

FSS Survey Series: 2013/01

Blue Whiting Acoustic Survey Cruise Report

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1 Introduction

Acoustic surveys targeting blue whiting (*Micromesistius poutassou*) spawning and post spawning aggregations in the north east Atlantic have been carried out by the Institute of Marine Research (IMR) Norway since the early 1970s. In the early 1980s a coordinated acoustic survey approach was adopted, with both Russia and Norway participating to estimate the size of this migratory stock within the main spawning grounds to the west of Ireland and Britain. Since 2004, an International coordinated survey program has expanded to include vessels from the EU (Ireland and the Netherlands) and the Faroes.

Due to the highly migratory nature of the stock a large geographical area has to be surveyed. Spawning takes place from January through to April along the shelf edge from the southern Porcupine Bank area northwards to the Faroe/Shetland Ridge including offshore areas as the Rosemary, Hatton and Rockall Banks. Peak spawning occurs between mid-March and mid April and acoustic surveys are timed to occur during this phase. To facilitate a more coordinated spatio-temporal approach to the survey participating countries meet annually to discuss survey methods and define effort allocation at the ICES led Working Group International Pelagic Surveys (WGIPS).

Data from the annual spawning stock abundance survey (March/April, western waters), juvenile surveys (May, Norwegian Sea and January-March, Barents Sea trawl survey) and commercial landings data are presented annually at the ICES Working Group of Widely Distributed Stocks (WGWIDE). Ultimately, combined data inputs into the management and catch advice for this international cross boundary stock.

The 2013 survey was part of an international collaborative survey using the vessels RV *Celtic Explorer* (Ireland), FV *Vilnius* (Russia), RV *Tridens* (Netherlands) and the RV *Magnus Heinason* (Faroes). The total combined area coverage extended from the Faroe Islands in the north (62° N) to south of Ireland (52° N), with east -west extension from 4°-19° W.

International survey participants meet shortly after the survey to present data and produce a combined relative abundance and biomass index the blue whiting spawning stock in western waters. The combined survey report is presented annually at the WGIPS meeting held in December. The information presented here relates to the Irish survey.

2 Materials and Methods

2.1 Scientific Personnel

<i>Organsiation</i>	<i>Name</i>	<i>Capacity</i>
FEAS	Ciaran O'Donnell	Acoustics (SIC)
FEAS	Turloch Smith	Acoustics
FEAS	Eugene Mullins	Acoustics
FEAS	Grahan Johnston	Acoustics
FEAS	Kieran McCann	Biologist
DTU Aqua	Jan Pedersen	Biologist
IWDG	Niall Keogh	MMO
GMIT	Amy Lusher	PhD

2.2 Survey Plan

2.2.1 Survey objectives

The primary survey objectives are listed below:

- Collect acoustic data on blue whiting spawning aggregations within the pre-determined areas based on terms agreed at the WGIPS meeting 2013
- Collect biological samples from directed trawling on fish echotraces to determine age structure and maturity state of survey stock
- Determine an age stratified estimate of relative abundance of blue whiting within the survey area using acoustic survey techniques
- Collect physical oceanography data as horizontal and vertical profiles from a deployed sensor array
- Submit survey data (acoustic, biological and hydrographic) to the internationally coordinated database
- Conduct a sighting survey of marine mammals and seabirds

2.2.2 Survey design and area coverage

The survey covered the core spawning area of blue whiting to the west of Ireland, Scotland and the Faroes-Shetland ridge (Figure 1). Coverage extended from the shelf slopes (250 m) westward into the Rockall Trough and was carried out in continuity from south to north.

Transect design and effort allocation was pre-agreed for each vessel at the WGIPS meeting in 2013. A parallel transect design was used to allow transect interlacing in co-surveyed target areas (east-west orientation). Offshore, transects extended to the 15° W. Transect spacing was set at 30 nmi for individual vessels and maintained throughout the survey.

In total, the Irish survey covered 56,833 nmi² using 1,960 nmi of transects. Survey design and methodology adheres to the methods laid out in the WGIPS acoustic survey manual.

2.3 Equipment and system details and specifications

2.3.1 Acoustic array

Equipment settings for the EK60 are based on established settings employed on previous surveys (O'Donnell *et al.*, 2004) and are shown in Table 1.

Acoustic data were collected using the Simrad ER60 scientific echosounder. A Simrad ES-38B (38 kHz) split-beam transducer is mounted within the vessels drop keel and lowered to the working depth of 3.3 m below the vessels hull or 8.8 m below the sea surface. Three other frequencies were used during the survey (18, 120 and 200 kHz) for trace recognition purposes, with the 38 kHz data used solely to generate the abundance estimate.

While on track the vessel is normally propelled using DC twin electric motor propulsion system with power supplied from 1 main diesel engine, so in effect providing “silent cruising” as compared to normal operations (ICES, 2002). Cruising speed is maintained at a maximum of 10 Kts (knots) where possible. During fishing operations normal 2 engine operations were employed to provide sufficient power to tow the net.

2.3.2 Calibration of acoustic equipment

The ER60 was calibrated in Donegal Bay on March 27 at the start of the survey and again in Killary Harbour on April 12 at the end. The results of the first calibration (38 kHz transducer) are shown in Table 1.

2.3.3 Inter-vessel calibration

Inter-vessel acoustic calibrations are carried out when participant vessels are working within the same general area and time and weather conditions allow for an exercise to be carried out. The procedure follows the methods described by Simmonds & MacLennan 2007.

2.3.4 Acoustic data acquisition

EK60 “RAW files” were logged via a continuous Ethernet connection to the vessels server and the EK60 hard drive as a backup. Sonar Data’s Echoview® Echolog (Version 4.8) live viewer was used to display the echogram during data collection to allow the scientists to scroll through echograms noting the locations and depths of fish shoals. A member of the scientific crew monitored the equipment continually. Time and location (GPS position) data was recorded for each transect within each target area. This log was used to monitor the time spent off track during fishing operations and hydrographic stations plus any other important observations.

2.3.5 Echogram scrutinisation

Acoustic data was backed up onto the vessels server every 24 hrs and scrutinised using Echoview.

EK60 “Raw” files were imported into Echoview for post-processing. The echograms were divided into transects. Echo integration was performed on regions defined by enclosing selecting marks or scatter that belonged to one of the target species categories. Echograms were analysed at a threshold of -70 dB and where necessary plankton were filtered out by thresholding to -65 dB where required.

Echograms were scrutinised into one of the following categories:

- a). Blue whiting (further classified as; Definitely, Probably, Possibly and Mixed)
- b). Mesopelagic fish
- c). Plankton
- d). Pelagic fish (Including herring and mackerel)

2.3.6 Biological sampling

A single pelagic midwater trawl with the dimensions of 70 m in total length and a fishing circle of 768 m was employed during the survey (Figure 10). Mesh size in the wings was 12.5 m through to 20 mm in the cod-end. The net was fished with a vertical mouth opening of approximately 50 m and was observed using a cable linked “BEL Reeson” netsonde (50 kHz). The net was also fitted with a Scanmar depth sensor. Spread between the trawl doors was monitored using Scanmar distance sensors, all sensors being configured and viewed through a Scanmar Scanbas system.

All components of the catch from the trawl hauls were sorted and weighed; fish and other taxa were identified to species level. Fish samples were divided into species composition by weight. Species other than blue whiting were weighed as a component of the catch. Age, length, weight, sex, stomach fullness and maturity data were recorded for individual blue whiting within a random 50 fish sample from each trawl haul with a further 100 random length and weight measurements were also taken. All blue whiting were aged onboard. The appropriate raising factors were calculated and applied to provide length frequency compositions for the bulk of each haul.

Decisions to fish on particular echo-traces were largely subjective and an attempt was made to target marks in all areas of concentration not just high density shoals. No bottom trawl gear was used during this survey.

2.3.7 Oceanographic data collection

Oceanographic stations were carried out during the survey at predetermined locations along the track (Figure 5). Data on temperature, depth and salinity were collected using a Seabird 911 sampler from 1 m subsurface to 1000 m where depth allowed or to within 10 m of the bottom on shelf slopes.

2.4 Analysis methods

2.4.1 Echogram partitioning and abundance estimates

The recordings of area back scattering strength (NASC) per nautical mile were averaged over one nautical mile, and the allocation of area backscattering strengths to species was made by comparison of the appearance of the echo recordings to trawl catches.

The allocation of NASC (Nautical Area Scattering Coefficient) values to blue whiting and other acoustic targets was based on the composition of the trawl catches and the appearance of the echotraces. To estimate the abundance, the allocated NASC values were averaged for 1° latitude by 2° longitude strata (4 ICES rectangles). For each strata, the unit area density of fish (S_A) in number per square nautical mile ($N \cdot nmi^{-2}$) was calculated using standard equations (Foote et al. 1987, Toresen *et al.* 1998).

For blue whiting a target strength (TS) of $= 20 \log_{10} - 65.2$ dB was applied based on Pedersen *et al.*, 2011.

To estimate the total abundance of fish, the unit area abundance for each statistical rectangle was multiplied by the number of square nautical miles in each statistical square and then summed for all statistical rectangles within defined sub areas and for the total area. Biomass estimation was calculated by multiplying abundance in numbers by the average weight of the fish in each statistical rectangle and then sum of all squares within defined sub areas and the total area.

2.5 Marine mammal and seabirds

Visual surveys for cetaceans and seabirds were undertaken between 27th March and 11th April 2013. Casual, auxiliary records were also obtained for cetaceans on 12th April. The survey area covered the eastern slopes of the Rockall Trough west of Co. Mayo and north to the waters between the Faeroe Islands and Shetland. Deep water canyons, seamounts and shelf habitats also featured on the survey track as well as coastal inshore waters at the start and end of the survey period.

Surveying was conducted from one of two platforms; the Crow's Nest (height of 17m) or the Bridge (height of 10m), scanning a 180° area ahead of the ship. Surveys were carried out from the Crow's Nest for the most part except when excessive swell and sea state made for unsafe working conditions there. During such times, surveying was continued from the Bridge. The length of watch periods varied but typically lasted up to 4 hours each, with suitable

breaks allowed. These were conducted twice a day at various times between 08:00am and 20:00pm depending on weather conditions.

Cetaceans were searched for with the naked eye, using binoculars (Swarovski 8x32 EL) only to confirm identification. Where species identification could not be confirmed, sightings were downgraded as appropriate (i.e. probable, possible, unidentified whale, unidentified dolphin etc.) according to criteria set out by the Irish Whale and Dolphin Group for their sightings database (IWDG 2009). The distance of any cetacean seen from the ship was estimated using a range finder (Heinemann 1981). The position of each cetacean sighting was digitally marked using a laptop with IFAW Logger 2000™ software (IFAW 2000) into which details such as group size, behaviour, distance from ship, bearing, heading, environmental conditions etc. were recorded. Other details such as changes in transect direction and continuous 15 minute updates on environmental conditions were also recorded. Auxiliary sightings of cetaceans seen outside of survey periods by staff and crew were also kept.

A list of seabird species seen during each watch period was kept in order to ascertain the frequency of occurrence of the more regularly encountered species. Furthermore, opportunistic counts of scarcer species or feeding aggregations were also made.

Records of any other marine mega fauna (i.e. seals, basking sharks, sunfish, jellyfish etc.) encountered were also kept.

3 Results

3.1 Blue whiting abundance and distribution

A total of 15 directed blue whiting trawls were carried out during the survey and a further 6 exclusively targeting mesopelagic echotraces (Figure 1, Table 2).

In total 1,031 echotraces were positively identified as blue whiting over the 22 strata surveyed (Table 9). Blue whiting spawning/post-spawning aggregations were most frequently encountered between 350-550m with a range extending from 250 to 730m. Positively identified schools at 730m represent the deepest schools encountered during the current survey time series.

The second most frequently encountered group of species were the Myctophidae present in all but one of the 15 survey hauls (Table 9). High density mesopelagic echotraces were observed in a number of areas during daylight hours. Dedicated sampling was undertaken at a number of locations during daylight and at night (Table 2, Figure 3c). The presence of mesopelagic species in trawl catches, outside of those directly targeting mesopelagics, are generally regarded as by-catch due to the passage of the trawl through the mesopelagic layer (70-200 m) to the target blue whiting layer (250-730 m).

Mackerel were encountered in 5 trawls along the shelf slopes. Maturity analysis revealed individuals to be in a pre-spawning state (stage 4). Stomach content analysis showed individuals were actively feeding on pearlsides (*Maurolicus muelleri*).

3.1.2 Blue whiting biomass and abundance

A full breakdown of the survey estimate is presented by distribution, age, length, biomass, abundance and area in Figures 2 & 4 and Tables 3-9.

Blue whiting	Millions	Biomass (t)	% contribution
<i>Total estimate</i>			
Definitely	21,577	2,710,913	100.0
Mixture	0	0	0.0
Probably	0	0	0.0
Total estimate	21,577	2,710,913	100
<i>SSB Estimate</i>			
Definitely	18075	2,464,326	100.0
Probably	0	0	0.0
Mixture	0	0	0.0
SSB estimate	18075	2,464,326	100

3.1.3 Blue whiting distribution

For the purposes of international survey effort the spawning area was broken down into target areas ranked according to historic core abundance areas (Figure 1).

Four target areas were surveyed with varying degrees of coverage as part of the agreed component of international effort allocation. Two of these target areas were poorly covered by this survey and thus are not representative as stand alone estimates. The Rockall trough, an open water area, was covered using 1 strata and accounted for <3,700nmi² of area coverage. As blue whiting distribution was generally closer to the shelf edge the number of echotraces encountered was low (n=10) contributing 0.6% to the TSB and 0.7% to total abundance (TSN). The northern Porcupine area was covered with 3 strata and covered a larger geographical area (>8,000nmi²). In total 107 echotraces were observed in this area along the shelf edge and contributed 6.2% of TSB and 6.0% of TSN.

Two target areas were more comprehensively surveyed; the Hebrides core area was covered using 13 strata relating to 60% (>34,000nmi²) of survey effort and the Faroe/Shetland area using 5 strata and 20% (>10,000nmi²) of effort.

Overall high density echotraces dominated the shelf regions from north to south within 8nmi of the shelf edge at depths of between 250-730m. The largest concentration of echotraces extended from 54° to 59°N in the Hebrides area and where the bulk of the stock was located. Echotraces along this latitude extended as far west as 14nmi from the 250m contour (Figure 3a). The Hebrides area accounted the highest density single strata representing 464,000t of biomass and 3,917 million individuals (Table 9, Figure 3b). Over 88% of the TSB and 89% of the SSB were recorded in the Hebrides area from 703 echotraces. The distribution of biomass within this area is consistent with the results from previous surveys.

Faroe/Shetland target area was the most northerly survey area and was primarily covered by Ireland and the Faroes. This area was characterised by fewer high density echotraces (n=211) than further south and was characterised mainly by immature individuals (Figure 3d). This area accounted for 20% of effort (c.11,000nmi²) and contributed 5.5% to the TSB and 3.8% to SSB.

3.1.4 Blue whiting stock structure

During the survey 650 fish were aged with length, weight, sex, maturity and stomach fullness data recorded. A further 1,301 fish were measured and weighed. Age analyses of otoliths showed individuals from 1 to 16-years old from trawl samples (Figure 4).

The age structure of survey stock was dominated by 3 strong year classes namely the 10, 5 and 3-year old fish respectively. Together these year classes represented 56% of the TSB and 55% of the TSN.

In terms of biomass the breakdown is as follows; 10-year old fish 25.7% (697,900t), 5-year old fish 17.4% (472,600t) and 3-year old fish 12.8% (346,600t). In terms of abundance: 10-year old fish 17.2% (3,720 million individuals), 2-year old fish 18.2% (3,922 million individuals) and 3-year old fish 19.1% (4,113 million individuals).

Maturity analysis of samples (international data) revealed that 18% 1-year old fish were mature, 54% of 2-year old fish and 82% of 3-year old fish. Of the mature fish sampled a high proportion were actively spawning or spent indicating the spawning was still underway. Over 90% of the surveyed stock was found to be mature with less than 9% immature. Immature fish were found in all strata surveyed (n=22) with the highest concentrations in the Faroe/Shetland area where over 37% of the biomass was immature.

3.2 Oceanography

Overall 35 CTD casts were carried out during the survey. Open water stations were conducted to a maximum of 1,000m. Horizontal profiles of temperature and salinity from 10m subsurface to 600m were compiled using international data from 150 individual casts (Figures 6-9).

Surface water conditions (10m) indicate relatively stable conditions south of 60°N in terms of temperature and salinity with the warmest area in the west and south. The most dominant feature is the influence of Arctic water (cooler and less saline) in the northeast in the Faroe/Shetland Channel and this is clearly evident in all depth profiles. At 200m depth temperature decreases progressively from the southwest to the northeast along with salinity (Figure 7). For deeper profiles, 400 and 600m temperature and salinity appear relatively stable for the main body of the survey area south of 60°N in the Rockall Trough (Figures 8 & 9). The 400 & 600m depth profiles are within the range where the bulk of the spawning stock was located during the survey. The comparable and relatively stable conditions at depth may have influenced the deep distribution of echotraces observed this year which reached a maximum 730m.

3.2 Inter-vessel calibration

No acoustic inter-calibration was carried out in 2013.

3.3 Marine mammal and seabirds

Effort

A total of 121 hours and 15 minutes of dedicated surveying was conducted between 27th March and 11th April 2013 with an average of 7 hours and 30 minutes surveyed per day (range of 2.5 hours to 10 hours). A total of 101 hours and 45 minutes was conducted from the Crow's Nest and a further 19 hours and 30 minutes conducted from the Bridge.

Survey conditions

Environmental data was collected at 500 stations along the survey track. Survey conditions during the first week were rather poor, with heavy swell and high winds. This improved as the survey progressed, with excellent conditions prevailing along the Northern part of the survey track. A sea state of 4 or less was encountered for approximately 78.2% of survey time with a sea state of 0-1 for 9.4%. Observations during sea state of 5 to 7 lasted 21.8% of survey time, mostly during the first week. In conjunction with this, approximately 60% of survey time with swell of 2-3 (i.e. moderate to heavy) was recorded and 40% with swell 0-1 (i.e. none to slight) also recorded. Visibility was generally good to excellent throughout with 94.8% of survey time with visibility between 6 and 15 km recorded. Reduced visibility to less than 5km or less than 1km at times was recorded during just 5.2% of surveying.

Sightings

In all, 39 sightings of 9 cetacean species were recorded, relating to a maximum of 256 individuals (Table 12). Of these, 27 were seen during dedicated survey periods and a further 12 logged as auxiliary sightings. In addition, a total of 18 seabird species (Table 13) and 8 terrestrial or coastal bird species were also seen.

More details and information can be found in the species accounts, in which taxonomy and nomenclature follows Shirihi and Jarrett (2006) for cetaceans and Irish Rare Birds Committee (2011) for all birds.

4 Discussion and Conclusions

4.1 Discussion

Overall, the survey objectives were carried out as planned and no time was lost due to bad weather or mechanical failure. Good weather conditions allowed for complete of pre-planned tracks and some additional transects to ensure good international coverage. Six dedicated mesopelagic trawls were undertaken after the survey was complete.

Communication between vessels was very good and this allowed for close spatio-temporal alignment and adaptive changes to the survey design to be implement quickly and efficiently.

The abundance estimate is considered as robust as the stock was considered well contained within the survey area (international coverage) and comprehensive trawl sampling was undertaken.

The distribution of the bulk of the stock in the mid latitudes indicated that the timing of the survey was good and post spawning migration was not fully underway.

Blue whiting school depth was recorded to a maximum of 720m during the survey and this represents some of the deepest high density schools observed during the survey time series (2004-2013).

4.2 Conclusions

As this survey forms part of larger cooperative survey covering the entire spawning range of the stock it is difficult to take the results from this survey as an indicator of the state of the stock over the entire area. However, the core area (Hebrides) commonly contributes the largest biomass to the total stock estimate (>50%). As Ireland covers this area comprehensively with a high degree of effort it is possible to determine if the overall estimate has increased or decreased. For the 2013 estimate this would indicate an increase in detected biomass for the Hebrides area as compared to last year.

The presence of immature fish (1-2 years old) within the survey area is encouraging, although the estimates of abundance of young fish from this survey are not considered reliable. The presence of young fish on the survey grounds are thought to be part of the residual stock of immature fish that have not yet recruited fully to the stock. That said indications of a strong year class may be visible due to the increased numbers on the grounds, especially in the northern area of the Hebrides and Faroes/Shetland. Such was the case of the current 4-year and 3-year old fish (2009 & 2010 year classes) which were tracked through survey estimates from two-year fish within during the international survey.

The stock appears to be in the third year of positive recruitment after a prolonged period of poor recruitment. Although episodic, periods of positive recruitment can have a strong influence on the stock within a short relatively short time frame.

Acknowledgements

We would like to express our thanks and gratitude to Dennis Rowan (Captain) and crew of the Celtic Explorer for their good will and professionalism during the survey.

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Table 1. Survey settings and calibration report for the Simrad ER60 echosounder. Blue whiting survey, March-April 2013.

Vessel :	R/V Celtic Explorer	Date :	27/3/2013
Echo sounder :	EK60 PC	Locality :	Donegal Bay
Type of Sphere :	WC-38,1	TS _{Sphere} :	-33.50 dB (Corrected for soundvelocity or t,S)
		Depth(Sea floor) :	33 m

Calibration Version 2.1.0.11

Comments: CE13006.BWAS.Mc Swynes Bay. 27.03.13. 38 kHz			
Reference Target:			
TS	-33.5 dB	Min. Distance	23.00 m
TS Deviation	5.0 dB	Max. Distance	28.00 m
Transducer: ES38B Serial No. 30227			
Frequency	38000 Hz	Beamtype	Split
Gain	26.5 dB	Two Way Beam Angle	-20.6 dB
Athw. Angle Sens.	21.90	Along. Angle Sens.	21.90
Athw. Beam Angle	7.10 deg	Along. Beam Angle	7.10 deg
Athw. Offset Angle	-0.00 deg	Along. Offset Angl	-0.00 deg
SaCorrection	-0.00 dB	Depth	8.8 m
Transceiver: GPT 38 kHz 009072033933 1 ES38B			
Pulse Duration	1.024 ms	Sample Interval	0.191 m
Power	2000 W	Receiver Bandwidth	2.43 kHz
Sounder Type: ER60 Version 2.4.0			
TS Detection:			
Min. Value	-50.0 dB	Min. Spacing	100 %
Max. Beam Comp.	6.0 dB	Min. Echolength	80 %
Max. Phase Dev.	8.0	Max. Echolength	180 %
Environment:			
Absorption Coeff.	9.8 dB/km	Sound Velocity	1493.9 m/s
Beam Model results:			
Transducer Gain =	25.46 dB	SaCorrection =	-0.76 dB
Athw. Beam Angle =	6.99 deg	Along. Beam Angle =	6.93 deg
Athw. Offset Angle =	-0.01 deg	Along. Offset Angle=	-0.06 deg
Data deviation from beam model:			
RMS = 0.18 dB			
Max = 0.41 dB No. = 182 Athw. = -1.7 deg Along = -1.8 deg			
Min = -0.63 dB No. = 157 Athw. = 0.7 deg Along = -4.2 deg			
Data deviation from polynomial model:			
RMS = 0.17 dB			
Max = 0.39 dB No. = 182 Athw. = -1.7 deg Along = -1.8 deg			
Min = -0.56 dB No. = 76 Athw. = -1.9 deg Along = -1.2 deg			

Comments :	
Wind Force :	4 Wind Direction NE
Raw Data File:	\\Expfiledstr\ER-60_Data\BWAS_2013\RAW_ER60_Files\Calibration\BWAS_2013
Calibration File:	\\Expfiledstr\ER-60_Data\ER-60\Calibrations_2013\BWAS_2013\38 kHz

Calibration :

Ciaran O'Donnell

Blue whiting Acoustic Survey Cruise Report, 2013

Table 2. Catch composition, time and location of trawl hauls. Blue whiting survey, March-April 2013.

No.	Date	Lat. N	Lon. W	Time	Bottom (m)	Target (m)	Bulk Catch (Kg)	Sampled (Kg)	Blue Whiting %	Mackerel %	Meso %	Herring %	Others %
1	28.03.13	54 23.49	011 28.01	01:30	>1000	480-530	55.0	55.0	-		90.0		10.0
2	29.03.13	54 55.95	010 51.49	17:15	2230	480-520	3,000.0	152.6	99.3	0.2	0.5		
3	30.03.13	55 24.92	010 01.17	04:26	850	405-455	30.0	29.2	99.2	0.3	0.5		
4	30.03.13	55 25.88	011 30.01	14:12	>1000	480-520	118.0	118.0	98.0		1.9		0.1
5	31.03.13	55 55.38	009 38.60	10:21	1500	480-520	2,000.0	138.7	100.0				
6	31.03.13	56 25.47	009 12.84	21:55	915	455-550	4,000.0	141.6	99.7	0.2	0.1		
7	01.04.13	56 56.10	010 19.16	15:15	>2000	470-510	2,000.0	128.0	99.2		0.9		
8	02.04.13	57 25.58	009 39.32	05:42	1128	440-500	1,000.0	129.8	99.7		0.1		0.2
9	02.04.13	57 56.99	009 43.07	11:20	900	400-550	1,500.0	123.1	98.9		0.5		0.6
10	03.04.13	58 25.73	010 26.05	12:15	1918	475-530	3,500.0	144.7	99.8		0.2		
11	04.04.13	58 56.10	008 20.19	06:11	1509	420-466	1,200.0	128.9	98.9		1.1		
12	04.04.13	59 26.06	006 51.10	16:22	>1000	220-300	93.2	93.2	67.2		1.2		31.6
13	05.04.13	59 55.73	006 44.98	04:19	650	350-450	300.0	119.4	97.9		2.0		0.1
14	07.04.13	60 36.01	003 35.07	17:08	510	490-520	19.1	19.1	58.0		5.4		36.6
15	08.04.13	61 21.96	003 42.95	12:35	1181	500-520	124.2	124.2	98.1		0.9		1.2
16*	08.04.13	60 43.05	003 24.50	22:37	2800	80-120	1.0	1.0		70.0	0.4		29.6
17*	09.04.13	59 14.49	007 15.32	17:13	686	260-280	4.0	-		96.0	0.1		3.9
18*	09.04.13	58 47.89	007 59.37	22:52	450	60-100	11.0	-			0.3		99.7
19*	10.04.13	55 40.38	009 32.65	23:13	>1000	20-120	1.0	-			0.5		99.5
20*	11.04.13	54 48.48	010 35.34	12:00	>1000	130-200	0.2	-			100.0		
21*	11.04.13	54 16.17	011 34.56	23:15	>1000	20-100m	3.0	-			98.0		2.0

Note: "Others" was used to represent fish and non-fish species occurring in the catch.

Table 3. Length frequency distribution of blue whiting from trawl samples. Blue whiting survey, March-April 2013.

Haul length (cm)	2	3	4	5	6	7	8	9	10	11	13	14	15	Total
17.5		1												1
18		1						1						2
18.5												4	1	5
19		3						2			2	2		9
19.5		2						1			2	8	2	15
20					1			4			3	2	5	15
20.5		1	1					1			1	6	3	13
21		2									2		5	9
21.5	1	4	1	1		1		2					7	17
22	1	3			1	1	1	3			1	2	2	15
22.5	1	3	1	2	3	5		4	1		1	2	5	28
23	1	7	1	1	3	3		6		1	4	10	7	44
23.5	3	6	1	1	1	5		2	1		1		10	31
24	2	8	1	1	3	4		1	1	1	8	15	13	58
24.5	1	5	1	2	3	1	1	7		1	5	21	13	61
25	1	5	2	2	6	5	2	2	2	2	6	6	9	50
25.5	4	5	4	1	2	1	1	2	1	1	1	6	4	33
26	3	5	5	2	6	1	1	5	1	1	5		5	40
26.5	5	8	6	5	7	3	2	6	1	1	2	6	2	54
27	10	9	8	5	7	3	7	7	1			2	3	62
27.5	8	6	7	8	9	4	6	6	1	1	2		1	59
28	8	3	9	6	13	3	9	6	1	5	3	2	1	69
28.5	10	4	6	2	7	2	6	5		7	2		1	52
29	5	3	4	6	7	2	9	5	3	3	2			49
29.5	6	2	3	3	3	1	7	3	1	1	2	2		34
30	5	1	3	5	4	3	9	4	3	5	4			46
30.5	6		5	5	3	5	5	1	5	3	1			39
31	3	1	5	9	2	7	9	1	9	4	1		1	52
31.5	3		5	5	1	7	4	3	6	7	4		1	46
32	3		2	7	1	7	3	1	13	5	2		1	45
32.5	1		3	4	1	3	2	2	10	1	4			31
33	1		2	3		4	1	1	9	12	6			39
33.5	1	1	3	1	1	5	1	4	8	5	10	2	1	43
34	1		2	3		6	3		5	7	10			37
34.5	2	1	3	1	1	1	1		4	5	5			24
35	3	1	3	2	1	3	4		2	7				26
35.5	1		3	2	1	2	2		4	4			1	20
36	1		2	1		1	3		2	3				13
36.5				1	1		1		1	1				5
37					1				1	1				3
37.5									1	2				3
38								1						1
38.5														
39										1				1
39.5														
40														
40.5										1				1
41														
41.5														
42														
42.5														
43									1					1
Total	101	101	102	97	100	99	100	98	100	99	102	98	104	1,301

Table 4. Blue whiting length at age (years) as abundance (millions) and biomass (000's tonnes).. Blue whiting survey, March-April 2013.

Length (cm)	Age																Abund (mils)	Biomass 000's t	Mn wt (g)
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16			
17.5	55.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	55.2	1.7	31.5
18	38.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	38.9	1.3	34.1
18.5	46.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	46.9	1.7	36.8
19	206.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	206.5	8.2	39.7
19.5	227.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	227.3	9.7	42.6
20	297.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	297.5	13.6	45.8
20.5	202.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	202.0	9.9	49.0
21	-	68.0	-	68.0	-	-	-	-	-	-	-	-	-	-	-	-	136.0	7.1	52.5
21.5	-	250.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	250.3	14.0	56.0
22	90.8	181.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	272.5	16.3	59.8
22.5	-	273.5	164.1	-	-	-	-	-	-	-	-	-	-	-	-	-	437.6	27.9	63.6
23	-	393.1	357.1	-	-	-	-	-	-	-	-	-	-	-	-	-	750.2	50.8	67.7
23.5	-	168.4	252.1	42.1	-	-	-	-	-	-	-	-	-	-	-	-	462.5	33.2	71.9
24	-	87.9	733.6	-	-	-	-	-	-	-	-	-	-	-	-	-	821.5	62.6	76.2
24.5	25.3	99.4	747.5	-	-	-	-	-	-	-	-	-	-	-	-	-	872.2	70.5	80.8
25	-	162.2	566.5	40.7	-	-	-	-	-	-	-	-	-	-	-	-	769.5	65.8	85.5
25.5	-	-	432.6	92.4	-	-	-	-	-	-	-	-	-	-	-	-	524.9	47.4	90.4
26	-	-	330.3	220.2	147.0	-	-	-	-	-	-	-	-	-	-	-	697.4	66.6	95.4
26.5	-	-	259.7	356.8	291.4	-	-	-	-	-	-	-	-	-	-	-	907.9	91.4	100.7
27	-	-	92.1	431.7	492.7	62.1	-	31.1	-	-	-	-	-	-	-	-	1109.7	117.7	106.1
27.5	-	-	34.4	174.0	698.2	104.2	-	-	-	-	-	-	-	-	-	-	1010.9	112.9	111.7
28	-	-	32.7	258.4	709.8	128.6	-	-	-	-	-	-	-	-	-	-	1129.6	132.7	117.5
28.5	-	-	32.0	255.8	544.5	32.0	-	-	-	-	-	-	-	-	-	-	864.3	106.7	123.4
29	-	-	45.9	182.8	227.9	364.8	45.9	-	-	-	-	-	-	-	-	-	867.3	112.4	129.6
29.5	-	-	-	176.3	226.8	151.4	-	24.9	-	-	-	-	-	-	-	-	579.4	78.8	136.0
30	-	-	-	91.2	365.8	213.2	-	60.5	30.7	60.5	30.7	-	-	-	-	-	852.7	121.6	142.6
30.5	-	-	-	37.8	112.7	112.7	-	37.8	37.8	299.6	37.8	-	-	-	-	-	676.0	101.0	149.3
31	-	-	32.5	97.4	-	259.7	64.9	64.9	97.4	259.7	-	-	-	-	-	-	876.4	137.0	156.3
31.5	-	-	-	29.3	57.8	116.4	-	57.8	87.1	377.5	87.1	-	-	-	-	-	812.9	132.9	163.5
32	-	-	-	-	-	31.3	61.9	31.3	93.3	373.1	124.6	31.3	-	-	-	-	746.9	127.6	170.9
32.5	-	-	-	-	-	-	34.7	34.7	69.4	311.0	103.5	34.7	-	-	-	-	587.8	104.9	178.5
33	-	-	-	-	-	87.9	-	87.9	87.9	307.2	43.6	-	-	-	-	-	614.4	114.5	186.3
33.5	-	-	-	-	-	-	33.7	33.7	33.7	578.7	101.8	-	-	-	-	-	781.5	151.9	194.4
34	-	-	-	47.7	47.7	47.7	-	-	96.1	335.9	47.7	-	47.7	-	-	-	670.4	135.9	202.6
34.5	-	-	-	-	-	-	-	39.9	39.9	199.3	39.9	39.9	39.9	-	-	-	398.5	84.1	211.1
35	-	-	-	-	-	-	-	32.4	-	243.0	48.5	16.0	16.0	-	-	16.0	372.0	81.8	219.8
35.5	-	-	-	-	-	-	-	35.5	-	177.5	53.4	-	-	17.6	-	-	284.0	65.0	228.8
36	-	-	-	-	-	-	-	21.5	-	107.5	43.0	43.0	-	-	-	-	215.0	51.2	238.0
36.5	-	-	-	-	-	-	-	-	-	52.2	-	-	-	-	-	-	52.2	12.9	247.4
37	-	-	-	-	-	-	-	-	-	16.3	16.3	-	-	-	-	-	32.5	8.4	257.0
37.5	-	-	-	-	-	-	-	-	-	-	-	28.0	-	-	-	-	28.0	7.5	266.9
38	-	-	-	-	-	-	-	-	-	8.3	-	-	-	8.3	-	-	16.7	4.6	277.0
38.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
39	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.6	2.0	298.0
39.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
40.5	-	-	-	-	-	-	-	-	-	6.6	-	-	-	-	-	-	6.6	2.2	331.4
41	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
41.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
42	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
42.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
43	-	-	-	-	-	-	-	-	-	-	-	-	-	8.3	-	-	8.3	3.3	392.3
Total																	21,577.1	2,710.9	
SSN (mil)	197.6	1,070.0	2,589.6	2,411.1	3,786.5	1,689.9	238.7	587.1	685.7	3,710.6	789.5	164.9	111.9	26.0	-	16.0	18,075.1	-	-
SSB (000s t)	10.2	71.4	224.6	279.6	458.3	240.5	39.0	103.0	122.2	696.4	150.6	33.7	23.9	7.3	-	3.5	-	2,464.3	-
Mn Wt (g)	45.1	67.2	84.3	114.7	120.5	142.2	163.5	174.8	178.1	187.6	190.8	204.5	213.7	281.3	-	219.8	-	-	-
Mn length (cm)	20.1	23.1	25.1	27.9	28.4	30.1	31.7	32.4	32.7	33.3	33.4	34.3	34.9	38.2	-	35.2	-	-	-

Table 5. Total blue whiting biomass at age. Blue whiting survey, March-April 2013.

Target area	Strata	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
Porc	5410	0	0.3	2.9	12.1	20.3	35.3	13.3	1.3	4.3	3.5	21.9	4.8	1.6	0.8	0.1	0	0.2	122.6
	5412	0	0.1	0.7	4.1	6.5	11	4.4	0.5	1.8	1.6	10.7	2.3	0.7	0.3	0.1	0	0.1	45.2
	5414	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hebrides	5508	0	1.6	7.5	23.2	24.4	38.7	22.1	3.7	7.9	9.2	49.7	10	2.4	0.9	0.3	0	0.3	202.1
	5510	0	6.7	21.4	70.3	67.6	104.1	39.4	5	15.5	14.1	90.5	19.5	5.6	2.8	0.9	0	0.7	464
	5608	0	0.5	7.3	18.5	16	26	14.7	2.7	6.3	8.4	45.7	9.2	1.6	1.3	0.3	0	0.2	158.8
	5610	0	0.3	7.2	15.7	11.9	18.1	13.6	2.9	6.8	9.3	50.7	10.3	1.8	1.5	0.3	0	0.3	150.5
	5708	0	8.4	13.5	37.5	51.6	87.9	42.3	5.2	12.3	11.1	69.3	14.9	4	1.3	0.4	0	0.5	360.3
	5710	0	4.7	8.7	23.7	31.2	52.4	27.3	3.9	9.1	9.4	55.4	12	3	1.4	0.6	0	0.3	243
	5808	0	4.7	8	21.2	22.5	37.1	22.3	4.1	11.9	14.8	82.6	20.1	3.8	2.9	1.5	0	0.4	257.8
	5810	0	0	0.7	3.8	5	6.1	11.3	3.8	8.2	11.9	61.2	14.2	3.1	2.8	2.4	0	0.1	134.5
	5906	0	8.7	11.6	41.4	21.3	31.6	20.9	4.4	12.4	20.7	107.4	21.1	4	5.8	0	0	0.1	311.3
	5908	0	0.7	1	3.9	2.8	4.7	3.4	0.6	2.3	3.2	17.7	4	0.8	0.8	0.1	0	0.1	46.1
	5910	0	0	0	0.3	0.5	0.8	0.7	0.1	0.5	0.6	3.7	0.9	0.2	0.1	0	0	0	8.6
	5904	0	0.3	0.4	1.3	0.6	0.9	0.6	0.1	0.4	0.6	3.2	0.6	0.1	0.2	0	0	0	9.3
	5806	0	0	0.2	1	1.7	3.2	2.6	0.4	1.9	2.3	13.4	3.5	0.7	0.5	0.1	0	0.1	31.6
	Faroe	6004	0	8.5	7.3	28.4	5.2	5.3	1.7	0.3	0.8	1.1	7	1.3	0.2	0.3	0	0	0
6006		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6104		0	1.3	3.9	8.6	1.7	1.1	0.3	0.1	0.1	0.1	0.9	0.2	0	0	0	0	0	18.3
6002		0	4.4	3.4	14	2.2	2	0.4	0.1	0.1	0.1	1.1	0.2	0	0	0	0	0	27.9
6102		0	2.5	7.3	16.2	3.2	2.1	0.5	0.1	0.3	0.2	1.7	0.4	0	0	0	0	0	34.5
Rockall	5512	0	0	0.2	1.5	2.3	3.8	1.6	0.2	0.7	0.7	4.4	1	0.3	0.1	0	0	0	16.9
Total		0	53.7	113.2	346.6	298.5	472.6	243.4	39.4	103.8	122.8	697.9	150.6	33.7	23.9	7.3	0	3.5	2,710.9
%		0	2	4.2	12.8	11	17.4	9	1.5	3.8	4.5	25.7	5.6	1.2	0.9	0.3	0	0.1	100

Table 6. Total blue whiting abundance at age. Blue whiting survey, March-April 2013.

Target area	Strata	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
Porc	5410	0	4.5	44.0	135.5	175.4	294.4	97.9	8.2	25.7	20.5	120.5	25.6	7.4	3.5	0.4	0.0	1.1	964.8
	5412	0	2.1	10.7	44.9	56.8	92.8	32.1	3.3	10.5	9.4	57.2	12.2	3.3	1.6	0.4	0.0	0.4	337.9
	5414	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hebrides	5508	0	37.1	113.7	270.4	211.7	325.2	156.4	23.4	46.4	53.9	270.9	54.6	11.9	4.5	1.5	0.0	1.1	1582.7
	5510	0	153.6	324.5	814.9	612.1	890.9	288.4	31.4	89.5	81.3	482.8	101.5	26.5	13.3	3.8	0.0	3.1	3917.6
	5608	0	8.3	106.5	223.6	136.4	215.5	101.3	16.4	36.3	47.2	247.6	49.4	8.3	6.4	1.4	0.0	1.1	1205.6
	5610	0	5.7	104.8	193.0	98.2	146.5	90.2	17.5	38.8	52.7	275.8	55.4	9.2	7.2	1.3	0.0	1.2	1097.5
	5708	0	181.9	206.2	429.0	439.4	727.9	308.7	33.2	74.2	66.4	376.2	80.0	19.0	6.4	1.6	0.0	2.2	2952.3
	5710	0	100.7	131.6	272.9	263.8	432.4	196.3	24.5	53.9	54.7	299.9	63.9	14.3	6.4	2.1	0.0	1.5	1918.9
	5808	0	101.4	120.1	248.4	189.8	303.7	152.8	24.8	66.0	80.6	430.0	100.9	18.5	13.1	4.7	0.0	2.0	1857.1
	5810	0	0.0	9.4	42.3	36.3	44.3	72.2	22.4	44.5	64.8	323.9	73.7	15.7	11.8	7.0	0.0	0.7	768.9
	5906	0	193.2	166.5	506.1	188.7	246.5	135.8	24.8	68.4	110.1	563.4	111.8	20.2	27.9	0.2	0.0	0.3	2363.7
	5908	0	15.2	14.4	47.2	23.7	36.4	22.2	3.4	12.4	16.9	90.3	20.1	3.7	3.9	0.3	0.0	0.4	310.6
	5910	0	0.0	0.5	2.9	3.4	6.4	4.6	0.7	2.8	3.4	18.5	4.5	0.9	0.7	0.2	0.0	0.1	49.5
	5904	0	6.1	5.2	15.8	5.8	7.4	4.0	0.7	2.0	3.3	16.7	3.3	0.6	0.8	0.0	0.0	0.0	71.7
	5806	0	0.1	1.9	10.8	12.9	24.8	16.8	2.2	10.2	12.0	67.1	16.5	3.1	2.5	0.5	0.0	0.6	181.9
	Faroe	6004	0	198.0	102.9	353.6	49.3	45.8	12.3	1.8	4.8	5.8	36.7	7.0	0.9	1.3	0.0	0.0	0.0
6006		0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6104		0	27.6	59.1	108.3	20.1	10.6	1.8	0.3	0.9	0.8	4.9	1.1	0.1	0.0	0.1	0.0	0.0	235.6
6002		0	102.0	48.2	173.9	20.9	18.2	3.2	0.3	0.9	0.3	5.5	1.0	0.0	0.0	0.0	0.0	0.0	374.4
6102	0	51.8	111.0	203.4	37.8	19.9	3.4	0.6	1.7	1.5	9.1	2.1	0.1	0.0	0.2	0.0	0.0	442.5	
Rockall	5512	0	0.9	3.2	16.0	20.1	32.4	11.4	1.3	4.1	3.8	23.2	5.0	1.3	0.7	0.2	0.0	0.1	123.5
Total		0	1190.2	1684.6	4112.9	2602.6	3922.2	1711.9	241.1	593.9	689.3	3720.2	789.4	164.9	111.9	25.9	0.0	16.0	21577.1
%		0	5.5	7.8	19.1	12.1	18.2	7.9	1.1	2.8	3.2	17.2	3.7	0.8	0.5	0.1	0.0	0.1	100.0
Cv (%)		0	27.0	25.0	21.0	18.0	17.0	14.0	16.0	14.0	14.0	14.0	14.0	16.0	15.0	30.0	NA	22.0	NA

Table 7. Total blue whiting biomass at maturity. Blue whiting survey, March-April 2013.

Target area	Strata	Imm	Mature	Spent	Total
Porc	5410	6.9	21.1	94.6	122.8
	5412	2.2	8.9	34.1	45.2
	5414	0	0	0	0
Hebrides	5508	14.9	34.2	153	202.1
	5510	45.4	79	339.6	464
	5608	11.1	30.6	117.1	158.8
	5610	9.7	30.7	110.1	150.5
	5708	29.6	62.8	267.9	360.3
	5710	18.1	45	179.9	243
	5808	16.5	57.4	183.9	257.8
	5810	2.1	36.7	95.8	134.5
	5906	30	66.7	214.6	311.3
	5908	2.7	11.3	32.1	46.1
	5910	0.1	2.4	6.1	8.6
	5904	0.9	2	6.4	9.3
Faroe	5806	0.5	8.9	22.2	31.6
	6004	24.1	7.3	36.1	67.4
	6006	0	0	0	0
	6104	6.5	1.4	10.4	18.3
	6002	12	2.2	13.6	27.9
Rockall	6102	12.3	2.7	19.5	34.5
	5512	0.8	3.5	12.6	16.9
Total		246.6	514.8	1,949.6	2,710.9
%		9.1	19.0	71.9	100.0

Table 8. Total blue whiting abundance at maturity. Blue whiting survey, March-April 2013.

Target area	Strata	Imm	Mature	Spent	Total
Porc	5410	80.6	136.9	747.3	964.8
	5412	25.7	54.0	258.1	337.9
	5414	0.0	0.0	0.0	0.0
Hebrides	5508	195.8	216.6	1170.4	1582.7
	5510	612.6	514.0	2791.1	3917.6
	5608	139.7	182.4	883.5	1205.6
	5610	123.4	177.0	797.1	1097.5
	5708	430.6	404.1	2117.6	2952.3
	5710	259.7	279.0	1380.2	1918.9
	5808	244.4	323.4	1289.3	1857.1
	5810	22.7	184.7	561.5	768.9
	5906	451.2	412.9	1499.7	2363.7
	5908	39.4	64.3	206.9	310.6
	5910	1.6	12.5	35.4	49.5
	5904	14.1	12.3	45.3	71.7
Faroe	5806	5.7	46.4	129.8	181.9
	6004	381.4	64.3	374.6	820.3
	6006	0.0	0.0	0.0	0.0
	6104	94.8	16.0	124.8	235.6
	6002	191.6	23.8	159.0	374.4
Rockall	6102	178.0	30.1	234.4	442.5
	5512	9.0	20.7	93.8	123.5
Total		3,502.1	3,175.2	14,899.9	21,577.1
%		16.2	14.7	69.1	100.0

Table 9. Results by strata. Blue whiting survey, March-April 2013.

Target area	Strata	No. transects	No. schools	Def schools	Mix schools	Prob schools	% zeros	Def Biomass	Mix Biomass	Prob Biomass	Biomass ('000t)	SSB ('000t)	Abundance millions
Porc	5410	2	79	79	0	0	0	122.6	0	0	122.6	115.7	964.8
	5412	2	28	28	0	0	0	45.2	0	0	45.2	42.9	337.9
	5414	1	0	0	0	0	100	0.0	0	0	0.0	0.0	0.0
Hebrides	5508	2	44	44	0	0	0	202.1	0	0	202.1	187.2	1,582.7
	5510	2	190	190	0	0	0	464.0	0	0	464.0	418.6	3,917.6
	5608	2	39	39	0	0	50	158.8	0	0	158.8	147.7	1,205.6
	5610	2	45	45	0	0	0	150.5	0	0	150.5	140.8	1,097.5
	5708	2	49	49	0	0	0	360.3	0	0	360.3	330.7	2,952.3
	5710	2	70	70	0	0	0	243.0	0	0	243.0	224.9	1,918.9
	5808	2	82	82	0	0	0	257.8	0	0	257.8	241.3	1,857.1
	5810	2	18	18	0	0	0	134.5	0	0	134.5	132.5	768.9
	5906	2	96	96	0	0	0	311.3	0	0	311.3	281.3	2,363.7
	5908	2	31	31	0	0	0	46.1	0	0	46.1	43.4	310.6
	5910	2	8	8	0	0	0	8.6	0	0	8.6	8.5	49.5
	5904	1	14	14	0	0	0	9.3	0	0	9.3	8.4	71.7
	5806	1	17	17	0	0	0	31.6	0	0	31.6	31.1	181.9
Faroe	6004	3	92	92	0	0	0	67.4	0	0	67.4	43.4	820.3
	6006	1	0	0	0	0	100	0.0	0	0	0.0	0.0	0.0
	6104	3	31	31	0	0	0	18.3	0	0	18.3	11.8	235.6
	6002	2	46	46	0	0	0	27.9	0	0	27.9	15.9	374.4
	6102	1	42	42	0	0	0	34.5	0	0	34.5	22.2	442.5
Rockall	5512	1	10	10	0	0	0	16.9	0	0	16.9	16.1	123.5
Total		40	1,031	1,031	0	0	8	2,710.9	0	0.0	2,710.9	2,464.3	21577.1
Cv (%)		-	-	-	-	-	-	-	-	-	14.0	NA	15

Table 10. Species occurrence from trawl stations. Blue whiting survey, March-April 2013.

Category	Common Name	Scientific Name	Occurrence
Pelagic	Blue Whiting	<i>Micromesistius poutassou</i>	14
	Mackerel	<i>Scomber scombrus</i>	3
	Horse mackerel	<i>Trachurus trachurus</i>	1
	Hake	<i>Merluccius merluccius</i>	0
Mesopelagics	Greater Argentine	<i>Argentina silus</i>	0
	Hatchet Fish (small)	<i>Argyropelecus hemigymnus</i>	0
	Myctophidae(combined)		11
	Hatchet Fish (large)	<i>Argyropelecus olfersi</i>	3
	None	<i>Astronethus gemmifer</i>	1
	Myctophidae	<i>Benthoosema glaciale</i>	0
	Alfonsino	<i>Beryx decadactylus</i>	0
	Ray's bream	<i>Brama brama</i>	1
	Blackfish	<i>Centrophagus niger</i>	1
	Sloanes Viper fish	<i>Chauliodus sloani</i>	2
	Myctophidae	<i>Diaphus raffinesqui</i>	0
	Myctophidae	<i>Diaphus metapoclampus</i>	0
	None	<i>Diretmus argentus</i>	1
	None	<i>Echiostoma barbatum</i>	0
	Myctophidae	<i>Electrona rissoi</i>	0
	Pipefish	<i>Entelurus aequoreus</i>	0
	Balbo sabretooth	<i>Evermanella balbo</i>	0
	None	<i>Gonastoma elongatum</i>	0
	None	<i>Howella sherborni</i>	1
	None	<i>Lampadena speculigera</i>	0
	Myctophidae	<i>Lampanyctus crocodilus</i>	0
	Myctophidae	<i>Lobianchia gemallari</i>	0
	Searsids	<i>Maulisia</i>	0
	Pearlside	<i>Maurolicus muelleri</i>	3
	Myctophidae	<i>Myctophum punctatum</i>	0
	Greenland Argentine	<i>Nansenia groenlandica</i>	0
	Forgotten argentine	<i>Nansenia oblita</i>	2
	Slender snipe-eel	<i>Nemichthys scolopaceus</i>	0
	Multipore Searside	<i>Normichthys operosus</i>	0
	None	<i>Notolepis rissoi</i>	7
	Myctophidae	<i>Notoscopelus krokeyeri</i>	0
	None	<i>Opisthoproctus soleatus</i>	0
	Shrimps	<i>Pandalidae</i>	6
	Silver Pomfret	<i>Pterycombus brama</i>	0
	Schnakenbeck's searside	<i>Sagamichthys schnakenbecki</i>	0
	None	<i>Scopelosaurus lepidus</i>	0
	None	<i>Searsia koefoedi</i>	0
	Bean's sawtoothed eel	<i>Serrivomer beani</i>	0
	None	<i>Sternoptyx diaphana</i>	0
	Scaly dragonfish	<i>Stomias boa</i>	0
	Myctophidae	<i>Symbolophoros veranyi</i>	0
	Greater Pipefish	<i>Syngnathus acus</i>	0
	Dealfish	<i>Trachipterus arcticus</i>	0
Bluntnout smooth-head	<i>Xenodermichthys copei</i>	0	
None	<i>Pseudoscopelus altipinnis</i>	0	
Demersal	Grey Gurnard	<i>Eutrigla gurnardus</i>	3
	Silvery Pout	<i>Gadiculus argentus</i>	2
	Norway Pout		0
Squid	saithe	<i>Pollachius Virens</i>	2
	Lesser flying squid	<i>Todaropsis elbanae</i>	0
	Northern flying squid	<i>Todarodes sagittatus</i>	0
	Short finned squid	<i>Omnastrephidae</i>	0
	Unknown squid		3
Other	Jellyfish		7
	Octopus		0
Total Number of Trawls			15
Total number of Species:			20

Table 11. Irish blue whiting survey time series. Blue whiting survey, March-April 2013.
*Note: 2012 onwards survey estimate calculated using the new TS-length relationship.

Year	2004	2005	2006	2007	2008	2009	2010	2011	2011	2012	2013
Target areas	2a	1	2b	1	1	1	1	Survey 1	Survey 2	1	1
	2b, 2c	2a, 2b		2a, 2b	2a, 2b	2b	2b	1, 2b	1, 2b	2b	2a, 2c
Age											
1	3.0	37.4	4.4	2.4	13.9	2.2	2.5	21.2	1.0	19.8	53.7
2	108.3	64.0	43.2	31.0	12.5	66.7	1.5	28.9	3.7	4.2	113.2
3	346.4	500.0	242.5	585.0	128.7	49.9	3.3	35.8	12.6	282.3	346.6
4	524.0	911.1	636.7	1681.0	1148.0	236.3	8.6	41.8	19.4	124.3	298.5
5	211.5	1010.0	342.6	1424.0	1445.7	1126.8	15.0	15.0	15.5	79.9	472.6
6	154.5	311.0	144.7	639.2	762.9	1444.3	81.7	107.3	23.3	155.3	243.4
7	72.8	111.0	50.4	219.3	200.0	563.6	143.3	255.3	26.8	86.7	39.4
8	34.7	69.9	18.0	126.2	33.1	117.6	104.2	489.5	85.6	212.3	103.8
9	4.1	20.5	0.0	14.6	0.0	31.4	19.2	319.2	41.2	514.9	122.8
10+	15.6	7.9	0.0	5.4	0.0	12.9	5.6	80.7	5.6	745.9	916.9
TSB ("000 t)	1,474.9	3,042.8	1,482.4	4,727.6	3,744.7	3,651.7	385.0	1,394.7	234.6	2,225.5	2,710.9
TSN (millions)	16,029.3	34,268.0	16,344.0	48,746.1	34,179.6	28,512.2	2,365.3	9,057.1	1,590.5	15,530.0	21,577.0
SSB ("000 t)	1,471.9	3,001.0	1,478.1	4,725.2	3,726.4	3,647.9	382.6	1,373.5	233.6	2,203.4	2,464.3

Target area 1: Hebrides & north Porcupine Bank; Target area 2a: western Porcupine Bank; Target area 2b: Rockall; Target area 2c Faroe/Shetland.

Table 12. Sightings, counts and group size ranges for cetacean species recorded during the survey.

Species	No. of sightings	No. of individuals	Group size range
<i>Sperm Whale</i>	3	17 (max.)	4-7
<i>Fin Whale</i>	1	1	-
<i>Killer Whale</i>	1	6	-
<i>Long-finned Pilot Whale</i>	9	67	3-20
<i>Cuvier's Beaked Whale</i>	1	5	-
<i>Sowerby's Beaked Whale</i>	1	3	-
<i>Common Bottlenose Dolphin</i>	3	26 (max.)	2-14
<i>Short-beaked Common Dolphin</i>	7	103	2-40
<i>Harbour Porpoise</i>	1	4	-
<i>Unidentified Whale</i>	7	8 (max.)	1-2
<i>Unidentified Small Whale</i>	2	2	-
<i>Unidentified Dolphin</i>	2	11	2-9
<i>Unidentified Cetacean</i>	1	3	-
Total	39	256 (max.)	n/a

Table 13. Seabird occurrence during the survey period with abundance for select species.

	F	Blue F	MX	OT	GX	SA	PL	NX	PU	RA	LK	GU	AUK	TE	CN	KI	LB	HG	IG	GB
27/03/13	x		22		x					x		x	x			x		x		x
28/03/13	x	5	1		x			5								x	x	x		x
29/03/13	x	1	1		x		1	3								x	x			x
30/03/13	x	1	13		x			4					x	2		x	x		1	x
31/03/13	x	3		1	x			4		x			x			x	x			x
01/04/13	x	3	2		x			4								x	x			x
02/04/13	x		1		x			3					x			x	x	x		x
03/04/13	x	2	1		x			2			1					x	x			x
04/04/13	x	1			x			3	4			x	x			x	x	x		x
05/04/13	x	2	1		x			1			1				1	x	x			
06/04/13	x	1			x			2			2	x				x	x			
07/04/13	x	3			x			1			1					x	x			
08/04/13	x	2			x			1				x				x	x			x
09/04/13	x				x	x		2					x			x	x	x		x
10/04/13	x		7		x			12	39							x	x			x
11/04/13	x	1	1		x			3	2			x				x	x			x
Total	-	25	50	1	-	-	1	50	45	-	5	-	-	2	1	-	-	-	1	-

Species codes: F = Fulmar, Blue F = 'Blue' Fulmar, OT = Sooty Shearwater, MX = Manx Shearwater, GX = Gannet, SA = Shag, PL = Grey Phalarope, NX = Bonxie, PU = Puffin, RA = Razorbill, LK = Little Auk, GU = Guillemot, AUK = Auk sp., TE = Sandwich Tern, CN = Common Tern, KI = Kittiwake, LB = Lesser Black-backed Gull, HG = Herring Gull, IG = Iceland Gull and GB = Great Black-backed Gull.

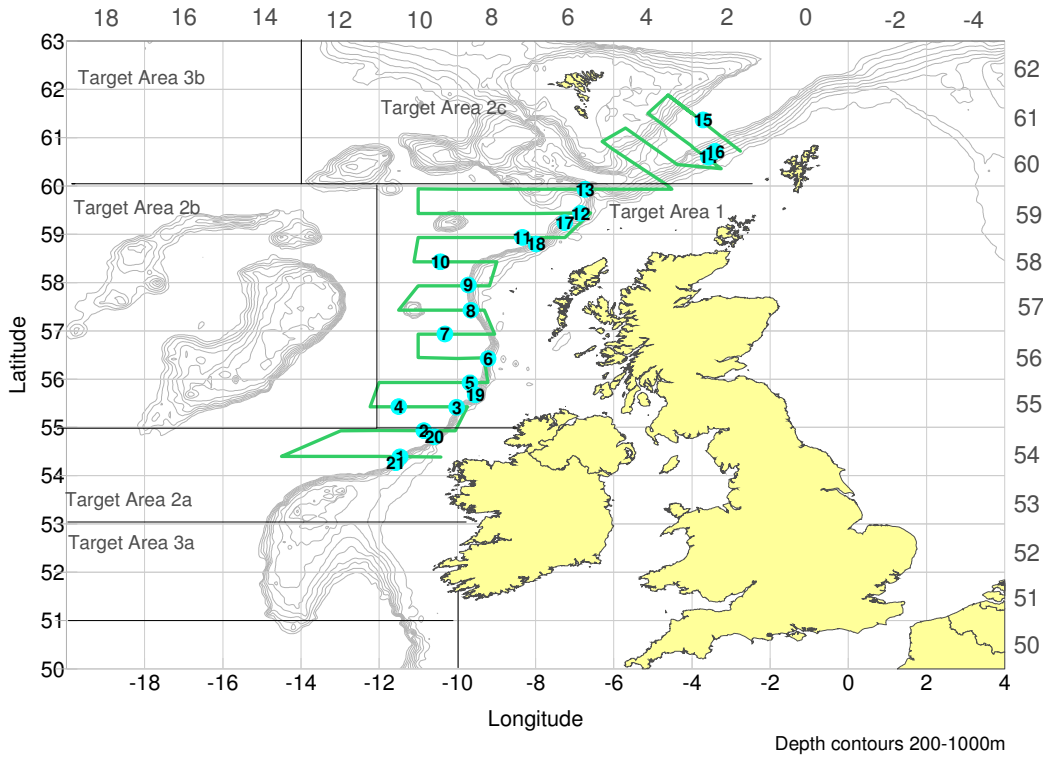


Figure 1. RV Celtic Explorer cruise track and trawl station positions and stratified target areas. Blue whiting survey, March-April 2013.

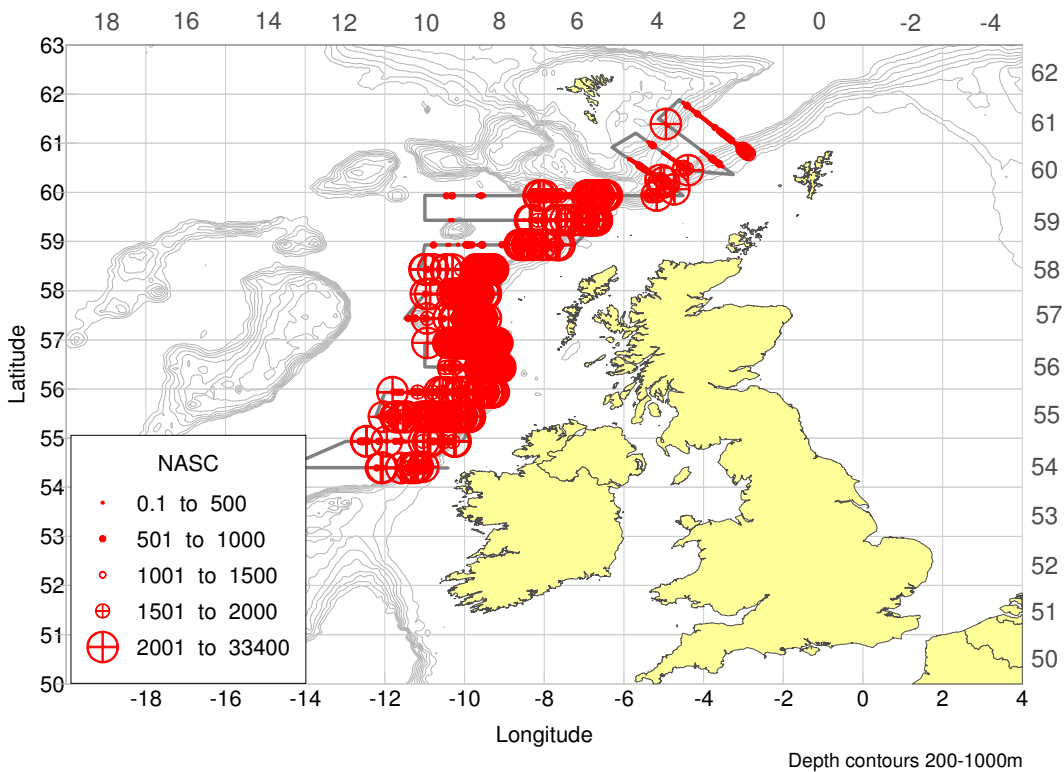
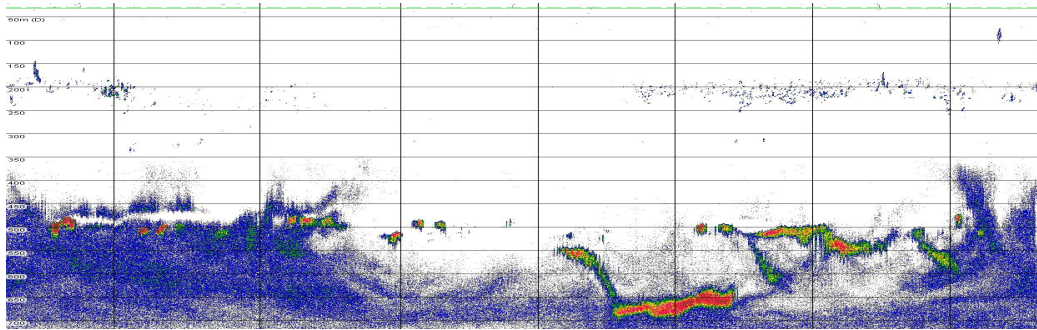
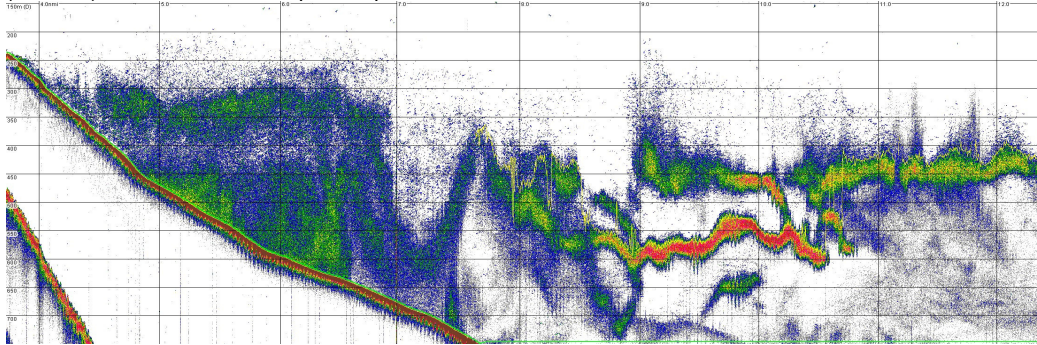


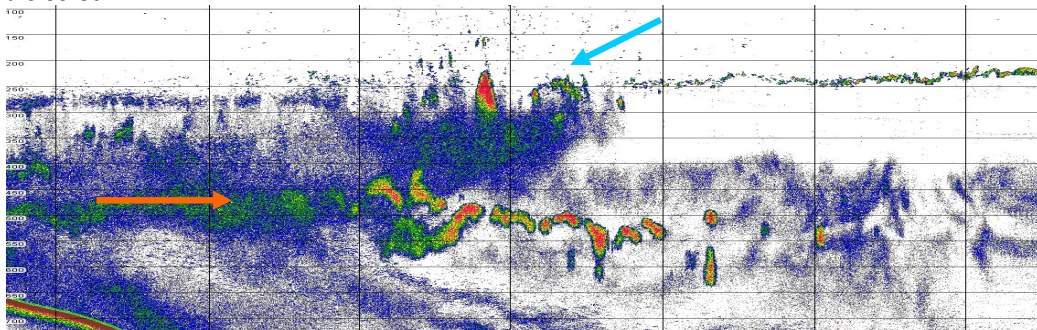
Figure 2. Blue whiting distribution as determined from survey data (NASC values). Blue whiting survey, March-April 2013.



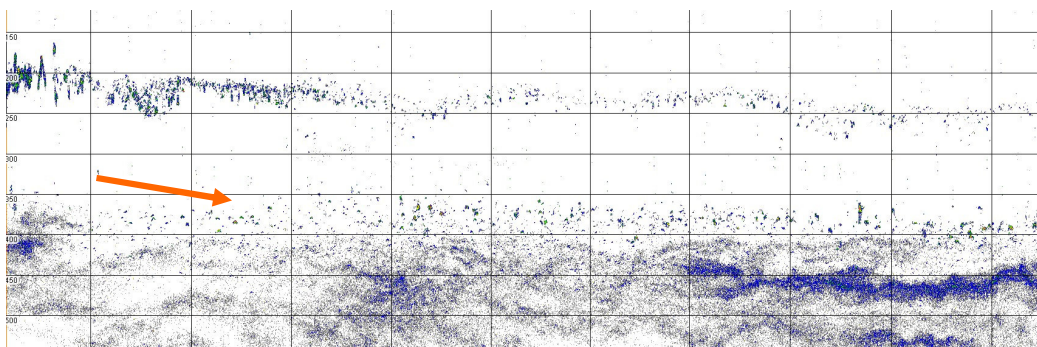
a). Open water blue whiting echotraces recorded along the 55°30'N some 15 nmi west of the shelf edge (Haul 04). Note the school depth of up to 680m.



b). The highest density blue whiting echotrace observed during the survey, recorded prior to Haul 06 on the 56°30'N.



c). A high density echotrace containing a blue whiting layer (orange arrow) and mesopelagic layer (blue arrow). The latter which was targeted during Haul 12 on the shelf edge to the south of 59°30'N and yielded primarily of pearlsheds.



d). Low density echotrace of blue whiting (orange arrow) typical of those observed in the NE of the survey area and composed in the main of juveniles. Haul 15 at 61°N along the shelf edge.

Figures 3a-d. Echotraces recorded on an EK60 echosounder (38 kHz) with images captured from Echoview. Note: Vertical bands on echogram represent 1nmi (nautical mile) intervals. Depth scale is shown in 50m bands.

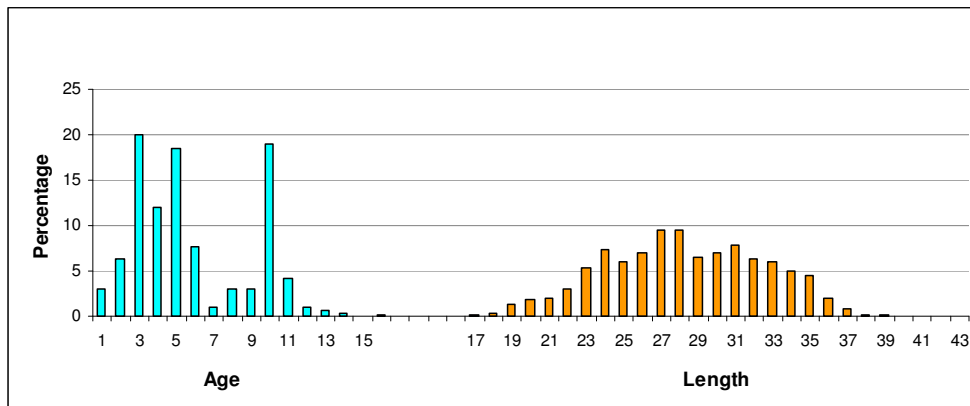


Figure 4. Combined age (left) and length (right) composition of trawl samples. Blue whiting survey, March-April 2013.

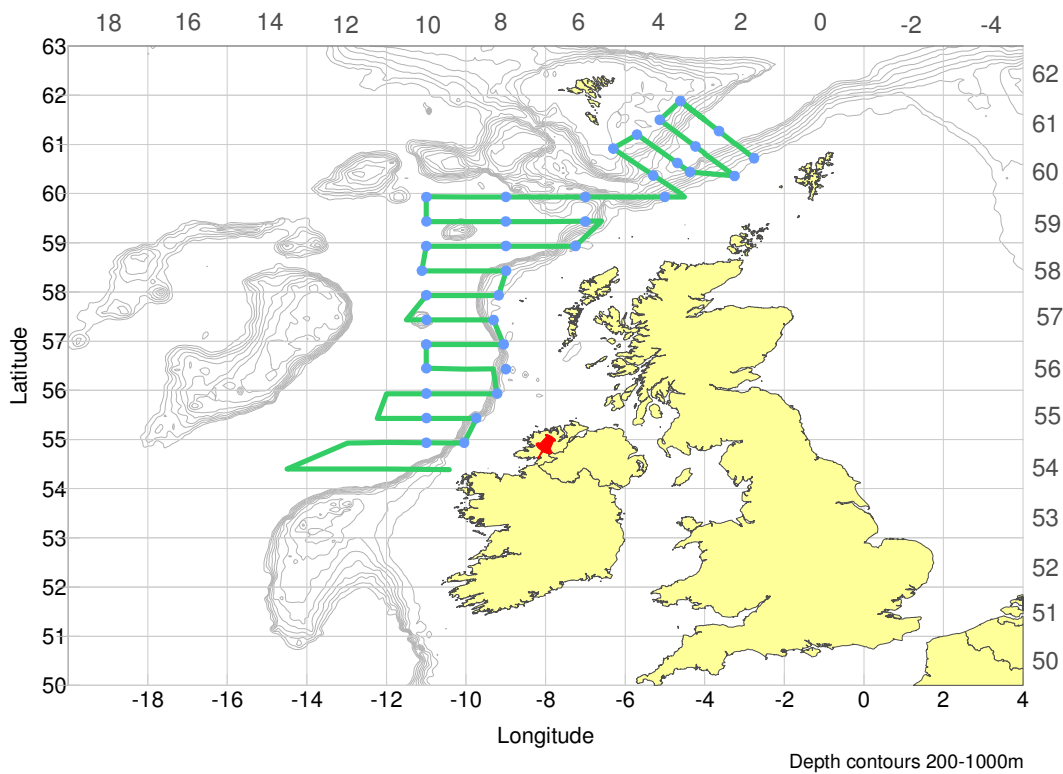


Figure 5. Position of hydrographic stations (blue points) and EK60 calibration site (red pin). Note: Open water stations were carried out to a maximum depth of 1000m. Blue whiting survey, March-April 2013.

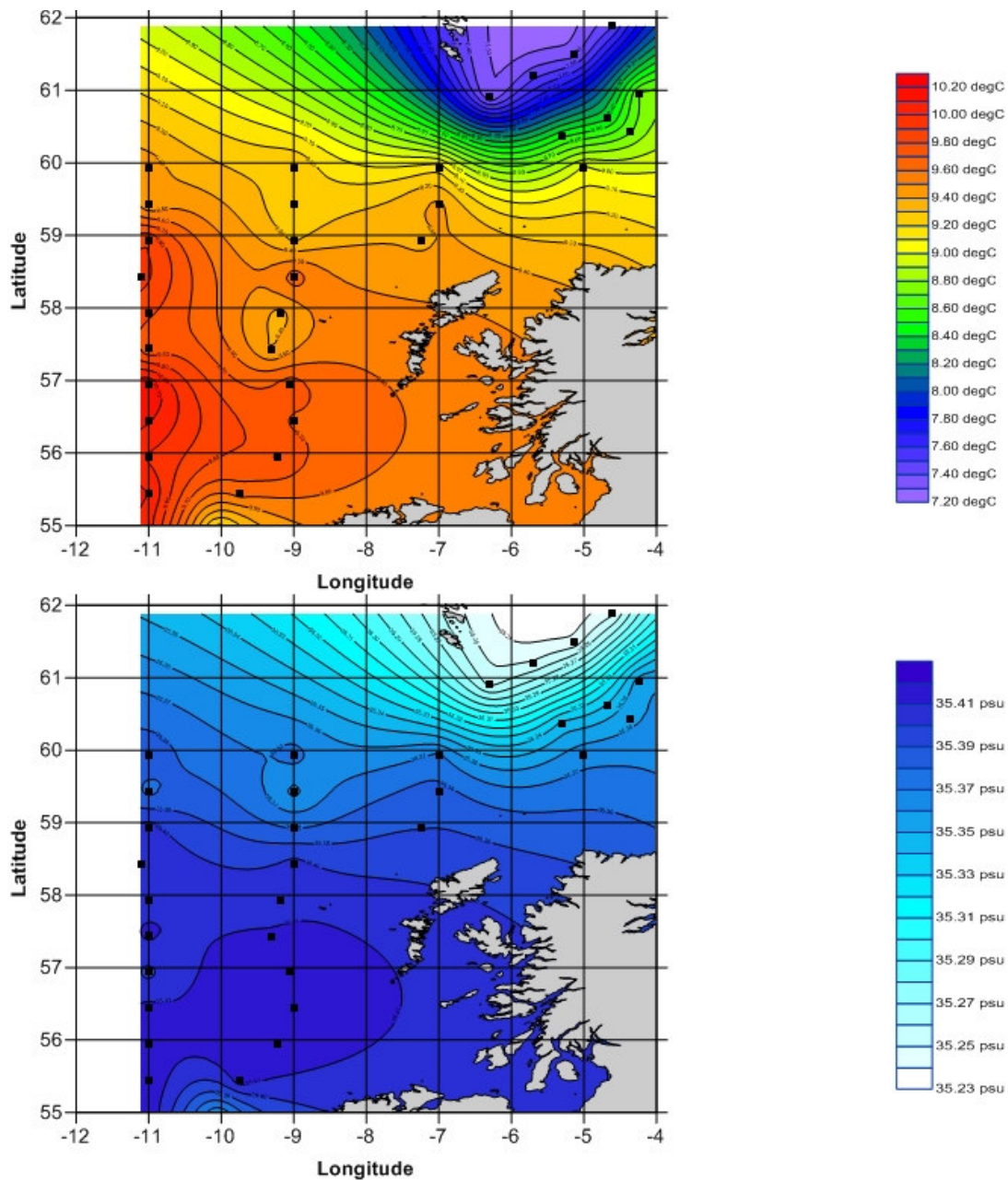


Figure 6. Horizontal temperature and salinity at 10m as compiled from international CTD stations (black dots). Blue whiting survey, March-April 2013.

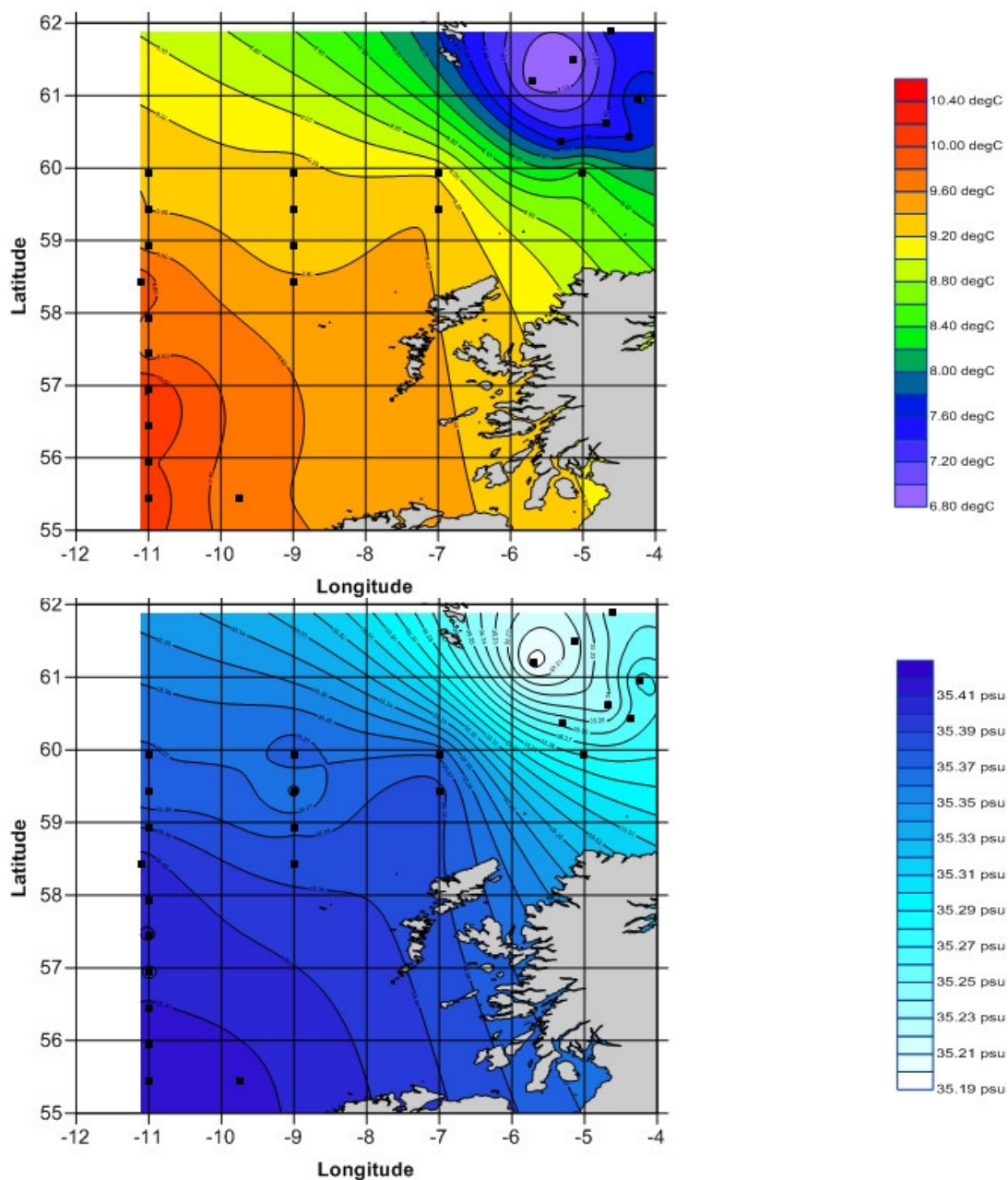


Figure 7. Horizontal temperature and salinity at 200m as compiled from international CTD stations (black dots). Blue whiting survey, March-April 2013.

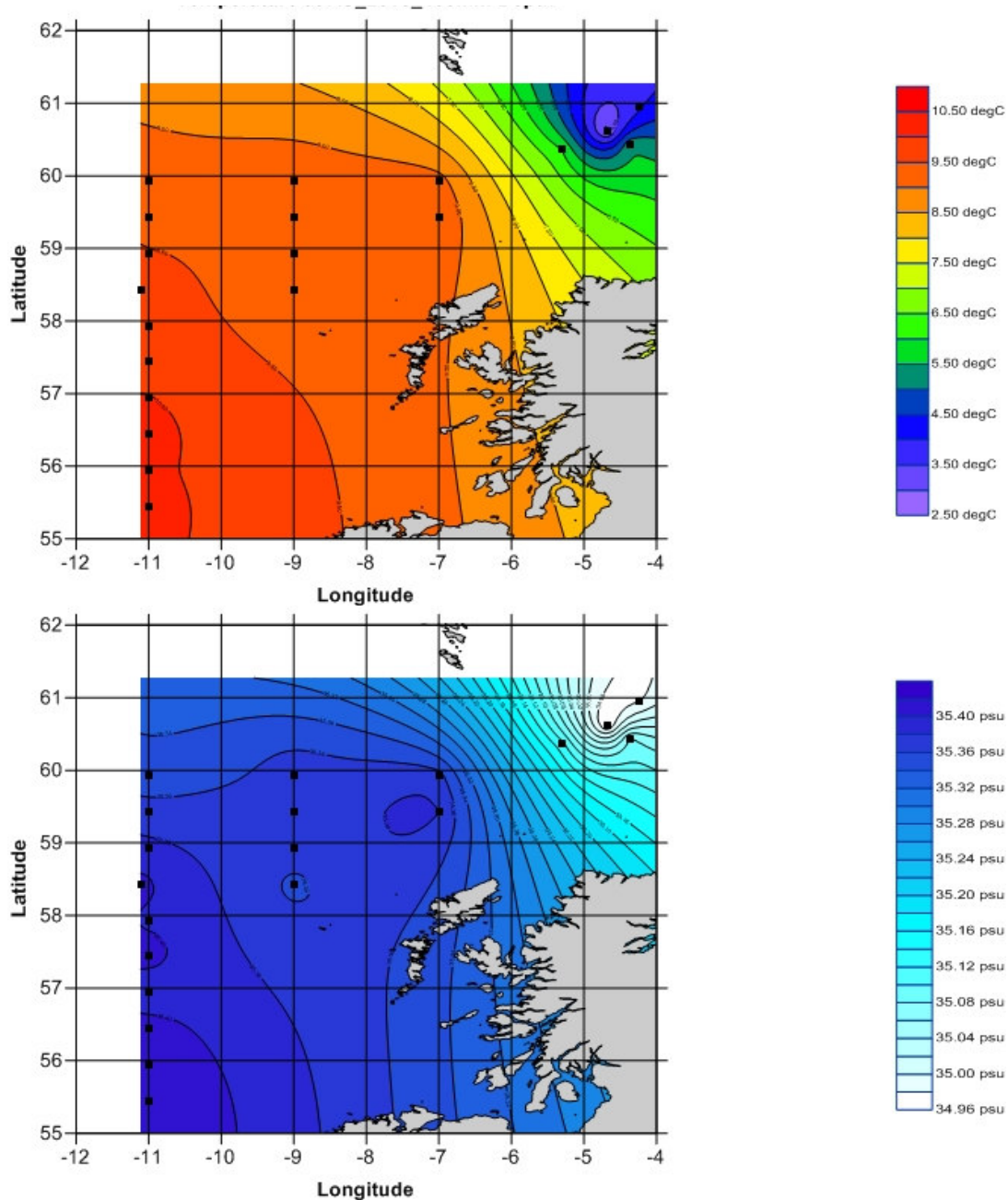


Figure 8. Horizontal temperature and salinity at 400m as compiled from international CTD stations (black dots). Blue whiting survey, March-April 2013.

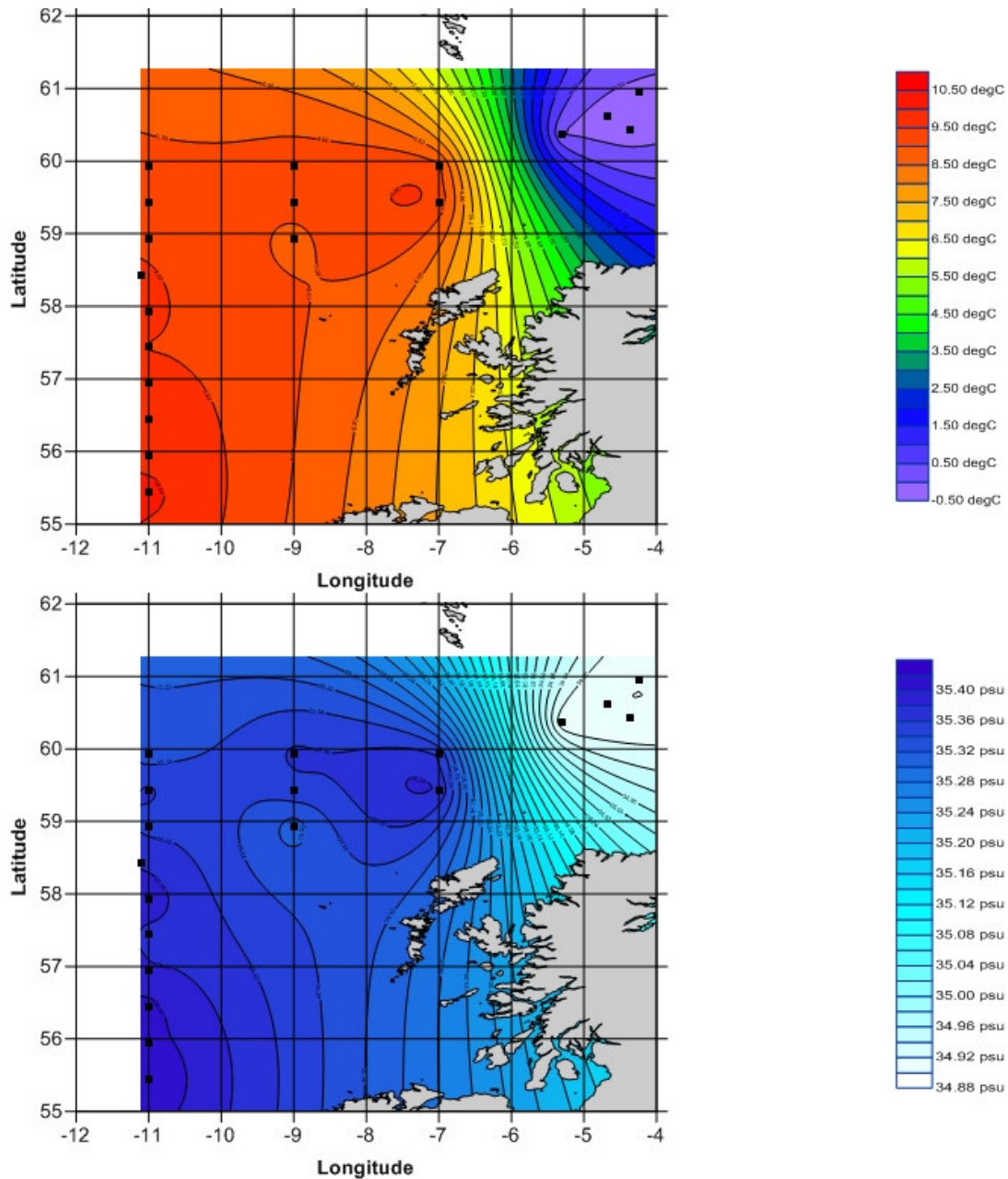
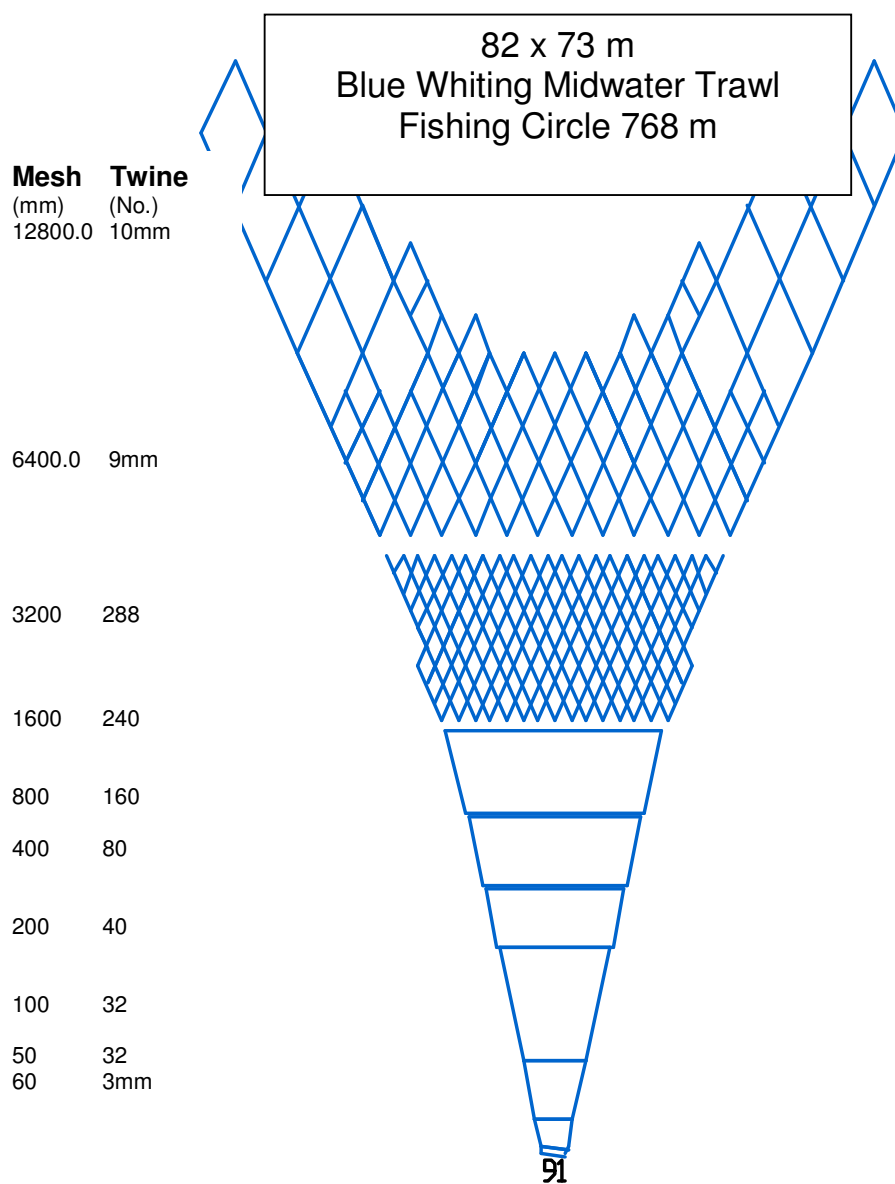


Figure 9. Horizontal temperature and salinity at 600m as compiled from international CTD stations (black dots). Blue whiting survey, March-April 2013.

**Net specifics**

Clump weights:	1000 Kg per side
Trawl doors:	Polyice pelagic 6m ² (750Kg weight in air)
Bridle length:	80m
Door spread:	170m
Vertical net opening:	50m

Figure 10. Pelagic midwater trawl employed during the Blue whiting Acoustic Survey, March-April 2013.