MARINE MAMMAL MONITORING IN BROADHAVEN BAY
JUNE – SEPTEMBER 2005

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COASTAL AND MARINE RESOURCES CENTRE
ENVIRONMENTAL RESEARCH INSTITUTE
UNIVERSITY COLLEGE CORK
IRELAND
MARINE MAMMAL MONITORING IN BROADHAVEN BAY
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SUMMARY

This report summarises the results of an ongoing marine mammal monitoring programme in Broadhaven Bay Special Area of Conservation (SAC). The work was conducted due to the proposed installation of a gas pipeline from the Corrib gas field and followed the successful implementation of a baseline monitoring project in 2001-2002 (Ó Cadhla et al., 2003), by the Coastal and Marine Resources Centre (CMRC), University College Cork.

Main objectives of the research project

- To provide an assessment of cetacean occurrence and habitat use in the waters of Broadhaven Bay SAC based on results from visual and acoustic surveys.
- To collaborate with the National Parks and Wildlife Service and RSKENSR Environment Ltd. in the development of a monitoring plan and of methods to minimise any impact of construction activities on marine mammals during the period of marine construction work.
- To further contribute to the international knowledge-base on marine mammals on the Irish west coast.

Due to interruptions in planned construction works, the pipeline was not installed in 2005. However, field research continued and contributes to the baseline study initiated in 2001-2002. A brief summary of key findings obtained by the CMRC research team is presented below.

Visual monitoring

- A total of 281 hours (on 46 separate days) of dedicated cliff-based surveys were carried out between June 12th and September 30th, 2005.
- The same period in the baseline study of 2002, totalled in 193.6 hours of cliff-based observation (on 28 days). However, the previous study additionally included 54.5 hours of boat based effort, resulting in 248.1 hours of total survey effort.
- Although the level of survey effort in 2005 exceeded that of 2002, marine mammal sighting rates were lower in 2005 (0.35 per hour) compared to 2002 (0.61 per hour). Most noteworthy was the much lower level of harbour porpoise sightings recorded (24% less per hour).
- Less favourable weather conditions experienced in 2005 may provide some explanation to the lower sighting rates found. A larger proportion (21%) of total survey effort took place in higher sea-states (four or above) in 2005 compared to 2002 (5%).
- Since vessel-based surveys were excluded in 2005 there was no opportunity of photo-id of bottlenose dolphins. To include photo-id is considered vital for future survey efforts.

Acoustic monitoring

- Acoustic equipment was deployed in Rossport Bay, operating satisfactorily from June 24 to September 30, resulting in a total of 99 days of acoustic surveillance in 2005. The same period in 2002 totalled in 86 days of surveillance.
- Harbour porpoises were detected acoustically in all months of deployment for both survey periods with detections made on 30 days in 2005 and on 17 days in 2002. This resulted in a detection rate of 0.032 minutes per hour in 2005 and 0.011 minutes per hour in 2002.
- Dolphins were only detected acoustically on two days in September 2005 and previously on three days in July and in September of 2002.
- All acoustic detections recorded in 2005 took place during the night or at other times when visual observation was not in place due to weather constraints.
- The higher detection rates in 2005 suggest that the presence of harbour porpoises in particular may have been overlooked by the observers and it is suggested that the use of acoustic methods need to be incorporated and expanded for continued survey effort.
1. INTRODUCTION

1.1 Background

A marine mammal monitoring programme was resumed in June 2005 in Broadhaven Bay, County Mayo, conducted by researchers from the Coastal and Marine Resources Centre (University College Cork). This work was carried out due to the planned construction of a gas pipeline and followed the successful implementation of a monitoring programme two years earlier (Ó Cadhla et al., 2003). This report describes marine mammal occurrence, distribution and movements within Broadhaven Bay Special Area of Conservation (SAC) recorded during the summer and autumn of 2005 and additionally includes comparisons with selected results of the study undertaken in 2001-2002.

Dedicated research into the distribution and numerical abundance of marine mammals in coastal and offshore Irish waters (e.g. Gordon, et al., 1999; Ó Cadhla et al., 2004, Pollock et al., 2000), together with historical data (Fairley, 1981) and voluntary records from the Irish Whale and Dolphin Group (IWDG – Berrow et al., 2001) have highlighted the potential importance of the waters of northwest Mayo for cetaceans (whales, dolphins and porpoises) and seals. Previous to the present study and baseline research in 2001-2002 (Ó Cadhla et al., 2003), very little was known about any details of cetacean distribution in these inshore waters.

Cetaceans are afforded protection within the 200-mile Exclusive Fishery Zone (EFZ) limit of the Irish State under the 1976 Wildlife Act and a 1982 amendment to the Whale Fisheries Act, a zone that was declared a whale and dolphin sanctuary in 1991 (Rogan & Berrow, 1995). Marine mammal legislation also protects all cetaceans as Annex IV species (species of community interest in need of strict protection) under the European Habitats Directive. Within this directive, there are five marine mammal species known to frequent Irish waters, and these are further listed as Annex II species (protected endangered and vulnerable animals), namely; bottlenose dolphin (Tursiops truncatus), harbour porpoise (Phocoena phocoena), grey seal (Halichoerus grypus), harbour/common seal (Phoca vitulina vitulina) and European otter (Lutra lutra). A more detailed description of legislation concerning particular species found off the west coast of Ireland and in the North Atlantic is provided in Appendix I of this report.

Broadhaven Bay was designated by the National Parks and Wildlife Services, Dept. of the Environment, Heritage and Local Government (NPWS) as a candidate Special Area of Conservation (cSAC) in 2000. This designation concerns (i) the presence of four key marine/coastal habitat types that are listed in Annex I of the EU Council Directive on the Conservation of Natural Habitats and of Fauna and Flora (Habitats Directive: 92/43/EEC, 1982), including Atlantic salt marsh, tidal mudflats, reefs and large shallow bays; (ii) the presence of a number of unusual marine communities and species, and; (iii) the seasonal presence of wintering wildfowl and breeding terns (Sterna spp.). Further more, the inner part of Broadhaven Bay known as Rossport Bay is designated as a Special Protection Area (SPA) and is together with the nearby Glenamoy Bog complex SAC important for wintering wildfowl species, in particular for Brent Goose (Branta bemicla), an Annex II species, listed under the EU Birds directive.

Marine construction work may cause environmental impacts on marine mammals in different ways. For the installation of a gas pipeline these impacts may occur before construction (e.g. during seismic surveys) as well as during trench digging or pipe-laying. Some impacts can be minimised, through care in site selection, construction design and operational planning. The implementation of a marine mammal monitoring scheme during various phases of construction work can be used to evaluate any impact on the marine environment and on marine mammals.
The marine construction work planned to take place in Broadhaven Bay concerns a sub-sea gas pipeline to be brought ashore from its source, 65 km offshore and laid down in a dredged trench through Broadhaven Bay, making landfall at Dooncarton in Rossport Bay (Fig. 1). The details of marine construction works are described in a monitoring plan set up by CMRC and RSKENSR. (Watson, 2005). Construction activities in 2005 were to include dredging, transportation of excavated sediment and rock-breaking. The work was to be carried out continuously, day and night for seven days a week when weather conditions allowed. All work was to be completed in a maximum of eight weeks, beginning in late May 2005.

RSKENSR Environment Ltd. commissioned the present study to examine and mitigate the potential impact of construction activities from the installation of the gas pipeline on marine mammals in Broadhaven Bay SAC. The study was conducted by a team from the CMRC Marine Mammal and Seabirds Group and took place from the 12th of June to the 30th of September, 2005.

1.2 Research objectives

The main objective of the study was to develop and implement a marine mammal monitoring programme in Broadhaven Bay during the pre-, during- and post-construction periods of pipeline installation. The objectives and approach to the study were worked out in consultation between the CMRC and RSKENSR Environment Ltd. (Watson, 2005). The resulting monitoring plan provides some technical description of the work to be undertaken by the CMRC, while a thorough description of methods used can be found in a report covering monitoring in 2001-2002 (Ó Cadhla et al., 2003).

The core objectives of the research project were to:

- Provide an assessment of cetacean occurrence and habitat use in the waters of Broadhaven Bay SAC, based on results from visual and acoustic survey methods.
- Collaborate with the National Parks and Wildlife Service and RSKENSR in the development of a monitoring plan and of mitigation methods to minimise the impact of construction activities on marine mammals during the period of marine construction work.
- Further contribute to the international knowledge-base on marine mammals on the Irish west coast.

The pipeline proposed was not installed during 2005. Therefore, the pre-, during- and post-construction investigations were not made as originally planned. The survey results instead represent a follow up of the baseline monitoring work performed in 2001-2002. The recommendations made in the final stages of this report (Section 5) use this baseline information to suggest further modifications to the existing monitoring plan, necessary mitigation measures and areas of further research.
2. MONITORING METHODS

Field methods included the use of elevated land-based sites for visual observation in combination with underwater deployment of passive acoustic devices. Passive acoustics enable extended monitoring effort during times when effective visual monitoring is not possible (e.g. in poor weather conditions or at night). Boat line-transect surveys and photo ID of bottlenose dolphins were planned but cancelled due to the change in construction work.

2.1 Visual survey methods

Visual observation from elevated sites on the shore or from boats is commonly used for monitoring of marine mammals in coastal areas. Due to the surface behaviour of marine mammals it is possible to locate, identify and follow many species using telescopes and other optical equipment.

2.1.1 Study area and observation sites

Broadhaven Bay is situated on the north-west coast of County Mayo. The bay opens northward, stretching between Erris Head on the west side and Kid Island on the east, with approximately 8.6km in between (Fig. 1). As in the study of 2001-2002, the present study incorporated the waters of Broadhaven Bay and the waters outside of the bay to approximately 10km off the coast.

A series of suitable sites were identified and used in the study of 2001-2002 (Ó Cadhla et al., 2003). These were selected because of their suitability for cliff-based observation, in particular in regard of height above sea level and the view they offered over the survey area. In order to ensure comparability of data, the same observations sites and methods were used in the survey of 2005. The primary site at Doonanierin Point was situated close to Rossport Bay and thus provided an excellent view over the central to eastern bay area and over the proposed location of the landfall site for the pipeline and thus of the main area of marine construction work. The other primary observation site used (Gubastuckaun) was located in the vicinity of Erris Head providing an excellent vantage point for monitoring marine mammals entering or leaving the centre to west bay area.

2.1.2 Data collection

Shore watches were conducted using the same type of equipment as in the study of 2001-2002. A telescope (Kowa) equipped with a 32x wide-angle eyepiece and a pair of 10x50 binoculars (Minolta) were used for scanning the survey area. A digital surveyor’s theodolite (Sokkia) was used at the Doonanierin site to derive accurate positions of sighted animals and to track their movements around the bay area. Range and bearing to animals sighted from the Gubastuckaun site were instead derived from the use of compass bearings and manual distance estimates by the observers. For a more detailed description of methods used, see Ó Cadhla et al., 2003.

Shore watches consisted of regular scans of the visible survey area using the telescope and binoculars (Plate 1). Each scan lasted for 60 minutes or for as long as was required to thoroughly scan the area (depending on weather and light conditions, and on the time needed for species identification). Shore watches were continued in this way for as long as daylight and weather conditions permitted. Prolonged tracking of sighted animals were attempted in the intervals between scans to provide information of animal movements within the bay area but were not allowed to influence upon the active scanning sessions. Additionally, sighting information was communicated between the sites to ensure observers were working in a coordinated manner.
Figure 1. Map showing Broadhaven Bay SAC (outer limit of the SAC indicated with a dotted line) with the eastern and western limits approximately 12.4km apart. The two primary observation sites Gubastuckaun and Doonanierin Point and the secondary site at Brandy Point are indicated with red circles.

Plate 1. Visual survey set-up at Doonanierin Point, showing an observer with telescope and a surveyor’s theodolite used for positioning of sighted animals.
2.1.3 Analysis of visual data

Visual survey data (i.e. sighting, effort and weather information) was compiled into a Microsoft Access database and analysed using Microsoft Excel and Instat software. Number of sightings was calculated per hour of effort (effort as summed duration of active scanning time) and averaged per month for comparative purposes. In order to enable comparisons between survey periods, data collected during the corresponding time period (June 12 to September 30) were utilised from the study of 2001-2002. Weather conditions, effort, sighting and acoustic detection data were compared in this exercise.

2.2 Acoustic survey methods

Acoustic survey methods provide an added advantage when conditions for visual survey methods are not ideal (Clark & Charif, 1998). Acoustic methods are particularly useful in the study of less obvious species that are difficult to observe in their natural environment. The most important example of such a species is the harbour porpoise, which exhibit particularly inconspicuous behaviour and is difficult to study in anything less than excellent conditions. Barlow et al. (1988) found that harbour porpoises spend about 23.9% of their time at or near the surface. Reed et al. (2000) calculated the percentage time spent submerged to be 89%. Animals which spend such long time periods submerged have a high probability of remaining undetected by land-based observers, resulting in an availability bias (Laake et al., 1997; Raum-Suryam & Harvey, 1998). Harbour porpoises are small, inconspicuous, generally surface without significant splashing, occur singly or in small groups and tend to avoid boats (Smith & Gaskin, 1983; Barlow, 1988; Raum-Suryam & Harvey, 1998). The probability of an observer detecting a harbour porpoise declines very rapidly as conditions deteriorate to higher sea states (Hammond et al., 1995) and in addition, the use of visual observations is restricted to daylight hours.

As cetaceans rely on sound for navigation, spatial orientation, communication and to locate their prey (Evans, 1973; Feruβ et al., 2005), there is a clear advantage to using acoustic detection methods in combination with visual techniques. At times when visual monitoring is hampered, acoustic monitoring can continue to operate regardless of weather or light conditions, and can therefore provide insights into the ecology of cetaceans not attainable by other methods (Clark & Charif, 1998).

Cetaceans produce a wide range of sounds, from the very low frequency calls of large whales, via mid frequency whistles of dolphin species to high frequency echolocation or sonar produced by odontocetes (toothed whales, dolphins and porpoises), with for example, the harbour porpoise echolocating around 110-150kHz. Echolocation signals from dolphins and porpoises are particularly well-suited for detection with specialised acoustic techniques. Echolocation is a highly directional, pulsed sound of high acoustic intensity (measured in decibel, dB) and normally emitted in click sequences recognized as click trains. These are emitted within very short time units (i.e. microseconds) and the reflected sound is received and interpreted by the animal through a complex auditory system (Richardson et al., 1995; Au, 2000). Equipment has been developed to listen for and log the incidence of such sounds and some can be left unattended in detection mode over extended periods of time.

Dolphins generally emit clicks that are short in duration and span over a wide range of frequencies, while clicks from harbour porpoises are longer, more narrowband and with a higher peak frequency (Fig. 2). These differences in properties of dolphin and porpoise clicks make it relatively uncomplicated to distinguish between the two. However, it is not yet quite as easy to distinguish between different dolphin species.
2.2.1 Acoustic equipment
Acoustic techniques have previously been used in monitoring of marine mammals in Irish waters (e.g. Gordon et al., 1999; Scali et al., 2002; O Cadhla et al., 2003; Aguilar de Soto et al., 2004). The acoustic equipment used in this study, T-PODs (Baines et al., 1999; Tregenza & Northridge, 1999), select tonal clicks resembling those emitted by echolocating cetaceans and log the time and duration of each such click to a resolution of 10 microsecond units. In contrast to conventional hydrophones often used in acoustic monitoring, the actual sound is not stored. The T-POD is set to perform six successive “scans” every minute. Each such scan lasts for 0.3 seconds and can be set to select clicks based on different criteria, thus making it possible to survey for different species and for sources of noise such as boat-sonar. Furthermore, any changes in battery voltage, deployment angle and system noise is additionally logged and saved in the memory of the units.

2.2.2 Deployment methods and data collection
Three T-POD units were deployed in Rossport Bay (Fig. 3). The exact same locations were used as in 2001-2002 and the equipment was left unattended for up to two months and retrieved twice during the survey period. Since the equipment has a theoretical range for detection of harbour porpoises of approximately 500 metres, the listening stations were placed close enough so that any echolocating porpoise or other cetacean entering or leaving the bay area would be likely to be detected.
2.2.3 Analysis of acoustic data

Data from T-PODs are downloaded to a computer and analysed using dedicated software (tpod.exe - www.chelonia.demon.co.uk). The software runs through the logged data and examines it for patterns that are characteristic of echolocation signals of cetaceans (i.e. click-trains). Those identified are separated into four classes as being more or less likely to be of cetacean origin. For these, “Cetacean High” and “Cetacean All” are the two classes normally used in analysis. Two lower classes, “Doubtful” and “Very Doubtful” are likely to be genuine detections if found close to higher classified trains. However, in order to minimise the risk of including false positive detections, these are not used for the analysis in this study.

A measure of harbour porpoise and dolphin occurrence was calculated using Detection Positive Minutes, DPM (i.e. any minute during which at least one cetacean click-train was detected). The use of DPM thus provides a minimum estimate of cetacean occurrence in minutes per hour of listening effort. Since the software used for extraction and analysis of acoustic detections has been modified and improved since the analysis made in 2002, those files collected during the previous study were computed yet again using the latest version of the software. DPM was used for this data-set as well, instead of the measure of Encounter Rate that was used in 2001-2002 (Ó Cadhla et al., 2003). The decision to use DPM was based on acoustic studies showing this measure to be superior for the study of cetacean habitat use (e.g. Teilmann et al., 2002). Encounter rate tends to be dependant on the time frame chosen to isolate distinct encounters. The use of DPM, (which is related to absolute effort), is considered as a more objective measure. All detections were verified manually through visual inspection, an action that is particularly important regarding times of low DPM values within the hourly time frame. This is because of the greater likelihood that such detections could occur by chance. In contrast, higher DPM values (2+ per hour) are more likely to be valid detections and less likely to occur by chance, and thus only such detections were included in the analysis.
Figure 4. Examples of *tpod.exe* screen with the top showing the colour coding of click-trains classified into Cetacean Hi and All (used in analysis) as well as Doubtful and Very Doubtful trains (not used). Below is an example showing the same time period and detections made but with colour coding representing the six channels or scans. Porpoise detections are shown as pink, blue, magenta and white and dolphin detections in green and yellow.
3. VISUAL OBSERVATION - RESULTS AND DISCUSSION

3.1 Visual survey effort

Shore-based monitoring commenced on June 12th and finished on September 30th, 2005. In total, the research team conducted cliff-based monitoring on 46 days during this period (i.e. 41.4% of the survey period). This included a total of 60 watches, with 191.7 hours with observers present at the cliff-site of Doonanierin Point, 185.0 hours at Gubastuckaun and 3.3 hours at Brandy Point. Out of this time, a total of 281.2 hours were spent actively scanning the survey area. The majority of survey effort was achieved in August (100.7 hours) and in July (79.8 hours), less in September (56.8 hours) and the least in June (43.9 hours).

Cliff-based survey effort achieved in 2005 was 31% higher than during the same period in 2002 (193.6 hours) and only in the month of July did the effort of 2002 exceed that of 2005 (Fig. 5). While no boat-based effort took place in 2005 the survey of 2002 included 54.5 hours of line-transect surveys, resulting in a total of 248.1 hours of survey effort. The vessel-based effort of 2002 took place in July (51%), August (38%) and September (11%). Effective simultaneous watching (i.e. time with at least one observer present at either of the primary observation sites), was possible for 51.7% of available survey time in 2005, and for 21.6% of available time in 2002. There were also finer scale differences in the weekly distribution of survey effort between the two survey years (Fig. 6).

![Figure 5](image_url)  
Figure 5. Graph illustrating the number of hours of observation per month (from the 12th of June until the end of September) of survey effort. Data from 2002 includes 54.5 hours of boat-based effort that took place in July and in August.

![Figure 6](image_url)  
Figure 6. Graph illustrating weekly effort in hours of monitoring of the two survey periods (data from 2002 includes 54.5 hours of boat-based effort).
Although proportionally, more time was spent on active cliff-based observation in 2005, there were important differences in prevailing weather conditions between the two survey periods. Most importantly, there were differences in the distribution of time relative to sea-states in which observations took place (Fig. 7a). In 2002, the majority (95 percent, fig 7b) of the monitoring was made in sea-states of three and below and therefore a very small proportion in sea-state above four, while in 2005, 21 percent took place in a sea-state of four or above. The effect of sea-state on the ability of an observer to detect the presence of a marine mammal is as mentioned well known and it is recognised that the ability to observe marine mammals decline rapidly in higher sea-states. For small inconspicuous species such as the harbour porpoises this decline is notable already in sea states above two (Hammond et al., 2002). Thus, to enable comparisons between the two survey periods and between other studies any survey effort achieved in a sea-state of four or above has been excluded from analysis, resulting in a total of 222 hours of effort in 2005 and 183.9 hours in 2002.

3.2 Marine mammal sightings

Marine mammals were sighted on 61% of available survey days (n=46) in 2005 and on 96% of available days in the same period of 2002 (n=28). A total of nine marine mammal species were recorded during the survey period, including seven species of cetaceans and two seal species. Sightings were recorded throughout the study area but with a majority occurring in the centre and outer parts of the bay (Fig 8). Further detail on the distribution of particular species is provided under separate species sections below.

Although the availability of comparable data from other sites on the Irish west coast is limited there are some examples. One four-month long study in Connemara (Co. Galway) showed a high occurrence of bottlenose dolphins and harbour porpoises, but on only one occasion was another species (common dolphins), sighted (Ingram et al., 2003). Another example is the Shannon Estuary, where the ecology of a resident population of bottlenose dolphins has been studied extensively. A combination of visual, acoustic and boat-based surveys has confirmed the residency of this species within the area (Ingram, 2000). Grey and harbour seals are also found in the estuary and harbour porpoises are occasionally observed but only in the autumn (unpublished data). Just outside of the Estuary, recent surveys (Ingram et al., 2005) have confirmed the occurrence of three further species (killer whale, Risso’s dolphin and grey seal). Similar surveys further south, in Bantry Bay (Rogan et al., 2003) have shown regular presence of harbour porpoises, minke whales and harbour seals.
So far, it is only in Broadhaven Bay that as many as 10 out of the 24 cetacean species currently known from Irish waters have been observed with any regularity. The high species richness and regular occurrence of marine mammals found in north-western Irish waters could partly be explained by the relative closeness to the shelf edge, known for its high productivity and marine mammal diversity (Ó Cadhla et al., 2004). Previous offshore surveys have also noted the importance of these regions to marine mammals (e.g. Fairley, 1981; Gordon et al., 1999).

Sighting results from 2005 compare well, at least in species diversity, to the results of the same period in 2002 (Table 1), in particular when effort in higher sea-states (four and above) have been excluded (Fig. 9). One additional species, the killer whale, had not been previously recorded in the area by the researchers, although this species was reported by local fishermen in 2002. Apart from this, two of the small dolphin species (white-sided and white-beaked) recorded in the 2001-2002 study were not identified in the area in 2005. It is possible that the presence of these two species could have been missed by the observers. The absence of vessel effort in 2005 is likely to have hampered the ability of observers to positively identify such small cetaceans at greater distances, particularly if they occurred in mixed species groups which were regularly recorded in 2002 (species composition of separate sub-groups was investigated through the use of the research vessel). There was one record of a river otter (Lutra lutra) in Rossport Bay in 2002, but no sightings of this species in the survey of 2005.

Both cetaceans and seals were shown to use most of the Bay area, including the inner parts (Fig. 8). Generally, patterns of occurrence were similar between the two survey periods (see Ó Cadhla et al., 2003). For example, Risso’s dolphins were observed in close proximity to the outer west side of the bay close to Erris Head, while minke whales were recorded mainly in the outer, deeper parts of the Bay area. Tracks showing the movement of observed marine mammals were not plotted in 2001-2002 and location of occurrence may be somewhat misleading as the data of 2005 is showing initial sighting positions as well as movements around the bay area. Any discussion regarding data from 2002 considers only initial positions recorded for each sighting. Initial sightings are therefore plotted for both survey years and presented in Appendix III.

Figure 8. Distribution of all initial marine mammal sightings recorded during the survey period of 2005 (n=66). Purple markers indicate positions of cetacean sightings (n=30), while turquoise markers symbolise sightings of seal species (n=36). Axis scales show Ordnance Survey of Ireland grid coordinates with each square representing 2x2 km.
Table 1. Summary of all marine mammal sightings in the study area between the 12th of June and the 30th of September, 2005 and in the baseline survey of 2001-2002. Group size range is also presented for all species.

<table>
<thead>
<tr>
<th>Species</th>
<th>Nr of sightings 2002</th>
<th>Nr of sightings 2005</th>
<th>Nr of animals 2002</th>
<th>Nr of animals 2005</th>
<th>Group size range 2002</th>
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<td>Minke whale (MI)</td>
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<tr>
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Figure 9. Sighting rates per hour of effort, excluding any effort undertaken in sea-state (SS) 4 or above.
A. Cetacean sightings

After the dataset was thoroughly examined for duplicates (see Ō Cadhla et al., 2003) and 12 such records were identified and excluded, a total of 30 distinct cetacean sightings remained (Table 1, fig. 10). The majority of initial sightings of cetaceans for which positions were obtained were observed within the SAC boundary (76% of positions recorded). The most commonly sighted cetacean species were bottlenose dolphins, which accounted for 27% of all cetacean sightings. The most rarely sighted species were the minke whale of which there was one single sighting in 2005. The highest daily sighting rates occurred in the months of July and August (Fig. 11).

As in the previous survey, some of the patterns observed in the distribution of marine mammals may be due to the location and nature of the observation sites used. However, for example in regard of the relatively easily recognized Risso’s dolphin, a concentration of sightings in the vicinity of Erris Head can not easily be explained solely by closeness to the observer as this species should be easily observed and identified at great distances due to size and presence of a prominent dorsal fin. As the same pattern of occurrence was observed in 2001-2002, this suggests that something else is controlling the distribution of this species.

A range of behaviours were observed in both survey periods, these included resting, travelling, foraging as well as social interaction for a number of cetacean species (details below in the species section). Foraging behaviours were observed in particular for minke whales in 2002 and for large groups of small dolphin species in both 2002 and 2005. Presence of calves within some groups of dolphins suggests that the region is used, at least partly, as a breeding/nursing ground during the summer months. In 2002, calves were observed in groups of common and white-sided dolphins and in 2005, again in groups of common dolphins but also within bottlenose dolphin groups. In general, cetacean sightings in 2005 were recorded on a flooding tide (Fig. 12). This was not evident in 2002 where more sightings were made at high or low tide.

![Figure 10. Sighting rates per species and per hour of total effort (excluding effort in sea-state 4 or above) comparing the two survey periods. (MI=minke whale, KW=killer whale, RD=Risso’s dolphin, BND=bottlenose dolphin, CD=common dolphin, WBD=white beaked dolphin, WSD=white sided dolphin, HP=harbour porpoise, Unid=unidentified dolphin or porpoise)
Figure 11. Average number of cetacean sightings per unit effort (in hours) during both years. Bars symbolise standard error about the mean.

Figure 12. The distribution of cetacean sightings in relation to tidal states compared between the two survey periods.
**BALEEN WHALES (Mysticeti)**

**Atlantic minke whale** (*Balaenoptera acutorostrata acutorostrata*)

One single sighting of a Minke whale (Plate 2) was recorded during the study of 2005. This animal was observed moving west at the entrance to Broadhaven Bay (Fig. 13). In 2002, this species were primarily seen in months not covered in the survey of 2005 with some sightings recorded in October of 2001. However, a total of 4 minke whales were observed during the same survey period in 2002 (Ó Cadhla *et al.*, 2003).

Plate 2. A minke whale surfacing among feeding seabirds. The presence of seabirds can often be an important cue in observations of this and other cetacean species.

Figure 13. Estimated sighting position of minke whale observed from the observation site at Doonanierin point on July 11, 2005. Axis scales show Ordnance Survey of Ireland grid coordinates with each square representing 2x2 km.
Five species of toothed cetaceans were identified in the survey area by CMRC researchers during the survey of 2005. One, the killer whale, had not previously been recorded by the research team and two smaller dolphin species recorded in 2001-2002 were not identified in 2005.

Killer whale (*Orcinus orca*)

Killer whales (Plate 3) were recorded on two different occasions in early July of 2005. Both sightings were recorded at the entrance of Broadhaven Bay (Fig. 14). On both instances, the group size was two to four individuals and since a single day separated the two sightings it is possible that the same group remained within the area. Although this species was not recorded in 2001-2002, fishermen reported their presence on two days in August, just off Achill Head which is close to the survey area (Ó Cadhla *et al.*, 2003). Also, this species has been previously recorded in County Mayo waters and occurs regularly all along the Irish west coast (Evans, 1988; Hammond & Lockyer, 1988; IWDG, 2003).

Plate 3. An adult male killer whale (a.k.a. Orca) with its easily identifiable tall dorsal fin and striking black body with white eye and grey saddle patch.

Figure 14. Positions of killer whales tracked in July 11 (blue) and a single position determined for July 09 (in pink). Arrow is showing the direction of movement on July 11. Axis scales show Ordnance Survey of Ireland grid coordinates with each square representing 2x2 km.
Risso’s dolphin \textit{(Grampus griseus)}

Risso’s dolphins (Plate 4) were observed in Broadhaven Bay on four different occasions in June, July and early August, 2005, resulting in a detection rate of 0.02 per hour of effort. Estimated group sizes ranged from one to five individuals and a juvenile was observed present on one occasion. Sightings of this species were mainly made close to the site at Gubastuckan (Fig. 15), an area known for its strong tidal eddies (Ó Cadhla \textit{et al.}, 2003). This species has previously been reported in Broadhaven Bay and surrounding waters, both during the study in 2001-2002 and by a number of earlier surveys (e.g. Lang, 1972; Nairn & Curry, 1976). Some of these surveys showed a coastal occurrence of Risso’s dolphin primarily in the summer months. Sightings have also been recorded off eastern, south-eastern and south-western coasts (Hammond \textit{et al.}, 1995; Berrow \textit{et al.}, 2002). Sightings recorded in 2002 showed the same pattern of distribution as in 2005 and may provide support to the suggestion that Risso’s dolphins show a level of residency within the area (Ó Cadhla \textit{et al.}, 2003), a question that future photo-id of this species may provide some answers to.

![Plate 4. Risso’s dolphin with its characteristic tall dorsal fin and body covered in scratches, resulting in a pale appearance.](image)

![Figure 15. Tracks of Risso’s dolphin movements, with the main area of occurrence concentrated close to Erris Head on the west side of Broadhaven Bay. Arrows indicate direction of movement. Axis scales show Ordnance Survey of Ireland grid coordinates with each square representing 2x2 km.](image)
Bottlenose dolphin (*Tursiops truncatus*)

There were a total of eight distinct sightings of bottlenose dolphins (Plate 5) in 2005, making this the most commonly recorded species of cetacean this year (27% of all sightings). Bottlenose dolphins were recorded in June, July and August, with the majority of sightings recorded in July and an overall detection rate of 0.04 per hour of survey effort. In 2002, the sighting rate of this species was 0.06 per hour of survey effort. Bottlenose dolphins also showed the widest spatial use of Broadhaven Bay among the species recorded (Fig 16). Group sizes recorded ranged between four animals up to around 20, a group size range commonly observed for this species (e.g. Ingram *et al.*, 2000).

Bottlenose dolphins appear to be relatively common in western Irish waters and the resident population in the Shannon Estuary (Co. Clare) has been studied for over ten years (Ingram, 2000; Rogan *et al.*, 2000; Ingram & Rogan, 2002). Other areas in which groups are known to occur include County Galway, Sligo and Donegal (Ingram *et al.*, 2001) as well as in County Mayo (Ó Cadhla *et al.*, 2003). This species has also been found to be relatively frequent in the Connemara region (Ingram *et al.*, 2003) and it is believed there could be several smaller populations present along the Irish west-coast (Ingram *et al.*, 2003).

The use of photo-id in the survey of 2001-2002 provided the successful identification of an estimated minimum of 25 (maximum 39) individually recognisable bottlenose dolphins in the Broadhaven Bay area. Some individuals were more commonly encountered than others which suggest that certain groups of this species may show a regular use of the area. Unfortunately, it was not possible due to operational reasons to follow up this important work in 2005 and thus it is not yet possible to determine the level to which the individuals recognised are to be encountered in the area.

As in 2002, bottlenose dolphins commonly displayed foraging behaviours in 2005. However, due to the much lower number of sightings any detailed comparison is inappropriate. Estimated group size and composition was similar to that recorded in 2002 with the difference that calves were observed in 2005. Although reported in groups of bottlenose dolphin from reliable sources in 2001-2002 (Ó Cadhla *et al.*, 2003), calves were not seen by researchers in 2002.
Figure 16. Bottlenose dolphin occurrence and movements within Broadhaven Bay during the study of 2005. Colours represent different visual records of dolphins groups tracked. Arrows associated with tracks indicate direction of travel. Axis scales show Ordnance Survey of Ireland grid coordinates with each square representing 2x2 km.

Short-beaked common dolphin (*Delphinus delphis*)

Relatively large groups of common dolphins (Plate 6) were observed in the study area during 2005. Five distinct sightings were recorded, resulting in a total estimate of 307 individuals. Group sizes were quite variable with groups of 10+ individuals regularly observed. The smallest group observed consisted of five individuals and the largest contained an estimated 250 dolphins. Most groups consisted solely of adults, but juveniles and calves were also observed, particularly in larger groups. Sightings were recorded primarily in the centre and outer parts of the bay (Fig. 17) with concentrated occurrence within 2.5km of Erris Head. Seabirds were regularly associated with foraging groups of common dolphins.

In 2002, this species was seen in large foraging schools and was commonly associated with other small dolphin species, including white-beaked and white-sided dolphins. Juveniles and calves were observed in both survey periods in the month of August. There are indications from other studies that the numbers of this species may increase for breeding purposes primarily through the summer months (Ó Cadhla *et al.*, 2001; 2004)

Common dolphins represented the only species for which the number of sightings in 2005 exceeded the records from the same period of 2002. Sightings of this species and associated groups of white-sided and white-beaked dolphins generally occurred close to the outer boundaries of the SAC in 2001-2002. Sightings of 2005 were more commonly recorded further into the bay area.
Plate 6. Two common dolphins surfacing, showing a characteristic yellowish pattern on their sides.

Figure 17. Summary of common dolphin movement in the area in summer of 2005. Separate colours represent different groups of dolphins and the arrows the directional movements of some of the groups. Axis scales show Ordnance Survey of Ireland grid coordinates with each square representing 2x2 km.
Harbour porpoise (*Phocoena phocoena*)

Harbour porpoises (Plate 7) were recorded on three occasions in 2005, once in mid June, and the two other times in early and late August. Observations were all of single animals that were seen for brief moments and that could not be tracked. However, initial sighting positions were obtained for all sightings made (Fig. 18). No harbour porpoises were observed close to the acoustic equipment deployed in Rossport Bay during the survey of 2005.

The number of harbour porpoise sightings recorded in 2005 was low in comparison with 2002. However, as already mentioned, the species is notorious for its inconspicuous behaviour, requiring excellent sea conditions to enable efficient monitoring. The absence of boat surveys in 2005 is likely to have affected the opportunity to accurately record this species within the bay area. Harbour porpoises were rarely observed in the outer part of the bay area in either year. Their presence in the inner parts of the bay is supported by the data obtained from the acoustic survey record (see Chapter 4). Harbour porpoises are regularly found stranded in European waters (Leopold *et al.*, 1992; Berrow & Rogan, 1997) and it is known that a main cause is the incidental by-catch in fishing gear and many research projects have been dedicated to finding solutions for this problem (e.g. Berggren *et al.*, 2001; 2002). Approximately 20% of harbour porpoise sightings in 2002 were made during vessel surveys and as no vessel based survey were made in 2005 this could explain some of the differences in sighting frequency.

![Plate 7. Post mortem of a by-caught harbour porpoise, showing the small triangular dorsal fin, dark colouration the blunt head.](image)

![Figure 18. Sightings of harbour porpoises recorded in Broadhaven Bay during the summer of 2005. Axis scales show Ordnance Survey of Ireland grid coordinates with each square representing 2x2 km.](image)
B. Incidental sightings of cetaceans

In addition to the information acquired via dedicated survey effort by the CMRC team, reports were received from local fishermen and other water-users in the area. A number of species were reported sighted before, during and after the survey period of 2005 at times when visual effort was not in place. For example, a group of 20 bottlenose dolphins were observed in Rossport Bay in the month of October. This was after visual survey effort had ended and the acoustic equipment had been retrieved. One minke whale was reported to have been seen about two miles NE of Blackrock Island (south west of Broadhaven). The most exceptional example was a report of the rare Cuvier’s beaked whale (*Ziphius cavirostris*) sighted from a helicopter in the month of June just south of Eagle Island (just west of Erris Head). Additionally, stranding events including bottlenose, common and white-sided dolphins as well as harbour porpoises were recorded on a number of occasions during the survey period.

**SEALS (Pinnipedia)**

C. Seal sightings

A total of 36 distinct seal sightings were recorded during the survey period (summarised in table 4). Seals observed were generally adults except for one individual considered to be a juvenile due to its small size and pale colour. Seal sightings were distributed widely within the survey area showing some species segregation with grey seals predominantly on the western side of the bay and harbour seals on the eastern side (Fig. 19). Sightings were mainly of single animals and only on one occasion were two grey seals seen in close proximity. Seals were recorded predominantly in the months of June and July (Fig. 20) and with lower frequency than during the same period in 2002. In total, seals were recorded on 79% of the survey days in 2002 and on 33% of available survey days in 2005. This discrepancy could be related to the differences in weather conditions between the two survey periods as seals can be difficult to observe when weather conditions deteriorate. Grey seals are known to be breeding on some of the islands close to the survey area (Kiely & Mayers, 1998; Lidgard *et al.*, 2002) and harbour seals further in towards Belmullet. There was no clear pattern to sightings of seals in relation to tide, but more sightings were made at a falling tide in 2005 and at high and low tide in 2002 (Fig. 21).

![Figure 19. Distribution of seal sightings recorded in Broadhaven Bay, 2005. Orange markers showing harbour seal positions and brown markers indicate positions of grey seals. Axis scales show Ordnance Survey of Ireland grid coordinates with each square representing 2x2 km.](image-url)
Plate 8. Harbour seals (Phoca vitulina vitulina) hauled out on a west coast location. One of the two seal species observed during the study.

Figure 20. Monthly average of seal sightings per hour of effort. Bars symbolise standard error about the mean.

Figure 21. The distribution of seal sightings in relation to tidal states compared between the two survey periods.
D. Unidentified marine mammals

Where there was uncertainty in species identification due to the distance of the animal or due to poor weather conditions, a classification of unidentified was assigned. It was not possible for the observers to determine the species of marine mammal observed at all times (23% of all cetacean and 3% of all seal sightings, Appendix III). This was due to a number of factors including weather and light conditions as well as distance from the observer. Additionally, small dolphin species sometimes travel and forage in mixed species groups, the composition of which can be difficult to distinguish to a species level at a distance. It is possible that some of the large groups of common dolphins observed could have included other species such as striped or white-beaked dolphins that have previously been observed in the area. It is possible that some of the sightings classified as unidentified could have been harbour porpoises. Generally, these animals would surface briefly and then not be seen again. This is typical with harbour porpoises with their very inconspicuous behaviour and small size.

E. Sightings of other species of interest

Species other than marine mammals were also observed during the course of the study. The survey team recorded two sightings of basking shark (*Cetorhinus maximus*, plate 9) in the month of July, 2005. Both sightings were of single animals, one of which was relatively small in size. There were also two sightings of sunfish (*Mola mola*, plate 10). These were also of single animals, recorded in June and in August, within 200m of the observation site at Erris Head (Fig 22). Sightings of basking sharks were widely distributed and more frequent in 2002, with a total of 17 distinct sightings between July and September. Basking sharks were observed singly except on one occasion in 2002 when two individuals were observed in close proximity. Three sightings of sunfish were made in August and September 2002 as well as one sighting of a turtle of unknown species. These observations were primarily made from the survey vessel during line-transect work and thus, the lack such surveys during 2005 in combination with less ideal weather conditions could explain some of the differences in sighting frequency. Both sunfish and turtles are relatively small and inconspicuous and difficult to observe from a distance. The basking shark should be more likely to be observed due to the large amounts of time it spends feeding at the surface; however, its fins are still relatively small and can easily be missed at a distance or in higher sea-states.

Plate 9. Basking shark, one of the two species of special interest of non-mammals seen during the survey period.
Plate 10. Sunfish showing the characteristic round body shape and proportionally large “shark-like” fin.

Figure 22. Distribution of basking shark and sunfish sightings recorded in Broadhaven Bay. Axis scales show Ordnance Survey of Ireland grid coordinates with each square representing 2x2 km.
4. ACOUSTIC SURVEYS – RESULTS AND DISCUSSION

4.1 Survey effort
Three T-PODs were deployed in Rossport Bay on June 24th and retrieved on August 19th for download of data and change of batteries. The equipment was subsequently re-deployed ten days later on August 29th (delay due to severe weather conditions) and operated satisfactorily until the end of the survey period on September 30th. The two deployment periods of 2005 resulted in acoustic surveillance on 99 days and a combined effort for the three listening stations of 6,590.8 hours. A lower level of acoustic surveillance was achieved during the same period of 2002. Technical problems with the acoustic equipment and shorter deployment periods resulted in surveillance on 82 days and a combined effort for the three listening stations of 5,003.1 hours. The deployments covered all tidal states equally due to the mode of continuous monitoring effort.

4.2 Detections of harbour porpoises
Acoustic detections obtained by the equipment included click-trains from both harbour porpoises and from dolphins. Harbour porpoises were detected on 30 days of the deployment period (30.3% of available days) and included a total of 202 Detection Positive Minutes (Fig. 23), resulting in a detection rate of 0.032 DPM per hour of effort. More than half of the detections (58% of the total) were made during the night and the remainder during weather conditions which did not allow for effective visual monitoring. No simultaneous visual and acoustic records were included in the data-set of 2005. Comparisons of harbour porpoise detections recorded for the two survey periods showed a difference in distribution over time (Fig. 23) and a lower level of detections (relative to effort) during 2002 (Fig. 24), in particular for the month of July. Detections of harbour porpoises were made on 17 days (19.7% of available days) in 2002 and included a total of 54 DPM (Fig. 25), resulting in a detection rate of 0.011 DPM per hour of effort.

The difference between levels of harbour porpoise detections in the survey of 2005 compared to previous survey is interesting, particularly as the number of sightings of porpoises was less, while the rate of acoustic detections was higher. The acoustic record has to be regarded with caution however as the equipment is continuously being improved and performance varies between available versions. Comparisons have been performed for validation and calibration purposes and the earlier versions were found to compare well to later types (Ingram et al., 2004). When considering an exposed bay like Broadhaven where weather conditions may seriously hamper the ability of visual survey methods it highlights the importance of including acoustic methods. Acoustic methods proved crucial for the monitoring of small inconspicuous species such as the harbour porpoise. An important difference between visual records and the acoustic record was found with the acoustics indicating a substantially greater presence of this species than would have been registered by visual surveillance alone.
Figure 23. Distribution of Detection Positive Minutes for harbour porpoises during the entire period of acoustic surveillance in 2005. Grey bars represent the period of time (August 19th to 29th) during which there were no T-PODs deployed in the bay, due to poor weather conditions preventing re-deployment.

Figure 24. Distribution of Detection Positive Minutes for harbour porpoises during the entire period of acoustic surveillance in 2002. The dotted line show hours of deployment per day and indicates times when acoustic surveillance was not achieved.
Differences in detection rate between listening stations in Rossport Bay (Fig. 26) were consistent with the pattern observed in 2002 (Ó Cadhla et al., 2003). As previously, the listening station closest to the south side of Rossport Bay registered the greatest number of detections of harbour porpoises. It is notable that this area corresponds to the site of marine construction work, a discovery that reiterates the necessity for monitoring and other management measures to be put in place for the protection of this species.
4.3 Detections of dolphins

Dolphins were detected on two separate days in September 2005 and for a total of 23 Detection Positive Minutes, resulting in a rate of 0.004 DPM per hour in total (Fig. 27). Detections of dolphins were exclusively logged during the night-time when no visual monitoring was in place. It is therefore not possible to be certain of the species of dolphins concerned. Detections of dolphins were relatively rare in both survey periods. However, although the acoustic effort achieved was higher in 2005 the detection rate of dolphins was higher in 2002 with a rate of 0.018 DPM per hour recorded (22% higher than in 2005). No detections were made during the months of June or August in either of the survey years. The number of detections made in 2005 did not allow for any clear patterns to be evident in detection rates between listening stations. However, the south side of Rossport Bay (Listening station 3) did supply most of the detections in 2005 as well as in 2002 (Fig. 28).

![Graph showing monthly comparison of dolphin detections between the two survey periods.](image)

**Figure 27.** Monthly comparison of dolphin detections between the two survey periods.

![Graph showing comparison of dolphin detections between the two survey periods and between the different listening stations used.](image)

**Figure 28.** Comparison of dolphin detections between the two survey periods and between the different listening stations used.
5. SCIENTIFIC CONCLUSIONS AND RECOMMENDATIONS

5.1 Implementation of the monitoring plan

The monitoring plan was revised due to changes in construction activities and the gas pipeline not being installed during the survey period. The first section of the plan including pre-construction monitoring was, however, successfully implemented and extended until the end of September 2005. Vessel-based work, including line-transect surveys and photo-id of bottlenose dolphins was however cancelled. The study of 2005 was successful in providing additional information to the more extensive 15 month survey of 2001-2002, resulting in enhanced baseline data on which to base future pre-, during- and after-construction comparisons. Information obtained further supports the need for effective monitoring and management of the waters of the SAC. Broadhaven Bay appears to be important for a variety of ecologically diverse species and thus, provides a wide range of habitat.

5.2 Ecological significance of Broadhaven Bay

Findings in 2005 further highlight the uniqueness of Broadhaven Bay and its neighbouring coastal waters. So far, no surveyed locations on the Irish west coast can match the diversity of marine mammals found in this area. As many as ten species were reported during 183.9 hours of observation in 2002 and nine species during 222 hours of observation in 2005. Although monitoring effort on the west coast is often inadequate, extensive cliff- and boat-based survey effort still provide a basis for comparisons. One such example is the Shannon Estuary, where long-term studies have revealed the presence of a resident population of bottlenose dolphins (Berrow et al., 1996; Ingram 2000; Rogan et al., 2000; Ingram & Rogan 2002). However, only occasionally are other species observed in the estuary, primarily in the outer parts, where some seasonal occurrence of Minke whales, harbour porpoises and seals have been reported and rare sightings of killer whales and Risso’s dolphins have also been reported. Another couple of examples are Connemara where one study included 163 hours of cliff-based monitoring (Ingram et al., 2003) and similarly, a north Kerry study that included 120 hours of cliff-based observation (Ingram et al., 2005). Neither of these studies revealed the presence of more than five marine mammal species.

The information gathered so far must still be considered baseline, especially since all seasons are not covered equally, with survey effort mainly concentrated around the summer months. Although the study of 2001-2002 included survey effort at other times of the year, data gathered in 2005 only enables comparisons between the months of June, July, August and September. It is not yet possible to identify factors that may explain or influence the occurrence or movements of marine mammals inside or outside the survey area. However, foraging behaviours were regularly observed in both study periods and the region thus appears to form part of a foraging/feeding area for some of the species recorded. Sightings of basking sharks and sunfish furthermore indicate high levels of primary production at certain times of the year. The presence of calves was noted among common dolphin groups in 2001-2002 and in 2005 as well as in groups of bottlenose dolphins in 2005. Thus, in relation to any potentially disruptive activities, it is important to consider that the area may function as a breeding/rearing ground for these species as well as for the harbour seal.

As previously mentioned, increasing sea-states severely affect the detectability of small cetaceans, in particular for the harbour porpoise (e.g. Hammond et al., 2002). This may provide some explanation to the observed differences in number of sightings between the two survey periods. It is important to note that useful observation was regularly unfeasible or unreliable due to weather constraints and some presence of marine mammals is likely to have been missed at such
times. This is supported by reports from other sources providing records of marine mammal sightings in the area at times when cliff-based observations were not possible.

5.3 Mitigation measures

Measures to mitigate against significant construction impacts on marine mammals in Broadhaven Bay during a period of construction have been discussed thoroughly during the course of the research programme. This includes the implementation of a “Code of Conduct” for vessel traffic involved in construction activities and the implementation of a marine mammal monitoring plan during the same time period. The issue of harbour porpoise presence close to the area of construction needs to be further addressed. Depending on the type of work to be performed, additional mitigation measures may need to be introduced for the protection of this species. In the unlikely event of blasting being required for future construction activities, further mitigation protocols would have to be discussed and implemented.

5.4 Suggestions for continued monitoring

It is suggested that further marine mammal monitoring is undertaken, commencing ideally at least one month before the start of any construction activities in Broadhaven Bay. The study of 2005 was initiated at a time when construction work had already begun and does not provide any data prior to the month of June. Comparisons with the baseline study for any other period of time are therefore not possible. The study of 2001-2002 recorded a peak in marine mammal occurrence in the month of April and it would therefore be advantageous to start cliff-based survey work at or before this time.

The survey of 2002 included the advantage of vessel-based effort. Although this was taken into account in the analysis, there are other important benefits of vessel-based surveys combined with cliff-based effort. A substantial proportion of the sightings in 2001-2002 (approximately 20%) were initially recorded on boat-based surveys. Some of these would probably have been detected by the cliff-based observers, while some may have been overlooked. Another important advantage lies in the identification of species that are too distant from cliff-based observers. It also provides the possibility of a more accurate estimation of group size and it is possible that the number of animals in larger groups of small dolphins were underestimated. These circumstances may also partly contribute to the relatively high number of unidentified cetaceans in the survey of 2005 (7 sightings of 75 individuals) compared to 2002 (4 sightings of 9 individuals) as well as to the absence of white-sided and white-beaked dolphins within the records of 2005 as these two species are difficult to distinguish from the relatively more abundant common dolphin at a distance. Most importantly, vessel-based work is vital for a better understanding of the occurrence of small inconspicuous species such as the harbour porpoise and the absence of boat based effort could partly explain the lower level of this species during 2005. The importance of vessel-based work is evident from the comparisons of results between the two survey periods and should be included in any future work.

Proper management must also address the question of whether bottlenose dolphin groups occurring in the area are comprised of the same individuals. The photo-id work performed during the survey of 2001-2002 recorded that a relatively high percentage of the bottlenose dolphins encountered had permanent, distinct marks on their dorsal fins (Ó Cadhla et al., 2003). Future studies including photo-id could allow the determination of population size and the relationship between the study animals and other known groups of this species and show whether there is a degree of site fidelity to the area by this species.

Continued acoustic monitoring of the construction area in Rossport Bay is considered essential. The difficulties in the observation of harbour porpoises in particular highlight the importance of such monitoring, particularly close to the area of construction work. Additional acoustic effort
extending into the larger bay area should also be considered in a continued monitoring programme. Listening-stations could be placed in the outer bay in order to investigate background presence of echolocating cetaceans as any such presence is unknown at all times when visual effort is unavailable. It is also important to note in regard of the impact that higher sea-states may have on the visual record. Other methods to investigate the influence on sighting probability should be tested, for example the extended use of acoustic equipment could facilitate such comparisons. If the effort is skewed to higher sea-state, monitoring could still continue although this may not provide comparable data for some species.

Other methods to obtain information related to marine mammal use of the bay could also be discussed for incorporation in future monitoring efforts. This could involve collection of hydrographical data, in particular salinity and temperature and sampling of chlorophyll levels as well as depth. Information about fish abundance would also be useful. This would enable researchers to address questions of seasonal changes in primary production and prey distribution and to relate the presence of potential prey to marine mammal sightings. This type of approach is currently underway in the ISPSG funded analysis of offshore cetacean data (V. Cummins pers. comm.). The outcome of this study, undertaken by CMRC and expected to be published in early 2006, could provide useful guidance for future interpretation of data from Broadhaven Bay (CMRC, 2005). Samples of environmental data could be collected on a number of sampling stations and taken during line-transect surveys. Additionally it is suggested that noise levels of marine construction work should be measured, either at regular intervals during the work period or at different stages when it may be expected that noise levels would be increased. This would be important in determining the potential effect from noise in the SAC and could be correlated with animal occurrence and movement patterns observed.

The completed installation of a gas pipeline in Broadhaven Bay SAC should be followed by regular annual monitoring in order to oversee any effects on marine mammal distribution in these waters. Such a long-term monitoring programme should ideally be conducted monthly in all seasons to have the potential to yield data on seasonal, annual and longer-term population trends. In order for accurate seasonal distribution patterns to be assessed, survey effort must be uniformly distributed throughout the year (Brereton et al., 2001). Data of this type could be used to identify early signs of decline or other changes that may be of conservation concern. It could also be used to evaluate the effectiveness of conservation strategies put in place. As cetaceans are top predators, their abundance can act as an indicator to assess the overall health of a marine system and of marine biodiversity in the area of concern.
ACKNOWLEDGEMENTS

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References


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. 51pp.


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* All cetaceans are listed on CI of Council regulation no. 3626/82. This means that all cetaceans in UK waters are treated as if they are actually listed in Appendix I.
CODE OF CONDUCT
FOR VESSELS AND PERSONNEL OPERATING WITHIN BROADHAVEN BAY SAC

The following protocol is based on a Code of Practice to protect small cetaceans in the Shannon Estuary and on Guidelines set up by the Department of Communications, Marine and Natural Resources (Marine Notice No 15). The Shannon Estuary is itself a marine SAC under National Parks and Wildlife Service NPWS. This Code of Conduct is designed to reduce the potential for vessel- and person-related impacts on local marine mammal populations, their natural behaviour and habitats in Broadhaven Bay SAC, Co. Mayo.

Under current National Legislation - S.I No. 94 of 1997, Natural Habitat Regulations, Cetaceans are listed, and regulations prohibit the deliberate disturbance of these species. Included are several measures proposed for the offshore and near shore construction vessels, which will be operating within the SAC. Craft that do encounter any species are encouraged to log all sightings and to advise officers of the National Parks and Wildlife Service, which is a division of the Department of Environment Heritage, and Local Government.

Marine mammal species likely to be encountered during works are: European otter (Lutra lutra), Grey seal (Halichoerus grypus), Harbour seal (Phoca vitulina), and various cetacean (i.e. whale and dolphin) species including Bottlenose dolphin (Tursiops truncatus), Harbour porpoise (Phocoena phocoena), Common dolphin (Delphinus delphis) and Minke whale (Balaenoptera acutorostrata).

Listed below are the guidelines to be followed to minimise the effects of the vessels on marine mammals:

1. Any vessel and/or person(s) shall attempt to maintain a minimum distance of 100m from any individual marine mammal or group thereof.

2. No vessel and/or person(s) shall actively approach within 10m of any cetacean, nor within 50m of any seal or otter situated in the water. Vessels that are themselves approached by marine mammals may remain but should gear their engines into Neutral providing this does not cause a safety hazard.

3. No vessel and/or person(s) shall approach or remain within 100m of any marine mammal(s) at any time for more than 30 minutes. Boats do not need to move off if they have been approached by the mammal. However in the case where a boat is working or otherwise the behaviour of marine mammals should be recorded and provided to CMRC personnel, especially in the event of a change in the conduct of work on or immediately surrounding the vessel.

4. No vessel shall, when less than 100m from the marine mammal(s), exceed a speed of 5 knots. Providing this does not cause a safety hazard.

5. No vessel shall alter speed or course suddenly when less than 100m from any marine mammal(s).

6. No person or vessel shall deliberately approach to less than 100m from any marine mammal(s) situated on land except under licence from the Minister or unless approved to do so by the relevant authority (i.e. NPWS) as part of a marine mammal rescue operation.

7. Persons ashore that are approached by marine mammals shall carefully make the animal(s) aware of their presence and shall allow the animal(s) free access and ample opportunity to move into the water. Under no circumstances shall a person behave in an obtrusive or noisy manner around the animal(s).

8. No vessel shall use underwater acoustic transmitters, except navigational echo sounders, when less than 100m from any marine mammal.

9. No person shall attempt to feed or throw objects near any marine mammal.

10. No unauthorised divers should be allowed to enter the water within 100m of any marine mammal. This will be in the interest of health and safety of the divers as well as any marine mammal. Commercial divers should be aware that they may be approached by mammals during the course of their work.

11. Nothing in these guidelines shall operate to prohibit anything done for the preservation of life at sea or in the interests of public safety.

12. Nothing in these guidelines shall operate to restrict the obligations on persons and vessels to obey rules for the prevention of collision at sea and the regulations enacted by statutory Harbour Authorities.

References

Marine Notice No. 15 of 2005. Guidelines for correct procedures when encountering whales and dolphins in Irish coastal waters. DEPARTMENT OF COMMUNICATIONS, MARINE AND NATURAL RESOURCES
Plots showing initial sightings of marine mammals in Broadhaven Bay for the survey of 2001-2002 (unfilled symbols) and 2005 (filled symbols). (MW=minke whale, RD=Rissos dolphin, BND=bottlenose dolphin, CD=common dolphin, HP=harbour porpoise, Unid=unidentified cetacean, GS=grey seal, HS=harbour seal).