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Short Note

Site Fidelity of Blainville's Beaked Whale (*Mesoplodon densirostris*) off Madeira Island (Northeast Atlantic)

Ana Dinis,[1] Raquel Marques,[2, 3] Luís Dias,[2] Dinarte Sousa,[4] Claudia Gomes,[5] Nicolau Abreu,[6] and Filipe Alves[1, 2]

[1]*CIIMAR/CIIMAR-Madeira, Interdisciplinary Centre of Marine and Environmental Research of Madeira, 9020-105 Funchal, Madeira, Portugal*
E-mail: ana.dinis@ciimarmadeira.org
[2]*VENTURA, Marina do Funchal, Madeira, Portugal*
[3]*Laboratoire MARBEC, Université de Montpellier, CC093, Place Eugène Bataillon, 34095 Montpellier Cedex 05, France*
[4]*H2O-Madeira, Calheta, Madeira, Portugal*
[5]*LOBOSONDA, Marina da Calheta, Madeira, Portugal*
[6]*VMT-Madeira, Marina do Funchal, Madeira, Portugal*

Beaked whales are among the least known of large mammals (Wilson, 1992). Patterns of residency or site fidelity of beaked whales (Family Ziphiidae) are hard to assess, mainly because of their short surfacing periods (Tyack et al., 2006), making it difficult to find and approach free-ranging individuals (McSweeney et al., 2007). Recent public and scientific concerns that beaked whales may be particularly vulnerable to anthropogenic noise, and especially to naval sonar (D'Amico et al., 2009), have focused much attention on addressing the many gaps in our knowledge of their population and behavioral ecology (Claridge, 2013). Site fidelity studies are useful to identify important habitats for local populations. Site fidelity is described as the tendency for individuals to return or to remain in the same area over a period of time (Baird et al., 2008). McSweeney et al. (2007) found high levels of site fidelity in Cuvier's (*Ziphius cavirostris*) and Blainville's (*Mesoplodon densirostris*) beaked whales off the west coast of Hawaii. These species are also found regularly in the Canary Islands (Aguilar de Soto, 2006; Reyes et al., 2011, 2014) and in The Bahamas (Claridge, 2006, 2013). Other studies examined movements and spatial use of Blainville's beaked whales around oceanic islands (Schorr et al., 2009; Tyack et al., 2011); however, little is known about the ecology and the use of the habitat of this species in the oceanic archipelago of Madeira. Blainville's beaked whale was first described in Madeira in 1917 (Harmer, 1924); and, nowadays, they are the most frequently sighted species of beaked whale in the area (Alves et al., 2017). In this study, we use opportunistic photographic data to confirm both the short- and long-term site fidelity of Blainville's beaked whale in this archipelago.

Data were collected off the southern coast of Madeira Island (33° N, 017° W), Portugal, from whale-watching vessels between September 2004 and June 2016. Photographs were analyzed, a photo-identification catalogue was compiled, and a dataset of capture histories was subsequently created following Würsig & Jefferson (1990). Individual beaked whales were identified using the unique pattern of scarring on the body and nicks in the dorsal fin. Distinctiveness was rated from 1 (poorly distinctive) to 4 (very distinctive) following McSweeney et al. (2007). Age class and sex of sighted individuals was based on body size, extent of scarring on the body (McSweeney et al., 2007; Mead, 2008), time between first and last sightings and associations with calves, and presence or absence of erupted teeth in the lower jaws. Photographs were assigned a quality grade ranging from 1 to 4 (with 4 being a high-quality photograph) based on the image size, focus, lighting, angle, and exposure of the photograph. Only good quality photographs (quality 3 and 4) of individuals with a distinctiveness rate of 3 and 4 (see Figure 1) were used in the analysis to enhance the reliability of matches. All matches were double-checked by a second researcher with experience in photo-identification. Resighting rates (RR) were defined as the number of individuals seen more than once divided by the total number of individuals identified during the study period. Resightings within the same day were not used in this analysis. Sex and age were

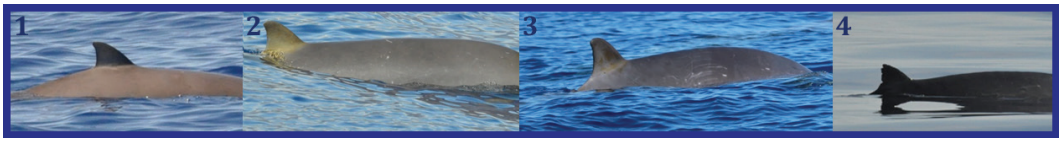

Figure 1. High-quality photographs of four different whales, ranging from poorly distinctive (1), less distinctive (2), distinctive (3), to very distinctive (4)

assigned based on the characteristics described by Mead (2008) using high-quality photographs of the head and thoracic region. The analysis was restricted to distinctive and very distinctive adult individuals. Short-term site fidelity was assigned when an individual was seen on multiple days within the same year, while long-term site fidelity was attributed to individuals seen in more than 1 y.

We identified 62 well-marked individuals throughout the study period (43 females and 19 males), with 17 being resighted (Supplemental Table 1; this table is available on the *Aquatic Mammals* website: www.aquaticmammalsjournal.org/index.php?option=com_content&view=article&id=10&Itemid=147). The overall RR was 0.27. Although the majority of whales were only seen in 1 y (median = 1, maximum = 3; Figure 2), eight of the 17 (47%) were sighted in multiple years, with the remaining nine whales seen within the same year on multiple days (Supplemental Table 1). Out of 17 resighted whales, five were adult males (corresponding to 26.3% of the total number of males identified) and 12 were adult females (corresponding to 27.9% of the total number of females identified), with two males (10.5%) and six adult females (13.9%) sighted in multiple years. Three pairs of females were observed together twice—two pairs on two consecutive days and one pair 30 d apart.

This study successfully used opportunistic data from whale-watching operators to create a photo-identification catalogue that allowed site fidelity of Blainville's beaked whale in the south coast of Madeira Island to be assessed over a 12-y period. Despite the relatively small catalog size (62 whales) and a limited number of photographs (as there was no dedicated effort to collect data), there was a relatively high number of individuals observed on more than one occasion. Site fidelity studies of this species off the island of Hawaii, in The Bahamas, and in the Canary Islands found RR of 0.34 (McSweeney et al., 2007) and 0.40 (Claridge, 2006; Aguilar de Soto & Hammond, 2014), respectively. These RR values are surprisingly similar despite being collected in separate oceanic archipelagos of two ocean basins. The RR values from Hawaii, The Bahamas, and the Canary Islands were obtained using data from dedicated regular surveys, and this might explain why they are higher than the RR obtained in this study with opportunistic data. However, our bias was reduced by using only good quality photos and distinct and very distinct individuals. In addition, the length of the study period leads us to believe that identification based on body scars were reliable given that scars on Blainville's beaked whales can remain visible for more than 10 y (McSweeney et al., 2007).

Inter-annual resightings of eight individuals suggest some degree of long-term site fidelity, particularly in adult females. Differences in apparent site fidelity for this species have been noted previously by Durban et al. (2001), who reported higher RR in adult females when compared with adult males. In this context, Clutton-Brock (1989) noted that for species in which the females are either solitary or live in small groups, like Blainville's beaked whales (Claridge, 2006, 2013; Reyes et al., 2011, 2014), males may search widely for females. By remaining in an area or returning to an area repeatedly, female occurrence is likely to be related to prey abundance or lower predator occurrence, whereas males move between concentrations of females for mating opportunities. The fact that three pairs of females were sighted together on two occasions suggests some level of association between females of Blainville's beaked whales. While this conclusion is limited by the small sample size studied here, and the fact that in two of the three pairs the association could be observed only in two consecutive days, it supports previous observations in Hawaii by McSweeney et al. (2007), who suggested that associations among adult females appeared to be relatively short (weeks to months). Despite the scarce existing information regarding the social organization of Blainville's beaked whale, Claridge (2006) noted that, in The Bahamas, this species appears to exhibit female defense polygyny, with a social group of females accompanied by one male who may deny access to the group by other males.

This study successfully demonstrates, for the first time, the short- and long-term site fidelity of Blainville's beaked whale off Madeira Island, indicating that, as reported for other areas in the world (Claridge, 2006; McSweeney et al., 2007; Reyes et al., 2011, 2014; Aguilar de Soto & Hammond, 2014), the Madeiran waters seem to be an important area for this species. The particular vulnerability of beaked whales to navy sonar has

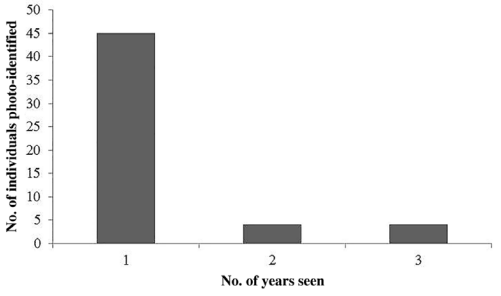

Figure 2. Number of years that Blainville's beaked whales (*Mesoplodon densirostris*) were photo-identified from high-quality photographs

highlighted the need for basic data on the distribution and ecology of beaked whales to improve the mitigation of the negative effects of such activities (Cox et al., 2006; Aguilar de Soto et al., 2016). A mass stranding event of Cuvier's beaked whale in Madeira in 2000 was concurrent with navy exercises occurring nearby (Freitas, 2004). Although no Blainville's beaked whale was reported dead in that event, this species has been present in mass strandings related to naval sonar in the Canary Islands (Martín et al., 2003). Behavioural studies show that Blainville's beaked whales are vulnerable to active sonars (McCarthy et al., 2011; Tyack et al., 2011) with responses such as ceasing foraging and avoidance of the area during multi-ship sonar exercises, returning after testing has ceased. Considering the above, the site fidelity of Blainville's beaked whales demonstrated herein suggests that precautionary principles such as avoiding use of military sonar and underwater explosions should be applied when planning naval exercises at the Madeira archipelago. Dedicated photo-identification surveys with a more robust analysis should be carried out in the Madeira archipelago to expand upon the findings reported herein. This will help inform policymakers about the importance of Madeira for the Blainville's beaked whale and will provide essential data for environmental impact assessment and management potential for future anthropogenic activities like military exercises using active sonars that may impact this species.

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Literature Cited

Aguilar de Soto, N. (2006). *Acoustic and diving behaviour of short-finned pilot whales and Blainville's beaked whales in the Canary Islands: Implications for their conservation* (Doctoral dissertation). University of La Laguna, Tenerife, Canary Islands.

Aguilar de Soto, N., & Hammond, P. (2014). *Population parameters of Blainville's and Cuvier's beaked whales* (Distribution Statement A: Approved for public release). Retrieved from https://www.onr.navy.mil/reports/FY14/mbaguila.pdf

Aguilar de Soto, N., Gkikopoulou, K., Hooker, S., Isojunno, S., Johnson, M., Miller, P., . . . Thomas, L. (2016). From physiology to policy: A review of physiological noise effects on marine fauna with implications for mitigation. *Proceedings of Meetings on Acoustics*, *27*, 040008. https://doi.org/10.1121/2.0000299.

Alves, F., Ferreira, R., Fernandes, M., Halicka, Z., Dias, L., & Dinis, A. (2017). *Occurrence and group dynamics of cetaceans in Madeira Island based on long-term fine-scale data from platforms of opportunity. Proceedings of the 31st Annual Conference of the European Cetacean Society*, Middelfart, Denmark.

Baird, R. W., Webster, D. L., Mahaffy, S. D., McSweeney, D. J., Schorr, G. S., & Ligon, A. D. (2008). Site fidelity and association patterns in a deep-water dolphin: Rough-toothed dolphins (*Steno bredanensis*) in the Hawaiian Archipelago. *Marine Mammal Science*, *24*, 535-553. https://doi.org/10.1111/j.1748-7692.2008.00201.x

Claridge, D. E. (2006). *Fine-scale distribution and habitat selection of beaked whales* (Master's thesis). University of Aberdeen, Aberdeen, Scotland. Retrieved from www.bahamaswhales.org/D_Claridge_MSc_Thesis.pdf

Claridge, D. E. (2013). *Population ecology of Blainville's beaked whales (*Mesoplodon densirostris*)* (Doctoral dissertation). University of St Andrews, St Andrews, Scotland. Retrieved from https://research-repository.st-andrews.ac.uk/handle/10023/3741

Clutton-Brock, T. H. (1989). Mammalian mating systems. *Proceedings of the Royal Society of London Series B*: Biological Sciences, *236*, 339-372. https://doi.org/10.1098/rspb.1989.0027

Cox, T. M., Ragen, T. J., Read, A. J., Vos, E., Baird, R. W., Balcomb, K., . . . Benner, L. (2006). Understanding the impacts of acoustic sound on beaked whales. *Journal of Cetacean Research and Management*, *7*, 177-187.

D'Amico, A., Gisiner, R. C., Ketten, D. R., Hammock, J. A., Johnson, C., Tyack, P. L., & Mead, J. (2009). Beaked whale strandings and naval exercises. *Aquatic Mammals*, *35*(4), 452-472. https://doi.org/10.1578/AM.35.4.2009.452

Durban, J., Claridge, D., Parsons, K., Ellifrit, D., & Balcomb, K. (2001). *Quantifying beaked whale occupancy: Resident females and roving males*. Proceedings of the Beaked Whale Workshop, Vancouver, BC, Canada.

Freitas, L. (2004). The stranding of three Cuvier's beaked whales *Ziphius cavirostris* in Madeira archipelago – May 2000. In P. G. H. Evans & L. A. Miller (Eds.), *Proceedings of the Workshop on Active Sonar and Cetaceans*. *ECS Newsletter, 42*(Special Issue), 28-32.

Harmer, S. F. (1924). On Mesoplodon and other beaked whales. *Proceedings of the Zoological Society*, *36*, 541-587. https://doi.org/10.1111/j.1096-3642.1924.tb01515.x

Martín, V., Servidio, A., & García, S. (2003). Mass strandings of beaked whales in the Canary Islands. In P. G. H. Evans & L. A. Miller (Eds.), *Proceedings of the Workshop on Active Sonar and Cetaceans*. *ECS Newsletter*, *42*(Special Issue), 33-36.

McCarthy, E., Moretti, D., Thomas, L., DiMarzio, N., Morrissey, R., Jarvis S., . . . Dilley, A. (2011). Changes in spatial and temporal distribution and vocal behaviour of Blainville's beaked whales (*Mesoplodon densirostris*) during multi-ship exercises with mid-frequency sonar. *Marine Mammal Science*, *27*, E206-E226. https://doi.org/10.1111/j.1748-7692.2007.00135.x

McSweeney, D. J., Mahaffy, S. D., & Baird, R. W. (2007). Site fidelity, associations and movements of Cuvier's (*Ziphius cavirostris*) and Blainville's (*Mesoplodon densirostris*) off the Island of Hawaii. *Marine Mammal Science*, *23*(3), 666-687. https://doi.org/10.1111/j.1748-7692.2007.00135.x

Mead, J. G. (2008). Beaked whales: Overview. In W. F. Perrin, B. Würsig, & J. G. M. Thewissen (Eds.), *Encyclopedia of marine mammals* (2nd ed., pp. 81-84). San Diego: Academic Press.

Reyes, C., Schiavi, A., & Aguilar de Soto, N. (2014). *An insight into the population of Blainville's and Cuvier's beaked whales off El Hierro (Canary islands): Abundance estimation*. International Symposium in Marine Sciences, Las Palmas de Gran Canaria, Spain.

Reyes, C., Schiavi, A., Pérez-González, C. J., & Aguilar de Soto, N. (2011). *S*ocial structure and temporal variations in individual associations of Blainville's beaked whales (*Mesoplodon densirostri*s) in El Hierro (Canary Islands). *Proceedings of the 25th Annual Conference of the European Cetacean Society*, Cadiz, Spain.

Schorr, G. S., Baird, R. W., Hanson, M. B., Webster, D. L., McSweeney, D. J., & Andrews, R. D. (2009). Movements of satellite-tagged Blainville's beaked whales off the island of Hawai'i. *Endangered Species Research*, *10*, 203-213. https://doi.org/10.3354/esr00229

Tyack, P. L., Johnson, M., Aguilar de Soto, N., Sturlese, A., & Madsen, P. T. (2006). Extreme diving of beaked whales. *Journal of Experimental Biology*, *299*, 4238-4253. https://doi.org/10.1242/jeb.02505

Tyack, P. L., Zimmer, W. M. X., Moretti, D., Southall, B. L., Claridge, D. E., Durban, J. W., . . . Boyd, I. L. (2011). Beaked whales respond to simulated and actual Navy sonar. *PLOS ONE*, *6*(3), e17009. https://doi.org/10.1371/journal.pone.0017009

Wilson, E. O. (1992). *The diversity of life*. Cambridge, MA: Belknap Press of Harvard University.

Würsig, B., & Jefferson, T. (1990). Methods of photo-identification for small cetaceans. *Report of the International Whaling Commission* (Special Issue 12), 43-52.