

A note on long-distance matches of bottlenose dolphins (*Tursiops truncatus*) around the Irish coast using photo-identification

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ABSTRACT

Images of 120 individual bottlenose dolphins from around the Irish coast were obtained from three photo-identification catalogues. Twenty three individuals were subsequently re-sighted, which is a re-sighting rate of 19%. The distance between re-sightings ranged from 130 to 650km and the duration from 26 to 760 days. Images were also compared to a catalogue of resident dolphins from the Shannon Estuary candidate Special Area of Conservation and from Wales but no matches were found. This short study provides strong evidence that bottlenose dolphins in Irish coastal waters are regularly undertaking large movements around the entire Irish coast and must be considered highly mobile and transient. These results have important implications for the conservation and management of this species.

KEYWORDS: NORTHERN HEMISPHERE; BOTTLENOSE DOLPHIN; PHOTO-ID; MONITORING; DISTRIBUTION; CONSERVATION; MANAGEMENT PROCEDURE

INTRODUCTION

Common bottlenose dolphins (*Tursiops truncatus*) are found throughout temperate and tropical waters of the world between 60°N and 50°S of the equator and in the Mediterranean Sea (Reynolds *et al.*, 2000). Bottlenose dolphins are widespread and abundant in Irish waters (Ingram *et al.*, 2001), which contain some of the highest concentrations of this species in Europe (Evans, 1992).

Photo-identification (photo-ID) is a technique commonly used to study the movements and behaviour of whales and dolphins worldwide and was first applied to bottlenose dolphins by Würsig and Würsig (1977). This technique works on the principle of photographing individual animals and identifying natural markings unique to that individual (Thompson and Hammond, 1992; Wilson, 1995; Wilson *et al.*, 1999; Würsig and Würsig, 1977). Photo-identification provides a means to gather information on movement patterns, site fidelity, associations and population dynamics (Hammond *et al.*, 1990; Kerr *et al.*, 2005). Movement patterns are sometimes unpredictable, ranging from year-round residency in a defined area to seasonal or continual migrations (Shane *et al.*, 1986) and the use of natural markings as a means of tracking animals can prove extremely effective.

In Ireland, a number of studies using photo-ID of bottlenose dolphins have been carried out. Most of these were in the Shannon Estuary candidate Special Area of Conservation, cSAC (Berrow *et al.*, 1996; Englund *et al.*, 2007; Ingram and Rogan, 2002; Ingram, 2000). These studies have shown dolphins to be resident with a high level of site fidelity and very limited movements outside the cSAC. The only match outside the boundary of the cSAC was in Tralee Bay, less than 15km away. Additional unpublished studies have also found some degree of site fidelity at a number of other locations in Ireland, including Donegal Bay, Co. Donegal; Broadhaven and Clew Bays, Co. Mayo; Connemara, Co. Galway; Brandon Bay and Kenmare

River, Co. Kerry and Cork Harbour (Englund *et al.*, 2007; Ingram *et al.*, 2001; Ingram *et al.*, 2003; O'Brien *et al.*, 2008; O'Cadhla *et al.*, 2003; Wilson and Smiddy, 1988). In this paper, matches of individually recognisable bottlenose dolphins are reported from all around the Irish coast and some implications for management are discussed.

METHODS

Images of bottlenose dolphins from around the Irish coast were obtained from a number of sources (Table 1). The Galway-Mayo Institute of Technology (GMIT) maintain a photo-ID catalogue comprised of 48 identifiable individuals from Galway and Clew Bay (Catalogue 1). Between July and September 2008, systematic surveys were carried out in Donegal Bay by the Irish Whale and Dolphin Group (IWDG), some of which were funded by the National Parks and Wildlife Service (NPWS). A total of eight surveys were carried out and 45 individual dolphins were identified (Catalogue 2). The IWDG have recently established an online photo-ID catalogue for a range of cetacean species recorded in Irish waters. Included in this catalogue are 27 individual bottlenose dolphins with recognisable markings collected from around the Irish coast by IWDG members and the public and it is accessible online at <http://www.iwdg.ie/photo-id> (Catalogue 3). Images from all three catalogues were combined and are referred to as the Irish Coastal Bottlenose Dolphin Catalogue (ICBDC).

Images from these three catalogues totalling 120 individuals were compared to determine whether any matches could be found between them. All images from Donegal Bay, Galway Bay and Clew Bay were taken using high resolution digital cameras, with minimum file sizes of 1.5Mb for each image. Some of the images submitted by the public were of a lower resolution but were still of usable quality. All images were viewed using Adobe *Photoshop* imaging software, in order to identify unique markings.

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Table 1
Summary of individual bottlenose dolphin sightings and re-sightings.

No. animals identified	Details of 1 st sighting				Details of 1 st re-sighting					Details of 2 nd re-sighting				
	Catalogue no.	Date	Lat	Long	Date	Lat	Long	Time (days)	Distance (km)	Date	Lat	Long	Time (days)	Distance (km)
1	BNDIRL1	15/05/2007	51.85	-8.32	10/06/2007	51.74	-9.53	26	175					
2	GB20	26/03/2007	53.14	-9.28	10/05/2008	51.84	-8.27	76	380					
3	GB19	26/03/2007	53.14	-9.28	10/05/2008	51.84	-8.27	76	380					
4	BNDIRL24	17/06/2007	55.07	-6.02	15/08/2008	54.49	-8.37	423	280	30/04/2009	52.1	-10.3	258	390
5	GB01	29/06/2005	53.21	-9.68	30/07/2007	53.86	-9.94	760	130					
6	GB27	26/03/2007	53.14	-9.28	15/08/2008	54.49	-8.37	462	200					
7	GB16	26/03/2007	53.14	-9.28	08/08/2008	54.56	-8.43	506	300					
8	GB18	26/03/2007	53.14	-9.28	23/07/2008	54.56	-8.43	499	300					
9	GB22	26/03/2007	53.14	-9.28	02/07/2008	51.93	-10.28	483	300	23/07/2008	54.56	-8.43	386	375
10	GB23	26/03/2007	53.14	-9.28	23/07/2008	54.56	-8.43	483	300					
11	GB07	26/03/2007	53.14	-9.28	08/08/2008	54.56	-8.43	499	300	19/05/2009	55.1	-6.12	284	240
12	GB25	26/03/2007	53.14	-9.28	08/08/2008	54.56	-8.43	499	300					
13	GB08	26/03/2007	53.14	-9.28	15/08/2008	54.49	-8.37	490	300					
14	CB40	11/06/2007	53.80	-9.90	02/07/2008	51.93	-10.28	385	260					
15	BNDIRL17	02/06/2008	53.35	-6.15	31/08/2008	53.23	-9.56	90	600	19/05/2009	55.1	-6.12	261	460
16	BNDIRL11	10/05/2008	51.84	-8.27	08/08/2008	54.56	-8.43	89	650					
17	BNDIRL22	17/06/2007	55.1	-6.02	30/04/2009	52.1	-10.3	683	575					
18	DB35	15/08/2008	54.5	-8.37	30/04/2009	52.1	-10.3	258	365					
19	DB09	23/07/2008	54.6	-8.43	19/05/2009	55.1	-6.12	277	365					
20	DB18	08/08/2008	54.6	-8.43	19/05/2009	55.1	-6.12	284	260					
21	BNDIRL10	10/05/2008	51.8	-8.27	15/08/2008	54.5	-8.37	97	575	19/05/2009	55.1	-6.12	276	365
22	GB11	26/03/2007	53.1	-9.28	31/08/2009	53.2	-9.57	523	30	19/05/2009	55.1	-6.12	261	460
23	GB47	31/08/2008	53.2	-9.57	19/05/2009	55.1	-6.12	261	460					

Markings used to identify individuals included nicks or notches on the trailing edge of the dorsal fin (ranging from one to several), scratches and a condition described as scoliosis, an abnormal curvature of the spine (Berrow and O'Brien, 2005). Images were graded using a Q-scale (1-3), where grade 1 images were of good quality and were mostly used to initially identify an individual and also to confirm matches. Images of grade 2 were of lesser quality but were sometimes sufficient to verify a match, while grade 3 were determined poor quality and were therefore unusable. The images presented throughout this document are compressed and therefore do not represent their true quality when viewed in their original format. Distances between re-sightings were calculated using Garmin *Mapsource* software as the latitude and longitude was known for all sightings.

In order to further explore the movements of bottlenose dolphins in the ICBDC, comparisons were made with two additional catalogues, one from Ireland and one from the UK. The Shannon Dolphin and Wildlife Foundation (SDWF) manages a catalogue of around 180 individually recognisable bottlenose dolphins from the Shannon Estuary obtained between May 1993 and October 2008. Sea Watch Foundation (SWF) manages a catalogue of bottlenose dolphins from West and North Wales since the 1990s comprising of 219 marked individuals (recognisable from both sides through nicks, big scars or pigmentations), plus 112 individuals identifiable only from one side (with no nicks or big scars/pigmentations).

RESULTS

The ICBDC catalogue included images of 120 individually recognisable dolphins and of these 23 individuals have been re-sighted elsewhere (Table 1). This equates to an overall re-sighting rate of 19%. Most re-sighted individuals (14) were from the Galway Bay (GB) catalogue, 13 from Donegal Bay (DB) and 10 from the IWDG catalogue (Table 2). The latter catalogue included dolphins from Counties Antrim, Cork, Dublin, Kerry, Galway and Mayo (Table 1, Fig. 1). The 23 individual matches are shown below for each re-sighting.

Table 2
Summary of sighting rates from four bottlenose dolphin ID catalogues.

Catalogue	Total identified	Number re-sighted	Re-sighting rate	% of re-sightings
GMIT	48	15	0.3	31
IWDG	25	9	0.4	36
DB	42	14	0.3	33
Total	114	24	0.2	21
SDWF	209*	0	0	0
SWF	204*	0	0	0

*Not identified as part of this study.

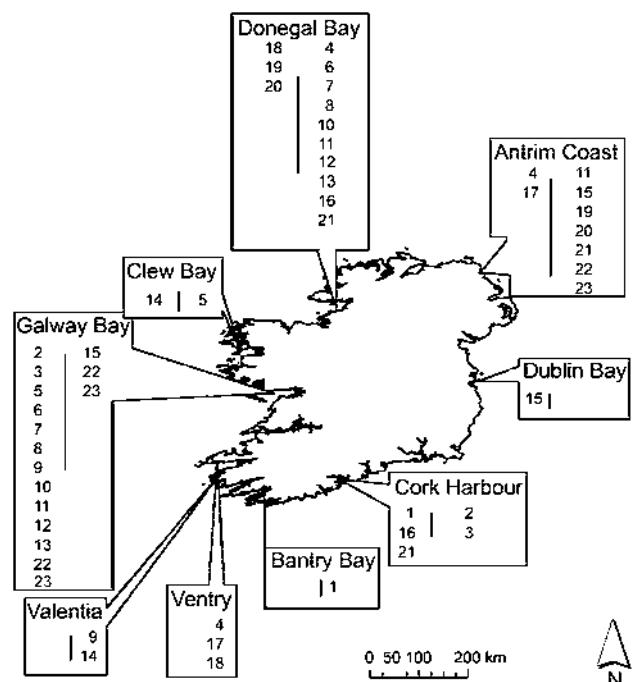


Fig. 1. Distribution map of bottlenose dolphin sightings (under each location column one represents where the animals was first sighted and column two represents where the animals was re-sighted). Numbers are according to Table 1, 'no. of animals identified'.

Of the 23 re-sighted dolphins, 13 animals (57%) were first identified in Galway Bay on 26 March 2007. Only 25 individual dolphins were identified amongst a group of 70–100 dolphins observed in Galway Bay and it is likely that if images of other individuals in this group were obtained, then additional matches would have been made as this group accounted for a high proportion of the long distance matches, e.g. Galway to Dublin (approximately 650km), Antrim (460km), Cork Harbour (380km) and Donegal Bay (300km). This group would appear to be highly migratory and transient as they were recorded across six months and three seasons, between the years 2005 and 2009 and therefore it is unlikely that these movements are seasonally influenced.

The time between sightings ranged from 26 to 760 days with a mean of 379 days (Table 1). The distances apart also ranged greatly from 130 to 650km with a mean of 400km. For three individuals the minimum mean distance travelled per day was recorded as 6.3km (BNDIRL1), 6.6km (BNDIRL17) and 7.3km (DB26).

No matches were found between the ICBDC catalogue and the SDWF or SWF catalogues from the Shannon Estuary and Wales. Intensive photo-ID is being carried out at both of these sites with high re-sighting rates, therefore re-sightings might be expected if dolphins from the ICBDC catalogue regularly entered these sites.

There was some evidence of associations between individuals; two dolphins (GB18 and GB22) recorded together in Galway Bay on 26 March 2007 were also recorded together in Donegal Bay on 23 July 2008; three dolphins (GB07, GB16, GB25) recorded on 26 March 2007 were together in Donegal Bay on 8 August 2008; two dolphins (GB19, GB20) in Galway Bay on 26 March 2007 were recorded together on 10 May 2008 in Cork harbour and two dolphins (GB07, GB11) recorded together in Galway Bay in March 2007 and a further two (GB11 and BNDIRL17) recorded in August 2008 were recorded together off Antrim in May 2009.

DISCUSSION

Results from the present study provide some of the most comprehensive evidence of wide-scale, long-distance movements of bottlenose dolphins in European waters. Re-sightings were recorded across three seasons between 2005 and 2009. These results demonstrate the potential of photo-ID as a technique for studying long-distance movements in this species. Previous photo-identification studies in Ireland recorded re-sightings of nine individuals, over two years off the south coast, 38km apart between Youghal Bay and Cork Harbour, and one individual first recorded off Connemara was re-sighted off the Cork coast, a distance of 380km (Ingram and Rogan, 2003). The only other comparable study carried out in European waters was by Wood (1998) who reported on the large-scale movements of Cornish dolphins during a three year period over a 650km stretch of coastline between Cornwall and West Wales. On one occasion he recorded a dolphin re-sighting of 1,076km in only 20 days, which was much greater than the maximum (650km) reported in the present study. It is, however, unclear as to whether there were regular movements of these distances or they were unique and may not have been a regular occurrence. More recently, Silva *et al.* (2008) reported long-distance movements of almost 300km by bottlenose dolphins in the Azores which were considered foraging or exploratory trips but they were unable to determine whether these wide-scale movements occurred year-round. Results

from studies elsewhere using satellite telemetry studies have recorded bottlenose dolphins travelling over large distances. Tanaka (1987) reported movements of bottlenose dolphins of 604km over an 18 day period, while Wells and Scott (1990) reported movements of 670km over a 74 day period.

The shortest time between sightings during the present study was between Portmagee, Co. Kerry and Donegal Bay (21 days) over a distance of 370km and between Cork Harbour and Glengarriff (26 days) over a distance of 175km. This means that these dolphins travelled a minimum of 6.7km and 17.6km per day. The re-sighting of dolphins 1,076km apart within 20 days reported by Wood (1998) requires travelling at an average of 54km per day.

The high re-sighting rate in the present study is remarkable, especially given that the sample size of individual dolphins was small. It is also remarkable that no dolphins from the Shannon Estuary cSAC were recorded outside the cSAC. It is suggested that a relatively small population of dolphins must occur around the Irish coast to produce such a high re-sighting rate. This suggestion is consistent with data from the SCANS II survey (SCANS II, 2008), which reported abundance estimates of bottlenose dolphin of 313 individuals (CV=0.81) for coastal Ireland. The present study suggests dolphins archived in the ICBDC are highly migratory and transient individuals.

Bottlenose dolphins are listed under Annex II of the EU Habitats Directive which requires that they be given strict protection in clearly identifiable areas (SACs). A total of 18 SACs have either been designated or proposed specifically for bottlenose dolphins within EU member states (Anon., 2006). In Ireland, there is currently only one candidate SAC for bottlenose dolphins (Shannon Estuary) on the west coast. It has been suggested from the western north Atlantic, that coastal stocks of bottlenose dolphins are comprised of residents, which are localised to certain areas, and transient animals, which migrate seasonally into and out of areas (Scott *et al.*, 1988). The evidence from Ireland supports this theory, since no matches were found between ICBDC and the Shannon Estuary, home to Ireland's only known resident group of bottlenose dolphins. Thus it can be speculated that the dolphins identified from around the Irish coast are transient and do not mix with the resident animals in the Shannon Estuary. The large-scale movement undertaken by these transient dolphins does create problems when trying to designate sites for their conservation, especially since these movements take them into both Irish and UK waters. Of the 23 re-sighted individuals, nine (39%) have been recorded off the Co. Antrim coast. Therefore the Irish government will need to work with the UK government to ensure successful conservation of the species. Wilson *et al.* (2004) reported on a population range expansion of bottlenose dolphins off northeast Scotland and suggested that site designations may afford less protection than originally envisioned. Our data suggest that some coastal dolphins regularly undertake long movements and site designation may not be suitable for species and habitat conservation. A better approach may involve a network of SACs with migrating corridors or a combination of habitat (site) designation and a more dynamic species conservation approach.

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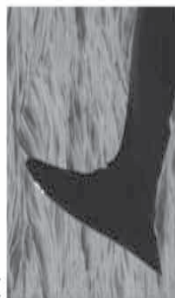
Date accepted: July 2009.

(1) BNDIRL1



BNDIRL1 Cork Harbour, 15/05/2007
Photo credit: Conor Ryan

(2) GB20



GB20 Galway Bay, 26/03/2007
Photo credit: Joanne O'Brien

(3) GB19



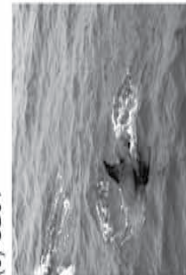
GB19 Galway Bay, 26/03/2007
Photo credit: Joanne O'Brien

(4) BNDIRL24



BNDIRL24 Antrim, 17/06/2007
Photo credit: Pauline Majury

(5) GB01



GB01 Galway Bay, 29/06/2005
Photo credit: Joanne O'Brien

(6) GB27



GB27 Galway Bay, 26/03/2007
Photo credit: Joanne O'Brien

(7) GB16



GB16 Galway Bay, 26/03/2007
Photo credit: Joanne O'Brien

(8) GB18



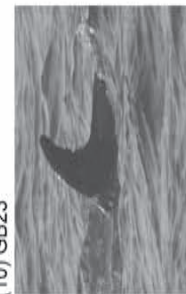
GB18 Galway Bay, 23/03/2007
Photo credit: Joanne O'Brien

(9) GB22



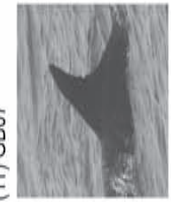
GB22 Galway Bay, 26/03/2007
Photo credit: Joanne O'Brien

(10) GB23



GB23 Galway Bay, 23/03/2007
Photo credit: Joanne O'Brien

(11) GB07



GB07 Galway Bay, 26/03/2007
Photo credit: Joanne O'Brien



DB14 Donegal Bay, 08/08/2008
Photo credit: Simon Berraw



GB07 North Antrim coast, 19/05/2009
Photo credit: Garry Burrows

(12) GB25



GB25 Galway Bay, 26/03/2007
Photo credit: Joanne O'Brien



DB27 Donegal Bay, 08/08/2008
Photo credit: Simon Berraw

(13) GB08



GB08 Galway Bay, 12/04/2007
Photo credit: Joanne O'Brien



DB32 Donegal Bay, 15/08/2008
Photo credit: Simon Berraw

(14) CB40

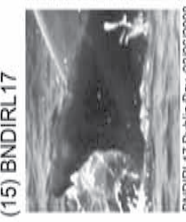


CB40 Clew Bay, 11/06/2007
Photo credit: Joanne O'Brien

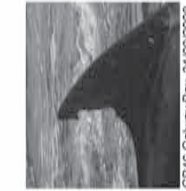


BNDIRL25 Portmagee, 02/07/2008
Photo credit: Phyllis Olsen

(15) BNDIRL17



BNDIRL17 Dublin Bay, 02/06/2008
Photo credit: Joanne O'Brien



GB46 Galway Bay, 31/03/2008
Photo credit: Joanne O'Brien



North Antrim coast, 19/05/2009
Photo credit: Garry Burrows



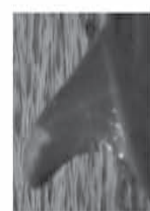
BNDIRL1 Bantry Bay, 10/06/2007
Photo credit: Maurice Fitzgerald



BNDIRL7 Cork Harbour, 10/05/2007
Photo credit: Conor Ryan



BNDIRL8 Cork Harbour, 10/05/2007
Photo credit: Conor Ryan



Ventry Harbour, 30/04/2009
Photo credit: Nick Massett



DB36 Donegal Bay, 15/08/2008
Photo credit: Simon Berraw



CB01 Clew Bay, 30/07/2007
Photo credit: Joanne O'Brien

(16) BNDIRL11



BNDIRL11 Cork Harbour, 10/05/2008
Photo credit: Conor Ryan



DB26 Donegal Bay, 08/08/2008
Photo credit: Simon Berrow

(20) DB18



DB18 Donegal Bay, 08/08/2008
Photo credit: Simon Berrow



North Antrim coast, 19/05/2009
Photo credit: Gary Burrows

(17) BNDIRL22



BNDIRL22 Antrim, 17/06/2007
Photo credit: Pauline Murray



BNDIRL22 Ventry Harbour, 30/04/2009
Photo credit: Nick Massett

(21) BNDIRL10



BNDIRL10 Cork Harbour, 10/05/2008
Photo credit: Conor Ryan



DB31 Donegal Bay, 15/08/2008
Photo credit: Conor Ryan



North Antrim coast, 19/05/2009
Photo credit: Gary Burrows

(18) DB35



DB35 Donegal Bay, 15/08/2008
Photo credit: Simon Berrow



Ventry Harbour, 30/04/2009
Photo credit: Nick Massett

(22) GB11



GB11 Galway Bay, 26/03/2007
Photo credit: Joanne O'Brien



North Antrim coast, 19/05/2009
Photo credit: Gary Burrows

(19) DB09



DB09 Donegal Bay, 15/08/2008
Photo credit: Simon Berrow



North Antrim coast, 19/05/2009
Photo credit: Gary Burrows

(23) GB47



GB47 Galway Bay, 31/08/2008
Photo credit: Joanne O'Brien



North Antrim coast, 19/05/2009
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