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Long range movements of bottlenose dolphins *Tursiops truncatus* and its implications for the protection of a declining Evolutionary Significant Unit in the coast of Patagonia, Argentina.

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Abstract

The foto-identification technique has contributed significantly to the knowledge of the small cetacean species. Bottlenose dolphins in Patagonia were among first populations in which this technique was used. The current information shows that this population may be genetically isolated. There have been suggestions that dorsal fin morphology could help to differentiate geographical subgroups. Along the last 40 years it has shown evidence of declining, but the causes are unknown. A displacement to other areas has been suggested, but the home range of the individuals is unknown. We examined a data base comprising 184 good quality

photographs and analyzed the captures of individually identified dolphins in San Antonio bay, Nuevo Gulf and the port of Rawson. During a span of 15 years dolphins were identified in the three localities; accounting individual movements of 450 km. Dorsal fins of both shapes were present in every location. San Antonio bay was established as a MPA, protecting the core habitat for this population, but our results indicate that these dolphins have large home ranges including the southernmost locality where bottlenose dolphins are regularly spotted.

Introduction

Photo identification techniques had significantly contributed to the knowledge of the biology and behavior of whales and dolphins (Hammond *et al.*, 1990). Photo ID data have been used extensively to estimate population size via capture-recapture methods (Calambokidis *et al.*, 1990; Payne *et al.*, 1990; Wilson *et al.*, 1999; Williams *et al.*, 1993), and also other population parameters like mortality, survival and reproductive rates (Slooten *et al.*, 1992), home range (Shane, 1990), patterns of associations among individuals (Bräger *et al.*, 1994), social structure (Whitehead, 1995), site fidelity (Ballance, 1990) and testing hypothesis on factors shaping the social structure (Coscarella *et al.*, 2011).

The first attempts to use and quantify the use of photo identification techniques date back to late 1970's when Würsig and Würsing (1977) were able to identify the movements of bottlenose dolphins *Tursiops truncatus* in Golfo San José, in Patagonia. Along the coasts of Argentina, bottlenose dolphins were studied along the coast of Buenos Aires province during the 70's and 80's (Bastida and Rodríguez, 2003), in Golfo San José (Würsig, 1978; Würsig and Harris, 1990; Würsig and Jefferson, 1990; Würsig and Würsig, 1977; Würsig and Würsig, 1979) and more recently in San Antonio Bay (Svendsen, 2013; Vermeulen and Cammareri, 2009a; Vermeulen and Cammareri, 2009b)

Bottlenose dolphins are cosmopolitan species and two of them have been recognized, *T. truncatus* and *T. aduncus* but the taxonomic status of each population around the globe is far from being completely

unraveled (Natoli *et al.*, 2004). A species or at least a subspecies status was proposed to the southwestern South Atlantic Ocean bottlenose coastal dolphins, including the individuals inhabiting from south Brasil to Golfo San José in Argentina (Bastida *et al.*, 2008). *T. truncatus gephyreus* is described based on intermediate features between *Tursiops* and *Sotalia* (Goodall *et al.*, 2011), although it is usually considered a synonym of *T. truncatus* (Bastida and Rodríguez, 2003). Despite this, studies have considered this subspecies (*T. t. gephyreus*), reporting its presence along the coast of Brazil (Barreto and Beaumord, 2002). In Argentina, the presence of two distinct forms of *Tursiops* was proposed based on photo identification, based on the shape of the dorsal fin, one off the coast of the Buenos Aires province and other for Chubut province in northern Patagonia (Bastida and Rodríguez, 2003). A recent study on the genetics of *Tursiops* found two distinct evolutionary significant units (ESUs) in the southwestern South Atlantic, namely one from Brazil and Uruguay and another inhabiting the San Antonio Bay in the Río Negro province, in northern Patagonia (Fruet *et al.*, 2014). The San Antonio Bay (SAB) ESU (*sensu* Fruet et al., 2014) is genetically distinctive unit located in the northern area of San Matías Gulf (Fig. 1) but unfortunately no samples were provided for Buenos Aires, leaving a gap in the information on the population structure.

The population estimate for the SAB ESU was 83 individuals including calves for the year 2008 (Vermeulen and Cammareri, 2009a). From the known individuals only ten were classified as year round residents, and 47 were present during part of the year. Vermuelen and Cammareri (2009b) also distinguished two shapes of dorsal fins, and proposed that four known individuals classified as residents are part of a distinct morph that inhabits the San José Gulf, and that the particular shape of the fin was described by Würsig in the 70's (Würsig, 1978; Würsig and Würsig, 1977). Unluckily, bottlenose dolphins seems to have abandoned San José Gulf and sightings of this species in the Chubut province is more sporadic than it used to be (Coscarella *et al.*, 2012; Vermeulen and Bräger, 2015). The population of bottlenose dolphins in Chubut province has declined at some point in time along the last 40 years and for the whole coastal area form port of Rawson to Puerto Lobos including both gulfs is estimated to be 34 individuals (Fig. 1) (Coscarella *et al.*, 2012).

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2012). No clear causation of this decline was established but no increased mortality rates (both natural or as part of incidental by catch) was detected (Coscarella *et al.*, 2012).



Figure 1: Map of the area including San Matías Gulf (SMG), Nuevo Gulf (NG) and port of Rawson (RW).

The home range of this particular population is unknown, but it is proposed that dolphins sighted in Chubut province are part, or at least share the same home range, with the dolphins sighted in San Antonio Bay. This can be an indication that the SAB ESU actually includes dolphins moving throughout several degrees of latitude and hundreds of kilometers, covering diverse coastal environments in North Patagonian gulfs. Hence, the objective of this work is to detect if individually identified dolphins moved among the study areas, using archived photographs of dorsal fins

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Materials and Methods

We analyzed images of dorsal fins of *Tursiops trunacatus* that were taken at port of Rawson (RW), Nuevo Gulf (NG) and San Matías Gulf (SMG) from opportunity platforms, during photo ID or behavioral studies aimed to other species or during dolphin watching trips (Coscarella *et al.*, 2011; Degrati *et al.*, 2013; Svendsen, 2013). We used pictures of the dorsal fins of the animals to make the individual recognition, using standard procedures (Würsig and Jefferson, 1990). Photographs were taken and analyzed according to the methodology described by Slooten *et al.* (1992). Only adult dolphins were included in the analysis. Subjective scales of photograph quality (Q: 0–3) and distinctiveness (D: 0–3) were used to decide whether an individual should be included in the data set: Q = 0, useless photograph; Q = 3, photograph sharply focused and perpendicular to dorsal fin; D = 0, with no visible mark; D = 3, nicks that have an excellent probability of being identified by photographs. Only photographs with Q ≥ 2 and D ≥ 2 were included in the analysis.

Out of the 487 pictures examined, 184 fulfilled the quality requirements. One hundred and nine were taken at NG from 2001 to 2015; 20 at RW from 1999 to 2007 and fifty five at SMG from 2006 to 2014. The photographs from 1999, 2001 and 2002 were KodakChrome © slides or Kodak Plus-Xpan© black and white films, that were digitalized using a Nikon Coolscan IV, and subjected to the same quality scale that the digital photos.

Results

The photos allowed us to identify a total of 63 individuals in a 15 years spam considering the three areas. Not every sampling occasion produced a recapture, and hence, the dates of sampling occasion with recaptures span 13 years. Out of the 63 individuals identified, only 11 were recaptured in 15 of the 24 sampling occasions (Table 1).

There were recaptures of individuals in all of the areas with a variable time span among recaptures. The shortest period between recaptures was four months (110 days) for a dolphin sighted in two consecutives sampling occasions in SMG (Tt13) and the longest was more than 14 years (4845 days) for a dolphin identified in NG and recaptured in SMG (Tt04). The maximum number of recaptures was 4 for Tt04. (Table 1)

Table 1: Capture history for *Tursiops truncatus* in San Matías Gulf (SMG), Nuevo Gulf (NG) and Rawson (RW).

	01/ 01	02/ 01	01/ 02	12/ 02	10/ 04	02/ 05	06/ 05	09/ 06	12/ 06	03/ 07	03/ 07	04/ 08	09/ 12	05/ 14
Individual	RW	NG	NG	RW	NG	NG	NG	SMG	SMG	SMG	SMG	SMG	NG	SMG
Tt01		-	-											
Tt02														
Tt03										_				
Tt04														
Tt05														
Tt06														
Tt09														
Tt10														
Tt11														
Tt12														
Tt13														

Seven of the 11 recaptured dolphins were sighted in different areas but no individual dolphin was sighted in all the three bays (Fig. 2). Three of the 4 dolphins recaptured in the same bay were sighted in NG (Tt02, Tt05, Tt06), while Tt13 was only sighted in SMG. These four animals were recorded within few months in same bay, while the recaptures done in different bays were generally years apart.

Interestingly, three pairs of dolphins were always sighted together, one of them four years apart. Tt01 and Tt02 were together in NG in February 2001 and were sighted again in the same gulf in January 2002. Tt05 and Tt06 were in the same group of Tt01 and Tt02 in January 2002 and were sighted two more times together in February and June 2005 again in NG. Finally Tt11 and Tt12 were seen together in SMG in April 2008 and sighted in NG in September 2012 (more than four years later).



a) Tt01: Left in Nuevo Gulf in 02/2001. Right in Rawson 12/2002



b) Tt04: Left Nuevo Gulf 02/2002. Right San Matías Gulf 05/2014



c) Tt09: Left: Rawson 01/2001. Right: San Matías Gulf 03/2007

Figure 2: Selected recaptures of *T. truncatus* in different the three different bays between 2001 and 2014.

Discussion

This study presents the first results regarding the extension of the home range for the Patagonian population of *T. truncatus* towards the end of its regular distribution range in the southern south Atlantic.

Also presents evidence on the overlap of the used areas by the same dolphins for three locations, two of them previously unreported (NG and RW). It is clear that the dolphins regularly sighted in SMG, NG and RW move along the coast more than 450 km, assuming they swim close to the shore as some models suggest for this area (Svendsen, 2013). Other bottlenose dolphin coastal populations are known to travel distances within this range (Scott *et al.*, 1990). The bottlenose dolphins studied during the seventies in Golfo San José (Fig. 1) have been reported to move over 300 km in a nine months period (Würsig, 1978). Some of the individual of the group of *T. truncatus* regularly sighted in San Antonio Bay (SMG) are known to travel distances of around 450 km towards the north (Vermeulen *et al.*, 2016). The bottlenose dolphins in the south Atlantic has been observed in Tierra del Fuego, but these records are considered to be rare and may be related to the ENSO events, and thus they may be considered as vagrant (Goodall *et al.*, 2011).

The number of identified individuals is within the range of the previously reported numbers using different source of information and different population estimates techniques (Coscarella *et al.*, 2012; Vermeulen and Bräger, 2015). Nevertheless 11% of the identified individuals were recaptured in different bays. This figure can be regarded as high, considering that the surveys are not systematic and the sampling effort is limited. This can be an indication of a large overlap of home range for different subgroups or that the home range of the Patagonian ESU (SAB *sensu* Fruet et al. 2014) is larger than previously thought. A limited number of tissue samples for these dolphins are available, but they have not been analyzed yet in order to establish a possible gene flow between SMG, NG and RW.

Regarding the possible differentiation of two geographical morphs based on the shape of the dorsal fins, one very triangular (Bonaerense type) and the other a falcate (Chubut type) (Bastida and Rodríguez, 2003; Svendsen, 2013; Vermeulen and Cammareri, 2009b), the dolphins identified in this study show that both morphs are present in all the areas (Figure 2). Tt09 clearly could be identified as a Bonaerense type bottlenose, but it has been spotted several times in RW, the most southern location where the bottlenose are regularly seen. This morphological difference at the moment cannot be regarded as an evidence of population differentiation.

The three pairs of dolphins recaptured together may indicate, considering the low sampling effort, that the group of bottlenose dolphins in Patagonia may have as part of their fluid fission-fusion society as inferred by the changes in the size of the sighted groups (Svendsen, 2013; Vermeulen and Cammareri, 2009a), long lasting bonds among individuals. This kind of association has been extensively described, especially between pairs of possible kin-related males (Wells, 1991). Determination of the sex of the dolphins compressing the pairs must be undertaken.

San Antonio Bay in SMG has been proposed as a core area for the species (Svendsen, 2013) and was declared MPA (Marine Protected Area) in 1993 and extended in 2008 by the Government of Río Negro Province (Giaccardi, 2014). Considering body of knowledge built in the past few years, which include the possible range extension or at least overlap of this population towards the north (Vermeulen *et al.*, 2016), the existence of some offshore records (Svendsen, 2013), the decline or at least the emigration from certain areas of the bottlenose in the study area (Coscarella *et al.*, 2012; Vermeulen and Bräger, 2015), and the presence of same SMG individuals in the port of Rawson area (this study), there is a need to tackle the conservation of this putative ESU in a more integrated approach. The declaration of MPAs aimed to protect cetacean species has proven to be of limited success (Hoyt, 2011), although they are the main took for cetacean habitat protection. Within this scenario, the effective management of the detected core area (San Antonio Bay) should be coupled with protective measures that include the Estuary of the Río Negro, the Golf o Nuevo and the adjacent area of port of Rawson, coordinating legislation and management measures between the Río Negro and Chubut provinces.

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