Cetaceans on the Frontier III

Pilot whales beside the R.V. Celtic Explorer, Whittard Canyon © Joanne O'Brien

24 February – 5 March 2012

Survey Team

Cetaceans: Joanne O'Brien[1], Conor Ryan[1,2], David Williams[2], Enda McKeogh[1], Randal Counihan[2], Roisin Pinfield[3], Suzanne Beck[1], Teresa Martin [1], Laurence Manning[1], Paddy Dwyer[1], Clodagh Collins[3], Mareike Volkenandt[1].

Birds: Jackie Hunt[4], Derek McLoughlin[4,5], Niall Keogh[6], Eamonn O Sullivan[7].

Plankton: Fergal Glynn[8], John Power[1], Catherine O Sullivan[2].

Basking Sharks: Lilian Lieber[9]

1 Galway-Mayo Institute of Technology, Dublin Road, Galway. **2** Irish Whale and Dolphin Group, Merchants Quay, Kilrush, Co. Clare. **3** Coastal Marine Resources Centre, University College Cork, Co. Cork. **4** MEER Consultants, Co. Mayo. **5** Institute of Technology, Sligo. **6** Birdwatch Ireland, Unit 20, Block D, Bullford Business Campus, Kilcoole, Co. Wicklow, Ireland. **7** National University of Ireland, Galway. **8** Queens University, Belfast. **9** University of Aberdeen, Scotland.

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INTRODUCTION

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) that 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 the PReCAST team applied for ship time under the Marine Institute's Ship Time Programme and was successful in 2009 and 2010, conducting a survey of slope and canyon habitat along the north and west slopes of the Porcupine Bank (Wall *et al.* 2009). The current project was aimed as a continuation of the "Cetacean on the Frontier" series.

VISUAL CETACEAN SURVEY

The main focus of the survey was to conduct a double platform, absolute abundance survey of cetaceans in key habitats on the slopes and canyon systems in the south Celtic Sea, primarily targeting baleen whales and offshore bottlenose dolphins.

PASSIVE ACOUSTIC MONITORING SURVEY

Simultaneous PAM surveys were carried out during daylight hours. This was to increase the detection rate of odontocetes within the hydrophone range and to highlight potential visual sightings missed by the visual observers.

CETACEAN PHOTO-ID

The use of photo-identification for estimating the abundance of coastal populations of cetaceans is becoming more widespread (Evans and Hammond, 2004). This approach can provide accurate

estimates with a measure of precision. Bottlenose dolphins lend themselves to this technique as they often have unique and permanent marks that can be easily photographed, but also fin, humpback and pilot whales.

CETACEAN BIOPSY SAMPLING

Remote biopsy darting of cetaceans has revolutionised our understanding of their ecology and population dynamics through genetic, chemical and immunohistological studies. Biopsy samples comprise a small plug of skin and the outer blubber layer of cetacean integument and are collected using a modified firearm. There are ongoing biopsy-based studies in Ireland chiefly on bottlenose dolphins (*Tursiops truncatus*), fin (*Balaenoptera physalus*) and humpback whales (*Megaptera noveaengliae*). Bottlenose dolphins are listed as Annex II under the EU Habitats Directive (1992/43EEC) and therefore require habitat protection by SAC designation. Genetic analysis and photo identification indicate that there are two distinct populations in Irish waters – residents in the Shannon Estuary and Cork Harbour, and coastal transients that range between Ireland, Scotland and England (Mirimin *et al.* 2009; O'Brien *et al.* 2010; Ryan *et al.* 2011). Genetic analysis of stranded bottlenose dolphins from along the western seaboard yielded results consistent with a third population, suggesting that an offshore population may exist. Observations of exceptionally large aggregations of bottlenose dolphins in offshore waters on previous Cetaceans on the Frontier cruises support this. By obtaining biopsy samples from offshore bottlenose dolphins will allow us to facilitate genetic studies to determine if there is a genetically distinct population of pelagic or offshore bottlenose dolphins in Irish waters, which would require very different management strategies to those of inshore waters.

SEABIRDS AT SEA SURVEY

Seabird surveys around Britain and Ireland began in the 1980's (Stone *et al.* 1995). Until then most seabird studies focussed on their breeding colonies and little was known about their dispersion at sea (Pollock *et al.* 1997). Intensive at-sea surveys were carried out in waters around Ireland between August 1994 and September 1997 (Pollock *et al.* 1997) and between July 1999 and September 2001 (Mackey *et al.* 2004). These surveys provided important seasonal data on seabird distribution, abundance and density in Irish waters. These baseline data on seabird populations in Irish waters (Hall *et al.* in press) was supplemented during the 2009 and 2010 research cruises, Cetaceans on the Frontier Cruise I and II. By using standard ESAS survey methods, the Cetaceans on the Frontier Cruise III (COFIII) provides further data on seabird numbers and distribution, to broaden this baseline.

The COFIII Cruise crossed the continental shelf south west of Ireland, followed the shelf slope including King Arthur and Wittard Canyons, the Goban Spur and the Porcupine Seabight. This route overlaps in part with the COFII Cruise and between-year results will be comparable. Data from offshore seabird surveys in the 1980's and 1990's may also be comparable.
sTotal numbers of seabirds recorded on the Cruise are presented in this report, together with species accounts. The survey data from the Cruise will be available to all cruise partners for further analysis (density and abundance estimates).

PLANKTON AND OCEANOGRAPHIC SURVEY

Studies have shown that deep-water canyons and slopes, such as those to the southwest of Ireland, may influence the abundance and distribution of phytoplankton and zooplankton. Such aggregations of plankton over these areas may also be linked to cetacean activity along the shelf edge and in the region of canyons. The aims of the plankton and oceanograhic survey were: to provide a trophic context for cetacean, elasmobranch and bird sightings; to sample near-surface phytoplankton in order to investigate the start of the spring phytoplankton bloom; to sample scyphozoan jellyfish, particularly *Pelagia noctiluca* for genetic analyses; to sample *P. noctiluca* and putative prey for carbon and nitrogen stable isotope analyses; to use a CTD probe to profile temperature, salinity, oxygen concentration and florescence with relation to depth.

BASKING SHARK SURVEY

The filter-feeding basking shark (*Cetorhinus maximus,* G. 1745*)* is the world's second largest fish and is designated by the IUCN Red list as "vulnerable" worldwide. Due to a lack of biological and ecological baseline data, it is currently accepted that the basking shark's global population structure is panmictic, exhibiting low worldwide genetic variability (Hoelzel *et al*, 2006). The basking shark is circum-globally distributed and has been shown to undertake trans-equatorial and trans-Atlantic movements. However, it has been established that the western region of the European shelf provides an important habitat for basking sharks in the Northeast Atlantic, with persistent seasonal aggregations around Ireland, south-west England and north-west Scotland, highly associated with feeding opportunities (Southall *et al*, 2005). Each spring, once phytoplankton is in bloom, basking shark aggregations are a common phenomenon in Irish inshore waters. However, during winter,

basking sharks spent more time offshore in well-mixed, deep waters and only return to coastal, stratified waters during spring and summer (Stephan *et al*, 2009; Sims *et al* 2003).

The primary objective of the cruise was to investigate basking shark distribution early in the season, when the sharks are thought to move towards Ireland, usually starting around March. This survey therefore allowed first insights into seasonal basking shark movement along the Irish continental shelf before surface sightings are recorded in coastal waters. The IWDG and the Irish Basking Shark Group have been researching basking shark movements in Irish waters through tagging studies and the established a dorsal fin photo ID catalogue. Since 2009, an IWDG team has been collecting genetic samples for the Aberdeen University shark ecology group (Fig. 1). Data collected during this survey will also be used for a collaborating PhD project at the University of Aberdeen, Scotland, on seascape genomics, health and spatial ecology of basking sharks. The additional collection of sea surface temperature and phytoplankton/zooplankton concentrations will allow further analyses on basking shark thermal preferences and habitat suitability at this time of the year towards modelling possible range shift due to climate change. An additional aim was to collect mucus scrapings for genetic and ecotoxicological analysis to further investigate population structure, health and movement of sharks in the Atlantic.

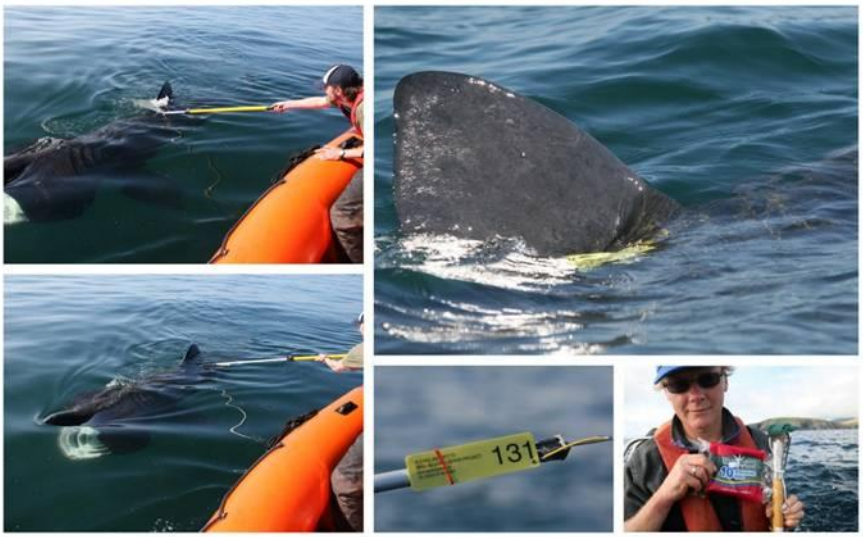

Fig 1: Illustration of the 2010 season's dorsal fin tagging with conventional coloured number tags and the non-invasive sampling procedure developed by Berrow and Johnston (2009) from the Irish Basking Shark Group using scouring pads attached to the end of a mop by cable ties, allowing for non-invasive sampling (©Emmet Johnston).

METHODS

The survey was conducted on board the Marine Institute's *R.V. Celtic Explorer*. Dedicated surveying was carried out between 24 February and 5 March 2012. The survey area covered waters over the Porcupine Bank, Porcupine Seabight, Whittard Canyon System and Celtic Shelf. The survey track was predominantly designed to target deep-water canyon and slope habitat (Fig. 1). The survey vessel travelled at an average speed of 10 knots while on transect between the hours of 08:00 to 18:00 each day and CTD's and plankton hauls were carried out between 18:00 and 07:30.

VISUAL CETACEAN SURVEY

A double platform cetacean survey design, based on methods used during the SCANS II and CODA surveys (Hammond & Macleod, 2006) was employed. The method was a combination of line transect distance sampling and mark-recapture methods. Three types of survey mode were used during the survey. In sea states up to sea state 4, double platform survey mode was used. In sea states of 5 and 6, single platform survey mode was employed. In sea states greater than 6, in heavy rain, very reduced visibility or where conditions were unsafe for surveying from the Monkey Island or Crow's nest, a watch was kept from the bridge. 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).

DOUBLE PLATFORM SURVEY MODE

A team of 6 surveyors was used to survey from two platforms. Two surveyors operated from the primary platform, located on the 'monkey island' 12m above the waterline (Fig. 2). The primary platform surveyors scanned the area around the ship, out to a distance of 1000m by eye. Sighting species identification and group size were confirmed with the aid of 8 X 50 binoculars. The port side primary surveyor scanned an arc from 10° starboard to 90° port, while the starboard side primary surveyor scanned an arc from 10° port to 90° starboard. Angles were read using an angleboard placed between the two observers and distances were measured using the aid of a distance measuring stick. Sightings were relayed to the data recorder and duplicate identifier via two-way radio. The second surveyor recorded a duplicate of the sighting data onto paper forms.

Another two surveyors surveyed from the tracker platform, located on the 'crows nest' 17m above the waterline (Fig. 2). The tracker platform surveyors surveyed ahead of the ship (500m+) in order to spot animals before they reacted to the presence of the ship and before the primary platform surveyors spotted them. The port side tracker scanned an arc 60° to port and starboard using 7 X 50 Opticron™ binoculars, while the starboard side tracker scanned an arc 40° to port and starboard using 7 X 50 Opticron™. Angles were read using an angle board placed between the two observers and distances were measured using the aid of a distance measuring stick. Sightings were relayed to the data recorder via two-way radio. The duplicate identifier recorded a duplicate of sighting data onto a paper form. The role of the trackers was to locate animals at a distance from the ship and track them as they approached or passed by the vessel.

The data recorder was positioned on the crow's nest deck within an enclosed survey platform (Fig. 2). The recorder logged details of primary and tracker platform sightings into an access database using IFAW Logger 2000™ (IFAW, 2000). The data recorder also logged details of observer rotations, waypoints and changes in environment every 30 minutes or as required.

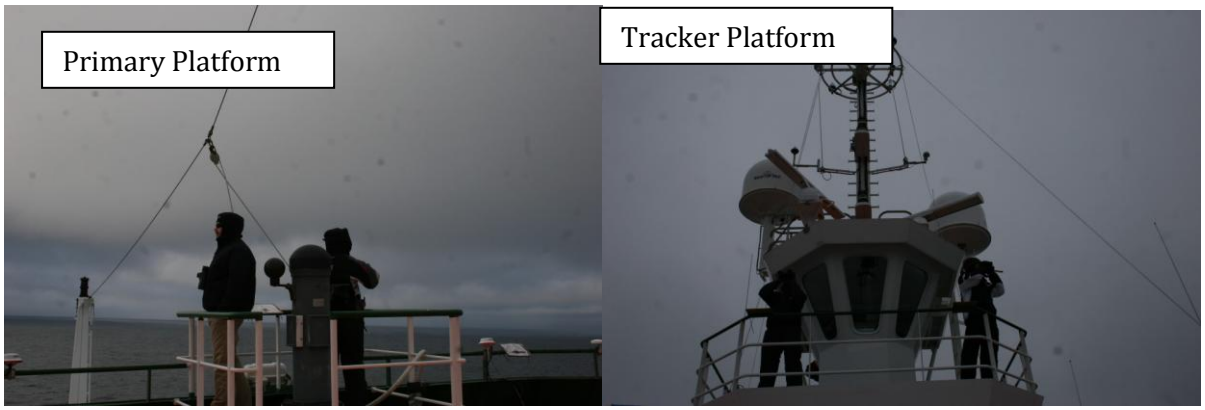

Figure 2. Primary and tracker observers on their observation platforms.

SINGLE PLATFORM SURVEY MODE

A team of 3 surveyors was used to survey using the primary platform. Two surveyors operated from the primary platform, located on the 'monkey island' 12m above the waterline. The primary platform surveyors scanned the area around the ship, out to a distance of 1000m by eye. Sighting species identification and group size were confirmed with the aid of 7X50 binoculars. The port side primary surveyor scanned an arc from 10° starboard to 90° port, while the starboard side primary surveyor scanned an arc from 10° port to 90° starboard. Angles were read using an angle board placed between the two observers and distances were measured using the aid of a distance measuring stick.

Sightings were relayed to the data recorder via two-way radio. The second surveyor recorded a duplicate of the sighting data onto paper forms.

BRIDGE WATCH MODE AND AUXILIARY SIGHTINGS

Two surveyors (either primary or tracker) kept a watch from the port and starboard wings of the bridge for any animals in the vicinity of the ship. Sightings were logged onto paper forms and were entered in the database as auxiliary sightings. Sightings recorded at by other time by members of the ships or scientific crew were also entered in the database as auxiliary sightings.

PAM SURVEY USING TOWED HYDROPHONE ARRAY

During visual surveys, a towed hydrophone array was deployed. This array consists of a 200m cable with two hydrophone elements (HP-03) situated 25cm apart in a fluid filled tube towards the end of the cable. The hydrophone connects to a MAGREC HP-27 buffer box which runs through a laptop computer, which is connected to a National Instrument DAQ-6255 USB soundcard. This allows for the detection of sounds outside the capability of the computers soundcard (i.e. harbour porpoise high frequency echolocation clicks). Detection software used during survey was PAMGUARD (freely available at www.pamguard.org) and IFAW´s, Logger and Rainbowclick (freely available at www.ifaw.org). The acoustic survey track line will be recorded via an external GPS receiver linked to the Logger software. PAMGUARD is a fusion of the IFAW suite and Ishmael and therefore has applications such as click detectors, tonal whistle detectors, capability to calculate bearings on maps, record a track log, spectrogram viewer, detection energy display, and has built in filters. The collection of acoustic data during visual surveys will add an extra dimension to the monitoring dataset. Acoustic monitoring can detect cetaceans which are beyond the visual observers view and therefore increase the capacity of a survey. Each day all acoustic files were backed up on a1TB external hard-drive.

DATA ANALYSES OF TOWED HYDROPHONE DATA

The use of biosonar by porpoises and dolphins has been extensively studied (Au, 1993), and has shown that porpoise and dolphin sonar characteristics differ greatly from each other, therefore making it possible to differentiate between these species. They can vary in click duration, inter-click interval, frequency, source level, and range. Harbour porpoises echolocation signals are characterised as being narrow-band, high frequency between 110 and 150kHz, with a detection range (for a single fish of ingestible size) of up to 30m. Variations in inter-click intervals (ICIs) can be

used to identify different acoustic behaviours such as feeding, approach behaviour and communication. Boat sonar and echo-sounders are the only sounds in the sea which are similar to harbour porpoise sonar, as other sounds are more broadband, have longer durations and occur at lower frequencies. Dolphins also have a highly developed sonar system for discriminating objects with bottlenose dolphin echolocation clicks characterised as broadband, between 200Hz and 150kHz, with a peak energy at 30-60kHz with a source level of 40-80dB *re* 1 µbar @ 1m. Dolphins also have the ability to produce frequency modulated sounds called whistles which are usually below 20kHz.

A PAM operator was present with the monitoring station and listened to the data stream in real time. This method served to reduce the amount of post processing and allowed for the species identification of detections where visual sightings occurred. Data analyses included the visual inspection of all sound files on spectrograms using IFAW's whistle detector and porpoise detector. All characteristics associated with detections including, inter-click interval of click trains, as well as frequency, shape and outline of whistles will be taken into account when identifying detections to species level (example Fig. 3). The track of all acoustic effort was mapped, with acoustic detections classed as "sightings", and these were overlain on the track similar to those from visuals surveys.

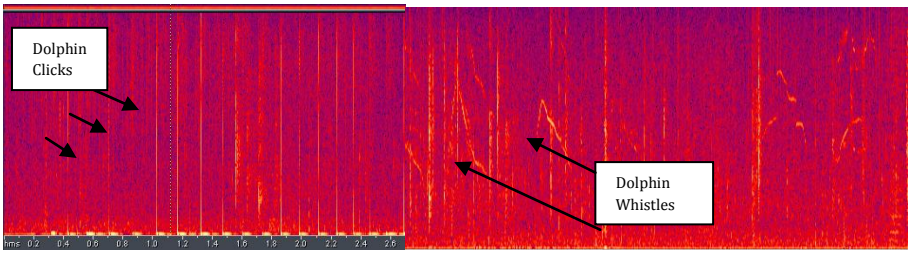

Figure 3. Spectrogram of dolphin clicks and whistles

CETACEAN PHOTO-ID

A six-meter rigid inflatable boat (RIB) was carried on board the ship in order to capitalise on photo-identification opportunities of offshore bottlenose dolphins and baleen whales during biopsy sampling. During this survey high quality digital cameras with f2.8 70-200 mm lense (including x2 converters) were used. If bottlenose dolphins or baleen whales were encountered, the track-line was broken and the dolphins/whales photographed to obtain images of all individuals present in the group. Confirmation to the Marine Notice 15 of 2005 was adhered to when biopsy sampling was not being carried out.

CETACEAN BIOPSY SAMPLING

A key priority of the cruise was to attempt to take skin and blubber biopsies from bottlenose dolphins, fin and humpback whales in offshore waters within the Irish EEZ from *R.V. Celtic Explorer* by deploying a 6m rigid-hulled inflatable *Muc Mhara.* The sampling technique uses a standard 150lb recurve crossbow (*Panzer V*) with Finn Larsen biopsy darts using 40mm and 25mm sampling tips. Tips were sterilised, cleaned in 99% ethanol and wrapped in solvent-washed foil.

Following sightings of suitable groups of target species during cetacean surveys, the decision was made to break track and launch the RIB to attempt biopsy samples. Observers on the crow's nest tracked target animals and communicated with the bridge and the RIB to help locate animals while on the water. Target animals were approached in the RIB until parallel and close enough to shoot (<25m). Photo ID was carried out simultaneously to identify biopsied individuals in order to prevent duplicate sampling. Behaviour before and after sampling as well as reaction strength to the biopsy darting were recorded. Samples were frozen for stable isotope and pollutant analyses in solvent washed foil. A subsample of skin was preserved in salt-saturated 20% DMSO (dimethyl sulfoxide) for molecular genetics.

Analyses of biopsy samples of fin and humpbacks are currently underway at GMIT and the Marine Institute from inshore sampling trips between 2003 and 2012 in the Celtic Sea. Persistent organochlorine pollutants such as PCBs (polychlorinated biphenyls) and brominated flame retardants in the blubber samples are being used to compare the diet of fin and humpbacks in the Celtic Sea, along with stable isotope analysis. Mixing models are being used to assign prey (plankton collected on COTF I and II and several fish species collected during the FSS Celtic Sea Acoustic Herring surveys) to the whales. Genetic analyses are also underway including gender, mitochondrial and microsatellite analyses. Samples from offshore waters would be invaluable for testing whether those whales exhibit the same stable isotope signatures and persistent pollutant burden as those that feed inshore.

SEABIRD SURVEY

Surveys of seabirds at sea were conducted from the R.V. Celtic Explorer between 25th February and 4th March 2012. The ship spent from 08:00 to 18:00 each day on transect, during which the average travel speed was 10 knots, except when heavy swell prohibited this (at which time surveying also stopped). A standardised line transect method with sub-bands to allow correction for species

detection bias and 'snapshots' to account for flying birds was used (following recommendations of Tasker *et al.* 1984; Komdeur *et al.*1992; Camphuysen *et al.* 2004), as outlined below.

Two observers (a primary observer and a scribe, who also acted as a secondary observer), in rotation from a pool of four surveyors, were allocated to survey shifts of two hours, surveying from 08.00 to 18.00 hours (dusk) each day. Environmental conditions, including wind force and direction, sea state, swell height, visibility and cloud cover, and the ship's speed and heading were noted at hourly intervals during surveys. No surveys were conducted in conditions greater than sea state five, when high swell made working on deck unsafe, or when visibility was reduced to less than 300m.

The seabird observation platform was the bridge deck, which is 10.5m above the waterline and provided a good view of the survey area. The survey area was defined as a 300m wide band operated on one side (in a 90° arc from the bow) and ahead of the ship. This survey band was sub-divided (A = 0-50m from the ship, B = 50-100m, C = 100-200m, D = 200-300m, E > 300m) to subsequently allow correction of species differences in detection probability with distance from the observer. A fixed-interval range finder (Heinemann 1981) was used to periodically check distance estimates. The area was scanned by eye, with binoculars used only to confirm species identification. All birds seen within the survey area were counted, and those recorded on the water noted as 'in transect'. All flying birds within the survey area were also noted, but only those recorded during a 'snapshot' were regarded as 'in transect'. This method avoids overestimating bird numbers in flight (Tasker *et al.* 1984). The frequency of the snapshot scan was ship-speed dependent, such that they were timed to occur at the moment the ship passed from one survey area to the next. Any bird recorded within the survey area that was regarded as being associated with the survey vessel was noted as such (to be excluded from abundance and density calculations). Survey time intervals were set at 5 minutes. Additional bird species observed outside the survey area were also recorded and added to the species list for the research cruise, but these will not be included in maps of seabird abundance or density.

In this report we present our daily total count data for each species each day along with the daily survey effort. It is envisaged that this data will be analysed in the future and the seabird abundance (birds per km travelled), and seabird density (birds per km^2) will be mapped per ¼ ICES square (15° latitude x 30° longitude), allowing comparison to the results of previous seabird surveys in Irish waters (e.g. Hall *et al.* in press, Mackey *et al.* 2004, Pollock *et al.* 1997). Through further analysis, species-specific correction factors will be applied to birds observed on the water. It is also hoped to combine this analysis with the results of the cetacean and plankton teams. Data for surveys of

inshore waters completed on the 3 and 4 of March are not presented in this report, but this data will also be available for analysis. The binomial species names for the birds recorded are presented in the species accounts.

PLANKTON AND OCEANOGRAPHIC SURVEY

All plankton and oceanographic survey work was carried out at night from ~6PM to ~8AM, so as to be complimentary to the daylight visual survey. At each survey station, a CTD probe was deployed with 700µm mesh bongo nets attached to sample plankton in a vertical column from the maximum depth to the surface. The CTD probe recorded data throughout the drop and haul, giving duplicate data for any given depth at each station (Fig. 4). At most stations, the probe was dropped to within 200m of the seabed. On reaching the surface, the nets were rinsed down with sea water, and the codends removed. All plankton samples were inspected for the presence of scyphozoans. The total plankton sample from one of the codends was transferred to a sample jar and fixed by adding an equal volume of 4% formalin in freshwater (for a final concentration of 2%) for future studies and as specimens for teaching in GMIT. The plankton from the other codend were transferred to a metal tray, labeled and frozen dry at -20°C for future stable isotope analysis. A third plankton sample was taken by dropping a weighted 53µm mesh net to a depth of ~20m (current dependent), and recovering it at a rate of ~30m/min. Plankton from this sample were fixed in seawater and lugol's iodine. Two stations were carried out differently, where a 1m aperture ring net of 250µm mesh was attached to the CTD probe. This was done so as to sample plankton in horizontal tidal currents. The probe rig was lowered to half the total depth of the station and soaked for 15-20 minutes. The purpose of this was to sample jellyfish in tidal currents.

Figure 4: (Clockwise from top left) Plankton team extracting sample from codends © Fergal Glynn. Bongo nets attached to CTD array used for zooplankton sampling © Lillian Lieber. A member of the plankton team conducting a phytoplankton sample © Catherine O'Sullivan.

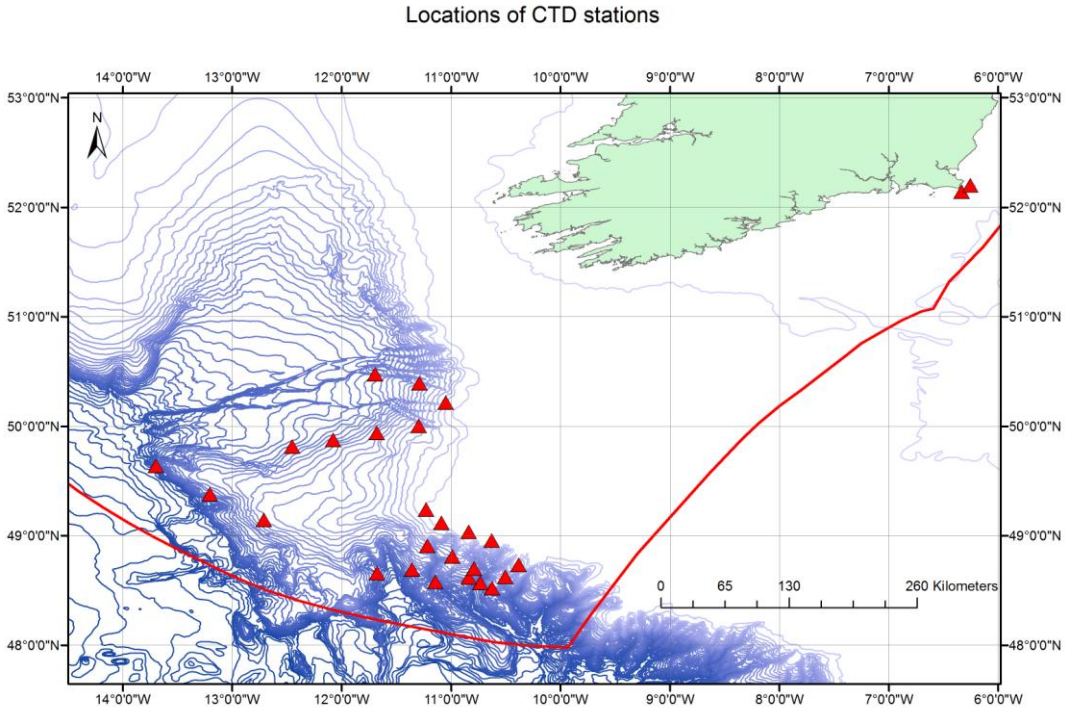

Figure 5: A chart showing the locations of CTD and sampling locations, the two inshore sites consisted of 20-25m plankton sampling for 15-20 minutes, with the net rigged horizontally.

BASKING SHARK SURVEY

Apart from the continuous watches conducted by the cetacean team, additional visual surveys for marine megafauna were conducted from the bridge deck, a platform which is located 10.5m above the water line (Fig. 5). This additional effort provided a good view of the survey area of 50-300m off the vessel. No surveys were conducted in conditions greater than sea state five, when high swell made working on deck unsafe, or when visibility was reduced to less than 300m.

Figure 5: Seabird and basking shark observers operating from the same observer platform from the bridge deck of the R.V. Celtic Explorer (©Teresa Martin). Binoculars were used to confirm species identification.

RESULTS

CETACEANS VISUAL SURVEYS

Environmental data was collected at 265 stations. Sea state was ≤3 at 69% of environmental stations, ≤4 at 15% of stations and ≤5 at 5% of stations. Swell of 2m+ was recorded at 72% of stations. Visibility was <1km at 8.3% of stations, 1-5km at 25.4% of stations and >5km at 66.3% of stations. Rainfall was recorded at 21.5% of stations, on 71.9% of these occasions precipitation intensity was recorded as continuous light (Fig. 6). Fog was encountered on 9.1% of stations.

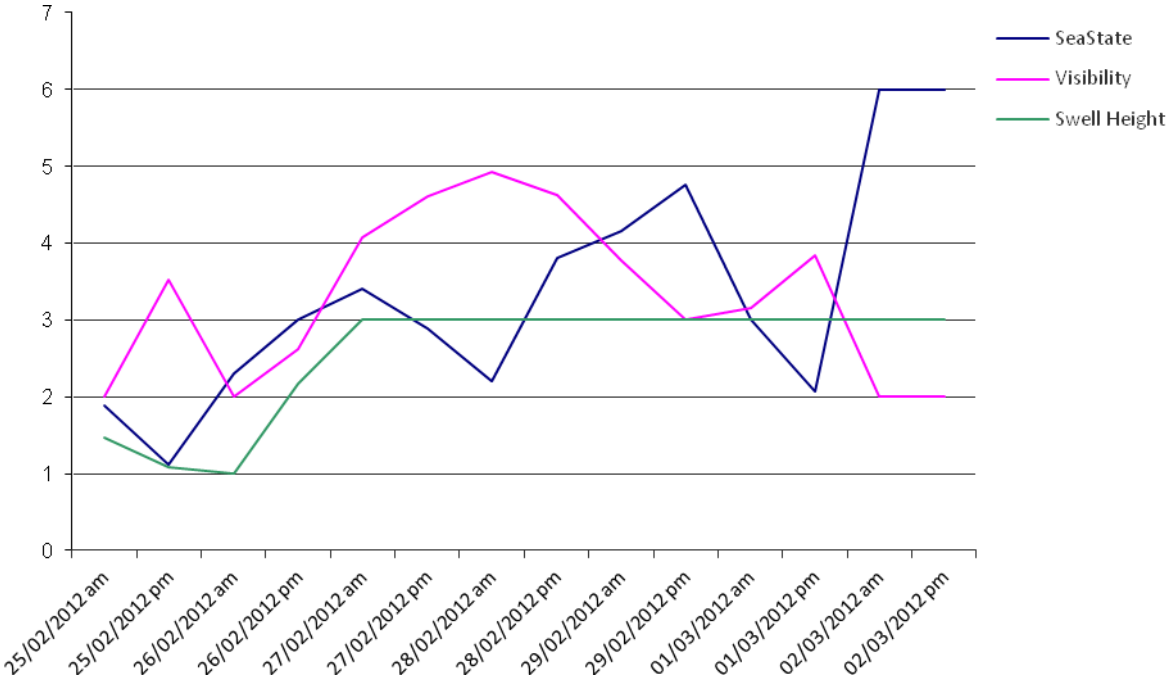

Figure 6. Sea state, swell conditions and visibility recorded twice daily during the survey.

VISUAL SURVEY

70hrs of on-effort survey time were logged with 90% (49hrs) of this at Beaufort sea state three or less; 15% (10hrs) at Beaufort sea state four or less and 6% (4hrs) at Beaufort sea state five or less. Additional time was spent watching from the bridge during poor weather, however these data were considered off-effort and sightings from these watched were logged as auxiliary sightings. 63hrs of double platform survey effort, 7hrs of single platform survey effort were logged (Fig. 8).

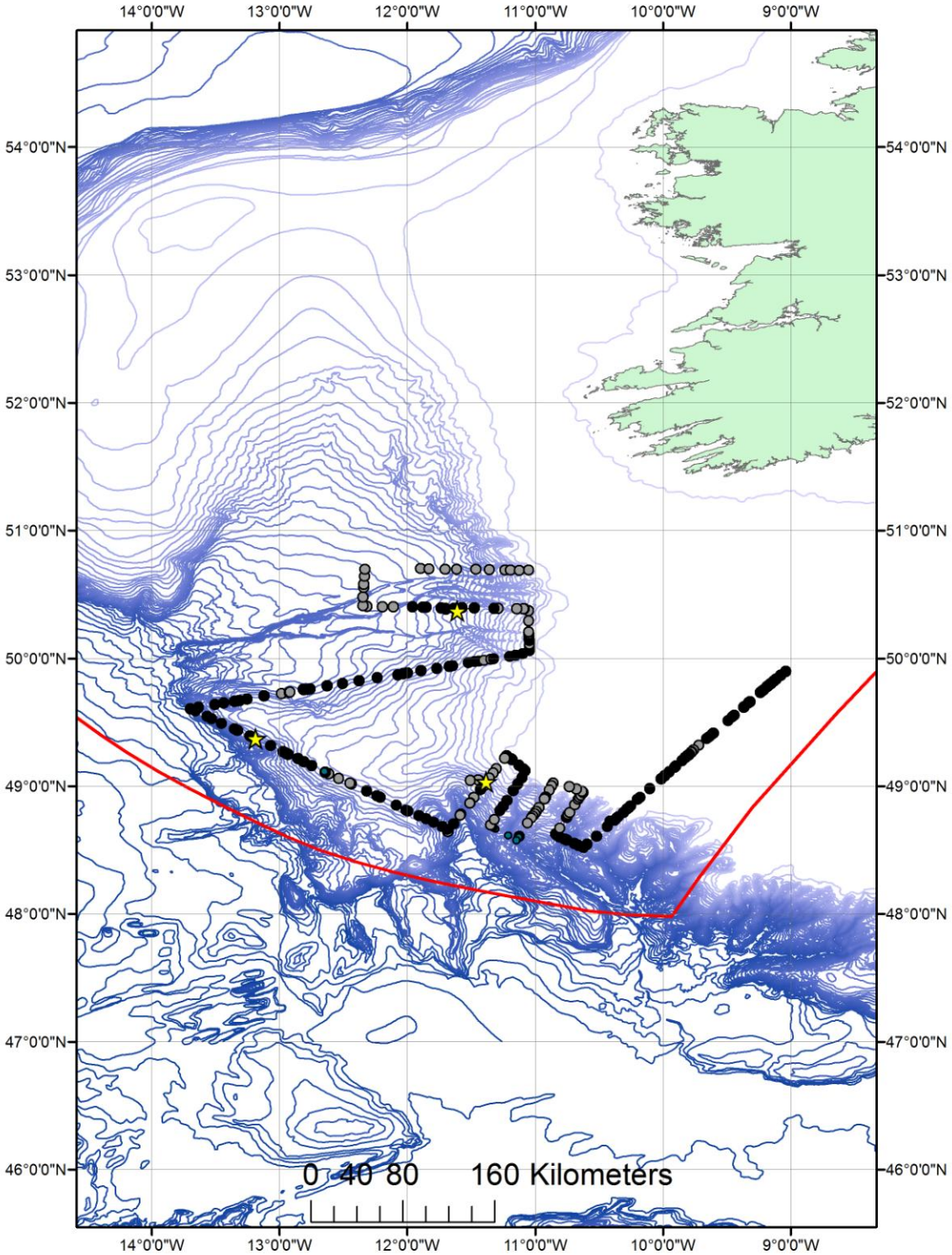

Fig. 8: Double (black), Single (grey) and bridge watch survey effort collected during the survey. RIB deployments are marked by yellow stars.

75 sightings of at least 6 cetacean species, totalling 795 individuals were recorded (Fig's. 9, 10, 11).

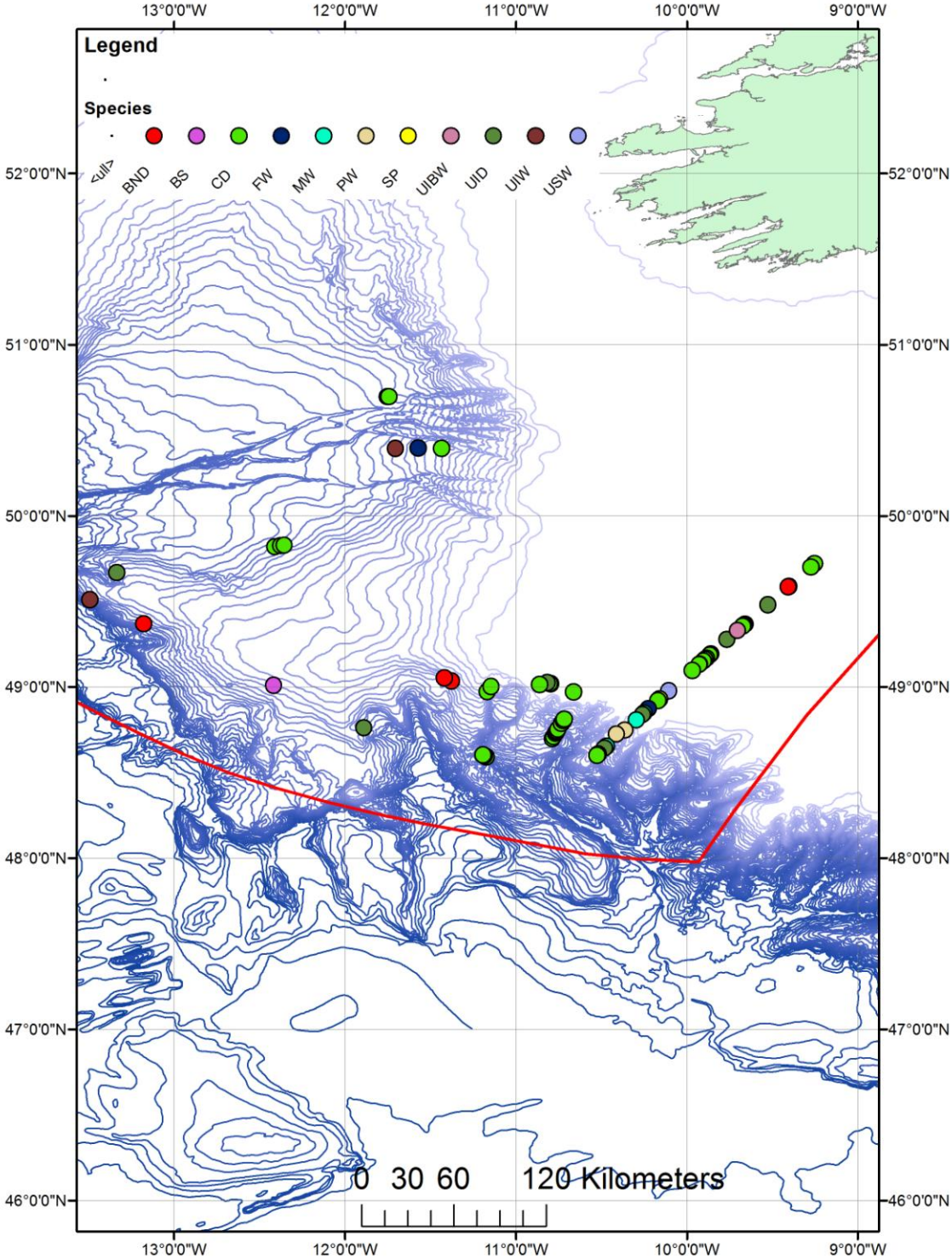

Figure 9: Sightings recorded during visual survey.

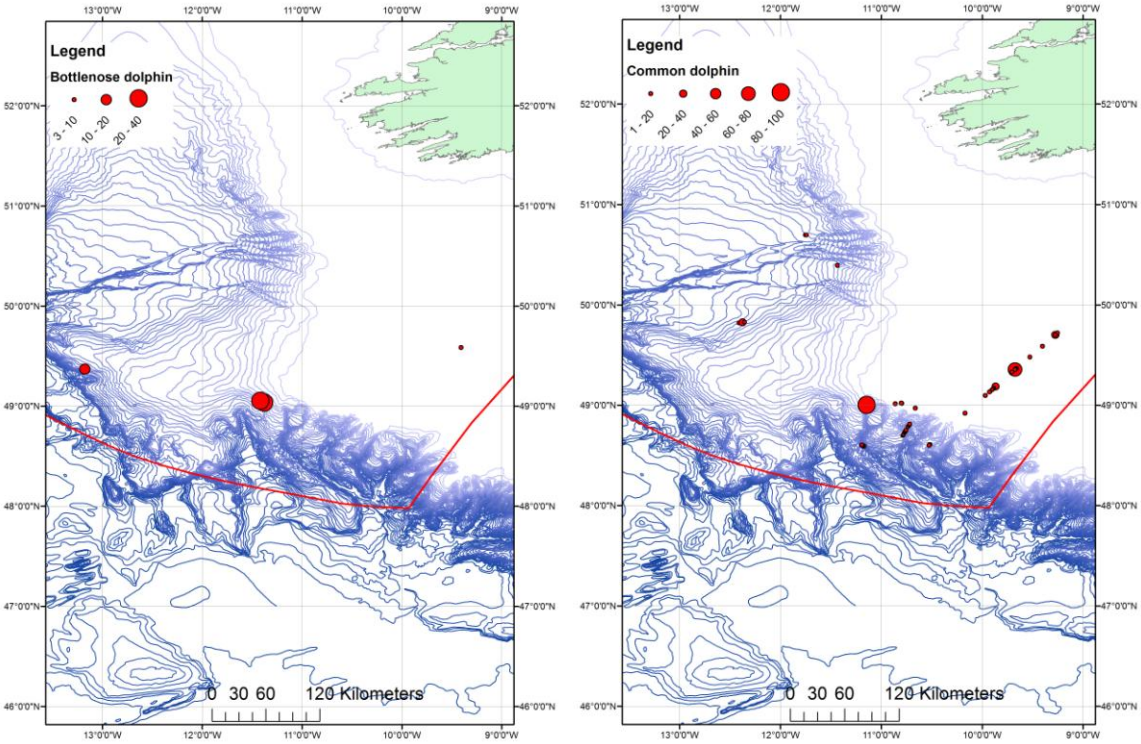

Figure 10 and 11. Distribution of Bottlenose dolphin and Common dolphin sightings recorded over the survey duration.

Identified cetacean species comprised fin whale (*Balaenoptera physalus*), long-finned pilot whale (*Globicephala melas*), bottlenose dolphinn (*Tursiops truncatus*), common dolphin (*Delphinus delphis*) Minke whale (*Balaenoptera acutorostrata*), and sperm whale (*Physeter macrocephalus*). All sightings of unidentified whale blows were thought to be of fin whales but were classed as fin/sei/blue according to the IWDG's cetacean sightings database classification scheme (IWDG 2010). A single probable beaked whale was seen breaching on 29 February. Common dolphins were the most commonly encountered and abundant species recorded during the survey (Table 1), with group sizes ranging from 2-100 animals. Bottlenose dolphin sightings were restricted to the shelf and upper shelf slopes in the southern-most region of our survey effort.

Table 1. Species, number of sightings and group size recorded during the survey.

Species	No. of sightings	No. of individuals	Group size
Bottlenose dolphin	6	56	3-30
Common dolphin	49	603	2-100
Pilot whale	2		
Sperm whale	1	1	1
Fin whale	2	5	1-4
Minke whale	3	3	1
Unidentified beaked whale	1	1	1
Unidentified dolphin	8	29	1-11
Unidentified whale	3	5	1-3

ACOUSTIC CETACEAN SURVEY

TOWED HYDROPHONE ARRAY

70 hours of PAM recordings were made during the survey. Preliminary analyses of the acoustic dataset resulted in a total of 28 acoustic detection events involving at least 4 species. From a PAM and visual dataset comparison, 3 events were identified as bottlenose dolphins, 13 as common dolphins, 2 as long-finned pilot whales, 1 as sperm whales, 3 as unidentified dolphin clicks and 6 as unidentified dolphin whistles (Fig's.12 and 13). A more detailed analyses of the acoustic dataset will be carried out and will also form part of an EPA funded project "Assessing Ocean Noise in Irish Waters" during 2012. This dataset will also be lodged with the National Biodiversity Data Centre.

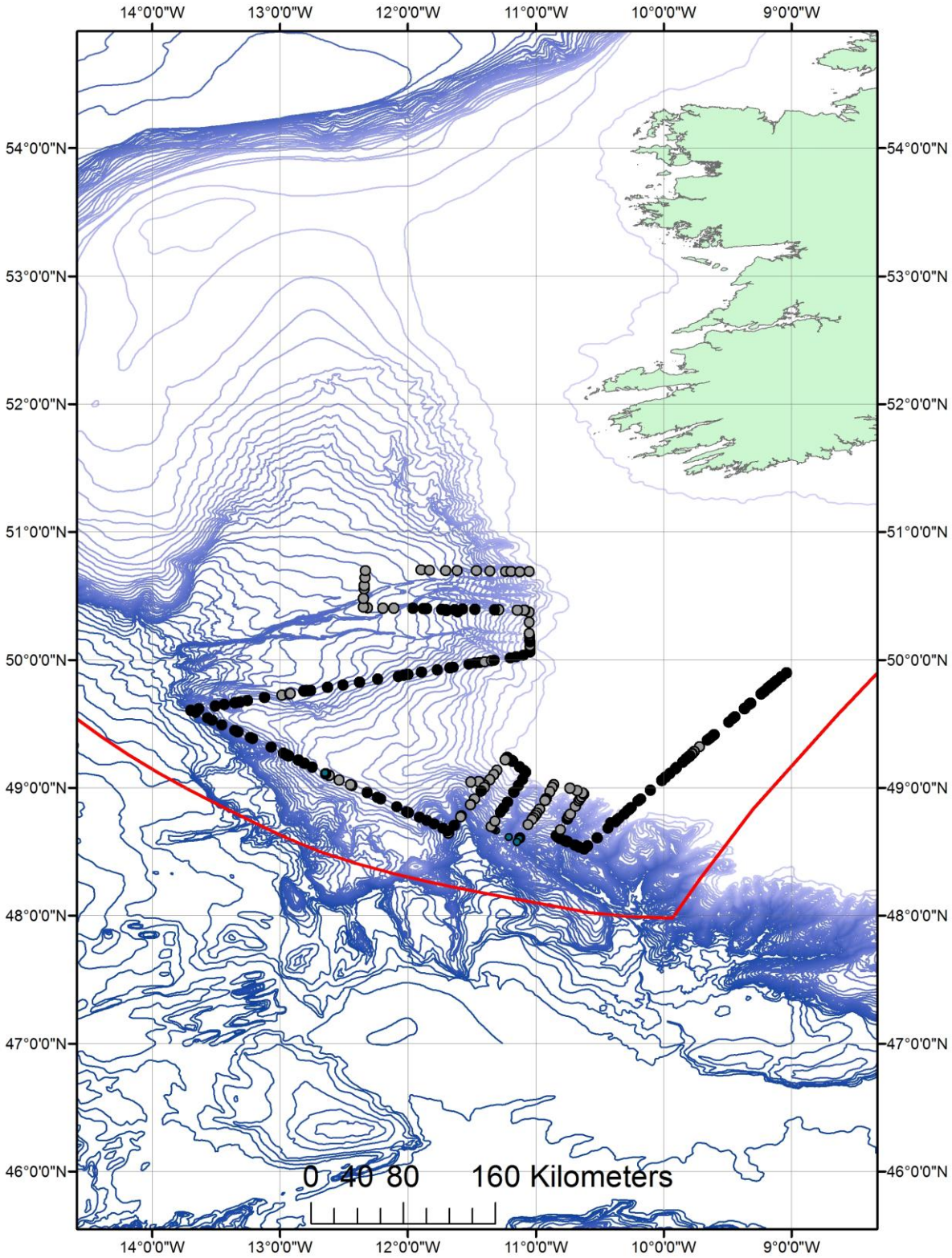

Figure 12. Track during which towed hydrophone was deployed.

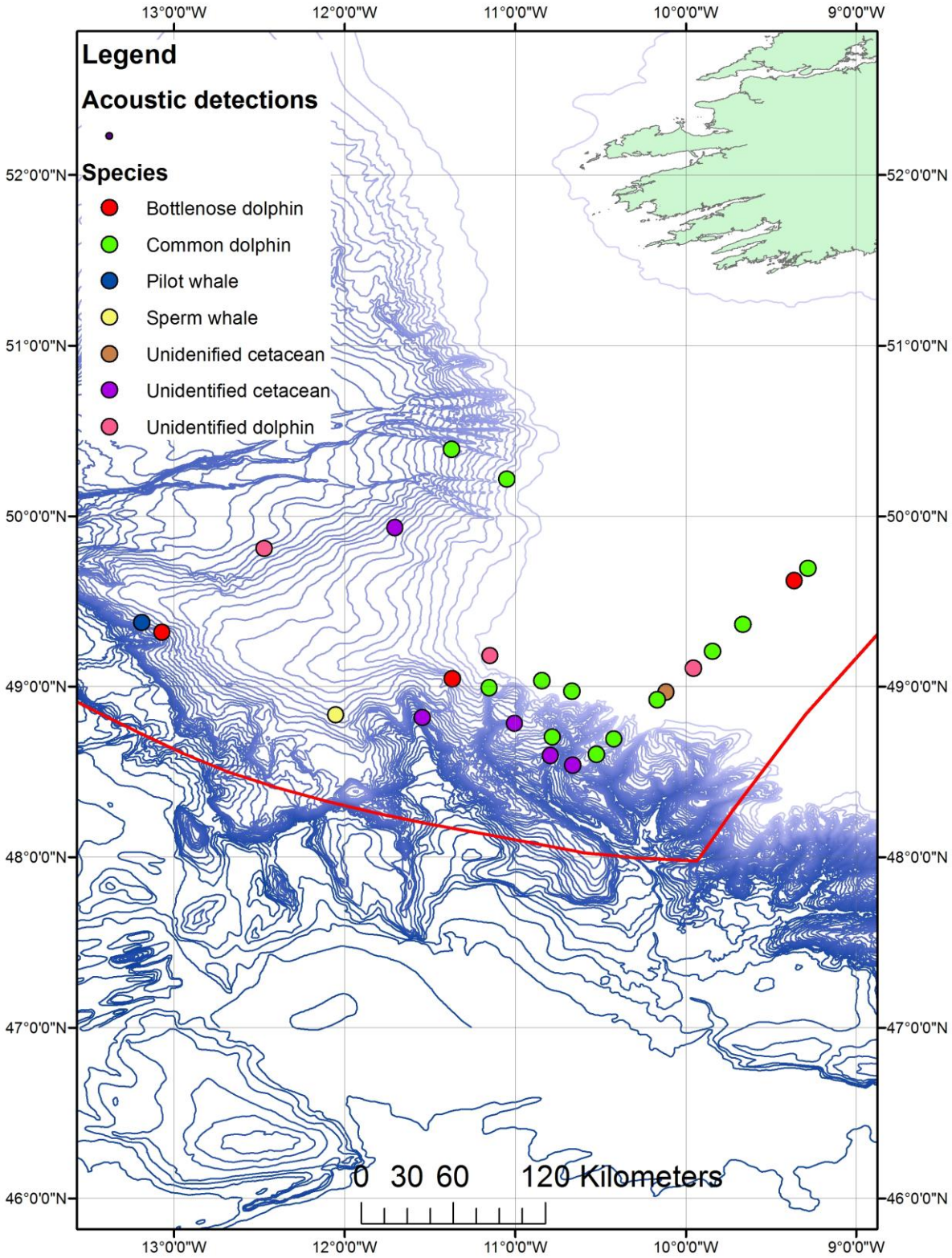

Figure 13. Acoustic detections recorded over the duration.

CETACEAN PHOTO-ID

The IWDG RIB was launched on three occasions for photo-identification and biopsy purposes. Following processing of these photographs, nine new bottlenose dolphin photo-identification images were obtained (Fig. 19). These images will be catalogued and available on the photo-identification section of the IWDG website (www.iwdg.ie).

Photo-identification images obtained during the encounter will be compared with existing catalogues of bottlenose dolphin fins from Ireland and Europe in an attempt to determine whether these are part of an inshore population, a resident group (e.g. Shannon Estuary) or are from a distinct population of offshore dolphins. Pilot whale encounters led to the identification of 15 individuals (Fig. 15), and a total of 5 bottlenose dolphins were identified (Fig. 14).

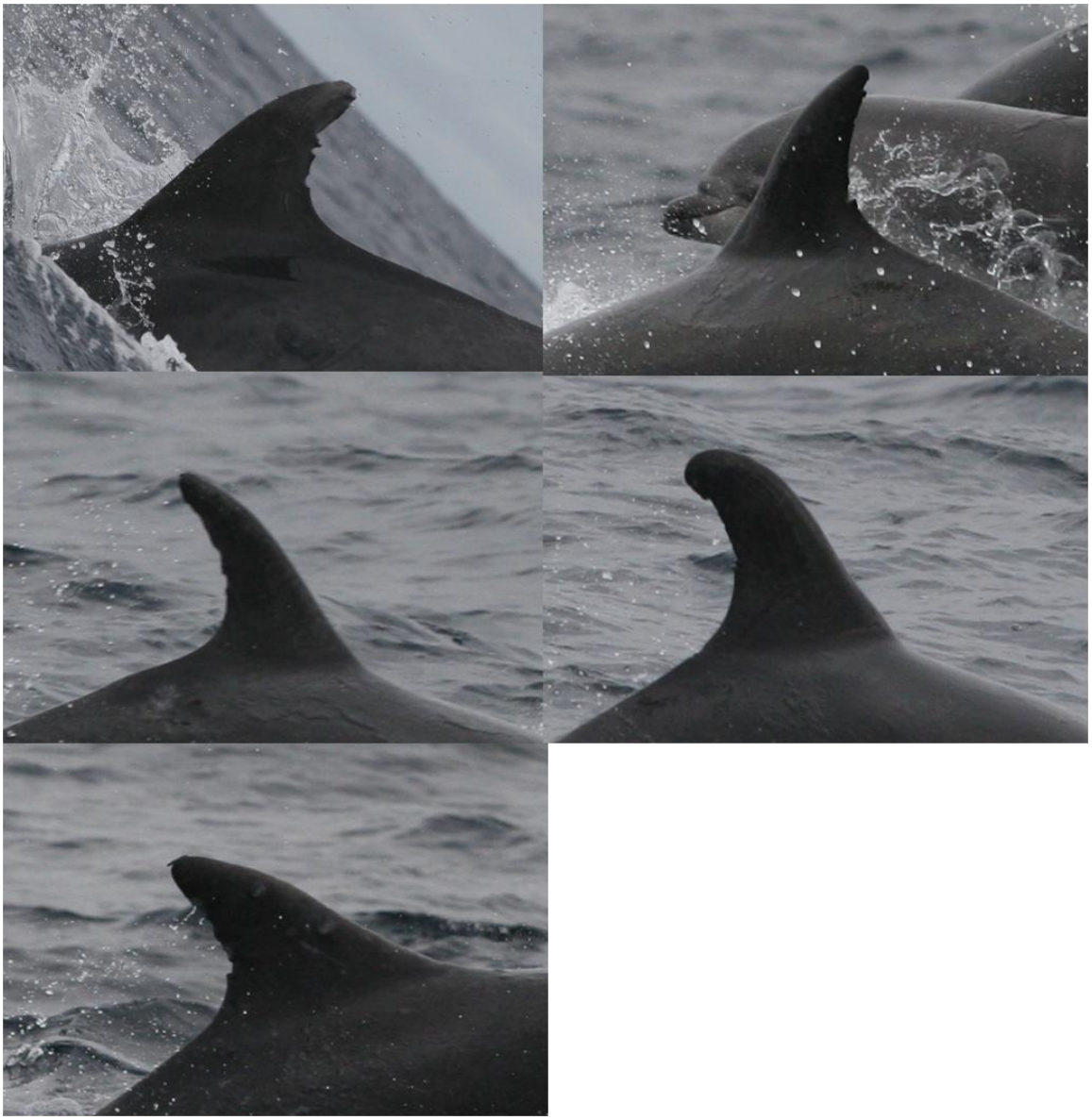

Figure 14. Bottlenose dolpin photo-identification images

Figure 15. Pilot whale photo-identification images

CETACEAN BIOPSY SAMPLING

A trial launching of the RIB was carried out in Cork Harbour on 24 February. The RIB was first launched offshore on 25 February at 16:20 when a mixed pod of bottlenose dolphins and pilot whales was sighted. The bottlenose dolphins disappeared however the pilot whales interacted with the RIB providing good photo ID opportunities. The first biopsy attempt was made at 13:00 on 27 February in a swell height of 2 to 3m and sea state 2. One skin and blubber biopsy was taken from an adult bottlenose dolphin among a group of 30. After several approaches, further sampling attempts were called off as the entire pod was exhibiting avoidance behaviour with long dives and unpredictable surfacing. On 28 February at 15:00 the RIB was launched to attempt to sample a group of bottlenose dolphins numbering (n=20). Three shots were fired however no samples were obtained. Conditions were challenging as the swell was 3m and sea state 3, making the dolphins difficult to track. The third and final biopsy attempt was made on 1 March at 14:40 when a group of 4-5 fin whales were sighted. The swell was between 3 and 3.5m with a sea state 2. Three close encounters were made and two shots fired, however no samples were obtained as the animals were difficult to approach, travelling at about 10 knots over the course of 7.5 nautical miles.

SEABIRD SURVEY

A total of 54hr 30mins of seabirds-at-sea survey data was gathered over a seven day period from 25th February to 2nd March, 2012. On all but one day weather conditions were exceptional for February allowing good species detection. Thirteen species were recorded including 3 terrestrial birds. The transect route covered a range of depths and bathymetric features, e.g. continental shelf, shelf edge, canyons, and abyssal plains. Each survey day travelled over one or more of these features and the numbers of birds appear to reflect some of these features.

Northern gannet and black-legged kittiwake comprised approximately 90% (n=5,350) of all birds observed on the survey transects. Fulmars, great skua, and Lesser black-backed gulls account for the majority of the remaining observations. Small numbers of puffin were recorded along with single observations of Manx shearwater, sooty shearwater, yellow-legged gull, and the very rare black-browed albatross. The species accounts are as follows:

Table 2**:** Total numbers of birds for the seven survey days (25th February-02nd March) for the six most observed species.

Day	Date	Effort (hr:mins)	Northern gannet	Northern fulmar	Great Skua	Black-legged kittiwake	Lesser black-backed Gull	Atlantic puffin
1	25/02	07:50	678	39	21	517	49	11
2	26/02	09:50	715	48	24	319	4	0
3	27/02	07:50	976	83	52	624	4	0
4	28/02	08:30	46	41	30	172	0	1
5	29/02	08:45	68	60	11	140	0	1
6	01/03	07:20	763	118	11	207	17	1
7	02/03	04:30	37	6	0	88	0	0
Total observations			**3283**	**395**	**149**	**2067**	**74**	**14**

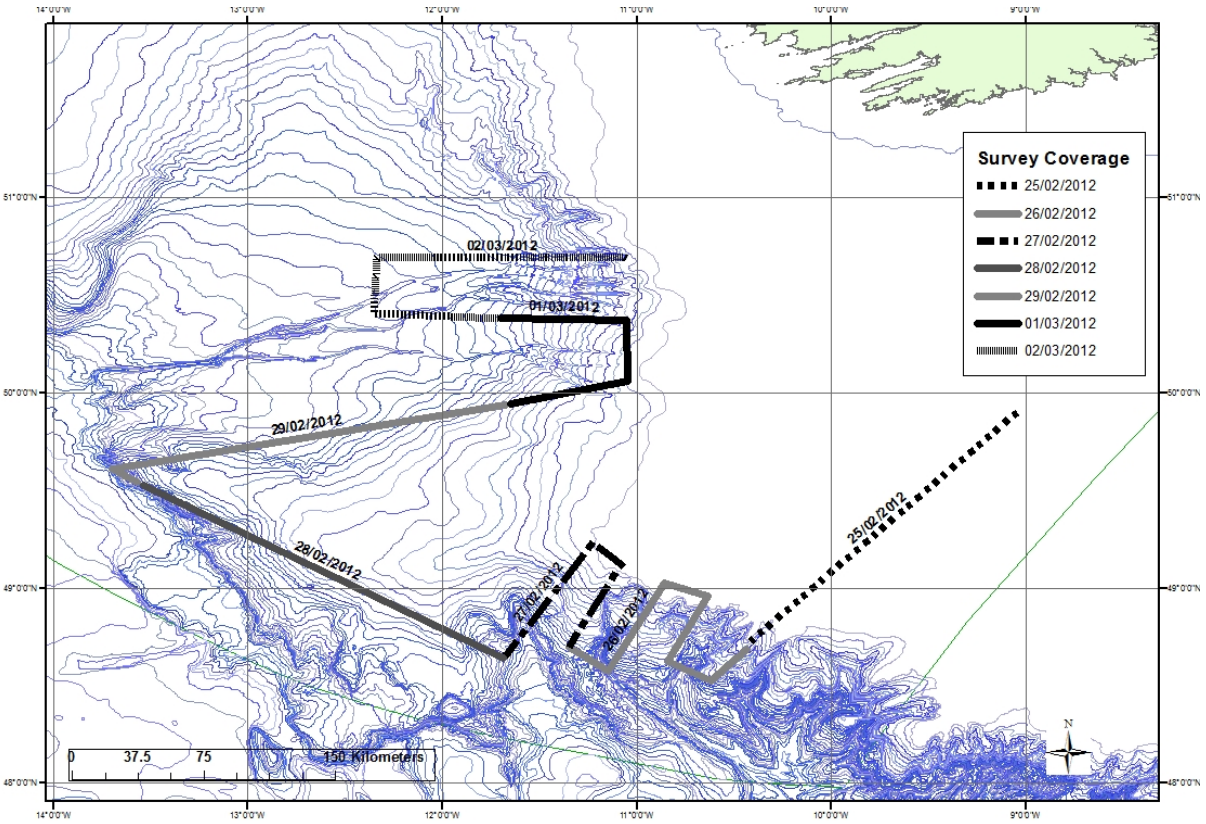

Figure16: Map of survey coverage between February 25th and March 2nd, 2012

SPECIES ACCOUNTS

BLACK-BROWED ALBATROSS (THALASSARCHE MELANOPHRIS)

An immature black-browed albatross was seen at 11:40am, approximately 160 nautical miles south west of Mizen Head (49°44.2 N, 12°54.9 W). It made two passes in front of and alongside the R.V. Celtic Explorer at a range of 100m during which time it was photographed (Photo 1). Although difficult to age accurately in non-adult plumages, it is likely that this individual was in its 2nd or 3rd year.

Black-browed albatross is an extremely rare vagrant in European waters with just 11 land based records and a single additional 'at-sea' record accepted by the Irish Rare Birds Committee (IRBC) to date (Irish Rare Bird Committee 2009). All previous records of black-browed albatross in Ireland have occurred between August and October with the exception of a single observation in May. As such, this will be the first February record, pending acceptance by the IRBC.

Photo 1: Black-browed Albatross © Conor Ryan

NORTHERN FULMAR (FULMARUS GLACIALIS)

A total of 395 northern fulmars were recorded over the seven survey days (Table BX). The highest daily total (n=118) was on the 1st March at the southeast corner of the Porcupine Seabight (Figure 16). The highest single count was of 54 birds feeding on the carcass of a cuvier's beaked whale on 29th February. Mackey et al. (2004) found peak relative abundance of this species occurred in February. Similarly, Pollock *et al.* (1997) reported peak densities of fulmars from February to March, often in areas with sudden changes in bathymetry. The majority of fulmars encountered were light

morphs, but a total of 12 dark morph, 'blue' fulmars (3%, n=12) were also noted (Photo 2). In contrast, only one 'blue' fulmar was noted during the 2010 survey (Hall *et al.* in press).

Photo 2: Blue Fulmar © Lilian Lieber

SOOTY SHEARWATER (PUFFINUS GRISEUS)

A single sooty shearwater was seen on the morning of 1st March, approximately 180km south west of Mizen Head (Photo 3). The 2010 survey also recorded a single bird on 21 February (Hall *et al.* in press). Mackey *et al.* (2004) only recorded sooty shearwaters in the Atlantic west of Ireland between May and November, whilst Pollock *et al.* (1997) only recorded birds between July and October. Sooty shearwater typically move out of the area in autumn, to breed in the southern hemisphere. However, the waters west of Ireland are thought to be important as feeding grounds for non-breeders (Warham 1996).

Photo 3: Sooty Shearwater with a Gannet © Lilian Lieber

MANX SHEARWATER (PUFFINUS PUFFINUS)

A single manx shearwater was seen during the evening of 26 February, approximately 330km south of Mizen Head. Manx shearwaters are summer breeders and passage migrants in Ireland, when they are typically occur between March and September (Pollock *et al.* 1997). However, this species has been recorded as early as February during previous surveys (Mackey *et al.* 2004) and was recorded in low densities in March and April (Pollock *et al.* 1997)

NORTHERN GANNET (MORUS BASSANUS)

Northern gannet was the most recorded bird on the survey (n=3,283; Table 2). The majority of these birds (c.95%) were recorded on 25, 26, 27 February and 1 March. These are the dates when transects covered either continental shelf or the steep-sloping shelf edge (Figure 16). The large majority of gannets recorded were adult or near-adult (4th-winter) birds. A small proportion of immature age classes were noted, consisting mostly of 2nd-winter & 3rd-winter birds, however, five 1st-winter birds were seen on the 27 February (Photo 4). Gannet was found to be one of the most numerous species in Irish waters by both Pollock *et al.* (1997) and Mackey *et al.* (2004). About 60% of the East Atlantic population of Gannet nests in Britain and Ireland (Wernham *et al.* 2002). During the winter months gannets are widely dispersed, some remaining in Irish waters while others (particularly immature birds) migrate south as far as west Africa (Cramp *et al.* 1974), before beginning to return to breeding colonies in January (Pollock *et al.* 1997).

Photo 4: 1st-winter Gannet © Lilian Lieber

LAPWING (VANELLUS VANELLUS)

Two migrant lapwing were seen associating with the survey vessel on the morning of 26th February, approximately 290km south of Mizen Head (Photo 5).

Photo 5: Lapwing © Lilian Lieber

GREAT SKUA (STERCORARIUS SKUA)

A total of 149 Great skuas (Bonxie) were recorded during the 2012 survey (Table 2; Photo 6). Numbers were highest in the southern part of the survey area and noticeably greater than those found during the 2010 survey (Hall *et al.* in press). The highest daily total was recorded on 27 February with 52 birds. Kleptoparasitic attacks by this species on black-legged kittiwakes were observed on only a handful of occasions but the association between great skuas and feeding flocks/aggregations of gulls was often quite apparent.

Great Skua was the most common Skua species recorded by both Pollock *et al.* (1997) and Mackey *et al.* (2004). While the data from this survey has yet to be analysed, it is likely that, for February, Great Skua have been recorded in both higher abundance and density than the surveys of Pollock and Mackey. Great Skua is a migratory species moving north in Spring to their breeding grounds (Pollock *et al.* 1997). Almost 60% of the NE Atlantic population breeds in Shetland and Orkney, but a few pairs have recently been discovered breeding in west Ireland (Mitchell *et al.* 2004).

Photo 6 Great Skua © Lilian Lieber

LESSER BLACK-BACKED GULL (LARUS FUSCUS GRAELLSII)

A total of 74 lesser black-backed gulls were recorded during the 2012 survey (Table 2), usually in singles or small groups and consisted entirely of adult birds except for one immature. The majority of these (n=49) were recorded on the continental shelf on 25 February (Figure 16). Hall *et al.* (in press) found that flocks of lesser black-backed gulls associated with the survey vessel during periods of bad weather, however, in 2012 this did not seem apparent. Lesser black-backed gulls move north from their wintering grounds between mid-February and early April (Hutchinson 1989), and are widely dispersed south of Ireland in spring (Pollock *et al.* 1997).

YELLOW-LEGGED GULL (LARUS MICHAHELLIS)

A 4th calendar-year yellow-legged gull (Photo 7) was seen associating with the survey vessel for most of the evening on 1 March (approximately 180km south west of Mizen Head) during which time we had broken track to follow a group of fin whales in order to attempt biopsy and photo-ID. It was also seen surface-feeding on fish in the company of black-legged kittiwakes. Yellow-legged gull is a scarce passage migrant and winter visitor in Ireland with the majority of records coming from the east and south coasts. This record is noteworthy, although (Pollock *et al.* 1997) recorded two individuals in May and July.

Photo 7: Yellow-legged Gull © Lilian Lieber

Black-legged Kittiwake (Rissa tridactyla)

Black-legged kittiwakes were the second most recorded bird (n=2,067) on the survey (Table 2). A high proportion of these were 1st-winter birds. Approximately 70% (n=1460) were recorded over the first three surveys days (25, 26 & 27 February; Figure 16) which appeared to coincide with the steep slopes of the shelf break and the top of these slopes on the continental shelf itself. Pollock *et al.* (1997) recorded the highest density of kittiwakes in February and March, whilst Mackey *et al.* (2004) also recorded a peak in abundance in February. Kittiwake is the most numerous gull breeding in Britain and Ireland (Wernham *et al.* 2002). Outside of the breeding season Kittiwake is distributed across the north Atlantic Ocean (Wernham *et al.* 2002).

Atlantic Puffin (Fratercula arctica)

A total of 14 puffins were recorded during the 2012 survey (Table 2). Eleven of these birds were found on the continental shelf on 25 February (Figure 16). Previous surveys in February found either low densities of puffins or none at all in the waters around Ireland (Hall *et al.* in press; Mackey *et al.* 2004; Pollock *et al.* 1997). In winter puffins disperse widely, adopting a pelagic lifestyle and are only found at low densities (Pollock *et al.* 1997). In late winter Puffin undergo a complete body moult (mostly between January and March), before returning to their breeding colonies (Harris & Yule 1977). This contrasts with other auk species which moult after the breeding season.

Skylark (Alauda arvensis)

Two skylarks were seen associating with the survey vessel on the morning of 26 February, approximately 300km south of Mizen Head.

Starling (Sturnus vulgaris)

A single starling was seen heading west over the survey vessel on 25th February, approximately 240km south of Mizen Head.

Plankton & Oceanographic Survey

While plankton samples taken at each station were a total sample of a water-column, casual observations of differences in plankton composition by bathymetry of station can be made. Stations with a deeper maximum depth contained taxa such as *Gigantocypris sp.* ostracods and swimming sea-slugs, as well as small, translucent, bony fish which will be identified at a later date. At shallower stations, copepods and euphausiids were prominent in their dominance of samples. Some gelatinous zooplankton were recorded in most samples, the majority being salps, while some hydromedusae were also noted. While no scyphozoans were sampled, this is not entirely unpredicted by the appearance of adult medusae of *P. noctiluca*, for example, in Summer and Autumn. One example of a planktonic cushion star larva, and several decapod zoea were also present (Fig. 17).

Fig. 17: (Clockwise from top left) A decapod zoea © Derek McLoughlin. *Tomopteris septendrionalis* © Derek McLoughlin. *Gigantocypris sp.* © Lillian Lieber. *Acanthephyra pelagica* © Derek McLoughlin. Zooplankton sample from station 4 © Lillian Lieber. Zooplankton sample from station 1 containing Euphasiids © Lillian Lieber.

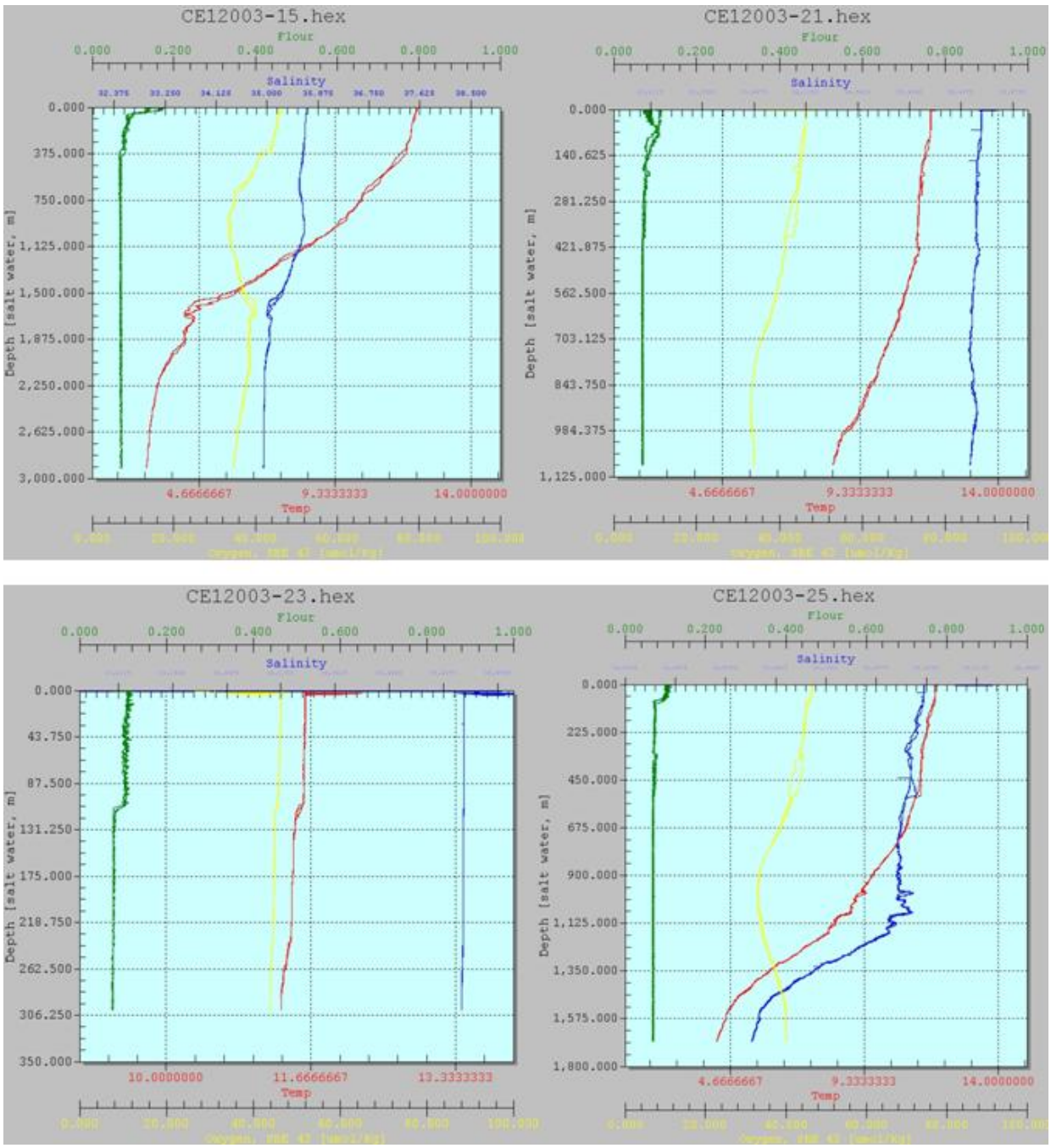

Figure 18: (Clockwise from top left) CTD profile showing data from station 15. CTD profile showing data from station 21. CTD profile showing data from station 23. CTD profile showing data from station 25.

BASKING SHARK SURVEY

During the entire survey, there were two unconfirmed sightings of a basking shark and one confirmed sighting shown in Fig. 19. The shark was sighted on the 28 February, 50m of the port side at 11.27am approximately 350km off the SW Irish Coast (Latitude: 40°01.021'N, Longitude: 12°.40.997'W).

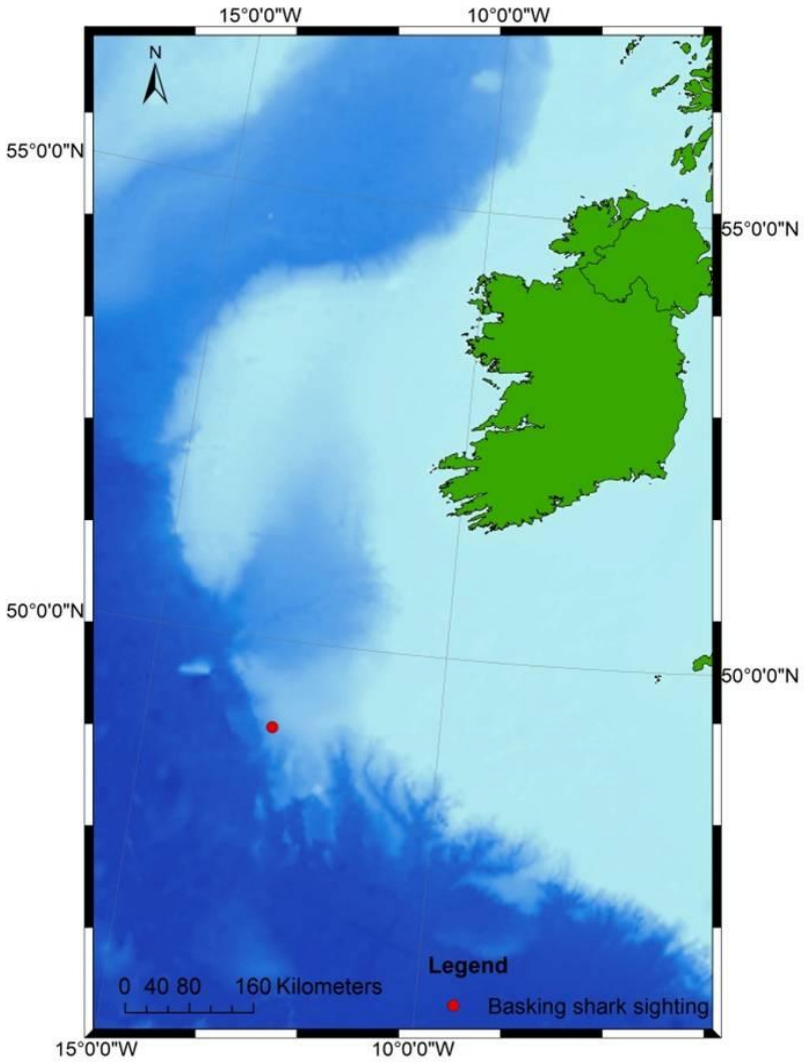

Figure 19. Basking Shark sighting, 28 Feb 2012.

DISCUSSION

This multidisciplinary cruise was designed to maximize the use of ship time by simultaneous surveys for cetaceans (acoustic and visual), seabirds and basking sharks during daylight hours, and back-tracking at night for plankton sampling. Other data were collected concurrently including EK60 sounder data, fluorometry, sea surface temperature and salinity. These data, along with bathymetric covariates (slope angle, slope direction and depth) will be useful in modeling those drivers of top predator (seabirds and cetaceans) distribution and abundance once sufficient temporal and spatial spread of observations have been achieved. The data collected in the current cruise will also provide continuity in long-term monitoring of both cetaceans and seabirds towards meeting Ireland's monitoring obligations under the EU Habitats and Birds Directives. Since the cessation of PReCAST, no coherent offshore cetacean survey programme has been put in place. As such, annual dedicated cetacean surveys such as the Cetaceans on the Frontier series will be critical in ensuring continuity in the Irish cetacean monitoring dataset.

Results from the seabird survey can be analysed to provide density and abundance estimates for the survey area. This data can be combined with existing seabird population data to describe patterns of seabird distribution in Irish frontier waters. Importantly, this data can also be combined with cetacean sighting data, plankton data and physical geographical data to give detailed insights into the distribution patterns of these top predators. The generation of this data is central to informing our understanding of the Irish marine ecosystem and is also essential in terms of bird conservation in marine areas. Currently, seabirds are protected largely at their breeding colonies, however, under the "Birds" Directive (79/409/EEC) Ireland is obliged to protect all migratory birds and their habitats. By gathering baseline data on seabird populations away from their breeding colonies, important foraging and moulting areas may be identified. Such data can be used in the protection of the migratory seabirds away from their breeding sites.

During this cruise, we carried out the first biopsy attempt for any cetaceans in offshore waters within the Irish EEZ (to our knowledge). While only one sample was taken, this will be very helpful in addressing the existence of a distinct offshore bottlenose dolphin population in Irish waters. One of the most important results of these biopsy attempts was that the approach adopted was workable. This study has proven that conducting offshore biopsy sampling in Irish waters, even during late winter from the state research vessel *R.V. Celtic Explorer*, from a small deployable RIB is feasible. Future offshore biopsy surveys would facilitate national and international research projects ongoing in the Marine Institute (Brendan McHugh), GMIT and the Irish Whale and Dolphin Group,

particularly if carried out during summer where both weather conditions and abundances of cetaceans would be more conducive to biopsy sampling.

ACKNOWLEDGEMENTS

We would like to thank Captain Denis Rowan and the crew of the *R.V. Celtic Explorer* for their help and professionalism during the course of this survey. Their skill was instrumental in us achieving previous unaccomplished goals in offshore waters. To Aodhán Fitzgerald, Barry Kavanagh, and Conor Cooney for their assistance during the planning of the survey.

Special thanks to Dr's Simon Berrow and Cillian Roden for their assistance in organization of equipment.

This survey on the R.V. Celtic Explorer was granted to GMIT/IWDG through the National Marine Research Vessels Ship-Time Grant Aid Programme 2010, which is funded under the Science Technology and Innovation Programme of National Development Plan 2007-2013.

Biopsy Sampling was carried out under licence from the National Parks and Wildlife Service: Derogation for Bottlenose dolphins beyond the 12 nm limit (DER/Dolphin2012-10) and for all waters within the Irish EEZ to sample various species of baleen whale (C159/2011).

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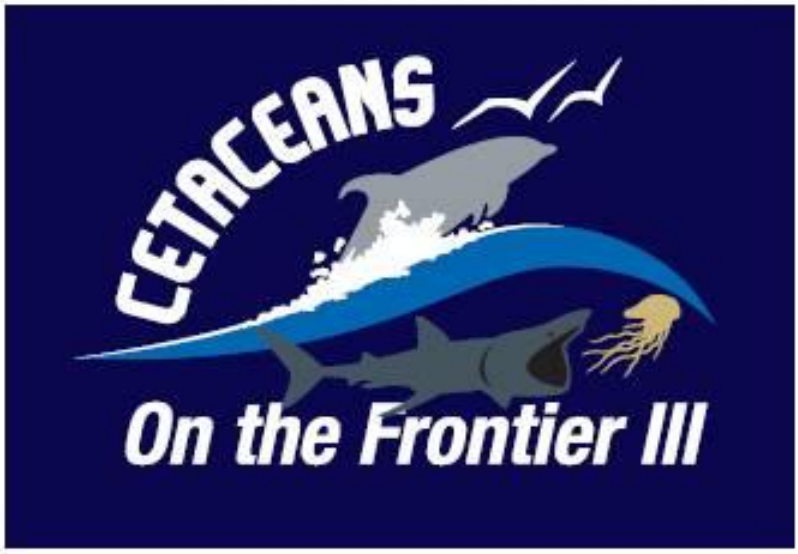
APPENDIX

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

Atlantic White-Sided Dolphin	*Lagenorhynchus acutus*
Beluga	*Delphinapterus leucas*†
Blue Whale	*Balaenoptera musculus*
Bottlenose Dolphin	*Tursiops truncatus*
Common Dolphin	*Delphinus delphis*
Cuvier's Beaked Whale	*Ziphius cavirostris*
False Killer Whale	*Pseudorca crassidens*
Fin Whale	*Balaenoptera physalus*
Gervais' Beaked Whale	*Mesoplodon europaeus**
Harbour Porpoise	*Phocoena phocoena*
Humpback Whale	*Megaptera novaeangliae*
Killer 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



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