Hippoglossus hippoglossus | | | | | | 3,28 | | | | | | | | | | | | | |
| Atlantic Catfish | Anarhichas lupus | | | | | | | 4,71 | 11,04 | | | 4,75 | | 6,97 | | | | | | |
| Lumpsucker | Cyclopterus lumpus | | | | | | | | 0,14 | | | | | | | | | | | |
| Monkfish | Lophius piscatorius | | 4,16 | | 4,18 | | | | | | | | | | | | | | | |
| Starry skate | Raja radiata | | 0,89 | 1,24 | | | 2,14 | 0,17 | 0,42 | | | | | | | | 1,98 | | | 1,89 |
| Cuckoo ray | Raja Leucoraja naevus | | | | | | | | | | | | | | | | | | | |
| Common skate | Raja batis | | | | | | | | | | | | | | | | | | | |
| Sandy ray | Raja circularis | | | | | | | | | | | | | | | | | | | |
| Garfish | Belona belona | | | | | | | | | | | | | | | 0,33 | | | | |
| Snake pipefish | Entelurus aequerius | | | | | | | | 0,02 | | | 0,04 | | | 0,44 | 1,46 | | | 1,63 | |
| Norway haddock | Sebastes marinus | | | | | | | | | | | | | | | | | | | |
| Norwegian redfish | Sebastes viviparus | | | | | | | 11,76 | 0,75 | 0,26 | | | | | | | | | | |
| Black-mouthed dogfis | Galeus melanostomus | | | | | | | | | | | | | | | | | | | |
| Dogfish | Scyliorhinus canicula | | | | | | | | | | | | | | | | | | | |
| Rabbit fish | Chimaera monstrosa | | | | | | | | | | | | | | | | | | | |
| Cephalopoda | | 0,19 | 0,13 | | 1,42 | | | 0,07 | 0,61 | 0,77 | 0,42 | 0,97 | | | | | | | | |
| Jellyfish | | | | | | | | | | | | | | | | | | | 2,72 | |
| Other | | 1,55 | | | | | | 1,92 | 1,35 | | 0,03 | 0,66 | | | | | | 4,69 | | |

| **Trawl station** | | PT300 | BT301 | PT302 | PT303 | BT306 | BT309 | PT310 | BT311 | PT312 | BT313 | PT314 | BT315 | PT316 | PT317 | PT318 | BT319 | BT320 | PT327 | PT328 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ICES rect** | | 44F2 | 44F3 | 42F5 | 43F2 | 43F3 | 46F4 | 43F2 | 43F3 | 43F4 | 43F4 | 43F5 | 43F5 | 44F5 | 44F4 | 44F4 | 44F3 | 44F2 | 44F3 | 44F4 |
| **Total catch (kg)** | | **34,68** | **358,15** | **12,74** | **10,82** | **779,86** | **116,14** | **3,38** | **479,53** | **51,83** | **282,27** | **19,26** | **144,70** | **0,00** | **1500,00** | **137,79** | **1181,48** | **316,35** | **8,16** | **759,97** |
| Herring | Clupea harengus | 0,66 | 5,00 | | | 0,13 | | | 1,26 | 2,19 | | 2,97 | | | 1200,00 | 0,11 | | | | 749,38 |
| Sprat | Sprattus sprattus | | | | | | | | | | | | | | | | | | | |
| Mackerel | Scombrus scombrus | 31,80 | | 1,61 | 8,95 | 14,29 | | 1,23 | | 36,52 | | | | | 225,00 | 108,48 | | | 4,76 | 7,47 |
| Horse mackerel | Tracurus tracurus | | | | | | | | | | 1,49 | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |
| Norway pout | Trisopterus esmarkii | | | | | 7,43 | | | | | | | 26,40 | | | 8,50 | | | | |
| Haddock | Melanogrammus aeglefinus | | | 0,00 | 0,01 | 360,19 | 36,98 | | | 0,01 | | | 52,90 | | | 0,19 | 403,20 | 4,16 | | |
| Whiting | Merlangius merlangus | 0,01 | | 0,32 | 0,05 | 280,26 | 5,35 | | 3,73 | | | 0,01 | 10,31 | | | 2,16 | 126,00 | 18,00 | 0,00 | |
| Blue-whiting | Micromesistius poutassou | | | | | | | | | | | | | | | | | | | |
| Saithe | Pollachius virens | | | | | | 1,36 | | | | | | | | | | | | | |
| Hake | Merluccius merluccius | | | | | | | | | | | | 5,17 | | | | | | | |
| Pollack | Pollachius pollachius | | | | | | | | | | | | | | | | | | | |
| Torsk | Brosme brosme | | | | | | | | | | | | | | | | | | | |
| Cod | Gadus morhua | | 1,32 | | | 0,59 | 7,11 | | | | | | 22,04 | | | | 6,26 | 1,30 | | |
| Poor cod | Trisopterus minutus | | | | | | | | | | | | 2,38 | | | | | | | |
| Silvery pout | Gadiculus argenteus | | | | | | | | | | | | | | | | | | | |
| Ling | Molva molva | | | | | | | | | | | | 1,45 | | | | | | | |
| Blue ling | Molva dipterygia | | | | | | | | | | | | | | | | | | | |
| Argentine | Argentina sphyraena | | | | | 0,01 | | | | | | | | | | | | | | |
| Greater Argentines | Argentina silus | | | | | | | | | | | | | | | | | | | |
| Common dragonet | Callionymus lyra | | | | | 0,04 | | | | | | | | | | | | | | |
| Spotted dragonet | Callionymus maculatus | | | | | | | | | | | | | | | | | | | |
| Sandeels | Ammodytidae spp | | 0,03 | | | | | | | | | | | | | | | | | |
| Gurnard | Trigla spp | | 4,00 | 0,45 | | 30,06 | 1,99 | 0,30 | 2,84 | 8,19 | 5,13 | 4,51 | 1,83 | | 65,00 | 18,36 | 10,55 | 8,83 | 1,36 | 0,60 |
| Tub gunard | Trigla lucerna | | | | | | | | | | | | | | | | | | | |
| Hook-nouse | Agonus cataphractus | | | | | | | | | | | | | | | | | 0,02 | | |
| Dab | Limanda limanda | | 312,20 | | | 65,70 | 48,40 | | 415,00 | | 267,00 | | 10,41 | | | | 620,96 | 261,79 | | |
| Sole | Solea solea | | | | | 0,31 | | | | | | | | | | | | | | |
| Plaice | Pleuronectes platessa | | | | | 3,69 | 3,90 | | 3,50 | | | | 3,46 | | | | 1,43 | 3,85 | | |
| Witch | Glyptocephalus cynoglossus | | | | | | | | | | | | | | | | | | | |
| Turbot | Scophthalmus maximus | | | | | | | | | | | | | | | | | | | |
| Lemon sole | Microstomus kitt | | 13,49 | | | 12,00 | 4,52 | | 27,60 | | | | 2,29 | | | | 1,45 | 6,38 | | |
| Long rough dab | Hippoglossoides platessoides | | 9,94 | | | 3,85 | 4,92 | | 25,60 | | 8,65 | | 0,75 | | | | 9,14 | 12,03 | | |
| Megrim | Lepidorhombus whiffiagoni | | | | | | | | | | | | | | | | | | | |
| Atlantic halibut | Hippoglossus hippoglossus | | | | | | | | | | | | | | | | | | | |
| Atlantic Catfish | Anarhichas lupus | | | | | | | | | | | | | | | | | | | |
| Lumpsucker | Cyclopterus lumpus | | | | | | | | | | | | | | | | | | 0,80 | 2,42 |
| Monkfish | Lophius piscatorius | | | | | | | | | | | | 1,65 | | | | | | | |
| Starry skate | Raja radiata | | 11,80 | | | | 0,59 | | | | | | 3,08 | | | | 2,50 | | | |
| Cuckoo ray | Raja Leucoraja naevus | | | | | | | | | | | | | | | | | | | |
| Common skate | Raja batis | | | | | | | | | | | | | | | | | | | |
| Sandy ray | Raja circularis | | | | | | | | | | | | | | | | | | | |
| Garfish | Belona belona | | | | | | | | | 0,30 | | | | | | | | | | |
| Snake pipefish | Entelurus aequerius | 2,21 | | | 1,72 | | | 1,50 | | 4,00 | | 5,07 | | | 10,00 | | | | 1,24 | 0,11 |
| Norway haddock | Sebastes marinus | | | | | | | | | | | | | | | | | | | |
| Norwegian redfish | Sebastes viviparus | | | | | | | | | | | | | | | | | | | |
| Black-mouthed dogfis | Galeus melanostomus | | | | | | | | | | | | | | | | | | | |
| Dogfish | Scyliorhinus canicula | | | | | | | | | | | | | | | | | | | |
| Rabbit fish | Chimaera monstrosa | | | | | | | | | | | | | | | | | | | |
| Cephalopoda | | | | | 0,05 | | | | | | | | | | | | | | | |
| Jellyfish | | | | 10,36 | | | | 0,35 | | | | 6,70 | | | | | | | | |
| Other | | | 0,37 | | 0,03 | 1,32 | 1,02 | | | 0,62 | | | 0,59 | | | | | | | |

| **Trawl station** | | PT329 | PT330 | BT331 | PT332 | PT333 | PT334 | PT335 | PT336 | PT337 | BT338 | BT343 | BT348 | PT349 | PT350 | PT351 | BT352 | PT353 | PT355 | BT364 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ICES rect** | | 44F5 | 45F5 | 45F2 | 45F2 | 45F2 | 45F5 | 45F4 | 46F3 | 46F3 | 46F2 | 46F2 | 46F2 | 47F3 | 46F4 | 48F3 | 48F2 | 48F2 | 45F5 | 46F2 |
| **Total catch (kg)** | | **244,67** | **170,75** | **200,52** | **302,13** | **175,02** | **213,06** | **230,19** | **4,88** | **401,91** | **132,42** | **76,99** | **285,66** | **54,69** | **72,27** | **29,05** | **199,31** | **238,99** | **103,86** | **256,61** |
| Herring | Clupea harengus | 193,40 | 49,87 | 0,26 | 225,00 | 56,40 | 0,10 | 79,80 | | 316,72 | 0,94 | 16,40 | 18,30 | 2,69 | 3,24 | 2,85 | | 26,03 | 2,51 | 25,98 |
| Sprat | Sprattus sprattus | | | | | | | | | | | | | | | | | | | |
| Mackerel | Scombrus scombrus | 51,00 | 25,16 | | 75,00 | 118,62 | 1,18 | 58,62 | 2,04 | 36,32 | | | | 34,10 | 8,45 | 2,36 | | 202,94 | | 54,67 |
| Horse mackerel | Tracurus tracurus | | | | | | | | 0,12 | | | | 0,16 | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |
| Norway pout | Trisopterus esmarkii | | | | | | | | | | 14,35 | 11,65 | 160,80 | | | | 14,80 | | 0,72 | 98,50 |
| Haddock | Melanogrammus aeglefinus | | | 51,28 | | | | 0,01 | | | 34,40 | 6,47 | 45,75 | | 0,03 | | 22,03 | | 52,56 | 15,45 |
| Whiting | Merlangius merlangus | | 0,07 | 44,40 | | | 0,12 | 0,01 | 0,02 | 0,01 | 8,57 | 4,76 | 10,82 | 0,02 | | | 2,01 | | 9,95 | 8,30 |
| Blue-whiting | Micromesistius poutassou | | | | | | 0,10 | | | | | 0,06 | | | | | | | | 2,55 |
| Saithe | Pollachius virens | | | 3,60 | | | 4,52 | | | | 40,43 | 26,20 | 11,62 | | | | 4,21 | | 2,49 | 15,40 |
| Hake | Merluccius merluccius | | | | | | | | | | 7,06 | 0,46 | 6,15 | | | | 96,28 | | | 5,12 |
| Pollack | Pollachius pollachius | | | | | | | | | | | | | | | | 2,72 | | | |
| Torsk | Brosme brosme | | | | | | | | | | | | | | | | 3,99 | | | |
| Cod | Gadus morhua | | | 2,31 | | | | | | | 4,10 | 1,35 | 3,34 | | | | 17,75 | | 5,27 | 1,50 |
| Poor cod | Trisopterus minutus | | | | | | | | | | | | | | | | 0,06 | | | |
| Silvery pout | Gadiculus argenteus | | | | | | | | | | | 0,15 | | | | | | | | 3,90 |
| Ling | Molva molva | | | | | | | | | | | | | | | | 0,69 | | | |
| Blue ling | Molva dipterygia | | | | | | | | | | | | | | | | | | | |
| Argentine | Argentina sphyraena | | | | | | | | | | | | | | | | | | | |
| Greater Argentines | Argentina silus | | | | | | | | | | 0,59 | 0,07 | | | | | 2,66 | | 1,49 | 0,99 |
| Common dragonet | Callionymus lyra | | | | | | | | | | 0,02 | | | | | | 0,03 | | | |
| Spotted dragonet | Callionymus maculatus | | | | | | | | | | | | | | | | | | | 0,01 |
| Sandeels | Ammodytidae spp | | | | | | | | | | | | | | | | | | | |
| Gurnard | Trigla spp | | | 3,20 | 1,74 | | | | | | | | 4,47 | | | | 2,02 | | 5,32 | 0,07 |
| Tub gunard | Trigla lucerna | | | | | | | | | | 1,88 | | | | | | | | | |
| Hook-nouse | Agonus cataphractus | | | | | | | | | | | | | | | | | | | |
| Dab | Limanda limanda | | | 86,40 | | | | | | | 6,90 | | 0,88 | | | | | | 8,80 | 0,46 |
| Sole | Solea solea | | | | | | | | | | | | | | | | | | | |
| Plaice | Pleuronectes platessa | | | | | | | | | | | | 0,48 | | | | | | 0,22 | |
| Witch | Glyptocephalus cynoglossus | | | | | | | | | | 0,13 | | 0,26 | | | | 0,29 | | | |
| Turbot | Scophthalmus maximus | | | | | | | | | | | | | | | | | | | |
| Lemon sole | Microstomus kitt | | | 5,36 | | | | | | | 3,49 | | 0,59 | | | | 4,79 | | 8,38 | |
| Long rough dab | Hippoglossoides platessoides | | | 3,50 | | | | | | | 8,07 | 3,58 | 9,60 | | | | 7,20 | | 2,78 | 17,60 |
| Megrim | Lepidorhombus whiffiagoni | | | | | | | | | | 0,29 | | 1,13 | | | | 3,43 | | | 1,98 |
| Atlantic halibut | Hippoglossus hippoglossus | | | | | | | | | | | | | | | | | | | |
| Atlantic Catfish | Anarhichas lupus | | | | | | | | | | | | 7,55 | | | | | | | |
| Lumpsucker | Cyclopterus lumpus | | 0,93 | | | | | | | 2,40 | | | | | | | | | | |
| Monkfish | Lophius piscatorius | | | | | | | | | | | | | | | | 4,68 | 0,35 | 1,06 | 1,81 |
| Starry skate | Raja radiata | | | | | | | | | | | | | | | | | | 0,43 | |
| Cuckoo ray | Raja Leucoraja naevus | | | | | | | | | | | | | | | | | | | 0,89 |
| Common skate | Raja batis | | | | | | | | | | | | | | | | | | | |
| Sandy ray | Raja circularis | | | | | | | | | | | | | | | | | | | |
| Garfish | Belona belona | 0,27 | | | 0,38 | | 0,33 | | | 1,82 | | | | | 0,40 | | | | | |
| Snake pipefish | Entelurus aequerius | | 0,23 | 0,06 | | | 0,05 | 0,35 | 2,70 | 1,44 | 0,01 | 0,04 | | 2,48 | 3,53 | 3,00 | | 4,06 | | 0,03 |
| Norway haddock | Sebastes marinus | | | | | | | | | | | | | | | | | | | |
| Norwegian redfish | Sebastes viviparus | | | | | | | | | | | | | | | | 8,61 | | 0,38 | |
| Black-mouthed dogfis | Galeus melanostomus | | | | | | | | | | | | | | | | | | | |
| Dogfish | Scyliorhinus canicula | | | | | | | | | | | | | | | | | | | |
| Rabbit fish | Chimaera monstrosa | | | | | | | | | | | | | | | | | | | |
| Cephalopoda | | | | | | | | | | | 0,11 | 1,37 | 0,48 | | 0,22 | | 1,06 | 0,01 | 0,22 | 0,11 |
| Jellyfish | | | 94,49 | | | | 68,80 | 91,40 | | 43,20 | | | 2,51 | 15,40 | 56,40 | 20,84 | | 5,60 | | |
| Other | | | | 0,16 | | | 137,86 | | | | 1,09 | 4,43 | 0,77 | | | | | | 1,29 | 1,30 |

**Table 4. RV "Johan Hjort" 29 June - 27 July 2006. Norwegian Acoustic area, F2-F6. Herring length (cm) distribution in trawl hauls where sample size>20 herring.**

| Trawl st | 285 | 292 | 294 | 295 | 296 | 301 | 311 | 312 | 314 | 317 | 328 | 329 | 330 | 332 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| serie number | 24305 | 24312 | 24314 | 24315 | 24316 | 24321 | 24331 | 24332 | 24334 | 24337 | 24348 | 24349 | 24350 | 24352 |
| ICES sq | 46F3 | 43F7 | 43F5 | 43F5 | 43F3 | 42F4 | 43F3 | 43F4 | 43F5 | 44F4 | 44F4 | 44F5 | 45F5 | 45F2 |
| Length (cm) | | | | | | | | | | | | | | |
| 16 | | | 1 | | | | | | | | | | | |
| 16,5 | | | 1 | | | | | | | | | | | |
| 17 | | | 3 | | | | | | | | | | | |
| 17,5 | | 1 | 7 | 1 | 1 | 1 | | | 2 | | 1 | | | |
| 18 | | 3 | 6 | 9 | 7 | 5 | 2 | | 2 | | | | | |
| 18,5 | | 2 | 10 | 6 | 20 | 19 | 1 | 1 | 5 | 3 | 2 | | | |
| 19 | | 22 | 20 | 11 | 49 | 38 | 4 | 7 | 16 | 18 | 4 | 9 | | 1 |
| 19,5 | | 7 | 14 | 8 | 15 | 14 | 5 | 11 | 11 | 11 | 7 | 5 | 2 | 1 |
| 20 | 1 | 20 | 9 | 2 | 6 | 10 | 3 | 18 | 14 | 22 | 17 | 14 | 1 | |
| 20,5 | | 13 | 14 | | 2 | 1 | 5 | 3 | 5 | 18 | 18 | 17 | 2 | 1 |
| 21 | 2 | 12 | 8 | | | 3 | 3 | 1 | 1 | 10 | 17 | 19 | 1 | 2 |
| 21,5 | 1 | 9 | 5 | | | | | | 1 | 3 | 12 | 18 | 7 | 3 |
| 22 | | 4 | 1 | | | | | | | 12 | 9 | 7 | 5 | 9 |
| 22,5 | 1 | 1 | | | | | | | | 3 | 4 | 7 | 5 | 8 |
| 23 | 2 | 1 | | | | | | | | | 2 | 2 | 2 | 14 |
| 23,5 | | 3 | | | | | | | | | 6 | 2 | 9 | 17 |
| 24 | 2 | | | | | | | | | | 1 | | 5 | 14 |
| 24,5 | 8 | 1 | | | | | | | | | | 1 | 18 | 13 |
| 25 | 13 | | | | | | | | | | 1 | | 19 | 12 |
| 25,5 | 6 | | 1 | | | | | | | | | | 5 | 4 |
| 26 | 9 | | | | | | | | | | | | 4 | 1 |
| 26,5 | 7 | | | | | | | | | | | | 6 | |
| 27 | 1 | | | | | | | | | | | | 4 | 1 |
| 27,5 | 3 | | | | | | | | | | | | 4 | |
| 28 | 1 | | | | | | | | | | | | | |
| 28,5 | | | | | | | | | | | | | 1 | |
| 29 | | | | | | | | | | | | | | |
| 29,5 | | | | | | | | | | | | | | |
| 30 | | | | | | | | | | | | | | |
| 30,5 | | 1 | | | | | | | | | | | | |
| 31 | | | | | | | | | | | | | | |
| 31,5 | | | | | | | | | | | | | | |
| 32 | | | | | | | | | | | | | | |
| 32,5 | | | | | | | | | | | | | | |
| 33 | | | | | | | | | | | | | | |
| 33,5 | | | | | | | | | | | | | | |
| 34 | | | | | | | | | | | | | | |
| 34,5 | | | | | | | | | | | | | | |
| 35 | | | | | | | | | | | | | | |
| 35,5 | | | | | | | | | | | | | | |
| Total N | 57 | 100 | 100 | 37 | 100 | 91 | 23 | 41 | 57 | 100 | 101 | 101 | 100 | 101 |
| mean W (g) | 25,4 | 20,6 | 19,7 | 19,0 | 19,2 | 19,3 | 20,0 | 20,0 | 19,7 | 20,5 | 21,2 | 21,2 | 24,5 | 23,8 |
| mean L (cm) | 138,4 | 71,8 | 60,6 | 51,4 | 50,1 | 54,9 | 54,9 | 53,5 | 52,1 | 72,1 | 78,1 | 79,7 | 119,8 | 107,4 |
| mean verteb | 56,44 | 56,24 | 56,36 | | 56,21 | 55,98 | | 56,46 | 56,22 | 56,3 | 56,54 | 56,31 | 56,27 | 56,4 |

**Table 4. Continued.**

| Trawl st | 333 | 335 | 337 | 343 | 346 | 347 | 348 | 350 | 353 | 369 | 370 | 372 | 373 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| serie number | 24353 | 24355 | 24357 | 24363 | 24366 | 24367 | 24368 | 24370 | 24373 | 24389 | 24390 | 24392 | 24393 |
| ICES sq | 45F2 | 45F4 | 46F3 | 46F2 | 46F2 | 47F3 | 46F2 | 46F4 | 48F2 | 49F4 | 49F3 | 50F3 | 50F2 |
| Length (cm) | | | | | | | | | | | | | |
| 16 | | | | | | | | | | | | | |
| 16,5 | | | | | | | | | | | | | |
| 17 | | | | | | | | | | | | | |
| 17,5 | | | | | | | | | | | | | |
| 18 | | 1 | | | | | | | | | | | |
| 18,5 | | | | | | | | | | | | | |
| 19 | | 1 | | | | | | | | | | | |
| 19,5 | | 4 | 2 | | | | | | | | | | |
| 20 | 3 | | 3 | | | | | | | | | | |
| 20,5 | 4 | 16 | 18 | | | | | | | | | | |
| 21 | 8 | 10 | 12 | | | 1 | | 1 | | | | | |
| 21,5 | 17 | 4 | 7 | | | | 2 | | | | | | |
| 22 | 10 | 8 | 11 | | | | | | | | | | |
| 22,5 | 12 | 6 | 4 | | 1 | | 2 | 1 | 1 | | | | |
| 23 | 10 | 4 | 7 | | 1 | 2 | 8 | 1 | 1 | 2 | | | |
| 23,5 | 12 | 7 | 2 | | 6 | 4 | 13 | 1 | 6 | 2 | 1 | | |
| 24 | 3 | 6 | 2 | | 2 | 3 | 6 | | 7 | 5 | 1 | 1 | |
| 24,5 | 13 | 8 | 2 | | 15 | 3 | 23 | 2 | 10 | 12 | 9 | 2 | 2 |
| 25 | 3 | 8 | 4 | | 9 | 8 | 17 | 5 | 8 | 12 | 4 | 1 | 1 |
| 25,5 | 1 | 8 | 4 | 5 | 17 | 22 | 14 | 2 | 10 | 15 | | 7 | 1 |
| 26 | 1 | 2 | 1 | 2 | 9 | 13 | 3 | 1 | 12 | 13 | 5 | 3 | 6 |
| 26,5 | 2 | 3 | 4 | 6 | 21 | 12 | 4 | 2 | 11 | 12 | 9 | 6 | 8 |
| 27 | | 1 | 3 | 1 | 6 | 7 | 2 | 2 | 8 | 10 | 5 | 5 | 7 |
| 27,5 | | 1 | 3 | 11 | 9 | 1 | 5 | 2 | 5 | 6 | 9 | 2 | 10 |
| 28 | 1 | 1 | 6 | 15 | 2 | 7 | | 1 | 11 | 4 | 7 | 4 | 7 |
| 28,5 | | | | 7 | 2 | 7 | | 1 | 4 | 4 | 6 | 1 | 3 |
| 29 | | 1 | 1 | 9 | | 3 | | 1 | 3 | 1 | | 3 | 4 |
| 29,5 | | | 4 | 7 | | 2 | | 1 | | | 9 | | 5 |
| 30 | | | | 6 | | 3 | | | 2 | 1 | 6 | 6 | 3 |
| 30,5 | | | | 2 | | | 1 | | | | 1 | | 3 |
| 31 | | | | 2 | | | | | 1 | | | 1 | 2 |
| 31,5 | | | | 2 | | | | | | 1 | | | |
| 32 | | | | | | | | | | | | 2 | |
| 32,5 | | | | | | | | | | | | 1 | |
| 33 | | | | | | | | | | | | 1 | |
| 33,5 | | | | | | | | | | | | | |
| 34 | | | | | | | | | | | | 1 | |
| 34,5 | | | | | | | | | | | | | |
| 35 | | | | | | | | | | | | | |
| 35,5 | | | | | | | | | | | | | |
| Total N | 100 | 100 | 100 | 75 | 100 | 98 | 100 | 24 | 100 | 100 | 72 | 47 | 62 |
| mean W (g) | 23,0 | 23,2 | 23,5 | 28,5 | 26,0 | 26,5 | 25,0 | 26,0 | 26,4 | 26,2 | 27,5 | 28,0 | 28,0 |
| mean L (cm) | 102,2 | 107,3 | 109,9 | 218,6 | 153,3 | 144,8 | 130,7 | 135,0 | 153,0 | 150,3 | 175,0 | 189,3 | 213,6 |
| mean verteb | 56,56 | 56,04 | 56,18 | | 56,34 | 56,26 | 56,13 | | 56,46 | 55,88 | | 56,19 | 56,51 |

**Table 5. RV "Johan Hjort" 29 June - 27 July 2006. Norwegian Herring Acoustic Area. Number of otolith pairs read by wr-group, length and maturity.**

| | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | 7 | 8 | 9+ | Totalt |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| L (cm) | im | m | im | m | im | m | im | m | im | m | m | m | m | m | |
| 16,0 | | | | | | | | | | | | | | | 0 |
| 16,5 | | | | | | | | | | | | | | | 0 |
| 17,0 | | | | | | | | | | | | | | | 0 |
| 17,5 | 3 | | | | | | | | | | | | | | 3 |
| 18,0 | 4 | | | | | | | | | | | | | | 4 |
| 18,5 | 24 | | 5 | | | | | | | | | | | | 29 |
| 19,0 | 61 | | 19 | | | | | | | | | | | | 80 |
| 19,5 | 53 | | 15 | | | | | | | | | | | | 68 |
| 20,0 | 42 | 2 | 33 | 1 | | | | | | | | | | | 78 |
| 20,5 | 39 | 2 | 31 | 4 | | | | | | | | | | | 76 |
| 21,0 | 25 | | 29 | 4 | | | | | | | | | | | 58 |
| 21,5 | 12 | 1 | 29 | 4 | 2 | | | | | | | | | | 48 |
| 22,0 | 13 | 1 | 21 | 7 | 1 | | 1 | | | | | | | | 44 |
| 22,5 | 12 | 1 | 7 | 5 | | 1 | | | | | | | | | 26 |
| 23,0 | 4 | | 15 | 7 | 5 | 2 | | | | | | | | | 33 |
| 23,5 | 2 | | 16 | 15 | 4 | 4 | | 1 | | | | | | | 42 |
| 24,0 | | | 6 | 14 | 2 | 3 | | 2 | | 1 | | | | | 28 |
| 24,5 | | | 10 | 25 | 7 | 21 | | 4 | | 3 | | | | | 70 |
| 25,0 | | | 2 | 13 | 5 | 20 | 1 | 5 | | 15 | | | | | 61 |
| 25,5 | | | 1 | 6 | 6 | 16 | 1 | 12 | 1 | 20 | 1 | | | | 64 |
| 26,0 | | | | 6 | 4 | 15 | 2 | 5 | 1 | 15 | 2 | | | | 50 |
| 26,5 | | | | 3 | 2 | 16 | | 12 | | 28 | 7 | 2 | | | 70 |
| 27,0 | | | | 1 | | 5 | 1 | 8 | 2 | 12 | 4 | 2 | | | 35 |
| 27,5 | | | | 2 | | 4 | | 10 | | 21 | 4 | 2 | | | 43 |
| 28,0 | | | | | | 4 | | 9 | | 16 | 5 | 4 | 2 | 1 | 41 |
| 28,5 | | | | | | | | 2 | | 2 | 3 | 2 | 1 | 1 | 11 |
| 29,0 | | | | | | | | 5 | | 9 | 2 | 5 | 2 | | 23 |
| 29,5 | | | | | | | | 2 | | 4 | 2 | 1 | 1 | | 10 |
| 30,0 | | | | | | 1 | | | | 6 | 3 | 2 | | 5 | 17 |
| 30,5 | | | | | | | | | | | 2 | 2 | | 1 | 5 |
| 31,0 | | | | | | | | | | | | 3 | | 2 | 5 |
| 31,5 | | | | | | | | | | | | | | | 0 |
| 32,0 | | | | | | | | 1 | | | | 1 | | | 2 |
| 32,5 | | | | | | | | | | | | | 1 | | 1 |
| 33,0 | | | | | | | | | | | | | 1 | | 1 |
| 33,5 | | | | | | | | | | | | | | | |
| 34,0 | | | | | | | | | | | 1 | | | | 1 |
| Totalt | 294 | 7 | 239 | 117 | 38 | 112 | 6 | 78 | 4 | 152 | 36 | 26 | 8 | 7 | 1124 |

**Table 6. RV "Johan Hjort" 29 June - 27 July 2006. Herring mean length, mean weight, numbers (millions) and biomass (thousands of tonnes) by age and maturity stages in the herring stocks in the Norwegian survey area.**

| WR | $L_{mean}$ | $W_{mean}$ | North Sea Autumn Spawners | | | | Western Baltic Spring Spawners | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | No (mill) | % | Biom ($10^3$) | % | No (mill) | % | Biom ($10^3$) | % |
| 1i | 20.2 | 74.7 | 139 | 10.2 | 10 | 6.1 | 81 | 21.0 | 6 | 13.4 |
| 1m | 21.3 | 81.1 | 2 | 0.1 | 0 | 0.1 | 1 | 0.3 | 0 | 0.2 |
| 2i | 22.0 | 90.2 | 328 | 24.1 | 30 | 17.4 | 38 | 10.0 | 3 | 7.2 |
| 2m | 24.6 | 121.7 | 258 | 19.0 | 31 | 18.4 | 33 | 8.6 | 4 | 9.0 |
| 3i | 24.6 | 116.8 | 35 | 2.6 | 4 | 2.3 | 35 | 9.2 | 4 | 9.4 |
| 3m | 26.0 | 134.7 | 125 | 9.2 | 17 | 9.8 | 113 | 29.5 | 15 | 33.8 |
| 4i | 25.2 | 126.7 | 5 | 0.3 | 1 | 0.4 | 6 | 1.6 | 1 | 1.6 |
| 4m | 27.6 | 156.9 | 76 | 5.6 | 12 | 7.2 | 69 | 18.0 | 11 | 23.0 |
| 5 | 27.5 | 157.8 | 268 | 19.7 | 42 | 24.9 | 6 | 1.4 | 1 | 1.9 |
| 6 | 29.3 | 178.1 | 52 | 3.8 | 9 | 5.4 | 0 | 0.1 | 0 | 0.2 |
| 7 | 30.5 | 187.2 | 44 | 3.2 | 8 | 4.8 | 1 | 0.2 | 0 | 0.4 |
| 8 | 30.3 | 196.7 | 18 | 1.3 | 4 | 2.1 | 0 | 0.0 | 0 | 0.0 |
| 9+ | 31.2 | 187.2 | 10 | 0.8 | 2 | 1.1 | 0 | 0.0 | 0 | 0.0 |
| Total | 25.5 | 123.8 | 1361 | 100 | 170 | 100 | 384 | 100 | 46 | 100 |
| Immature | 21.5 | 88.5 | 507 | 37 | 45 | 26 | 160 | 42 | 14 | 32 |
| Mature | 27.3 | 145.7 | 853 | 63 | 126 | 74 | 223 | 58 | 31 | 68 |

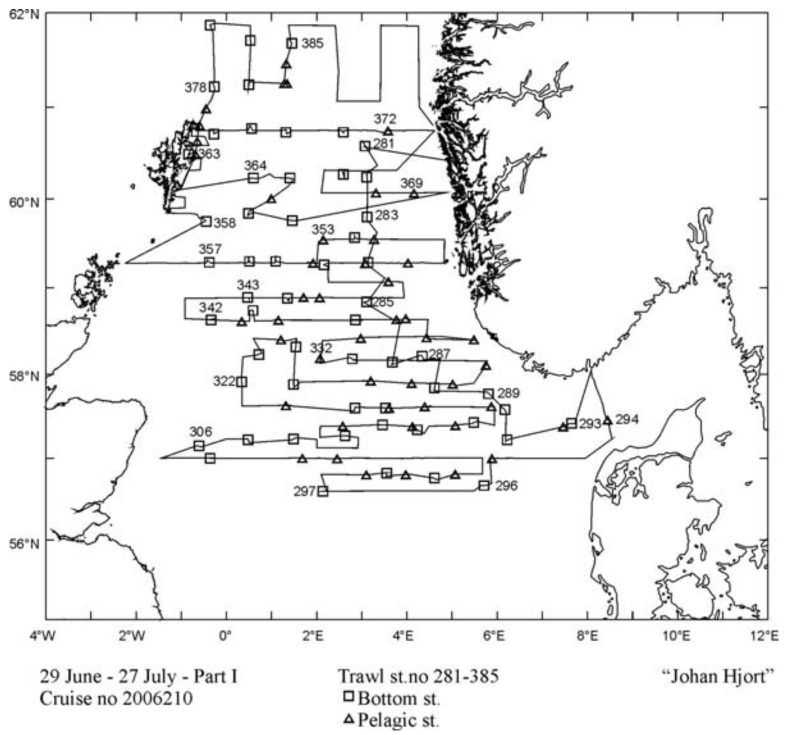


**Figure 1: RV "Johan Hjort" 29 June - 27 July 2006. Cruise track and fishing trawls undertaken during the acoustic survey. △Pelagic trawl haul, □ Bottom trawl haul.**

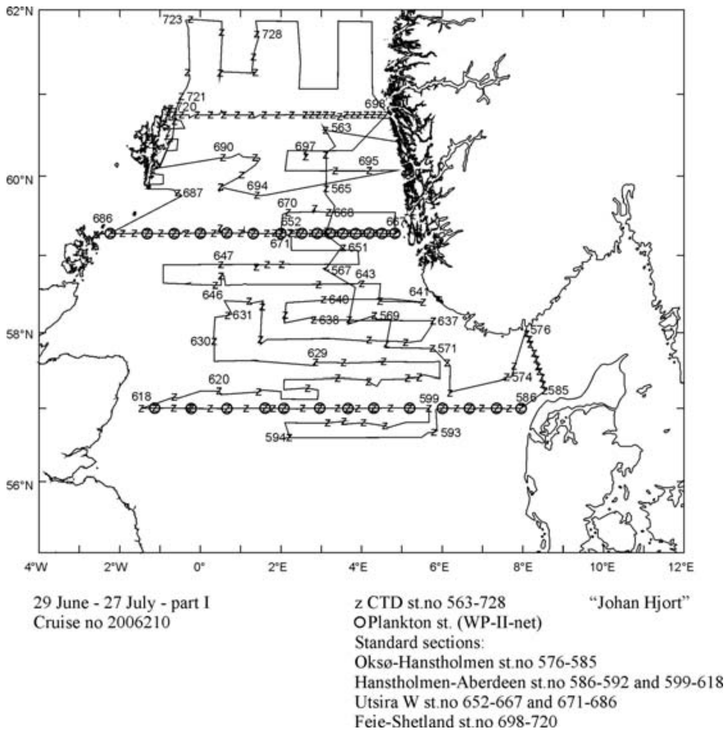


**Figure 2: RV "Johan Hjort" 29 June - 27 July 2006. Cruise track,CTD-stations ad plankton-stations taken during the acoustic survey.**

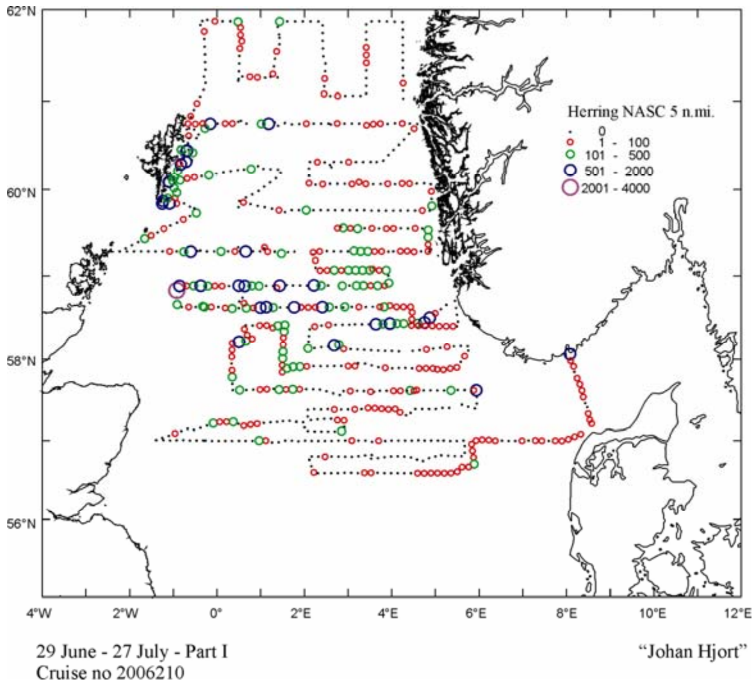


**Figure 3: RV "Johan Hjort" 29 June - 27 July 2006. Distribution of NASC -values attributed to herring per 5 n.mi. along the cruise track.**

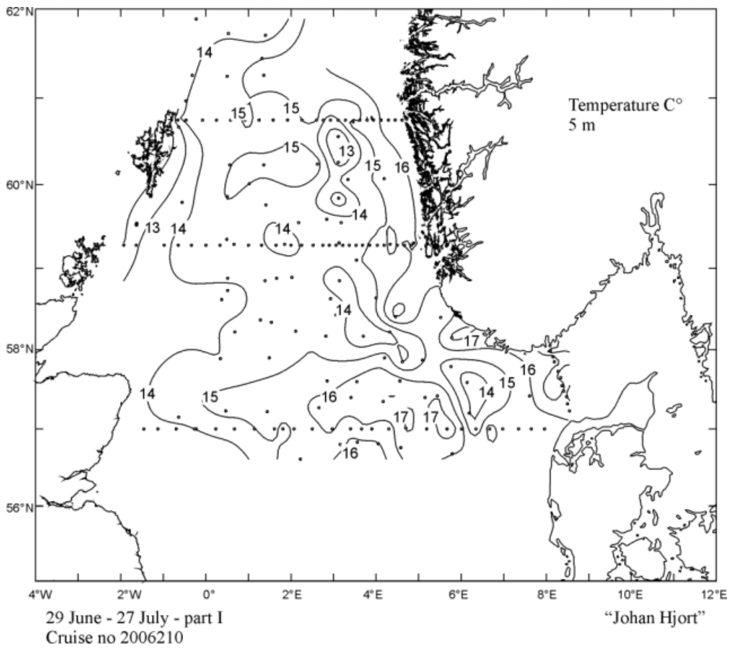


**Figure 4a: RV "Johan Hjort" 29 June - 27 July 2006. The horizontal distribution of temperature at 5 m.**

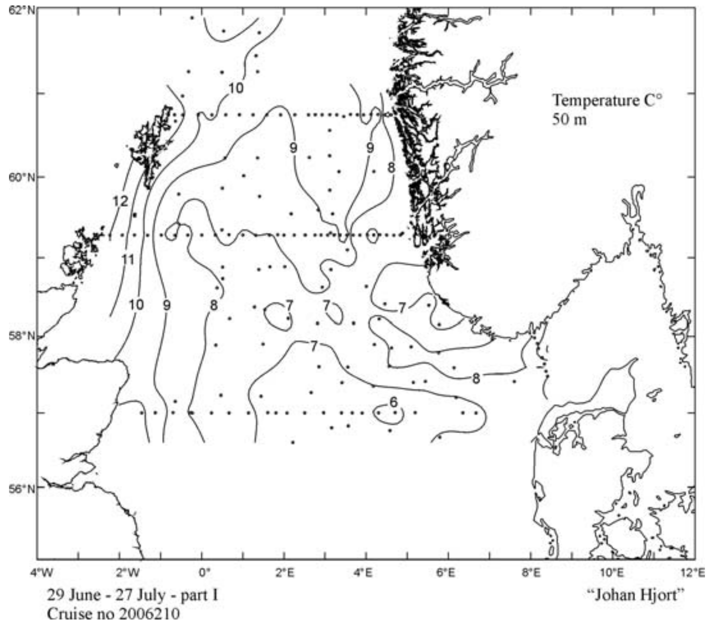


**Figure 4b: RV "Johan Hjort" 29 June- 27 July 2006. The horizontal distribution of temperature at 50m depth.**

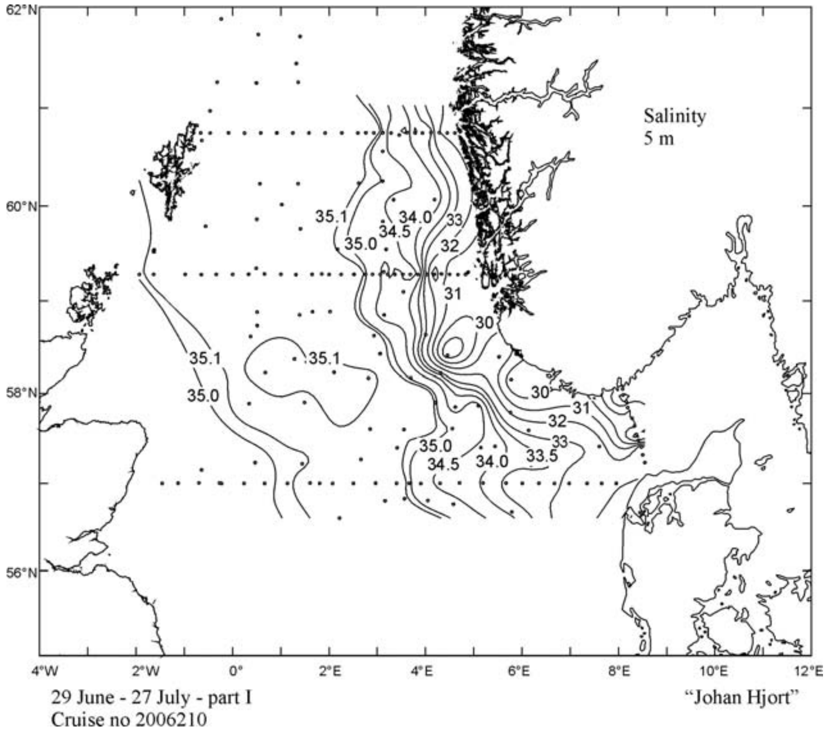


**Figure 5a: RV "Johan Hjort" 29 June - 27 July 2006. The horizontal distribution of salinity at 5 m.**

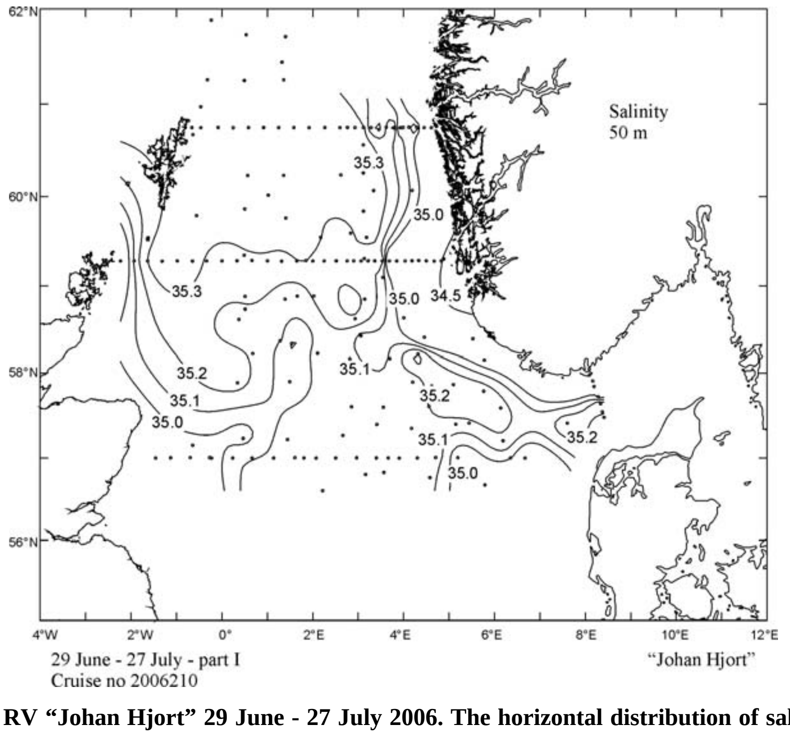


**Figure 5b: RV "Johan Hjort" 29 June - 27 July 2006. The horizontal distribution of salinity at 50 m depth.**

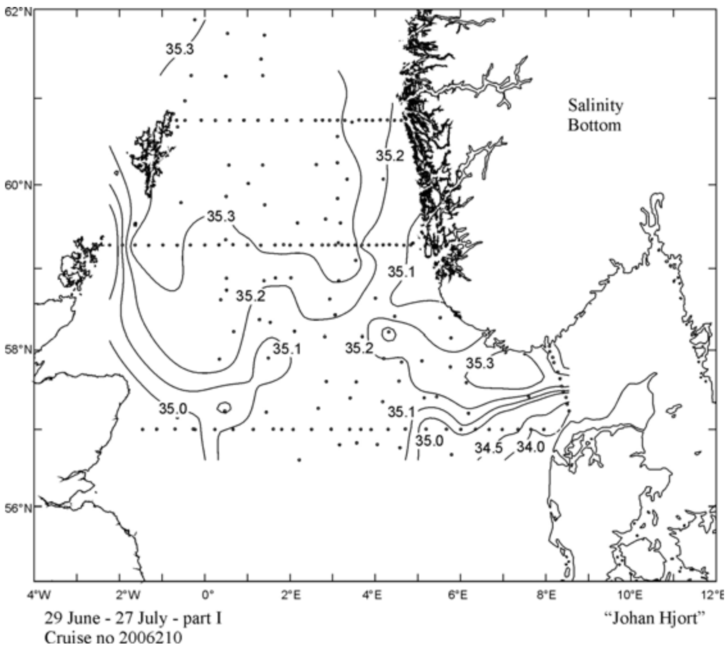


**Figure 5c: RV "Johan Hjort" 29 June - 27 July 2006. The horizontal distribution of salinity at bottom.**

## Annex 2D: Scotland (East)

**Survey report for RV "Scotia"**

1 - 21 July 2006

P. G. Fernandes, FRS Marine Lab Aberdeen.

# 1. INTRODUCTION

***Background***

An acoustic survey for herring was carried out by FRS Marine Laboratory around the Orkney Shetland peninsula in the northern North Sea (ICES Div IV) from the 1st to the 21st July 2006 on the FRV *Scotia*. The main objective of the survey was to provide an abundance estimate for herring in this area and to map the distribution of this species.

The survey was carried out as a part of the ICES coordinated herring acoustic survey of the North Sea and adjacent waters. The data from this survey were combined with other surveys in the North Sea to provide an age disaggregated abundance index for use in the assessment process. The assessment will be carried out by the ICES Herring Assessment Working Group (HAWG) to be held in March 2007. This survey has been carried out by the Marine Laboratory at this time every year since 1984.

***Objectives***

1 ) To conduct an acoustic survey to estimate the abundance and distribution of herring in the north western North Sea and north of Scotland between 58º15-61.45'N and 4ºW to 2ºE, excluding Faroese waters.
2 ) To obtain biological samples for echosounder trace identification using a pelagic trawl.
3 ) To obtain samples of herring for biological analysis, including age, length, weight, sex, maturity, ichthyophonus infection and fat content.
4 ) To obtain hydrographic data for comparison with the horizontal and vertical distribution of herring.
5 ) To obtain plankton samples map the distribution and abundance of zooplankton.
6 ) To test the multisampling pelagic cod-end.
7 ) To test FRS' new Methot Isaacs Kidd nets.
8 ) To obtain holographic images of the low frequency scattering layer.

# 2. SURVEY DESCRIPTION AND METHODS

### 2.1 Personnel

| | |
|---|---|
| Paul Fernandes | (In Charge) |
| Sandy Robb | Fisheries Biologist |
| Robert Watret | Fisheries Biologist |
| Phil Copland | Acoustic Technician |
| Stephen Keltz | Fisheries Biologist |
| John Dunn | Oceanographic Technician |
| Jim Hunter | Oceanographic Technician |
| Lindsay McPherson | Student, Aberdeen University |
| Alex Brown | MSc Student Aberdeen, 1st pt |
| Palap Tiptus | MSc Student Aberdeen, 1st pt |
| Hongyue Sun | Aberdeen University, 2nd pt |
| Nick Burns | Aberdeen University, 2nd pt |

## 2.2 Narrative

All gear was loaded in Aberdeen on 28 June. Scientific staff joined the vessel at 08:00 UTC on 01 July and it departed at 09:30 on the same day. A small meeting was held with all scientists to explain the objectives of the survey and to describe general operating procedures. The survey commenced just outside Aberdeen at 10:00 on 1 July. Transects progressed northwards along lines of latitude, at spacings of 15 or 7.5 nautical miles (n.mi.). Transect spacing was based on the results of previous surveys and transects were placed relative to ICES rectangles. Transects extended as far east as 1° 45E, and as far as safely possible to the west on approaching the coast. Calibration of all four transducers took place in Scapa Flow in the early hours of the morning of Tuesday 4 July and the survey resumed afterwards at 09:35 of the same day. A half landing took place on 11 July in Lerwick in accordance with rest provision for the working time directive and for the exchange of personnel (Alex Brown and Palap Tiptus for Nick Burns and Hongyue Sun). The vessel resumed surveying at 11:00 on 12 July. West of the Shetland Isles, transects extended from the coast to the shelf edge or longitude 4° west. The survey was completed on 20 July at 12:45. All four transducers were calibrated successfully once again in Scapa Flow on 20 July. The vessel returned to Aberdeen on the morning of 21 July.

## 2.3 Survey design

The survey track (Fig IID.1) was selected to cover the area with three levels of sampling intensity based on agreed boundaries to the east, west and south, and the limits of herring densities found in previous years to the north and Northwest. A transect spacing of 15 nautical miles was used in most parts of the area with the exception of areas to the east of Shetland where short additional transects were carried out at 7.5 n.mi. spacing and the area south of 58° 30'N where 30 nmi transect spacing was used. On the administrative boundaries of 2°E the ends of the tracks were positioned at twice the track spacing from the area boundary, giving equal track length in any rectangle within the area. The between-track data was then included in the data analysis. Transects at shelf break were continued to the limits of the stock and the transect ends omitted from the analysis. Transects at the coast were continued as close inshore as practical, those on average less than half a transect spacing from the coast were excluded from the analysis, those at greater distance were included in the analysis. The origin of the survey grid was selected randomly within a 15 n.mi. interval the track was then laid out with systematic spacing from the random origin. Where the 7.5 and 30 n.mi. transect spacing was used the same random origin was used (as a proportion of the intertansect space). Finally, at the request of the Dutch, an additional two ICES rectangles were sampled (45F0 and 45F1): these were sampled using a zigzag design to minimise the passage time back to the Scotia's survey track (see Figure IID.1).

## 2.4 Calibration

Two calibrations were carried out of the EK60 echosounder system used during the survey: one near the beginning of the survey on 4 July in Scapa Flow and one at the end of the survey on 20 July in Scapa Flow. Standard sphere calibrations were carried using 38.1mm diameter tungsten carbide sphere for 18, 38, 120 and 200 kHz. Agreement between the calibrations for 38 kHz was approximately 0.1dB. The calibration settings and results for 38kHz are given in Table IID.1.

## 2.5 Acoustic data collection

The acoustic survey on FRV *Scotia* was carried out using a Simrad EK60 multifrequency echosounder with all four transducers (18, 38, 120 and 200 kHz) mounted on the drop keel. For most of the survey the keel was kept at 3m extension placing the transducer at 8.5m depth. Data was archived for further data analysis which was carried out using Sonardata Echoview software and Marine Lab Analysis systems. Data were collected from 0200 to 2200 GMT. A total of 2255 n.mi. were surveyed and included in the analysis.

### 2.6 Biological data - fishing trawls

A total of 40 trawl hauls (positions shown in Figure IID.1) were carried out during the survey on the denser echo traces. The fishing gear used throughout the survey was the PT160 pelagic trawl; in the latter half of the survey this was augmented by the addition of a three cod-end multisampling trawl. Each haul was monitored using a Simrad FS903 scanning netsonde. The catch from each haul was sampled for length, age, maturity and weight of individual herring. In addition weights of gonads and livers were also collected. Between 250 and 500 fish were measured at 0.5 cm intervals from each haul. Otoliths were collected with one per 0.5 cm class below 20.5 cm, three per 0.5cm class from 21–25.5cm and ten per 0.5 cm class for 26.0 cm and above. The same fish were sampled for whole weight, gonad weight, liver weight, sex, maturity, stomach contents and macroscopic evidence of Ichthyophonus infection. The maturity scale used in data collection was the Scottish 8 point scale.

### 2.7 Hydrographic data

Surface temperature and salinity was collected throughout the survey at each trawl station and at additional plankton stations. Only salinity and temperature were collected. A total of 49 deployments of the ARIES vehicle were made which, in addition to the above, collected integrated whole water column plankton data in two PUP nets and, on occasion, depth specific plankton samples. In addition some holographic images were collected from areas associated with a strong 38 kHz scattering layer.

### 2.8 Data analysis

Data from the echo integrator were averaged over quarter hour periods (2.5 n.mi. at 10 knots). Echo integrator data was collected from 12 m below the surface (transducer at 8.5 m depth) to 0.5 m above the seabed, for most of the survey. The data were divided into seven categories, by visual inspection of the echo-sounder paper record and the integrator cumulative output;

1 ) Definitely herring traces,
2 ) Probably herring traces"
3 ) Possible herring traces"
4 ) Norway pout
5 ) shallow herring schools above 50 m,

To calculate integrator conversion factors the target strength of herring and for gadoid species were estimated using the TS/length relationship recommended by the acoustic survey planning group (Anon, 1992):

$$\text{herring TS} = 20\log_{10}L - 71.2 \text{ dB per individual}$$

$$\text{gadoid TS} = 20\log_{10}L - 67.5 \text{ dB per individual}$$

The weight of herring at length was determined by weighing individual fish from each trawl haul. Lengths were recorded by 0.5 cm intervals to the nearest 0.5 cm below.

To process the data for extraction of herring schools the variable computation method available in Echoview was used. The multifrequency thresholding method described in earlier reports was used to isolate fish schools from other targets. The schools were then detected and finally identified according to the categories defined above by examination of school shape, echo intensity and the dB difference at 18, 38, 120 and 200 kHz.

North of 58° 30’N data were allocated to quarter statistical rectangles by their midpoint location, south of this latitude data were allocated to whole statistical rectangles in accordance with the design criteria of the 30 nautical mile spacing. This required two analyses to be carried out in the national calculation programme (MILAP) – one at quarter rectangle resolution and one at whole rectangle resolution. The estimate is composed of the quarter rectangle analysis north of 58°30'N and the whole rectangle analysis south of this latitude. Estimates of density were obtained as the arithmetic mean of all values weighted by duration of the run to accommodate the small number of short EDSUs. Biological information was used in the post stratified method based on Kolmogorov Smirnov test (see MacLennan and Simmonds 2005).

# 3. RESULTS

## 3.1 Acoustic data

The distribution of NASC values along the cruise track is shown in Figure IID.2. The distribution of fish was similar to 2005, with most of the fish being detected towards the southern end of the area and very little (none in fact) detected at the northern extremes. A number of large herring schools were detected towards the southern edge, around 58 just east of the meridian. Strong marks were also detected close inshore all around Shetland and on Papa Bank (northwest of Orkney). Most of the herring schools were of the short pillar shape, but many were detected as large block like schools not dissimilar from wrecks. On one notable occasion, a wreck was passed over and a strange echotrace was encountered on top of the wreck – this turned out to be a ghost fishing net.

## 3.2 Biological data

Fishing was generally successful; 40 trawl hauls were carried out, of which 25 contained more than 30 herring (Figure IID.1). The positions, dates and time of these are given in Table IID.2. In addition to length frequency data, a total of 2563 herring were sampled for weight, sex, maturity and otoliths. A subset of these were sampled for fat content. The 25 hauls with significant numbers of herring were used to define five survey sub areas (Figure IID.3):

I. BIG: Large (big) fish with a mean size of 28.5 cm.

II. VBI: Larger (very big) with a mean size of 31.7 cm.

III. MED: Medium size fish with a mean size of 27.1 cm.

IV. SMA: Small fish with a mean size of 25.3 cm.

V. MSD: Medium sized fish in the south of the area (south of 58°30 N) with a mean size of 26.8 cm.

Note that for the export of data to FishFrame the single rectangle sampled to the west of 4°W (ref 49E5) was assigned to a dummy in number VI with the same properties as the adjacent area in number I.

Table IID.3 shows the total catch by species. The length frequency distributions, mean lengths, weights and target strengths for each haul and for each sub area are shown in Table IID.4. The spatial distribution of mean length is shown in Figure IID.3. Five age length keys, one per area, were constructed. There is again evidence of no icthyophonus in the population. Not a single herring from the 2563 herring sampled were found to show macroscopic evidence of infection. The stratified weight at length data was used to define the weight-length relationship for herring, which was:

$$W = 0.0015\ L^{3.53}\ \text{g (L measured in cm to greater 0.5 cm)}$$

The proportions of 2, 3 and 4 ring herring that were mature were estimated at 81.5, 88.9 and 97.7% respectively.

### 3.3 Biomass and Abundance estimates

The total biomass estimates for the survey were:

| | | |
|---|---|---|
| Total herring | 2,048,271 tonnes | |
| Spawning stock biomass | 1,950,115 tonnes | 95.2% |
| Immature | 98,157 tonnes | 4.8% |

The numbers and biomass of fish by quarter ICES statistical rectangle are shown in Figure IID.4. A total estimate of 11,184 million herring or 2,048 thousand tonnes was calculated for the survey area. 1,950 thousand tonnes of these were mature. Herring were generally found in similar water depths and location to 2005 however, the distributions were concentrated closer to the coast than in previous years. The proportion of the 2000 year class was once again quite high. Table IID.6 shows the estimated herring numbers mean lengths, weights, biomass, and proportion mature at age and year class.

In addition to herring, a variety of other fish species were caught although examination of the catch by species (Table IID.3) shows that aside from herring the numbers caught were very small. The dominant species other than herring were mackerel, followed by Norway pout, haddock and whiting. No cod were caught as by-catch in any of the hauls.

### 3.4 Ichthyophonus Infection

None of the 2563 fish examined for macroscopic evidence of ichthyophonus were found to be infected.

**Table 2D.1: Simrad EK60 and analysis settings and calibration results from the Scotia herring acoustic survey 1-21 July 2006.**

| | | |
|---|---|---|
| **TRANSCEIVER PARAMETERS** | | |
| Frequency | 38 kHz | |
| Sound speed | 1500 m.s$^{-1}$ | |
| Max. Power | 2000 W | |
| Equivalent two-way beam angle | -20.9 dB | |
| Default Transducer Sv gain | 23.22 dB | |
| 3 dB Beamwidth | 7.1° | |
| **CALIBRATION DETAILS** | | |
| | 4 July 2006 | 20 July 2006 |
| TS of sphere | -42.33 dB | -42.33 |
| Range to sphere in calibration | 12.10 m | 12.63 |
| Measured NASC value for calibration | 2129 | 2208 |
| Calibrated Sv gain | 23.35 | 23.22 |
| Calibration constant for MILAP (optional) | 1.1005 at -35 dB | |
| **EDSU** | | |
| Echoview integration cell size | 15 minutes (approx 2.5 n.mi. at 10 knots) | |
| **OPERATION** | | |
| Ping interval | 1 s at 250 m range<br>2.5 at 500 m range | |
| **ANALYSIS SETTINGS** | | |
| Bottom margin (backstep) | 0.5 m | |
| Integration start (absolute) depth | 12 m | |
| Range of thresholds used | -70 dB on 38<br>-170 on combined blurred 38,120,200 | |

**Table 2D.2: Details of the fishing trawls taken during the Scotia herring acoustic survey, 1-21 July 2006: No. = trawl number; Trawl depth = depth (m) of headrope; Gear type PT160 = pelagic trawl + MS = multisampler; Duration of trawl (minutes); Use h=used to qualify herring acoustic data (blank if not); Total catch in kg.**

| No. | Date | Position | Time (UTC) | Water depth | Trawl Depth | Gear Type | Duration (mins) | Use | Total (kg) |
|---|---|---|---|---|---|---|---|---|---|
| 273 | 01/07/2006 | 57˚18.46N 1˚ 9.73W | 13:09 | 82 | 62 | PT 160 | 30 | | 0 |
| 274 | 02/07/2006 | 57˚59.8N 0˚ 58.48E | 20:31 | 137 | 117 | PT 160 | 38 | H | 1215 |
| 275 | 03/07/2006 | 57˚48.36N 2˚ 13.63W | 13:12 | 106 | 86 | PT 160 | 62 | | 2 |
| 276 | 04/07/2006 | 58˚39.09N 2˚ 22.46W | 12:06 | 71 | 51 | PT 160 | 42 | H | 0 |
| 277 | 04/07/2006 | 58˚39.17N 0˚ 47.57W | 15:53 | 130 | 110 | PT 160 | 19 | H | 8817 |
| 278 | 05/07/2006 | 58˚39.27N 0˚ 15.30E | 03:06 | 139 | 119 | PT 160 | 43 | H | 582 |
| 279 | 05/07/2006 | 58˚45.92N 1˚ 45.01E | 09:46 | 108 | 88 | PT 160 | 52 | H | 1473 |
| 280 | 05/07/2006 | 58˚54.51N 0˚ 46.68E | 15:42 | 139 | 119 | PT 160 | 39 | H | 3548 |
| 281 | 06/07/2006 | 58˚54.03N 1˚ 30.07W | 04:14 | 121 | 101 | PT 160 | 41 | H | 1166 |
| 282 C1 | 06/07/2006 | 59˚9.12N 1˚ 16.81W | 15:45 | 107 | 87 | PT 160+ MS | 47 | H | 626 |
| 282 C2 | 06/07/2006 | 59˚9.12N 1˚ 16.81W | 15:45 | 107 | 87 | PT 160+ MS | 47 | H | 238 |
| 283 C1 | 07/07/2006 | 59˚24.17N 0˚ 37.25E | 11:29 | 138 | 118 | PT 160+ MS | 87 | | 0 |
| 283 C2 | 07/07/2006 | 59˚24.17N 0˚ 37.25E | 11:29 | 138 | 118 | PT 160+ MS | 87 | H | 1098 |
| 284 | 07/07/2006 | 59˚24.05N 0˚ 34.06W | 17:59 | 138 | 118 | PT 160 | 27 | H | 5948 |
| 285 | 07/07/2006 | 59˚24.12N 1˚ 16.14W | 21:29 | 108 | 88 | PT 160 | 41 | H | 754 |
| 286 | 08/07/2006 | 59˚24.08N 2˚ 8.34W | 04:57 | 77 | 57 | PT 160 | 63 | H | 867 |
| 287 C1 | 08/07/2006 | 59˚39.37N 1˚ 41.48W | 11:39 | 90 | 70 | PT 160+ MS | 73 | H | 418 |
| 287 C2 | 08/07/2006 | 59˚39.37N 1˚ 41.48W | 11:39 | 90 | 70 | PT 160+ MS | 73 | H | 276 |
| 288 C1 | 08/07/2006 | 59˚39.095N 0˚ 54.38E | 21:55 | 120 | 100 | PT 160+ MS | 27 | | 4 |
| 288 C2 | 08/07/2006 | 59˚39.095N 0˚ 54.38E | 21:55 | 120 | 100 | PT 160+ MS | 27 | | 0 |
| 289 C1 | 09/07/2006 | 59˚54.11N 1˚ 15.93E | 08:20 | 123 | 103 | PT 160+ MS | 98 | H | 1284 |
| 289 C2 | 09/07/2006 | 59˚54.11N 1˚ 15.93E | 08:20 | 123 | 103 | PT 160+ MS | 98 | | 0 |
| 290 C1 | 09/07/2006 | 59˚54.21N 0˚ 59.26W | 18:46 | 109 | 89 | PT 160+ MS | 50 | H | 1387 |
| 290 C2 | 09/07/2006 | 59˚54.21N 0˚ 59.26W | 18:46 | 109 | 89 | PT 160+ MS | 50 | H | 1140 |
| 290 C3 | 09/07/2006 | 59˚54.21N 0˚ 59.26W | 18:46 | 109 | 89 | PT 160+ MS | 50 | H | 19 |
| 291 C1 | 10/07/2006 | 60˚9.18N 0˚ 6.7E | 06:25 | 168 | 148 | PT 160+ MS | 89 | H | 11 |
| 291 C2 | 10/07/2006 | 60˚9.18N 0˚ 6.7E | 06:25 | 168 | 148 | PT 160+ MS | 89 | H | 0 |
| 292 C1 | 10/07/2006 | 60˚9.255N 0˚ 43.415E | 11:57 | 155 | 135 | PT 160+ MS | 76 | H | 2305 |
| 293 | 12/07/2006 | 60˚19.53N 0˚ 15.775W | 13:14 | 124 | 104 | PT 160+ MS | 35 | | 0 |
| 294 C1 | 12/07/2006 | 60˚26.91N 0˚ 30.535W | 18:40 | 124 | 104 | PT 160+ MS | 26 | H | 1049 |
| 295 C1 | 12/07/2006 | 60˚30.92N 0˚ 45.57W | 21:20 | 88 | 68 | PT 160+ MS | 55 | H | 263 |
| 295 C2 | 12/07/2006 | 60˚30.92N 0˚ 45.57W | 21:20 | 88 | 68 | PT 160+ MS | 55 | | 2 |
| 296 C1 | 13/07/2006 | 60˚41.62N 0˚ 32.45W | 07:24 | 130 | 110 | PT 160+ MS | 69 | H | 665 |
| 296 C2 | 13/07/2006 | 60˚41.62N 0˚ 32.45W | 07:24 | 130 | 110 | PT 160+ MS | 69 | H | 505 |
| 297 C1 | 13/07/2006 | 60˚49.29N 0˚ 39.085W | 11:55 | 107 | 87 | PT 160+ MS | 48 | | 2 |
| 297 C2 | 13/07/2006 | 60˚49.425N 0˚ 39.085W | 11:55 | 107 | 87 | PT 160+ MS | 48 | H | 2729 |
| 298 | 14/07/2006 | 61˚9.185N 0˚ 5.805W | 00:00 | 155 | 135 | PT 160+ MS | 46 | | 0 |
| 299 | 15/07/2006 | 61˚23.72N 1˚ 45.685E | 05:38 | 155 | 135 | PT 160+ MS | 77 | | 0 |
| 300 | 15/07/2006 | 61˚24.18N 0˚ 49.545E | 12:46 | 178 | 158 | PT 160 | 40 | | 0 |
| 301 C1 | 16/07/2006 | 61˚26.665N 0˚ 45.135W | 05:47 | 180 | 160 | PT 160+ MS | 76 | | 4 |
| 302 C1 | 16/07/2006 | 61˚2.02N 1˚ 36.265W | 14:35 | 122 | 102 | PT 160+ MS | 51 | | 6 |
| 303 C1 | 17/07/2006 | 60˚39.255N 1˚ 51.315W | 05:52 | 128 | 108 | PT 160+ MS | 57 | H | 530 |
| 303 C2 | 17/07/2006 | 60˚39.255N 1˚ 51.315W | 05:52 | 128 | 108 | PT 160+ MS | 57 | H | 3030 |
| 304 C1 | 17/07/2006 | 60˚23.785N 1˚ 33.42W | 12:35 | 150 | 130 | PT 160+ MS | 64 | H | 314 |
| 304 C2 | 17/07/2006 | 60˚23.785N 1˚ 33.42W | 12:35 | 150 | 130 | PT 160+ MS | 64 | H | 66 |
| 305 C2 | 18/07/2006 | 60˚9.075N 2˚ 40.045W | 07:32 | 100 | 80 | PT 160+ MS | 54 | H | 23 |
| 306 C1 | 18/07/2006 | 60˚9.215N 2˚ 33.035W | 09:52 | 100 | 80 | PT 160+ MS | 39 | H | 383 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 307 C2 | 18/07/2006 | 60˚9.075N 1˚ 51.94W | 13:29 | 50 | 30 | PT 160+ MS | 34 | | 0 |
| 308 C1 | 18/07/2006 | 60˚5.08N 1˚ 32.045W | 17:05 | 90 | 70 | PT 160+ MS | 64 | H | 7860 |
| 309 C1 | 19/07/2006 | 59˚54.125N 2˚ 42.86W | 04:03 | 86 | 66 | PT 160+ MS | 49 | H | 524 |
| 310 C1 | 19/07/2006 | 59˚54.105N 3˚ 53.91W | 09:15 | 156 | 136 | PT 160+ MS | 60 | H | 2225 |
| 310 C2 | 19/07/2006 | 59˚54.105N 3˚ 53.91W | 09:15 | 156 | 136 | PT 160+ MS | 60 | H | 5425 |
| 311 C1 | 19/07/2006 | 59˚27.185N 3˚ 3.07W | 17:43 | 74 | 54 | PT 160+ MS | 50 | H | 734 |
| 312 C1 | 20/07/2006 | 59˚13.24N 3˚ 43.5W | 07:01 | 140 | 120 | PT 160+ MS | 69 | H | 686 |

**Table 2D.3a: Total catch by species for trawl hauls from the Scotia acoustic survey 1-21/07/2006. Estimated total catch is given in kg and numbers by individual species**

| Haul no. | Est catch (kg) | Herring | Mackerel | Horse Mackerel | Saithe | Blue Whiting | Haddock | Whiting | Grey gurnard | Hake | N.Pout | Snake pipefish |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *Clupea harengus* | *Scomber scombrus* | *Trachurus trachurus* | *Pollachius virens* | *M. Poutassou* | *Melanogrammus aeglefinus* | *Merlangius merlangus* | *Eutrigla gurnardus* | *Merluccius merluccius* | *Trisopterus esmarki* | *Entelurus aequoreus* |
| 273 | 1 | | | | | | | | 4 | | | |
| 274 | 210 | 1215 | | | | | | | | | 29 | |
| 275 | 0.25 | 2 | | | | 9 | 2 | 1 | | | 72 | 1 |
| 276 | 25 | | 57 | | | | | | | | | 3 |
| 277 | 1500 | 8817 | | | | | | | | | | |
| 278 | 120 | 582 | 2 | | | | | | | | | |
| 279 | 300 | 1471 | | | | | | | | | | 1 |
| 280 | 750 | 3548 | | | 7 | | | | | | 21 | |
| 281 | 150 | 1173 | | | | | | | | | | |
| 282 C1 | 90 | 626 | | | | | | 2 | 32 | | | |
| 282 C2 | 45 | 238 | | | | | | 1 | | | | |
| 283 C1 | 10 | 0 | 15 | | | | | | | | | |
| 283 C2 | 210 | 1098 | | | | | | | | | 37 | |
| 284 | 1200 | 5948 | | | | | | | | | | |
| 285 | 180 | 754 | | | | | | 4 | 6 | | | |
| 286 | 120 | 867 | | | | | | | 5 | | | |
| 287 C1 | 60 | 418 | | | | | | | | | | |
| 287 C2 | 45 | 276 | | | | | | | | | | |
| 288 C1 | 1 | 4 | | | | | | | | | | |
| 289 C1 | 270 | 1284 | | | | | 3 | | | | | |
| 290 C1 | 300 | 1387 | | | | | | | | | | |
| 290 C2 | 300 | 1140 | | | | | | | | | | |
| 290 C3 | 6 | 19 | | | | | | | | | | |
| 291 C1 | 2.6 | 11 | | | | | | | | | | |
| 291 C2 | 5 | 0 | 23 | | | | | | | | | 3 |
| 292 C1 | 600 | 2305 | | | | | | | | | | |
| 293 | 25 | 0 | | | | | 1 | | | | 703 | 2 |
| 294 C1 | 240 | 1049 | | | | | | | | | 88 | |
| 295 C1 | 60 | 263 | | | | | | | | | | |
| 295 C2 | 0.5 | 2 | | | | | | | | | 380 | |
| 296 C1 | 150 | 665 | 8 | | | | | | | | | |
| 296 C2 | 150 | 505 | | | | | 3 | 2 | | 3 | | |
| 297 C1 | 25 | 2 | 205 | | | | | | | | | |
| 297 C2 | 900 | 2729 | 1080 | | | | 2 | | | | | |
| 298 | 0 | 0 | | | | | | | | | | |
| 299 C3 | 0 | 0 | | | | | | | | | | 16 |
| 300 | 10 | 0 | | | 6 | | | | | | | |

**Table 2D.3b: Total catch by species for trawl hauls from the Scotia acoustic survey 1-21/07/2006. Estimated total catch is given in kg and numbers by individual species**

| Haul No | Est catch (kg) | Herring | Mackerel | Horse Mackerel | Saithe | Blue Whiting | Haddock | Whiting | Grey gurnard | Hake | N.Pout | Snake pipefish |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *Clupea harengus* | *Scomber scombrus* | *Trachurus trachurus* | *Pollachius virens* | *M. Poutassou* | *Melanogrammus aeglefinus* | *Merlangius merlangus* | *Eutrigla gurnardus* | *Merluccius merluccius* | *Trisopterus esmarki* | *Entelurus aequoreus* |
| 301 C1 | 5 | 4 | | | | | | | | | | |
| 302 C1 | 5 | 6 | 3 | 12 | | | | | | | | |
| 303 C1 | 120 | 530 | 72 | | | | | | | | | |
| 303 C2 | 750 | 3030 | 36 | | | | | | | | | |
| 304 C1 | 75 | 314 | 3 | | | | 1 | 4 | | | 1 | |
| 304 C2 | 20 | 66 | 1 | | | | | 26 | | | 45 | |
| 305 C1 | 22 | 23 | 134 | | | | | | | | | |
| 306 C1 | 70 | 383 | 199 | | | | | | 6 | | | 2 |
| 307 C2 | 1.2 | 0 | 6 | | | | | | | | | 10 |
| 308 C1 | 1500 | 7860 | 360 | | | | | | 20 | | | |
| 309 C1 | 90 | 524 | 50 | | | | | | | | | 3 |
| 310 C1 | 750 | 5425 | | | | | | | | | | |
| 310 C2 | 1500 | 2225 | 6 | | | | | | | | | |
| 311 C1 | 90 | 734 | 2 | | | | | | | | | |
| 312 C1 | 120 | 686 | 6 | | | | | | | | | 2 |

**Table 2D.4a: Herring length frequency proportion for individual trawl hauls by subarea (Figure IID.3) for the *Scotia* acoustic survey (1-21/07/2006) length in cm, weight in g, calculated target strength in dB per individual using TS=-71.2+20log(L).**

| Subarea | | | | | | | | I | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Haul / Length | 278 | 279 | 280 | 283 | 284 | 289 | 290 | 291 | 292 | 294 | 295 | 296 | 297 | 303 | 304 | 305 |
| 18.5 | | | | | | | | | | | | | | | | |
| 19 | | | | | | | | | | | | | | | | |
| 19.5 | | | | | | | | | | | | | | | | |
| 20 | | | | | | | | | | | | | | | | |
| 20.5 | | | | | | | | | | | | | | | | |
| 21 | | 0.2 | | | | | | | | | | | | | | |
| 21.5 | 0.2 | | | | | | | | | | | | | | | |
| 22 | | | | | | | | | | | | | | | | |
| 22.5 | | | | | | | | | | | | | | | | |
| 23 | | | 0.2 | | | | | | | | | | 0.3 | | | |
| 23.5 | 0.2 | 0.2 | | | | | | | | | | | | | | |
| 24 | 0.5 | 0.5 | 0.4 | 0.6 | 0.2 | | | | | | | | 0.5 | | | |
| 24.5 | 0.5 | 0.7 | 1.2 | 3.8 | | 1.4 | 0.9 | | 0.4 | | 0.4 | | 0.3 | | | |
| 25 | 0.5 | 0.7 | 1.6 | 5.3 | 0.2 | 2.6 | 2.6 | | 0.4 | 0.3 | 0.8 | | 4.4 | 0.2 | 0.3 | |
| 25.5 | 2.6 | 3.4 | 3.4 | 6.6 | 2.7 | 4.9 | 5.4 | | 1.5 | 1.2 | 4.9 | 3.0 | 8.2 | 0.2 | 1.1 | 4.3 |
| 26 | 5.5 | 10.2 | 5.4 | 10.4 | 5.8 | 7.7 | 8.6 | | 2.2 | 4.9 | 9.1 | 5.1 | 7.0 | 0.5 | 3.9 | 13.0 |
| 26.5 | 9.5 | 11.1 | 9.5 | 8.5 | 7.8 | 7.9 | 10.1 | | 3.7 | 7.6 | 12.8 | 9.2 | 11.2 | 2.8 | 7.9 | 13.0 |
| 27 | 14.4 | 19.5 | 11.7 | 10.7 | 14.5 | 13.1 | 17.0 | | 4.8 | 7.9 | 19.2 | 10.1 | 11.0 | 4.7 | 10.8 | 8.7 |
| 27.5 | 15.8 | 16.5 | 13.1 | 9.4 | 17.2 | 12.9 | 16.3 | | 7.2 | 11.9 | 20.4 | 11.8 | 11.0 | 9.1 | 12.9 | 17.4 |
| 28 | 20.1 | 14.3 | 17.1 | 11.9 | 22.1 | 13.8 | 16.6 | 18.2 | 10.6 | 16.5 | 18.9 | 12.6 | 10.5 | 13.8 | 15.5 | 17.4 |
| 28.5 | 11.9 | 9.7 | 13.3 | 9.7 | 12.5 | 10.7 | 11.2 | 18.2 | 12.6 | 13.7 | 5.7 | 11.0 | 15.1 | 14.0 | 13.4 | 8.7 |
| 29 | 10.3 | 8.8 | 10.7 | 9.6 | 9.8 | 10.3 | 6.3 | 18.2 | 15.4 | 14.0 | 3.0 | 12.9 | 8.5 | 15.6 | 13.2 | |
| 29.5 | 3.6 | 1.8 | 4.4 | 5.9 | 3.8 | 6.3 | 2.0 | 27.3 | 10.0 | 4.9 | 3.0 | 6.0 | 3.3 | 9.7 | 5.8 | 8.7 |
| 30 | 1.9 | 1.4 | 4.2 | 3.2 | 2.0 | 4.2 | 0.5 | | 10.4 | 5.8 | 1.5 | 6.5 | 2.6 | 9.8 | 5.8 | |
| 30.5 | 1.9 | 1.2 | 2.8 | 2.4 | 0.2 | 2.1 | 0.9 | 9.1 | 8.9 | 3.3 | | 4.5 | 2.3 | 5.6 | 5.0 | 8.7 |
| 31 | 0.7 | | 0.4 | 1.5 | 0.2 | 0.9 | 0.7 | 9.1 | 6.3 | 4.1 | 0.4 | 2.8 | 1.8 | 5.5 | 0.8 | |
| 31.5 | | | 0.6 | 0.2 | 0.2 | 0.7 | 0.8 | | 3.3 | 1.2 | | 2.4 | 1.0 | 3.3 | 2.4 | |
| 32 | | | | 0.5 | 0.5 | 0.5 | | | 1.3 | 1.2 | | 0.7 | 0.5 | 2.3 | 1.1 | |
| 32.5 | | | | | | | 0.2 | | 0.9 | 0.3 | | 0.3 | 0.3 | 1.3 | | |
| 33 | | | | | | | | | | 0.3 | | | | 0.6 | 0.3 | |
| 33.5 | | | | | | | | | 0.2 | 0.3 | | 0.3 | | 0.3 | | |
| 34 | | | | | | | | | | | | 0.7 | 0.3 | 0.4 | | |
| 34.5 | | | | | | | | | | | | | 0.0 | 0.1 | | |
| 35 | | | | | | | | | | 0.5 | | | | | | |
| 35.5 | | | | | | | | | | | | 0.3 | | 0.1 | | |
| Number | 582 | 1473 | 3548 | 1098 | 5961 | 1284 | 2546 | 11 | 2305 | 1049 | 265 | 1175 | 2934 | 3563 | 380 | 23 |
| L (cm) | 28.2 | 27.9 | 28.3 | 28.0 | 28.3 | 28.2 | 27.9 | 29.7 | 29.5 | 28.9 | 27.8 | 28.8 | 28.1 | 29.6 | 28.8 | 28.2 |
| W (g) | 202.0 | 194.3 | 204.5 | 197.0 | 202.7 | 203.6 | 194.9 | 240.8 | 236.2 | 220.6 | 191.9 | 219.4 | 200.8 | 239.5 | 217.4 | 201.0 |
| TS/id | -42.2 | -42.3 | -42.2 | -42.3 | -42.2 | -42.2 | -42.3 | -41.7 | -41.8 | -42.0 | -42.3 | -42.0 | -42.2 | -41.8 | -42.0 | -42.2 |
| TS/kg | -35.2 | -35.2 | -35.3 | -35.2 | -35.2 | -35.3 | -35.2 | -35.6 | -35.5 | -35.4 | -35.1 | -35.4 | -35.2 | -35.6 | -35.4 | -35.2 |

**Table 2D.4 continued: Herring length frequency proportion for individual trawl hauls by subarea (Figure IID.3) for the *Scotia* acoustic survey (1-21/07/2006) length in cm, weight in g, calculated target strength in dB per individual using TS=-71.2+20log(L).**

| SUBAREA | I | | II | III | | | | | | | IV | | | | | V |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HAUL /LEN | 306 | MEAN | 310 | 277 | 285 | 287 | 308 | 309 | 312 | MEAN | 281 | 282 | 286 | 311 | MEAN | 274 |
| 18.5 | | | | | | | | | | | 0.4 | | | | 0.1 | |
| 19 | | | | | | | 0.3 | | | 0.0 | | | | | | |
| 19.5 | | | | | | | | | | | 2.1 | | | | 0.5 | |
| 20 | | | | | | | | | | | 1.5 | | | | 0.4 | |
| 20.5 | | | | | | | | | | | 2.8 | | | | 0.7 | |
| 21 | | 0.0 | | | | | 0.5 | | | 0.1 | 4.9 | | | | 1.2 | |
| 21.5 | | 0.0 | | | | | 0.3 | | | 0.0 | 5.4 | | | | 1.3 | 0.6 |
| 22 | | | | | | | | | | | 3.2 | 0.2 | | | 0.9 | 0.9 |
| 22.5 | | | | | | | 0.5 | | | 0.1 | 5.4 | 0.5 | | | 1.5 | 1.1 |
| 23 | | 0.0 | | 0.2 | | | | | | 0.0 | 11.8 | 5.3 | 2.2 | 0.3 | 4.9 | 1.5 |
| 23.5 | | 0.0 | | 1.7 | | 0.7 | 0.3 | | | 0.4 | 10.7 | 10.0 | 8.0 | 0.3 | 7.2 | 2.9 |
| 24 | 0.3 | 0.2 | | 5.3 | 3.4 | 2.9 | 0.5 | 0.4 | | 2.1 | 13.6 | 18.1 | 12.0 | 9.5 | 13.3 | 4.6 |
| 24.5 | | 0.6 | | 6.0 | 3.7 | 6.5 | 0.5 | 5.5 | | 3.7 | 11.3 | 17.1 | 17.0 | 18.3 | 15.9 | 5.5 |
| 25 | 1.3 | 1.2 | | 11.5 | 8.0 | 12.0 | 5.9 | 13.5 | 2.3 | 8.9 | 10.7 | 18.3 | 24.0 | 19.3 | 18.1 | 7.2 |
| 25.5 | 4.4 | 3.4 | | 11.7 | 8.8 | 8.6 | 10.9 | 18.8 | 8.5 | 11.2 | 6.0 | 10.5 | 13.5 | 16.6 | 11.7 | 7.5 |
| 26 | 7.6 | 6.3 | | 13.8 | 13.3 | 12.7 | 13.5 | 21.4 | 15.2 | 15.0 | 5.5 | 8.2 | 14.8 | 15.0 | 10.9 | 10.7 |
| 26.5 | 11.7 | 8.5 | | 13.0 | 11.1 | 10.5 | 13.5 | 17.6 | 15.2 | 13.5 | 2.6 | 4.4 | 4.0 | 9.0 | 5.0 | 15.8 |
| 27 | 13.6 | 11.3 | | 14.6 | 16.4 | 14.9 | 18.6 | 12.5 | 19.8 | 16.1 | 0.9 | 4.4 | 1.3 | 5.7 | 3.1 | 10.7 |
| 27.5 | 11.7 | 12.6 | 0.2 | 9.4 | 14.1 | 9.9 | 9.2 | 4.0 | 14.0 | 10.1 | 0.4 | 1.5 | 1.3 | 1.6 | 1.2 | 13.2 |
| 28 | 15.4 | 15.6 | 0.1 | 8.1 | 11.1 | 8.6 | 11.2 | 3.8 | 12.5 | 9.2 | 0.3 | 0.5 | 0.6 | 2.2 | 0.9 | 6.6 |
| 28.5 | 13.6 | 12.1 | 1.5 | 3.4 | 6.1 | 4.1 | 6.6 | 1.5 | 6.1 | 4.6 | 0.3 | 0.8 | 0.9 | 0.8 | 0.7 | 6.9 |
| 29 | 11.5 | 10.5 | 3.3 | 0.6 | 1.1 | 2.7 | 4.3 | 0.6 | 3.5 | 2.1 | | | 0.6 | 0.8 | 0.3 | 2.0 |
| 29.5 | 4.7 | 6.5 | 9.9 | 0.4 | 0.5 | 5.9 | 1.8 | 0.4 | 2.3 | 1.9 | | 0.2 | | 0.5 | 0.2 | 1.7 |
| 30 | 1.8 | 3.6 | 8.9 | | 1.1 | | 1.3 | | 0.3 | 0.4 | | | | | | |
| 30.5 | 0.3 | 3.5 | 11.0 | | 1.1 | | | | | 0.2 | | | | | | 0.3 |
| 31 | 0.3 | 2.1 | 17.3 | | 0.3 | 0.1 | | | 0.3 | 0.1 | 0.3 | | | | 0.1 | 0.3 |
| 31.5 | 0.8 | 1.0 | 16.2 | | | | 0.3 | | | 0.0 | | | | | | |
| 32 | | 0.5 | 13.6 | | | | 0.3 | | | 0.0 | | | | | | |
| 32.5 | 0.8 | 0.2 | 8.0 | | | | | | | | | | | | | |
| 33 | 0.3 | 0.1 | 6.8 | | | | | | | | | | | | | |
| 33.5 | | 0.1 | 1.7 | | | | | | | | | | | | | |
| 34 | | 0.1 | 0.8 | 0.2 | | | | | | 0.0 | | | | | | |
| 34.5 | | 0.0 | 0.4 | | | | | | | | | | | | | |
| 35 | | 0.0 | 0.3 | | | | | | | | | | | | | |
| 35.5 | | 0.0 | | | | | | | | | | | | | | |
| Number | 383 | | 7652 | 8817 | 754 | 734 | 7860 | 527 | 686 | | 1173 | 864 | 867 | 734 | | 1220 |
| L (cm) | 28.2 | 28.5 | 31.7 | 26.7 | 27.2 | 27.1 | 27.3 | 26.6 | 27.5 | 27.1 | 24.1 | 25.3 | 25.5 | 26.0 | 25.3 | 26.8 |
| W (g) | 202.1 | 209.9 | 303.4 | 167.3 | 178.3 | 175.7 | 181.6 | 163.7 | 185.2 | 175.3 | 118.2 | 138.4 | 142.0 | 150.9 | 137.4 | 170.8 |
| TS/id | -42.2 | -42.1 | -41.2 | -42.7 | -42.5 | -42.5 | -42.5 | -42.7 | -42.4 | -42.5 | -43.5 | -43.1 | -43.0 | -42.9 | -43.1 | -42.6 |
| TS/kg | -35.2 | -35.3 | -36.0 | -34.9 | -35.0 | -35.0 | -35.0 | -34.8 | -35.1 | -35.0 | -34.3 | -34.5 | -34.6 | -34.7 | -34.5 | -34.9 |

**Table 2D.5: FRV Scotia 1–21/07/2006. Numbers of herring otolithed at length and at age, lengths in cm measured to the nearest 0.5 cm below, ages in winter rings (wr).**

| Len/Age wr | 1 | 2I | 2M | 3I | 3M | 4I | 4M | 5 | 6 | 7 | 8 | 9+ | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.5 | 1 | | | | | | | | | | | | 1 |
| 19 | 1 | | | | | | | | | | | | 1 |
| 19.5 | 1 | | | | | | | | | | | | 1 |
| 20 | 1 | | | | | | | | | | | | 1 |
| 20.5 | | 1 | | | | | | | | | | | 1 |
| 21 | 2 | | | 1 | | | | | | | | | 3 |
| 21.5 | 3 | 1 | | | | | | | | | | | 4 |
| 22 | | 2 | 1 | | | | | | | | | | 3 |
| 22.5 | 3 | 6 | 4 | | | | | | | | | | 13 |
| 23 | 1 | 13 | 7 | 1 | 1 | | | | | | | | 23 |
| 23.5 | 2 | 16 | 8 | 6 | 2 | 1 | | | | | | | 35 |
| 24 | | 17 | 21 | 6 | 11 | | | | | | | | 55 |
| 24.5 | 1 | 20 | 29 | 13 | 7 | 2 | 2 | 2 | | | | | 76 |
| 25 | | 13 | 40 | 10 | 11 | 1 | 7 | 13 | | | | 1 | 96 |
| 25.5 | | 6 | 51 | 5 | 20 | 1 | 12 | 28 | 1 | 1 | | 1 | 126 |
| 26 | | | 47 | | 24 | | 11 | 49 | 1 | | | | 132 |
| 26.5 | | | 28 | 1 | 22 | | 20 | 62 | 4 | 1 | | | 138 |
| 27 | | | 28 | | 20 | 1 | 20 | 63 | | 2 | | | 134 |
| 27.5 | | | 23 | | 39 | | 71 | 96 | 11 | 8 | 2 | 1 | 251 |
| 28 | | | 15 | | 35 | | 72 | 86 | 14 | 14 | 6 | 2 | 244 |
| 28.5 | | | 4 | | 17 | | 60 | 114 | 32 | 12 | | | 239 |
| 29 | | | 5 | | 14 | | 40 | 84 | 34 | 25 | | 2 | 204 |
| 29.5 | | | 1 | | 4 | | 30 | 80 | 33 | 35 | 5 | 4 | 192 |
| 30 | | | 1 | | 2 | | 17 | 61 | 25 | 33 | 5 | 6 | 150 |
| 30.5 | | | | | 2 | | 7 | 49 | 25 | 37 | 4 | 5 | 129 |
| 31 | | | | | | | 3 | 25 | 27 | 32 | 2 | 4 | 93 |
| 31.5 | | | | | | | 1 | 20 | 18 | 29 | 4 | 3 | 75 |
| 32 | | | | | | | 3 | 6 | 9 | 22 | 2 | 10 | 52 |
| 32.5 | | | | | | | 2 | 1 | 5 | 16 | 1 | 5 | 30 |
| 33 | | | | | | | | | 1 | 6 | 3 | 9 | 19 |
| 33.5 | | | | | | | | 1 | 3 | 6 | | 6 | 16 |
| 34 | | | | | | | | | 3 | 4 | 6 | 2 | 15 |
| 34.5 | | | | | | | | 1 | 1 | 1 | 2 | | 5 |
| 35 | | | | | | | | | 2 | | 1 | | 3 |
| 35.5 | | | | | | | | | | 1 | 1 | 1 | 3 |
| Grand Total | 16 | 95 | 313 | 43 | 231 | 6 | 378 | 841 | 249 | 285 | 44 | 62 | 2563 |

**Table 2D.6: Mean length, mean weight, biomass (thousands of tonnes) and numbers (millions) breakdown by age (winter rings) and maturity obtained during the Scotia 1 to 21 July 2006 herring acoustic survey. I= immature; M=mature; A=All.**

| YR CLASS | AGE/MATURITY | MEAN LENGTH(CM) | MEAN WEIGHT (G) | NUMBER (MILLIONS) | BIOMASS (KT) |
|---|---|---|---|---|---|
| 2004 | 1A | 19.6 | 75.1 | 113 | 9 |
| 2003 | 2I | 23.8 | 119.7 | 495 | 59 |
| 2003 | 2M | 25.3 | 148.6 | 2,179 | 324 |
| 2002 | 3I | 24.6 | 132.2 | 173 | 23 |
| 2002 | 3M | 26.6 | 174.6 | 1,382 | 241 |
| 2001 | 4I | 25.4 | 148.6 | 44 | 7 |
| 2001 | 4M | 27.4 | 193.4 | 1,889 | 365 |
| 2000 | 5A | 27.4 | 194.4 | 3,672 | 714 |
| 1999 | 6A | 29.0 | 237.4 | 552 | 131 |
| 1998 | 7A | 29.5 | 251.6 | 550 | 138 |
| 1997 | 8A | 29.7 | 259.9 | 70 | 18 |
| 1996 | 9+ | 29.2 | 274.3 | 64 | 18 |
| | Average | 26.8 | 183.1 | | |
| | | | Total | 11,184 | 2,048 |
| | | | Spawning stock | 10,359 | 1,950 |
| | | | Immature | 826 | 98 |

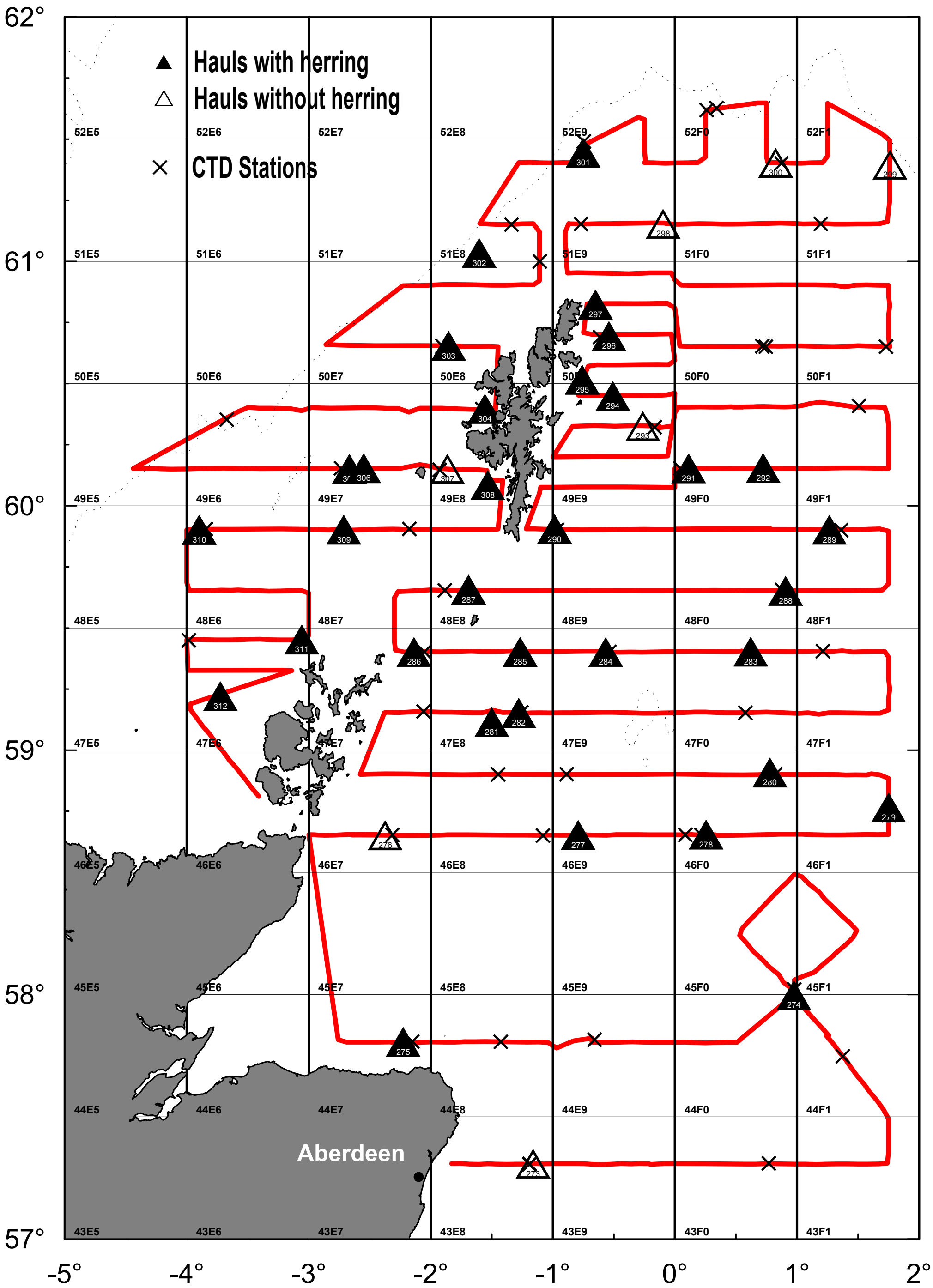


**Figure 2D.1: Map of the North Sea showing the cruise track (solid lines) of FRV Scotia for the acoustic survey 1 - 21 July 2006 indicating the location of trawl and CTD stations (symbols defined in legend).**

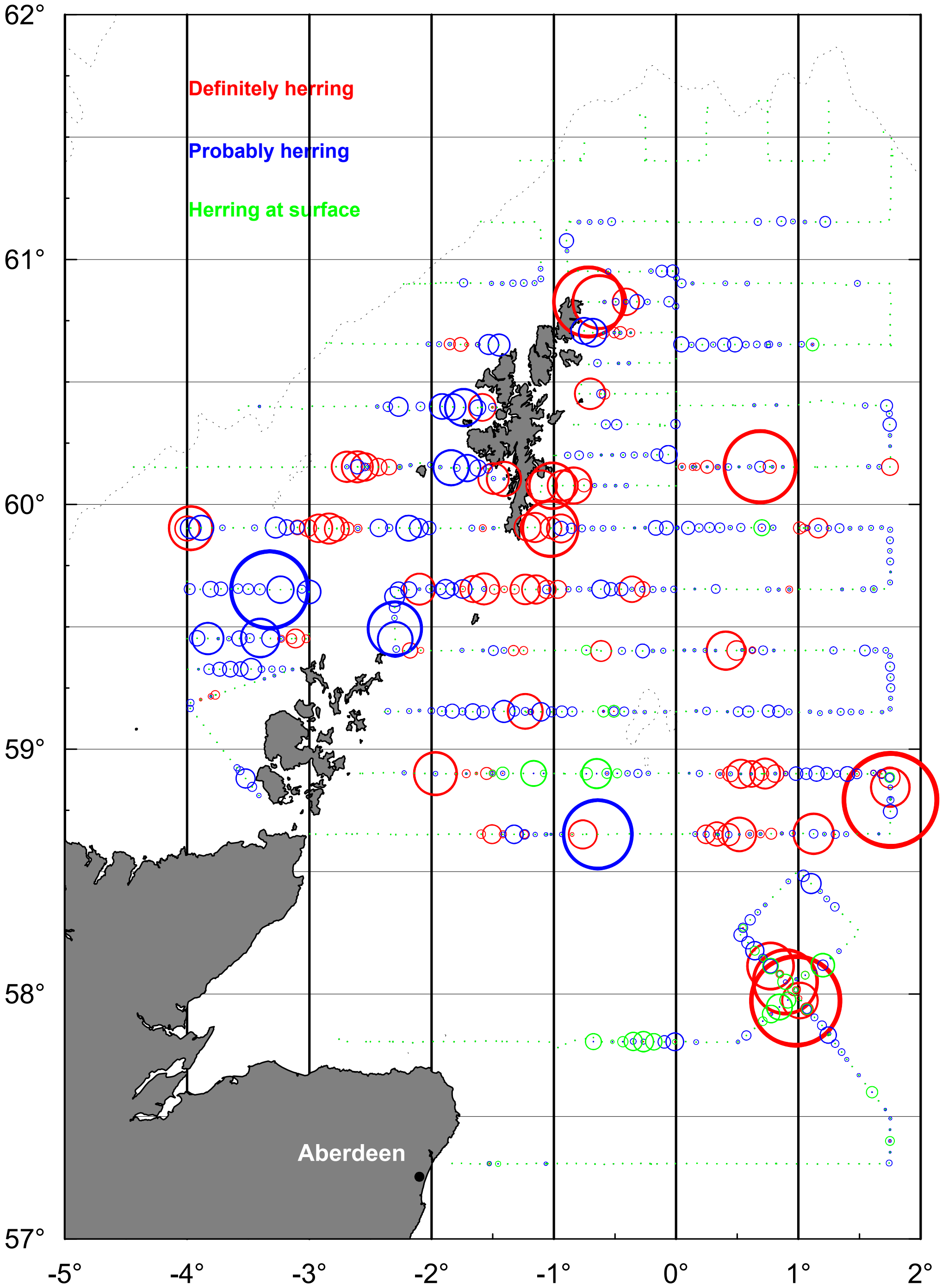


**Figure 2D.2: Map of the North Sea showing the distribution of NASC values attributed to herring from the herring acoustic survey on FRV SCOTIA for 1-21 July 2006. NASC values proportional to circle area (max = 11990).**

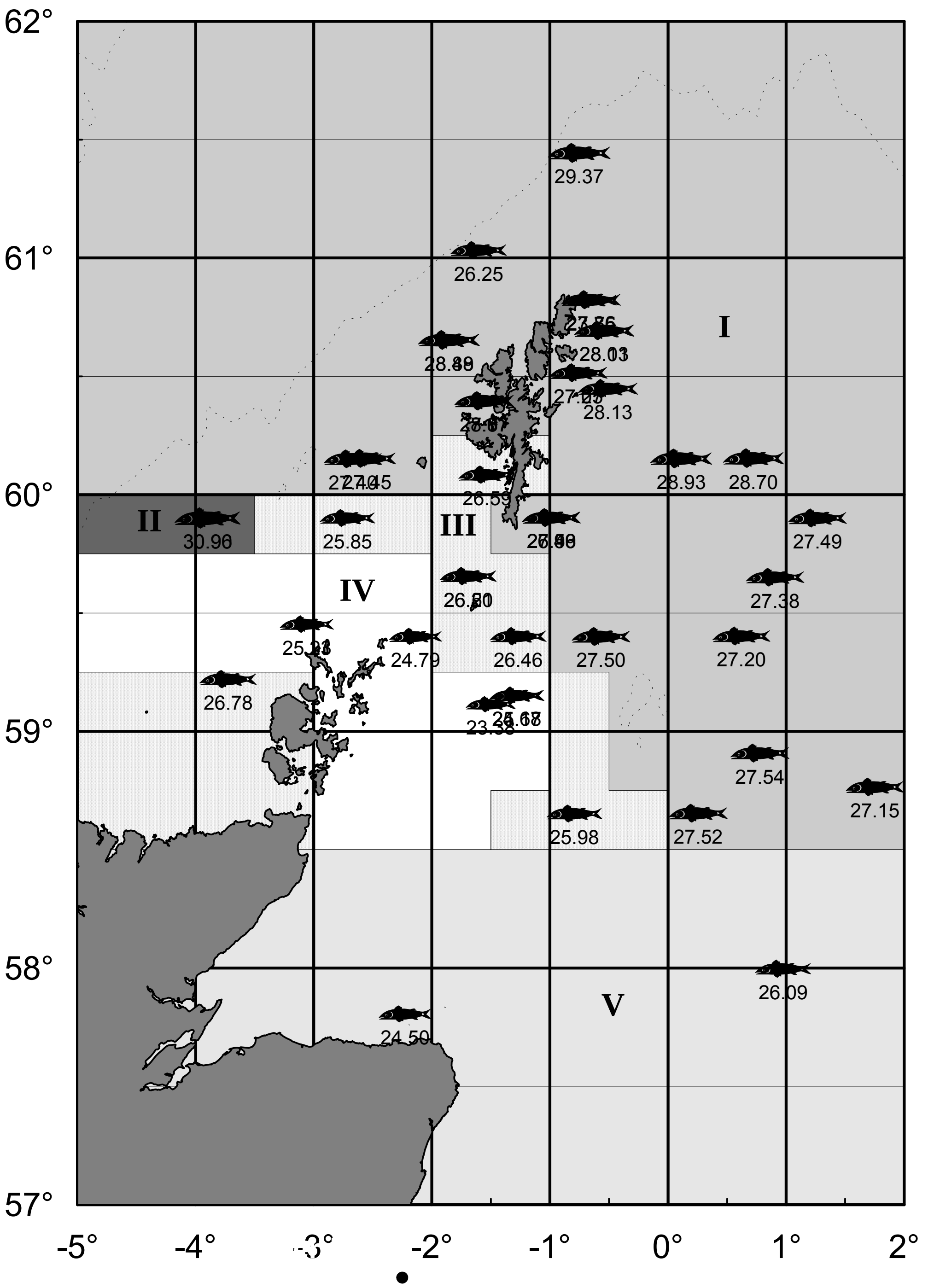


**Figure 2D.3: Map of the North Sea showing the mean length of herring from pelagic trawl catches from FRV SCOTIA for 1-21 July 2006 trawl station numbers are given in Figure IID.1 and details in Tables IID.1 and IID.2. The five analysis areas are shaded and numbered with roman numerals (I-V) and the length distributions, mean lengths, weights and target strengths are given by area in Table IID.4.**

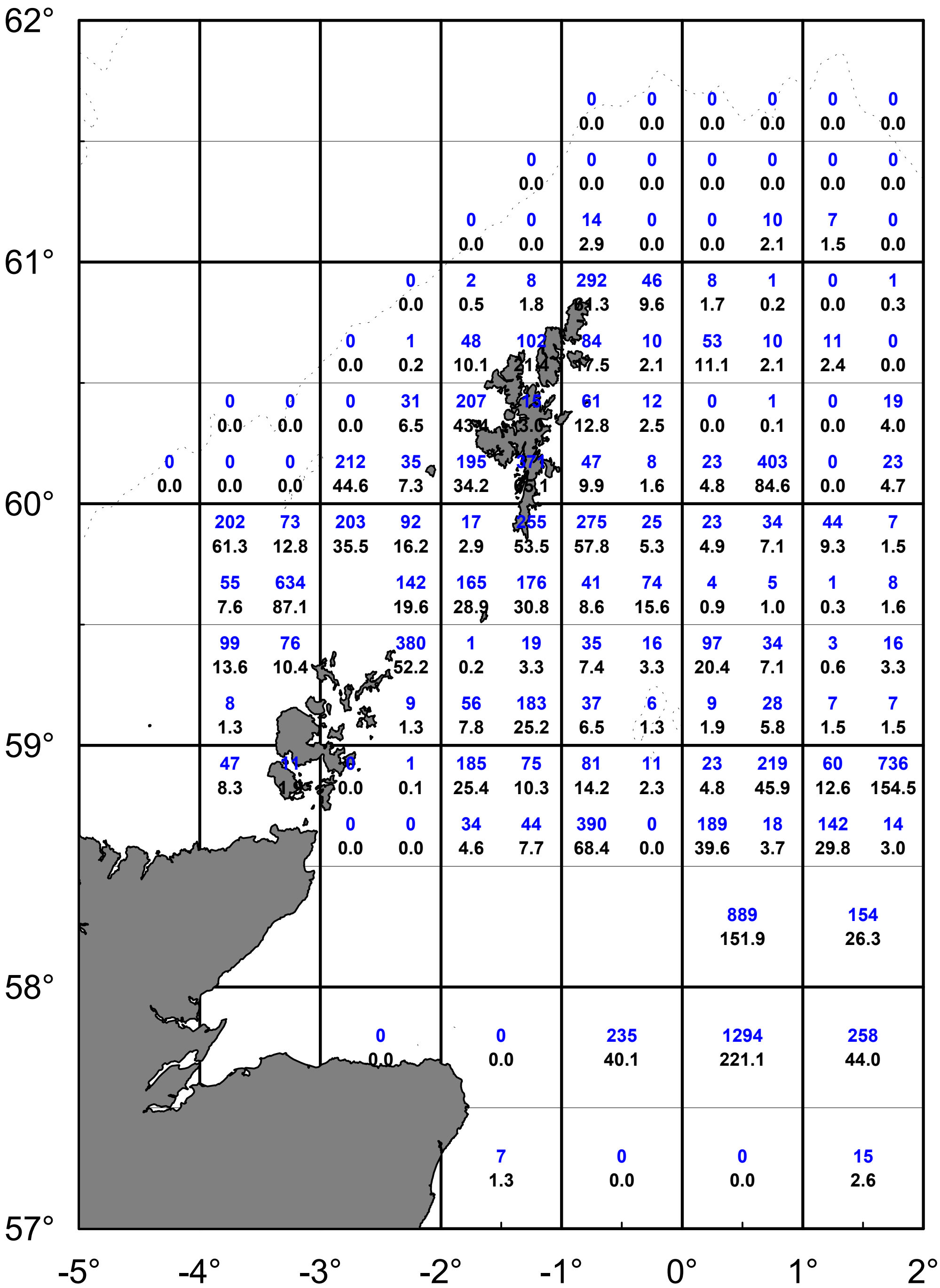


**Figure 2D.4: Map of the North Sea showing the estimated numbers (millions) and biomass (thousands of tonnes) by quarter statistical rectangle from the herring acoustic survey on FRV SCOTIA for 1-21 July 2006.**

## Annex 2E: Netherlands

**North Sea hydro acoustic herring survey**

**Survey report for RV "TRIDENS"**

**26 June – 21 July 2006**

**Sytse Ybema**

# 1. Introduction

The Netherlands Institute for Fisheries Research (RIVO) participates in the international North Sea hydro acoustic survey for herring since 1991. Participants in this survey are Scotland, Norway, Germany, Denmark and Netherlands. The survey is part of the EU data collection framework and is coordinated by the Planning Group fro Herring Surveys (PGHERS). The aim of this survey is to provide an abundance estimate of the whole North Sea herring population. This estimate is used as a tuning index by the ICES Herring Assessment Working Group (HAWG) in its assessment of the population size. In this report the results are presented of the survey in the central North Sea, carried out by the Dutch vessel RV "Tridens".

*Cruise plan*

The survey is currently changing from a separate National survey approach with traditional area's for each participant towards a more robust international survey with interlaced transects. The survey was split into two periods of 2 weeks. The planned cruise track and hydrographical positions are presented in Figure 2.3.1. In order to avoid large time gaps between neighbouring transects covered by different participants, radio and email contact between vessels was frequent. The actual surveyed transects therefore differ from the planned transects.

# 2. Methods

## 2.1 Scientific Staff

| RIVO STAFF | WK 26 | WK 27 | WK 28 | WK 29 |
|---|---|---|---|---|
| Bram Couperus (cruise leader) | X | x | | |
| Kees Bakker | X | x | x | x |
| Mario Stoker | X | x | | |
| Dirk Burggraaf | X | x | | |
| Cindy van Damme | | x | | |
| Sytse Ybema (cruise leader) | | | x | x |
| Marcel de Vries | | | x | x |
| Pablo Tjoe-Awie | | | x | x |
| Lisa Borges | | | x | x |
| Mark Dickey-Collas | | | x | x |

Guest researchers: Deborah Davidson from the University of Aberdeen.

## 2.2 Narrative

*Week 26*

On Monday 26 June at 11:00h Tridens left the port of Scheveningen and headed towards Scapa Flow. On its way the equipment for the calibration was prepared and 1 test haul was conducted. Arrival at Scapa Flow was Wednesday at 06.00 GMT. Both 38 kHz and 200 kHz transducers were calibrated (for more detailed information see paragraph "Calibration"). At 15:00h Tridens steamed towards the beginning of the first transect. Right at the beginning of the first transect, heavy acoustic noise was observed. Using the hull mounted transducer, in a near bottom haul a mix of haddock, Norway pout and a little bit of herring was found. A second calibration was performed in Scape Flow. Arrival in Aberdeen at Saturday, 1 July 10:15h.

*Week 27*

Departure from Aberdeen was on Monday 3 July at 00:15h heading for the 56.55N transect. Sailing towards the Devil's Hole small surface schools were found but in order to save lost time no haul was made on these schools. Catches in the afternoon and evening show gadoids and some herring. In the evening radio contact is made with RV "Scotia" and "Enterprise". Most strong acoustic detections were found east of 0 degrees throughout the area whereas most gadoids found in the catches were observed west of 0 degrees.

*Week 28*

Tridens left Scheveningen port on Monday, 10 July at 13:30h local time. Only at the beginning of this transect small schools were seen near the bottom. Juvenile herring was observed in a nearby catch. In agreement with the coordinator of this survey it was decided to hand over of our transects to the RV "Solea". It wasn't till the end of the next day that we observed small schools of fish. Absence of fish made us decide to lower survey intensity around 55.40 degrees north. In order to arrive on time in Thyburon (Denmark) it was decided to change the east/west direction of the 55.40 transect. In the night from Thursday to Friday we sailed towards the beginning of the eastern part the survey area, near the German Bight. No fish was observed offshore. Reaching the shallow coastal areas fish was seen disaggregated and in high densities. Arrival in Thyburon on Saturday 16 July at 09.00h local time.

*Week 29*

Departure on Sunday 17 July at midnight, arriving at the first transect (56.10) near shore at 05.00h local time. No fish was observed in contradiction to the coastal part of the transect covered on Friday. It wasn't till Thursday that some small schools were observed on the 54.25 transect. Arrival in Scheveningen port around 10.00h local time.

## 2.3 Survey design

The survey was carried out from 26 June to 21 July 2005, covering an area east of Scotland from latitude 54°40 to 58°25 North and from longitude 3° West (off the Scottish/English coast) to 8° East. Following the survey design in 2005, an adapted survey design was applied, partly based on the herring distribution from previous years and the aim of a more international integrated survey. As a result, parallel transects along latitudinal lines were used with spacing between the lines set at 7.5, 15, 30 or even 55 nautical mile, depending on the expected distributions. Acoustic data from transects running north-south close to the shore (that is parallel to the depth isolines) were excluded from the dataset.

In 2005, PGHERS (Planning Group for Herring Surveys) had decided to experiment with interlaced transects in the whole survey area. Time coordination is therefore important. Every other day, individual vessels send their cruise progress to a scientific coordinator. This year, it was agreed by "Tridens" and RV "Solea" that the most southern planned transect of "Tridens" was to be covered by "Solea". Because hardly any fish was observed around 55°50N and 55°35N tranects by both RV "Tridens" and RV "Solea", it was decided to merge them into one transect on 55°40.

The actual cruise track from which data was used for stock estimate and trawl positions is presented in Figure 1.

### 2.4 Calibration of acoustic equipment

The transducers in the towed body were checked before the survey. Three calibrations were executed in Scapa Flow, Orkney Islands. Both the towed body's 200kHz transducer and the 38kHz transducers from both towed body and hull mounted had low values for which the software had to correct for relatively strong. Values are accepted but during the beginning of the cruise heavy noise make these transducers not usable. A second calibration was performed in Scapa Flow using new cables but once surveying the noise was still present. The Heel and pitch sensor cable proved to cause problems and was therefore not used during the rest of the survey. Calibration results of the second calibration were used and are given in **the national cruise report.**

| | | |
|---|---|---|
| a) | 38 kHz in the towed body: | moderate results |
| b) | 200 kHz in the towed body: | bad results |
| c) | 38 kHz hull mounted: | moderate results |

Two out of three calibrations were performed successful. The target strength values (TS) of all the reference targets were found lower than expected. The cause of this low acoustic reflection is to be looked at. Although the relatively low acoustic performance, the 200KHz transducer was used for dual frequency species extraction.

### 2.5 Acoustic data collection

*Data collection*

A Simrad 38 kHz split beam transducer was operated in a towed body (type "Shark") 6-7 m under the water surface. The settings of the EK60 are listed in **Table 1**. Acoustic data were collected with a Simrad EK60 scientific echo sounder and logged with Sonardata Echoview software in 1 nautical mile intervals. The EK60 received the vessel speed from the ship's GPS. A vessel speed of 10.5 knots was used on one engine without disturbing the acoustic image.

All echoes were recorded with a threshold of -80dB up to a depth of 150 meters below the transducer. A ping rate of 0.6 sec was used during the entire survey. This ping rate has proven most suitable at depths of 50 - 150 m at which depth herring occur in most of the area.

During a few days, the weather conditions allowed to use the hull mounted transducer in stead of the towed body. Using the hull mounted transducer, the vessel speed was increased (up to 14 knots, compared to 10 knots when using the towed body) and the saved time was used to catch up time loss by the second calibration.

A 200 kHz transducer was used for species separation by acoustic means. The algorithms used for this extraction were developed within the EU project "SIMFAMI" and made it easier to distinguish non-swimbladdered fish like sandel and mackerel from swimbladdered fish like herring and sprat. The algorithm itself is explained in the cruise report of 2005.

### 2.6 Biological data collection

*Fishing*

The acoustic recordings were verified by fishing with a 2000 mesh pelagic trawl with 20 mm meshes in the cod-end. Fishing was carried out when there was doubt about the species composition of recordings observed on the echo sounder and to obtain biological samples of herring and sprat. In general, after it was decided to make a tow with a pelagic trawl, the vessel turned and fished back on its track line. If the recordings showed schools, a Simrad SD570 60kHz sonar was used to be able to track schools that were swimming away from the track line. In all hauls the footrope was very close to the ground with vertical net openings varying from 10 to 20 m (specifications are listed in the PGHERS manual).

A Furuno FS20/25 trawl sonar (vertical and horizontal scan direction) was used to control the catch.

Trawl station data was recorded by a tool which allowed to record data from the ship's own data acquisition system.

*Biological samples*

For all fish:

- Total species weight of the catch
- 150 to 250 specimens for individual length measurement depending on the catch weight, a subsample technique are used, based on weights.

Stratified samples of 5 fish per length class are taken from the 150-250 herring and sprat. The following parameters are sampled from these fish:

- Age of herring and sprat, by means of otolith reading
- Gender
- Maturity stage
- Fecundity of female herring (see below)
- Ovary weight of mature female herring (see below)
- Fat content (see below)

*Fecundity of female herring*

The relationship between lipid content and fecundity in fish with different spawning strategies is investigated, including North Sea herring. Therefore fecundity and lipid samples of 100 female herring were collected. In order to get a good view of the North Sea herring, the 100 females were collected throughout the survey, across time and space. Since it is very important for the fecundity to know the spawning type of the herring also 1 otolith of all 100 females was collected for spawning type reading. Difference between ripe and non-ripe fish proved difficult to observe this year. Total ovaries were therefore preserved for further analysis at the lab.

*Fat content*

Supplementary this year was the use of the Torry Fish Fatmeter (TFFM), made by Distell Inc. This is a portable, handheld meter that uses microwave emissions to measure the fat content of fish species that store their fat reserves in the muscles and mesenteries. The TFFM actually measures the water content of the fillet, and converts this into the fat content using the strong inverse relationship between water and fat, in fish. 903 herring were sampled.

*Loss of weight by freezing herring*

To quantify the effect of freezing on the length and weight of herring the following two experiments were already done during the IBTS in February and was done again during this survey to measure a seasonal effect. The most ideal way was to sample a least three trawls for every experiment resulting in a total of 900 individuals. The trawls have to be separated in time and area and fish of different length have to be sampled.

- ± 150 herring per trawl were measured (mm) and weighted (grams) direct after the trawl. All fish were stored in the freezer after being put on ice for 3 to 5 days. Total weight was then compared with the total weight before put on ice.
- ± 150 herring per trawl were measured (mm) and weighted (grams) direct after the trawl. All fish were stored in a froster after being put on ice water for half a day to 1 day.

### 2.7 Hydrographical data

Hydrographical data have been collected in 36 stations, all at fixed locations (Figure 2). A Seabird CTD device, type SBE 9plus in combination with a corresponding water sampler 9plus in combination with a corresponding Seabird SBE 32C carousel water sampler was used in this survey. It had been successfully calibrated in advance by the manufacturer. Conductivity, temperature and depth were measured.

Data were analysed using SAS software and stored in an international OceanDataView format. Ocean dataView version 2.1 was used for gridded data presentation. The used “VG Gridding” analyzes the distribution of the data points and constructs a variable resolution, rectangular grid, where grid-spacing along X and Y direction varies according to data density.

In addition, some environmental variables were continuously measured by the ships own “Data acquisition system” (DAS). These continuous measuring sensors had not been calibrated and were used to compare results with Seabird CTD results.

### 2.8 Data handling, analysis and presentation

*Data analysis*

The target species herring and sprat are often observed in mixed catches and since the schools of these species are often found to be similarly shaped the distribution in these areas was based on trawl catch distributions.

For each ICES rectangle, species composition and length distribution were determined as the un-weighted mean of all trawl results for this rectangle. From these distributions the mean acoustic cross section “sigma” was calculated according to the target strength-length relationships (TS) recommended by the ICES Planning Group for Herring Surveys (ICES, 2000).

The following target strength equations have been used: TS=(20logL+b20). The value of b20 is predefined.

| HERRING | SPRAT | MACKEREL | NORWAY POUT | GADOIS | SANDEEL |
|---|---|---|---|---|---|
| 71.2 | 71.2 | 86.9 | 67.1 | 67.4 | 93.7 |

The breakdown of sprat and herring in “definitely”, “probably” and “possibly” serves merely as a relative indication of certainty within the subjective process of integral partitioning (“scrutinising”). For the analysis “definitely” and “possibly herring/sprat” integrator counts were summed to obtain a “best herring/sprat” estimate.

Then the numbers of herring and sprat per ICES rectangle were calculated by dividing the $S_A$ value in a rectangle by the overall sigma in the corresponding rectangle.

The biological samples, used for stock structure and biomass calculations were grouped in 5 strata for herring and 1 stratum for sprat, based on similar length frequency distribution in the area (Figure 3). The numbers per year/maturity class were calculated, based on the age/length key for each stratum. For each separate stratum the mean weight per year/maturity class was then calculated.

All calculations were performed by SAS (SAS Institute) routines. Hydro acoustic – biological and hydrographical data are being stored in the HERSUR format.

## 3. Results

### 3.1 Acoustic data results

*Horizontal and vertical distribution patterns*

The north-western part of this year's survey area held most of the herring observed (Figure 4). Interlaced transects in this area were covered by RV 'Scotia', making a good description of the distribution pattern observed by "Tridens" difficult. Fish aggregations near the Danish coast were much more disperse than in other areas.

### 3.2 Trawl data results

In all, 23 trawl hauls have been conducted. Herring was found in 18 hauls of which 16 samples were taken. Sprat was found in 7 hauls of which 6 samples were taken (see also 2.8 *Data analysis*). In 11 hauls herring was the most abundant species in weight. In 2 hauls sprat was the most abundant species. This year, only one haul contained a few sandeels. The trawl list is presented in Table 2a, the catch weights per haul and species are presented in Table 2b and the length frequency proportions are presented in Table 2c.

In total 903 biological fish samples of herring and 239 of sprat were collected and used for length, age and maturity keys (Table 3a for herring and Table 3b for sprat) from which most herring were 1 year old.

By the age of 3 (having 3 winter rings) almost all herring is mature where in 2005 this age was 4 and in 2004 this age was also 4

### 3.3 Biomass estimates

The stock biomass estimate of herring found in the Tridens survey area:

Total sub stock 404 thousand tonnes

Spawning sub stock 131 thousand tonnes

The stock biomass estimate of sprat found in the Tridens survey area:

Total sub stock 31 thousand tonnes

Spawning sub stock 28 thousand tonnes

Figure 5 shows the estimated numbers and biomass of herring by ICES rectangle in the area surveyed by RV "Tridens". Table 4 summarizes stock estimates per stratum as defined in Figure 2.8.1. Table 5a summarizes the sub stock estimates for all strata for herring and Table 5b summarizes it for sprat.

### 3.4 Hydrographical measurements

Although survey intensity of most ICES rectangles covered by "Tridens" was relatively low, due to a more integrated survey approach this year, CTD measurements at surface showed comparable patterns with other data sources, such as the ship's data acquisition system and infrared satellite images of the area surveyed.

*Temperature*

Water temperature samples were collected by conducting vertical CTD samples and using a continuous temperature measurement using the ships temperature sensor placed in the water intake system.

During summer, temperature distribution at sea surface usually differs highly from near bottom or even mid water distribution due to stratification. Relative warm surface water does hardly mix with deeper water layers. Similar distribution patterns at these depths were therefore not expected to be found. Continuous surface temperature recordings were used for a general real-time overview. A daily and weekly by satellite constructed mean surface temperature from the North Sea was used as a reference during the survey. Satellite images of phytoplankton at the surface were collected weekly to compare fish distribution with in a later stag.

Surface temperatures maps shown below indicate warmer areas in the eastern part of the North Sea where water depth is down to 20-30 meters. Further to the north-west, where the North Sea is deeper, the water is cooler.

**Table 1: Simrad EK60 settings used in the June 2006 North Sea hydroacoustic survey for herring, RV "Tridens".**

| | HULL MOUNTED | TOWED BODY |
|---|---|---|
| Absorption coefficient | 9.5 dB/km | 9.5 dB/km |
| SA correction | -0.50 | -0.54 dB |
| Pulse duration | 1.024 ms | 1.024 ms |
| Bandwidth | 2.43 kHz | 2.43 kHz |
| Max Power | 2000 W | 2000 W |
| Two-way beam angle | -20.6 dB | -20.6 dB |
| 3 dB Beam width | 6.85 dg | 7.16 dg |
| | | |
| TS of sphere | -33.6 dB | -33.6 dB |
| Range to sphere in calibration | 20 | 14.00 m |
| Transducer gain | 26.16 | 23.30 dB |
| Log/Navigation Menu | | |
| Speed, position, vessel log | Serial from ship's GPS | |
| Operation Menu | | |
| Ping interval (s) | 0.6 | 0.6 |
| Display/Printer Menu | | |
| TVG | 20 log R | 20 log R |
| Integration line | N/A | N/A |
| TS colour min. | -50 dB | -50 dB |
| Sv colour min. | -70 dB | -70 dB |

**Table 2a: Details of the trawl hauls taken. "Tridens", North Sea acoustic survey 2006.**

| sample | haul | ICES | date | time (GMT) | position | haul duration (min) | depth (m) | geardepth (m) | wind direction (□) | wind force (m/s) | comment (Dutch) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 5400336 | 1 | 42F0 | 27/06/2006 | 14:48 | 56.52N-00.12E | 48 | 88 | 73 | 359 | 4 | 1 ton schelvis en wijting |
| 5400337 | 2 | 45E8 | 29/06/2006 | 12:30 | 58.24N-01.31W | 100 | 108 | 90 | 203 | 7 | 3 ton makreel, schelvis, kevers en haring |
| 5400338 | 3 | 45E9 | 29/06/2006 | 16:30 | 58.16N-00.44W | 45 | 108 | 95 | 203 | 4 | 8 ton mooie haring, paaltje gerooid |
| 5400339 | 4 | 42E9 | 03/07/2006 | 08:45 | 56.54N-00.49W | 45 | 63 | 10 | 158 | 4 | makreel, zeenaald, 0j schelvis, totaal 13.3 kg |
| 5400340 | 5 | 42E9 | 03/07/2006 | 09:40 | 56.55N-00.31W | 60 | 74 | 59 | 158 | 2 | halve mand schelvis, poon, haring |
| 5400341 | 6 | 42F1 | 03/07/2006 | 17:00 | 56.55N-01.27E | 100 | 93 | 76 | 158 | 2 | 900 kg haring |
| 5400342 | 7 | 42F1 | 04/07/2006 | 05:48 | 56.48N-01.07E | 42 | 93 | 76 | 158 | 2 | 1250 kg haring (kever, schelvis) |
| 5400343 | 8 | 42F0 | 04/07/2006 | 15:35 | 56.41N-00.59E | 60 | 96 | 78 | 359 | 2 | 800 kg schone haring |
| 5400346 | 9 | 41F0 | 05/07/2006 | 04:45 | 56.24N-00.40E | 60 | 67 | 50 | 359 | 2 | 1/2 zakje grovere schelvis |
| 5400344 | 10 | 42F0 | 05/07/2006 | 04:55 | 56.33N-00.34E | 115 | 76 | 58 | 359 | 2 | geen vangst |
| 5400345 | 11 | 42E9 | 05/07/2006 | 10:38 | 56.33N-00.38W | 42 | 69 | 52 | 158 | 2 | 1/2 zakje kleine schelvis en haring |
| 5400347 | 12 | 41E8 | 11/07/2006 | 11:10 | 56.05N-01.36W | 26 | 64 | 43 | 248 | 9 | 2 ton jonge haring |
| 5400348 | 13 | 40F1 | 12/07/2006 | 15:55 | 55.40N-01.47E | 50 | 61 | 42 | 203 | 7 | halve mand schelvis, mand poon, 23 haringen |
| 5400349 | 14 | 40E9 | 13/07/2006 | 07:50 | 55.40N-00.19W | 95 | 59 | 42 | 203 | 7 | helemaal niks in |
| 5400350 | 15 | 41F7 | 14/07/2006 | 14:45 | 56.24N-07.19E | 55 | 30 | 14 | 338 | 6 | 1/2 zakje jonge kleine haring (toters) |
| 5400351 | 16 | 41F7 | 14/07/2006 | 17:45 | 56.24N-07.43E | 75 | 22 | 4 | 0 | 5 | Kleine makreel, horse makreel en poon |
| 5400352 | 17 | 41F6 | 17/07/2006 | 08:55 | 56.24N-06.41E | 45 | 41 | 23 | 359 | 2 | 3 ton jonge haring |
| 5400353 | 18 | 41F4 | 17/07/2006 | 19:30 | 56.09N-04.13E | 45 | 62 | 42 | 225 | 1 | klein spul (cod) |
| 5400354 | 19 | 40F6 | 18/07/2006 | 12:36 | 55.44N-06.13E | 72 | 45 | 45 | 315 | 2 | 1 ton jonge haring |
| 5400355 | 20 | 38F6 | 19/07/2006 | 07:33 | 54.44N-06.21E | 21 | 25 | 40 | 359 | 1 | kleine sprot |
| 5400356 | 21 | 38F4 | 19/07/2006 | 16:01 | 54.44N-04.15E | 50 | 45 | 31 | 90 | 3 | 1 ton jonge haring |
| 5400357 | 22 | 37F3 | 20/07/2006 | 09:05 | 54.24N-03.23E | 10 | 45 | 30 | 90 | 2 | 1.5 ton (90% sprot 10 % haring) |

**Table 2b: Trawl catches. "Tridens", North Sea acoustic survey 2006 (in kg).**

| | 5400336 | 5400337 | 5400338 | 5400339 | 5400340 | 5400341 | 5400342 | 5400343 | 5400344 | 5400345 | 5400346 | 5400347 | 5400348 | 5400349 | 5400350 | 5400351 | 5400352 | 5400353 | 5400354 | 5400355 | 5400356 | 5400357 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 889.1 | 1.8 | | | | | | | | | | | | | | | | | | | | |
| Ammodytes | | | | | | | | | | | | | | | | 0.7 | | | | | | |
| Cod | | | | | | | | | | | 0.8 | | | | | | | 0.0 | | | | |
| Dab | | | | | | | | | | | 1.3 | | | | 0.1 | | | | | | | |
| Greater argentine | | 1.5 | | | | | | | | | | | | | | | | | | | | |
| Grey gurnard | 6.0 | | | | 2.0 | 0.8 | 2.1 | 0.9 | 0.4 | 7.2 | 4.6 | | 21.9 | 0.4 | 18.4 | 17.1 | 12.7 | 0.4 | 3.8 | 1.1 | 7.1 | 2.7 |
| Haddock | 889.1 | | | 0.2 | 6.6 | | 2.3 | | 0.9 | 209.0 | 542.0 | 0.1 | 30.4 | 3.3 | | | | | | | | |
| Hake | | 3.0 | | | | | | | | | | | | | 0.3 | | | | | | | |
| Herring | 120.3 | 53.4 | 7000.0 | | 2.7 | 2000.0 | 1500.0 | 80.0 | 3.4 | | 0.3 | 1958.9 | 1.5 | | 940.2 | | 2854.3 | | 814.0 | 0.4 | 557.9 | 26.5 |
| Horse mackerel | | | | | | | | | | | | | | | 58.7 | 60.7 | 1.5 | | | 0.3 | | |
| Lemon sole | | | | | | | | | | | 0.5 | | | | | | | | | | | |
| Long rough dab | | | | | | | | | | | 0.0 | | | | | | | | | | | |
| Lumpsucker | | | | | | | | | | | | | | | | | | 6.9 | 0.8 | | 2.5 | |
| Mackerel | 60.1 | 21.7 | | 12.9 | 17.0 | 1.3 | 1.3 | | 0.5 | 6.1 | 1.4 | 10.3 | | 0.4 | 20.2 | 609.5 | | | 0.2 | 0.5 | | |
| Norway pout | 6.0 | | | | | | | | | 6.8 | | | | | | | | | | | | |
| Plaice | | | | | | | | | | | | | | | | | | | | 0.2 | | |
| Poor cod | | 0.3 | | | | | | | | | | | | | | | | | | | | |
| Red gurnard | | 2.5 | | | | | | | | | | | | | | | | | | | | |
| Saithe | | | | | | | | | | | | | | | | | | | | | | |
| Snake pipefish | | 0.2 | | 0.2 | | | | | | | | | 0.3 | | 0.1 | 0.0 | | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| Sprat | | | | | | | | | | | | 136.6 | | | 0.3 | | 312.2 | | 0.0 | 28.0 | 238.4 | 800.4 |
| Todaropsis eblanae | | | | | | | | | | | | | | | | | | | | | | |
| Whiting | 28.1 | 18.0 | | 0.0 | | 0.3 | 0.3 | | | 13.0 | | | 1.6 | 0.3 | 0.3 | 0.1 | 0.1 | 0.0 | | 0.1 | | 0.0 |

**Table 2c: Length frequency proportions of herring by haul. "Tridens", North Sea acoustic survey 2006.**

| Haul | 1 | 2 | 3 | 5 | 6 | 7 | 8 | 9 | 11 | 12 | 13 | 15 | 17 | 19 | 20 | 21 | 22 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Length (cm) | | | | | | | | | | | | | | | | | |
| 7.5 | | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | | |
| 8.5 | | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | | |
| 9.5 | | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | 2.2 | 0.3 | | | | |
| 10.5 | | | | | | | | | | | | 1.6 | 1.3 | | | | |
| 11 | | | | | | | | | | | | 3.5 | 2.4 | | | | |
| 11.5 | | | | | | | | | | | | 6.7 | 1.3 | | | | |
| 12 | | | | | | | | | | | | 4.4 | 1.7 | | | | |
| 12.5 | | | | | | | | | | | | 2.2 | 0.7 | | | | |
| 13 | | | | | | | | | | | | | | | | | |
| 13.5 | | | | | | | | | | | | 0.6 | | | | | 2.4 |
| 14 | | | | | | | | | | | | 0.6 | | | | 0.3 | 2.4 |
| 14.5 | | | | | | | | | | | | 2.2 | 0.3 | | | 0.7 | 2.4 |
| 15 | | | | | | | | | | | | 3.8 | 2.7 | 2.6 | | 1.0 | 6.0 |
| 15.5 | | | | | | | | | | 0.9 | | 7.3 | 8.4 | 6.6 | 8.3 | 9.3 | 12.0 |
| 16 | | | | | | | | | | 2.9 | | 15.9 | 9.8 | 18.9 | 8.3 | 13.2 | 12.0 |
| 16.5 | | 1.0 | | | | | | | | 9.7 | | 22.9 | 15.8 | 18.4 | 16.7 | 15.9 | 18.1 |
| 17 | | 1.6 | | | | | | | | 13.5 | | 11.7 | 18.2 | 22.4 | 25.0 | 20.2 | 16.9 |
| 17.5 | | 4.1 | | | | | | | | 12.4 | | 7.0 | 13.8 | 16.8 | 33.3 | 18.5 | 15.7 |
| 18 | 1.1 | 9.8 | | | | | | | | 16.5 | | 5.1 | 11.1 | 11.7 | | 11.6 | 9.6 |
| 18.5 | 1.1 | 6.2 | | | 0.4 | | | | | 15.9 | 4.3 | 1.6 | 5.7 | 2.0 | 8.3 | 7.3 | |
| 19 | 8.1 | 4.1 | | 2.6 | 0.4 | | | | 25.0 | 8.8 | | 0.6 | 4.7 | 0.5 | | 1.3 | 1.2 |
| 19.5 | 16.8 | 4.1 | | 7.9 | | 1.4 | 0.8 | 20.0 | 25.0 | 8.8 | 13.0 | | 0.3 | | | 0.7 | 1.2 |
| 20 | 29.2 | 5.2 | | 10.5 | 4.6 | 0.5 | 1.7 | 8.6 | | 4.1 | 21.7 | | 1.0 | | | | |
| 20.5 | 22.2 | 5.2 | | 26.3 | 7.1 | 2.4 | 4.6 | 17.1 | 25.0 | 4.4 | 30.4 | | | | | | |
| 21 | 8.6 | 2.6 | 0.7 | 34.2 | 5.4 | 3.3 | 5.9 | 8.6 | | 0.9 | 17.4 | | | | | | |
| 21.5 | 5.4 | 3.6 | | 2.6 | 4.1 | 1.9 | 9.7 | 2.9 | | 0.6 | 13.0 | | | | | | |
| 22 | 1.6 | 4.7 | 1.5 | 2.6 | 6.2 | 3.8 | 4.2 | 2.9 | | 0.6 | | | | | | | |
| 22.5 | 2.2 | 5.2 | 5.8 | | 4.1 | 3.3 | 3.8 | 8.6 | 25.0 | | | | | | | | |
| 23 | 0.5 | 7.3 | 5.8 | 5.3 | 5.0 | 5.2 | 5.9 | 2.9 | | | | | | | | | |
| 23.5 | 1.6 | 8.3 | | 2.6 | 6.6 | 9.0 | 17.7 | 2.9 | | | | | | | | | |
| 24 | 1.1 | 4.7 | 11.7 | 2.6 | 7.1 | 10.4 | 13.1 | 2.9 | | | | | | | | | |
| 24.5 | 0.5 | 6.2 | 10.2 | 2.6 | 7.9 | 9.9 | 9.3 | 5.7 | | | | | 0.3 | | | | |
| 25 | | 5.2 | 16.8 | | 7.1 | 12.7 | 5.1 | 5.7 | | | | | | | | | |
| 25.5 | | 6.2 | 19.7 | | 11.2 | 11.3 | 5.9 | 2.9 | | | | | | | | | |
| 26 | | 2.1 | 16.1 | | 7.5 | 12.7 | 4.2 | | | | | | | | | | |
| 26.5 | | 2.1 | 8.0 | | 6.6 | 6.6 | 3.8 | 5.7 | | | | | | | | | |
| 27 | | 0.5 | 1.5 | | 3.3 | 2.8 | 3.8 | 2.9 | | | | | | | | | |
| 27.5 | | | 1.5 | | 2.5 | 0.9 | 0.4 | | | | | | | | | | |
| 28 | | | 0.7 | | 1.2 | 0.9 | | | | | | | | | | | |
| 28.5 | | | | | 0.4 | 0.5 | | | | | | | | | | | |
| 29 | | | | | 0.4 | 0.5 | | | | | | | | | | | |
| 29.5 | | | | | 0.4 | | | | | | | | | | | | |
| 30 | | | | | | | | | | | | | | | | | |
| 30.5 | | | | | 0.4 | | | | | | | | | | | | |

**Table 3a: Age/maturity-length keys for herring (Stratum A, B, C, D and E). "Tridens", North Sea acoustic survey 2006.**

| Stratum A | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yearclass | 2005 | 2004 | 2003 | 2002 | 2001 | 2000 | 1999 | 1998 | 1997 | 1996 | | | | |
| lengthclass | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | numbers | biomass | mean weight (g) | proportion mature |
| 7.5 - 8.5 | | | | | | | | | | | 0.0 | | | |
| 8.5 - 9.5 | | | | | | | | | | | 0.0 | | | |
| 9.5 - 10.5 | | | | | | | | | | | 0.0 | | | |
| 10.0 - 11.0 | 26.3 | | | | | | | | | | 26.3 | 0.2 | 6.6 | 0.0 |
| 10.5 - 11.5 | 30.2 | | | | | | | | | | 30.2 | 0.2 | 7.7 | 0.0 |
| 11.0 - 12.0 | 60.1 | | | | | | | | | | 60.1 | 0.5 | 9.0 | 0.0 |
| 11.5 - 12.5 | 82.4 | | | | | | | | | | 82.4 | 0.8 | 10.3 | 0.0 |
| 12.0 - 13.0 | 63.0 | | | | | | | | | | 63.0 | 0.7 | 11.8 | 0.0 |
| 12.5 - 13.5 | 29.8 | | | | | | | | | | 29.8 | 0.4 | 13.4 | 0.0 |
| 13.5 - 14.5 | | 31.3 | | | | | | | | | 31.3 | 0.5 | 17.0 | 0.0 |
| 14.0 - 15.0 | | 34.7 | | | | | | | | | 34.7 | 0.7 | 19.1 | 0.0 |
| 14.5 - 15.5 | | 57.9 | | | | | | | | | 57.9 | 1.2 | 21.3 | 0.0 |
| 15.0 - 16.0 | | 165.2 | | | | | | | | | 165.2 | 3.9 | 23.7 | 0.0 |
| 15.5 - 16.5 | | 448.9 | | | | | | | | | 448.9 | 11.8 | 26.3 | 0.0 |
| 16.0 - 17.0 | | 717.6 | | | | | | | | | 717.6 | 20.8 | 29.0 | 0.0 |
| 16.5 - 17.5 | | 935.6 | | | | | | | | | 935.6 | 29.9 | 32.0 | 0.0 |
| 17.0 - 18.0 | | 919.4 | | | | | | | | | 919.4 | 32.3 | 35.1 | 0.0 |
| 17.5 - 18.5 | | 738.4 | | | | | | | | | 738.4 | 28.4 | 38.5 | 0.0 |
| 18.0 - 19.0 | | 505.3 | | | | | | | | | 505.3 | 21.2 | 42.0 | 0.0 |
| 18.5 - 19.5 | | 171.0 | | | | | | | | | 171.0 | 7.8 | 45.8 | 0.0 |
| 19.0 - 20.0 | | 86.2 | | | | | | | | | 86.2 | 4.3 | 49.8 | 0.0 |
| 19.5 - 20.5 | | 22.7 | | | | | | | | | 22.7 | 1.2 | 54.1 | 0.0 |
| 20.0 - 21.0 | | 6.9 | 3.5 | | | | | | | | 10.4 | 0.6 | 58.5 | 0.0 |
| 20.5 - 21.5 | | | | | | | | | | | 0.0 | | | 0.0 |
| 21.5 - 22.5 | | | | | | | | | | | 0.0 | | | |
| 22.5 - 23.5 | | | | | | | | | | | 0.0 | | | |
| 23.5 - 24.5 | | | | | | | | | | | 0.0 | | | |
| 24.5 - 25.5 | | | | 3.5 | | | | | | | 3.5 | 0.4 | 110.7 | 1.0 |
| 25.5 - 26.5 | | | | | | | | | | | 0.0 | | | |
| 26.5 - 27.5 | | | | | | | | | | | 0.0 | | | |
| 27.5 - 28.5 | | | | | | | | | | | 0.0 | | | |
| 28.5 - 29.5 | | | | | | | | | | | 0.0 | | | |
| 29.5 - 30.5 | | | | | | | | | | | 0.0 | | | |
| 30.5 - 31.5 | | | | | | | | | | | 0.0 | | | |
| a_tsn | 291.7 | 4841.0 | 3.5 | 3.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 5139.7 | | | |
| b_tsb | 2.9 | 164.7 | 0.2 | 0.4 | | | | | | | 168.2 | | | |
| b_tssb | 0.0 | 0.0 | 0.0 | 0.4 | | | | | | | 0.4 | | | |
| c_mean_length | 11.4 | 16.8 | 20.0 | 24.5 | | | | | | | 16.5 | | | |
| d_mean_weight | 10.1 | 34.0 | 58.5 | 110.7 | | | | | | | 32.7 | | | |
| e_mean_condition | 6.8 | 7.1 | 7.3 | 7.5 | | | | | | | | | | |
| f_percentage_ssb | 0.0 | 0.0 | 0.0 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | | |

| Stratum B | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yearclass | 2005 | 2004 | 2003 | 2002 | 2001 | 2000 | 1999 | 1998 | 1997 | 1996 | | | | |
| lengthclass | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | numbers | biomass | mean weight (g) | proportion mature |
| 7.5 - 8.5 | | | | | | | | | | | 0.0 | | | |
| 8.5 - 9.5 | | | | | | | | | | | 0.0 | | | |
| 9.5 - 10.5 | | | | | | | | | | | 0.0 | | | |
| 10.5 - 11.5 | | | | | | | | | | | 0.0 | | | |
| 11.5 - 12.5 | | | | | | | | | | | 0.0 | | | |
| 12.5 - 13.5 | | | | | | | | | | | 0.0 | | | |
| 13.5 - 14.5 | | | | | | | | | | | 0.0 | | | |
| 14.5 - 15.5 | | | | | | | | | | | 0.0 | | | |
| 15.5 - 16.5 | | | | | | | | | | | 0.0 | | | |
| 16.0 - 17.0 | | 15.3 | | | | | | | | | 15.3 | 0.4 | 29.0 | 0.0 |
| 16.5 - 17.5 | | 50.5 | | | | | | | | | 50.5 | 1.6 | 32.1 | 0.0 |
| 17.0 - 18.0 | | 70.4 | | | | | | | | | 70.4 | 2.5 | 35.4 | 0.0 |
| 17.5 - 18.5 | | 64.3 | | | | | | | | | 64.3 | 2.5 | 39.0 | 0.0 |
| 18.0 - 19.0 | | 85.8 | | | | | | | | | 85.8 | 3.7 | 42.8 | 0.0 |
| 18.5 - 19.5 | | 82.7 | | | | | | | | | 82.7 | 3.9 | 46.8 | 0.0 |
| 19.0 - 20.0 | | 45.9 | | | | | | | | | 45.9 | 2.3 | 51.2 | 0.0 |
| 19.5 - 20.5 | | 45.9 | | | | | | | | | 45.9 | 2.6 | 55.7 | 0.0 |
| 20.0 - 21.0 | | 21.4 | | | | | | | | | 21.4 | 1.3 | 60.6 | 0.0 |
| 20.5 - 21.5 | | 23.0 | | | | | | | | | 23.0 | 1.5 | 65.8 | 0.0 |
| 21.0 - 22.0 | | 4.6 | | | | | | | | | 4.6 | 0.3 | 71.2 | 0.0 |
| 21.5 - 22.5 | | 1.5 | 1.5 | | | | | | | | 3.1 | 0.2 | 77.0 | 0.0 |
| 22.0 - 23.0 | | | 3.1 | | | | | | | | 3.1 | 0.3 | 83.1 | 1.0 |
| 22.5 - 23.5 | | | | | | | | | | | 0.0 | | | 0.0 |
| 23.5 - 24.5 | | | | | | | | | | | 0.0 | | | |
| 24.5 - 25.5 | | | | | | | | | | | 0.0 | | | |
| 25.5 - 26.5 | | | | | | | | | | | 0.0 | | | |
| 26.5 - 27.5 | | | | | | | | | | | 0.0 | | | |
| 27.5 - 28.5 | | | | | | | | | | | 0.0 | | | |
| 28.5 - 29.5 | | | | | | | | | | | 0.0 | | | |
| 29.5 - 30.5 | | | | | | | | | | | 0.0 | | | |
| 30.5 - 31.5 | | | | | | | | | | | 0.0 | | | |
| a_tsn | 0.0 | 511.4 | 4.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 516.0 | | | |
| b_tsb | | 22.8 | 0.4 | | | | | | | | 23.1 | | | |
| b_tssb | | 0.0 | 0.3 | | | | | | | | 0.3 | | | |
| c_mean_length | | 18.1 | 21.8 | | | | | | | | 18.2 | | | |
| d_mean_weight | | 44.5 | 81.1 | | | | | | | | 44.8 | | | |
| e_mean_condition | | 7.3 | 7.8 | | | | | | | | | | | |
| f_percentage_ssb | 0.0 | 0.0 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | | |

| Stratum C | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yearclass | 2005 | 2004 | 2003 | 2002 | 2001 | 2000 | 1999 | 1998 | 1997 | 1996 | | | | |
| lengthclass | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | numbers | biomass | mean weight (g) | proportion mature |
| 7.5 - 8.5 | | | | | | | | | | | 0.0 | | | |
| 8.5 - 9.5 | | | | | | | | | | | 0.0 | | | |
| 9.5 - 10.5 | | | | | | | | | | | 0.0 | | | |
| 10.5 - 11.5 | | | | | | | | | | | 0.0 | | | |
| 11.5 - 12.5 | | | | | | | | | | | 0.0 | | | |
| 12.5 - 13.5 | | | | | | | | | | | 0.0 | | | |
| 13.5 - 14.5 | | | | | | | | | | | 0.0 | | | |
| 14.5 - 15.5 | | | | | | | | | | | 0.0 | | | |
| 15.5 - 16.5 | | | | | | | | | | | 0.0 | | | |
| 16.5 - 17.5 | | | | | | | | | | | 0.0 | | | |
| 17.5 - 18.5 | | | | | | | | | | | 0.0 | | | |
| 18.5 - 19.5 | | 15.7 | | | | | | | | | 15.7 | 0.8 | 49.6 | 0.0 |
| 19.5 - 20.5 | | 75.8 | | | | | | | | | 75.8 | 4.3 | 56.9 | 0.0 |
| 20.0 - 21.0 | | 102.2 | 14.6 | | | | | | | | 116.8 | 7.1 | 60.7 | 0.0 |
| 20.5 - 21.5 | | 164.3 | 41.1 | | | | | | | | 205.4 | 13.3 | 64.8 | 0.0 |
| 21.0 - 22.0 | | 109.0 | 77.8 | | | | | | | | 186.8 | 12.9 | 69.0 | 0.0 |
| 21.5 - 22.5 | | 48.6 | 8.1 | | | | | | | | 56.7 | 4.2 | 73.3 | 0.0 |
| 22.5 - 23.5 | | | | | | | | | | | 0.0 | | | 0.0 |
| 23.0 - 24.0 | | | 19.1 | | | | | | | | 19.1 | 1.7 | 87.3 | 0.0 |
| 23.5 - 24.5 | | | | 9.5 | | | | | | | 9.5 | 0.9 | 92.4 | 0.0 |
| 24.0 - 25.0 | | | | 9.5 | | | | | | | 9.5 | 0.9 | 97.6 | 1.0 |
| 24.5 - 25.5 | | | 9.5 | | | | | | | | 9.5 | 1.0 | 102.9 | 0.0 |
| 25.5 - 26.5 | | | | | | | | | | | 0.0 | | | |
| 26.5 - 27.5 | | | | | | | | | | | 0.0 | | | |
| 27.5 - 28.5 | | | | | | | | | | | 0.0 | | | |
| 28.5 - 29.5 | | | | | | | | | | | 0.0 | | | |
| 29.5 - 30.5 | | | | | | | | | | | 0.0 | | | |
| 30.5 - 31.5 | | | | | | | | | | | 0.0 | | | |
| a_tsn | 0.0 | 515.6 | 170.2 | 19.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 704.9 | | | |
| b_tsb | | 33.0 | 12.2 | 1.8 | | | | | | | 47.0 | | | |
| b_tssb | | 0.0 | 0.0 | 0.9 | | | | | | | 0.9 | | | |
| c_mean_length | | 20.4 | 21.2 | 23.8 | | | | | | | 20.7 | | | |
| d_mean_weight | | 64.0 | 71.4 | 95.0 | | | | | | | 66.6 | | | |
| e_mean_condition | | 7.5 | 7.4 | 7.1 | | | | | | | | | | |
| f_percentage_ssb | 0.0 | 0.0 | 0.0 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | | |

| Stratum D | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yearclass | 2005 | 2004 | 2003 | 2002 | 2001 | 2000 | 1999 | 1998 | 1997 | 1996 | | | | |
| lengthclass | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | numbers | biomass | mean weight (g) | proportion mature |
| 7.5 - 8.5 | | | | | | | | | | | 0.0 | | | |
| 8.5 - 9.5 | | | | | | | | | | | 0.0 | | | |
| 9.5 - 10.5 | | | | | | | | | | | 0.0 | | | |
| 10.5 - 11.5 | | | | | | | | | | | 0.0 | | | |
| 11.5 - 12.5 | | | | | | | | | | | 0.0 | | | |
| 12.5 - 13.5 | | | | | | | | | | | 0.0 | | | |
| 13.5 - 14.5 | | | | | | | | | | | 0.0 | | | |
| 14.5 - 15.5 | | | | | | | | | | | 0.0 | | | |
| 15.5 - 16.5 | | | | | | | | | | | 0.0 | | | |
| 16.5 - 17.5 | | 0.5 | | | | | | | | | 0.5 | 0.0 | 42.2 | 0.0 |
| 17.0 - 18.0 | | 0.8 | | | | | | | | | 0.8 | 0.0 | 45.7 | 0.0 |
| 17.5 - 18.5 | | 2.1 | | | | | | | | | 2.1 | 0.1 | 49.3 | 0.0 |
| 18.0 - 19.0 | | 5.6 | | | | | | | | | 5.6 | 0.3 | 53.1 | 0.0 |
| 18.5 - 19.5 | | 3.8 | | | | | | | | | 3.8 | 0.2 | 57.1 | 0.0 |
| 19.0 - 20.0 | | 5.5 | 0.8 | | | | | | | | 6.3 | 0.4 | 61.2 | 0.0 |
| 19.5 - 20.5 | | 18.2 | 3.3 | | | | | | | | 21.5 | 1.4 | 65.6 | 0.0 |
| 20.0 - 21.0 | | 17.2 | 5.7 | | | | | | | | 22.9 | 1.6 | 70.1 | 0.0 |
| 20.5 - 21.5 | | 18.2 | 5.6 | | 1.4 | | | | | | 25.2 | 1.9 | 74.8 | 0.1 |
| 21.0 - 22.0 | | 7.2 | 6.1 | | | | | | | | 13.2 | 1.1 | 79.7 | 0.0 |
| 21.5 - 22.5 | | 6.9 | 4.2 | | | | | | | | 11.1 | 0.9 | 84.8 | 0.0 |
| 22.0 - 23.0 | | | 6.9 | | | | | | | | 6.9 | 0.6 | 90.1 | 0.0 |
| 22.5 - 23.5 | | 0.6 | 8.9 | 0.6 | | | | | | | 10.1 | 1.0 | 95.6 | 0.0 |
| 23.0 - 24.0 | | | 7.8 | 0.7 | | | | | | | 8.5 | 0.9 | 101.3 | 0.1 |
| 23.5 - 24.5 | | | 13.8 | 1.8 | | | | | | | 15.7 | 1.7 | 107.2 | 0.2 |
| 24.0 - 25.0 | | | 6.1 | 5.1 | | | | | | | 11.1 | 1.3 | 113.3 | 0.4 |
| 24.5 - 25.5 | | | 7.9 | 2.6 | | | 0.7 | | | | 11.2 | 1.3 | 119.6 | 0.5 |
| 25.0 - 26.0 | | | 4.1 | 2.7 | 1.4 | | | | | | 8.2 | 1.0 | 126.1 | 0.8 |
| 25.5 - 26.5 | | | 1.6 | 2.7 | 1.6 | 1.6 | | | | | 7.7 | 1.0 | 132.9 | 1.0 |
| 26.0 - 27.0 | | | 0.2 | 1.0 | | 1.7 | 0.2 | | | | 3.2 | 0.5 | 139.9 | 1.0 |
| 26.5 - 27.5 | | 1.0 | 1.0 | | 3.0 | 1.0 | | | | | 6.0 | 0.9 | 147.0 | 1.0 |
| 27.0 - 28.0 | | | | | 0.3 | 3.0 | 0.3 | | | | 3.7 | 0.6 | 154.5 | 1.0 |
| 27.5 - 28.5 | | | | 0.1 | 0.2 | | | | | | 0.2 | 0.0 | 162.1 | 1.0 |
| 28.5 - 29.5 | | | | | | | | | | | 0.0 | | | |
| 29.5 - 30.5 | | | | | | | | | | | 0.0 | | | |
| 30.5 - 31.5 | | | | | | | | | | | 0.0 | | | |
| a_tsn | 0.0 | 87.6 | 84.0 | 17.4 | 7.9 | 7.4 | 1.2 | 0.0 | 0.0 | 0.0 | 205.6 | | | |
| b_tsb | | 6.1 | 8.2 | 2.1 | 1.0 | 1.1 | 0.2 | 0.0 | | | 18.7 | | | |
| b_tssb | | 0.2 | 1.9 | 1.2 | 0.9 | 1.1 | 0.1 | 0.0 | | | 5.4 | | | |
| c_mean_length | | 19.9 | 22.6 | 24.4 | 25.0 | 26.4 | 25.5 | | | | 21.9 | | | |
| d_mean_weight | | 70.0 | 97.8 | 119.2 | 128.2 | 145.2 | 133.1 | | | | 90.8 | | | |
| e_mean_condition | | 8.8 | 8.4 | 8.1 | 8.1 | 7.9 | 8.0 | | | | | | | |
| f_percentage_ssb | 0.0 | 4.1 | 34.9 | 22.3 | 16.4 | 20.0 | 2.3 | 0.0 | 0.0 | 0.0 | | | | |

| Stratum E | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yearclass | 2005 | 2004 | 2003 | 2002 | 2001 | 2000 | 1999 | 1998 | 1997 | 1996 | | | | |
| lengthclass | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | numbers | biomass | mean weight (g) | proportion mature |
| 7.5 - 8.5 | | | | | | | | | | | 0.0 | | | |
| 8.5 - 9.5 | | | | | | | | | | | 0.0 | | | |
| 9.5 - 10.5 | | | | | | | | | | | 0.0 | | | |
| 10.5 - 11.5 | | | | | | | | | | | 0.0 | | | |
| 11.5 - 12.5 | | | | | | | | | | | 0.0 | | | |
| 12.5 - 13.5 | | | | | | | | | | | 0.0 | | | |
| 13.5 - 14.5 | | | | | | | | | | | 0.0 | | | |
| 14.5 - 15.5 | | | | | | | | | | | 0.0 | | | |
| 15.5 - 16.5 | | | | | | | | | | | 0.0 | | | |
| 16.5 - 17.5 | | | | | | | | | | | 0.0 | | | |
| 17.5 - 18.5 | | | | | | | | | | | 0.0 | | | |
| 18.5 - 19.5 | | | | | | | | | | | 0.0 | | | |
| 19.5 - 20.5 | | 4.7 | 1.2 | | | | | | | | 5.9 | 0.3 | 54.5 | 0.0 |
| 20.0 - 21.0 | | 20.9 | | | | | | | | | 20.9 | 1.2 | 59.3 | 0.0 |
| 20.5 - 21.5 | | 31.2 | 7.8 | | | | | | | | 39.0 | 2.5 | 64.4 | 0.0 |
| 21.0 - 22.0 | | 21.3 | 17.8 | | | | | | | | 39.1 | 2.7 | 69.8 | 0.0 |
| 21.5 - 22.5 | | 7.1 | 17.9 | | | | | | | | 25.0 | 1.9 | 75.5 | 0.3 |
| 22.0 - 23.0 | | 3.7 | 40.2 | 3.7 | | | | | | | 47.5 | 3.9 | 81.5 | 0.2 |
| 22.5 - 23.5 | | | 48.2 | 6.9 | | | | | | | 55.1 | 4.8 | 87.9 | 0.2 |
| 23.0 - 24.0 | | | 52.1 | 14.2 | | | | | | | 66.4 | 6.3 | 94.6 | 0.4 |
| 23.5 - 24.5 | | | 44.8 | 19.9 | | | | | | | 64.7 | 6.6 | 101.6 | 0.8 |
| 24.0 - 25.0 | | | 40.2 | 72.4 | | 8.0 | | | | | 120.7 | 13.2 | 109.0 | 0.9 |
| 24.5 - 25.5 | | | 38.7 | 77.4 | | | | | | | 116.1 | 13.6 | 116.7 | 1.0 |
| 25.0 - 26.0 | | | 40.4 | 70.8 | | 40.4 | | | | | 151.6 | 18.9 | 124.9 | 1.0 |
| 25.5 - 26.5 | | | 10.9 | 43.8 | 21.9 | 98.5 | | | | | 175.1 | 23.4 | 133.4 | 1.0 |
| 26.0 - 27.0 | | | | 10.7 | 32.2 | 75.2 | 32.2 | | | | 150.3 | 21.4 | 142.3 | 1.0 |
| 26.5 - 27.5 | | | 6.8 | | 20.3 | 61.0 | | | | | 88.2 | 13.4 | 151.7 | 1.0 |
| 27.0 - 28.0 | | | | 2.1 | 6.3 | 23.1 | | | | | 31.5 | 5.1 | 161.4 | 1.0 |
| 27.5 - 28.5 | | | | 2.3 | 2.3 | 11.3 | 2.3 | 2.3 | | | 20.3 | 3.5 | 171.6 | 1.0 |
| 28.0 - 29.0 | | | | 1.3 | 4.0 | 6.7 | | | | | 12.1 | 2.2 | 182.2 | 1.0 |
| 28.5 - 29.5 | | | | 1.2 | | 1.2 | 1.2 | | | | 3.7 | 0.7 | 193.3 | 1.0 |
| 29.0 - 30.0 | | | | | 1.2 | 1.2 | | 1.2 | | | 3.7 | 0.8 | 204.9 | 1.0 |
| 29.5 - 30.5 | | | | | | | 1.7 | | | | 1.7 | 0.4 | 216.9 | 1.0 |
| 30.5 - 31.5 | | | | | | | | | | 1.7 | 1.7 | 0.4 | 242.4 | 1.0 |
| a_tsn | 0.0 | 88.9 | 367.0 | 326.7 | 88.3 | 326.7 | 37.4 | 3.5 | 0.0 | 1.7 | 1240.2 | | | |
| b_tsb | | 5.8 | 36.6 | 38.6 | 13.0 | 46.4 | 5.6 | 0.6 | | 0.4 | 147.0 | | | |
| b_tssb | | 0.2 | 23.1 | 35.5 | 13.0 | 46.3 | 5.6 | 0.6 | | 0.4 | 124.7 | | | |
| c_mean_length | | 20.6 | 23.3 | 24.6 | 26.2 | 26.0 | 26.3 | 28.0 | | 30.5 | 24.5 | | | |
| d_mean_weight | | 65.6 | 99.7 | 118.2 | 147.1 | 142.0 | 149.2 | 183.3 | | 242.4 | 118.6 | | | |
| e_mean_condition | | 7.5 | 7.8 | 7.9 | 8.1 | 8.1 | 8.1 | 8.3 | | 8.5 | | | | |
| f_percentage_ssb | 0.0 | 0.2 | 18.5 | 28.5 | 10.4 | 37.1 | 4.5 | 0.5 | 0.0 | 0.3 | | | | |

**Table 4a: Herring. Mean length, mean weight, biomass (thousands of tonnes) and numbers (millions) breakdown by age and maturity obtained during the July 2006 North Sea hydro acoustic survey for herring, FRV "Tridens".**

| yearclass | age | mean weight (g) | mean length (cm) | numbers (millions) | biomass (1000 tonnes) | numbers %) | biomass (%) |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| 2005 | 0imm | 10.06 | 11.37 | 291.72 | 2.93 | 3.74 | 0.73 |
| 2005 | 0mat | | | 0.00 | 0.00 | 0.00 | 0.00 |
| 2004 | 1imm | 42.82 | 17.82 | 6039.78 | 231.98 | 77.37 | 57.42 |
| 2004 | 1mat | 104.15 | 23.12 | 4.89 | 0.44 | 0.06 | 0.11 |
| 2003 | 2imm | 77.14 | 21.52 | 402.32 | 32.34 | 5.15 | 8.00 |
| 2003 | 2mat | 110.92 | 24.00 | 226.91 | 25.18 | 2.91 | 6.23 |
| 2002 | 3imm | 99.43 | 23.55 | 49.19 | 4.86 | 0.63 | 1.20 |
| 2002 | 3mat | 117.03 | 24.61 | 317.40 | 38.01 | 4.07 | 9.41 |
| 2001 | 4imm | 82.33 | 21.16 | 1.55 | 0.13 | 0.02 | 0.03 |
| 2001 | 4mat | 144.77 | 26.15 | 94.61 | 13.87 | 1.21 | 3.43 |
| 2000 | 5imm | 108.98 | 24.00 | 1.07 | 0.12 | 0.01 | 0.03 |
| 2000 | 5mat | 142.49 | 26.01 | 333.07 | 47.36 | 4.27 | 11.72 |
| 1999 | 6imm | 119.59 | 24.50 | 0.35 | 0.04 | 0.00 | 0.01 |
| 1999 | 6mat | 147.81 | 26.27 | 38.31 | 5.70 | 0.49 | 1.41 |
| 1998 | 7imm | | | 0.00 | 0.00 | 0.00 | 0.00 |
| 1998 | 7mat | 183.31 | 28.03 | 3.48 | 0.64 | 0.04 | 0.16 |
| 1997 | 8imm | | | | | | |
| 1997 | 8mat | | | | | | |
| 1996 | 9imm | | | 0.00 | 0.00 | 0.00 | 0.00 |
| 1996 | 9mat | 242.38 | 30.50 | 1.72 | 0.42 | 0.02 | 0.10 |
| imm | | | | 6785.98 | 272.40 | 86.93 | 67.42 |
| mat | | | | 1020.38 | 131.62 | 13.07 | 32.58 |
| totals | | | | 7806.36 | 404.03 | 100.00 | 100.00 |

**Table 4b: Sprat. Mean length, mean weight, biomass (thousand tonnes) and numbers (millions) breakdown by age and maturity obtained during the July 2006 North Sea hydro acoustic survey for herring, FRV "Tridens".**

| yearclass | age | mean weight (g) | mean length (cm) | numbers (millions) | biomass (1000 tonnes) | numbers %) | biomass (%) |
|---|---|---|---|---|---|---|---|
| | 0imm | | | | | | |
| | 0mat | | | | | | |
| | 1imm | 6.54 | 9.42 | 604.46 | 3.95 | 20.86 | 12.51 |
| | 1mat | 9.27 | 10.61 | 1070.60 | 9.93 | 36.94 | 31.43 |
| | 2imm | 10.06 | 10.94 | 12.37 | 0.12 | 0.43 | 0.39 |
| | 2mat | 14.11 | 12.27 | 997.99 | 14.09 | 34.43 | 44.59 |
| | 3imm | 11.56 | 11.50 | 0.30 | 0.00 | 0.01 | 0.01 |
| | 3mat | 16.43 | 12.93 | 202.29 | 3.32 | 6.98 | 10.52 |
| | 4imm | | | 0.00 | 0.00 | 0.00 | 0.00 |
| | 4mat | 16.56 | 13.00 | 10.29 | 0.17 | 0.36 | 0.54 |
| | 5imm | | | | | | |
| | 5mat | | | | | | |
| | 6imm | | | | | | |
| | 6mat | | | | | | |
| | 7imm | | | | | | |
| | 7mat | | | | | | |
| | 8imm | | | | | | |
| | 8mat | | | | | | |
| | 9imm | | | | | | |
| | 9mat | | | | | | |
| imm | | | | 617.14 | 4.08 | 21.29 | 12.91 |
| mat | | | | 2281.17 | 27.51 | 78.71 | 87.09 |
| totals | | | | 2898.31 | 31.59 | 100.00 | 100.00 |

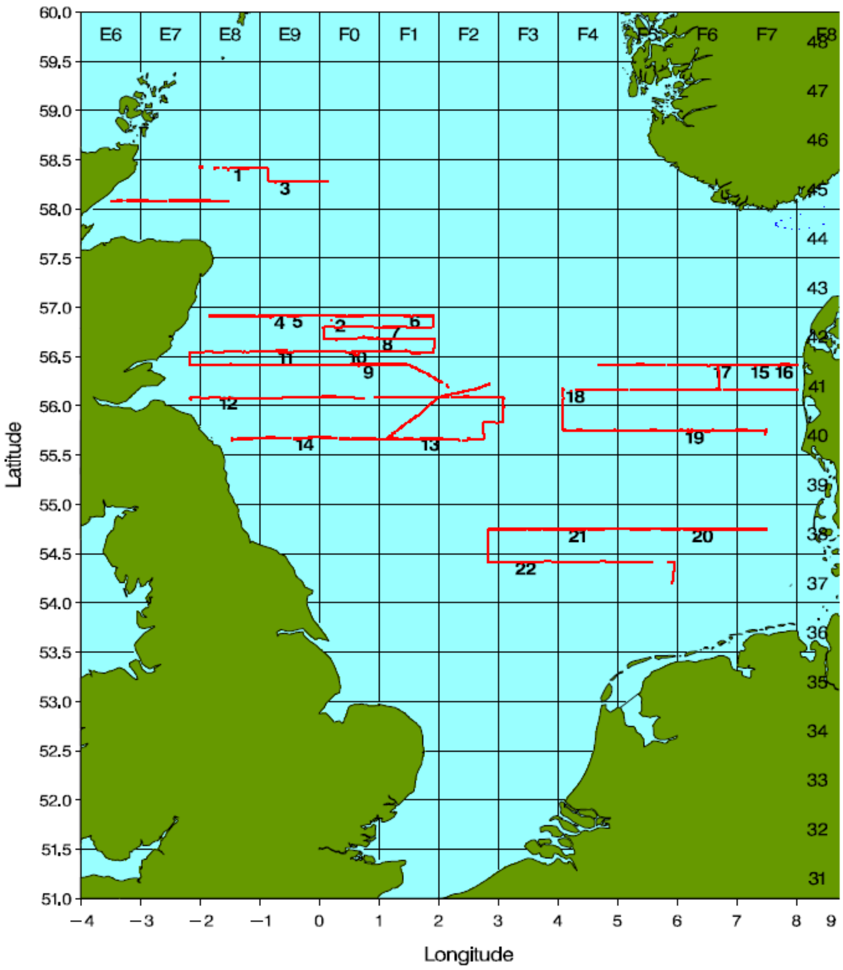


**Figure 1: Cruise track and positions of trawl stations and hydrographical stations during the June-July 2006 North Sea herring hydro acoustic survey on RV "Tridens".**

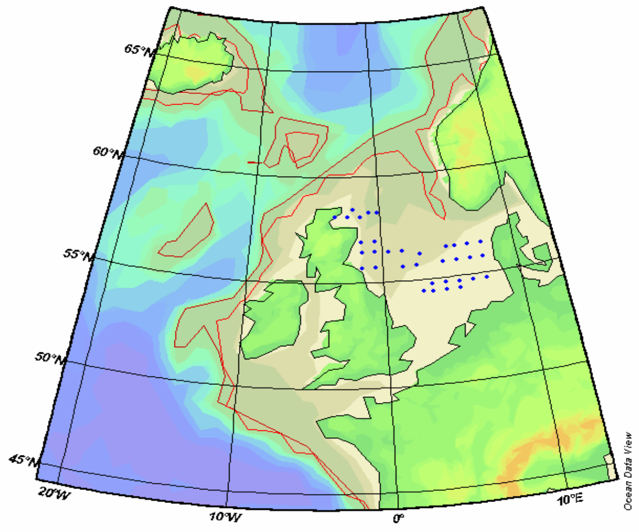


**Figure 2: Positions of CTD stations during the July 2006 North Sea herring hydroacoustic survey by RV "Tridens".**

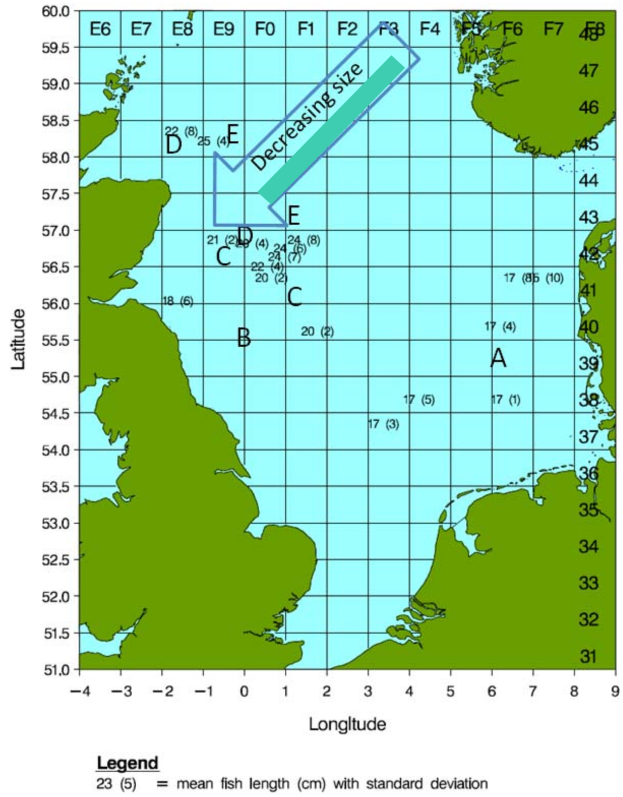


**Figure 3: Post plot of herring mean length from RV "Tridens", observed during the July 2006 North Sea hydro acoustic survey for herring. Strata-areas A to E are indicated.**

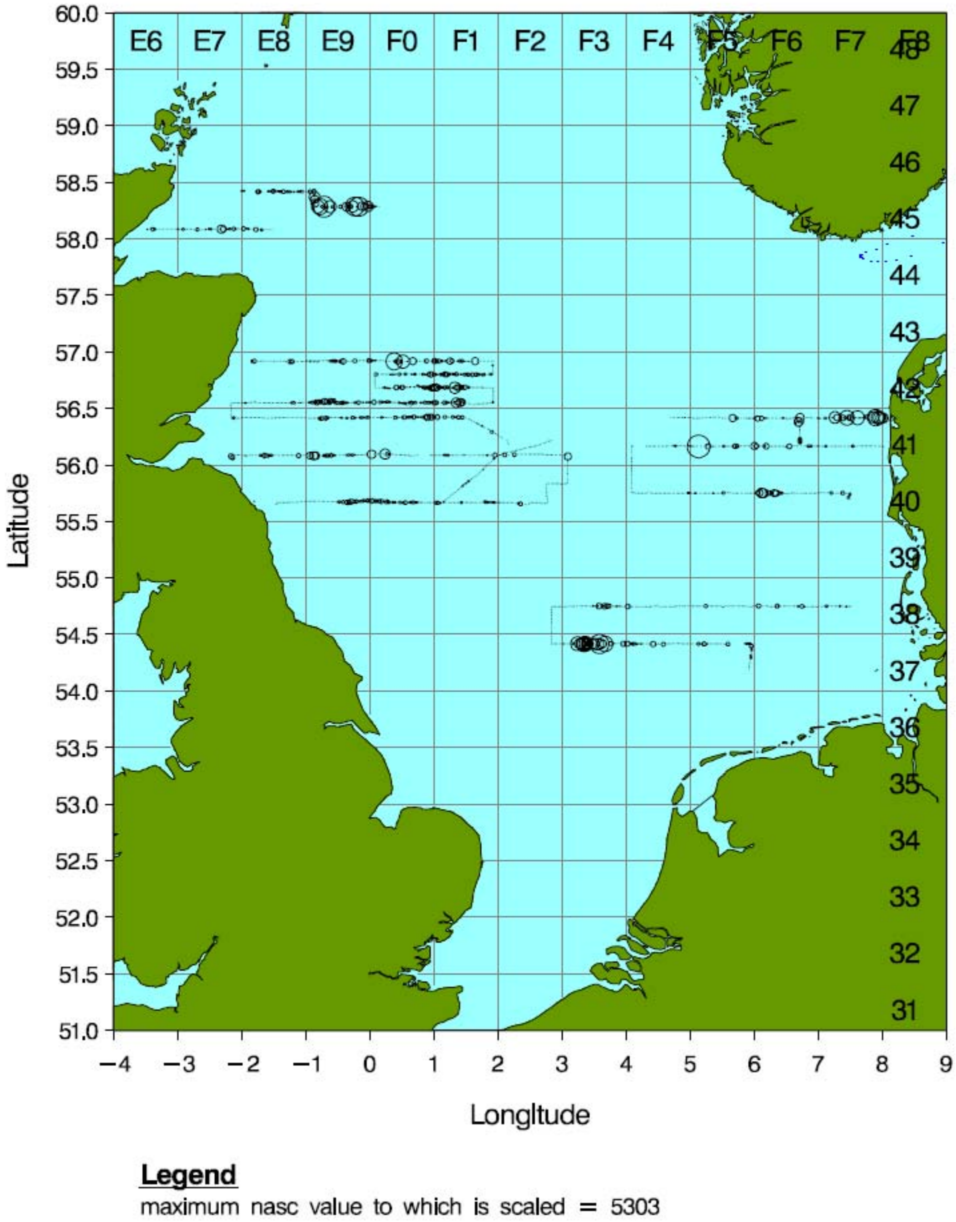


**Figure 4: Post plot showing the distribution of total herring $S_A$ values (on a proportional square root scale relative to the largest value of 5303) obtained during the June-July 2006 North Sea herring hydro acoustic survey on RV “Tridens”.**

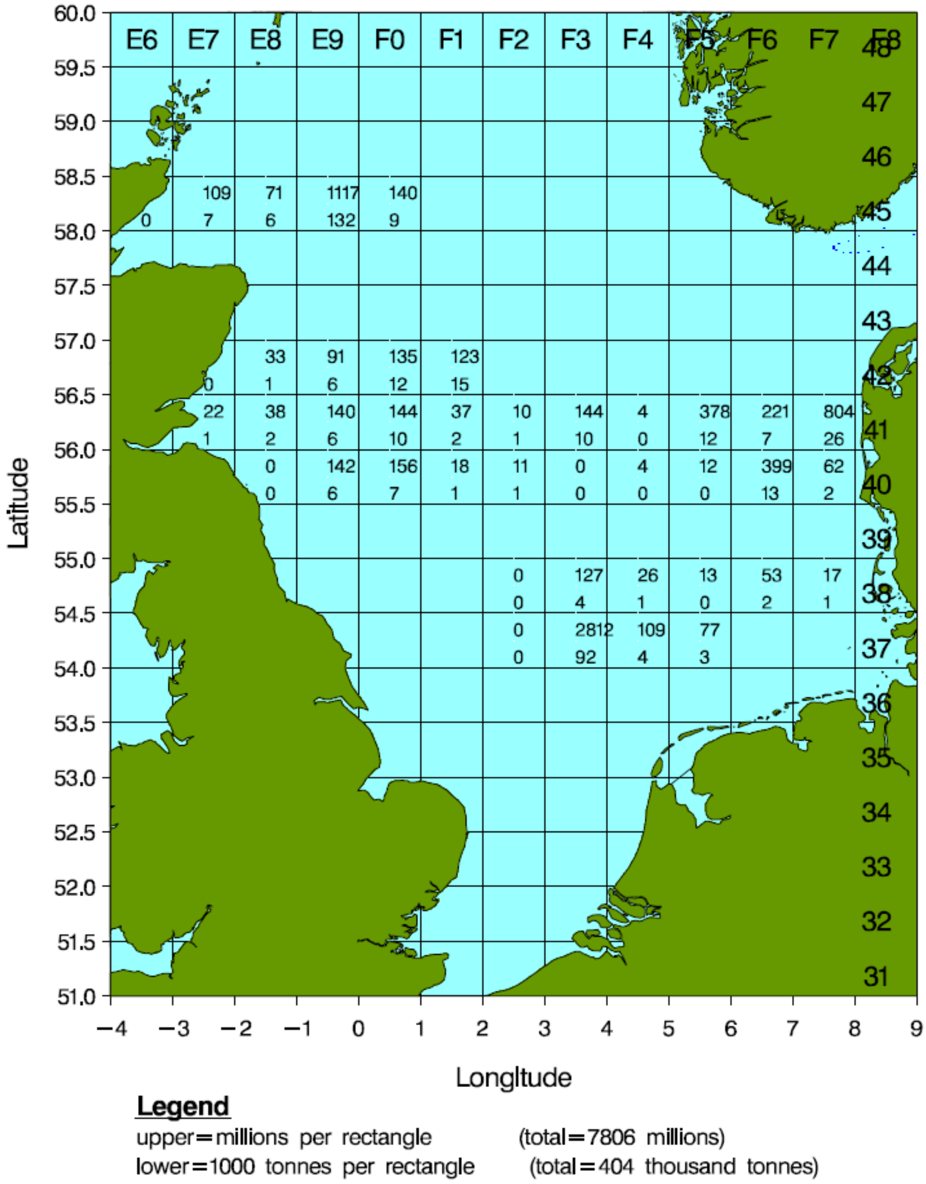


**Figure 5: Estimated numbers of herring in millions (upper half square) and biomass in thousands of tonnes (lower half of square) by ICES rectangle. Results from the July 2006 North Sea hydro acoustic survey, RV "Tridens".**

## Annex 2F: Germany

**Survey report for FRV “Solea”, cruise 559**

International Herring Acoustic Survey in the North Sea

29 June 2006 – 18 July 2006

Norbert Rohlf, Jens Ulleweit, Inst Sea Fisheries (ISH)

Eckhard Bethke, Inst Fishing Technology and Fishery Economics (IFF), Hamburg

# 1. Introduction

**Background**: FRV “Solea” cruise 559 was conducted in the framework of the international hydroacoustic survey on pelagic fish in the North Sea, which is coordinated by the ICES Planning Group for Herring Surveys (PGHERS). Further contributors to the quasi-synoptic survey are the national fisheries research institutes of Scotland, Norway, Denmark and The Netherlands. The results are delivered to the ICES Herring Assessment Working Group. Since 1984 they represent an important fishery independent dataset (i.e. biomass estimate) for the assessment of herring stocks in the area.

The working area for “Solea” was confined to the southern and south-Eastern North Sea. This area is regarded to be one of the main distribution areas for juvenile herring. Since 2001, PGHERS calculates a juvenile biomass index for the North Sea herring assessment, mainly based on the survey results from the SE North Sea and the Kattegat/Skagerrak area. During the last years, the survey area was significantly extended to the south (to about 52°N) in an attempt to reach the southern distribution limit of sprat, and this area was again covered this year. Interlaced transects between the German and the Dutch vessel are included in the design, and the survey intensity is comparable to last year.

**Objectives:** Hydroacoustic recording of pelagic fish stocks for abundance and biomass estimation, biological sampling for the verification of echoes, calibration of the hydroacoustic equipment, hydrographic investigations, sampling of data and specimens for a number of national and international projects (BFA Fi: Univ. Aberdeen/ISH; Univ. Hamburg/GLOBEC; FTZ Büsum, IfM Kiel).

# 2. Survey description and methods

## 2.1 Personnel

| NAME | FUNCTION | INSTITUTION |
|---|---|---|
| E. Bethke | scientist in charge, hydroacoustics | IFF |
| M. Drenckow | Hydroacoustics | IFF |
| J. Ulleweit | Fishery biology | ISH |
| G. Gentschow | Fishery biology | ISH |
| N. Rohlf | Fishery biology | ISH |
| D. Risch | Fishery biology/cetacean observation | FTZ / Uni Kiel |
| C. Konrad | Fishery biology | Uni Aberdeen |

## 2.2 Narrative

FRV “Solea” left the port of Cuxhaven on 29 June, and tried to calibrate the hydroacoustic equipment south of the isle of Helgoland. But due to currents stronger than expected this calibration exercise failed. Calibration was successfully done the following night at 55°21’N, 006°01’E.

Recording of hydroacoustic measurements started the same day north of the “White Bank” at 55°22’ N, 006°0’ E, but had to be stopped on 9 July because of the rough sea surface, resulting in air bubbles below the ships keel. But on the other hand, this was the only disturbance of the hydroacoustic recordings. The weather conditions were very favourable for the rest of the cruise, but fishing activity was limited by the relatively low number of fish schools detected in the acoustics, especially north of 54°30’. So Solea was also able to survey four ICES rectangles from the area of the Tridens, which could not cover these rectangles due to technical problems.

The recordings were terminated in the afternoon of 17 July. FRV “Solea” reached her home port on the same evening, having sailed 3046 nautical miles.

### 2.3 Survey design

The working area for the German vessel contributing to the survey was interlaced with the area covered by the Dutch vessel “Tridens”. The survey effort was comparable to last year. The southern survey limit was chosen in order to reach a southern distribution limit of sprat in July. This would be a prerequisite for the development of a sprat biomass index in the near future using this acoustic survey. The survey area was confined to the southern and central North Sea between 52°N and the 20 m depth contour off Frisia to the south, the 20 m depth line off the English coast to the west and off the German and Danish coast to the east, and 55°30’ N to the north, respectively.

Hydroacoustic measurements were conducted on east-west or north-south transects with 7.5, 15 or 30 nautical miles distance (as done by other research vessels participating in the survey) on fixed latitudes. In general, each ICES statistical rectangle was surveyed with at least one transect, and with higher intensity where historically a high abundance or variability in abundance of juvenile herring or sprat had been detected.

### 2.4 Calibration

The hull mounted transducers (one in the keel, one in the starboard blister) were calibrated just prior to the start of the survey on 30 June at open sea on 55°21’N and 006°01’E. Water depth was below 20 m. The conditions were reasonable; the vessel was anchored and tidal or wind induced currents were low. The calibration procedure required six hours for both transducers. The calibration methods are described in the ‘Manual for Herring Acoustic Surveys in ICES Divisions III, IV and VI’ (ver. 3.1, ICES CM 2003/G:03, Appendix 4). Important parameters and settings are listed in Table 1.

### 2.5 Acoustic data collection

The acoustic investigations were performed during daylight (04:00 to 18:00 UTC), using a Simrad EK60 echosounder with standard frequencies of 38 and 120 kHz. The echograms were continuously recorded and evaluated using the EchoView 3 software package. The specific settings of the hydroacoustic equipment were used as described in the ‘Manual for Herring Acoustic Surveys in ICES Divisions III, IV and VI’ (ver. 3.1, ICES CM 2003/G:03, Appendix 4). Basic settings are documented in Table 1. The operational speed of the vessel was 10 -11 knots during the acoustic measurements and it sailed 3046 n.mi. on cruise 559. Almost 2000 nautical miles were used for the acoustic data collection, while the remaining ones belong to the cetacean observation programme and ship’s steaming transects.

### 2.6 Biological data - fishing trawls

For the identification of echo traces and further biological sampling, 31 trawl hauls were conducted either on specific large schools (after turning the ship) or, if small schools occurred frequently, continuing the survey track. On “Solea”, a small pelagic trawl (PSN388, approx. 8

m vertical opening, and mesh size in the codend 10 mm) was used both in the midwater and close to the bottom. The net was equipped with a Simrad trawl sonar FS20. Standard tow periods were 30 mins; however, they varied between 7 and 61 mins depending on the indication of net filling. 21 statistical rectangles have been sampled.

From each trawl, the mass of the total catch and species composition (on subsamples, if needed) was determined. Length frequency distributions were produced for each species. Length-stratified samples (10 samples per half cm class per ICES stat rectangle) of herring and sprat were taken for the determination of maturity (using a 4 point scale), sex and individual body mass, and otoliths were removed for age reading. One station showed a high concentration of juvenile clupeids just below the surface down to 5 m. A subsample of the catch was frozen for further processing and species identification at the institute in Hamburg.

### 2.7 Hydrographic data

Hydrographic data were sampled just prior or after fishing activity and in distances of 30 n.mi. At each of these stations, vertical profiles of temperature, salinity and depth were recorded using a "Seabird SBE 19 plus- multiprobe" CTD (Figure 1). Water samples for calibration purposes were taken on every second or third station.

### 2.8 Acoustic and visual recording of cetaceans

The abundance of harbour porpoise (*Phocoena phocoena*) in the North Sea was to be determined by means of visual and acoustic methods (recording of harbour porpoise "clicks" in the range 110-140 kHz with a towed hydrophone chain). Due to interferences between the vessel's transducers and the hydrophone, recording was only conducted during night when the vessel sailed at about 3 knot speed and the EK60 was switched off. Samples of fish were taken to correlate harbour porpoise detections with prey abundance and prey energy content (fatty acids) as well as the porpoise position in the food chain (stable isotopes).

### 2.9 Data analysis

The echo integration, i.e. the allocation of the nautical area backscattering cross section (NASC) to the species herring and sprat was done using the EchoView 3 software package, using information from trawl hauls usually targeting specific schools. Herring and sprat were exclusively found in characteristic "pillars". The NASC attributed to clupeoids was estimated for each ESDU of 1 nautical mile. Contributions from air bubbles, bottom structures and scattering layers were manually removed from the echogram using the EchoView software. It is not possible to distinguish between herring and sprat within clupeid schools. To allocate the integrator readings to a single species, species composition was based on the trawl results (see above).

For each rectangle the species composition and length distribution of herring and sprat were determined as the weighted mean of all trawl results in this rectangle. For rectangles without valid hauls a mean of the catch results of the neighbouring rectangles was used. From these distributions the mean cross section $\sigma$ was calculated according to the following target strength-length (TS) relationship:

TS = 20 log L (cm) - 71.2 (ICES 1983/H:12)

The total number of fish (total N) in one rectangle was estimated to be the product of the mean area scattering cross section NASC and the rectangle area (or more precisely the area with a water depth of more than 20 m), divided by the corresponding mean cross section. This total number was divided into species and age/maturity classes according to the trawl catch results.

# 3. Results and discussion

## 3.1 Acoustic data

As in previous years, clupeids were exclusively found in characteristic schools, appearing in single clusters of some n.mi. extension. Echoes attributed to plankton were not considered to be problematic for the identification of fish schools.

The highest nautical area scattering coefficients (NASCs) have been found in the inner German Bight. The maximum mean value (as a sum over 5 n.mi.) is of 6.149 m2n.mi.-2. Figure 2 gives the NASC distribution on a basis of 5 n.mi. EDSUs for clupeids (herring and sprat combined).

## 3.2 Biological data

The pelagic trawl PSN388 has been deployed at 31 stations. 42 rectangles were covered during the acoustic survey, of which 21 have been sampled with trawl hauls (Figure 1 and Table 2). Valid results (at least one haul with more than 200 clupeids h-1 trawling) were obtained for 14 rectangles. Those were used for raising unsampled rectangles. The majority of the unsampled rectangles had no or only minimal NASCs. Total catch varied between 0.1 and 2310 kg.

Herring was mainly found in the north-eastern part of the area, but also on some spots in the western part of the investigation area, while sprat was concentrated in the south. It is not likely that the summer southern distribution limit for sprat in the Channel was reached during the survey.

Trawling resulted in 15 species and was dominated by sprat, which was present in 21 of the total 31 catches. Species diversity is listed in Table 3. Sprat were also most abundant in term of biomass (7543 kg, equal to 86%), followed by herring (11%). All other species occurred only on occasion. Remarkable were the catches of snake-pipefish (*Entelurus aequorius*). This species occurred in 12 hauls of the pelagic net.

## 3.3 Biomass and abundance estimates

The total estimates for the survey:

- Herring total biomass: 83’200 t (2005: 77’600 t)
- Herring spawning stock biomass: 5’330 t / 6.4% (2005: 168 t / 0.2%)
- Herring total abundance: 5’454 mill. (2005: 6’600 mill.)
- Herring spawning stock abundance: 0.04 mill. / 0.1% (2005: 7.5 mill. / 0. 1%)
- Sprat total biomass: 420’300 t (2005: 513’200 t tonnes)
- Sprat spawning stock biomass: 417’000 t / 99% (2005: 360’700 t / 70%)
- Sprat total abundance: 41’300 mill. (2005: 72’500 mill.)
- Sprat spawning stock abundance: 40’500 mill. / 98% (2005: 42’600 mill. / 59%)

Compared to last year, herring abundance has decreased by almost 20%, while the biomass has slightly increased. The vast majority (> 99 %) of herring in this area still consists of 0- and 1-wr (Age 1 and 2).

Sprat biomass and abundance have been significantly decreased as compared to last year. Most sprats are mature fish. Detailed information on abundance and biomass by statistical rectangle can be found in Figure 3 and 4.

### 3.4 Acoustic and visual recording of cetaceans

Visual observations between fishing activity were possible almost all day round due to low wind speeds and calm sea surface. In total, three different whale species and two species of pinnipedians could be detected during the cruise. Minke whales and harbour porpoises were found to be relatively abundant around the western part of the Doggerbank. In addition, three grey seals were observed in the same area. On 7 July, three dolphins were recorded visually and by acoustic detection via the hydrophone in parallel.

### 3.5 Hydrographic data

Again a dense net of hydrography stations have been sampled: 64 vertical profiles have been recorded, with a maximum distance of 30 n.mi. between the two stations. The water column was clearly stratified on the offshore stations in the north; surface temperatures ranged between 12° in the north-western parts and 19°C around Helgoland. Bottom temperatures were significantly lower (below 10 °C) when a thermocline was observed. Going further south, the water column becomes more mixed and no stratification was present in the entrance to the English Channel.

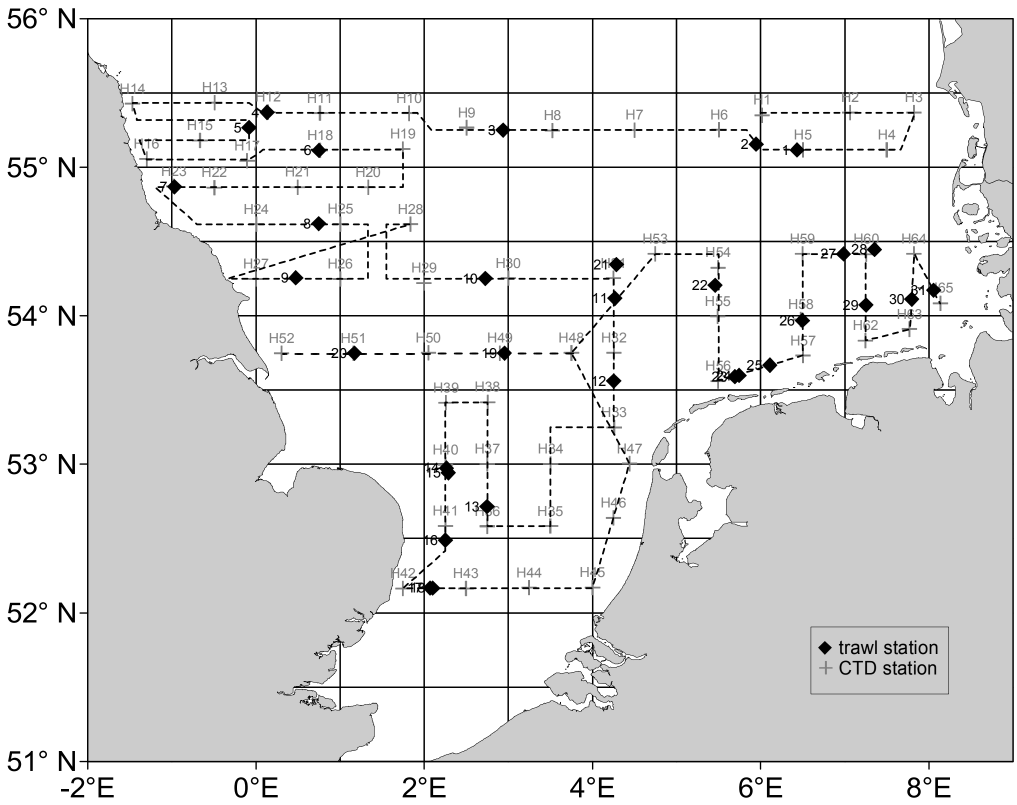


**Figure 1: FRV "Solea", cruise 559. Cruise track, fishing stations (black dots) and hydrographic stations (grey crosses).**

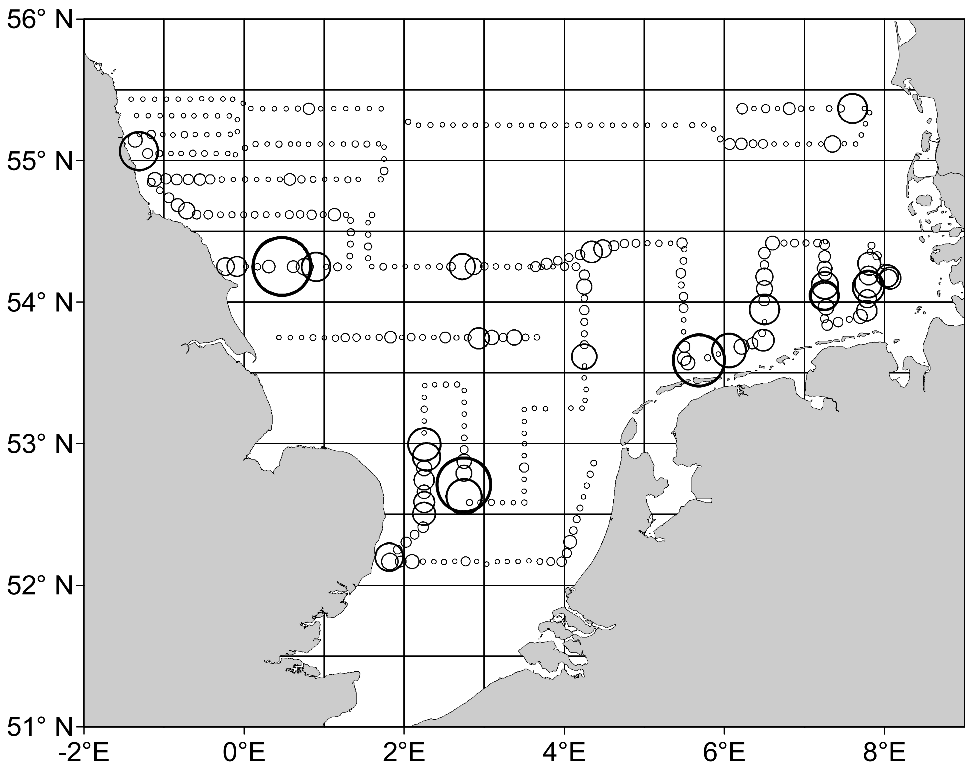


**Figure 2: FRV "Solea", cruise 559. Distribution of total NASC values attributed to clupeoids (sum per 5 n. mi., on a proportional square root scale relative to the largest value of 6150 m²n.mi.⁻²). Smallest dots indicate zero values.**

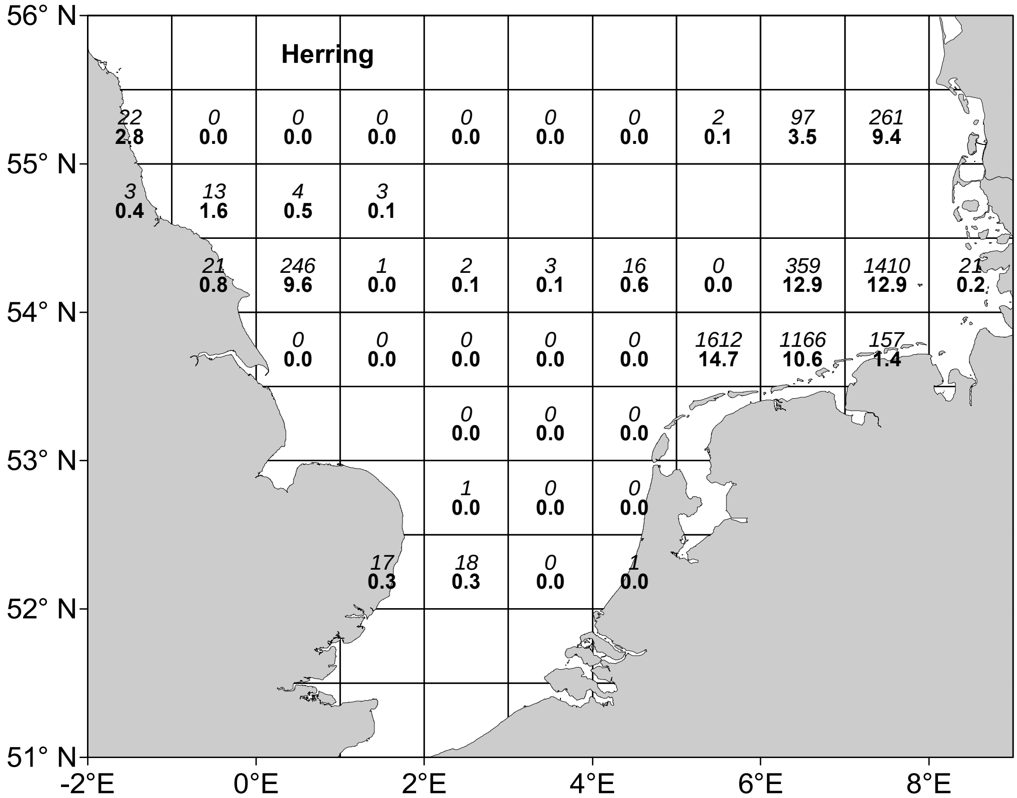


**Figure 3: FRV "Solea", cruise 559. Abundance (Mill. Individuals, upper value in italics) and biomass (thousand t, lower value in bold) of herring per statistical rectangle.**

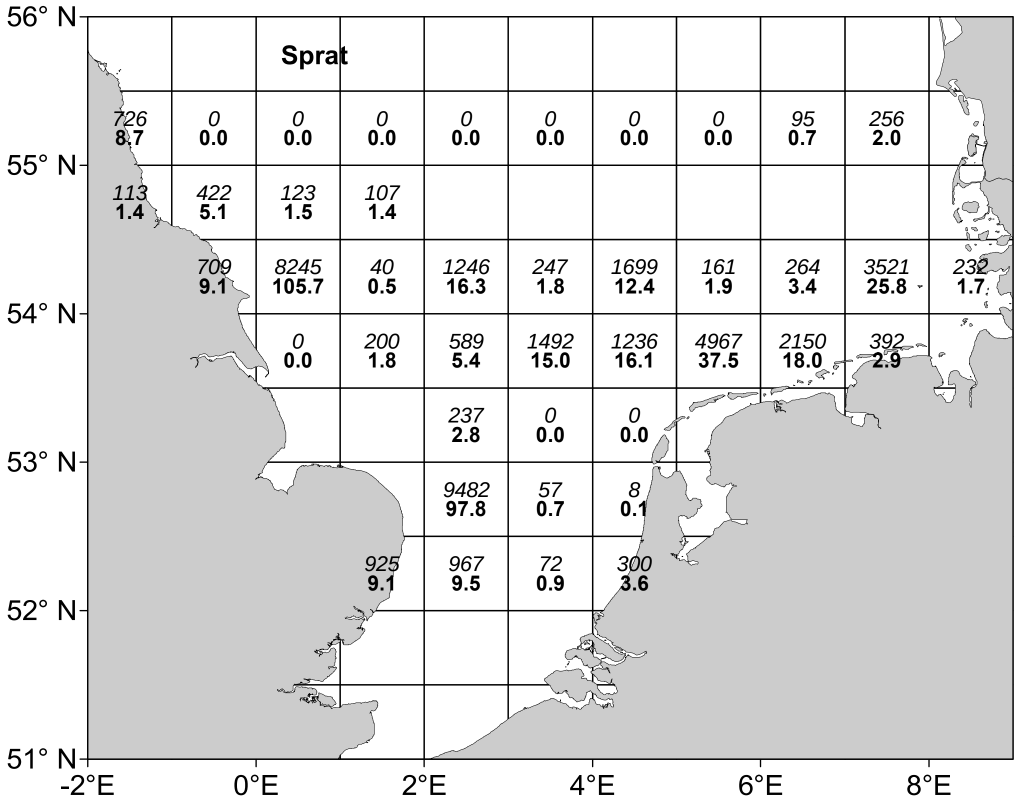


**Figure 4: FRV "Solea", cruise 559. Sprat abundance (in Mill. Individuals, upper value in italics) and biomass (thousand t, lower value in bold) per statistical rectangle.**

**Table 1: FRV „Solea", cruise 559. Herring international hydroacoustic survey in the North Sea, 29.06.–18.07.06. Simrad EK60 calibration report.**

**# Calibration Version 2.1.0.11**
# Date: 2006-06-30

**# Comments:**
# Position: 55°21 N, 006.01 E, Wind 3 Beaufort. Good conditions

**# Reference Target:**
# TS -33.60 dB Min. Distance 12.00 m
# TS Deviation 5.0 dB Max. Distance 16.00 m

| | | | |
|---|---|---|---|
| **# Transducer:** | ES38B | Serial No. 30545 | |
| # Frequency | 38000 Hz | Beamtype | Split |
| # Gain | 26.50 dB | Two Way Beam Angle | -20.6 dB |
| # Athw. Angle Sens. | 21.90 | Along. Angle Sens. | 21.90 |
| # Athw. Beam Angle | 7.10 deg | Along. Beam Angle | 7.10 deg |
| # Athw. Offset Angle | 0.00 deg | Along. Offset Angle | 0.00 deg |
| # SaCorrection | 0.00 dB | Depth | 0.00 m |

**# Transceiver**: GPT 38 kHz 009072056b06 1 ES38B
# Pulse Duration 1.024 ms Sample Interval 0.192 m
# Power 2000 W Receiver Bandwidth 2.43 kHz

**# Sounder Type:**
# EK60 Version 2.1.1

**# TS Detection:**

| | | | |
|---|---|---|---|
| # Min. Value | -45.0 dB | Min. Spacing | 100% |
| # Max. Beam Comp. | 6.0 dB | Min. Echolength | 80% |
| # Max. Phase Dev. | 3.0 | Max. Echolength | 180% |

**# Environment:**
# Absorption Coeff. 8.4 dB/km Sound Velocity 1502.0 m/s

**# Beam Model results:**

| | | | |
|---|---|---|---|
| # Transducer Gain | = 26.28 dB | SaCorrection | = -0.57 dB |
| # Athw. Beam Angle | = 6.91 deg | Along. Beam Angle | = 6.95 deg |
| # Athw. Offset Angle | =-0.07 deg | Along. Offset Angle | = 0.01 deg |

**# Data deviation from beam model:**
# RMS = 0.15 dB
# Max = 0.41 dB No. = 294 Athw. = -3.0 deg Along = 2.8 deg
# Min = -0.38 dB No. = 82 Athw. = -4.8 deg Along = -1.7 deg

**# Data deviation from polynomial model:**
# RMS = 0.12 dB
# Max = 0.44 dB No. = 378 Athw. = -4.2 deg Along = 3.0 deg
# Min = -0.43 dB No. = 251 Athw. = -4.0 deg Along = 0.7 deg

**Table 2: FRV “Solea”, cruise 559. International hydroacoustic survey on herring in the North Sea, 29.06.2006- 18.07.2006. Trawl station data.**

| Stat | Haul | Rect | Date | Time of day (hhmm UTC) | Trawl | ShotPosLat (°°MM.MM) | ShotPosLon (°°MM.MM) | Water Depth (m) | Catch Depth (m) | Catch Time (min) |
|---|---|---|---|---|---|---|---|---|---|---|
| 495 | 1 | 39F6 | 20060701 | 1308 | PSN388 | 550695N | 0062595E | 45 | 35 | 30 |
| 496 | 2 | 39F5 | 20060701 | 1522 | PSN388 | 550788N | 0055902E | 40 | 30 | 30 |
| 500 | 3 | 39F2 | 20060702 | 1310 | PSN388 | 551504N | 0025621E | 30 | 16 | 30 |
| 504 | 4 | 39F0 | 20060703 | 1022 | PSN388 | 552201N | 0000469E | 76 | 64 | 30 |
| 508 | 5 | 39E9 | 20060704 | 920 | PSN388 | 551429N | 0000476W | 73 | 63 | 30 |
| 512 | 6 | 39F0 | 20060705 | 1105 | PSN388 | 550695N | 0004215E | 77 | 65 | 30 |
| 518 | 7 | 38E9 | 20060706 | 1301 | PSN388 | 545190N | 0005456W | 67 | 58 | 30 |
| 521 | 8 | 38F0 | 20060707 | 756 | PSN388 | 543718N | 0004118E | 65 | 56 | 35 |
| 524 | 9 | 37F0 | 20060707 | 1631 | PSN388 | 541499N | 0002469E | 59 | 43 | 30 |
| 528 | 10 | 37F2 | 20060708 | 1145 | PSN388 | 541508N | 0024060E | 41 | 29 | 30 |
| 531 | 11 | 37F4 | 20060709 | 514 | PSN388 | 540535N | 0041559E | 45 | 35 | 30 |
| 533 | 12 | 36F4 | 20060709 | 933 | PSN388 | 533553N | 0041591E | 30 | 20 | 30 |
| 538 | 13 | 34F2 | 20060710 | 1311 | PSN388 | 524058N | 0024482E | 41 | 29 | 30 |
| 543 | 14 | 34F2 | 20060711 | 843 | PSN388 | 525968N | 0021520E | 43 | 3 | 15 |
| 544 | 15 | 34F2 | 20060711 | 1011 | PSN388 | 525879N | 0021569E | 40 | 28 | 30 |
| 546 | 16 | 33F2 | 20060711 | 1435 | PSN388 | 522690N | 0021522E | 40 | 28 | 30 |
| 548 | 17 | 33F2 | 20060712 | 619 | PSN388 | 521012N | 0020209E | 36 | 1 | 20 |
| 549 | 18 | 33F2 | 20060712 | 712 | PSN388 | 520997N | 0020329E | 39 | 28 | 30 |
| 556 | 19 | 36F2 | 20060713 | 707 | PSN388 | 534498N | 0025999E | 42 | 28 | 30 |
| 559 | 20 | 36F1 | 20060713 | 1421 | PSN388 | 534518N | 0011184E | 28 | 1 | 15 |
| 562 | 21 | 37F4 | 20060714 | 655 | PSN388 | 542111N | 0041928E | 48 | 38 | 20 |
| 565 | 22 | 37F5 | 20060714 | 1422 | PSN388 | 541452N | 0052899E | 37 | 29 | 40 |
| 568 | 23 | 36F5 | 20060715 | 615 | PSN388 | 533530N | 0054086E | 20 | 10 | 8 |
| 569 | 24 | 36F5 | 20060715 | 712 | PSN388 | 533562N | 0054290E | 20 | 5 | 15 |
| 570 | 25 | 36F6 | 20060715 | 917 | PSN388 | 533974N | 0060528E | 22 | 9 | 10 |
| 572 | 26 | 36F6 | 20060715 | 1438 | PSN388 | 535613N | 0062994E | 26 | 6 | 30 |
| 575 | 27 | 37F6 | 20060716 | 526 | PSN388 | 542502N | 0065309E | 33 | 13 | 61 |
| 577 | 28 | 37F7 | 20060716 | 839 | PSN388 | 542538N | 0071486E | 30 | 20 | 60 |
| 579 | 29 | 37F7 | 20060716 | 1418 | PSN388 | 540309N | 0071523E | 31 | 14 | 20 |
| 582 | 30 | 37F7 | 20060717 | 510 | PSN388 | 540750N | 0074793E | 38 | 23 | 14 |
| 584 | 31 | 37F8 | 20060717 | 1013 | PSN388 | 541084N | 0080207E | 23 | 13 | 14 |

**Table 3: FRV "Solea", cruise 559. International acoustic survey on herring in the North Sea, 29.06.-18.07.06. Species distribution per haul (catch in kg).**

| Station | Haul | *Alosa fallax* | *Ammodytes marinus* | *Belone belone* | ***Clupea harengus*** | *Echiichthys vipera* | *Entelurus aequoreus* | *Eutrigla gurnadus* | *Glyptocephalus cynoglossus* | *Hyperoplus lancoleatus* | *Hyperoplus tobianus* | *Melanogrammus aeglefinus* | *Merlangius merlangus* | ***Sardina pilchardus*** | *Scomber scombrus* | ***Sprattus sprattus*** | *Trachurus trachurus* | *Trisopterus luscus* | No of Species | Herring (n in 60min haul) | Herring (% of clupeid catch) | Sprat (n in 60min haul) | Sprat (% of clupeid catch) | Number of clupeids / 60min |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 495 | 1 | | | | 21.57 | | 0.01 | 0.946 | | | | | 0.002 | | | 3.83 | | | 5 | 1,060 | 85 | 1,038 | 15 | 2,098 |
| 496 | 2 | | | | 3.702 | | | 0.71 | | | | | 0.012 | | | | | | 3 | 178 | 100 | 0 | 0 | 178 |
| 500 | 3 | | | | | | 0.04 | 0.606 | | | | | | | | | | | 2 | 0 | 0 | 0 | 0 | 0 |
| 504 | 4 | | | | | | 0.044 | 0.222 | | | | | | | | | | | 2 | 0 | 0 | 0 | 0 | 0 |
| 508 | 5 | | | | | | 0.088 | 0.472 | | | | | | | | | | | 2 | 0 | 0 | 0 | 0 | 0 |
| 512 | 6 | | | | | | 0.016 | 0.244 | | | | | | | | | | | 2 | 0 | 0 | 0 | 0 | 0 |
| 518 | 7 | | | | 0.69 | | 0.77 | | | | | 1.78 | 7.745 | | | 1.456 | | 0.104 | 6 | 10 | 32 | 264 | 68 | 274 |
| 521 | 8 | | | | | | 0.04 | 4.126 | | | | | 0.198 | | | 0.041 | | | 4 | 0 | 0 | 5 | 100 | 5 |
| 524 | 9 | | | | 24.3 | 0.024 | 0.024 | 0.878 | | | | | | | | 303.7 | | | 5 | 1,346 | 7 | 45,200 | 93 | 46,546 |
| 528 | 10 | | | | 0.16 | | 0.028 | 0.92 | | | | | 0.002 | | | 22.12 | | | 5 | 10 | 1 | 3,072 | 99 | 3,082 |
| 531 | 11 | | | | 8.27 | | | 0.056 | | | | | | | | 115.7 | | | 3 | 520 | 7 | 37,932 | 93 | 38,452 |
| 533 | 12 | | | | | | | 0.042 | | | | | | | 0.2 | 51.2 | | | 3 | 0 | 0 | 7,646 | 100 | 7,646 |
| 538 | 13 | | | | 0.886 | 0.028 | | | | | | | | | 0.44 | 2307 | | | 4 | 62 | 0 | 433,640 | 100 | 433,702 |
| 543 | 14 | | | | 27.37 | | | | | | | | | | | 27.37 | | | 2 | 113,536 | 50 | 68,932 | 50 | 182,468 |
| 544 | 15 | 1.36 | | | 0.046 | 0.402 | | | | | 0.034 | | | | | 1099 | | | 5 | 4 | 0 | 367,798 | 100 | 367,802 |
| 546 | 16 | | | | 5.346 | 0.072 | | | | | | | 0.18 | | 0.194 | 71.87 | | | 5 | 564 | 7 | 14,282 | 93 | 14,846 |
| 548 | 17 | | | | 0.062 | 2.136 | | | | | 0.052 | | 0.004 | | 0.974 | | | | 5 | 3 | 100 | 0 | 0 | 3 |
| 549 | 18 | | | | 0.48 | 2.776 | | | | | | | 0.248 | | | 54.6 | | | 4 | 22 | 1 | 18,010 | 99 | 18,032 |
| 556 | 19 | | | | | | | | | | | | | | 0.256 | 120.8 | | | 2 | 0 | 0 | 31,842 | 100 | 31,842 |
| 559 | 20 | | | | | | | | 0.001 | 0.076 | | | 0.002 | | | | | | 3 | 0 | 0 | 0 | 0 | 0 |
| 562 | 21 | 0.7 | | | 6.915 | | 0.02 | 0.364 | | | | | | | | 154.9 | | | 5 | 564 | 4 | 79,194 | 96 | 79,758 |
| 565 | 22 | | | | | 0.206 | 0.004 | 0.19 | | | | | | | 1.848 | 7.9 | 42.7 | | 6 | 0 | 0 | 804 | 100 | 804 |
| 568 | 23 | | | | 307.2 | | | | | 0.028 | | | | | 0.314 | 827.5 | 1.858 | | 5 | 288,330 | 27 | 888,638 | 73 | 1,176,968 |
| 569 | 24 | | | | | | 0.004 | | | 0.236 | | | | 0.148 | 6.325 | | 1.63 | | 5 | 0 | 0 | 0 | 0 | 4 |
| 570 | 25 | | | | 260.5 | | | | | 0.14 | | | | | 0.704 | 364.9 | | | 4 | 184,968 | 42 | 274,458 | 58 | 459,426 |
| 572 | 26 | | | | 33.5 | | | | | 0.892 | | | | | 0.406 | 452.8 | | | 4 | 6,700 | 7 | 79,070 | 93 | 85,770 |
| 575 | 27 | | | | 2.716 | | | 1.068 | | | | | | 0.136 | 42.2 | 0.79 | 5.83 | | 6 | 71 | 75 | 52 | 22 | 124 |
| 577 | 28 | | 0.014 | | | | | 0.59 | | 0.462 | | | 0.006 | | 70.2 | | 6.195 | | 6 | 0 | 0 | 0 | 0 | 0 |
| 579 | 29 | | | 0.296 | 4.91 | | | 0.366 | | | | | | | 0.524 | 306.1 | | | 5 | 1,743 | 2 | 119,775 | 98 | 121,518 |
| 582 | 30 | | | | 107 | | | 0.372 | | | | | | | 6.985 | 105 | | | 4 | 71,901 | 50 | 64,067 | 50 | 135,969 |
| 584 | 31 | | | | 5.87 | | | 0.064 | | 0.076 | | | | | 1.47 | 97.03 | | | 5 | 4,393 | 6 | 48,776 | 94 | 53,169 |
| Total | | 2.06 | 0.014 | 0.296 | 821.4 | 5.644 | 1.088 | 12.24 | 0.001 | 1.91 | 0.086 | 1.78 | 8.399 | 0.284 | 133 | 6496 | 58.21 | 0.104 | 17 | 8,509 | 11 | 55,631 | 89 | 64,141 |

**Table 4a: FRV “Solea”, cruise 559. Herring length-frequency proportion (%) by trawl haul (Length in cm).**

| | Stat: | 495 | 496 | 518 | 524 | 528 | 531 | 538 | 543 | 544 | 546 | 548 | 549 | 562 | 568 | 570 | 572 | 575 | 579 | 582 | 584 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Haul: | 1 | 2 | 7 | 9 | 10 | 11 | 13 | 14 | 15 | 16 | 17 | 18 | 21 | 23 | 25 | 26 | 27 | 29 | 30 | 31 |
| | Rect: | 39F6 | 39F5 | 38E9 | 37F0 | 37F2 | 37F4 | 34F2 | 34F2 | 34F2 | 33F2 | 33F2 | 33F2 | 37F4 | 36F5 | 36F6 | 36F6 | 37F6 | 37F7 | 37F7 | 37F8 |
| Length | Total | | | | | | | | | | | | | | | | | | | | |
| 4.75 | | | | | | | | | | | | | | | | | | | | | |
| 5.25 | **3.3** | | | | | | | | 14 | | | | | | | | | | | | |
| 5.75 | **9.2** | | | | | | | | 39 | | | | | | | | | | | | |
| 6.25 | **7.5** | | | | | | | | 32 | | | | | | | | | | | | |
| 6.75 | **3.3** | | | | | | | | 14 | | | | | | | | | | | | |
| 7.25 | | | | | | | | | | | | | | | | | | | | | |
| 7.75 | | | | | | | | | | | | | | | | | | | | | |
| 8.25 | | | | | | | | | | | | | | | | | | | | | |
| 8.75 | **1.2** | | | | | | | | | | | | | | | | | | | 8 | 3 |
| 9.25 | **14.5** | | | | | | | | | | | | | | 18 | 1 | | | 4 | 59 | 48 |
| 9.75 | **23.4** | | | | | | | | | | 1 | | | | 37 | 30 | | | 40 | 27 | 31 |
| 10.25 | **19.6** | | | | | | | | | | | | | | 26 | 40 | 3 | | 37 | 6 | 14 |
| 10.75 | **8.8** | | | | | | | | | | 1 | | | | 9 | 20 | 27 | | 12 | | 3 |
| 11.25 | **5.,3** | | | | | 20 | | | | | 7 | | | | 7 | 7 | 46 | | 6 | | |
| 11.75 | **1.7** | | | | | | | | | | 20 | | 9 | | 2 | 2 | 19 | | 1 | | |
| 12.25 | **0.5** | | | | | | | | | | 21 | | | | 1 | 1 | 5 | | 1 | | |
| 12.75 | **0.0** | | | | | | | 3 | | | 12 | | | | | | | | | | |
| 13.25 | **0.0** | | | | | | | 3 | | | 3 | | | | | | | | | | |
| 13.75 | **0.0** | | | | | | 1 | 16 | | | 3 | | | | | | | | | | |
| 14.25 | **0.0** | | | | 1 | 20 | 4 | 3 | | 50 | 5 | | | 1 | | | | | | | |
| 14.75 | **0.1** | | | | 9 | | 4 | 26 | | | 13 | | 18 | 5 | | | | | | | |
| 15.25 | **0.1** | | | | 8 | | 19 | 16 | | | 5 | | 18 | 6 | | | | 4 | | | |
| 15.75 | **0.1** | | | | 10 | | 23 | 10 | | 50 | 4 | | | 12 | | | | 13 | | | |
| 16.25 | **0.1** | 2 | 1 | | 6 | | 22 | 6 | | | 2 | | | 13 | | | | 17 | | | |
| 16.75 | **0.2** | 8 | 7 | | 6 | | 13 | 13 | | | 1 | | 9 | 18 | | | | 29 | | | |
| 17.25 | **0.2** | 27 | 26 | | 4 | | 8 | 3 | | | | | 9 | 12 | | | | 19 | | | |
| 17.75 | **0.2** | 26 | 26 | | 7 | 40 | 3 | | | | | | | 19 | | | | 15 | | | |
| 18.25 | **0.2** | 23 | 34 | | 7 | 20 | 1 | | | | | | 9 | 11 | | | | 3 | | | |
| 18.75 | **0.1** | 11 | 6 | | 13 | | | | | | | | | 3 | | | | | | | |
| 19.25 | **0.1** | 2 | | | 14 | | | | | | | | | 2 | | | | | | | |
| 19.75 | **0.0** | | 1 | | 7 | | | | | | | 100 | 9 | | | | | | | | |
| 20.25 | **0.0** | | | | 4 | | | | | | | | 9 | | | | | | | | |
| 20.75 | **0.0** | | | | 2 | | | | | | | | 9 | | | | | | | | |
| 21.25 | **0.0** | | | | 1 | | | | | | | | | | | | | | | | |
| 21.75 | | | | | | | | | | | | | | | | | | | | | |
| 22.25 | | | | | | | | | | | | | | | | | | | | | |
| 22.75 | **0.0** | | | 20 | | | | | | | | | | | | | | | | | |
| 23.25 | **0.0** | | | 20 | | | | | | | | | | | | | | | | | |
| 23.75 | **0.0** | | | 20 | | | | | | | | | | | | | | | | | |
| 24.25 | | | | | | | | | | | | | | | | | | | | | |
| 24.75 | | | | | | | | | | | | | | | | | | | | | |
| 25.25 | **0.0** | | | 20 | | | | | | | | | | | | | | | | | |
| 25.75 | | | | | | | | | | | | | | | | | | | | | |
| 26.25 | **0.0** | | | 20 | | | | | | | | | | | | | | | | | |
| Total n | **121.5** | 0.5 | 0.1 | 0.0 | 0.7 | 0.0 | 0.3 | 0.0 | 28.4 | 0.0 | 0.3 | 0.0 | 0.0 | 0.2 | 38.4 | 30.8 | 3.4 | 0.1 | 0.6 | 16.8 | 1.0 |
| mean | **14.5** | 17.8 | 17.8 | 24.3 | 17.6 | 15.9 | 16.0 | 15.1 | 6.0 | 15.0 | 13.1 | 19.8 | 16.8 | 16.9 | 10.1 | 10.3 | 11.2 | 16.8 | 10.2 | 9.4 | 9.6 |

**Table 4b: FRV "Solea", cruise 559. Sprat length-frequency proportion (%) by trawl haul (Length in cm).**

| | **STAT:** | **495** | **518** | **521** | **524** | **528** | **531** | **533** | **538** | **543** | **544** | **546** | **549** | **556** | **562** | **565** | **568** | **570** | **572** | **575** | **579** | **582** | **584** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **HAUL:** | **1** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **18** | **19** | **21** | **22** | **23** | **25** | **26** | **27** | **29** | **30** | **31** |
| | **RECT:** | **39F6** | **38E9** | **38F0** | **37F0** | **37F2** | **37F4** | **36F4** | **34F2** | **34F2** | **34F2** | **33F2** | **33F2** | **36F2** | **37F4** | **37F5** | **36F5** | **36F6** | **36F6** | **37F6** | **37F7** | **37F7** | **37F8** |
| Length | Total | | | | | | | | | | | | | | | | | | | | | | |
| 3.75 | | | | | | | | | | | | | | | | | | | | | | | |
| 4.25 | | | | | | | | | | | | | | | | | | | | | | | |
| 4.75 | | | | | | | | | | | | | | | | | | | | | | | |
| 5.25 | **0.3** | | | | | | | | | 12 | | | | | | | | | | | | | |
| 5.75 | **0.3** | | | | | | | | | 12 | | | | | | | | | | | | | |
| 6.25 | **1.0** | | | | | | | | | 47 | | | | | | | | | | | | | |
| 6.75 | **0.3** | | | | | | | | | 12 | | | | | 0 | | | | | | | | |
| 7.25 | **0.2** | | | | | | | | | 6 | | | 4 | | 1 | | | | | | | | |
| 7.75 | **0.9** | | | | | | 2 | | | | 2 | | 9 | 0 | 8 | | | | | | | | |
| 8.25 | **4.6** | | | | | | 11 | | | | 15 | | 18 | 4 | 17 | | | | | | | | |
| 8.75 | **11.1** | 3 | 3 | | | | 23 | 0 | 1 | 6 | 29 | | 21 | 10 | 20 | 1 | 14 | 2 | | | 1 | 11 | |
| 9.25 | **20.5** | 27 | 5 | | | | 32 | 0 | 5 | 6 | 24 | | 18 | 19 | 28 | | 55 | 30 | | | 8 | 41 | 8 |
| 9.75 | **17.5** | 50 | 8 | | | 1 | 16 | 1 | 8 | | 15 | 2 | 14 | 24 | 14 | | 21 | 47 | 3 | | 61 | 37 | 45 |
| 10.25 | **9.9** | 8 | 6 | | 1 | | 8 | 2 | 12 | | 7 | 7 | 8 | 13 | 5 | 1 | 6 | 13 | 8 | | 27 | 9 | 33 |
| 10.75 | **8.2** | 6 | 13 | | 7 | 2 | 6 | 9 | 15 | | 4 | 20 | 5 | 7 | 2 | 3 | 3 | 5 | 26 | | 3 | 2 | 12 |
| 11.25 | **9.8** | 5 | 20 | 33 | 26 | 9 | 1 | 20 | 20 | | 2 | 25 | 2 | 8 | 2 | 20 | 2 | 3 | 39 | 4 | | | 3 |
| 11.75 | **7.0** | | 15 | 33 | 33 | 18 | 1 | 26 | 17 | | 0 | 21 | | 5 | 1 | 22 | | 1 | 16 | 11 | | | |
| 12.25 | **5.1** | | 14 | | 18 | 31 | | 18 | 13 | | 2 | 15 | | 4 | 1 | 27 | | 1 | 5 | 58 | | | |
| 12.75 | **2.0** | | 10 | 33 | 8 | 25 | | 13 | 5 | | | 5 | | 3 | | 22 | | | 3 | 19 | | 1 | |
| 13.25 | **0.9** | 1 | 5 | | 4 | 11 | | 7 | 2 | | 0 | 3 | | 2 | | 3 | | | | 4 | | | |
| 13.75 | **0.3** | | 2 | | 2 | 3 | | 3 | 1 | | | 1 | | | | 1 | | | | 4 | | | |
| 14.25 | **0.0** | | | | | | | 1 | | | | 0 | | | | | | | | | | | |
| 14.75 | **0.1** | | | | | | | 0 | 0 | | | | | | | | | | | | | | |
| Total n ('000) | **794.6** | 0.5 | 0.1 | 0.0 | 22.6 | 1.5 | 19.0 | 3.8 | 216.8 | 17.2 | 183.9 | 7.1 | 9.0 | 15.9 | 26.4 | 0.5 | 118.5 | 45.7 | 39.5 | 0.1 | 39.9 | 14.9 | 11.4 |
| mean length | **10.4** | 9.8 | 11.3 | 11.9 | 11.8 | 12.3 | 9.3 | 11.9 | 11.2 | 6.5 | 9.2 | 11.5 | 9.0 | 10.1 | 9.1 | 12.0 | 9.4 | 9.8 | 11.2 | 12.3 | 9.9 | 9.5 | 10.0 |

**Table 5: FRV "Solea", cruise 559. Herring age/maturity-length key (sampled numbers not raised to the abundance in the survey area).**

| **WR:** | **0** | **1** | **1** | **2** | **2** | **3** | **4** | **5** | **6** | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Maturity:** | **1** | **1** | **2** | **1** | **2** | **2** | **2** | **2** | **2** | |
| Length (cm) | | | | | | | | | | Sum |
| 4.75 | | | | | | | | | | 0 |
| 5.25 | | | | | | | | | | 0 |
| 5.75 | | | | | | | | | | 0 |
| 6.25 | | | | | | | | | | 0 |
| 6.75 | | | | | | | | | | 0 |
| 7.25 | | | | | | | | | | 0 |
| 7.75 | | | | | | | | | | 0 |
| 8.25 | | | | | | | | | | 0 |
| 8.75 | 10 | | | | | | | | | 10 |
| 9.25 | 32 | | | | | | | | | 32 |
| 9.75 | 40 | | | | | | | | | 40 |
| 10.25 | 34 | | | | | | | | | 34 |
| 10.75 | 32 | | | | | | | | | 32 |
| 12.75 | 35 | 2 | | | | | | | | 37 |
| 13.25 | 29 | 2 | | | | | | | | 31 |
| 13.75 | 17 | 10 | | | | | | | | 27 |
| 14.25 | 8 | 15 | | | | | | | | 23 |
| 14.75 | 2 | 40 | | | | | | | | 42 |
| 15.25 | 1 | 40 | | | | | | | | 41 |
| 15.75 | | 37 | | | | | | | | 37 |
| 16.25 | | 42 | | | | | | | | 42 |
| 16.75 | | 51 | | | | | | | | 51 |
| 17.25 | | 53 | | | | | | | | 53 |
| 17.75 | | 48 | | | | | | | | 48 |
| 18.25 | | 33 | | 3 | | | | | | 36 |
| 18.75 | | 27 | | 2 | | | | | | 29 |
| 19.25 | | 17 | | 1 | | | | | | 18 |
| 19.75 | | 12 | | 2 | | | | | | 14 |
| 20.25 | | 4 | | 7 | | | | | | 11 |
| 20.75 | | 1 | | 5 | | 1 | | | | 7 |
| 21.25 | | | | 3 | | | | | | 3 |
| 22.25 | | | | | | | | | | 0 |
| 22.75 | | | | | | | 1 | | | 1 |
| 23.75 | | | | | | | 1 | | | 1 |
| 24.25 | | | | | | | 1 | | | 1 |
| 24.75 | | | | | | | | | | 0 |
| 25.25 | | | | | | | 1 | | | 1 |
| 25.75 | | | | | | | | | | 0 |
| 26.25 | | | | | | | | 1 | | 1 |
| Sum | 240 | 434 | 0 | 23 | 0 | 1 | 4 | 1 | 0 | 703 |

**Table 6: FRV Solea, cruise 559. SPRAT age/maturity-length key (sampled numbers not raised to the abundance in the survey area) separately for the area east and west of 3°E.**

| | Stations east of 3°E (Rectangles F3 - F8) | | | | | | | | Stations west of 3°E (Rectangles E9 - F2) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Age** | **1** | **1** | **1** | **1** | **2** | **2** | **2** | **Sum** | **1** | **1** | **1** | **1** | **2** | **2** | **2** | **3** | **3** | **3** | **4** | **Sum** | **Sum** |
| **Maturity** | **1** | **2** | **3** | **4** | **2** | **3** | **4** | | **1** | **2** | **3** | **4** | **2** | **3** | **4** | **2** | **3** | **4** | **2** | | **total** |
| **Length (cm)** | | | | | | | | | | | | | | | | | | | | | |
| **6.25** | | | | | | | | 0 | | | | | | | | | | | | 0 | *0* |
| **6.75** | | | | | | | | 0 | | | | | | | | | | | | 0 | *0* |
| **7.25** | 1 | | | | | | | 1 | 1 | | | | | | | | | | | 1 | *2* |
| **7.75** | 11 | | | | | | | 11 | 9 | | | | | | | | | | | 9 | *20* |
| **8.25** | 6 | 4 | | | | | | 10 | 13 | 10 | | 2 | | | | | | | | 25 | *35* |
| **8.75** | | 16 | | 23 | | | | 39 | 1 | 23 | 1 | 12 | | | | | | | | 37 | *76* |
| **9.25** | | 8 | 10 | 40 | | 1 | | 59 | | 26 | 2 | 5 | 2 | 1 | | | | | | 36 | *95* |
| **9.75** | | 13 | 7 | 40 | | 1 | | 61 | | 18 | 6 | 8 | 5 | 2 | 3 | | | | | 42 | *103* |
| **10.25** | | 5 | 11 | 44 | | 1 | 3 | 64 | | 14 | 9 | 1 | 13 | 3 | 2 | | | | | 42 | *106* |
| **10.75** | | 12 | 5 | 21 | 1 | 11 | 13 | 63 | | 4 | 5 | 3 | 15 | 16 | 12 | | 1 | | | 56 | *119* |
| **11.25** | | 4 | 7 | 6 | 5 | 18 | 11 | 51 | | 1 | 5 | 1 | 15 | 29 | 9 | | 1 | | | 61 | *112* |
| **11.75** | | | 2 | 1 | 3 | 18 | 16 | 40 | | | 2 | | 12 | 29 | 13 | 3 | 2 | | | 61 | *101* |
| **12.25** | | | 1 | 1 | 3 | 23 | 16 | 44 | | | | | 7 | 34 | 14 | | 3 | 1 | | 59 | *103* |
| **12.75** | | | | | 5 | 22 | 10 | 37 | | | | | 18 | 27 | 12 | 1 | 1 | | | 59 | *96* |
| **13.25** | | | | | 1 | 14 | 5 | 20 | | | | | 12 | 26 | 9 | 3 | | | | 50 | *70* |
| **13.75** | | | | | 4 | 6 | 2 | 12 | | | | | 7 | 16 | 5 | 4 | 2 | | | 34 | *46* |
| **14.25** | | | | | 1 | 3 | | 4 | | | | | 3 | 1 | 3 | 2 | | | | 9 | *13* |
| **14.75** | | | | | | | | | | | | | | | | 1 | | 1 | | 2 | *2* |
| **15.25** | | | | | | | | | | | | | | | | 2 | | | 1 | 3 | *3* |
| **Sum** | 18 | 62 | 43 | 176 | 23 | 118 | 76 | 516 | 24 | 96 | 30 | 32 | 109 | 184 | 82 | 16 | 10 | 2 | 1 | 586 | *1102* |

# Annex 3: Survey Report for RV "Solea"

5–24 October 2006

Federal Research Centre for Fisheries, Germany

Eberhard Götze [1] and Tomas Gröhsler [2]

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## 1 Introduction

The joint German/Danish survey is part of the **Baltic International Acoustic Survey,** which is coordinated within the scope of ICES and has the main objective to assess the clupeoid resources of herring and sprat in the Baltic Sea in autumn. The reported acoustic survey is conducted every year to supply the ICES "Herring Assessment Working Group" (HAWG) and "Baltic Fisheries Assessment Working Group" (WGBFAS) with an index value for the stock size of herring and sprat, respectively, in the Western Baltic area (Subdivisions 22, 23 and 24).

## 2 Methods

### 2.1 Personnel

| PARTICIPANTS/CALIBRATION OF ACOUSTIC EQUIPMENT/ 5 – 7 OCTOBER 2006: | |
|---|---|
| Dr. E. Bethke | Institute for Fishing Technology and Fishery Economics, Hamburg |
| M. Drenckow | Institute for Fishing Technology and Fishery Economics, Hamburg |
| E. Götze | Institute for Fishing Technology and Fishery Economics, Hamburg, Cr. Leader |
| M. Sasse | Institute for Fishing Technology and Fishery Economics, Hamburg |
| **PARTICIPANTS/ACOUSTIC SURVEY/7 – 24 OCTOBER 2006:** | |
| K. Dittmann | Institute for Baltic Sea Fisheries, Rostock |
| M. Drenckow | Institute for Fishing Technology and Fishery Economics, Hamburg |
| D. Gloe | Institute for Baltic Sea Fisheries, Rostock |
| E. Götze | Institute for Fishing Technology and Fishery Economics, Hamburg, Cr. Leader |
| J. Hansen Rye | FTZ, Büsum |
| M. Koth | Institute for Baltic Sea Fisheries, Rostock |
| S.-E. Levinsky | DIFRES, Charlottenlund, Denmark |

### 2.2 Narrative

The 564th cruise of RV 'Solea' represents the 19th subsequent survey. RV 'Solea' left the port of Rostock/Marienehe on 5th October 2006. The joint German-Danish acoustic survey covered the area of Subdivisions 21, 22, 23 and 24. The survey ended on 24th October 2006 in Rostock/Marienehe.

### 2.3 Survey design

The ICES statistical rectangles were used as strata for all Subdivisions (ICES, 2003). The area was limited by the 10 m depth line. The survey area in the Western Baltic Sea is characterised by a number of islands and sounds. Parallel transects would lead in consequence to an unsuitable coverage of the survey area. Therefore a zigzag track was used to cover all depth strata regularly. The survey area was 13,788 n.mi.$^2$. The cruise track (Figure 1) totally reached a length of 1,330 nautical miles.

### 2.4 Calibration

The hull mounted transducer ES38B was calibrated on 6 October 2006 north of the Isle of Rügen at a water depth of 21 m. The calibration procedure was carried out as described in the 'Manual for the Baltic International Acoustic Surveys (BIAS)' (ICES, 2003). Because of strong wind conditions the measurements were difficult. The quality of the results was nevertheless good. The difference to the last calibration of the sounder was only 0.07 dB.

### 2.5 Acoustic data collection

The acoustic investigations were performed during night time. The main pelagic species of interest were herring and sprat. The acoustic equipment was an echosounder EK60 on 38 kHz (120 kHz). The specific settings of the hydroacoustic equipment were used as described in the 'Manual for the Baltic International Acoustic Surveys (BIAS)' (ICES, 2003). The post-processing of the stored echosignals was done by EchoView 3.10. The mean volume back scattering values ($s_v$) were integrated over 1 n.mi. intervals from 8 m below the surface to the bottom. Contributions from air bubbles, bottom structures and scattering layers were removed from the echogram.

### 2.6 Biological data – fishing stations

Trawling was done with the pelagic gear 'PSN388' in the midwater as well as near the bottom. The mesh size in the codend was 10 mm. The intention was to carry out at least two hauls per ICES statistical rectangle. The trawling depth and the net opening were controlled by a netsonde. The trawl depth was chosen in accordance to the 'characteristic indications' by the echogram. Normally a net opening of about 8-10 m was achieved. The trawling time lasted usually 30 minutes, but in dense concentrations the duration was reduced. From each haul sub-samples were taken to determine length and weight of fish. Samples of herring and sprat were frosted for additional investigations (e.g. determining sex, maturity, age). The hydrographic condition was investigated after each trawl haul by a CTP-$O_2$ probe.

### 2.7 Data analysis

The pelagic target species sprat and herring are usually distributed in mixed layers in combination with other species so that the integrator readings cannot be allocated to a single species. Therefore the species composition was based on the trawl catch results. For each rectangle the species composition and length distribution were determined as the unweighted mean of all trawl results in this rectangle. From these distributions the mean acoustic cross section σ was calculated according to the following target strength-length (TS) relation:

| | TS | References |
|---|---|---|
| Clupeoids | = 20 log L (cm) - 71.2 | ICES 1983 |
| Gadoids | = 20 log L (cm) - 67.5 | Foote et al. 1986 |

The total number of fish (total N) in one rectangle was estimated as the product of the mean area scattering cross section ($s_A$) and the rectangle area, divided by the corresponding mean cross section. The total number was separated into herring and sprat according to the mean catch composition.

In accordance with the guidelines in the 'Manual for the Baltic International Acoustic Surveys (BIAS)' (ICES, 2003) the further calculation was performed in the following way:

| Fish species considered: |
|---|
| *Aphia minuta* |
| *Clupea harengus* |
| *Engraulis encrasicolus* |
| *Gadus morhua* |
| *Gasterosteus aculeatus* |
| *Merlangius merlangius* |
| *Sprattus sprattus* |
| *Trachurus trachurus* |
| **Exclusion of trawl hauls with low catch level:** |
| Haul No. 45 (41G2/SD 21) |
| Haul No. 52 (44G1/SD 21) |
| Haul No. 53 (43G1/SD 21) |
| **Usage of neighboring trawl information for rectangles, which are only containing acoustic investigations:** |
| 40F9 (SD 22) filled with Haul No. 33 (40G0/SD 22) |
| 40G1 (SD 22) filled with Haul No. 36 (40G0/SD 22) |
| 37G4 (SD 24) filled with Haul No. 5 (37G3/SD 24) Haul No. 6 and 7 (38G4/SD 24) |

# 3 Results

## 3.1 Biological data

In total 54 trawl hauls were carried out. 14 hauls were done in SD 21, 17 hauls in SD 22, 5 haul in SD 23 and 18 hauls in SD 24. 2,090 herring and 1,158 sprat were frozen for further investigations (e.g. determining sex, maturity, age).

The results of the catch composition by Subdivision are presented in Tables 1-4. The mean catch by Subdivision was higher in all areas than in the previous year. High concentrations of adult herring were found as in the years before in the Sound (Subdivision 23). Large quantities of young sprat were caught predominantly in the Arkona basin (Subdivision 24). The sprat year-class 2006 was overall exceptional strong. In the Kattegat and the northern part of Subdivision 22 anchovy was observed in larger quantities.

The length distributions of herring and sprat of the years 2005 and 2006 are presented by Subdivision in Figures 2 and 3. The comparison of the herring length distributions in the last two years are characterised by the following changes:

- Decreasing importance of younger herring in Subdivision 21
- Increasing contribution of the already existing dominant part of younger herring in Subdivision 22
- Higher contribution of older herring (> 26 cm) in Subdivision 23
- Lost dominance of new incoming year class in Subdivision 24

The length distributions of sprat in 2005 and 2006 show a somewhat different picture in all areas (Figure 2). The amount of young sprat now increased in Subdivisions 22-24 but in contrast to last years results are not dominating any more in Subdivision 21. The new incoming year-class, which already dominated in both years in Subdivision 24, is now even making the highest contribution in Subdivision 22.

## 3.2 Acoustic data

The survey statistics concerning the survey area, the mean $s_A$, the mean scattering cross section $\sigma$, the estimated total number of fish, the percentages of herring and sprat per Subdivision/rectangle are shown in Table 5.

The horizontal distribution of $s_A$ values is quite similar compared to last years result and is typical for the distribution pattern of herring and sprat in autumn (Figure 4):

- The highest values were observed in the Sound (SD 23). These values were twice as high as the long term average. The high concentrations were caused by high densities of adult herring in the southern part of the Sound. The density values increased year by year in this area since 2002.
- Extremely high $s_A$ values were measured in the Arkona Basin around Isle of Rügen (SD 24). They were caused by high densities of young sprat.
- Small but dense herring concentrations were also detected in the Southern part of the Kattegat (SD 21).
- The northern part of the Kattegat (SD 21) and the Beltsea (SD 22) were characterised by low fish densities.

### 3.3 Abundance estimates

The total abundance of herring and sprat are presented in Table 5. The estimated number of herring and sprat by age group and Subdivision/rectangle are given in Table 6 and Table 9. The corresponding mean weights by age group and Subdivision/rectangle are shown in Table 7 and Table 10. The estimates of herring and sprat biomass by age group and Subdivision/rectangle are summarised in Table 8 and Table 11.

The herring stock in Subdivisions 21-24 was estimated to be 7.2 x $10^9$ fish or about 256.5 x $10^3$ tonnes. For the included area of Subdivisions 22-24 the number of herring was calculated to be 5.7 x $10^9$ fish or about 213.9 x $10^3$ tonnes. The abundance estimates were dominated by young herring as in former years (Figure 2 and Table 6). Adult herring, which was concentrated in former years mostly in the Sound, could during the last four years also be found in deeper areas of the Arkona Sea.

The estimated sprat stock in Subdivisions 21-24 was 26.6 x $10^9$ fish or 164.4 x $10^3$ tonnes. For the included area of Subdivisions 22-24 the number of sprat was calculated to be 26.2 x $10^9$ fish or 157.6 x $10^3$ tonnes. The abundance estimates of sprat were dominated as in former years (except for 2004) by young sprat (Figure 3 and Table 9).

## 4 Discussion

The total number of herring in Subdivisions 22-24 slightly increased by 6% compared to 2005. This overall small increase is characterised by higher numbers in Subdivisions 22 and 23 (+111% and +8%) and lower numbers in Subdivision 24 (-17%). This small increase in numbers is also leading to a small increase of total biomass in Subdivisions 22-24 (+ 8%; 2006: 213.9 x $10^3$, 2005: 197.7 x $10^3$ t).

As in 2005 the number of age-groups 0-1 is the main contributor in Subdivisions 22-24 (2006: 77% and 2005: 74%).

The number of age groups 2-4 constitutes 15% in 2006 (2005: 21%). The actual contribution of the age-group 0 in Subdivisions 22-24 is 64% in numbers and 17% in biomass (2005: 62% in numbers and 17% in biomass).

The overall abundance of sprat in the Western Baltic (Subdivisions 22-24) increased significantly compared to the very low level during the former last two years (2006/2005: +144%). This year higher abundance estimates resulted from extraordinary high estimates in Subdivision 24 (Subdivision 22: +58%, Subdivision 23: -59% and Subdivision 24: +322%). Last years already existing dominant contribution of 0-group abundance even increased in 2006 (2006: 83%; 2005: 57%). Again this overall increase of the 0-group abundance occurred mainly in Subdivision 24 (Subdivision 22: 2.3 times higher, Subdivision 23: 1.2 times higher and Subdivision 24: 5.9 times higher). The present contribution of the age-group 0 in Subdivisions 22-24 is 58% in biomass (2005: 30%).

## 5 References


ICES. 1983. Report of the Planning Group on ICES co-ordinated herring and sprat acoustic surveys. ICES CM 1983/H:12.

ICES. 2003. Report of the Baltic International Fish Survey Working Group. ICES CM 2003/G:05 Ref.: D, H.: Annex 3.

Foote, K. G., Aglen, A., and Nakken, O. 1986. Measurement of fish target strength with a split-beam echosounder. J.Acoust.Soc.Am. 80(2): 612-621.


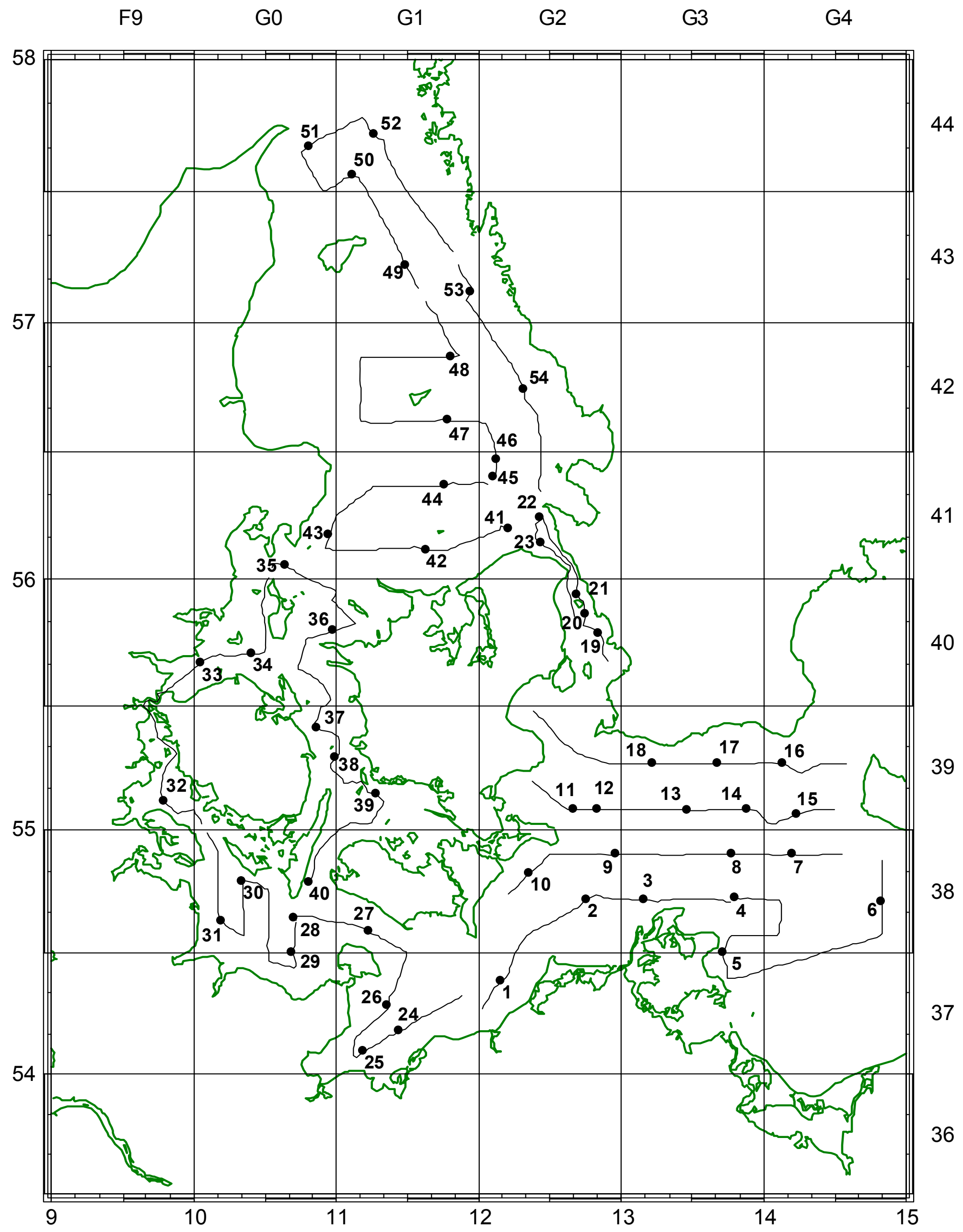


**Figure 1: Cruise track and trawl positions for the 2006 October acoustic survey on RV "Solea".**

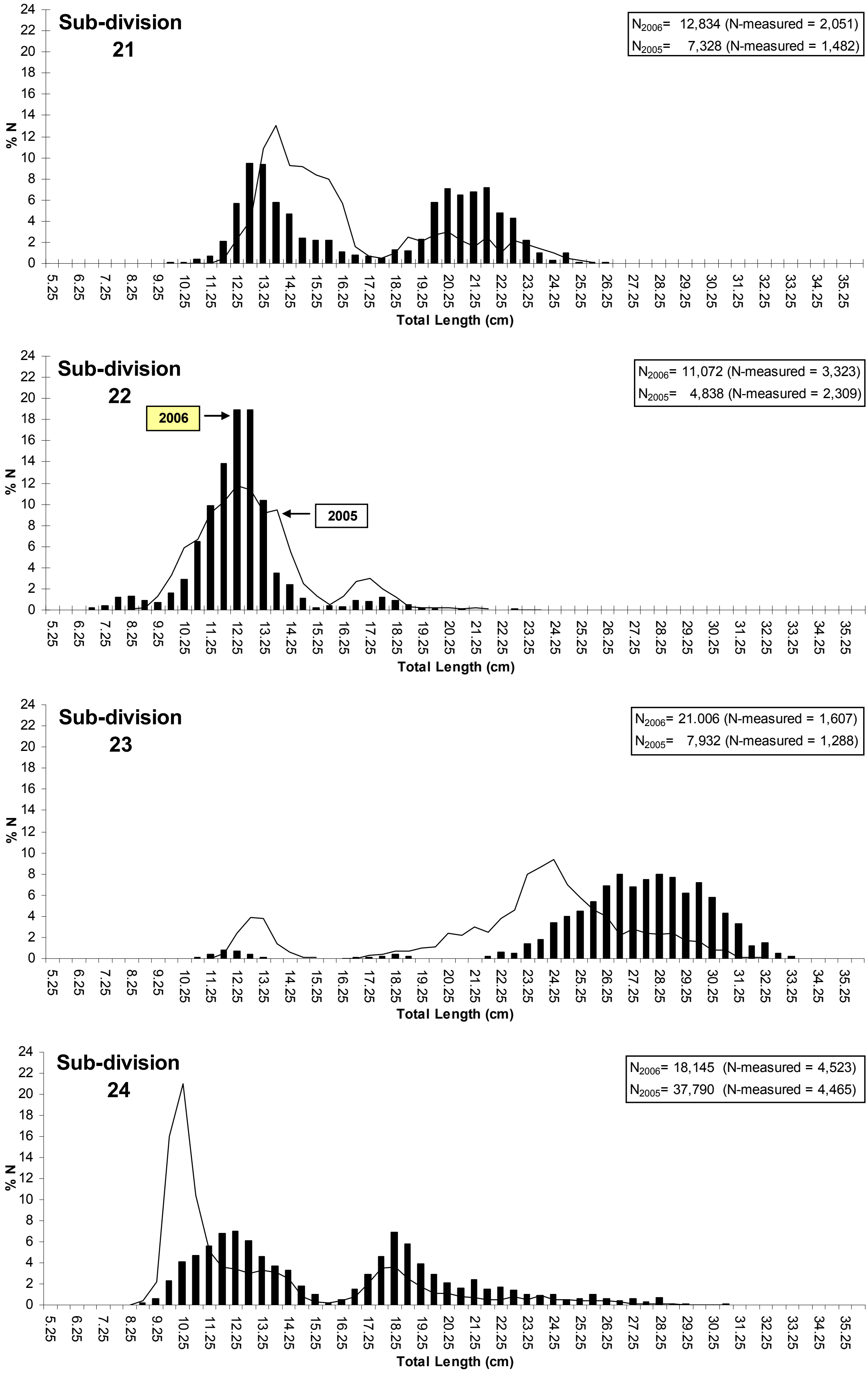


**Figure 2: Length distributions of herring in Subdivisions 21, 22, 23 and 24 obtained during the 2005 (=line) and 2006 (=bar) October acoustic survey on RV "Solea".**

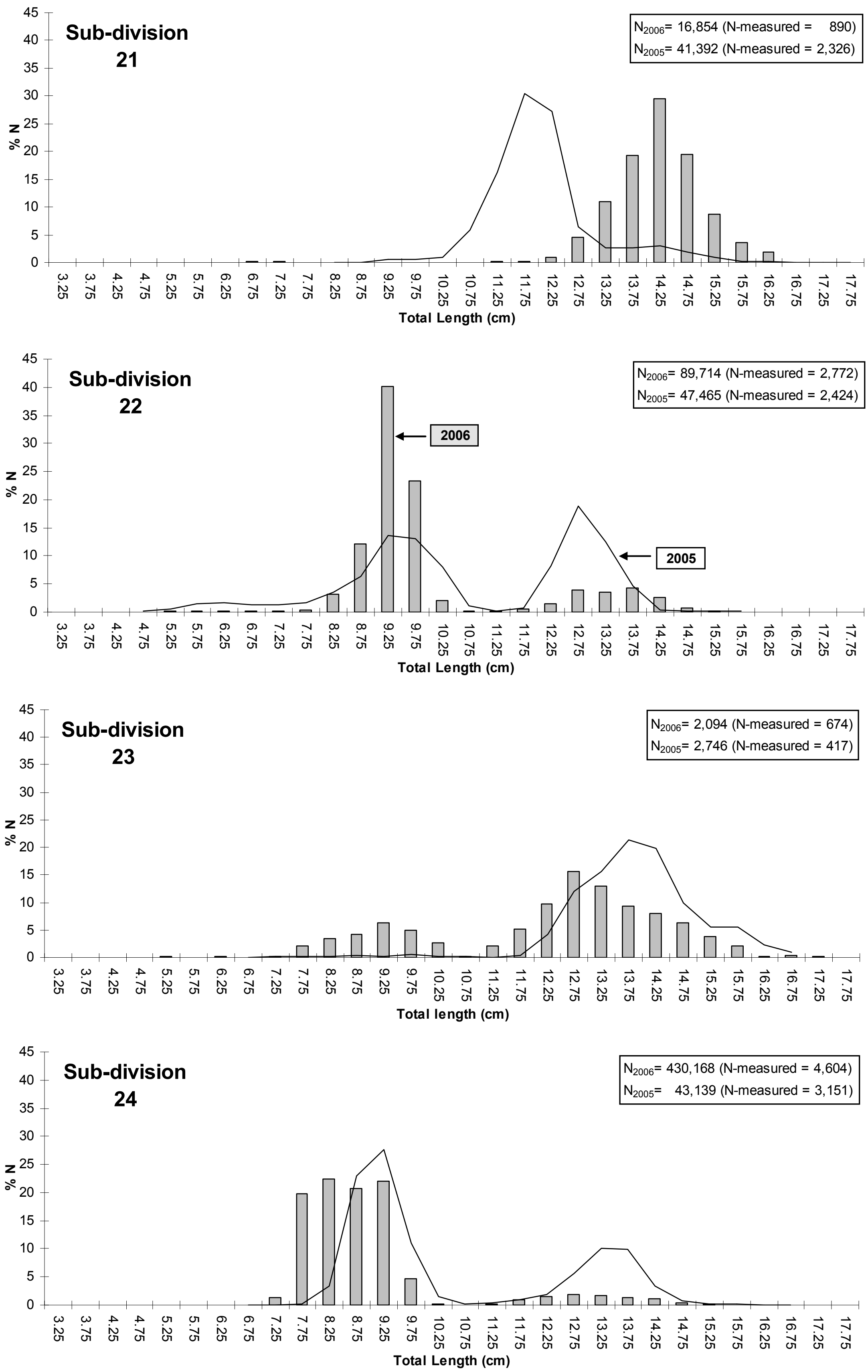


**Figure 3: Length distributions of sprat in Subdivisions 21, 22, 23 and 24 obtained during the 2005 (=line) and 2006 (=bar) October acoustic survey on RV "Solea".**

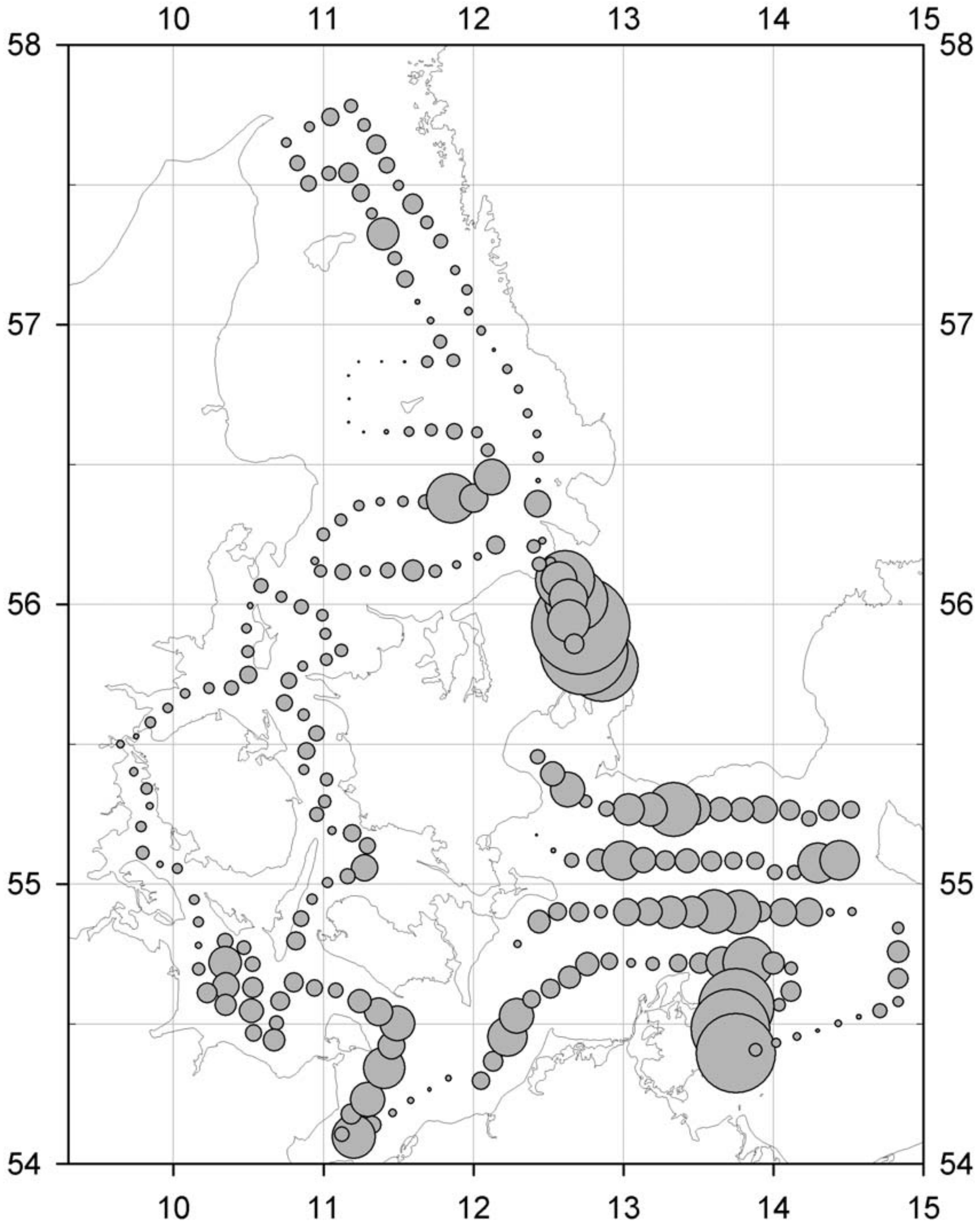


**Figure 4: Distribution of $s_A$-values obtained during the October 2006 acoustic survey on RV "Solea".**

**Table 1: Catch composition (kg/0.5 h) by trawl haul in Subdivision 21.**

| **Haul No.** | **41** | **42** | **43** | **44** | **45** | **46** | **47** | **48** | **49** |
|---|---|---|---|---|---|---|---|---|---|
| **Species/ICES Rectangle** | **41G2** | **41G1** | **41G0** | **41G1** | **41G2** | **41G2** | **42G1** | **42G1** | **43G1** |
| **APHIA MINUTA** | | | 0.02 | + | | | + | + | 0.06 |
| **CARCINUS** | | | | | | | | | |
| **CLUPEA HARENGUS** | 38.32 | 47.29 | 7.83 | 18.97 | 0.03 | 388.31 | 5.46 | 2.11 | 3.05 |
| **CTENOLABRUS RUPESTRIS** | | | | | | | + | | |
| **CYCLOPTERUS LUMPUS** | | | | | | | | | |
| **ELEDONE** | | | | | | | 0.01 | | |
| **ENGRAULIS ENCRASICOLUS** | 2.24 | 53.09 | 1.55 | 19.64 | 70.05 | 29.33 | 6.05 | 4.47 | 1.04 |
| **EUTRIGLA GURNARDUS** | | | | 0.01 | | 0.08 | | | |
| **GADUS MORHUA** | | | | | | 2.29 | | | |
| **GASTEROSTEUS ACULEATUS** | 0.03 | 0.02 | | | | | | | |
| **LIMANDA LIMANDA** | | | 0.05 | | | | 0.11 | 0.03 | |
| **LOLIGO FORBESI** | 0.03 | + | 0.22 | 0.18 | | | 0.38 | 0.44 | 0.17 |
| **MERLANGIUS MERLANGUS** | | 0.01 | 0.18 | 0.58 | | 0.17 | 1.15 | 0.18 | 0.03 |
| **MERLUCCIUS MERLUCCIUS** | | | | | | | + | + | |
| **MULLUS SURMULETUS** | | | 0.02 | | | 0.02 | | | |
| **POMATOSCHISTUS MINUTUS** | | | | | | | 0.02 | + | |
| **SCOMBER SCOMBRUS** | | | | 0.52 | 0.49 | 5.21 | 3.32 | 0.61 | 0.70 |
| **SPRATTUS SPRATTUS** | 0.10 | 0.03 | 1.03 | 3.71 | | 347.26 | 1.34 | 0.02 | |
| **TRACHINUS DRACO** | 0.08 | 0.26 | 0.07 | 1.12 | 0.06 | 0.98 | 2.37 | 1.36 | |
| **TRACHURUS TRACHURUS** | 0.61 | 9.14 | 0.38 | 0.71 | 0.27 | 0.55 | 1.82 | 0.14 | 0.10 |
| **Total** | **41.41** | **109.84** | **11.35** | **45.44** | **70.90** | **774.20** | **22.03** | **9.36** | **5.15** |
| **Medusae** | 2.2 | 3.0 | 7.0 | 3.2 | 1.9 | 2.7 | 0.8 | 4.3 | 1.1 |

| **Haul No.** | **50** | **51** | **52** | **53** | **54** | **Total** |
|---|---|---|---|---|---|---|
| **Species/ICES Rectangle** | **44G1** | **44G0** | **44G1** | **43G1** | **42G2** | |
| **APHIA MINUTA** | | + | | + | | **0.08** |
| **CARCINUS** | | 0.01 | 0.07 | | | **0.08** |
| **CLUPEA HARENGUS** | 28.33 | 6.93 | 0.15 | | 0.33 | **547.11** |
| **CTENOLABRUS RUPESTRIS** | | | | | | **0.00** |
| **CYCLOPTERUS LUMPUS** | 2.66 | | | | | **2.66** |
| **ELEDONE** | | 0.02 | 0.04 | | | **0.07** |
| **ENGRAULIS ENCRASICOLUS** | 47.70 | 2.98 | 1.60 | 0.38 | 0.25 | **240.37** |
| **EUTRIGLA GURNARDUS** | | | | | | **0.09** |
| **GADUS MORHUA** | | | | | | **2.29** |
| **GASTEROSTEUS ACULEATUS** | | | | | | **0.05** |
| **LIMANDA LIMANDA** | | | | | | **0.19** |
| **LOLIGO FORBESI** | 2.11 | 1.08 | 0.52 | 0.14 | 0.01 | **5.28** |
| **MERLANGIUS MERLANGUS** | 0.29 | 0.66 | 0.30 | 0.51 | 0.25 | **4.31** |
| **MERLUCCIUS MERLUCCIUS** | | | | | + | **0.00** |
| **MULLUS SURMULETUS** | | | | | | **0.04** |
| **POMATOSCHISTUS MINUTUS** | | | | | | **0.02** |
| **SCOMBER SCOMBRUS** | 0.08 | 0.47 | | 0.11 | | **11.51** |
| **SPRATTUS SPRATTUS** | | 2.96 | 0.35 | | 0.67 | **357.47** |
| **TRACHINUS DRACO** | + | | | 0.58 | + | **6.88** |
| **TRACHURUS TRACHURUS** | 0.47 | 0.13 | 0.11 | 0.10 | 0.18 | **14.71** |
| **Total** | **81.64** | **15.24** | **3.14** | **1.82** | **1.69** | **1193.21** |
| **Medusae** | 2.3 | 0.4 | 0.0 | 2.4 | 4.0 | **35.2** |

+ = < 0.01 kg

**Table 2: Catch composition (kg/0.5 h) by trawl haul in Subdivision 22.**

| **Haul No.** | **24** | **25** | **26** | **27** | **28** | **29** | **30** | **31** | **32** |
|---|---|---|---|---|---|---|---|---|---|
| **Species/ICES Rectangle** | **37G1** | **37G1** | **37G1** | **38G1** | **38G0** | **37G0** | **38G0** | **38G0** | **39F9** |
| AGONUS CATAPHRACTUS | | | | | | | | | |
| APHIA MINUTA | | | + | 0.01 | | + | | | |
| BELONE BELONE | | | | | | | 0.02 | | |
| CHELON LABROSUS | | | | | | 8.04 | | | |
| CLUPEA HARENGUS | 2.49 | 9.80 | 20.31 | 4.42 | 2.14 | 3.78 | 45.74 | 10.45 | 0.15 |
| CRANGON CRANGON | | | | | | | + | | |
| CTENOLABRUS RUPESTRIS | | | | | | | | | |
| CYCLOPTERUS LUMPUS | | | | | | | | | |
| ELEDONE | | 0.01 | | | | | | | |
| ENGRAULIS ENCRASICOLUS | 0.52 | 0.13 | | 92.03 | 1.88 | 1.21 | 1.04 | 6.49 | 0.50 |
| EUTRIGLA GURNARDUS | | | 0.01 | | | | | | |
| GADUS MORHUA | | | 3.95 | | | | | | |
| GASTEROSTEUS ACULEATUS | + | 1.49 | 0.01 | 0.13 | + | + | + | | 0.10 |
| GOBIUS NIGER | | | | 0.01 | | | | | |
| HYPEROPLUS LANCEOLATUS | | | | | | 0.01 | | | |
| LEANDER | | | | | | | | | |
| LIMANDA LIMANDA | | | + | 0.51 | | 0.27 | | | |
| LOLIGO FORBESI | | | + | + | | | | | |
| MERLANGIUS MERLANGUS | 0.09 | 0.32 | 3.37 | 2.67 | 0.02 | 1.20 | 0.33 | 0.29 | 0.06 |
| POMATOSCHISTUS MINUTUS | | | | 0.01 | | + | + | | |
| PSETTA MAXIMA | 0.02 | | 0.05 | | | | | 0.03 | |
| SCOMBER SCOMBRUS | | | 0.39 | | 0.20 | | | 0.20 | |
| SPRATTUS SPRATTUS | 0.13 | 212.47 | 390.77 | 10.94 | 7.49 | 12.47 | 3.20 | 0.01 | 1.58 |
| SYNGNATHUS ROSTELLATUS | | | | | | + | + | | |
| SYNGNATHUS TYPHLE | | | | | | | | | |
| TRACHINUS DRACO | | | | | | | | | |
| TRACHURUS TRACHURUS | 0.09 | 0.02 | 3.72 | 0.61 | 7.71 | 0.67 | 0.72 | 143.33 | 0.57 |
| TRISOPTERUS ESMARKI | | | | | | | | | |
| **Total** | **3.34** | **224.24** | **422.58** | **111.34** | **19.44** | **27.65** | **51.05** | **160.80** | **2.96** |
| **Medusae** | 3.3 | 231.7 | 422.6 | 111.3 | 20.1 | 27.7 | 51.1 | 160.8 | 2.8 |

| **Haul No.** | **33** | **34** | **35** | **36** | **37** | **38** | **39** | **40** | **Total** |
|---|---|---|---|---|---|---|---|---|---|
| **Species/ICES Rectangle** | **40G0** | **40G0** | **41G0** | **40G0** | **39G0** | **39G0** | **39G1** | **38G0** | |
| AGONUS CATAPHRACTUS | 0.03 | + | | | | | + | | **0.03** |
| APHIA MINUTA | 0.01 | 0.02 | 0.14 | 0.01 | + | 0.05 | 0.03 | + | **0.27** |
| BELONE BELONE | | | | | | | | | **0.02** |
| CHELON LABROSUS | | | | | | | | | **8.04** |
| CLUPEA HARENGUS | 0.37 | 33.96 | 1.87 | 4.41 | 2.55 | 0.60 | 0.12 | 1.07 | **144.23** |
| CRANGON CRANGON | | + | | | | | + | + | + |
| CTENOLABRUS RUPESTRIS | | + | | | | | | | + |
| CYCLOPTERUS LUMPUS | | | | | 0.43 | | | | **0.43** |
| ELEDONE | | | | | | | | | **0.01** |
| ENGRAULIS ENCRASICOLUS | 0.10 | 0.36 | 9.08 | 2.33 | 4.62 | 0.21 | 0.09 | 2.82 | **123.41** |
| EUTRIGLA GURNARDUS | + | | | | | | | | **0.01** |
| GADUS MORHUA | | | | | | | | | **3.95** |
| GASTEROSTEUS ACULEATUS | 0.01 | 0.01 | | | + | + | 3.21 | | **4.96** |
| GOBIUS NIGER | | | | | | | + | | **0.01** |
| HYPEROPLUS LANCEOLATUS | 0.01 | | | | | | | | **0.02** |
| LEANDER | + | | | | | | | | + |
| LIMANDA LIMANDA | 0.10 | 0.47 | | + | | | 0.18 | 0.02 | **1.55** |
| LOLIGO FORBESI | + | 0.03 | 0.09 | + | + | + | + | | **0.12** |
| MERLANGIUS MERLANGUS | 0.26 | 0.46 | | 0.34 | 0.14 | 0.02 | 0.06 | 0.32 | **9.95** |
| POMATOSCHISTUS MINUTUS | 0.01 | 0.01 | | | + | | 0.02 | 0.01 | **0.06** |
| PSETTA MAXIMA | | | | | | | | | **0.10** |
| SCOMBER SCOMBRUS | | | | | | | | | **0.79** |
| SPRATTUS SPRATTUS | 9.43 | 4.78 | 0.07 | 0.60 | 2.74 | 0.31 | 2.05 | | **659.04** |
| SYNGNATHUS ROSTELLATUS | | + | | | | | + | | + |
| SYNGNATHUS TYPHLE | | | | | | | + | | + |
| TRACHINUS DRACO | | 0.01 | | 0.46 | | | + | | **0.47** |
| TRACHURUS TRACHURUS | 0.10 | 1.04 | 1.64 | 1.11 | 0.32 | 0.38 | 0.10 | 0.51 | **162.64** |
| TRISOPTERUS ESMARKI | | + | + | | + | | | + | + |
| **Total** | **10.43** | **41.15** | **12.89** | **9.26** | **10.80** | **1.57** | **5.86** | **4.75** | **1120.11** |
| **Medusae** | 10.4 | 41.2 | 12.9 | 9.3 | 10.8 | 1.6 | 5.9 | 4.8 | **1128.1** |

+ = < 0.01 kg

**Table 3: Catch composition (kg/0.5 h) by trawl haul in Subdivision 23**

| Haul No. | 19 | 20 | 21 | 22 | 23 | Total |
|---|---|---|---|---|---|---|
| Species/ICES Rectangle | 40G2 | 40G2 | 40G2 | 41G2 | 41G2 | |
| APHIA MINUTA | | | | 0.01 | 0.01 | 0.02 |
| CLUPEA HARENGUS | 449.26 | 1564.18 | 1367.16 | 3.54 | 6.05 | 3390.19 |
| CRANGON CRANGON | | | | + | | + |
| ELEDONE | | | | | + | + |
| ENGRAULIS ENCRASICOLUS | | | | | 0.01 | 0.01 |
| EUTRIGLA GURNARDUS | | | 0.11 | | | 0.11 |
| GADUS MORHUA | 61.60 | 132.76 | 24.14 | | 2.34 | 220.84 |
| GASTEROSTEUS ACULEATUS | | | | 0.01 | 0.01 | 0.02 |
| LOLIGO FORBESI | | | | 0.01 | 0.01 | 0.02 |
| MELANOGRAMMUS AEGLEFINUS | | | 3.79 | | | 3.79 |
| MERLANGIUS MERLANGUS | 4.09 | 1.08 | 2.38 | 0.03 | 0.13 | 7.71 |
| MERLUCCIUS MERLUCCIUS | | | | + | | + |
| SPRATTUS SPRATTUS | 4.51 | 9.14 | 15.33 | 0.11 | 0.17 | 29.26 |
| TRACHINUS DRACO | | | | 0.30 | 0.25 | 0.55 |
| TRACHURUS TRACHURUS | 1.19 | 0.12 | 0.09 | 0.01 | + | 1.41 |
| **Total** | **520.65** | **1707.28** | **1413.00** | **4.02** | **8.98** | **3653.93** |
| **Medusae** | 2.3 | 0.4 | 1.6 | 0.8 | 1.4 | 6.5 |

+ = < 0.01 kg

**Table 4: Catch composition (kg/0.5 h) by trawl haul in Subdivision 24.**

| Haul No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| Species/ICES Rectangle | 37G2 | 38G2 | 38G3 | 38G3 | 37G3 | 38G4 | 38G4 | 38G3 | 38G2 |
| ALOSA FALLAX | | | | | 0.04 | | | | |
| APHIA MINUTA | | | | | | | | | + |
| BELONE BELONE | 0.11 | 0.04 | | | | | | | |
| CLUPEA HARENGUS | 2.43 | 3.58 | 3.35 | 2.30 | 5.95 | 19.64 | 1.45 | 17.84 | 25.64 |
| CRANGON CRANGON | | | | | | | | | |
| ENGRAULIS ENCRASICOLUS | 0.15 | 0.14 | 0.04 | | | | | 0.02 | 0.01 |
| EUTRIGLA GURNARDUS | | | | | | | | | |
| GADUS MORHUA | | | | 1.00 | 68.94 | + | | | |
| GASTEROSTEUS ACULEATUS | + | 0.01 | 0.01 | | | | | | 0.06 |
| LIMANDA LIMANDA | | 0.22 | | | | | | | |
| MERLANGIUS MERLANGUS | 0.43 | 0.34 | 0.02 | 0.12 | 0.94 | 0.14 | | 1.07 | 0.04 |
| OSMERUS EPERLANUS | | | | | 0.24 | | | | |
| PLEURONECTES PLATESSA | | | | | | | | | |
| POMATOSCHISTUS MINUTUS | + | | + | | + | | | | 0.02 |
| POMATOSCHISTUS PICTUS | | | + | | | | | | |
| SCOMBER SCOMBRUS | | 1.06 | | 1.26 | | | | | |
| SPRATTUS SPRATTUS | 21.50 | 201.25 | 2.55 | 582.85 | 420.07 | 10.28 | 49.48 | 150.98 | 7.07 |
| TRACHURUS TRACHURUS | 0.27 | 0.29 | 0.09 | 0.02 | 0.03 | | | 0.02 | + |
| **Total** | **24.89** | **206.93** | **6.06** | **587.55** | **496.21** | **30.06** | **50.93** | **169.93** | **32.84** |
| **Medusae** | 80.6 | 131.5 | 81.1 | 5.0 | 24.8 | 3.3 | 8.9 | 32.5 | 56.4 |

| Haul No. | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Species/ICES Rectangle | 38G2 | 39G2 | 39G2 | 39G3 | 39G3 | 39G4 | 39G4 | 39G3 | 39G3 | |
| ALOSA FALLAX | | | | | | | | | | 0.04 |
| APHIA MINUTA | | | + | | | | | | | 0.00 |
| BELONE BELONE | | | | | | | | | | 0.15 |
| CLUPEA HARENGUS | 2.53 | 4.43 | 4.78 | 15.94 | 11.85 | 15.06 | 169.39 | 159.67 | 150.54 | 616.37 |
| CRANGON CRANGON | | + | | | | | | | | 0.00 |
| ENGRAULIS ENCRASICOLUS | | | 0.01 | | | | | | | 0.37 |
| EUTRIGLA GURNARDUS | | 0.01 | | 0.01 | | | | | | 0.02 |
| GADUS MORHUA | | 2.92 | 0.90 | 2.50 | 9.03 | 4.14 | 7.25 | 4.39 | 9.08 | 110.15 |
| GASTEROSTEUS ACULEATUS | 0.02 | + | + | + | | | | | | 0.10 |
| LIMANDA LIMANDA | | | | | | | | | | 0.22 |
| MERLANGIUS MERLANGUS | 1.13 | 0.06 | 0.47 | | 1.46 | | | | + | 6.22 |
| OSMERUS EPERLANUS | | | | | | | | | | 0.24 |
| PLEURONECTES PLATESSA | | | 0.46 | | | | | | 0.28 | 0.74 |
| POMATOSCHISTUS MINUTUS | | 0.02 | 0.45 | | | | 0.01 | 0.01 | 0.02 | 0.53 |
| POMATOSCHISTUS PICTUS | | | | | | | | | | 0.00 |
| SCOMBER SCOMBRUS | 0.09 | | 0.07 | | | | | | | 2.48 |
| SPRATTUS SPRATTUS | 52.34 | 0.97 | 29.64 | 59.40 | 41.98 | 58.98 | 24.33 | 37.43 | 234.70 | 1985.80 |
| TRACHURUS TRACHURUS | + | 0.09 | 0.12 | + | | | | | | 0.93 |
| **Total** | **56.11** | **8.50** | **36.90** | **77.85** | **64.32** | **78.18** | **200.98** | **201.50** | **394.62** | **2724.36** |
| **Medusae** | 197.6 | 8.5 | 18.2 | 97.8 | 16.2 | 21.1 | 0.4 | **3.6** | **2.8** | **790.3** |

+ = < 0.01 kg

**Table 5: Survey statistics by area (RV "Solea" October 2006).**

| Sub-division | ICES Rectangle | Area (nm²) | Sa (m²/NM²) | Sigma (cm²) | N total (million) | Herring (%) | Sprat (%) | NHerring (million) | NSprat (million) |
|---|---|---|---|---|---|---|---|---|---|
| 21 | 41G0 | 108.1 | 70.9 | 1.447 | 52.97 | 61.35 | 6.33 | 32.50 | 3.35 |
| 21 | 41G1 | 946.8 | 276.1 | 1.469 | 1,779.95 | 27.58 | 4.00 | 490.83 | 71.21 |
| 21 | 41G2 | 432.3 | 373.0 | 2.606 | 618.82 | 38.30 | 34.18 | 236.98 | 211.49 |
| 21 | 42G1 | 884.2 | 55.7 | 1.854 | 265.70 | 13.71 | 4.71 | 36.42 | 12.50 |
| 21 | 42G2 | 606.8 | 59.7 | 1.228 | 294.99 | 7.94 | 20.11 | 23.41 | 59.31 |
| 21 | 43G1 | 699.0 | 176.6 | 1.107 | 1,114.81 | 34.38 | 0.00 | 383.30 | 0.00 |
| 21 | 44G0 | 239.9 | 129.1 | 1.379 | 224.58 | 41.60 | 20.17 | 93.42 | 45.29 |
| 21 | 44G1 | 580.5 | 193.0 | 1.757 | 637.76 | 28.18 | 0.00 | 179.71 | 0.00 |
| | Total | 4,497.6 | | | 4,989.58 | | | 1,476.57 | 403.15 |
| 22 | 37G0 | 209.9 | 281.4 | 0.956 | 617.60 | 12.42 | 75.64 | 76.70 | 467.17 |
| 22 | 37G1 | 723.3 | 450.7 | 1.345 | 2,424.15 | 26.90 | 63.14 | 652.10 | 1,530.50 |
| 22 | 38G0 | 735.3 | 242.0 | 1.234 | 1,441.89 | 29.03 | 16.01 | 418.61 | 230.80 |
| 22 | 38G1 | 173.2 | 475.1 | 1.593 | 516.63 | 4.94 | 26.48 | 25.50 | 136.83 |
| 22 | 39F9 | 159.3 | 72.7 | 0.794 | 145.90 | 2.39 | 68.11 | 3.48 | 99.38 |
| 22 | 39G0 | 201.7 | 132.2 | 0.964 | 276.74 | 20.11 | 22.66 | 55.64 | 62.71 |
| 22 | 39G1 | 250.0 | 199.7 | 0.339 | 1,471.16 | 0.29 | 14.09 | 4.29 | 207.34 |
| 22 | 40F9 | 51.3 | 57.1 | 0.728 | 40.21 | 1.93 | 93.58 | 0.78 | 37.63 |
| 22 | 40G0 | 538.1 | 123.6 | 0.911 | 730.12 | 35.94 | 42.72 | 262.37 | 311.91 |
| 22 | 40G1 | 174.5 | 125.3 | 0.859 | 254.42 | 40.36 | 9.77 | 102.69 | 24.85 |
| 22 | 41G0 | 173.1 | 115.2 | 0.867 | 230.05 | 7.22 | 0.27 | 16.62 | 0.62 |
| | Total | 3,389.7 | | | 8,148.87 | | | 1,618.78 | 3,109.74 |
| 23 | 40G2 | 164.0 | 3,206.6 | 7.250 | 725.32 | 89.05 | 9.20 | 645.94 | 66.72 |
| 23 | 41G2 | 72.3 | 898.4 | 1.561 | 416.17 | 79.56 | 3.03 | 331.10 | 12.61 |
| | Total | 236.3 | | | 1,141.49 | | | 977.04 | 79.33 |
| 24 | 37G2 | 192.4 | 551.0 | 0.821 | 1,291.07 | 4.65 | 92.72 | 59.99 | 1,197.11 |
| 24 | 37G3 | 167.7 | 2,627.5 | 0.639 | 6,899.93 | 0.16 | 99.77 | 11.12 | 6,884.15 |
| 24 | 37G4 | 875.1 | 37.9 | 0.987 | 336.19 | 10.04 | 89.90 | 33.76 | 302.23 |
| 24 | 38G2 | 832.9 | 297.9 | 0.993 | 2,499.53 | 21.21 | 77.62 | 530.15 | 1,940.23 |
| 24 | 38G3 | 865.7 | 1,005.8 | 1.056 | 8,245.16 | 10.46 | 87.79 | 862.60 | 7,238.34 |
| 24 | 38G4 | 1,034.8 | 202.0 | 1.168 | 1,788.89 | 14.98 | 84.96 | 268.03 | 1,519.91 |
| 24 | 39G2 | 406.1 | 289.6 | 1.254 | 938.04 | 28.15 | 68.17 | 264.08 | 639.48 |
| 24 | 39G3 | 765.0 | 621.3 | 1.634 | 2,908.02 | 24.74 | 75.10 | 719.56 | 2,184.04 |
| 24 | 39G4 | 524.8 | 476.5 | 1.791 | 1,396.21 | 24.62 | 75.26 | 343.68 | 1,050.75 |
| | Total | 5,664.5 | | | 26,303.04 | | | 3,092.97 | 22,956.24 |
| 22-24 | Total | 9,290.5 | | | 35,593.40 | | | 5,688.79 | 26,145.31 |
| 21-24 | Total | 13,788.1 | | | 40,582.98 | | | 7,165.36 | 26,548.46 |

**Table 6: Numbers (millions) of herring by age and area (RV "Solea" October 2006).**

| Sub-division | Rectangle/ W-rings | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8+ | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 21 | 41G0 | 32.18 | 0.32 | | | | | | | | 32.50 |
| 21 | 41G1 | 391.26 | 89.19 | 5.69 | 2.35 | 1.43 | 0.14 | 0.78 | | | 490.84 |
| 21 | 41G2 | 11.24 | 108.25 | 63.01 | 43.68 | 8.73 | 2.07 | | | | 236.98 |
| 21 | 42G1 | 9.97 | 23.13 | 2.44 | 0.73 | 0.05 | | 0.11 | | | 36.43 |
| 21 | 42G2 | 20.08 | 3.24 | | | | | 0.09 | | | 23.41 |
| 21 | 43G1 | 365.18 | 17.97 | | | | | 0.15 | | | 383.30 |
| 21 | 44G0 | 92.01 | 1.41 | | | | | | | | 93.42 |
| 21 | 44G1 | 170.47 | 9.24 | | | | | | | | 179.71 |
| | Total | 1,092.39 | 252.75 | 71.14 | 46.76 | 10.21 | 2.21 | 1.13 | 0.00 | 0.00 | 1,476.59 |
| 22 | 37G0 | 75.80 | 0.89 | | | 0.01 | | | | | 76.70 |
| 22 | 37G1 | 579.24 | 69.45 | 1.38 | 0.99 | 1.04 | | | | | 652.10 |
| 22 | 38G0 | 397.35 | 19.88 | 0.36 | 0.71 | 0.32 | | | | | 418.62 |
| 22 | 38G1 | 24.12 | 1.38 | | | | | | | | 25.50 |
| 22 | 39F9 | 3.39 | 0.09 | | | | | | | | 3.48 |
| 22 | 39G0 | 51.78 | 3.82 | | | 0.04 | | | | | 55.64 |
| 22 | 39G1 | 4.29 | | | | | | | | | 4.29 |
| 22 | 40F9 | 0.78 | | | | | | | | | 0.78 |
| 22 | 40G0 | 261.84 | 0.53 | | | | | | | | 262.37 |
| 22 | 40G1 | 102.07 | 0.62 | | | | | | | | 102.69 |
| 22 | 41G0 | 16.30 | 0.31 | | | 0.01 | | | | | 16.62 |
| | Total | 1,516.96 | 96.97 | 1.74 | 1.70 | 1.42 | 0.00 | 0.00 | 0.00 | 0.00 | 1,618.79 |
| 23 | 40G2 | | 6.43 | 45.83 | 151.98 | 158.87 | 117.73 | 79.29 | 59.97 | 25.85 | 645.95 |
| 23 | 41G2 | 269.95 | 60.49 | 0.66 | | | | | | | 331.10 |
| | Total | 269.95 | 66.92 | 46.49 | 151.98 | 158.87 | 117.73 | 79.29 | 59.97 | 25.85 | 977.05 |
| 24 | 37G2 | 54.06 | 3.98 | 0.50 | 0.60 | 0.69 | 0.09 | 0.06 | 0.01 | | 59.99 |
| 24 | 37G3 | 8.92 | 0.37 | 0.34 | 0.46 | 0.48 | 0.24 | 0.16 | 0.11 | 0.04 | 11.12 |
| 24 | 37G4 | 20.72 | 6.38 | 1.52 | 1.72 | 2.02 | 0.62 | 0.48 | 0.25 | 0.06 | 33.77 |
| 24 | 38G2 | 422.51 | 71.27 | 7.24 | 12.71 | 12.44 | 2.14 | 1.21 | 0.55 | 0.08 | 530.15 |
| 24 | 38G3 | 512.15 | 158.32 | 46.68 | 52.82 | 50.93 | 19.17 | 14.37 | 6.53 | 1.64 | 862.61 |
| 24 | 38G4 | 139.21 | 71.50 | 13.93 | 15.02 | 18.28 | 4.45 | 3.85 | 1.56 | 0.23 | 268.03 |
| 24 | 39G2 | 209.15 | 27.19 | 7.14 | 6.91 | 8.10 | 2.51 | 1.82 | 1.15 | 0.09 | 264.06 |
| 24 | 39G3 | 407.54 | 143.81 | 41.95 | 42.85 | 46.33 | 16.23 | 12.93 | 7.13 | 0.78 | 719.55 |
| 24 | 39G4 | 101.09 | 78.19 | 35.38 | 42.94 | 42.86 | 17.51 | 16.09 | 7.92 | 1.70 | 343.68 |
| | Total | 1,875.35 | 561.01 | 154.68 | 176.03 | 182.13 | 62.96 | 50.97 | 25.21 | 4.62 | 3,092.96 |
| 22-24 | Total | 3,662.26 | 724.90 | 202.91 | 329.71 | 342.42 | 180.69 | 130.26 | 85.18 | 30.47 | 5,688.80 |
| 21-24 | Total | 4,754.65 | 977.65 | 274.05 | 376.47 | 352.63 | 182.90 | 131.39 | 85.18 | 30.47 | 7,165.39 |

**Table 7: Mean weight (g) of herring by age and area (RV "Solea" October 2006).**

| Sub-division | Rectangle/ W-rings | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8+ | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 21 | 41G0 | 13.95 | 37.30 | | | | | | | | 14.19 |
| 21 | 41G1 | 14.15 | 44.25 | 68.91 | 92.45 | 111.51 | 112.53 | 36.10 | | | 20.97 |
| 21 | 41G2 | 15.63 | 62.14 | 75.32 | 87.21 | 109.54 | 112.27 | | | | 70.24 |
| 21 | 42G1 | 21.98 | 48.87 | 63.79 | 77.83 | 84.32 | | 36.10 | | | 43.10 |
| 21 | 42G2 | 20.93 | 32.41 | | | | | 36.10 | | | 22.58 |
| 21 | 43G1 | 20.54 | 25.79 | | | | | 36.10 | | | 20.79 |
| 21 | 44G0 | 13.39 | 26.76 | | | | | | | | 13.59 |
| 21 | 44G1 | 20.94 | 26.30 | | | | | | | | 21.21 |
| | Total | 17.49 | 50.11 | 74.41 | 87.33 | 109.69 | 112.29 | 36.10 | | | 28.82 |
| 22 | 37G0 | 9.51 | 32.72 | | | 31.48 | | | | | 9.78 |
| 22 | 37G1 | 10.89 | 36.02 | 67.93 | 91.80 | 31.48 | | | | | 13.84 |
| 22 | 38G0 | 11.02 | 30.92 | 78.00 | 95.25 | 31.48 | | | | | 12.18 |
| 22 | 38G1 | 10.66 | 34.71 | | | | | | | | 11.96 |
| 22 | 39F9 | 11.99 | 18.19 | | | | | | | | 12.16 |
| 22 | 39G0 | 9.24 | 34.26 | | | 31.48 | | | | | 10.97 |
| 22 | 39G1 | 11.23 | | | | | | | | | 11.23 |
| 22 | 40F9 | 8.21 | | | | | | | | | 8.21 |
| 22 | 40G0 | 9.18 | 36.63 | | | | | | | | 9.23 |
| 22 | 40G1 | 6.93 | 36.63 | | | | | | | | 7.10 |
| 22 | 41G0 | 12.90 | 31.64 | | | 31.48 | | | | | 13.25 |
| | Total | 10.26 | 34.83 | 70.01 | 93.24 | 31.48 | | | | | 11.90 |
| 23 | 40G2 | | 82.16 | 120.72 | 134.30 | 160.25 | 187.02 | 195.11 | 207.12 | 231.81 | 166.93 |
| 23 | 41G2 | 10.68 | 35.40 | 31.17 | | | | | | | 15.24 |
| | Total | 10.68 | 39.89 | 119.45 | 134.30 | 160.25 | 187.02 | 195.11 | 207.12 | 231.81 | 115.53 |
| 24 | 37G2 | 8.57 | 32.98 | 44.17 | 41.60 | 37.50 | 34.61 | 56.56 | 51.91 | | 11.24 |
| 24 | 37G3 | 6.61 | 40.56 | 73.74 | 81.20 | 84.50 | 99.22 | 94.50 | 104.22 | 182.20 | 21.08 |
| 24 | 37G4 | 8.41 | 37.82 | 54.20 | 58.17 | 55.14 | 69.96 | 68.88 | 79.07 | 140.84 | 24.10 |
| 24 | 38G2 | 8.84 | 33.74 | 43.85 | 36.73 | 37.59 | 44.10 | 53.86 | 52.45 | 58.12 | 14.31 |
| 24 | 38G3 | 8.45 | 37.23 | 58.01 | 64.82 | 60.79 | 76.51 | 87.82 | 73.05 | 91.70 | 26.44 |
| 24 | 38G4 | 9.80 | 37.65 | 48.43 | 49.73 | 45.91 | 50.93 | 56.41 | 56.99 | 58.12 | 25.61 |
| 24 | 39G2 | 9.21 | 36.68 | 55.48 | 50.06 | 46.82 | 69.98 | 55.05 | 97.61 | 58.12 | 16.81 |
| 24 | 39G3 | 11.84 | 37.35 | 56.13 | 63.92 | 57.20 | 77.37 | 83.62 | 88.52 | 111.15 | 29.18 |
| 24 | 39G4 | 11.67 | 39.23 | 60.89 | 78.05 | 75.76 | 95.77 | 101.50 | 102.61 | 146.05 | 50.54 |
| | Total | 9.63 | 37.10 | 56.47 | 63.83 | 59.61 | 78.88 | 86.53 | 86.58 | 113.50 | 26.44 |
| 22-24 | Total | 9.97 | 37.06 | 71.02 | 96.47 | 106.19 | 149.34 | 152.62 | 171.44 | 213.87 | 37.60 |
| 21-24 | Total | 11.69 | 40.43 | 71.90 | 95.33 | 106.29 | 148.89 | 151.62 | 171.44 | 213.87 | 35.79 |

**Table 8: Total biomass (t) of herring by age and area (RV "Solea" October 2006).**

| Sub-division | Rectangle/ W-rings | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8+ | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 21 | 41G0 | 448.9 | 11.9 | | | | | | | | 460.8 |
| 21 | 41G1 | 5,536.3 | 3,946.7 | 392.1 | 217.3 | 159.5 | 15.8 | 28.2 | | | 10,295.9 |
| 21 | 41G2 | 175.7 | 6,726.7 | 4,745.9 | 3,809.3 | 956.3 | 232.4 | | | | 16,646.3 |
| 21 | 42G1 | 219.1 | 1,130.4 | 155.6 | 56.8 | 4.2 | | 4.0 | | | 1,570.1 |
| 21 | 42G2 | 420.3 | 105.0 | | | | | 3.2 | | | 528.5 |
| 21 | 43G1 | 7,500.8 | 463.4 | | | | | 5.4 | | | 7,969.6 |
| 21 | 44G0 | 1,232.0 | 37.7 | | | | | | | | 1,269.7 |
| 21 | 44G1 | 3,569.6 | 243.0 | | | | | | | | 3,812.6 |
| | Total | 19,102.7 | 12,664.8 | 5,293.6 | 4,083.40 | 1,120.0 | 248.2 | 40.80 | 0.00 | 0.0 | 42,553.5 |
| 22 | 37G0 | 720.9 | 29.1 | | | 0.3 | | | | | 750.3 |
| 22 | 37G1 | 6,307.9 | 2,501.6 | 93.7 | 90.9 | 32.7 | | | | | 9,026.8 |
| 22 | 38G0 | 4,378.8 | 614.7 | 28.1 | 67.6 | 10.1 | | | | | 5,099.3 |
| 22 | 38G1 | 257.1 | 47.9 | | | | | | | | 305.0 |
| 22 | 39F9 | 40.6 | 1.6 | | | | | | | | 42.2 |
| 22 | 39G0 | 478.4 | 130.9 | | | 1.3 | | | | | 610.6 |
| 22 | 39G1 | 48.2 | | | | | | | | | 48.2 |
| 22 | 40F9 | 6.4 | | | | | | | | | 6.4 |
| 22 | 40G0 | 2,403.7 | 19.4 | | | | | | | | 2,423.1 |
| 22 | 40G1 | 707.3 | 22.7 | | | | | | | | 730.0 |
| 22 | 41G0 | 210.3 | 9.8 | | | 0.3 | | | | | 220.4 |
| | Total | 15,559.6 | 3,377.7 | 121.8 | 158.50 | 44.7 | 0.0 | 0.00 | 0.00 | 0.0 | 19,262.3 |
| 23 | 40G2 | | 528.3 | 5,532.6 | 20,410.9 | 25,458.9 | 22,017.9 | 15,470.3 | 12,421.0 | 5,992.3 | 107,832.2 |
| 23 | 41G2 | 2,883.1 | 2,141.3 | 20.6 | | | | | | | 5,045.0 |
| | Total | 2,883.1 | 2,669.6 | 5,553.2 | 20,410.9 | 25,458.9 | 22,017.9 | 15,470.3 | 12,421.0 | 5,992.3 | 112,877.2 |
| 24 | 37G2 | 463.3 | 131.3 | 22.1 | 25.0 | 25.9 | 3.1 | 3.4 | 0.5 | | 674.6 |
| 24 | 37G3 | 59.0 | 15.0 | 25.1 | 37.4 | 40.6 | 23.8 | 15.1 | 11.5 | 7.3 | 234.8 |
| 24 | 37G4 | 174.3 | 241.3 | 82.4 | 100.1 | 111.4 | 43.4 | 33.1 | 19.8 | 8.5 | 814.3 |
| 24 | 38G2 | 3,735.0 | 2,404.6 | 317.5 | 466.8 | 467.6 | 94.4 | 65.2 | 28.8 | 4.6 | 7,584.5 |
| 24 | 38G3 | 4,327.7 | 5,894.3 | 2,707.9 | 3,423.8 | 3,096.0 | 1,466.7 | 1,262.0 | 477.0 | 150.4 | 22,805.8 |
| 24 | 38G4 | 1,364.3 | 2,692.0 | 674.6 | 746.9 | 839.2 | 226.6 | 217.2 | 88.9 | 13.4 | 6,863.1 |
| 24 | 39G2 | 1,926.3 | 997.3 | 396.1 | 345.9 | 379.2 | 175.6 | 100.2 | 112.3 | 5.2 | 4,438.1 |
| 24 | 39G3 | 4,825.3 | 5,371.3 | 2,354.7 | 2,739.0 | 2,650.1 | 1,255.7 | 1,081.2 | 631.1 | 86.7 | 20,995.1 |
| 24 | 39G4 | 1,179.7 | 3,067.4 | 2,154.3 | 3,351.5 | 3,247.1 | 1,676.9 | 1,633.1 | 812.7 | 248.3 | 17,371.0 |
| | Total | 18,054.9 | 20,814.5 | 8,734.7 | 11,236.4 | 10,857.1 | 4,966.2 | 4,410.5 | 2,182.6 | 524.4 | 81,781.3 |
| 22-24 | Total | 36,497.6 | 26,861.8 | 14,409.7 | 31,805.8 | 36,360.7 | 26,984.1 | 19,880.8 | 14,603.6 | 6,516.7 | 213,920.8 |
| 21-24 | Total | 55,600.3 | 39,526.6 | 19,703.3 | 35,889.2 | 37,480.7 | 27,232.3 | 19,921.6 | 14,603.6 | 6,516.7 | 256,474.3 |

**Table 9: Numbers (millions) of sprat by age and area (RV "Solea" October 2006).**

| Sub-division | Rectangle/ Age group | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8+ | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 21 | 41G0 | 0.05 | 0.49 | 2.23 | 0.59 | | | | | | 3.36 |
| 21 | 41G1 | 0.56 | 16.89 | 42.09 | 11.43 | 0.23 | | | | | 71.20 |
| 21 | 41G2 | 10.07 | 33.24 | 110.40 | 49.11 | 8.24 | | 0.44 | | | 211.50 |
| 21 | 42G1 | 0.19 | 1.06 | 8.68 | 2.43 | 0.14 | | | | | 12.50 |
| 21 | 42G2 | 0.31 | 13.34 | 35.43 | 9.70 | 0.53 | | | | | 59.31 |
| 21 | 43G1 | | | | | | | | | | 0.00 |
| 21 | 44G0 | 11.05 | 10.98 | 18.78 | 4.18 | 0.31 | | | | | 45.30 |
| 21 | 44G1 | | | | | | | | | | 0.00 |
| | Total | 22.23 | 76.00 | 217.61 | 77.44 | 9.45 | 0.00 | 0.44 | 0.00 | 0.00 | 403.17 |
| 22 | 37G0 | 460.78 | 2.13 | 1.14 | 2.90 | 0.22 | | | | | 467.17 |
| 22 | 37G1 | 843.84 | 79.91 | 72.97 | 478.42 | 50.60 | 3.28 | | 1.48 | | 1,530.50 |
| 22 | 38G0 | 228.51 | 0.94 | 0.16 | 0.73 | 0.36 | 0.08 | | 0.03 | | 230.81 |
| 22 | 38G1 | 132.97 | 1.73 | 0.34 | 1.56 | 0.21 | | | 0.02 | | 136.83 |
| 22 | 39F9 | 98.64 | 0.74 | | | | | | | | 99.38 |
| 22 | 39G0 | 46.36 | 7.42 | 2.30 | 5.74 | 0.81 | | | 0.09 | | 62.72 |
| 22 | 39G1 | 206.37 | | 0.19 | 0.71 | 0.06 | | | | | 207.33 |
| 22 | 40F9 | 37.63 | | | | | | | | | 37.63 |
| 22 | 40G0 | 307.30 | 2.20 | 0.69 | 1.44 | 0.27 | | | 0.01 | | 311.91 |
| 22 | 40G1 | 24.19 | 0.25 | 0.10 | 0.27 | 0.04 | | | | | 24.85 |
| 22 | 41G0 | 0.25 | 0.18 | 0.06 | 0.10 | 0.03 | | | | | 0.62 |
| | Total | 2,386.84 | 95.50 | 77.95 | 491.87 | 52.60 | 3.36 | 0.00 | 1.63 | 0.00 | 3,109.75 |
| 23 | 40G2 | 17.03 | 19.54 | 12.53 | 13.36 | 3.54 | 0.73 | | | | 66.73 |
| 23 | 41G2 | 2.63 | 5.02 | 2.54 | 2.04 | 0.33 | 0.05 | | | | 12.61 |
| | Total | 19.66 | 24.56 | 15.07 | 15.40 | 3.87 | 0.78 | 0.00 | 0.00 | 0.00 | 79.34 |
| 24 | 37G2 | 1,130.90 | 42.35 | 11.04 | 8.20 | 4.05 | 0.57 | | | | 1,197.11 |
| 24 | 37G3 | 6,884.15 | | | | | | | | | 6,884.15 |
| 24 | 37G4 | 245.19 | 22.49 | 10.37 | 17.42 | 5.12 | 1.24 | 0.39 | | | 302.22 |
| 24 | 38G2 | 1,791.35 | 67.91 | 22.70 | 41.57 | 12.65 | 2.79 | 1.27 | | | 1,940.24 |
| 24 | 38G3 | 6,132.31 | 442.24 | 186.79 | 352.24 | 94.57 | 22.39 | 7.80 | | | 7,238.34 |
| 24 | 38G4 | 1,089.64 | 169.67 | 78.24 | 131.44 | 38.59 | 9.36 | 2.97 | | | 1,519.91 |
| 24 | 39G2 | 631.12 | 3.63 | 1.40 | 2.43 | 0.74 | 0.08 | 0.08 | | | 639.48 |
| 24 | 39G3 | 876.48 | 474.55 | 232.73 | 435.85 | 128.04 | 27.21 | 9.17 | | | 2,184.03 |
| 24 | 39G4 | 570.21 | 200.68 | 80.30 | 143.50 | 42.03 | 10.83 | 3.19 | | | 1,050.74 |
| | Total | 19,351.35 | 1,423.52 | 623.57 | 1,132.65 | 325.79 | 74.47 | 24.87 | 0.00 | 0.00 | 22,956.22 |
| 22-24 | Total | 21,757.85 | 1,543.58 | 716.59 | 1,639.92 | 382.26 | 78.61 | 24.87 | 1.63 | 0.00 | 26,145.31 |
| 21-24 | Total | 21,780.08 | 1,619.58 | 934.20 | 1,717.36 | 391.71 | 78.61 | 25.31 | 1.63 | 0.00 | 26,548.48 |

**Table 10: Mean weight (g) of sprat by age and area (RV "Solea" October 2006).**

| Sub-division | Rectangle/ Age group | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8+ | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 21 | 41G0 | 5.32 | 15.74 | 18.99 | 19.18 | 12.74 | | | | | 18.35 |
| 21 | 41G1 | 3.01 | 12.93 | 14.36 | 14.84 | 19.70 | | | | | 14.03 |
| 21 | 41G2 | 5.00 | 14.27 | 18.63 | 20.77 | 24.95 | | 28.00 | | | 18.06 |
| 21 | 42G1 | 4.88 | 13.85 | 19.25 | 20.21 | 23.32 | | | | | 18.80 |
| 21 | 42G2 | 6.40 | 14.75 | 18.23 | 19.58 | 21.51 | | | | | 17.64 |
| 21 | 43G1 | | | | | | | | | | 0.00 |
| 21 | 44G0 | 2.36 | 14.06 | 15.86 | 17.11 | 15.43 | | | | | 12.24 |
| 21 | 44G1 | | | | | | | | | | 0.00 |
| | Total | 3.66 | 14.03 | 17.53 | 19.52 | 24.29 | | 28.00 | | | 16.66 |
| 22 | 37G0 | 5.26 | 10.07 | 15.05 | 16.60 | 17.59 | | | | | 5.38 |
| 22 | 37G1 | 5.33 | 14.52 | 16.70 | 18.19 | 18.32 | 22.46 | | 15.92 | | 10.85 |
| 22 | 38G0 | 5.39 | 10.95 | 15.92 | 15.92 | 20.05 | 21.75 | | 15.92 | | 5.48 |
| 22 | 38G1 | 5.28 | 13.19 | 14.43 | 17.49 | 16.24 | | | 15.92 | | 5.56 |
| 22 | 39F9 | 4.31 | 9.67 | | | | | | | | 4.35 |
| 22 | 39G0 | 4.88 | 14.32 | 14.57 | 15.61 | 15.10 | | | 15.92 | | 7.48 |
| 22 | 39G1 | 4.19 | | 17.59 | 17.59 | 17.59 | | | | | 4.25 |
| 22 | 40F9 | 4.45 | | | | | | | | | 4.45 |
| 22 | 40G0 | 4.08 | 14.05 | 14.74 | 15.77 | 14.58 | | | 15.92 | | 4.24 |
| 22 | 40G1 | 3.48 | 14.34 | 15.50 | 16.27 | 15.43 | | | 15.92 | | 3.79 |
| 22 | 41G0 | 4.62 | 13.80 | 13.97 | 15.07 | 14.12 | | | 15.92 | | 10.37 |
| | Total | 4.98 | 14.30 | 16.58 | 18.14 | 18.25 | 22.44 | | 15.92 | | 7.88 |
| 23 | 40G2 | 4.79 | 14.29 | 17.27 | 20.13 | 21.35 | 22.66 | | | | 14.06 |
| 23 | 41G2 | 1.13 | 13.61 | 16.95 | 19.07 | 19.18 | 20.85 | | | | 12.74 |
| | Total | 4.30 | 14.15 | 17.22 | 19.99 | 21.16 | 22.54 | | | | 13.85 |
| 24 | 37G2 | 4.41 | 12.16 | 12.98 | 14.72 | 13.84 | 15.21 | | | | 4.87 |
| 24 | 37G3 | 3.27 | | | | | | | | | 3.27 |
| 24 | 37G4 | 3.78 | 12.64 | 14.68 | 16.29 | 15.82 | 16.74 | 19.29 | | | 5.81 |
| 24 | 38G2 | 4.67 | 11.60 | 14.85 | 15.97 | 15.95 | 17.07 | 19.29 | | | 5.37 |
| 24 | 38G3 | 4.57 | 12.27 | 14.68 | 16.93 | 15.89 | 17.04 | 19.29 | | | 6.10 |
| 24 | 38G4 | 4.13 | 12.64 | 14.68 | 16.29 | 15.82 | 16.74 | 19.29 | | | 7.08 |
| 24 | 39G2 | 4.55 | 12.55 | 14.57 | 16.56 | 16.35 | 19.29 | 19.29 | | | 4.68 |
| 24 | 39G3 | 4.95 | 12.64 | 15.06 | 16.51 | 15.93 | 16.94 | 19.29 | | | 10.86 |
| 24 | 39G4 | 5.15 | 12.19 | 14.83 | 16.38 | 15.74 | 16.82 | 19.29 | | | 9.35 |
| | Total | 4.11 | 12.40 | 14.82 | 16.56 | 15.85 | 16.92 | 19.29 | | | 5.75 |
| 22-24 | Total | 4.20 | 12.54 | 15.06 | 17.07 | 16.24 | 17.21 | 19.29 | 15.92 | | 6.03 |
| 21-24 | Total | 4.20 | 12.61 | 15.63 | 17.18 | 16.43 | 17.21 | 19.44 | 15.92 | | 6.19 |

**Table 11: Total biomass (t) of sprat by age and area (RV "Solea" October 2006).**

| Sub-division | Rectangle/ Age group | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8+ | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 21 | 41G0 | 0.3 | 7.7 | 42.3 | 11.3 | | | | | | 61.6 |
| 21 | 41G1 | 1.7 | 218.4 | 604.4 | 169.6 | 4.5 | | | | | 998.6 |
| 21 | 41G2 | 50.4 | 474.3 | 2,056.8 | 1,020.0 | 205.6 | | 12.3 | | | 3,819.4 |
| 21 | 42G1 | 0.9 | 14.7 | 167.1 | 49.1 | 3.3 | | | | | 235.1 |
| 21 | 42G2 | 2.0 | 196.8 | 645.9 | 189.9 | 11.4 | | | | | 1,046.0 |
| 21 | 43G1 | | | | | | | | | | 0.0 |
| 21 | 44G0 | 26.1 | 154.4 | 297.9 | 71.5 | 4.8 | | | | | 554.7 |
| 21 | 44G1 | | | | | | | | | | 0.0 |
| | Total | 81.4 | 1,066.3 | 3,814.4 | 1,511.4 | 229.6 | 0.0 | 12.3 | 0.0 | 0.0 | 6,715.4 |
| 22 | 37G0 | 2,423.7 | 21.4 | 17.2 | 48.1 | 3.9 | | | | | 2,514.3 |
| 22 | 37G1 | 4,497.7 | 1,160.3 | 1,218.6 | 8,702.5 | 927.0 | 73.7 | | 23.6 | | 16,603.4 |
| 22 | 38G0 | 1,231.7 | 10.3 | 2.5 | 11.6 | 7.2 | 1.7 | | 0.5 | | 1,265.5 |
| 22 | 38G1 | 702.1 | 22.8 | 4.9 | 27.3 | 3.4 | | | 0.3 | | 760.8 |
| 22 | 39F9 | 425.1 | 7.2 | | | | | | | | 432.3 |
| 22 | 39G0 | 226.2 | 106.3 | 33.5 | 89.6 | 12.2 | | | 1.4 | | 469.2 |
| 22 | 39G1 | 864.7 | | 3.3 | 12.5 | 1.1 | | | | | 881.6 |
| 22 | 40F9 | 167.5 | | | | | | | | | 167.5 |
| 22 | 40G0 | 1,253.8 | 30.9 | 10.2 | 22.7 | 3.9 | | | 0.2 | | 1,321.7 |
| 22 | 40G1 | 84.2 | 3.6 | 1.6 | 4.4 | 0.6 | | | | | 94.4 |
| 22 | 41G0 | 1.2 | 2.5 | 0.8 | 1.5 | 0.4 | | | | | 6.4 |
| | Total | 11,877.9 | 1,365.3 | 1,292.6 | 8,920.2 | 959.7 | 75.4 | 0.0 | 26.0 | 0.0 | 24,517.1 |
| 23 | 40G2 | 81.6 | 279.2 | 216.4 | 268.9 | 75.6 | 16.5 | | | | 938.2 |
| 23 | 41G2 | 3.0 | 68.3 | 43.1 | 38.9 | 6.3 | 1.0 | | | | 160.6 |
| | Total | 84.6 | 347.5 | 259.5 | 307.8 | 81.9 | 17.5 | 0.0 | 0.0 | 0.0 | 1,098.8 |
| 24 | 37G2 | 4,987.3 | 515.0 | 143.3 | 120.7 | 56.1 | 8.7 | | | | 5,831.1 |
| 24 | 37G3 | 22,511.2 | | | | | | | | | 22,511.2 |
| 24 | 37G4 | 926.8 | 284.3 | 152.2 | 283.8 | 81.0 | 20.8 | 7.5 | | | 1,756.4 |
| 24 | 38G2 | 8,365.6 | 787.8 | 337.1 | 663.9 | 201.8 | 47.6 | 24.5 | | | 10,428.3 |
| 24 | 38G3 | 28,024.7 | 5,426.3 | 2,742.1 | 5,963.4 | 1,502.7 | 381.5 | 150.5 | | | 44,191.2 |
| 24 | 38G4 | 4,500.2 | 2,144.6 | 1,148.6 | 2,141.2 | 610.5 | 156.7 | 57.3 | | | 10,759.1 |
| 24 | 39G2 | 2,871.6 | 45.6 | 20.4 | 40.2 | 12.1 | 1.5 | 1.5 | | | 2,992.9 |
| 24 | 39G3 | 4,338.6 | 5,998.3 | 3,504.9 | 7,195.9 | 2,039.7 | 460.9 | 176.9 | | | 23,715.2 |
| 24 | 39G4 | 2,936.6 | 2,446.3 | 1,190.8 | 2,350.5 | 661.6 | 182.2 | 61.5 | | | 9,829.5 |
| | Total | 79,462.6 | 17,648.2 | 9,239.4 | 18,759.6 | 5,165.5 | 1,259.9 | 479.7 | 0.0 | 0.0 | 132,014.9 |
| 22-24 | Total | 91,425.1 | 19,361.0 | 10,791.5 | 27,987.6 | 6,207.1 | 1,352.8 | 479.7 | 26.0 | 0.0 | 157,630.8 |
| 21-24 | Total | 91,506.5 | 20,427.3 | 14,605.9 | 29,499.0 | 6,436.7 | 1,352.8 | 492.0 | 26.0 | 0.0 | 164,346.2 |

# Annex 4: ICES Coordinated Acoustic Survey of ICES Divisions IIIa, IVa, IVb, IVc and VIa (North) 2006 Results

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### Abstract

Six surveys were carried out during late June and July covering most of the continental shelf north of 52°N in the North Sea and to the west of Scotland to a northern limit of 62°N. The eastern edge of the survey area was bounded by the Norwegian and Danish, Swedish and German coastline and to the west by the shelf edge between 200 and 400 m depth. The surveys are reported individually in the report of the planning group for herring surveys, and this combined report has been prepared from the data from all surveys. The combined survey results provide spatial distributions of herring abundance by number and biomass at age by statistical rectangle; and distributions of mean weight and fraction mature at age.

The estimates of North Sea autumn spawning herring SSB are reasonably consistent with previous years, at 2.1 million tonnes and 11,830 millions herring (Table 2). The survey again shows two well-above year classes of herring (1998 and 2000). Growth of the 2000 year class seems still to be slower than average, individuals of this year class having almost the same size and weights than the one year younger fish of the 2001 year class.

The estimates of Western Baltic spring spawning herring SSB are 336,500 tonnes and 4,026 million herring (Table 3), which is a strong increase following last years small decrease, but the Western Baltic survey is known to produces a rather noisy signal. The indications are that the stock might has recovered and is dominated by 1 and 2 ring fish.

The West of Scotland estimates of SSB are 472,000 tonnes and 2.6 billion herring. This is a substantial increase compared to last years estimate, and the SSB has more than doubled. The SSB is in the same order of magnitude that it had during the last ten years. The abundance by year class is consistent with previous years and also with results from the adjacent North Sea area. The 1998 year class is now depleted, but there were a significant number of 2 and 5 ring fish seen on the survey.

### Introduction

Six surveys were carried out during late June and July covering most of the continental shelf north of 52°N in the North Sea and to the west of Scotland to a northern limit of 62°N. The eastern edge of the survey area was bounded by the Norwegian and Danish, Swedish and German coastline and to the west by the shelf edge between 200 and 400 m depth. The surveys are reported individually in appendices 2A-F of the report of the planning group for herring surveys (ICES, 2004). The vessels, areas and dates of cruises are given below and in Figure 1:

**Table 1: Vessels, areas and cruise dates during the 2007 herring acoustic surveys.**

| VESSEL | PERIOD | AREA | RECTANGLES |
|---|---|---|---|
| FV Enterprise (SCO) | 1 July – 21 July | 56°- 60°30’ N, 3° - 10° W | 41E0-E3, 42E0-E3, 43E0-E3, 44E0-E3, 45E0-E4, 46E2-E5, 47E2-E6, 48E3-E6, 49E5 |
| Johan Hjort (NOR) | 19 June – 16 July | 56°30’ N - 62° N, 2°-6°E | 42F2-F5, 43F2-F5, 44F2-F5, 45F2-F5, 46F2- F4, 47F2-F4, 48F2-F4, 49F2-F4, 50F2-F4, 51F2-F4, 52F2-F4, plus overlap area A |
| Scotia (SCO) | 1 July – 21 July | 57° - 62° N, 2/4°W - 2°E | 43E8-F1, 44E6-F1, 45F0-F1, 46E6-F1, 47E6-F1, 48E6-F1, 49E6-F1, 50E7-F1, 51E8-F1, 52E9-F1 |
| Tridens (NED) | 26 June – 21 July | 53°30’ – 58°30’ N, Eng/Sco to Den/Ger coasts | 38F2-F7, 40E8-F7, 41E7-F7, 42E7- F1, 45E6-E9 |
| Solea (GER) | 29 June – 18 July | 52° - 56°30’ N, Eng to Den/Ger coasts | 33F1-F4, 34F2-F4, 35F2-F4, 36F0-F7, 37E9- F8, 38E9-F1, 39E8-F7 |
| Dana (DEN) | 25 June – 6 July | Kattegat north of 56° + Skagerrak and North Sea north of 56°30’ N, east of 6° E | 41G1-G2, 42F6-F7, 42G0-G3, 43F6-G2, 44F6-G1, 45F6, 45F8-G1, 46F9-G0 |

The data have been combined to provide an overall estimate. Estimates of numbers at age, maturity stage and mean weights at age are calculated as weighted means of individual survey estimates by ICES statistical rectangle. The weighting applied is proportional to the length of survey track for each vessel that has covered each statistical rectangle. The data have been combined and estimates of North Sea autumn spawning herring, Western Baltic spring spawning herring, and West of Scotland (VIa north) herring are provided.

### Methods

The acoustic surveys were carried out using Simrad EK60, 38 kHz sounder echo-integrator with transducers mounted on the hull, drop keel and towed bodies. Further data analysis was carried out using either BI500, Echoview or Echoann software. The survey track was selected to cover the area giving a basic sampling intensity over the whole area based on the limits of herring densities found in previous years. A transect spacing of 15 nautical miles was used in most parts of the area with the exception of some relatively high density sections, east and west of Shetland, in the Skagerrak where short additional transects were carried out at 7.5 n. mi spacing, and in most of the southern North Sea, where transect spacing was reduced to 30 n. mi.

The following target strength to fish length relationships have been used to analyse the data:

herring $TS = 20 \log L - 71.2$ dB

sprat $TS = 20 \log L -71.2$ dB

gadoids $TS = 20 \log L - 67.5$ dB

mackerel $TS = 21.7 \log L - 84.9$ dB

### Combined Acoustic Survey Results for 2006

The estimates of North Sea autumn spawning herring SSB are reasonably consistent with previous years, at 2.1 million tonnes and 11,830 millions herring (Table 2). The survey again shows two well-above year classes of herring (1998 and 2000).

The abundance of the 2005 year class is well in the range of the most recent years, but is estimated to be two times higher when comparable to 2004. Growth and individual weights are found to be higher in the 2005 year class, compared to 2004.

Growth of the 2000 year class seems still to be slower than average, individuals of this year class having almost the same size and weights than the one year younger fish of the 2001 year class.

The estimates of Western Baltic spring spawning herring SSB are 336,500 tonnes and 4,026 million herring (Table 3), which is a strong increase following last years small decrease, but the Western Baltic survey is known to produces a rather noisy signal. The indications are that the stock might has recovered and is dominated by 1 and 2 ring fish.

Both the stock estimate as well as the SSB estimate for the herring in VIa(N) (West of Scotland) have significantly increased when compared to last years estimate. Given the known difficulties of quantifying young fish on this survey, the SSB estimate is likely to give the better index of change. The estimates of SSB are 472,000 tonnes and 2.6 billion herring (Table 4), which means the SSB has more than doubled. It is in the same order of magnitude than it had during the last ten years. The abundance by year class is consistent with previous years and also with results from the adjacent North Sea area. The 1998 year class is now depleted, but there were a significant number of 2 and 5 ring fish seen on the survey.

The area covered during the individual acoustic surveys is given in Figure 1. The spatial distributions of the abundance (numbers and biomass) of autumn spawning herring are shown in Figure 2. The distribution of numbers by age is shown in Figure 3 for 1 ring, 2 ring and 3+ ring autumn spawning herring. The survey provides estimates of maturity and weight at age: the mean weight at age for 1 and 2 ring herring along with the proportion mature for 2 and 3 ring herring are shown in Figure 4. The spatial distribution of mature and immature autumn spawning herring is shown in Figures 5 and 6 respectively. The spatial distributions of the abundance (numbers and biomass) of Western Baltic spring spawning herring are shown in Figure 7. The distribution of numbers by age is shown in Figure 8 for 1 ring, 2 ring and 3+ ring. The mean weight at age for 1 and 2 ring herring along with the proportion mature for 2 and 3 ring herring are shown in Figure 9. The spatial distribution of mature and immature Western Baltic spring spawning herring is shown in Figures 10 and 11 respectively.

The time series of abundance for all three stocks, North Sea autumn spawners, Western Baltic spring spawners and West of Scotland herring are given in Tables 5, 6 and 7, illustrated in Figures 12, 13 and 14 respectively. In each of them, a 3 year running mean is included to show the general trend more clearly.

## References

ICES. 2004. Report of the Herring Assessment Working Group for the Area South of 62°N. ICES CM 2005/ACFM:10.

ICES. 2003. Report of the Planning Group for Herring Surveys. ICES CM 2003/G:05.

**Table 2: Total numbers (millions of fish) and biomass (thousands of tonnes) of North Sea autumn spawning herring in the area surveyed in the acoustic surveys July 2006, with mean weights and mean lengths by age ring.**

| AGE ( RING) | NUMBERS | BIOMASS | MATURITY | WEIGHT(G) | LENGTH (CM) |
|---|---|---|---|---|---|
| 0 | 4621.8 | 42.1 | 0.00 | 9.1 | 10.65 |
| 1 | 6822.8 | 305.2 | 0.00 | 44.7 | 17.92 |
| 2 | 3772.3 | 477.8 | 0.66 | 126.7 | 24.22 |
| 3 | 1997.2 | 315.2 | 0.88 | 157.9 | 25.96 |
| 4 | 2097.5 | 394.3 | 0.98 | 188.0 | 27.19 |
| 5 | 4175.1 | 784.4 | 1.00 | 187.9 | 27.23 |
| 6 | 618.2 | 139.2 | 1.00 | 225.2 | 28.68 |
| 7 | 562.1 | 136.5 | 1.00 | 242.8 | 29.33 |
| 8 | 84.3 | 20.5 | 1.00 | 243.9 | 29.50 |
| 9+ | 70.4 | 18.6 | 1.00 | 265.0 | 30.19 |
| Immature | 12994.4 | 503.9 | | 38.8 | 15.92 |
| Mature | 11827.3 | 2129.9 | | 180.1 | 26.83 |
| Total | 24821.7 | 2633.8 | | 106.1 | 21.12 |

**Table 3: Total numbers (millions of fish) and biomass (thousands of tonnes) of Western Baltic spring spawning herring in the area surveyed in the acoustic surveys July 2006, with mean weights, mean length and fraction mature by age ring.**

| AGE ( RING) | NUMBERS | BIOMASS | MATURITY | WEIGHT(G) | LENGTH (CM) |
|---|---|---|---|---|---|
| 0 | 5.4 | | | 5.9 | 10.19 |
| 1 | 2081.1 | 112.6 | 0.19 | 54.1 | 19.18 |
| 2 | 2217.0 | 160.4 | 0.67 | 72.4 | 21.23 |
| 3 | 1780.4 | 158.7 | 0.91 | 89.1 | 23.22 |
| 4 | 490.0 | 56.2 | 0.96 | 114.8 | 24.96 |
| 5 | 180.4 | 23.7 | 1 | 131.6 | 26.21 |
| 6 | 27.0 | 4.1 | 1 | 153.2 | 27.61 |
| 7 | 9.5 | 1.6 | 1 | 169.2 | 28.89 |
| 8 | 0.0 | 0.0 | | | |
| 9+ | 0.1 | 0.0 | 1 | 178.0 | 29.80 |
| Immature | 2764.2 | 180.9 | | 65.5 | 20.36 |
| Mature | 4026.7 | 336.5 | | 83.6 | 22.37 |
| Total | 6790.9 | 517.4 | | 76.2 | 21.55 |

**Table 4: Total numbers (millions of fish) and biomass (thousands of tonnes) of autumn spawning of West of Scotland herring in the area surveyed in the acoustic surveys July 2006, with mean weights, mean lengths and fraction mature by age ring.**

| AGE ( RING) | NUMBERS | BIOMASS | MATURITY | WEIGHT(G) | LENGTH (CM) |
|---|---|---|---|---|---|
| 0 | | | | | |
| 1 | 112.3 | 8.4 | 0 | 74.99 | 20.57 |
| 2 | 835.2 | 112.5 | 0.808 | 134.52 | 24.66 |
| 3 | 387.9 | 64.3 | 0.965 | 165.72 | 26.33 |
| 4 | 284.5 | 52.8 | 1 | 185.42 | 27.29 |
| 5 | 582.2 | 112.2 | 1 | 192.48 | 27.60 |
| 6 | 414.7 | 84.8 | 1 | 204.13 | 28.11 |
| 7 | 227.0 | 48.0 | 1 | 211.22 | 28.39 |
| 8 | 21.7 | 4.8 | 1 | 224.04 | 29.92 |
| 9+ | 59.3 | 13.7 | 1 | 231.01 | 29.17 |
| Immature | 284.5 | 29.9 | | | |
| Mature | 2640.1 | 471.7 | | | |
| Total | 2924.6 | 501.5 | | | |

**Table 5: Estimates of North Sea autumn spawners (millions) at age from acoustic surveys, 1984-2006. For 1984-1986 the estimates are the sum of those from the Division IVa summer survey, the Division IVb autumn survey, and the Divisions IVc, VIId winter survey. The 1987 to 2006 estimates are from the summer survey in Divisions IVa,b and IIIa excluding estimates of Division IIIa/Baltic spring spawners. For 1999 and 2000 the Kattegat was excluded from the results because it was not surveyed.**

| Age (rings) | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 551 | 726 | 1,639 | 13,736 | 6,431 | 6,333 | 6,249 | 3,182 | 6,351 | 10,399 | 3,646 | 4,202 |
| 2 | 3,194 | 2,789 | 3,206 | 4,303 | 4,202 | 3,726 | 2,971 | 2,834 | 4,179 | 3,710 | 3,280 | 3,799 |
| 3 | 1,005 | 1,433 | 1,637 | 955 | 1,732 | 3,751 | 3,530 | 1,501 | 1,633 | 1,855 | 957 | 2,056 |
| 4 | 394 | 323 | 833 | 657 | 528 | 1,612 | 3,370 | 2,102 | 1,397 | 909 | 429 | 656 |
| 5 | 158 | 113 | 135 | 368 | 349 | 488 | 1,349 | 1,984 | 1,510 | 795 | 363 | 272 |
| 6 | 44 | 41 | 36 | 77 | 174 | 281 | 395 | 748 | 1,311 | 788 | 321 | 175 |
| 7 | 52 | 17 | 24 | 38 | 43 | 120 | 211 | 262 | 474 | 546 | 238 | 135 |
| 8 | 39 | 23 | 6 | 11 | 23 | 44 | 134 | 112 | 155 | 178 | 220 | 110 |
| 9+ | 41 | 19 | 8 | 20 | 14 | 22 | 43 | 56 | 163 | 116 | 132 | 84 |
| Total | 5,478 | 5,484 | 7,542 | 20,165 | 13,496 | 16,377 | 18,262 | 12,781 | 17,173 | 19,326 | 13,003 | 11,220 |
| SSB (‘000t) | 807 | 697 | 942 | 817 | 897 | 1,637 | 2,174 | 1,874 | 1,545 | 1,216 | 1,035 | 1,082 |

| Age (rings) | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 6,198 | 9,416 | 4,449 | 5,087 | 24,735 | 6,837 | 23,055 | 9,829 | 5,183 | 3,113 | 6,823 |
| 2 | 4,557 | 6,363 | 5,747 | 3,078 | 2,922 | 12,290 | 4,875 | 18,949 | 3,415 | 1,890 | 3,772 |
| 3 | 2,824 | 3,287 | 2,520 | 4,725 | 2,156 | 3,083 | 8,220 | 3,081 | 9,191 | 3,436 | 1,997 |
| 4 | 1,087 | 1,696 | 1,625 | 1,116 | 3,139 | 1,462 | 1,390 | 4,189 | 2,167 | 5,609 | 2,098 |
| 5 | 311 | 692 | 982 | 506 | 1,006 | 1,676 | 795 | 675 | 2,590 | 1,211 | 4,175 |
| 6 | 99 | 259 | 445 | 314 | 483 | 450 | 1,031 | 495 | 317 | 1,172 | 618 |
| 7 | 83 | 79 | 170 | 139 | 266 | 170 | 244 | 568 | 328 | 140 | 562 |
| 8 | 133 | 78 | 45 | 54 | 120 | 98 | 121 | 146 | 342 | 127 | 84 |
| 9+ | 206 | 158 | 121 | 87 | 97 | 59 | 150 | 178 | 186 | 107 | 70 |
| Total | 18,786 | 22,028 | 16,104 | 15,107 | 34,928 | 26,124 | 39,881 | 38,110 | 23,722 | 16,805 | 20,199 |
| SSB(‘000t) | 1,446 | 1,780 | 1,792 | 1,534 | 1,833 | 2,622 | 2,948 | 2,999 | 2,584 | 1,868 | 2,130 |

**Table 6: Numbers (millions) of Western Baltic Spring Spawning herring at age (rings) from acoustic surveys 1989 to 2006. The 1999 survey was incomplete due to the lack of participation by RV “DANA”.**

| Year | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | 31 | | 3,853 | 372 | 964 | | | | | | |
| 1 | | 135 | | 277 | 103 | 5 | 2,199 | 1,091 | 128 | 138 | 1367 | 1509 |
| 2 | 1,105 | 1,497 | 1,864 | 2,092 | 2,768 | 413 | 1,887 | 1,005 | 715 | 1,682 | 1143 | 1891 |
| 3 | 714 | 549 | 1,927 | 1,799 | 1,274 | 935 | 1,022 | 247 | 787 | 901 | 523 | 674 |
| 4 | 317 | 319 | 866 | 1,593 | 598 | 501 | 1,270 | 141 | 166 | 282 | 135 | 364 |
| 5 | 81 | 110 | 350 | 556 | 434 | 239 | 255 | 119 | 67 | 111 | 28 | 186 |
| 6 | 51 | 24 | 88 | 197 | 154 | 186 | 174 | 37 | 69 | 51 | 3 | 56 |
| 7 | 16 | 10 | 72 | 122 | 63 | 62 | 39 | 20 | 80 | 31 | 2 | 7 |
| 8+ | 4 | 5 | 10 | 20 | 13 | 34 | 21 | 13 | 77 | 53 | 1 | 10 |
| Total | 2,288 | 2,680 | 5,177 | 10,509 | 5,779 | 3,339 | 6,867 | 2,673 | 2,088 | 3,248 | 3,201 | 4,696 |
| 3+ group | 1,183 | 1,017 | 3,313 | 4,287 | 2,536 | 1,957 | 2,781 | 577 | 1,245 | 1,428 | 691 | 1,295 |

**Table 6: continued.**

| YEAR | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|
| 0 | | | | 0 | | 5 |
| 1 | 66 | 3,346 | 1,833 | 1,668 | 2,687 | 2,081 |
| 2 | 641 | 1,576 | 1,110 | 930 | 1,342 | 2,217 |
| 3 | 452 | 1,392 | 395 | 726 | 464 | 1,780 |
| 4 | 153 | 524 | 323 | 307 | 201 | 490 |
| 5 | 96 | 88 | 103 | 184 | 103 | 180 |
| 6 | 38 | 40 | 25 | 72 | 84 | 27 |
| 7 | 23 | 18 | 12 | 22 | 37 | 10 |
| 8+ | 12 | 19 | 5 | 18 | 21 | 0.1 |
| Total | 1,481 | 7,002 | 3,807 | 3,926 | 4,939 | 6,791 |
| 3+ group | 774 | 2,081 | 864 | 1,328 | 910 | 2,487 |

**Table 7: Numbers at age (millions) and SSB of West of Scotland Autumn Spawning herring at age (rings) from acoustic surveys 1987, 1991 to 2006. In 1997 the survey was carried out one month early in June as opposed to July when all the other surveys were carried out.**

| AGE | 1987 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997[#] | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 249 | 338 | 74 | 3 | 494 | 441 | 41 | 792 | 1,221 | 534 | 448 | 313 | 425 | 439 | 564 | 50 | 112 |
| 2 | 578 | 295 | 503 | 750 | 542 | 1,103 | 577 | 642 | 795 | 322 | 316 | 1,062 | 436 | 1039 | 275 | 243 | 835 |
| 3 | 551 | 328 | 211 | 681 | 608 | 473 | 803 | 286 | 667 | 1,389 | 337 | 218 | 1,437 | 933 | 760 | 230 | 388 |
| 4 | 353 | 368 | 258 | 653 | 286 | 450 | 329 | 167 | 471 | 432 | 900 | 173 | 200 | 1472 | 442 | 423 | 285 |
| 5 | 753 | 488 | 415 | 544 | 307 | 153 | 95 | 66 | 179 | 308 | 393 | 438 | 162 | 181 | 577 | 245 | 582 |
| 6 | 112 | 176 | 240 | 865 | 268 | 187 | 61 | 50 | 79 | 139 | 248 | 133 | 424 | 129 | 56 | 153 | 415 |
| 7 | 48 | 99 | 106 | 284 | 407 | 169 | 77 | 16 | 28 | 87 | 200 | 103 | 152 | 347 | 62 | 13 | 227 |
| 8 | 16 | 90 | 57 | 152 | 174 | 237 | 78 | 29 | 14 | 28 | 95 | 52 | 68 | 114 | 82 | 39 | 22 |
| 9+ | 7 | 58 | 64 | 156 | 132 | 202 | 115 | 24 | 37 | 35 | 65 | 35 | 60 | 75 | 76 | 27 | 59 |
| SSB: | 273 | 452 | 352 | 866 | 534 | 452 | 370 | 141 | 376 | 460 | 500 | 359 | 549 | 739 | 396 | 168 | 472 |

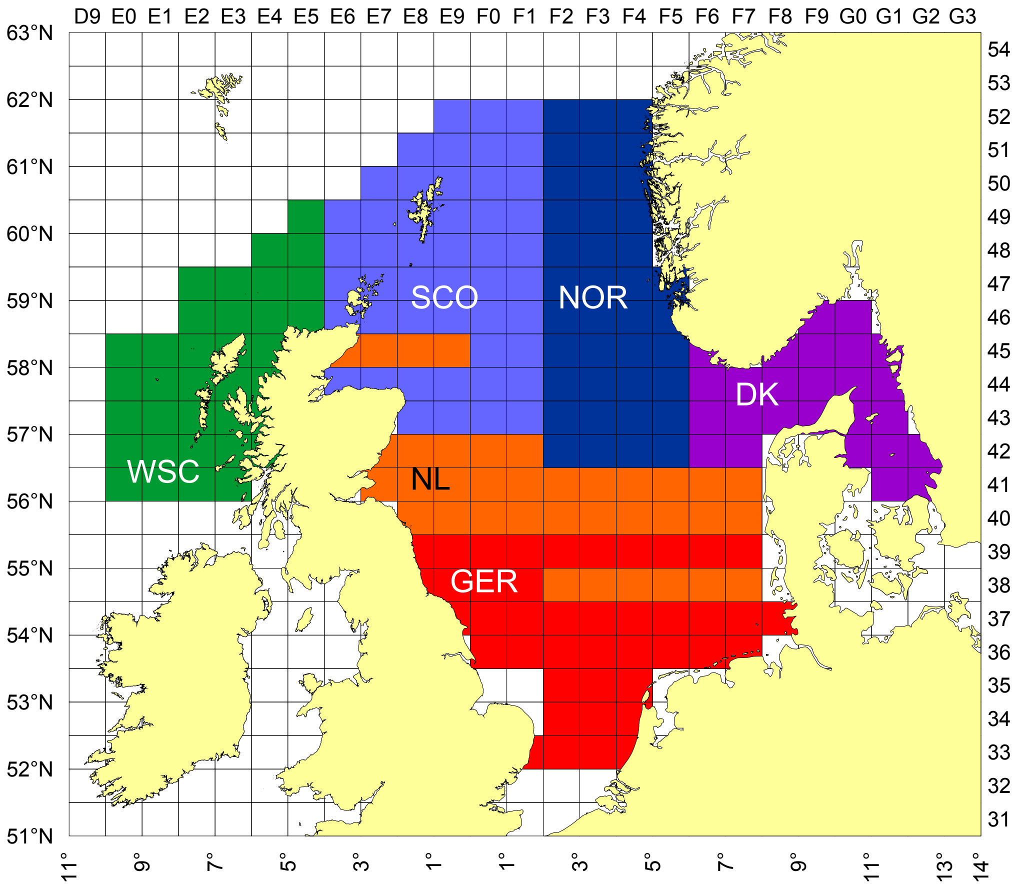


**Figure 1: Survey area coverage in the herring acoustic surveys in 2006, by rectangle and nation (WSC = West of Scotland charter vessel; SCO = Scotia; NOR = Johan Hjort; DK = Dana; NL = Tridens; GER = Solea).**

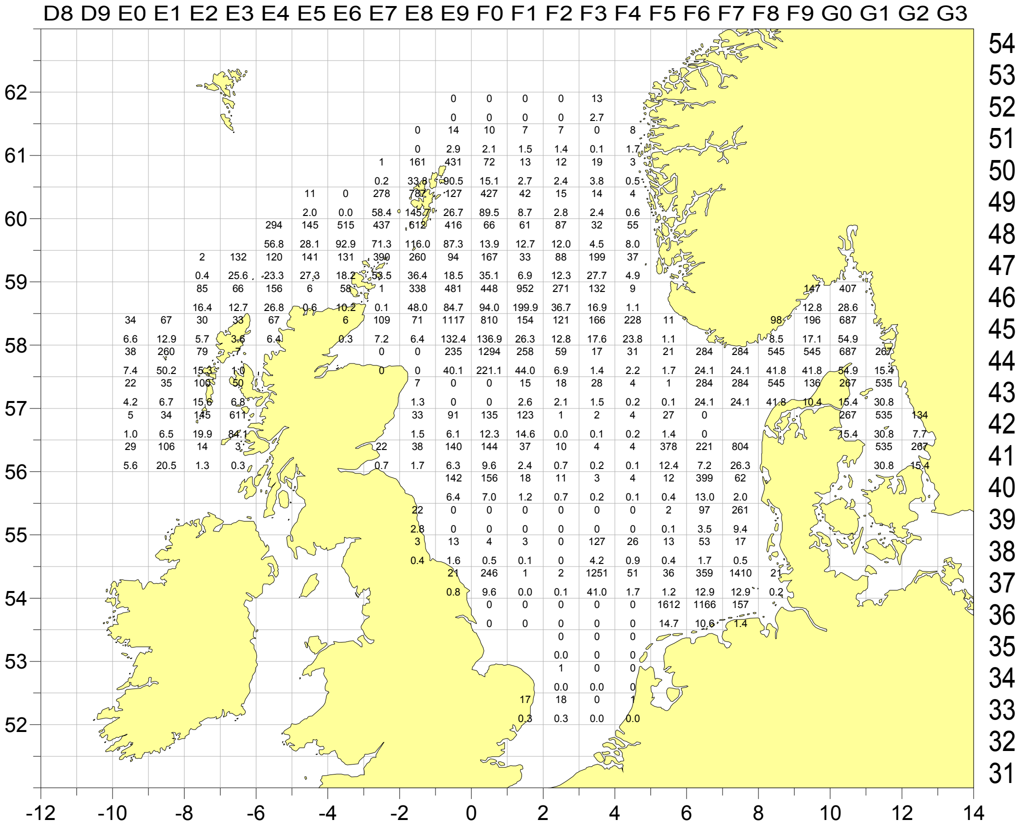


**Figure 2: Abundance of Autumn spawning herring 1-9+ from combined acoustic survey July 2006. Numbers (millions) (upper figure) and biomass (thousands of tonnes) (lower figure).**

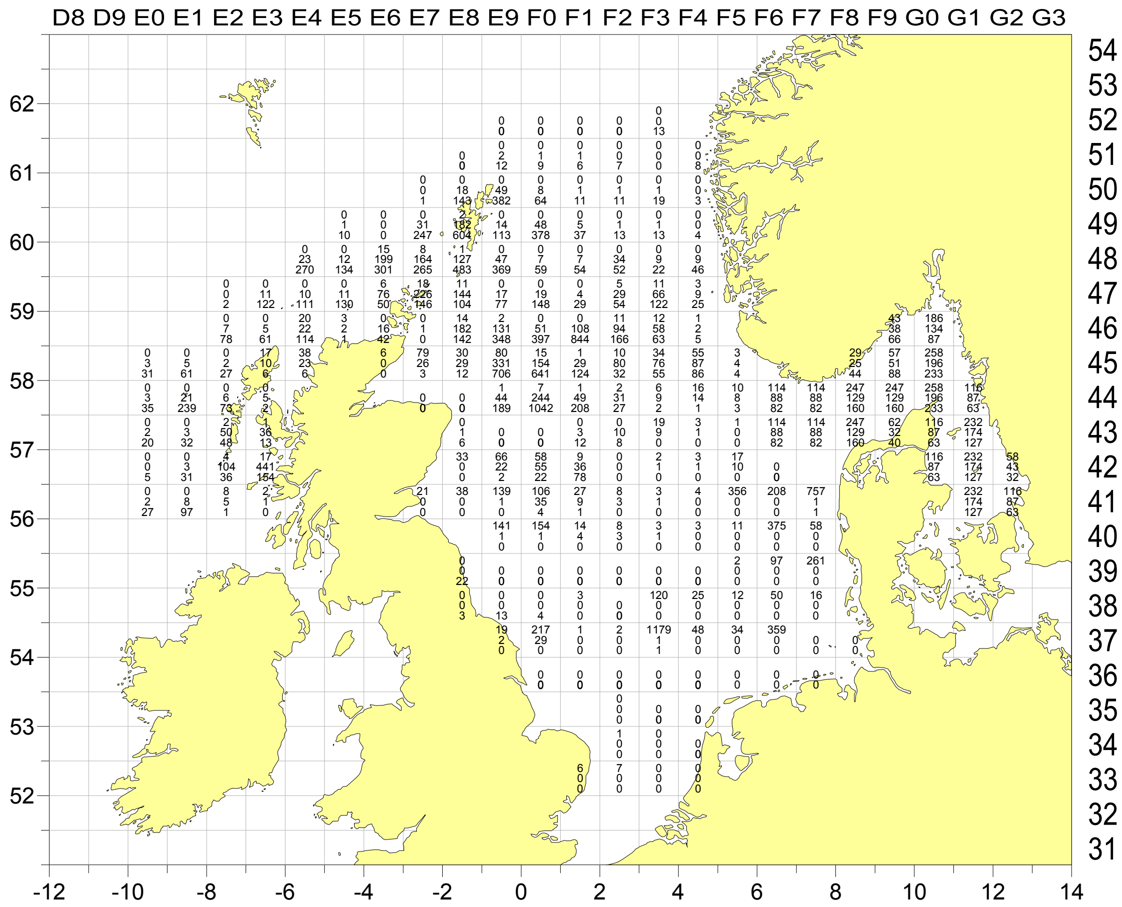

**Figure 3: Numbers (millions) of Autumn spawning herring from combined acoustic survey June – July 2006. 1 ring (upper figure), 2 ring (centre figure), 3+ (lower figure).**

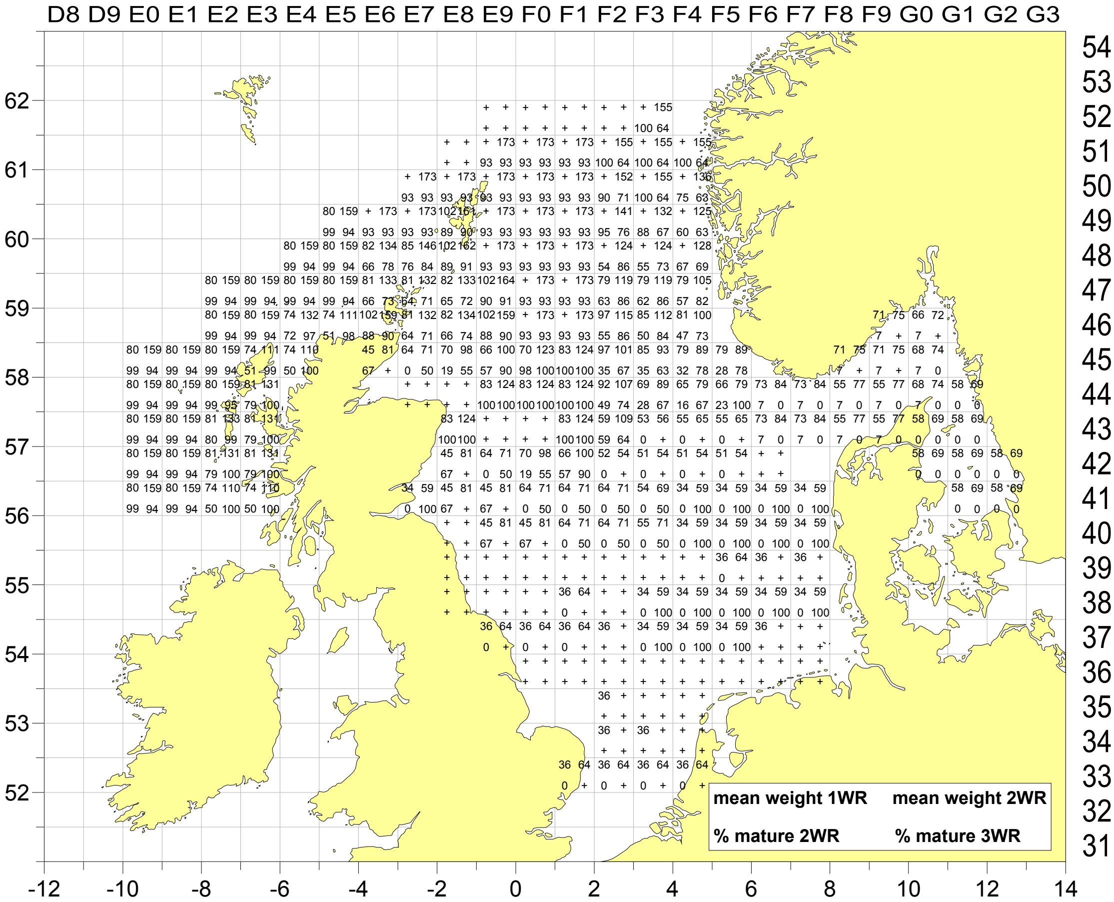


**Figure 4: Mean weight and maturity of autumn spawning herring from combined acoustic survey June – July 2006. Four values per ICES rectangle, percentage mature of 2 ring (lower left) and 3 ring fish (lower right), mean weights gram of 1 ring (upper left) and 2 ring fish (upper right), 0 indicates measured percentage mature, + indicates surveyed with zero abundance, blank indicates an unsurveyed rectangle.**

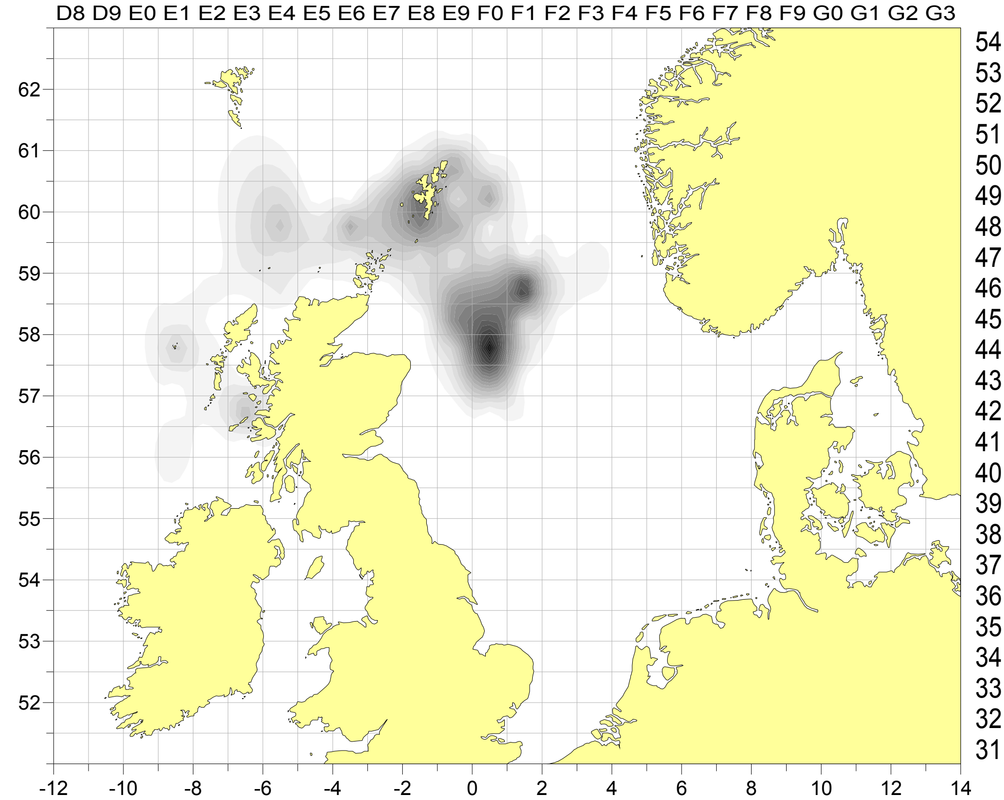


**Figure 5: Biomass of mature autumn spawning herring from combined acoustic survey in June – July 2006.**

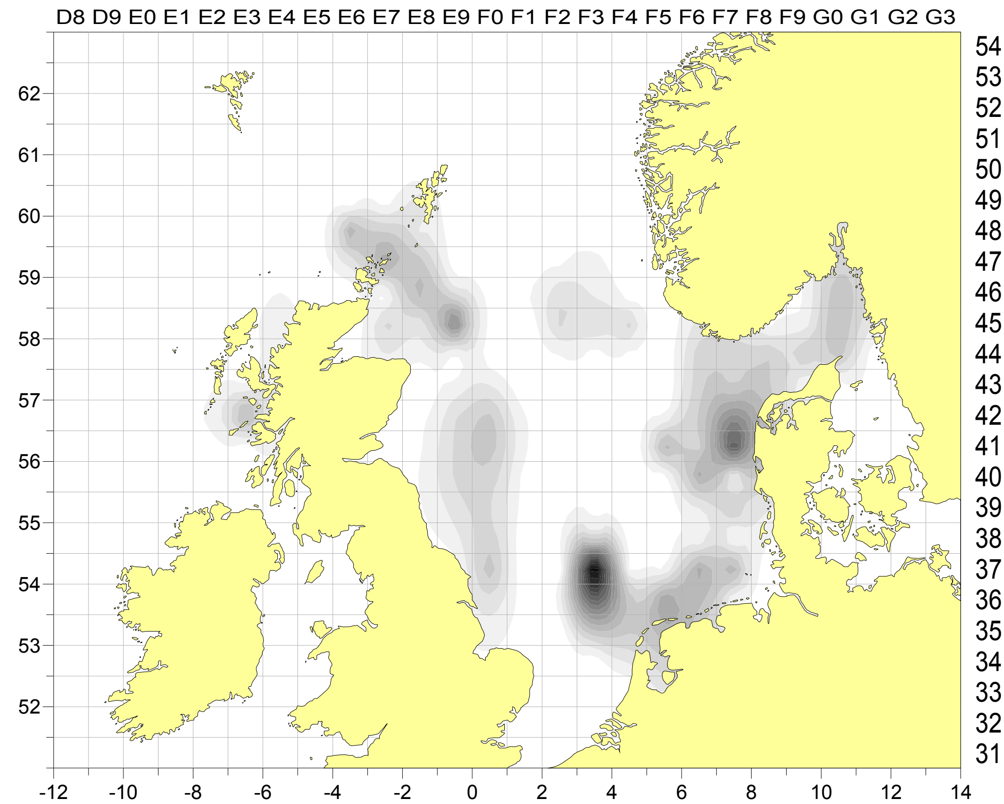


**Figure 6: Biomass of immature autumn spawning herring from combined acoustic survey in June – July 2006.**

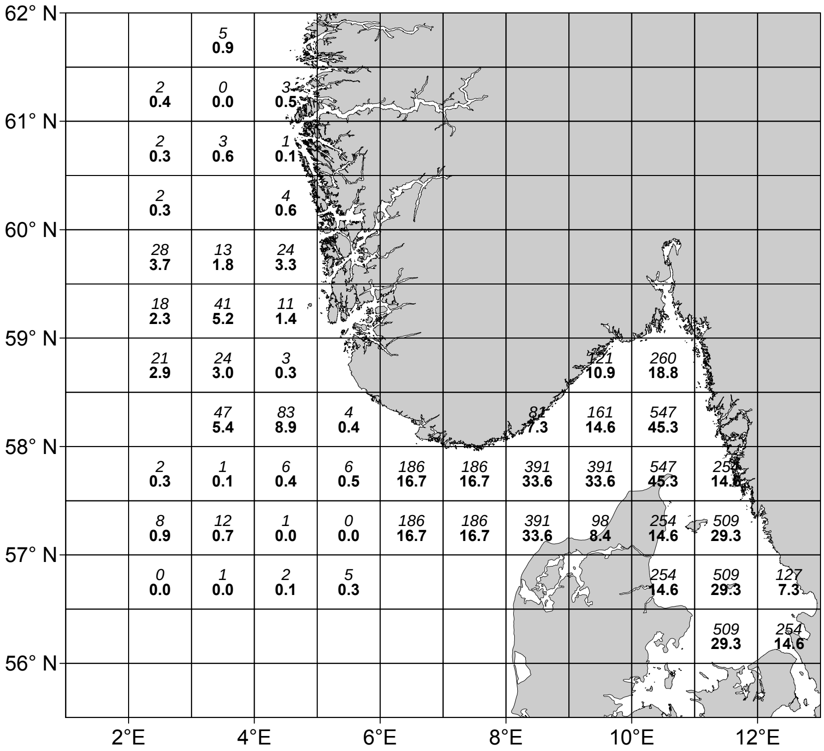


**Figure 7: Abundance of western spring spawning herring 1-9+ from combined acoustic survey July 2006. Numbers (millions) (upper figure) and biomass (thousands of tonnes) (lower figure).**

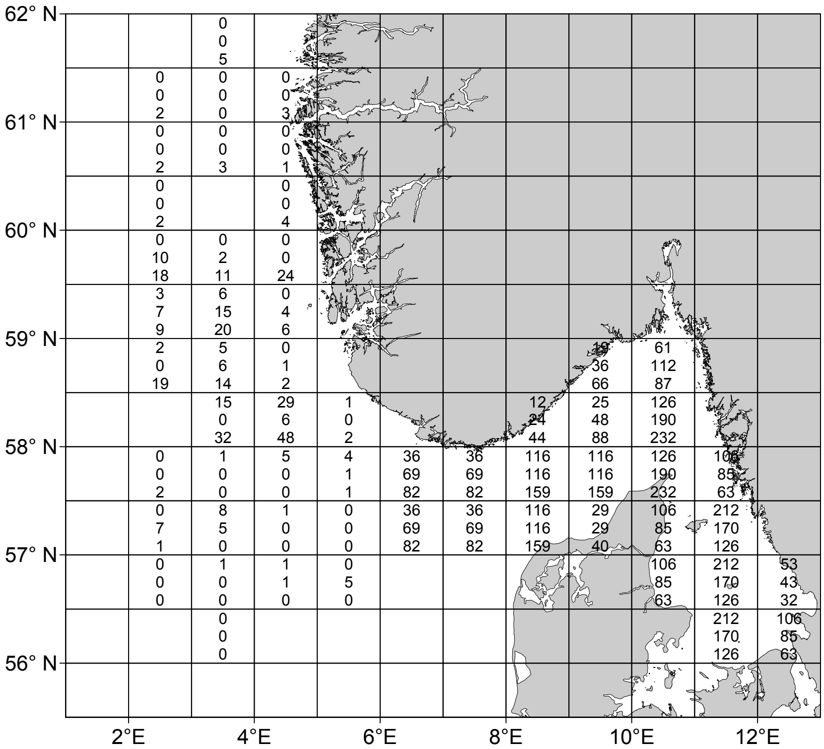


**Figure 8: Numbers (millions) of western Baltic spring spawning herring from combined acoustic survey June – July 2006. 1 ring (upper figure), 2 ring (centre figure), 3+ (lower figure).**

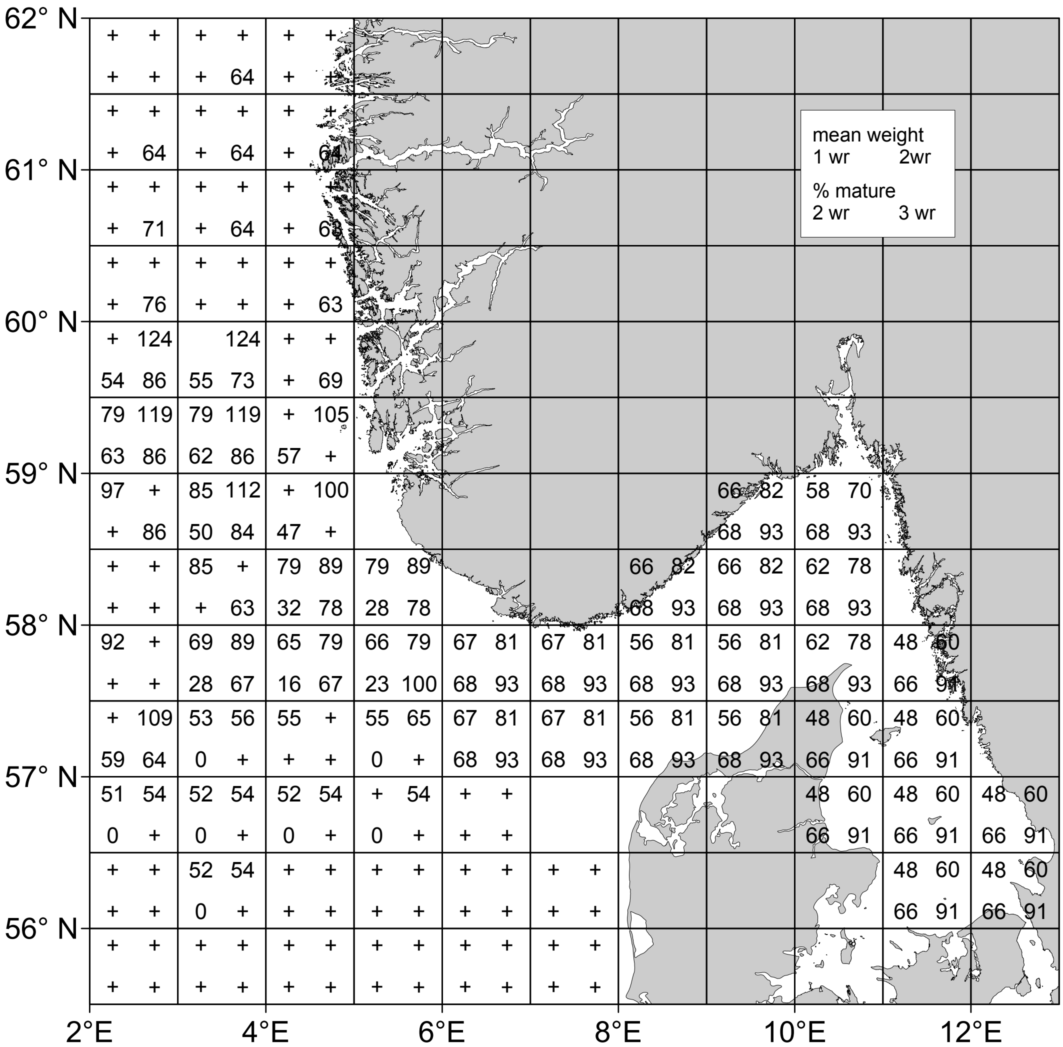


**Figure 9: Mean weight and maturity of western Baltic spring spawning herring from combined acoustic survey June – July 2006. Four values per ICES rectangle, percentage mature of 2 ring (lower left) and 3 ring fish (lower right), mean weights gram of 1 ring (upper left) and 2 ring fish (upper right), 0 indicates measured percentage mature, + indicates surveyed with zero abundance, blank indicates an unsurveyed rectangle.**

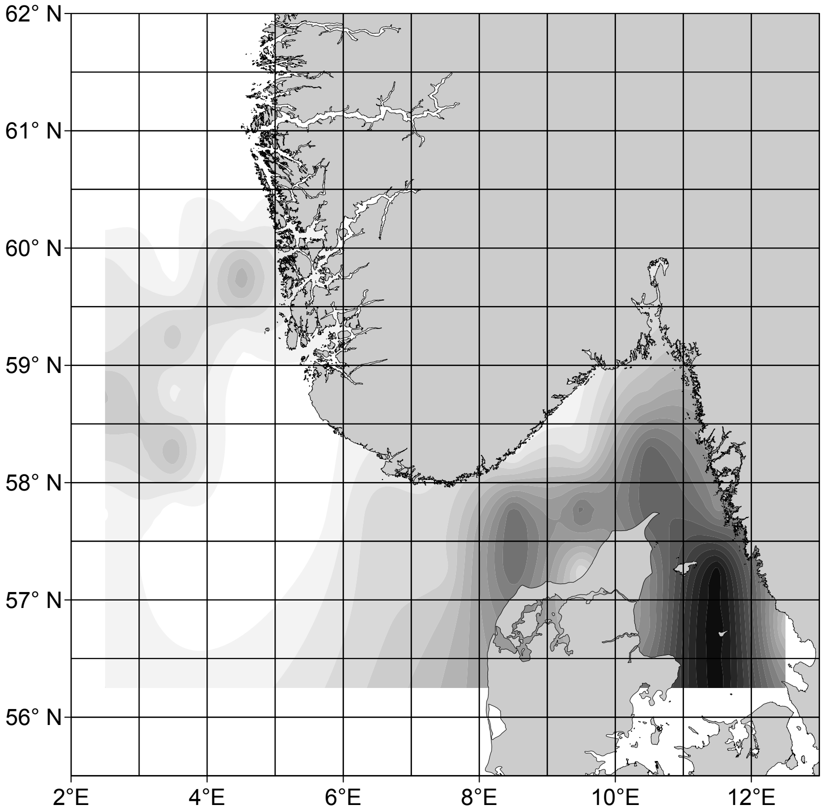


**Figure 10: Numbers of mature western Baltic spring spawning herring from combined acoustic survey in June – July 2006.**

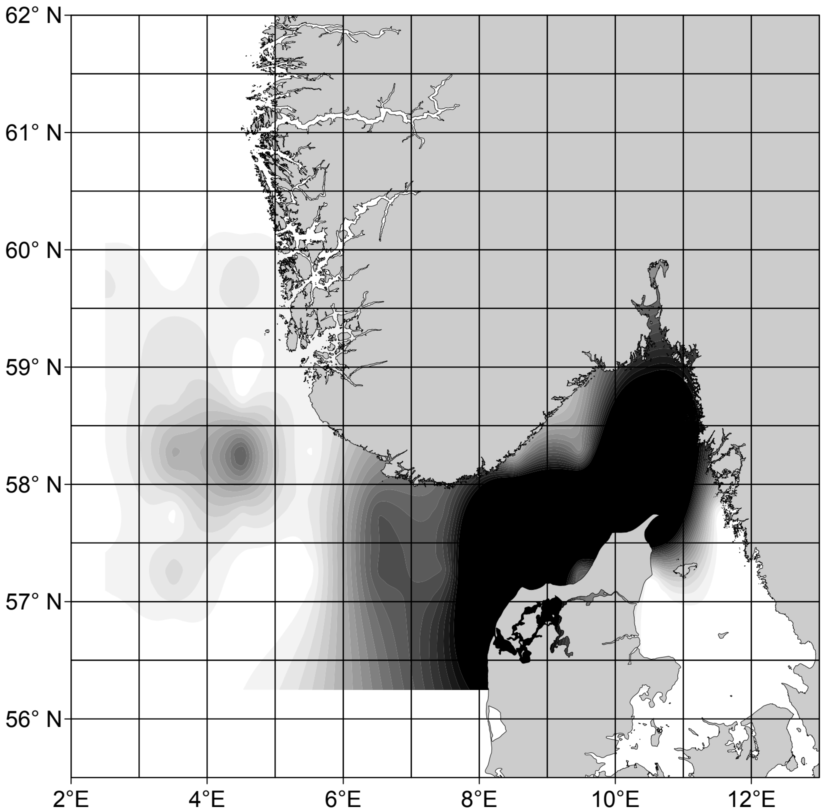


**Figure 11: Numbers of immature western Baltic spring spawning herring from combined acoustic survey in June – July 2006.**

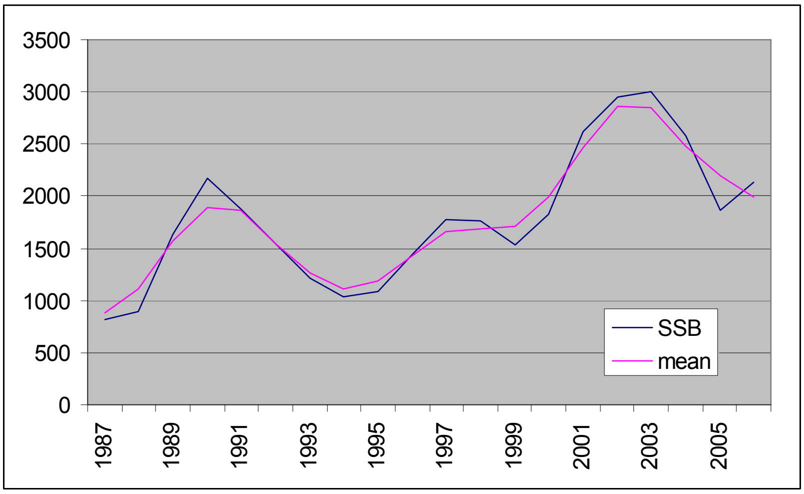


**Figure 12: Time series of SSB of North Sea autumn spawning herring with three year running mean.**

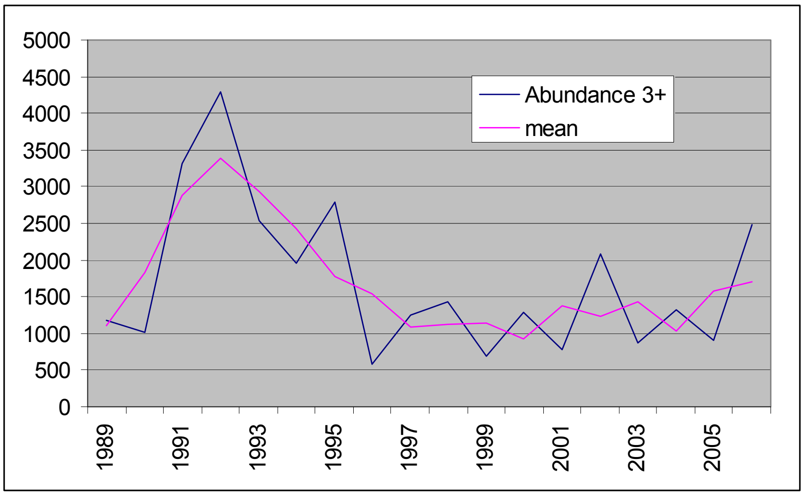


**Figure 13: Time series of 3+ abundance of Western Baltic spring spawning herring with three year running mean.**

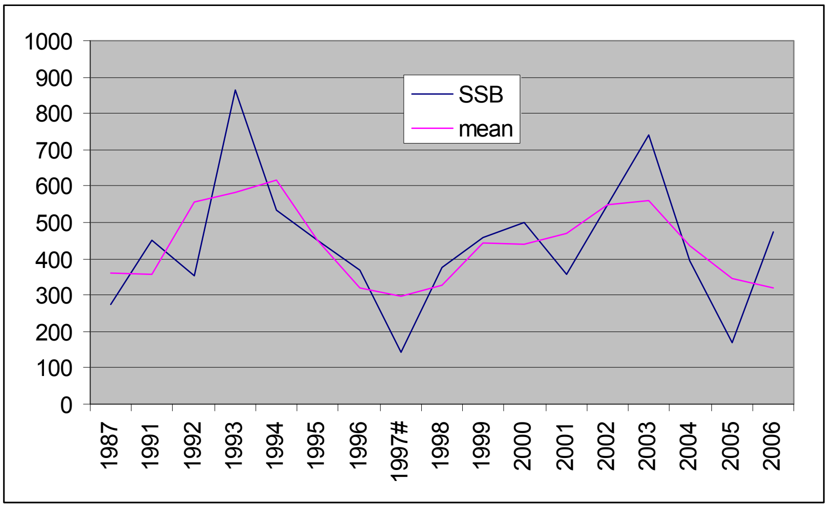


**Figure 14: Time series of SSB of West of Scotland herring with three year running mean.**

# Annex 5: Working Documents to PGHERS

## Annex 5A: Correction to the 2005 survey report for RV "Scotia"

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### INTRODUCTION

An acoustic survey for herring was carried out by FRS Marine Laboratory around the Orkney Shetland peninsula in the northern North Sea (ICES Division IV) from the 28th June to the 18th July 2005 on the FRV *Scotia*. The main objective of the survey was to provide an abundance estimate for herring in this area and to map the distribution of this species.

The survey was carried out as a part of the ICES coordinated herring acoustic survey of the North Sea and adjacent waters (ICES, 2006a). The data from this survey were combined with other surveys in the North Sea to provide an age disaggregated abundance index for use in the assessment of North Sea herring which was carried out by the ICES Herring Assessment Working Group (HAWG) in March 2006 (ICES, 2006b).

This paper provides revised results of the 2005 Scotia survey data after correction due to a mistake in the 2005 analysis brought about by changes in working practices.

### METHODS

The 2005 acoustic survey track (Figure1) consisted of three levels of sampling intensity: transect spacings of 30 nautical miles (southern area east of Aberdeen), 15 (most of the survey area), and 7.5 nautical miles (east of Shetland and west of Orkney). The data were originally allocated to quarter statistical rectangles by their midpoint location and the estimate of density was obtained as the arithmetic mean of all values weighted by duration of the run to accommodate the small number of short EDSUs. However, this method only produces an estimate for each quarter ICES rectangle and any unsampled quarter ICES rectangle is not estimated. In 2005, 30 nautical mile transects were incorporated in the southern area to allow for the new survey design where other nations survey part of the original Scottish area. A 30 nautical mile transect will leave quarter rectangles unsampled but implicit in the design is the acknowledgement that the samples are raised to the whole rectangle, not just the quarter rectangles. The estimation software used to generate the results for this survey does not allow for a mixture of resolutions (i.e. quarter and whole rectangles). When the analysis was carried out at the higher resolution there were, therefore, several quarter rectangles which were not estimated in the individual survey report in the southern area. It was thought the combination software used by PGHERS may have been able to account for this but this was not the case, and so the global estimates are also in error. This occurred partly due to a misunderstanding with the way that the combination software works, but mostly due to a focus on developing the new combination software at the 2006 meeting.

A correction was made by analysing the two areas separately; using quarter rectangle resolution for the main part of the survey, north of 58°30'N; and whole rectangle resolution in the area south of this latitude. The numbers and biomass at age in the southern area were taken from the latter analysis and added to the results from the area to the north in the former. As the differences were so small no attempt was made to adjust the mean lengths and weights.

### RESULTS

The original 2005 numbers estimates for the area south of 58° by quarter rectangle are given in Table 1. The revised numbers estimates for the area south of 58° by *whole* rectangle are given in Table 2. The difference between the original and revised estimates for the area south of 58° by whole ICES rectangle are given in Table 3. Table 4 compares the original and corrected estimates of herring numbers, biomass, and proportion mature at age and year class for the whole survey area for the Scotia survey. The new estimate of abundance for the 2005 Scotia survey is just over 5% higher; estimates of biomass are 3% higher. The revised numbers and biomass of fish by quarter and whole ICES statistical rectangle are shown in Figure 2. Revised estimates of 11,743 million herring or 2,261 thousand tonnes were calculated for the survey area (c.f. 11,180 and 2,183 thousand tonnes). The overall picture has not changed with the proportion of 4 ring herring was once again quite high, reflecting the dominance of the 2000 year class. The increase in numbers has mainly affected the 2 and 3 ring fish.

The revised estimates for the Scotia survey have been combined into the combined survey estimates. Table 5 shows the original total estimates for the entire international survey. These are the data that were submitted to HAWG in 2006. The revised estimates for the whole survey area are given in Table 6. Table 7 gives the change in numbers at age between the original and revised estimates. The effect on the combined survey estimate is even smaller, as would be expected. The revised estimate of abundance is 2.5% higher and the biomass only 2.8% higher. The revised estimates in Table 6 are those that should be supplied to HAWG for its meeting in March 2007.

## DISCUSSION

The new philosophy in the International North Sea Herring Acoustic Survey is to integrate survey designs such that the situation described above will occur again (i.e. 30 nautical mile transects). Provision should be made for in the new combination system (FishFrame acoustics) to account for this.

## REFERENCES

ICES. 2006a. Report of the planning group on herring surveys (PGHERS). ICES CM 2006/LRC:04, 239 pp.

ICES. 2006b. Report of the Herring Assessment Working Group South of 62º N (HAWG). ICES CM 2006/ACFM:20, 642 pp.

**Table 1: Previous (ICES, PGHERS 2006) estimates of herring numbers and survey mileage for the 2005 Scotia North Sea herring acoustic survey by quarter rectangle for the area south of 58° N.**

| LAT | LONG | AREA | ICES RECTANGLE | NUMBER (MILLIONS) | MILEAGE (N.MI.) |
|---|---|---|---|---|---|
| 57.125 | -1.75 | A | 43E8 | 0.00 | 15.00 |
| 57.125 | -1.25 | A | 43E8 | 180.41 | 15.00 |
| 57.125 | -0.75 | A | 43E9 | 0.00 | 17.50 |
| 57.125 | -0.25 | A | 43E9 | 0.00 | 15.00 |
| 57.125 | 0.25 | A | 43F0 | 0.12 | 17.50 |
| 57.125 | 0.75 | A | 43F0 | 0.41 | 17.50 |
| 57.125 | 1.25 | A | 43F1 | 66.37 | 15.00 |
| 57.125 | 1.75 | A | 43F1 | 8.37 | 15.00 |
| 57.375 | 1.75 | A | 43F1 | 79.99 | 15.00 |
| 57.625 | -1.25 | A | 44E8 | 0.00 | 15.00 |
| 57.625 | -1.75 | A | 44E8 | 0.00 | 10.00 |
| 57.625 | -0.75 | A | 44E9 | 0.00 | 17.50 |
| 57.625 | -0.25 | A | 44E9 | 0.00 | 17.50 |
| 57.625 | 0.25 | A | 44F0 | 0.00 | 15.00 |
| 57.625 | 0.75 | A | 44F0 | 26.93 | 15.00 |
| 57.625 | 1.25 | A | 44F1 | 258.08 | 17.50 |
| 57.625 | 1.75 | A | 44F1 | 12.09 | 12.50 |

**Table 2: Revised (ICES, PGHERS 2007) estimates of herring numbers and survey mileage for the 2005 Scotia North Sea herring acoustic survey by whole rectangle for the area south of 58° N.**

| LAT | LONG | AREA | ICES RECTANGLE | NUMBER (MILLIONS) | MILEAGE (N.MI.) |
|---|---|---|---|---|---|
| 57.375 | -1.75 | A | 43E8 | 326 | 28.8 |
| 57.375 | -0.75 | A | 43E9 | 0 | 32.5 |
| 57.375 | 0.25 | A | 43F0 | 1 | 35.0 |
| 57.375 | 1.25 | A | 43F1 | 206 | 45.0 |
| 57.875 | -1.25 | A | 44E8 | 0 | 24.5 |
| 57.875 | -0.75 | A | 44E9 | 0 | 33.0 |
| 57.875 | 0.25 | A | 44F0 | 54 | 30.0 |
| 57.875 | 1.25 | A | 44F1 | 609 | 29.2 |

**Table 3: The original and revised estimates of herring numbers and survey mileage for the 2005 Scotia North Sea herring acoustic survey for the area south of 58° by whole ICES rectangle**

| ICES RECTANGLE | REVISED NUMBERS (MILLIONS) | ORIGINAL NUMBERS (MILLIONS) | REVISED MILEAGE (N.MI.) | ORIGINAL MILEAGE (N.MI.) |
|---|---|---|---|---|
| 43E8 | 326 | 180.4 | 28.8 | 30 |
| 43E9 | 0 | 0.0 | 32.5 | 32.5 |
| 43F0 | 1 | 0.5 | 35.0 | 35 |
| 43F1 | 206 | 154.7 | 45.0 | 45 |
| 44E8 | 0 | 0.0 | 24.5 | 25 |
| 44E9 | 0 | 0.0 | 33.0 | 35 |
| 44F0 | 54 | 26.9 | 30.0 | 30 |
| 44F1 | 609 | 270.1 | 29.2 | 30 |
| Grand Total | 1195 | 632.768496 | 258.0 | 262.5 |

**Table 4: Original (grey) and updated (black) numbers (millions) and biomass (thousands of tonnes) breakdown by age (winter rings) and maturity obtained during the Scotia 28 June to 18 July 2005 herring acoustic survey. I= immature; M=mature; A=All.**

| Yr class | Ring/ maturity | Original Number (millions) | Revised Number (millions) | Difference Number (millions) | % | Original Biomass ('000 t) | Revised Biomass ('000 t) | Difference Biomass ('000 t) | % |
|---|---|---|---|---|---|---|---|---|---|
| 2003 | 1 | 94.94 | 96.53 | 1.59 | 1.67 | 6.9 | 7.00 | 0.10 | 1.49 |
| 2002 | 2I | 60.61 | 97.15 | 36.54 | 60.29 | 7.09 | 11.03 | 3.94 | 55.54 |
| 2002 | 2M | 1036.84 | 1164.98 | 128.14 | 12.36 | 162.63 | 179.26 | 16.63 | 10.22 |
| 2001 | 3I | 46.37 | 82.37 | 36.00 | 77.64 | 5.9 | 10.48 | 4.58 | 77.61 |
| 2001 | 3M | 3027.9 | 3203.71 | 175.81 | 5.81 | 532.14 | 557.54 | 25.40 | 4.77 |
| 2000 | 4I | 8 | 8.00 | 0.00 | 0.00 | 1.33 | 1.33 | 0.00 | 0.00 |
| 2000 | 4M | 4397.14 | 4577.18 | 180.04 | 4.09 | 844.79 | 870.55 | 25.76 | 3.05 |
| 1999 | 5 | 1113.82 | 1115.41 | 1.59 | 0.14 | 261.8 | 262.10 | 0.30 | 0.11 |
| 1998 | 6 | 1105.73 | 1108.38 | 2.65 | 0.24 | 277.89 | 278.36 | 0.47 | 0.17 |
| 1997 | 7 | 89.68 | 89.68 | 0.00 | 0.00 | 24.64 | 24.64 | 0.00 | 0.00 |
| 1996 | 8 | 103.49 | 103.49 | 0.00 | 0.00 | 29.61 | 29.61 | 0.00 | 0.00 |
| 1995 | 9+ | 96.29 | 96.29 | 0.00 | 0.00 | 28.96 | 28.96 | 0.00 | 0.00 |
| Total | | 11180.8 | 11743.16 | 562.36 | 5.03 | 2183.45 | 2260.85 | 77.40 | 3.55 |
| Spawning stock | | 10970.9 | 11459.1 | 488.2 | 4.45 | 2162.5 | 2231.0 | 68.6 | 3.17 |
| Immature | | 209.9 | 284.0 | 74.1 | 35.31 | 21.2 | 29.8 | 8.6 | 40.62 |

**Table 5: Original numbers (millions) and biomass (thousands of tonnes) breakdown by age (winter rings) and maturity obtained for the 2005 International North Sea Herring Acoustic Survey.**

| North Sea | Numbers (millions) | Biomass ('000 t) | Maturity | Weight (g) | Length (cm) |
|---|---|---|---|---|---|
| 0 | 5015.9 | 16.0 | 0.00 | 3.2 | 7.9 |
| 1 | 3112.5 | 134.7 | 0.01 | 43.3 | 17.5 |
| 2 | 1890.2 | 255.4 | 0.76 | 135.1 | 24.5 |
| 3 | 3436.4 | 587.8 | 0.97 | 171.0 | 26.2 |
| 4 | 5609.3 | 1014.4 | 0.96 | 180.8 | 26.6 |
| 5 | 1211.3 | 276.8 | 1.00 | 228.5 | 28.5 |
| 6 | 1172.3 | 290.3 | 1.00 | 247.6 | 29.2 |
| 7 | 139.9 | 35.3 | 1.00 | 252.6 | 29.5 |
| 8 | 126.5 | 34.7 | 1.00 | 274.4 | 30.2 |
| 9+ | 106.7 | 31.5 | 1.00 | 295.1 | 30.7 |
| Immature | 8920.4 | 234.8 | | | |
| Mature | 9577.8 | 1867.9 | | | |
| Total | 21821.0 | 2676.9 | | | |
| 1+ group | 16805.1 | | | | |

**Table 6: Revised numbers (millions) and biomass (thousands of tonnes) breakdown by age (winter rings) and maturity obtained for the 2005 International North Sea Herring Acoustic Survey.**

| NORTH SEA | NUMBERS (MILLIONS) | BIOMASS ('000 T) | MATURITY | WEIGHT (G) | LENGTH (CM) |
|---|---|---|---|---|---|
| 0 | 5015.9 | 16.0 | 0.00 | 3.2 | 7.9 |
| 1 | 3114.1 | 134.8 | 0.01 | 43.3 | 17.5 |
| 2 | 2055.1 | 276.0 | 0.76 | 134.3 | 24.4 |
| 3 | 3648.5 | 617.8 | 0.96 | 169.3 | 26.1 |
| 4 | 5789.6 | 1040.2 | 0.96 | 179.7 | 26.5 |
| 5 | 1212.9 | 277.1 | 1.00 | 228.5 | 28.5 |
| 6 | 1174.9 | 290.7 | 1.00 | 247.5 | 29.2 |
| 7 | 139.9 | 35.3 | 1.00 | 252.6 | 29.5 |
| 8 | 126.5 | 34.7 | 1.00 | 274.4 | 30.2 |
| 9+ | 106.7 | 31.5 | 1.00 | 295.1 | 30.7 |
| Immature | 8994.7 | 243.5 | | | |
| Mature | 9890.7 | 1911.1 | | | |
| Total | 22384.3 | 2754.2 | | | |
| 1+ group | 17368.4 | | | | |

**Table 7: Difference in number at age between original and revised estimates for the 2005 International North Sea Herring Acoustic Survey.**

| AGE | % CHANGE | NUMBER CHANGE |
|---|---|---|
| 0 | 0.00% | 0.0 |
| 1 | 0.05% | 1.6 |
| 2 | 8.73% | 164.9 |
| 3 | 6.17% | 212.1 |
| 4 | 3.21% | 180.3 |
| 5 | 0.13% | 1.6 |
| 6 | 0.23% | 2.7 |
| 7 | 0.00% | 0.0 |
| 8 | 0.00% | 0.0 |
| 9+ | 0.00% | 0.0 |
| Immature | 0.83% | 74.2 |
| Mature | 3.27% | 312.9 |
| Total | 2.58% | 563.2 |
| 1+ group | 3.35% | 563.2 |

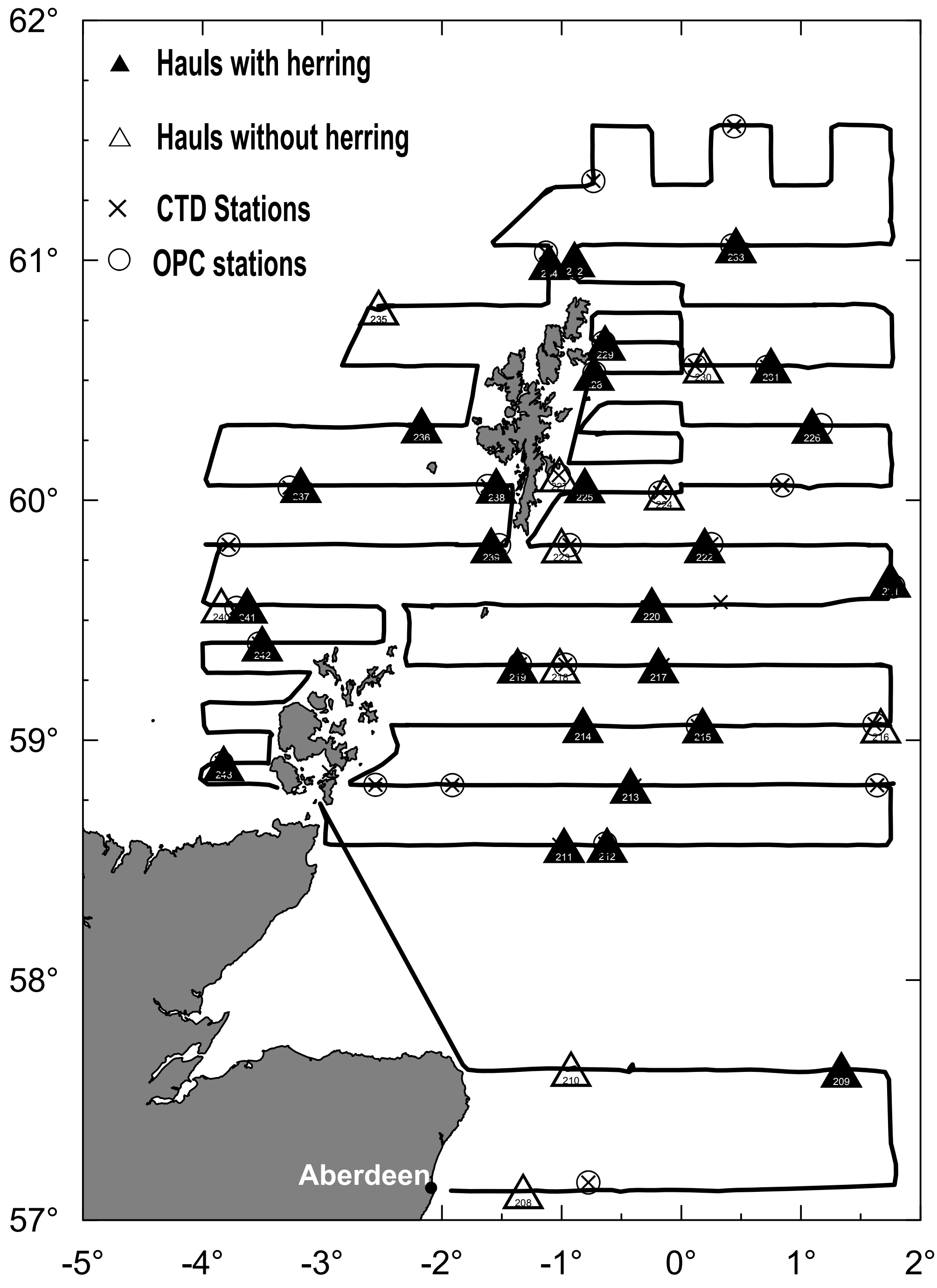


**Figure 1: Map of the North Sea showing the Cruise track (solid lines) of FRV SCOTIA for the acoustic survey 28 June-18 July 2005 indicating the location of trawl, CTD and OPC stations (symbols defined in legend).**

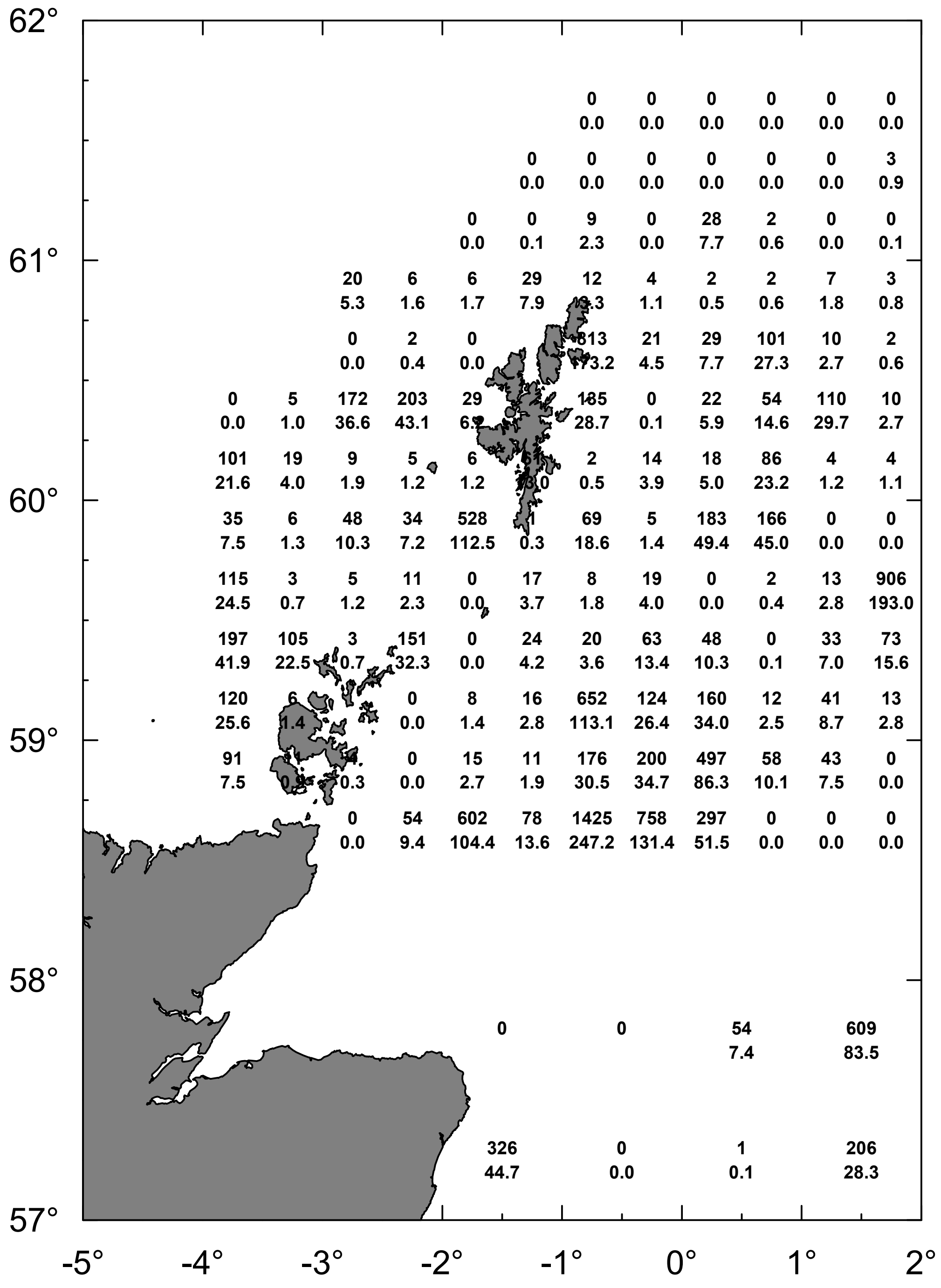


**Figure 2: Map of the North Sea showing the estimated numbers (millions) and biomass (thousands of tonnes) from the herring acoustic survey on FRV SCOTIA for 28 June-18 July 2005, by quarter ICES statistical rectangle north of 58°30'N and at whole statistical rectangle south of this latitude.**

# Annex 5B: A new stratification of the Rügen herring larvae Survey (RHLS) in the Greifwalder Bodden

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## Introduction

During a peer review of the Rügen herring larvae survey (RHLS) in November 2006, the current design of the herring larvae survey was discussed. Especially the current stratification was questioned: The high total number of strata, the high number of strata with only one station and the variable number of days needed to sample the 35 stations of the weekly surveys. Survey results of the last decade were again checked and summarized to develop a new survey stratification and design which will already be used during the 2007 season.

The following requirements were defined as basis of the new design:

- The number of stations should not be reduced and the same fixed stations should be used as in the past.
- All stations of a survey should be sampled within two days (under normal weather conditions).
- The sequence of the stations should be the same every week.
- The stations of the weekly survey should be chosen in such a way that the data of the first day can be used to estimate the unbiased mean density of larvae and unbiased mean length frequency of larvae in the Greifswalder Bodden.
- The stratification of the Greifswalder Bodden should be optimised to reduce the variability of the recruitment index.

## Stratification of the Greifswalder Bodden

The area under investigation, the Greifswalder Bodden, was previously stratified into 15 strata. In some strata only one station was sampled during every survey so that variance estimates could not be calculated. Figure 1 shows the Greifswalder Bodden and the defined strata. Apart from the Greifswalder Bodden also the north westerly located Strelasund is covered each week by five stations. The currently used stratification is based on the known spawning places of the spring spawning herring (Figure 2, Scabel 1988)

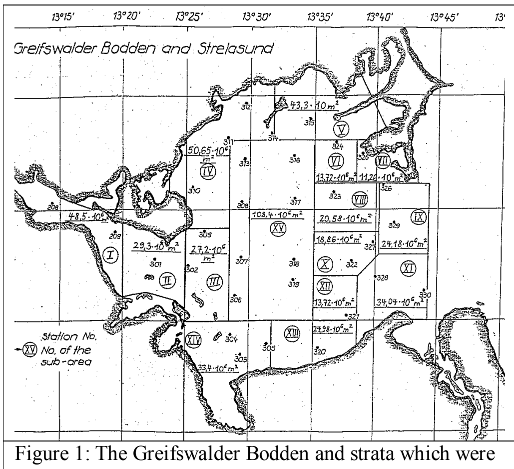


Figure 1: The Greifswalder Bodden and strata which were previously used by the Rügen herring larvae survey

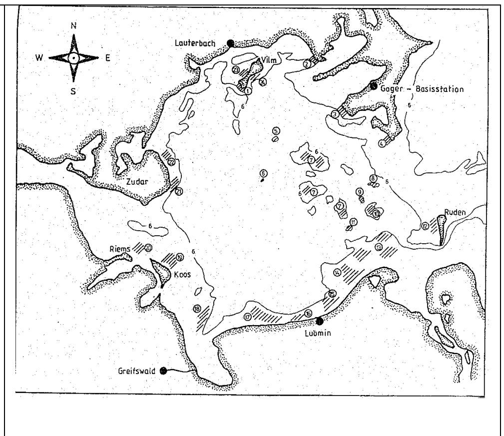


Figure 2: The Greifswalder Bodden and spawning locations of the spring spawning herring obtained by SCUBA diving (Scabell 1988)

The areas of the 15 strata together with the assigned station numbers are given in Table 1 and the positions of the fixed stations are presented in Table 2. The strategy of fixed stations is used because gillnets are frequently used in the Greifswalder Bodden which are located in the same area every year during the spawning season of herring.

**Table 1: Currently used strata with area in m² and assigned stations.**

| STRATUM | AREA | STATIONS ASSIGNED |
|---|---|---|
| | *100 000 m² | |
| 1 | 48.50 | 205, 206, 207, 208, 209 |
| 2 | 29.30 | 301 |
| 3 | 27.20 | 302, 309 |
| 4 | 50.65 | 310, 311, 312, 314 |
| 5 | 43.30 | 315 |
| 6 | 13.72 | 324 |
| 7 | 11.26 | 325 |
| 8 | 20.58 | 323 |
| 9 | 24.18 | 326, 329 |
| 10 | 18.86 | 322, 327 |
| 11 | 34.04 | 328, 330 |
| 12 | 13.72 | 321 |
| 13 | 24.98 | 320 |
| 14 | 33.40 | 303, 304, 305 |
| 15 | 108.40 | 306, 307, 308, 313, 316, 317, 318, 319 |

**Table 2: Positions of the fixed stations of the Rügen herring larvae survey in the Greifswalder Bodden.**

| STATION | LATITUDE N | | | LONGITUDE E | | |
|---|---|---|---|---|---|---|
| | ° | ' | " | ° | ' | " |
| 205 | 54 | 19 | 0 | 13 | 8 | 20 |
| 206 | 54 | 16 | 80 | 13 | 8 | 30 |
| 207 | 54 | 16 | 85 | 13 | 11 | 10 |
| 208 | 54 | 15 | 30 | 13 | 14 | 30 |
| 209 | 54 | 14 | 15 | 13 | 19 | 30 |
| 301 | 54 | 12 | 80 | 13 | 22 | 60 |
| 302 | 54 | 12 | 60 | 13 | 25 | 20 |
| 303 | 54 | 8 | 50 | 13 | 29 | 35 |
| 304 | 54 | 9 | 50 | 13 | 28 | 60 |
| 305 | 54 | 9 | 0 | 13 | 31 | 70 |
| 306 | 54 | 11 | 10 | 13 | 28 | 80 |
| 307 | 54 | 13 | 0 | 13 | 29 | 40 |
| 308 | 54 | 15 | 30 | 13 | 29 | 40 |
| 309 | 54 | 14 | 10 | 13 | 26 | 30 |
| 310 | 54 | 16 | 25 | 13 | 25 | 50 |
| 311 | 54 | 18 | 30 | 13 | 28 | 35 |
| 312 | 54 | 19 | 70 | 13 | 29 | 60 |
| 313 | 54 | 17 | 20 | 13 | 29 | 60 |

| STATION | LATITUDE N | | | LONGITUDE E | | |
|---|---|---|---|---|---|---|
| | ° | ' | " | ° | ' | " |
| 314 | 54 | 18 | 40 | 13 | 31 | 90 |
| 315 | 54 | 19 | 5 | 13 | 34 | 70 |
| 316 | 54 | 17 | 40 | 13 | 33 | 50 |
| 317 | 54 | 15 | 50 | 13 | 33 | 50 |
| 318 | 54 | 12 | 75 | 13 | 33 | 50 |
| 319 | 54 | 11 | 50 | 13 | 33 | 50 |
| 320 | 54 | 8 | 75 | 13 | 35 | 35 |
| 321 | 54 | 10 | 30 | 13 | 37 | 60 |
| 322 | 54 | 12 | 70 | 13 | 37 | 90 |
| 323 | 54 | 15 | 80 | 13 | 36 | 50 |
| 324 | 54 | 18 | 5 | 13 | 36 | 80 |
| 325 | 54 | 17 | 45 | 13 | 38 | 80 |
| 326 | 54 | 16 | 20 | 13 | 40 | 50 |
| 327 | 54 | 13 | 55 | 13 | 39 | 90 |
| 328 | 54 | 12 | 0 | 13 | 40 | 0 |
| 329 | 54 | 14 | 40 | 13 | 41 | 50 |
| 330 | 54 | 11 | 35 | 13 | 44 | 0 |
| | | | | | | |

Results of the weekly surveys from 1992 to 2002 were used to evaluate possibilities to optimise the stratification of the Greifswalder Bodden. The following criteria were defined to select the optimum stratification:

- The number of strata should be reduced (to a maximum of six stations, Cochran 1972)

- Each stratum should contain more than two stations to allow an estimation of the variance of the mean density and length frequency
- The variance of the density and of the length frequency should be minimised.

Two methods were used to analyse the spatial distribution of newly hatched and larger larvae. Graphical presentations of the density distribution of larvae [numbers / m²] at the stations (by GIS) were used to detect areas which can be characterised by homogeneous or heterogeneous distribution of larvae, and to identify areas of intensive larvae hatching. The spatial and temporal distribution of the areas of intensive larvae hatching are important because the number of hatched larvae induces the highest variability of larvae density. It was further evaluated whether some areas have significantly different distribution patterns of larvae (more homogenous or more heterogeneous) because it can be expected that the density distribution of the newly hatched and larger larvae are highly variable between the subsequent weekly surveys and between different years. The data were also used to analyse whether newly hatched larvae are spatially stationary for one or two weeks.

Cluster analyses which used the Euclidian distance between the length frequencies from different stations of the same survey were also used to define areas which have comparable distribution patterns. The analyses have shown that one stratification does not exist which is optimal for all surveys and all years. The variability of the hatching intensity is very high in space and time. Therefore, different versions of stratification of the Greifswalder Bodden were defined which present strata with relative homogeneous larvae distributions during many surveys based on the Cluster analyses and the graphical presentations. Investigations of Rostock University on the distribution of the macrophytes used as substrate for eggs (Scabell 1988) and the development of spawned eggs (Klinkhardt, 1986) were used as additional information.

For all proposed stratifications the areas of the strata were estimated. Then, stratified means and the variances of the stratified means of total larvae density and of the density by length intervals were estimated.

Figures 3 to 5 show the proposed stratifications. The different versions subdivide the Greifswalder Bodden in different numbers of strata. Version 1 (Figure 3) uses 4 strata which subdivide the Greifswalder Bodden in four parts with similar sizes. Version 2 (Figure 4) subdivides the Greifswalder Bodden in south western and north eastern parts. Version 3 (Figure 5) combines the northern area in one stratum.

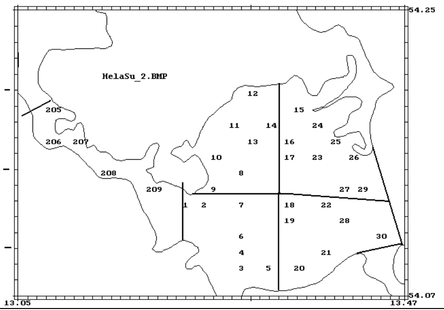

Figure 3: Version 1 of the stratification of the GB

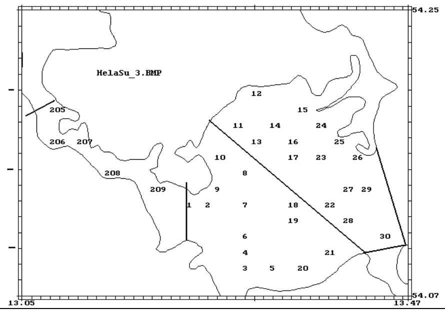

Figure 4: Version 2 of the stratification of the GB

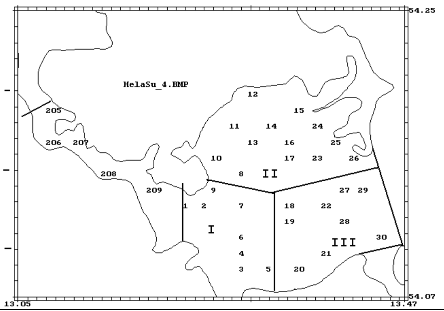

Figure 5: Version 3 of the stratification of the GB

The mean stratified length frequencies and their stratified standard deviations of the three proposed stratifications were estimated for all surveys from 1992 to 2002. The data demonstrated that no stratification could be found which minimises the standard deviation for all surveys in the investigated period. The standard deviations based on version 1 were the smallest in the most cases. The standard deviations of version 3 were similar to the estimates of version 1 in most cases, but were slightly larger in the most cases. The standard deviations of version 2 were in general significantly larger than the estimates of version 1 and 3.

### Proposed design and stratification of the Rügen herring larvae survey from 2007 onwards

Version 1 of the studied stratification will be used in the future (Figure 6). The positions of the corners of the different strata are given in Table 3 and the areas of the strata as well as the numbers of planned stations by strata are given in Table 4.

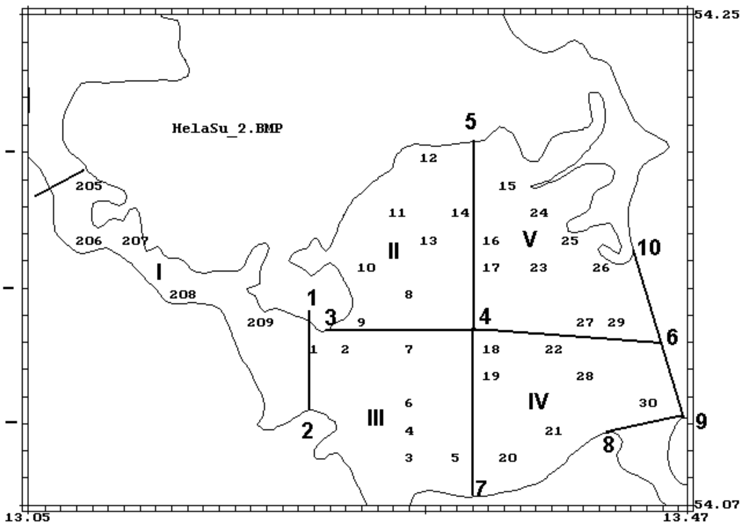


**Figure 6: Proposed stratification of the area under investigation.**

**Table 3: Positions of the corners of the proposed strata.**

| NUMBER | LATITUDE N | LONGITUDE E |
|---|---|---|
| 1 | 54° 13.8 | 13° 22.5 |
| 2 | 54° 10.5 | 13° 22.5 |
| 3 | 54° 13.5 | 13° 24.0 |
| 4 | 54° 13.5 | 13° 33.0 |
| 5 | 54° 20.5 | 13° 33.0 |
| 6 | 54° 13.0 | 13° 44.7 |
| 7 | 54° 07.5 | 13° 33.0 |
| 8 | 54° 09.7 | 13° 41.3 |
| 9 | 54° 10.2 | 13° 46.2 |
| 10 | 54° 16.2 | 13° 43.2 |

**Table 4: Areas of the strata in km² and number of stations by area**

| STRATA | AREA IN M² | NUMBER OF STATIONS |
|---|---|---|
| I | 69 | 5 |
| II | 100 | 7 |
| III | 95 | 7 |
| IV | 138 | 7 |
| V | 105 | 9 |

## Sequence of stations

Two requirements for the amendment of the survey design were given above: All stations should be realised within two days, and it should be possible that the results of the first day already provide unbiased estimates of the larvae density and length frequency. Therefore, the sequence of stations is chosen in such a way that the number of stations in each stratum and their depth distributions are similar for both days. Three different proposed sequences were discussed with the captain of the research platform used, the vessel “Clupea”, to incorporate the crew’s experience especially on the distribution patterns of gillnets during the survey period. The following sequence of stations was agreed based on these discussions: The survey starts with station 205, the northernmost station in the Strelasund, on Monday. After covering the stations in the Strelasund (205 - 209) three or four stations are realised in each stratum (Figure 7) in a counte-rclockwise movement. The chosen track provides that unbiased mean estimates of total larvae density and of the length frequency are possible because data of all strata are available at the end of day 1. During the second day the remaining stations will be realized in clockwise sequence to finalise the total survey close to the Strelasund with a short distance back to the harbour of Stralsund where the cruises of the following investigations of the same week usually start. Table 5 presents the sequence of stations of the first day together with the positions of the stations, the minimum distance between the subsequent stations, the water depth of the stations and the stratum number. Table 6 provides the same information for the second day. A consequence of the proposed sequence of stations is that the time between the realisations of stations in the same stratum is different for the first and second day. The shortest period between the stations is in stratum II and the largest period in stratum III. This problem could only be solved when the sequence of stations were altered during the second day, which would have significant consequences for the use of the research vessel for programs conducted during the rest of the week.

**Table 5: Sequence of stations of the first day with position, distance between the subsequent stations, water depth of the stations and stratum number.**

| Station | Latitude | | | Longitude | | | Distance in nm | Water depth [m] | Stratum |
|---|---|---|---|---|---|---|---|---|---|
| 205 | 54 | 19 | 0 | 13 | 8 | 20 | 2.2 | 9 | 1 |
| 206 | 54 | 16 | 80 | 13 | 8 | 30 | 1.6 | 11 | 1 |
| 207 | 54 | 16 | 85 | 13 | 11 | 10 | 2.4 | 9 | 1 |
| 208 | 54 | 15 | 30 | 13 | 14 | 30 | 3.1 | 5 | 1 |
| 209 | 54 | 14 | 15 | 13 | 19 | 30 | 2.4 | 7 | 1 |
| 301 | 54 | 12 | 80 | 13 | 22 | 60 | 2.5 | 4 | 3 |
| 309 | 54 | 14 | 10 | 13 | 26 | 30 | 2.1 | 5 | 2 |
| 307 | 54 | 13 | 0 | 13 | 29 | 40 | 4.2 | 5 | 3 |
| 305 | 54 | 9 | 0 | 13 | 31 | 70 | 2.7 | 6 | 3 |
| 319 | 54 | 11 | 50 | 13 | 33 | 50 | 2.7 | 7 | 4 |
| 321 | 54 | 10 | 30 | 13 | 37 | 60 | 2.2 | 4 | 4 |
| 328 | 54 | 12 | 0 | 13 | 40 | 0 | 2.6 | 4 | 4 |
| 329 | 54 | 14 | 40 | 13 | 41 | 50 | 3.4 | 6 | 5 |
| 325 | 54 | 17 | 45 | 13 | 38 | 80 | 2.1 | 8 | 5 |
| 323 | 54 | 15 | 80 | 13 | 36 | 50 | 2.4 | 3 | 5 |
| 316 | 54 | 17 | 40 | 13 | 33 | 50 | 2.3 | 7 | 5 |
| 313 | 54 | 17 | 20 | 13 | 29 | 60 | 1.3 | 6 | 2 |
| 311 | 54 | 18 | 30 | 13 | 28 | 35 | 1.6 | 6 | 2 |
| 312 | 54 | 19 | 70 | 13 | 29 | 60 | | 5 | 2 |

**Table 6: Sequence of stations of the second day with position, distance between the subsequent stations, water depth of the stations and stratum number.**

| Station | Latitude N | | | Longitude E | | | Distance in nm | Water depth [m] | Stratum |
|---|---|---|---|---|---|---|---|---|---|
| 314 | 54 | 18 | 40 | 13 | 31 | 90 | 1.8 | 6 | 2 |
| 315 | 54 | 19 | 5 | 13 | 34 | 70 | 3.6 | 7 | 5 |
| 317 | 54 | 15 | 50 | 13 | 33 | 50 | 3.2 | 6 | 5 |
| 324 | 54 | 18 | 5 | 13 | 36 | 80 | 2.8 | 6 | 5 |
| 326 | 54 | 16 | 20 | 13 | 40 | 50 | 2.7 | 6 | 5 |
| 327 | 54 | 13 | 55 | 13 | 39 | 90 | 3.3 | 7 | 5 |
| 330 | 54 | 11 | 35 | 13 | 44 | 0 | 3.8 | 6 | 4 |
| 322 | 54 | 12 | 70 | 13 | 37 | 90 | 2.6 | 4 | 4 |
| 318 | 54 | 12 | 75 | 13 | 33 | 50 | 4.1 | 7 | 4 |
| 320 | 54 | 8 | 75 | 13 | 35 | 35 | 3.5 | 7 | 4 |
| 303 | 54 | 8 | 50 | 13 | 29 | 35 | 1.1 | 5 | 3 |
| 304 | 54 | 9 | 50 | 13 | 28 | 60 | 1.6 | 4 | 3 |
| 306 | 54 | 11 | 10 | 13 | 28 | 80 | 2.6 | 5 | 3 |
| 302 | 54 | 12 | 60 | 13 | 25 | 20 | 3.6 | 4 | 3 |
| 308 | 54 | 15 | 30 | 13 | 29 | 40 | 2.5 | 6 | 2 |
| 310 | 54 | 16 | 25 | 13 | 25 | 50 | | 5 | 2 |

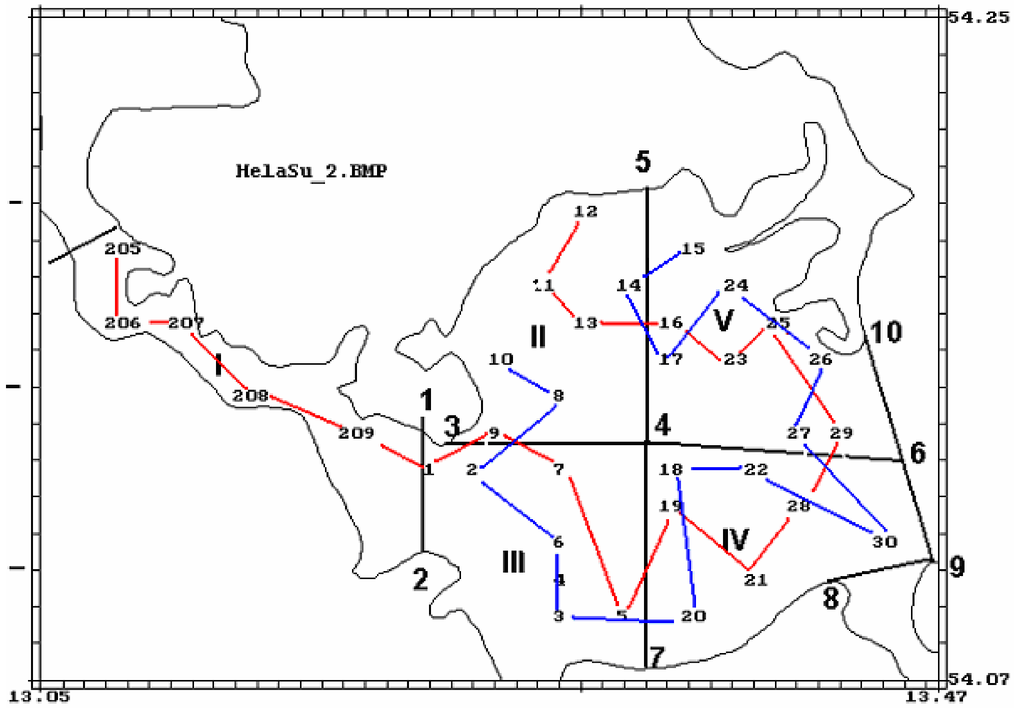


**Figure 7: Sequence of the stations of the first (red) and second (blue) day during the herring larvae surveys in the Greifswalder Bodden. Starting point is in Stralsund at the left edge of the map, the night can be spent in Lauterbach (north of position 12). Survey tracks might have to be altered to account for set nets in the area.**

## Consequences of the new stratification of the Rügen herring larvae survey in the Greifswalder Bodden and the Strelasund

The analyses concerning the optimum stratification of the Greifswalder Bodden have shown that the proposed new stratification reduces the variance. Therefore, it is useful to recalculate the estimates of the past based on the proposed stratification. The new estimated mean length frequencies and densities will be available for the next benchmark assessment of the Western Baltic spring spawning herring.

## References


Cochran, W. G. 1972. Stichprobenverfahren. Walter de Gruyter, Berlin, New York. 474 pp.

Klinkhardt, M. 1986. Ergebnisse von Untersuchungen zur Schlupf- und Dottersackphase der Larven von Rügenschen Frühjahrsheringen (*Clupea harengus* L.). Fischerei-Forschung 24 (1986) 2: 28-30

Scabell, J. 1988. Der Rügensche Frühjahrshering – Das Laichgeschehen. Dissertation Universität Rostock.