Acoustic Herring Survey report for RV "DANA"

21th June – 5th July 2017

Karl Johan Stæhr
Section for monitoring, data and technic
DTU-Aqua, National Institute of Aquatic Resources

Cruise summary

Total days	15
Days of monitoring	13
Number of nautical miles monitored	2139 + 150 miles for calibration
Number of trawl hauls	38
Number of CTD stations	39
Number of WP2 stations	22
Fish catch in kg	21591
Number of measured herring	15453
Number of measured mackerel	2114
Number of measured sprat	1440
Number of species measured	47
Total number of measured fish	28229
Number of herring frozen for age and race-split	2670
Number of sprat frozen for age	441

1. INTRODUCTION

Since 1991 the DTU National Institute of Aquatic Resources (DTU AQUA) has participated in the ICES co-ordinated herring acoustic survey of the North Sea and adjacent waters with the responsibility for the surveying the Skagerrak and Kattegat area.

The actual 2017-survey with R/V DANA, covering the Skagerrak and Kattegat, was conducted in the period June 21 June to July 5 2017, while calibration was done during June 21 to June 23 2017.

2. SURVEY

2.1 Personnel

During calibration 21/6– 23/6 2017
Karl-Johan Stæhr (cruise leader)
Torben Filt Jensen (assisting cruise leader)
Ronny Sørensen
Christian Petersen
Eleni Theofania Skorda, student
Laura Diernæs, student

Giovanna Albani, student
Claus Halle

During acoustic monitoring 23/6 - 5/7-2017
Karl-Johan Stæhr (cruise leader)
Torben Filt Jensen (assisting cruise leader)
Annegrete D. Hansen (lytterum)
Susanne Hansen(fiskelab)
Rene Erlandsen (fiskelab)
Louise Scherffenberg Lundgaard (fiskelab)
Mads Jensen (fiskelab)
Eleni Theofania Skorda, student
Laura Diernæs, student
Giovanna Albani, student
Ronny Sørensen (Teknik)

2.2 Survey design

The survey was carried out in the Kattegat and Skagerrak area, east of 6° E and north of 56° N (Fig. 1). The area is split into 4 sub-areas.

In principal the survey is designed with parallel survey tracks at right angles to the depth lines with a spacing of 15 nm in strata 151, 17.5 nm in strata 41 and 10 nm in strata 31 and 21. Due to limitations regarding available time periods and places for fishing (late morning, early afternoon and immediately before and after midnight; and a limited amount of fishable positions for bottom trawl hauls) this structure cannot not be kept strictly.

2.3 Calibration

The echosounders were calibrated at Bornö in the Gullmar Fjord, Sweden during June 21 - June 23 2016. The calibration was performed according to the procedures established for EK60 with three frequencies (18, 38 and 120 kHz). This was the second calibration of the year, the previous one just before a cruise to the Norwegian Sea in April. The calibration of the paravane split-beam transducer at 38 kHz was done against a 60 mm copper sphere. The calibration of the three hull-mounted split-beam transducers at 18, 38 and 120 kHz were carried out against 63mm, 60 mm and 23 mm copper spheres, respectively. The results were close to those from the previous calibration earlier in April, and for 38 kHz on the towed body close to results from previous years. The calibration and setup data of the EK60 38 kHz used during the survey are shown in Table 1.

The 120 kHz echosounder still showed large differences in the angel discrimination like last year. As the 120 kHz is not the used frequency for the data collection the survey can be conducted with a possible failure on this echosounder.

2.4 Acoustic data collection

Acoustic data were collected using mainly the Simrad EK60 38 kHz echosounder with the transducer (Type ES 38 7x7 degrees main lobe) in a towed body. The towed body runs at approx. 3 m depth in good weather and down to about 6 -7 m, as needed, depending on the weather conditions, this year mostly at 4 – 5 m. The speed of the vessel during acoustic sampling was 9 – 11 knots. Also EK60 18 kHz and 120 kHz data were collected. They have not been directly used for the survey estimate, but as an aid during judging when distinguishing between fish and plankton. The acoustic data were recorded as raw data on hard disk 24 hours a day also during fishing operations. During trawl hauls the towed body is taken aboard and the EK60 38 kHz echosounder run on the hull transducer, but data taken during fishing periods are not used for the biomass estimate. The sampling unit (ESDU) was one nautical mile (nm). For the purpose of the later judging process, raw data is pre-integrated into 1 m meter samples for each ping. These samples are stored in separate files one for each ESDU. Integration is conducted from 3 m below the transducer to 1 m above the bottom or to max 500 m depth.

2.5 Biological data - fishing trawls

The trawl hauls were carried out during the survey for species identification. Pelagic hauls were carried out using a FOTÖ trawl (16 mm in the codend), while demersal hauls were carried out using an EXPO trawl (16 mm in the codend). Trawling was carried out in the time intervals 1000 to 1600 and 2030 to 0300 UTC , usually two day hauls (pelagic on larger depth and demersal in shallow waters) and two night hauls (mostly surface or midwater). The strategy was to cover most depth zones within each geographical stratum with trawl hauls. One-hour hauls were used as a standard during the survey.
The total weight of each catch was estimated and the catch sorted into species. Total weight per species and length measurements were made. The clupeid fish were measured to the nearest 0.5 cm total length below, other fish to 1 cm, and the weight to the nearest 0.1g wet weight. From each trawl haul 6 herring (if available) per 0.5 cm length class were collected and frozen for individual determination in land-laboratory of length, weight, age, race (North Sea autumn spawners or Baltic Sea spring spawners) and maturity. Fourier Shape Analyses calibrated to micro-structure formed in the otoliths during the larval period was used for the discrimination of herring race. Maturity was determined according to an 8-stage scale as also used by Scotland.

2.6 Hydrographic data

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

2.7 Plankton data

During the survey WP2 samples has been taken 2 times a day late evening and noon. Sampling has been conducted from 150 m or 5 m above bottom to surface with a 180 µm netting. The samples have been fractionised in size groups by filters of 2000 µm, 1000 µm and 180 µm. The samples have been dried for 24 hours and frozen for dry weight measurements at shore.

2.8 Data analysis

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

For each subarea (21, 31, 41, 42, 151 and 152 in Fig.1) the mean backscattering cross section was estimated for herring, sprat, gadoids and mackerel based on the standardized TS-relationships given in the ICES SIPS 9: Manual for International Pelagic Surveys (IPS):

Herring TS = 20 log L – 71.2 dB
Sprat TS = 20 log L – 71.2 dB
Gadoids TS = 20 log L – 67.5 dB
Mackerel TS = 20 log L – 84.9 dB

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

Length-age and length weight relationships by race for the herring were made based on the age and race analysis made on the frozen samples of single fish after the cruise.

2.9 Cruise leader course

Three students from DTU-Aqua`s MSc Eng. In Aquatic Science and Technology have participated in the survey during a 5 ECTS Cruise leader course. One student has been working with linking chlorophyll A and fish abundance, one student has been working with hydrographic fronts and fish abundance and one with use of uncalibrated dual beam transducers for fish abundance estimation. The students have worked together with the rest of the scientific crew under supervision of Karl-Johan Stæhr.

3. RESULTS & DISCUSSION

3.1 Narrative

The survey of R/V Dana started on June 21th at 04.15 UTC with departure from Hirtshals heading towards Bornö in Gullmar Fjord, Sweden for calibration of the acoustic equipment. The vessel was anchored at Bornö in the Gullmar Fjord, Sweden June 21th at 12.00 UTC. The calibration was initiated in the afternoon of June 21th and continued until the morning of June 23th.

At June 23rd at 04.00 UTC Dana left Bornö to arrive in Skagen June 23rd at 9.45 UTC for exchange of the scientific crew. R/V Dana left Skagen at 10.45 UTC to steam northwest towards the border between Skagerrak and the North Sea.

Monitoring data collection was started the June 23 at 58º 05'N, 6º 21'E at 00.00 UTC with a CTD and a trawl haul.

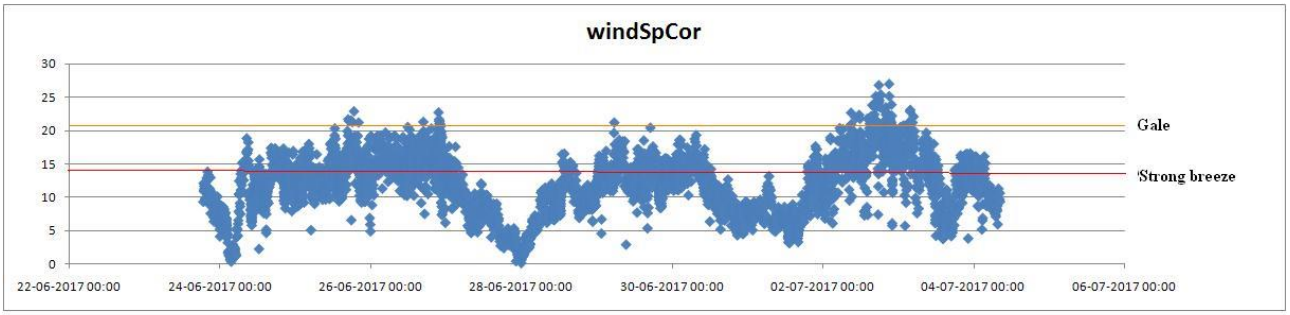
The North Sea was covered during the period June 23 – 28, Skagerrak during June 28 - July 2 and Kattegat during July 2-5.

The acoustic integration was ended July 5 at 57º 51'N, 10º 20'E at 10.29 UTC.

R/V Dana arrived at Hirthals at 13.00 UTC on July 5.

Totally the survey covered about 2139 nautical miles of monitoring. Data from the 38 kHz echosounder were recorded mainly using a 38 kHz paravane transducer running at depths of 3 – 5 m, the depth depending on the sea state and sailing direction relative to the waves. Simultaneously, data from the 120 kHz and 18 kHz echosounders using hull-mounted transducers were also recorded. During trawling hull-mounted transducers were used for all three frequencies.

The quality of the data is strongly dependent on the weather conditions. During the 2017 HERAS survey with Dana we have much more wind than for the last 10 years during this survey. During most of the survey we have had wind speeds corrected for the ships speed around 15 m/s or higher.



This will have an influence on the survey results as the high wind speed will introduce air bobbles in the upper water. It has been possible to conduct most of the planned acoustic transects due to the use of the towed body for the 38 kHz transducer. But 4 trawl hauls has been cancelled due to the wind. This accounts for one haul in the south-eastern corner of strata 151(see figure 1), two trawl hauls in the southern part of 31 and one trawl haul in the north-eastern strata 21.

3.2 Acoustic data

The total number of acoustic sample units of 1 nm (ESDU's) collected for the stock size calculation is 1969 cruise line for integration is given in Figure 2. During the survey acoustic data have been prepared for scrutinization at shore and stock calculation in the Danish program. Data from transect shown in Figure 4 will be used in the stock estimation by StoX.

3.3 Biological data

During the survey in 2017 38 hauls were conducted, 21 surface hauls and 17 bottom hauls. The geographical distribution of hauls and details on the hauls are given in Figure 2 and Table 2. Catches by species is given in Table 3.

Length distributions of herring, mackerel and sprat by haul are given in table 5 to 7.

The total catch for the survey was 21,6 tons. Herring was present in 36 hauls with a total catch of 7.3 tons or 33.6 % of the total catch. Totally 15,463 herring have been measured. Length distributions of herring per haul are given in Table 5.

The total sprat catch was 0.9 tons or 4.2 % of the total catch. Totally 1,440 sprat have been measured. Length distributions of sprat per haul are given in table 6.

Mackerel were present in 28 hauls with a total catch of 4.9 ton or 22.7 % of the total catch. Totally 2,114 mackerel have been measured. Length distributions of Mackerel per haul are given in table 7.

For the total survey area herring, mackerel and sprat contributed to the total catch by 33.6 %, 22.7 % and 4.2 % respectively.

Herring maturity

Based on the frozen single fish herring samples (2662 specimens) from each haul, where race analysis of the otoliths was used to differentiate between North Sea herring and Western Baltic herring, a maturity by age key was made for both races. It is given in the text table below. For North Sea autumn spawners specimens with maturity stage ≥3 and/or age ≥5 are regarded as mature and for Baltic spring spawners specimens with maturity stage ≥2 and/or age ≥5 are regarded as mature.

North Sea autumn spawners:

Kattegat, Strata 21					
WR	0i	1i	1m	2i	2m
%	100,0	99,7	0,3	69,7	30,3

Skagerrak, Strata 31, 41 and 42										
WR	0	1i	1m	2i	2m	3i	3m	4i	4m	5m
%		100,0	0,0	96,9	3,1	84,1	15,9	14,5	85,5	100,0

North Sea, Strata 151 and 152										
WR	0	1i	1m	2i	2m	3i	3m	4i	4m	5m
%		100,0	0,0	91,3	8,7	54,2	45,8	55,7	44,3	100,0

Baltic Sea spring spawners:

Kattegat, Strata 21												
WR	0	1i	1m	2i	2m	3i	3m	4i	4m	5m	6m	7m
%	100,0	91,0	9,0	30,2	69,8	9,9	90,1	0,0	100,0	100,0	0,0	100,0

Skagerrak, Strata 31, 41 and 42														
WR	0	1i	1m	2i	2m	3i	3m	4i	4m	5m	6m	7m	8m	9m
%		93,4	6,6	65,2	34,8	12,4	87,6	3,5	96,5	100,0	100,0	100,0	100,0	100,0

North Sea, Strata 151 and 152														
WR	0	1i	1m	2i	2m	3i	3m	4i	4m	5m	6m	7m	8m	9m
%		99,1	0,9	59,3	40,7	0,0	100,0	0,0	100,0	100,0	100,0	100,0	100,0	100,0

Sprat maturity

Based on 470 sprat collected over all length classes and hauls including sprat age, weight and maturity keys were established. The maturity key for sprat is shown in the text table below. Sprat with maturity stage ≥2 and/or age ≥3 are regarded as mature

Kattegat, strata 21								
WR	0	1i	1m	2i	2m	3m	4m	5m
%		0,0	100,0	0,0	100,0	100,0	100,0	100,0

North Sea, strata 151						
WR	0	1i	1m	2i	2m	3m
%		0,0	100,0	0,0	100,0	100,0

3.3 Biomass estimates

Herring

The total herring biomass estimate for the Danish acoustic survey with R/V Dana in June-July 2017 is 62,846 tonnes of which 41.6 % or 26,159 tonnes is North Sea autumn spawners and 58.4 % or 36,687 tonnes is Baltic Sea spring spawners.
For the total number of herring the survey results give 1,349 mill, of which 47.9 % are North Sea autumn spawners and 52.4 % are Baltic Sea spring spawners.

The estimated total number of herring, mean weight, mean length and biomass per age and maturity stage in each of the surveyed strata are given in Table 9 and 10 for North Sea autumn spawners and Baltic spring spawners respectively.

Relative distribution on all herring (combined North Sea autumn spawners and Baltic spring spawners) is given in Figure 4.

A comparison for the results of the last 10 years surveys are given in the text table below.

	Autumn spawners		**Spring spawners**	
Year	Number in mill.	Biomass in tons	Number in mill.	Biomass in tons
2006	1530	98786	6407	471850
2007	4443	315176	8847	614048
2008	4473	80469	7367	450505
2009	9679	157707	1326	146590
2010	2723	148946	1461	88597
2011	5156	165589	3699	179898
2012	4805	259947	1955	122901
2013	1070	62126	1013	83601
2014	4576	58974	798	32875
2015	2950	103423	4874	179954
2016	1163	38650	1085	59660
2017	646	26159	703	36687

Sprat

The total abundance estimate of sprat for the Danish acoustic survey with R/V Dana in June-July 2017 is 404 million corresponding to a biomass at 6178 ton. Sprats were in 2017 found in Kattegat, Strata 21, with 70.8 % and in the North Sea, Strata 151 (ICES 41F6, 42F6 and 42F7) with 29.3 %.

Abundance, biomass, mean length and mean weight per WR and strata are given in Table 11. Relative distribution on sprat along the cruise line is given in Figure 5

3.4 Hydrography

39 CTD stations have been taken. Information on the stations and distribution is given in Table 7 and Figure 3. Data from the CTD stations will be delivered to ICES hydrographical data base.

3.5 Plankton

22 WP2 stations have been taken. Information on the stations and distribution is given in Table 8 and Figure 3. Dry weight will be measured ashore for each of the three fractions 2000 µm, 1000 µm and 180 µm. The weight per fraction and station is given in Table 8. Distribution on size groups are shown in Figure 6.

4 Cruise leader course

Three students from DTU-Aqua`s MSc Eng. In Aquatic Science and Technology have participated in the survey during a 5 ECTS Cruise leader course. One student has been working with linking

chlorophyll A and fish abundance, one student has been working with hydrographic fronts and fish abundance and one with use of uncalibrated dual beam transducers for fish abundance estimation. The students have worked together with the rest of the scientific crew under supervision of Karl-Johan Stæhr.

For more details see appendix 1.

Appendix 1

Cruise report

Vessel:	R/V DANA
Cruise:	ICES survey – SISP 9 Manual for International Pelagic Surveys (IPS)
Period:	21. June - 05. July 2017
Author	Laura Diernæs
Project	Linking chlorophyll A and fish abundance.

The project:
This survey focus on distribution, abundance and age of small pelagic fish in species including sprat, sardines, mackerel and anchovy. In addition, an equal importance is that it aims to improve the understanding of the role of these species in the pelagic ecosystem by simultaneously sampling the multiple trophic levels and the physical oceanography.
By focusing on tropical level this project was seeking a relation between phytoplankton and fish abundance. It is of interest, if it is possible to estimate whereabouts fish are present in the water by looking at chlorophyll.

Satellite:
Maps showing surface chlorophyll was supposed to be prepared from land the days before the cruise but complications happened and this will be corrected when returning. Surface chlorophyll obtained from Copernicus will be used to compare the collected chlorophyll data. If there are a correlation between satellite obtained surface chlorophyll and collected chlorophyll data, it will be possible to only look at maps from satellites to estimate fish present in the water, so far there are a relation between fish abundance and chlorophyll.

CTD:
Chlorophyll-, temperature-, oxygen- and salinity information from SeaBird SBE11 CDT with fluorescence measurement device was obtained during the cruise, to make maps of spring layers and chlorophyll peaks in the water column. The profile given by the CTD gave an idea of how the chlorophyll was distributed down the water column. However, no calibration had been made of chlorophyll, so the data did not give confident values of chlorophyll in the water. This problem will be corrected back at land, where chlorophyll will be measured afterwards from water samples that have been collected during the cruise.

Water samples:
With Rosette SBE 32 Carousel Water Sampler, water were collected at each CTD station. It varied between 6 to 5 water samples depending on the depth at each station. Water were not collected below 70 meters in depths.
1 L water at each depth have been filtered through a Glass-fibre filter using a multiple vacuum filtration system. The filter have been stored in -18°C freezer and will be transported back to DTU where chlorophyll will be extracted and measured using a fluorescence meter.
5 mL of water was transported from each depth to glass vials to count the total amount of cells per mL in each depth. After collecting water, the samples were fixed with lugol (2% concentration), and counted manually using a Sedgewick-rafter counter.

For each station a sample was collected to analyze the most abundant species. However, due to bad weather and low phytoplankton abundance this was close to impossible. 1L water sample were therefore filtered and the filter was examined afterwards for most dominant species in the water. Many diatoms and dinoflagellates were present in the water from start to the end. However due to the filter, many small species might have been missed in this examination of the filters. An Utermöhl Chamber is recommended to sediment and concentrate the water samples, so no species will be missed in the future.

Results:
On the cruise I have been able to count cells manually using the Sedgewick-rafter chamber. A small increase in cells per mL can be observed from the start of the cruise in the North Sea to the end of the cruise in Kattegat (figure 1).

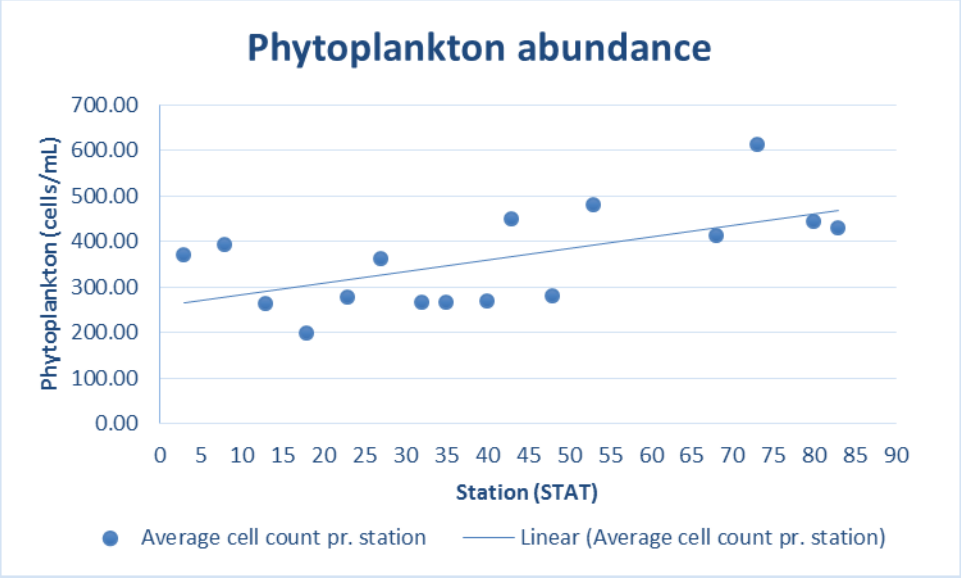


Figure 1: phytoplankton abundance showed in cells per mL for each station.

Chlorophyll have also been measured a 5 m depth over the entire cruise, and show similar pattern.

Examination of collected data:
After the cruise chlorophyll will be extracted from the filters and measured. The length and weight data of maceral and herring at each transect will be available and used to compare the phytoplankton abundance at each station.

First, the total weight of maceral and/or herring will be compared with phytoplankton abundance in respectively North Sea, Skagerrak and/or Kattegat. Secondly, the depth of chlorophyll peak and depth of maceral and/or herring will be compared.

Observations indicate that thermocline can explain a chlorophyll peak, which will then be examined further afterwards.
Zooplankton data will be available, which will be used to make a model of the pelagic ecosystem and possible trophic link explaining fish abundance.

Cruise Survey 2017

Student: Albani Giovanna

Number: s161181

Project: Hydrography and fish abundance

The main aim of this project is to combine the information derived from the CTD, used to define fronts during the cruise, with the catch from the trawl. The possibility to match this data and to find a relation between the distribution of fish among the fronts in the North Sea, Kattegat and Skagerrak, would represent an interesting parameter to consider the distribution of the main fish stock.

The development of my project is divided in two parts. One part is about collection of data from the CTD profile for each station of the survey, such as Temperature, Salinity, Density, and Oxygen along depth. These are the CTD data that usually are collected during every survey and through them it is possible define the profile of the water column and therefore the structure of fronts for each station. The second part is to analyze the fishing data from trawls, especially focusing on Herring and Mackerel.

During the survey I have taken part for the CTD sample, observing the profile chart to identify the spring layer and how Oxygen, Temperature and Salinity change in depth. It is important to consider that the raw data, take from the CTD profile, give us information among the whole water column (in depth). Instead the data collected from satellite represent the SST Sea Surface Temperature, and only indirectly through elaboration with algorithm it is possible figure out the parameters in depth.

To develop my data I'm using the program Ocean Data View, in which it is possible to run raw data collected directly from the CTD, due to the fact that it can handle the Sea-Bird CNV format. Furthermore, it is possible to import different kind of format in Ocean Data View (txt., csv., spreadsheet files etc.) useful to have an overview of all hydrographic variables necessary to make maps.

The first purpose of this project is to map the fronts on the area of our survey, and it is fundamental to take in consideration every data about location during the survey for each station (coordinates, time…). Another point that is possible to define a section across many stations among latitude/longitude hence it is available a transect that easily show how the parameters change through each station, latitude/longitude and deep/shallow water. The main advantage on using this approach is to have a wider overview on which and where parameters change in the survey. Furthermore, if we consider that it is possible to define fronts only where we had a CTD station, the possibility to make transects between many stations give us the chance to extent the fronts profile among the whole section.

The second purpose of my project regards to match the CTD stations with the trawl stations for the main commercial species Herring and Mackerel, and consider their Mean length (cm) and Catch weight (Kg) for each station. Having the map of the trawl stations it is possible to figure out if there is a relation between the size of catches (weight and the mean length) and characteristics of the water column and if the presence of fronts at different depth (where found) could influence the distribution and abundance of fishes.

The final purpose of this project is to be able to find a relation between the results that I produced defining fronts with the catches from trawls. During the survey, I started to analyze the data from the previous year (2016) and meanwhile I'm working on the new data collected during this survey (2017). This approach could help me to have a larger range of data to work on and to reduce the risk of error. My plane is to use these data to make a model of the abundance of fishes and to find out if

there is any correlation between the hydrography and the distribution of fishes on the area under survey.

Appendix:

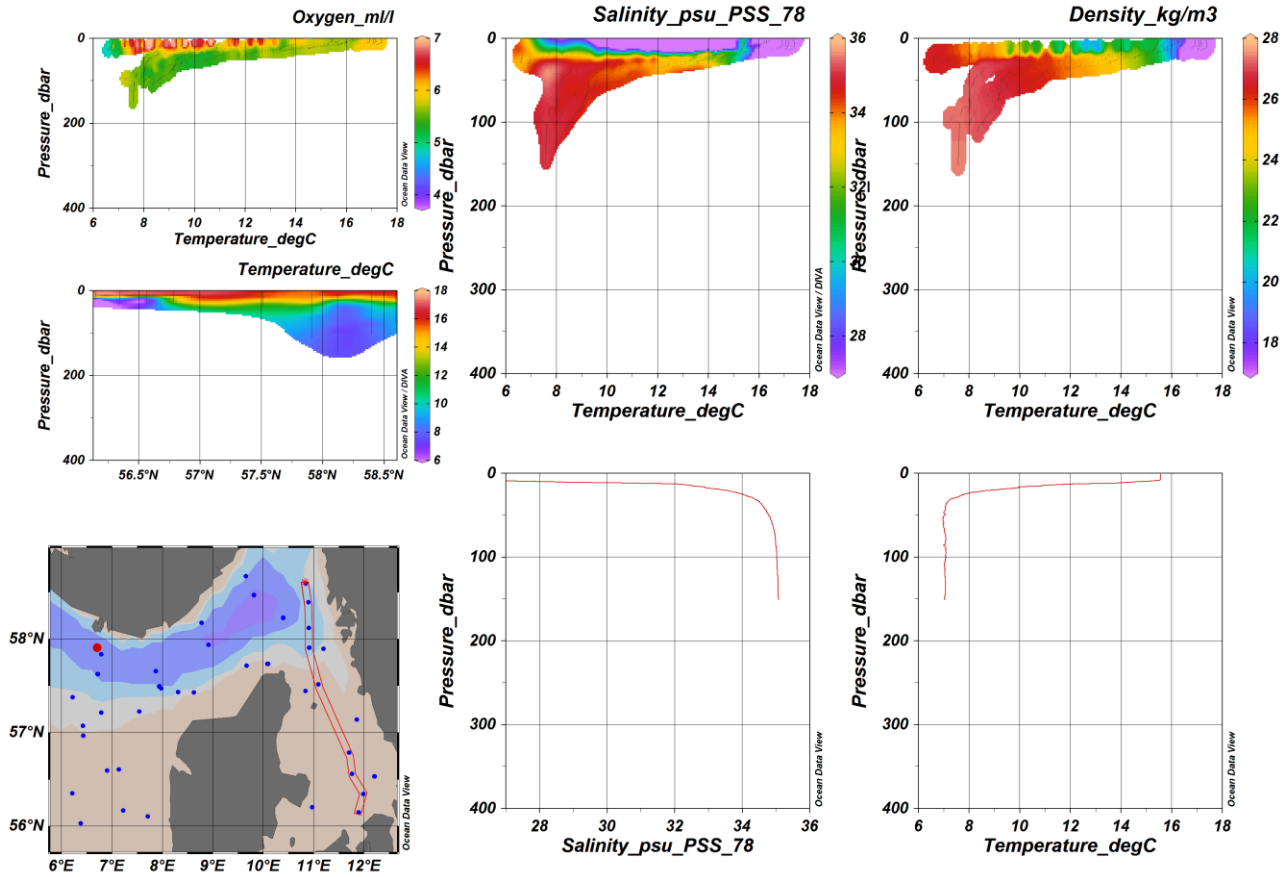


Figure 1: example of transect along latitude, made with Ocean Data View. (data from the survey 2016)

Description of the Project on Dana Cruise

Eleni Theofania Skorda
S161375

Title

"Estimation of the mean target strength (TS) of fishes."

The purpose of this project is to estimate the density or the target strength of the fishes from trawling which they will reflect in each haul. First and foremost, I collected data from the catches from trawls. These data provide information about the weight, the length and the population of each species and also the overall weight of each haul. Furthermore, using the excel sheet I calculated the target strength for each species and then the mean target strength for each haul using the equation 1.

Equation 1:

$$TS = ALOG(L) - B$$

For the calculation of the equation 1, I needed information for the length of the fishes and the weight. Details for specific parameters (A and B) have been given from the cruise leader. The next step is to explain what influence the target strength of the species. The length of the fishes plays crucial role but also there are some other factors which correlated with species.

The final step is to convert the acoustical measurements to biological measurements in order to compare the TS from the ECHOVIEW and data from the catches. However, this part could not complete because the time of the cruise is not enough in order to analyze the data from ECHOVIEW. Moreover, the ECHOVIEW software is sophisticated and I needed more time in order to acquire the knowledge for using the software.

In general, in Dana cruise I participated at the calibration of the acoustic equipment which will take place in the fjord of Gullmarn in Sweeden. The calibration last for two days from 21-6 to 23-6. After the calibration procedure, I estimated the mean target of the target species for each haul. In order to do that, I participated in the fish lab distinguishing species and measuring the length of them for each species. The estimation will be happened using data from the trawls. The fishing with trawl will occurred four times per day. Two of them, they will be to sea surface (night) and the last two will be to the bottom (day). Its haul from the trawl it will last approximately 1 hour.

Figure 1. Map showing the survey area for the Danish acoustic survey with R/V Dana in June-July 2017. The map shows the subareas (strata) used in the abundance estimation.

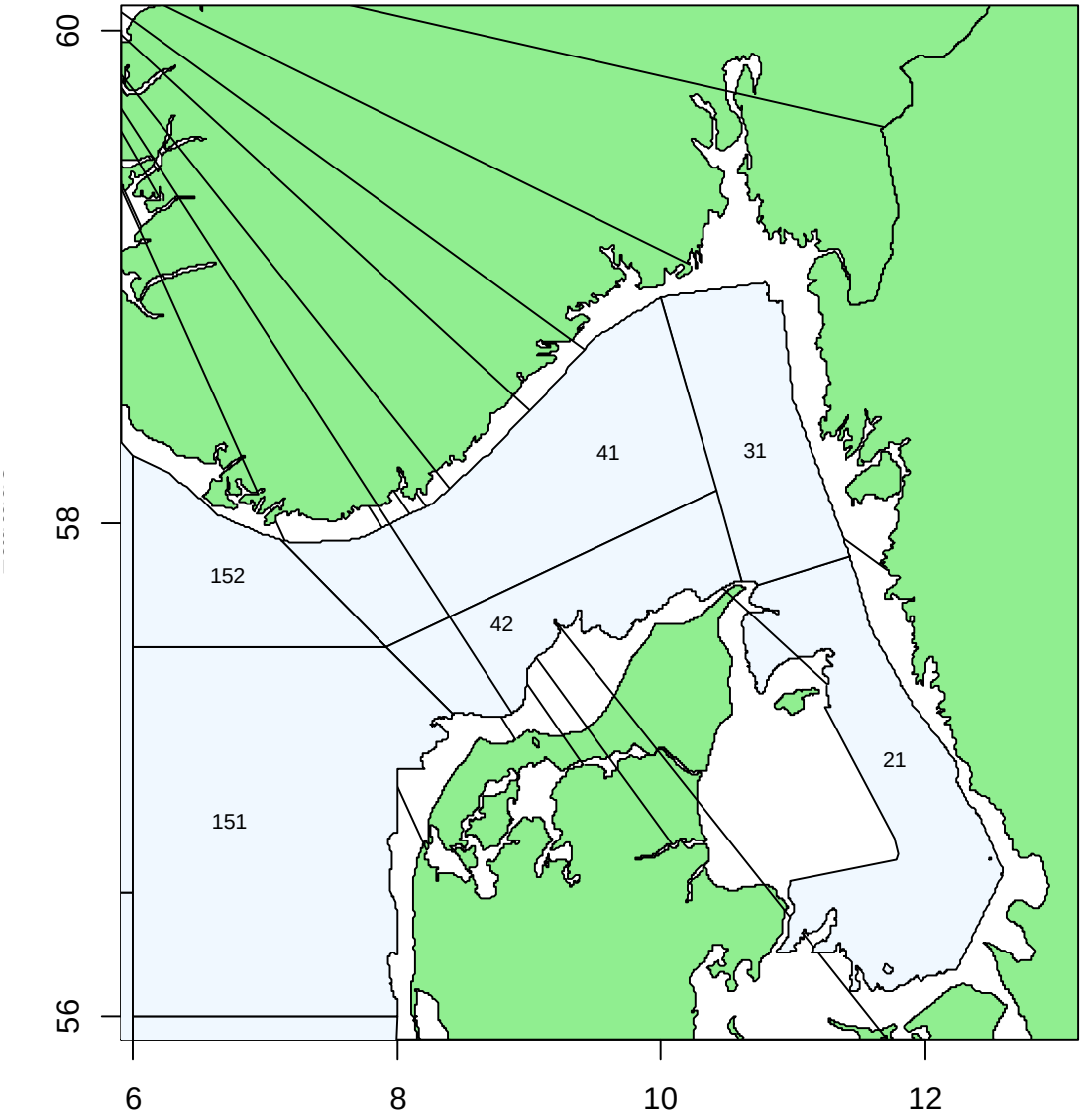


Figure 2. Map showing sailed route and trawl stations during the Danish acoustic survey with R/V Dana in June-July 2017. Read is pelagic hauls and blue is demersal hauls.

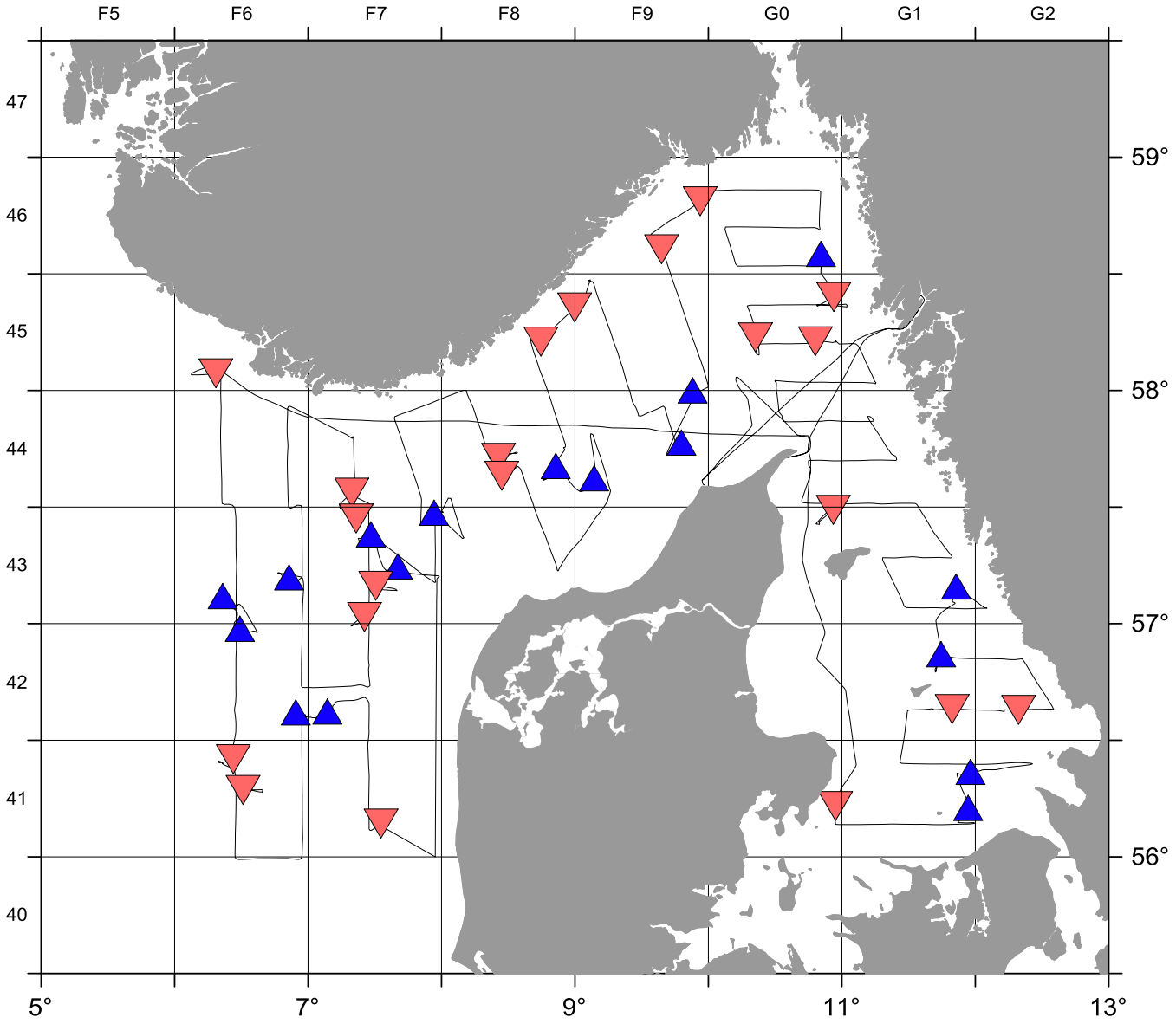


Figure 3. Map showing CTD and WP2 stations during the Danish acoustic survey with R/V Dana in June-July 2017. X are CTD stations and squares are combined CTD and WP2 stations.

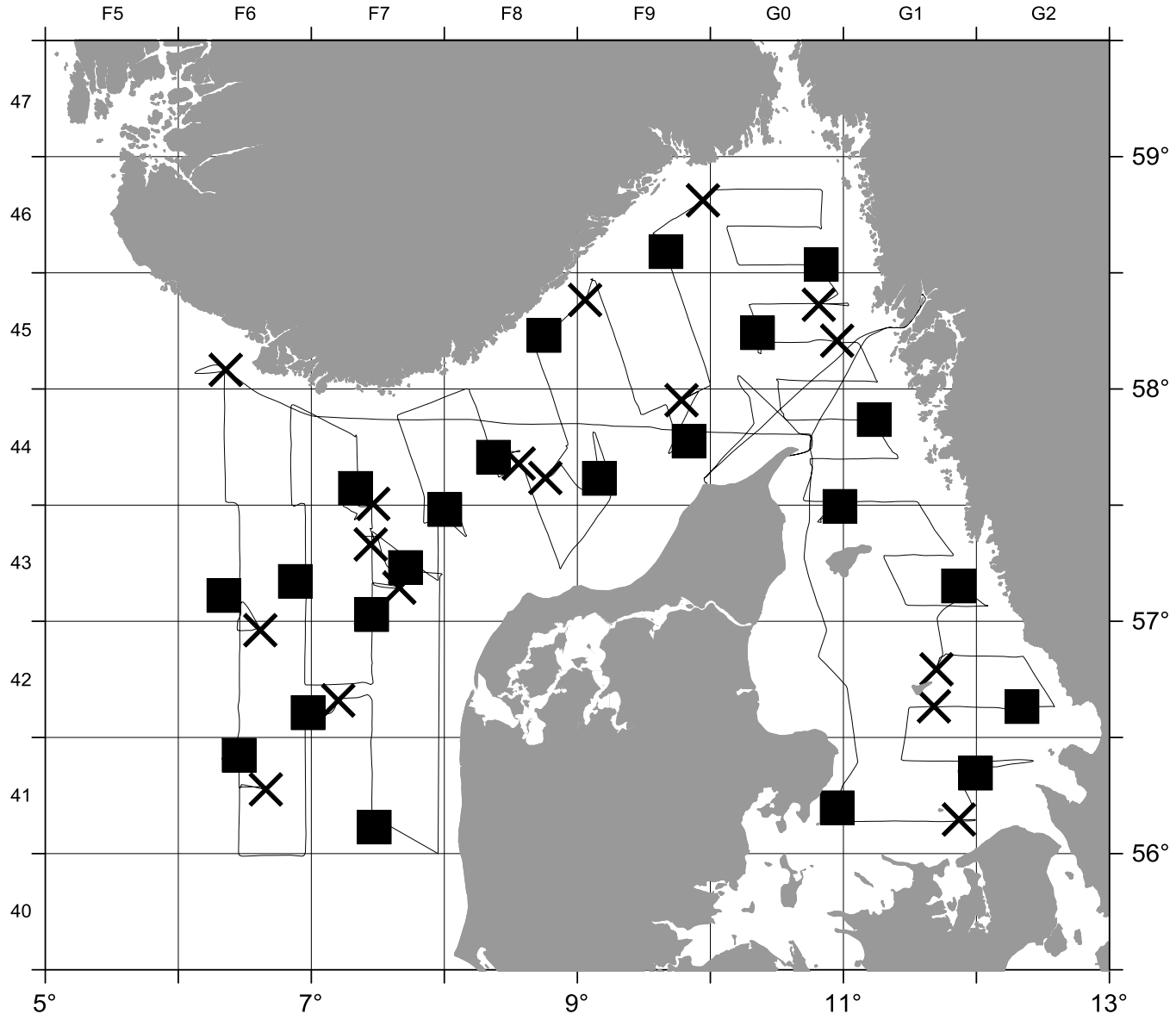


Figure 4. Relative herring density (in numbers per nm²) along the track of the Danish acoustic survey with R/V Dana in June-July 2017. Red circles indicate relative density of herring per ESDU.

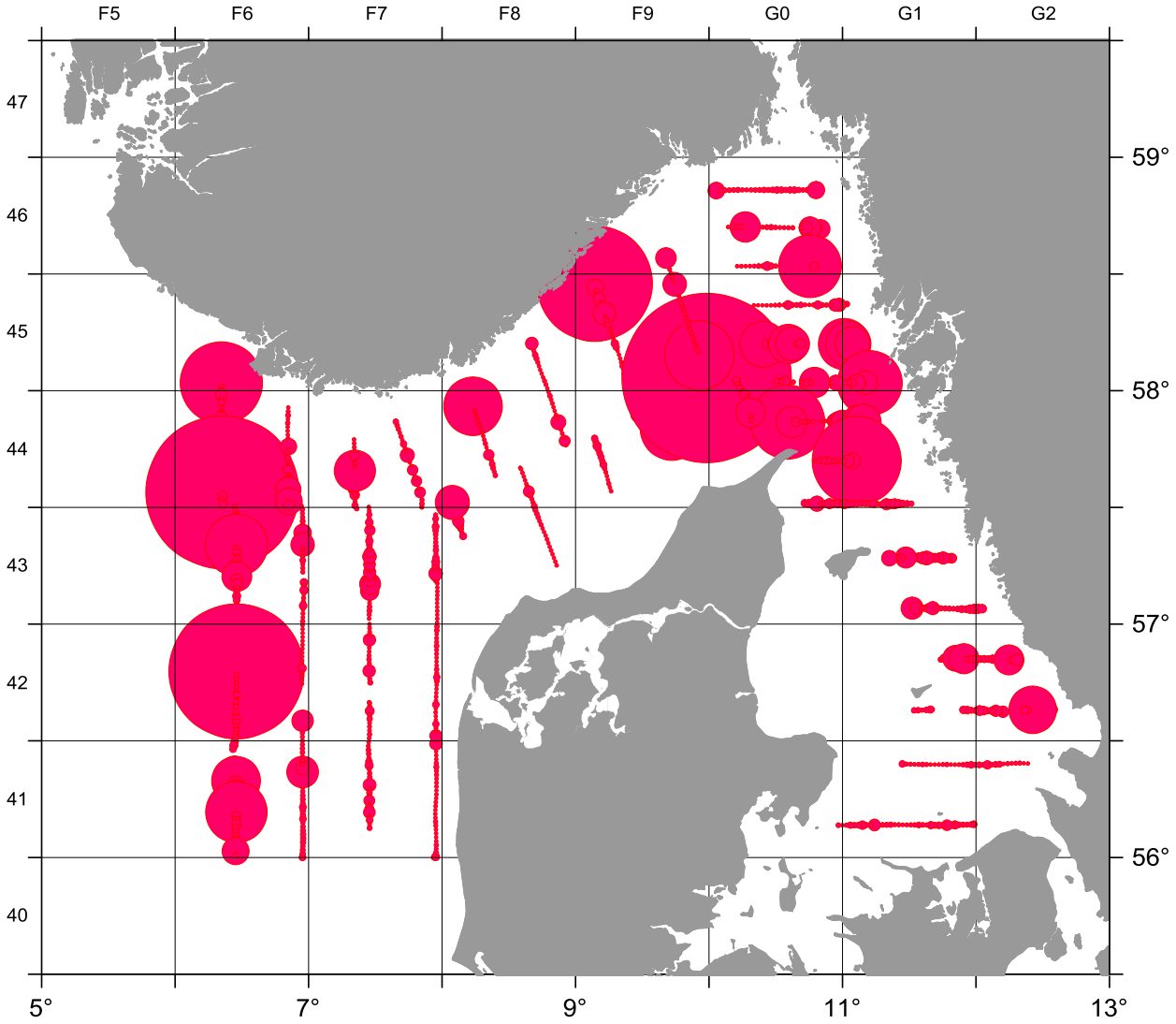


Figure 5. Relative sprat density (in numbers per nm²) along the track of the Danish acoustic survey with R/V Dana in June-July 2017. Red circles indicate relative density of sprat per ESDU.

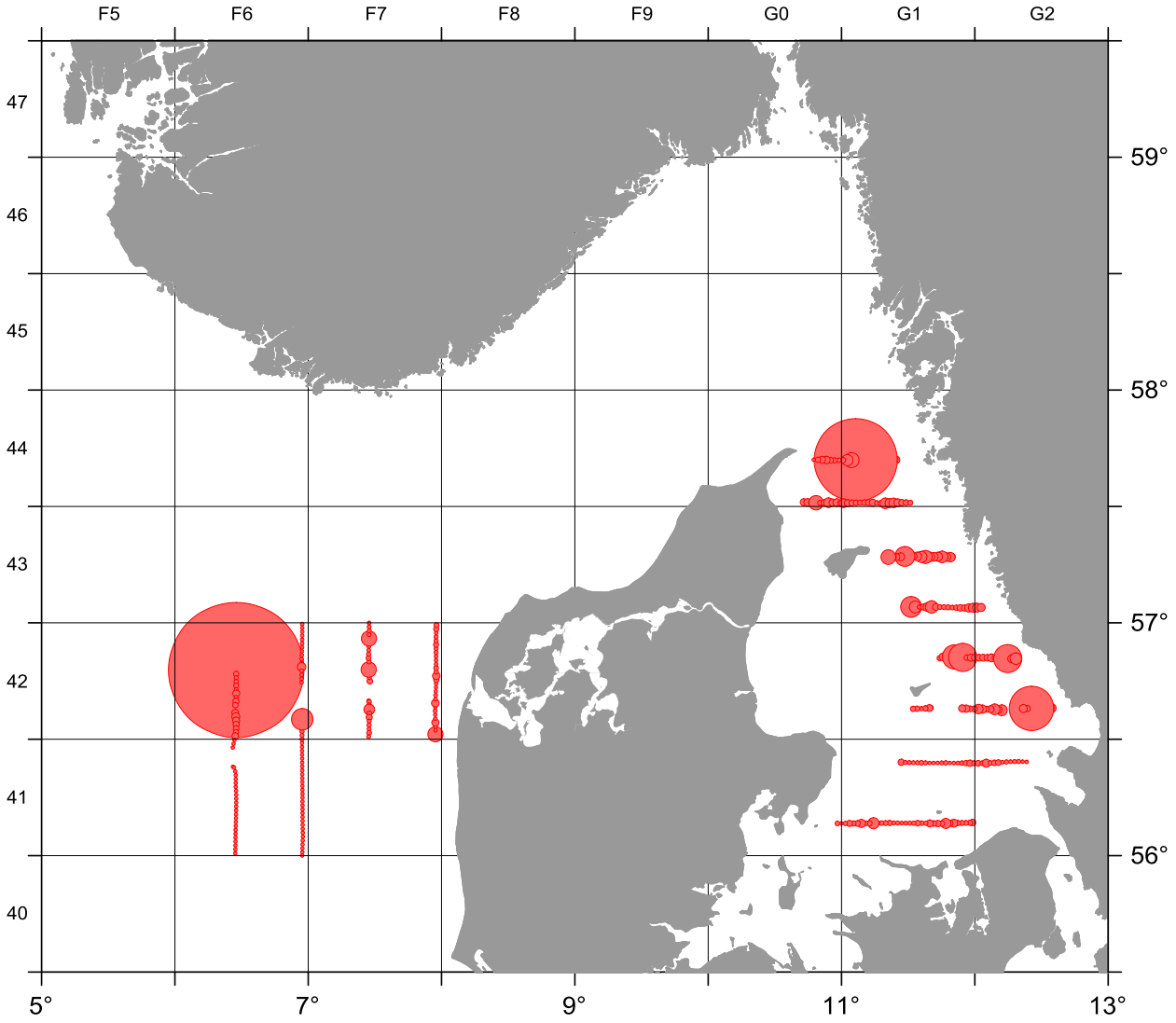


Figure 6. Distribution of dry weight in mg/m^2 in 2017. A: Total weight, B: fractions 2000 µm, C: fraction 1000 µm and D: fraction 180 µm.

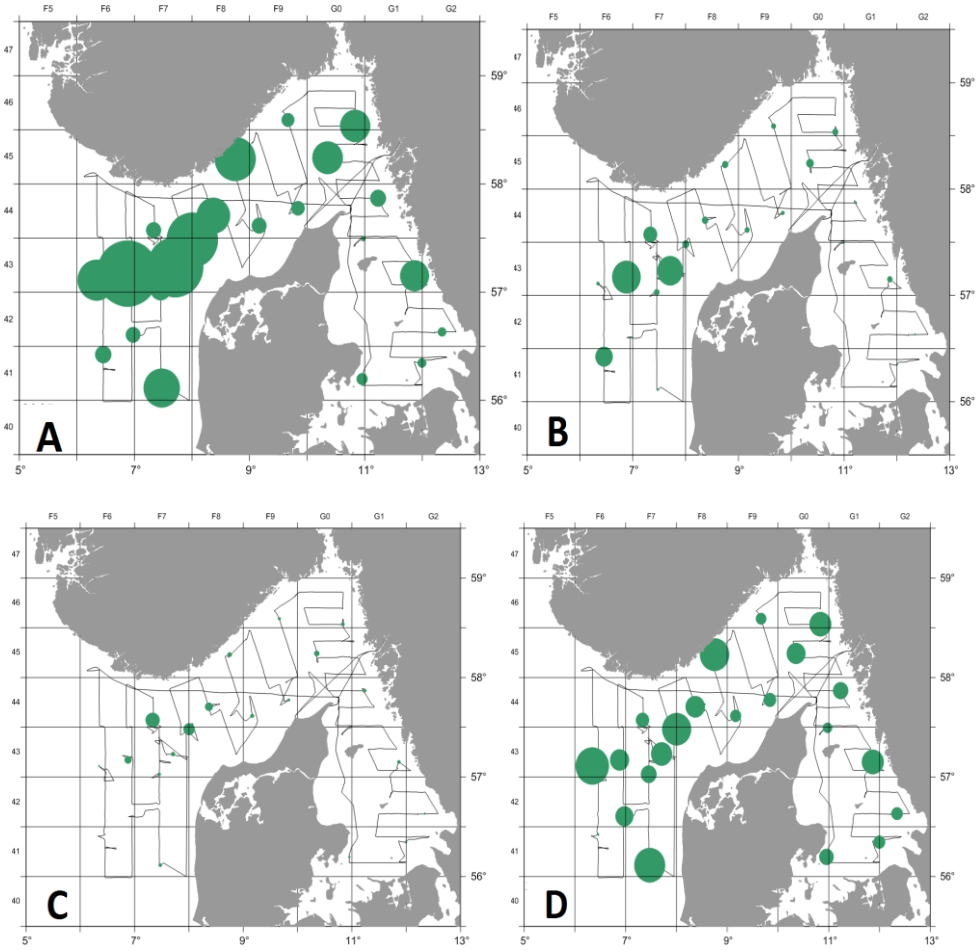


Table 1. . Simrad EK60 and analysis settings used during the Acoustic Herring Survey with R/V Dana Cruise June-July 2017

Transceiver Menu	
Frequency	38 kHz
Sound speed	1508 $m.s^{-1}$
Max. Power	2000 W
Equivalent two-way beam angle	-20.5 dB
Transducer Sv gain	25.40 dB
3 dB Beamwidth	6.9°
Calibration details	
TS of sphere	-33.6 dB
Range to sphere in calibration	9.56 m
Measured NASC value for calibration	19300 m^2/nmi^2
Calibration factor for NASCs	1.00
Absorption coeff	6.063 dB/km
Log Menu	
Distance	1,0 n.mi. using GPS-speed
Operation Menu	
Ping interval	1 s external trig
Analysis settings	
Bottom margin (backstep)	1.0 m
Integration start (absolute) depth	7 - 9 m
Range of thresholds used	-70 dB

Table 2. Trawl hauls details for the Danish acoustic survey with R/V Dana in June-July 2017.

Trawl hauls Acoustic survey in Kattegat and Skagerrak 06/2017 23 June to 5 July 2017																	
						Trawl	Wire	Trawl	Cath	Mean	Total		Trawling	Trawling	Wind		Trawling
Date	Haul	Time	ICES	Position		Direction	length	type	depth	depth	catch	Main Species	speed	duratin	speed	Sea state	distance
dd-mm-yy	no.	UTC	Square	Latitude	Longitude	deg.	m		m	m	kg		Kn	min,	m/s		NM
24-06-17	4	00:56	45F6	58.04.411 N	006.18.569 E	271	300	Fotö	Surface	343	312	Herring, Mackerel	3.9	60	6	3	4.938
24-06-17	88	11:01	43F6	57.06.012N	006.21.598E	134	360	Expo	Bottom	58	274	Herrring	3.3	60	11.7	4	3.301
24-06-17	100	13:30	42F6	56.57.603N	006.29.357E	73	310	Expo	Bottom	55	153	Cod	3.3	60	11.9	4	3.341
24-06-17	156	21:19	41F6	56.25.126N	006.26.388E	257	350	Fotö	Surface	41	180	Mackerel	3.9	60	12.8	5	3.550
25-06-17	168	00:21	41F6	56.17.196N	006.30.769E	90	370	Fotö	Surface	41	296	Herring	3.8	60	10.5	5	4.029
25-06-17	258	11:57	42F7	56.36.093N	006.54.481E	111		Expo	Bottom	39	355	Sprat	3.3	60	16.4	6	3.266
25-06-17	266	13:56	42F7	56.36.316N	007.08.692E	357	300	Expo	Bottom	37	420	Mackerel, Herring	3.0	60	11.7	6	2.970
25-06-17	315	21:57	41F7	56.08.560N	007.32.790E	52	320	Fotö	Surface	27	272	Mackerel	2.7	60	12.3	6	2.700
26-06-17	422	12:16	43F7	57.13.652N	007.40.341E	252	320	Expo	Bottom	71	109	Herring	2.9	60	17.9	6	2.903
26-06-17	436	15:06	43F7	57.21.895N	007.28.238E	275	440	Expo	Bottom	115	204	Herring, Haddock	3.1	60	16.7	6	3.050
26-06-17	464	21:51	44F7	57.33.701N	007.19.677E	225	350	Fotö	Surface	262	835	Herring	3.8	60	14.7	6	4.241
27-06-17	476	00:25	43F7	57.27.049N	007.21.621E	34		Fotö	Surface	182	100	Herring	3.7	60	15.1	6	3.806
27-06-17	575	12:28	43F6	57.10.841N	006.51.471 E	315	320	Expo	Bottom	66	268	Herring	3.2	60	6.8	4	3.183
27-06-17	649	15:20	42F7	57.01.686N	007.25.350E	226	315	Fotö	Surface	42	105	Mackerel	3.9	60	3.4	4	3.721
28-06-17	667	00:18	43F7	57.09.733N	007.30.432E	99	305	Fotö	Surface	50	1303	Mackerel	4.3	60	3.6	1	4.229
28-06-17	759	11:35	43F7	57.27.457N	007.56.630E	231	600	Expo	Bottom	137	1396	Norway pout	3.0	60	12.8	3	3.039
28-06-17	833	21:20	43F8	57.42.651N	008.25.594E	67	230	Fotö	Surface	268		INVALID	3.8	60	10.7	4	
29-06-17	851	00:22	44F8	57.38.032N	008.27.098E	57	300	Fotö	Surface	181	84	Mackerel, Herring	3.8	60	12.2	4	4.243
29-06-17	939	11:33	44F9	57.36.323N	009.03.835E	228	160	Expo	Bottom	34	276	Sandell	3.3	60	9.5	5	3.348
29-06-17	954	13:50	44F8	57.39.494N	008.51.359E	232	405	Expo	Bottom	84	800	Norway pout	3.3	60	14.4	5	3.276
29-06-17	1008	21:39	45F8	58.12.544N	008.44.678E	53	270	Fotö	Surface	369	450	Herring	3.9	60	13.2	5	1.944
30-06-17	1020	00:29	45F9	58.21.345N	008.59.841E	42	270	Fotö	Surface	358	1093	Mackerel, Herring	3.8	60	12.5	5	2.629
30-06-17	1089	10:51	44F9	57.45.497N	009.47.863E	257	240	Expo	Bottom	38	2197	Herring	3.4	60	9.6	5	3.466
30-06-17	1112	14:09	44F9	57.58.927N	009.52.908E	222	460	Expo	Bottom	104	3353	Norway pout	3.2	60	9.4	5	3.232
30-06-17	1162	21:19	46F9	58.36.316N	009.38.948E	324	300	Fotö	Surface	473	950	Herring	3.9	60	7.5	3	4.021
01-07-17	1180	00:16	46G0	58.48.659N	009.56.314E	42	300	Fotö	Surface	184	673	Herring	3.7	51	8.0	3	2.804
01-07-17	1282	12:13	46G0	58.34.057N	010.50.612E	182	390	Expo	Bottom	89	253	Norway pout	3.2	60	4.2	3	3.230
01-07-17	1294	14:31	45G0	58.24.021N	010.50.142E	240	380	Fotö	10-40	115	3	Mackerel, Herring	3.7	60	7.4	3	3.806
01-07-17	1340	21:13	45G0	58.13.637N	010.21.150E	175	300	Fotö	Surface	229	1989	Herring, Mackerel	3.9	60	13.5	4	4.233
02-07-17	1359	00:33	45G0	58.12.636N	010.48.083E	99	300	Fotö	Surface	165	955	Mackerel, Herring	3.9	60	10.8	4	4.091
02-07-17	1499	21:04	43G0	57.29.262N	010.56.145E	232	300	Fotö	Surface	54	300	Mackerel	3.8	60	17.7	6	4.533
03.07-17	1608	10:48	43G1	57.08.476N	011.51.361E	189	280	Expo	Bottom	55	87	Herring	2.9	60	12.1	5	2.972
03-07-17	1628	13:53	42G1	56.51.045N	011.44.615E	209	280	Expo	Bottom	41	823	Sprat, Herring	3.2	60	5.3	5	3.211
03-07-17	1681	21:11	42G2	56.37.803N	012.19.428E	277	270	Fotö	Surface	40	27	Mackerel, Herring	3.9	60	11.0	4	3.644
04-07-17	1697	00:17	42G1	56.38.012N	011.49.579E	268	300	Fotö	Surface	37	172	Mackerel	4.0	60	13.6	4	4.320
04-07-17	1770	10:50	41G1	56.20.792N	011.57.862E	293	230	Expo	Bottom	32	420	Sprat, Herring	2.9	60	5.4	3	2.959
04-07-17	1785	14:00	41G1	56.11.520N	011.56.786E	224	190	Expo	Bottom	25	65	Sprat, Herring	3.3	60	5.7	3	3.380
04-07-17	18.35	20:43	41G0	56.13.066N	010.57.162E	18	300	Expo	Surface	21	102	Sprat, Herring, Mackerel	3.9	60	5.8	3	3.822

Table 3. Catch composition in trawl hauls for the Danish acoustic survey with R/V Dana in June – July 2017

		Station		4	88	100	156	168	258	266	315	422	436	464	476	575
		ICES sq.		45F6	43F6	42F6	41F6	41F6	42F7	42F7	41F7	43F7	43F7	44F7	43F7	43F6
		Gear		Fotö	Expo	Expo	Fotö	Fotö	Expo	Expo	Fotö	Expo	Expo	Fotrö	Fotö	Expo
		Fishing depth		Surface	Bottom	Bottom	Surface	Surface	Bottom	Bottom	Surface	Bottom	Bottom	Surface	Surface	Bottom
		Total depth		343	58	55	41	41	39	37	27	71	115	262	182	66
		Day/Night		N	D	D	N	N	D	D	N	D	D	N	N	D
%		Total catch	Total	312	274	153	180	296	355	420	272	109	204	835	100	268
0.00	Anchovy	*Engraulis encrasicolus*	0.410													
0.00	Lesser silver smelt	*Argentina sphyraena*	0.364										0.008			
0.28	Blue whiting	*Micromesistius poutassou*	60.340											25.130	21.050	
4.20	Sprat	*Sprattus sprattus*	907.270				0.016		200.690							
0.45	Squids, octopusses	*Cephalopoda sp*	97.007	0.091	0.757	0.214		0.030	0.700	1.110	0.689	1.510	2.222	0.160	0.184	1.478
0.02	Norway lobster	*Nephrops norvegicus*	4.366													
0.05	Common weaver	*Trachinus draco*	11.218													
0.00	Solenette	*Buglossidium luteum*	0.034						0.024	0.010						
0.00	Poor-cod	*Trisopterus minutus*	0.205									0.059				
0.07		*Anarhichas lupus*	16.110										9.460			2.370
0.03	Anglerfish	*Lophiuspiscatorius*	5.600													5.600
0.03	Halibut	*Hippoglossus hippoglossus*	5.620			2.250										3.370
0.01	Horse mackerel	*Trachurus trachurus*	3.079		0.325	0.126					0.312					0.450
0.21	Garfish	*Belone belone*	44.602	0.550			0.806	1.252			1.600			6.330		
0.64	Long rough dab	*Hippoglosides plattessoides*	137.833		0.597	0.160			1.424	0.684		0.274	0.098			0.180
4.67	Whiting	*Merlangius merlangus*	1008.281	0.031	50.600	19.080	0.016	0.150	38.635	81.816		18.012	4.386			13.518
0.39	Invertebrates	*Invertebrata*	84.716		0.247	0.224	0.018		0.316	0.220		0.034	0.554			2.960
1.81	Dab	*Limanda limanda*	391.875		39.570	12.000			22.840	17.570		13.860				1.780
0.51	Hake	*Merluccius merluccius*	109.590			0.484			10.730	9.240			3.990			7.200
0.95	Gurnard	*Trigala spp.*	204.340		12.710	7.090	14.490	23.250	7.274	7.160	92.786	10.342	0.472		0.348	5.240
0.11	Krill	*Euphausidae spp.*	24.349												17.090	
1.50	Haddock	*Melanogrammus aeglefinus*	323.799		6.190	10.844						3.276	66.370			40.200
0.00	Ling	*Molva molva*	0.914													
0.09	Pollack	*Pollachius pollachius*	20.092													14.300
0.00	Pearlside	*Mauorolicus muelleri*	1.078												1.074	
22.72	Mackerel	*Scomber scombrus*	4904.439	94.280			124.120	52.010	0.530	178.450	159.176	0.408		144.198	1.690	1.796
1.79	Saithe	*Pollachius virens*	387.177			0.122						1.458	3.970		7.390	32.780
0.00		*Callionymus maculatus*	0.074				0.006									
0.00	Turbot	*Psetta maxima*	0.870			0.870										
0.00	Picked Dogfish	*Squalus acanthias*	0.872	0.507												
0.26	Plaice	*Pleuronectes platessa*	56.603		5.140	3.060			3.700	10.600		0.282	0.656			4.620
0.27	Lemon sole	*Microstomus kitt*	57.383		3.748	19.420			0.278	1.742		3.194				2.250
0.00		*Echiichthys vipera*	0.030						0.030							
0.00	Common dragonet	*Callionymus lyra*	0.255		0.037				0.076	0.054						
33.58	Herring	*Clupea harengus*	7250.798	201.980	100.730	1.275	27.090	194.610	58.657	107.309	0.734	31.160	82.230	644.587	43.580	82.290
0.01	Gray sole	*Glyptocephalus cynoglossus*	2.368													
0.00	Flounder	*Platichthys flesus*	0.238													
0.00		*Mullus surmuletus*	0.398						0.398							
0.04	Snake blenny	*Lumpenus lampretaeformis*	9.394													
0.01	Edible crab	*Cancer pagurus*	2.942													
0.00	Brill	*Scophthalmus rhombe*	0.252													
0.00		*Dasyatis pastinaca*	0.926							0.926						
19.40	Norway pout	*Trisopterus esmarki*	4188.798			0.120							4.198			
0.16	Lumpsucker	*Cyclopterus lumpus*	35.592											6.420	3.530	
1.56	Large Medusa	*Scyphozoa sp.*	336.170	14.450	4.334	15.490	13.630	24.290	8.154		6.511	3.100	1.150	8.175	4.110	2.640
0.08	Twaite shad	*Alosa fallax*	17.990								9.820				0.084	
0.10	Greater sandeel	*Hyperoplus lanceolatus*	21.676		1.892	3.058			0.516	3.082		0.054				0.142
0.62	Sandeel	*Ammodytes marinus*	134.563			0.032			0.016	0.010	0.012					1.218
0.00	Sole	*Solea solea*	0.250													
3.29	Cod	*Gadus Morhua*	710.860		47.350	56.690						22.320	22.480			42.020
0.03	Tarry ray	*Raja radiata*	6.562										1.002			
0.00	Butter fish	*Phalis qunnellus*	0.024													
0.00	Sculpin	*Myoxocephalus scorpius*	0.352													

.

Table 3. continued.

		Station		649	667	759	851	939	954	1008	1020	1089	1112	1162	1180	1282
		ICES sq.		42F7	43F7	43F7	44F8	44F9	44F8	45F8	45F9	44F9	44F9	46F9	46G0	46G0
		Gear		Fotö	Fotö	Expo	Fotö	Expo	Expo	Fotö	Fotö	Expo	Expo	Fotö	Fotö	Expo
		Fishing depth		Surface	Surface	Bottom	Surface	Bottom	Bottom	Surface	Surface	Bottom	Bottom	Surface	Surface	Bottom
		Total depth		42	50	137	181	34	84	369	358	38	104	473	184	89
		Day/Night		N	N	D	N	D	D	N	N	D	D	N	N	D
%		Total catch	Total	105	1303	1346	84	276	800	450	1093	2197	3353	950	673	253
0.00	Anchovy	*Engraulis encrasicolus*	0.410													
0.00	Lesser silver smelt	*Argentina sphyraena*	0.364			0.356										
0.28	Blue whiting	*Micromesistius poutassou*	60.340				14.160									
4.20	Sprat	*Sprattus sprattus*	907.270													
0.45	Squids, octopusses	*Cephalopoda sp*	97.007	0.112	0.764	4.740	0.782	35.730	2.454	0.090		39.640	1.268	0.226	0.092	1.304
0.02	Norway lobster	*Nephrops norvegicus*	4.366													1.590
0.05	Common weaver	*Trachinus draco*	11.218					1.072								
0.00	Solenette	*Buglossidium luteum*	0.034													
0.00	Poor-cod	*Trisopterus minutus*	0.205			0.052							0.094			
0.07		*Anarhichas lupus*	16.110						4.280							
0.03	Anglerfish	*Lophiuspiscatorius*	5.600													
0.03	Halibut	*Hippoglossus hippoglossus*	5.620													
0.01	Horse mackerel	*Trachurus trachurus*	3.079				0.456					0.292				
0.21	Garfish	*Belone belone*	44.602	0.766			1.550			1.074	2.840			0.586	0.066	
0.64	Long rough dab	*Hippoglosides plattessoides*	137.833			21.543			3.080			0.066	51.023			35.531
4.67	Whiting	*Merlangius merlangus*	1008.281			64.740		9.440	53.895			505.451	70.940			15.950
0.39	Invertebrates	*Invertebrata*	84.716			11.157		0.078	0.330			2.692	14.192			25.551
1.81	Dab	*Limanda limanda*	391.875			0.150		7.530	1.655			92.625				
0.51	Hake	*Merluccius merluccius*	109.590			30.100		19.010	1.466			23.760	2.940			0.480
0.95	Gurnard	*Trigala spp.*	204.340	0.730				7.530				10.380	0.380			
0.11	Krill	*Euphausidae spp.*	24.349				4.040			3.219						
1.50	Haddock	*Melanogrammus aeglefinus*	323.799			20.920			93.577			4.040	75.250			3.132
0.00	Ling	*Molva molva*	0.914			0.914										
0.09	Pollack	*Pollachius pollachius*	20.092						3.910				1.882			
0.00	Pearlside	*Mauorolicus muelleri*	1.078				0.004									
22.72	Mackerel	*Scomber scombrus*	4904.439	97.510	1215.102		38.940	0.364		172.239	545.710	3.300		189.998	161.383	
1.79	Saithe	*Pollachius virens*	387.177			132.340	10.040	21.590	25.060			0.804	130.790			20.823
0.00		*Callionymus maculatus*	0.074			0.012										
0.00	Turbot	*Psetta maxima*	0.870													
0.00	Picked Dogfish	*Squalus acanthias*	0.872													0.365
0.26	Plaice	*Pleuronectes platessa*	56.603			1.562		4.000	1.580			14.520	2.242			0.181
0.27	Lemon sole	*Microstomus kitt*	57.383			11.658		1.850	4.889			6.700	0.848			0.264
0.00		*Echiichthys vipera*	0.030													
0.00	Common dragonet	*Callionymus lyra*	0.255									0.046				
33.58	Herring	*Clupea harengus*	7250.798		85.640	59.660	10.318	0.028	78.760	270.491	526.721	1405.663	26.680	751.090	468.917	5.330
0.01	Gray sole	*Glyptocephalus cynoglossus*	2.368			2.038							0.330			
0.00	Flounder	*Platichthys flesus*	0.238													
0.00		*Mullus surmuletus*	0.398													
0.04	Snake blenny	*Lumpenus lampretaeformis*	9.394													9.360
0.01	Edible crab	*Cancer pagurus*	2.942													
0.00	Brill	*Scophthalmus rhombe*	0.252													
0.00		*Dasyatis pastinaca*	0.926													
19.40	Norway pout	*Trisopterus esmarki*	4188.798			928.502			357.288				2796.526			102.120
0.16	Lumpsucker	*Cyclopterus lumpus*	35.592							1.278				0.356		
1.56	Large Medusa	*Scyphozoa sp.*	336.170	5.390		1.567	3.640	7.220	0.170	1.609	17.723			7.744	37.850	8.233
0.08	Twaite shad	*Alosa fallax*	17.990	0.446	1.488											
0.10	Greater sandeel	*Hyperoplus lanceolatus*	21.676					12.700								
0.62	Sandeel	*Ammodytes marinus*	134.563					133.275								
0.00	Sole	*Solea solea*	0.250													
3.29	Cod	*Gadus Morhua*	710.860			53.310		14.390	167.600			87.000	177.600			17.696
0.03	Tarry ray	*Raja radiata*	6.562			0.470										5.090
0.00	Butter fish	*Phalis qunnellus*	0.024													
0.00	Sculpin	*Myoxocephalus scorpius*	0.352													

Table 3. continued.

		Station		1294	1340	1359	1499	1608	1628	1681	1697	1770	1785	1835
		ICES sq.		45G0	45G0	45G0	43G0	43G1	42G1	42G2	42G1	41G1	41G1	41G0
		Gear		Fotö	Fotö	Fotö	Fotö	Expo	Expo	Fotö	Fotö	Expo	Expo	Expo
		Fishing depth		10-40	Surface	Surface	Surface	Bottom	Bottom	Surface	Surface	Bottom	Bottom	Surface
		Total depth		115	229	165	54	55	41	40	37	32	25	21
		Day/Night		D	N	N	N	D	D	N	N	D	D	N
%		Total catch	Total	3	1989	955	300	87	823	27	165	420	65	102
0.00	Anchovy	*Engraulis encrasicolus*	0.410				0.174			0.108	0.102			0.026
0.00	Lesser silver smelt	*Argentina sphyraena*	0.364											
0.28	Blue whiting	*Micromesistius poutassou*	60.340											
4.20	Sprat	*Sprattus sprattus*	907.270				0.096	0.020	422.748	0.648	3.848	223.744	13.540	41.920
0.45	Squids, octopusses	*Cephalopoda sp*	97.007			0.316	0.270		0.016				0.052	0.006
0.02	Norway lobster	*Nephrops norvegicus*	4.366					0.656	2.120					
0.05	Common weaver	*Trachinus draco*	11.218		0.024	0.054	6.800		0.498	0.216	1.192	0.108	0.506	0.748
0.00	Solenette	*Buglossidium luteum*	0.034											
0.00	Poor-cod	*Trisopterus minutus*	0.205											
0.07		*Anarhichas lupus*	16.110											
0.03	Anglerfish	*Lophiuspiscatorius*	5.600											
0.03	Halibut	*Hippoglossus hippoglossus*	5.620											
0.01	Horse mackerel	*Trachurus trachurus*	3.079		1.118									
0.21	Garfish	*Belone belone*	44.602		8.340	2.760	15.300			0.254				0.528
0.64	Long rough dab	*Hippoglosides plattessoides*	137.833					5.120	14.122			3.315	0.616	
4.67	Whiting	*Merlangius merlangus*	1008.281					9.262	25.135	0.064		24.430	2.690	0.040
0.39	Invertebrates	*Invertebrata*	84.716					0.278	10.715			6.446	7.940	0.764
1.81	Dab	*Limanda limanda*	391.875					3.730	115.257			37.788	25.520	
0.51	Hake	*Merluccius merluccius*	109.590					0.190						
0.95	Gurnard	*Trigala spp.*	204.340					0.542	1.158	0.198	0.036	1.140	0.642	0.442
0.11	Krill	*Euphausidae spp.*	24.349											
1.50	Haddock	*Melanogrammus aeglefinus*	323.799											
0.00	Ling	*Molva molva*	0.914											
0.09	Pollack	*Pollachius pollachius*	20.092											
0.00	Pearlside	*Mauorolicus muelleri*	1.078											
22.72	Mackerel	*Scomber scombrus*	4904.439	0.066	851.740	478.285	213.460		2.372	7.190	148.020	0.622		21.480
1.79	Saithe	*Pollachius virens*	387.177					0.010						
0.00		*Callionymus maculatus*	0.074					0.056						
0.00	Turbot	*Psetta maxima*	0.870											
0.00	Picked Dogfish	*Squalus acanthias*	0.872											
0.26	Plaice	*Pleuronectes platessa*	56.603					0.776	0.638			1.330	0.782	0.934
0.27	Lemon sole	*Microstomus kitt*	57.383					0.436	0.106					
0.00		*Echiichthys vipera*	0.030											
0.00	Common dragonet	*Callionymus lyra*	0.255					0.042						
33.58	Herring	*Clupea harengus*	7250.798	0.322	1085.293	414.480	25.202	60.760	223.404	6.762	9.076	119.337	10.212	30.420
0.01	Gray sole	*Glyptocephalus cynoglossus*	2.368											
0.00	Flounder	*Platichthys flesus*	0.238									0.238		
0.00		*Mullus surmuletus*	0.398											
0.04	Snake blenny	*Lumpenus lampretaeformis*	9.394					0.018				0.016		
0.01	Edible crab	*Cancer pagurus*	2.942					1.226	1.716					
0.00	Brill	*Scophthalmus rhombe*	0.252						0.252					
0.00		*Dasyatis pastinaca*	0.926											
19.40	Norway pout	*Trisopterus esmarki*	4188.798					0.044						
0.16	Lumpsucker	*Cyclopterus lumpus*	35.592		20.698			0.582	0.236		0.154			2.338
1.56	Large Medusa	*Scyphozoa sp.*	336.170	3.000	21.785	58.542	33.108	3.150	1.753	11.720	2.530	0.432	1.290	1.680
0.08	Twaite shad	*Alosa fallax*	17.990			0.562	5.590							
0.10	Greater sandeel	*Hyperoplus lanceolatus*	21.676						0.024			0.052	0.156	
0.62	Sandeel	*Ammodytes marinus*	134.563											
0.00	Sole	*Solea solea*	0.250											0.250
3.29	Cod	*Gadus Morhua*	710.860					0.424	0.608			1.002	0.370	
0.03	Tarry ray	*Raja radiata*	6.562											
0.00	Butter fish	*Phalis qunnellus*	0.024										0.024	
0.00	Sculpin	*Myoxocephalus scorpius*	0.352						0.072				0.280	

Table 4. Measured length distribution of herring by haul for the Danish acoustic survey with R/V Dana in June-July 2017.

Station	4	88	100	156	168	258	266	315	422	436	464	476	575	667
ICES sq.	45F6	43F6	42F6	41F6	41F6	42F7	42F7	41F7	43F7	43F7	44F7	43F7	43F6	43F7
Gear	Fotö	Expo	Expo	Fotö	Fotö	Expo	Expo	Fotö	Expo	Expo	Fotrö	Fotö	Expo	Fotö
Fishing depth	Surface	Bottom	Bottom	Surface	Surface	Bottom	Bottom	Surface	Bottom	Bottom	Surface	Surface	Bottom	Surface
Total depth	343	58	55	41	41	39	37	27	71	115	262	182	66	50
Day/Night	N	D	D	N	N	D	D	N	D	D	N	N	D	N
Total catch,kg	312	274	153	180	296	355	420	272	109	204	835	100	268	1 303
Total catch Herring,kg	201.980	100.730	1.275	27.090	194.610	58.657	107.309	0.734	31.160	82.230	644.587	43.580	82.290	85.640
Sample Herring,kg	33.500	25.822	1.275	12.826	19.168	13.740	15.240	0.734	17.958	15.846	46.840	19.230	20.282	16.604
5.5														
6														
6.5														
7														
7.5														
8														
8.5														
9														
9.5														
10														
10.5														
11														
11.5														
12														
12.5						3								
13						6								
13.5						19	6							
14						33	90							4
14.5				1	34	101	237	2	1					22
15		4	1	43	266	171	162	4	1	5		1	4	97
15.5		50	6	134	292	136	86	1	22	20		6	44	208
16	1	178	9	157	87	52	32	1	67	69	2	19	123	138
16.5	3	237	8	61	6	17	9		110	113	5	56	105	50
17	14	165	11	20	3	2	2		125	86	27	82	108	22
17.5	49	88	3	5	1	1	1		97	54	55	90	101	7
18	76	37	2						49	47	80	57	37	2
18.5	70	11							17	18	75	32	13	1
19	44	1						1	1	4	58	16	1	
19.5	37	1						4	1		34	11		
20	37							1		4	37	12		1
20.5	32							2	1	2	31	8		
21	38			1						1	30	8		1
21.5	26							1		1	22	7		1
22	33								1	1	14	5		2
22.5	20								1		20	5		
23	11									1	15	2		
23.5	15										10	1		
24	6								1		11			
24.5	5										6			1
25	3								1		14	2		
25.5	1										12			1
26	1										11			
26.5	1										11			
27										1	6			
27.5	1										8			
28											6			
28.5	1										7			
29											2			
29.5											5			
30											2			
30.5											1			
31														
31.5											1			
32														
32.5														
Total no.	525	772	40	422	689	541	625	17	496	427	618	420	536	558
Mean Length	19.79333	16.64054	16.4875	15.88507	15.3389	15.03789	14.7216	17.64706	16.99395	16.98126	20.49595	17.87143	16.73787	15.76075

Table 4. continued.

Station	759	851	939	954	1008	1020	1089	1112	1162	1180	1282	1294	1340	1359
ICES sq.	43F7	44F8	44F9	44F8	45F8	45F9	44F9	44F9	46F9	46G0	46G0	45G0	45G0	45G0
Gear	Expo	Fotö	Expo	Expo	Fotö	Fotö	Expo	Expo	Fotö	Fotö	Expo	Fotö	Fotö	Fotö
Fishing depth	Bottom	Surface	Bottom	Bottom	Surface	Surface	Bottom	Bottom	Surface	Surface	Bottom	10-40	Surface	Surface
Total depth	137	181	34	84	369	358	38	104	473	184	89	115.3	229	165
Day/Night	D	N	D	D	N	N	D	D	N	N	D	D	N	N
Total catch,kg	1 346	84	276	800	450	1 093	2 197	3 353	950	673	253	3	1 989	955
Total catch Herring,kg	59.660	10.318	0.028	78.760	270.491	526.721	1405.663	26.680	751.090	468.917	5.330	0.322	1085.293	414.480
Sample Herring,kg	31.178	10.318	0.028	24.290	35.932	62.410	23.367	26.680	46.801	29.310	5.330	0.322	48.376	25.794
5.5														
6														
6.5														
7														
7.5														
8														
8.5														
9														
9.5														
10														
10.5														
11														
11.5														
12														
12.5														
13														
13.5											1			
14														
14.5	6						1				2			
15	16			11										
15.5	25		1	36	1		12						1	
16	52	2		83	3	2	26		1	1	1			
16.5	74	3		75	2	4	51	8	6	3			2	5
17	50	4		74	18	15	52	17	2	4	1		2	32
17.5	58			66	19	30	70	27	9	8			11	37
18	26	4		39	37	36	79	23	25	21	5		69	75
18.5	12			30	66	60	66	20	38	50	3	2	88	121
19	9			19	48	30	49	26	71	71	6	2	106	96
19.5	12	3		26	67	70	39	30	91	84	8	1	88	64
20	5			50	69	54	24	23	107	75	11	2	50	30
20.5	20	1		25	33	60	22	37	101	50	5	1	57	15
21	20	1		15	40	35	6	46	75	24	10		31	10
21.5	18	1		6	36	33	3	41	52	22	11		42	12
22	23	6		3	18	18	2	41	28	17	10		41	6
22.5	21	5		1	16	16		38	22	11	4		28	5
23	21	8		1	10	5		22	19	7	3		15	
23.5	7	6		1	6	12		11	5	7	5		15	
24	9	8		2	6	5		7	3				7	
24.5	9	3			2	3		2	3	2			13	
25	4	5			3	1		1	2		1		9	
25.5	5	5				1					2		6	
26	2	4			1				1				8	
26.5	5	2								1			6	
27	4	3			1								3	
27.5	2	1			1	1							1	
28	5	4											1	
28.5	5	1												
29		3											2	
29.5	3	2												
30	1	2												
30.5		2												
31	1	1												
31.5														
32														
32.5		1												
Total no.	530	91	1	563	503	491	502	420	661	458	89	8	702	508
Mean Length	19.08302	23.81319	15.5	17.7016	19.85388	19.85743	18.06175	20.44286	20.23222	19.84279	20.58989	19.375	20.30342	18.80807

Table 4. continued

Station	1499	1608	1628	1681	1697	1770	1785	1835
ICES sq.	43G0	43G1	42G1	42G2	42G1	41G1	41G1	41G0
Gear	Fotö	Expo	Expo	Fotö	Fotö	Expo	Expo	Expo
Fishing depth	Surface	Bottom	Bottom	Surface	Surface	Bottom	Bottom	Surface
Total depth	54	55	41	40	37	32	25	21
Day/Night	N	D	D	N	N	D	D	N
Total catch,kg	300	87	823	27	165	420	65	21
Total catch Herring,kg	25.202	60.760	223.404	6.762	9.076	119.337	10.212	30.42
Sample Herring,kg	25.202	20.350	15.974	6.762	9.076	16.918	10.212	21.011
5.5								
6								
6.5								
7								
7.5								
8								
8.5								
9								
9.5					1			
10								
10.5								
11								
11.5								
12								
12.5								
13			12		2			
13.5			15		11			
14	6		15		12			
14.5	29		27		16	1		
15	32	1	46		15	10	1	2
15.5	23		64		20	34	9	2
16	15	2	66		14	83	15	2
16.5	21	50	51	2	11	91	20	4
17	26	189	42	1	14	67	41	18
17.5	69	144	63	5	21	62	61	110
18	101	70	50	3	36	48	60	166
18.5	95	42	27	11	20	31	38	104
19	57	10	7	15	12	7	7	34
19.5	40	8	3	13	13	14	6	17
20	29	6	6	12	14	7	3	14
20.5	27	2	2	19	7	11	1	10
21	14	6		21	1	4	2	3
21.5	13	3	1	11	5	3	2	3
22	1		3	4	2			2
22.5				1	3			1
23			3	3				
23.5								
24			2					
24.5				1				
25						1		
25.5								
26								
26.5								
27								
27.5								
28								
28.5								
29								
29.5								
30								
30.5								
31								
31.5								
32								
32.5								
Total no.	598	533	505	122	250	474	266	492
Mean Length	17.96739	17.52251	16.4604	20.03689	17.172	17.14662	17.62218	18.20833

Table 5. Measured length distribution of mackerel by haul for the Danish acoustic survey with R/V Dana in June-July 2017.

Station	4	156	168	258	266	315	422	464	476	575	649	667	851
ICES sq.	45F6	41F6	41F6	42F7	42F7	41F7	43F7	44F7	43F7	43F6	42F7	43F7	44F8
Gear	Fotö	Fotö	Fotö	Expo	Expo	Fotö	Expo	Fotrö	Fotö	Expo	Fotö	Fotö	Fotö
Fishing depth	Surface	Surface	Surface	Bottom	Bottom	Surface	Bottom	Surface	Surface	Bottom	Surface	Surface	Surface
Total depth	343	41	41	39	37	27	71	262	182	66	42	50	181
Day/Night	N	N	N	D	D	N	D	N	N	D	N	N	N
Total catch,kg	311.891	180.192	295.593	355	420	271.64	109.349	835	100.13	268	104.954	1303	83.93
Total catch Mackerel,kg	94.28	124.12	52.01	0.53	178.45	159.176	0.408	144.198	1.69	1.796	97.51	1215.102	38.94
Sample Mackerel,kg	16.75	12.93	13.564	0.53	20.4	14.19	0.408	36.69	1.69	1.796	13.81	5.21	24.18
Length in cm													
15													
16													
17					2								
18	2	2	1		11						12	7	
19	11	10	13		68	4				1	48	31	2
20	6	16	27		87	7		1		2	74	31	
21	10	11	24		17	6		1			20	6	
22	23	17	7		8	13		3		1	5	1	
23	38	12	10		8	15		3			6	1	2
24	34	9	10		5	19		1			1	1	14
25	12	7	8			20					1		10
26	1	3	3		1	2		1					10
27		1				1		1					3
28		2	2		1			4					4
29		2			3			5			1		5
30		2	4		7	4		26	2				9
31	1	5	4	1	2	5		23	1				6
32		2	1	1	1	1		9	1		2		5
33		2	1					13			1		2
34	3	2			1	1		17	2	1	1		4
35			1		3			5		2	1		4
36	2		1			2		6			1		3
37			1		1	1		3					2
38			2			1	1	1		1			2
39						1		3					1
40													1
41	1							2					1
42					1								1
43													2
44													
45													
46													
47													1
48													
49													
50													
51													
52													
53													
54													
55													
56													
57													
58													
59													
60													
61													
Total no.	144	105	120	2	227	103	1	128	6	8	174	78	94
Mean length	23.21528	23.33333	23	31.5	20.98678	24.61165	38	31.53906	31.83333	27.875	20.43678	19.61538	29.56383

Table 5. continued

Station	939	1008	1020	1089	1162	1180	1340	1359	1499	1628	1681	1697	1770	1835
ICES sq.	44F9	45F8	45F9	44F9	46F9	46G0	45G0	45G0	43G0	42G1	42G2	42G1	41G1	41G0
Gear	Expo	Fotö	Fotö	Expo	Fotö	Fotö	Fotö	Fotö	Fotö	Expo	Fotö	Fotö	Expo	Expo
Fishing depth	Bottom	Surface	Surface	Bottom	Surface	Surface	Surface	Surface	Surface	Bottom	Surface	Surface	Bottom	Surface
Total depth	34	369	358	38	473	184	229	165	54	41	40	37	32	21
Day/Night	D	N	N	D	N	N	N	N	N	D	N	N	D	N
Total catch,kg	276	450	1093	2197	950	673	1989	955	300	823	27.16	165	420	21
Total catch Mackerel,kg	0.364	172.239	545.71	3.3	189.998	161.383	851.74	478.285	213.46	2.372	7.19	148.02	0.622	21.48
Sample Mackerel,kg	0.364	12.96	10.934	3.3	11.76	10.324	6.86	7.71	6.51	2.372	7.19	9.84	0.622	8
Length in cm														
15														
16														
17														
18														
19								2	2		6	1		
20		8	4		2	2	6	9	12		16	13		7
21		15	24		14	3	18	33	36		18	34		21
22		20	32	1	22	11	25	30	22		11	21		33
23		29	30		32	17	19	17			7	15		21
24		19	14		26	15	2	7			2	3		6
25		10	4		7	8	1	1						
26		3	1		2	3	1	2			1	1		1
27						1			1		1	1		
28					1	1								
29					1									
30		1				2		2	2		1			
31		2	1	1		5			1					
32				1	1	2					1		1	
33				1		1				1	1			
34				1		1						1	1	
35	1		1	1							1			
36						1	1			1	1			
37						1				1		1		
38		1		2	1					1	1	1		
39				1				1				1		
40												1		
41										1				
42														
43														
44														
45														
46														
47		1												
48														
49														
50														
51														
52														
53														
54														
55														
56														
57														
58														
59														
60														
61														
Total no.	1	109	111	9	109	74	73	104	76	5	68	94	2	89
Mean length	35	23.33028	22.57658	33.55556	23.22936	24.97297	22.19178	22.17308	21.52632	37	22.35294	22.47872	33	22.02247

Table 6. Measured length distribution of sprat by haul for the Danish acoustic survey with R/V Dana in June-July 2017.

Station	156	258	1499	1608	1628	1681	1697	1770	1785	1835
ICES sq.	41F6	42F7	43G0	43G1	42G1	42G2	42G1	41G1	41G1	41G0
Gear	Fotö	Expo	Fotö	Expo	Expo	Fotö	Fotö	Expo	Expo	Expo
Fishing depth	Surface	Bottom	Surface	Bottom	Bottom	Surface	Surface	Bottom	Bottom	Surface
Total depth	41	39	54	55	41	40	37	32	25	21
Day/Night	N	D	N	D	D	N	N	D	D	N
Total catch.kg	180.192	355	300	87.322	823	27.16	165	420	64.62	21
Total catch Sprat,kg	0.016	200.69	0.096	0.02	422.748	0.648	3.848	223.744	13.54	41.92
Sample Sprat,kg	0.016	3.362	0.096	0.02	4.576	0.648	3.848	3.494	3.498	3.88
Length in cm										
5.5										
6										
6.5										
7										
7.5										
8										
8.5				1			4			
9							3			
9.5										
10							2			
10.5		18			2		1		1	
11		37			10		6	1	4	1
11.5		62	1		8		2	3	3	6
12		57	3		40	8	8	17	11	26
12.5	1	38	1		79	11	17	52	49	54
13		24		1	75	6	42	55	72	68
13.5		6			47	7	52	48	43	45
14		4			18	4	51	20	18	16
14.5			1		5	1	23	13	8	4
15						1	3	1	3	2
15.5							4			
16									1	
16.5										
17										
17.5										
18										
18.5										
19										
19.5										
20										
Total no.	1	246	6	2	284	38	218	210	213	222
Mean Length	12.5	11.85772	12.41667	10.75	12.76232	12.93421	13.26376	13.07619	13.04695	12.93018

Table 7. CTD station details for the Danish acoustic survey with R/V Dana in June-July 2017.

Date	Stat.	Time	ICES	Position		Bottom depth	Wind speed	Sea state	Associated fishery
dd-mm-yy	no.	UTC	Square	Latitude	Longitude	m	m/s		station
24-06-17	1	00:05	45F6	58.04.924N	006.21.380E	345	7.6	3	4
24-06-17	88	10:03	43F6	57.06.658N	006.20.559E	58	7.4	4	88
24-06-17	105	15:05	42F6	56.57.691N	006.36.993E	54	10.3	4	100
24-06-17	156	20:50	41F6	56.25.429N	006.27.421E	38	9.2	5	156
25-06-17	175	01:51	41F6	56.16.578N	006.39.480E	42	11.6	5	168
25-06-17	254	10:48	42F6	56.36.357N	006.58.528E	39	15.0	6	258
25-06-17	270	15:23	42F7	56.39.632 N	007.12.149E	40	15.2	6	266
25-06-17	314	20:53	41F7	56.06.852N	007.28.349E	28	13.4	6	315
26-06-17	419	11:24	43F7	57.13.886N	007.42.486E	51	13.7	6	422
26-06-17	442	17:27	43F7	57.19.843N	007.26.785E	65	12.6	6	436
26-06-17	463	20:29	44F7	57.34.331N	007.19.912E	272	14.7	6	464
27-06-17	482	01:58	44F7	57.30.324N	007.27.966E	216	12.7	6	476
27-06-17	571	11:47	43F6	57.10.306N	006.52.806E	68	8.6	4	575
27-06-17	648	20:48	43F7	57.01.709N	007.27.250E	38	3.1	4	649
28-06-17	674	01:45	43F7	57.08.682N	007.39.698E	46	4.0	2	667
28-06-17	759	10:45	43F8	57.28.853N	008.00.221E	147	7.6	3	759
28-06-17	832	20:03	44F8	57.42.392N	008.22.174E	286	8.6	3	832
29-06-17	858	12:14	44F8	57.40.737N	008.33.548E	183	15.0	4	851
29-06-17	939	10:53	44F9	57.36.889N	009.09.914E	36	11.6	5	939
29-06-17	963	15:19	44F8	57.37.018N	008.45.560E	84	13.5	5	954
29-05-17	1005	19:59	45F8	58.13.815N	008.44.978E	289	12.1	5	1008
30-06-17	1023	01:53	45F9	58.22.969N	009.03.505E	388	15.0	5	1020
30-06-17	1089	10:04	44F9	57.46.254N	009.50.379E	40.4	13.4	5	1089
30-06-17	1117	15:50	44F9	57.57.092N	009.46.991E	104	9.4	5	1112
30-06-17	1161	20:17	46F9	58.35.461N	009.39.959E	500	5.8	3	1162
01-07-17	1188	01:53	46F9	58.48.708N	009.56.639E	172	8.1	3	1180
01-07-17	1279	11:10	46G0	58.32.162N	010.50.025E	95	7.1	3	1282
01-07-17	1299	15:54	45G0	58.21.743N	010.48.905E	128	5.3	3	1294
01-07-17	1339	20:03	45G0	58.14.516N	010.21.271E	307	9.6	3	1340
02-07-17	1366	01:59	45G0	58.12.457N	010.57.172E	138	10.4	4	1359
02-07-17	1438	12:00	44G1	57.52.090N	011.13.908E	68	16.7	5	
02-07-17	1498	14:09	43G0	57.29.678N	010.58.467E	41	17.8	5	1499
03-07-17	1608	10:01	43G1	57.09.110N	011.51.921E	55	16.0	5	1608
03-07-17	1633	15:26	42G1	56.47.592N	011.42.020E	31	11.5	5	1628
03-07-17	1680	20:23	42G2	56.37.964N	012.20.755E	35	13.9	4	1681
04-07-17	1703	01:42	42G1	56.38.034N	011.40.851E	33	12.6	4	1697
04-07-17	1770	10:08	41G1	56.20.774N	011.59.590E	32	6.7	3	1770
04-07-17	1791	15:22	41G1	56.08.806N	011.52.123E	24	2.8	3	1785
04-07-17	1834	19:58	41G0	56.11.848N	010.57.207E	22	8.1	3	1835

Table 8. WP2 station details for the Danish acoustic survey with R/V Dana in June-July 2017.

					Mean	WP2	Wind		Associated	Associated	Dry Weight			
Station	Time	ICES	Position		depth	depth	speed	Sea state	CTD	Fishery	mg dry weight/m*2			
no.	UTC	Square	Latitude	Longitude	m	m	m/s		Station	Station	SumDryWt	Frac2000	Frac1000	Frac180
88	10:25	43F6	57.06.047N	006.21.108E	58	51,4	9,5	4	88	88	7167,2	506,8	303,2	6357,2
156	20:50	41F6	56.25.463N	006.27.673E	36	31,2	11,5	5	156	156	4280,8	3004,4	196,8	1079,6
254	11:05	42F6	56.36.478N	006.58.837E	37	31,5	14,0	6	254	258	4061,6	200,8	116,0	3744,8
314	20:53	41F7	56.06.927N	007.28.798E	26	18,6	11,4	6	314	315	6919,2	321,2	652,0	5946,0
419	11:11	43F7	57.13.839N	007.41.985E	52	46,1	13,9	6	419	422	9536,8	4472,8	800,4	4263,6
463	21:10	44F7	57.34.367N	007.20.812E	273	Failed	16,3	6	463	464				
571	12:01	43F6	57.10.329N	006.59.912E	68	62,8	8,4	4	571	575	10270,4	4980,0	1349,2	3941,2
648	20:51	43F7	57.01.743N	007.27.263E	39	32,1	3,7	4	648	649	4903,2	908,0	635,6	3359,6
759	10:43	43F8	57.28.711N	008.00.582E	144	138,8	9,4	3	759	759	8905,6	1120,0	2160,4	5625,2
832	20:40	44F8	57.42.287N	008.22.681E	281	154,9	10,6	3	832	833	6557,2	1054,4	1521,6	3981,2
939	11:00	44F9	57.36.823N	009.09.672E	36	27,3	14,8	5	939	939	4090,8	786,0	742,4	2562,4
1007	20:51	45F8	58.12.413N	008.43.328E	324	148,8	11,6	5	1005	1008	7550,8	1007,6	863,6	5679,6
1089	10:19	44F9	57.46.362N	009.50.260E	40	35,3	13,2	5	1089	1089	3915,2	552,8	534,8	2827,6
1161	10:04	46F9	58.35.375N	009.39.832E	505	160,1	4,7	3	1161	1162	3829,2	779,2	568,4	2481,6
1279	11:23	46G0	58.32.177N	010.50.025E	95	91,5	6,2	3	1279	1281	6113,6	978,0	721,6	4414,0
1339	20:40	45G0	58.14.194N	010.21.194E	311	157,4	10,2	3	1339	1340	6162,8	1256,0	1017,2	3889,6
1438	12:15	44G1	57.29.129N	011.14.303E	71	61,3	15,0	5	1438		4218,4	204,0	727,6	3286,8
1498	20:22	43G0	57.29.597N	010.58.511E	42	32,6	17,0	5	1498	1499	2766,4	254,8	232,4	2279,2
1608	10:23	43G1	57.09.014N	011.51.950E	53	48,8	13,9	5	1608	1608	5946,0	858,4	651,6	4436,0
1680	20:43	42G2	56.38.031N	012.20.811E	34	31,1	14,1	4	1680	1681	3258,4	240,4	383,2	2634,8
1770	10:21	41G1	56.20.791N	011.59.562E	32	28,1	6,8	3	1770	1770	3288,0	160,8	436,0	2691,2
1834	20:05	41G0	56.11.790N	010.57.102E	22	11,3	8,2	3	1835	1834	3596,4	3,6	440,0	3152,8

Table 9. Abundance, mean weight, mean length and biomass by age group and sub area for North Sea autumn spawning herring in the Danish acoustic survey with R/V Dana in June-July 2017

Numbers Autumn spawning herring in mill.										
WR	0	1i	1m	2i	2m	3i	3m	4i	4m	5
21	1,917369	122,2931	0,368073	0,46881	0,203867					
31		88,76508		16,45335	0,420855	3,463976	0,412895		0,846857	
41		117,3327		18,96614	0,717595	3,421254	0,883182	0,287781	0,689856	0,157329
42		44,99355		3,980214	0,140225	0,803918	0,158517		0,155711	0,024885
151		133,4438		1,13469	0,05153	0,360803	0,145208	0,032204	0,036925	
152		69,52633		7,538506	0,779674	1,303142	1,260841	0,884828	0,691285	0,297982
Biomass Autumn spawning herring in ton.										
WR	0	1i	1m	2i	2m	3i	3m	4i	4m	5
21	36,33721	3907,555	16,93137	21,82319	15,1921					
31		4699,323		1106,038	45,71233	264,0523	45,08048		134,97	
41		6931,956		1506,981	85,57061	294,9036	127,4362	36,07008	114,673	32,21627
42		2168,153		300,3678	13,48891	65,30264	21,86734		24,57857	5,847991
151		3891,145		90,94086	3,96782	37,38707	21,45348	3,89666	5,206369	
152		69,52633		7,538506	0,779674	1,303142	1,260841	0,884828	0,691285	0,297982
Mean length Autumn spawning herring in cm.										
WR	0	1i	1m	2i	2m	3i	3m	4i	4m	5
21	15,18	16,57	18,50	19,57	21,01					
31		19,07		20,93	23,28	21,82	23,22		27,05	
41		19,46		21,41	23,77	22,05	25,06	25,04	27,18	28,18
42		18,47		21,24	22,82	21,74	24,75		26,92	29,00
151		15,80		21,48	21,50	23,46	25,97	27,00	25,50	
152		18,77		21,75	23,99	22,97	25,88	25,06	28,56	27,50
Mean weight Autumn spawning herring in g.										
WR	0	1i	1m	2i	2m	3i	3m	4i	4m	5
21	18,95	31,95	46,00	46,55	74,52					
31		52,94		67,22	108,62	76,23	109,18		159,38	
41		59,08		79,46	119,25	86,20	144,29	125,34	166,23	204,77
42		48,19		75,47	96,19	81,23	137,95		157,85	235,00
151		29,16		80,15	77,00	103,62	147,74	121,00	141,00	
152		53,54		87,92	124,58	101,13	160,05	126,28	199,32	180,00

Table 10. Abundance, mean weight, mean length and biomass by age group and sub area for Baltic Sea spring spawning herring in the Danish acoustic survey with R/V Dana in June-July 2017

Numbers Spring spawning herring in mill.														
WR	0	1i	1m	2i	2m	3i	3m	4i	4m	5	6	7	8	9
21	0,613394	73,88358	7,318906	3,358304	7,748625	0,337762	3,085416		0,849044	0,365735		0,09281		
31		52,86279	1,360269	22,2568	7,976351	1,893485	7,460118		4,68578	0,340801	0,946928			
41		67,81143	9,287707	20,70054	14,58751	0,809976	10,29469	0,46761	7,183078	1,700724	1,377924	0,192073	0,091872	0,063159
42		31,06256	3,415116	4,994905	3,044052	0,063322	1,82225		0,95974	0,226051	0,21467	0,0405	0,00195	0,002841
151		207,5674		2,578021	1,237819		0,751999		0,325019	0,162579	0,108904	0,083976		
152		60,85347	2,380275	13,00294	9,437162		11,69918		8,80198	3,110204	2,122272	0,211882	0,254259	0,211882
Biomass Spring spawning herring in ton.														
WR	0	1i	1m	2i	2m	3i	3m	4i	4m	5	6	7	8	9
21	14,10806	2427,713	302,2193	181,8928	405,4506	16,21257	215,395		57,36467	21,30354		5,847052		
31		2687,087	57,13128	1448,737	601,0898	159,0243	680,6036		557,0768	53,28049	104,2299			
41		3595,991	577,9754	1495,601	1261,896	71,43836	1019,456	24,31572	874,4745	259,1914	190,4162	38,74636	15,60683	13,31571
42		1313,173	161,5927	324,0482	240,4166	4,559187	190,0812		119,213	34,0777	26,04921	7,031793	0,380153	0,727168
151		5945,698		181,4643	100,5933		88,34147		53,14551	27,34625	19,53377	14,76769		
152		2988,875	125,1974	980,8361	812,6091		1313,033		1203,596	510,0325	329,9431	51,91109	40,68141	43,85966
Mean length Spring spawning herring in cm.														
WR	0	1i	1m	2i	2m	3i	3m	4i	4m	5	6	7	8	9
21	15,50	16,81	18,07	20,00	19,80	19,15	21,81		21,87	21,07		20,50		
31		18,74	18,50	20,54	21,54	22,56	23,00		24,85	27,13	24,01			
41		18,80	19,72	20,86	22,09	22,74	23,38	18,00	24,81	26,86	26,32	29,35	27,99	29,62
42		17,80	18,18	20,33	21,50	22,50	23,69		25,04	26,91	25,10	27,70	30,50	31,00
151		15,84		20,53	21,55		24,24		27,10	28,07	28,25	28,21		
152		18,34	19,09	20,84	21,77		24,19		25,56	27,66	27,96	31,50	27,00	29,50
Mean weight Spring spawning herring in g.														
WR	0	1i	1m	2i	2m	3i	3m	4i	4m	5	6	7	8	9
21	23,00	32,86	41,29	54,16	52,33	48,00	69,81		67,56	58,25		63,00		
31		50,83	42,00	65,09	75,36	83,98	91,23		118,89	156,34	110,07			
41		53,03	62,23	72,25	86,51	88,20	99,03	52,00	121,74	152,40	138,19	201,73	169,88	210,83
42		42,28	47,32	64,88	78,98	72,00	104,31		124,21	150,75	121,35	173,63	195,00	256,00
151		28,64		70,39	81,27		117,48		163,52	168,20	179,37	175,86		
152		49,12	52,60	75,43	86,11		112,23		136,74	163,99	155,47	245,00	160,00	207,00

Table 11. Abundance, mean weight, mean length and biomass by age group and sub area for sprat in the Danish acoustic survey with R/V Dana in June-July 2017.

Numbers sprat in mill.								
WR	0	1i	1m	2i	2m	3	4	5
21			17,60447		181,8903	79,07502	7,295419	0,165253
31								
41								
42								
151			50,78476		57,03484	10,27502		
152								
Biomass sprat in ton.								
WR	0	1i	1m	2i	2m	3	4	5
21			208,2687		2831,318	1398,57	149,6111	3,797887
31								
41								
42								
151			603,3229		804,7767	177,8267		
152								
Mean length sprat in cm.								
WR	0	1i	1m	2i	2m	3	4	5
21			11,58		12,69	13,47	14,29	15,16
31								
41								
42								
151			11,26		12,15	13,19		
152								
Mean weight sprat in g.								
WR	0	1i	1m	2i	2m	3	4	5
21			11,83		15,57	17,69	20,51	22,98
31								
41								
42								
151			11,88		14,11	17,31		
152								