Cruise report hydro acoustic survey for blue whiting (Micromesistius poutassou) with R.V. “Tridens”, 11 March - 03 April 2009

Sytse Ybema, Kees Bakker, Thomas Pasterkamp, Eric Armstrong, Matthias Kloppmann, Jeppe Dalgaard Balle, Joanne O’Brien, Sven Gastauer, Silja Tribuhl, Christiaan van Assendelft, Flemming Thaarup

Report number 09.007

Institute for Marine Resources and Ecosystem Studies

Wageningen *IMARES*

Location IJmuiden

Publication Date: 20 April 2009

- Wageningen ***IMARES*** conducts research providing knowledge necessary for the protection, harvest and usage of marine and costal areas.
- Wageningen ***IMARES*** is a knowledge and research partner for governmental authorities, private industry and social organisations for which marine habitat and resources are of interest.
- Wageningen ***IMARES*** provides strategic and applied ecological investigation related to ecological and economic developments.

Wageningen IMARES is registered in the Dutch trade record
Amsterdam nr. 34135929,
BTW nr. NL 811383696B04.

A_4_3_2-V5

Contents

Summary

This is the report of the Dutch part of the international North East Atlantic hydro acoustic survey for blue whiting. The survey is coordinated by ICES and has been executed annually. Ireland, Russia, Iceland, Denmark, Faroe Islands and Norway also participate in the survey. The purpose of the survey is to estimate the blue whiting stock of the North East Atlantic. The ICES uses this estimation as a "tuning index" to assess the North East Atlantic blue whiting stock. For this purpose a Simrad 38kHz splitbeam echo sounder was used. The applied method was echo integration. By sailing transects over the survey area, the total acoustic cross-section can be calculated by surface area sampled. Trawling was used to identify species composition of localized schools. The length composition of each species was determined. Blue whiting were examined for age and fecundity. The survey has been very successful in terms of acoustic coverage (100%), number of trawl hauls, acoustic data quality and communication.
Blue whiting were found throughout the survey area associated with the continental shelf edge, but showed a more open ocean distribution reaching the northern part of the area surveyed by Tridens. Most juveniles (age 1 and 2) were found related to near bottom trawls. Overall, new recruiting age classes (2 and 3 years) were scarce, indicating a continued low recruitment.

Effective survey days:	12
Effective nautical miles surveyed:	1853
Successful trawl hauls:	11
Successful CTD downcasts:	25

This years' survey contained several improvements ranging from equipment upgrade to science outreach.

Hardware upgrade:	The acoustic system has been upgraded. New computers were permanently installed onboard and a complete backup of the hardware is now available.
Deep sea species identification:	Further development of implementation of ecosystem approach in this survey by focusing on deep sea fish species composition and distribution.
Multi-frequency acoustics:	Although it has proved to be impossible to use the 120 kHz in combination with the 38 kHz to identify blue whiting, the extra frequency proves very useful in identifying mackerel, horse mackerel and plankton on the shelf brake.
Marine mammal observation:	Both a visual and acoustic survey were conducted on board as an ancillary project of the Blue Whiting Hydro Acoustic Survey 2009. Acoustic surveys coupled with visual observations provided a very robust data-set. It is recommended that marine mammal observers carry out visual cetacean surveys during future Blue Whiting surveys, as the repetition of these surveys would lead to a better understanding of the diversity and abundance of cetaceans occurring in the blue whiting habitat.
Science outreach:	A new website was launched, designed to improve communication between scientist and the public. It had been updated daily with findings of interest from the ongoing research programme. By using such a Virtual Marine Platform, information is made available quickly to each stakeholder of the sea; the public, managers, scientists and fishermen.

Gestimuleerd door klimaatverandering

Onderzoek blauwe wijting uitgebreid

IJMUIDEN – Vorige week woensdag is de 'Tridens' vertrokken naar de blauwe wijting visgronden om het jaarlijkse internationale hydroakoestische onderzoek uit te voeren. Het blauwe wijtingonderzoek wordt belangrijk uitgebreid naar het hele 'mesopelagische ecosysteem'.

Een internationaal team doet onderzoek naar belangrijke onderdelen van het mesopelagische ecosysteem (de diepzee in de oceaan tussen 200 en 1000 meter diepte) ten westen van Ierland, tussen 51°30' en 56°30' NB. Aan boord van de 'Tridens' zijn onderzoekers van Wageningen IMARES, versterkt met internationale wetenschappers en een student van de Hogeschool Zeeland.

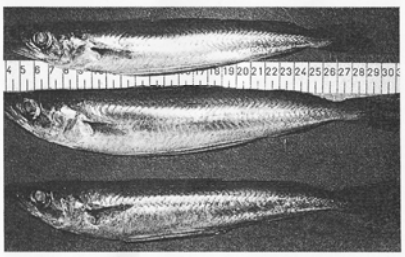
Onderzoek wordt gedaan naar de verspreiding en de populatiedichtheid van de paairijpe blauwe wijting ten westen van de Britse eilanden. De bevindingen van het onderzoek vormen de basis voor adviezen en uiteindelijk het vaststellen van de jaarlijkse blauwe wijting-TAC's.

Maar er wordt niet alleen gekeken naar de blauwe wijting. In overeenstemming met de nieuwe Marine Strategy van de EU worden dit jaar alle gevangen mesopelagische vissoorten en ongewervelde dieren onderzocht. Dit om inzicht te krijgen in het mogelijke effect van de exploitatie van de blauwe wijting op deze andere mesopelagische organismen.

De huidige klimaatverandering stimuleert het onderzoek naar deze onbekende maar belangrijke diepzeesoorten vanwege hun unieke leefomgevingseisen.

Wageningen IMARES heeft dan ook het voortouw genomen in de ontwikkeling van een fotodeterminatiegids voor deze vissen, om toekomstig onderzoek te vergemakkelijken. Daarnaast zal er om de ecosysteemaanpak compleet te maken, worden uitgekeken naar verschillende zeezoogdieren en vogelsoorten.

Meer informatie is beschikbaar op de websites www.imares.nl, http://www.surveyswageningenimares.wur.nl/UK/ en www.cvo.wur.nl.



1. Introduction

In spring 2009, five research vessels representing the Faroe Islands, Ireland, the Netherlands, Norway and Russia surveyed the spawning grounds of blue whiting west of the British Isles. International co-operation allows for wider and more synoptic coverage of the stock and more rational utilization of resources than uncoordinated national surveys. The survey was the sixth coordinated international blue whiting spawning stock survey since mid-1990s. The primary purpose of the survey was to obtain estimates of blue whiting stock abundance in the main spawning grounds using acoustic methods as well as collecting hydrographic information. Results of all the surveys are also presented in national reports (Fridtjof Nansen: Oganin et al. 2009; Celtic Explorer: O'Donnell et al. 2009; Gardar: Holst et al. 2009; M. Heinason: Jacobsen et al. 2009; Tridens: Ybema et al. 2009).

Results on new introduced topics are presented in the appendix.

2. Assignment

Wageningen IMARES, Institute for Marine Resources & Ecosystem Studies has participated in the international North East Atlantic hydro acoustic survey for blue whiting since 2004. The survey is part of the EU data collection framework. The aim of this survey is to provide an abundance estimate of the whole North East Atlantic blue whiting population and to determine the spatial distribution at this time of year. This estimate is used as a tuning index by ICES to determine the size of the population. In this report the results are presented of the survey west of Ireland, carried out by FRV "Tridens".

3. Materials and Methods

3.1 Scientific staff

IMARES staff

1. Sytse Ybema (Cruise leader)
2. Kees Bakker (Technician)
3. Thomas Pasterkamp (Research assistant)
4. Silja Tribuhl (Biologist)
5. Sven Gastauer (Student)
6. Christiaan van Assendelft (Student)

Guest scientists

7. Eric Armstrong (Acoustic survey specialist, FRS, Scotland)
8. Matthias Kloppmann (Fishery biologist, vTI-SF, Germany)
9. Flemming Thaarup (Research assistant, DTU Aqua, Denmark)
10. Jeppe Dalgaard Balle (Marine mammal scientist, SMRU, Scotland)
11. Joanne O'Brien (Marine mammal scientist, GMIT, Ireland)

3.2 Narrative

The temporal progression of the survey is shown in figure 3.3.

Week 11/12
Wednesday, 11th of March, around 13.00 hrs, the research vessel MS Tridens set sail from Scheveningen in perfect weather conditions. 13th of March, 9.00 hrs, arrival in Cork harbour. Monday, 16th March at 8.00 hrs the vessel set course for Dunmanus Bay to calibrate the transducers. Calibration lasted the rest of the day.
Tuesday, 17th March the survey started, the first trawl on mackerel was accomplished the same day. Altogether 8 trawls and 15 CTD samples were carried out the first week. Also a deep sea trawl at around 900 meters was accomplished. Pictures from deep sea species will be used to further develop the deep-sea species photo guide and to develop a database (see appendix D). Due to the very good weather conditions, the survey proceeded according to plan. Blue whiting was mostly found on the continental slope.

Week 13
During the beginning of the second week no large schools of blue whiting, worth fishing on, were found. Only small groups of blue whiting were observed regularly throughout the survey area. CTD samples were taken regularly. Weather conditions slowly deteriorated and the survey had to be suspended for two days, from the 26th to the 27th of March. Shelter from the strong gale was found in Oban bay for the first night. On the second day fresh water was bunkered on the Isle of Mull. The survey continued on Saturday 28th March. Two trawls were carried out the same day, one deep sea trawl and one trawl on blue whiting.

Week 14
The last trawl on blue whiting was performed on Monday, 30th of March. The survey ended the same day. Post calibration was carried out with good results on the 1st of April in Penzance Bay. After the calibration MS Tridens set sail for Scheveningen, The Netherlands, where it arrived on Thursday, 2nd of April 20:00h.

3.3 Survey design

The survey was carried out from the 11th March to the 3rd of April 2008, covering an area west of Ireland from latitude 51.45° to 56.18° North and from longitude 9° West to 18° West (Fig. 3.1).
As in 2008 an adapted survey design was applied, based on recommendations made by PGNAPES in 2008. Tridens was to cover the expected core area. The entire survey was carried out within 4 weeks. Parallel transects along latitudinal lines were used with spacing between the lines set at 30 nm in areas with no interlaced transects, while 60 nm spacing was used in the rest of the area. Acoustic data from transects running north-south close to the shelf edge (that is parallel to the depth isolines) were excluded from the dataset.
As previous surveys show fish closely related to the shelf edge west of Porcupine Bank, westbound transects in this area were cut short when no fish were observed for several hours. Since no fish was observed in areas with a water depth shallower than 250m, all transects were ended at the 200m depth contour. CTD stations were planned in advance but extra stations were added or removed, depending on the weather conditions.
The survey cruise track, trawl and CTD positions are presented in figure 3.2.

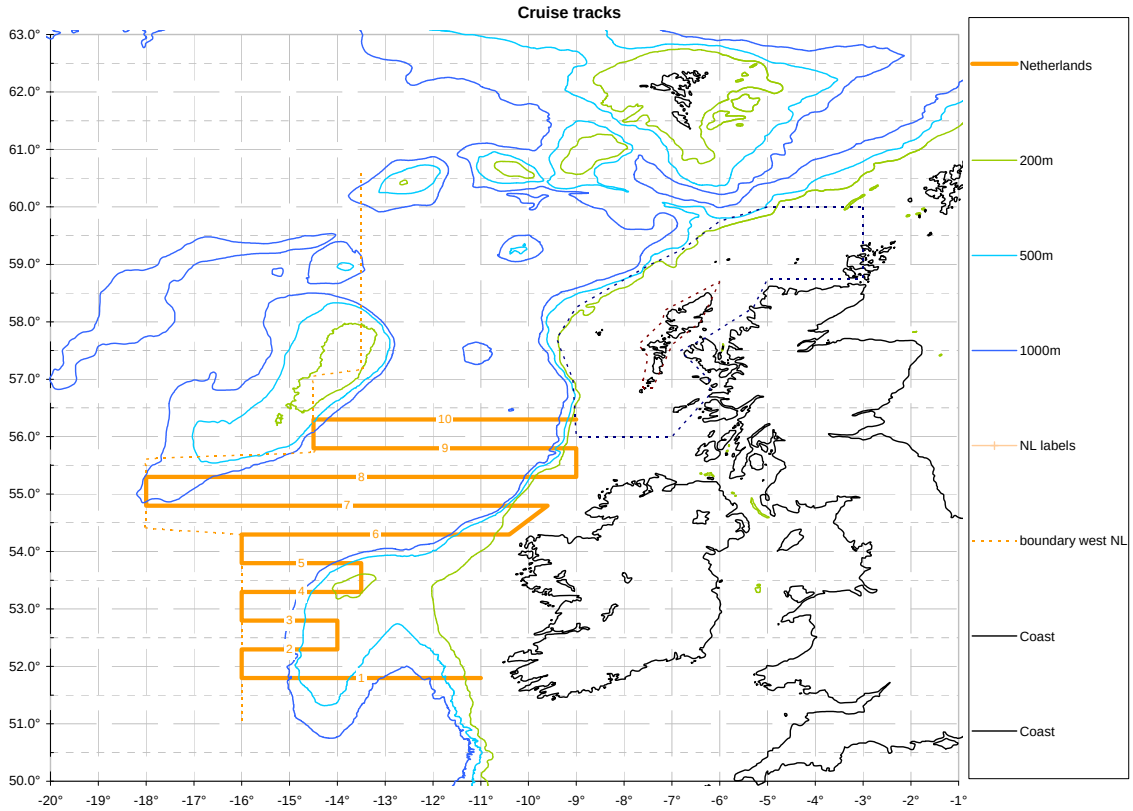


Figure 3.1. Planned and executed cruise track of the BWHTS, 11 March – 03 April 2009.

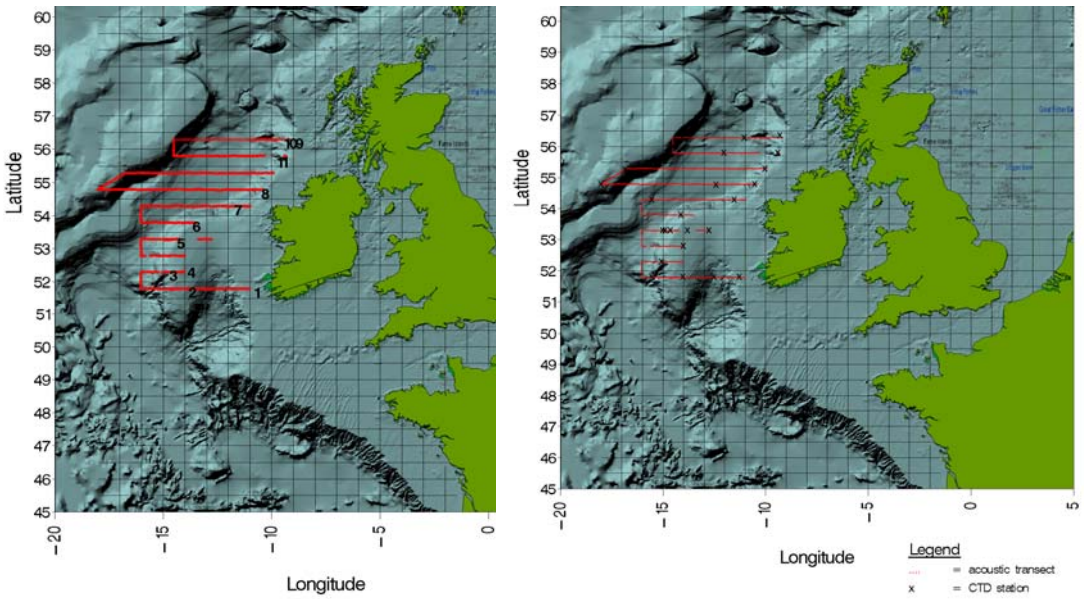


Figure 3.2. Executed trawl hauls and CTD stations of the BWHTS, 11 March – 03 April 2009.

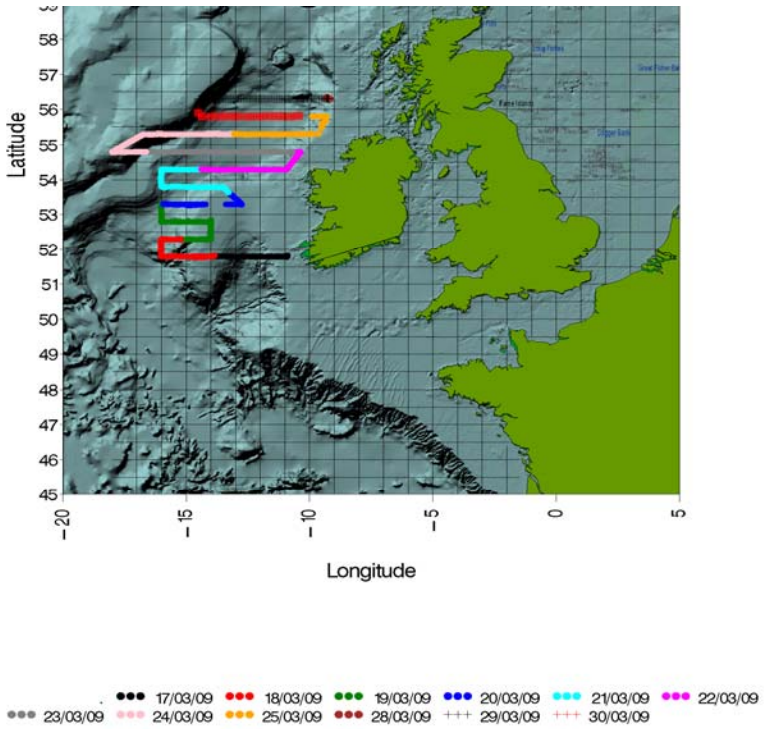


Figure 3.3. Temporal progression of the survey, 11 March – 03 April 2009.

3.4 Acoustic calibrations

Both transducers were calibrated in Dunmanus Bay, Ireland, according to standard IMARES procedures using results from the first run, as an input for the next run. Seven calibrations were executed with varying results given moderate weather conditions. A post calibration in Penzance Bay, England, was successfully executed (Table 3.1). The calibration results used in this survey are listed in appendix A.

Table 3.1 Calibration overview

	Frequency	**Transducer ID**	**# calibrations**	**Final results**
Pre-calibration				
	120 kHz	619	3	Medium
	38 kHz	28887	2	Good
	38 kHz	30501	2	Goood
Post-calibration				
	120 kHz	619	2	Good
	38 kHz	28887	2	Good

3.5 Acoustic data collection

A Simrad 38 kHz and, for the first time, a 120 kHz Simrad split beam transducer were operated in a towed body (type "Shark") 6-7 m below the water surface. Acoustic data were collected with a Simrad EK60 scientific echo sounder. The data were logged with Sonardata Echoview software. The EK60 received position data and vessel speed from the ship's GPS. A variable ping rate was used near the shelf edge to avoid false bottom echoes. The data were logged in 1 nautical mile intervals. A vessel speed of 10 knots was used on one engine, to avoid interference with the acoustic data. The acoustic values (NASC's) from each log interval were only assigned to the category "blue whiting". All echoes were recorded with a threshold of -80dB up to a depth of 750 meters below the transducer.
Eric Armstrong, guest scientist from the Marine Lab in Aberdeen assisted in the use of Sonardata Echoview. The species detection algorithm created in 2007 was further developed. The aim of this exercise was to automate the subjective scrutiny method normally applied.

Acoustic signal check

Two methods were tested for monitoring the stability of all 4 segments of the transducer. If combined, the acoustic system can not just be monitored but also corrected for drop outs and weakening of the signal.

1. Echoview was used as a software monitor tool. An algorithm allows us to monitor the total acoustic energy closely and in real time. This method proved to be essential to find sudden changes in output energy.
2. A watchdog setup tested the hardware directly. This method should have allowed us to keep track of signal behaviour of each of the 4 transducer segments but the system failed to function.

3.6 Biological data collection

Acoustic recordings were identified using a 5600 mesh pelagic trawl with 20 mm meshes in the cod-end. Fishing was carried out when there was doubt about the species composition of recordings observed on the echo sounder and to obtain biological samples of blue whiting. In general, after it was decided to make a tow with a pelagic trawl, the vessel turned and fished back on its track.
Fish samples were divided into species by weight. Length measurements were taken to the 1.0 cm below for all species. For blue whiting length representative samples were taken for sex, maturity, age (otolith extraction) and weight. Age readings were not yet verified at the Norwegian Lab 'IMR' at the time of writing; international coordination is still in progress In all cases, specimens of non-target species, were frozen and photographed for species determination in the lab.

Incorporating the 'Ecosystem approach': Focus on deep sea species
A deep-sea species photo guide was created during the blue whiting surveys of 2007 and 2008. This photo guide will be available as a stand alone document to all PGNAPES and PGTIPS coordinated surveys. A word of caution is appropriate here: All the determinations have been done on board aided by available literature and equipment. All identifications are based on Muus and Nielsen (1999) and the three volume compilation by Whitihead et al. (1986). If in doubt, http://www.fishbase.org (FishBase 2008) was consulted. Most, if not all, of the identifications are, therefore, correct. However, due to the catch method, some of the species were not in a suitable state to allow them to be identified immediately. Discriminating features were taken from various individuals of a group of specimens, which we were confident represented one species. It is possible that inconsistencies may have occurred. The user of the guide is not encouraged to view it as a final version, but as a product in development and as an aid to expanding and improving the list of know species of the investigation area. The following references have been used:

1. Froese, R. and D. Pauly. Editors. 2008. FishBase. http://www.fishbase.org version (01/2008). World Wide Web electronic publication.
2. Muus, B.J. and J.G. Nielsen, 1999. Sea fish. Scandinavian Fishing Year Book, Hedehusene, Denmark. 340 p.
3. Whitehead, P.J.P., M.-L. Bauchot, J.-C. Hureau, J. Nielsen and E. Tortonese (eds.), 1986. Fishes of the North-eastern Atlantic and the Mediterranean. UNESCO, Paris. Vols. I-III: 1473 p. (FNAM)

3.7 Hydrographical data collection

All vessels were able to take CTD stations, to an average depth of 2000 meter or more, except Tridens who only took CTD stations up to 1100 meters. Hydrographic data have been collected at 25 CTD stations, (Figure 3.2). The CTD device was not specifically calibrated for this cruise. In addition, some environmental variables were continuously measured by the ships own data acquisition system" (DAS). The continuous measuring sensors had not been calibrated and are therefore not used for further analysis. Due to insufficient national observations, results are only made available in the international cruise report, this can be found on the PGNAPES website.

At selected positions on the so called Porcupine hydrographic transect (fig. 3.4) Tridens conducted measurements of temperature and salinity down to a maximum depth of 1000 m or to close to the sea floor. This kind of investigation is done in order to examine the physical environment of blue whiting within the research area.

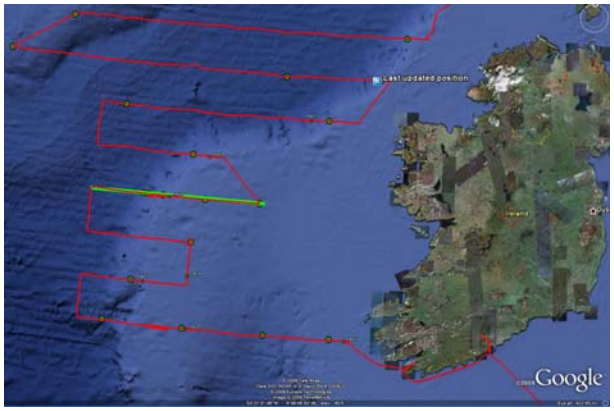


Figure 3.4. Location of the Porcupine transect (in green).

3.8 Data analysis and online presentation

Acoustic – biological and hydrographic data were stored in the PGNAPES format for further analysis at the cruise post meeting In Galway, Ireland.
Based on last years results, semi automated data fusion was used to create a better overview of the survey progress and to allow sharing of data amongst research vessels (Fig 3.5).This data fusion project includes not only data collected during the survey but also live environmental data, weather forecasts and other relevant information from this cruise. It has proven to be highly valuable to national and international survey design.

A ship's journal written by the scientific crew was presented online at www.7seas-outreach.com.

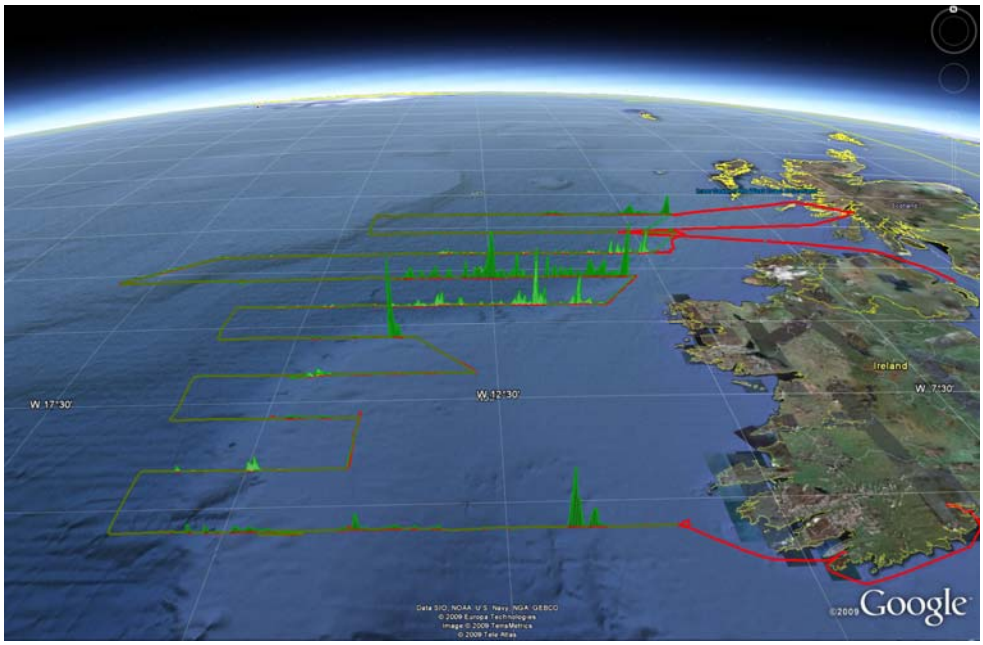


Figure 3.5 Overview of cruise track and relative acoustic values of blue whiting using Google Earth, 11 March – 03 April 2009.

Further analysis of international data will take place in Galway, Ireland, 21-23 April 2009, to result in a combined survey report.

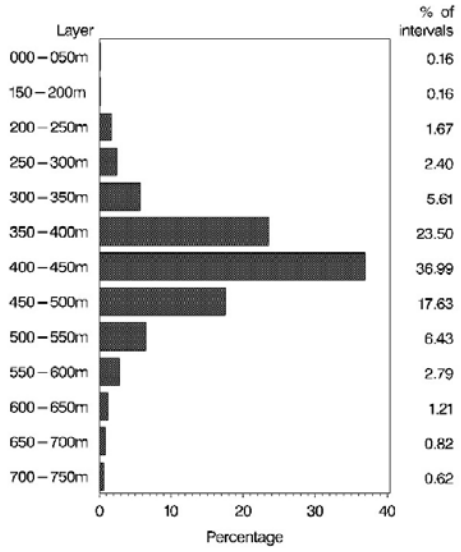
4. Results

4.1 Acoustics

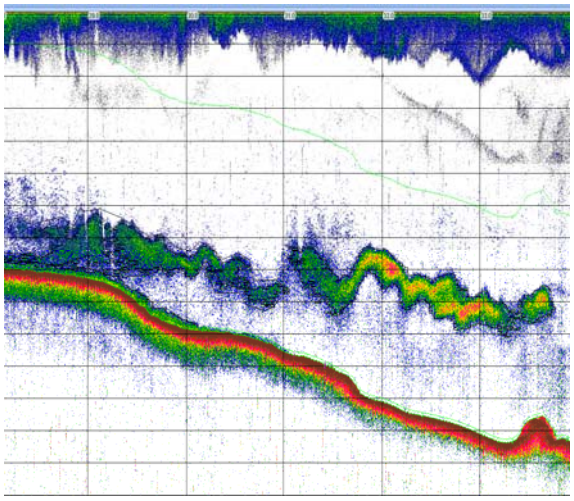
A total transect length of 1853 nautical miles was covered, which is substantially more than in previous years. This was mainly due to the relatively good weather conditions and a low number of trawl hauls.

Detectability
Blue whiting marks were found eel-like throughout the entire survey area indicating spawning activity, but in some regions north of Porcupine bank scattered schools dominated. A special blue whiting detection algorithm was created in Sonardata Echoview during the 2008 survey and has proven to be capable of selecting the same schools as those that would have been selected manually. From an ecological point of view it remains a challenge to distinguish faint blue whiting marks from stronger plankton. This fine tuning of the algorithm is expected to only have a marginal effect on biomass estimation when blue whiting is abundant.

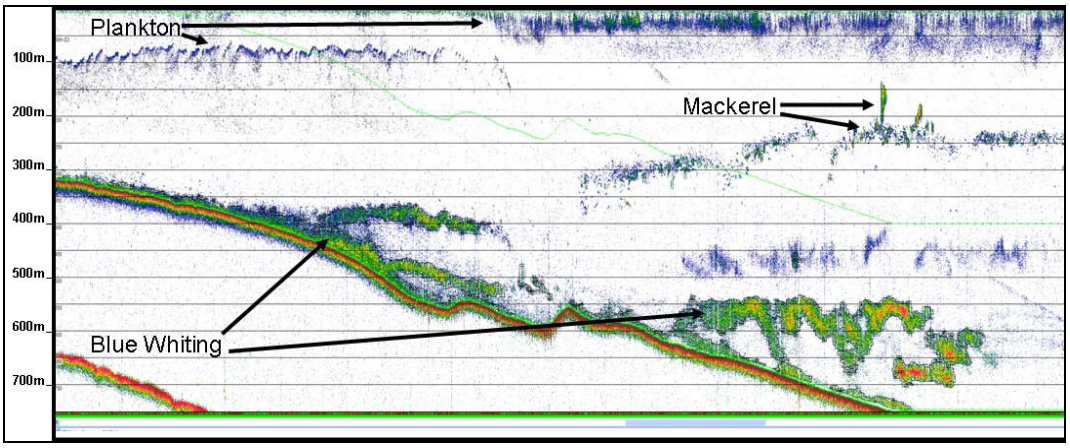
In general, the strongest blue whiting traces were observed between 350-500m, sometimes rising to 300m or shallower on the shelf break (Fig. 4.1 C).



A



B



C

Figure 4.1. Blue whiting were mostly seen distributed around 450m (figure A). Most schools were typically eel-shaped and followed the shelf break (figure B and C). In the southern part of the survey area, blue whiting were often found together with mackerel (figure C).

Geographical distribution patterns

As in previous years, in the northern part of the survey area, blue whiting schools were encountered in the deep water off the shelf edge.

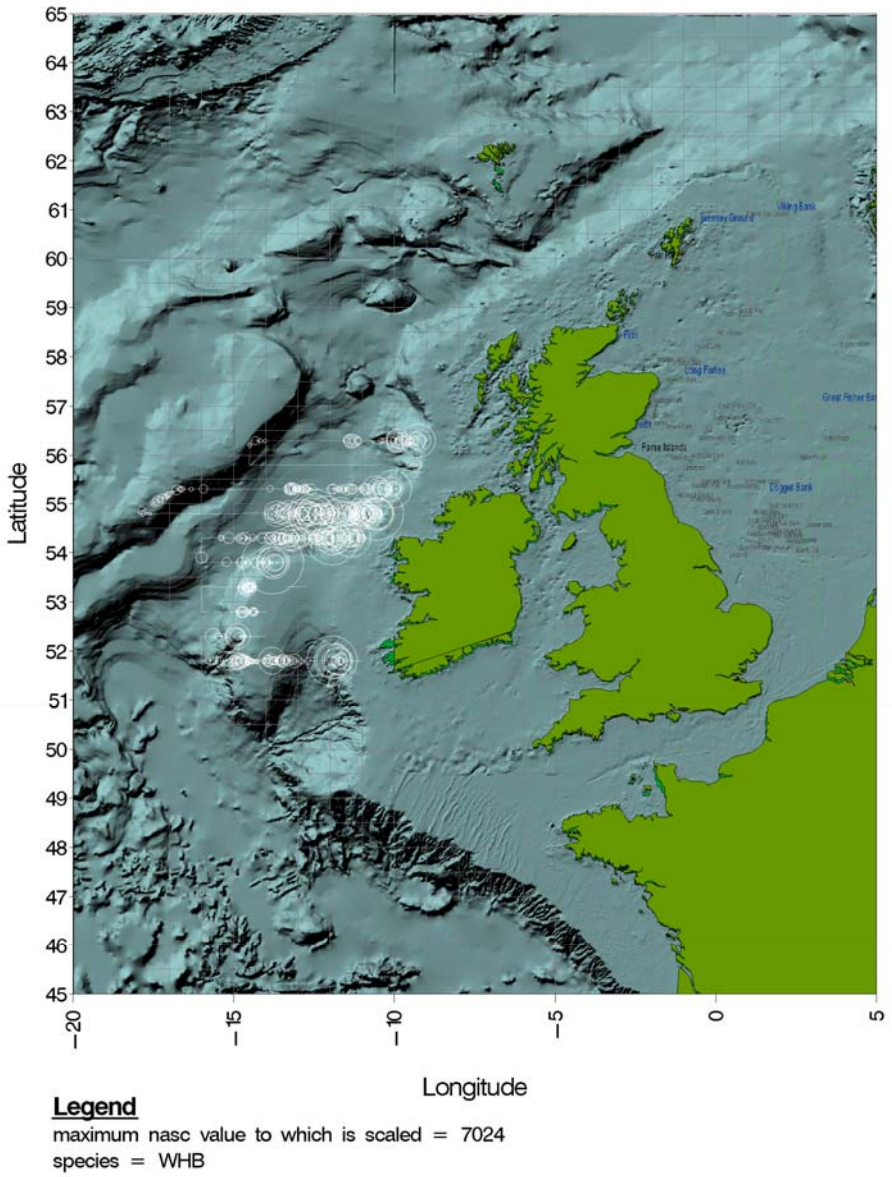


Figure 4.2. Post plot showing the distribution of **total blue whiting** NASC values (on a proportional square root scale relative to the largest value of 7024).

4.2 Catch results

From a total of 11 trawl hauls, 9 contained significant quantities of blue whiting (Table 4.1 and 4.2). Two trawls were targeted, just below the 'blue whiting zone', to obtain samples of deep sea fish species. For these hauls, since no multisampler gear was available, it was not possible to determine from which depth the blue whiting came.

Table 4.1. Details of the trawl hauls taken during the March 2009 North East Atlantic hydro acoustic survey, FRV"Tridens".

haul	sample	validity	ICES	date	time_GMT	position	duration	depth	geardepth	wind_direction	wind_force	total_sample_weight
1	5400101	valid	51.500_-12.50	17/03/2009	08:20	51.47N-10.59W	70	150	150	135	7	337015008
2	5400102	valid	51.500_-15.50	18/03/2009	01:10	51.48N-13.56W	43	400	400	0	4	665000
3	5400103	valid	52.500_-16.50	18/03/2009	23:35	52.18N-14.49W	55	500		23	4	195000
4	5400104	valid	52.500_-15.50	19/03/2009	10:30	52.24N-13.59W	48	210		135	7	442000
5	5400105	valid	53.500_-16.50	20/03/2009	09:30	53.17N-14.28W	120	2000		359	2	357000
6	5400106	valid	53.500_-15.50	21/03/2009	03:15	53.47N-13.46W	60	450	375	359	2	922000
7	5400107	valid	54.500_-13.50	22/03/2009	09:35	54.17N-11.51W	66		420	270	4	5789000
8	5400108	valid	54.500_-12.50	22/03/2009	21:35	54.47N-10.36W	70	400		270	7	33740000
9	5400109	valid	56.500_-11.50	28/03/2009	17:57	56.17N-09.01W	154	1500	840	0	9	990000
10	5400110	valid	56.500_-11.50	29/03/2009	00:00	56.17N-09.17W	45		400	180	9	2475000
11	5400111	valid	55.500_-11.50	30/03/2009	17:00	55.44N-09.40W	120	1300	900	293	4	3300000

Table 4.2. Trawl catches during the March 2009 North East Atlantic hydro acoustic survey, FRV "Tridens" in kg. Scientific and English species names are listed in appendix B.

species	5400101	5400102	5400103	5400104	5400105	5400106	5400107	5400108	5400109	5400110	5400111
Anglerfish										3.3	
Argyropelecus hemigymnus					0.011516		0.0023				
Bean's sawtoothed eel											0.003
Birdbeak dogfish					7.48				2.65		
Black scabbardfish					0.654						
Blackfish		1.93			2						
Blue whiting			192		109.6	918	5779.023	959	636.6	2464	3282
Boarfish	1045										
Borostomias antarcticus					0.472161						
Brama		0.73									
Chauliodus sloani					8.406774						0.986
Chiasmodon niger					0.690968						0.206
Cornish blackfish		1.64			5.7		0.58	0.368		1.9	5.18
Diaphus rafinesquei			0.014				0.012	0.021			
Frostfish			0.038								
Greater argentine					0.333968				0.604	0.006	
Grey gurnard				0.38					305.7	1.5	
Hachetfish							0.0093				
Hake		6.06		5.3		4.42			92.7		1.19
Halargyreus johnsonii									0.063		
Horse mackerel			0.295	117.7				0.384	2.9	0.238	
Lampadena speculigera								0.001			
Lampanyctus crocodilus								0.374			
Leafscale gulper shark					5.93				5.14		
Lobianchia gemellarii					2.360806						
Mackerel	8584	51.3	3.02	317				4.12	13.6	4.83	80.3
Malacosteus niger					0.460645						
Myctophum punctatum			0.092					0.005			
Nansenia oblita								0.09			
Nesiarchus nasutus											1.03
Normichthys operosus								0.11			
Notolepis rissoi		0.11	0.42		165.625			0.064	1.2		0.568
Notoscopelus kroeyeri		1.24	2.137333				0.108			0.442	0.132
Paralepididae spec1									0.0145		
Pearl side		0.013	0.068			0.01			0.0016	0.004	0.0035
Poromitra capito									0.006		
Pseudoscopelus altipinnis					0.86371						
Ray's bream			1.06	1.9							
Schnakenbeck's searsid									0.303		
Silvery pout		0.05				0.272		0.03	0.045		
Slender snipe-eel					1.232226				0.456		0.516
Smalltooth velvet dogfish									3.49		
Smooth grenadier					0.034				0.022		
Stomias boa					3.385742			0.027	0.528		0.176
Xenodermichthys copei									4.9		

Table 4.3. Numbers of fish caught by area, during the March 2009 North East Atlantic hydro acoustic survey, FRV "Tridens" in numbers.

latin name	english name	hebrides	south porcupine bank	north porcupine bank
Aphanopus carbo	Black scabbardfish			2
Argentina silus	Greater argentine	3		58
Argyropelecus hemigymnus				15
Argyropelecus olfersi	Hachetfish			14
Benthodesmus elongatus	Frostfish		1	
Borostomias antarcticus				12
Brama			1	
Brama brama	Ray's bream		3	
Capros aper	Boarfish		32972	
Centrolophus niger	Blackfish		1	1
Centrophorus squamosus	Leafscale gulper shark	1		1
Chauliodus sloani		89		1679
Chiasmodon niger		17		3227
Deania calceus	Birdbeak dogfish	1		3
Diaphus rafinesquei			26	482
Eutrigla gurnardus	Grey gurnard	1859	2	
Gadiculus argenteus	Silvery pout	2	6	17
Halargyreus johnsonii		538		
Lampadena speculigera				2
Lampanyctus crocodilus				29
Lobianchia gemellarii				3813
Lophius piscatorius	Anglerfish	1		
Malacosteus niger				564
Maurolicus muelleri	Pearl side	33	40	6
Merluccius merluccius	Hake	81	20	6
Micromesistius poutassou	Blue whiting	52838	8137	61863
Myctophum punctatum			233	25
Nansenia oblita				1
Nemichthys scolopaceus	Slender snipe-eel	20		48
Nesiarchus nasutus		1		
Nezumia aequalis	Smooth grenadier	42		1462
Normichthys operosus				21
Notolepis rissoi		99	46	7535
Notoscopelus kroeyeri		69	139	27
Paralepididae spec1		320		
Poromitra capito		4		
Pseudoscopelus altipinnis				454
Sagamichthys schnakenbecki	Schnakenbeck's searsid	41		
Schedophilus medusophagus	Cornish blackfish	11	4	13
Scomber scombrus	Mackerel	72	106751	30
Scymnodon obscurus	Smalltooth velvet dogfish	6		
Serrivomer beani	Bean's sawtoothed eel	1		
Stomias boa		53		13
Trachurus trachurus	Horse mackerel	12	971	1
Xenodermichthys copei		515		

Length frequency distributions per haul of blue whiting caught are shown in figure 4.3.

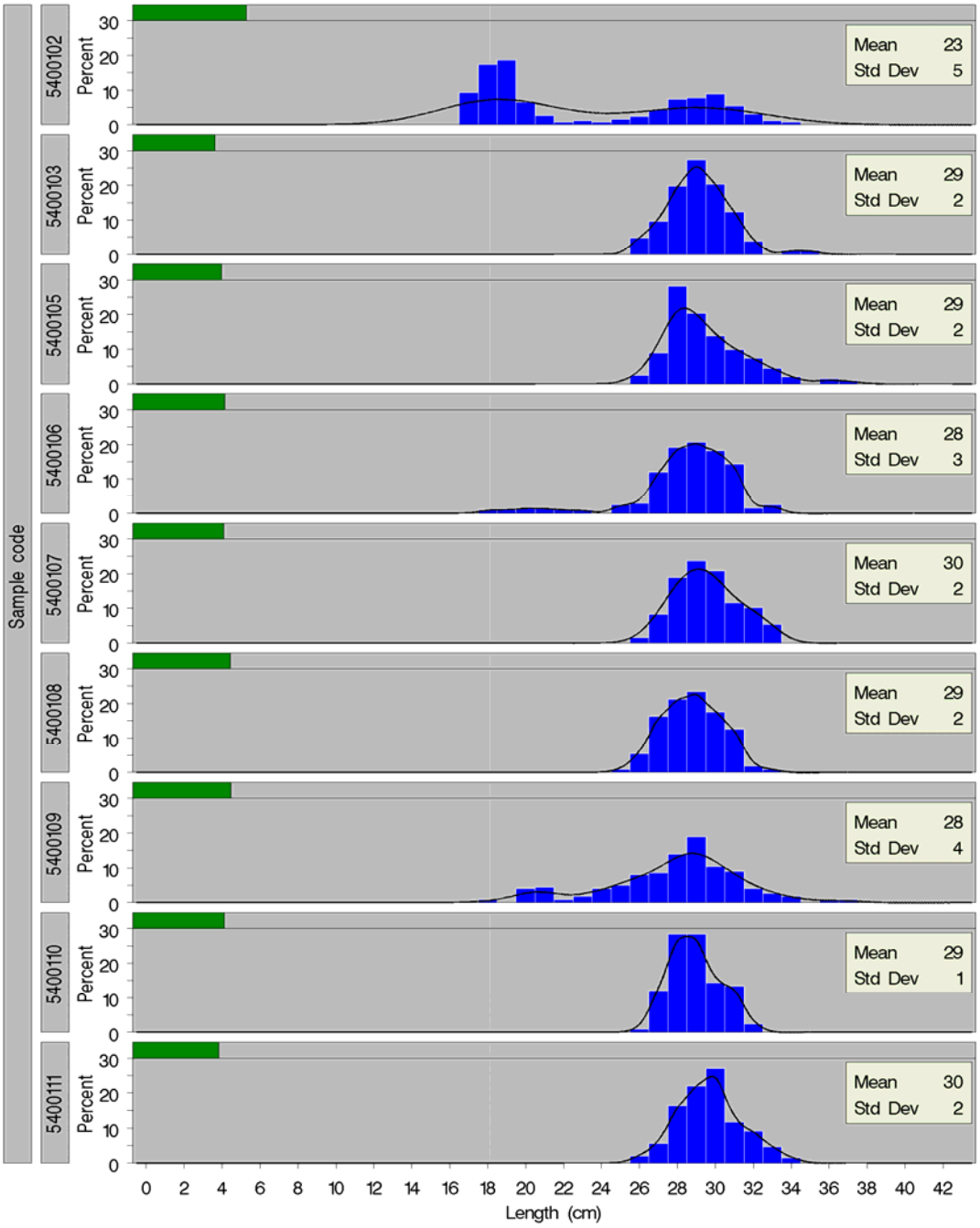


Figure 4.3. Length frequency distributions of blue whiting. Smoothing is obtained by normal kernel density estimates. The green bars indicate the relative amount of samples used.

In total 450 biological samples of blue whiting were collected and used for length, age, weight and maturity keys. In addition 50 mackerel and 25 horse mackerel samples were collected and used for length, weight and maturity keys.

An age/maturity structure of the blue whiting samples is shown below (Figure 4.4). Stock in the Tridens survey area is dominated by age classes 5 and 6 years (year classes 2004 and 2003).

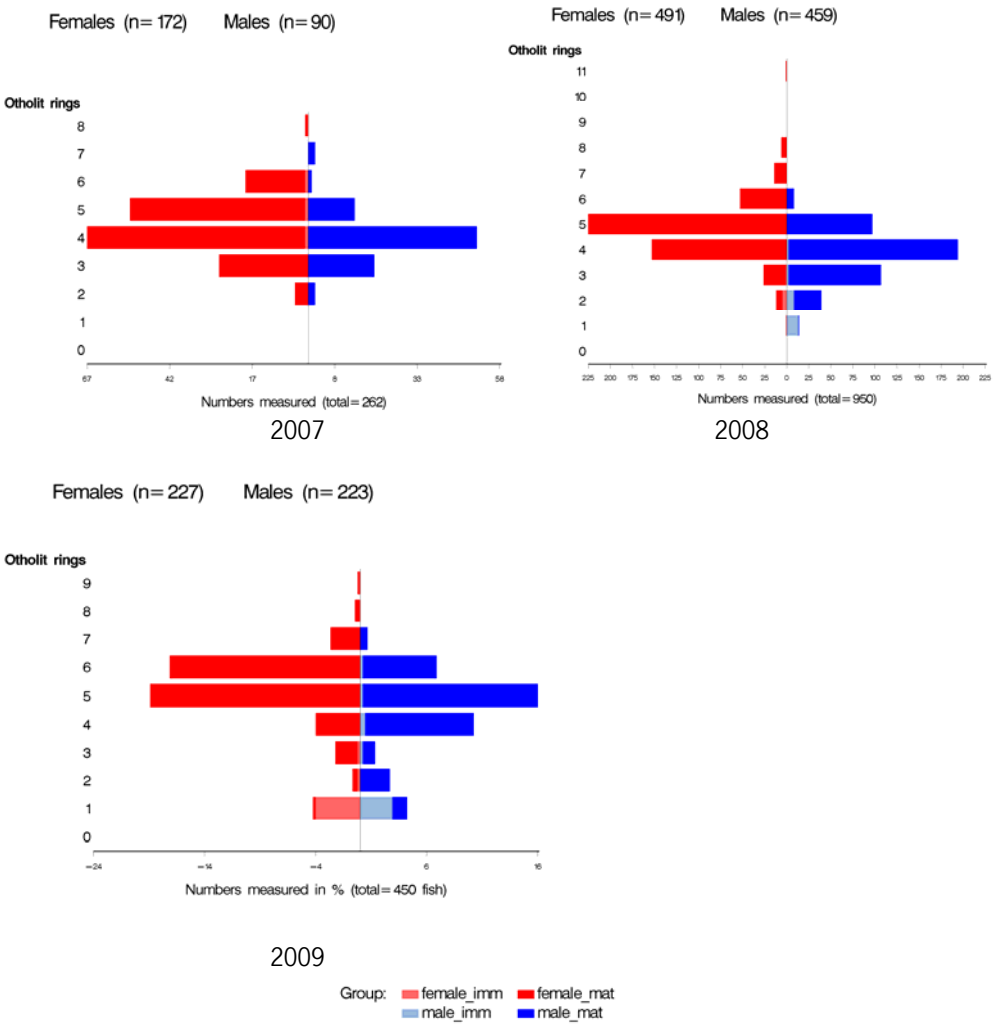
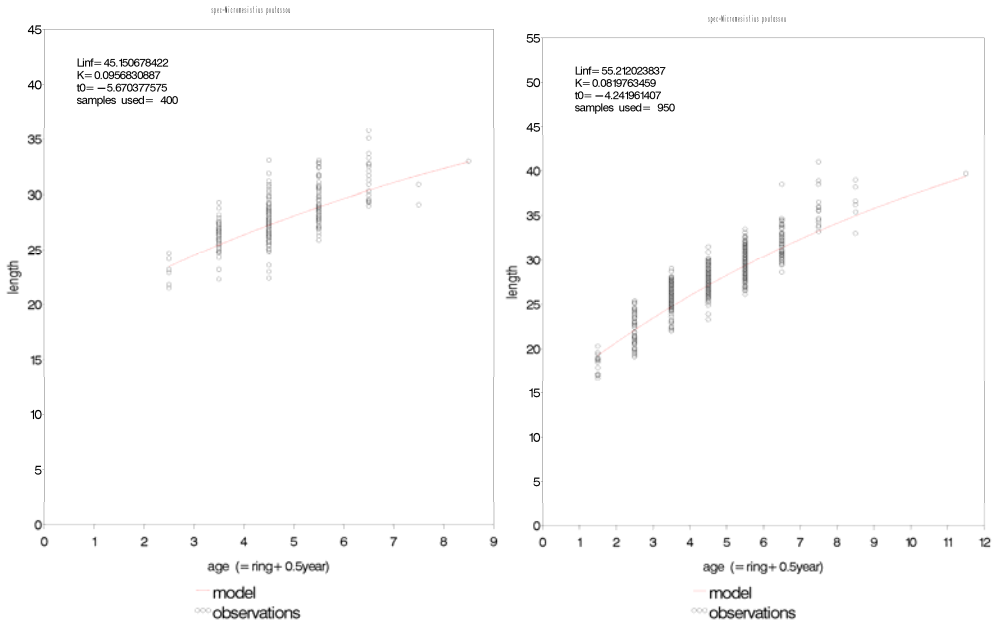


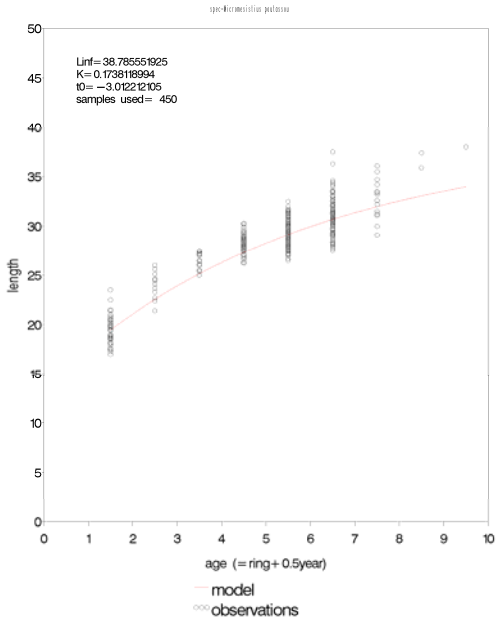
Figure 4.4. Age-maturity structure of collected biological samples of blue whiting by haul during the March 2007, 2008 and 2009 North East Atlantic hydro acoustic surveys, FRV "Tridens".

Growth

Just for the record, the 2009 growth curve has been plotted here (Figure 4.5) to be able to compare it to the ones obtained in 2007 and 2008.

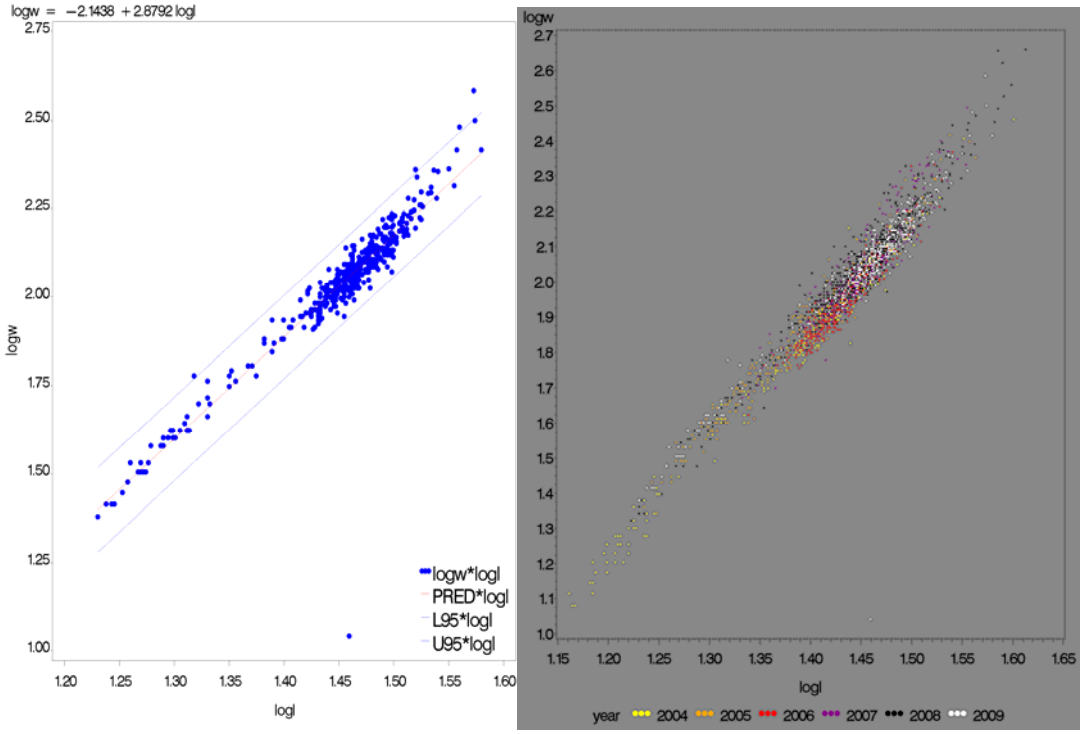


2007 2008



2009

Figure 4.5. Von Bertalanffy growth curves of blue whiting caught during the March 2007, 2008 and 2009 survey.



A B

Figure 4.6. Length-weight relationships of blue whiting caught during the March 2009 survey (A) and the combined relationships for all survey years (B).

4.3 Hydrography section at Porcupine Bank

At selected positions Tridens conducted measurements of temperature and salinity down to a maximum depth of 1000 m or to close to the sea floor. This kind of investigation is done in order to examine the physical environment of blue whiting within the research area. Unlike birds and mammals fish are unable to maintain a constant body temperature, and thus their bodily functions are ultimately linked to the ambient temperatures. This is particularly true for the development and ripening of the gonads and, hence, the timing of spawning. Temperature differences around 1 °C can already make a difference of several weeks.

Furthermore, analysis of the relationship between temperature and salinity can provide information about characteristics and origin of surrounding water masses. These information can then be utilized to describe the climatological regime during the spawning season and may allow for predictions of recruitment in a fish species.

During the current cruise sea surface temperatures (SST) ranged between 10.3 and 11.5 °C
within the investigated area. The low temperatures being encountered in areas closer the coast while surface temperatures above the greater depths were generally higher. This is illustrated by a transect we conducted across Porcupine Bank at about 53° 18' N (Figure 4.7).

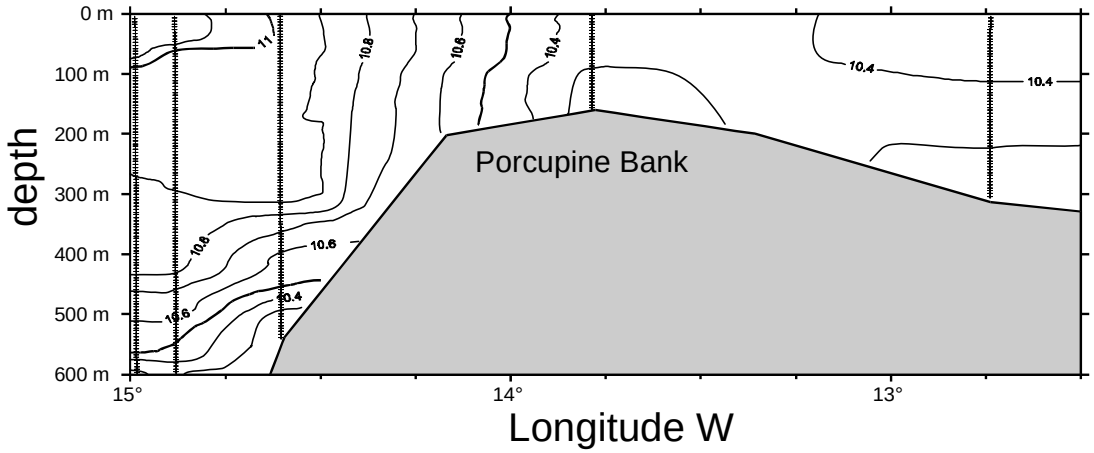


Figure 4.7: Temperature distribution along a transect across Porcupine Bank in the upper 600 m during the 2009 Hydroacoustic Survey on Blue Whiting with Dutch RV Tridens

The CTD downcasts are marked as vertical rows of little crosses; the curves mark lines of equal temperature (isothermals). Also shown is a section through the bottom topography across Porcupine Bank. In the surface layers to about 100 m depth temperatures decrease gradually from > 11.1 °C in the West to < 10.4 °C above Porcupine Bank, further to the East SST increase again slightly to values > 10.4 °C. Over the deeper waters west of Porcupine Bank there is not much change in the temperatures down to about 300 – 400 m. Illustrated by the narrowing isothermals, temperatures decrease at a faster rate thereafter. Striking features above the western slope of Porcupine Bank are the steep and almost vertical isothermals that illustrate upwelling of cool waters from the depth. Here, upwelling is predominantly caused by the impingement of tidal currents onto the slopes of Porcupine Bank (Mohn 2000). The upwelled water carries nutrients from depth into the illuminated layers and promotes enhanced production above the bank (McMahon et al. 1995, White et al. 1996, Hillgruber and Kloppmann 1999).

The situation described in Figure 1 is almost identical to the situation found by a German expedition in 1994 at almost exactly the same time of the year and in the same area (Figure 4.8). As during this cruise the researchers found warmest temperatures in the surface layers west of Porcupine Bank with temperatures declining to the East. Also in 1994 upwelling was discernible above the slopes of Porcupine Banks (Kloppmann et al. 2001). The only striking difference is that almost throughout the complete water masses temperatures were roughly 1 °C cooler in 1994 than today.

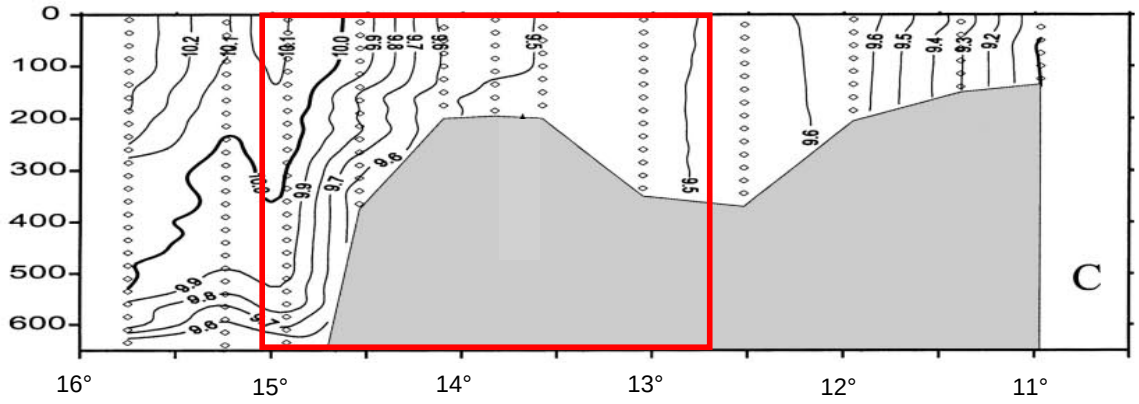


Figure 4.8: Temperature distribution along a transect across Porcupine Bank in the upper 650 m during the 1994 survey on blue whiting eggs and larvae with German RV Heincke. The red box indicates the area that has been sampled with CTD probes during the 2009 Tridens cruise.

Based on the high number of blue whiting eggs found in their ichthyoplankton catches Kloppmann et al. (2001) concluded that spawning was at its peak at the respective time of the year. This year, many of the examined blue

whiting had spent gonads, indicating that peak spawning in 2009 is already over. It is most likely that the higher water temperatures made blue whiting spawn earlier than observed in the mid 90s of the past century.

Literature

Hillgruber, N. and M. Kloppmann (1999). Distribution and feeding of blue whiting Micromesistius poutassou larvae in relation to different water masses in the Porcupine Bank area, west of Ireland." Marine ecology progress series 187: 213-225.

Kloppmann M., Mohn C. and J. Bartsch (2001). The distribution of blue whiting eggs and larvae on Porcupine Bank in relation to hydrography and currents. Fisheries Research 50, 89-109.

McMahon, T., Raine, R., Titov, O. and S. Boychuk (1995). Some oceanographic features of northeastern Atlantic waters west of Ireland. ICES J. Mar. Sci. 52, 221-232.

Mohn, C. (2000). Über Wassermassen und Strömungen im Bereich des europäischen Kontinentalrandes westlich von Irland. Dissertation, Universität Hamburg, Germany, 138 pp.

White, M., C. Mohn and M. Orren (1998). Nutrient distributions across the Porcupine - Bank,
ICES J. Mar. Sci. 55 , 1082-1094.

Appendix A. Calibration results

Echo Sounder System Calibration

Vessel :	MS Tridens	Date :	16-3-2009
Echo sounder :	ER60 PC	Locality :	Irland
Type of Sphere :	CU-64	TS_{Sphere}: (**Corrected for soundvelocity or t,S**)	-33.60 dB
		Depth(Sea floor) :	25 m

Calibration Version 2.1.0.12

Comments:
Dunmanus #2

Reference Target:

TS	-33.60 dB	Min. Distance	10.00 m
TS Deviation	5.0 dB	Max. Distance	13.00 m

Transducer: ES38B Serial No. 28887

Frequency	38000 Hz	Beamtype	Split
Gain	25.15 dB	Two Way Beam Angle	-20.6 dB
Athw. Angle Sens.	21.90	Along. Angle Sens.	21.90
Athw. Beam Angle	7.04 deg	Along. Beam Angle	6.95 deg
Athw. Offset Angle	-0.02 deg	Along. Offset Angl	0.03 deg
SaCorrection	-0.68 dB	Depth	0.00 m

Transceiver: GPT 38 kHz 009072017a3b 1-1 ES38B

Pulse Duration	1.024 ms	Sample Interval	0.191 m
Power	2000 W	Receiver Bandwidth	2.43 kHz

Sounder Type:
EK60 Version 2.2.0

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	1489.2 m/s

Beam Model results:

Transducer Gain =	25.07 dB	SaCorrection =	-0.71 dB
Athw. Beam Angle =	7.09 deg	Along. Beam Angle =	7.07 deg
Athw. Offset Angle =	0.00 deg	Along. Offset Angle=	-0.04 deg

Data deviation from beam model:
RMS = 0.20 dB
Max = 0.34 dB No. = 290 Athw. = -3.2 deg Along = -1.5 deg
Min = -0.73 dB No. = 287 Athw. = -4.7 deg Along = 0.8 deg

Data deviation from polynomial model:
RMS = 0.13 dB
Max = 0.32 dB No. = 285 Athw. = -4.9 deg Along = 0.7 deg
Min = -0.52 dB No. = 46 Athw. = -1.0 deg Along = 0.7 deg

Comments :

Wind Force : 3 kn. **Wind Direction :** degrees
Raw Data File: D:\USERDATA\Acoustic EK60 RAW data\2009BWHTS\cal_-D20090316-T153721.raw
Calibration File: D:\USERDATA\Calibration\Txdr No 28887\38 160309 #2

Calibration responsibles : Sytse Ybema, Eric Armstrong

Vessel :	MS Tridens	Date :	4-1-2009
Echo sounder :	ER60 PC	Locality :	Penzance bay,England
Type of Sphere :	CU-64	TS_{Sphere}: -33.60 dB (Corrected for soundvelocity or t,S)	Depth(Sea floor) : 30 m

Calibration Version 2.1.0.12

Comments:
Penzance Bay Cal #2

Reference Target:

TS	-33.60 dB	Min. Distance	10.00 m
TS Deviation	5.0 dB	Max. Distance	13.00 m

Transducer: ES38B Serial No. 28887

Frequency	38000 Hz	Beamtype	Split
Gain	25.07 dB	Two Way Beam Angle	-20.6 dB
Athw. Angle Sens.	21.90	Along. Angle Sens.	21.90
Athw. Beam Angle	7.09 deg	Along. Beam Angle	7.07 deg
Athw. Offset Angle	0.00 deg	Along. Offset Angl	0.04 deg
SaCorrection	-0.71 dB	Depth	0.00 m

Transceiver: GPT 38 kHz 009072017a3b 1-1 ES38B

Pulse Duration	1.024 ms	Sample Interval	0.191 m
Power	2000 W	Receiver Bandwidth	2.43 kHz

Sounder Type:
EK60 Version 2.2.0

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.	9.9 dB/km	Sound Velocity	1492.3 m/s

Beam Model results:

Transducer Gain =	25.10 dB	SaCorrection =	-0.64 dB
Athw. Beam Angle =	6.93 deg	Along. Beam Angle =	6.95 deg
Athw. Offset Angle =	0.02 deg	Along. Offset Angle=	-0.06 deg

Data deviation from beam model:
RMS = 0.18 dB
Max = 0.51 dB No. = 195 Athw. = 3.5 deg Along = 3.8 deg
Min = -0.80 dB No. = 226 Athw. = -2.3 deg Along = 4.4 deg

Data deviation from polynomial model:
RMS = 0.13 dB
Max = 0.56 dB No. = 195 Athw. = 3.5 deg Along = 3.8 deg
Min = -0.60 dB No. = 111 Athw. = 1.1 deg Along = -4.4 deg

Comments :

Wind Force : 2 kn. **Wind Direction :** degrees
Raw Data File: D:\USERDATA\Acoustic EK60 RAW data\2009BWHTS\BWHTS2009_postcal-D20090401-T120348.raw
Calibration File: D:\USERDATA\Calibration\Txdr No 28887\20090401 #2

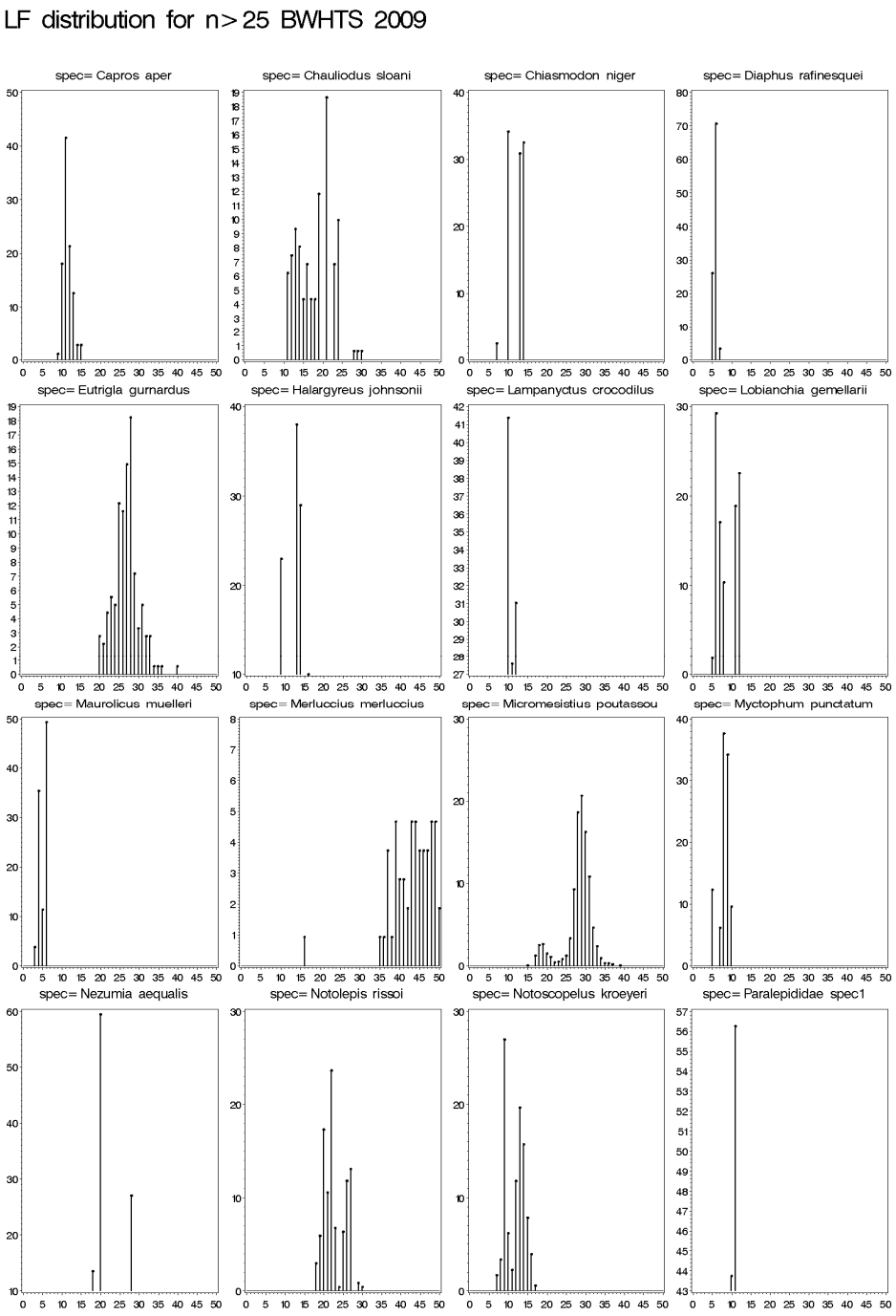
Calibration responsibles : Sytse Ybema, Eric Armstrong

Appendix B. Species names

Note: not all species caught have been able to put into the database system. Overall 60 species were found of which only 45 are listed here.

3 letter code	NODC code	tsn	Dutch name	Scientific name	English name
	8850020301	172	Zwarte kousenbandvis	Aphanopus carbo	Black scabbardfish
ARG	8756010203	162064	Grote zilversmelt	Argentina silus	Greater argentine
	8759020106	162219	Kleine bijlvis	Argyropelecus hemigymnus	
	8759020107	162220	Bijlvis	Argyropelecus olfersi	Hachetfish
	8850020103		Frostfish	Benthodesmus elongatus	Frostfish
	8759030203	182869		Borostomias antarcticus	
	8835710100	170288	Brama	Brama	
	8835710102	170290	Braam	Brama brama	Ray's bream
	8811060301	166320	Evervis	Capros aper	Boarfish
	8851010301	172520	Zwarte vis	Centrolophus niger	Blackfish
	8710010302	160635	Bruine doornhaai	Centrophorus squamosus	Leafscale gulper shark
	8759060103	162281		Chauliodus sloani	
	8840160101	171086		Chiasmodon niger	
	8710011401	160742	Spitssnuitdoornhaai	Deania calceus	Birdbeak dogfish
	8762140218	162620		Diaphus rafinesquei	
GGU	8826020601	167044	Grauwe poon	Eutrigla gurnardus	Grey gurnard
ZIK	8791032101	164772	Zilverkabeljauw	Gadiculus argenteus	Silvery pout
	8791010601	164692	H. johnsonii	Halargyreus johnsonii	
	8762141204	162708		Lampadena speculigera	
	8762140317	162649	L. crocodilus	Lampanyctus crocodilus	
	8762142102	162756		Lobianchia gemellarii	
MON	8786010103	164501	Zeeduivel	Lophius piscatorius	Anglerfish
	8759050101	162269		Malacosteus niger	
	8759010501	162187	Zalmharing	Maurolicus muelleri	Pearl side
HKE	8791040105	164795	Heek	Merluccius merluccius	Hake
WHB	8791032201	164774	Blauwe wijting	Micromesistius poutassou	Blue whiting
	8762141504	162723	Stippellantaarnvis	Myctophum punctatum	
	8756010104			Nansenia oblita	
	8741210202	161624	Slanke snipaal	Nemichthys scolopaceus	Slender snipe-eel
	8850010701	172370	N. nasutus	Nesiarchus nasutus	
	8794010801	165394	Gladde grenadier	Nezumia aequalis	Smooth grenadier
	8756040701			Normichthys operosus	
	8762070201	162471	Risso's barracudina	Notolepis rissoi	
	8762140405	162661	Kroeyers lantaarnvis	Notoscopelus kroeyeri	
	8762070001		Paralepididae spec1	Paralepididae spec1	
	8808020202	166109		Poromitra capito	
	8840160301	171094		Pseudoscopelus altipinnis	
	8756040401		Sagamichthys	Sagamichthys schnakenbecki	Schnakenbeck's searsid
	8851010302		Gestekelde zwarte vis	Schedophilus medusophagus	Cornish blackfish
MAC	8850030302	172414	Makreel	Scomber scombrus	Mackerel
	8710011602	160756	S. obscurus	Scymnodon obscurus	Smalltooth velvet dogfish
	8741200102	161606	S. beani	Serrivomer beani	Bean's sawtoothed eel
	8759070205			Stomias boa	
HOM	8835280103	168588	Horsmakreel	Trachurus trachurus	Horse mackerel
	8760011201	162340		Xenodermichthys copei	

Appendix C. Length frequency proportions of most abundant species



Appendix D. Deep sea species

Findings

A striking feature in the bycatch of the cruises of the preceding years was the occurrence of large amounts of snake pipefish (*Entelurus aequoreus*) and dealfish (*Trachipterus arcticus*). Except for only 1 specimen of snake pipefish in the second haul, none of those 2 species were caught during this year. Also, the bycatch revealed only very few specimens of the Cornish blackfish (*Schedophilus medusophagus*) which always summed up to at least one to several baskets during last year's cruise. While the dramatically increased occurrence of snake pipefish between 2004 and 2008 might be attributed to a rare and short period of mass propagation of a single relatively short lived species the lower presence of the other 2 species may indicate at a shift in hydrological regime in the blue whiting spawning area. Both have a broadly northern temperate to subarctic distribution pattern, and their centers of abundance might have been shifted further northwards recently. This might be confirmed by greater abundances of species like *Gonostoma elongatum*, *Bolinichthys supralateralis* or *Capros aper* that have a sub-tropical to temperate distribution pattern. However, the interpretation of these findings has to be validated by a thorough examination of the fish assemblages that have been encountered during this cruise.

Deep sea species guide

Last year Matthias Kloppmann, Joe Freijser and Sytse Ybema started documenting the by-catch analysis in the form of a picture book (Trawling the Deep, Meso- and bathypelagic fishes in the Rockall and Porcuppine Bank area), which was updated this year, with a special emphasis on 3 deep sea trawls. In order to make this information more accessible to other research vessels, we came up with the idea of creating a Wikipedia-like platform about these deep sea fishes. The big advantage of this database is, that other scientists can, if they register and are accepted by our team as eligible editors, add and share their own results of by-catch analysis of their cruise. Beside the fact that a more complete dataset of species present in the meso- and bathypelagic zones of the sea can be collected, the website can also be used as a help of identification for deep sea species. The structure of the website follows the track of the above mentioned book, with additional information on family characteristics, and can as such be used just like a hardcopy picture guide.
The website was built using an opensource Mediawiki Template (www.mediawiki.org) and a mysql database. Special templates and a helpfile have been developed to make it easier, even without any php programming knowledge, to update the database.
The DeepSea-Wiki can be found at www.7seas-outreach.com/wiki

Appendix E. Marine mammal observations

Beaked whale recordings

Acoustic survey cruise report, IMARES Blue Whiting cruise 16 March to 3 April 2009

Introduction

Beaked whales belong to one of the marine mammal families that we know the least about. The reason for this is their infrequent encounter rates, off-shore habitat use and extensive deep and long lasting dives (Heyning 2002, Mead 2002, Pitman 2002). The beaked whale family is widely distributed on a global scale (Cox et al. 2006, MacLeod et al. 2006, Podestá et al. 2006) and concentrated in deep-water habitats, continental slopes or submarine canyons (D'Amico et al. 2003, Johnson et al. 2008, MacLeod and Mitchell 2006, Mead 2002, Reeves et al. 2002, Whitehead et al. 1997, Williams et al. 2002). Their general diving pattern limits the time the animals spend on the surface and encounter rates of beaked whales during visual surveys are therefore typically low (ANON 2004, Barlow 1999, Barlow et al. 2006).

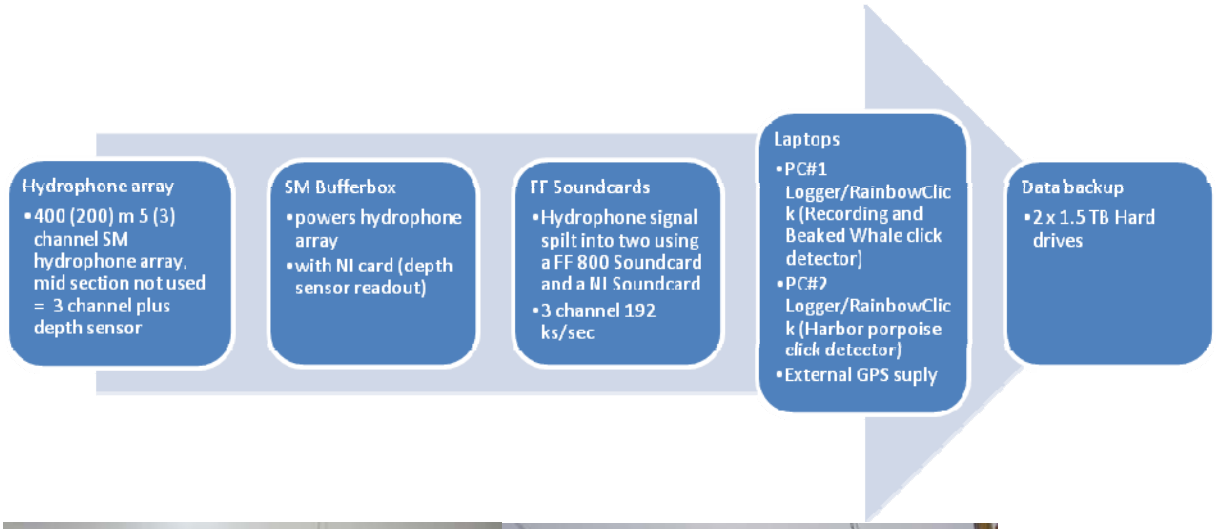
In the past few years mass stranding incidents involving mostly Mesoplodon and Ziphius species has been linked with military activity and mid-frequency sonar exercises (Cox et al. 2006, Evans and England 2001, Fernandez et al. 2005, Hildebrand 2005, Jepson et al. 2003, Simmonds and Lopezjurado 1991, Weilgart 2007). Beaked whales seem to be especially vulnerable to military sonar sounds. The reason for this is unknown. The need for development of mitigation methods is important. The use, development and implementation of passive acoustic monitoring (PAM) systems could be one way to achieve this.

Several beaked whale species are believed to produce clicks and some species also use whistles as part of their vocal repertoire (Dawson et al. 1998, Hobson and Martin 1996, Hooker and Whitehead 2002, MacLeod and D`Amico 2006, Rogers and Brown 1999). Beaked whales use ultrasonic frequency clicks with most of the energy in the 26-50 kHz frequency range. The frequency modulated search clicks are 175 to 270 µs long with inter click intervals (ICI) of between 0.2 and 0.4 sec. (Johnson et al. 2008, Johnson et al. 2004, 2006, Madsen et al. 2005, Zimmer et al. 2005).

The potential of using near surface towed hydrophones to detect beaked whales from ships like the RS Tridens conducting active acoustic surveys is unknown. The data collected on the Blue Whiting survey can be very important combined with the dedicated visual and acoustic 2007 CODA survey for cetaceans (CODA 2009). This survey experienced problems due to high noise levels from the ship involved in the UK sector (Block_01), which is the same survey area of the Blue Whiting. The objective from a acoustic marine mammal perspective is to i; investigate the potential of collection passive acoustic data on a active acoustic survey vessel with these dimensions and ii; generate data on distribution, abundance and habitat use of beaked whales.

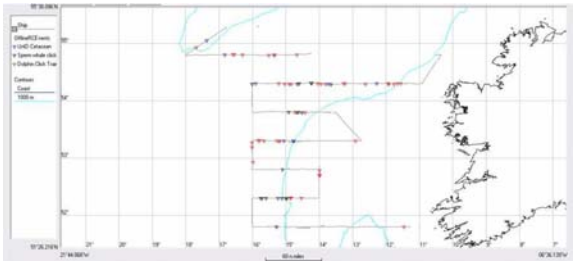
Setup

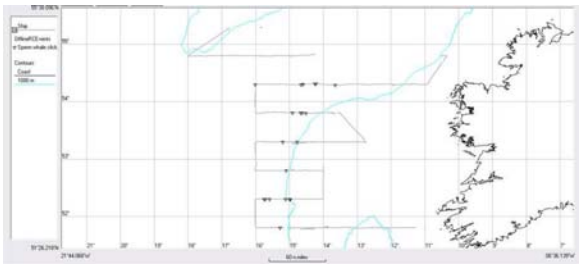
The acoustic setup initially onboard RS Tridens consist of a 400 m 5 element potted hydrophone manufactured by Seiche Measurement, having a front section at 200 m and a rear section at 400 m. Front section having two elements separated by 25 cm, and a depth sensor, rear part having 3 elements separated with 25, 275 and 300 cm and a depth sensor. Only the rear part of the array has been used in this survey. Each channel was sampled at 192 ks/sec, providing a 2-96 kHz frequency range. The acoustic array was connected to a custom build Seiche Measurement buffer-box providing the array with power and containing a Measurement Computing (MC) card for depth sensor readouts. A RME FF800 soundcard connected the output from the buffer-box to a laptop. This laptop used IFAW´s Logger ver. 4.06.0001, RainbowClick ver. 4.08.0001 software and PAMQUARD ver. 1.2.00 Beta software for data acquisition and beaked whale click detection. An external GPS unit provided GPS data to the setup. A second pc using Logger and Rainbowclick was set up to detect Harbour porpoise clicks in real time. Two 1.5 TB hard drives provided storage and backup facility for the data collected. Raw recordings and click files were stored and backed up every day.

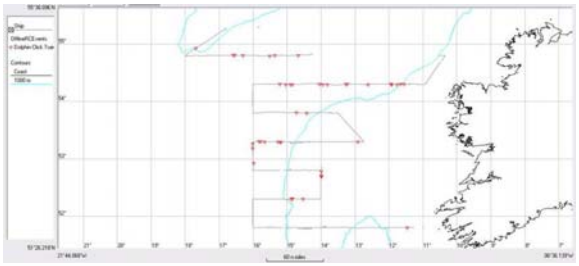


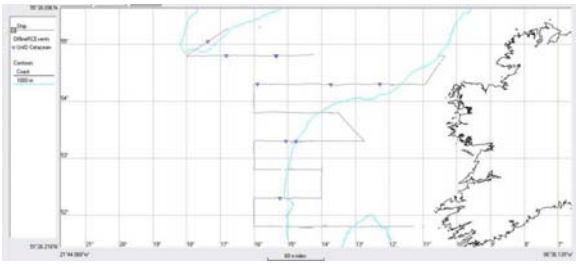
Preliminary results

Total hours of recordings from the hydrophone array have been calculated to be approximately 139 hours. This data has been pre analysed coming up with a total of 72 identified acoustic detection events with various species and number of animals. This is only rough analysis and estimate, changes in dataset should be expected. However 42 detection events have been identified as dolphin events, 18 as sperm whales and 12 as unidentified cetacean events (needs further and more in depth analysis).









Recommendations

Integrating an active acoustic survey with a passive acoustic survey has several problems. A passive acoustic survey relies on good signal to noise ratios, active sounders used in the active acoustic survey operates in the same frequencies as the cetaceans of interest. This pilot study has showed that it is possible to conduct both with a reasonable result with respect to detection range and rates of the passive acoustic system. The implementation of passive acoustic monitoring system on future surveys is there for of great benefit for marine mammal studies.
However a few changes in the future could make the implementation and use of a passive acoustic system onboard RS Tridens more productive. During this trial 200 meter of the array was used, adding the final 200 meters would have decreased the noise from RS Tridens engine and propeller, improving the detection conditions. At the same time the depth of the rear end of the hydrophone would increase which also would improve the detection conditions. With a survey speed of 10 knots the rear end of a 200 meter array is only in 5-7 meters of depth. In the Atlantic large swells and waves in combination with this towing depth creates a lot of noise every time the hydrophone is close to the surface which of course reduce the detection probability. The use of a 400 meter hydrophone array would demand the use of a winch in the launching and hauling process, such a winch was not available on this cruise. The array was launched from starboard side approximately 3 meters off the side using one of the cranes. This was done to avoid the hydrophone being towed directly behind the propeller. Using the (I DONT KNOW THEIR NAME) would further improve the detection conditions as the hydrophone would be towed even further away from the direct line of the propeller. Having these changes in mind, an passive acoustic system could be monitored next to the active system and being post possessed and analysed afterwards. As such it would not need further personal onboard, although it is recommendable to have a person with some passive acoustic background onboard for potential trouble shooting.

Cetacean Distribution & Relative Abundance

Surveyor: Joanne O'Brien

Marine Biodiversity Research Group
Galway-Mayo Institute of Technology
Dublin Road
Galway
Ireland

Introduction

The waters of Ireland's Exclusive Economic Zone (EEZ) are thought to represent one of the most important cetacean (whales, dolphins and porpoise) habitats in Europe. To date 24 species of cetacean have been recorded (Appendix I), with seven of these having been confirmed as calving within the Irish EEZ, while a number of other species are possibly calving (e.g. minke whale and northern bottlenose whale) (Berrow 2001). In recognition of their importance for cetaceans, the Irish government declared all Irish waters (within the EEZ) to be a whale and dolphin sanctuary in 1991 (Rogan and Berrow 1995). Despite this recognition, information on the distribution and relative abundance of cetaceans within the Irish EEZ, especially in offshore waters, is very limited (Wall et al. 2006).
The Irish Whale and Dolphin Group (IWDG) have been collecting data on the distribution and relative abundance of cetaceans in Irish waters (including Northern Ireland) since 1991. The IWDG casual and constant effort sightings schemes record data mainly from land-based sightings and surveys (Berrow et al. 2001). The IWDG has conducted cetacean surveys on board commercial ferries since 2001 and on board the Irish Marine Institute's offshore research vessel 'Celtic Explorer' since 2003.

In 2008, the IWDG in collaboration with the Galway-Mayo Institute of Technology commenced PReCAST, a three-year project (2008-2011) which aims to provide robust scientific data to support conservation policy and provide guidance to state agencies in implementing national and international obligations. PReCAST is committed to gaining a more complete understanding of the seasonal distribution, relative abundance and habitat use of cetaceans within the Irish EEZ.

As part of this project, a cetacean distribution and relative abundance survey was conducted on board the F.R.V Tridens during IMARES 2009 Blue Whiting Hydro-Acoustic Survey.

Methods

The survey was conducted on board the F.R.V. Tridens as an ancillary project of the Blue Whiting Hydro Acoustic Survey 2009. The survey areas were opportunistic and based on predetermined locations chosen by IMARES.

A single marine mammal observer was present on board during the survey and conducted watches from the bridge deck. Observer effort focused on a 90 degree arc ahead of the ship; however sightings located up to 90 degrees to port and starboard were also included. The observer scanned the area by eye and using 8 X 32 binoculars. Bearings to sightings were measured using an angle board and distances were estimated with the aid of distance measuring stick. Environmental data were recorded every 15 minutes using Logger 2000 software (IFAW 2000). Sightings were also recorded using Logger 2000. Automated position data were obtained through a laptop computer linked to a feed from the ships GPS.

On average the vessel travelled at a speed of 10 knots but this was reduced to 2-3 knots when fishing, while the vessel was stationary when taking CTD samples.

Surveying was conducted up to Beaufort sea-state 6 and in visibility ≥500m. As this was a survey onboard a vessel of opportunity, the survey was conducted in 'passing mode' and cetaceans sighted were not approached. Sightings were identified to species level where possible, with species identifications being graded as definite, probable or possible. Where species identification could not be confirmed, sightings were downgraded (e.g. unidentified dolphin / unidentified whale / unidentified beaked whale etc.) according to criteria established for the IWDG's cetacean sightings database (IWDG 2009).

Results

Environmental Conditions

Visual observations commenced on the 16 of March as the vessel departed Cork Harbour until the evening of the 25 March before the vessel returned to port at Oban in Scotland due to gale force conditions. Environmental conditions varied over the duration of the survey with sea state ranging from 0-8, and swell height ranging from light to heavy. Environmental data was recorded at 287 stations. Sea state 5-6 persisted for 50% of the survey duration, while 37% of observations were carried out in a sea state 3-4.

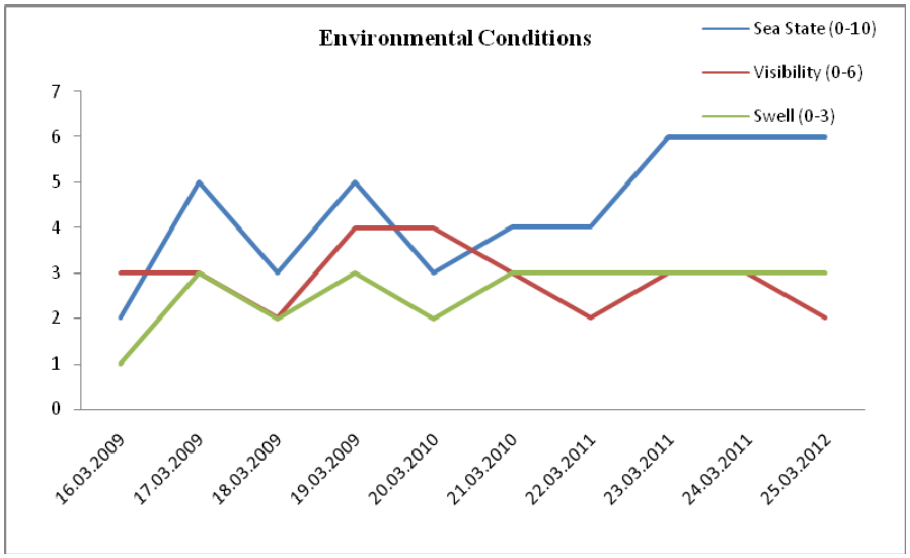


Fig. 1: Sea state, swell conditions and visibility recorded daily during the survey.

Cetacean Survey Results

71.44 hours of survey time were logged over 6,400km, with 37% of this at Beaufort sea state three to four; 50% at Beaufort sea state five to six. 16 sightings of five cetacean species, totalling 81 individuals were recorded (fig. 2).

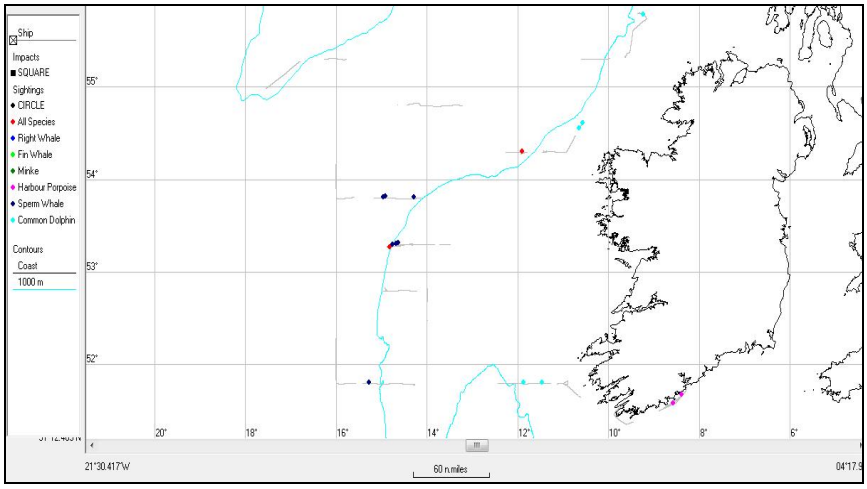


Fig. 2 Distribution of all cetacean species recorded during the current survey

Identified cetacean species were harbour porpoise (Phocoena phocoena), common dolphin (Delphinus delphis), pilot whale (Globicephala melas), sperm whale (Physeter macrocephalus) and Cuvier's beaked whale (Ziphius cavirostris). Sperm whales were found to be the most frequently sighted species, while common dolphins were found to be the most abundant.

Table 1: Sightings, counts and group size ranges for cetaceans sighted during current survey.

Species	No. Sightings	No. Individuals	Range of Group Size
Common dolphin	5	46	2-20
Harbour porpoise	2	5	2-3
Pilot whale	1	15	15
Sperm whale	7	14	1-5
Cuvier's beaked whale	1	1	1

Common Dolphin & Sperm Whale
(© Joanne O'Brien)

Bird activity

Daily species lists were made of all seabird species seen around the survey vessel. 15 seabird species were recorded during the survey (table 2): fulmar (Fulmarus glacialis); gannet (Morus bassanus); great skua (Stercorarius skua); kittiwake (Rissa tridactyla); black-headed gull (Larus ridibundus); herring gull (Larus

argentatus); lesser black backed gull (Larus fuscus); great black-backed gull (Larus marinus); storm petrel (Hydrobates pelagicus); Arctic skua (Stercorarius parasiticus); puffin (Fratercula arctica); house martin (Delichon urbica); guillemot (Uria aalge); shag (Phalacrocorax aristotelis) and cormorant (Phalarocorax carbo).

Gannet
(© Joanne O'Brien)

Table 2: Daily seabird species lists recorded during current survey.

	March									
Species	16	17	18	19	20	21	22	23	24	25
Fulmar	x	x	x	x	x	x	x	x	x	x
Gannet	x	x	x	x	x	x	x	x	x	x
Great skua			x	x	x	x	x	x	x	x
Kittiwake	x	x	x	x	x	x	x	x	x	x
Black -headed gull	x	x								
Herring gull	x	x	x							
Lesser black-backed	x			x	x	x	x		x	x
Greater black-backed				x	x	x	x			
Storm petrel					x		x			
Arctic skua					x					
Puffin										x
House martin					x					
Guillemot	x									
Cormorant	x									
Shag	x									

Recommendations

Cetacean sightings recorded during the Blue Whiting Survey 2009 will contribute to an Irish-based project called PReCAST (Policy and Recommendations from Cetacean Acoustics, Surveying and Tracking). This three-year project (2008-2011) aims to provide robust scientific data to support conservation policy and provide guidance to state agencies in implementing national and international obligations and in so doing to build national capacity in the area of automated assessment and monitoring of cetacean populations. PReCAST is a collaboration between the Galway Mayo Institute of Technology (www.gmit.ie) and the Irish Whale and Dolphin Group (www.iwdg.ie), and is funded by the Marine Institute and the National Parks and Wildlife Service of the Department of the Department of Environment, Heritage and Local Government under the Sea Change Programme (A Marine Knowledge, Research & Innovation Strategy for Ireland 2007-2013).

The distribution and abundance of cetaceans in Irish waters is still being mapped. Differences in species distribution and abundance across relatively short geographical distances may be great with implications for conservation management. Using platforms of opportunity is a very practical and cost effective method to conduct a comprehensive, adequate, ongoing monitoring programme for cetaceans within the Irish EEZ as done during this year's Blue Whiting Survey. Fisheries surveys which are carried out annually are potentially very important as they cover offshore areas which are often hard to get survey coverage within. They also facilitate the repetition of surveying offshore area's seasonally. Therefore, we would recommend that an MMO carry out visual cetacean surveys during future Blue Whiting surveys, as the repetition of these surveys would lead to a better understanding of the diversity and abundance of cetaceans occurring off our coasts.

During the present survey, acoustic surveying using a towed hydrophone array was carried out by SMRU. This method of surveying increases the amount of effort over the survey duration as it could be carried out at night and during conditions that can restrict visual observations, such as increasing sea state and poor visibility, and hence increases the probability of detecting animals. Acoustic surveys coupled with visual observations provide a very robust data-set. Furthermore, we recommend that a hydrophone be towed where possible during future surveys.

Appendix II: List of cetacean species recorded within the Irish EEZ and adjacent waters.

Atlantic White-Sided Dolphin	Lagenorhynchus actus
Beluga	Delphinapterus leucas†
Blue Whale	Balaenoptera musculus
Bottlenose Dolphin	Tursiops truncatus
Common Dolphin	Delphis delphis
Cuvier's Beaked Whale	Ziphius cavirostris
False Killer Whale	Pseudorca crassidens
Fin Whale	Balaenoptera physalus
Gervais' Beaked Whale	Mesplodon europaeus*
Harbour Porpoise	Phocoena phocoena
Humpback Whale	Orcinus orca
Minke Whale	Balaenoptera acutorostrata
Northern Bottlenose Whale	Hyperoodon ampullatus
Northern Right Whale	Eubalaena glacialis
Pilot Whale (long-finned)	Globicephala melas
Pygmy Sperm Whale	Kogia breviceps
Risso's Dolphin	Grampus griseus
Sei Whale	Balaenoptera borealis
Sowerby's Beaked Whale	Mesplodon bidens
Sperm Whale	Physeter macrocephalus
Striped Dolphin	Stenella coeruleoalba
True's Beaked Whale	Mesplodon mirus
White-Beaked Dolphin	Lagenorhynchus albirostris

† Vagrant * Recorded only from Stranding

Appendix F. Introduction of new acoustic frequency

Noise corrected echograms of 38 and 120 kHz, depth range 750m.

During the 2008 blue whiting survey it was argued that an extra 120 kHz frequency could facilitate the acoustic separation of blue whiting from plankton or other fish species. During the 2009 survey this extra frequency was used but with little success. It has proved to be impossible to use the 120 kHz in combination with the 38 kHz to identify blue whiting, as they are predominantly found below 300m during this survey. Only blue whiting found on the shelf brake could benefit form this multi frequency approach. This occurred only on 2 % of the 1 nautical mile intervals where blue whiting was found (see figure 4.1A of the report)

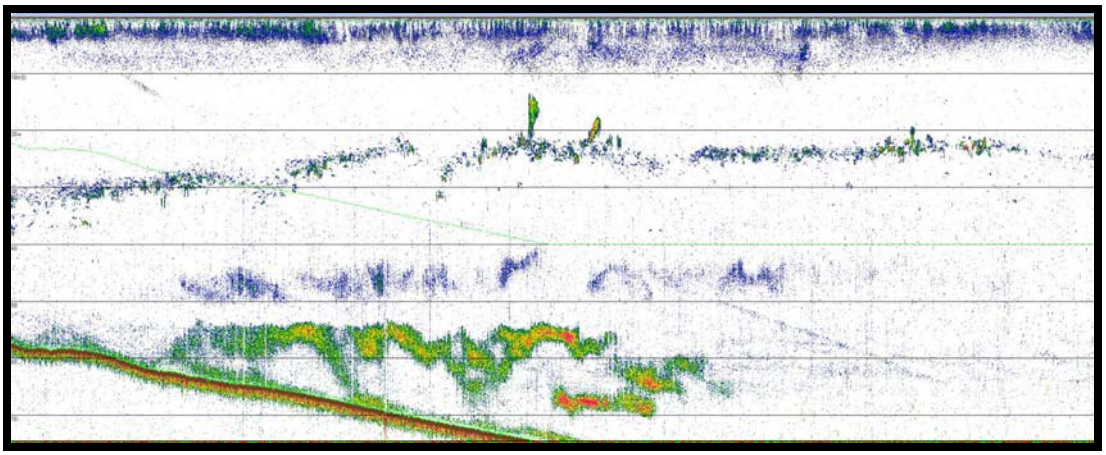


Figure 1 (38 kHz) clearly shows a number of distinct fish layers, with plankton from 0 to 100m, mackerel from 150 to 300m and blue whiting from 500 to 700m.

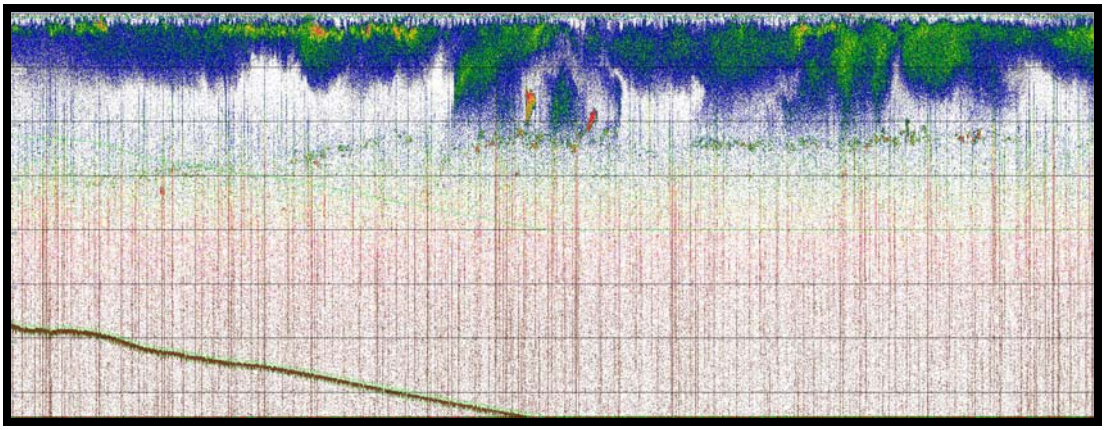


Figure 2 (120 kHz), organisms can only be resolved to a depth of around 250m before noise becomes the dominant part of the return signal, completely obscuring any organisms present.