Inshore boat-based surveys for cetaceans: North Donegal

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Cover image: Sea-state 0 off Tory Island, Co Donegal during survey of North Coast © DAHG

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Summary

A single platform line-transect survey using distance sampling was carried out off the north coast of Ireland on 9 August 2012. Sea conditions were excellent throughout the survey with 100% of survey effort carried out in sea-state ≤3 and 63.5% in sea-state ≤1. A total of 178 km of track-line was surveyed in 654 minutes (10.9 hrs). Five acoustic events were logged during the survey: three harbour porpoise records and one each of common dolphin and Risso's dolphin. All acoustic events were recorded concurrent with visual sightings. Thus most (77%) of the harbour porpoise sightings and all minke whale sightings obtained during the survey were not detected acoustically.

A total of 33 sightings were recorded comprising 158 individuals among five marine mammal species, which suggests good species diversity in the area at this time of year. These included 11 harbour porpoise sightings, one sighting of a large group of common dolphins, two sightings of Risso's dolphins and six sightings of single minke whales. A total of 13 sightings of individual seals were also made and all were thought to be grey seals. Sightings occurred more frequently towards the start and end of the prescribed survey area. Harbour porpoises were mainly recorded off Inishtrahull and Malin Head with one sighting off Tory Island at the end of the survey. Minke whales were only recorded in the western half of the survey block especially around Tory Island and off the Rossguil peninsula. Similarly grey seals were seen at the start and end of the survey area with highest concentrations off Inishtrahull island.

Group sizes of harbour porpoise varied from 1 to 5 individuals with a mean of 1.9. All minke whales and grey seal sightings comprised single animals and the two Risso's dolphin sightings were close together and were probably of one social group. One calf and one juvenile were recorded in the group of 15 Risso's dolphins and several calves were recorded in the group of around 100 common dolphins. Sighting rates were greatest for harbour porpoise but relative abundance was greatest for common dolphin due to the comparatively large size of the group recorded.

Harbour porpoise and minke whale were the most frequently recorded cetacean species which was consistent with some previous inshore surveys off the northwest, west and southwest coasts and in the Irish Sea. Common dolphins are also widespread in Irish waters though they are recorded less frequently off the north coast compared to the south and southwest coasts. Risso's dolphins tend to have a more patchy sightings distribution in Ireland than many toothed cetaceans but this species has previously been recorded in the Donegal area on a number of occasions.

The sighting rate for harbour porpoise off the north coast during 2012 was very similar to that recorded in a similar standardised line-transect survey off the southwest in 2010 but relative abundance was twice as high. Sighting rates and relative abundances for harbour porpoise were less than those recorded in the Irish Sea in 2011. With only one sighting of common dolphins during the survey the sighting rate was low and similar to the southern Irish Sea in 2011 but as this single group was comparatively large in size the relative abundance was high for this species and only the western block surveyed in 2010 had a higher relative abundance. The sighting rate for minke whales was the highest recorded from all six blocks surveyed to date and only one site (northern Irish Sea) had a higher relative abundance than that recorded in the present survey. Risso's dolphins were also reported off the northwest coast in 2011 but with a lower sighting rate and relative abundance. The sighting rate for grey seal was the highest reported at any of the six sites surveyed to date.

The numbers of acoustic detections obtained during the survey were low, with a total of five encounters recorded over the entire survey duration. Three cetacean species, comprising Risso's dolphin, common dolphin and harbour

porpoise, were detected, with an acoustic encounter averaging 8.6 minutes in duration, or 0.2 minutes per km travelled. All acoustic detections were recorded simultaneously with visual sightings.

These surveys are aimed at filling gaps in coverage to obtain a better understanding of the distribution and abundance of cetaceans in Irish waters. They can also provide good baseline data for monitoring purposes and may in time enable the identification of areas with higher relative abundance and diversity of cetaceans and potentially important habitats for these species.

Introduction

Waters within the Irish Exclusive Economic Zone (EEZ) are known to be some of the most important in Europe for cetaceans (Berrow *et al.* 2001). While there has been a steady increase in cetacean research in Ireland, dedicated surveys to estimate the abundance of cetaceans in a defined area are limited to date and are presently insufficient to detect population trends (O'Brien *et al.* 2009).

Since 1994 there has been a concerted effort to map the distribution and relative abundance of all cetacean species occurring within the Irish EEZ largely using platforms of opportunity. These surveys including initiatives such as European Seabirds at Sea (ESAS) research, ISCOPE and PReCAST have attempted to include seasonal coverage, especially of offshore waters (Pollock *et al*. 1997; Ó Cadhla *et al*. 2004; Wall *et al*. 2006; 2012; Berrow *et al.* 2006; 2010).

The first dedicated double-platform cetacean survey in Ireland was SCANS-I (Small Cetacean Abundance in the North Sea) carried out during summer of 1994, but it only covered the Celtic Shelf region of the Irish EEZ (Hammond *et al.* 2002). During 2000, the SIAR survey covered both inshore and offshore waters of the western seaboard using a double-platform visual survey technique from which the abundance of common and white-sided dolphins was estimated (Ó Cadhla *et al.* 2004). In summer 2005, a second SCANS survey (SCANS-II, 2008) was carried out which this time included all Irish continental shelf waters and the Irish Sea. Abundance estimates for a variety of species including harbour porpoise, common, bottlenose and white-beaked dolphin and minke whale were derived (SCANS-II, 2008). In 2007, a survey of species in European Atlantic waters beyond the continental shelf (CODA) was carried out offshore and provided abundance estimates for common, striped and bottlenose dolphins and long-finned pilot, sperm, minke, fin whales and beaked whales (Hammond *et al*. 2010).

Small scale dedicated surveys were carried out at eight survey locations since 2007 in coastal waters and bays using a single-platform line transect technique to estimate the abundance of harbour porpoises (Berrow *et al*., 2008a; 2008b; 2009; Ryan *et al.* 2010; Berrow *et al.* 2011a; 2011b). Land-based surveys through ISCOPE attempted to record and monitor cetacean's inshore (Berrow *et al*. 2010). However, there are still some gaps in coverage (see Wall *et al*. 2012).

The Irish Whale and Dolphin Group (IWDG) was contracted to carry out a concurrent visual and passive acoustic survey off the north coast of Donegal in the summer of 2012. This survey was to complement similar standardised line-transect surveys carried out off the southwest, west, northwest and east coasts during 2010 and 2011.

Objectives

As in 2010 and 2011, the objectives of the present survey were to:

(a) Determine the occurrence of cetacean species and other marine species of interest;
(b) Determine species relative abundance (no. of sightings/individuals per unit effort);
(c) Determine cetacean species abundance (i.e. population/density estimation) where possible,

Methods

Survey blocks

The inshore survey block off the north coast of Donegal is shown in Figure 1. The block was 336 nm^2 (1152 km^2) in surface area with a perimeter of 48nm by 7nm and was located between 6nm and 12nm from shore off the coast of County Donegal.

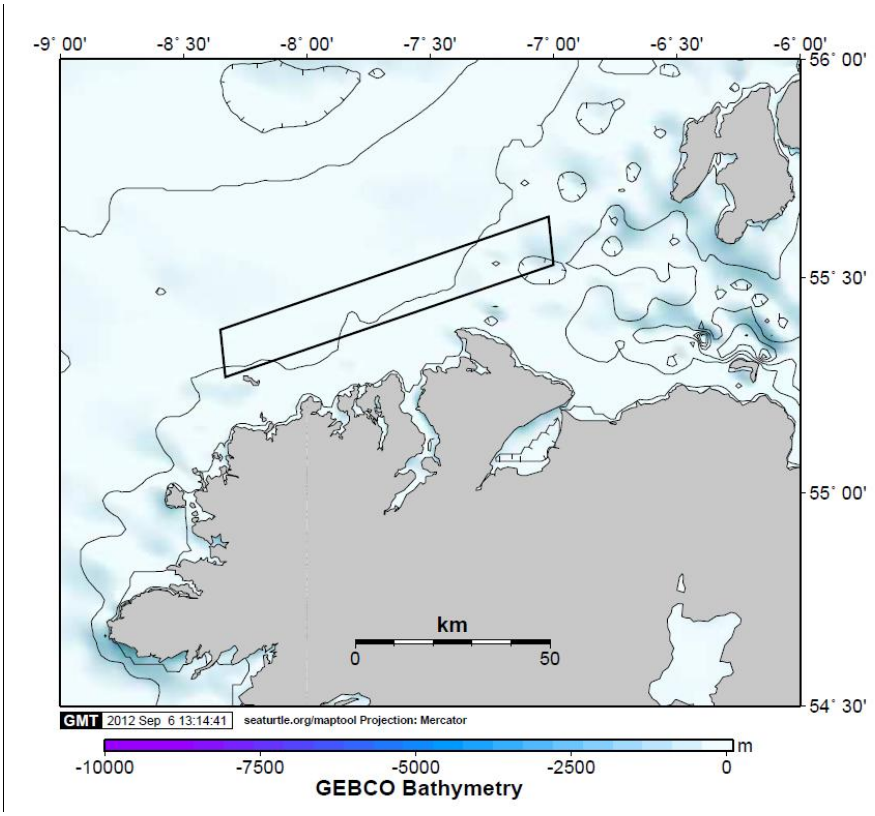


Figure 1. Map of the north coast of Ireland showing the location of the survey block.

Survey platform

The vessel *MV Smoothhound* (Fig. 2) was chartered for the survey. *MV Smoothound* is an 11m Vigilante with flying bridge and is capable of speeds up to 25kts. It was previously chartered by the IWDG in 2008 (Berrow *et al*. 2008), 2010 (Ryan *et al*. 2010) and 2011 (Berrow *et al*. 2011b) and provided a good platform height above sea level (i.e., 3m) and the capability of transiting fast to the start of the survey area.

Survey methodology

A conventional single platform line-transect survey was carried out along pre-determined track-lines supplied by the NPWS. These were similar in survey design to NPWS-contracted survey blocks off western Ireland in 2010 (Ryan *et al.* 2010) and off eastern Ireland in 2011 (Berrow *et al*. 2011a).

During survey effort, the vessel travelled at a speed of 12-16 km hr^{-1} (8-10 knots), which is approximately 2-3 times the average speed of the species most likely to be encountered (e.g., common dolphin, minke whale, bottlenose dolphin, harbour porpoise) as recommended by Dawson *et al.* (2008). Two primary observers were positioned on the flying bridge. Primary observers were experienced in cetacean visual surveys and species identification in Irish waters. Observers scanned with the naked eye from dead ahead to 90° to port or starboard depending on which

side of the vessel they were stationed. Opticron 10x50 marine binoculars with reticle eyepieces were used to confirm species identification and assist in distance estimation. In addition, sightings of seals and any other marine megafauna (e.g. basking shark, sunfish) were also recorded.

Figure 2. The *MV Smoothound*
Note: flying bridge on wheelhouse

During the line-transect survey the position of the survey vessel was tracked continuously through a GPS receiver fed directly into a laptop while survey effort, including environmental conditions (sea-state, wind strength and direction, glare etc.) were recorded directly onto LOGGER software (©IFAW) every 15 minutes.

When a sighting was made the position of the vessel was recorded immediately and the angle of the sighting from the track of the vessel and the radial distance of the sighting from the vessel were recorded. These data were communicated to the recorder in the wheelhouse via two-way VHF radio. The angle was recorded to the nearest degree via an angle board attached to the vessel immediately in front of each observer. Accurate distance estimation is essential for distance sampling. Distance sticks were made for observers using the Heinemann Equation (Heinemann 1981) which were used to aid distance estimation.

Maps were created using Irish Grid (TM65_Irish Grid) with ArcView 3.2 and using SeaTurtle.org Maptool© while design coordinates for the survey areas were obtained from NPWS. Data related to transects, effort, location of visual and acoustic detections, abundance and density estimates were stored in a single MS Access database, which was queried from within the GIS to produce maps.

Sightings rate and relative abundance

Sightings rate was calculated as the number of sightings per km travelled or hour of survey effort, while relative abundance was calculated as the number of animals recorded per km of transect or per hour of survey effort. Both measures were restricted to observations made in sea state ≤3. If a sufficient number of sighting records were obtained, estimation of density (i.e. no. per km^2) and abundance (i.e. no. within the overall survey area) would be carried out.

Passive Acoustic Monitoring

Passive Acoustic Monitoring (PAM) was carried out using a towed hydrophone at a distance approximately 200m astern of the survey vessel and at a depth of c.2 to 5m beneath the sea surface.

The towed hydrophone array consisted of a 200m-long cable containing two high frequency hydrophone elements (HP-03) situated 25cm apart in a fluid filled tube at the end of the cable. The hydrophone was connected to a MAGREC HP-27 buffer-box which was connected to a National Instrument DAQ-6255 USB soundcard run through a laptop computer. The track-line of the acoustic survey effort was recorded using an external GPS receiver, which provides NMEA data to PAMGUARD software (version 1.6.01 Beta). A dedicated acoustic observer continuously monitored the incoming audio stream both visually (audio-spectrogram) and aurally using PAMGUARD. Acoustic detections of cetacean vocalisations (both clicks and whistles) were noted, described and their time and GPS locations recorded. Raw recordings were saved continuously as .WAV files and backed-up on an external hard-drive.

An acoustic encounter was considered a separate encounter when a silent period of 10 minutes was recorded between acoustic detections. This followed the method used by Aguilar de Soto *et al.* (2004) and the protocol established under PReCAST (O'Brien *et al.* 2012) and was consistent with previous standardised inshore surveys (Ryan *et al.* 2010; Berrow *et al.* 2011a; 2011b). Harbour porpoise echolocation clicks are characterized as being narrow-band, high frequency between 110 and 150 kHz, with an average click duration of 2µs and a mean source level of 150dB. In comparison, dolphin clicks are characterized as being broadband ranging in frequency from 200Hz to 150 kHz. This makes identification to species level quite difficult, Post-survey analysis of the acoustic dataset was carried out in the lab.

Results

The line-transect design within the survey block was surveyed on 9 August 2012 in sea-state ≤3, as per NPWS specifications (Fig. 3). Just under one half (44%) of all survey effort was carried out in sea-state 0 and 63.5% in sea-state ≤1, with just 12.5% of effort in sea-state 3 (Fig. 3). The increase in sea-state coincided with an ebb tide through Inishtrahull Sound and a gentle east/southeast breeze off Malin Head which seemed to combine to increase the prevailing local sea-state. The visibility was 15-20 km or greater throughout the survey, with no precipitation. Swell height was zero/calm for 59% and ≤1m for 41% of the survey. A total transect length of 178km was surveyed. Track-lines were surveyed in a general east to west direction.

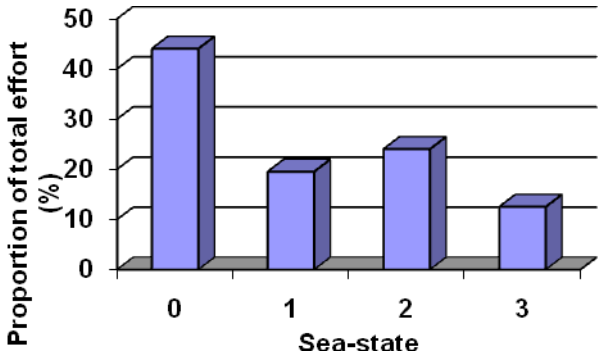


Figure 3. Sea-state conditions during the survey of the north Donegal survey block.

Table 1. Summary of line-transect effort and sightings recorded during the north Donegal survey.

Date	No. of track-lines completed	Total proportion of survey in sea-state ≤3	Number of sightings	Total no. of marine mammals
9 August 2012	12	100%	33	158

A total of 33 sightings was recorded comprising 158 individuals among five marine mammal species (Table 1). This included 11 harbour porpoise sightings, one sighting of a large group of common dolphins, two sightings of Risso's dolphins and six sightings of single minke whales. A total of 13 seal sightings were made and these were all thought to be grey seals (Table 2). The track-line was broken at the beginning of line 10 when a group of dolphins were observed, in order to confirm species identity (common dolphin). The vessel returned to the track-line once species identification was confirmed. Images of individual Risso's dolphin were collected during the first sighting of this species at the start of the survey but these images were not suitable for use in the photo-identification of individual dolphins.

Table 2. Species recorded in the north Donegal survey block during the survey in August 2012.

Species	Sightings	Individuals	Group Size (Mean)	Group Size (Range)
Harbour porpoise	11	21	1	1-5
Minke whale	6	6	1	1
Risso's dolphin	2	18	9	3-15
Common dolphin	1	100	100	100
Grey seal	13	13	1	1

Sightings occurred more frequently towards the eastern and western ends of the survey area with harbour porpoise mainly recorded off Inishtrahull and Malin Head with one sighting off Tory Island at the western end of the survey block (Fig. 3a). Minke whales were only recorded in the western half of the survey block especially around Tory Island and off the Rossguil peninsula (Fig. 3b). Similarly grey seals were seen at the start and end of the survey area with concentrations noted off Inishtrahull Island (Fig. 3d). The lower sightings rate in the middle of the survey area (e.g., harbour porpoise records) may be attributed to higher sea-states (sea-state 2 and 3) which occurred during this part of the survey. However conditions were still favourable and species such as minke whales and dolphins would nevertheless be likely to be observed if they were present.

Group sizes of harbour porpoise varied from 1 to 5 with a mean of 1.9 animals per group. Of the 21 harbour porpoise recorded, two were recorded as calves which delivered a proportion of 9.5% calves in the overall harbour porpoise dataset. All minke whales and grey seal sightings consisted of single animals and the two Risso's dolphin sightings were close together (Fig. 3c) and probably composed one social group. One calf and one juvenile were recorded in the group of 15 Risso's dolphins and several calves were also noted in the group of approximately 100 common dolphins (Fig. 3c).

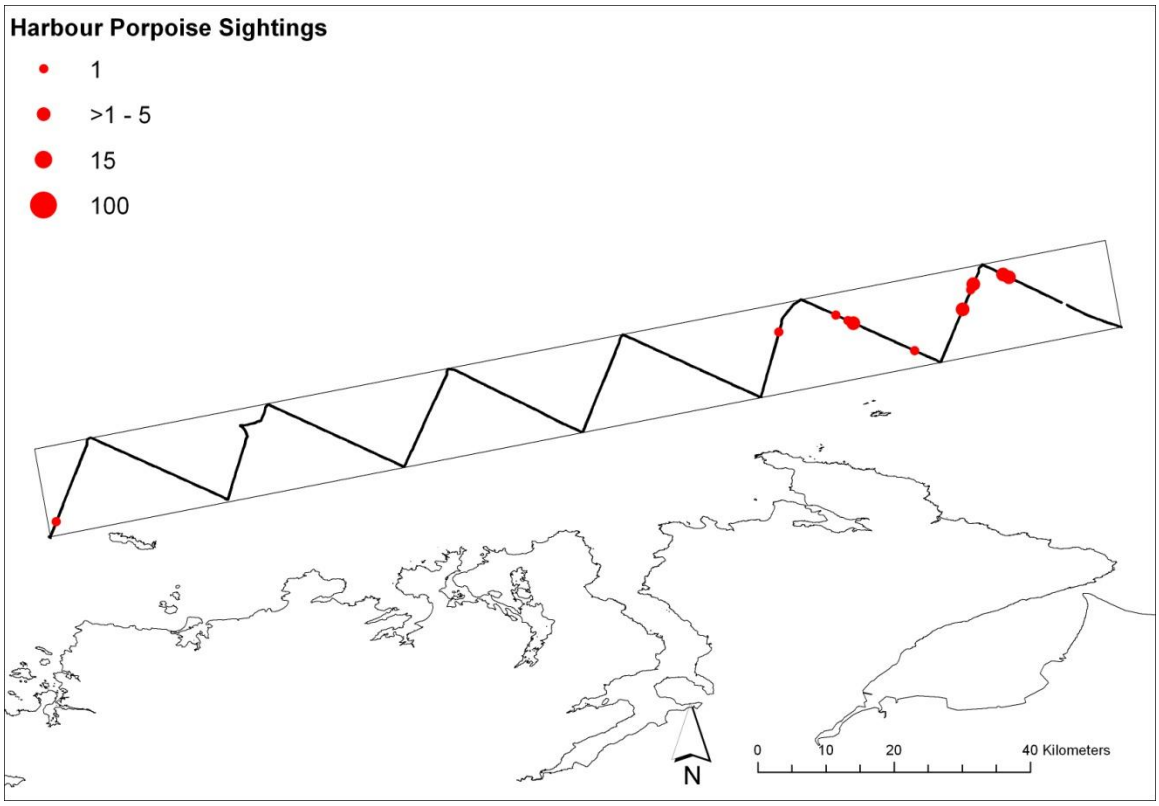


Figure 3a. Location of sightings and numbers of harbour porpoise recorded during the survey in August 2012

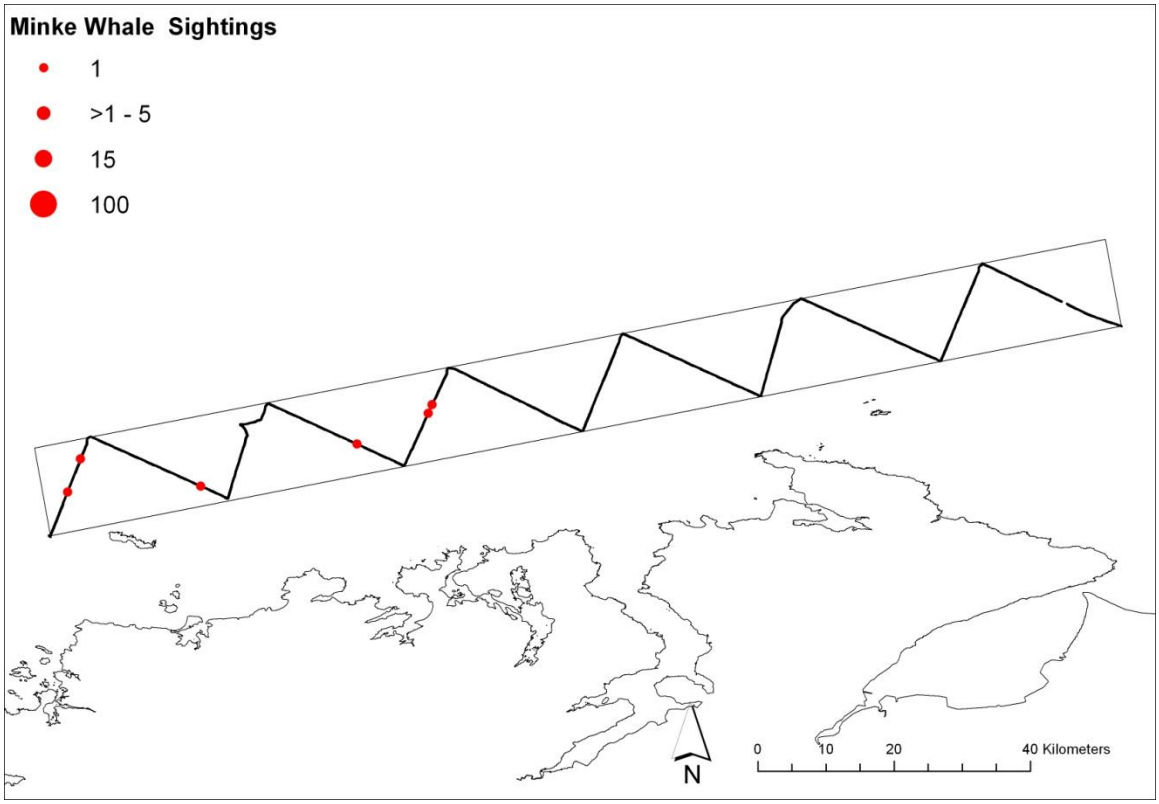


Figure 3b. Location of sightings and numbers of minke whales recorded during the survey in August 2012

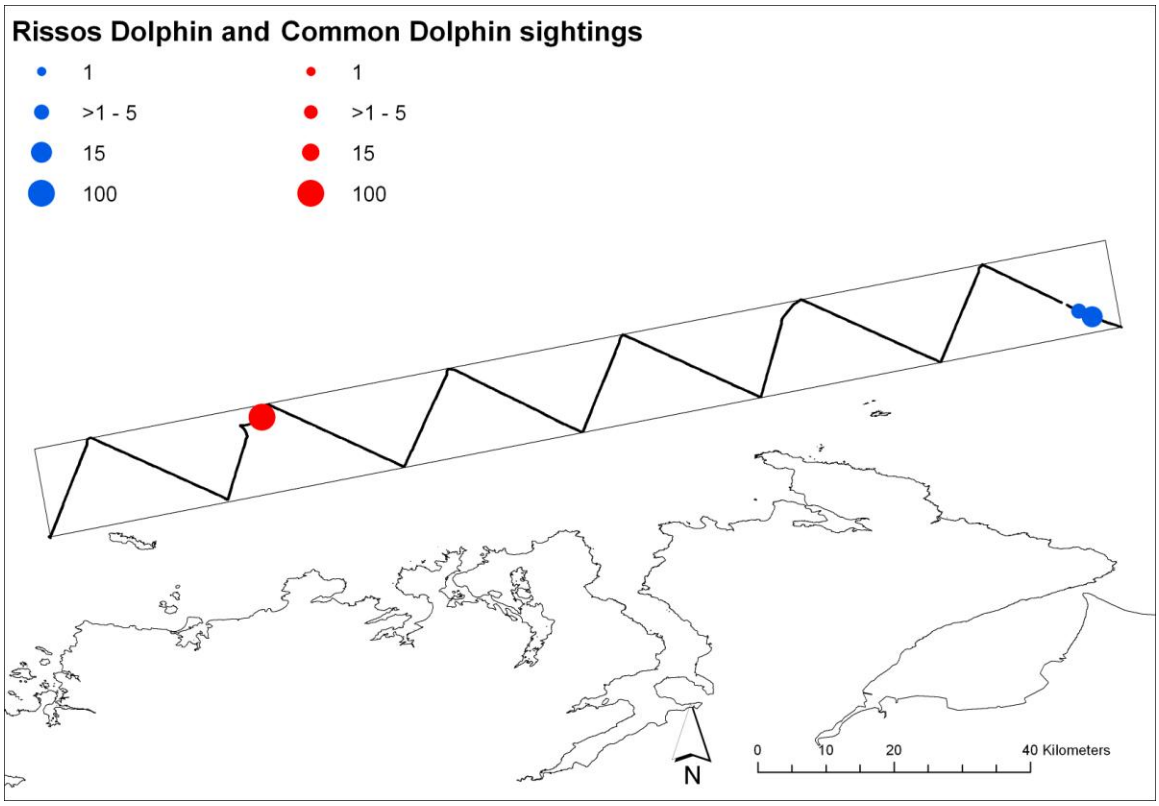


Figure 3c. Location of sightings and numbers of dolphins recorded during the survey in August 2012

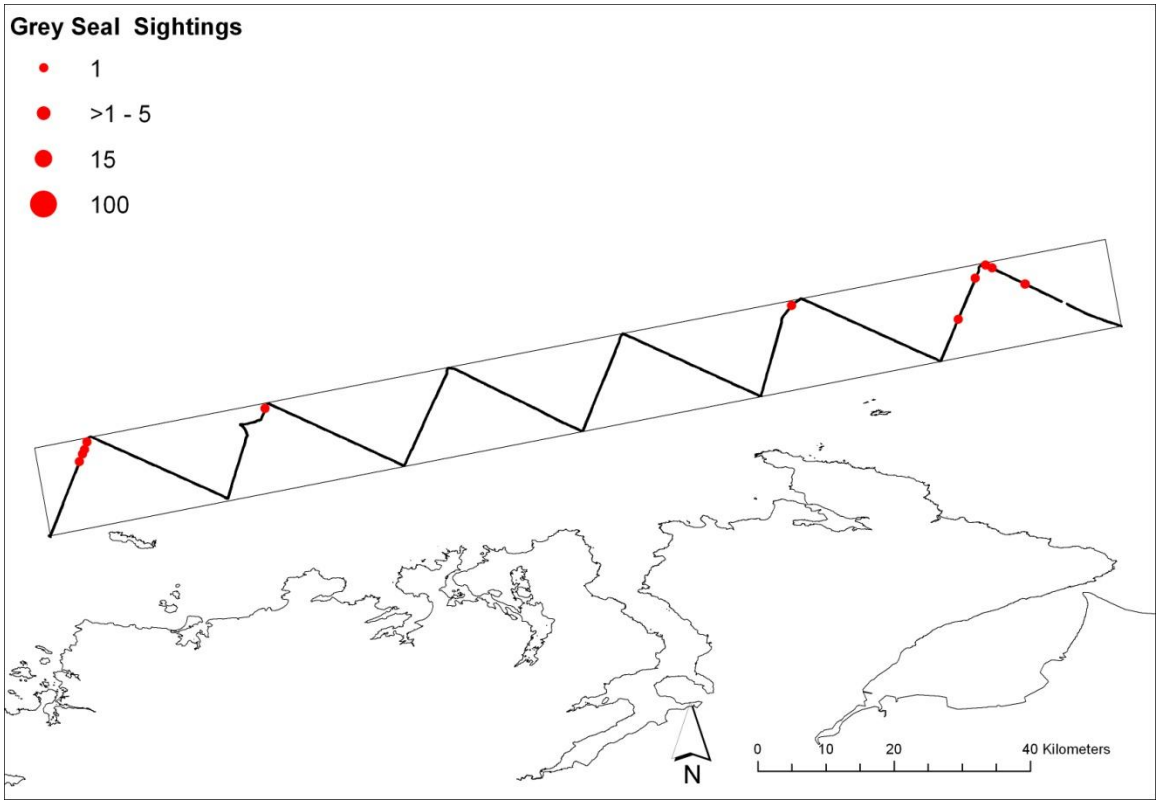


Figure 3d. Location of sightings and numbers of grey seals recorded during the survey in August 2012

Relative abundance

A total of 178 km of track-line was surveyed in 654 minutes (10.9 hrs). Sighting rates (per km and per hour) for the number of sightings and the number of individuals are shown in Table 4. The sighting rate was greatest for harbour porpoise but relative abundance was greatest for common dolphin due to the large size of the single group recorded.

Table 4. Relative abundance of cetaceans and seals recorded in the north Donegal survey block.

	No. of sightings	No. of individuals	Sightings per km	Numbers per km	Sightings per hour	Numbers per hr
Harbour porpoise	11	21	0.062	0.118	1.009	1.927
Minke whale	6	6	0.033	0.033	0.550	0.550
Risso's dolphin	2	18	0.011	0.101	0.183	1.651
Common dolphin	1	100	0.006	0.562	0.092	9.174
Grey seal	13	13	0.073	0.073	1.193	1.193

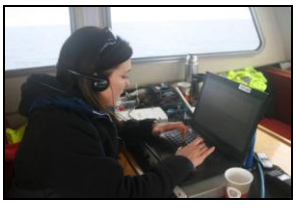
No absolute abundance or density estimates could be calculated from the present survey since the total number of sightings, for any one species, were too few. Buckland *et al.* (2001) recommend a minimum of around 40-60 sightings per species or species group for a robust estimate using the DISTANCE abundance/density estimation software.

Acoustic Detections

Five acoustic events were logged during the survey; three harbour porpoise and one each of common dolphin and Risso's dolphin (Fig. 4). All acoustic records were concurrent with visual sightings. Thus most (77%) of harbour porpoise sightings and all minke whale sightings obtained during the survey were not detected acoustically. A summary of acoustic detections is presented in Table 5.

Table 5. Summary of cetacean acoustic detections recorded within the north Donegal survey block during 2012

Species sighted	Clicks	Whistles	Total detections	Encounter duration min-max (secs)	Mean encounter duration (secs)
HP	Y	N	3	30-60	30
RD	Y	Y	1	18	18
CD	Y	Y	1	22	22



Joanne O'Brien monitoring acoustic signal via PAMGUARD during survey

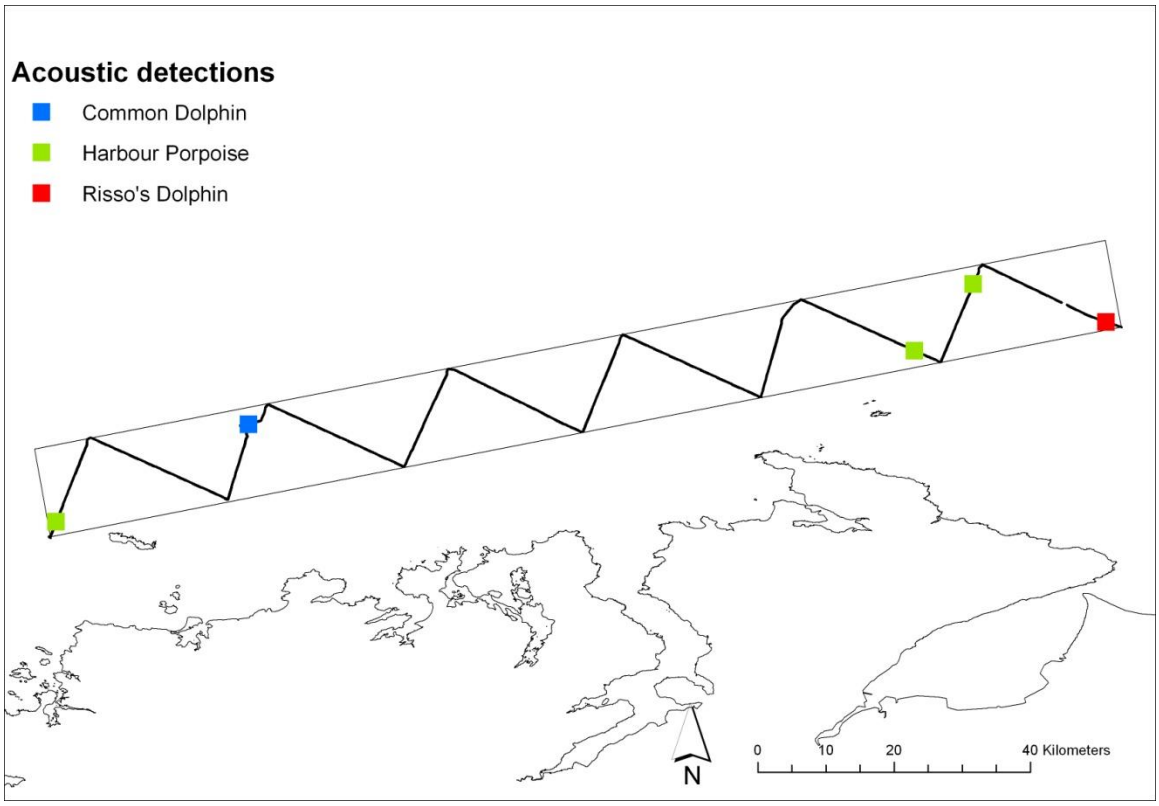


Figure 4. Acoustic survey track (solid line) and the location of acoustic detections recorded during the north Donegal survey in 2012

Discussion

This survey off the north Donegal coast was carried out in very suitable sea conditions. Conditions were less than sea-state 3 for the entire survey but ≤1 for 64% of the entire survey effort. This sea-state is required to survey effectively for harbour porpoise (Berrow *et al.* 2009), while dolphins and whales can be surveyed effectively in up to sea-state 3. A total of 33 sightings, including 20 cetacean sightings and 13 seal sightings resulted in a comparatively high sighting rate and overall relative abundance. A total of five species were recorded, including four cetacean species which suggests comparatively good species diversity in the survey area. Interestingly a group of bottlenose dolphins (*Tursiops truncatus*) were recorded off Portstewart, Co Derry on the same day as this survey was carried out (*see* IWDG sightings database), which is approximately 80-100 km to the southeast of the survey area.

Harbour porpoise and minke whale were the most frequently recorded cetacean species during the August 2012 survey with two species of dolphin (Risso's dolphin and common dolphin) also recorded. This is consistent with previous inshore surveys with harbour porpoise and minke whale occurring in five of the six standardised survey blocks surveyed to date (Table 6). Harbour porpoise and minke whale are widespread in the coastal waters of Ireland during the summer (Berrow *et al.* 2010) and have also been previously recorded in this area (Wall *et al*. 1996; Berrow *et al.* 2010).

Common dolphins are also widespread in Irish waters though they are less frequently recorded off the north coast compared to the south and southwest coasts (Berrow *et al.* 2010). Risso's dolphins have a more patchy distribution in Ireland but this species has been previously recorded in this area on a number of occasions (Wall *et al.* 1996; Berrow *et al.* 2010).

Table 6. Cetacean species list for six survey blocks surveyed around Ireland between 2010 and 2012

	Year	Harbour porpoise	Minke whale	Common dolphin	Risso's dolphin	Bottlenose dolphin	Killer whale
North Donegal	2012	√	√	√	√		
Northern Irish Sea	2011	√	√				
Southern Irish Sea	2011	√					
	2011*	√	√	√			
Southwest	2010	√	√	√			√
West	2010			√		√	
Northwest	2010	√	√		√		

* A repeat survey was carried out on 11 July 2011.

Relative Abundance

Data on the relative abundance of small cetaceans recorded during similar line-transect surveys elsewhere in Ireland are comparatively limited but broad comparisons can be made between this survey and similar standardised surveys carried out during 2010 and 2011.

The harbour porpoise sighting rate off the north Donegal coast during 2012 was very similar to that recorded off the southwest in 2010 (Ryan *et al.* 2010) but they were twice as abundant during the present survey due to differences in group size (Table 7). This suggests that harbour porpoise are more abundant off the north coast than suggested by previous studies (Reid *et al.,* 2003; O'Cadhla *et al.* 2004; Wall *et al.* 2006). Reid *et al.* (2003) did show a patchy distribution off the north coast but O'Cadhla *et al. (*2004) had no sightings of harbour porpoise in this area. Wall *et al.* (2006) put most effort into this area and recorded one definite sighting of 1-2 individuals but these surveys were all from large Ships of Opportunity and not from small vessels carrying out dedicated surveys. Berrow *et al.* (2010) used a combination casual land and boat-based sightings and showed a continuous distribution of sighting records along the north coast. Sighting rates and relative abundance recorded for harbour porpoise off the north coast were notably lower than those recorded in the Irish Sea during 2011 (Berrow *et al.* 2011a) which is consistent with previous studies (Reid *et al.* 2003).

With only one sighting of common dolphins the sighting rate was low and similar to the southern Irish Sea in 2011 (Berrow *et al.* 2011a), but since this single group was comparatively large the relative abundance of this species in the 2012 survey was high. The sighting rate and relative abundance of common dolphins in the western and south-western blocks in 2010 were much higher (Table 8). Common dolphin sightings off north Donegal are scarce with only 4-5 sighting records reported by Berrow *et al.* (2010) and none by Reid *et al.* (2003), O'Cadhla *et al*. (200) or Wall *et al.* (2006).

The sighting rates for minke whale within the north Donegal survey area were notable, being the highest recorded among all six blocks surveyed to date (Table 9) and only one site (northern Irish Sea) had a higher relative abundance. Although minke whales were reported by Reid *et al*. (2003) and Wall *et al*. (2006) off north Donegal records were very few. Berrow *et al.* (20100 reported a bit cluster of minke whale casual sightings off north Donegal and one during effort surveys. The present survey confirms the area is a good site for minke whales with relative high abundance.

Risso's dolphins were also reported off the northwest coast in 2011 with a sighting rate of 0.03 sightings per km and a relative abundance of 0.59 animals per km (Berrow *et al.* 2011b) which was lower than that reported off the north Donegal coast (with 0.01 sightings per km but a relative abundance of 1.65 animals per km). Although two

groups were recorded during the present survey they were close together and were likely to be part of the same social group. Risso's dolphins are known to regularly occur off north Donegal (Berrow *et al.* 2010). Two records were reported by Wall *et al.* (2006) and one by Reid *et al.* (2003).

The sighting rate for grey seal was the highest reported at any of the six sites surveyed to date, with a rate of 0.07 sightings per km and a relative abundance of 1.19 animals per km. This was to be expected as the survey area was within 10km of Inistrahull which is an important haul out site for this species with up to 100 regularly reported in the spring and summer (Lyons 2004).

Visual and Acoustic Detections

Although PAM did not provide additional detections to augment visual observations made during the overall survey it does suggest that no dolphins were missed during the line-transect survey as whistles can be detected from a number of kilometres away. Detections of harbour porpoise is more constrained as there clicks are highly directional and porpoise tend to move away from vessels during these surveys limiting the probability of acoustic detections.

PAM can serve as an added resource when visual observations are impaired, e.g., due to increasing sea state, but as the present survey was carried out in ideal conditions it appeared to add little value to the survey effort and its results on this occasion.

Table 7. Sighting rates and relative abundance of harbour porpoise recorded around Ireland from standardised surveys carried out in 2010-2012

	Year	Sightings per km	Numbers per km	Sightings per hour	Numbers per hr
North Donegal	2012	0.06	0.12	1.01	1.93
Irish Sea - north	2011	**0.29**	**0.50**	**5.24**	**9.15**
Irish Sea - south	2011	0.10	0.16	1.91	3.00
	2011*	0.09	0.09	1.41	1.51
Southwest	2010	0.06	0.03	0.56	1.11
West	2010	0.00	0.00	0.00	0.00
Northwest	2010	0.01	0.01	0.20	0.20

* A repeat survey was carried out on 11 July 2011.

The line-transect survey carried out in August 2012 was a successful survey with good sea conditions overall and a comparatively high sighting rate, and it provides useful baseline data from a relatively poorly surveyed area off the north coast of Ireland. When compared to other areas covered using the same standardised methodology it provided an opportunity to compare survey results for a range of marine mammal species across six regional sites covered to date.

These surveys can also provide a good framework for comparing results across years for monitoring purposes, and may in time assist in identifying potentially important habitats for these species. This would be a long-term commitment but the present survey and its predecessors form an important first step in fulfilling such an objective.

Table 8. Sighting rates and relative abundance of common dolphin recorded around Ireland from standardised surveys carried out in 2010-2012

	Year	Sightings per km	Numbers per km	Sightings per hour	Numbers per hr
North Donegal	2012	0.01	0.56	0.09	9.17
Irish Sea - north	2011	0.00	0.00	0.00	0.00
Irish Sea - south	2011	0.00	0.00	0.00	0.00
	2011*	0.01	0.12	0.10	2.01
Southwest	2010	**1.39**	**0.19**	**3.00**	**23.00**
West	2010	0.23	1.52	4.09	30.8
Northwest	2010	0.00	0.00	0.00	0.00

* A repeat survey was carried out on 11 July 2011.

Table 9. Sighting rates and relative abundance of minke whale recorded around Ireland from standardised surveys carried out in 2010-2012

	Year	Sightings per km	Numbers per km	Sightings per hour	Numbers per hr
North Donegal	2012	**0.03**	**0.03**	**0.55**	**0.55**
Irish Sea - north	2011	**0.03**	**0.03**	**0.64**	**0.64**
Irish Sea - south	2011	0.00	0.00	0.00	0.00
	2011*	0.01	0.01	0.10	0.10
Southwest	2010	0.01	0.01	0.22	0.22
West	2010	0.00	0.00	0.00	0.00
Northwest	2010	0.01	0.01	0.01	0.01

* A repeat survey was carried out on 11 July 2011

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