Distribution and abundance of harbour porpoises and other cetaceans in Roaringwater Bay, Co. Cork

Report to the National Parks and Wildlife Services

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Summary

Harbour porpoises (*Phocoena phocoena*) are listed on Annex I of the EU Habitats Directive, which requires member states to designate Special Areas of Conservation (SACs) for this species and to undertake surveillance of its conservation status. Roaringwater Bay, in south-west Cork, has been proposed as a candidate SAC for harbour porpoises. This study aimed to provide baseline data on porpoise abundance and distribution within the bay during the summer of 2005.

Four approaches were used to assess the abundance and distribution of harbour porpoises and other cetaceans in Roaringwater Bay. Harbour porpoise sightings data from the Cape Clear Bird Observatory (CCBO) log, dating back to 1979, were collated in order to look for long-term temporal patterns in abundance. Sightings were collected during land-based visual surveys, carried out from four sites, between 15th August and 4th October, 2005. In total, 18 land-based surveys (lasting between 2 and 3 hours each) were completed, amounting to 49 hours of observation from land. 18 opportunistic boat-based surveys (from ferries) were also carried out during this period. T-PODs were used to acoustically monitor around-the-clock activity of porpoises and dolphins at three sites.

Harbour porpoises were the most frequently-recorded cetacean in the CCBO data. There was a distinct seasonality in both effort and effort-corrected sightings rates of porpoises per month, with a peak in mean number of porpoises sighted per hour of seawatch in October, in the majority of years. Number of porpoise sightings, as a proportion of all cetacean sightings in a month, showed no trend in July, August and October, but showed a slight downward trend between 1979 and 2004, in the month of September.

Porpoises were sighted on all but one of the land-based surveys from Castle Point, on three out of four surveys from both Bullig Point (Cape Clear) and Sherkin Island, and on all three surveys from Long Island. The maximum number of individuals observed per 30-minute scan was 22, at Castle Point. Three other species were observed during land-based surveys: grey seals (*Halichoerus grypus*), common dolphins (*Delphinus delphis*) and a sunfish (*Mola mola*). Land-based survey data were insufficient to carry out statistical analyses. The proportion of porpoise-positive scans was highest at Castle Point (67%). Porpoises were sighted on 12 of the boat-based surveys, and were most often sighted on the ferry route between Baltimore and Cape Clear.

Acoustic surveys revealed differing levels of habitat use by porpoises and dolphins at deployment locations off Long Island, Sherkin Island and between the Middle and West Calf Islands. At all sites, detection rates were considerably higher for porpoises than for dolphins. Porpoise detection rates were significantly greater at Sherkin Island, where they were present for a mean of 3.583 minutes in every hour, than at the Calf Islands where the mean detection rate was 0.629 minutes per hour. T-POD data from Long Island could not be compared with data from the other two sites, since no analysis of the relative sensitivity of the unit at Long Island was carried out. Porpoises were detected both during the day and at night, at all three sites. At Sherkin Island, detection rates were significantly higher during the day than at night. At the Calf Islands and Long Island, detection rates were higher at night time than during the day.

Boat-based transect surveys of Roaringwater Bay, as well as an array of T-PODs deployed year-round, would provide even coverage of the entire area and would better enable an assessment of total numbers of porpoises using the bay, and seasonal fluxes in this habitat use. Roaringwater Bay also appears to be used regularly by common dolphins.

Introduction

The harbour porpoise (*Phocoena phocoena* L.) occurs primarily in temperate waters of the North Pacific and North Atlantic, mainly but not exclusively over the continental shelves of these regions (Reid *et al.* 2003). It is the most abundant marine mammal in the north-western European shelf waters; the SCANS II survey in July 2005 (MacLeod 2006) produced estimates of 380,000 animals in the North Sea and European Atlantic. At the meeting of the International Whaling Commission (IWC) Scientific Committee in 1995, the sub-committee for small cetaceans stated their concern regarding the status of the harbour porpoise throughout its range, which, in terms of abundance and distribution, is poor compared to half a century ago (Donovan & Bjørge 1995). The primary cause of decline of harbour porpoise populations is accidental mortality in fishing nets, which in certain areas may be unsustainable (Donovan & Bjørge 1995, ASCOBANS 1991). The harbour porpoises of the north-east Atlantic live in one of the most polluted and heavily fished marine environments in the world (Aguilar & Borrell 1995), and thus are at great risk from these activities.

Harbour porpoises are the most commonly observed species of cetacean in Irish waters. The 2005 SCANS II survey estimated 10,000 harbour porpoises on the west and south coasts of Ireland (MacLeod 2006). They are listed on the European Commission's Habitats Directive (1992), requiring all EU member states to designate a Special Area of Conservation (SAC), "representing the physical and biological factors essential to their life and reproduction", for this species. In addition, member states are required to implement monitoring of the conservation status of porpoises and their habitat.

The coastal distribution of porpoises, at least for part of the year (Bjørge 2003), makes them amenable to well-replicated, relatively low-cost studies by means of surveying from land. Land-based studies also afford the opportunity to study animals in a localised area, without disturbing them by the use of research vessels (Stone *et al*. 1995). Passive acoustic monitoring, a recent advance in survey techniques which has great potential for harbour porpoises, is being used increasingly to monitor habitat use by many species of cetacean (Lewis et al. 1998, Akamatsu et al. 2001, Goold & Jefferson 2002, Leeney & Tregenza 2006). Visual and acoustic survey methods present different limitations and opportunities. All cetaceans must breathe, but they are visible on the surface for this purpose only a small fraction of the time. Most cetaceans produce sounds, but it is not known for any one species what fraction of individuals produce sounds, or what factors influence acoustic activity. A recent study by Akamatsu et al. (2007), using acoustic tags, suggests that harbour porpoises produce intense sonar signals almost continuously. Sighting probabilities are dependent on many varying factors, whereas acoustic detection is less variable and can occur over much greater ranges than visual detection (Fristrup & Clark 1997). Thus, visual and acoustic survey methods are increasingly being used in combination (eg. Fristrup & Clark 1997, Akamatsu et al. 2001).

This study used a combination of visual and acoustic survey methods to assess habitat use by harbour porpoises, at a number of sites within Roaringwater Bay, during August and September 2005. These data will enable a better assessment of the suitability of the bay as an SAC for harbour porpoises. This report also presents data collected on other species of marine vertebrate observed during the study, and summarises the sightings data for harbour porpoises from Cape Clear Bird Observatory records from 1979 to 2004.

Methods

Roaringwater Bay extends between Baltimore to the east N 51° 28', W 009° 23', and Brow Head to the west N 51° 26', W 009° 46' (Fig. 1).

Four methods were used for this study. Cetacean sightings data from the Cape Clear Bird Observatory was collated in order to give an overview of patterns of relative abundance of harbour porpoises over nearly four decades of observations. During the months of August and September 2005, field studies were carried in Roaringwater Bay; comprising land-based visual monitoring, opportunistic boat-based visual surveys and acoustic surveys.

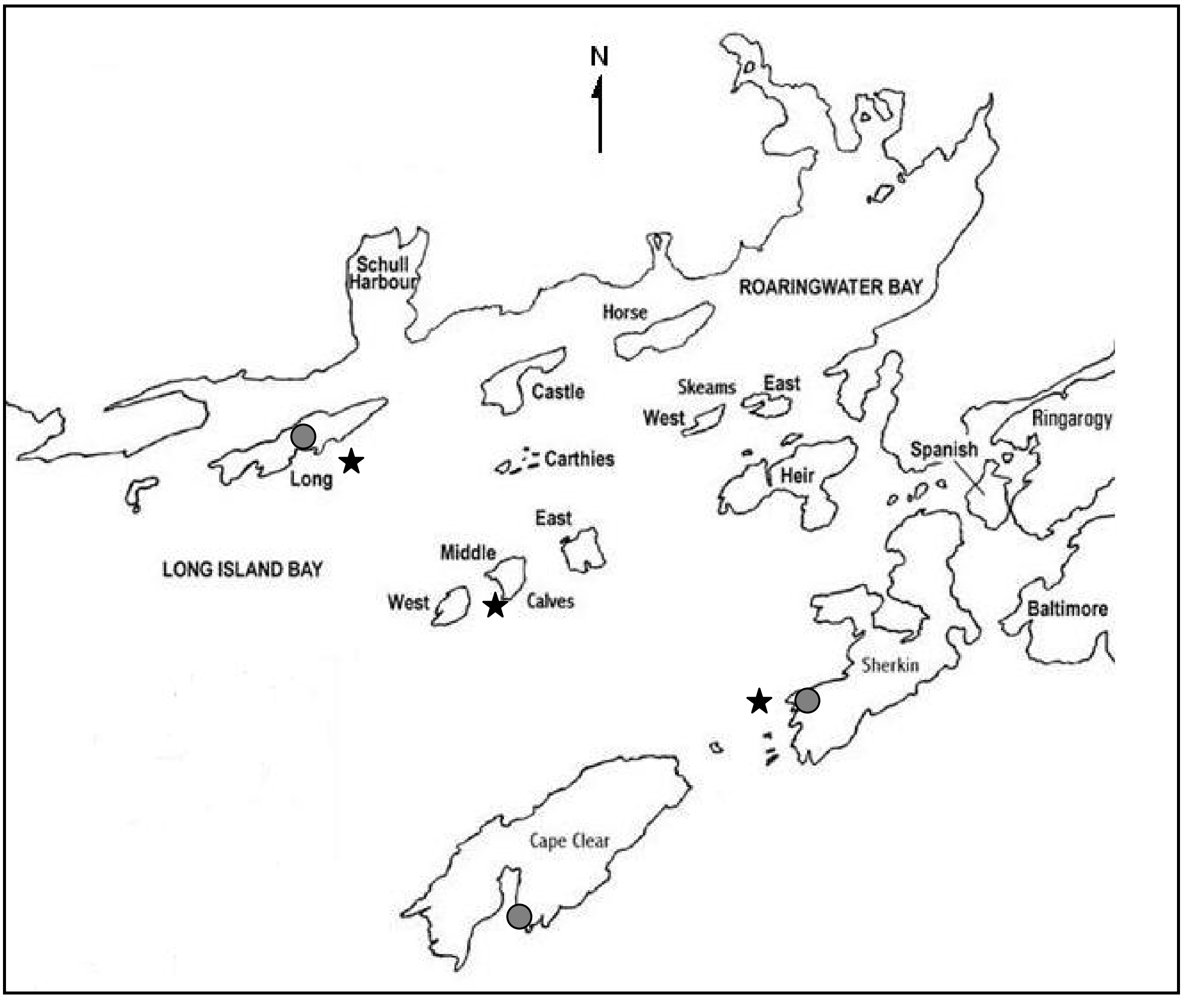

Fig. 1: Roaringwater Bay. Grey circles represent approximate positions of land-watch sites on Cape Clear, Sherkin Island and Long Island; Castle Point is west of the borders of this map. Stars represent approximate offshore positions of the three T-PODs. Map taken from Sherkin Island Marine Station website, http://www.sherkinmarine.ie/roaringmap.htm.

1. Cape Clear Bird Observatory data

Harbour porpoise sightings data were extracted from the yearly logs from 1979 to 2004. Although a wide diversity of species is observed in the waters surrounding Cape Clear, some species (such as sei whales *Balaenoptera borealis*, striped dolphins *Stenella coeruleoalba* and Atlantic white-sided dolphins *Lagenorhynchus acutus*) are sighted only rarely. In addition, most of these sightings are recorded by bird-watchers and not all observers have equal experience in identifying cetaceans. Thus, for the purpose of this report, only records of harbour porpoises were analysed in detail, since the study focused on the importance of Roaringwater Bay as a habitat for this Habitats Directive-listed species. The harbour porpoise is also commonly sighted in the region, and is thus well-known by bird-watchers, making records of this species relatively reliable.

Graphs were plotted of total effort in each year, number of days in which any cetacean was recorded ('cetacean-positive days'; CPD) for each of the four months with peak sightings rates (July through October) and number of harbour porpoises sighted in each of the four months of peak sightings rates, as a proportion of all sightings in each year. Data was also available on number of seawatching hours per month, allowing a more fine-scale analysis of monthly patterns in sighting rates. In every year, number of porpoises sighted per month was divided by number of seawatching hours per month. Porpoise sightings rate per hour were calculated for each of the four months of peak sightings rates.

2. Land-based visual surveys

Land-based watches were carried out from four sites: Castle Point (N 51° 29.549' W 009° 37.381', 26 m elevation), Long Island (N 51° 29.639' W 009° 33.330', 14 m), Sherkin Island Marine Station (N 51° 28.556' W 009° 25.988', 15 m) and Bullig Head on Cape Clear (N 51° 25.646' W 009° 29.855', 62 m) (see Fig. 1). Surveys were carried out in sea state 2 (Beaufort) or less, in conditions of good visibility (at least 4-5 km). Surveys lasted between 2 and 3 hours. A standardised system of data collection, termed 'scan sampling' (Altmann 1974, Martin & Bateson 1986), was used to monitor short-term changes in the number of animals present at a site. This method involves slowly scanning the study site from one side to another, at regular intervals, and counting all individuals sighted. Scan sampling was carried out every 30 minutes, using a 20x telescope. A pair of 10x binoculars was also used to scan inshore areas. At the end of every 30-minute period, the total number of individuals of each cetacean species sighted was recorded, including the presence of calves. In addition, sea state (using the Beaufort wind scale) and visibility were also recorded.

Previous studies have shown that tidal phase and tidal state can affect the distribution and abundance of harbour porpoises and other cetaceans (Leeney & Crowe a, in review; Mendes *et al.* 2002). Surveys were thus distributed as randomly as possible throughout the tidal cycle, to avoid confounding of the data.

3. Boat-based surveys

The large size of Roaringwater Bay makes it difficult to adequately collect sightings data for the whole study area from land. Thus, the ferries operating to Cape Clear from Schull and Baltimore were used as "vessels of opportunity", in order to collect some additional sightings data from these two routes. Several trips from Cape Clear and Schull to the

Fastnet Rock also provided sightings data for the outer part of Roaringwater Bay. Vessel-based surveys were carried out in a range of conditions varying from sea state 1 to 4. A single observer was stationed on the bow of the ferry (Naomh Ciaran) or on the starboard side of the wheelhouse (Karycraft), and scanned the area from straight ahead to approximately 60˚ to either side of the vessel's heading. All marine mammals sighted were recorded.

4. Acoustic Surveys

Three T-PODs (Fig. 2) were available for this study – one version 4 T-POD and two version 3 units. All units were set to detect dolphins as well as porpoises (see Appendix II, Table II for details of T-POD settings).

Two field calibration deployments were carried out prior to commencement of the acoustic monitoring, in order to compare the sensitivities of these three units. During these deployments, T-PODs were set to detect porpoises only. T-PODs 183 and 228 together in a single lobster pot, for a 17 h period, off Sherkin Island. This was followed by a deployment of T-PODs 183 and 502 for a 25 hour period. T-PODs were fixed into opposite ends of a lobster pot, and so were approximately 0.6 m apart (Fig. 2). Data from the joint deployment of T-PODs 183 and 228 were filtered to remove all non-cetacean trains (ie. analysis of Cet All trains only), and expressed as Detection Positive Minutes per hour ($DPM.h^{-1}$). No clicks were recorded during the deployment of units 183 and 502. A further calibration deployment for these two T-PODs was planned for the end of the field period, but the malfunction of all units at the end of the study prevented this from taking place.

Following the calibration trial, the units were deployed off Sherkin Island (N 51° 28.328' W 009° 26.243'), between Middle Calf and West Calf Islands (N 51° 28.354' W 009° 30.580') and off Long Island (N 51° 29.228' W 009° 34.486') (see Fig. 1). Unit 183 was deployed off Sherkin Island on August 7, while unit 228 was deployed at the Calf Islands and unit 501 at Long Island, on August 14. Thereafter, all T-PODs were visited periodically to upload data, check the battery status and replace batteries as required. T-PODs were retrieved in mid-November, but there were technical difficulties with all units including high power consumption, and the final deployment resulted in only two to three weeks of data for two units, and no data at all for the Sherkin Island T-POD.

T-POD data was filtered using the programme TPOD 8.1 (www.chelonia.co.uk), and data for dolphins and porpoises was extracted separately. Data was expressed as Detection Positive Minutes per hour ($DPM.h^{-1}$). There were generally more detections per hour on T-POD 183 than on T-POD 228 (Fig. IIa, Appendix II). Detection rates on the two units were highly correlated (Pearson correlation statistic, $r = 0.964$; $P < 0.001$). In order that results from Sherkin Island (unit 183) and the Calf Islands (unit 228) could be compared, data from T-POD 228 were adjusted using the correction factor (*C*), calculated as follows:

$$C = \frac{D_{183}}{D_{228}},$$

where D is the mean detection rate for a given T-POD, over the 17 h deployment. *C* was calculated as 1.54. A GLM with negative binomial errors and log link function was used to check for differences between T-POD 183 data and the adjusted values from T-POD 228, using the programme R (R Development Core Team 2006).

Fig. 2: T-POD in lobster pot deployment gear.

To compare nocturnal and daytime activity, 'day' and 'night' periods were selected from data collected at each site, between August 19 and 30, and between September 1 and 12. Over these dates, all sunrises occurred between 05:00 and 06:00, and all sunsets between 19:00 and 20:00 (sunrise and sunset times for Schull harbour, http://www.srrb.noaa.gov/highlights/sunrise/sunrise.html). Thus, 'day' periods were defined as between 06:00 and 19:00, and 'night' as between 20:00 and 05:00. DPM.h^{-1} was exported for each hour in every day and night period. Since detection rates in successive hours would likely be autocorrellated, a mean detection rate was calculated for each day and night period. A GLM with negative binomial errors and log link function was used to compare detection rates between sites (Sherkin and Calf Islands only), and between day and night, using R (R Development Core Team 2006).

Results

1. Bird observatory data

Cetaceans were not recorded in the observatory log in 1984, 1999 or 2001, thus these years are not included in the data. Data from the bird observatory are totals for each day, and thus do not reflect abundance at a single site (sightings from the ferry and several seawatching sites on Cape Clear may be included, S. Wing pers. comm.) or group size.

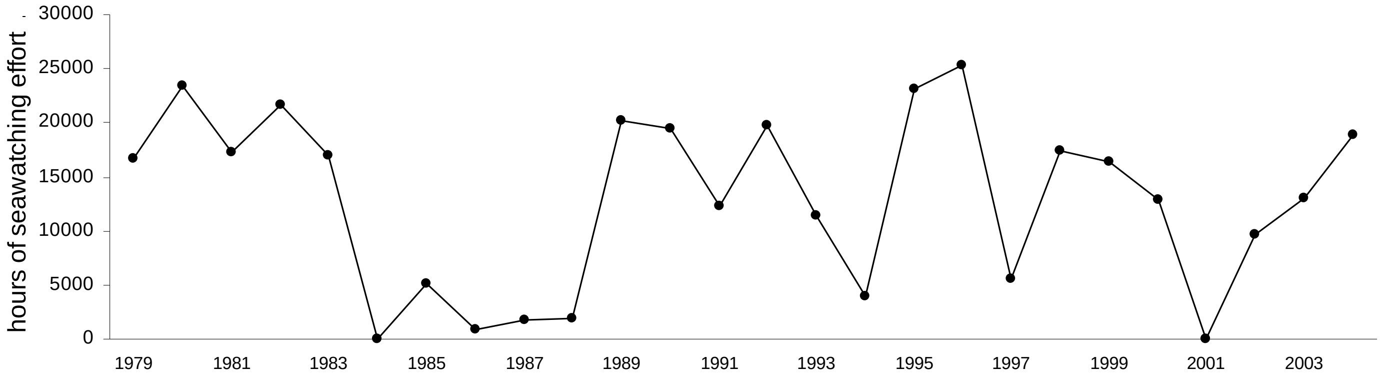

Fig. 3: Hours of seawatching effort per year, from Cape Clear Bird Observatory log books.

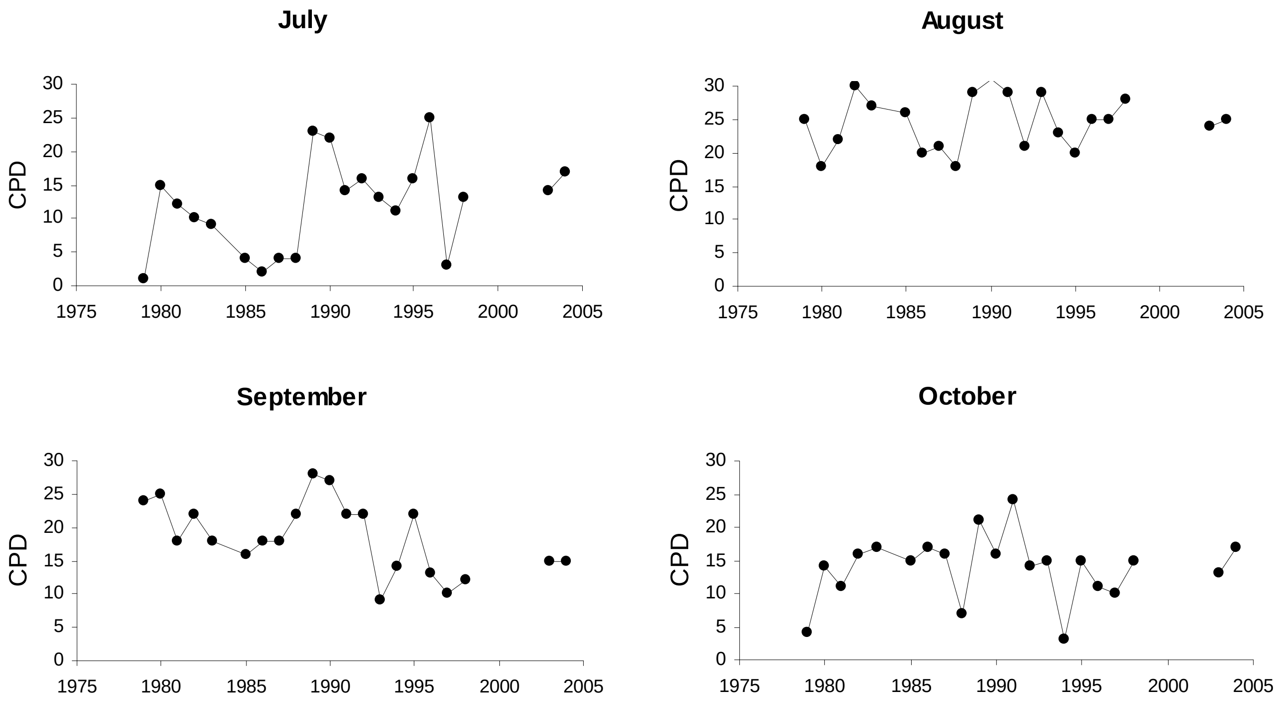

Fig 4: Number of Cetacean Positive Days (CPD) in the four months of peak sightings, 1979-2004. No records available for 1999 through 2002.

Seawatch effort varies greatly from year to year, with a maximum of 25314 hours in 1996, and only 905 hours in 1986 (Fig. 3). No pattern in numbers of cetacean-positive days is distinguishable in any month over the years (Fig. 4). Porpoise sightings rates were relatively constant among years, in all four months of peak sightings rates. Mean sighting rates were 0.19 (±0.05 s.e.) porpoises per hour in July, 0.45 (±0.05) in August, 0.75 (±0.13) in September and 1.41 (±0.58) in October, suggesting an increase in porpoise abundance around Cape Clear between July and October.

Fig. 5 shows the trend in number of porpoises as a proportion of all cetaceans sighted, in each of the four peak sightings months. July, August and October show little trend in frequency of porpoise sightings across years. However, September shows a decrease in the proportion of all sightings which are harbour porpoises (Fig. 5; slope m = -0.0081) from 1979 to 2004.

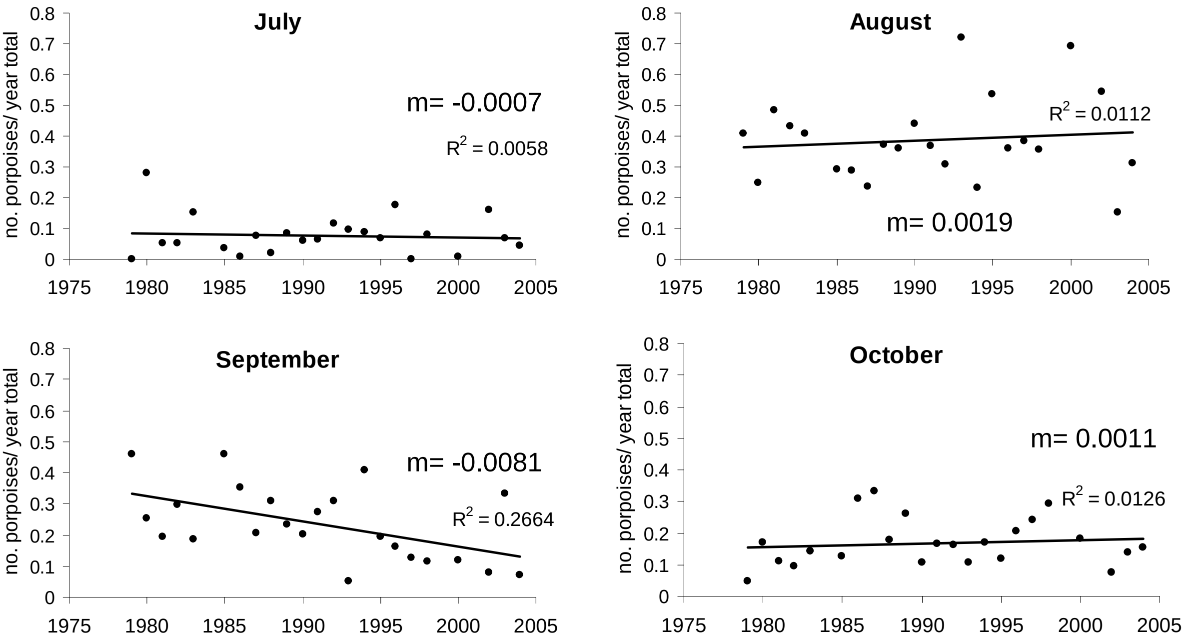

Fig 5: Number of harbour porpoises sighted in each of the four months of peak sightings rates, as a proportion of all sightings in each year, 1979-2004. No records for 1984, 1999, 2001.

2. Land-based visual surveys

18 land-based surveys were carried out as shown in Table Ia (Appendix I). Porpoises were sighted on six out of seven surveys at Castle Point, with a large group of at least 22 sighted on one occasion. Small numbers of porpoises were sighted on three out of four surveys at Sherkin Island and Bullig Point, and on all three surveys at Long Island. At Long Island, porpoises were more often seen at some distance from the watch site, at an estimated 800 to 1000 m away, in the direction of the Calf Islands. At Castle Point and Sherkin Island, porpoises were observed both at distance and close to the watch point. On three occasions and at three different sites, harbour porpoises and common dolphins were sighted during the same survey and within several hundred metres of each other. Common dolphins were

sighted in larger groups of up to at least 40 individuals. Grey seals were also sighted on four occasions, from Castle Point and Sherkin Island (Fig. 6).

Insufficient data was collected to allow for detailed analyses relating to sightings probabilities or patterns of abundance in relation to spatial and temporal factors. Mean numbers of porpoises per scan were highest at Castle Point and Bullig Point, and were lowest at Sherkin Island (Appendix I, Table Ib). The proportion of porpoise-positive scans was also highest at Castle Point, and was lowest at Bullig Point.

3. Boat-based surveys

18 boat-based surveys were carried out as shown in Table Ic (Appendix I); sightings shown in Fig. 7. Porpoises were the most commonly-sighted species, with between one and 5 individuals sighted on 10 out of 14 surveys (71%) between Cape Clear and Baltimore. On five occasions, a calf was sighted on the route between Baltimore and Cape Clear. Grey seals were sighted on 7 surveys, and common dolphins on one survey.

Fig. 6: Grey seal

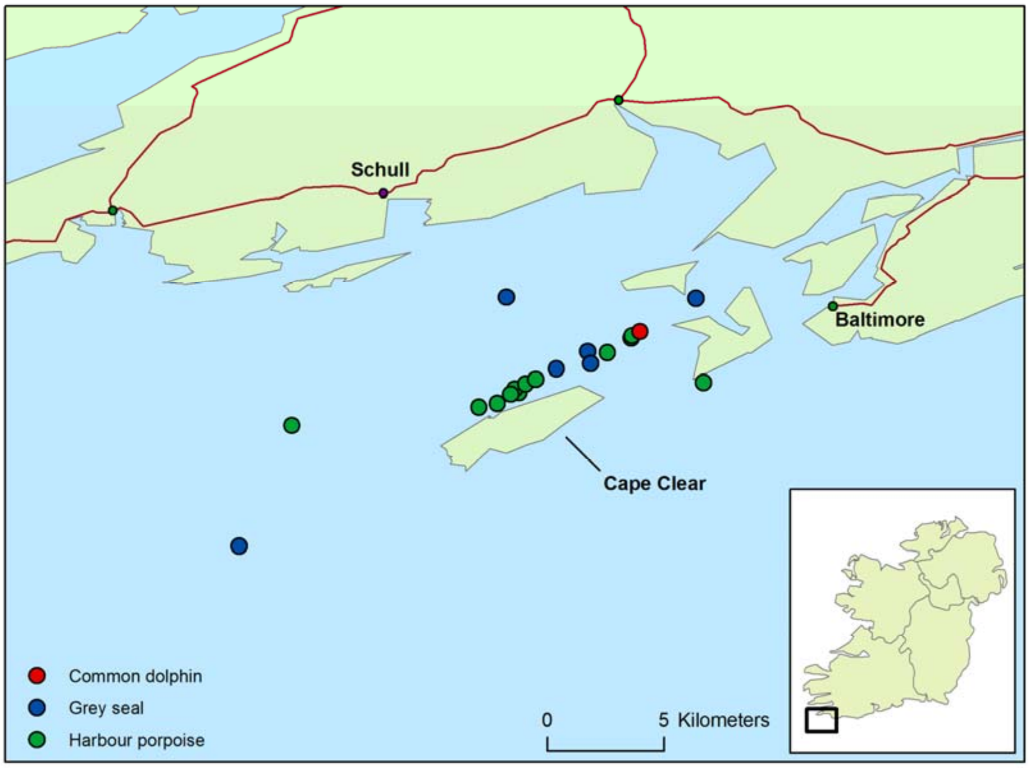

Fig. 7: Map of sightings from vessels of opportunity

4. Acoustic data

No significant difference was found between the detection rate on T-POD 183 and the corrected values from T-POD 228 (*P* = 1; Fig. IIb, Appendix II). This calibration factor applies only to porpoise detections. T-POD data amounted to 66 days at the Calf Islands, 52 days at Long Island, and 45 days at Sherkin Island (Appendix III, Table III). It was not possible to use data from the final deployment at Sherkin Island due to power consumption problems with the T-POD at this site.

In the analysis of the effects of site and day/night on porpoise detection rate, the full model included both factors and the interaction term. There was a small but non-significant interaction between site and day/night ($P = 0.0549$), with greater levels of daytime activity than nocturnal activity, at Sherkin Island (Fig. 8a). The interaction term was then removed, as well as the main effect day/night ($P = 0.183$). In the final model, the effects of site was highly significant ($P < 0.0001$), with detection rates clearly higher at Sherkin Island than at the Calf Islands (Fig. 8a). $\theta = 7.42$, indicating that the data was overdispersed. Nocturnal activity was greater than daytime activity at Long Island (Fig. 8b), although this was not statistically tested.

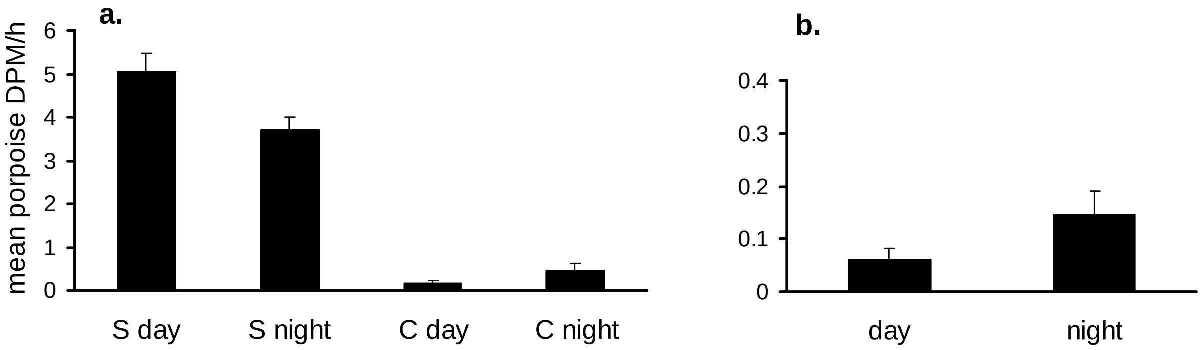

Fig. 8: Mean day and night porpoise detection rates at (a) Sherkin Island (S) and the Calf Islands (C); and (b) at Long Island (note different y-axis scale).

Rates of dolphin detections were considerably lower than the porpoise detection rate at all sites, as would be expected from fewer sightings of dolphin species. The dolphin detection rate was on average 26.5 % of the porpoise detection rate at the Calf Islands (range 3-42%); but detections of both species were generally low at this site (Appendix III, Table III). At Sherkin Island, dolphin detection rate was 2.4% of the porpoise detection rate, whilst at Long Island it was 4.6%.

Discussion

CCBO data

The 25-year data set provided by the Cape Clear Bird Observatory provides some insight into the relative abundance of harbour porpoises around the island over this time period. As effort has varied greatly over the years, it is difficult to detect trends in sightings rates. However, there is a clear seasonality evident in the data, with greatest proportions of sightings occurring from July through October. Effort is also greatest during these months, as large numbers of birdwatchers are present on Cape Clear. This may be at least in part responsible for the seasonal peak in numbers of porpoise sightings around Cape Clear, but it is likely that this is also a real signal in porpoise phenology. Reid et al. (2003) state that the seasonal movements and local abundances of porpoises in north-west European waters are poorly known; however, previous studies have recorded high abundances of this species during the summer and autumn months in the Irish Sea (Jones et al. 2004, Evans 1996). Whilst numbers of porpoises as a proportion of all sightings appears relatively constant in July, August and October, the data show a decrease in numbers of porpoises as a proportion of all cetaceans sighted, in the month of September, with time. This may be due to a greater presence, or greater awareness and recording of other cetacean species, during this month. Certainly, there is an increasing awareness of the diversity of cetacean species in Irish waters which may have lead to more sightings reports of less common species such as sei whales, pilot whales and Risso's dolphins in recent years. Alternatively, this downward trend could indicate that there are fewer porpoises in the area in September. This could be due to a decrease in population size, or alternatively to a range shift. Such changes in habitat range have been documented for bottlenose dolphins *Tursiops truncatus* in north-east Scotland (Wilson et al. 2004).

The nature of the effort data for the Cape Clear Bird Observatory records creates several difficulties for interpreting the data. The lack of "negative" data points, where a watch was carried out and no cetaceans were observed, makes it impossible to distinguish between days when no cetaceans were present, and days when no observations were carried out. In addition, the primary focus of most of the watches carried out from Cape Clear is on bird species. Thus, many cetaceans, particularly the small and inconspicuous harbour porpoise, may have been present but not recorded, resulting in lower sightings rates. It should also be noted that this dataset applies only to the waters around Cape Clear Island and thus provides no information on porpoise abundance in the rest of Roaringwater Bay.

Visual survey data

The small number of land-based surveys at each site made it difficult to investigate the effects of spatial and temporal factors on the abundance of harbour porpoises in Roaringwater Bay. However, the data produced has proved useful in some respects. Common dolphins and harbour porpoises were sighted in relatively close proximity to each other, during several land-based surveys. It is thus essential to ensure that acoustic surveys use settings which can detect both porpoises and delphinids, and distinguish between them. Dolphin clicks have a high frequency component which will be detected in porpoise frequency settings, and would thus otherwise add false positive porpoise detections to the acoustic data. Bottlenose dolphins and other delphinid species have also been sighted within Roaringwater Bay, however, which will make it impossible to attribute detections on the T-POD's dolphin channels to any one species, with the current model of the T-POD. The digital version of this device, the D-POD, will be available in 2007 and will be capable of distinguishing between different species of dolphin (N. Tregenza, pers. comm.).

Porpoises were sighted from all four land-based sites, indicating that these areas do comprise part of the harbour porpoise habitat within the bay. From all land-based study sites, at least one porpoise was sighted in over 50% of all scans carried out. This suggests that these sites are regularly used by harbour porpoises in Roaringwater Bay. Porpoises were sighted on nearly three quarters of boat-based surveys between Baltimore and Cape Clear, suggesting that this area comprises important harbour porpoise habitat. This is further supported by the fact that mother-calf pairs were sighted on five of these surveys. The other ferry routes were not surveyed often enough to assess whether porpoises or other species were often sighted in waters between Schull and Cape Clear or the Fastnet.

Acoustic data

The two T-PODs used for this study were found to differ somewhat in their sensitivities, with T-POD 183 on average recording 67% of the number of DPM per day recorded on T-POD 228. Other studies have also found differences in sensitivity between T-PODs (Teilmann et al. 2002, Diederichs et al. 2002). T-POD sensitivity can be modified through tank calibration and field testing, or a calibration index can be devised for any number of units in order to make them comparable (Dähne et al. 2006). These methods are necessary for any long-term monitoring project in which data from multiple sites and units must be compared. Current versions of the T-POD (version 5) have more standardized sensitivities (N.Tregenza, pers.comm.).

The acoustic data collected during this study suggest that, of the three sites monitored, highest levels of habitat use for harbour porpoises are around the southwest coast of Sherkin Island. The area where the T-POD was deployed is immediately north of the sound which runs between Cape Clear and Sherkin Island. Although acoustic data from Long Island cannot be compared with the other two sites, sightings made from land-based sites suggest that porpoises do regularly use the waters around Long Island. Future static acoustic monitoring of Roaringwater Bay should thus include a station in this area. Nocturnal activity was detected on all three T-PODs and suggests that, as in other areas of habitat for this species (Leeney & Crowe 2006b), porpoises are active around the clock.

It should be noted that acoustic data does not provide an estimate of porpoise density. Thus, whilst data from this study suggest that porpoises use the waters around Sherkin Island for greater periods of time than the area around the Calf Islands, it is not possible to determine whether more individuals frequent the former site. Nonetheless, these findings show the Sherkin Island area to be an important part of porpoise habitat in Roaringwater Bay.

Dolphins were also detected at the three acoustic monitoring stations, but at considerably lower levels. It is likely that common dolphins in particular, which are often sighted offshore in the waters around southwest Cork (Wall et al. 2006), occasionally venture into Roaringwater Bay, perhaps through the sound between Cape Clear and Sherkin Island. In this area, water is channelled between the islands when the tides are running, which could potentially create a tidally dynamic foraging zone.

Conclusion

This study provides evidence that Roaringwater Bay is a regularly-used habitat for harbour porpoises throughout the year, and that, during the months of August and September, porpoises are regularly sighted in areas of the bay as far east as Sherkin Island, west to Castle Point, and south of Cape Clear. The evidence from boat-based surveys and T-PODs, in particular, suggests that the waters around and between Sherkin Island and Cape Clear may be important for this species. Bycatch is one of the main threats to harbour porpoises around the Irish coast, thus the lack of commercial fishing activity in Roaringwater Bay makes it particularly suitable as a Special Area of Conservation for this species, since no gear or area restrictions will need to be implemented. Further monitoring is recommended, both by means of boat-based surveys during the summer and long-term deployment of an array of T-PODs or similar static acoustic monitoring devices. Boat transects will provide an estimate of total numbers of porpoises using the bay, and may highlight key habitat areas, whilst acoustic monitoring will elucidate both short- and long-term temporal patterns of fine-scale habitat use. Due to the presence of other species of odontocete in Roaringwater Bay, further static acoustic monitoring must use the appropriate detection frequency settings in order to distinguish porpoises from dolphins.

The identification of possible ‘critical habitat’ areas for harbour porpoises in Roaringwater Bay will aid in determining whether this area is suitable for designation as a SAC. The European Habitats Directive states that SAC sites should be proposed ‘where there is a clearly identifiable area representing the physical and biological factors essential to a species’ life and reproduction’. Examples of such habitats might include a breeding or nursery ground (Sonntag et al. 1999), or an important feeding area. Many recent studies have aimed to identify critical habitats for cetaceans (Gregr & Trites 2001, Harwood 2001, Ingram & Rogan 2002) and such data can be used to support the creation of marine protected areas (Dawson & Slooten 1993, Hooker et al. 1999). In order to support management actions, ongoing information on cetacean distribution and behaviour is required (Hastie et al. 2003). Difficulties in setting up a network of protected areas for the harbour porpoise include insufficient knowledge of its habitat requirements, throughout its range (Evans & Pascual 2001). This study provides some initial data on porpoise habitat use, however more detailed data will be required in order to understand the spatial and temporal patterns of porpoise distribution within Roaringwater Bay.

Acknowledgements

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Appendix I: Sightings data

Table Ia: Numbers of porpoises, and other species, sighted during land-based surveys from Castle Point (CP), Sherkin Island (S), Bullig Point on Cape Clear (B) and Long Island (L).

date	site	maximum number of porpoises	other species sighted** (maximum numbers)
15 Aug	CP	3	
19 Aug*	CP	3	1 gs
30 Aug	CP	0	
08 Sep	CP	4	1 sunfish
10 Sep	CP	2	
17 Sep	CP	22	8 cd
03 Oct	CP	4	
16 Aug	S	1	1 gs, 6 cd
22 Aug*	S	0	1 gs
12 Sep	S	2	
20 Sep	S	3	2 gs
31 Aug	B	0	
06 Sep	B	14	
07 Sep	B	4	
17 Sep	B	6	40 cd
20 Sep	L	2	
04 Oct	L	4	
11 Sep	L	5	

* surveys carried out in sea state 4
** Grey seal (gs) and common dolphin (cd)

Table Ib: Mean sightings rates and proportion of porpoise-positive scans (PPS; number of scans in which at least one porpoise was detected as a proportion of all scans carried out) for land-based surveys. Site abbreviations as for Table Ia.

site	mean no. porpoises per scan	proportion of PPS (%)
CP	3	67
S	1	53
B	2.7	43
L	1.4	60

Table Ic: Total numbers of porpoises (and number of calves in parentheses), and other species, sighted on boat-based surveys between Baltimore and Cape Clear (B), Schull and Cape Clear (S), and on one trip from Schull to Fastnet Rock (F). Other species annotated as in Table 1.

date	route	no. porpoises sighted	other species sighted
14/08	B	0	0
14/08	B	2	0
17/08	B	1	0
18/08	B	0	4 cd
30/08	B	2 (1)	1 gs
01/09	B	2 (1)	0
05/09	B	5 (1)	1 gs
06/09	B	3	0
07/09	B	1	1 gs
12/09	B	0	0
13/09	B	5	0
14/09	B	2 (1)	1 gs
17/09	B	0	0
01/10	B	2 (1)	2 gs
29/08	S	3	1 gs
29/08	S	0	0
08/09	S	0	0
16/08	F	4	1 gs

Appendix II: T-POD

Table II: v3 and v4 T-POD settings

Settings for v3 T-PODs:

Scan	**1**	**2**	**3**	**4**	**5**	**6**
Target (A) filter frequency	50	130	50	130	50	130
Reference (B) filter frequency	90	90	90	90	90	90
Selectivity (ratio A/B)	4	5	4	5	4	5
'A' integration period	short	short	short	short	short	short
'B' integration period	long	long	long	long	long	long
Minimum intensity	6	6	6	6	6	6
Scan limit On N of clicks logged	160	160	160	160	160	160

Settings for v4 T-POD:

Scan	**1**	**2**	**3**	**4**	**5**	**6**
Target (A) filter frequency	50	130	50	130	50	130
Reference (B) filter frequency	70	92	70	92	70	92
Click bandwidth	5	5	5	5	5	5
Noise adaptation	++	++	++	++	++	++
Sensitivity	6	6	6	6	6	6
Scan limit On N of clicks logged	200	200	200	200	200	200

In all cases, T-PODs were set to log clicks longer than 0 secs (i.e. all clicks), and the switch angle was set to 100˚.

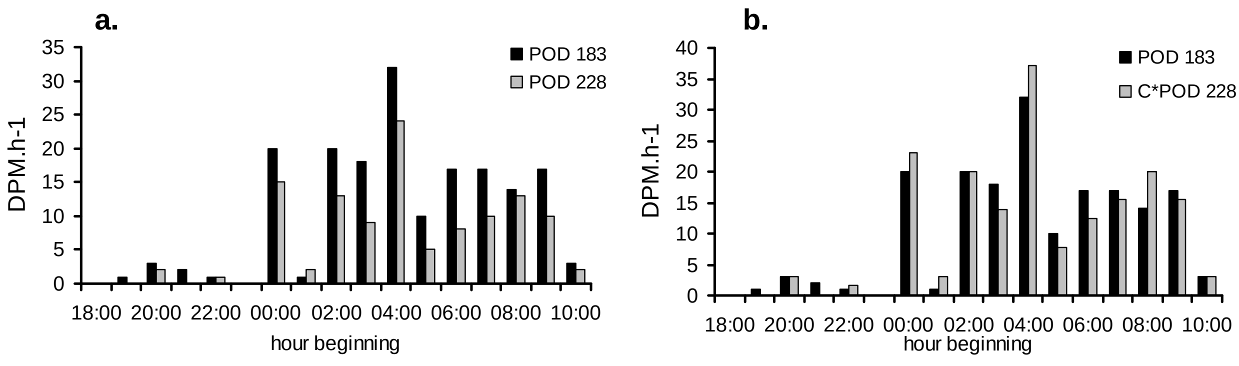

Fig. II: Detection rates for T-PODs 183 and 228, during a trial deployment at Sherkin Island, 6-7 August 2005. (a) uncorrected data; (b) with adjusted data for T-POD 228.

Appendix III: T-POD data from individual deployments

Table III: Exported values of mean number of DPM.h^{-1} for dolphins and porpoises, for each uploaded file from T-PODs at the Calf Islands (T-POD 183), Sherkin Island (T-POD 228; data corrected) and Long Island (T-POD 502; data not comparable with units 228 and 183).

site	time period	mean no. dolphin DPM.h^{-1}	mean no. porpoise DPM.h^{-1}	dolphin detection rate relative to porpoise detection rate %
Calf Islands	18/08/05 – 31/08/05	0.066	0.157	42
	05/09/05 – 19/09/05	0.118	0.581	20
	19/09/05 – 02/10/05	0.045	1.354	3
	02/10/05 – 28/10/05	0.177	0.427	41
	overall mean	**0.102**	**0.629**	**26.5**
Sherkin Island		(uncorrected)[a]	(corrected)[b]	
	18/08/05 – 31/08/05	0.026	4.824	0.8[c]
	31/08/05 – 02/10/05	0.069	2.342	4[c]
	overall mean	**0.047**	**3.583**	**2.4**
Long Island	18/08/05 – 31/08/05	0.003	0.152	2
	05/09/05 – 02/10/05	0.008	0.066	11
	02/10/05 – 14/10/05	0.003	0.476	0.7
	overall mean	**0.005**	**0.231**	**4.6**

(a) No correction factor was calculated for dolphin detections, thus these data cannot be directly compared with the dolphin data from the Calf Islands.
(b) Correction factor of 1.54 applied to all data.
(c) Relative values were calculated using uncorrected porpoise detection data.