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Abstract

This paper reviews all available information on the distribution, movement patterns, abundance and population structure of the bottlenose dolphin *Tursiops truncatus* in Argentina. Data point out the dramatic decrease in sightings of the species in this country, most likely related to a serious population decline in their southernmost range of the Southwest Atlantic Ocean. Available data indicate the presence of perhaps two remaining populations, of approximately 90-133 and <40 individuals respectively. Furthermore, preliminary genetic data indicate a low genetic diversity and suggest the presence of two genetically isolated populations, information to be taken into account for conservation purposes in the absence of more substantial data. Overall, the reduction of the species along the Argentine coast has remained largely unstudied, resulting in a lack of consistent data to assess the population status, as well as possible factors affecting its conservation. In this review, suggestions are made on the possible effect of a reduced reproductive outcome on the population dynamics. It is strongly recommended that data collection efforts on the species in the country are drastically increased as soon as possible in order to assess this hypothesis, and formulate management strategies.

Introduction

Due to the extensive geographical range of the common bottlenose dolphin (*Tursiops truncatus*) and its apparently complex taxonomy, it is challenging to produce a comprehensive threat assessment for the species, even after decades of intensive research (Reeves and Leatherwood, 1994; Reeves et al., 2003). Consequently, the global population trend of the species remains unknown (Hammond et al., 2012). Irrespective of this glaring lack of knowledge, its worldwide conservation status is still listed as least concern by the IUCN (Hammond et al., 2012).

Therefore, the International Whaling Commission agreed on a review of the genus *Tursiops* as a priority topic for three Scientific Committee meetings (2015-2017). As bottlenose dolphins are among the most widely distributed cetacean genera, with complex taxonomy and population structures, it was agreed that its review would be completed in three annual stages, the first being to develop an assessment framework and to conduct general reviews of the available information in relatively well-studied regions.

As human urbanisations continue to grow along the world's coastlines, coastal bottlenose dolphins are particularly susceptible to ensuing anthropogenic pressures (Sutherland, 2008). Consequently, in recent years an ever-increasing number of coastal bottlenose dolphin populations has been reported to be vulnerable or declining worldwide, including in Argentina (Vermeulen and Bräger, 2015). Officially, the species is still considered to be “not endangered” by the Argentinean National Ministry of Environmental and Sustainable Development

(Resolution 1030/04) and as “low concern - conservation dependent” in the Red Book of the “Sociedad Argentina para el Estudio de los Mamíferos (SAREM)” (Ojeda, 2012). The species is protected, along with all other marine mammals, from intentional persecution by the national law 25.577/2002. As in many other regions of the world, the bottlenose dolphin has been studied only in relatively restricted geographical locations in Argentina, making any overall assessment of the distribution, movement patterns, overall abundance and conservation status of this highly mobile species challenging. Additionally, due to the need for cost-effective research methods, areas with low densities have received little to no attention. We thus believe that collaborative research efforts along the nation’s coastline are essential to gain a comprehensive insight into various aspects of the species’ life history and population status. Excellent examples of such large-scale approaches can be found in the Mid-Atlantic Bottlenose Dolphin Catalog project (Urian et al., 1999) and the Pelagos Sanctuary Marine Protected Area project (Gnone et al., 2011). In this report, we aim to combine all available data, and to attempt a first comprehensive review of the historical and current distribution, movement patterns, abundance and population structure of the bottlenose dolphin in coastal Argentina. We make recommendations and prioritize research needs and potential conservation measures for the recovery of the species.

Material and Methods

Study area

The Argentinean coastline is over 6,800 km long, extending from the Río de la Plata down to the Canal de Beagle. It includes four large gulfs (Golfo San Matías, Golfo San José, Golfo Nuevo and Golfo San Jorge) as well as various large estuaries (e.g. estuary of Río de la Plata and Bahía Blanca). The continental shelf has a surface of approx. 960,000 km², being 210 km wide in the North (38°S) and up to 850 km in the South (52°S) (Boltovskoy, 2009). The waters of the Argentinean part of the Atlantic Ocean are generally temperate, and contain a mix of waters from the cold Malvinas/Falkland Current of Subantarctic origin and from the Subtropical Brazil Current. From a biological point of view, the Argentinean Sea can be classified into two biogeographical provinces (Lutz et al., 2003; Bastida et al., 2005; Balech and Ehrlich, 2008); the biogeographical Argentine province dominated by the warmer waters of the Brazil Current, which extends along the coast from South Brazil (up to approx. 23°S), Uruguay and the province of Buenos Aires southwards to the area of Península Valdés (approx. 42°S; province of Chubut). It is believed to be a transition zone between Subantarctic and Subtropical complexes (Bastida et al., 2005). The biogeographical Magellan province, on the other hand, is dominated by the colder waters of the Malvinas/Falkland Current, and covers the South Patagonian coast and shelf, from the province of Tierra del Fuego northwards to the area of Península Valdés. Both biogeographic provinces differ from each other, not only in oceanographic characteristics, but also in fauna and flora species (Bastida et al., 2005).

Aside from the province of Buenos Aires, where 40% of the country’s urbanisation is located, the Argentinean coastline is fairly uninhabited with a population density of approximately 1.9 inhabitant / km² at the coasts of the provinces of Río Negro, Chubut, Santa Cruz and Tierra del Fuego (i.e. the Patagonian coast; Boltovskoy, 2009). The anthropogenic pressures on the largest part of the Argentinean coastal environment thus appear to be relatively low compared to other coastal regions worldwide. However, Boltovskoy (2009) describes the rapid increase in demographic and industrial growth along the Patagonian coast over the past decades, which resulted in increased pressures on the natural resources.

Data collection

For this status report, records of bottlenose dolphins in Argentina were compiled from a variety of sources, including published and unpublished articles, conference proceedings, museum records, reports, books, unpublished data of the authors, newspaper articles and opportunistic photographs. All cetacean researchers in the country were invited to participate with their own (dedicated or opportunistic) knowledge, and to aid in the search for additional information. Similarly, governmental and newspaper agencies were contacted, as well as captains of large fishing vessels of the province of Buenos Aires and the association of whale watching guides in the provinces of Río Negro and Chubut, to obtain both historical and recent data on bottlenose dolphin sightings. Additionally, local inhabitants of various towns along the Argentinean coastline were contacted through email and the facebook page “Toninas de la Bahía” (a facebook group set up by the lead author in 2013 dedicated to bottlenose dolphins in Argentina: www.facebook.com/groups/157084411154762), with the request to submit any opportunistic photographs and/or sighting information of the species. All received data were verified by the authors on accuracy and/or reliability. Any opportunistic data that could not be verified were excluded from this report.

Between 1973 and 1976, data on the presence of bottlenose dolphins were collected between San Clemente del Tuyú and Miramar, based on a set of questionnaires (Bastida, unpubl. data). Between 2001 and 2006, Failla

(unpubl. data) conducted standardised questionnaires (based on Filion, 1980) among 30 key informants in the larger area of El Cóndor (Fig. 1A) regarding the historical and current presence of bottlenose dolphins. In the first stage, the informants were queried about various species of marine mammals to ensure correct species identification. In a second stage, they were questioned specifically about bottlenose dolphins in their region. Together, the research groups involved in this review have accomplished substantial marine mammal survey effort in various regions along the Argentinean coastline and continental shelf. Their respective databases were consulted for bottlenose dolphin sightings, and to infer the absence of the species (Table 1).

Table 1: List of co-authors of this review (from North to South) who have their study areas in Argentina, including their affiliation, predominant areas, focus species and years of study.

Province	Study area	Organisation	Respective co-author	Main focus species	Since
Buenos Aires	Bahía Samborombón, Cabo San Antonio, Bahía Blanca, Bahía San Blas, Pinamar and Villa Gesell	Fundación Aqua Marina	Pablo Bordino, Leonardo Berninsone	Franciscana dolphin (<i>Pontoporia blainvillei</i>)	1998 - ongoing
	Mar del Plata	Universidad Nacional de Mar del Plata	Ricardo Bastida	Cetaceans	1973 - ongoing
	Bahía Blanca	Gekko-Grupo de Estudios en Conservación y Manejo-Universidad Nacional del Sur	Pablo Petracci	Bottlenose dolphin, Franciscana dolphin	1999 - ongoing
Río Negro	Estuario Río Negro	Fundación Cethus	Mauricio Failla	Bottlenose dolphin, Franciscana dolphin	2001 - ongoing
	Bahía San Antonio	Whalefish (previously Fundación Marybio)	Els Vermeulen	Bottlenose dolphin, Southern right whales (<i>Eubalaena australis</i>)	2006 - 2012
Chubut	Golfo San José	Wildlife Conservation Society	Guillermo Harris	Bottlenose dolphin	1981 - 1990
		Instituto de Conservación de Ballenas	Mariano Sironi	Southern right whales	1995 - ongoing (between July and October)
	Golfo San Jorge	Universidad Nacional de la Patagonia	Laura Reyes	Cetaceans	2003 - 2007
Santa Cruz	Río Deseado, Bahía San Julián, Río Santa Cruz, Río Gallegos and Cabo Vírgenes	Fundación Cethus	Miguel Iñíguez	Cetaceans	1986 - ongoing
Tierra del Fuego	Bahía San Sebastián, Puerto Harberton	Museo Acatushún de Aves y Mamíferos Marinos Australes	María Marchesi	Marine mammals	1975 - ongoing

Results

Distribution and Occurrence

Before 1970:

The oldest record found for the presence of bottlenose dolphins in Argentina dates from 1904, when Lahille (1908) caught two individuals (male and female) in the La Plata River, Quilmes (near the city of Buenos Aires; Fig. 1A), which he later described as *Tursiops geophyreu*s. The same author further reported the occurrence of bottlenose dolphins along the rest of the coast of Buenos Aires, including in the area of Necochea (Fig. 1A). Furthermore, Cabrera and Yepes (1940) reported the presence of bottlenose dolphins along the Argentinean coast, including in the Estuario de Río de la Plata (province of Buenos Aires) and Golfo San Matías (province of Río Negro) (Fig. 1A). The authors referred to the species as *T. truncatus*, considering it to be synonymous to *T. geophyreu*s at that time (Hershkovitz, 1963; Bastida and Rodríguez, 2006).

Other historical data (before 1970) for the species in the province of Buenos Aires comprise the accidental bycatch of a bottlenose dolphin approximately 120 km up the Río Uruguay, near Gualeguaychú (33°07' S; 58°21' W; not shown on map) in 1932 (Castello et al., 1983) and a stranding in Punta Blanca in 1951 (Fig. 1A; Marelli, 1953). Unpublished data and anecdotal records report the presence of the species in Mar del Plata and

Bahía Blanca in the 1950's (Fig. 1A; pers. obs. R. Bastida). Especially in Mar del Plata, the bottlenose dolphin was considered a common species by local inhabitants and tourists, which could be seen at least once a week (pers. obs. R. Bastida).

For the province of Río Negro, historical data (before 1970) are available from a standardized questionnaire (based on Filion, 1980) sent out by Failla between 2001 and 2006 (unpubl. data) in the area around El Cónдор (Estuario del Río Negro; Fig. 1A). Results from these questionnaires indicated the presence of bottlenose dolphins along this stretch of coastline from as early as 1952, as well as up to 60 km upstream the Río Negro (near the city of Viedma and San Javier; Fig. 1A).

For the province of Chubut, anecdotal records were found confirming the presence of the species in Golfo Nuevo (Fig. 1A) from 1958 onward (Lodi et al., in press). No data prior to 1970 were discovered for the provinces of Santa Cruz and Tierra del Fuego.

1970-1990:

In the province of Buenos Aires, a dedicated survey on the species commenced off the northern coast in the mid-1970s. This study documented a coastal population of bottlenose dolphins residing between Punta Piedras (35°23'S, 57°7'W; Fig. 1B) and Necochea (38°37'S, 58°50'W) (Bastida and Rodríguez, 2003). This study initiated after data, collected by means of questionnaires, indicated the frequent presence of the species in this stretch of coastline (Bastida, unpubl. data). In the same general area, Mermoz (1977) also indicated the presence of bottlenose dolphins in Punta Indio (35°16'S, 57°14'W; Fig. 1B), just north of Punta Piedras. Castello et al. (1983) reported a stranding in this locality in 1976, and reviewed what was known about the species in the country to that date. Castello's report indicated a general distribution area along the coast of the province of Buenos Aires, Río Negro and Chubut, and mentioned the sighting of two bottlenose dolphins nearly 400 km up the Río Uruguay, near the dam of Salto Grande (30°37'S, 57°50'W; not shown on map) (Castello et al., 1983). Beade et al. (1988) reported on the bottlenose dolphins present in Bahía Samborombón (Fig. 1C) between 1983 and 1986, which were seen on at least 47 different occasions in that time period. Bastida et al. (1992a) reported the stranding of an adult female in 1987 at Chapadmalal Beach (38°12'S, 57°41'W), just south of the city of Mar del Plata (Fig. 1A). Additionally, a few manuscripts informed on the accidental bycatch of bottlenose dolphins in coastal fisheries near the port of Mar del Plata in January 1982 (Moreno et al., 1984; Bastida and Lichtschein, 1986) and in the port of Necochea and Claromecó (Fig. 1B) between 1988 and 1990, although mortality through bycatch appears to have been low (Crespo et al., 1994). Anecdotal records report the species in San Bernardo (approx. 40 km south of Bahía Samborombón) and off Miramar (50 km south of Mar del Plata) between 1976 and 1981 (Fig. 1B; pers. obs. M. Iñiguez). Interestingly the town "Las Toninas" (Fig. 1B) was founded in this area in 1960, the name of which related to the frequent sightings of bottlenose dolphins (its common name in Argentina being "tonina") along the coast.

Further south in the province of Buenos Aires, Balbiano and Suárez (2000) reported the recurrent presence of a single bottlenose dolphin along the beach of Monte Hermoso in the summer of 1974 (approx. 30 km east of Bahía Blanca; Fig. 1B) interacting with swimmers. Also Bastida (unpubl. data) took note of a single bottlenose dolphin interacting with bathers in Monte Hermoso in February 1968. Whether or not these records comprises the same individual remains undetermined.

Bastida and Lichtschein (1986) informed on the frequent occurrence of bottlenose dolphins along the entire coast of the province of Buenos Aires as well as the North Patagonian coast, a geographical region commencing in the adjacent province of Río Negro. The standardized questionnaires directed at stakeholders (based on Filion, 1980) conducted by Failla (unpubl. data) between 2001 and 2006, reported the occurrence of bottlenose dolphins in the province of Río Negro in the 1970s and 1980s, including up to 60 km upstream the Río Negro near the city of Viedma and San Javier. The questionnaires also rendered information on 2 strandings as a result of bycatch, both in El Cónдор (in the autumn of 1976 and summer of 1983).

In the province of Chubut, the first dedicated study of coastal bottlenose dolphins was conducted during 21 months from 1974 to 1976 (Würsig and Würsig, 1977). This study recorded the year-round presence of coastal bottlenose dolphins in Golfo San José, Península Valdés (42°23'S, 64°03'W; Fig. 1B,C) (Würsig and Würsig, 1977, Würsig, 1978; Würsig and Würsig, 1979). A few years later, based on substantial survey effort in the region between 1981 and 1988, Würsig and Harris (1990) reported a notable decrease in sightings in Golfo San José. The authors suggested this may be related to a range shift out of Golfo San José, although clear evidence for this hypothesis was not provided.

In 1977, one bottlenose dolphin was found stranded in the province of Tierra del Fuego (Goodall, 1989; Goodall et al., 2011). Another unique record is the stranding of two male bottlenose dolphins in Dunnose Head, Isla Gran

Malvinas/ West Falkland Islands (51° 45'S, 60° 25'W; Fig. 1B) in May 1984 (Strange, 1992). The author reported these animals stranded together with a group of approx. 100 pilot whales (*Globicephala melas*).

1990-2016:

In the early 1990s, all dedicated research on the species in the province of Buenos Aires ceased due to a general lack of sightings (Bastida and Rodríguez, 2009). Although Bastida and Rodríguez (2003) reported on the occurrence of the species in Bahía Samborombón, in recent years only one live sighting (19 May 2007) was recorded as well as one stranding (a possible case of bycatch; 14 Dec. 2004) in this bay by Fundación Aqua Marina (unpubl. data) (Fig. 1C). Furthermore, Bastida and Rodríguez (2003) reported on the irregular occurrence of the species in Bahía Samborombón, while Bastida (2003; 2015) reported on the absence of the species from the area of Mar del Plata despite one opportunistic sighting of a single individual in Necochea in 2011 (J. Bastida, pers. obs.). Data on bottlenose dolphins further south in the province of Buenos Aires, in the area of Bahía Blanca, has been collected since 1999 by Petracci et al. (in prep.) and between 2003 and 2011 by Fundación Aqua Marina (unpubl. data). The presence of the species in this area was also documented by Vermeulen et al. (2016). According to these records, sightings took place in all months of the year, most frequently in the internal channels of the estuary of the Ría Bahía Blanca. Vermeulen et al. (2016) and unpublished data of Fundación Aqua Marina also indicated the presence of the species in the area of Bahía San Blas.

In the province of Río Negro, a dedicated study of coastal bottlenose dolphins commenced in 2006. This research documented the presence of a resident community of the species in the Northwest of Golfo San Matías (Vermeulen and Cammareri, 2009a), ranging from Bahía San Antonio to 60 km upstream the Río Negro (Vermeulen et al., 2016; Failla et al., in press). In total, 11 strandings were recorded for this area between 2001 and 2015 (Vermeulen and Failla, unpubl. data), of which one was a live stranding of 3 individuals near the city of San Antonio Oeste in 2014 which were refloated successfully (Diario Río Negro, 2014). At least two of the other strandings were related to fishing activities; one was bycaught in a gillnet, whereas the other individual was observed inside the freezer of an artisanal fisherman who claimed to consume the animals' meat (photographs and data verified on 9 Oct. 2012 by Vermeulen, unpubl. data). It remains undetermined, however, whether or not the latter animal was incidentally bycaught or purposefully killed. Opportunistic sightings of the species were made also along the coast of Pozos Salados, Playas Doradas (115 km south of Bahía San Antonio) (Vermeulen, unpubl. data) and Puerto Lobos (Vermeulen and Cammareri, 2009b) (Fig. 1C).

In the province of Chubut, Coscarella et al. (2012) reported on the presence of coastal bottlenose dolphins along the outer coastline of Península Valdés, inside Golfo San José and inside Golfo Nuevo since 1999, albeit in relatively low numbers. The presence appeared to occur year-round in Golfo Nuevo, and seasonally in adjacent areas (in winter and spring). Romero et al. (2014) reported on the stranding of 6 bottlenose dolphins between 1997 and 2012 in northern Patagonia (40° 30' to 43° 30' S, 64° to 65° W), one of which took place in Playa Union (43° 24' S, 65° 03' W; Fig. 1C) (Sánchez et al., 2002). Observations made by Coscarella and Crespo (2009) indicated bottlenose dolphins might use the area of Playa Union as a feeding area, and reported on their interaction with Commerson's dolphins (*Cephalorhynchus commersonii*). Aerial surveys of Crespo et al. (2008) indicated the presence of bottlenose dolphins in Golfo San Jorge, just north of the city Comodoro Rivadavia (45°41'S, 66°53'W; Fig. 1C). Additionally, an article of the local newspaper reported the live stranding of two bottlenose dolphins on the 15 Feb. 2011 in Bajada de los Palitos (46°05' 67°36'W), also located in Golfo San Jorge (Fig. 1C; Fig. 3 right; Diario Crónica, 2011). It was stated that both individuals were successfully refloated.

Bastida and Rodríguez (2006, 2009) mentioned the sighting of an individual bottlenose dolphins in the province of Santa Cruz. This individual was sighted on the 15 Feb. 2001 in Cabo Blanco (47°12'S, 65°44'W; Fig. 1C) within a group of 3 Peale's dolphin (*Lagenorhynchus australis*) (R. Bastida, pers. obs.). No further records could be found on sightings or strandings of bottlenose dolphins in this province.

Down south in the province of Tierra del Fuego, Goodall et al. (2011) reported a confirmed sighting of at least 3 bottlenose dolphins in the Canal de Beagle (54°55'S, 67° 34'W, Fig. 1C) in 2003. Goodall et al. (2011) also mentioned the stranding of at least 7 individuals in the province of Tierra del Fuego between 2003 and 2006 (in Bahía San Sebastián, Punta Popper and Puerto Harberton at Canal de Beagle; Fig. 1C). In adjacent Chilean waters, Olavarría et al. (2010) reported a sighting of 5 bottlenose dolphins near Tierra del Fuego, in the Estrecho de Magallanes (Estero Cóndor, 53°22' S, 72°38'W) which stayed in the area for nearly a week. These two records appear to comprise the southernmost records of bottlenose dolphins worldwide.

273 Although offshore populations of bottlenose dolphins are described for many regions worldwide, including in the
274 Southeast Pacific and South Brazil (Van Waerebeek et al., 1990; Simões-Lopes, 1996), to date no offshore
275 population has been verified for Argentina despite numerous oceanographic offshore cruises conducted along
276 the Continental Shelf, the north sector of the Continental Slope and deep waters off Argentina between 1960 and
277 2016 (e.g. Bastida et al., 1992b; Mandiola et al., 2015; Fundación Cethus, unpubl. data). Further research and
278 data collection is expected to clarify this matter.
279

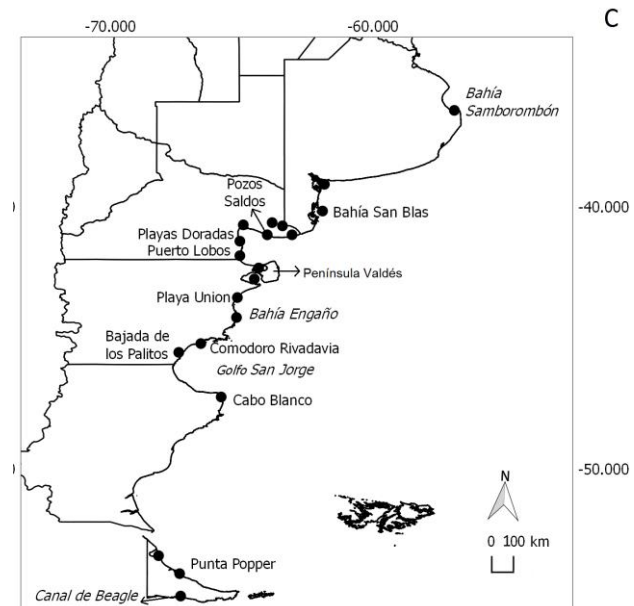
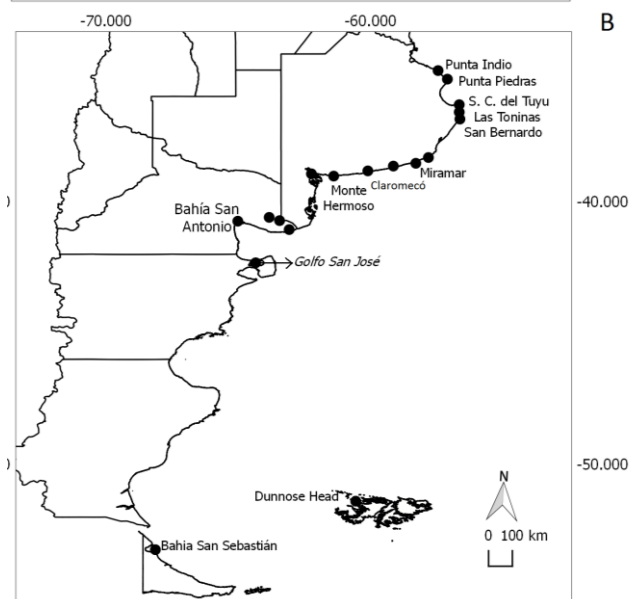
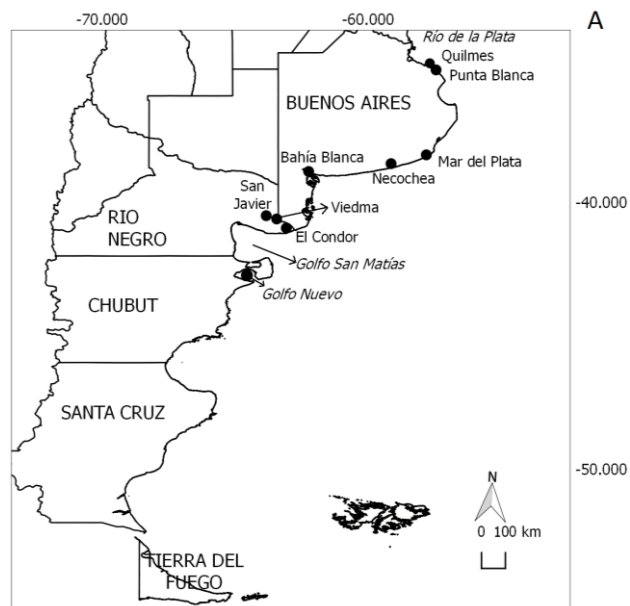


Figure 1: Maps of the Argentinean coastline (as well as Islas Malvinas/Falkland Islands) indicating bottlenose dolphin records (sightings and strandings combined) in Argentina (A) before 1970, (B) between 1970 and 1990, and (C) between 1990 - 2016. Capital letters indicate the name of the provinces, regular font indicates localities, and italic font indicates larger areas such as bays or gulfs.

Residency and ranging patterns

Relatively little is known about the residency and ranging patterns of bottlenose dolphins in Argentina. In the late-1970s to mid-1980s, Bastida photo-identified around 30 individual bottlenose dolphins through which the ranging behaviour of various individuals could be recorded over a coastal stretch of nearly 400 km (between Bahía Samborombón and Necochea - 38°37'S, 58°50'W) (Bastida and Rodríguez 2003; Bastida unpubl. data). In Bahía Blanca, a total of 21 individuals could be photo-identified repeatedly between 2008 and 2016 from opportunistically obtained photographs (Vermeulen et al., 2016). Of these individuals, 4 were re-sighted in two different years (up to 6 years apart), and 2 other individuals were re-sighted in the area in 3 different years (Vermeulen et al., 2016). Although preliminary, these results suggest some degree of site-fidelity of various individuals to the region of Bahía Blanca. Vermeulen et al. (2016) further described the ranging distance of one individual travelling at least 180 km between Bahía Blanca and Bahía San Blas.

In the province of Río Negro, a community of coastal bottlenose dolphins was reported between 2006 and 2012 to reside in Bahía San Antonio (Vermeulen and Cammareri, 2009a; Vermeulen et al., 2016). A total of 67 bottlenose dolphins could be identified individually up to 44 times on separate days in the study area (median = 16; mean = 17.6; SD = 11.1; Vermeulen et al., 2016). The median Residency Index value (the proportion of months an individual was re-sighted out of the number of months with sufficient survey effort) for all 67 identified dolphins in the study area combined (2007 - 2011) was 0.24, ranging up to 0.56 (for an individual that was re-sighted in 25 of the 45 study months; Vermeulen et al., 2016). The same authors reported that the highest likelihood of re-identification was found during the winter months, and that dolphins which used the area more regularly throughout the year also tended to exhibit a higher between-year site-fidelity in Bahía San Antonio (Vermeulen et al., 2016). However, 20 of the 67 individuals identified in Bahía San Antonio were reported to range northeast to the Estuario del Río Negro (El Cóndor; 200 km one way), with a minimum interval of 8 days between sightings in both areas (equivalent to a mean travel speed of 25 km*day⁻¹) (Vermeulen et al., 2016). The same authors also reported the maximum recorded distance of 290 km (one way) between sightings in Bahía San Antonio and Bahía San Blas covered by 2 identified individuals. Vermeulen and Cammareri (2009b) mentioned a ranging distance of 150 km one way for 3 identified individuals from Bahía San Antonio to Puerto Lobos.

In the province of Chubut, Würsig and Würsig (1977) indicated the ranging patterns of identified coastal bottlenose dolphins over 300 km (one way). The authors further recorded the residency of at least 5 individuals in Golfo San José during their entire 21-month study in 1974 - 1976. Six other individuals were present in the first study year, with 4 of them being re-sighted again in the area 30 months after commencement of the study (Würsig and Harris, 1990). No information is available on residency and ranging patterns in this area in more recent years.

Comparison of the photo-identification catalogue of bottlenose dolphins gathered between Bahía Blanca and Bahía San Antonio between 2006 and 2012 (Vermeulen, 2014; Vermeulen et al., 2016) with the photo-identification catalogue collated between San Clemente del Tuyú and Miramar between 1976 and 1986 (Bastida, unpubl. data), did not result in any matches (re-identifications). Further comparison of all photo-identification images with the catalogue assembled in Golfo San José between 1974 and 1976, and partially published by Würsig and Würsig (1977), did not result in any matches either. However, data sets are strongly geographically and temporarily segregated and the comparison with older photo-identification catalogues can be challenging.

Abundance and sighting frequency

In the province of Buenos Aires, a population of approximately 100 coastal bottlenose dolphins was estimated to reside between San Clemente del Tuyú and Miramar in the mid-1970s - mid-1980s, of which 30 individuals were identified (Bastida and Rodríguez, 2003). A decrease in sightings was noted in this area in the late 1980s, after which subsequently in the 1990s, sighting numbers dropped dramatically (Bastida and Rodríguez, 2003; ; Bastida, 2003, 2015). Despite continued survey effort of approx. 3 days/month year- round, the last individual sighted in this region by the corresponding authors was in 1992, in Punta Mogotes, Mar del Plata (R. Bastida, pers. obs.). In Bahía Samborombón, Beade et al. (1988) reported at least 47 sightings between 1983 and 1986, although total search effort is unknown. In recent years, only one sighting of a live bottlenose dolphin and one stranding was recorded in this bay despite research effort in the area by Fundación Aqua Marina since 1998 (Fundación Aqua Marina, unpubl. data). These data suggest an extremely low sighting frequency of the species in the province of Buenos Aires during the last decades. Although anecdotal, local artisanal fishers and regional park rangers also observed the decrease of bottlenose dolphin sightings in this area during the last two decades (Fundación Aqua Marina, unpubl. data). Notwithstanding occasional sightings of the species for nearly 60 years

in the northern part of the province of Buenos Aires, it is clear the most frequent records occurred some 40 years ago between 1974 and 1980 (Lodi et al., in press).

In Bahía Blanca and Bahía San Blas (southern province of Buenos Aires), a total of 21 and 5 individuals, respectively, were photo-identified between 2008 and 2016 from opportunistically obtained photographs (Vermeulen et al., 2016). Although no precise information is available on the sighting frequency or abundance of the species in this region, it is believed that the local abundance does not exceed 50 individuals (Petracci et al., in prep).

For the area of El Cóndor (Estuario del Río Negro), province of Río Negro, Failla et al. (in press) reported a SPUE (sighting rate per unit effort) of 0.66 dolphin groups / hour during the months April-June of 2008 to 2011. Almost no observations were made during the rest of the year due to the general absence of the species in the wider area as well as the need for cost-effective research effort. So far, no information is available about the density of bottlenose dolphins in this region. However, all 20 identified dolphins are known to be part of the community of coastal bottlenose dolphins described by Vermeulen et al. (2016) mentioned below.

In Bahía San Antonio, Vermeulen and Cammareri (2009a) indicated a SPUE from land-based observation between 2006 and 2008 of 0.24 sightings / hour year round, with each sighting containing 1.3 dolphin groups on average. In the same bay, a total of 67 individuals were identified between 2006 and 2011 (Vermeulen and Bräger, 2015). The annual rate of first-time identifications diminished notably over the years, with no new adults identified in the final 2 years of the study, suggesting that all adult individuals in the population were identified by the end of 2009. Total abundance, corrected for unmarked individuals, ranged from 40 (95% CI = 16.1 - 98.8) to 83 (95% CI = 45.8 - 151.8) individuals. The proportion of marked individuals in the population averaged 0.65 (± 0.05 SD), and seemed to increase over the years (reported to be 0.53 in 2008; Vermeulen and Cammareri, 2009a). The extremely low genetic diversity of this population reported by Fruet et al. (2014) further indicated a small population size. In the larger area between Bahía San Antonio and the Estuario del Río Negro, Failla and Vermeulen (unpubl. data) recorded 11 stranding events over 15 years (2001 to 2015), resulting in an average of 0.7 stranding events/year.

In the province of Chubut, Würsig and Würsig (1977) identified a total of 53 individuals in Golfo San José. Although no abundance estimates are available, this number was regarded to be a minimum, because unidentified bottlenose dolphins were sighted at the same time outside the study area (B. Würsig in Coscarella et al., 2012). Würsig and Würsig (1977) further reported that dolphins were sighted in their study area on 44% of their survey days. A decade later, Würsig and Harris (1990) reported that this number had decreased to 5% for the same area, with mostly the same individuals having been sighted (G. Harris, pers. obs.).

For more recent times, Coscarella et al. (2012) reported that 17 bottlenose dolphin groups were observed during 33 aerial surveys conducted in the province of Chubut (Península Valdés to Bahía Engaño) between 1999 and 2007, of which only one was sighted inside Golfo San José in December 2005. These data resulted in an extremely low SPUE of < 0.001 groups / km surveyed (Coscarella et al., 2012). Based on the aerial surveys conducted, an abundance estimate resulted in 34 (95% CI = 22 - 51) bottlenose dolphins spread over the larger area of central Patagonia (Península Valdés to Bahía Engaño; Coscarella et al., 2012). The same authors reported 361 boat-based surveys conducted between 2001 and 2007 in Golfo San José (25 surveys) and Golfo Nuevo (336 surveys). On average, bottlenose dolphins were sighted on 15.5% of the survey days in Golfo Nuevo (85 dolphin groups) whereas they were not at all sighted in Golfo San José (Coscarella et al., 2012). In total, 28 of these sightings in Golfo Nuevo (33%) concerned the same individual associated with dusky dolphins (*Lagenorhynchus obscurus*; Coscarella et al., 2012), an individual well known in the area (Yadzi, 2002). The overall SPUE from these boat-based surveys amounted to 0.063 sightings / hour for Golfo Nuevo, with the highest SPUE during summer decreasing to 0 in winter.

In Bahía Engaño, the proportion of successful sighting days was reported to be slightly higher (29.8%) based on land-based surveys (Coscarella and Crespo, 2009; Coscarella et al., 2012), with no change in sighting frequency among seasons.

Opportunistic sightings confirm the low sighting rate of bottlenose dolphins in the area around Península Valdés. Despite the intensive shore-based observations between July and October and aerial photo-identification surveys for southern right whales each September since 1995 in Golfo San José and Golfo Nuevo, only 2 sightings of solitary bottlenose dolphins were recorded in Golfo Nuevo (in 2001 and 2005) and none in Golfo San José for the period 1995-2015 (M. Sironi, pers. obs.). In light of > 300 opportunistic records of dusky dolphins during these surveys, this lack of sightings confirms the extremely low sighting frequency of bottlenose dolphins in this area since 1995, at least during winter and early spring (June-October). Nonetheless, two decades earlier, Würsig and Würsig (1977) observed bottlenose dolphins regularly from the same site where these shore-based observations in Golfo San José were made.

In Golfo San Jorge, a few records were made of bottlenose dolphins (Crespo et al., 2008), including one live stranding (Diario Crónica, 2011). However, data presented by Reyes (2006) on cetacean presence in this bay reveals the general absence of the species despite substantial survey effort, at least between 1993 and 2004.

The situation appears to be similar in the province of Santa Cruz; apart from a sole record of a single bottlenose dolphin in 2001 (Bastida, unpubl. data), no other bottlenose dolphin sightings or stranding were recorded despite the intensive marine mammal research effort by Iñíguez and Fundación Cethus since 1986 and 1992 respectively in Río Deseado, Bahía San Julián, Río Santa Cruz, Río Gallegos and Cabo Vírgenes (Fundación Cethus, unpubl. data).

In the province of Tierra del Fuego, despite survey effort, the only reported live sighting in the Canal de Beagle was made opportunistically, and species identification was verified by Goodall et al. (2011) through obtained photographs. Although just outside Argentinean waters, Olavarria et al. (2010), based on extensive research survey effort, also indicated that the presence of bottlenose dolphins in Chilean waters of the Magallanes region appears to be quite infrequent. The authors further comment on the apparent absence of the species in a 1,000 km stretch of the Chilean coast between 45°S and 53°S despite extensive survey effort in that area. Similarly, the species appears to be absent from a stretch of > 800 km of Argentine coastline between 47°12'S (a single sighting in Cabo Blanco; Bastida, unpubl. data) and 53°S (northern most stranding in Bahía San Sebastián; Goodall et al., 2011). The latter absence is particularly surprising given the survey effort of Fundación Cethus in the province of Santa Cruz over several decades.

In terms of strandings, Goodall et al. (2011) reported a total of 8 strandings for the province of Tierra del Fuego between 1977 and 2006. After the first recorded stranding in 1977, no other stranding was recorded until 2003 despite constant search effort in the area for stranded marine mammal specimens (Goodall et al. 2011). Seven of the 8 strandings were thus recorded in a 4-year time span between 2003 and 2006 (5 individuals in 2003 of which 3 stranded together, one in 2004 and one in 2006, i.e. 5 stranding events) (Goodall et al. 2011). This equates to an average of 1.25 stranding events / year, considerably higher than the 0.7 stranding events / year from a resident community in North Patagonia (Vermeulen and Failla, unpubl. data). Although survey effort and length of uninhabited coastline are not entirely comparable, the frequency of stranding in Tierra del Fuego appears high considering the scarcity of live sightings in this region.

Group size and composition

In the province of Buenos Aires, bottlenose dolphins recorded in the 1970s-1980s between San Clemente del Tuyú and Miramar were most often seen in groups of 4 to 6 individuals, with the maximum recorded group size no more than 30 individuals (Bastida, unpubl. data). In general, calves were observed in approx. 15% of the groups encountered, but never more than one calf per group (Bastida, unpubl. data). In Bahía Samborombón, groups between 10 and 100 individuals could be seen during the early 1980s (Beade et al., 1988), although on one occasion in the summer of 1985 a group of an estimated 1,000 individuals was observed (pers. comm. M. Beade, 16 May 2016). Whether or not this sighting was related to offshore individuals remains undetermined. In recent years, the single sighting of a bottlenose dolphin in Bahía Samborombón made by Fundación Aqua Marina (unpubl. data) comprised a single individual.

For the area of Bahía Blanca, records made between 1999 and 2016 indicated a median group size of 4 individuals in the area ($n = 166$; $\max = 20$; Fidalgo 2004; Fundación Aqua Marina, unpubl. data; Petracci et al., in prep). The presence of calves in these groups was observed regularly, although data was never precisely recorded (P. Petracci, pers. obs.). No information is available on median group size for the sightings in Bahía San Blas. However, anecdotal information and opportunistic video footage indicate the occurrence of groups ranging from 1 individual to >10 individuals (E. Vermeulen, pers. obs., Iñíguez, pers. obs.; Fundación Aqua Marina, unpubl. data).

In the Estuario del Río Negro, province of Río Negro, Failla et al. (in press) found that most groups observed contained between 1 - 5 individuals (37%), although occasional aggregations of up to 20 dolphins (2%) were recorded. The authors further reported that in total, 31% of the observed groups contained calves, but never more than one calf per group.

In Bahía San Antonio, Vermeulen et al. (2015) recorded a median group size of 4 individuals, ranging from 1 to 50. The most frequently observed group size was 4 to 6 individuals (20%), with only 8% of the sighted dolphin groups containing > 20 individuals. The recorded group size varied significantly across seasons, with the largest groups found in winter. Furthermore, the behaviour appeared to affect the group size, with the largest groups seen during surface feeding bouts (Vermeulen et al., 2015). Vermeulen et al. (2015) also reported that on average 75% of the dolphin groups encountered contained calves (between 1 and 8 calves per group).

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460 In the province of Chubut, Würsig (1978) reported a mean group size of 14.9 individuals, ranging from 8 to 22.
461 The author further indicated that calves made up on average 10% of the sighted dolphin groups, with a mean of
462 1.5 calves per group. For the period 2001 - 2007, Coscarella et al. (2012) indicated a mean group size of 2.5
463 individuals (median = 2, max = 9) in the larger area between Península Valdés and Bahía Engaño based on aerial
464 surveys. During boat-based surveys, the authors recorded a median group size of 3.5 individuals inside Golfo
465 Nuevo (mean = 2.8; max = 10), with a decrease from 5 to 2 individuals between 2001 and 2007 (Coscarella et
466 al., 2012). Based on land-based surveys, the median group size observed in Bahía Engaño was 3 individuals
467 (mean = 2.3), with a maximum of 12 (Coscarella et al., 2012). Remarkably, these authors reported that calves
468 were never observed in the entire area between 1999 and 2007, although one juvenile was regularly observed in
469 Bahía Engaño (Coscarella and Crespo, 2009).

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Table 2. An overview of available information on group size, presence of calves in groups, sighting frequency and abundance of bottlenose dolphins in the provinces of Buenos Aires, Río Negro and Chubut between 1974 and 2016. Provinces of Santa Cruz and Tierra del Fuego are not included due to the existence of only occasional sightings of bottlenose dolphins in these regions.

	Time period	Individuals identified	Group size	Presence of calves in groups	SPUE	Local abundance	References
Province of Buenos Aires							
Bahía Samborombón	1983 - 1986	0	Between 10 - 100	NA	NA	NA	Beade et al., 1988
	1998 - 2016	NA	NA	NA	Near 0	NA	Fundación Aqua Marina, unpubl. data
San Clemente del Tuyú - Miramar	1974 - 1992	30	Most frequently between 4 - 6; max = 30	15% of groups; 1 calf per group	NA	approx. 100 (rough estimate)	Bastida and Rodríguez, 2003
	1993 - present	0	NA	NA	0	Near 0	Bastida, unpubl. data;
Bahía Blanca	2003 - 2016	17	Median = 4; max = 20	NA	NA	< 50 (rough estimate)	Vermeulen et al., 2016; Fundación Aqua Marina, unpubl. data; Petracci et al., in prep
Bahía San Blas	2008 - 2016	5	Ranging between 1 to >10 (anecdotal)	NA	NA	NA	Vermeulen et al., 2016, Fundación Aqua Marina, unpubl. data
Province of Río Negro							
Estuario del Río Negro	2008 - 2015	21	Most frequently between 1 - 5; max = 20	31% of groups; 1 calf per group	0.66 groups/hour between April- June, near 0 rest of year	NA	Failla et al., in press
Bahía San Antonio	2006 - 2012	67	Median = 4; max = 50	75% of groups; 1-8 calves per group	0.24 sightings/hour 82% of survey days	83 (95%CI = 45.8 - 151.8)	Vermeulen and Cammareri, 2009a; Vermeulen et al., 2015, 2016; Vermeulen and Bräger, 2015
Province of Chubut							
Golfo San José	1974 - 1976	53	Mean = 14.9; max = 22	10% of groups; 1.5 calves per group	40% of survey days	> 53	Würsig and Würsig, 1977
	1981 - 1988	0	Between 5-8	NA	5% of survey days	NA	Würsig and Harris, 1990; G. Harris, pers. obs.
	1999 - 2007	NA	One group of 2 ind. observed	0	0	34 (95%CI = 22 - 51)	Coscarella et al., 2012
Golfo Nuevo	2001 - 2007	NA	Mean = 2.8; max = 10 (decrease from 5 to 2 over years)	0	0.063 groups/hour 15.5% of the survey days	Included in estimate above	Coscarella et al., 2012
Bahía Engaño	1999 - 2002	NA	Mean = 2.3; max = 12	0	29.8% of surveyed days	Included in estimate above	Coscarella et al., 2012

Survival and reproduction

Very little information is available on the survival rate and reproductive parameters of bottlenose dolphins in Argentina. A dedicated study on these topics was conducted in Bahía San Antonio between 2006 and 2012 (Vermeulen and Bräger, 2015). Of an estimated population of approximately 83 individuals in this area, the authors indicated an annual adult survival rate between 0.97 (\pm 0.037 SE) and 0.99 (\pm 0.010 SE). During the same study, a total of 25 different calves were registered with 14 reproductive females, resulting in an estimated annual calf mortality of 22% or 0.7 calves/year. Vermeulen and Bräger (2015) further found that 83% of the calves were born in late spring/early summer, and that the reproductive females had an average calving interval of 3.5 years (ranging from 2 to 5 years). The same study estimated 3.5 births / year in the whole population, which resulted in a minimum annual birth rate of 4.2% / year for an estimated population size of 83 individuals. Based on these data, Vermeulen and Bräger (2015) raised concerns on the low number of reproductive females in the population (14 females in a photo-identification catalogue of 57 adult individuals), and suggested this to be a potential reason for the population decline, as indicated by a Population Viability Analysis. The authors also suggested the recruitment rate of calves into the adult population to be insufficient to sustain the population at its current size.

For the province of Chubut, Würsig (1978) recorded that calves were born during all seasons but winter in his 21-month study in Golfo San José in the 1970s. Coscarella et al. (2012), however, reported that no calves were observed in the larger area from Península Valdés to Bahía Engaño between 1999 and 2007.

Morphology

Lahille (1908) published the first known record of bottlenose dolphins in Argentina in 1904, and described the species as *Tursiops gephyreus* based on its morphology similar to the coastal bottlenose dolphins found in Uruguay and South Brazil. To date this species name has not been recognized, and it has remained a junior synonym to *T. truncatus* frequently used by some authors (e.g. Cabrera and Yepes, 1940, 1960; Hershkovitz, 1963; Marcovecchio et al., 1990, 1994; Bastida and Rodríguez, 2003, 2006). A preliminary description of the population structure of coastal bottlenose dolphins in the Southwest Atlantic in the 1980s used the dolphins' morphology to suggest the existence of two distinct coastal populations (Castello et al., 1983; Bastida and Rodríguez, 2003; Bastida et al., 2007). A northern population was described to range along the coasts of South Brazil, Uruguay and the province of Buenos Aires (Argentina). Bottlenose dolphins in this area display a triangular dorsal fin, a relatively longer beak and a light grey colouration, as described by Lahille (1908) as *T. gephyreus*. In contrast, a southern coastal population was reported to range along the coast of the province of Chubut (Würsig and Würsig, 1977), where they display a more falcate dorsal fin, a shorter beak and a darker colouration.

Although the province of Río Negro was not mentioned in the description above, photographic images indicate that the dolphins in this province also have a triangular dorsal fin shape, a longer beak and lighter colouration, and would thus belong to the morphological form described by Lahille (1908) as *Tursiops gephyreus*.

All recent photographic data gathered from the province of Buenos Aires and from the province of Chubut over the years, confirm this population structure based on morphology still exists to date, however with an overlapping distribution. For example, Vermeulen and Cammareri (2009b) reported the year-round presence of 3 individuals in Bahía San Antonio which showed a morphology as described for the area of the province of Chubut (falcate dorsal fin, shorter beak and dark colouration) (Fig. 2). Due to their subsequent re-identification in Puerto Lobos (Fig. 1C) it was suggested that the 3 individuals might have originated from the southern population in the province of Chubut. In Bahía San Antonio, these 3 individuals were only seen together in a tight group that interacted on multiple occasions with other bottlenose dolphins in the area (Vermeulen and Cammareri, 2009b). During observations of these interactions from a research vessel (e.g. Fig. 2 right), a size difference was noted as well, with the form presenting triangular dorsal fins being notably smaller in body length than the other form (E. Vermeulen, pers. obs.).

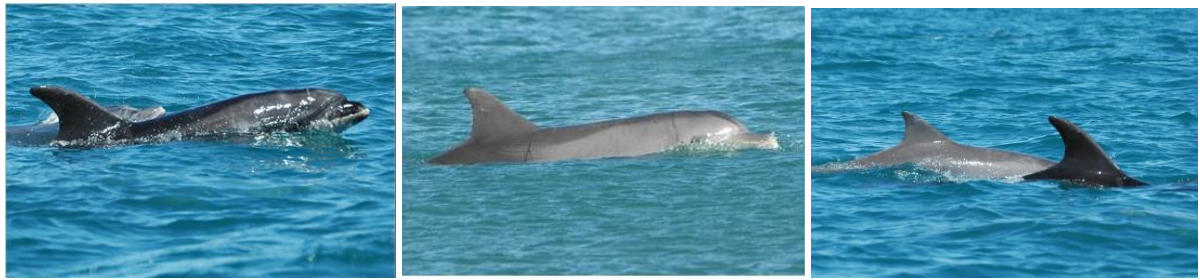


Figure 2. Left: adult bottlenose dolphin identified in Bahía San Antonio, province of Río Negro; morphological form described for the province of Chubut. Middle: adult bottlenose dolphin identified in Bahía San Antonio, province of Río Negro; morphological form described as *T. geophyreus* (Lahille, 1908). Right: adult individuals of both morphological forms photographed together in Bahía San Antonio.

Furthermore, photographs taken in Playa Unión in 2007 (Fig. 1C) and opportunistically gathered in 2012 clearly show bottlenose dolphins of the morphological form described by Lahille (1908) as *T. geophyreus* (Failla, unpubl. data; Fig. 3 left). A photograph taken during the stranding of two live bottlenose dolphins in Bajada de los Palitos (46°05' 67°36'W) (Fig. 3 right; Diario Crónica, 2011), shows a bottlenose dolphin which appears to lack the characteristics of the morphological form described for the larger area of Chubut (i.e. more falcate dorsal fin, shorter beak and darker colouration, Fig. 2 left).



Figure 3: Left: photograph of two bottlenose dolphins sighted in Playa Unión, province of Chubut, showing dorsal fin and beak (photo by Sebastián Pérez Astutti; Failla, unpubl. data). Right: photograph of a live stranded bottlenose dolphin in Bajada de los Palitos, province of Chubut (Diario Crónica, 2011).

No clear information is available about the morphology (triangular dorsal fin shape vs. falcate dorsal fin shape as described above), ecotype (inshore or offshore) or species (*Tursiops truncatus* or *T. aduncus*) of the bottlenose dolphins sighted in the Canal de Beagle (Goodall et al., 2011). Similarly, the sighting reported by Olavarría et al. (2010) in the Estrecho de Magallanes nearby (Estero Cándor; 53°22'S) could not be confirmed for species of bottlenose dolphin, morphotype or ecotype. However, due to the large distance to other Chilean sightings (>1,000 km), Olavarría et al. (2010) suggest they may have been of Atlantic origin. Additionally, no clear conclusion was possible regarding the morphology of the individuals stranded on the Argentinean side of the Tierra del Fuego island (Goodall et al., 2011). In contrast to the suggestion of Olavarría et al. (2010), Goodall et al. (2011) suggested that their stranded animals might have originated from the southern South Pacific. The skull size of the Fuegian specimens was found to be smaller than those proposed to be the *geophyreus*-type (Lahille, 1908; Barreto, 2000) and matched more closely with the *truncatus*-type of North Brazil (Goodall et al., 2011; Table 2). Concurrently, the total length of the individuals stranded in Tierra del Fuego (Goodall et al., 2011) appears to have been shorter than the total length of adults of the *T. geophyreus*-type (Lahille, 1908; Fig. 2 centre; Table 3), adding to the difficulty of attributing these animals to a particular type. The origin of the bottlenose dolphins stranded in Tierra del Fuego therefore remains unresolved. Goodall et al. (2011) emphasised the need for DNA analyses to clarify these aspects. Figure 4 provides an overview of the distribution of the morphological forms of bottlenose dolphins in Argentina.

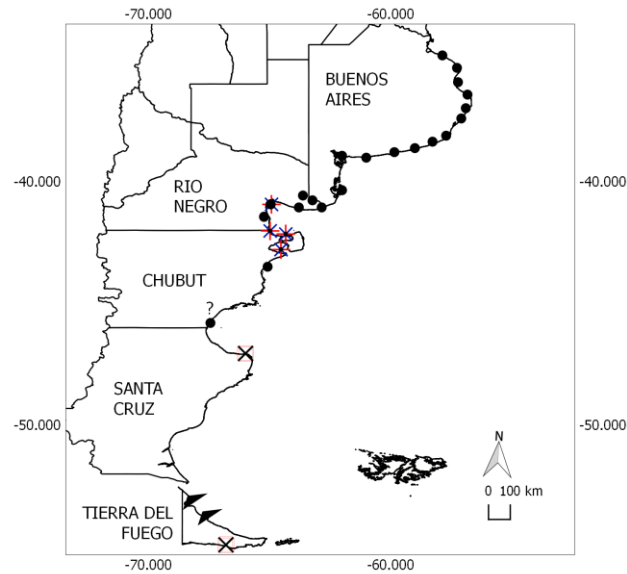


Figure 4: Map of the Argentinean coast indicating the historical and present distribution of bottlenose dolphins, as summarized in this review (capital letters indicate the provinces). Dots indicate the presence of the morphological form described by Lahille (1908) as *T. geophyreus*, one of which remained unconfirmed (marked with a question mark); Stars indicate the presence of a morphological form with falcate dorsal fins, short beak and darker colouration (cf. Fig. 2 left). Triangles indicate an unknown form of bottlenose dolphins which appears to display a different morphology as the ones indicated with a dot or star. Crosses indicate sightings and strandings of bottlenose dolphins with undetermined morphology.

Table 3: Measurements of body length and condylobasal length of bottlenose dolphins in North Brazil, South Brazil, Uruguay and Argentina.

	Bottlenose dolphins in North Brazil	Morphological form type <i>T. geophyreus</i> (Lahille, 1908), present in South Brazil, Uruguay and Argentina	Morphological form of Argentina displaying falcate dorsal fin, shorter beak and darker coloration (cf. Fig. 2 left)	Individuals stranded in province of Tierra del Fuego, Argentina (Goodall et al., 2011)
Length snout to fluke notch (parallel)	Adult female: 255 - 288 cm (Meirelles et al., in press) Adult male: 258 - 310 cm (Di Benedetto and Ramos, 2000; Meirelles et al., in press)	Adult female: 300 - 316 cm (Barreto, 2000; Bastida et al., 1992a; Vermeulen unpubl. data) Adult male: 343 - 386 cm (Barreto, 2000; Fruet et al., 2012; Bastida et al., unpubl. data)	Data not available, apparently larger than type <i>T. geophyreus</i> (Vermeulen, unpubl. data)	Adult female: 278.5 cm Adult male: 286.2 - 305.7 cm
Condylobasal length (range adult females and males combined)	494 - 541 mm (Barreto, 2000)	486 - 607 mm (Barreto, 2000) / 540 - 604 mm (Lucero et al., 2009)	NA	508 - 538 mm

Population genetics in Argentina

After decades of debate about taxonomic status and population structure, it was only recently that genetic data were used to investigate population connectivity of coastal bottlenose dolphins along the southern portion of the Southwest Atlantic (Fruet et al., 2014). The study accessed both mitochondrial control region sequences and microsatellite multilocus genotyping obtained from skin biopsy samples collected from six bottlenose dolphin populations inhabiting the coastal waters of southern Brazil, Uruguay and Argentina. The results of this study of both molecular markers revealed a surprising degree of genetic differentiation at both regional and local levels despite the lack of obvious physical barriers. At broad scale, remarkably strong differentiation was evident between the five dolphin populations sampled to the North (in southern Brazil - Uruguay) and dolphins from Bahía San Antonio (Fig. 1C; mtDNA $\Phi_{ST} = 0.43$; nuclear $F_{ST} = 0.46$), with negligible contemporary gene flow detected between them based on Bayesian estimates. Dolphins sampled in Bahía San Antonio had unique mtDNA haplotype not shared with coastal dolphins from Brazil and Uruguay, but differing only one mutational step. Based on these results, it was proposed that the bottlenose dolphin populations of Bahía San Antonio and southern Brazil - Uruguay should be treated as two distinct Evolutionary Significant Units. These results confirm

the existence of a northern population ranging from southern Brazil to central Argentina (extending further south to what was earlier proposed), but showed marked within population sub-division (i.e. Bahía San Antonio vs. southern Brazil – Uruguay). As all samples used in the study of Fruet et al. (2014) potentially came from the morphological type described as *gephyreus* (according to early morphological descriptions of Lahille, 1908), it may represent the first description of subdivision for the *gephyreus*-type.

Regarding the southern coastal population in Argentina described by Würsig and Würsig (1977), which display a more falcate dorsal fin, shorter beak and darker colouration, little information is available. Preliminary nuclear DNA analysis, however, suggested that the three animals displaying the morphology of a falcate dorsal fin (i.e. Fig. 2 left) and that regularly interact with bottlenose dolphins of the *gephyreus*-type in Bahía San Antonio (Vermeulen and Cammareri, 2009b) possibly were offshore migrants, with no current gene flow with the coastal *gephyreus*-type population. This assignment was also consistent with their close positioning with the Southwest Atlantic offshore ecotype in the reconstructed mtDNA haplotype genealogy, reinforcing their possible origin from an offshore population (Fruet et al., 2016 - submitted to this IWC meeting), despite the general description of their occurrence in coastal waters (Würsig and Würsig, 1977; Vermeulen and Cammareri, 2009b).

Discussion

Available data on the presence of bottlenose dolphins in Argentina indicate a serious decrease in sightings of the species at least along the coast of the provinces of Buenos Aires and Chubut (as suggested previously by Bastida and Rodríguez, 2003; Coscarella et al., 2012). Although no conclusion can be drawn based on long-term data for the province of Río Negro, more recent data do suggest a current population decline in the region as well (Vermeulen and Bräger, 2015). Overall, available data suggests perhaps the remaining existence of a resident population of coastal bottlenose dolphins in the region between Bahía Blanca and Bahía San Antonio of probably around 90 - 133 individuals (Vermeulen and Bräger, 2015; Vermeulen et al., 2016; Petracci et al., in prep.), and a possibly very small population in the province of Chubut with < 40 individuals (Coscarella et al., 2012). Available data on the genetic population structure indicated the presence of two genetically distinct “types” of bottlenose dolphins in the country with overlapping home ranges but no evidence of admixture (see also Fruet et al., 2016 - submitted to this IWC meeting). One of them was shown to relate to the offshore ecotype of the species despite the lack of evidence for such a population in Argentinean offshore waters. Furthermore, genetic data indicated a low genetic diversity in the coastal bottlenose dolphins of Bahía San Antonio as well as their genetic isolation from the bottlenose dolphins off the coast of Uruguay (Fruet et al., 2014). The origin and taxonomic classification of the bottlenose dolphins stranded and sighted along the coastline of the province of Tierra del Fuego remain unresolved.

Conservation outlook

The population decline of bottlenose dolphins in Argentina was first noted by Bastida and Rodríguez (2003), and subsequently by Vermeulen and Cammareri (2009a), Coscarella et al. (2012) and Vermeulen and Bräger (2015). Since the first publication more than a decade ago, warning signs have been ignored. Vermeulen and Bräger (2015) suggested that a general belief of the species being “common” might have obfuscated the need for more extensive research and conservation efforts in the past. Consequently, no verifiable information is available about the possible underlying causes of the observed population declines. However, bottlenose dolphins have disappeared from areas both with and without significant urbanisations (e.g. the city of Mar del Plata vs. the UNESCO heritage site Golfo San José), and research has indicated that there is little to no interaction between the bottlenose dolphin and fisheries in Argentina, with very low bycatch rates (Crespo et al., 1994, 1997; Crespo et al., 2008). Hypotheses have therefore been formulated about the wide-ranging effects of increasing environmental pressures, for example, through overfishing and contamination (Moreno et al., 1984; Bastida and Rodríguez, 2003; Coscarella et al., 2012). Vermeulen and Bräger (2015) also stated their concern on the possible effect of the elevated levels of contamination in the waters of North Patagonia on the reproduction of their study population. As such, the authors reported on the low recruitment rate of calves due to the low number of reproductive females observed in the study population, fearing it may be too low to sustain the current population size. Similarly, Bastida (unpubl. data) noticed a possible anomaly in the reproduction in his study population due to the extremely low presence of calves in the dolphin groups observed in the province of Buenos Aires in the 1970s and 1980s. Even more so, in the province of Chubut, Coscarella et al. (2012) reported the complete absence of calves in all sightings, at least between 1999 and 2007. Currey et al. (2011) indicated that a reduced recruitment rate lies at the basis of the declining trend of the endangered population of bottlenose dolphins in Doubtful Sound, New Zealand. Indeed, although adult survival is often believed to be a determining factor in the dynamics of K-selected species, a recent study showed that reproductive rates may be of vital

importance (Manlik et al., 2016). The authors explained the difference in the viability of two small populations of bottlenose dolphins by the difference in their reproductive rate rather than in adult survival, with the more stable population exhibiting a higher reproductive output and a lower adult survival. This suggests that raising the reproductive output of such a population is a more effective way of reversing population declines, whereas increasing adult survival rates appears ineffective (Manlik et al., 2016).

Detecting the effect of a low reproductive and/or recruitment rate in the dynamics of a population requires years of data. Even so, when the reproductive failures occur in the early stages of reproduction or gestation and no obvious physical evidence is available (e.g. for early calf mortality), they might occur unnoticed. This was suggested to occur in the population studied in Bahía San Antonio (Vermeulen and Bräger, 2015), when a concern was raised on the apparent low number of successfully reproducing females in the entire population. This could be related to a large number of unsuccessful females, or to a possibly skewed sex ratio in the population. Random genetic samples taken from identified adult bottlenose dolphins in Bahía San Antonio by Fruet et al. (2014), resulted in a sex ratio of 11 males to only 3 females, significantly diverging from a 1:1 ratio based on a binomial test ($p < 0.01$). The same ratio was found in the identification catalogue in the same area (14 reproductive females (i.e. associated with a calf) in a catalogue of 67 individuals between 2006 and 2012). However, whether or not this apparently skewed sex ratio is related to the study area or a bias in photo-identification and sampling effort remains to be clarified.

In any case, if a reduced reproductive outcome is the basis of the general bottlenose dolphin population decline in Argentina, it might explain why this alarming situation did not raise concern in the past (due to low obvious mortality), and consequently received little attention compared to the large concern, for example, for the potential effect of bycatch on the population of franciscana dolphins in the country (e.g. Bordino et al., 2002) or the recent southern right whale die-offs in Península Valdés (Rowntree et al., 2013). Furthermore, unravelling the potential factors impacting reproductive outcome could be extremely difficult, especially when no specific hypothesis can be formulated. Previous research has shown an influence of a wide range of factors on the reproductive success and/or calf survival in bottlenose dolphins, including behaviour (e.g. inexperience of primiparous females; Mann et al., 2000), water depth (probably related to predation pressure; Mann et al., 2000), food availability and foraging success (Mann et al., 2000), thermal stress (Currey et al., 2011) and pollutant load (Schwacke et al., 2002; Wells et al., 2005).

Therefore, going forward, an increased research effort on the species in Argentina is strongly recommended, with a primary focus on determining the possible causes of a reduced reproductive outcome and its effect on the overall population dynamics. Multiple approaches may be recommended, including sampling for detailed toxicological studies and health evaluation, sex-ratio determination, nutritional stress assessments and foraging ecology (stable isotope and fatty acid analyses). Samples could be used further to investigate population connectivity and genetic diversity. Mark-recapture methods, including temporal symmetry capture-recapture models which allow direct estimation of population growth rates without estimating abundance (e.g. Currey et al., 2011), should be used to build on the currently existing database for a continued monitoring of the population dynamics and infer the weight of various demographic parameters.

As long as no clear causes of the observed population decline can be identified, the ability to formulate precise actions for an improved conservation management strategy remains limited. Therefore, it is recommended that resources are made available for such studies, and that they be regarded as a priority action. Based on improved data, an accurate reassessment of the conservation status of the bottlenose dolphin in Argentina and the formulation of management directives is then highly recommended.

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