Cruise report

The international acoustic survey in the Norwegian Sea in May 2009

R/V DANA Cruise No. 4/2009

Calibration of Echo-sounders

28/4 – 30/4 2009

International Acoustic Monitoring of Herring and Blue whiting

1/5 – 28/5 2009

Cruise participants

Calibration 28/4 – 30/4

Karl-Johan Stæhr	Denmark (Cruise leader)
Bo Lundgren	Denmark
An H. Pham	Denmark
Torben Filt Jensen	Denmark
Peter Faber	Denmark
Thyge Dyrnesli	Denmark
Mads Larsen	Denmark
Mogens Rokjær Sørensen	Denmark
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Acoustic monitoring 1/5 - 14/5

Karl-Johan Stæhr (Cruise leader) (acoustic)	Denmark
Torben Filt Jensen (acoustic)	Denmark
Bram Couperus (acoustic)	Netherlands
Niels Jørgen Phil (plankton/fishlab)	Denmark
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Susanne Hansen (plankton/fishlab)	Denmark
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An H. Pham (Phd. Study)	Denmark
Mogens Rokjær Sørensen (technician)	Denmark

Acoustic monitoring 14/5-28/5

Bram Couperus (Cruise leader) (acoustic)	Netherlands
Ryan Saunders (acoustic)	Ireland
Jan-Erik Johansson (acoustic)	Sweden
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Mark Etherton (plankton/fishlab)	England
Matthias Kloppmann (plankton/fishlab)	Germany
Mogens Rokjær Sørensen (technician)	Denmark

Cruise summary

Effective survey days	19
Mileage	2594
Number of trawl hauls	38
Number of CTD stations	43
Number of WP2 stations	43
Number of biological samples - herring	654
Number of biological samples – blue whiting	132
Remarks	

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 29th and 30th April 2009.
The calibration was performed according standard operation procedures as described in the PGNAPES/PGIPS 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 SIMRAD BI500 and Sonardata Echoview software (only second half.

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 (August).

Hydrographical and zooplankton data

At approximately every 60 nautical miles plankton samples were taken by means of vertical tows from 200 m to the surface with a WP2 equipped with 180 µm mesh. The sample 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 determination 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 43 combined 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 Turbo Pelagic trawl, Millionaire Trawl, was used either at the surface or in midwater down to a maximum of 450 m depth. A total of 38 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).

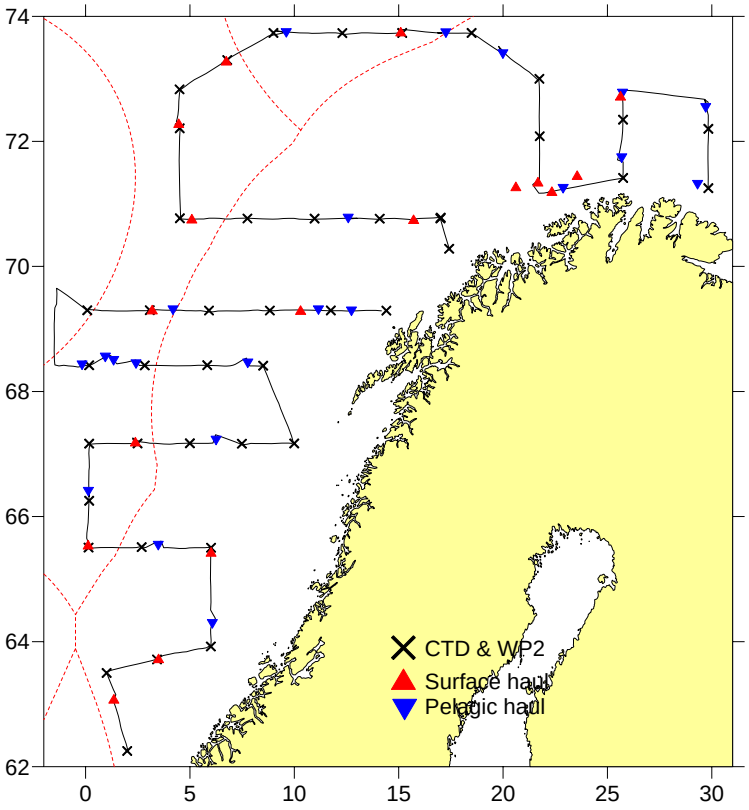


Figure 1. CTD stations (down to 1000 m), WP2 stations and trawl stations taken by R/V Dana from 1 May to 28 May 2009.

Catches were sorted and weighed by species. Length measurements were taken for all species (up to a maximum of 400 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 and otoliths were sampled and mounted on microscope slices whereas in blue whiting only otoliths were taken. Scales and otolithes will be read at Aqua DTU. In total 654 samples of individual herring and 132 samples of individual blue whiting were taken.

Together with the examination for sex and maturity harts of herrings were visually checked for Ichthyophonus. Totally 604 individuals from 18 hauls containing herrings were examined.

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 the PGNAPES database at the Faeroes at the end of the survey.

Itinerary of the survey(times in UTC)

R/V Dana left Hirtshals, Denmark on Tuesday 28 April at 14:00. The calibration site at Bornö Island was reached at the same day and calibration was carried out during 29 and 30 April, 2008. On 30 April Dana arrived back at Hirtshals for crew exchange early evening. On 1 May Dana left Hirtshals again and started Echo integration at 01:09 on the 3st of May. The proposed cruise track was followed northwards and at 12th of May 22:29 the track was left for change of crew and scientists in Tromsø, Norway. Tromsø was left again at 17:00 hours the following day. Echo integration was resumed at 22:00 on the 14th of May and completed on the 22th of May at 20:12. Dana headed south towards Hirtshals and arrived there on 28 May at 00:00 hours.

Deviations from the programme and comments

1. Unlike last year (2008) the time allocated to the second part of the cruise was enough. Due to the fact that in the northwestern part of the area hardly any fish was recorded and the good whether, there was time enough to take frequent hauls in the north east and two extra hauls along the coast.
2. The new Millionaire trawl, which is bigger than the Foto trawl was used for the first time last year with some start up problems, performed reasonably well. Catches were in general bigger than they would have been with the Foto trawl which meant in some cases that a biological sample could be taken whereas that would not have been possible with the Foto trawl. Trawling on schools in non-surface layers is still very difficult. Most schools – certainly suspected herring schools – are missed due to the slow winches.
3. The wireless depth sensors on the trawl did not always work properly. In at least one case it was not possible to fish at recordings above the bottom, because the trawl could not be lowered deeper than 40m above the bottom.
3. The WP2 trawl was repaired again really needs to be replaced.

4. In number of occasions, especially during the first part of the trip the hull mounted transceiver was accidentally installed with the paravane transducer. This was the case in some of the raw EK files created on 040509 to 070509 and 150509-160509. This means that the data have been logged on the BI500 with calibration settings of the hull mounted.

Results

Catch composition

Table 1 presents the species compositions of the trawl hauls.

Distribution and density of herring and blue whiting

Herring was found in between 62° and 70° North in the surveyed area. Below 70° the western border of the distribution was clearly not reached in the European part of the survey. Above 70° no herring was recorded in the western part (figure 2). Herring was found mostly in small schools at the surface and occasionally (in the western part) as big schools pelagically.
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 (in kg) for all trawl hauls carried out during the 2009 ASH survey with RV Dana, 1 – 28-2009.

Station	date	Latitude	Longitude	Trawl depth [m]	total catch [kg]	*Anarhichas denticulatus*	*Arctozenus rissoi*	*Argentina silus*	*Argyropelecus hemigymnus*	*Benthosema glaciale*	*Boreogadus saida*	Cephalopoda	*Clupea harengus*	*Cyclopterus lumpus*	*Euphausiaceae*	*Gadiculus argenteus*	*Gadus morhua*	*Invertebrata*	*Mallotus villosus*	*Maurolicus muelleri*	*Melanogrammus aeglefinus*	*Micromesistius poutassou*	*Myctophidae gen. sp.*	*Pollachius virens*	*Salmo salar*	*Schedophilus medusophagus*	*Scomber scombrus*	*Sebastes mentella*	*Todarodes sagittatus*	*Trachipterus arcticus*
10	04.05.2009	63°43,902' N	003°29,594' E	10	1009,7		0,04						378,76	7,13	95,37					0,02		19,69	1,96			15,63	480,21			10,90
13	04.05.2009	64°17,050' N	006°04,414' E	320	4,4		0,20	3,08						0,65		0,01				0,50										
14	04.05.2009	65°26,142' N	006°00,755' E	10	1067,0		0,02						1,00	2,23	37,62												1024,86		1,23	
16	05.05.2009	65°32,049' N	003°28,812' E	150	61,5									2,75	6,30					52,49										
21	06.05.2009	65°33,004' N	000°07,313' W	10	397,0								386,79	0,99													9,26			
24	06.05.2009	66°23,956' N	000°07,881' W	186	0,9									0,88																
29	07.05.2009	67°11,974' N	002°22,98' E	10	14,2								2,51	0,91													10,80			
32	07.05.2009	67°12,983' N	006°15,082' E	25	23,6								20,92	1,04											0,762		0,89			
39	08.05.2009	68°27,024' N	007°46,165' E	30	25,6								24,54												1,030					
44	09.05.2009	68°26,295' N	002°24,887' E	20	0,2								0,21																	
45	09.05.2009	68°29,407' N	001°20,576' E	251	33,6		0,45			0,00			0,38	4,11								24,91					0,32	3,44		
46	09.05.2009	68°32,752' N	000°56,602' E	20	0,6		0,07						0,27														0,31			
49	09.05.2009	68°25,176' N	000°10,243' W	30	58,0								56,16														1,81			
54	11.05.2009	69°18,597' N	003°11,518' E	10	0,5							0,54																		
55	11.05.2009	69°17,929' N	004°11,335' E	400	4,5		0,20		0,01	0,38			0,22	1,21	0,20			0,06			0,79	1,40								
60	12.05.2009	69°18,186' N	010°18,075' E	10	1545,9								1545,01	0,88																
61	12.05.2009	69°18,092' N	011°09,246' E	245	4,3		0,10			0,22					0,53			0,10		0,00		1,13		1,58				0,60		
64	12.05.2009	69°16,933' N	012°44,335' E	25	450,0								449,99																	
72	15.05.2009	70°45,273' N	015°42,969' E	10	4529,0								4505,66	22,70											0,628					
75	15.05.2009	70°45,955' N	012°34,929' E	380	14,4		0,48			0,57			0,67									10,29						0,63		
81	16.05.2009	70°45,787' N	005°05,34' E	10	25,2									22,20	2,94				0,10											
86	17.05.2009	72°17,413' N	004°27,727' E	10	20,8						0,01	4,22		16,00	0,51				0,11											
91	17.05.2009	73°17,362' N	006°44,228' E	10	39,0							1,34		37,40	0,25															
94	18.05.2009	73°44,055' N	009°36,88' E	460	11,7	0,99	3,15	0,02		2,40		0,07		2,41	2,61															
100	19.05.2009	73°43,833' N	017°15,585' E	120	4,2																4,19									
103	19.05.2009	73°23,725' N	019°59,687' E	170	267,2					0,01				2,62			8,40		11,47		244,70									
108	20.05.2009	71°21,271' N	021°40,329' E	10	929,5								913,99	10,24							3,42				1,410		0,48			
109	20.05.2009	71°12,203' N	022°20,478' E	10	3602,1								3550,00	48,70											3,350					
110	20.05.2009	71°14,524' N	022°52,844' E	100	18,6																18,60									
113	21.05.2009	71°43,818' N	025°41,161' E	60	75,4									7,90							67,50									
116	21.05.2009	72°45,879' N	025°43,375' E	60	837,9									1,75			4,68		829,00		2,50									
117	21.05.2009	72°43,746' N	025°37,758' E	10	2519,1									18,50					2500,00									0,63		
118	22.05.2009	72°32,138' N	029°42,734' E	180	144,3								0,09	2,26					120,00		21,90									
123	22.05.2009	71°18,398' N	029°19,307' E	20	357,3									9,60							347,73									
124	23.05.2009	71°27,558' N	023°33,229' E	10	1909,4								1880,00	25,20							0,67				3,572					
125	23.05.2009	71°16,861' N	020°36,923' E	10	27,3								1,358	25,900																

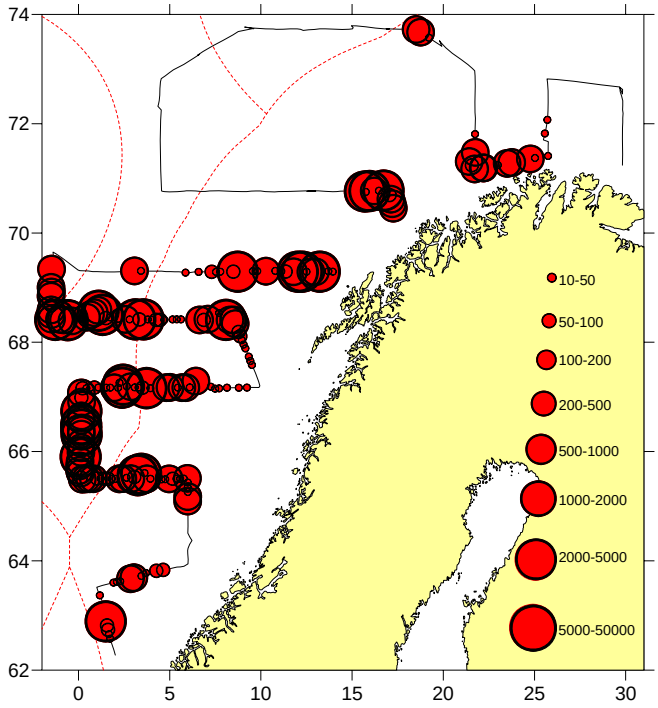


Figure 2. Distribution and area echo abundance (mean NASC per 5 nm) of herring recorded by R/V Dana during 3 May to 21 May 2009.

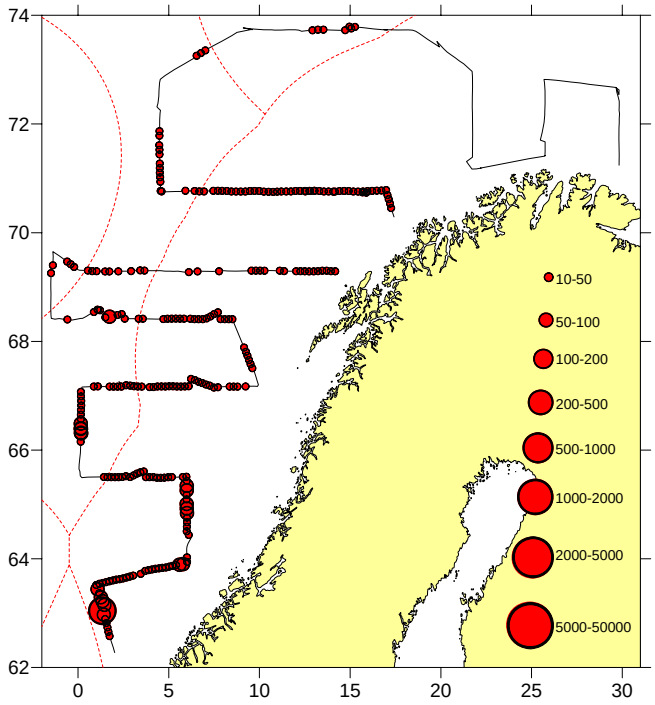


Figure 3. Distribution and area echo abundance (mean NASC per 5 nm) of blue whiting recorded by R/V Dana during 3 May to 21 May 2009.

Size distribution

Means length of herring increased westwards. The length of herring in the most north eastern part of the survey area was much smaller than in the south and the west (figure 4). The herring of Finmarken seemed to consist of one and two year old herring, although some adults were encountered as well. The number of blue whiting in the samples was too small to draw any conclusions from it.

Ichthyophonus

As outbreak of Ichthyoponus in the herrings in Icelandic waters has been reported herrings from the catches during the survey were examined for visual traces of Ichthyophonus. 604 individuals from 18 hauls containing herrings were examined. Out of the 604 individuals 2 individuals were found to have infection on the heart.
Both herring were males at 33.5 and 34 cm respectively and at age 6 and 8. Both Stations were south of 67° N and east of 2° E, Station 10 and 29.

Hydrographic conditions

The observed temperature range during this cruise was very similar to that of previous cruises with surface values between 5 and > 8°C decreasing to values < 0°C at with increasing depth. The frontal area between cold arctic water and warmer Atlantic water was apparent at all depths from the surface and down to 200 m only in the northwest and northeast of the survey area while at its western margin it became apparent only at depths below 100 m. (figure 5, and see figures of hydrographic cross sections in Annex 2). The warmer North Atlantic water formed a rather narrow tongue that stretched far northwards with temperatures > 7 °C in the surface layers. With increasing depth this core of warm water quickly eroded being more confined to areas closer to the Norwegian coast and forming a narrow band of warmer water centered along the 15° meridian in the North.

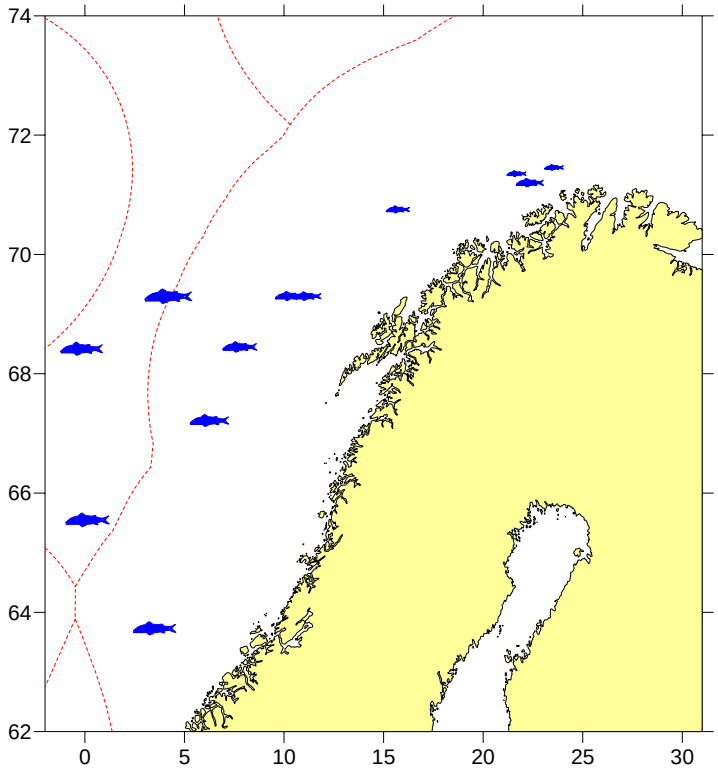


Figure 4. Average length of the herring from the samples shown graphically. The smaller size classes were to be found in the southern part of the survey area.

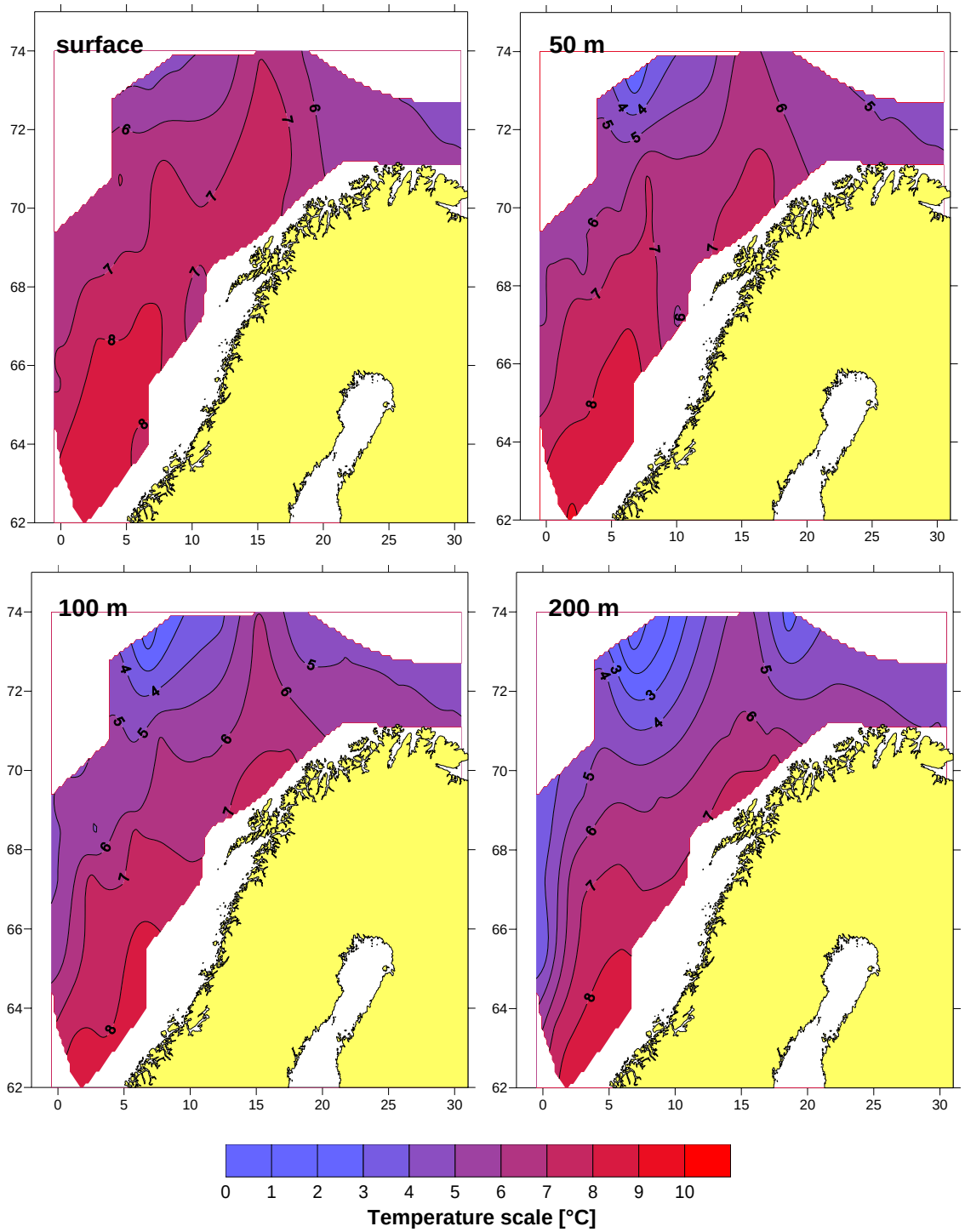


Figure 5. Contour plots of the temperature at surface (10 m), 50, 100 and 200 m depth as measured by CTD stations taken by R/V Dana during 1 May to 28 May 2009.

Discussion

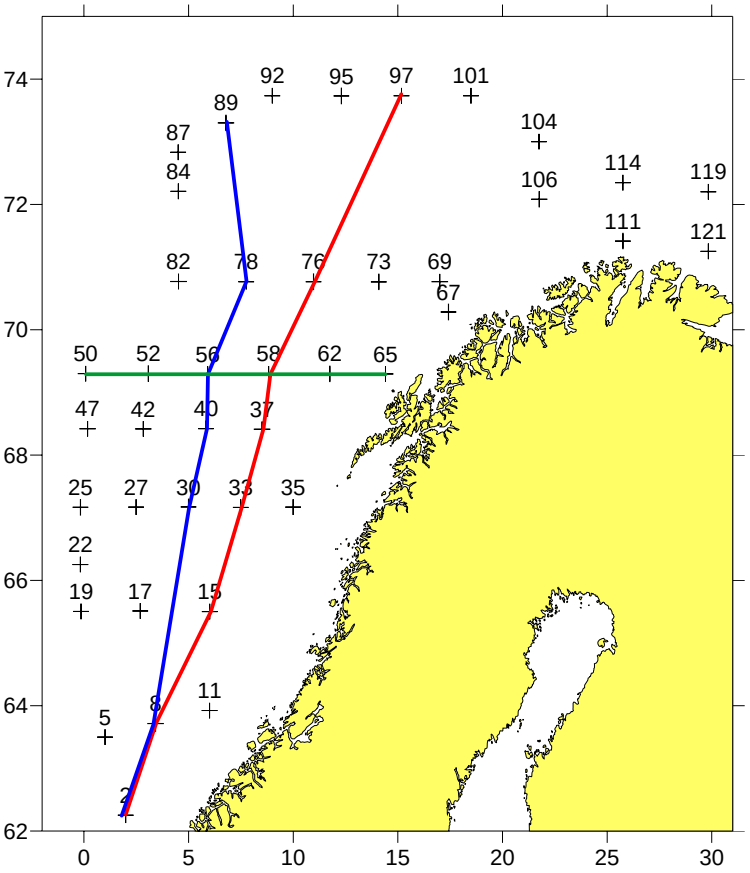
Scrutiny and trawling

The scrutiny of the acoustic data has been executed on the BI500. Almost no schools of blue whiting has been recorded. Hence the NASC's that have been assigned to blue whiting are all based on individual targets in deeper layers. The percentage NASC's assigned to Blue whiting was between 15-70 percent at -69 db threshold. It should be emphasized that any blue whiting estimations during this survey are based on these stray individual blue whiting at depth while the distribution between blue whiting and other mesopelagic fish can not be derived from the fish catches. Hence NASC's assigned to blue whiting are very rough estimates if not assumptions. Relative biases made during the scrutiny process are therefore most likely in the order of magnitude of hundreds of percents. Now that the blue whiting stock is very low, the survey estimates has fallen beyond a reasonable level of confidence and current sampling techniques are now inadequate to detect blue whiting appropriately (see also annex 3).
Scrutiny of herring did not encounter any problems.

Annex 1 - Calibration report.

Transceiver Menu	
Frequency	38 kHz
Sound speed	1470 $m.s^{-1}$
Max. Power	2000 W
Equivalent two-way beam angle	-20.5 dB
Default Transducer Sv gain	25.05 dB
3 dB Beamwidth	6.7°
Calibration details	
TS of sphere	-33.6 dB
Range to sphere in calibration	12.6 m
Measured NASC value for calibration	13500 m^2/nmi^2
Calibration factor for NASCs	1.00
Absorption coeff	7,727 dB/km
Log Menu	
Distance	1,0 n.mi. using GPS-speed
Operation Menu	
Ping interval	1 s
Analysis settings	
Bottom margin (backstep)	1.0 m
Integration start (absolute) depth	7 - 9 m
Range of thresholds used	-70 dB

Annex 2 - Cross sections Norwegian sea

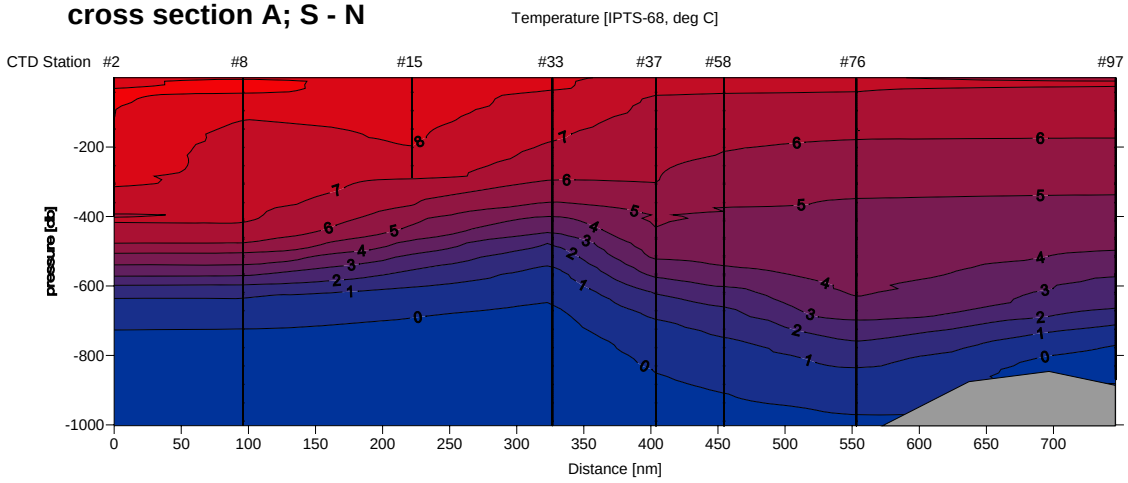


cross section A

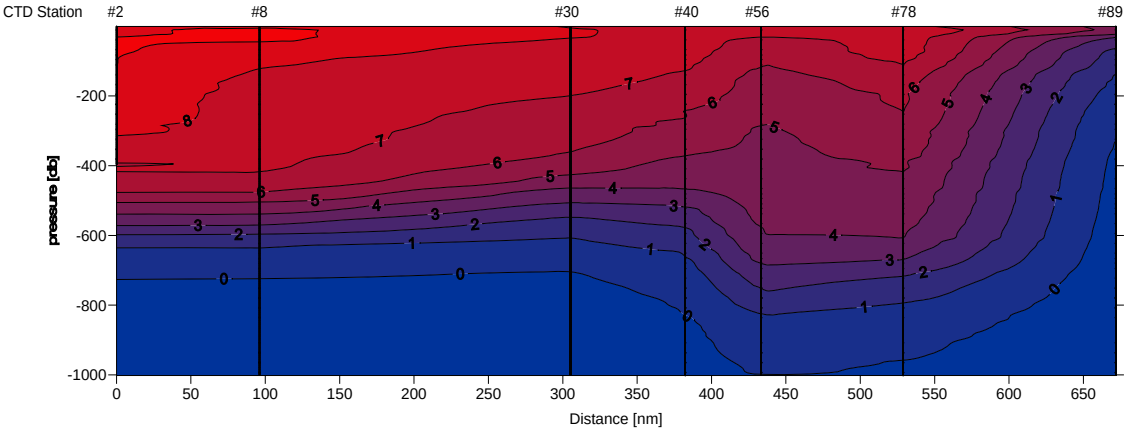
cross section B

cross section C

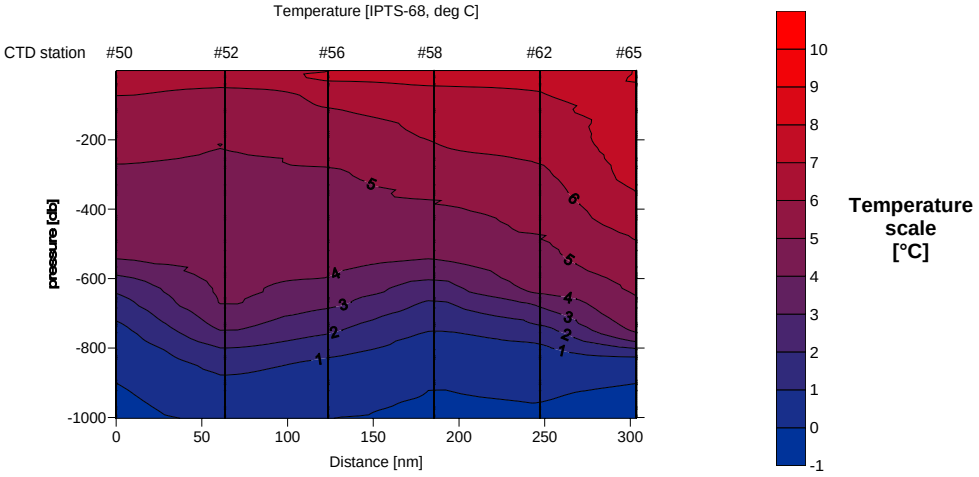
cross section A; S - N



cross section B; S - N



cross section C, W - E



Annex 3 - BI500 – Echoview comparison

We attempted to compare the output of herring data processed in BI software to that processed in Echoview. Similar regions of herring were identified in both software packages using visual scrutinization and net-haul data. The acoustic integral of herring targets were exported for every one nautical mile of cruise track for the comparison. Processing and exporting the data in Echoview was slow due to the low memory capacity of the onboard computers. Preliminary results showed that there was little overlap between the two methods. NASC values of herring exported from Echoview were consistently higher than those from the BI, and there few matches in peaks/troughs throughout the data. However, a closer inspection of the Echoview data showed a possible problem with the exported data. The date/time stamps of the exported regions were erroneous in the latter part of data series and there were NASC values for parts of the cruise transect where no herring regions had been identified in the echogram. This suggests that problems occurred when manually exporting the data from Echoview. Due to the slow processing capacity of the computers, we did not attempt to re-export the data and repeat the analysis. The EV files all appear valid. We therefore recommend that the analysis be undertaken at a later date using a faster computer.