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North Sea hydro acoustic herring survey Survey report for R/V "TRIDENS" 26 June - 21 July 2006

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Samenvatting

Dit is het verslag van de Nederlandse deelname aan de Noordzee akoestische survey voor haring. Deze, door ICES gecoördineerde survey wordt sinds 1991 jaarlijks uitgevoerd. Naast Nederland nemen Schotland, Duitsland, Denemarken en Noorwegen deel aan de survey.
Tot voor kort had ieder deelnemend land de verantwoordelijkheid over een eigen gebied wat jaarlijks bemonsterd werd. Sinds 2005 wordt er gewerkt aan een volledig geïntegreerde survey waarbij gebieden door meer dan één schip bemonsterd worden. Het doel van de survey is het maken van een schatting van de grootte van de Noordzee haring populatie. Deze schatting wordt gebruikt als een "tuning index" door de ICES Herring Assessment Working Group (HAWG) om de omvang van de populatie vast te stellen.
Voor de survey wordt gebruik gemaakt van een Simrad 38kHz splitbeam transducer met een EK60 echolood. De toegepaste methode is echo-integratie. Door transecten te varen in het gebied wordt het totale akoestische oppervlak per oppervlakteeenheid bepaald. Door het uitvoeren van vistrekken wordt de soort-samenstelling bepaald. Van haring en sprot worden daarnaast biologische monsters genomen om leeftijd en rijpheid te bepalen. Voor deze soorten kan aldus een schatting van de populatie, uitgesplitst naar leeftijd en rijpheid, gemaakt worden.
De biomassa van de totale haring-populatie in het door het Nederlandse schip bemonsterde gebied wordt geschat op 404 duizend ton, die van sprot op 31 duizend ton. De paai-biomassa van haring wordt geschat op 131 duizend ton.

Summary

This is the report of the Dutch part of the international North Sea hydro acoustic survey for herring. The survey is coordinated by ICES and has been executed annually since 1991. Scotland, Germany, Denmark and Norway also participate in the survey.
Until recently each country had its own national area which was covered yearly. Since 2005, the survey is in the process of being fully integrated with interlaced transects. The purpose of the survey is to estimate the herring stock of the North Sea. The ICES Herring Assessment Working Group (HAWG) uses this estimation as a "tuning index" to assess the North Sea herring stock.
For this survey a Simrad 38kHz splitbeam transducer was used together with a Simrad EK60 echo sounder. The applied method was echo integration. By sailing transects over the survey area, the total acoustic cross-section can be calculated by surface area. Trawling identified species composition of localized schools. The length composition of each species was determined. Herring and sprat were examined on age and fecundity from which a split up of the stock structure was made.
Total biomass in the area covered by the Dutch vessel of the herring population was estimated to be 404 thousand tonnes from which 131 thousand tonnes was mature fish. For sprat the total biomass was estimated to be 31 thousand tonnes.

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 R/V "Tridens".

Cruise plan
The survey is currently changing from a separate National survey approach with traditional area's for each participant towards a more integrated 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

The objective in this survey has gradually shifted from estimating herring abundance into a more ecosystem survey. This ecosystem approach involves extra focus on non-target fish species as well as environmental parameters such as temperature and plankton. For the first time water samples were taken, in the first place to calibrate the CTD device but also to gather information on chemical contents in the water column. Acoustic observations not only target herring but also sprat, mackerel and sandeel using specific algorithms designed for species recognition. Satellite images of phytoplankton at the surface were collected weekly (Figure D3 in appendix D) to relate acoustic images of plankton to satellite images of the same plankton layers.

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 38kHz and 200kHz 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 showed gadoids and some herring. In the evening radio contact is made with R/V 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 R/V 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 R/V 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 R/V Tridens and R/V Solea, it was decided to merge them into one transect on 55°40.

The planned surveyed cruise track and trawl positions are presented in figure 2.3.1. Actual cruise track from which data was used for stock estimate and trawl positions are presented in figure 2.3.2.

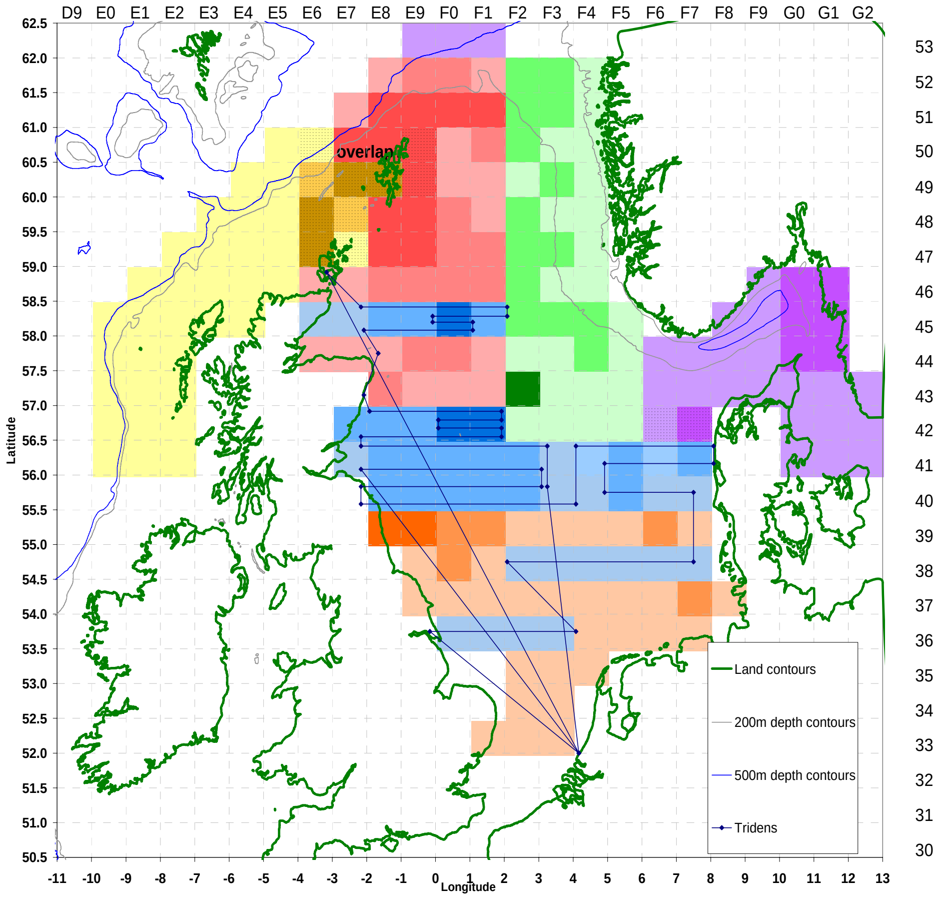

Figure 2.3.1. Map of planned cruise track and positions of trawl stations and hydrographical stations during the June-July 2006 North Sea herring hydro acoustic survey on R/V "Tridens".
The color of the rectangles indicate by which vessel it should have been covered whereas the intensity of the color increases with the survey intensity.

- *Yellow=charter vessel*
- *Pink=Scotia*
- *Blue =Tridens*
- *Orange=Solea*
- *Purple=Dana*
- *Green=Johan Hjort*

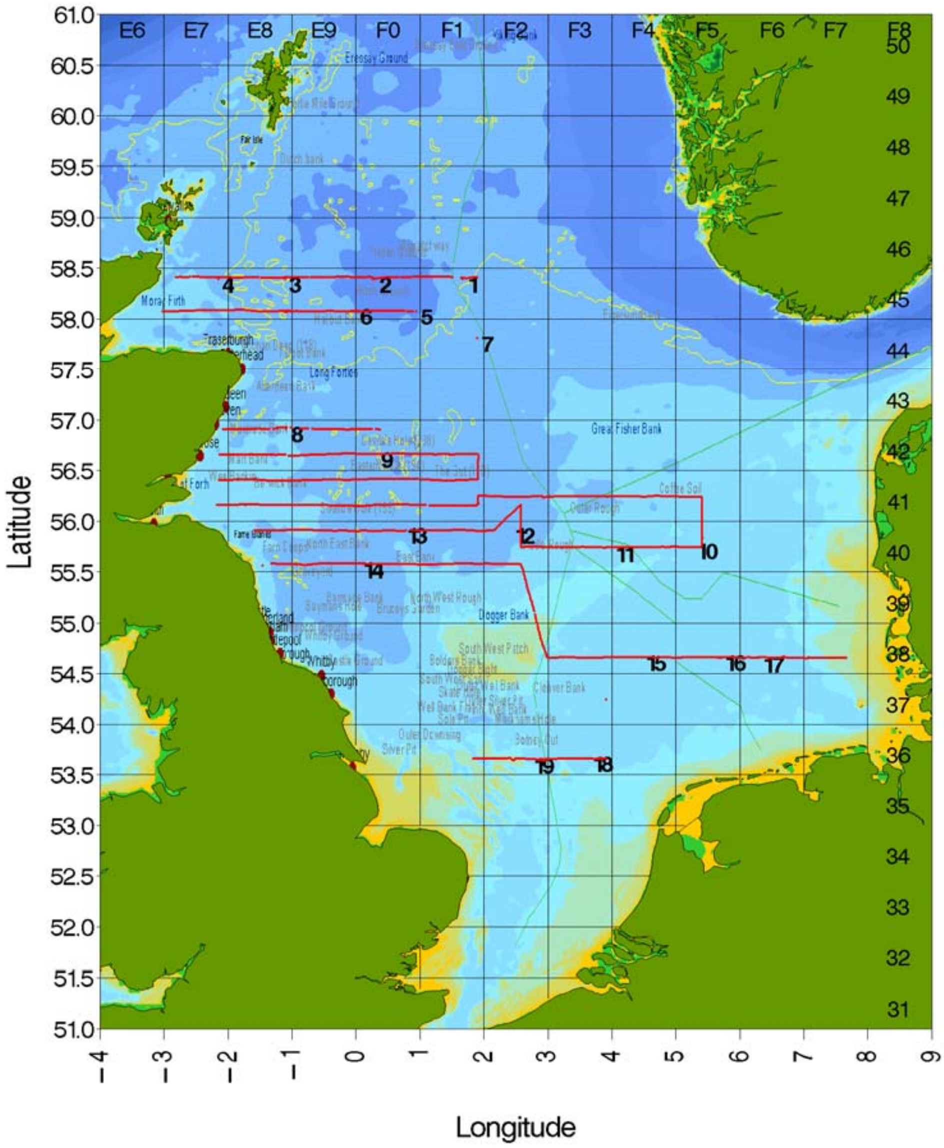

Figure 2.3.2. Map of executed cruise track and positions of trawl stations and hydrographical stations during the June-July 2006 North Sea herring hydro acoustic survey on R/V "Tridens".

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 were accepted but during the beginning of the cruise heavy noise made these transducers useless. The Heel and pitch sensor cable proved to cause problems and was therefore not used during the rest of the survey. A second calibration was performed in Scapa Flow using new cables but once surveying the noise was still present. Calibration results of the second calibration were used and are given in appendix A.

1. 38 kHz in the towed body: moderate results

2. 200 kHz in the towed body: bad results
3. 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 appendix B. 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 -85dB 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 12 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 200kHz 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 (ICES PGHERS Report 2005 ICES CM 2005/G:04, Ref. D, HAWG).
A Furuno FCV-1500 echosounder was used to control the catch (fig. 2.6.1). Trawl station data was recorded by a tool which allowed to record data from the ship’s own data acquisition system.

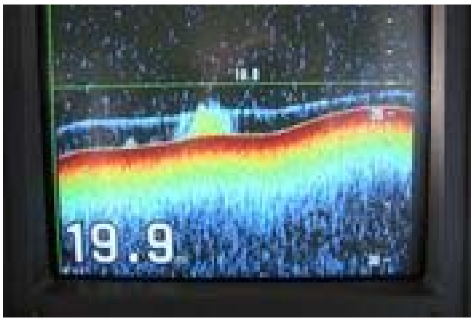

Figure 2.6.1 Screen image of a herring school observed with the Furuno FCV-1500 echosounder. The dark brown line shows the bottom, the blue/yellow 'cloud' shows herring or sprat escaping below the ground rope of the net. The depth at time was 19.9m.

Biological samples

For all fish:

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

Stratified samples of 5 fish per length class were 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.

During the Herring acoustic survey samples were collected for the project on the investigation of the relationship between lipid content and fecundity in North Sea herring. Due to the fact that low numbers of female mature herring were caught in the Dutch survey area, only 44 females were sampled. Next to the standard biological parameters lipid content, ovary weight en gutted weight were measured and of each fish one otolith was collected for the determination of spawning type and ovaries were put on 4% formaldehyde for later determination of fecundity.
No results were available at the time of writing.

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.

During both two week trips 150 individual herring were sampled for both experiments. In total 600 herring were measured and weighted during the survey for this experiment. No results were available at the time of writing.

2.7 Hydrographical data

Hydrographical data have been collected in 36 stations, all at fixed locations (Figure 2.7.1). 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 (appendix G). 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 directions 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 are placed in the water intake system and had not been calibrated and were used to compare results with Seabird CTD results.

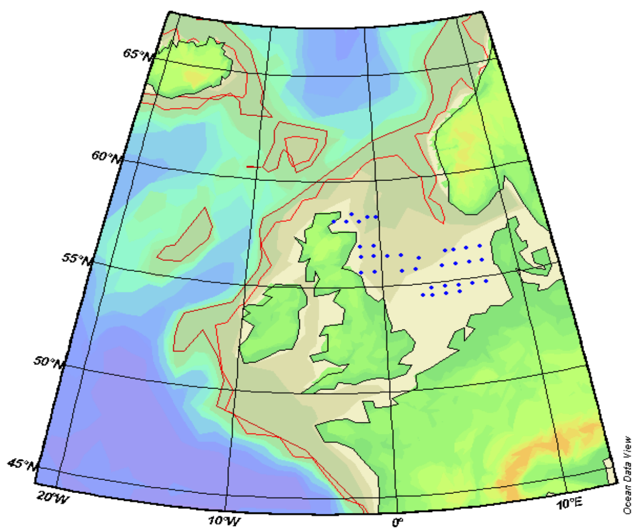

Figure 2. 7.1. Positions of CTD stations during the July 2006 North Sea hydro acoustic survey for herring by R/V “Tridens”.

2.8 Acoustic 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 (Table 2.8.1).

herring	sprat	mackerel	Norway pout	gadoids	sandeel
71.2	71.2	86.9	67.1	67.4	93.7

Table 2.8.1 Use values for b20 reference value during the June-July 2006 North Sea herring hydro acoustic survey on R/V “Tridens”.

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 2.8.1). In the western part of the survey area, size distributions showed a decrease in mean length in herring in a line from the north east to the south west. 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.

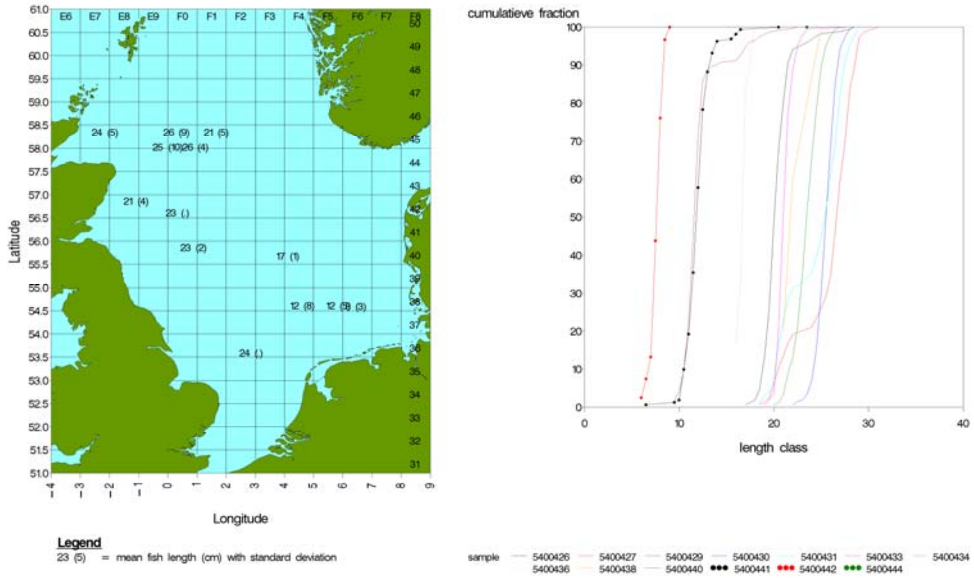

Figure 2.8.1. Post plot of herring mean length from R/V "Tridens", observed during the July 2006 North Sea hydro acoustic survey for herring. Based on geographical differences in size distributions strata A to E were defined. The 54…. Numbers refer to the sample ID's stored in the IMARES database.

3. Results

3.1 Acoustic data results

In total data from 1897 surveyed nautical miles were used for the biomass estimate of herring and sprat.

Horizontal and vertical distribution patterns
Fish aggregations near the Danish coast appeared much more disperse than in other areas (Fig. 3.1.3). This typical aggregation pattern of clupeids was also found near the Dutch coast in other surveys.

The north-western part of this year's survey area held most of the herring observed (Fig. 3.1.4A). Interlaced transects in this area were covered by R/V 'Scotia', making a good description of the distribution pattern observed by Tridens difficult.

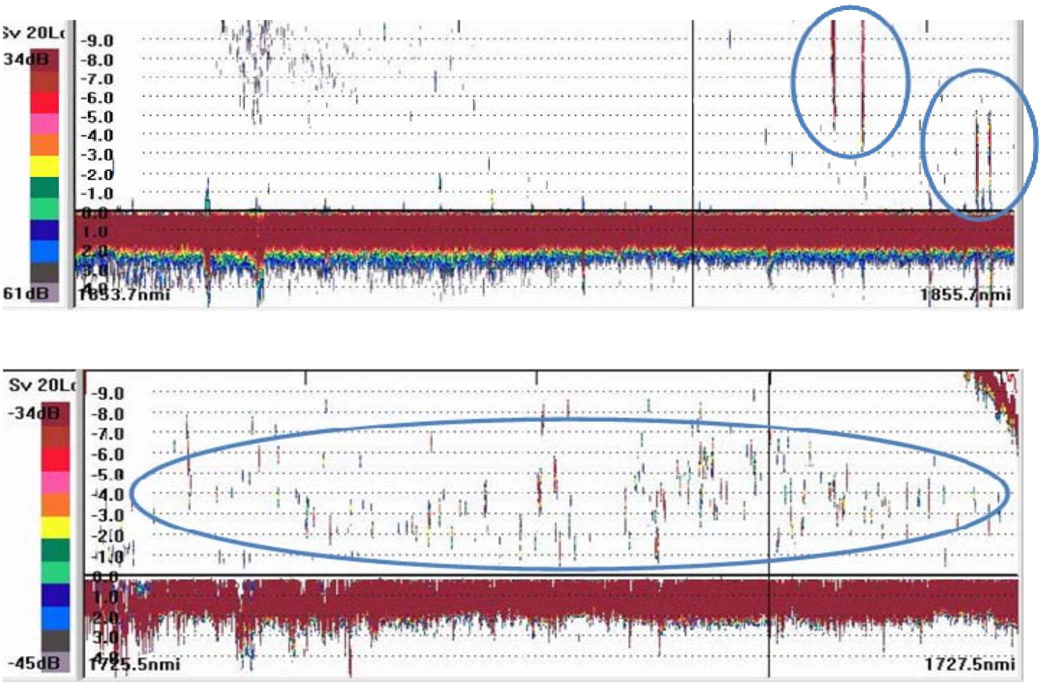

Figure 3.1.3. Sample echograms obtained during the June-July 2006 North Sea herring hydro acoustic survey on R/V "Tridens". The upper image shows herring/sprat schools in the central north sea whereas the lower image shows a typical aggregation pattern in the German Bight, near the Danish coast. Recording distance is 2 nautical miles (3.7km).

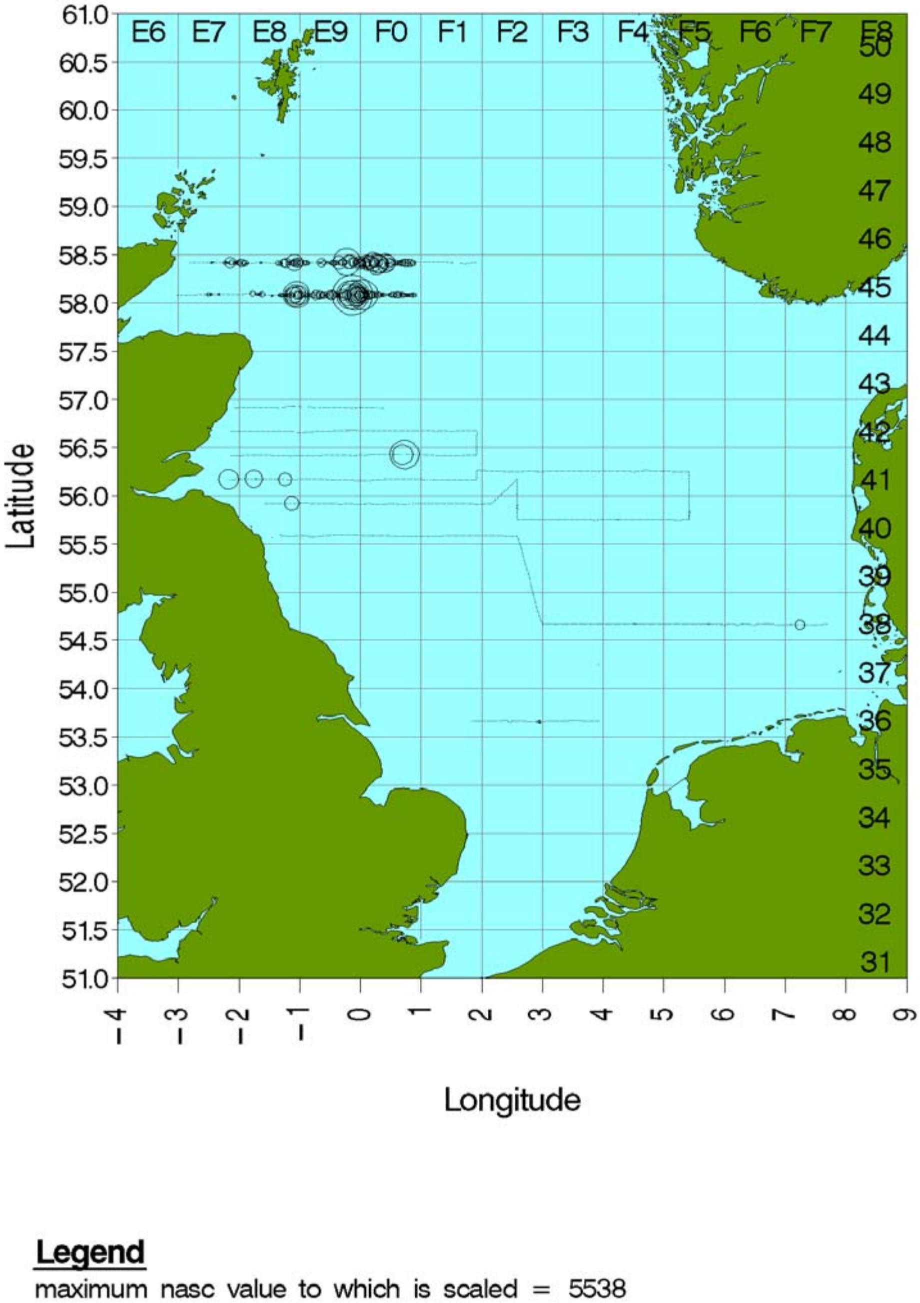

*Figure 3.1.4A. Post plot showing the distribution of **total herring** S_A values (on a proportional square root scale relative to the largest value of 5303) obtained during the June-July 2006 North Sea herring hydro acoustic survey on R/V "Tridens".*

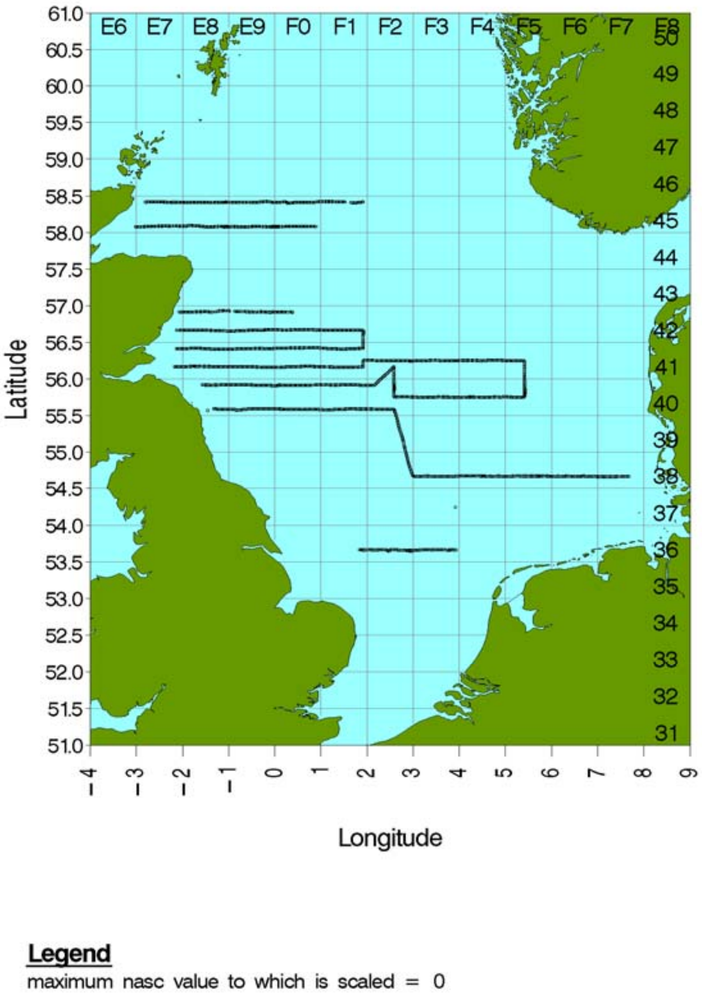

Figure 3.1.4B. Post plot showing the distribution of ***total sprat*** *S_A values (on a proportional square root scale relative to the largest value of 1425) obtained during the June-July 2006 North Sea herring hydro acoustic survey on R/V "Tridens".*

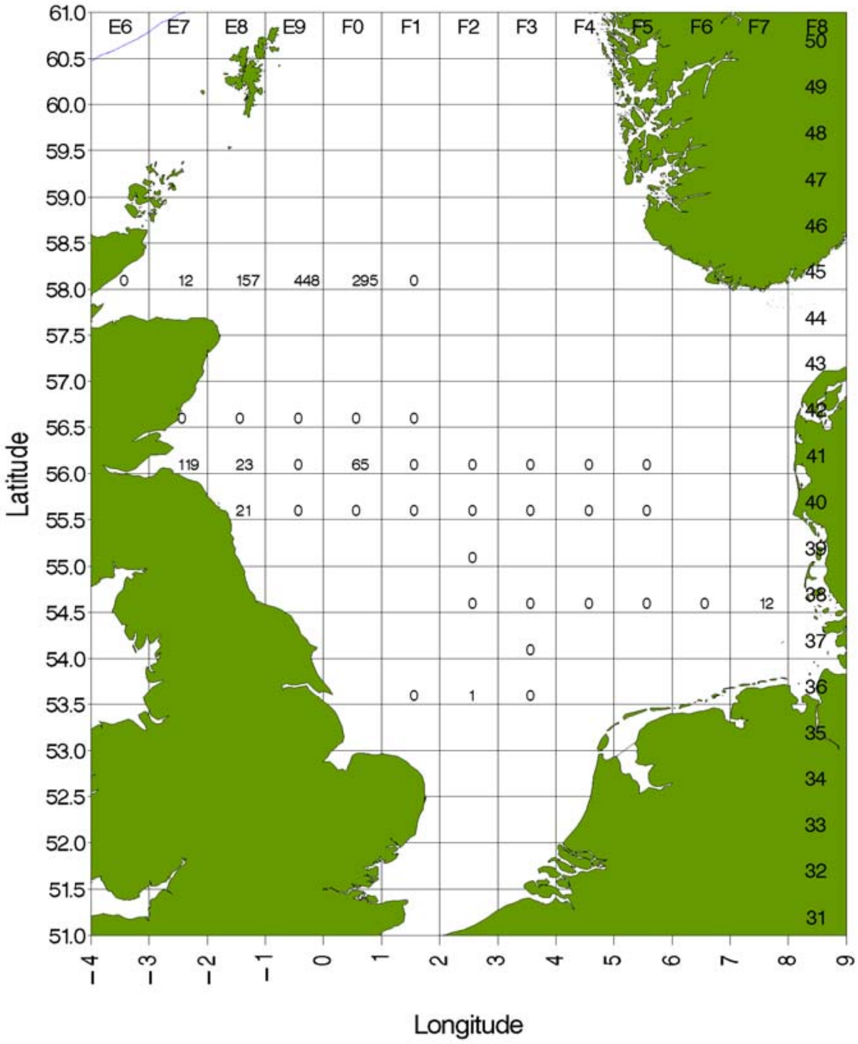

*Figure 3.1.5. Mean acoustic density (s_A, m^2/nm^2) **herring** per ICES rectangle obtained during the March 2006 North East Atlantic blue whiting hydro acoustic survey on R/V "Tridens".*

3.2 Trawl data results

In all, 23 trawl hauls have been conducted (figure 2.3.2). 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 appendix C,table C1, catch weights per haul and species are presented in table C2 and the length frequency proportions are presented in figure C1.

In total 903 biological fish samples of herring and 239 of sprat were collected and used for length, age and maturity keys from which most herring were 1 year old's (Figure 3.2.1). A lack of 2 and 3 year old mature males is probably due to sampling strategy but has be looked at.

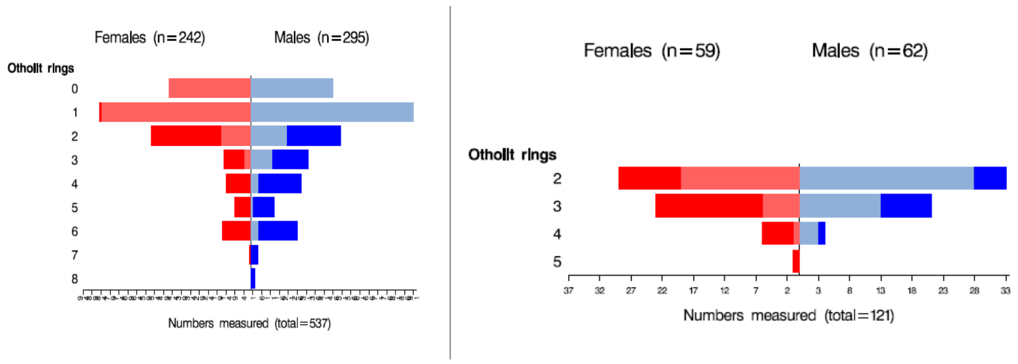

Figure 3.2.1 Overview of collected biological samples of herring (left panel) and sprat (right panel) during the June-July 2006 North Sea hydro acoustic survey for herring, R/V "Tridens". The light shaded colours represent juveniles.

By the age of 3 (having 3 winter rings) almost all herring is mature (Fig. 3.2.2) where in 2005 this age was 4 and in 2004 this age was also 4. Growth parameters are shown in figure 3.2.3.

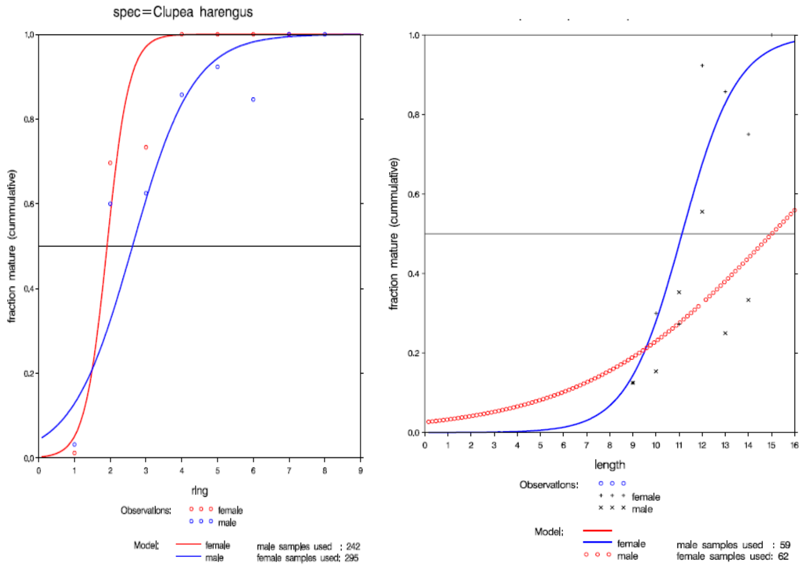

Figure 3.2.2. Maturity related to otholith rings during the June-July 2006 North Sea hydro acoustic survey for herring, R/V "Tridens". In both stratum A ,B and C no mature herring was observed (<1%).

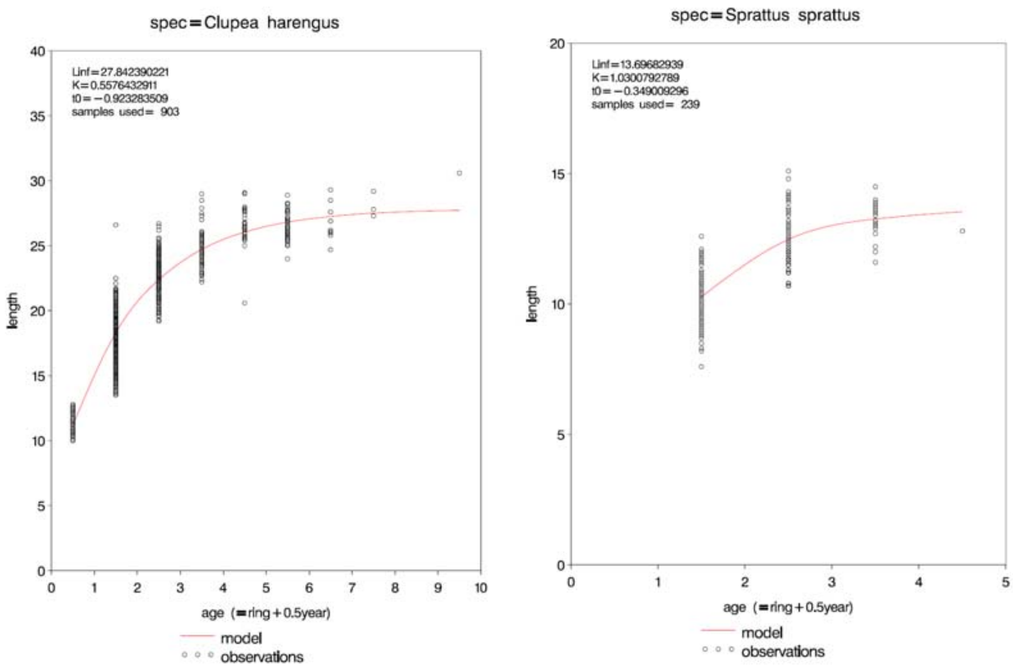

Figure 3.2.3 Von Bertalanffy growth curves of herring and sprat.

3.3 (Sub)stock 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 3.3.1 shows the estimated numbers and biomass of herring by ICES rectangle in the area surveyed by R/V Tridens. Table 3.3.1 summarizes the sub stock estimates for all strata. Table C3 in Appendix C summarizes stock estimates per stratum as defined in figure 2.8.1.

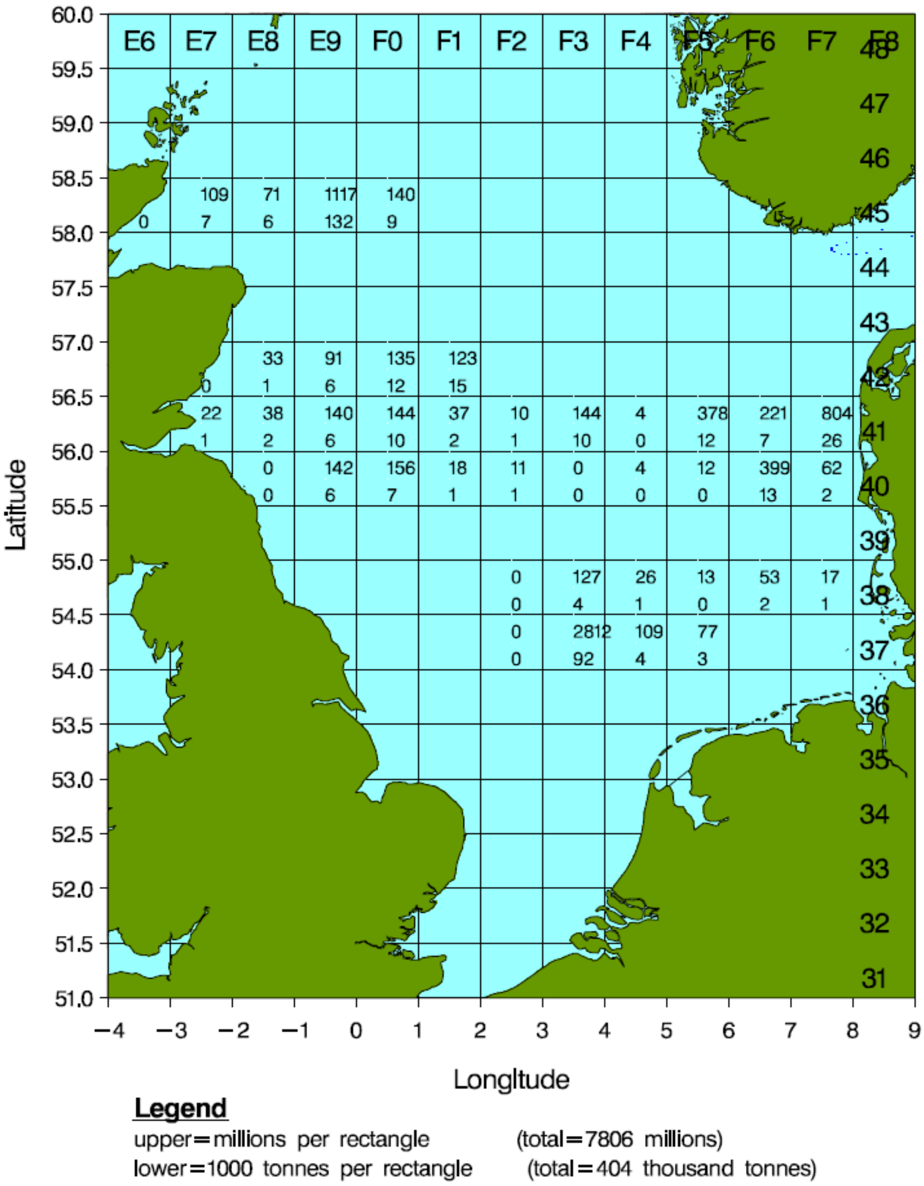

Figure 3.3.1. Estimated numbers of herring in millions (upper half square) and biomass in thousands of tonnes (lower half of square) by ICES rectangle. Results from the July 2006 North Sea hydro acoustic survey, R/V "Tridens".

Table 3.3.1. Sub stock estimate. Results from the July 2006 North Sea hydro acoustic survey, R/V "Tridens".

Total area											
yearclass	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996	Total
	0	1	2	3	4	5	6	7	8	9	
b_tsb	2.9	232.4	57.5	42.9	14.0	47.5	5.7	0.6	0.0	0.4	404.0
b_tssb	0.0	0.4	25.2	38.0	13.9	47.4	5.7	0.6	0.0	0.4	131.6

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
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 (figureD1 in appendix D). Continuous surface temperature recordings were used for a general real-time overview (figure D2). A daily and weekly by satellite constructed mean surface temperature from the North Sea was used as a reference during the survey (Figure D3 in appendix D).

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.

4. Discussion

Results

Highest concentrations of mature herring were observed in the most northern region of the survey area, close to the main spawning grounds and around the Devil Holes. Highest concentrations of juveniles were found close to the Danish coast where they mixed with sprat. Total biomass observed this survey mainly consisted of the 2004 yearclass. The strong 2000 yearclass still makes 47% of the spawning stock biomass in the area surveyed and all fish from this group are finally mature. Results from this year's cruise should not be compared directly with previous year's results as the survey area of Tridens differs from year to year.

Survey design

Through overlapping coverage in some areas, information on the spatial and temporal dynamics of herring is gained and should give a better idea of accuracy of the results. As no other vessels covered the ICES rectangles covered by Tridens, no variability in vessel-specific acoustic observations could be seen this year. It still proves difficult to conduct interlaced transects with multiple vessels in a pre-planned time period. Tridens was not able to cover all of the most northern part of their survey area in the first survey week and as a result R/V Scotia was willing to cover this area. Long east-west transect covering the entire North Sea asked for a flexible planning, but the pre-agreed weekend break in the second half of the survey resulted in Dana taking over the most southern transect of Tridens' survey area. Pelagic surveys have a high variability in fish detection. Especially for long transects it can therefore be difficult to predict the time span of covering these. As mentioned in previous years R/V Tridens is tied to weekly breaks while having to work closely together to 2 other research vessels in its area. This makes it difficult to implement long transects in the cruise planning.

Appendix A Calibration results of EK60

Towed Body 38 kHz

```
#  Calibration  Version   2.1.0.11
#
#  Date:  6/30/2006
#
#  Comments:
#    2de keer Scapa Flow, nadat was gebleken dat de kabel niet goed was aan begin survey
#
#  Reference Target:
#    TS                  -33.60 dB       Min. Distance         11.50 m
#    TS Deviation           5.0 dB       Max. Distance         13.50 m
#
#  Transducer:  ES38B_TB2  Serial No.   30501
#    Frequency            38000 Hz       Beamtype                Split
#    Gain                 23.30 dB       Two Way Beam Angle   -20.6 dB
#    Athw. Angle Sens.      21.90        Along. Angle Sens.      21.90
#    Athw. Beam Angle     7.74 deg       Along. Beam Angle    7.17 deg
#    Athw. Offset Angle   0.29 deg       Along. Offset Angle  0.07 deg
#    SaCorrection        -0.49 dB        Depth                 0.00  m
#
#  Transceiver:  GPT  38 kHz 009072017a3b 1 ES38B_TB2
#    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           -50.0 dB       Min. Spacing            100 %
#    Max. Beam Comp.        6.0 dB       Min. Echolength          80 %
#    Max. Phase Dev.           8.0       Max. Echolength         180 %
#
#  Environment:
#    Absorption Coeff.   9.5 dB/km       Sound Velocity     1499.4 m/s
#
#  Beam Model results:
#    Transducer Gain    = 24.12 dB       SaCorrection       = -0.54 dB
#    Athw. Beam Angle   = 7.25 deg       Along. Beam Angle  = 6.98 deg
#    Athw. Offset Angle = 0.00 deg       Along. Offset Angle= 0.04 deg
#
#  Data deviation from beam model:
#    RMS =    0.36 dB
#    Max =    1.18 dB  No. =   362  Athw. =  1.8 deg  Along =  3.3 deg
#    Min =   -2.10 dB  No. =   340  Athw. = -2.3 deg  Along = -3.3 deg
#
#  Data deviation from polynomial model:
#    RMS =    0.31 dB
#    Max =    0.93 dB  No. =   327  Athw. = -3.6 deg  Along = -3.3 deg
#    Min =   -1.97 dB  No. =   340  Athw. = -2.3 deg  Along = -3.3 deg
```

Towed Body 200 kHz

```
#  Calibration  Version   2.1.0.11
#
#  Date:  6/30/2006
#
#  Comments:
#    2de keer ScapaFlow
#
#  Reference Target:
#    TS                   -45.00 dB       Min. Distance          7.00 m
#    TS Deviation           7.0 dB       Max. Distance          9.00 m
#
#  Transducer:  ES200-7  Serial No.   116
#    Frequency            200000 Hz       Beamtype                Split
#    Gain                  23.96 dB       Two Way Beam Angle   -20.7 dB
#    Athw. Angle Sens.      23.00         Along. Angle Sens.      23.00
#    Athw. Beam Angle      6.67 deg       Along. Beam Angle    6.53 deg
#    Athw. Offset Angle  -0.18 deg       Along. Offset Angle  0.04 deg
#    SaCorrection          -0.39 dB       Depth                 0.00  m
#
#  Transceiver:  GPT 200 kHz 009072017a36 1 ES200-7
#    Pulse Duration       0.256 ms       Sample Interval     0.048   m
#    Power                  300  W       Receiver Bandwidth  10.64 kHz
#
#  Sounder Type:
#    EK60 Version  2.1.1
#
#  TS Detection:
#    Min. Value           -55.0 dB       Min. Spacing           100 %
#    Max. Beam Comp.        6.0 dB       Min. Echolength         80 %
#    Max. Phase Dev.          8.0        Max. Echolength        180 %
#
#  Environment:
#    Absorption Coeff.  55.8 dB/km       Sound Velocity     1499.4 m/s
#
#  Beam Model results:
#    Transducer Gain    = 21.65 dB       SaCorrection       = -0.49 dB
#    Athw. Beam Angle   = 6.96 deg       Along. Beam Angle  = 6.87 deg
#    Athw. Offset Angle =-0.16 deg       Along. Offset Angle=-0.23 deg
#
#  Data deviation from beam model:
#    RMS =    0.91 dB
#    Max =    2.57 dB  No. =    80  Athw. =  3.8 deg  Along = -0.2 deg
#    Min =   -1.99 dB  No. =   223  Athw. =  1.6 deg  Along = -3.7 deg
#
#  Data deviation from polynomial model:
#    RMS =    0.89 dB
#    Max =    2.64 dB  No. =    80  Athw. =  3.8 deg  Along = -0.2 deg
#    Min =   -2.08 dB  No. =   232  Athw. =  2.5 deg  Along = -2.9 deg
```

Hull mounted 38 kHz

```
#  Calibration  Version   2.1.0.11
#
#  Date:  6/28/2006
#
#  Comments:
#    hull mounted
#
#  Reference Target:
#    TS                   -33.60 dB       Min. Distance         18.00 m
#    TS Deviation            4.0 dB       Max. Distance         22.00 m
#
#  Transducer:  ES38B_HM  Serial No.   0000
#    Frequency             38000 Hz       Beamtype                Split
#    Gain                  26.16 dB       Two Way Beam Angle   -20.6 dB
#    Athw. Angle Sens.       21.90        Along. Angle Sens.      21.90
#    Athw. Beam Angle      7.04 deg       Along. Beam Angle    6.85 deg
#    Athw. Offset Angle  -0.08 deg       Along. Offset Angle -0.08 deg
#    SaCorrection          -0.59 dB       Depth                 4.00  m
#
#  Transceiver:  GPT  38 kHz 009072017a3b 1 ES38B_HM
#    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            -50.0 dB       Min. Spacing            100 %
#    Max. Beam Comp.         6.0 dB       Min. Echolength          80 %
#    Max. Phase Dev.           8.0        Max. Echolength         180 %
#
#  Environment:
#    Absorption Coeff.   9.5 dB/km       Sound Velocity     1499.4 m/s
#
#  Beam Model results:
#    Transducer Gain    = 24.64 dB       SaCorrection       = -0.50 dB
#    Athw. Beam Angle   = 7.16 deg       Along. Beam Angle  = 7.02 deg
#    Athw. Offset Angle = 0.05 deg       Along. Offset Angle=-0.09 deg
#
#  Data deviation from beam model:
#    RMS =    0.19 dB
#    Max =    0.75 dB  No. =   195  Athw. = -2.2 deg  Along =  4.5 deg
#    Min =   -0.71 dB  No. =   214  Athw. =  2.1 deg  Along =  4.1 deg
#
#  Data deviation from polynomial model:
#    RMS =    0.17 dB
#    Max =    0.58 dB  No. =   195  Athw. = -2.2 deg  Along =  4.5 deg
#    Min =   -0.65 dB  No. =   214  Athw. =  2.1 deg  Along =  4.1 deg
#
```

Appendix B Simrad EK60 settings

Table B1. Simrad EK60 settings used on the June 2006 North Sea hydro acoustic survey for herring, R/V “Tridens”.

Transceiver menu	**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
Calibration details		
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	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

Appendix C Trawl results

Table C1. Details of the trawl hauls taken during the June-July 2006 North Sea hydro acoustic survey for herring, R/V "Tridens".

sample	haul	ICES	date	time (GMT)	position	haul duration (min)	depth (m)	geardepth (m)	wind direction (º)	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 C2. Trawl catches during the June-July 2006 North Sea hydro acoustic survey for herring, R/V "Tridens" in kg. Scientific and English species names are listed in **appendix I**.

	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

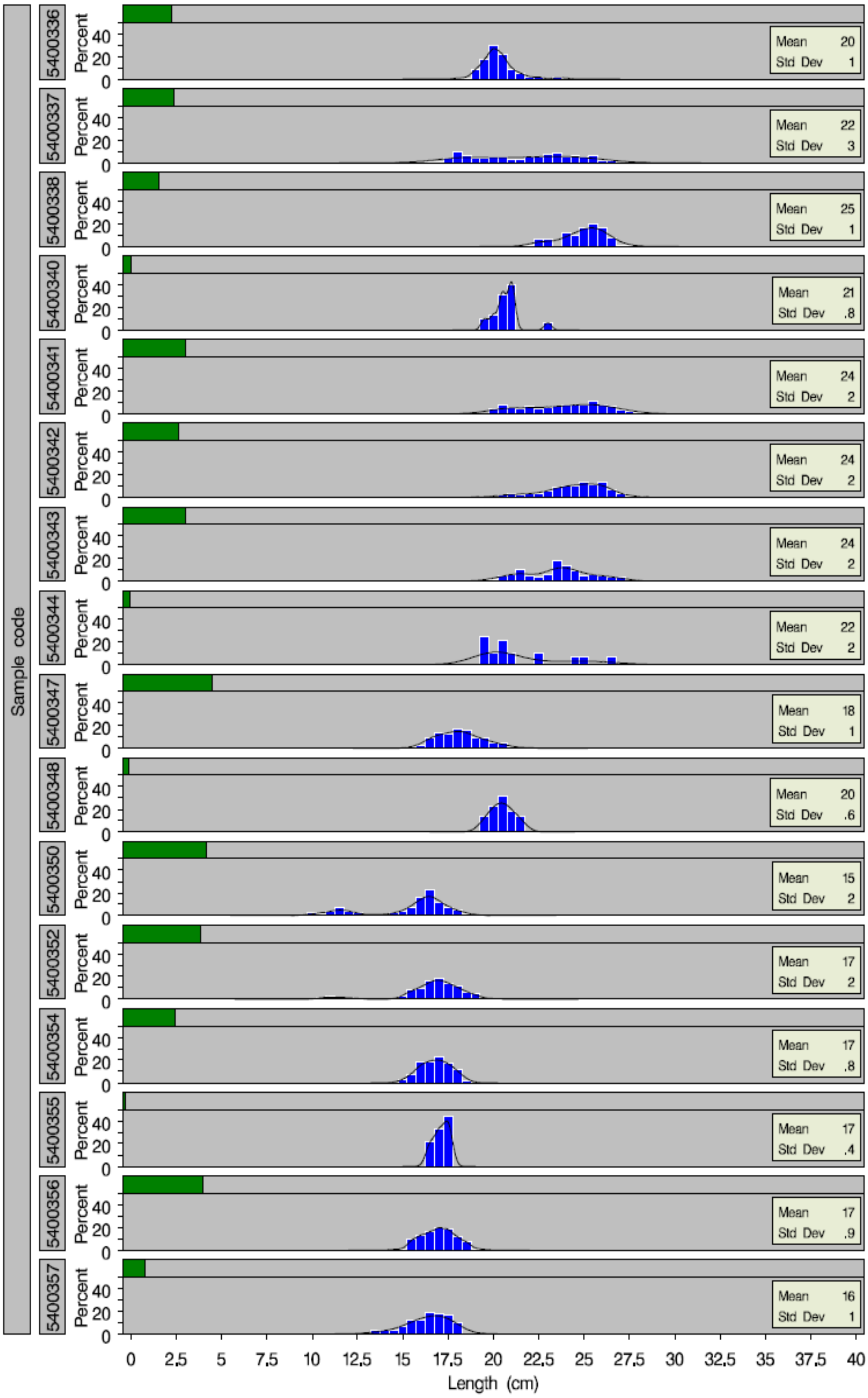

Figure C1. Length frequency distributions of herring during the June-July 2006 North Sea hydro acoustic survey for herring, R/V "Tridens". Smoothing is obtained by normal kernel density estimates. The green bars indicate the relative amount of samples used.

Table C3. Sub stock estimates of herring for strata A to E during the June-July 2006 North Sea hydro acoustic survey for herring, R/V “Tridens” in kg. Strata definition can be found in paragraph 2.8.

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 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				

Appendix D Hydrography

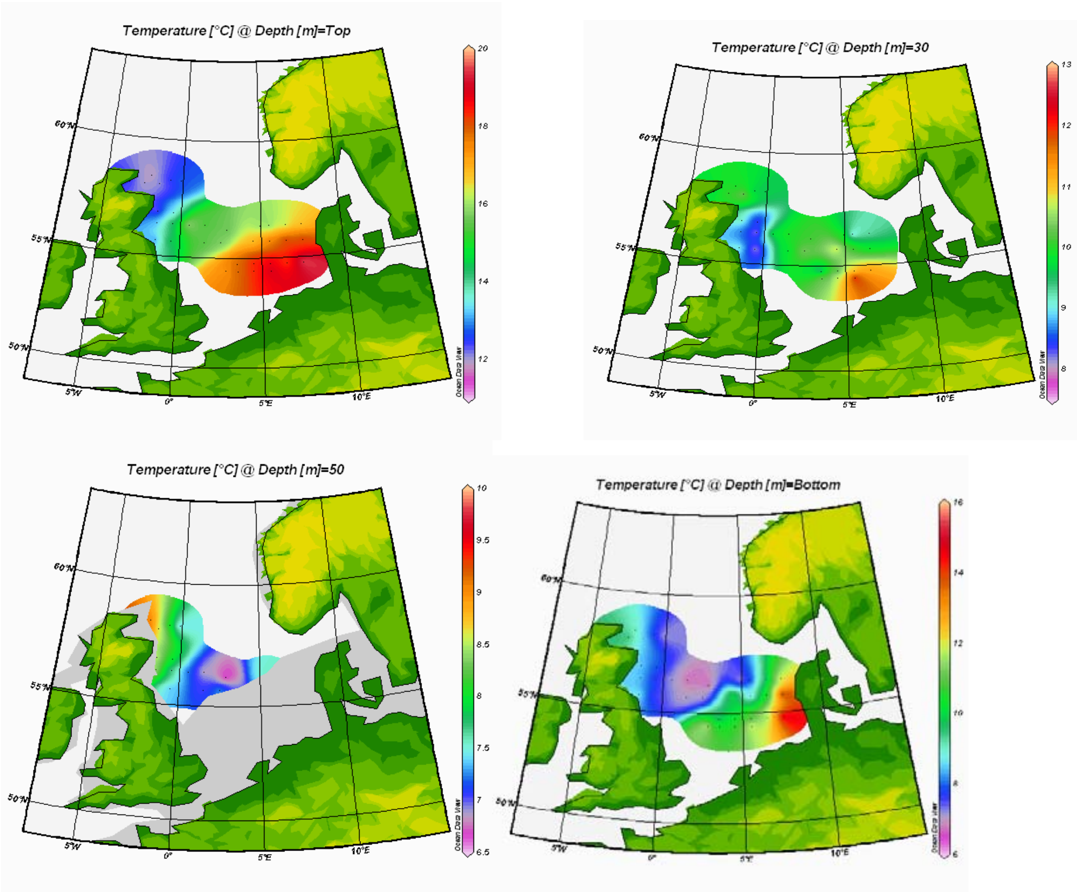

Figure D1. Upper panel shows the water temperature at **surface**, the second panel at **30m** depth, the third panel at **50m** depth and the lower panel shows temperature at **bottom** all recorded by the Seabird CTD device. The lower panels show Sea **Bottom** temperature distribution recorded by Seabird CTD device.

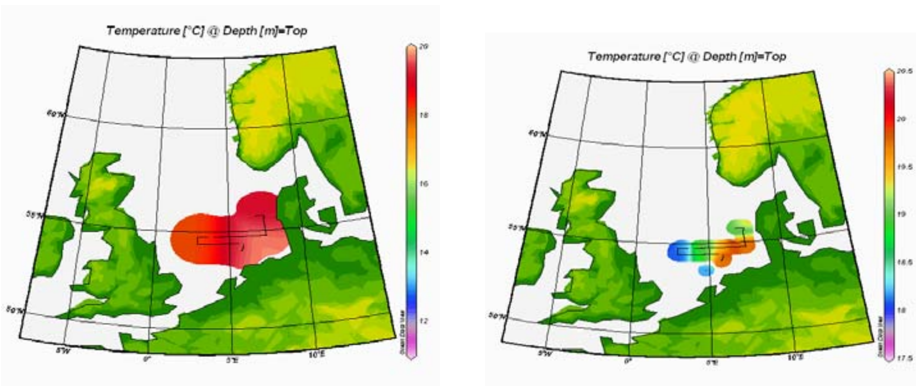

Figure D2. Both panels show the sea **surface** temperature (SST) distribution recorded in the water intake system from ship. The left panel uses the same temperature range as used in figure D1.

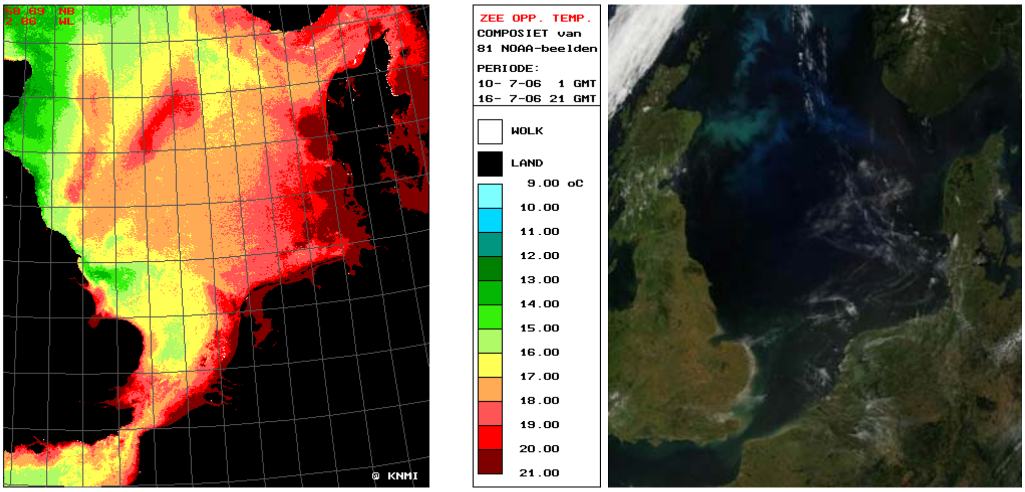

Figure D3. Right: Mean sea **surface** temperature (SST) from NOAA satellite for the period 10 to 16 July 2006. Source: www.knmi.nl. Left: Satellite image of the North Sea indicating the distribution of surface phytoplankton. (indicated in light blue). Recorded on 15 July 2005. Source: http://rapidfire.sci.gsfc.nasa.gov .

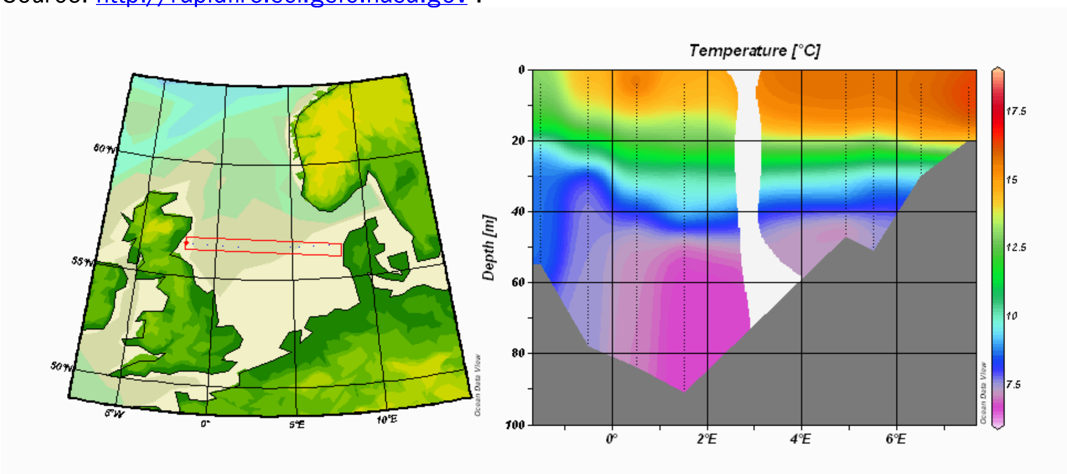

Figure D4. Temperature pattern along an east/west transect in the central North Sea during the June-July 2006 North Sea hydro acoustic survey for herring, R/V "Tridens". Time span between eastern part and western part is about a week.

Appendix E Data acquisition on board

In line with last cruise data handling improvements, an expended concept was implemented resulting in the first version of an onboard database. This MySQL database is now filled with trawl station data from acoustic surveys only but will gradually incorporate more types of data from different surveys. Haul and station information was recorded automatically after which this data was automatically merged with biological datasheet. Continuous station information (date, time and position) was also used for live cruise tracks and survey planning.

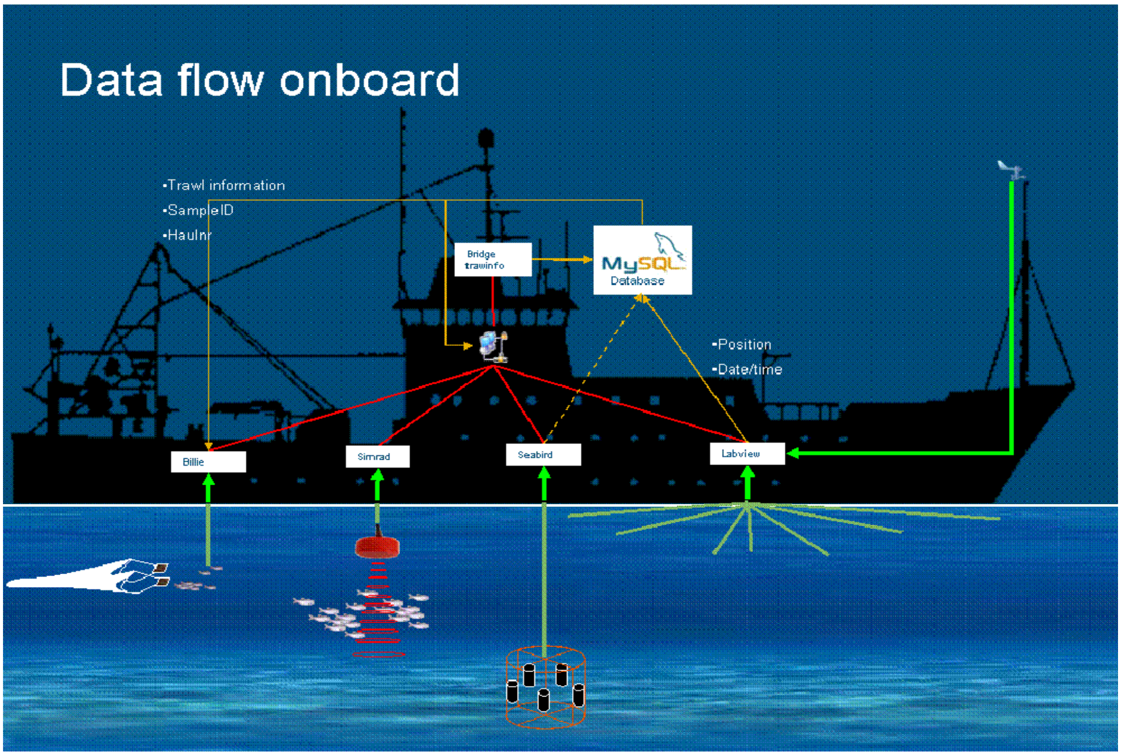

Figure G1. Schematic overview of the data flow from all input sources to the final analysis results during the June-July 2006 North Sea hydro acoustic survey for herring, R/V "Tridens".

Green lines	: indicates raw data flow from measuring device to recording device
Orange lines	: indicates automatic data flow to and from database. Dashed lines indicate non-implemented data flows.
Red lines	: indicates automatic backup of raw data to central server

Appendix F Species list

species_code	NODC_code	tsn	Dutch_name	Scientific_name	English_name
ZSP	8845010100	171671	Ammodytes	Ammodytes	
ARG	8756010203	162064	Grote zilversmelt	Argentina silus	Greater argentine
RGU	8826020801	167049	Engelse poon	Aspitrigla cuculus	Red gurnard
HER	8747010201	161722	Haring	Clupea harengus	Herring
LSU	8831091501	167612	Snotolf	Cyclopterus lumpus	Lumpsucker
AZN	8820022101	166591	Adderzeenaald	Entelurus aequoraeus	Snake pipefish
GGU	8826020601	167044	Grauwe poon	Eutrigla gurnardus	Grey gurnard
COD	8791030402	164712	Kabeljauw	Gadus morhua	Cod
LSC	8857040603	172877	Lange schar	Hippoglossoides platessoides	Long rough dab
DAB	8857040904	172881	Schar	Limanda limanda	Dab
HAD	8791031301	164744	Schelvis	Melanogrammus aeglefinus	Haddock
WHG	8791031801	164758	Wijting	Merlangius merlangus	Whiting
HKE	8791040105	164795	Heek	Merluccius merluccius	Hake
LEM	8857041202	172888	Tongschar	Microstomus kitt	Lemon sole
PLE	8857041502	172902	Schol	Pleuronectes platessa	Plaice
POK	8791030901	164727	Zwarte koolvis	Pollachius virens	Saithe
MAC	8850030302	172414	Makreel	Scomber scombrus	Mackerel
SPR	8747011701	161789	Sprot	Sprattus sprattus	Sprat
	5707150801	205728	Todaropsis	Todaropsis eblanae	
HOM	8835280103	168588	Horsmakreel	Trachurus trachurus	Horse mackerel
NOP	8791031703	164756	Kever	Trisopterus esmarkii	Norway pout
POD	8791031701	164754	Dwergbolk	Trisopterus minutus	Poor cod

Appendix G CTD calibration settings

```
Date: 07/17/2006

ASCII file: C:\Documents and Settings\All Users\Documents\CTD
data\HERAS 2006\TitaniumCTDconfig.con

Configuration report for SBE 911/917 plus CTD
---------------------------------------------
Frequency channels suppressed : 0
Voltage words suppressed      : 0
Computer interface            : RS-232C
Scans to average              : 1
Surface PAR voltage added     : No
NMEA position data added      : Yes
Scan time added               : No

1) Frequency channel 0, Temperature

   Serial number : 2344
   Calibrated on : 18-May-05
   G             : 4.33368393e-003
   H             : 6.46441919e-004
   I             : 2.40647038e-005
   J             : 2.32662311e-006
   F0            : 1000.000
   Slope         : 1.00000000
   Offset        : 0.0000

2) Frequency channel 1, Conductivity

   Serial number : 2093
   Calibrated on : 6-May-05
   G             : -1.06057050e+001
   H             : 1.54865809e+000
   I             : -3.41846210e-003
   J             : 3.29774225e-004
   CTcor         : 3.2500e-006
   CPcor         : -9.57000000e-008
   Slope         : 1.00000000
   Offset        : 0.00000

3) Frequency channel 2, Pressure, Digiquartz with TC

   Serial number : 70773
   Calibrated on : 23-May-05
   C1            : -5.104473e+004
   C2            : -8.603752e-001
   C3            : 1.368040e-002
   D1            : 4.093700e-002
   D2            : 0.000000e+000
   T1            : 2.975743e+001
   T2            : -5.557625e-004
   T3            : 4.153610e-006
   T4            : 5.291250e-010
   T5            : 0.000000e+000
```

```
   Slope          : 1.00004000
   Offset         : 0.45930
   AD590M         : 1.283697e-002
   AD590B         : -9.090950e+000

Date: 07/17/2006

ASCII file: C:\Documents and Settings\All Users\Documents\CTD
data\HERAS 2006\NIOZ_CTDconfig.con

Configuration report for SBE 911/917 plus CTD
---------------------------------------------

Frequency channels suppressed : 2
Voltage words suppressed      : 4
Computer interface            : RS-232C
Scans to average              : 1
Surface PAR voltage added     : No
NMEA position data added      : Yes
Scan time added               : No

1) Frequency channel 0, Temperature

   Serial number : 1219
   Calibrated on : 10-dec-04
   G             : 4.86278506e-003
   H             : 6.78094041e-004
   I             : 2.67996223e-005
   J             : 2.14701526e-006
   F0            : 1000.000
   Slope         : 1.00000000
   Offset        : 0.0000

2) Frequency channel 1, Conductivity

   Serial number : 2142
   Calibrated on : 18-dec-04
   G             : -1.06468555e+001
   H             : 1.51048063e+000
   I             : -2.35374123e-003
   J             : 2.67576812e-004
   CTcor         : 3.2500e-006
   CPcor         : -9.57000000e-008
   Slope         : 1.00000000
   Offset        : 0.00000

3) Frequency channel 2, Pressure, Digiquartz with TC

   Serial number : 0261
   Calibrated on : 28-feb-06
   C1            : -3.975465e+004
   C2            : 6.132040e-002
   C3            : 1.251060e-002
   D1            : 4.019100e-002
   D2            : 0.000000e+000
   T1            : 3.008636e+001
   T2            : -2.600940e-004
   T3            : 4.636930e-006
```

```
T4            : 7.126440e-010
T5            : 0.000000e+000
Slope         : 1.00003000
Offset        : -1.78010
AD590M        : 1.153000e-002
AD590B        : -8.189100e+000
```

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Internal report
Number: 06.015

North Sea hydro acoustic herring survey
Survey report for R/V "TRIDENS"
26 June - 21 July 2006

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Samenvatting

Dit is het verslag van de Nederlandse deelname aan de Noordzee akoestische survey voor haring. Deze, door ICES gecoördineerde survey wordt sinds 1991 jaarlijks uitgevoerd. Naast Nederland nemen Schotland, Duitsland, Denemarken en Noorwegen deel aan de survey.
Tot voor kort had ieder deelnemend land de verantwoordelijkheid over een eigen gebied wat jaarlijks bemonsterd werd. Sinds 2005 wordt er gewerkt aan een volledig geïntegreerde survey waarbij gebieden door meer dan één schip bemonsterd worden. Het doel van de survey is het maken van een schatting van de grootte van de Noordzee haring populatie. Deze schatting wordt gebruikt als een "tuning index" door de ICES Herring Assessment Working Group (HAWG) om de omvang van de populatie vast te stellen.
Voor de survey wordt gebruik gemaakt van een Simrad 38kHz splitbeam transducer met een EK60 echolood. De toegepaste methode is echo-integratie. Door transecten te varen in het gebied wordt het totale akoestische oppervlak per oppervlakteeenheid bepaald. Door het uitvoeren van vistrekken wordt de soort-samenstelling bepaald. Van haring en sprot worden daarnaast biologische monsters genomen om leeftijd en rijpheid te bepalen. Voor deze soorten kan aldus een schatting van de populatie, uitgesplitst naar leeftijd en rijpheid, gemaakt worden.
De biomassa van de totale haring-populatie in het door het Nederlandse schip bemonsterde gebied wordt geschat op 404 duizend ton, die van sprot op 31 duizend ton. De paai-biomassa van haring wordt geschat op 131 duizend ton.

Summary

This is the report of the Dutch part of the international North Sea hydro acoustic survey for herring. The survey is coordinated by ICES and has been executed annually since 1991. Scotland, Germany, Denmark and Norway also participate in the survey.
Until recently each country had its own national area which was covered yearly. Since 2005, the survey is in the process of being fully integrated with interlaced transects. The purpose of the survey is to estimate the herring stock of the North Sea. The ICES Herring Assessment Working Group (HAWG) uses this estimation as a "tuning index" to assess the North Sea herring stock. For this survey a Simrad 38kHz splitbeam transducer was used together with a Simrad EK60 echo sounder. The applied method was echo integration. By sailing transects over the survey area, the total acoustic cross-section can be calculated by surface area. Trawling identified species composition of localized schools. The length composition of each species was determined. Herring and sprat were examined on age and fecundity from which a split up of the stock structure was made.
Total biomass in the area covered by the Dutch vessel of the herring population was estimated to be 404 thousand tonnes from which 131 thousand tonnes was mature fish. For sprat the total biomass was estimated to be 31 thousand tonnes.

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 R/V “Tridens”.

Cruise plan
The survey is currently changing from a separate National survey approach with traditional area’s for each participant towards a more integrated 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

The objective in this survey has gradually shifted from estimating herring abundance into a more ecosystem survey. This ecosystem approach involves extra focus on non-target fish species as well as environmental parameters such as temperature and plankton. For the first time water samples were taken, in the first place to calibrate the CTD device but also to gather information on chemical contents in the water column. Acoustic observations not only target herring but also sprat, mackerel and sandeel using specific algorithms designed for species recognition. Satellite images of phytoplankton at the surface were collected weekly (Figure D3 in appendix D) to relate acoustic images of plankton to satellite images of the same plankton layers.

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 38kHz and 200kHz 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 showed gadoids and some herring. In the evening radio contact is made with R/V 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 R/V 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 R/V 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 R/V Tridens and R/V Solea, it was decided to merge them into one transect on 55°40.

The planned surveyed cruise track and trawl positions are presented in figure 2.3.1. Actual cruise track from which data was used for stock estimate and trawl positions are presented in figure 2.3.2.

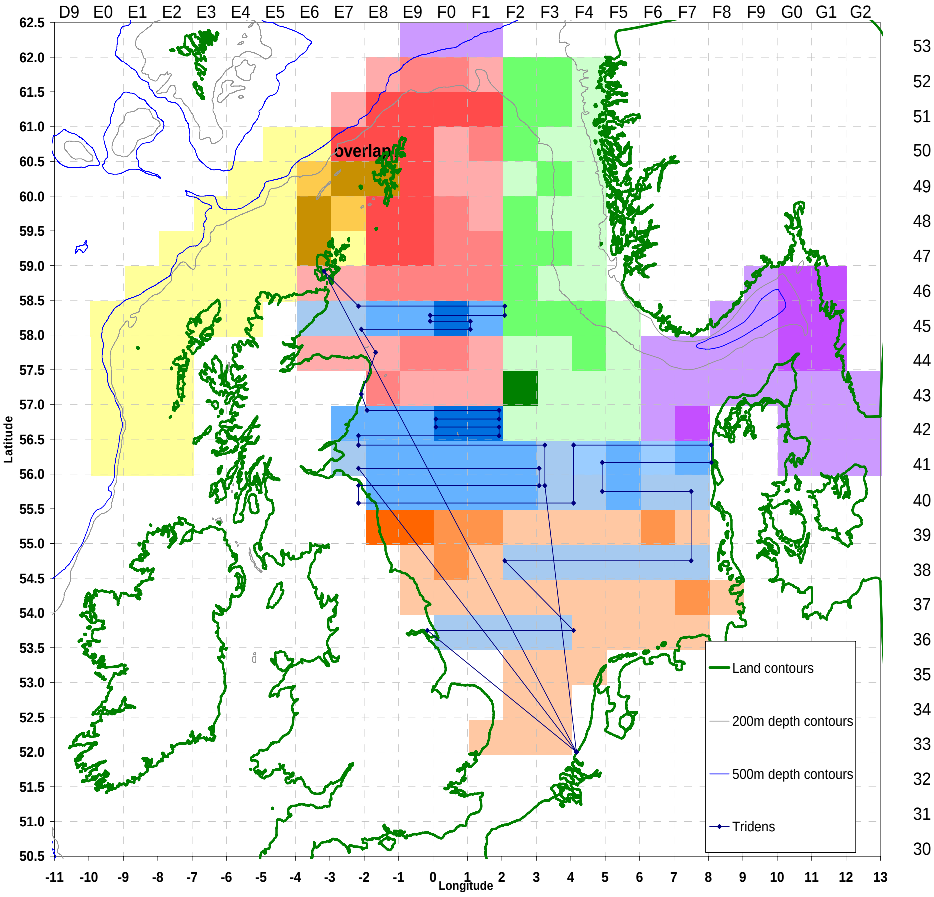

Figure 2.3.1. Map of planned cruise track and positions of trawl stations and hydrographical stations during the June-July 2006 North Sea herring hydro acoustic survey on R/V "Tridens".
The color of the rectangles indicate by which vessel it should have been covered whereas the intensity of the color increases with the survey intensity.

- *Yellow=charter vessel*
- *Pink=Scotia*
- *Blue =Tridens*
- *Orange=Solea*
- *Purple=Dana*
- *Green=Johan Hjort*

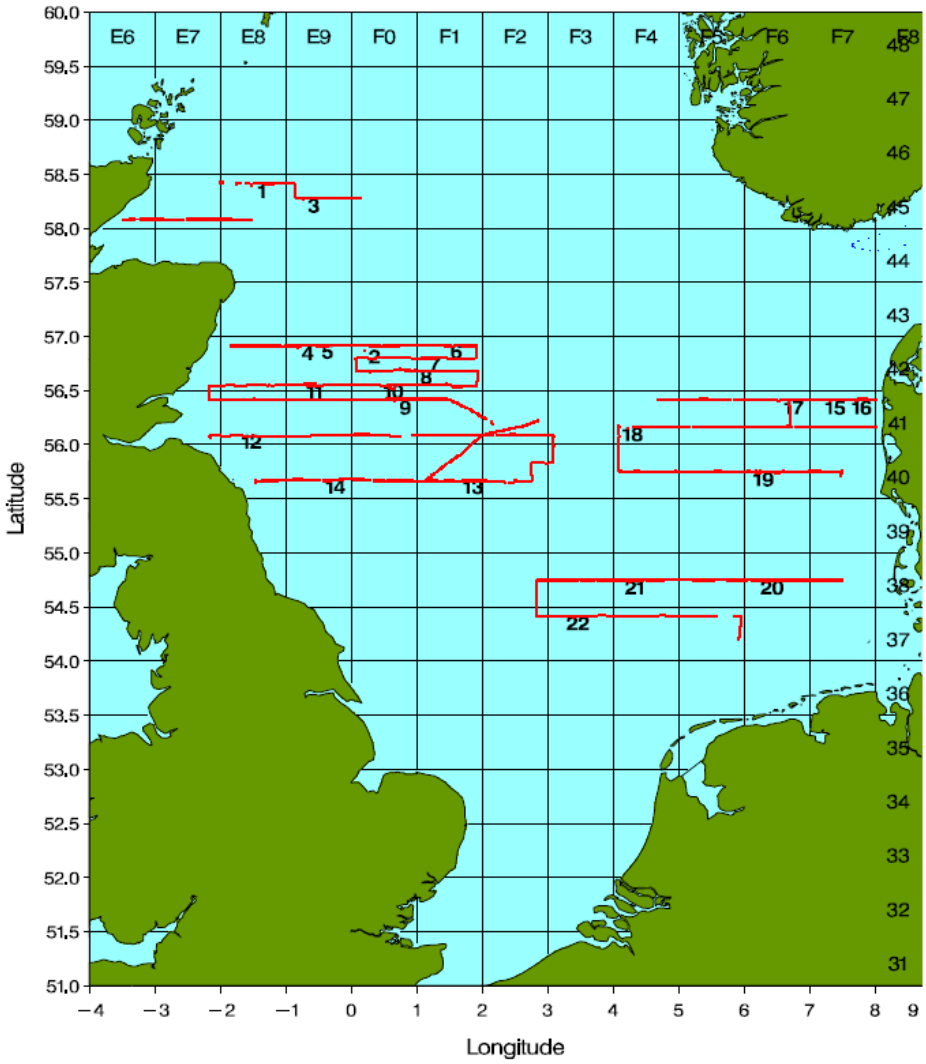

Figure 2.3.2. Map of executed cruise track and positions of trawl stations and hydrographical stations during the June-July 2006 North Sea herring hydro acoustic survey on R/V "Tridens".

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 were accepted but during the beginning of the cruise heavy noise made these transducers useless. The Heel and pitch sensor cable proved to cause problems and was therefore not used during the rest of the survey. A second calibration was performed in Scapa Flow using new cables but once surveying the noise was still present. Calibration results of the second calibration were used and are given in appendix A.

1. 38 kHz in the towed body: moderate results
2. 200 kHz in the towed body: bad results
3. 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 appendix B. 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 -85dB 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 12 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 200kHz 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 (ICES PGHERS Report 2005 ICES CM 2005/G:04, Ref. D, HAWG).
A Furuno FCV-1500 echosounder was used to control the catch (fig. 2.6.1). Trawl station data was recorded by a tool which allowed to record data from the ship’s own data acquisition system.

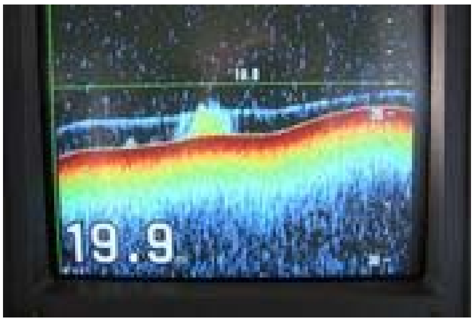

Figure 2.6.1 Screen image of a herring school observed with the Furuno FCV-1500 echosounder. The dark brown line shows the bottom, the blue/yellow 'cloud' shows herring or sprat escaping below the ground rope of the net. The depth at time was 19.9m.

Biological samples

For all fish:

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

Stratified samples of 5 fish per length class were 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.

During the Herring acoustic survey samples were collected for the project on the investigation of the relationship between lipid content and fecundity in North Sea herring. Due to the fact that low numbers of female mature herring were caught in the Dutch survey area, only 44 females were sampled. Next to the standard biological parameters lipid content, ovary weight en gutted weight were measured and of each fish one otolith was collected for the determination of spawning type and ovaries were put on 4% formaldehyde for later determination of fecundity.
No results were available at the time of writing.

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.

During both two week trips 150 individual herring were sampled for both experiments. In total 600 herring were measured and weighted during the survey for this experiment. No results were available at the time of writing.

2.7 Hydrographical data

Hydrographical data have been collected in 36 stations, all at fixed locations (Figure 2.7.1). 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 (appendix G). 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 directions 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 are placed in the water intake system and had not been calibrated and were used to compare results with Seabird CTD results.

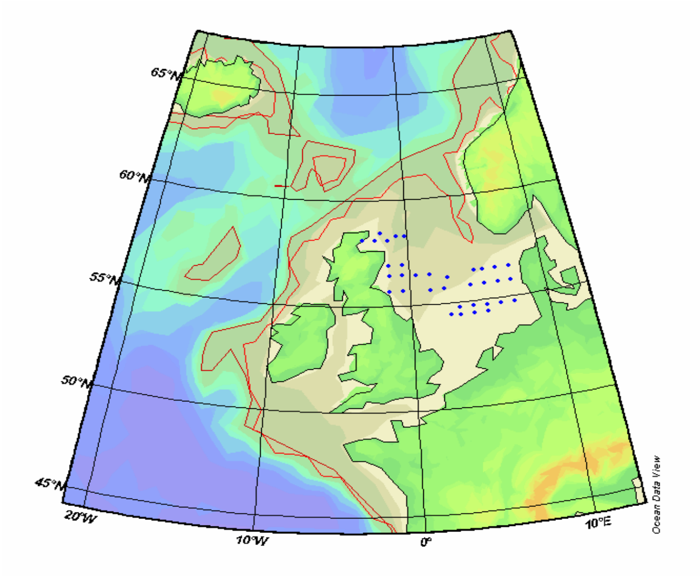

Figure 2. 7.1.Positions of CTD stations during the July 2006 North Sea hydro acoustic survey for herring by R/V "Tridens".

2.8 Acoustic 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 (Table 2.8.1).

herring	sprat	mackerel	Norway pout	gadoids	sandeel
71.2	71.2	86.9	67.1	67.4	93.7

Table 2.8.1 Use values for b20 reference value during the June-July 2006 North Sea herring hydro acoustic survey on R/V "Tridens".

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 2.8.1). In the western part of the survey area, size distributions showed a decrease in mean length in herring in a line from the north east to the south west. 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.

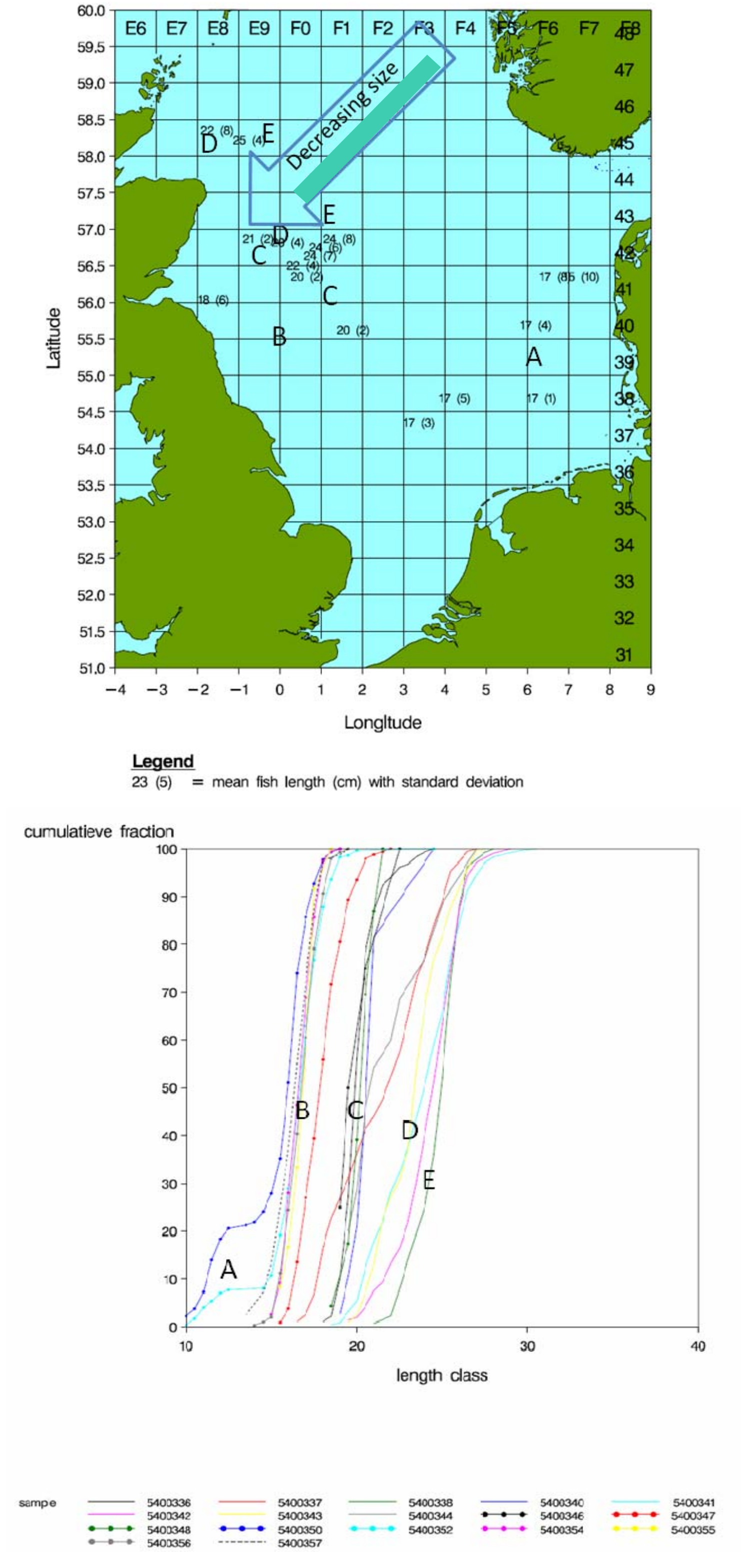

Figure 2.8.1. Post plot of herring mean length from R/V "Tridens", observed during the July 2006 North Sea hydro acoustic survey for herring. Based on geographical differences in size distributions strata A to E were defined. The 54…. Numbers refer to the sample ID's stored in the IMARES database.

3. Results

3.1 Acoustic data results

In total data from 1897 surveyed nautical miles were used for the biomass estimate of herring and sprat.

Horizontal and vertical distribution patterns
Fish aggregations near the Danish coast appeared much more disperse than in other areas (Fig. 3.1.3). This typical aggregation pattern of clupeids was also found near the Dutch coast in other surveys.

The north-western part of this year's survey area held most of the herring observed (Fig. 3.1.4A). Interlaced transects in this area were covered by R/V 'Scotia', making a good description of the distribution pattern observed by Tridens difficult.

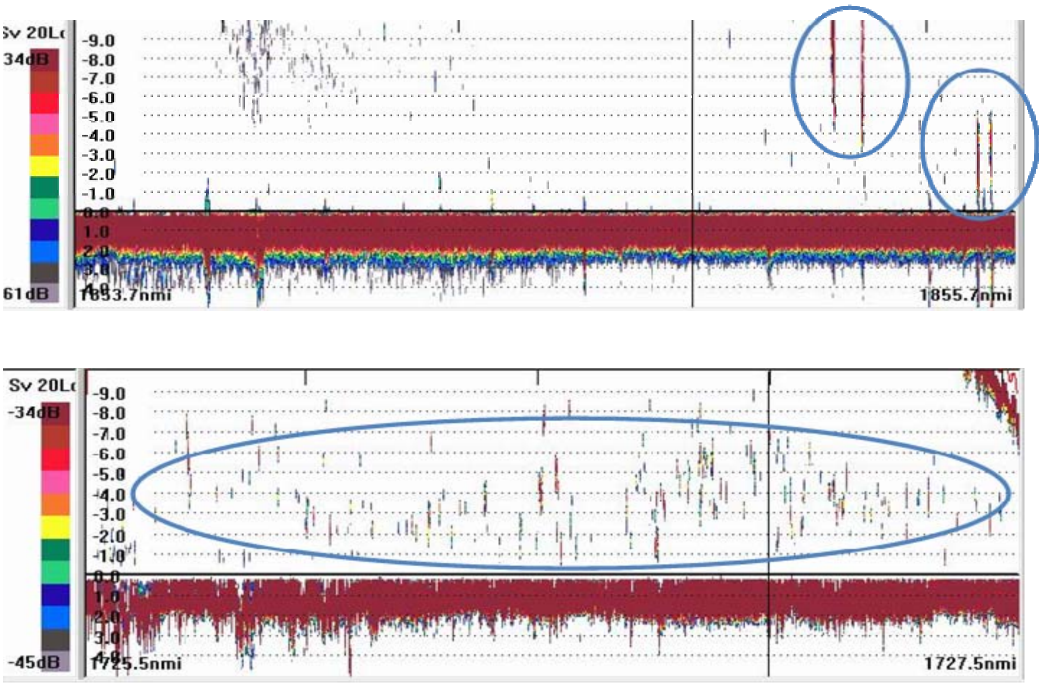

Figure 3.1.3. Sample echograms obtained during the June-July 2006 North Sea herring hydro acoustic survey on R/V "Tridens". The upper image shows herring/sprat schools in the central north sea whereas the lower image shows a typical aggregation pattern in the German Bight, near the Danish coast. Recording distance is 2 nautical miles (3.7km).

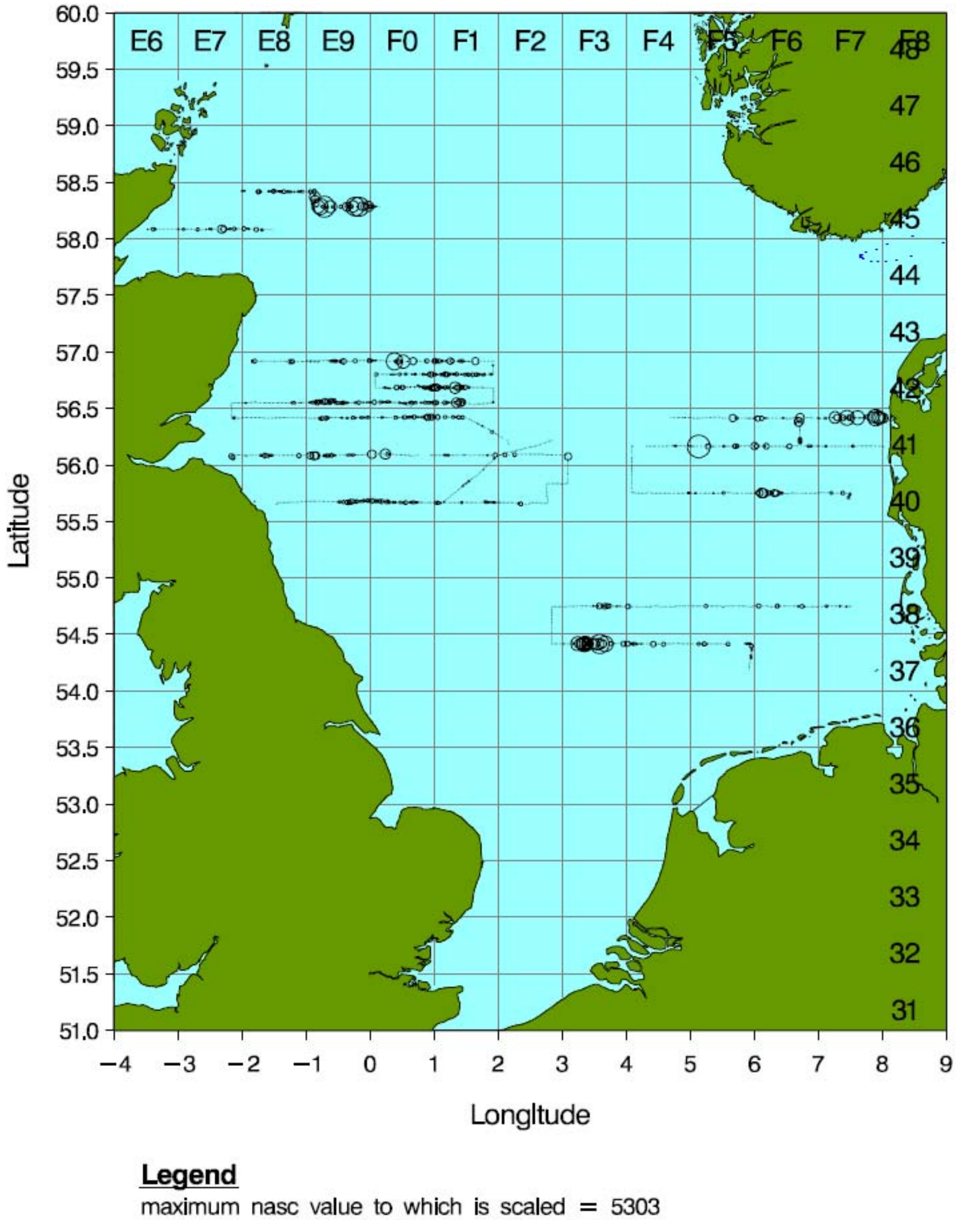

Figure 3.1.4A. Post plot showing the distribution of ***total herring*** *S_A values (on a proportional square root scale relative to the largest value of 5303) obtained during the June-July 2006 North Sea herring hydro acoustic survey on R/V "Tridens".*

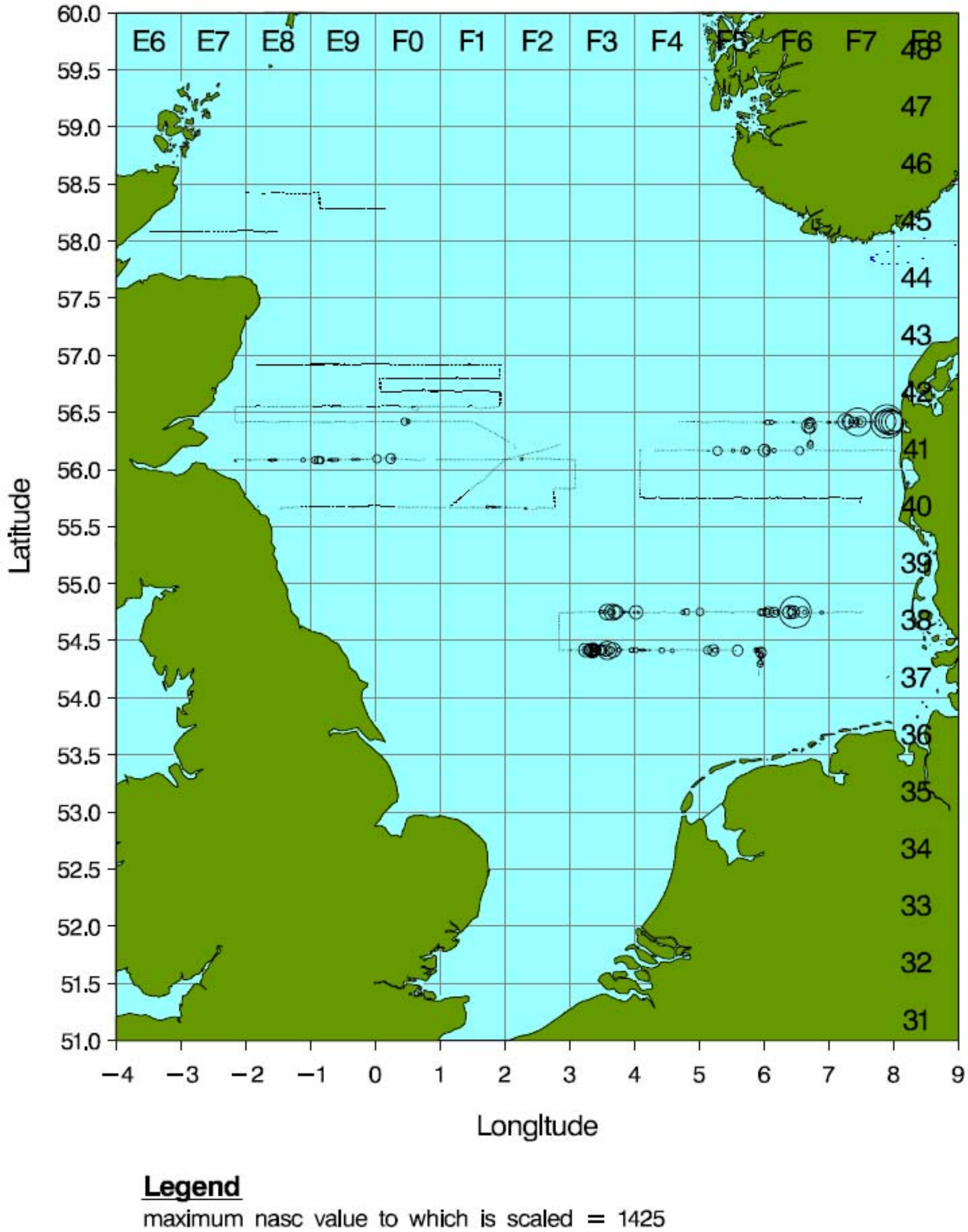

*Figure 3.1.4B. Post plot showing the distribution of **total sprat** S_A values (on a proportional square root scale relative to the largest value of 1425) obtained during the June-July 2006 North Sea herring hydro acoustic survey on R/V "Tridens".*

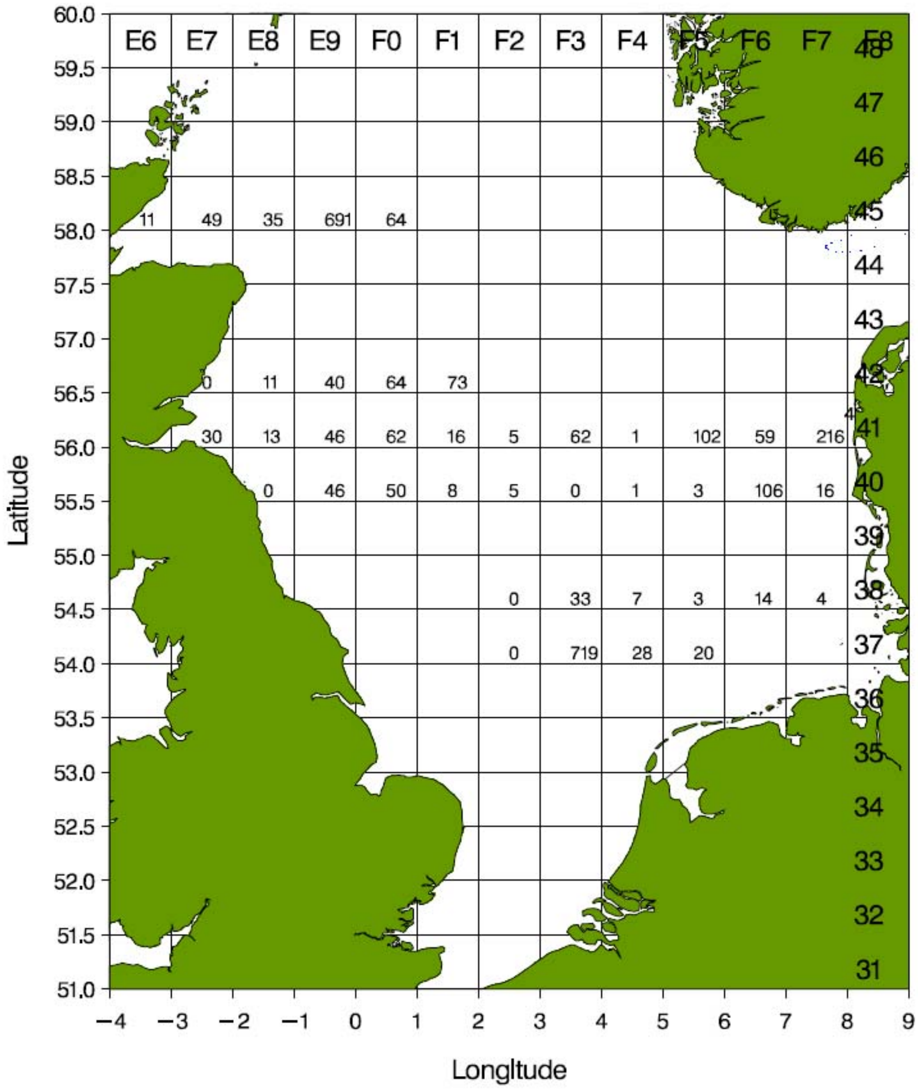

*Figure 3.1.5. Mean acoustic density ($s_{A,}$ m^2/nm^2) **herring** per ICES rectangle obtained during the March 2006 North East Atlantic blue whiting hydro acoustic survey on R/V "Tridens".*

3.2 Trawl data results

In all, 23 trawl hauls have been conducted (figure 2.3.2). 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 appendix C,table C1**,** catch weights per haul and species are presented in table C2 and the length frequency proportions are presented in figure C1.

In total 903 biological fish samples of herring and 239 of sprat were collected and used for length, age and maturity keys from which most herring were 1 year old's (Figure 3.2.1). A lack of 2 and 3 year old mature males is probably due to sampling strategy but has be looked at.

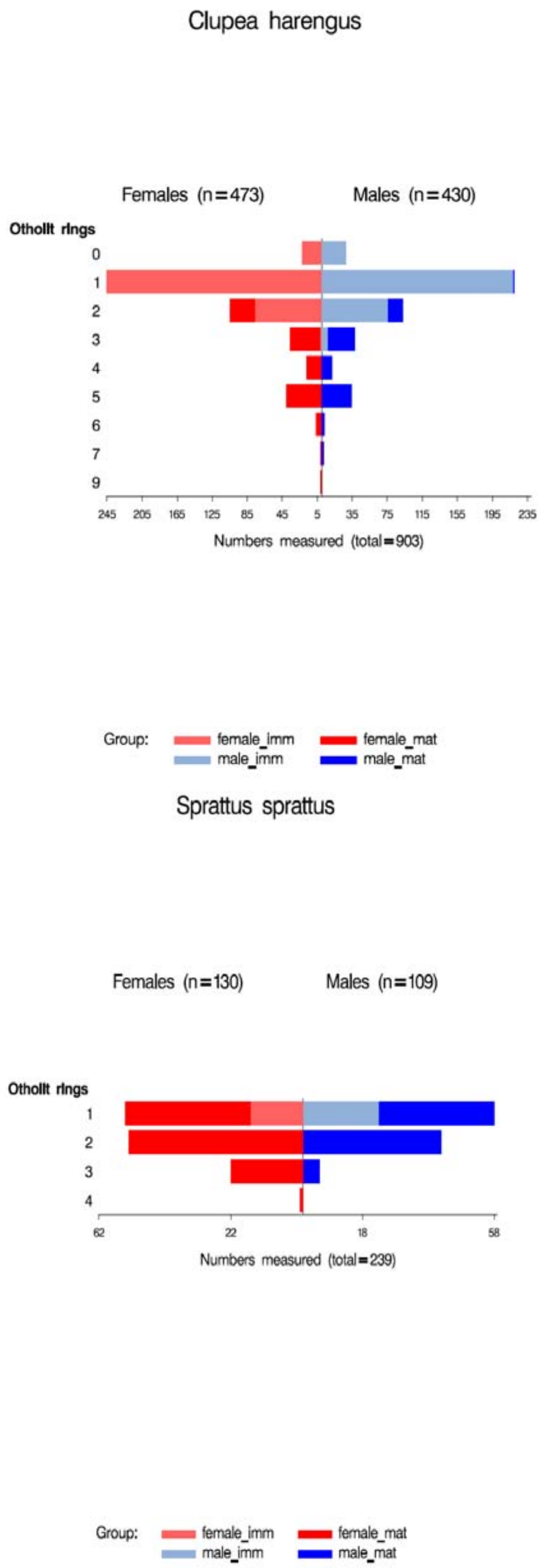

Figure 3.2.1 Overview of collected biological samples of herring (left panel) and sprat (right panel) during the June-July 2006 North Sea hydro acoustic survey for herring, R/V "Tridens". The light shaded colours represent juveniles.

By the age of 3 (having 3 winter rings) almost all herring is mature (Fig. 3.2.2) where in 2005 this age was 4 and in 2004 this age was also 4. Growth parameters are shown in figure 3.2.3.

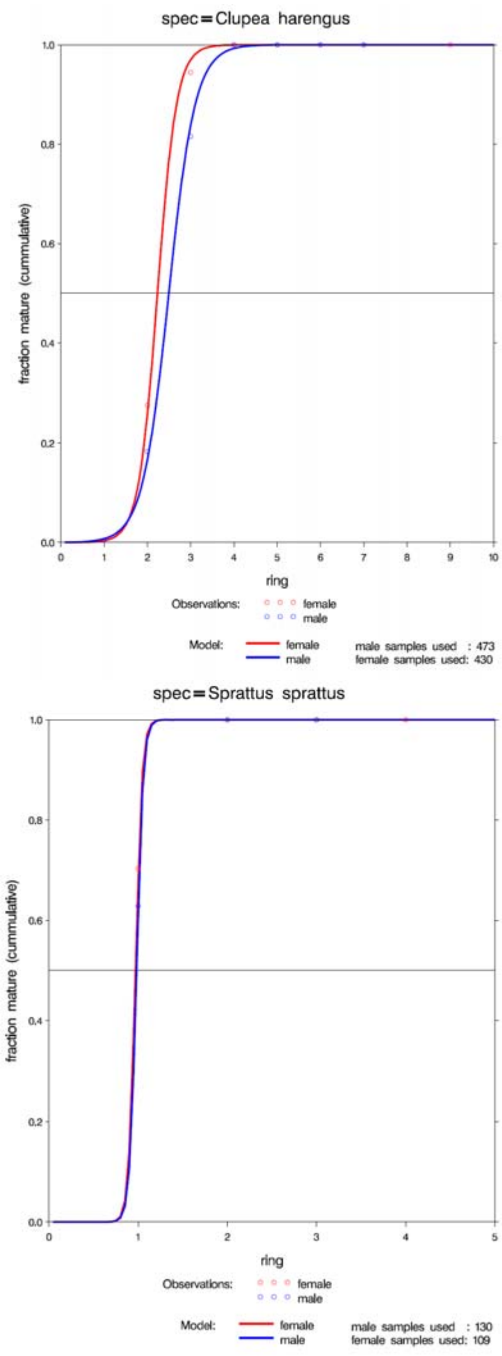

Figure 3.2.2. Maturity related to otholith rings during the June-July 2006 North Sea hydro acoustic survey for herring, R/V "Tridens". In both stratum A ,B and C no mature herring was observed (<1%).

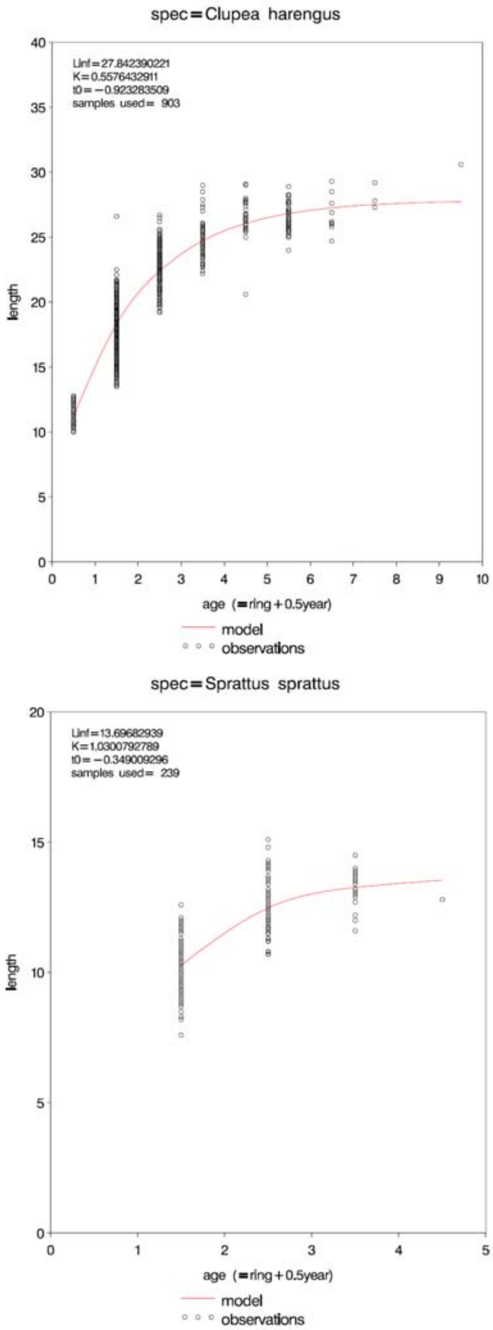

Figure 3.2.3 Von Bertalanffy growth curves of herring and sprat.

3.3 (Sub)stock 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 3.3.1 shows the estimated numbers and biomass of herring by ICES rectangle in the area surveyed by R/V Tridens. Table 3.3.1 summarizes the sub stock estimates for all strata. Table C3 in Appendix C summarizes stock estimates per stratum as defined in figure 2.8.1.

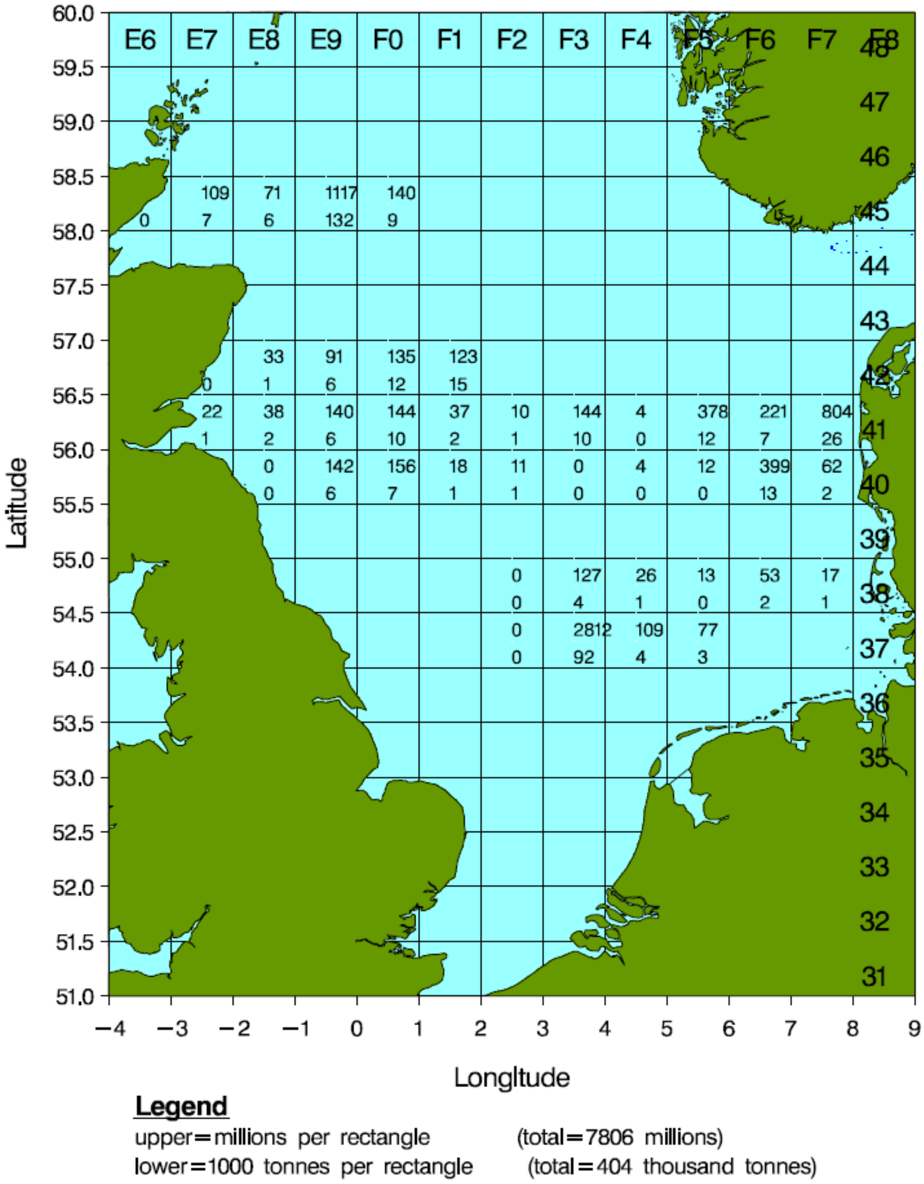

Figure 3.3.1. Estimated numbers of herring in millions (upper half square) and biomass in thousands of tonnes (lower half of square) by ICES rectangle. Results from the July 2006 North Sea hydro acoustic survey, R/V "Tridens".

Table 3.3.1. Sub stock estimate. Results from the July 2006 North Sea hydro acoustic survey, R/V "Tridens".

Total area											
yearclass	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996	Total
	0	1	2	3	4	5	6	7	8	9	
b_tsb	2.9	232.4	57.5	42.9	14.0	47.5	5.7	0.6	0.0	0.4	404.0
b_tssb	0.0	0.4	25.2	38.0	13.9	47.4	5.7	0.6	0.0	0.4	131.6

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
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 (figureD1 in appendix D). Continuous surface temperature recordings were used for a general real-time overview (figure D2). A daily and weekly by satellite constructed mean surface temperature from the North Sea was used as a reference during the survey (Figure D3 in appendix D).

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.

4. Discussion

Results
Highest concentrations of mature herring were observed in the most northern region of the survey area, close to the main spawning grounds and around the Devil Holes. Highest concentrations of juveniles were found close to the Danish coast where they mixed with sprat. Total biomass observed this survey mainly consisted of the 2004 yearclass. The strong 2000 yearclass still makes 47% of the spawning stock biomass in the area surveyed and all fish from this group are finally mature. Results from this year's cruise should not be compared directly with previous year's results as the survey area of Tridens differs from year to year.

Survey design
Through overlapping coverage in some areas, information on the spatial and temporal dynamics of herring is gained and should give a better idea of accuracy of the results. As no other vessels covered the ICES rectangles covered by Tridens, no variability in vessel-specific acoustic observations could be seen this year. It still proves difficult to conduct interlaced transects with multiple vessels in a pre-planned time period. Tridens was not able to cover all of the most northern part of their survey area in the first survey week and as a result R/V Scotia was willing to cover this area. Long east-west transect covering the entire North Sea asked for a flexible planning, but the pre-agreed weekend break in the second half of the survey resulted in Dana taking over the most southern transect of Tridens' survey area. Pelagic surveys have a high variability in fish detection. Especially for long transects it can therefore be difficult to predict the time span of covering these. As mentioned in previous years R/V Tridens is tied to weekly breaks while having to work closely together to 2 other research vessels in its area. This makes it difficult to implement long transects in the cruise planning.

Appendix A Calibration results of EK60

Towed Body 38 kHz

```
#  Calibration  Version   2.1.0.11
#
#  Date:  6/30/2006
#
#  Comments:
#    2de keer Scapa Flow, nadat was gebleken dat de kabel niet goed was aan begin survey
#
#  Reference Target:
#    TS                  -33.60 dB       Min. Distance         11.50 m
#    TS Deviation           5.0 dB       Max. Distance         13.50 m
#
#  Transducer:  ES38B_TB2  Serial No.   30501
#    Frequency            38000 Hz       Beamtype                Split
#    Gain                 23.30 dB       Two Way Beam Angle   -20.6 dB
#    Athw. Angle Sens.       21.90       Along. Angle Sens.      21.90
#    Athw. Beam Angle     7.74 deg       Along. Beam Angle    7.17 deg
#    Athw. Offset Angle   0.29 deg       Along. Offset Angle  0.07 deg
#    SaCorrection         -0.49 dB       Depth                 0.00  m
#
#  Transceiver:  GPT  38 kHz 009072017a3b 1 ES38B_TB2
#    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           -50.0 dB       Min. Spacing            100 %
#    Max. Beam Comp.        6.0 dB       Min. Echolength          80 %
#    Max. Phase Dev.           8.0       Max. Echolength         180 %
#
#  Environment:
#    Absorption Coeff.   9.5 dB/km       Sound Velocity     1499.4 m/s
#
#  Beam Model results:
#    Transducer Gain    = 24.12 dB       SaCorrection       = -0.54 dB
#    Athw. Beam Angle   = 7.25 deg       Along. Beam Angle  = 6.98 deg
#    Athw. Offset Angle = 0.00 deg       Along. Offset Angle= 0.04 deg
#
#  Data deviation from beam model:
#    RMS =    0.36 dB
#    Max =    1.18 dB  No. =   362  Athw. =  1.8 deg  Along =  3.3 deg
#    Min =   -2.10 dB  No. =   340  Athw. = -2.3 deg  Along = -3.3 deg
#
#  Data deviation from polynomial model:
#    RMS =    0.31 dB
#    Max =    0.93 dB  No. =   327  Athw. = -3.6 deg  Along = -3.3 deg
#    Min =   -1.97 dB  No. =   340  Athw. = -2.3 deg  Along = -3.3 deg
```

Towed Body 200 kHz

```
#  Calibration  Version   2.1.0.11
#
#  Date:  6/30/2006
#
#  Comments:
#    2de keer ScapaFlow
#
#  Reference Target:
#    TS                    -45.00 dB       Min. Distance          7.00 m
#    TS Deviation             7.0 dB       Max. Distance          9.00 m
#
#  Transducer:  ES200-7  Serial No.   116
#    Frequency             200000 Hz       Beamtype                Split
#    Gain                   23.96 dB       Two Way Beam Angle   -20.7 dB
#    Athw. Angle Sens.       23.00         Along. Angle Sens.      23.00
#    Athw. Beam Angle       6.67 deg       Along. Beam Angle    6.53 deg
#    Athw. Offset Angle  -0.18 deg         Along. Offset Angle  0.04 deg
#    SaCorrection          -0.39 dB        Depth                 0.00  m
#
#  Transceiver:  GPT 200 kHz 009072017a36 1 ES200-7
#    Pulse Duration        0.256 ms        Sample Interval     0.048   m
#    Power                   300  W        Receiver Bandwidth  10.64 kHz
#
#  Sounder Type:
#    EK60 Version  2.1.1
#
#  TS Detection:
#    Min. Value            -55.0 dB        Min. Spacing            100 %
#    Max. Beam Comp.         6.0 dB        Min. Echolength          80 %
#    Max. Phase Dev.           8.0         Max. Echolength         180 %
#
#  Environment:
#    Absorption Coeff.  55.8 dB/km         Sound Velocity     1499.4 m/s
#
#  Beam Model results:
#    Transducer Gain    = 21.65 dB         SaCorrection       = -0.49 dB
#    Athw. Beam Angle   = 6.96 deg         Along. Beam Angle  = 6.87 deg
#    Athw. Offset Angle =-0.16 deg         Along. Offset Angle=-0.23 deg
#
#  Data deviation from beam model:
#    RMS =     0.91 dB
#    Max =     2.57 dB  No. =    80  Athw. =  3.8 deg  Along = -0.2 deg
#    Min =    -1.99 dB  No. =   223  Athw. =  1.6 deg  Along = -3.7 deg
#
#  Data deviation from polynomial model:
#    RMS =     0.89 dB
#    Max =     2.64 dB  No. =    80  Athw. =  3.8 deg  Along = -0.2 deg
#    Min =    -2.08 dB  No. =   232  Athw. =  2.5 deg  Along = -2.9 deg
```

Hull mounted 38 kHz

```
#  Calibration  Version   2.1.0.11
#
#  Date:  6/28/2006
#
#  Comments:
#    hull mounted
#
#  Reference Target:
#    TS                  -33.60 dB       Min. Distance         18.00 m
#    TS Deviation          4.0 dB        Max. Distance         22.00 m
#
#  Transducer:  ES38B_HM  Serial No.   0000
#    Frequency             38000 Hz       Beamtype                Split
#    Gain                  26.16 dB       Two Way Beam Angle   -20.6 dB
#    Athw. Angle Sens.        21.90       Along. Angle Sens.      21.90
#    Athw. Beam Angle      7.04 deg       Along. Beam Angle     6.85 deg
#    Athw. Offset Angle  -0.08 deg        Along. Offset Angle -0.08 deg
#    SaCorrection         -0.59 dB        Depth                 4.00  m
#
#  Transceiver:  GPT  38 kHz 009072017a3b 1 ES38B_HM
#    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            -50.0 dB       Min. Spacing            100 %
#    Max. Beam Comp.         6.0 dB       Min. Echolength          80 %
#    Max. Phase Dev.           8.0        Max. Echolength         180 %
#
#  Environment:
#    Absorption Coeff.   9.5 dB/km        Sound Velocity     1499.4 m/s
#
#  Beam Model results:
#    Transducer Gain    = 24.64 dB        SaCorrection        = -0.50 dB
#    Athw. Beam Angle   = 7.16 deg        Along. Beam Angle  = 7.02 deg
#    Athw. Offset Angle = 0.05 deg        Along. Offset Angle=-0.09 deg
#
#  Data deviation from beam model:
#    RMS =    0.19 dB
#    Max =    0.75 dB  No. =   195  Athw. = -2.2 deg  Along =  4.5 deg
#    Min =   -0.71 dB  No. =   214  Athw. =  2.1 deg  Along =  4.1 deg
#
#  Data deviation from polynomial model:
#    RMS =    0.17 dB
#    Max =    0.58 dB  No. =   195  Athw. = -2.2 deg  Along =  4.5 deg
#    Min =   -0.65 dB  No. =   214  Athw. =  2.1 deg  Along =  4.1 deg
#
```

Appendix B Simrad EK60 settings

Table B1. Simrad EK60 settings used on the June 2006 North Sea hydro acoustic survey for herring, R/V "Tridens".

Transceiver menu	**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
Calibration details		
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	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

Appendix C Trawl results

Table C1. Details of the trawl hauls taken during the June-July 2006 North Sea hydro acoustic survey for herring, R/V “Tridens”.

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 C2. Trawl catches during the June-July 2006 North Sea hydro acoustic survey for herring, R/V “Tridens” in kg. Scientific and English species names are listed in **appendix I**.

	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

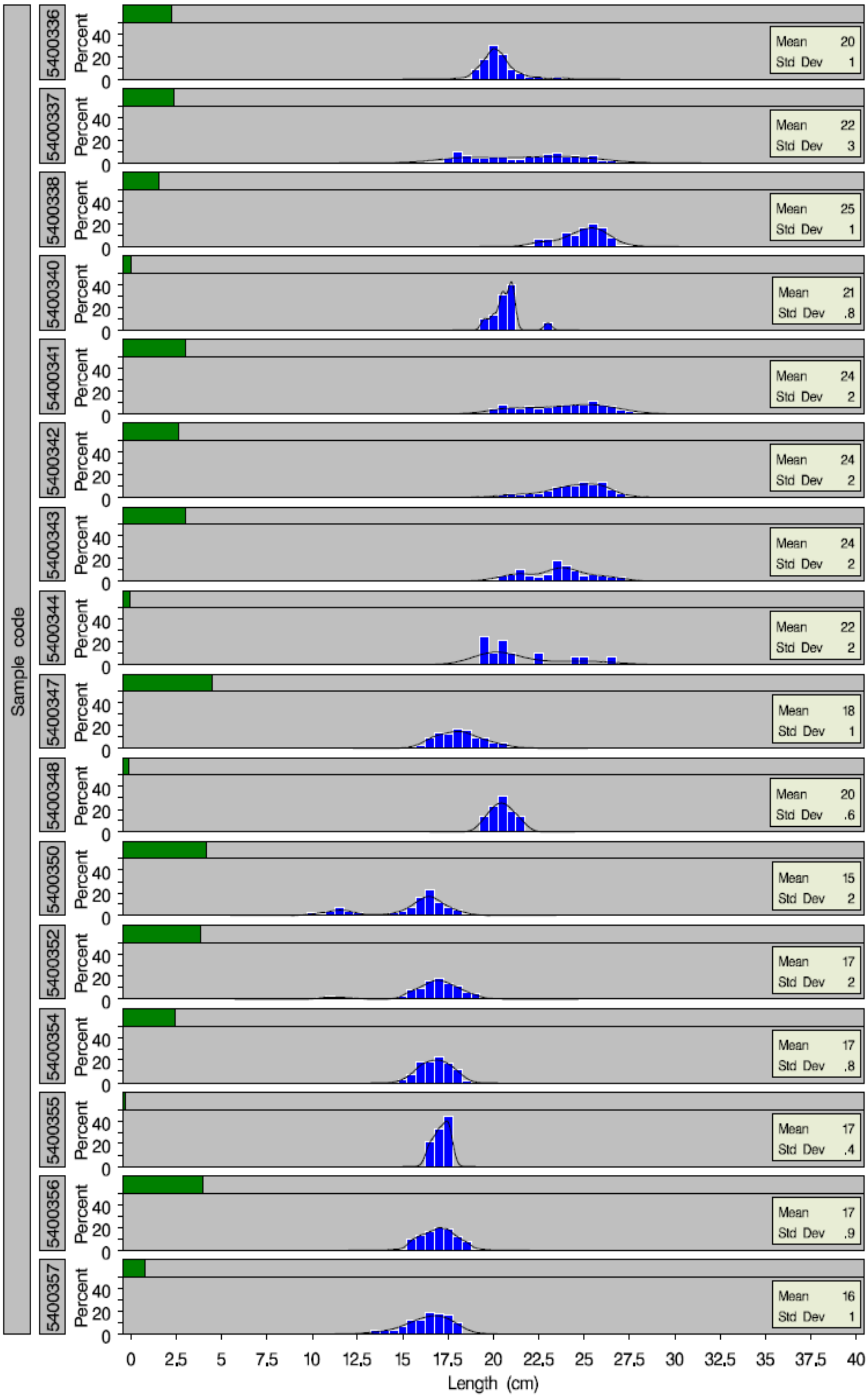

Figure C1. Length frequency distributions of herring during the June-July 2006 North Sea hydro acoustic survey for herring, R/V "Tridens". Smoothing is obtained by normal kernel density estimates. The green bars indicate the relative amount of samples used.

Table C3. Sub stock estimates of herring for strata A to E during the June-July 2006 North Sea hydro acoustic survey for herring, R/V "Tridens" in kg. Strata definition can be found in paragraph 2.8.

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 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				

Appendix D Hydrography

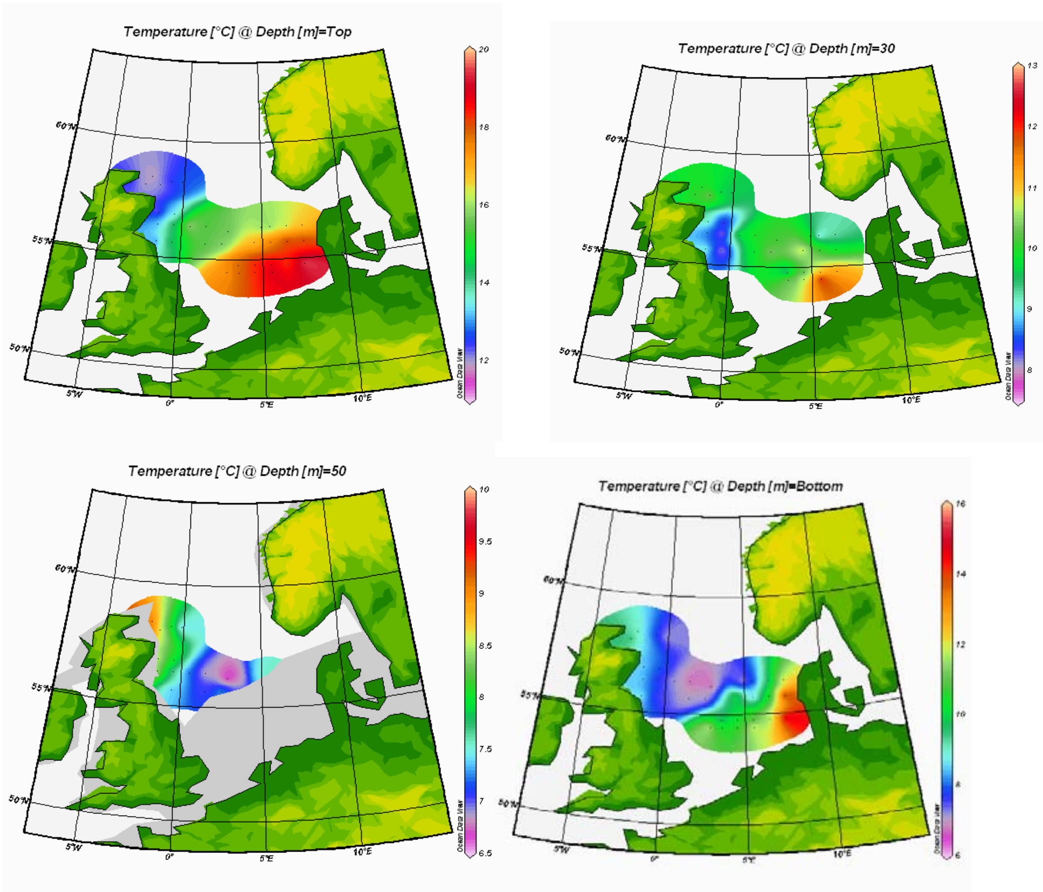

Figure D1. Upper panel shows the water temperature at **surface**, the second panel at **30m** depth, the third panel at **50m** depth and the lower panel shows temperature at **bottom** all recorded by the Seabird CTD device. The lower panels show Sea **Bottom** temperature distribution recorded by Seabird CTD device.

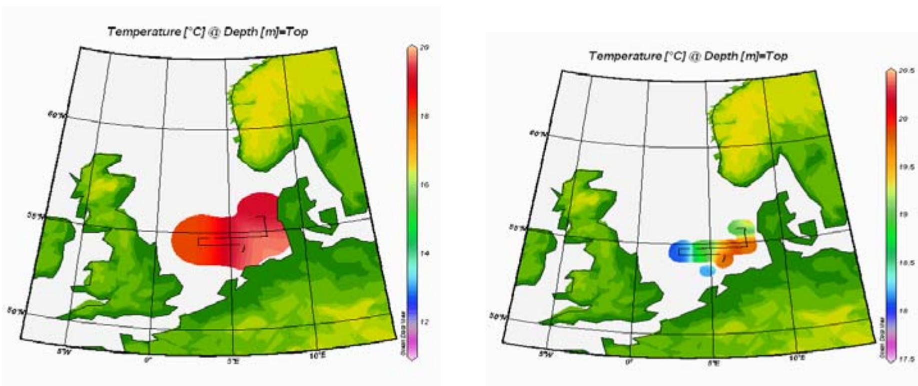

Figure D2. Both panels show the sea **surface** temperature (SST) distribution recorded in the water intake system from ship. The left panel uses the same temperature range as used in figure D1.

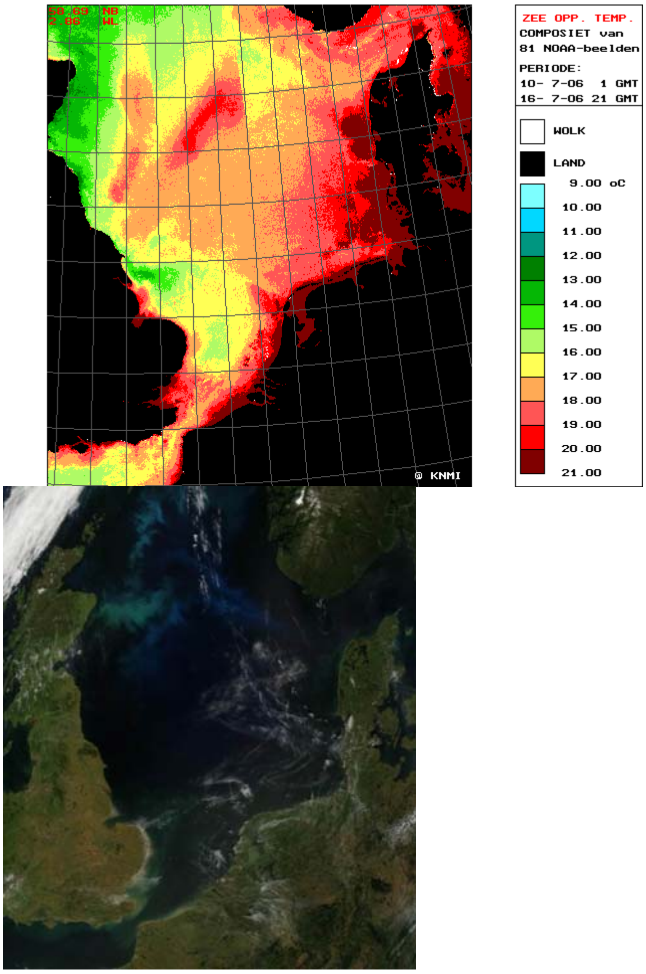

Figure D3. Right: Mean sea **surface** temperature (SST) from NOAA satellite for the period 10 to 16 July 2006. Source: www.knmi.nl. Left: Satellite image of the North Sea indicating the distribution of surface phytoplankton. (indicated in light blue). Recorded on 15 July 2005. Source: http://rapidfire.sci.gsfc.nasa.gov .

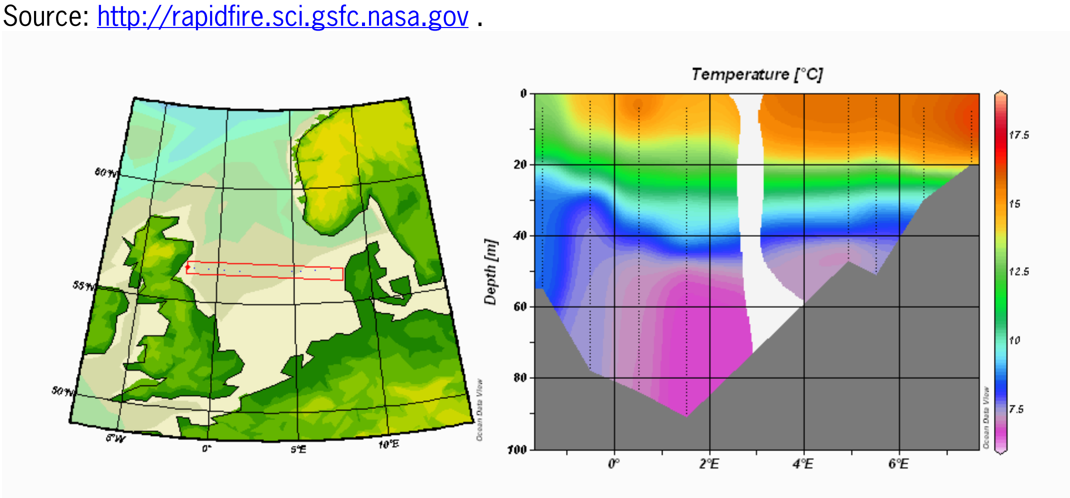

Figure D4. Temperature pattern along an east/west transect in the central North Sea during the June-July 2006 North Sea hydro acoustic survey for herring, R/V "Tridens". Time span between eastern part and western part is about a week.

Appendix E Data acquisition on board

In line with last cruise data handling improvements, an expended concept was implemented resulting in the first version of an onboard database. This MySQL database is now filled with trawl station data from acoustic surveys only but will gradually incorporate more types of data from different surveys. Haul and station information was recorded automatically after which this data was automatically merged with biological datasheet. Continuous station information (date, time and position) was also used for live cruise tracks and survey planning.

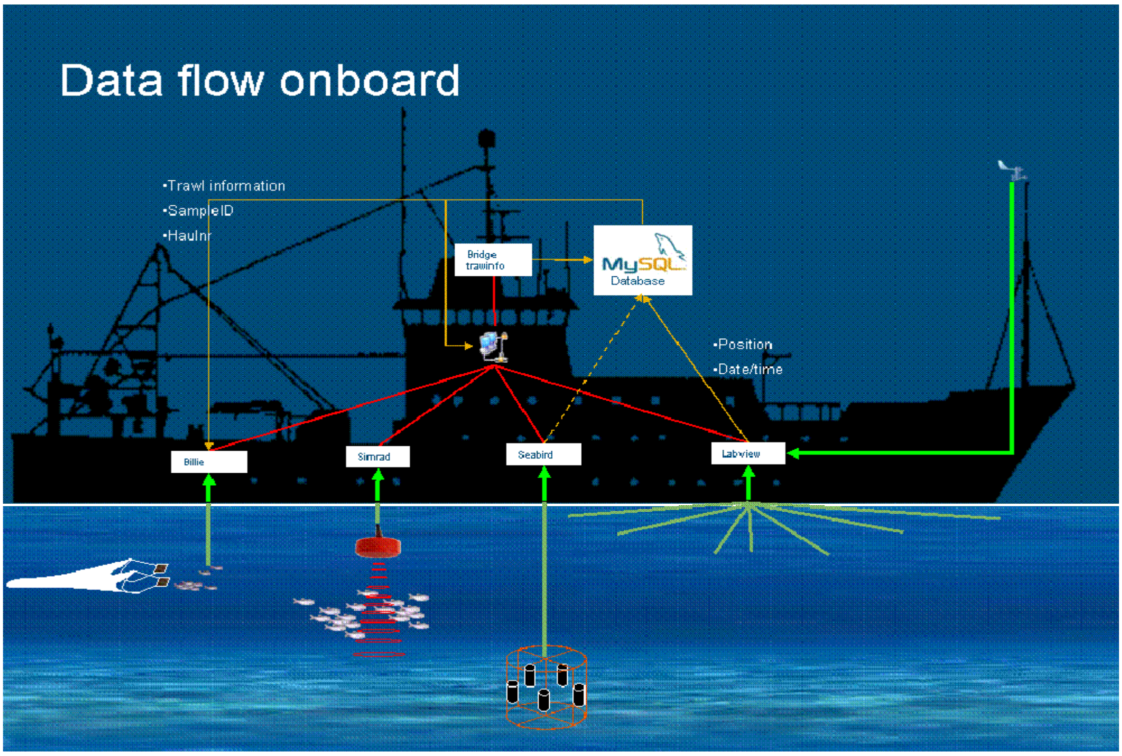

Figure G1. Schematic overview of the data flow from all input sources to the final analysis results during the June-July 2006 North Sea hydro acoustic survey for herring, R/V "Tridens".

Green lines : indicates raw data flow from measuring device to recording device

Orange lines : indicates automatic data flow to and from database. Dashed lines indicate non-implemented data flows.

Red lines : indicates automatic backup of raw data to central server

Appendix F Species list

species_code	NODC_code	tsn	Dutch_name	Scientific_name	English_name
ZSP	8845010100	171671	Ammodytes	Ammodytes	
ARG	8756010203	162064	Grote zilversmelt	Argentina silus	Greater argentine
RGU	8826020801	167049	Engelse poon	Aspitrigla cuculus	Red gurnard
HER	8747010201	161722	Haring	Clupea harengus	Herring
LSU	8831091501	167612	Snotolf	Cyclopterus lumpus	Lumpsucker
AZN	8820022101	166591	Adderzeenaald	Entelurus aequoraeus	Snake pipefish
GGU	8826020601	167044	Grauwe poon	Eutrigla gurnardus	Grey gurnard
COD	8791030402	164712	Kabeljauw	Gadus morhua	Cod
LSC	8857040603	172877	Lange schar	Hippoglossoides platessoides	Long rough dab
DAB	8857040904	172881	Schar	Limanda limanda	Dab
HAD	8791031301	164744	Schelvis	Melanogrammus aeglefinus	Haddock
WHG	8791031801	164758	Wijting	Merlangius merlangus	Whiting
HKE	8791040105	164795	Heek	Merluccius merluccius	Hake
LEM	8857041202	172888	Tongschar	Microstomus kitt	Lemon sole
PLE	8857041502	172902	Schol	Pleuronectes platessa	Plaice
POK	8791030901	164727	Zwarte koolvis	Pollachius virens	Saithe
MAC	8850030302	172414	Makreel	Scomber scombrus	Mackerel
SPR	8747011701	161789	Sprot	Sprattus sprattus	Sprat
	5707150801	205728	Todaropsis	Todaropsis eblanae	
HOM	8835280103	168588	Horsmakreel	Trachurus trachurus	Horse mackerel
NOP	8791031703	164756	Kever	Trisopterus esmarkii	Norway pout
POD	8791031701	164754	Dwergbolk	Trisopterus minutus	Poor cod

Appendix G CTD calibration settings

```
Date: 07/17/2006

ASCII file: C:\Documents and Settings\All Users\Documents\CTD
data\HERAS 2006\TitaniumCTDconfig.con

Configuration report for SBE 911/917 plus CTD
---------------------------------------------
Frequency channels suppressed : 0
Voltage words suppressed      : 0
Computer interface            : RS-232C
Scans to average              : 1
Surface PAR voltage added     : No
NMEA position data added      : Yes
Scan time added               : No

1) Frequency channel 0, Temperature

   Serial number : 2344
   Calibrated on : 18-May-05
   G             : 4.33368393e-003
   H             : 6.46441919e-004
   I             : 2.40647038e-005
   J             : 2.32662311e-006
   F0            : 1000.000
   Slope         : 1.00000000
   Offset        : 0.0000

2) Frequency channel 1, Conductivity

   Serial number : 2093
   Calibrated on : 6-May-05
   G             : -1.06057050e+001
   H             : 1.54865809e+000
   I             : -3.41846210e-003
   J             : 3.29774225e-004
   CTcor         : 3.2500e-006
   CPcor         : -9.57000000e-008
   Slope         : 1.00000000
   Offset        : 0.00000

3) Frequency channel 2, Pressure, Digiquartz with TC

   Serial number : 70773
   Calibrated on : 23-May-05
   C1            : -5.104473e+004
   C2            : -8.603752e-001
   C3            : 1.368040e-002
   D1            : 4.093700e-002
   D2            : 0.000000e+000
   T1            : 2.975743e+001
   T2            : -5.557625e-004
   T3            : 4.153610e-006
   T4            : 5.291250e-010
   T5            : 0.000000e+000
   Slope         : 1.00004000
```

```
   Offset         : 0.45930
   AD590M         : 1.283697e-002
   AD590B         : -9.090950e+000

Date: 07/17/2006

ASCII file: C:\Documents and Settings\All Users\Documents\CTD
data\HERAS 2006\NIOZ_CTDconfig.con

Configuration report for SBE 911/917 plus CTD
---------------------------------------------

Frequency channels suppressed : 2
Voltage words suppressed      : 4
Computer interface            : RS-232C
Scans to average              : 1
Surface PAR voltage added     : No
NMEA position data added      : Yes
Scan time added               : No

1) Frequency channel 0, Temperature

   Serial number : 1219
   Calibrated on : 10-dec-04
   G             : 4.86278506e-003
   H             : 6.78094041e-004
   I             : 2.67996223e-005
   J             : 2.14701526e-006
   F0            : 1000.000
   Slope         : 1.00000000
   Offset        : 0.0000

2) Frequency channel 1, Conductivity

   Serial number : 2142
   Calibrated on : 18-dec-04
   G             : -1.06468555e+001
   H             : 1.51048063e+000
   I             : -2.35374123e-003
   J             : 2.67576812e-004
   CTcor         : 3.2500e-006
   CPcor         : -9.57000000e-008
   Slope         : 1.00000000
   Offset        : 0.00000

3) Frequency channel 2, Pressure, Digiquartz with TC

   Serial number : 0261
   Calibrated on : 28-feb-06
   C1            : -3.975465e+004
   C2            : 6.132040e-002
   C3            : 1.251060e-002
   D1            : 4.019100e-002
   D2            : 0.000000e+000
   T1            : 3.008636e+001
   T2            : -2.600940e-004
   T3            : 4.636930e-006
   T4            : 7.126440e-010
   T5            : 0.000000e+000
```

```
Slope          : 1.00003000
Offset         : -1.78010
AD590M         : 1.153000e-002
AD590B         : -8.189100e+000
```