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INTERNATIONAL WHALING COMMISSION

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ABSTRACT

The Santos Basin Beach Monitoring Program (*Projeto de Monitoramento de Praias da Bacia de Santos* - PMP-BS) is one of the monitoring programs required by the Brazilian federal environmental agency, IBAMA, for the environmental licensing of the oil and natural gas production and transport by Petrobras at the pre-salt province (25º05'S 42º35'W to 25º55'S 43º34'W), between 2100m and 2300m isobaths. Since late 2015, approximately 1040km of coastline are being systematically monitored, either daily (65% of the area) or weekly (14% of the area), or through calls from local population (21% of the area), to evaluate the potential impacts of these activities on marine turtles, seabirds and marine mammals. From September 2015 to March 2020, 215 baleen whales and 4,162 toothed whales were recorded stranded along the states of São Paulo, Paraná and Santa Catarina. At least 7 species of mysticetes and 20 of odontocetes were recorded, but humpback whales (*Megaptera novaeangliae*) were responsible for 36.4% of baleen whale strandings and franciscanas (*Pontoporia blainvillei*) and Guiana dolphins (*Sotalia guianensis*) for 80.6% of all toothed whales. Distribution of strandings was also heterogeneous, with areas of higher concentrations in all states. The intensive monitoring that has been underway along this large area revealed a much higher number of carcasses than previously recorded the institutions that for decades have been working in the area, especially concerning small cetaceans. For franciscanas, the number of stranded animals seems to indicate unsustainable levels of bycatch in fisheries.

INTRODUCTION

The Brazilian legal framework requires that activities classified as having "significant environmental impact" must undergo an environmental licensing process, that is coordinated by federal or local agencies, depending on the magnitude of the impact and affected environments. Offshore oil activities are listed as having potential for significant impacts and, considering that they may involve large areas, the environmental licensing process is coordinated at the federal instance, by IBAMA, the Brazilian federal environmental agency. In order to license the oil and natural gas production and transport from the pre-salt province of the Santos Basin (25º05'S 42º35'W a 25º55'S 43º34'W) between 2100m and 2300m isobaths, PETROBRAS, the largest oil company operating in the area, was required to develop many monitoring programs, including regular beach monitoring to assess strandings of marine fauna.

Since August 2015, the Santos Basin Beach Monitoring Program (*Projeto de Monitoramento de Praias da Bacia de Santos* - PMP-BS) has been underway, recording all marine turtles, seabirds and marine mammals that strand along approximately 1040km of coastline on the states of Santa Catarina, Paraná and São Paulo. All data is archived in a single database, supporting integrated analyses in the future. It must be noted that in September 2016 beach monitoring began along the coast of Rio de Janeiro, adding further 904km of monitored coastline. However, as it began more than one year after the first phase, it was decided not to include that data in this analysis. The complete PMP-BS executive project, with information on other monitoring projects required by the environmental licensing process, can be found at http://www.comunicabaciadesantos.com.br.

The present paper aims to (i) provide an overview of cetacean strandings patterns recorded in the first four years of the PMP-BS, and also (ii) highlight concerns about the stranding rates for franciscanas, Guiana and bottlenose dolphins along the south and southeast Brazilian coast.

MATERIALS AND METHODS

The area selected for this study corresponds to 1,040.4Km of beaches monitored by the PMP-BS between the cities of Ubatuba (São Paulo State; 23º22'31"S 42º44'00"W) and Laguna (Santa Catarina State; 28º29'42"S 48º45'36"W). Due to the logistical problems and difficulties to access specific beaches, 716.4Km are actively monitored by land (674.1Km daily, 42.3Km weekly) and 106.4Km are weekly monitored by boat (beaches with no access by land). Additionally, a network has been stablished with local communities, contributing with indirect monitoring of another 217.6Km of beaches, where any stranding that occur is informed to the PMP-BS and attended by field teams.

All animals found on the beaches, dead or alive, are recorded by the field teams and their data included in a data management system that was developed specifically for the PMP-BS. For each animal, data regarding taxonomy, stranding location, body condition, external markings and any evidence of interactions with human activities (e.g. marks of fishing nets on body, wounds made by propellers, presence of oil, etc.) are recorded, together with standard biometry (IBAMA, 2005). Dead animals up to category 5 (*sensu* Geraci & Lousnbury, 2005) are taken to the laboratory and necropsied to collect biological samples and identify the cause of death, whenever possible. Live animals that need treatment, are transferred to the project's rehabilitation centers.

The area being monitored has records of both common (*Tursiops truncatus*) and Lahille's bottlenose dolphins (*T. gephyreus*) (Hohl et al. 2020; Wickert *et al.* 2016). Since there is still divergence regarding the taxonomic status of common bottlenose dolphins in the area (Costa et al., 2016, 2020; Ott *et al.* 2017), all bottlenose dolphins were considered to be common bottlenose dolphins.

RESULTS AND DISCUSSION

Between September/2015 and March/2020 a total of 1,147,538.65 Km of beaches were monitored, with the effort evenly distributed (monthly average = 20,864.3km; std. dev.=1,126.6). During this time 4,429 cetaceans (Table 1) were recorded in the area, of which 4.9% (n=215) were mysticetes, 94.0% (n=4,162) odontocetes and 1.2% (n=52) could not be identified due to the advanced stage of decomposition. Most were found during regular monitoring (64.4%) but calls from local communities amounted to a little more than 1/3 of the animals, showing the importance of this strategy. Species richness was 29, representing 78% of all baleen whales and 47% of toothed whales already recorded in Brazil (Miranda *et al*., 2019). However, strandings rates were very different among species, with only three species comprising 87.3% of all stranded odontocetes: franciscanas (*Pontoporia blainvillei*), Guiana dolphins (*Sotalia guianensis*), and common bottlenose dolphins (*Tursiops truncatus*).

A temporal pattern was observed in the monthly number of strandings, with more animals recorded in the second semester (Figure 1). While this was expected for baleen whales, due to their migratory cycles, for odontocetes it was unexpected. However, when looking at the three most abundant species (Figure 2) it seems that the pattern is mostly caused by franciscana strandings. The species is not known to exhibit seasonal movements and has relatively small home ranges (Bordino, 2002; Paitach et al., 2017; Wells et al., 2013) but in Santa Catarina its main birthing period is between October and January (Cremer et al., 2013) and recent data from aerial surveys indicate that in austral summer months the species aggregate in shallower habitats (Sucunza et al., 2020). Also, along all its range, franciscanas are subjected to high levels of bycatch (Negri et al., 2012; Ott et al., 2002; Pinedo 1994; Rocha-Campos *et al.*, 2010). Thus, the increased numbers of stranded animals in the second semester probably reflect an interaction factors, including seasonality of specific fisheries, higher vulnerability of younger animals, and proximity to shore.

The second most common species, Guiana dolphins, also exhibited more stranded animals in the second semester, but on a lower scale. As it is also subject to high rates of incidental captures in coastal gillnets (Azevedo *et al.* 2017; Cantor *et al.* 2012; Cremer et al., 2017; Domiciano et al., 2016; Rocha-Campos *et al.* 2011), it seems that bycatch in fisheries that are more active in the second semester might be the main driver of this pattern. However, the increase in the number of Guiana dolphins stranded in late 2017 occurred mainly in the northernmost monitored area. A high mortality of Guiana dolphins was detected in November of 2017 in Rio de Janeiro state, just north of the monitored area, as the result of an outbreak of morbillivirus (Flach et al., 2019; Groch et al., 2018).

Table 1. Number of stranded cetaceans recorded by the Santos Basin Beach Monitoring Program (PMP-BS), from September 2015 to March 2020 along beaches of south and southeast Brazil.

Suborder	**Family**	**Species**	**N**	**% within suborder**
Mysticeti	Balaenidae	*Eubalaena australis*	11	5,12%
	Balaenopteridae	*Balaenoptera acutorostrata*	12	5,58%
		Balaenoptera borealis	2	0,93%
		Balaenoptera brydei	4	1,86%
		Balaenoptera edeni	10	4,65%
		Balaenoptera physalus	1	0,47%
		Balaenoptera sp.	18	8,37%
		Megaptera novaeangliae	78	36,28%
	Unidentified mysticete		79	36,74%
Odontoceti	Delphinidae	*Delphinus delphis*	12	0,29%
		Feresa attenuata	1	0,02%
		Globicephala macrorhynchus	1	0,02%
		Lagenodelphis hosei	1	0,02%
		Orcinus orca	1	0,02%
		Peponocephala electra	1	0,02%
		Pseudorca crassidens	1	0,02%
		Sotalia guianensis	904	21,72%
		Stenella attenuata	1	0,02%
		Stenella clymene	1	0,02%
		Stenella coeruleoalba	3	0,07%
		Stenella frontalis	75	1,80%
		Stenella longirostris	3	0,07%
		Stenella sp.	72	1,73%
		Steno bredanensis	44	1,06%
		Tursiops truncatus	278	6,68%
		Unidentified Delphinidae	203	4,88%
	Ziphiidae	*Ziphius cavirostris*	1	0,02%
	Pontoporidae	*Pontoporia blainvillei*	2,450	58,87%
	Kogiidae	*Kogia breviceps*	9	0,22%
		Kogia sima	3	0,07%
		Kogia sp.	1	0,02%
	Phocoenidae	*Phocoena dioptrica*	2	0,05%
	Physeteridae	*Physeter macrocephalus*	1	0,02%
	Unidentified odontocete		93	2,23%
Unidentified cetacean			52	1,17%
Total			**4,429**	

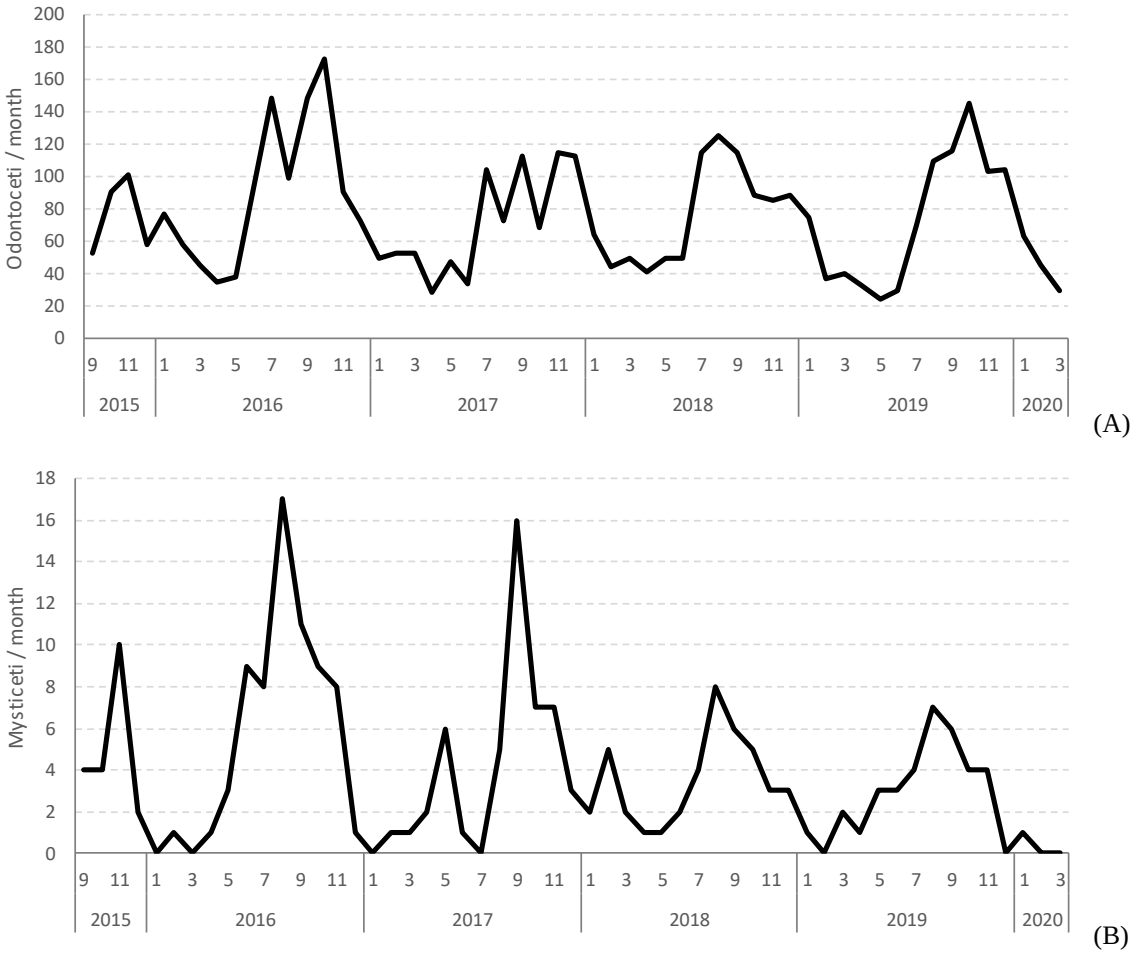


Figure 1. Temporal pattern of stranded (A) Odontoceti and (B) Mysticeti per month, from September 2015 to March 2020 along beaches of south and southeast Brazil, recorded by the Santos Basin Beach Monitoring Program (PMP-BS).

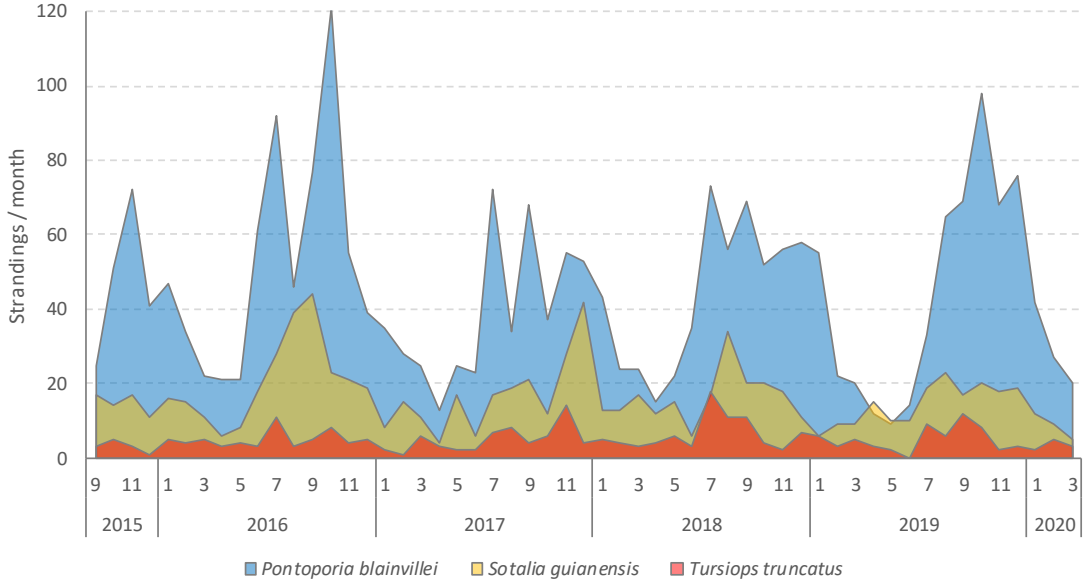
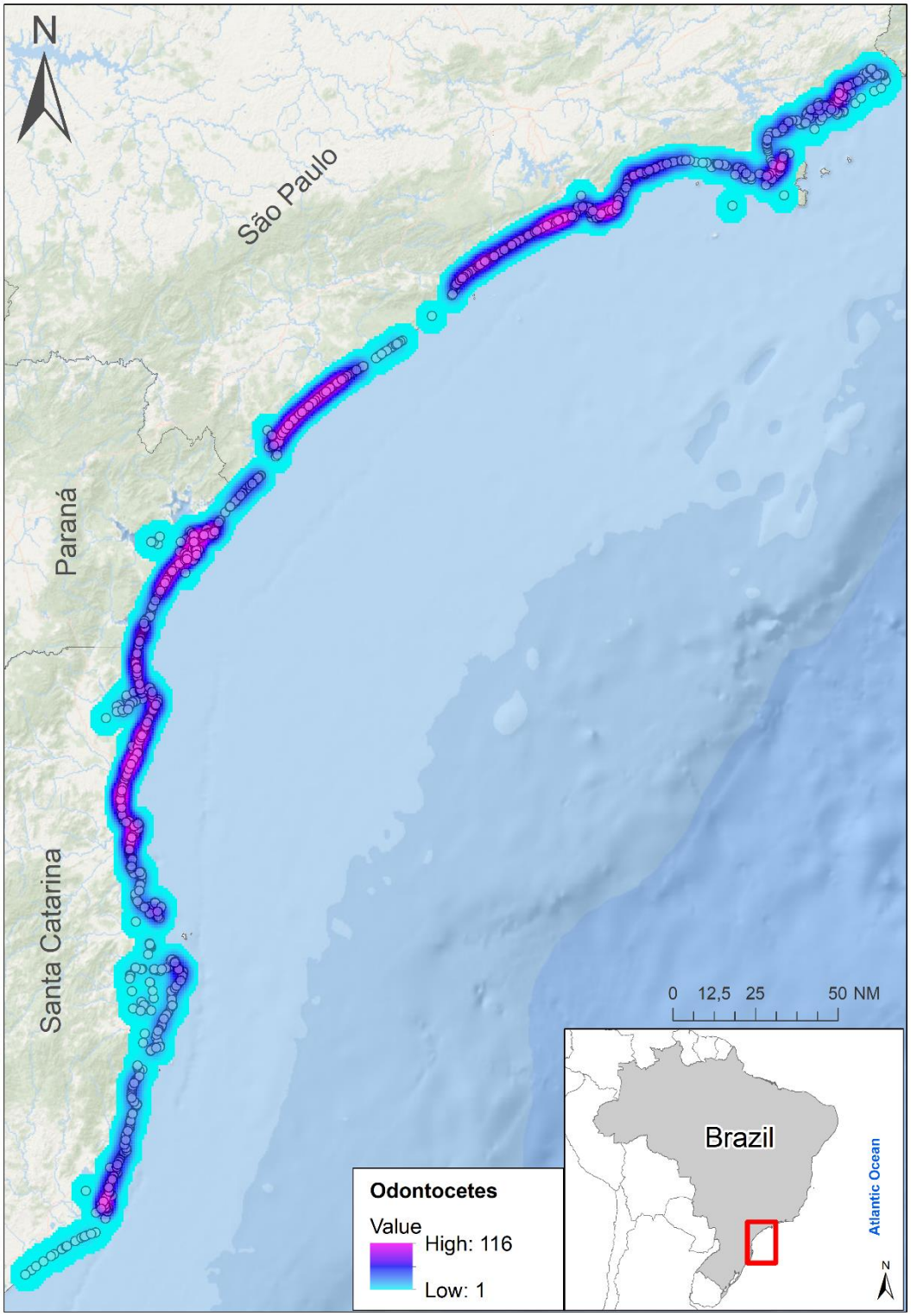
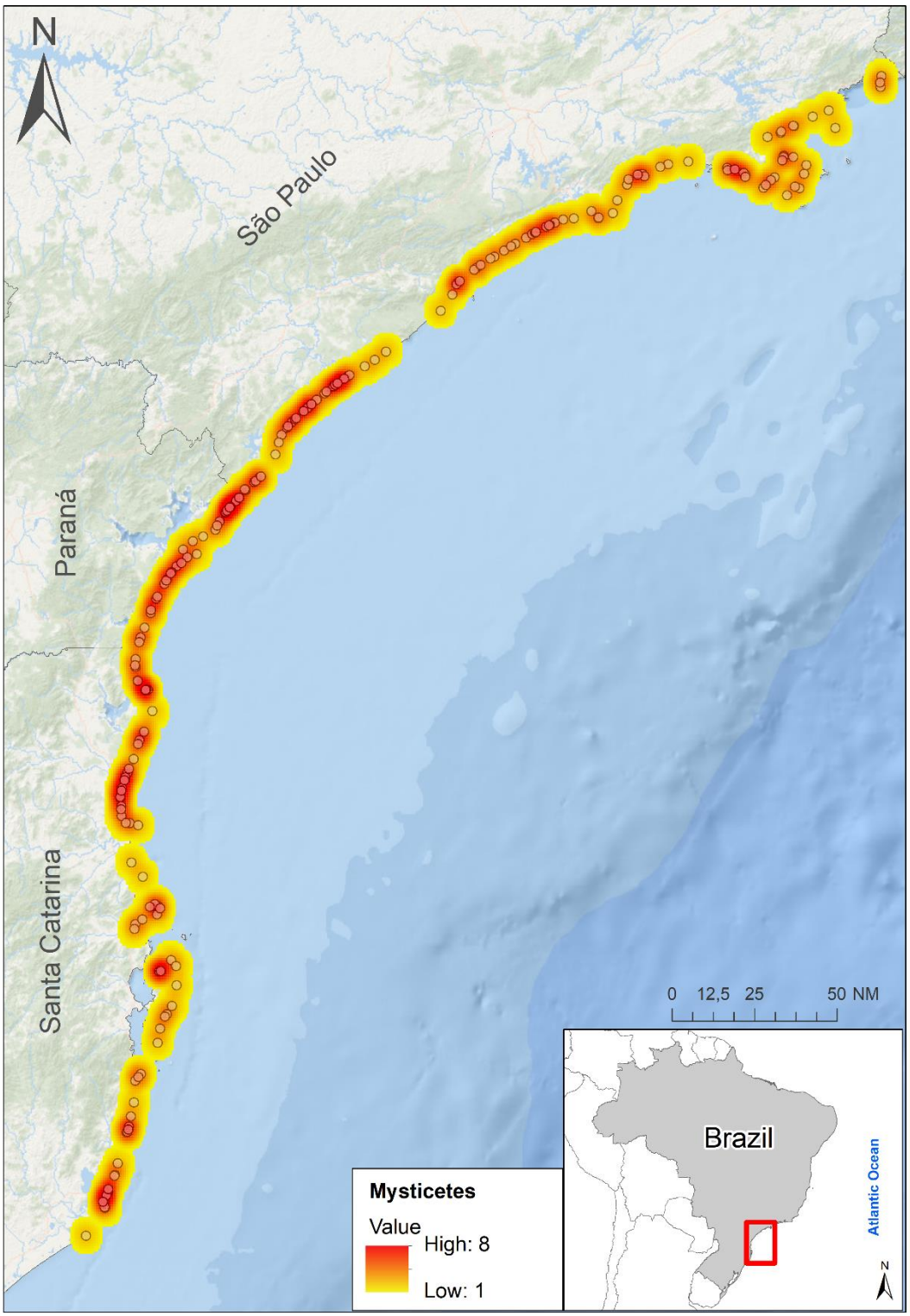


Figure 2. Number of the three mostly common stranded Odontoceti per month, from September 2015 to March 2020 along beaches of south and southeast Brazil, recorded by the Santos Basin Beach Monitoring Program (PMP-BS).


N
São Paulo
Paraná
Santa Catarina
0 12,5 25 50 NM
Odontocetes
Value
High: 116
Low: 1
Brazil
Atlantic Ocean
N

(A)



(B)

Figure 3. Occurrence of cetaceans along the area along the states of Santa Catarina, Paraná and São Paulo, monitored by the Santos Basin Beach Monitoring Program (PMP-BS) for (A) Odontocetes and (B) Mysticetes. Distribution created using a kernel biweight (quartic) function with radius of 10Km.

The high number of small cetaceans recorded in the four years of monitoring by the PMP-BS was much higher than what was expected by the researchers involved in the project, particularly for franciscanas, Guiana and bottlenose dolphins. These species were known to be under high pressure of anthropogenic activities, particularly the first two, and also Lahille's bottlenose dolphin, which is the more coastal form of bottlenose dolphins, commonly seen in the south of the monitored area (Lodi et al.; 2017; Ott *et al.*,

2017; Wickert et al., 2016). However, the intensive monitoring employed by the PMP-BS revealed a greater number of carcasses than those previously recorded in the area, by the same institutions that now participate in the project. In 2018 a working paper was presented at SC67B, reporting the results of the first two years of the project. The patterns then observed remained constant, causing great concern to all involved.

The annual average of 543.0 (CV=0.13) stranded franciscanas should be considered a minimum value, as only a fraction of animals that die entangled in gillnets reach the beaches (Prado *et al*., 2013). Thus, considering the recent published estimates of franciscana abundance on FMA II of 6,827 (CV = 0.26), the present level of mortality seems unsustainable.

The results presented here suggest that the turnover of carcasses on the beaches can be quite high and thus beach monitoring with lower frequencies may underestimate stranding rates. As the PMP-BS is scheduled to continue with the present methodology at least until the end of 2022, it will provide a robust database to assess anthropogenic impacts on marine mammals in the area and to support better decisions for conservation policies.

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