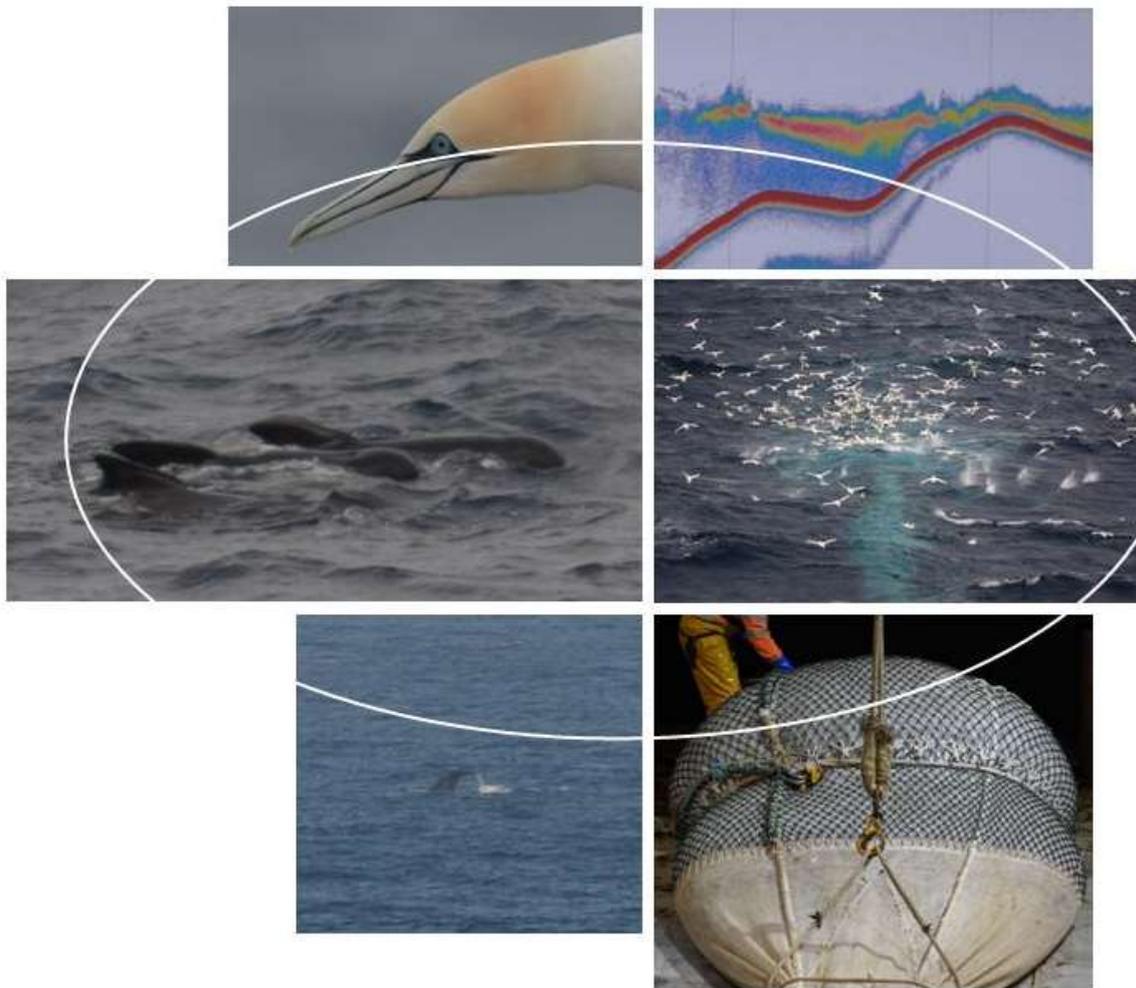


# Cetacean Monitoring undertaken during the Blue Whiting Acoustic Survey (BWAS) 2014



**Report to the National Parks & Wildlife Service,  
Department of Arts, Heritage and the Gaeltacht**

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## Executive Summary

A line transect survey for cetaceans was conducted in offshore Irish and UK Atlantic waters during the annual Blue Whiting Acoustic Survey led by Ireland's Marine Institute. This took place aboard the RV Celtic Explorer between 22 March and 10 April 2014. A total of 31 sightings of an estimated 138 individuals were recorded during 120 hours of dedicated line transect survey effort. Long-finned pilot whale (n=16 records), sperm whale (n=6 records) and short-beaked common dolphin (n=3 records) were the most frequently sighted species. In addition sightings were recorded of bottlenose dolphin and grey seal, as well as an unidentified beaked whale, an unidentified small whale and two unidentified groups of dolphins. Distribution patterns and relative abundance of the species observed were in general accordance with the findings of previous studies in Irish offshore waters, and reaffirmed the occurrence of these species in Irish offshore waters in the spring. Long-finned pilot whales were recorded in or adjacent to areas with steep bathymetry along the continental slope and sperm whales sightings were confined to deep waters (>1000m depth) in the northern section of the survey area, west of the Outer Hebrides.

## Introduction

The waters of Ireland's Exclusive Economic Zone (EEZ) represent an important marine habitat for cetaceans in Europe. All whale and dolphin species and seal species occurring in Irish waters are protected under the Irish Wildlife Acts 1976 to 2012. In 1991, the Irish government recognised the importance of Irish waters for cetaceans and declared all waters within its EEZ a whale and dolphin sanctuary (Rogan & Berrow, 1995). In addition to the national legislation, the EU Habitats Directive obliges Ireland to introduce protective and conservation measures for selected species and habitats considered to be at risk or in need of protection (i.e., listed under Annex I, Annex II, Annex IV, Annex V). Under the Convention on the Conservation of Migratory Species (Bern Convention), the Convention on the Conservation of European Wildlife and Natural Habitats (Bonn Convention) and the OSPAR Convention there are further obligations on Ireland to protect and conserve marine megafauna and their marine habitats.

The conservation status of many cetacean species occurring in Irish offshore waters is currently not well known (NPWS, 2013; Table 1), and information on their population status and structure, distribution and habitat use is often lacking. To date, 24 species of cetacean have been recorded in Ireland, of which 18 species are either present year-round (*e.g.* Berrow, 2001) or known to be seasonally present. The remaining six species are very rarely recorded and currently considered to be vagrant species (NPWS, 2013).

Irish EEZ waters collectively comprise a biologically productive area within the north-east Atlantic Ocean. They cover extensive areas of shallower continental shelf, oceanic deep waters and waters overlying the continental slope (DEHLG, 2009). The latter form a natural transition between the shallow continental shelf seas and deep oceanic waters. The typical steep bathymetry that characterises the shelf edge habitat generates local upwelling of nutrient rich waters, which sustain high levels of biomass. Historically, the shelf edge region off north-west Ireland formed an important habitat for large migratory whales which were hunted commercially (Fairley, 1981).

Since 1994 a number of dedicated studies on cetaceans have been conducted in Ireland, providing data on the presence, distribution and abundance of many cetacean species in coastal and offshore waters (e.g. Pollock et al., 1997; Ó Cadhla et al., 2004; Hammond et al., 2009; Wall et al., 2013). The majority of these surveys used visual survey and passive acoustic monitoring techniques to detect and record cetacean presence and abundance (e.g. Ó Cadhla et al., 2004; Hammond et al., 2009; Wall et al., 2013). In addition, acoustic data recorded as part of a US military surveillance program (i.e. SOSUS) provided important information on the presence of larger baleen whale species in Irish and adjacent oceanic waters over a ten-year period (Charif & Clark, 2009).

Table 1. Population status and current population estimates for cetaceans occurring in Irish waters (modified from NPWS (2013). *The status of EU protected Habitats and Species in Ireland*).

Species Name	Annex	Population Status	Population Estimate	
			minimum	maximum
<b>Toothed whales and dolphins</b>				
Sperm Whale ( <i>Physeter macrocephalus</i> )	IV	Unknown	1404	3073
Northern Bottlenose Whale ( <i>Hyperoodon ampullatus</i> )	IV	Unknown	1372	12683
Killer Whale ( <i>Orcinus orca</i> )	IV	Unknown	75	
Long-finned Pilot Whale ( <i>Globicephala melas</i> )	IV	Favourable	13251	47550
Cuvier's Beaked Whale ( <i>Ziphius cavirostris</i> )	IV	Unknown	1735	11519
Sowerby's Beaked Whale ( <i>Mesoplodon bidens</i> )	IV	Unknown	1725	10356
True's Beaked Whale ( <i>Mesoplodon mirus</i> )	IV	Unknown	N/A	
Gervais' Beaked Whale ( <i>Mesoplodon europaeus</i> )	IV	Unknown	N/A	
False Killer Whale ( <i>Pseudorca crassidens</i> )	IV	Unknown	N/A	
Pygmy Sperm Whale ( <i>Kogia breviceps</i> )	IV	Unknown	N/A	
Beluga/White Whale ( <i>Delphinapterus leucas</i> )	IV	Unknown	N/A	
Bottlenose Dolphin ( <i>Tursiops truncatus</i> )	II, IV	Favourable	10539	27982
Common Dolphin ( <i>Delphinus delphis</i> )	IV	Favourable	13487	74433
Harbour Porpoise ( <i>Phocoena phocoena</i> )	II, IV	Favourable	87088	189718
Risso's Dolphin ( <i>Grampus griseus</i> )	IV	Unknown	19	
White-sided Dolphin ( <i>Lagenorhynchus acutus</i> )	IV	Favourable	1134	10015
White-beaked Dolphin ( <i>Lagenorhynchus albirostris</i> )	IV	Favourable	1192	44589
Striped Dolphin ( <i>Stenella coeruleoalba</i> )	IV	Favourable	32543	139653
<b>Baleen whales</b>				
Blue Whale ( <i>Balaenoptera musculus</i> )	IV	Unknown	2	1500
Fin Whale ( <i>Balaenoptera physalus</i> )	IV	Favourable	477	22151
Sei Whale ( <i>Balaenoptera borealis</i> )	IV	Unknown	6	1164
Minke Whale ( <i>Balaenoptera acutorostrata</i> )	IV	Favourable	3161	42101
Humpback Whale ( <i>Megaptera novaeangliae</i> )	IV	Unknown	21	12000
Northern Right Whale ( <i>Eubalaena glacialis</i> )	IV	Unknown	N/A	

In recent years oceanographic and fisheries surveys have provided scientists with platforms of opportunity to conduct cetacean research in more remote offshore waters that are difficult to access by other means (e.g. Wall et al., 2006). Pelagic fisheries surveys in particular can offer suitable conditions for collecting data on whales and dolphins using visual line transect survey methods. Once such survey, the annual Blue Whiting Acoustic Survey (BWAS) is carried out across a significant portion of Ireland's Atlantic waters and it includes coverage of offshore waters west of the continental shelf including the Rockall Trough (Fig. 1). The stock assessment survey has been conducted since the 1970s when it was initiated by the Norwegian Institute for Marine Research. Ireland's Marine Institute has participated in these surveys since 2004 and it has facilitated the conduct of visual surveys for cetaceans by dedicated observers in parallel with the fisheries survey.

This report documents the results of cetacean surveying carried out in parallel with the Blue Whiting Acoustic Survey aboard the RV Celtic Explorer in March/April 2014. The work was undertaken on behalf of the National Parks & Wildlife Service of the Department of Arts, Heritage and the Gaeltacht (DAHG), as part of Ireland's ongoing programme for monitoring cetacean species. The main objectives of the project were to conduct a visual survey for cetaceans during the fisheries survey and to deliver detailed scientific information on the occurrence and distribution of cetaceans encountered in Irish offshore waters.

## Methods

The acoustic survey conducted by the Marine Institute covers the core spawning area of the blue whiting (*Micromesistius poutassou*) stock wintering off the west of Ireland and Scotland and it is performed as part of an international collaborative stock assessment. The study area comprises comparatively deep offshore waters to the west and northwest of Ireland, commonly known as "Ireland's Atlantic Margin". In 2014 the survey design covered western slopes of the Porcupine Seabight and a large part of the Rockall Trough, and extended north to the Anton Dohrn Seamount and Rosemary Bank off western Scotland (Fig. 1). Survey coverage in 2014 extended from the 200m depth contour over the continental shelf to deep oceanic waters over 2000 m deep (Fig. 1).

A single experienced observer conducted a dedicated visual survey for cetaceans during daylight hours from 22 March to 10 April 2014. The ship's crow's nest (Fig. 2), located 19m above sea-level, formed the primary survey platform. The monkey island (14m elevation) and the bridge level (11m elevation) served as secondary platforms during periods of inclement weather. The observer surveyed within an arc of 180 degrees in front of moving vessel (i.e. from 90 degrees to starboard to 90 degrees to port of the ship's track line), with an emphasis on the middle 120 degrees in front of the survey vessel. Visual survey effort included scanning with 7x30 binoculars (Steiner Navigator with built-in compass) and with the naked eye. Binoculars were used to conduct systematic scans and to assist with species identification, the estimation of group size and group composition for distant sightings.

The line transect survey design for BWAS 2014 included repeated cross-sections of continental slope waters and adjacent deep water canyons, seamounts and shelf habitat, as well as inshore waters at the start and end of the survey period. The survey was conducted aboard the RV Celtic Explorer (Fig. 2), which has been used as the participating Irish survey

vessel since 2004. Vessel speed during the fisheries acoustic survey ranged between 7 and 10 knots, with a slower vessel speed (i.e. 2-3 knots) adopted during trawling operations.

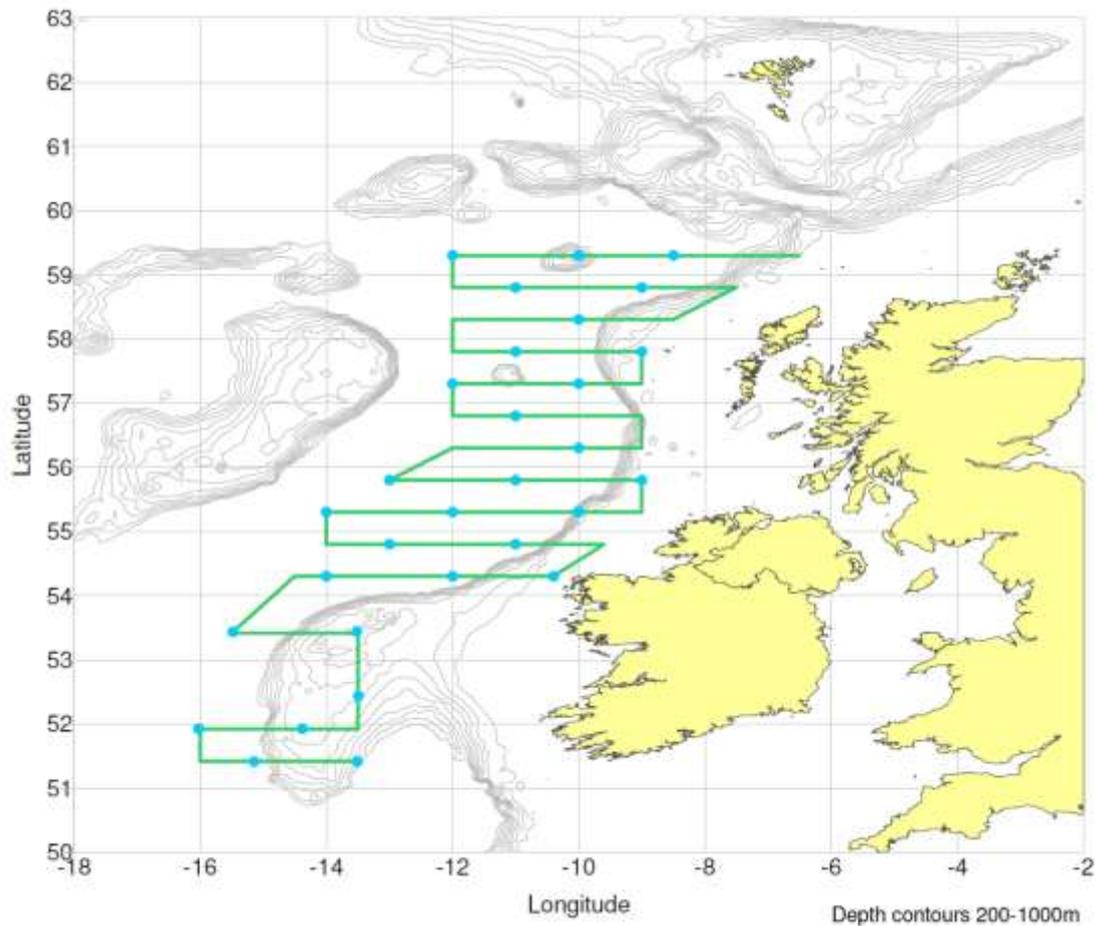


Figure 1. Planned transect coverage (green lines) for the Blue Whiting Acoustic Survey 2014. Blue circles shown represent hydrographic sampling stations. (Source: Marine Institute, 2014).

Visual survey effort, environmental and sightings data were recorded systematically by the observer using Logger 2000 software (IFAW) running on a rugged laptop (Panasonic Toughbook CF18 with Globalsat BU353 receiver). Logger was set to automatically store GPS metadata including the vessel's position, speed and course. Environmental conditions were recorded by the observer every 15 minutes and entered into a customised effort form in Logger which included parameters such as sea state (WMO Scale), wind strength (Beaufort scale), wind direction, swell height, cloud cover, visibility (km) and glare (%). For each cetacean sighting the species, group size, group composition and behavioural characteristics were recorded. The distance to the sighted animal(s) was estimated using a distance measuring stick (Heinemann, 1981) or estimated visually by the observer. The distance to the sighting, together with the recorded angle from the ship's track, were used to calculate the position and direction of movement of the sighted animal(s).



Figure 2. Top left clockwise to bottom: the RV Celtic Explorer; View of the survey set-up inside the Crow's nest 19m above sea-level; Front view from the bow of the RV Celtic Explorer showing the three visual survey platforms: crow's nest, monkey island and bridge.

## Results

### ***Effort and sighting conditions***

In total, 120 hours of visual survey effort were conducted by the observer between 22 March and 10 April 2014 (Fig. 3), totalling over 1,500 km of survey track coverage (Fig. 5). On average 6.0 hours of visual survey was conducted per day (range: 0.5-10.3h) between 07:15 AM and 20:30 PM (Fig. 3D). In total, 106.11 hours (88%) of survey effort was conducted from the primary observation platform in the crow's nest with an additional 11.5 hours and 2.12 hours from the ship's bridge and monkey island respectively.

In total 50.75 hours (42%) of the survey effort was conducted in sea state <4, 35.5 hours (30%) in sea state 4 and 25.25 hours (21%) in sea state 5 (Fig. 3A-C, Fig. 4). Sea conditions during the entire survey period remained relatively good, especially the swell height which for most of the time remained below 3m. Despite relatively good sea conditions, visual effort was periodically constrained by limited visibility due to sea fog, which intensified and caused restricted visibility during periods with little wind.

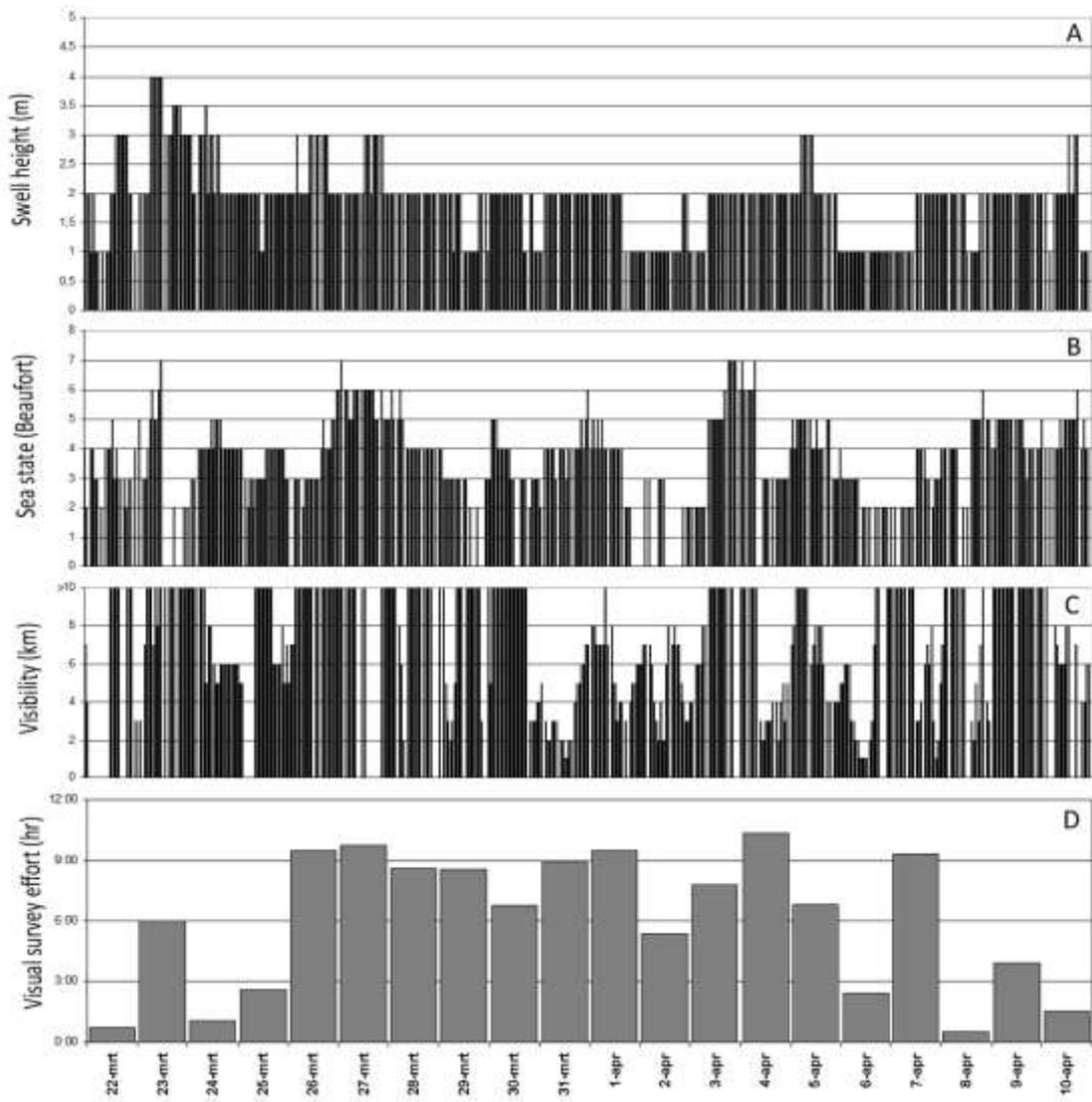


Figure 3A-D. Summary of the environmental conditions and visual survey effort recorded between 22 March and 10 April 2014: A) Swell height (m); B) Sea state; C) Visibility (km); D) Visual survey effort (hrs).

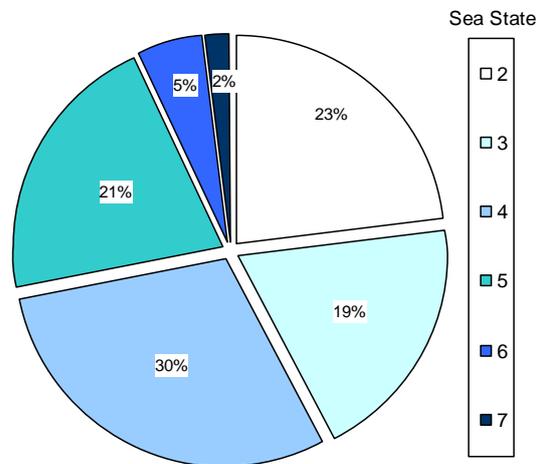


Figure 4. Proportion of the visual survey effort classified by the sea states encountered during the BWAS 2014 survey.

### **Sighting records**

In total 31 sightings of five identifiable marine mammal species were recorded, totalling 138 individuals (Table 2, Appendix I). Four cetacean sightings could not be identified to species level and were categorised according to standard groupings.

Table 2. The recorded number of sightings, individuals, calves and juveniles, and the range of group sizes of all marine mammal species recorded between 22 March and 10 April 2014.

Species	nr. sightings	nr. individuals	nr. calves - Juveniles	range of group-size
Grey seal ( <i>Halichoerus grypus</i> )	1	1		1
Common dolphin ( <i>Delphinus delphis</i> )	3	10	2 - 0	2 - 6
Long-finned pilot whale ( <i>Globicephala melas</i> )	16	97	7 - 6	2 - 25
Bottlenose dolphin ( <i>Tursiops truncatus</i> )	1	10		6
Sperm whale ( <i>Physeter macrocephalus</i> )	6	7		1 - 2
Unidentified beaked whale	1	1		1
Unidentified dolphin	2	11		5 - 6
Unidentified small whale	1	1		1
Total	31	138		

#### **Long-finned pilot whale (*Globicephala melas*)**

Long-finned pilot whales were the most frequently observed species with 16 confirmed sightings and a total of 97 individuals recorded (Table 2). Pilot whale groups with calves were observed on six occasions, yielding a total of seven calves and six juveniles/sub-adults. All sightings of long-finned pilot whales were recorded in or adjacent to areas with steep bathymetry along the continental shelf edge and west of the Rosemary Bank (Fig. 5). The majority of sightings, 10 out of 16, were recorded on the morning of April 1<sup>st</sup> when surveying in continental slope waters 90 km west of Barra in the Outer Hebrides. These sightings were recorded within relative close proximity of each other and close to a comparatively small group of bottlenose dolphins (*Tursiops truncatus*).

#### **Sperm whale (*Physeter macrocephalus*)**

The sperm whale was the second most frequently observed species, with six distinct sightings and a total of seven whales recorded. Sperm whale sightings were confined to deep waters (>1000m depth) in the northern section of the survey area, west of the Outer Hebrides (Fig. 5). A single individual was observed in waters to the east of the Anton Dohrn seamount. Four individuals were recorded within 12 km of each other, north of the continental slope approximately 120 km northwest of the Outer Hebrides. A single sighting of two sperm whales was recorded the next day 50 km north of the location where the four whales were recorded the previous day. All but two sperm whales encountered were observed to raise their tail flukes above the sea surface, indicating the onset of a deep-foraging dive.

#### **Short-beaked common dolphin (*Delphinus delphis*)**

Common dolphins were recorded on three separate occasions. One group of six dolphins including two calves was recorded within Dunmanus Bay during the pre-survey calibration of the fisheries survey equipment. The movement and behaviour of the group indicated that individuals were herding and possibly foraging on fish within the bay. This group approached the stationary vessel to within 300-500m at times. Two further small groups of common

dolphins comprising 2-3 individuals were observed bow-riding the survey vessel on separate occasions during the survey. Both sightings were made in continental shelf waters.

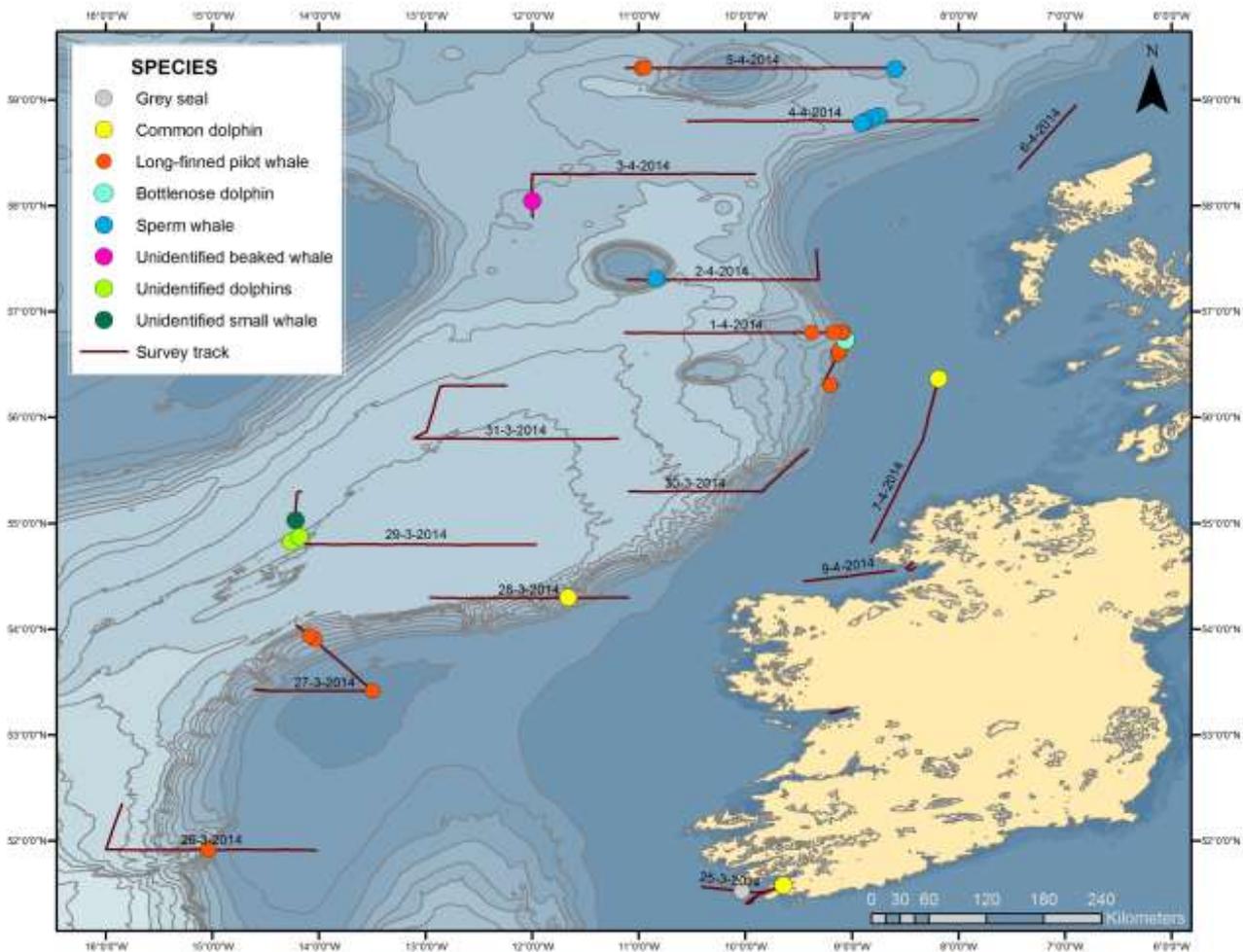


Figure 5. Map of the visual survey effort (survey track line) and the sighting locations of marine mammal species (coloured circles) recorded during BWAS 2014 between 22 March and 10 April 2014.

### **Bottlenose dolphins (*Tursiops truncatus*)**

One group of bottlenose dolphins was observed close to the continental shelf edge approximately 90 km west of Barra in the Outer Hebrides. This group occurred in an area also containing groups of long-finned pilot whales. Due to the behaviour of the dolphins and the short observation time no attempt was made to collect photo-identification data.

### **Unidentified beaked whale (*Ziphiidae*)**

A single breaching event by an unidentified beaked whale was observed by seabird observer Niall Keogh (Birdwatch Ireland) while conducting a survey from the bridge deck. The animal was recorded in the deep waters of the Rockall Trough and was not resighted despite its close proximity to the vessel when originally observed. Niall Keogh described the unidentified beaked whale as uniformly dark grey in colour with a sleek head, distinct tailstock and smaller in size than a long-finned pilot whale, but larger than a dolphin.

### **Unidentified dolphins (*Delphinidae*)**

Two groups of 5 and 6 dolphins that could not be identified to species level were sighted in the deep waters of the Rockall Trough. Both dolphin groups were seen beyond a reasonable distance by which the species could be confirmed.

### **Unidentified whale**

An unidentified small whale, possibly a minke whale (*Balaenoptera acutorostrata*), was observed surfacing once at a distance of c. 300m off the starboard side of the vessel. The animal was not observed again, which prevented the full identification of the species.

### **Grey seal (*Halichoerus grypus*)**

A single grey seal was also observed during the survey, approximately 10 km from the coast south of Dursey Island, Co Cork.

## **Discussion**

Long-term monitoring can provide valuable information on the relative abundance and distribution of cetacean species and additional information such as the interaction of certain species or groupings with fisheries activity. Furthermore long-term datasets enable the study of temporal patterns in occurrence across a range of scales. Cetacean surveys conducted so far during Irish Blue Whiting Acoustic Surveys provide a detailed overview of species' presence and distribution in Irish offshore waters between March and April. The current study formed the seventh dedicated cetacean survey carried out in collaboration with the Marine Institute, and between 2005 and 2014 a total of 13 species of cetacean have been recorded (Table 3). Three species have been encountered frequently during these surveys: short-beaked common dolphin, long-finned pilot whale and sperm whale. The relatively higher sighting frequency of these species may reflect their relative abundance, being among the more abundant species recorded in Irish offshore waters (Ó Cadhla et al., 2004; Hammond et al., 2009; Wall et al., 2013; NPWS, 2013). Moreover the BWAS survey design covering the shelf edge and adjacent deep oceanic waters overlaps the observed distribution of the long-finned pilot whale and sperm whale within Atlantic Margin waters.

The distribution of short-beaked common dolphin is usually associated more with continental slope, shelf and coastal waters than with deeper oceanic habitat (Ó Cadhla et al., 2004; Wall et al., 2013). This is reflected in the fact that the majority of sightings during acoustic surveys for blue whiting have been recorded in coastal and continental shelf waters or during transit between the offshore areas and ports (O'Donnell et al., 2008, 2013; O'Brien, 2009; Fennelly, 2011).

Long-finned pilot whales were the most frequently recorded species during this survey both in number of sightings and the total number of individuals observed. This feature of the BWAS surveys is consistent with previous surveys of this kind in Ireland (Ó Cadhla et al., 2004; Wall et al., 2013). Sperm whales were the only large whale species observed during the survey. Sightings during the blue whiting surveys to date confirm the species' presence in the Rockall Trough in early spring and reflect the general distribution and relative abundance of this species in deep oceanic and continental slope waters to the west/northwest of Ireland (Ó Cadhla et al., 2004; Wall et al., 2013).

Table 3. Summary overview of cetacean sighting data (i.e. species and number of individuals) recorded during Blue Whiting Acoustic Surveys from 2005 to 2014.

Year	2014	2013	2011	2009	2008	2006	2005
Observer	Oudejans, M.G.	Keogh, N.T.	Fennely, S.	O'Brien, J.	Wall, D.	Mackey, M	Mackey, M
Species							
Common dolphin ( <i>Delphinus delphis</i> )	3 (10)	7 (103)	23 (78)	5 (46)	2 (151)		
Long-finned pilot whale ( <i>Globicephala melas</i> )	16 (97)	9 (76)	3 (20)	1 (15)	16 (132)	5 (53)	4 (40)
Bottlenose dolphin ( <i>Tursiops truncatus</i> )	1 (10)	3 (26)			1 (7)		
Sperm whale ( <i>Physeter macrocephalus</i> )	6 (7)	3 (17)		7 (14)	3 (5)		1 (1)
Fin whale ( <i>Balaenoptera physalus</i> )		1 (1)					
Killer whale ( <i>Orcinus orca</i> )		1 (6)					
Sowerby's beaked whale ( <i>Mesoplodon bidens</i> )		1 (3)			1 (3)		
Cuviers beaked whale ( <i>Ziphius cavirostris</i> )		1 (5)		1 (1)			
Northern bottlenose whale ( <i>Hyperoodon ampullatus</i> )							1 (2)
Risso's dolphin ( <i>Grampus griseus</i> )			1 (5)				
White-beaked dolphin ( <i>Lagenorhynchus albirostris</i> )							2 (-)
White-sided dolphin ( <i>Lagenorhynchus acutus</i> )					3 (18)		
Harbour porpoise ( <i>Phocoena phocoena</i> )		1 (4)	1 (1)	2 (5)			
Unidentified whale			1 (1)		1 (3)		
Unidentified beaked whale	1 (1)						
Unidentified dolphin	2 (11)	2 (11)	2 (8)		3 (18)		4 (-)
Unidentified small whale	1 (1)	2 (2)			2 (2)		
Total	31 (138)	39 (256)	32 (114)	16 (81)	33 (339)	5 (53)	12 (43)

No baleen whales were observed during the BWAS 2014 survey with the exception of a small unidentified whale which was possibly a minke whale. Overall, baleen whales have been observed infrequently during the blue whiting surveys carried out so far in this Atlantic region (Table 3); it suggests that these species occur in low abundance in Irish offshore waters during these months. In recent years the fin whale (*Balaenoptera physalus*) has been the most frequently observed large baleen whale species in Irish waters with most sightings recorded in the summer and autumn months (Wall et al., 2013). Interestingly acoustic monitoring under the US Navy's SOSUS program between 1996 and 2005 identified a peak in offshore baleen whale occurrence in the vicinity of the Irish EEZ during the winter months (December and January); after this detection rates declined towards May and June (Charif & Clark, 2009). The low sighting rate of large baleen whales during blue whiting surveys carried out to date could therefore correspond with a seasonal occurrence or movement away from the Rockall Trough area as suggested by the SOSUS data. However the acoustic data only relate to vocalising whales and further visual and acoustic survey work would help to improve the picture regarding the seasonal occurrence and distribution of such species.

The single sighting of a breaching beaked whale during this survey follows a trend of occasional sightings of beaked whales during blue whiting surveys in previous years. The Sowerby's beaked whale (*Mesoplodon bidens*) and Cuvier's beaked whale (*Ziphius cavirostris*) sightings recorded in previous years demonstrate the species' presence in the deep waters of the Rockall Trough to the west of Ireland and the Outer Hebrides during the spring months (Table 3; O'Brien, 2009; O'Donnell et al., 2008, 2013). Beaked whales are comparatively inconspicuous and are notoriously difficult to study, particularly in areas with rough sea conditions such as the north-east Atlantic Ocean. As a result little is known about the true abundance and distribution of these species in Irish and UK waters and much of the knowledge is based on stranded individuals and incidental sightings. In general beaked

whale distribution in Irish waters appears to be linked with deep oceanic waters and canyonated areas with steep bathymetry (Ó Cadhla et al., 2004; Hammond et al., 2009; Wall et al., 2013). Hence it is likely that the continental slope together with adjacent waters >2,000m deep form a suitable and possibly important habitat for these species. A dedicated beaked whale survey in the Rockall Trough recorded at least six acoustic detections in waters overlying the continental slope and deeper waters to the west of Ireland and Scotland but did not record any visual sightings, further illustrating the difficulty in studying these species (Boisseau et al., 2011).

A single group of bottlenose dolphins was observed along the continental shelf edge 90 km west of Barra in the Outer Hebrides. The bottlenose dolphin is a frequent observed species in Irish waters and its distribution covers a broad range of habitats including inshore, coastal, continental shelf and deep oceanic waters (Ingram, 2000; Ó Cadhla et al., 2004; Oudejans et al., 2010; Wall et al., 2013). Three comparatively distinct population groupings have been identified in Irish waters based on genetic studies (Mirimin et al., 2011). Recent genetic and social studies have provided further evidence for inshore and offshore 'ecotypes' inhabiting Irish coastal and continental shelf/offshore waters respectively (Louis et al., 2014; Oudejans et al., *in review*). Given the geographic location of the sighting recorded during the BWAS 2014 survey it is likely that the group was part of an offshore community. Due to the behaviour of the individuals it was not possible to collect any photographic identification data on this occasion.

The distribution of cetaceans can often be related to foraging behaviour, prey distribution and habitat type (Hastie et al., 2004). We would therefore expect relatively high sighting rates during this survey for those cetacean species that can forage on blue whiting. Long-finned pilot whales, sperm whales and beaked whales are capable of diving to and well beyond 400-600m depth, the general depth at which the blue whiting aggregates in high densities during the spawning season. These large densities of fish can therefore potentially act as a source of food for these species during the spring. Long-finned pilot whales in the Atlantic Ocean have been identified to forage on squid and fish species, including blue whiting (Desportes & Mouritsen, 1993) and mackerel (*Scomber scombrus*; Gannon et al., 1997). In the Strait of Gibraltar long-finned pilot whales shifted their diets as a result of differences in prey availability between seasons (De Stephanis et al., 2008). Hence, it is possible that the long-finned pilot whale forages on blue whiting during the winter and spring months when high density aggregations occur in deep Atlantic waters off the Irish and UK coasts.

Sperm whales in the north-east Atlantic Ocean are believed to feed almost exclusively on squid and octopus (Santos et al., 1999). Similarly, stomach content analysis on a Cuvier's beaked whale that stranded on the island of North Uist in the Outer Hebrides in February 1999 showed that the animal had foraged principally on oceanic cephalopods. The stomach contents of this individual, which stranded in relative proximity to the current survey area, consisted of over 6,800 cephalopods beaks suggesting the animal had been feeding on cephalopods for several days prior to being stranded (Santos et al., 2001). In contrast a multiple stranding of Sowerby's beaked whales in the Azores islands of Portugal showed that individual whales had foraged on mesopelagic fish (Pereira et al., 2011). Additional research of the foraging strategies of these offshore species is required in order to determine if their distribution patterns correspond to foraging behaviour and prey distribution (Macleod et al., 2003).

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## References

Berrow SD, (2001) Biological diversity of cetaceans (whales, dolphin and porpoises) in Irish waters. In *Marine Biodiversity in Ireland and Adjacent waters*. Ed. Nunn, J.D. Ulster Museum, Belfast, pp. 115-119.

Boisseau O, Moscrop A, Cucknell A, McLanaghan R, & Wall D, (2011) An acoustic survey for beaked whales in the Rockall Trough. Report to the IWC. Available online: <http://iwc.int/private/downloads/94qneb1rkt8g048scgg4s4s8o/SC-63-SM2.pdf>

Charif RA, & Clark CW, (2009) Acoustic monitoring of large whales in deep waters north and west of the British Isles: 1996 - 2005. Cornell University technical report 08-07. Available online: [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/196484/OES\\_UK\\_SOSUS\\_10year\\_report.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/196484/OES_UK_SOSUS_10year_report.pdf)

DEHLG, (2009) Conservation Plan for Cetaceans in Irish waters. The National Parks and Wildlife Service, Department of the Environment, Heritage and Local Government. Available online: [http://www.npws.ie/publications/speciesactionplans/2009\\_Cetaceans\\_CP.pdf](http://www.npws.ie/publications/speciesactionplans/2009_Cetaceans_CP.pdf)

Desportes G & Mouritsen R, (1993) Preliminary results on the diet of long-finned pilot whales off the Faroe Islands. Report to the International Whaling Commission, special issue 14:305-32.

De Stephanis R, García-Tíscar S, Verborgh P, Esteban-Pavo R, Pérez S, Minvielle-Sebastia, & Guinet C, (2008) Diet of the social groups of long-finned pilot whales (*Globicephala melas*) in the Strait of Gibraltar. *Marine Biology* 154(4):603-612.

Fairley SJ, (1981) Irish whales and whaling. Blackstaff Press Belfast.

Fennelly S, (2011) Cetacean Distribution and Relative Abundance Survey during FSS Blue Whiting Survey 2011. Report to the Marine Institute, Oranmore, Galway, Ireland.

Gannon DP, Read AJ, Craddock JE, Fristrup KM, & Nicolas JR, (1997) Feeding ecology of long-finned pilot whales *Globicephala melas* in the western North Atlantic. *Marine Ecology-Progress Series* 148:1-10.

Hammond PS, MacLeod K, Gillespie D, Swift R, Winship A, et al. (2009) The Cetacean Offshore Distribution and Abundance in the European Atlantic (CODA). Available online: [http://biology.standrews.ac.uk/coda/documents/CODA\\_Final\\_Report\\_11-2-09.pdf](http://biology.standrews.ac.uk/coda/documents/CODA_Final_Report_11-2-09.pdf)

Hastie GD, Wilson B, Wilson LJ, Parsons KM, & Thompson PM, (2004) Functional mechanisms underlying cetacean distribution patterns: hotspots for bottlenose dolphins are linked to foraging. *Marine Biology* 144(2):397-403.

Ingram SN, (2000) The ecology and conservation of bottlenose dolphins in the Shannon estuary, Ireland. PhD thesis University College Cork.

Louis M, Viricel A, Lucas T, Peltier H, Alfonsi E, Berrow S, Brownlow A, Covelo P, Dabin W, Deaville R, de Stephanis R, Gally F, Gauffier P, Penrose R, Silva MA, Guinet C, & Simon-Bouhet B, (2014) Habitat-driven population structure of bottlenose dolphins *Tursiops truncatus* in the North-East Atlantic *Molecular Ecology* 23:857–874.

MacLeod CD, Santos MM, & Pierce GJ, (2003) Review of data on diets of beaked whales: evidence of niche separation and geographic segregation. *Journal of the Marine Biological Association of the United Kingdom* 83:651–665.

Mirimin L, Miller R, Dillane E, Berrow SD, Ingram SN, Cross TF, & Rogan E, (2011) Fine-scale population genetic structuring of bottlenose dolphins in Irish coastal waters. *Animal Conservation* 14:342-353.

NPWS, (2013) The Status of EU Protected Habitats and Species in Ireland. Species Assessments Volume 3. Version 1.0. National Parks & Wildlife Services. Department of Arts, Heritage and the Gaeltacht, Dublin, Ireland. available online: <http://www.npws.ie/publications/article17assessments/article172013assessmentdocuments/Article17PrintVol3reportspeciesv11.pdf>.

O'Brien J, (2009) Cetacean Distribution and Relative Abundance Survey during FSS Blue Whiting Survey 2009, Report to the Marine Institute, Oranmore, Galway, Ireland.

O'Donnell C, Mullins E, Johnston G, & Keogh N, (2013) Blue Whiting Acoustic Survey Cruise Report March 26- April 15 2013. Marine Institute.

O'Donnell C, Mullins E, Power G, Goddijn L, & Mackey M, (2005) Blue Whiting Acoustic Survey Cruise Report March-April 2005. Marine Institute.

O'Donnell C, Mullins E, Johnston G, Lyons K, Bethke E, Holst G, & Wall D, (2008) Blue Whiting Acoustic Survey Cruise Report Spring 2008. FSS Survey Series Marine Institute.

Ó Cadhla O, Mackey M, Aguilar de Soto N, Rogan E, & Connolly N, (2004) Cetaceans and Seabirds of Ireland's Atlantic Margin. *Volume II – Cetacean distribution and abundance. Report on research carried out under the Irish Infrastructure Programme (PIP):* Rockall Studies Group (RSG) projects 98/6 and 00/13, Porcupine Studies Group project P00/15 and Offshore Support Group (OSG) project 99/38.

Oudejans MG, Visser F, Englund A, Rogan E, & Ingram SN, (in review) Distinct inshore and offshore communities of bottlenose dolphins in the North East Atlantic: evidence for ecotype differentiation. PLOS One.

Pollock CM, Reid JR, Webb A, & Tasker ML, (1997) The distribution of seabirds and cetaceans in the waters around Ireland. JNCC Report No. 267. Joint Nature Conservation Committee, Peterborough.

Pereira JN, Neves VC, Prieto R, Silva MA, Cascao I, Oliveira C, Cruz MJ, Medeiros JV, Barreiros JP, Porteiro FM & Clarke D, (2011) Diet of mid-Atlantic Sowerby's beaked whales *Mesoplodon bidens*. Deep-Sea Research I 58:1084-1090.

Rogan E & Berrow, SD, (1995) The management of Irish waters as a whale and dolphin sanctuary. In A.S. Blix, L. Walløe & Ø. Ulltang. (eds.) *Whales, seals, fish and man*. Elsevier Science. Amsterdam. pp. 671-681.

Santos, MB, Pierce GJ, Boyle PR, Reid RJ, Ross HM, Patterson IAP, Kinze CC, Tougaard S, Lick R, Piatkowski U & Hernández-García V, (1999) Stomach contents of sperm whales *Physeter macrocephalus* stranded in the North Sea 1990-1996. Marine Ecology Progress Series 183:281-294.

Santos MB, Pierce GJ, Herman J, Lopez A, Guerra A, Mente E, & Clarke MR, (2001) Feeding ecology of Cuvier's beaked whale (*Ziphius cavirostris*): a review with new information on the diet of this species. Journal of the Marine Biological Association of the United Kingdom 81:687-694.

Wall D, O'Brien J, Allen BM & Meade J, (2006) Summer Distribution and Relative Abundance of Cetaceans off the West Coast of Ireland. *Biology and Environment: Proceedings of the Royal Irish Academy*. 106B(2):135-142.

Wall D, Murray C, O'Brien J, et al. (2013) Atlas of the distribution and relative abundance of marine mammals in Irish offshore waters 2005 - 2011. Irish whale and dolphin group, Merchant Quay, Kilrush, Co. Clare.

Appendix I. List of sightings of marine mammal species recorded during the BWAS 2014 survey between 22 March and 10 April 2014 and selected record details. Record Type comprised both On-effort (dedicated) and Off-effort (opportunistic or incidental) sightings.

Date Time (UTC)	Latitude (N)	Longitude (W)	Species	Group size			Group composition			Record Type
				Minimum Estimate	Best Estimate	Maximum Estimate	Number of adults	Number of juveniles	Number of calves	
25-03-14 7:55	51,5817	-9,6402	<i>Delphinus delphis</i>	5	6	7	4	0	2	On-effort
25-03-14 9:46	51,5268	-10,0301	<i>Halichoerus grypus</i>	1	1	1	1	0	0	Off-effort
26-03-14 13:02	51,9169	-15,0443	<i>Globicephala melas</i>	2	3	3	3	0	0	On-effort
27-03-14 13:58	53,4180	-13,4993	<i>Globicephala melas</i>	1	1	1	1	0	0	Off-effort
27-03-14 18:12	53,9019	-14,0421	<i>Globicephala melas</i>	8	9	11	7	0	2	On-effort
27-03-14 18:30	53,9409	-14,0875	<i>Globicephala melas</i>	3	3	5	2	0	1	On-effort
28-03-14 17:01	54,2972	-11,6630	<i>Delphinus delphis</i>	2	2	3	2	0	0	Off-effort
29-03-14 16:27	54,8078	-14,2130	<i>Unidentified Delphinidae</i>	2	5	8	5	0	0	On-effort
29-03-14 16:43	54,8507	-14,2160	<i>Unidentified Delphinidae</i>	4	6	8	6	0	0	On-effort
29-03-14 17:48	55,0305	-14,2233	<i>Unidentified small whale</i>	1	1	1	1	0	0	On-effort
1-04-14 7:42	56,3031	-9,2072	<i>Globicephala melas</i>	10	12	14	11	0	1	Off-effort
1-04-14 11:08	56,5969	-9,1342	<i>Globicephala melas</i>	20	25	30	21	4	0	Off-effort
1-04-14 11:19	56,6292	-9,1189	<i>Globicephala melas</i>	2	2	3	1	0	1	On-effort
1-04-14 11:23	56,6412	-9,1117	<i>Globicephala melas</i>	5	7	10	4	2	1	On-effort
1-04-14 11:52	56,7263	-9,0630	<i>Globicephala melas</i>	4	5	7	5	0	0	On-effort
1-04-14 11:55	56,7352	-9,0590	<i>Tursiops truncatus</i>	6	10	12	10	0	0	On-effort
1-04-14 11:59	56,7474	-9,0541	<i>Globicephala melas</i>	2	2	3	2	0	0	On-effort
1-04-14 12:35	56,8010	-9,0831	<i>Globicephala melas</i>	2	2	3	2	0	0	On-effort
1-04-14 12:37	56,8010	-9,0977	<i>Globicephala melas</i>	2	2	3	2	0	0	On-effort
1-04-14 12:51	56,8005	-9,1699	<i>Globicephala melas</i>	1	1	2	1	0	0	On-effort
1-04-14 13:29	56,8007	-9,3622	<i>Globicephala melas</i>	5	6	8	6	0	0	On-effort
2-04-14 8:21	57,3017	-10,8439	<i>Physeter macrocephalus</i>	1	1	1	1	0	0	On-effort
3-04-14 9:19	58,0423	-12,0003	<i>Unidentified Ziphiidae</i>	1	1	1	1	0	0	Off-effort
4-04-14 13:25	58,8021	-8,8027	<i>Physeter macrocephalus</i>	1	1	1	1	0	0	On-effort
4-04-14 13:37	58,8009	-8,8665	<i>Physeter macrocephalus</i>	1	1		1	0	0	On-effort
4-04-14 13:49	58,8002	-8,9297	<i>Physeter macrocephalus</i>	1	1	1	1	0	0	On-effort
4-04-14 14:47	58,7991	-8,9998	<i>Physeter macrocephalus</i>	1	1	1	1	0	0	On-effort
5-04-14 11:39	59,3013	-10,9637	<i>Globicephala melas</i>		7		7	0	0	Off-effort
5-04-14 11:43	59,3011	-10,9433	<i>Globicephala melas</i>	8	10	12	9	0	1	On-effort
5-04-14 19:48	59,2882	-8,5995	<i>Physeter macrocephalus</i>	2	2	2	2	0	0	On-effort
7-04-14 8:10	56,3658	-8,1884	<i>Delphinus delphis</i>	2	2	3	2	0	0	Off-effort