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Short Communication

Inter-island movements of common bottlenose dolphins *Tursiops truncatus* among the Canary Islands: online catalogues and implications for conservation and management

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A total of 313 individual common bottlenose dolphins *Tursiops truncatus* was photo-identified in four Special Areas of Conservation (SACs) in the western Canary Islands, Spain (El Hierro, La Palma, La Gomera and Tenerife), over a 10-year period (2001–2011). Of these, 36 individuals were resighted subsequently off two or more different islands, determined using online and conventional photo-identification catalogues. This study provides the first evidence of regular, long-distance movements undertaken by common bottlenose dolphins in the Canary Islands. Distances travelled ranged from 30 to 130 km between islands, demonstrating that the species is highly mobile within the archipelago. These results have important implications for the conservation and management of this species in this region and highlight the need to evaluate the efficiency of existing SACs and to further explore residency patterns.

Keywords: marine protected area, photo-identification, SAC, site fidelity

Introduction

The common bottlenose dolphin *Tursiops truncatus* is a cosmopolitan species distributed in all oceans of the world (Rice 1989; Jefferson et al. 1994; Wells and Scott 2002). Despite the fact that this is one of the most-studied cetacean species, information about its movements and home ranges around oceanic islands remains scarce.

The bottlenose dolphin has been recorded in waters off all the Canary Islands. Twelve Special Areas of Conservation (SACs) have been designated under the European Habitat Directive to protect the species and its habitat in the archipelago. Despite several studies on cetacean abundance and distribution in the islands (Martín et al. 2000; Mayr and Ritter 2005; Pérez-Vallazza et al. 2008), few data are available from photo-identification (photo-ID) studies. This technique is a powerful tool for monitoring the movements and home ranges of cetaceans (e.g. Würsig and Würsig 1977; Hammond et al. 1990; Dufault and Whitehead 1995) as well as sharks (e.g. Delaney et al. 2012). Photo-ID studies have shown that range patterns of individual bottlenose dolphins can vary from small (25–65 km; Ballance 1992) to large displacements (165–4 200 km; Wells and Scott 1990; Wells et al. 1999; Silva et al. 2008; O'Brien et al. 2009; Robinson et al. 2012), depending on a variety of factors that include food availability, reproductive cycle, season, calf care (Würsig and Würsig 1977; Würsig et al. 1991; Bearzi et al. 1999) and species ecotype (Hersh and Duffield 1990; Kenney 1990; Mead and Potter 1995; Walker et al. 1999). Presently there is insufficient information to identify any ecotype(s) present in the Canary Islands. Also, there are few data about the home range of bottlenose dolphins in the archipelago.

This study describes for the first time inter-island movements of bottlenose dolphins in the Canary Islands, based on photo-ID data collected by several local research groups over a period of more than 10 years. Also, we present a new, public, online catalogue for Canary Island bottlenose dolphins and discuss its potential use as a tool for the management of this species within marine protected areas.

Material and methods

Bottlenose dolphin movements between islands were recorded using standard photo-ID methods. Photographs were taken over the period 2000 to 2011 off El Hierro, La Palma, Tenerife and La Gomera (Figure 1). Sources of the images and related sightings data are presented in Table 1. Using a 10-year subset of the data, from 2001 to 2011, individual dolphins were identified from natural markings visible from photographs of the dorsal fin, and only those with clear and permanent marks were compared (Würsig and Würsig 1977; Hammond et al. 1990; Wilson et al. 1999).

Dorsal fin images were entered into a digital database using the software Darwin 2.0 (Eckerd College), which was used to assist the matching of individual dolphins (Figure 2). All individuals from El Hierro, La Palma and La Gomera were combined in the same catalogue. Photographs archived at the University of La Laguna and MEER were included in the 'Cetaceans sighting database' (www.cetabase.info), the first online photo-ID catalogue for the Canary Islands. This tool allows the sharing of images that are stored in a database that includes information about species, sighting location and area, number of animals, image quality categories and natural markings on individual animals. Individuals resighted off more than one island were classified as 'travellers'.

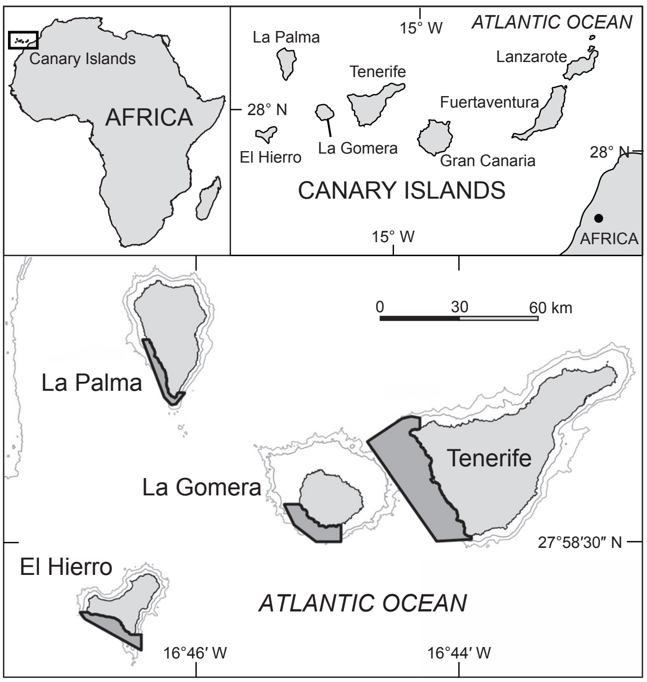

Figure 1: Study area in the western Canary Islands. Common bottlenose dolphins were photographed in four Special Areas of Conservation (shaded): Mar de las Calmas (ES7020057) off El Hierro; Franja marina Santiago-Valle Gran Rey (ES7020123) off La Gomera; Franja marina de Fuencaliente (ES7020122) off La Palma and Franja marina Teno-Rasca (ES7020017) off Tenerife

Results

A total of 313 dolphins was identified: 166 individuals were photographed off El Hierro, 70 off La Palma and 87 off La Gomera. In an earlier study off Tenerife, 30 animals were catalogued by Verme and Iannacone (2011), and these data were included in our study. Sampling period and effort by location are detailed in Table 1.

In all, 36 individuals were classified as travellers, constituting 10.2% of all identified animals. Of these, five were females, identified by their close association with calves (as defined by Grellier et al. 2003), and 31 were of unknown gender (Table 2). Traveller dolphins showed different degrees of site fidelity. Three dolphins were photographed in consecutive years off El Hierro: two of them were documented over three years (Tt110IC and Tt083IC) and the other was observed over four years (Tt036IC) (Table 2). Other dolphins showed less site fidelity, with 17 individuals resighted over two non-consecutive years at the same island and 16 sighted only once.

The degree of movement between islands also varied among travellers. Of the 36 individuals, 32 were observed at two islands and only four were recorded at three islands.

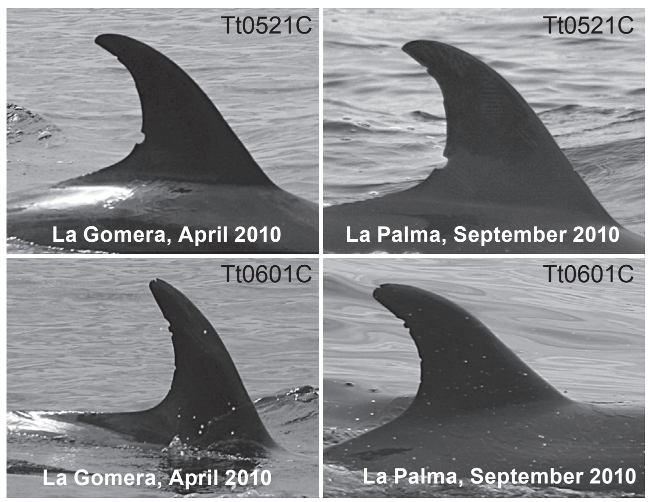

Figure 2: Dorsal fins of two identified bottlenose dolphins (Tt052IC and Tt060IC) resighted at different islands (La Palma and La Gomera)

Table 1: Sighting effort, number of marked dolphins and observed travellers for each island

Parameter	El Hierro	La Palma	La Gomera	Tenerife
Special Area of Conservation	ES7020057	ES7020122	ES7020123	ES7020017
Study period	2004–2011	2010–2011	2000–2011	2005–2006
Photo-ID effort (days)	67	20	43	161
Photographs selected (no.)	14 000–15 000	1 500–2 000	1 000–1 500	3 000
Identifiable dolphins (no.)	166	70	87	30
Travellers (no.)	30	26	12	6
Source	ULL	ULL	MEER	Verme and Iannacone (2011)

MEER: Mammals, Encounters, Education and Research, Berlin
ULL: Department of Animal Biology, University of La Laguna, Tenerife

Of these four, one (Tt035IC) was recorded off La Palma, La Gomera and Tenerife, and three were seen off El Hierro, La Palma and La Gomera. Two of these dolphins (Tt002IC and Tt044IC) were sighted together in three consecutive years (2008, 2009 and 2010; Table 2) off different islands, indicating long-term associations between the individuals. The same two animals were also resighted together with two other travellers (Tt007IC and Tt032IC) off El Hierro and La Palma. All travellers identified in our study were associated with others.

The distance between resightings of traveller dolphins ranged from 30 km (between Tenerife and La Gomera) to 130 km (between Tenerife and El Hierro), with an average of 65 km (SD 36). Within the total of 53 months analysed during the study period, travellers were detected in 39 months (74%). The average interval between first and last sightings of travellers was 36 months (SD 0.93). Intervals between consecutive resightings of the same individual off different islands varied between one and 84 months, at distances of 80–130 km apart.

Discussion

Cetaceans can travel long distances for feeding and reproductive purposes (Hoelzel 1998). There may be intraspecific differences in movement patterns and home range sizes, reflecting adaptations to specific habitats (Botsford and Lawrence 2002; Chivers et al. 2006; Klaassen et al. 2012). Hence the study of movement patterns and home ranges of individuals is important in understanding the ecology of cetacean populations, especially for protected species that require conservation and management (Austin et al. 2004). However, monitoring movement patterns in cetacean species that have extended home ranges is difficult and costly. Cooperative studies among research groups at different locations, using tools such as online photo-ID catalogues, can help to overcome these challenges. For example, a combination of conventional catalogues of coastal bottlenose dolphins and an online catalogue assisted O'Brien et al. (2009) to elucidate dolphin movements around Ireland. All of these movements were outside the SACs

Table 2: Resighting locations of 36 bottlenose dolphins photo-identified off four of the Canary Islands (El Hierro [EH], La Palma [LP], La Gomera [LG] and Tenerife [TF]), 2002–2011

Individual	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Tt002IC							EH	LG	LP	
Tt007IC							EH		LP	EH
Tt016IC							EH		LP	EH
Tt017IC ♀							EH	EH	LP	
Tt018IC			EH						LP	
Tt027IC							EH		LP	
Tt031IC									LP	EH
Tt032IC							EH	EH	LP	
Tt033IC									LP	EH
Tt034IC							EH		LP	EH
Tt035IC				TF*	TF*				LP, LG	
Tt036IC ♀			EH	EH			EH	EH	LP	
Tt039IC					EH				LP	
Tt040IC		LG		EH					LP	EH
Tt044IC							EH	LG	LP	
Tt049IC			EH				EH		LP	
Tt050IC ♀				EH			EH		LP	
Tt052IC									LP, LG	
Tt056IC									LP, LG	
Tt060IC									LP, LG	
Tt062IC ♀					EH				EH, LP	
Tt064IC				TF*	TF*		EH			
Tt074IC							EH		EH	LG
Tt082IC							EH		LP	EH
Tt083IC								EH	EH, LG	EH
Tt093IC			EH					EH	LP	
Tt110IC	LG							EH	EH	EH
Tt114IC			EH					EH		LG
Tt118IC				TF*	TF*		EH			
Tt141IC ♀									EH, LP	
Tt148IC				TF*	TF*				EH	
Tt165IC				TF*, EH	TF*, EH					
Tt188IC							EH		LP	EH
Tt216IC			EH			LG				
Tt243IC									LP	LG
Tt258IC				TF*	TF*					LG

* Data for Tenerife from Verme and Iannacone (2011). Sightings data combined for two-year period 2005–2006
♀ Individuals Tt017IC, Tt036IC, Tt050IC, Tt062IC and Tt141IC were classified as females. The rest were of unknown gender

designated for the species, and hence the research had the potential to inform management decisions. Similarly, the comparison of the three photo-ID catalogues carried out in the present study led to the detection of dolphin movements between four islands of the Canary Islands archipelago. Hence the technique can be used to study the distribution, home range and connectivity of bottlenose dolphins in the archipelago and neighbouring areas.

Our study demonstrated that a minimum of 36 individuals travelled between islands in the western Canary Islands. This constituted 10.2% of the 313 catalogued individuals, which is similar to the 7% of 966 individuals sighted in the Azores archipelago (Silva et al. 2008). Site fidelity was apparently higher off the Hawaiian Islands (<1% of 336 individuals were travellers; Baird et al. 2009) and off Abaco Island in the Bahamas (2% of 247 individuals; Parsons et al. 2006). Individuals classified as travellers may, however, show some degree of site fidelity to an island. In our study, three individuals (Tt110IC, Tt083IC and Tt036IC; Table 2) were associated with El Hierro. Similarly, in the Greek Mediterranean Sea, nine bottlenose dolphins were sighted at two sites that were 200 km apart, yet showed high fidelity to one of these sites (Bearzi et al. 2010).

Reasons for inter-island movements may include the search for food, or reproduction (Hooker and Gerber 2004). In some locations the movements of bottlenose dolphins have been shown to be strongly related to enhanced prey abundance as a result of high primary productivity (Würsig and Würsig 1977; Würsig et al. 1991; Silva et al. 2008; Berens McCabe et al. 2010). The oligotrophic waters of the Azores and Canary Island archipelagos (Braun 1980) may explain the high mobility of bottlenose dolphins compared with those from the Hawaiian Islands, where primary productivity in shallow coastal waters is higher (Hooker and Gerber 2004; Silva et al. 2008; Baird et al. 2009). Dolphin prey in the western Canary Islands may have a more patchy distribution and may be of lower density.

To be protected effectively, these highly mobile animals require large marine protected areas (MPAs) that would include parts of their oceanic (offshore) habitat (Game et al. 2009). Currently, there are 12 SACs that are designated for conservation of the bottlenose dolphin and the loggerhead sea turtle *Caretta caretta* in the Canary Islands. However, they cover only relatively small coastal areas. In the Azores, Silva et al. (2012) showed that the boundaries of a local inter-island MPA should be extended in order to be ecologically meaningful with regard to the protection of bottlenose dolphins. Likewise, our results show that the distribution of bottlenose dolphins may exceed the limits of the existing SACs in the study area, and that home ranges of the species may include more than one island. The offshore areas between the islands appear to be an important – perhaps even essential – part of their habitat, a fact that should be taken into consideration in the amendment of the management plans and revisions of the boundaries of SACs.

Our findings are also of relevance as input into population abundance estimates for the archipelago. Most data, however, were from a single island, El Hierro. Potentially, with greater research effort at other islands, or with more users of the online database and greater collaboration between them, the proportion of travellers in the population may be shown to be higher than suggested by our study. If so, simple summation of the number of animals observed at each island would result in an overestimation of the total population size.

The results presented here should be regarded as preliminary. They demonstrate that further studies are required in order to investigate bottlenose dolphin residency and the frequency of inter-island movements in the Canary Islands archipelago, and also to investigate the importance of inter-island offshore habitats.

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References

Austin D, Bowen WD, McMillan JI. 2004. Intraspecific variation in movement patterns: modeling individual behaviour in a large marine predator. *Oikos* 105: 15–30.

Ballance LT. 1992. Ranges and habitat utilization patterns of the bottlenose dolphin, *Tursiops truncatus*, in the Gulf of California, Mexico. *Marine Mammal Science* 8: 262–274.

Baird RW, Gorgone AM, McSweeney DJ, Ligon AD, Deakos MH, Webster DL, Schorr GS. 2009. Population structure of island-associated dolphins: evidence from photo-identification of common bottlenose dolphins (*Tursiops truncatus*) in the main Hawaiian Islands. *Marine Mammal Science* 25: 251–274.

Bearzi G, Bonizzoni S, Gonzalvo J. 2010. Mid-distance movements of common bottlenose dolphins in the coastal waters of Greece. *Journal of Ethology* 29: 369–374.

Bearzi G, Politi E, Notarbartolo di Sciara G. 1999. Diurnal behavior of free-ranging bottlenose dolphins in the Kvarneric (northern Adriatic Sea). *Marine Mammal Science* 15: 1065–1097.

Berens McCabe EJ, Gannon DP, Barros NB, Wells RS. 2010. Prey selection by resident common bottlenose dolphins (*Tursiops truncatus*) in Sarasota Bay, Florida. *Marine Biology* 157: 931–942.

Botsford L, Lawrence C. 2002. Patterns of co-variability among California Current chinook salmon, coho salmon, Dungeness crab, and physical oceanographic conditions. *Progress in Oceanography* 53: 283–305.

Braun JG. 1980. Estudios de producción en aguas de las Islas Canarias. Hifrografía, nutrientes y producción primaria. *Boletin del Instituto Español de Oceanografía* 5: 147–154.

Chivers SJ. 2009. Cetacean life history. In: Perrin WF, Würsig B, Thewissen JGM (eds), *Encyclopedia of marine mammals* (2nd edn). San Diego: Elsevier Press. pp 215–220.

Delaney DG, Johnson R, Bester MN, Gennari E. 2012. Accuracy of using visual identification of white sharks to estimate residency patterns. *PLoS ONE* 7: e34753.

Dufault S, Whitehead H. 1995. An assessment of changes with time in the marking patterns used for photoidentification of individual sperm whales, *Physeter macrocephalus*. *Marine Mammal Science* 11: 335–343.

Game ET, Grantham HS, Hobday AJ, Pressey RL, Lombard AT, Beckley LE, Gjerde K, Bustamante R, Possingham HP, Richardson AJ. 2009. Pelagic protected areas: the missing dimension in ocean conservation. *Trends in Ecology & Evolution* 24: 360–369.

Grellier K, Hammond PS, Wilson B, Sanders-Reed CA, Thompson PM. 2003. Use of photo-identification data to quantify mother–calf association patterns in bottlenose dolphins. *Canadian Journal of Zoology* 81: 1421–1427.

Hammond PS, Mizroch SA, Donovan GP. 1990. Individual recognition of cetaceans: use of photo-identification and other techniques to estimate population parameters. *Reports of the International Whaling Commission* (Special Issue 12): 3–17.

Hersh SL, Duffield DA. 1990. Distinction between northwest Atlantic dolphins based on hemoglobin profile and morphometry In: Leatherwood S, Reeves RR (eds), *The bottlenose dolphin*. San Diego: Academic Press. pp 129–164.

Hoelzel AR. 1998. Genetic structure of cetacean populations in sympatry, parapatry and mixed assemblages: implications for conservation policy. *The Journal of Heredity* 89: 451–458.

Hooker SK, Gerber LR. 2004. Marine reserves as a tool for ecosystem-based management: the potential importance of megafauna. *BioScience* 54: 27–39.

Jefferson TA, Leatherwood S, Webber MA. 1994. *FAO species identification guide. Marine mammals of the world.* Rome: Food and Agriculture Organization.

Kenney RD. 1990. Bottlenose dolphins off the northeastern United States. In: Leatherwood S, Reeves R (eds), *The bottlenose dolphin*. London: Academic Press, Inc. pp 369–386.

Klaassen M, Hoye BJ, Nolet B, Buttemer W. 2012. Ecophysiology of avian migration in the face of current global hazards. *Philosophical Transactions of the Royal Society of London, Series B* 367: 1719–1732.

Martín V, Carrillo M, López Jurado LF. 2000. Life project technical report: Apoyo a la Conservación de la tortuga boba *Caretta caretta* y del delfín mular *Tursiops truncatus* en las Islas Canarias. Consejería de Política Territorial y Medio Ambiente Gobierno de Canarias.

Mayr I, Ritter F. 2005. Photo-identification of rough-toothed dolphins off La Gomera (Canary Islands) with new insights into social organization. In: Abstract book. 19th Annual Conference of the European Cetacean Society, 2–7 April 2005, La Rochelle, France. p 77-f.

Mead JG, Potter CW. 1995. Recognizing two populations of the bottlenose dolphin (*Tursiops truncatus*) off the Atlantic coast of North America: morphologic and ecologic considerations. *IBI Reports* [International Marine Biology Institute, Kamogawa, Japan] 5: 31–44.

O'Brien J, Berrow S, Ryan C, McGrath D, O'Connor I, Pesante G, Burrows G, Massett N, Klötzer V, Whooley P. 2009. A note on long-distance matches of bottlenose dolphins (*Tursiops truncatus*) around the Irish coast using photo-identification. *Journal of Cetacean Research Management* 11: 71–76.

Parsons KM, Durban JW, Claridge DE, Herzing DL, Balcomb KC, Noble LR. 2006. Population genetic structure of coastal bottlenose dolphins (*Tursiops truncatus*) in the northern Bahamas. *Marine Mammal Science* 22: 276–298.

Pérez-Vallazza C, Álvarez-Vázquez R, Cardona L, Pintado C, Hernández-Brito J. 2008. Cetacean diversity at the west coast of La Palma Island (Canary Islands). *Journal of Marine Biological Association of the United Kingdom* 88: 1289–1296.

Rice WR. 1989. Analysing tables of statistical tests. *Evolution* 43: 223–225.

Robinson K, O'Brien JM, Berrow S, Cheney B, Costa M, Eisfeld SM, Haberlin D, Mandleberg L, O'Donovan M, Oudejans MG, Ryan C, Stevick PT, Thompson PM, Whooley P. 2012. Discrete or not so discrete: long distance movements by coastal bottlenose dolphins in UK and Irish waters. *Environmental Research* 12: 365–371.

Silva MA, Prieto R, Magalhães S, Seabra MI, Santos RS, Hammond PS. 2008. Ranging patterns of bottlenose dolphins living in oceanic waters: implications for population structure. *Marine Biology* 156: 179–192.

Silva MA, Rui P, Magalhaes S, Seabra MI, Machete M, Hammond PS. 2012. Incorporating information on bottlenose dolphin distribution into marine protected area design. *Aquatic Conservation: Marine and Freshwater Ecosystems* 22: 122–133.

Verme V, Iannacone J. 2011. A photo-identification catalogue of bottlenose dolphin (*Tursiops truncatus*) in the Canary Islands, Spain: a baseline information for its conservation. *The Biologist* (Lima) 9: 105–119.

Walker JL, Potter CW, Macko SA. 1999. The diets of modern and historic bottlenose dolphin populations reflected through stable isotopes. *Marine Mammal Science* 15: 335–350.

Wells R[S], Rhinehart H, Cunningham P. 1999. Long distance offshore movements of bottlenose dolphins. *Marine Mammal Science* 15: 1098–1114.

Wells RS, Scott MD. 1990. Estimating bottlenose dolphin population parameters from individual identification and capture-recapture techniques. *Reports of the International Whaling Commission* (Special Issue 12): 407–415.

Wells RS, Scott MD. 2002. Bottlenose dolphins: *Tursiops aduncus* and *Tursiops truncatus*. In: Perrin WF, Würsig B, Thewissen JGM (eds), *Encyclopedia of marine mammals.* San Diego: Academic Press. pp 122–128.

Wilson B, Hammond PS, Thompson PM. 1999. Estimating size and assessing trends in a coastal bottlenose dolphin population. *Journal of Applied Ecology* 9: 288–300.

Würsig B, Cipriano F, Würsig M. 1991. Dolphin movement patterns: information from radio and theodolite tracking studies In: Pryor K, Norris KS (eds), *Dolphin societies: discoveries and puzzles*. Berkeley: University of California Press. pp 79–111.

Würsig B, Würsig M. 1977. The photographic determination of group size, composition and stability of coastal porpoises (*Tursiops truncatus*). *Science* 198: 755–756.

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