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Short Note

Revillagigedo Archipelago, Mexico: A Probable Calving Area for Common Bottlenose Dolphins (*Tursiops truncatus*)

Erica Carone,[1] Frida Lara Lizardi,[2,3] Fabio Favoretto,[4,5]
Jesús Erick Higuera Rivas,[6] and Hiram Rosales Nanduca[5]

[1]*Departamento Académico de Ciencias Marinas y Costeras, Universidad Autónoma de Baja California Sur, Carretera Transpeninsular al sur km 5.5, Colonia el Mezquitito, CP 23080, La Paz, Baja California Sur, México*
[2]*Orgcas, Tuparam 322, CP 23095, La Paz, Baja California Sur, México*
[3]*MigraMar, 1235 Michele Way, Santa Rosa, CA 95404, USA*
[4]*Centro para la Biodiversidad Marina y la Conservación, AC, Calle del Pirata 420, CP 23080, La Paz, Baja California Sur, México*
[5]*Departamento Académico de Ingeniería en Pesquerías, Universidad Autónoma de Baja California Sur, Carretera Sur km 5.5, Colonia el Mezquitito, CP 23080, La Paz, Baja California Sur, México*
E-mail: hrosales@uabcs.mx
[6]*Protección y Conservación Pelágica AC, Mexico City, CDMX, México*

Waters around oceanic islands are often considered marine biodiversity hotspots. Their high productivity and complex bathymetry provide refuge, food sources, and nurseries for many species (Clark et al., 2010; Friedlander et al., 2019). Despite their ecological importance, oceanic islands are often overlooked in area-based protection planning because they are considered preserved due to their remoteness. However, factors such as illegal fishing and increasing ecotourism with close proximity to marine megafauna make it urgent to document information about key species that inhabit these waters (Aburto-Oropeza et al., 2017; Cisneros-Montemayor et al., 2020).

In the Eastern Pacific Ocean, an important area for marine megafauna is the Revillagigedo Archipelago (Aguirre-Muñoz et al., 2015), which is located 400 km south of the Baja California Peninsula in Mexico. This Archipelago is composed of four islands—Clarión, Roca Partida, San Benedicto, and Socorro (Figure 1)—and was declared a Biosphere Reserve in 1994. In 2016, the Archipelago was listed as a UNESCO World Heritage site (http://whc.unesco.org/en/list/1510); and in 2017, the Mexican government declared it a National Park, creating the largest Marine Protected Area in North America (with an area of 14.8 million ha) (Comisión Nacional de Áreas Naturales Protegidas [CONANP], 2017). The islands are uninhabited by humans, except for Clarión and Socorro, which host local authorities (Mexican Navy and the Mexican Natural Protected Area Commission). Despite their remote location, authorized diving liveaboards regularly visit the surrounding waters from November to June (Cisneros-Montemayor et al., 2020). Marine megafauna are the most prominent attractions for scuba diving tourism, which has focused mainly on elasmobranchs, such as the whale shark (*Rhincodon typus*), scalloped hammerhead (*Sphyrna lewini*), and giant manta (*Mobula birostris*) (Becerril-García et al., 2020). Marine mammals have also been documented in the Archipelago, with species including humpback whales (*Megaptera novaeangliae*), Cuvier's beaked whales (*Ziphius cavirostris*), killer whales (*Orcinus orca*), false killer whales (*Pseudorca crassidens*), spinner dolphins (*Stenella longirostris*), and common bottlenose dolphins (*Tursiops truncatus*) (González et al., 2007; Rosales-Nanduca et al., 2011). While sightings for most of these species are sporadic in the water surrounding the islands, common bottlenose dolphins are frequently observed. Furthermore, in popular recreational diving sites (e.g., El Boiler, El Cañón, Cabo Pearce; Figure 2), they swim and repeatedly interact with scuba divers (Carone, pers. obs., November 2018).

To date, there are no scientific publications about bottlenose dolphin habitat use in this Archipelago, and little is generally known about this species' reproductive behavior around oceanic islands. The lack of information about potential critical habitats within which animals socialize, breed, and take care of their young may hamper the development of appropriate management protocols of tourist activities, as well as assessments

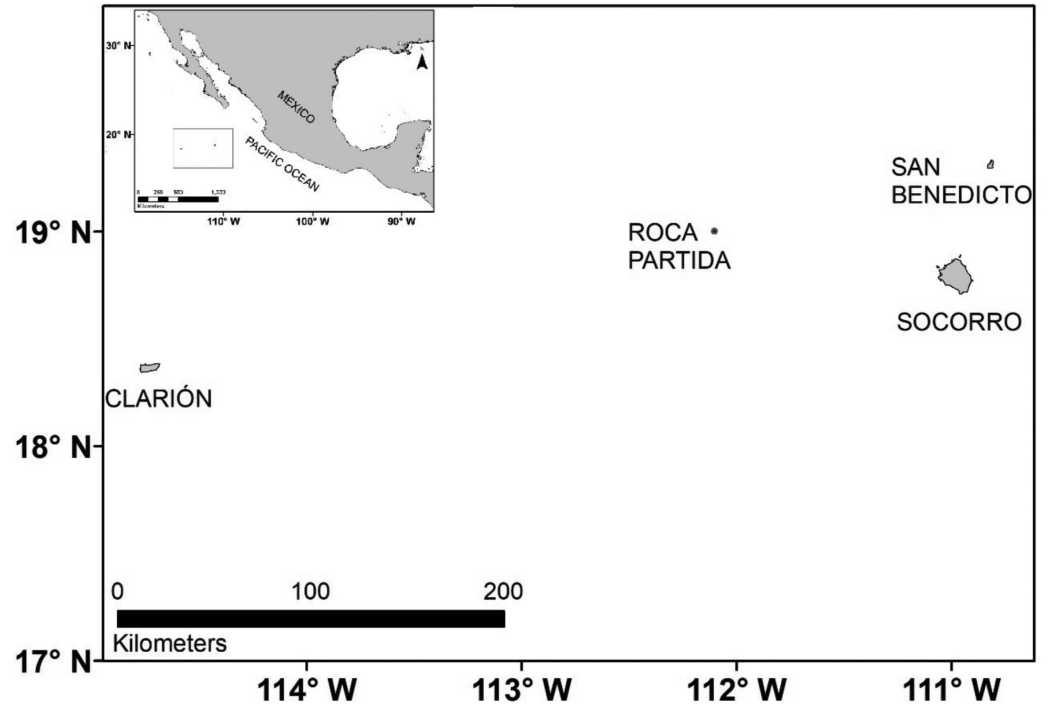

Figure 1. Map showcasing the islands within the Revillagigedo Archipelago. From east to west: Clarión, Roca Partida, Socorro, and San Benedicto. The inset box shows the position of the Archipelago, located 400 km south of the Baja California peninsula in the Pacific Ocean.

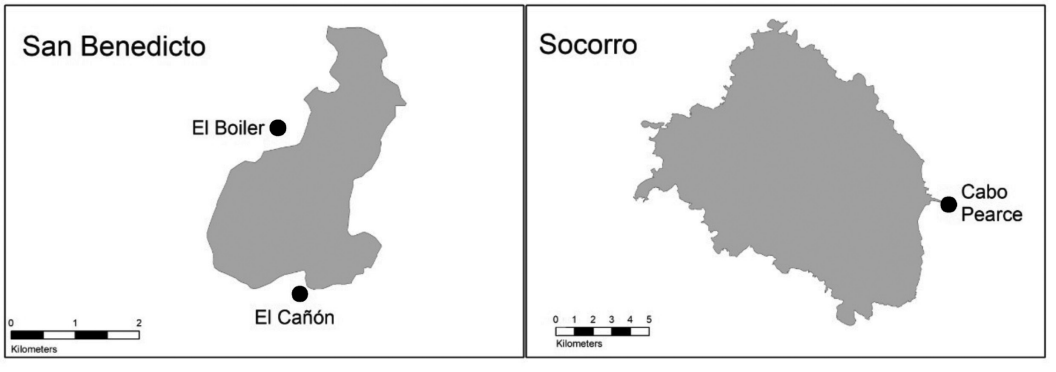

Figure 2. Map of the recreational diving sites where sightings of bottlenose dolphin (*Tursiops truncatus*) calves were made within the citizen science project: El Cañon and El Boiler in San Benedicto Island; and Cabo Pearce in Socorro Island.

of present and future anthropogenic impacts (Silva et al., 2008; Tobeña et al., 2014). Most information comes from coastal populations, which indicates that home ranges vary greatly in bottlenose dolphins and are mainly linked to food availability (Stevick et al., 2002; Viddi et al., 2010; Martínez-Serrano et al., 2011; Sprogis et al., 2016). Within a home range, bottlenose dolphins can also modify their spatial pattern depending on their reproductive state (Gibson et al., 2013). For instance, after a 12-mo gestation, female dolphins often give birth in protected shallow waters, utilizing them as calving areas. These waters likely offer calves protection from predators and also provide sufficient prey availability for the high energy demands of lactating females (Scott et al., 1990; Wang et al.,

1994; Barco et al., 1999; Caldwell, 2001). Herein, we report the underwater observation of a female bottlenose dolphin in labor, along with sightings of 13 different calves in the same location of the Revillagigedo Archipelago. Preliminary data about the habitat use of this species in the Archipelago are presented in this short note, with a suggestion that a popular diving site should be considered as a potential calving area for bottlenose dolphins.

As part of the FIN-Project citizen science program, which involves the participation of various stakeholders, opportunistic sightings of bottlenose dolphins in the Archipelago were gathered from 2017 to 2021. Each time a group (aggregation of more than one dolphin including all age classes) or a solitary dolphin was observed, it was recorded as a sighting. Scuba divers involved in this project shared their pictures (using both professional and semiprofessional cameras) and information about where and when each photograph was taken. Dolphins were identified by their natural markings, visible in photographs or videos of the dorsal fin; and only those with clear and permanent marks were included in the created catalog of individuals (Hammond et al., 1990; Wilson et al., 1999). Calves were distinguished by the continued association with an adult (presumed mother) and their small size (less than ½ length of the adult) (Wells et al., 1987; Dudzinski & Ribic, 2017). Lastly, calves were considered born within the past 2 mo when they exhibited fetal folds (Cockcroft & Ross, 1990).

In 11 opportunistic sightings, 13 different calves were recorded at El Boiler, a seamount 1 km northwest of San Benedicto (19° 19' 48" N, 110° 48' 48" W; Figure 2; Table 1). All calves were observed in spring (from March to June) and autumn (November) between 2017 and 2021. A singular sighting occurred on 11 May 2018, during an expedition aboard the diving vessel *Quino el Guardian*, when citizen scientist divers observed a portion of a dolphin calf's successful birth (Figure 3). At 1503 h, three common bottlenose dolphins (referred to as "A," "B," and "C") approached a group of divers. After a few seconds, dolphin A left the group, moved close to three divers (~2 m), and assumed a vertical position during which the distension of the genital orifice was evident (Figure 3a). At 1515 h, a tail protruded from the genital orifice (Figure 3b). During this time, dolphin A was observed closing her eyes repeatedly and seemed to prefer a vertical position most of the time, swimming only enough to maintain her position (between 15 to 25 m depth; Figure 3c) or to breathe. During this event, dolphins B and C (sex unknown) did not approach the divers but swam 15 to 20 m from the divers and dolphin A. When the calf was about one-third emerged from the mother's genital orifice, a weak tail movement and a short recession back into the mother's body were observed. At 1527 h, dolphin A assumed a horizontal position near the surface, and her tail movements became more intense. After a few minutes, dolphin A left the divers and swam away. On the same day, dolphin A was observed accompanied by a newborn calf that appeared to be in good condition by a different group of scuba divers on a private expedition at El Boiler.

Table 1. Sightings of 13 different bottlenose dolphin (*Tursiops truncatus*) calves at El Boiler diving sites. Information provided from a citizen science project. The table includes date for each event (sighting), number of sightings, number of calves' present at each sighting, and the ID #. The resighted individual (ID-008) is indicated in bold.

Date	Sighting	Number of calves	ID #
7 March 2017	1	1	ID-001
23 May 2017	2	1	ID-002
11 May 2018	3	1	ID-003
13 June 2019	4	2	ID-004 ID-005
4 April 2021	5	2	ID-006 ID-007
15 April 2021	6	1	**ID-008**
30 April 2021	7	1	ID-009
2 May 2021	8	1	**ID-008**
6 May 2021	9	2	ID-010 ID-011
8 May 2021	10	1	ID-012
7 November 2021	11	1	ID-013

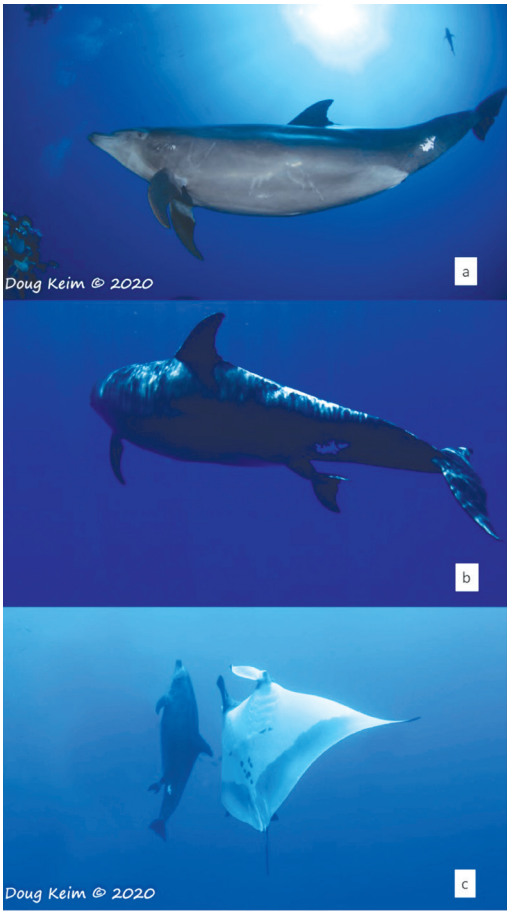

Figure 3. Pictures of dolphin A's labor, recorded for the first time in the wild: (a) distension of the genital orifice (*Photo credit:* D. Keim), (b) the calf's tail hanging from the genital orifice (*Photo credit:* B. Lazcano), and (c) dolphin A in a vertical position with a giant manta (*Manta birostris*) (*Photo credit:* D. Keim).

Figure 4. Dolphin neonates observed at the El Boiler dive site on different dates: (a) 13 June 2019 (*Photo credit:* J. E. Higuera Rivas), and (b) 4 April 2021 (*Photo credit:* I. Kai).

In all other sightings, calves were observed swimming in groups of six to ten dolphins. But while adults have been observed interacting with scuba divers in some cases, mother–calf pairs displayed more elusive behavior. The quality of citizen-provided videos and photographs allowed for the discernment of fetal folds only in six of 13 calves. Two newborns of approximately the same size were observed in the same sighting on 13 June 2019 (Figure 4a). Similarly, on 4 April 2021, two different mother–calf pairs swimming in the same group were observed (Figure 4b). During these sightings, a high degree of adult–calf behavioral synchrony was observed, with the calf often assuming the echelon position (Gubbins et al., 1999; Shoele & Zhu, 2015). Finally, a newborn recorded on 15 April 2021 was observed again on 2 May 2021 in the same area (Figure 5a & b; Table 1). For each calf recorded, a different presumed mother was observed, and there are no historical data for these individuals.

These preliminary data provide more information about the habitat use of bottlenose dolphins near oceanic islands and suggest the potential role of the Revillagigedo Archipelago as a calving area. San Benedicto Island hosts a popular diving site, the seamount El Boiler, which is an important location for megafaunal communities due to its high fish biomass (Morato & Clark, 2007; Aburto-Oropeza & Hull, 2008; Aburto-Oropeza et al., 2017). Several cetaceans reportedly use seamounts consistently as feeding grounds (Kaschner, 2007; Cascão et al., 2020). However, the use of seamounts by dolphins for reproductive purposes was previously undocumented. Our observations of dolphin calves (with one resighting) and a partial birth suggest the area near El Boiler may be an important calving or nursery area for bottlenose dolphins. This seamount is relatively close to the main island and offers shallow water that can be used as a refuge from predators. Because the hurricane season runs from July to October, tourists do not visit the Archipelago during those months; therefore, we have no information from that time of the year in regards to dolphin sightings or habitat use. For this reason, future systematic studies should implement new techniques to understand whether there is a seasonal pattern in

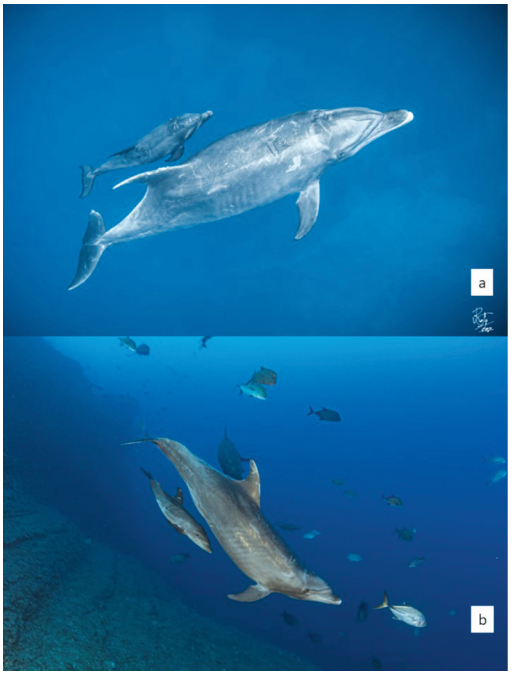

Figure 5. (a) Dolphin ID-008 observed at El Boiler on 15 April 2021 (*Photo credit:* R. Fernandez Caballero), and (b) Dolphin ID-008 resighted on 2 May 2022 at the same site (*Photo credit:* H. Klostermann).

reproduction as observed in other dolphin populations (Harrison & Ridgway, 1971; Urian et al., 1996; McFee et al., 2014; Smith et al., 2016; Blasi et al., 2020).

Cetacean births in the wild have only been documented for a few species (Mills & Mills, 1979; Weilgart & Whitehead, 1986; Beland et al., 1990; Notarbartolo di Sciara et al., 1997; Zani et al., 2008; Faria et al., 2013; Patton & Lawless, 2021; Ransome et al., 2022). Despite numerous bottlenose dolphin births documented for animals in captivity (McBride & Kritzler, 1951; Sweeney et al., 2010; Baumgartner et al., 2018), there is only one published observation of birth in the wild (Perrtree et al., 2016). Still, while Perrtree et al. (2016) reported the observation immediately after parturition, we report the observation of one dolphin prior to the birth for the first time. When labor started, dolphin A isolated herself from two other dolphins. In captivity, different behaviors were observed at the surface (e.g., resting near the surface, whacking the water surface with the flukes) during the first stage of labor (McBride & Kritzler, 1951; Cornell et al., 1987; Muraco, 2015). In contrast, in our observations, dolphin A stayed in the vertical position at greater depths. We could not document how long this labor lasted, and we cannot exclude the possibility that the presence of scuba divers may have influenced this birth. However, since another group of scuba divers observed the newborn later the same day, we can assume that labor was relatively swift as reported for successful births in captivity (McBride & Kritzler, 1951; Robeck et al., 2001; Deng et al., 2019). During sightings 4, 5, 6, and 8, calves were primarily observed in the echelon position, which is known to be the most used position (between 70 and 100% of swimming time) within a calf's first month (Gubbins et al., 1999; Mann & Smuts, 1999; Shoele & Zhu, 2015), offering indirect evidence confirming the recent birth of these individuals. Most of our sightings were females with calves in a group of six or more individuals. These observations are similar to what has been observed in other studies where females occur in larger groups during a calf's first year (Gibson & Mann, 2008) when the mortality rate is highest (Mann et al., 2000). Also, in sightings 4 and 5, two calves of similar age were observed alternating between a close association with their respective mothers and a socializing behavior with each other. Observation of these two calves and their mothers suggests this area might be used by nursery groups, which is assumed to offer protection and provide socialization opportunities as has been documented elsewhere for bottlenose dolphins (Wells, 2014).

With the growth of marine ecotourism, changes have been documented in marine mammal behavior in proximity to tourist activities (Lusseau & Higham, 2004; Bearzi, 2017; Machernis et al., 2018). Some studies showed vessel disturbance could alter dolphin habitat use through displacement (Janik & Thompson, 1996; Allen & Read, 2000; Lusseau & Higham, 2004). Disturbance can be particularly detrimental when it occurs during vulnerable times for the animal—for example, when caring for the young with higher energetic costs (Oftedal, 2000). Mother–calf bottlenose dolphin pairs, for instance, increase their dive duration in the presence of boats, suggesting some form of avoidance behavior (Constantine et al., 2004; Zeppel, 2009; Guerra et al., 2014). There are still no regulations in place for swimming or diving with wild dolphins in Mexico, which exposes populations that inhabit these waters to potential risk. Divers usually visit Revillagigedo waters under the supervision of certified guides, and the area is monitored by the National Commission of Natural Protected Areas (CONANP), which is in charge of regulating tourism activities. Despite this, different levels of human interactions have been observed around dolphins during our sightings. Furthermore, adult dolphins appeared to swim more elusively as a group away from scuba divers

when accompanied by calves. To date, data are insufficient to determine whether the behaviors recorded were impacted by human approaches, calf age, other disturbance factors (e.g., engines), or all of the above. However, protection of habitats that are linked to critical periods (such as resting, breeding, or caring for young) is crucial for maintaining species using that habitat (Zeppel, 2009). Therefore, our observations emphasize the importance of citizen science data in monitoring marine organisms by offering critical information that will help develop guidelines for a diving code of conduct (good practices) with dolphins, particularly in vulnerable areas.

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