The international acoustic survey in the Norwegian Sea in May 2008

R/V DANA Cruise No. 3/2008

Calibration of Echo-sounders

26/4 – 28/4 2008

International Acoustic Monitoring of Herring and Blue whiting

29/4 – 27/5 2008

Cruise participants

Calibration 26/4-28/4	
Karl-Johan Staehr	Denmark
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Torben Filt Jensen	Denmark
Thyge Dyrnesli	Denmark
Bo Tegen Nielsen	Denmark
Frederik Matthiassen	Denmark
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Ole Skov	Denmark
Francois Martin	France
Acoustic monitoring 29/4-12/5	
Karl Johan Staehr (cruiseleader) (acoustics)	Denmark
Bjarne Stage (acoustics)	Denmark
Sytse Ybema (acoustics)	Netherlands
Niels Jørgen (plankton/fishlab)	Denmark
Peter V. Larsen (plankton/fishlab)	Denmark
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Acoustic monitoring 13/5-27/5	
Bram Couperus (Cruise leader) (acoustics)	Netherlands
Sytse Ybema (acoustics)	Netherlands
Ryan Saunders (acoustics)	Ireland
Frank Hansen (plankton/fishlab)	Denmark
Helle Andersen (plankton/fishlab)	Denmark
Ann-Marie Palmen Bratt (plankton/fishlab)	Sweden
Matthias Kloppmann (plankton/fishlab)	Germany
Mogens Rokjaer Sørensen (acoustic/technician)	Denmark

Cruise summary

Effective survey days	21
Mileage	3222,7
Number of trawl hauls	27
Number of CTD stations	56
Number of WP2 stations	112
Number of biological samples - herring	649
Number of biological samples – blue whiting	113
Remarks	herring otoliths taken in samples from stations 140 and 141 will be send to the Netherlands for age reading.

Introduction

The Norwegian spring spawning herring is a highly migratory and straddling stock carrying out extensive migrations in the NE Atlantic. After spawning, the main spawning areas being in the Norwegian Fjord from 62°N to 64°N in February – March, the herring migrates NE-wards towards the Norwegian Sea feeding grounds. In general, the main feeding has taken place along the polar front from the island of Jan Mayen and NE-wards towards Bear Island. During the latter half of the 1990's there has been a gradual shift of migration pattern with the herring migrations shifting north and eastwards. In 2002 - 2004 this development seems to have stopped and the herring had more southerly distribution at the end of the feeding season than in 2001. After feeding, the herring have concentrated in August in the northern parts of the Norwegian Sea prior to the southern migration towards the Vestfjord wintering area (68°N, 15°E). Since the winter 2002-2003 part of the stock seems to winter in the Norwegian Sea off Lofoten. In January the herring start their southerly spawning migrations.

Besides herring, abundant stocks of blue whiting and mackerel exploit the Norwegian Sea as an important feeding area. Blue whiting is the fish species that currently is supporting the largest fishery of the Northeast Atlantic. The main spawning areas are located along the shelf edge and banks west of the British Isles. The eggs and larvae drift both northwards and southwards, depending on location and oceanographic conditions. The northward drift spreads juvenile blue whiting to all warmer parts of the Norwegian Sea and adjacent areas from Iceland to the Barents Sea. Adult blue whiting carry out active feeding and spawning migrations in the same area. Blue whiting has consequently an important role in the pelagic ecosystems of the area, both by consuming zooplankton and small fish, and by providing a resource for larger fish and marine mammals.

Background and objective of the survey

This survey is carried out in order to investigate distribution and migrations of the Atlanto-Scandian herring, blue whiting and other pelagic fish and to produce a biomass index for herring and a recruitment index for blue whiting for the Working Group for Northern Pelagics and Blue Whiting Fisheries (WGNPPW). Furthermore hydrographic conditions and plankton abundance in the Norwegian Sea and adjacent waters are monitored in order to investigate distribution and migration of herring and other pelagic fishes are influenced by environmental conditions.

This survey was coordinated with Norway as an international survey with participation of Norway, Iceland, Faroe Islands and EU, where the Danish R/V Dana conducted the EU survey part. The acoustic survey tracks of Dana are shown in figure 1.
With the exceptions of 2002 and 2003 the survey is carried out since 1997 with participation of EU countries together with Norway, Russia, Iceland and the Faeroese Islands.

Calibration

The echo sounders were calibrated immediately before the survey at Bornö Island in the Gullmar Fjord, Sweden during the 27th April 2008.
The calibration was performed according standar operation procedures as decribed in the PGNAPES/PGTIPS manual for three frequencies (18, 38 and 120 kHz).
The calibration of the towed body split-beam transducer at 38 kHz was conducted against a 60 mm copper sphere. 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 resulting calibration parameters are shown in Annex 1 and were used during the subsequent survey.

Materials and methods

Acoustic data

Acoustic data was collected with EK60 using a 38 kHz splitbeam transducer, mounted in a towed body (paravane). During trawling, acoustic data was collected by the EK60 using the hull mounted 38 kHz transducer: the recordings during trawling were only used for scrutiny of the echograms. Echo integration was conducted continuously and the data was scrutinized daily during the survey utilizing Sonardata Echoview software.

A biomass estimate will not be carried out based data of this cruise alone, but the data will be included in the survey's database from all participating vessels from which a biomass index will be calculated. The final estimate methodology is presented in the coming PGNAPES report.

Hydrographical and zooplankton data

At approximately every 60 nautical miles two plankton samples were taken by means of vertical tows from 200 m to the surface with a WP2 equipped with 180 µm mesh. One of those samples was stored in 4 % buffered formaldehyde-seawater solution, whereas the other was fractioned into three size groups (180 µm, 1000 µm and 2000 µm) of zooplankton for biomass estimation. The biomass samples were oven-dried on board at 70 °C for 24 hours, and subsequently frozen for later weight determiniation at DTU Aqua.

At the same positions of plankton sampling CTD casts were carried out to a maximum depth of 1000 m or 5 m above the seabed with a Seabird CTD and rosette water sampler.

The following parameters were measured: depth (pressure), temperature, conductivity (salinity) and oxygen. All together Dana carried out 112combined CTD and WP2 stations (Figure 1).

Each day water samples were taken once close to the surface and at 1000 m depth in order to calibrate the conductivity sensor of the CTD unit. Additionally, sea surface temperature, salinity and fluorescence were continuously monitored from the ship's bow intake and were stored along with information on meteorological conditions (e.g. wind direction, wind speed etc.) utilizing R/V Dana's hydrographic and meteorological analysis system.

Biological data

During the survey fishing was carried out regularly on acoustic registrations to verify the species scrutinized and to give information about the size composition to be used in the biomass estimation. A Millionär Trawl and a Fotö midwater trawl were used either at the surface or in midwater down to a maximum of 450 m depth. A total of 27 trawl stations were carried out during the survey, well spread over the surveyed area, but more frequently in areas with high fish densities (Figure 1).

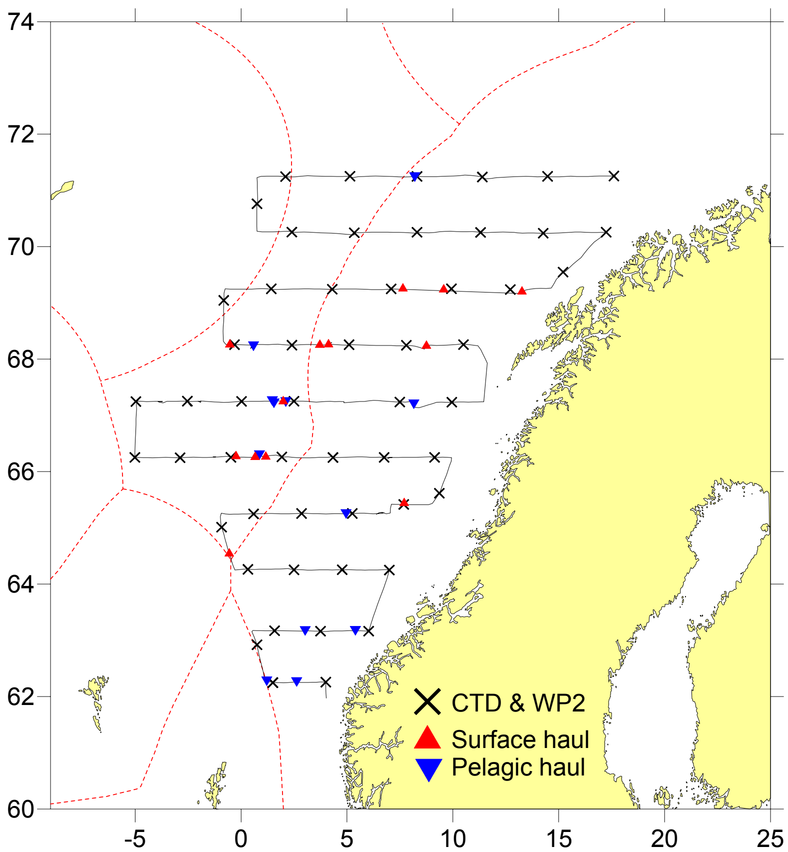


Figure 1. CTD stations (down to 1000 m), WP2 stations and trawl stations taken by R/V Dana from 1 May to 22 May 2008.

Catches were sorted and weighed by species. Length measurements were taken for all species (up to a maximum of 150 specimens). For herring and blue whiting samples of 50 fish were also randomly taken in order to determine individual length to weight relationships as well as age, gender and maturity. For age determination in herring scales were sampled and mounted on microscope slices whereas in blue whiting otoliths were taken. Approximately 100 otoliths were sampled in herring from 2 stations for comparative reasons. Scales will be send to Norway for age reading. In total 649 samples of individual herring and 113 samples of individual blue whiting were taken.

All trawl data were entered into the Babelfisk database and validated. The data were also stored in the PGNAPES formats and sent by email to IMR, Bergen at the end of the survey.

Itinerary of the survey(times in UTC)

R/V Dana left Hirtshals, Denmark on Tuesday 26 April at 14:00. The calibration site at Bornö island was reached at the same day and calibration was carried out during 27 April, 2008. On 28 April Dana arrived back at Hirthals for crew exchange. On 29 April Dana left Hirtshals again and started Echo integration at 08:35 on the 1st of May. The proposed cruise track was followed northwards and at 12th of May 03:54 the track was left for change of crew and scientists in Bodö, Norway. Bodö was left again at 18:00 hours the following day. Echo integration was resumed at 02:04 on the 14th of May and completed on the 22th of May at 13:13. Dana headed south towards Hirtshals and arrived there on 26 May at 07:00 hours.

Deviations from the programme during the survey

1. The time allocated to the second part of the cruise was far too short to cover all proposed transects properly. This has been dealt with by reducing the number of trawl hauls on the transects where very little fish was encountered. Also, two transects had to be shortcutted (see 5.)
2. After the first half of the survey the trawl gear had to be changed. After having fished with a bigger trawl than in the previous years (millionaire trawl) with good success, it was decided to switch back to the smaller Fotø trawl after the break in Bodo due to technical problems with the winches. This fact made our decision not to fish during the relative empty northern transects easier, because we knew from previous surveys that fishing with the Fotø trawl on deep isolated schools would not be successful anyway.
3. The first two transects could not be completed, because the western end was in UK water and there was no UK permit.
4. The 66°15 and 67°15 transects had to be extended by 48 nm from 3°W to 5°W to cover the gap between the Dana/GO Sars and the Magnus Heinason.
5. In order to save time, the 70°15 and 71°15 transects were shortcutted by 40 nm from 0°50E to 0°50W.

Results

Catch compostion

Table 1 presents the species compositions of the trawl hauls.

Distribution and density of herring and blue whiting

Most herring were found in the western part of the surveyed area in Smuthavet (the international area), between 64°30N and 68°30N. In contrast, in the eastern part of the area herring were observed to be equally spread from south to north in smalls schools in the surface layers (figure 2).
Blue whiting were very scarce in the whole area. Only in the far south and far north of the surveyed area moderate concentrations of blue whiting were found (figure 3).

Table 1. Catch composition (kg). At station 6 – 104 the big Millionär trawl -, at station 111 onwards the smaller Fotø trawl was used.

station	date	Latitude	Longitude	Trawl depth [m]	*Anarhichas lupus*	*Arctozenus rissoi*	*Argentina sphyraena*	*Benthosema glaciale*	*Centrolophus niger*	*Clupea harengus*	*Cyclopterus lumpus*	*Engraulis encrasicolus*	*Entelurus aequoreus*	*Mallotus villosus*	*Maurolicus muelleri*	*Melanogrammus aeglefinus*	*Micromesistius poutassou*	*Notoscopelus kroeyeri*	*Pollachius virens*	*Salmo salar*	*Scomber scombrus*	*Sebastes mentella*	unidentified	remarks
6	01.05.2008	62°15.589' N	002°37.584' E	200 - 230					0.394		4.210	0.030	0.025		19.645	0.752								
11	01.05.2008	62°16.459' N	001°12.864' E	400 - 440		0.178			0.418						5.876		0.048	1.032			43.200	1.492	0.002	lot of krill
18	02.05.2008	63°10.010' N	003°01.746' E	100 - 130					0.434						147.923			0.090			9.120			lot of krill
22	02.05.2008	63°10.222' N	005°23.842' E	75 - 125					0.312						314.696	2.106			18.800					lot of krill
37	04.05.2008	64°32.577' N	000°33.233' W	15 - 50																				
47	05.05.2008	65°14.782' N	004°57.418' E	125 - 150		0.052				0.498					33.113			0.009						
52	05.05.2008	65°26.279' N	007°42.049' E	25		0.814							0.814		44.798									lot of krill
71	07.05.2008	66°17.670' N	000°52.006' E	300 - 325		0.724							0.004				6.690	1.084						
72	07.05.2008	66°16.246' N	000°14.306' W	10 - 35						1988.502														
76	08.05.2008	66°15.449' N	001°20.134' W	10-40						3686.008														
80	08.05.2008	66°15.835' N	002°49.835' W	10 - 40						1177.075	0.930													
87	09.05.2008	67°14.206' N	003°53.145' W	500 - 525																				
91	09.05.2008	67°12.990' N	002°26.676' W	300 - 320		3.574	0.022			14.337			0.001					2.680						
92	09.05.2008	67°14.868' N	002°00.716' W	20 - 50						718.443	1.542													
97	10.05.2008	67°15.295' N	001°28.579' E	200 - 270		0.050				13.590	1.782						14.600							
104	11.05.2008	67°11.894' N	008°09.685' E	200		0.876		0.733									4.572	0.046						
111	14.05.2008	68°14.078' N	008°45.098' E	10						80.495	9.700		0.002							1.588				
118	15.05.2008	68°15.667' N	004°07.750' E	25 - 50	0.001	0.024				6.676	9.485		0.003	0.334	0.001									
119	15.05.2008	68°15.125' N	003°43.055' E	20 - 50						1742.666	7.340		0.006											
123	15.05.2008	68°13.813' N	000°35.296' E	200													0.908							
127	15.05.2008	68°15.411' N	000°31.756' W	25						26.000			0.016	0.022										
140	17.05.2008	69°15.144' N	007°38.723' E	25						50.000	20.900			0.226						2.300				
141	17.05.2008	69°14.149' N	009°34.049' E	25						5799.994	9.000													
148	18.05.2008	69°11.987' N	013°15.995' E	25						2014.005	4.600													
184	21.05.2008	71°14.247' N	008°12.147' E	240		0.126		0.190		14.900	2.200				0.002		7.292					0.700		

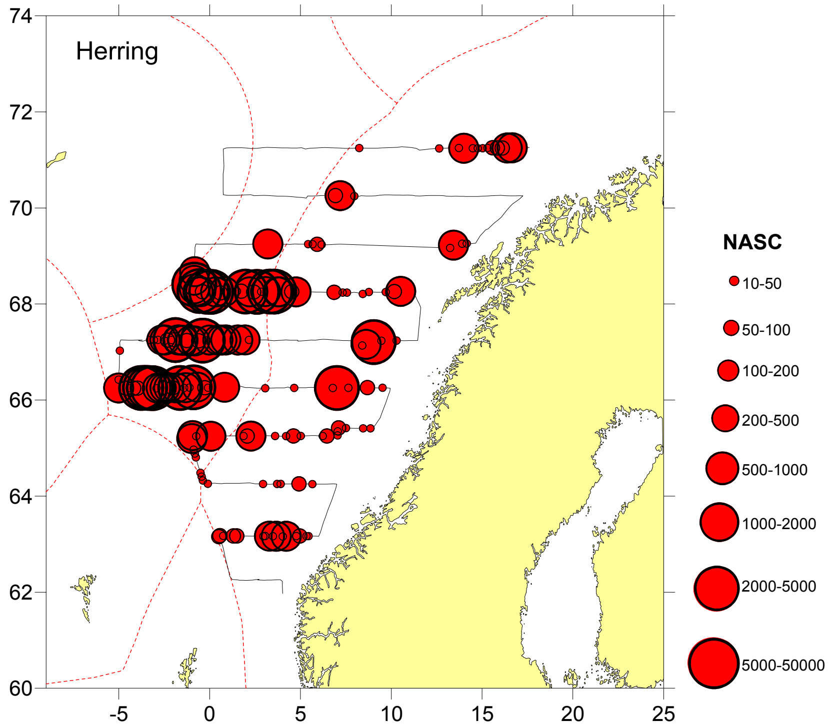


Figure 2. Distribution and area echo abundance (mean NASC per 5 nm) of herring recorded by R/V Dana during 1 May to 22 May 2008.

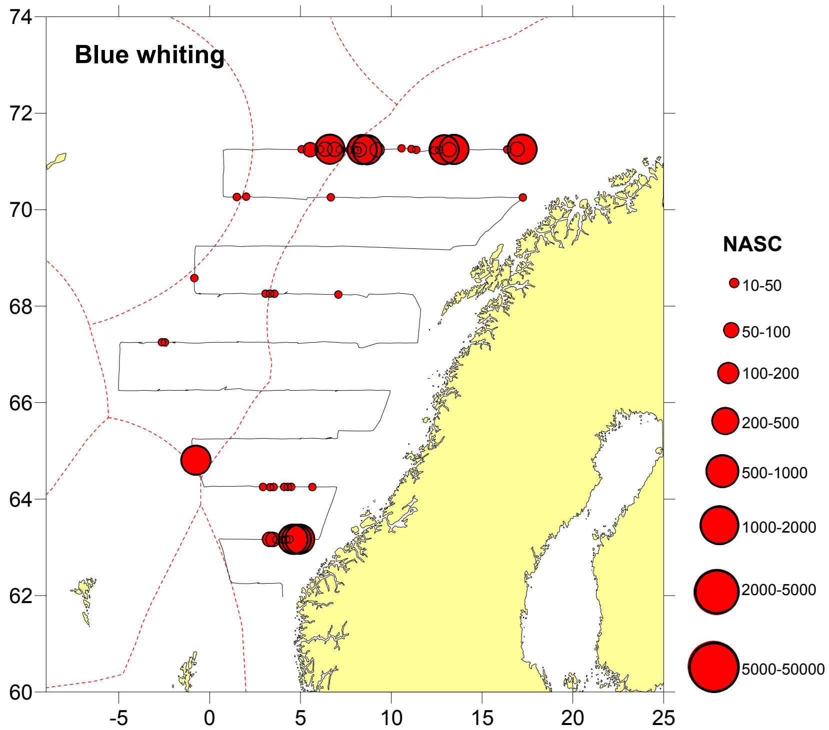


Figure 3. Distribution and area echo abundance (mean NASC per 5 nm) of blue whiting recorded by R/V Dana during 1 May to 22 May 2008.

Size distribution

In the southern part of the survey area the observed mean length of herring was clearly smaller than in the northern part of the area (figure 4). Mean herring length seemed to increase towards the northwest of the area were almost exclusively large herring were found. In the stations closer to the coast also small herring appeared among the generally large individuals. The number of blue whiting in the samples was too small to draw any conclusions from it.

Hydrographic conditions

The hydrographical conditions were similar to previous year's conditions. The frontal area between cold arctic water and warmer Atlantic water was apparent at all depths from the surface and down to 200 m west of the 0-Meridian (figure 5). However, temperatures were slightly cooler in the surface layers as well as in the layers below which points to a weakening influence of North Atlantic waters in the Norwegian Sea. A fact that might also be reflected in the lower numbers of snake pipefish in the samples compared to the previous years, particularly 2005.

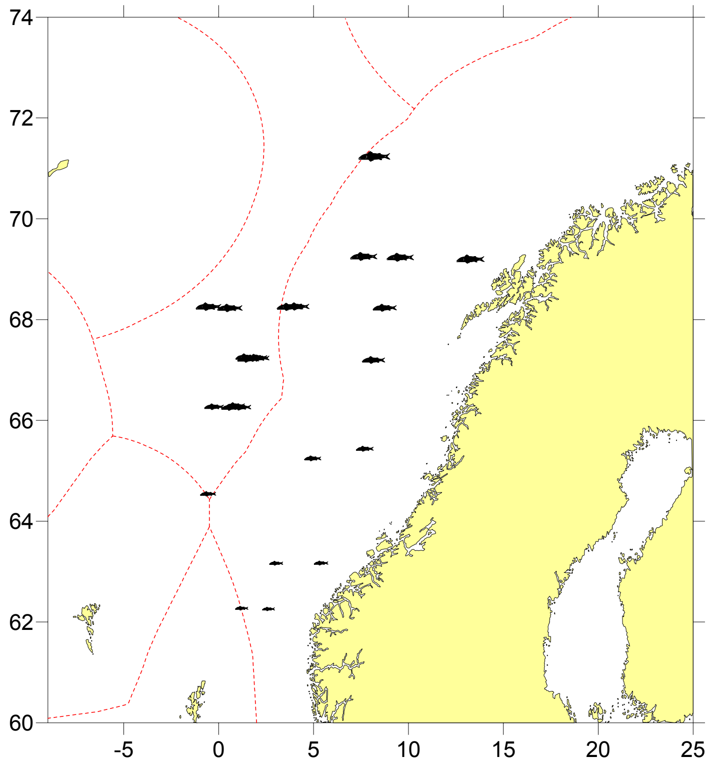


Figure 4. Average length of the herring from the samples shown graphically. The smaller size classes were to be found in the southern part of the survey area.

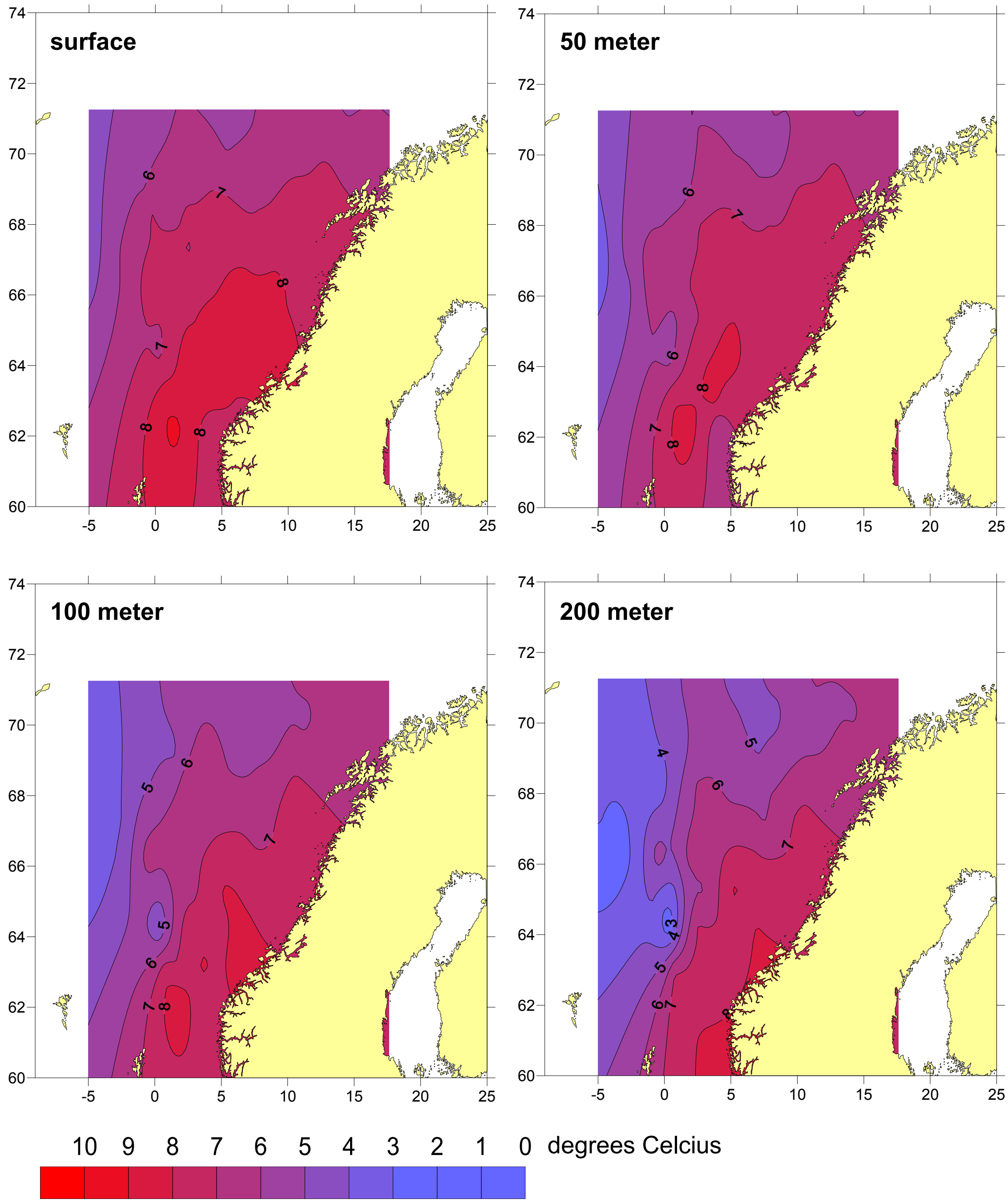


Figure 5. Contour plots of the temperature at surface (5 m), 50, 100 and 200 m depth as measured by CTD stations taken by R/V Dana during 1 May to 22 May 2008.

Discussion

Scrutiny and trawling

Problems in the scrutiny process occurred only and particularly on the northernmost transect. Big isolated schools were encountered there but no validation trawls could be conducted due to the above mentioned disadvantages of the small Fotø trawl. Part of the NASC found there was assigned to blue whiting, but may very well had originated from herring.

PGNAPES exchange format

A format description of the exchange format was used taken from the preliminary acoustic survey manual. The survey manual will be officially used from PGNPES 2008 meeting onwards. The species codes used are based on the DANA's onboard coding system since no official list was available. During the PGNAPES 2007 meeting it was agreed to use TSN only but the PGNAPES exchange format in the manual does not indicate so.

Annex 1 - Caibration report.

Echo Sounder System Calibration

Vessel :	R/V Dana	Date :	27/04/2008
Echo sounder :	ER60 PC	Locality :	Bornø, Sweden
		TS_{Sphere}:	-33.60 dB
Type of Sphere :	CU-64	**(Corrected for soundvelocity o**	Depth(Sea floor) ? m

Calibration Version 2.1.0.11

Comments:

Reference Target:			
TS	-33.60 dB	Min. Distance	8.00 m
TS Deviation	4.0 dB	Max. Distance	12.00 m
Transducer: ES38PB Serial No. 381			
Frequency	38000 Hz	Beamtype	Split
Gain	25.47 dB	Two Way Beam Angle	-20.5 dB
Athw. Angle Sens.	21.90	Along. Angle Sens.	21.90
Athw. Beam Angle	6.87 deg	Along. Beam Angle	6.84 deg
Athw. Offset Angle	0.00 deg	Along. Offset Angl	0.00 deg
SaCorrection	-0.59 dB	Depth	0.00 m
Transceiver: GPT 38 kHz 00907205aeb9 1 ES38PB			
Pulse Duration	1.024 ms	Sample Interval	0.188 m
Power	2000 W	Receiver Bandwidth	2.43 kHz
Sounder Type:			
EK60 Version 2.1.2			
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.	5.2 dB/km	Sound Velocity	1468.0 m/s
Beam Model results:			
Transducer Gain =	25.42 dB	SaCorrection =	-0.54 dB
Athw. Beam Angle =	6.91 deg	Along. Beam Angle =	6.67 deg
Athw. Offset Angle =	0.02 deg	Along. Offset Angle=	0.07 deg

Data deviation from beam model:
RMS = 0.16 dB
Max = 0.76 dB No. = 385 Athw. = -1.5 deg Along = -4.0 deg
Min = -1.09 dB No. = 401 Athw. = -2.6 deg Along = -4.2 deg

Data deviation from polynomial model:
RMS = 0.13 dB
Max = 0.78 dB No. = 385 Athw. = -1.5 deg Along = -4.0 deg
Min = -0.77 dB No. = 401 Athw. = -2.6 deg Along = -4.2 deg

Comments :

Wind Force : kn. **Wind Direction :** degrees

Raw Data File: E:\EK60 RAW acoustic data (all cruises - original)\Cruise0308\Calibration\Cruise032008-D20080429T143654.raw

Calibration File: E:\EK60 RAW acoustic data (all cruises - original)\Cruise0308\Calibration\Kuglekal-parav-038-60mm-1439.kal

Calibration responsibles : Karl-Johan Stær

Annex 2 Acoustic data collection and data use onboard R/V Dana

Sytse Ybema
May 2008

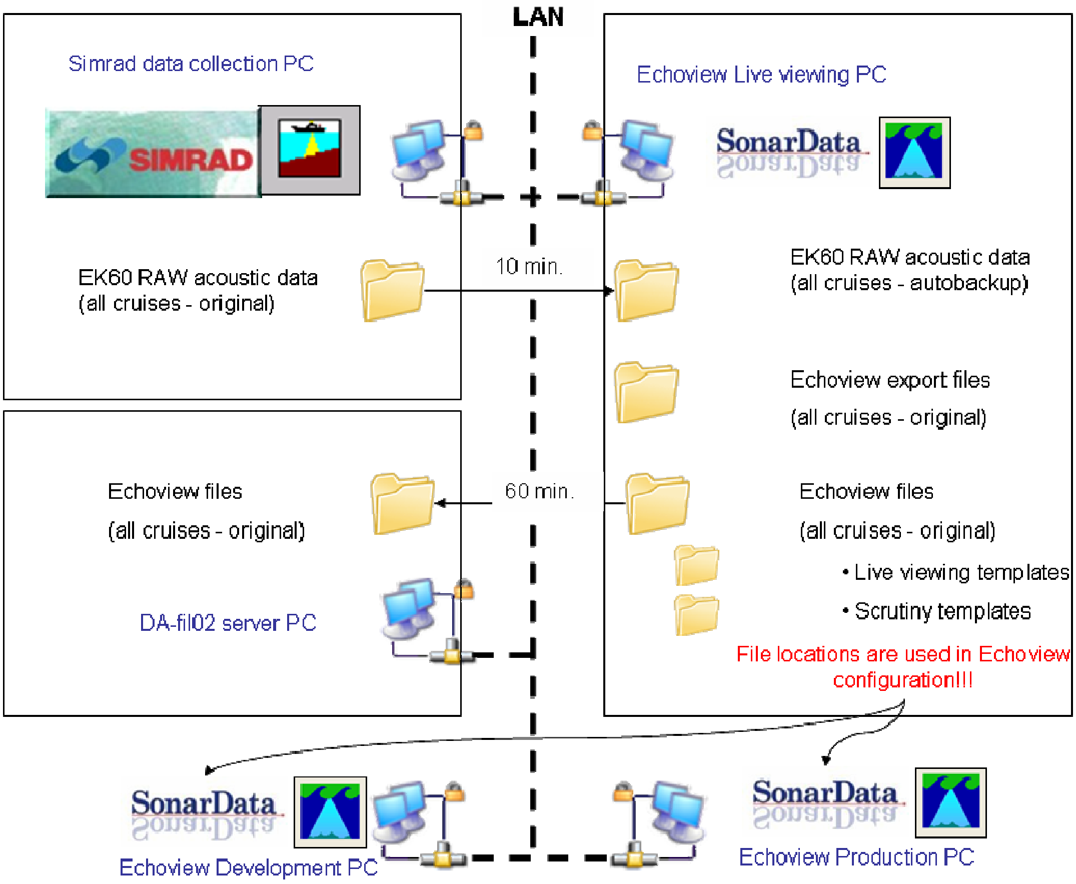
During the International Ecosystem Survey in the Nordic Seas (IESNS) 2008 the BI500 post-processing software used for analyzing the acoustic data was replaced by Sonardata's Echoview software (version 4.40). The idea behind this upgrade was to have more control over the scrutiny process during a time when the Planning Group for North-East Atlantic Pelagic Ecosystem Surveys (PGNAPES) is aiming to establishing a more repetative approach in the scrutinizing process. A second argument to switch to Echoview was to use this surveys time more efficient. In comparison to the old BI500 system was calculated to save around half the time on data processing.

Data collection

Acoustic data were collected by Simrad ER60 software on the DAWSECHO-02 computer and stored directly on the USB external drive. An automatic backup of this data is made every 10 minutes by a software package called 'SyncBack', installed on the DAWSECHO-01 computer. The backup is localized on an external USB hard drive on the same machine. This USB hard drive also contains Echoview files (EV-files, templates and CSV export files). SyncBack is again used for backing up these Echoview related files and the acoustic RAW files from this USB drive to the ships' server computer 'DA-fil02'. Backups from different data types are set as individual 'Profiles' in SynchBack which are editable (e.g. backup frequency). Just right click the profile to enter the configuration.

Folder sharing

When using Echoview it is recommended to notify the software where to find the files so you start looking for your files in the correct folder. This can be achieved by specifying the correct file pathway in the configuration menu. Make sure that all folders are shared and that permissions for Echoview folders are set to maximum. This also applies to the backup folder for EK60 RAW files. The EK60 RAW original file folder should also be shared in order to be used by the backup software.The image below shows the general setup used in May 2008:



Hardware requirements
Specific requirements for this setup depend on the complexity of the acoustic classification algorithm and the amount of variables opened simultaneously in Echoview. The template discussed in this document requires at least 2Gb of RAM memory, preferably 4Gb. RAW data requires around 200Mb per 1 hour recording using 4 frequencies and a pre-agreed recording depth of 750m for this survey. All these data are transferred continuously over the ships local area network for live viewing, backup and scrutinizing. A high local network speed is therefore essential.

Since both live viewing and data scrutiny use multiple windows for looking separately at specific depth ranges, frequencies and target species, it is essential to use large screen displays for viewing the echograms. Many features, like surface schools are easily missed when displays are too small.

Using Echoview species categorization and school detection algorithms

This is a general description of the use of Echoview's module 'Virtual echogram' illustrated by a mind map used in the International Ecosystem Survey in the Nordic Sea (IESNS) 2008. The algorithm presented here is based on the 38kHz frequency only.

Preparing scrutiny in Echoview

Scrutiny of biological targets should only be conducted by an experienced Echoview user who is familiar with the target species and survey area. Before data is scrutinized, the following preparations need to be done:

1. Create a new EV file using an existing template. This template contains the decision tree, species names, fixed depth lines etc.
2. Load data files into the EV file. One day file sets are often used.
3. Do a preliminary check on the cruise track. Is all data complete? No missing areas?
4. Save the file using a logic name (e.g. cruiseID_date → ASH2008_20080325)
5. Check the calibration settings of the raw data (for all frequencies if using a multi-frequency approach).
6. Block out bad data (e.g. noise, missing data, false bottoms)
7. Create a bottom line (e.g. 38 kHz bottom detection, edited with a c. 5 m offset)
8. Detect schools according to the template and the species you would like to output.

- School detections for a specific species need to have the correct settings, so store your species-specific settings somewhere.

Please refer to the Echoview EV file for more detailed settings.

Species classification mind map

Preparation
Before starting to use or design a new template for (semi)-automatic scrutiny it should be clear what can be expected. You should ask yourself the following questions:

1. *Does the survey prescribe or require scrutiny to species level in the first place?*

2. *Can we use multi frequencies in the algorithm?*
   - Have all transducers been calibrated? Without calibrated transducers no multi-frequency work can be done.
   - Where are the transducers located, i.e. deployed on a towed body or mounted on the vessel? Is there a sidelong or forward offset? It's possible to correct for forward offset, not for sidelong.

   Note: If we will use multiple frequencies onboard DANA, a complete beam overlap between the hull-mounted and towed body transducers is estimated to occur at c. 250m depth. Beware that the beams still cover different areas at this depth.

   Also note: Hull mounted transducers are very sensitive to air bubbles / noise, especially in bad weather.

3. *Is there any literature on Sv thresholds of the target species?*

4. *Do we have to start from scratch or can we use (parts of) a template from other surveys?*

Which species are targeted and what do we find in the catch?
During the IESNS herring, blue whiting, pearlside and mesopelagics were the main species in the catch. Notice that the gear is size and species selective so not all targets on the echogram have to be visible (e.g. plankton).

What are the characteristics of the target species as seen on the echogram?
The idea here is to find species specific features which you can use to isolate those species during the target scrutiny process. It should be noted that these specific features can often be only applicable to certain areas or seasons. For example, migrating blue whiting has a different schooling pattern from spawning fish although the specific depth range seems to be rather similar in both seasons. There are 2 approaches which can be used here:

1. The tested method, where schooling characteristics have been studied and published.
2. The expert judgment method which more resembles fishermen's knowledge. This knowledge is usually based on numerous trawl hauls taken in the area and time window of interest.

Several points of departure could be used here:

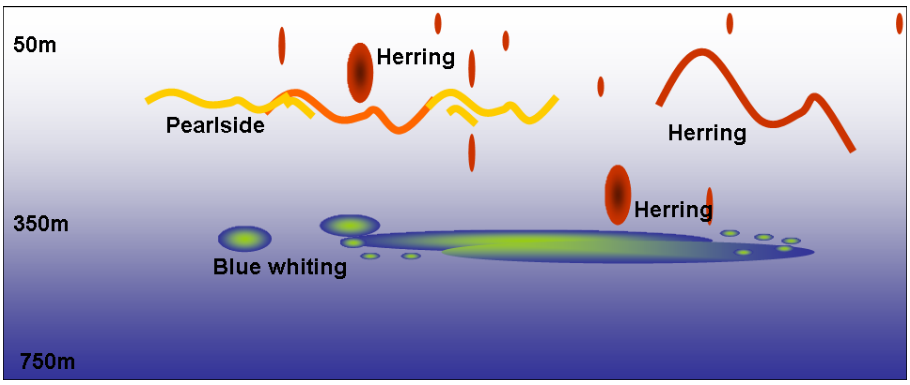
- Layer treatment
- Species treatment

Which method to pick depends largely on the school characteristics and the target species in the area. For example: if the target species is clearly detectable throughout the entire water column, regardless of any other species around, no layer treatment is needed and an ordinary threshold will be sufficient to filter out our target species. However, if the target species is the strongest backscatter in the lower layers and the highest in upper layers compared to other observed species, a different approach is needed. In our example, herring was present as strong pillar shaped backscatter marks (c. -40 dB) from 0 to 200m but it also formed diffuse snake-like schools in a layer shared with pearlside which also forms weak (c. -55 dB), snake-like schools. This overlapping layer by these two species was therefore treated separately.

Note: Always use a default Sv or color range in both Simrad and Echoview. You'll find it much easier to compare species characteristics in this way. The default range which is mostly used is -70dB to -34dB
The following example is based on the 2008 IESNS survey.

1. Herring:
   - 0m – 300m
   - *Common*: Dens, red dots in the depth range 0m – 300m. Only trawl validation for the first 100m.
   - *Common*: Tiny strong to middle strong schools in the upper most layer, just below the near field of the transducer (set to 7m for a standard 38kHz).
   - *Rare*: Weaker yellow, orange to red layer in the first 50m. This has been seen in the most western part of the 2008 survey. Steep diving patterns are typical.
2. Blue whiting:
   - 300m - deeper
   - *Common*: Mostly fluffy schools have been observed around weak to dens plankton layers in the Norwegian Sea where blue whiting is feeding. Where the plankton layer is strong you might find it difficult to separate from fish.
   - *Rare*: snake like layer of medium to low density. These fish are on their return from the spawning grounds west of the British Isles.
3. Pearlside:
   - 75m – 250m
   - *Common*: Medium strong thin layers, coming up and dying out softly often very scattered so it looks like a chain of separate schools.
4. Algae:
   - 0m – 40m
   - *Common*: Medium strong to strong backscatter at the surface decreasing to a max depth of around 40m.

Make a schematic drawing of the situation as shown below. Do layers containing individual species show overlap?

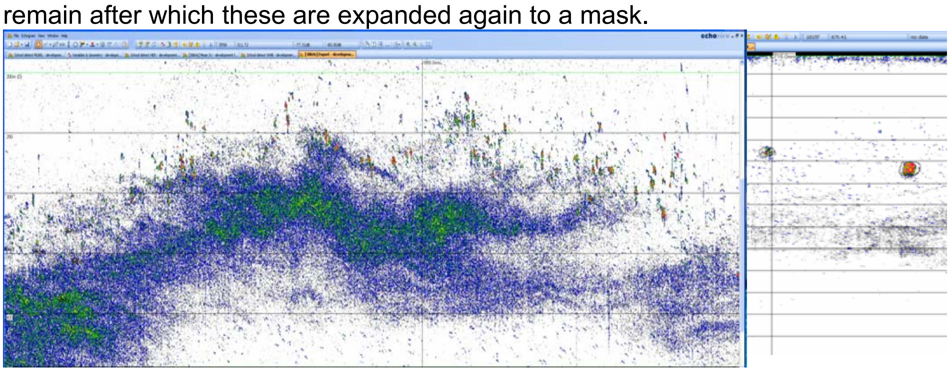


The approach used in the IESNS 2008 is shown below.

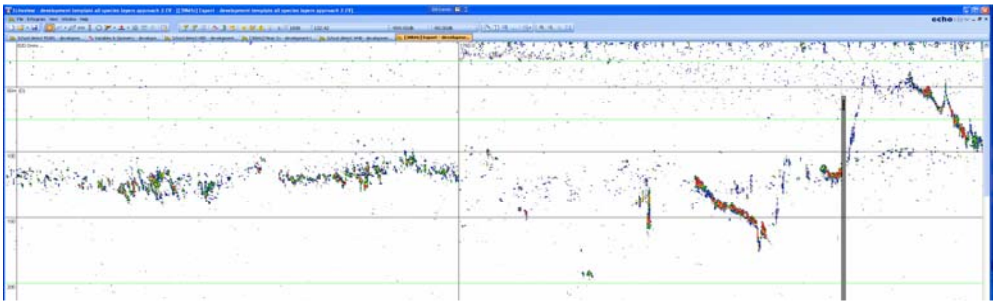
Thresholding is the key method used to isolate fish species from other layers such as plankton. The threshold values used here were based on expert judgment and a priori knowledge of the fish species, and plankton was removed by applying a default value (-60dB). The difference with using the Bergen Integrator system is the ability to apply a pre-defined threshold to the Echogram based on pervious experience. Every target species follows its own decision path where these fixed thresholds are being used along the way. The threshold to be used for data export is set automatically in the 'Export' variable to a minimum of -85dB. In Echoview this decision tree is then reconstructed using the powerful 'Virtual Echogram' module. This module is object orientated, which means you can put your decisions in separate 'building blocks', representing individual steps in the mind map.

For the IESNS 2008, the following steps were followed based on available trawl information and expert judgment.

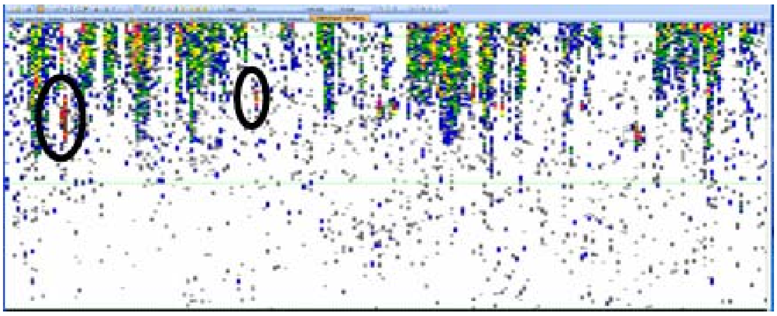
1. Keep data between bottom -5m and near field of the 38kHz transducer (7m near field used). Discarding the rest of the echogram will speed up the processing speed of the algorithm.
2. Remove noise by subtracting the generated noise level from the original variable. The higher the frequency, the more noise is expected to interfere with the target species.
3. Treat individual layers till you end up with a mask of schools.
    I. Blue whiting layer (>200m). Blue whiting was characterized by being the only species in the deep layers. Sometimes overlap in density occurs when schools are weak and plankton is strong. Threshold strongly till small blue whiting schools remain after which these are expanded again to a mask.



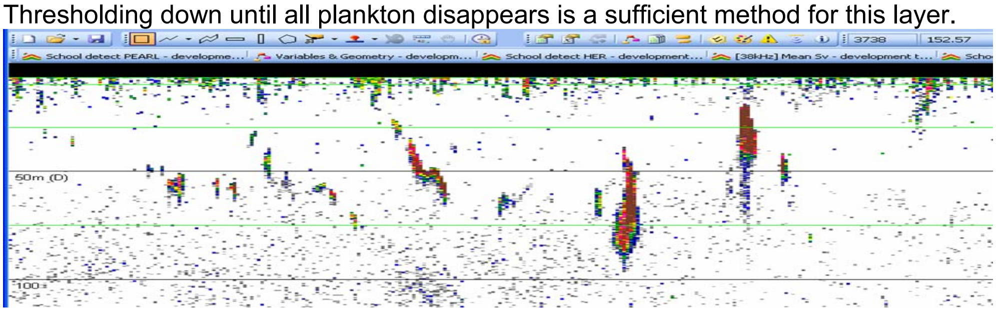
    II. Mixed herring and pearlside layer (75m – 200m). Depth ranges for pearlsides published in the literature (100m-200m) differ from trawl observations obtained in this survey (75m - 200m). Pearlside is shown on the left half of the figure below. Herring in this mixed layer showed identical school shape but a stronger overall backscatter. The word "overall" is used here because both species show equally strong fuzzy parts of the snake like schools. Herring is shown on the right half of the image below. A "mean Sv by school" approach should be used here to identify the species.



III. Herring in the surface layer (<30m) where it is sometimes hidden in thick algae/plankton layers. The plankton backscatter starts very strong close to the near field of the transducer and weakens with depth. The difficulty here is that almost 100% overlap in backscatter density between plankton and herring occurs throughout a large part of this layer. It has therefore been removed from analysis. The deeper part of the algae layer has been treated to threshold down this layer till only little spikes of herring is left and next to expand these spikes to larger schools to be used in the mask.

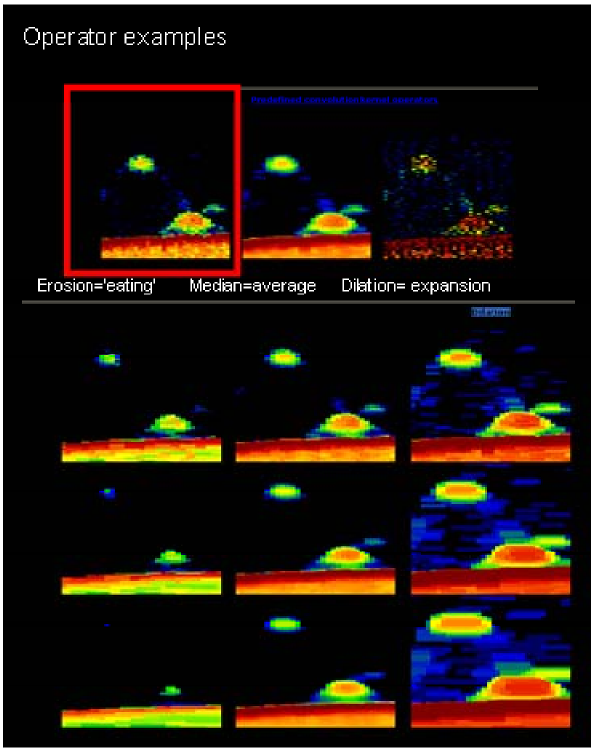


IV. Herring in the layer between surface (c) and mixed layer (b) has not been observed mixed in any way with other species or thick plankton layers (30m – 75m). Thresholding down until all plankton disappears is a sufficient method for this layer.

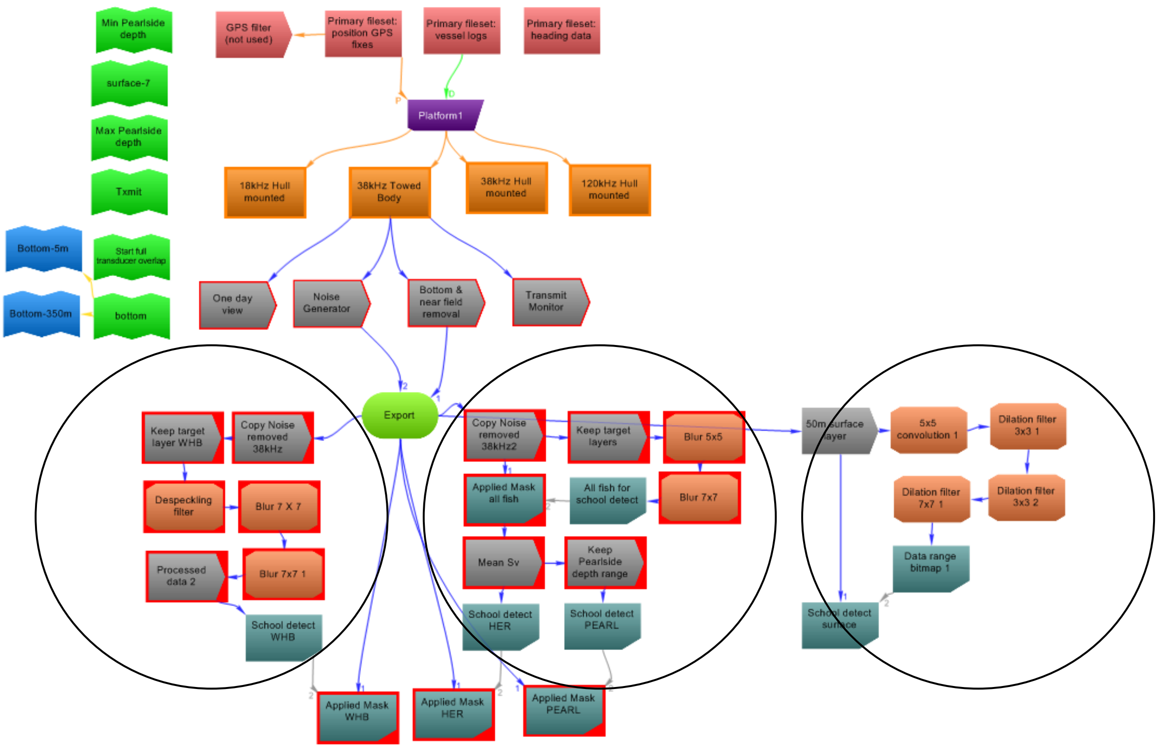


4. Then merge all masks.
5. This mask can then be used to extract regions using the School Detection module. It will produce all regions (schools) to be stamped in future steps.
6. The mean of these regions when displayed as a virtual echogram (placed over the original data) highlight differences in the frequency response of the schools detected.
7. Based on trawl information and expert judgment these differences are then (for each individual layer) used in species classification data range bitmaps according to the following Sv threshold:
    - Herring: -20dB to -50dB
    - Blue whiting: -50dB to -66dB
    - Pearlside: -60dB to -65dB

The figure below shows how different techniques can be used to isolate single schools or layers.



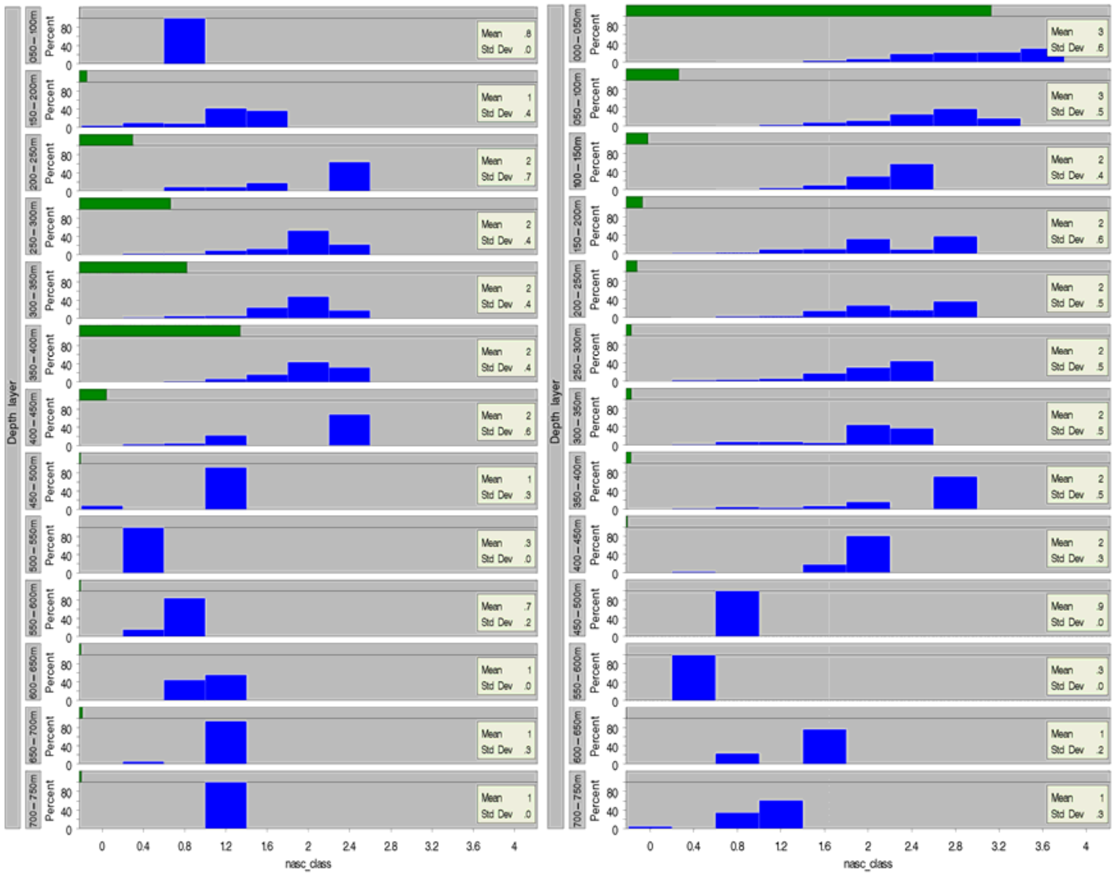
An example used in the IESNS 2008 is shown in the diagram below. Individual circles mark the areas where individual species are isolated. This flowchart has been used for this cruise scrutiny purposes. An algorithm version has already been developed but was not used in production yet.



The above flow chart shows the variables used to extract information from 38kHz in an attempt to develop a technique to separate/identify fish species. In this example the left circle isolates blue whiting at a specific depth, the second circle separates herring from pearlside based on their acoustic density. The third circle isolates herring from a dense algae layer at the surface.

Scrutiny exploration for the IESNS survey 2008.

The scrutiny method of the 2008 data has been altered comparing to previous years by applying the school detection algorithm on the processed data. Automated species classification is still under development and was therefore not used during this cruise. Scrutiny was done by 'stamping' pre-detected schools with most likely species class. The figure below illustrates this species classification over the standard depth ranges. It shows a preferred depth range of 0m – 50m for herring and 200m – 400m for blue whiting. However, herring has been scrutinized down to depths of 750m and small blue whiting schools has been scrutinized in the upper most 200m.



Blue whiting Herring

The figure shows the Nasc frequency distribution over the surveyed 50m depth ranges. The X-axis represents the NASC value on a log scale, the Y-axis represent the different depth layers. The green bar indicates the relative number of schools.