Aquatic Mammals 2003, **29.3,** 378–382

Bottlenose dolphins using the Sound of Barra, Scotland

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Abstract

Though widely reported around the European Atlantic coast, details relating to the overall distribution and site fidelity of bottlenose dolphins (*Tursiops truncatus*) in these waters remains poorly documented. Studies in areas where the majority of sightings occur have found evidence of seasonal, or year round, residency and social interaction among sympatric individuals. However, the degree of individual and genetic mixing between these studied communities, and their relevance to true biological populations, remains largely unknown. To better understand the wide-scale population structure of bottlenose dolphins off Western Europe, these lesser-known concentrations also need to be investigated.

In this study, we examined one such area off the west coast of Scotland where bottlenose dolphins have been repeatedly sighted. The Sound of Barra is a shallow passage between two of a chain of islands, the Outer Hebrides, that run roughly north-south 50 to 70 km west of the Scottish mainland. Boat based surveys were carried out in the Sound in September 1995 and June 1998. Bottlenose dolphins were found during both survey periods. Repeat identifications of the same individuals in both years suggested that animals are site faithful. Application of photo-identification data to a two-sample Petersen mark-recapture analysis suggested that this community is small, at between six to 15 individuals.

The results of this study enhance knowledge of bottlenose dolphin distribution and site fidelity off western Europe and we suggest that there is little, if any, regular interchange of individuals occurring between the Barra group and its nearest known neighbouring large community off eastern Scotland. The relative importance and long-term viability of small clusters of animals, such as those in the Sound of Barra, compared to the larger, better known, communities remains to be established.

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Key words: bottlenose dolphin, distribution, Europe, management procedure, mark-recapture, movements, photo-identification, site fidelity, *Tursiops*.

Introduction

Bottlenose dolphins (*Tursiops truncatus*) are among the best known and widespread of the small cetaceans, occurring in nearly all tropical and temperate seas (Leatherwood & Reeves, 1983). Studies in coastal areas suggested that they often form discrete resident assemblages, termed communities, within which each individual will associate with most others (Wells *et al*., 1987; Williams *et al*., 1993; Wilson, 1995; Bearzi *et al*., 1997; Ingram, 2000). Community size appears variable, ranging from just a few individuals, to a hundred or more (Wells & Scott, 1990; Williams *et al.* 1993; Wilson *et al*., 1999). These units could be geographically isolated, or have ranges that directly abut (Wells *et al*., 1987; Wilson *et al*., 1999). Interchange of individuals or genetic material has only been quantified in one area. In this case, directly abutting communities off western Florida appeared to exchange few individuals in any particular year (<3%). However, genetic interchange associated with breeding was relatively high, with 32% of calves being sired by males from other communities (Wells & Scott, 1990; Duffield & Wells, 1991). Corresponding levels of interchange between geographically separated populations are unknown, as is their relationship to true biological populations. Being apparently widespread, these communities are perhaps an integral part of bottlenose dolphin social organization and are, therefore, important in both ecological studies and conservation of coastal dolphin populations.

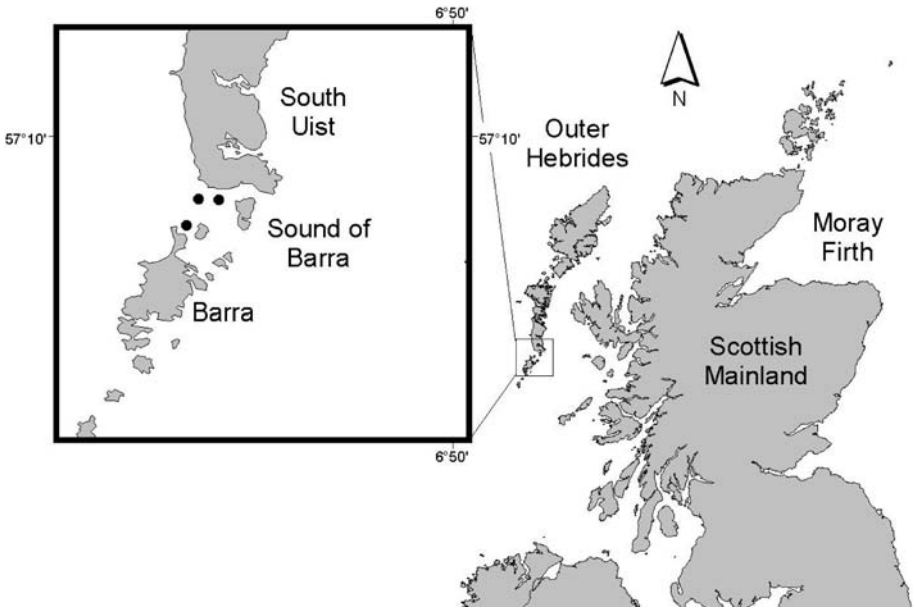

Figure 1. Map of Scotland with an expanded view showing the Sound of Barra. Filled circles denote locations of bottlenose dolphin sightings.

The coastal distribution of bottlenose dolphins off northwestern Europe is discontinuous and is broken into a series of discrete regions. Current areas where bottlenose dolphins are consistently seen include offshore islands around Brittany, France (Guinet *et al*., 1993), various parts of the English Channel, including waters around the Channel Islands, Durlstone Head, Devon and Cornwall (Williams *et al*., 1997; Wood, 1998), Cardigan Bay, Wales (Arnold, 1993), off southern and western Ireland (Evans, 1992; Berrow *et al*., 1996; Ingram & Rogan, 2002) and around the Moray Firth and the adjacent Scottish east coast (Wilson *et al*., 1999). While regularly seen in these locations, the number of individuals and patterns of long term residence have only been documented for a few, and levels of individual or genetic interchange between communities are undescribed. In addition to these known or suspected communities, anecdotal sightings of bottlenose dolphins are occasionally reported from other areas. One such area is the Sound of Barra, northwest Scotland, where records of cetacean sightings have been kept on a regular basis since 1993 (M. Bones & J.A. Campbell, pers. comm.).

In this study, we investigated the numbers and site fidelity of bottlenose dolphins reported in the Sound of Barra. Our results suggested that the community is small and, if not resident, has used the area over a period of at least 3 years. Implications of these findings in the wider context of neighbouring communities are discussed.

Materials and Methods

The Outer Hebrides is an island archipelago 50 to 70 km west of the Scottish mainland. The Sound of Barra separates the islands of Barra and South Uist at the southern end of the Hebridean island chain (Figure 1). The Sound is less than 10 km across at its widest point and its shallow waters (typically less than 10 m deep) are interspersed by several small islets. The seabed is composed of sand, rock, and kelp beds (Admiralty Chart No. 2,770; 1987). Waters east and west of the Sound are deeper and more exposed, typifying the open sea.

Forty-two hours of boat based search effort in sea states less than Beaufort Force 4 were conducted in the Sound during 9 days in September 1995 and 2 days in June 1998. Surveys were carried out from an 11.5 m (12 person) passenger ferry, a small fishing boat, and a 27.4 m chartered sailing vessel. Between one and four observers were positioned at vantage points on the boats and scanned the sea by eye and using binoculars. Observations were made from heights of between 3 m and 26 m above the water. A VHF radio was used to contact other boats to extend our search effort. When dolphins were found, the survey vessel slowly approached them, and ran parallel to their

Table 1. Bottlenose dolphins photographed on the left (L) or right (R) sides of their dorsal fins during surveys in 1995 and 1998 and matches between years.

Dolphin ID no.	1995		1998	Years seen
	9 September	14 September	12 June	
1	L	L	L, R	Both
2	R	L, R	L, R	Both
3	L		L, R	Both
4	L	L, R		1995 only
5			L, R	1998 only
6		R	L, R	Both
7	L			1995 only
8	R	R		1995 only
Group size	7–10	6–8	5	
No. ID'd	6	5	5	

course. At this point, the number of individuals was counted, the location was noted and photo-identification pictures (Würsig & Würsig, 1977) were taken using autofocus cameras and colour slide film. A school was defined as 'all animals within 100 m of each other engaged in similar activities' (after Wells *et al*., 1987).

To estimate site fidelity and numbers, individual dolphins were identified from photographs using unique markings, such as scratches and nicks, on their dorsal fins and backs (Würsig & Würsig, 1977; Wilson *et al*., 1999). Only pictures of high quality were considered and all individuals photographed bore sufficient marks to be individually identifiable in these pictures. A two-sample Petersen estimator was fitted to individual sightings records from photographs taken in 1995 and 1998 following the protocol outlined by Smith *et al.* (1999).

Results

Bottlenose dolphins were seen during both 1995 and 1998 surveys. Body size varied, but no dolphins small enough to be dependent calves (<4 years-old) were observed.

Dolphins were always found in schools. School sizes ranged from five to 10 individuals (Table 1). Sightings in both years were within the Sound (Figure 1). The dolphins engaged in a variety of behaviours, including approaching boats, riding bow and stern waves, and leaping clear of the water.

Photographs taken of animals in each school showed that individuals had unique markings, including skin scratches and dorsal fin nicks. Using these marks, between six and seven individuals were identified in 1995 (Table 1), four of which were seen on both days. Of these animals, four had marks that were still recognizable in pictures taken in 1998. In addition, one apparently new identification was made in 1998. It is unclear whether this addition represented a new individual not seen in 1995, or was one of the individuals previously seen, but not subsequently recognized due to mark loss in the intervening years.

Assuming demographic closure, application of a Petersen estimator to the photographic data in the 2 years yielded separate left- and right-side dorsal fin estimates with upper and lower 95% log normal confidence intervals ranging from six to 15 individuals (variances ranged from 1.8 to 5, Table 2).

Discussion

The re-identification in 1998 of the same bottlenose dolphins originally photographed in 1995 suggested that the dolphins either repeatedly use the Sound of Barra or are resident. While 129 ($\pm$ 15) bottlenose dolphins were estimated to use the Moray Firth and surrounding parts of the Scottish east coast (Wilson *et al*., 1999), the numbers occurring in the Sound of Barra are smaller. The largest single school seen in either year of this study was of seven to 10 individuals and, coupled with the mark-recapture estimate, this suggested a total number of dolphins in the range 15 or fewer individuals. It is possible that we encountered the same individuals by chance; if so then the community could well be bigger than we suggest here. At this time, it is unclear what proportion of bottlenose dolphins occupying the whole Scottish west coast these dolphins represent. Sightings occur in other west coast regions, with groups typically being reported in localized areas for periods of days, weeks, or months (Branson, 1999; Jeewoonarain, 2000). Comparison of photo-identification pictures of these bottlenose dolphins with those from the Sound of Barra could help determine how many animals use the Scottish west

Table 2. Results of two-sample Petersen mark-recapture estimates comparing photo-identification pictures collected in 1995 versus 1998.

Side	Estimate	Variance	Log-normal 95% CIs lower	upper
Left	8	1.8	5.8	11.1
Right	9	5	5.6	14.5

coast and delimit the range of the animals seen in the Sound of Barra. Certainly, no matches were found between photographs of Barra dolphins, and the 10-year archive of pictures from the east coast of Scotland (Aberdeen University, unpublished data), suggesting that high rates of mixing or translocation do not occur between these two groups. This is consistent with the conclusions of Wilson *et al.* (1999) who found rates of recruitment in the Moray Firth community concordant with the number of calves born, rather than the ingress of individuals from other communities. However, simple comparisons of photographic archives of individuals from different communities have limited power to detect low rates of translocation or temporary migrations that might be associated with breeding. Targeted studies of age groups likely to disperse or, better still, studies of genetic similarity between communities and paternity of calves, are likely to give a better indication of the relationship between geographically defined communities and the biological population(s) in European waters. However, in the absence of genetic sampling, maintaining or increasing photo-identification effort in this and other wider areas could also prove useful; photo-identification is currently the only technique used at an individual level, and efforts at wider geographic scales could yield useful data on community cross-over and individual ranging patterns.

At present, dispersed small aggregations of bottlenose dolphins, such as those in the Sound of Barra, have the potential to represent remnant, stable or founding communities, productive or non-productive breeding units, genetic islands, or genetic corridors. Clearly, until they are better understood, they should not be overlooked when trying to understand the wide-scale community ecology of coastal bottlenose dolphins in European waters.

In addition to coastal sightings, bottlenose dolphins are occasionally encountered in oceanic waters to the west of the British Isles and have been caught in the Faeroes pilot whale drive fishery at 62°N (Bloor *et al.*, 1996; Stone, 1998). The relationship between these dolphins and those resident in coastal waters along the European seaboard is unclear. In the western Atlantic, distinct forms termed ecotypes (differing in morphology, blood chemistry and genetic make-up) are found in abutting coastal and offshore habitats (Hersh & Duffield, 1990; Hoelzel *et al.*, 1998); off southern Africa, inshore and offshore types are less distinct from each other (Hoelzel *et al.*, 1998). Whether bottlenose dolphins of more than one type occur off NW Europe is unknown. However, if interchange between offshore and coastal communities were to occur, the effective population size of 'coastal' dolphins off northwestern Europe would be far larger than is currently recognized. Therefore, long-term management of coastal dolphins also would need to take into account impacts on animals in offshore areas.

Regardless of their relationship with other communities, highlighting that bottlenose dolphins display some degree of site fidelity in the Sound of Barra is another important step in mapping the European distribution of bottlenose dolphins. Furthermore, with local issues such as the recent construction of a causeway spanning part of the Sound (Scott, 2001), fishing and oil-related activities, and the potential growth of dolphin watching boat traffic, baseline information on the residence and size of this group is valuable and this study highlights the need for bottlenose dolphins to be acknowledged in local conservation and management initiatives.

Acknowledgments

We thank Mary Bones, John Alec Campbell, Gordon Hastie, John Love, Callum McLennan, Willie Rusk, Sally-Ann Wilson and the skipper and crew of *Carrie* for their help and enthusiasm in making this work possible. Paul Thompson, Beth Mackey, Stuart Middlemas and René Swift (University of Aberdeen), Phil Hammond (University of St Andrews), Randy Wells (Chicago Zoological Society), Simon Ingram (University College Cork) and one anonymous reviewer provided useful comments on the manuscript. We are also grateful to the Ministry of Agriculture, Fisheries and Food (MAFF) and the Department for the Environment, Transport and the Regions (DETR) for financial support and BBC Scotland for logistical support.

Literature Cited

Arnold, H. (1993) Distribution, abundance, and habitat use of bottle-nosed dolphins in Cardigan Bay, Wales, 1992. *European Research on Cetaceans* **7,** 63–66.

Bearzi, G., Notarbartolo di Sciara, G. & Politi, E. (1997) Social ecology of bottlenose dolphins in the Kvarneric (Northern Adriatic Sea). *Marine Mammal Science* **13,** 650–668.

Berrow, S. D., Holmes, B. & Kiely, O. (1996) Distribution and abundance of bottlenose dolphins in the Shannon estuary. Biology and environment. *Proceedings of the Royal Irish Academy* **96B,** 1–9.

Bloor, P., Reid, J., Webb, A., Begg, G. & Tasker, M. (1996) The distribution of seabirds and cetaceans between the Shetland and Faroe Islands. *Joint Nature Conservation Committee Reports*, 226.

Branson, A. (1999) Wildlife Reports. *British Wildlife* **11,** 127–129.

Duffield, D. A. & Wells, R. S. (1991) The combined application of chromosome, protein and molecular data for the investigation of social unit structure and dynamics in *Tursiops truncatus. Reports of the International Whaling Commission* **(Special Issue 13)** pp. 155–169, Cambridge, UK.

Evans, P. G. H. (1992) Status review of cetaceans in British and Irish waters, pp. 98, Unpublished report to the Department of the Environment, SeaWatch Foundation, Oxford.

Guinet, C., Allali, P., Carcaillet, C., Creton, P., Liret, C. & Ridoux, V. (1993) Bottle-nosed dolphins (*Tursiops truncatus*) in Western Brittany. *European Research on Cetaceans* **7,** 306.

Hersh, S. L. & Duffield, D. A. (1990) Distinction between Northwest Atlantic offshore and coastal bottlenose dolphins based on hemaglobin profile and morphometry. In: S. Leatherwood & R. R. Reeves (eds.) *The Bottlenose Dolphin*, pp. 653. Academic Press, Inc. San Diego, California.

Hoelzel, A. R., Potter, C. W. & Best, P. B. (1998) Genetic differentiation between parapatric 'nearshore' and 'offshore' populations of the bottlenose dolphin. *Proceedings of the Royal Society B* **265,** 1177–1183.

Ingram, S. N. (2000) The ecology and conservation of bottlenose dolphins in the Shannon estuary, Ireland, pp. 213, PhD thesis, University College Cork.

Ingram, S.N. and Rogan, E. (2002) Identifying critical areas and habitat preferences of bottlenose dolphins *Tursiops truncatus. Marine Ecology Progress Series* **244,** 247–255.

Jeewoonarain, T., Parsons, E. C. M. & Evans, P. G. H. (2000) Operation sightings: Sightings of cetaceans in the Southern Hebrides, Scotland. *European Research on Cetaceans* **13,** 237–241.

Leatherwood, S. & Reeves, R. R. (1983) *The Sierra Club Handbook of Whales and Dolphins*, pp. 302. Sierra Club Books, San Francisco.

Scott, S. (2001) A causeway too far. *Scottish Wildlife* **44,** 10–13.

Smith, T. D., Allen, J., Clapham, P. J., Hammond, P. S., Katona, S., Larsen, F., Lien, J., Mattila, D., Palsbøll, P. J., Sigurjónsson, J., Stevick, P. T. & Øien, N. (1999) An ocean-basin-wide mark-recapture study of the North Atlantic humpback whale (*Megaptera novaeangliae*). *Marine Mammal Science* **15,** 1–32.

Stone, C. J. (1998) Cetacean observations during seismic surveys in 1997. *Joint Nature Conservation Committee Reports* 278.

Wells, R. S., Scott, M. D. & Irvine, A. B. (1987) The social structure of free-ranging bottlenose dolphins. In: H. H. Genoways (ed.) *Current Mammalogy*, Vol. 1, pp. 522. Plenum Press, New York and London.

Wells, R. S. & Scott, M. D. (1990) Estimating bottlenose dolphin population parameters from individual identification and capture-release techniques. *Reports of the International Whaling Commission* **(Special Issue 12)**, pp. 407–415, Cambridge, UK.

Williams, J. A., Dawson, S. M. & Slooten, E. (1993) The abundance and distribution of bottlenose dolphins (*Tursiops truncatus*) in Doubtful Sound, New Zealand. *Canadian Journal of Zoology* **71,** 2080–2088.

Williams, A. D., Williams, R., Heimlich-Boran, J. R., Evans, P. G. H., Treganza, N. J. C., Ridoux, V., Liret, C. & Savage, S. (1997) A preliminary report on an investigation into bottlenose dolphins (*Tursiops truncatus*) of the English Channel: a collaborative approach. *European Research on Cetaceans* **10,** 217–220.

Wilson, B. (1995) The ecology of bottlenose dolphins in the Moray Firth: a population at the northern extreme of the species' range, pp. 218, PhD thesis, University of Aberdeen.

Wilson, B. Hammond, P. S. & Thompson, P. M. (1999) Estimating size and assessing trends in a coastal bottlenose dolphin population. *Ecological Applications* **9,** 288–300.

Wood, C. (1998) Movement of bottlenose dolphins around the southwest coast of Britain. *Journal of Zoology, London* **246,** 155–163.

Würsig, B. & Würsig, M. (1977) The photographic determination of group size, composition, and stability of coastal porpoises (*Tursiops truncatus*). *Science* **198,** 399–412.