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Southern Right Whales (*Eubalaena australis*) in an Urbanized Area off the Southwestern Atlantic Ocean: Updated Records and Conservation Issues

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Abstract

The southern right whale (*Eubalaena australis*) has been placed in the category of "least concern" in the International Union for Conservation of Nature's *Red List of Threatened Species* and in the category of "endangered" in the *Brazilian Red List of Threatened Fauna*. The aim of this study was to update sighting and stranding records of right whales along the southeastern Brazilian coast between 2000 and 2015 and to assess the main threats they face. Records occurred mainly between May and October, and mother and calf pairs represented 78% of all sightings, evidencing the use of the southeast coast of Brazil as part of the breeding and possibly calving area. A total of eight strandings was reported. On 6 September 2012, the first confirmed ship strike on a right whale was reported in the surveyed area. The intensified conflicts between coastal development and the use of protected and calm waters along southeastern Brazil by southern right whales as breeding areas should be considered in management plans.

Key Words: Cetacea, Balaenidae, southern right whale, *Eubalaena australis*, vessel strike

Introduction

Southern right whales (*Eubalaena australis*; Desmoulins, 1822) are easily recognized by the absence of the dorsal fin, a relatively large head compared to their bulky body size, black coloured body with ventral white patches, bowed mouthline, large and paddle-shaped pectoral flippers, and callosities on the head (Jefferson et al., 1993; Kenney, 2009). These characteristics make these whales easily detectable by local onlookers in coastal breeding areas where these whales are often found (Best et al., 2001; International Whaling Commission [IWC], 2012). Southern right whales have a circumpolar distribution in the southern hemisphere, from 20º to 55º S, with eventual records down to 63º S (Jefferson et al., 1993; Best et al., 2001; IWC, 2012; Reilly et al., 2013). In summer, *E. australis* migrates to feeding grounds in higher latitudes; and in winter, it moves to lower latitudes for breeding and calving areas, usually occupying coastal areas (Best et al., 1993, 2001; IWC, 2012; Zerbini et al., 2015).

The southern right whale population was significantly reduced in the southern hemisphere by commercial whaling in the 1900s (Townsend, 1935; Reeves et al., 2007). Since the 17th century, right whales have been captured in the coastal waters of South America, from the Rio de Janeiro State coast, southeast Brazil, to Uruguay and Argentina (Best et al., 2001). In south and southeastern Brazil, several small-scale hunting stations were operated from the 1600s to the 1800s (Ellis, 1969). Due to the detection of a reduction of the southern hemisphere population, protests to protect the species and halt commercial whaling began in the 1930s (Kenney, 2009). Thus, since 1935, right whales have been protected by the IWC in the southern hemisphere. However, in the 1960s, Soviets illegally hunted more than 3,300 individuals in the southern hemisphere (Tormosov et al., 1998); and in Brazil, the last southern right whale was captured in 1973 (Palazzo & Carter, 1983). In recent years, the International Union for Conservation of Nature's (IUCN) *Red List of Threatened Species* switched the status of the southern right whale from "vulnerable" to extinction to "least concern" based on the increase in

the southern hemisphere population's abundance detected in the last decades due to conservation efforts (Reilly et al., 2013). The IWC estimated a population of 7,500 individuals in 1997 (Best et al., 2001) and 13,600 in 2009 (IWC, 2013). Another effort to evaluate the abundance of right whales in the southern hemisphere estimated a population of ~4,000 whales, including calves, in 2012, with a 6% increase in the Península Valdés (Argentina) region (IWC, 2012). According to the IUCN, the southern hemisphere population is still very small compared to its original size, and several stocks have fewer individuals, which means they require special care (Reilly et al., 2013).

The southern right whale is classified as "endangered" by the *Brazilian List of Threatened Species* (Ott et al., 2008). The occurrence of *E. australis* along the Brazilian coast is related to the species' migratory habits to tropical waters in winter and spring for breeding and calving areas, with peaks in August and September (Lodi et al., 1996). Annual sightings of *E. australis* are common in the shallow waters off the Brazilian southern coast, where groups of one to six individuals (usually mother and calf pairs) spend a few days or even weeks (Ellis, 1969; Lodi et al., 1996; Groch, 2001). Even though their main reproductive area in Brazil is located on the southern coast, right whales have been reported along a wider area that includes the southeastern coast (*ca*. 22º to 32º S) (Ellis, 1969; Lodi et al., 1996; Santos et al., 2001, 2010), and they are thought to be reoccupying old areas of use in the Southwestern Atlantic Ocean (Lodi et al., 1996; Santos et al., 2001). Throughout the ~1,700 km of shoreline where they can be found, just around the southern coast of Santa Catarina (28º S), their main occupation area (Groch, 2001), there is a specific marine reserve with ~156,000 ha and 130 km of shoreline established by a federal decree in 2000 to protect right whales known as *Área de Proteção Ambiental da Baleia Franca*. Along the remaining usage area, these whales are vulnerable to threats directly related to several human activities such as fishing, boat traffic (large and small vessels), drilling, and noise pollution, among others (Santos et al., 2010). As a consequence, right whales' health and the way they use the area in southeastern Brazil may be affected similar to what was reported with their congener from the Atlantic basin of the northern hemisphere, where the intense human activities in the coastal areas reduces the potential recovery of the species (Kraus & Rolland, 2007).

The southeastern Brazilian coast stands out for its increasing development, highlighting not only its economic prominence but also biodiversity conservation conflicts. Campos and Santos basins represent two of the most productive oil and gas basins found in this area. It comprises the most urbanized shoreline in Brazil, holding five of the largest ports, five smaller ones, and several marinas.

Based on the described scenario, the aim of this study was to update data on strandings and sightings of *E. australis* along the southeastern Brazilian coast, as well as to discuss several issues related to the concerns about the protection of the species in a highly urbanized area. As ship strikes have become one of the main causes of concern regarding the conservation of right whales in the Atlantic basin (e.g., Knowlton et al., 2007; Moore et al., 2007; Van Waerebeek et al., 2007; Campbell-Malone et al., 2008), emphasis was given to evaluating the development of boat traffic from a recent historical perspective along the southeast coast of Brazil.

Methods

The study area includes approximately 15% (1,130 km) of the Brazilian coastline, ranging from 21.7º to 26º S (Figure 1). The area comprises the States of São Paulo, Rio de Janeiro, and Paraná, representing the 1st, 3rd, and 6th most populated states in Brazil (Instituto Brasileiro de Geografia e Estatística [IBGE], 2010).

Stranding and sighting records from 2000 to 2015 were gathered through direct observation; a literature review; research on newspaper files (e.g., *Folha de São Paulo*, *O Estado de São Paulo*, *A Tribuna*, *O Globo*, *Extra*, *Meia Hora*, and *Expresso*); and information from museums, aquaria, and other institutions that had proof of the presence of *E. australis* off the coast of southeastern Brazil. Each record used in this evaluation had precise data on date, location, and one or more photo(s)/video footage that allowed for unequivocal identification of the species based on its taxonomic characteristics. These criteria are the same as those used in a previous study which updated similar data up to 1999 (see Santos et al., 2001). Photos and videos found in the World Wide Web were also included if they met the established criteria. Special care was taken when the images permitted individual identification of a sighted right whale based on the callosity pattern to better evaluate their movements along the coast, as well as to use sightings from closer timeframes in adjacent areas to avoid the overestimation of recordings of distinct individuals. For the cases in which individual identification was not possible, sightings were considered to be of different whales.

Annual reports of port authorities from São Paulo and Rio de Janeiro (Companhia Docas de Estado de São Paulo [CODESP], Companhia Docas de São Sebastião, and Companhia Docas do Rio de Janeiro [CDRJ]) were analysed in order to ascertain the magnitude of boat traffic in the study area. When possible, stranding records were

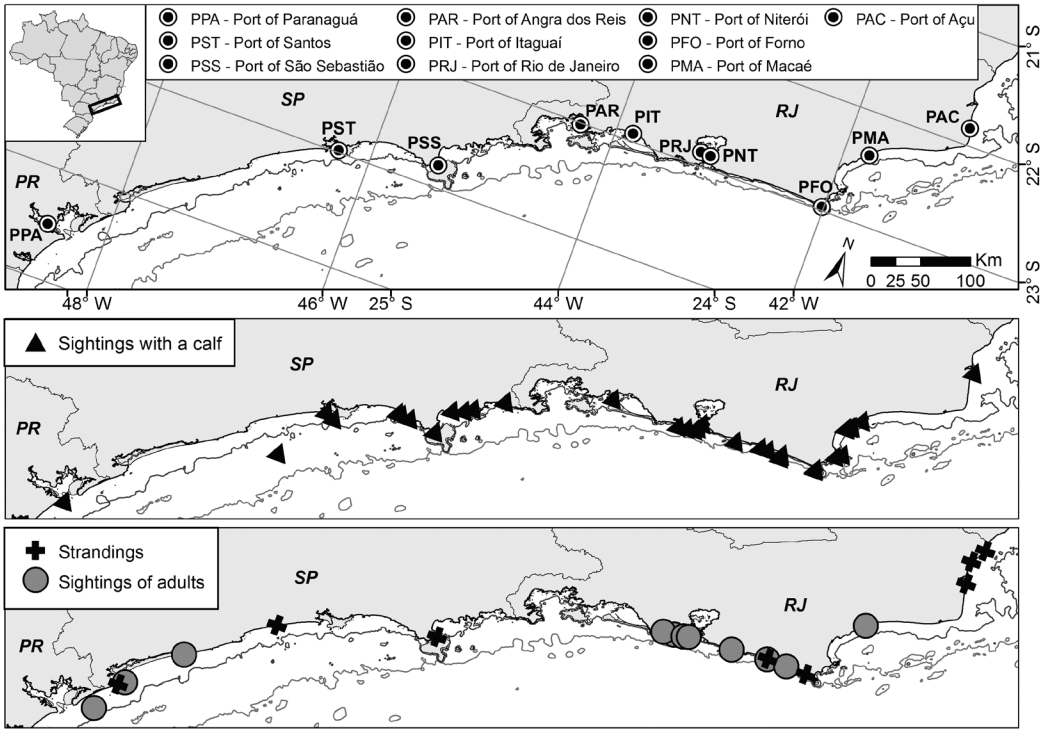

Figure 1. Map of the study area, including the States of Paraná (PR), São Paulo (SP), and Rio de Janeiro (RJ). The image on the top shows the location of the ports (by their initials) distributed along the shoreline, the image in the middle shows the sightings of mother and calf pairs, and the image on the bottom shows the sightings of adults (circles) and strandings (crosses).

investigated to better understand the main factors that could have driven such events.

Results

From 2000 to 2015, a total of 57 records of southern right whales were observed in southeastern Brazil, including 83 individuals in 49 sightings (Table 1; Figure 1) and eight strandings (Table 2; Figure 1). Sightings were more numerous and frequent near the Rio de Janeiro coast ($n = 31$; 63%; 1.9 sightings/y) than in the remaining area ($n = 18$; 37%; 1.1 sightings/y). Strandings followed the same pattern, with five (62.5%) observed in the Rio de Janeiro coast and three (37.5%) in the remaining area of southeast Brazil (Table 2). The male that stranded on 14 January 2004 was the only animal that stranded alive. The whale managed to get back to the sea but stranded again and died at the beach. Sightings were concentrated between May and October, with 41% observed in August and 36% in September (Tables 1 & 2). Mother and calf pairs represented 78% of all sightings. A neonate calf was found washed ashore on 15 August 2007, and another calf was sighted on 2 September 2013 accompanied by its mother (Tables 1 & 2). An adult female that stranded on 6 September 2012 had a sharp trauma that caused the amputation of its tail stock (Figure 2).

Annual data gathered from port authorities on vessel traffic from 1976 to 2014 in the Port of Santos, the largest in Latin America (Companhia Docas de São Paulo [CODESP], 1992), are presented in Figure 3. There was a marked increase in boat traffic from 1999 to 2008 and a small decrease since 2012. Figure 4 shows the traffic in the main ports of the study area (1,500+ vessels/y). The ports of Rio de Janeiro and Niterói were grouped together since they are both placed inside the Guanabara Bay. The number of boats operating in both of these ports increased significantly since 2008, and they are now higher than in the Port of Santos. Even though the Port of São Sebastião has a considerable number of boats, most operations are related to small fishing, sailing, and supply boats.

Table 1. Sighting records of southern right whales (*Eubalaena australis*) along the southeastern Brazilian coast between 2000 and 2015; coordinates are in decimal degrees, # = number of individuals, and + and ++ indicate sightings of the same individuals on different dates. RJ = Rio de Janeiro, SP = São Paulo, and PR = Paraná States. DO = direct observation, DO* = direct observation by other researchers, AM = article in media, LR = literature review, and PW = picture or video found on the Internet.

Date	Locality	Latitude	Longitude	#	Source
11 Aug 2000	Praia Grande, Arraial do Cabo, RJ	-22.9500	-42.0500	2	DO
18 Aug 2000	Praia de Jaconé, Maricá, RJ	-22.9667	-42.3830	2	DO
25 Aug 2000	Praia Seca, Araruama, RJ	-22.9333	-42.3833	2	DO
7 to 10 Aug 2001	Baía de Sepetiba, RJ	-22.9833	-43.9833	2	AM
17 and 18 Sept 2001	Copacabana/Leme, Rio de Janeiro, RJ	-22.9667	-43.1730	2	AM
24 Sept 2001	Baía de Guanabara, Rio de Janeiro, RJ	-22.9167	-43.1500	2	AM
18 Aug 2002	Praia de Jaconé, Maricá, RJ	-22.9667	-42.8167	2	DO
3 Aug 2003	Barra do Una, São Sebastião, SP	-23.7670	-45.7690	2	DO*
16 Aug 2003	Ubatumirim, Ubatuba, SP	-23.3430	-44.8933	2	DO*
16 Oct 2003	Ipanema/Leblon, Rio de Janeiro, RJ	-22.9923	-43.2000	2	AM
11 to 16 Aug 2004	Praia de Jaconé, Saquarema, RJ	-22.9403	-42.5833	2	DO, AM
11 Aug 2004	Praia da Vila, Saquarema, RJ	-22.9403	-42.4833	1	DO
13 Aug 2004	Praia do Vargas, Araruama, RJ	-22.9423	-42.3000	1	DO
7 Sept 2005	Tucuns, Armação de Búzios, RJ	-22.7833	-41.9167	2	DO
8 Sept 2005	Foz do rio Itapebussus, Rio das Ostras, RJ	-22.4923	-41.8833	2	DO
9 Sept 2005	Macaé, RJ	-22.3503	-41.7500	1	AM
May 2007	Arraial do Cabo, RJ	-22.9667	-42.0500	2	PW
5 to 14 Aug 2007	Ubatumirim, Ubatuba, SP	-23.3430	-44.8900	2	DO*, AM
15 Aug 2007+	Barra da Tijuca, Rio de Janeiro, RJ	-23.0157	-43.3500	1	AM
16 Aug 2007	Praia Brava, Armação de Búzios, RJ	-22.7500	-41.8670	2	DO
26 Aug 2007+	Barra da Tijuca/Recreio dos Bandeirantes, Rio de Janeiro, RJ	-23.0267	-43.4500	1	AM, PW
4 Oct 2008	Praia da Vila, Saquarema, RJ	-22.9383	-42.5083	2	DO
27 July 2009	Leblon/São Conrado, Rio de Janeiro, RJ	-23.0050	-43.2673	2	AM

26 Aug 2009	Camburi, São Sebastião, SP	-23.7817	-45.6523	2	DO*
3 Sept 2009	Juquehy, São Sebastião, SP	-23.7722	-45.7380	2	PW
7 Sept 2009	São Sebastião Channel, SP	-23.8173	-45.4002	2	PW
9 Sept 2009	Cocanha, Caraguatatuba, SP	-23.5830	-45.3170	2	PW
11 June 2010	São Conrado, Rio de Janeiro, RJ	-23.0050	-43.2667	1	AM
12 July 2010	Leblon, Rio de Janeiro, RJ	-22.9923	-43.2170	1	PW
July 2010	Ipanema, Rio de Janeiro, RJ	-22.9920	-43.2000	2	PW
16 Sept 2010	Costazul, Rio das Ostras, RJ	-22.5121	-41.9070	2	PW
Sept 2011	Ilha do Mel, PR	-25.5500	-48.3333	2	PW
5 Oct 2011	Barra da Tijuca, Rio de Janeiro, RJ	-23.0157	-43.3500	2	AM
7 Oct 2011	Praia Seca, Araruama, RJ	-22.9433	-42.3830	2	DO
19 July 2012[↔]	Praia do Gaiúba, Guarujá, SP	-24.0167	-46.3000	2	AM
22 to 26 July 2012[↔]	São Vicente/Santos, SP	-23.9833	-46.3833	2	DO*, PW
23 Aug 2012[↔]	São Sebastião, SP	-23.8167	-45.4000	2	DO*
1 Sept 2012[↔]	São Sebastião Channel, SP	-23.8167	-45.4000	2	PW
Sept 2012[↔]	Maranduba, Ubatuba, SP	-23.5444	-45.2153	2	PW
11 to 17 Sept 2012[↔]	Lázaro, Ubatuba, SP	-23.5000	-45.1433	2	DO*, PW
3 Aug 2013	Barra de São João, RJ	-21.6500	-41.0000	2	AM
28 Aug 2013	Itapebussus, Rio das Ostras, RJ	-22.4833	-41.8667	2	AM
28 Aug 2013	Juruvaúva, Ilha Comprida, SP	-24.7000	-47.4500	1	PW
31 Aug 2013	Guaraqueçaba, PR	-25.4333	-48.0500	1	AM
2 Sept 2013	Queimada Grande, Itanhaém, SP	-24.3500	-46.5833	2	DO
2 Sept 2013	Ilha do Bom Abrigo, Cananéia, SP	-25.1167	-47.8667	1	PW
3 Sept 2013	Praia do Pecado, Macaé, RJ	-22.4000	-41.8000	2	PW
11 Sept 2013	Costazul, Rio das Ostras, RJ	-22.5167	-41.9167	2	MA, PW
20 Aug 2014	Praia da Barra, Maricá, RJ	-22.9667	-42.8167	1	AM

Table 2. Stranding records of *E. australis* along the coasts of São Paulo (SP) and Rio de Janeiro (RJ) States between 2000 and 2015; coordinates are in decimal degrees. *Reported by Santos et al. (2001) and **Reported by Santos et al. (2010).

Date	Locality	Latitude	Longitude	Length	Sex
14 Jan 2000*	Ilha do Cardoso, Cananéia, SP	-25.0000	-48.9167	7.5 m	Unknown
3 Sept 2000	Praia Lagoa Doce, São Francisco do Itabapoana, RJ	-21.3502	-40.9642	> 12 m	Unknown
8 Sept 2000	Praia de Grussaí, São João da Barra, RJ	-21.6890	-41.0237	> 12 m	Unknown
17 Jan 2004	Praia de Itaúna, Saquarema, RJ	-22.9364	-42.4787	7.8 m	Male
29 Aug 2004	Monte Alto, Arraial do Cabo, RJ	-22.9510	-42.1101	13 m	Male
15 Aug 2007**	Itanhaém, SP	-24.1667	-46.7500	4.5 m	Male
4 Oct 2011	Ilhabela, SP	-23.7733	-45.3533	Unknown	Unknown
6 Sept 2012	Praia de Santa Clara, São Francisco do Itabapoana, RJ	-21.4833	-41.0500	> 14 m	Female

Figure 2. Southern right whale (*Eubalaena australis*) stranded on 6 September 2012 showing amputation of the tail stock

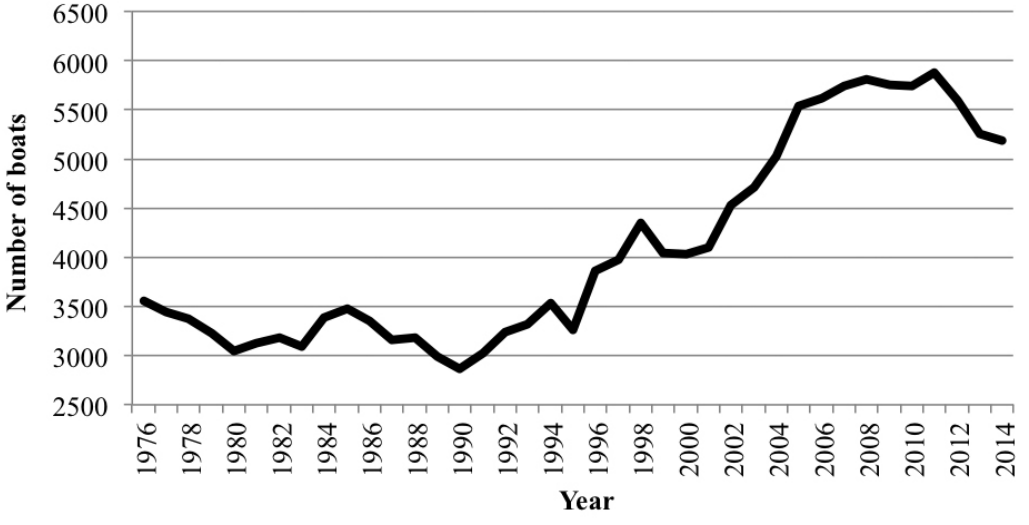

Figure 3. Annual number of boats departing from the Port of Santos, southeastern Brazil, between 1976 and 2014 (CODESP, 2015)

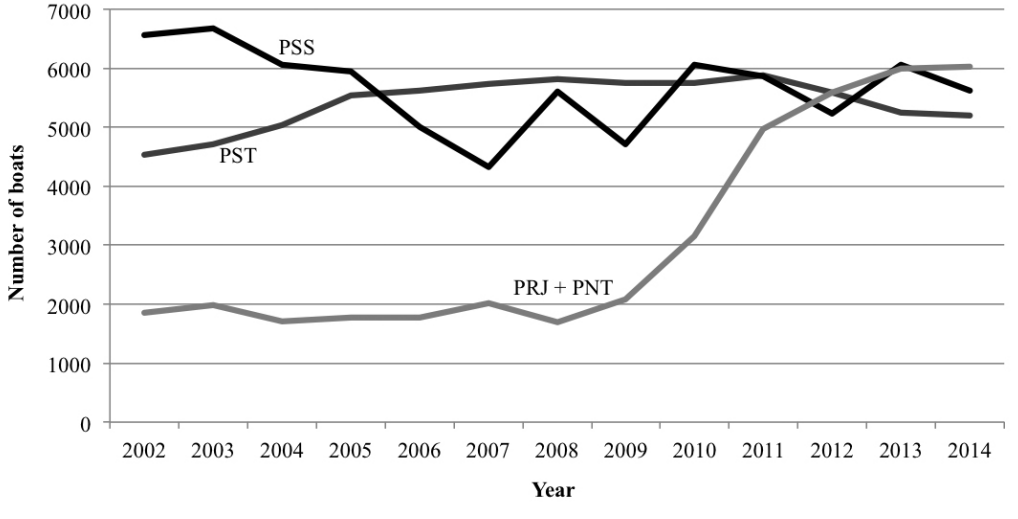

Figure 4. Annual number of boats departing from two major ports of São Paulo State (SP) and Rio de Janeiro State (RJ), Brazil, from 2002 to 2014. PST = Port of Santos, PSS = Port of São Sebastião, PRJ = Port of Rio de Janeiro, and PNT = Port of Niterói (CRDJ, 2014; CODESP, 2015; Companhia Docas de São Sebastião, 2015).

Discussion

Different from core breeding and feeding grounds of southern right whales where dozens to hundreds of individuals are regularly sighted every year (Bannister, 2001; Best et al., 2001; Cooke et al., 2001; Patenaude & Baker, 2001; Groch et al., 2005), our data indicate that southern right whales can be considered occasional visitors of the coastal area in southeastern Brazil.

Occurrences of right whales in coastal, populated areas quickly attract local onlookers and media attention, and they are likely to be reported when they are found close to the shore, especially

near the two overpopulated states of São Paulo and Rio de Janeiro in southeastern Brazil. As a consequence, these relatively uncommon sightings are publicized in the media, possibly on all occasions when these whales are observed. Thus, the newspaper files used by this study to gather data on the presence of right whales in the surveyed area can be considered useful and reliable, particularly in light of the new 21st century technologies to access information. Videos and photos posted in social media were also of great help to recover sighting data of right whales in southeastern Brazil. A total of 23 sightings were recovered from social media, including more than one record of the same individual on the same date and location; these were added to the sighting records reported by the authors. The records found on social media were especially important after 2009, when in some years they represent the major source for right whale sightings (Table 1).

Considering the annual population growth rates estimated at 14% by Groch et al. (2005) and 12% by the IWC (2012) to the Brazilian stock, and 6% by the IWC (2012) to the population in Argentina, it is expected that this population may expand its range far from the main breeding area, possibly reoccupying pre-whaling grounds as was reported for other areas (Rayment et al., 2012; Carroll et al., 2013; Roux et al., 2015). Yet, the intense urbanization of the southeastern Brazilian coast and the increase in vessel traffic may affect this stock recovery (see Figures 3 & 4). Human activities, such as boat traffic; fishing; seismic survey activities; and oil, gas, and mineral extraction and production (among other activities), increase noise pollution in the low frequency (< 500 Hz), causing entanglements and collisions, which lead to cumulative human-induced impacts to cetaceans (see examples in Lodi et al., 1996; Best et al., 2001; Johnson et al., 2007; Knowlton & Brown, 2007; Moore et al., 2007, 2013; Van Waerebeek et al., 2007, Zappes et al., 2013; Thomas et al., 2016). According to Rolland et al. (2012), an increase in hormonal metabolites associated with stress can be related to noise pollution in the North Atlantic, causing responses such as habitat shift, behaviour, and vocal repertoire changes, with negative effects on endangered populations. Kraus & Rolland (2007) showed that urbanization, an increase in boat traffic, and other human activities had a negative influence on the North Atlantic stock, inducing the whales to leave the coast and to occupy areas as far as 80 km from their historical locations.

In 2008, two southern right whales that stranded along the Rio de Janeiro coast were tested and found to be infected by the potentially harmful bacteria *Aeromonas veronii* biogroup *veronii* and *Aeromonas hydrophila* (Pereira et al., 2008). Both types of bacteria can be associated with waters which have poor adequate treatment and are contaminated by run-off. Whether they were sick animals or were infected when in migration to coastal waters is a matter of speculation. Indeed, this information is a snapshot of the severe deterioration of water quality in coastal waters off southeastern Brazil due to raw sewage and chemical effluents disposed inappropriately (Moura et al., 2011). Southern right whales were once so common in their use of inner waters of the Guanabara Bay, Rio de Janeiro, that paintings of whale hunting were common by the mid-1700s. The record of a mother-calf pair visiting the Rio de Janeiro harbour on 24 September 2001 (Table 1) is now a reminiscence of past times. The polluted waters of the Guanabara Bay have exposed both mothers and calves to contaminants in modern times.

In the last decade, the detection and exploitation of large oil and gas reserves offshore southeast Brazil, along with the expansion of the main ports from São Paulo and Rio de Janeiro, has caused an alarming increase in boat traffic, posing risks to cetaceans (Santos et al., 2010). Deaths of southern right whales due to vessel collision are a recent cause of concern. A study conducted between 1986 and 2005 in the North Atlantic showed that vessel strikes were responsible for 38% of the deaths of the North Atlantic right whale (*Eubalaena glacialis*) (Moore et al., 2007). According to Van Waerebeek (2007), 48 out of the 79 cases of large cetacean deaths by vessel collision in the southern hemisphere occurred with southern right whales, representing 61% of all reports. Campbell-Malone et al. (2008) identified vessel collision as the most probable cause of death in 21 of 40 right whale necropsies in the North Atlantic, with 11 resulting from sharp trauma. The same type of trauma was identified in the adult female that stranded in 2012 in São Francisco do Itapaboana (Figure 2), Rio de Janeiro. A sharp trauma, most likely caused by a large ship propeller (see examples in Moore et al., 2013), resulted in the amputation of the peduncle and, thus, the death of the whale. This was the first confirmed record of vessel strike as the cause of death of a right whale in this area. The boat traffic records presented in Figures 3 and 4 represent only the ports with 1,500+ vessels/y. Other smaller ports (Figure 1) and dozens of marinas also contribute to intense traffic in the area, increased noise pollution, and enhanced odds of vessel strike. Marinas are usually built in protected bays, highlighting the conflicts between right whales and urbanization.

The large number of mother and calf pair records observed in the present study (76% of all sightings) is in agreement with the previous studies (Lodi et al., 1996; Santos et al., 2001).

Records of mother-calf pairs, such as the sighting on 2 September 2013, added to stranded calves showing umbilical cord remains reported by Santos et al. (2001) and the neonate calf washed ashore on 15 August 2007, may indicate that these individuals were possibly born in southeast Brazil. Could these records from the southeast Brazilian coast represent a recent expansion to a new breeding and calving ground and/or a historical area being reoccupied by southern right whales? Considering cetaceans as sentinels of their environment (Moore, 2008) and the expansion of human activities in southeast Brazil, shouldn't this be the moment to evaluate the nature and intensity of these human impacts on this stock of southern right whales? To answer these questions, bio-ecological and oceanographic features related to the presence of *E. australis* in tropical waters must be better evaluated. Is there a movement pattern along the coast? Are those movements erratic? How do oceanographic events influence their behaviour and movements in breeding and calving areas? Will it be possible for right whales to use the highly developed coast as a new important calving area, or will they shift to remote and deeper waters? It is time to invest in robust research and conservation precautionary actions to protect southern right whales before a similar scenario as the one observed with the North Atlantic right whale begins to happen in the southern hemisphere. The authors recommend that specific regulations should be implemented in local waters in winter months such as the management of the traffic of large ships from the main, bigger ports and the ban of gillnets in coastal shallow waters where right whales have been recently sighted. We also recommend that port authorities invest in acoustic monitoring of right whales in local waters in winter, posing a better opportunity to avoid collisions and possibly entrapments.

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