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# The use of Cork Harbour by bottlenose dolphins (*Tursiops truncatus* (Montagu, 1821))

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*The bottlenose dolphins in Cork Harbour were studied using photo-identification to monitor individual dolphins and to assess whether they were resident in the area or transients. Land-based observations were carried out, to examine how the occurrence of dolphins varied over time and were influenced by the tidal cycle.*

**Keywords:** bottlenose dolphin, Cork Harbour, photo-identification, site fidelity, *Tursiops truncatus*

## INTRODUCTION

Bottlenose dolphins (*Tursiops truncatus* (Montagu, 1821)) are protected under the Irish Wildlife Act (39/1976 and 38/2000). They are also afforded a high status of protection under the E.U. Habitats Directive (43/1992), to which Ireland is a signatory state. They are listed as an Annex II species and therefore their habitats may require the designation of Special Areas of Conservation (SACs). Bottlenose dolphins are a ubiquitous species occurring from sub-polar to tropical waters worldwide. It is believed that the waters around Ireland may host the highest densities of bottlenose dolphins in Europe (Evans 1980).

To date, only one resident group of bottlenose dolphins is known in Ireland, in the Shannon Estuary, but others have probably been overlooked (Berrow 2008). For example, studies throughout the west coast of Ireland suggest that other resident or seasonally resident groups may exist there (e.g. Ingram *et al.* 2001, Ingram *et al.* 2003, O'Brien *et al.* 2009a). Resident bottlenose dolphins often occur in proximity to major estuaries and bays in north-west Europe and so it is not surprising that this species also occurs in Cork Harbour (Figs 1 and 2) on the south coast; the second largest estuary in Ireland. They are also known to feed in areas where constriction of a watercourse creates tidal races which apparently make fish prey easier to catch. In general, the

occurrence of inshore bottlenose dolphins has been shown to be predictable and dependent on tidal state due to favourable and dependable foraging conditions (Wilson *et al.* 1997).

## STUDY AREA

Cork Harbour is the most heavily industrialized estuary in Ireland with pharmaceutical, electrochemical and petrochemical industries established around the coastline. The ecosystem processes there are subject to conflicting demands from heavy industry, waste disposal, fisheries and eco-tourism (Johnson *et al.* 2002). It is a fully tidal, semi-enclosed estuary and is sheltered from prevailing wind and swell by a narrow opening between Roche's Point and Weaver's Point (Fig. 2). The harbour has an average tidal range of 3.7 m and a tidal velocity of up to 1.5 m s<sup>-1</sup> near the mouth (Fig. 2). The bathymetry is characterized by a deepwater channel and several banks, rocks and shelves.

## METHODS

### *Photo-identification*

Photo-identification surveys were carried out on an *ad hoc* basis between February 2006 and February 2009 when the sea state was in Beaufort Scale of  $\leq 3$ . Attempts were made to photograph both sides of the dorsal fin of each animal present (Fig. 4). Each photo-identification session lasted



Figure 1. One of the resident bottlenose dolphins bow-riding the MT 'Galway Fisher' in the busy shipping lanes at the mouth of Cork Harbour. This is possibly as a means of travelling more efficiently between preferred feeding areas. Photo Conor Ryan.

less than one hour and dolphins were approached from the side or behind (and not head-on) at a speed not exceeding five knots in order to minimize disturbance to the animals. Searches for animals were conducted at 12 knots and using 10×50 binoculars (following Ingram 2000).

The following unique features on the dorsal fins determined individual identity (in order of utility): 1. Nicks or notches on the trailing edge; 2. Rake marks, linear parallel scars from teeth of conspecifics; 3. Fin shape; and 4. Cutaneous lesions. A catalogue was thus compiled where individual animals were assigned a numerical code and voucher images were continuously updated as individuals accumulated new scars. The date, time and GPS location at first sighting were recorded for each encounter. This catalogue was compared to the Irish Coastal Bottlenose Dolphin Catalogue (lodged with the National Biodiversity Data Centre) and the Irish Whale and Dolphin Group catalogue, which includes dolphins from both the Shannon Estuary and Irish coastal waters (O'Brien *et al.* 2009a).

### Land-based observations

Visual observations were carried out at an elevation of 15 m from the vantage of Roche's Point (W825600) (Fig. 2) on an *ad hoc* basis in Beaufort sea state  $\leq 3$  using 10×50 and tripod-mounted 20×100 binoculars. This headland was chosen as it gives a panoramic view of the entire outer harbour area presenting a maximum possible distance to the horizon of about 14 km. Fifteen-minute systematic scans of the sea were carried out. When dolphins were sighted the time, group size, approximate location and

predominant behaviour type (*e.g.* feeding, milling, travelling and bow-riding) were recorded. Attempts were made to undertake both land watches and photo-identification surveys every month throughout the course of the study.

## RESULTS

### Photo-identification

A total of 1221 images of bottlenose dolphins was examined and 19 individuals were recognized and catalogued during the study. Six of these individuals occurred regularly in the study area while the remaining 13 were observed there only once (Table 1). Comparison between all catalogues (collectively comprising 320 bottlenose dolphins) revealed four matches (Table 2 and Fig. 3). No matches were found between the Cork Harbour and Shannon Estuary resident group. The six regularly re-sighted individuals were not matched to any other catalogue. The most notable match was that of ID 10 which was first identified in Cornwall in 1996 (Wood 1998, Colin Wood 2008 pers. comm.), in Galway Bay in 2007 (O'Brien *et al.* 2009a) and now in Cork Harbour in 2008 (Fig. 3). A separate study matched this individual at both Mull and the Moray Firth in Scotland between 2001 and 2007 (O'Brien *et al.* 2009b).

Between February 2006 and December 2008, bottlenose dolphins were photo-identified or observed from land in the vicinity of Roche's Point during all months of the year except for September (when no observations were carried out). Six dolphins showed strong site fidelity but not permanent residency in Cork Harbour (Fig. 2). On two occasions within this time

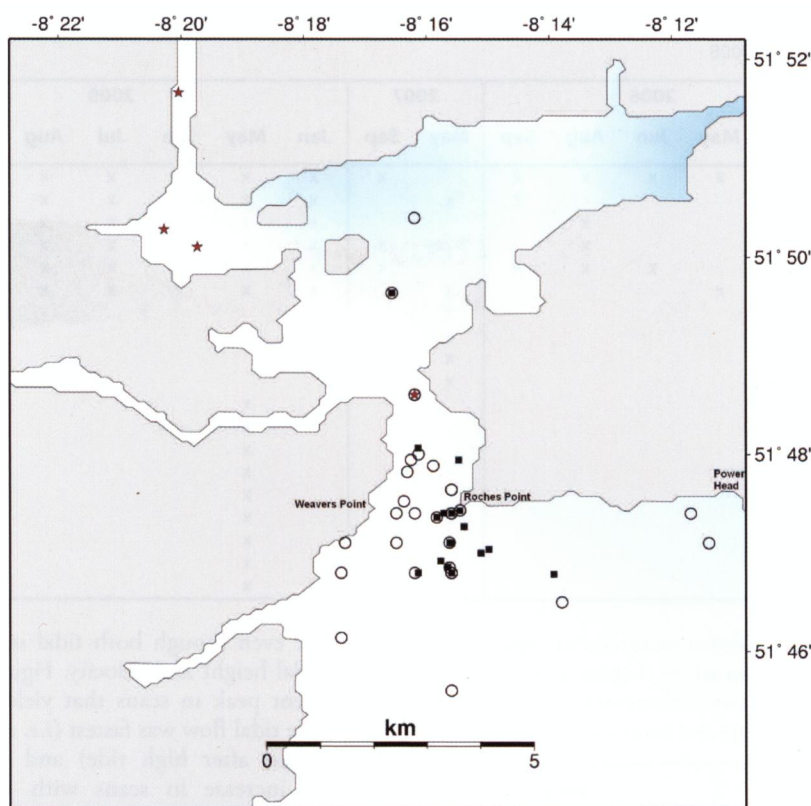


Figure 2. Lower Cork Harbour area showing all land and boat-based sightings. Open circle = land-based semi-resident dolphin sightings, solid square = boat based semi-resident dolphins (i.e. photo-ID trips), star = non-resident dolphin sightings (all boat-based). Mapped using SeaTurtle Maptool © www.seaturtle.org.

period (14 May 2007 and 10 May 2008) groups of other individually recognizable bottlenose dolphins comprising 9 and 30 individuals respectively, entered Cork Harbour. Despite extensive searches of the harbour, none of the six regularly re-sighted dolphins were found to be associating with this more transient group, which also ventured further into the inner harbour and into shallower water than the regularly re-sighted dolphins.

**Land-based observations**

Between February 2006 and December 2008, 69 15-minute scans were carried out from Roche's Point (Table 3). Bottlenose dolphins were sighted on 55 per cent (n=38) of scans and a single harbour porpoise was observed once (Ryan 2008). Group size (Fig. 5) ranged from one to six (mean=5.73±1.6 SD) and rarely varied (CV=0.28). However, group size on photo-identification trips varied from 2 to 30 (mean=8.09±7.09 SD) with a large coefficient of variation (CV=0.88) due to aforementioned

encounters with two large groups of dolphins. It was not possible to take images suitable for photo-identification from the headland, given that the dolphins were usually too distant. Therefore, for land-based observations, it was assumed that any group of dolphins comprising six or less individuals was probably the semi-resident dolphins, considering that these were the only individuals recorded during all but two of the photo-identification surveys.

While there were insufficient data to a test for significance of the effect of season on dolphin presence, 75 per cent (n=28 scans) of samples in winter yielded sightings compared with just 33.3 per cent (n=12) in summer.

To test whether tidal state had an effect on the presence of dolphins at Roche's Point, the data from field observations were retrospectively correlated with either flooding or ebbing tidal conditions and analyzed using Chi-squared tests. The null hypothesis that the presence of dolphins visible from Roche's Point was not influenced by tide was tested. Results showed there were

Table 1. Photo-identification log of the individually identified bottlenose dolphins in Cork Harbour between February 2006 and December 2008

| Dolphin ID | 2006 |     |     |     |     | 2007 |     | 2008 |     |     |     |     |     |     |
|------------|------|-----|-----|-----|-----|------|-----|------|-----|-----|-----|-----|-----|-----|
|            | Feb  | May | Jun | Aug | Sep | May  | Sep | Jan  | May | Jun | Jul | Aug | Oct | Dec |
| 1          |      | x   | x   | x   | x   |      | x   | x    | x   | x   | x   |     |     | x   |
| 2          |      |     |     |     | x   | x    |     | x    | x   | x   | x   | x   |     | x   |
| 3          |      |     |     | x   |     |      |     | x    | x   | x   | x   | x   | x   | x   |
| 4          |      |     |     | x   |     |      | x   | x    | x   | x   | x   | x   | x   | x   |
| 5          |      |     | x   | x   | x   |      | x   | x    | x   | x   | x   | x   | x   | x   |
| 6          | x    | x   |     |     |     | x    |     | x    | x   | x   | x   | x   | x   | x   |
| 7          |      |     |     |     |     | x    |     |      |     |     |     |     |     |     |
| 8          |      |     |     |     |     | x    |     |      |     |     |     |     |     |     |
| 9          |      |     |     |     |     | x    |     |      |     |     |     |     |     |     |
| 10         |      |     |     |     |     | x    |     |      |     |     |     |     |     |     |
| 11         |      |     |     |     |     |      |     |      | x   |     |     |     |     |     |
| 12         |      |     |     |     |     |      |     |      | x   |     |     |     |     |     |
| 13         |      |     |     |     |     |      |     |      | x   |     |     |     |     |     |
| 14         |      |     |     |     |     |      |     |      | x   |     |     |     |     |     |
| 15         |      |     |     |     |     |      |     |      | x   |     |     |     |     |     |
| 16         |      |     |     |     |     |      |     |      | x   |     |     |     |     |     |
| 17         |      |     |     |     |     |      |     |      | x   |     |     |     |     |     |
| 18         |      |     |     |     |     |      |     |      | x   |     |     |     |     |     |
| 19         |      |     |     |     |     |      |     |      | x   |     |     |     |     |     |

Table 2. Photo-identification ‘recaptures’ of bottlenose dolphins photographed in Cork Harbour during this study showing the nature of movements between Irish coasts and between Irish and British coasts.

| Dolphin | Date      | Location                     | Time (days) | Min. distance (km) |
|---------|-----------|------------------------------|-------------|--------------------|
| ID 07   | 15-May-07 | Cork Harbour                 |             |                    |
|         | 10-Jun-07 | Bantry Bay                   | 26          | 94                 |
| ID 10   | 15-Feb-96 | Penzance, Cornwall           |             |                    |
|         | 2001-2007 | Moray Firth and Isle of Mull | n/a         | 675 to 810         |
|         | 26-Mar-07 | Galway Bay                   | n/a         | 276                |
|         | 10-May-08 | Cork Harbour                 | 319         | 205                |
| ID 11   | 26-Mar-07 | Galway Bay                   |             |                    |
|         | 10-May-08 | Cork Harbour                 | 319         | 205                |
| ID 14   | 10-May-08 | Cork Harbour                 |             |                    |
|         | 08-Aug-08 | Donegal Bay                  | 89          | 351                |

significantly more sightings on a flooding tide (n=33) than on an ebbing tide (n=5) ( $\chi^2=13.66$ , 1 df,  $P<0.001$ ). The percentage of scans with sightings versus no sightings shows that the presence of dolphins near Roche’s Point does not appear to be influenced by tidal height *per se*, but the direction of tidal flow (Fig. 6). For example, there were no sightings at 1.5 hours after low tide (0 %, n=5 scans) while there were more sightings than not (60 %, n=13 scans) at 1.5 hours before

low tide even though both tidal states give the same tidal height and velocity. Figure 7 shows a prominent peak in scans that yielded sightings when the tidal flow was fastest (*i.e.* c. three hours before and after high tide) and conversely a marked increase in scans with no sightings during slacker tidal states (*i.e.* c. 0, 6 and 12 hours after high tide).

DISCUSSION

Resident groups of bottlenose dolphins generally comprise groups of 40 to 150 individuals (Wood 1998, Lusseau *et al.* 2003, Englund *et al.* 2008 and Genov *et al.* 2008). In light of this, a small, stable group of just six dolphins in Cork Harbour appears to be unusual but not unprecedented (Ridoux *et al.* 1997, Grellier and Wilson 2003).

The large groups of dolphins observed in Cork Harbour during summer months were probably transient or nomadic dolphins, a pattern also observed in Moray Firth and Cornwall (Wilson *et al.* 1997, Colin Wood 2008 pers. comm.). Indeed, there is an apparent distinction between resident and transient bottlenose dolphins in Ireland; with the former rarely straying from their resident site and the latter being recorded to move long distances (O’Brien *et al.* 2009a, 2009b). During this study, 21 per cent of dolphins recorded in Cork Harbour were matched to other catalogues in Britain and Ireland suggesting that such long-distance movements are unlikely to be once-off



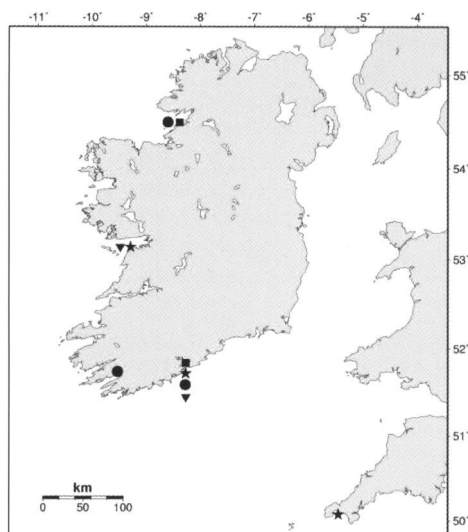


Figure 3. Locations of the four bottlenose dolphins re-sighted outside of Cork Harbour. Circle = ID 07 (IWDG code: BNDIRL 1), Star = ID 10 (IWDG code: BNDIRL 7), Triangle = ID 11 (IWDG code: BNDIRL 8), Square = ID 14 (IWDG code: BNDIRL 10). (See Table 1). Mapped using SeaTurtle Maptool<sup>®</sup>; [www.seaturtle.org](http://www.seaturtle.org)

events. Thus, Cork Harbour is probably an important habitat for a small number of semi-resident dolphins and part of a network of habitats for more transient dolphins (O'Brien *et al.* 2009a).

The Shannon Estuary is the only other location in Ireland where bottlenose dolphins are known to be resident. Dolphins occur there during all months of the year, but there is an apparent reduction in their abundance during winter months (Ingram 2000, Berrow 2009). However, while a sample with no sightings in the Shannon Estuary is rare (pers. obs.), the six dolphins are not always seen in Cork Harbour (but this may be due to their lower abundance here, rendering them less conspicuous). Therefore, we use the term 'semi-resident' to describe their occurrence in Cork Harbour. Maximum abundance is observed in mid-summer in the Shannon when the estuary is thought to be an important calving area (Ingram and Rogan 2002). While occasional increases in abundance were observed in Cork Harbour exclusively in summer months, these were temporary and erratic and were unlikely to represent calving events. Indeed, just one neonate, denoted by pale neonatal folds, was observed in Cork Harbour during this study in May 2007.



Figure 4. A photo identification image showing deep scratches and small nicks which persisted for the duration of the study. Photo Conor Ryan.



Figure 5. The resident dolphins often swam in close proximity of one another for prolonged periods of time and singletons were never observed. Photo Conor Ryan

Cork Harbour exhibits many physiographic features in common with other sites in the north-east Atlantic where bottlenose dolphins are resident. Constriction of the water's course by narrows in estuary mouths is believed to provide ideal foraging conditions for bottlenose dolphins due to the presence of deep water, rapid tidal flow, steep bathymetry, turbulent upwelling and abundant salmonids (Wilson *et al.* 1997, Mendes *et al.* 2002, Ingram and Rogan 2002). In accordance with most similar studies, it was found that dolphins are more frequently observed in proximity to these narrows, especially during flood tide. A higher abundance of fish larvae (and hence predatory fish on which the dolphins prey) on a flooding tide than on an ebbing tide may account for this observation (Moore *et al.* 1995, Churchill *et al.* 1999).

The average swimming speed for a foraging bottlenose dolphin is  $1.8 \text{ m s}^{-1}$  and the cost of locomotion against a tidal stream of  $2.7 \text{ m s}^{-1}$  is 96 per cent greater than in non-flowing water (Ridoux *et al.* 1997). The average tidal speed

Table 3. Land observations made from Roche's Point. Locations were estimated by distance and direction from the headland and GPS coordinates were thus determined using MapSource® GIS software.

| Date      | Start time | GPS location |        | Location     | N |
|-----------|------------|--------------|--------|--------------|---|
|           |            | N            | W      |              |   |
| 18-Feb-06 | 1500       | 51.790       | -8.260 | Roche's      | 6 |
| 28-Apr-06 | 1130       | 51.790       | -8.260 | Roche's      | 6 |
| 25-May-06 | 1500       | 51.800       | -8.269 | Roche's      | 5 |
| 25-May-06 | 1415       | 51.797       | -8.272 | Roche's      | 5 |
| 27-Jun-06 | 2100       | 51.790       | -8.275 | Roche's      | 6 |
| 18-Jul-06 | 1500       | 51.775       | -8.230 | Roche's      | 6 |
| 04-Oct-06 | 1445       | 51.799       | -8.271 | Roche's      | 5 |
| 14-Oct-06 | 1545       | 51.810       | -8.270 | Roches       | 8 |
| 22-Oct-06 | 1545       | 51.800       | -8.270 | Myrtleville  | 6 |
| 17-Nov-06 | 1200       | 51.800       | -8.260 | Myrtleville  | 6 |
| 26-Nov-06 | 0910       | 51.790       | -8.260 | Weaver Point | 6 |
| 21-Dec-06 | 1230       | 51.800       | -8.260 | Harbour Rock | 6 |
| 25-Dec-06 | 1400       | 51.790       | -8.180 | Inch         | 6 |
| 05-Jan-07 | 1040       | 51.790       | -8.180 | Roche's      | 6 |
| 24-Feb-07 | 1200       | 51.780       | -8.260 | Mouth        | 6 |
| 03-Mar-07 | 1230       |              |        | No sighting  | 0 |
| 06-Apr-07 | 1500       | 51.790       | -8.260 | Roche's      | 6 |
| 05-May-07 | 1100       |              |        | No sighting  | 0 |
| 05-Oct-07 | 1100       |              |        | No sighting  | 0 |
| 22-Dec-07 | 1020       | 51.760       | -8.260 | Roche's      | 6 |
| 06-Feb-08 | 0945       | 51.790       | -8.180 | Inch         | 6 |
| 27-Feb-08 | 1400       |              |        | No sighting  | 0 |
| 03-Apr-08 | 1200       | 51.780       | -8.270 | Harbour Rock | 1 |
| 14-Apr-08 | 1815       |              |        | No sighting  | 0 |
| 29-Apr-08 | 1850       |              |        | No sighting  | 0 |
| 10-May-08 | 1100       |              |        | No sighting  | 0 |
| 23-Dec-08 | 1430       |              |        | No sighting  | 0 |

encountered by dolphins in the mouth of Cork Harbour three hours before high tide (when they were most often observed) is  $1.5\text{ m s}^{-1}$ , approximating the average swimming speed (Hartnett 2005). An increase in energy consumption will be accrued while feeding in the mouth Cork Harbour against a tidal flow. This cost must be compensated for by an increased foraging efficiency under these conditions. Therefore, the regular occurrence of dolphins in areas of rapid tidal flow in the mouth of Cork Harbour during the fastest period of a flood tide is most likely due to an increased foraging efficiency, outweighing the elevated costs of locomotion under such conditions.

Many advantages of inshore residency in cetaceans have been proposed including: shelter, safe calving, predictability of food and the cultural transmission of spatio-temporal attributes pertaining to optimal foraging conditions, which in turn strengthen social bonds and reduce the risk of predation and competition (Connor *et al.* 2000). Spatio-temporal predictability of vulnerable prey probably accounts for a major benefit of

residency for the Cork Harbour dolphins, which were occasionally observed foraging close to channel buoys. These large buoys were possibly being used to corral fish against or perhaps they provide localised ecological enhancement associated with fouling thus attracting prey. Conversely, residency has associated disadvantages including interspecific and intraspecific competition for limited resources leading to territoriality (Ross and Wilson 1996). This may explain the cooperative fatal attack of the semi-resident dolphins on a harbour porpoise (*Phocoena phocoena*) (Ryan 2008) as the two species have been shown to exhibit considerable overlap in diet in British waters (Santos *et al.* 2004). However, a comprehensive study on the diet of both species in French waters found that only partial diet overlap exists there, and that interference competition is unlikely to be attributed exclusively to dietary similarity in that region (Spitz *et al.* 2006).

Temporary residency of Odontocetes in Cork Harbour is not without precedent. In the past, killer whales (*Orcinus orca*) and bottlenose dolphins were found to be feeding on Atlantic

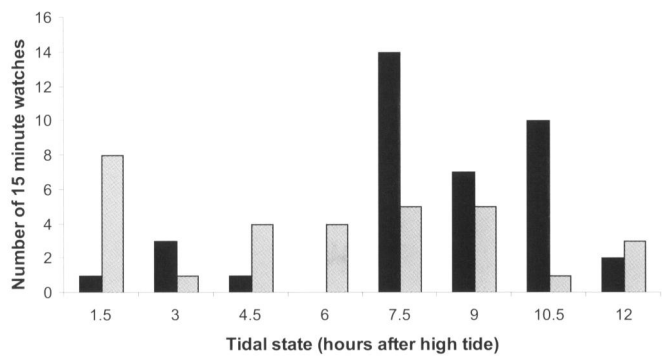


Figure 6. The number of 15 minute land-based scans from Roche's Point that resulted in sightings, or no sightings of bottlenose dolphins between February 2006 and December 2008 at different stages of tide. Mean group size=5.72 (SD=1.6). Black bars = sightings, grey bars = no sightings.

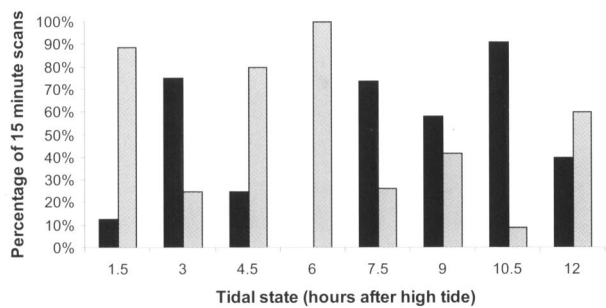


Figure 7. The effect of tidal state on the percentage of sightings and no sightings of bottlenose dolphins from 15 minute scan samples at Roche's Point between February 2006 and December 2008. Mean group size=5.72 + 1.6 SD. Black bars = sightings, grey bars = no sightings.

salmon (*Salmo salar*) (Ryan and Wilson 2003, McHugh *et al.* 2007) and juvenile cod (*Gadus morhua*), respectively (Wilson and Smiddy 1988). By examining images of fish being carried or tossed into the air, it was apparent that the semi-resident bottlenose dolphins studied herein were feeding on Atlantic salmon, sand eel (*Ammodytes* spp.), Atlantic horse mackerel (*Trachurus trachurus*), Atlantic mackerel (*Scomber scombrus*) and flatfish species and exclusively in water deeper than 10 m. Although fewer observations were carried out on the foraging behaviour of the more transient dolphins given their shorter visits, they were photographed feeding on thick-lipped grey mullet (*Chelon labrosus*) in very shallow water (*c.*1.5 m) over mudflats. The spatio-temporal predictability, abundance and diversity of fish prey in Cork Harbour may account for the strong site fidelity

exhibited by semi-resident bottlenose dolphins.

A CONSERVATION ISSUE

Several boats in Cork Harbour are offering dolphin-watching tours. Individual dolphins other than the six semi-resident bottlenose dolphins are rare in the area. In the absence of a monitoring scheme, it is likely that these few individuals are being exposed to potentially detrimental levels of disturbance by dolphin-watching boats (Constantine *et al.* 2004) during favourable sea conditions. Persistent harassment by high-speed pleasure craft was often observed during summer months. It is, therefore, recommended that continued monitoring of these dolphins be carried out. Should these semi-resident dolphins persist in Cork Harbour, or should additional individuals supplement their



numbers in time, this would make an interesting case study with potential insights into the reasons for residency in this species. In this event, however, guidelines and a monitoring scheme must be put in place to ensure that any ecotourism (an important facet of conservation given its capacity for education and awareness) is carried out in a sensible and sustainable manner.

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