Report of the *Sotalia guianensis* Pre-Assessment Workshop: Main Results and Status of Current Knowledge

São Paulo, Brazil, 26-28 November 2019

Report of the *Sotalia guianensis* Pre-Assessment Workshop: Main Results and Status of Current Knowledge[1]

Report authors:

Camila Domit[1,2], Susana Caballero[3], Adriana Miranda[1,4], Pedro Fruet[5,6,7], Juan Pablo Torres-Florez[4], Haydee Cunha[8], Ana Paula Farro[9], Alexandre Azevedo[8], Tatiana Bisi[8], Yurasi Briceño[10], Marta J. Cremer[11], Rodrigo Tardin[12], Andre S. Barreto[13], Carolina P. Bertozzi[14,15], José Lailson Brito Jr.[8], Hector Barrios-Garrido[16], Tara Van Belleghem[1], Laura May-Collado[17], Juliana Di Tullio[5,6,7], Ana Paula L. Bracarense[18]; Mauricio Cantor[19,20], Artur Andriolo[21,22].

Affiliations

1. *Laboratório de Ecologia e Conservação, Centro de Estudos do Mar, Universidade Federal do Paraná. 83255-000, Paraná, Brazil. cadomit@gmail.com.*
2. *Associação MarBrasil, Pontal do Paraná, PR, Brazil.*
3. *Laboratorio de Ecologia Molecular de Vertebrados Acuáticos (LEMVA), Departamento de Ciencias Biológicas, Universidad de los Andes, Bogota, Colombia.*
4. *Centro Nacional de Pesquisa e Conservação de Mamíferos Aquáticos/ICMBio-MMA.*
5. *Kaosa, 96206-010, Rio Grande, RS, Brazil.*
6. *Museu Oceanográfico Prof. Eliézer de C. Rios. Universidade Federal do Rio Grande (FURG), Brazil.*
7. *Laboratório de Ecologia e Conservação da Megafauna Marinha, Universidade Federal do Rio Grande (FURG), Brazil.*
8. *Laboratório de Mamíferos Aquáticos e Bioindicadores (MAQUA), Faculdade de Oceanografia, Universidade do Estado do Rio de Janeiro (UERJ). Rio de Janeiro, RJ, Brazil.*
9. *Laboratório de Genética e Conservação Animal, CEUNES, Universidade Federal do Espírito Santo (UFES), São Mateus, ES, Brazil.*
10. *Instituto Venezolano de Investigaciones Científicas (IVIC), Centro de Ecologia, Venezuela.*
11. *Laboratório de Ecologia e Conservação de Tetrápodes Marinhos e Costeiros, Universidade da Região de Joinville, 89240-000, São Francisco do Sul, Brazil.*
12. *Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil.*
13. *Laboratório de Informática da Biodiversidade e Geomática, Universidade do Vale do Itajaí, Itajaí, SC, Brazil*
14. *Laboratório de Biologia e Conservação de Organismos Pelágicos, Instituto de Biociências, câmpus do Litoral Paulista, Universidade Estadual Paulista, CLP/UNESP, Brazil.*
15. *Instituto Biopesca, São Paulo, Brazil.*
16. *Laboratorio de Ecologia General, Departamento de Biología, Facultad Experimental de Ciencias. La Universidad del Zulia, 04005; Maracaibo, Venezuela.*
17. *Department of Biology, University of Vermont, USA.*
18. *Laboratory of Animal Pathology, Universidade Estadual de Londrina, rodovia Celso Garcia Cid, km 380, 86057-970, Londrina, Paraná, Brazil.*
19. *Departamento de Ecologia e Zoologia, Universidade Federal de Santa Catarina, Brazil.*
20. *Department for the Ecology of Animal Societies, Max Planck Institute of Animal Behavior, Konstanz, Germany.*
21. *LABEC, Departamento de Zoologia, ICB, Universidade Federal de Juiz de Fora, Juiz de Fora, MG, Brazil.*
22. *Instituto Aqualie, Juiz de Fora, MG, Brazil.*

We thank the following for valuable information and data provided: Renata Emin, Salvatore Siciliano, Paulo Andre Flores, Leonardo Flach, Marcos Rossi Santos, Lara Gama Vidal, Fernando Trujillo, Nínive Espinoza-Rodríguez, Kareen De Turris-Morales, Gabriel Mello-Santos, Flavio Lima, Maria Camila Rosso-Londoño, Daiane Marcondes, Estela Dibos Soares, Fabia Luna, Marina Leite and all the participants of the Workshop and the online survey.

The Guiana dolphin (GD) Pre-Assessment Workshop was funded and organised by the International Whaling Commission (IWC) and Aquatic Mammals Center CMA/ICMBIO. We are grateful to ICMBIO/CMA team, the IWC Secretariat, and also to Alex Zerbini and Lindsay Porter for their great support during the Workshop.

[1]Presented to the Scientific Committee as SC/68B/REP/05.

1. CHAIRS SUMMARY

In 2014, a Resolution was approved by the IWC for establishing new, specific *Terms of Reference* to consolidate the Scientific Committee's mandate on small cetaceans within its broader working program. This program opens the possibility of periodic reviews about the current knowledge and threats, as well as the possibility to implement *Conservation Plans for Endangered Species* within the scope of the IWC when appropriate. The first *Conservation and Management Plan* for a small cetacean was proposed for the franciscana dolphin (*Pontoporia blainvillei*) and **endorsed** by the Commission in 2016. In recent years, the Scientific Committee has worked to better understand the extent of multiple disturbances on small cetaceans - habitat degradation, incidental and intentional catches (for human consumption, bait, trade and traditional use) - to mitigate these threats. This task force resulted in a series of workshops to enable local research groups to collect, share and analyse data aiming to paint a clearer broad picture of the conservation status of these species.

River and estuarine dolphins in South America have been of great concern by the Small Cetacean Sub-committee (SM). During the IWC/67b Scientific Committee Meeting, held in Bled in 2018, Slovenia, the sub-committee on small cetaceans listed the Guiana dolphin (*Sotalia guianensis*) as a priority species for an evaluation of its conservation status in the upcoming years (2019/20 – presented at the meeting as SC/67b/SM/WP/12). The Guiana dolphin is restricted to coastal areas, including estuaries and bays in western tropical South America, from Nicaragua in Central America to Santa Catarina state in southern Brazil (Flores and Da Silva, 2009). Due to its exclusive coastal habits, the distribution of Guiana dolphins overlaps with densely human coastal populations, raising concerns on the status of various populations (Avila *et al.*, 2018). It is important to clarify that although the taxonomy of this genus has been controversial, some of the main questions, regarding the taxonomic identification of *Sotalia* dolphins in the Maracaibo Lake and in the Orinoco River, have been recently confirmed to be *Sotalia guianensis* (Caballero *et al.*, 2018; Caballero *et al.*, 2010).

The Guiana dolphin was previously listed by IUCN Red List as 'Data deficient' (DD) because the data available on abundance, trends, and mortality levels or rates were considered inadequate for assigning it to a single Red List category at the time (Secchi, 2012). However, the current assessment classified the species as 'Near threatened' (NT) (Secchi *et al.*, 2018), approaching criterion A2d+3d+4d. Regional assessments classified the species in different categories depending on the country and availability of data on each population (details in the section 'Management and Conservation actions').

In 2006, the SM reviewed the status of the *Sotalia* genus, as part of a review of the small cetaceans of the Caribbean and the western tropical Atlantic. Since then, not only the taxonomy of the genus has been clarified, but also new data on the dolphin populations from the Orinoco River, French Guiana and Maracaibo Lake has been collected and analysed. While bycatch in artisanal gillnets is a major threat to Guiana dolphin populations, other threats such as intentional captures for bait, habitat loss, high contaminant load, and diseases (MeCV, herpesvirus, skin diseases of unknown aetiology), are emerging factors depleting some Guiana dolphin populations. For example, recently a high mortality event in the populations of Sepetiba and Ilha Grande bays in southeastern Brazil has been associated with morbillivirus (Groch *et al.*, 2018). Also, deliberate capture of Guiana dolphins for human consumption has been recorded in Maracaibo Lake (Yurasi Briceño, pers. comm.; Barrios-Garrido *et al.* (2015) where the population is exposed to pollutants, particularly from oil spills (Espinoza-Rodríguez *et al.*, 2019). Throughout its distribution, Guiana dolphins are facing habitat degradation and loss due to anthropogenic activities, such as high boat traffic and their high noise levels, eutrophication due to run-off and pollution from agriculture, mining and industrial activities to name but a few (Barrios-Garrido *et al.*, 2016; Crespo *et al.*, 2010; Secchi *et al.*, 2018). Given these threats, an assessment of population structure and viability, temporal trends in abundance and in space use, and estimative of population connectivity are urgently needed to guide discussions by the SM sub-committee, regarding the sub-committee priority agenda focusing on riverine and estuarine dolphins from South America (IWC, 2019).

A pre-assessment of the status of knowledge about *Sotalia guianensis* was proposed, due to the difficulty in obtaining summarised data in a timely manner during IWC annual Scientific Committee meetings, since much information is scattered in grey literature in local research groups along the wide distribution range of the species. The pre-assessment plan included holding two intersessional workshops following SC68B and probably SC69A. Dr. Camila Domit volunteered to lead the organisation of these workshops in partnership with Centro Nacional de Pesquisa e Conservação de Mamíferos Aquáticos do Instituto Chico Mendes de Conservação a Biodiversidade (CMA/ICMBio), Brazil. The first Guiana Dolphin (GD) Pre-Assessment Workshop was held in the city of Lima in October 2018, during the SOLAMAC meeting. The attendance was limited and composed mainly of researchers from south/southeastern Brazil, in addition to one researcher from Colombia. They mapped resident populations of Guiana dolphins and the ongoing research efforts, as well as they listed the research teams working with the species along its distribution that would be relevant to conduct the review. The group also delineated a participative strategy to compile the knowledge about Guiana dolphins supporting a future assessment. Because the species distribution is transboundary, covering an extensive coastal area, and there are many experts focusing on this species, the group decided to develop an online questionnaire to circulate for all institutions, research teams and individuals identified. A total of 35 experts answered the questionnaire (see Annex B for their contact details), including their opinions for prioritising locations and scientific researches in supporting improvements in conservation actions. The results are summarised in the 'Expert elicitation' section of this report.

The Second Intersessional Workshop for Pre-Assessing the Status of Knowledge of Guiana Dolphins had two goals. The first was gathering and analysing information collected by the online questionnaire; the second, was compiling the available information on a series of population, biological and ecological parameters, as well as about threats, along the species distribution. Supported by the compiled knowledge, the participants collaborated to delineate conservation measures and research needs both in national and international contexts.

The second Workshop was held in Santos, São Paulo, from 26-28 November 2019, at the Instituto Chico Mendes de Conservação da Biodiversidade/Centro Nacional de Pesquisa e Conservação de Mamíferos Aquáticos (ICMBIO/CMA). The Workshop was divided into five sessions, following the priority topics listed by the IWC for the conservation of the species:

(1) population structure;
(2) abundance and population trends;
(3) biological parameters;
(4) threats and its potential effects; and
(5) management and conservation.

A list of experts relevant to the aims of the Workshop from each country were identified during the SC/67b and the Guiana Dolphin Workshop held in Peru during the 2018 SOLAMAC meeting, and in consultation with the Scientific Committee (SC) Vice-Chair, and co-Chairs of SM. There were 13 experts on Guiana dolphin research from three countries (Brazil, Colombia and Venezuela) and another 20 participants to the Workshop. Information gathered from the literature review, ongoing projects and the expert elicitation via online questionnaire were used by the group of Point of Contact (POCs) and other co-authors to compile and present the best up-to-date information on the species. The participants list is given as Annex A and the Agenda is given as Annex C.

2. MEETING OPENING

2.1 Opening remarks

The Workshop was held 26-28 November 2019 in São Paulo, Brazil. Filardi, on behalf of Luna, the chief of the 'Centro Nacional de Pesquisa e Conservação de Mamíferos Aquáticos' (CMA), part of the ICMBIO, an agency of the Brazilian Ministry of Environment, welcomed participants and thanked IWC and ICMBio for hosting the Workshop. Domit welcomed participants and provided a brief overview on the IWC structure and assessments workflow. She also mentioned the working paper proposing an assessment for *Sotalia guianensis* presented during the IWC Conservation and Scientific Committee in May 2018 (Bled, Slovenia), which included the steps required to develop such assessment and outlined the aims of the current Workshop.

2.2 Appointment of Rapporteurs

Fruet and Torres-Florez were appointed as rapporteurs. Duff (Secretariat) assisted with references.

2.3 Available documents

The documents developed by POCs available to the Workshop were included in the report and summarised on recommendations and conclusion.

3. WORKSHOP AIMS AND OBJECTIVES

3.1 Overview

River and estuarine dolphins in South America have been of great concern to the SM sub-committee. During the SC/67b Scientific Committee meeting, held in Bled, Slovenia in 2018, the sub-committee on small cetaceans had listed the Guiana dolphin (*Sotalia guianensis*) as a priority species for an evaluation of its conservation status in the upcoming years (2019/20). Due to a large amount of scattered data, ongoing research, and grey literature, the SM sub-committee proposed an intersessional process to document the current knowledge on the Guiana dolphin and inform the review of the status of the species to be conducted by the Scientific Committee in the upcoming Annual Meetings. It was agreed by the participants that the intersessional process should include, in principle, two meetings to fulfil this aim. A Steering Group (SG) was established to ensure progress on this topic between SC meetings. The SG is tasked with articulation with researchers and stakeholders to plan and run the workshops. The first of which took place in Lima, Perú, in 2018, when it mapped the main Guiana dolphin populations being studied and research effort and the groups of scientists working with the species. This second Workshop focuses on compiling the available data on population structure, abundance and trends, population parameters, threats and conservation policy, and identify research gaps and priorities.

3.2 Workshop aims

(1) Review the information available on Guiana dolphin (focusing on population structure, biological parameters, abundance estimates, and management and conservation actions).
(2) Integrate and consolidate the current knowledge on Guiana dolphin.
(3) Prepare a report with recommendations for presentation at the SC68B meeting.

4. REVIEW OF INFORMATION ON THE GUIANA DOLPHIN

In 2010, the *Latin American Journal of Aquatic Mammals* published a special issue regarding *Sotalia* genus[2]. These articles served as a baseline information and were updated during this pre-assessment Workshop. Some critical points about the species taxonomy and population structure have been addressed along the last ten years and opened an opportunity for better assessing the conservation status of Guiana dolphins.

The POCs provided presentations with an overview of the current knowledge on Guiana dolphin: Caballero (Colombia) and Cunha (Brazil) for population structure; Briceño (Venezuela) for management and conservation actions; Azevedo (Brazil) for abundance and density estimate; and Cremer (Brazil) for biological parameters. The POCs presentations were discussed in regional groups during the Workshop. The participants had the opportunity to include extra data, and the results and recommendation of each topic were discussed by the plenary. A summary of the information presented and discussed is provided in Items 4.1 to 4.5 below.

4.1 Distribution and population structure

Guiana dolphins (*Sotalia guianensis*) inhabit the coastal waters of the Caribbean Sea and the Atlantic Ocean of Central and South America. The species distribution range from Florianópolis, southern Brazil (27°35’S) in the south to the Caribbean Sea and along the coast of Central America to central Honduras at La Mosquitia, 14°00’N, 83°20’W (Da Silva *et al.*, 2010; Fig. 1). Although to date the species is thought to occur along this entire range, Guiana dolphins usually form discrete populations (Borobia *et al.*, 1991; Da Silva *et al.*, 2010; Flores and Da Silva, 2009), in which individuals typically display relatively small home ranges (Flores and Bazzalo, 2004; Oshima and Santos, 2016; Santos and Rosso, 2008).

Cunha, Farro and Caballero (scientific paper submitted for SC68B; SC/68B/SDDNA/06rev1) reviewed the available population genetic data for the species, including published and unpublished studies, and presented the results at the Guiana dolphin pre-assessment Workshop. Twelve studies have been carried out along the distribution of the species, using two molecular markers: the mitochondrial control region and microsatellites. Five macro-scale studies focused either on the northern part of the distribution (Caballero *et al.*, 2010; 2018) or on its southern portion (Cunha *et al.*, 2005; 2007; SC/68B/SDDNA/06rev1). Moreover, several genetic studies with large sampling at regional level also indicated fine-scale population structure. Combining all evidences, Cunha *et al.* proposed the delimitation of 12 Management Units (MUs) for Guiana dolphin across its distribution. The authors also listed ongoing genetic studies that will confirm or refine the available information, all expected to be concluded in 2021.

Thus, based on the presented analyses, the participants of the Workshop **agreed** that for the time being, the genetic population structure with 12 MU should be adopted by the group and guide discussions on the other priorities topics (e.g. population abundance and trends, biological parameters, threats, and management and conservation actions). These MUs will be hereafter named as proposed by Cunha, Farro and Caballero: CCOL, VEML, VEOR, FRGU, BRNO, BRNE1, BRNE2, BRNE3, BRNE4, BRSE1, BRSE2, BRS/SE (SC/68B/SDDNA/06rev1; Fig. 1). The Workshop participants discussed and **recognised** that in the absence of samples from the northern range of distribution (Panama, Costa Rica, Nicaragua), and to be as parsimonious as possible, the populations from these areas should be considered panmictic within the CCOL MU (northeastern management unit analysed so far). Trinidad and Tobago might be part of the Orinoco Management unit (FOR), due to its closeness to the mouth of the river, however, this region still has an important gap in knowledge that should be addressed in the near future. It is important to note that information to delineate these MUs is not equally complete, or representative for each of these (in terms of number of samples and molecular analysis), and additional research is needed for particular MUs in different subjects (Fig. 2).

Despite the delineation of these MUs, the Workshop participants **recognised** the need to establish as **priorities** for further studies to better understand the population substructure within the distribution of the species, and areas that are still not sampled.

Priorities in terms of management unit definition for the species are summarised as follows.

- DNA samples from Sucre State (Venezuela) where there seems to be established a resident population (proposed to be conducted during the next 24 months).
- DNA samples from Panama, Costa Rica, Nicaragua and Trinidad and Tobago (proposed to be conducted in 36 months).
- DNA samples from those places where population abundance data and/or biology parameters already exist (proposed to be conducted during the next 36 months).
- Analyses of all data using a genomics approach (e.g. Radseq), joint research initiative being conducted by Cunha and Caballero (proposed to be conducted during the next 24 months).

Other lines of evidence that could support these proposed delineations for management units were discussed during the pre-assessment Workshop. These include body morphology, levels of pollutants and ecotoxicology, bioacoustics, residence patterns, movements between populations, reproduction and life history parameters, and trophic levels and

[2]*http://lajamjournal.org/index.php/lajam/issue/view/20/showToc.*

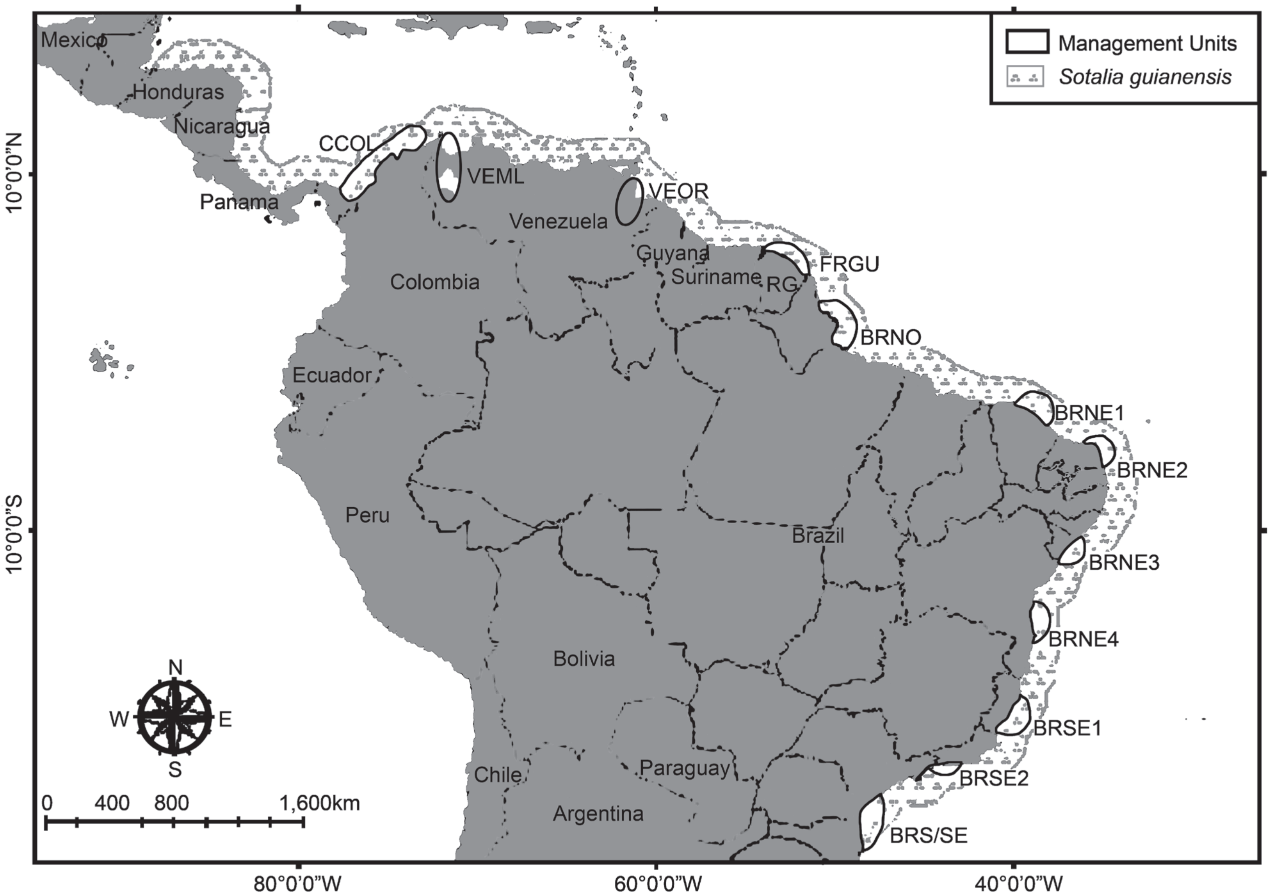

Fig. 1. Population limits according to genetic studies, identifying 12 management units (MU), named as proposed by Cunha *et al.*: CCOL, VEML, VEOR, FRGU, BRNO, BRNE1, BRNE2, BRNE3, BRNE4, BRSE1, BRSE2, BRS/SE.

feeding habitats as informed by stable isotopes analyses (SC/68B/SDDNA/06rev1). Notwithstanding, these other lines of evidence should be taken with caution to omit studies that did not compare areas, but instead characterised a single area or a Management Unit. It is important to notice that differences exist regarding the number and geographic coverage of these studies, with a high number of studies focused in southern and southeastern Brazil (e.g. on acoustics, pollutants, morphology, etc.), decreasing in number for north and northeastern Brazil and with little representation and coverage for other countries, particularly the northern limit of the range, including Nicaragua, Costa Rica and potentially Honduras. A summary of studies and information available from these other lines of evidence is represented in Fig. 3.

Additionally, an ongoing regional effort led by Melos-Santos and May-Collado uses acoustic data to identify the drivers of geographical variation on *Sotalia* whistle repertoires (Deecke and Janik, 2006). The effort has resulted in an acoustic database from 1998 to 2017 comprising 16 different sites throughout the distribution of both *Sotalia* species, namely: Costa Rica coast, Lake Maracaibo and Gulf of Venezuela (Venezuela Coast), French Guiana coast, the coast of Pará state (northern Brazil), the Tocantins River (Pará state, northern Brazil) Japurá and Solimões Rivers (Central Amazon, Amazonas State, northern Brazil), Juruá River (Amazonas State, northern Brazil), Colombian Amazon, Peruvian Amazon, Napo River (Ecuadorian Amazon), the coast of Rio Grande do Norte State (northeastern Brazil), Sepetiba Bay (coast of Rio de Janeiro state, southeastern Brazil), Ilha Grande Bay (coast of Rio de Janeiro state, southeastern Brazil), Cananéia Estuary (São Paulo state, southeastern Brazil), Paranaguá Estuarine Complex (Paraná state, southern Brazil) and Babitonga Bay (Santa Catarina, southern Brazil). The preliminary results from this ongoing analysis indicate that both (freshwater and coastal) Guiana dolphin species have rich whistle repertoires, but also suggest that *Sotalia* dolphin from the Tocantins river has a repertoire of their own. The taxonomic identity of Tocantins Guiana dolphins remains uncertain. Furthermore, a non-metric multidimensional scaling (NMDS) analysis suggests that the whistle repertoire of coastal dolphins from Costa Rica, Venezuela, French Guiana, and Ilha Grande Bay is significantly distinct from each other. In the case of Costa Rica this could be due to high geographical isolation as one of the northernmost Guiana dolphin populations. Interestingly, the populations of the Brazilian coast grouped close to each other indicating similar repertoire and connectivity between these populations.

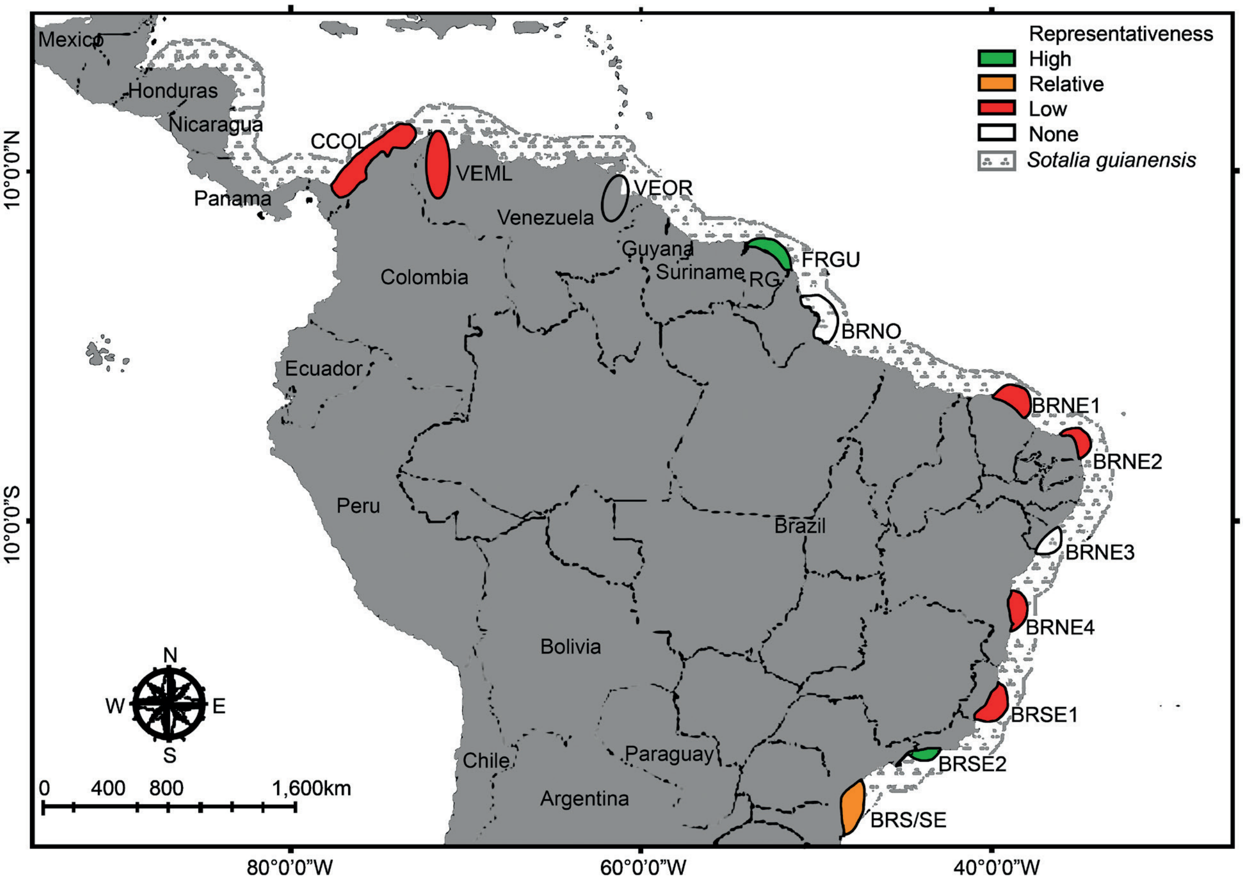

Fig. 2. Data representativeness supporting the proposed management units (MU) for Guiana dolphins along the species distribution area.

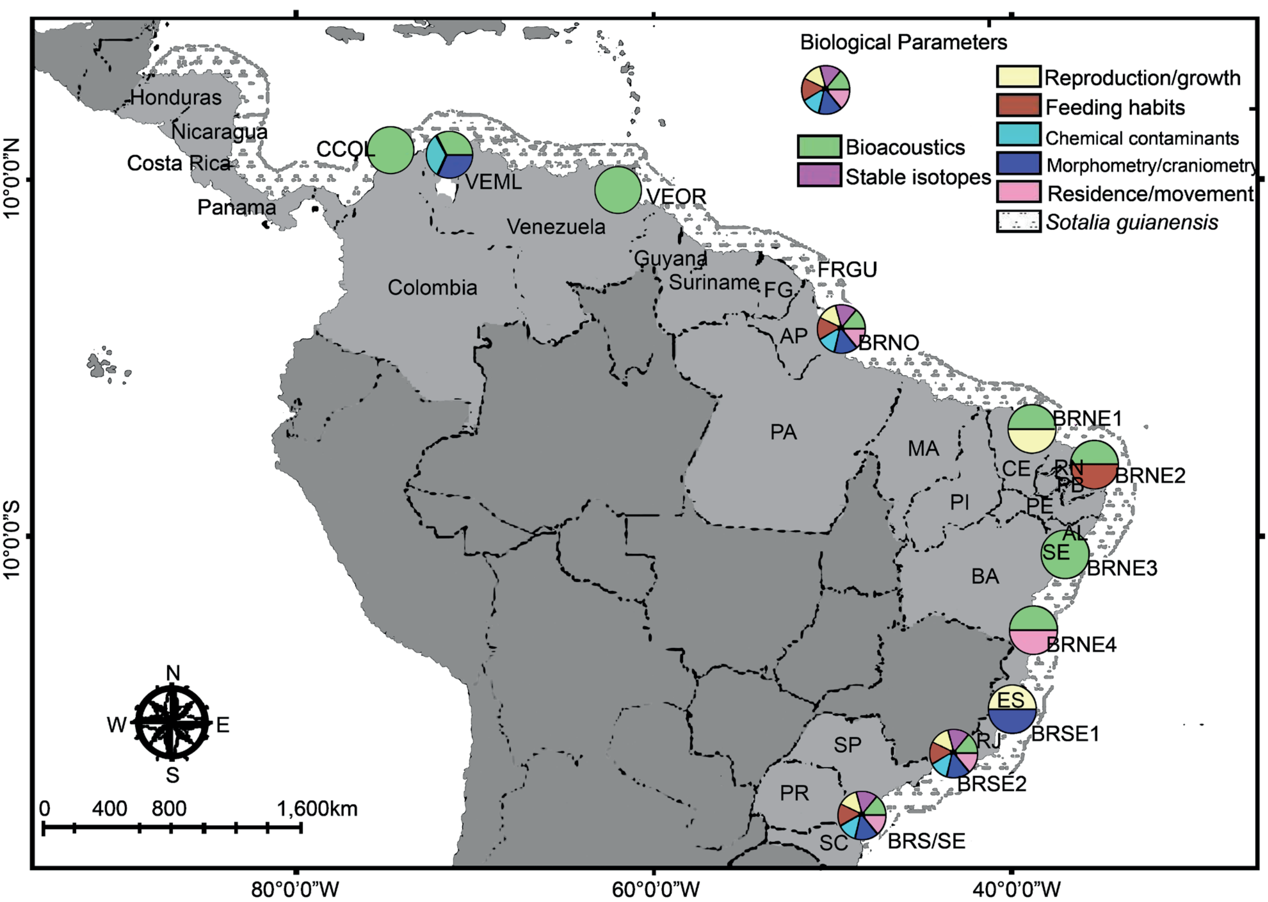

Fig. 3. Studies and information available from other scientific lines of evidence supporting population structure of Guiana dolphin.

4.2 Abundance and trends

Our knowledge on abundance and density estimates of Guiana dolphins is relatively scarce along its distribution. Santos *et al.* (2010) compiled ~20 documents on abundance and/or density estimates conducted in Brazil from 1989 to 2008, carried out in seven sheltered areas. The authors also reported one study in Nicaragua and another in Colombia. The two major shortcomings identified by this early review were: (i) the short-term sampling of the studies; and (ii) concentration in specific areas of the south (S) and southeast (SE) of Brazil. Santos *et al.* (2010) also identified mark-recapture and distance sampling (linear-transects; Buckland *et al.*, 2004) as the two principal methods used to estimate density estimate and/or abundance for Guiana dolphin.

To update the information about abundance and density of Guiana dolphin, this report summarises all data available in *adhoc* articles, theses and dissertations published between 2000 and 2019 (see Table 1). The compiled knowledge is plotted following the Management Units (Fig. 4) defined during the Workshop (see above). A total of 36 studies on population abundance or density estimation of Guiana dolphin were listed. Overall, a similar pattern was found as that described by Santos *et al.* (2010), where most of the studies were conducted with local populations in estuaries and bays of southern (S) and southeastern (SE) Brazil, covering small sampling areas. In northeast of Brazil, a lower number of abundance estimates are available, while for north of Brazil this information is scarce. In French Guiana, two recent studies estimate Guiana dolphin abundance in the whole EEZ. In Venezuela, Colombia, Costa Rica/Panama and Nicaragua efforts for abundance estimation were employed for few localised areas. No abundance survey effort has been conducted in Surinam, Guyana, Trinidad and Tobago and Honduras. This compilation reveals two main troubles to understanding Guiana dolphin abundance: the low amount of research over the years and the absence of efforts on medium/large geographical scales (except for French Guiana). The effort conducted in the last 20 years can be summarised as follows.

(1) Brazil: 24 studies at 14 sites. Efforts, estimated area covered: 12,700km^2. Of this total 9,300km^2 were conducted in BRSE1 on 2019.
(2) French Guiana: two studies in whole EEZ. Efforts, estimated area covered: 62,000km^2.
(3) Surinam: No effort.
(4) Guyana: No effort.
(5) Venezuela: four studies in three sites. Efforts, estimated area covered: 1,100km^2.
(6) Trinidad and Tobago: No effort.
(7) Colombia: two studies in Golfo de Morrosquilo. Efforts, estimated area covered: 310km^2.
(8) Costa Rica/Panama: one study. Efforts, estimated area covered: 10km^2.
(9) Nicaragua: No effort during the last 20 years. Edwards and Schnell (2001) conducted the last sampling in 1998.
(10) Honduras: No effort.

Data on trends in abundance are rare. The only two studies we found were conducted with two local populations: (i) Azevedo *et al.* (2017) reported that Guiana dolphin population in Guanabara Bay, Rio de Janeiro state (BRSE1) is declining drastically; and (ii) Cantor *et al.* (2012) pointed out a stable population at Cavarelas River Estuary, Bahia state (BRNE4).

Summary by management units

Brazil

BRS/SE

This MU is one of the most studied and has been monitored continuously since the end of the 1990s. Abundance is available for three sites/populations: Babitonga Bay, and Paranaguá and Cananéia Estuarine Complexes. Guiana dolphin abundances in some sites from BRS/SE have been estimated in hundreds or thousands of individuals: between 2001-03, Cremer (2007) estimated between 147-365 individuals in Babitonga Bay (Santa Catarina State) using distance sampling. Seven years later (2010-11), Schulze (2012) estimated that there were 174-252 individuals in the same area using a mark-recapture approach. In Paranaguá Estuarine Complex (Paraná State), Miranda (2017) conducted distance sampling surveys between 2012-13 and estimated a population size of 1,371-2,393 individuals. In Cananéia Estuarine Complex (São Paulo State), a recent mark-recapture study estimated around 392-438 individuals (Mello *et al.*, 2019). Coastal areas outside those estuarine zone/bays have not been assessed yet for abundance/density estimates, totalling about 400km of survey gap along the coastline within the species distributional range in this MU.

BRSE2

Monitoring of some populations in this MU has been conducted since the late 1980s, particularly in three sites: Ilha Grande Bay, Sepetiba Bay and Guanabara Bay, all three located in Rio de Janeiro State. Guanabara Bay abundance (37- 40 individuals; Azevedo *et al.*, 2017) contrasts with Sepetiba Bay (588-1,004 individuals; Flach (2015) and Ilha Grande Bay (602-1,296; Souza, 2013). Similar to BRS/SE, BRSE2 populations using bays and estuaries contrast in size, but most are large, numbering thousands of individuals. However, studies in open coastal waters are still lacking for abundance/density estimates. In this MU, unsampled coastal areas represent more than 400km of coastline within the species distributional range.

BRSE1

There are only two studies conducted in two different coastal areas along this MU: Cepile, 2008; 81-141 individuals, and Mamede, 2015; 59-78 individuals. However, since 2019, aerial surveys have been conducted along Espírito Santo coast covering a large geographical area, as part of the impact assessment of the Mariana environmental disaster. In this survey, abundance/density was estimated for the whole BRSE1: summer 2019 393-1,256 and winter 2019 137-840 (RRDM – Rede Rio Doce Mar – FEST, 2019).

BRNE4, BRNE3, BRNE2, BRNE1

There are few studies on these MUs: sampling areas are small and there are only five studies about abundance/density along 3,000km of Guiana dolphin distribution. Very low abundances were estimated for one location in BRNE4 (28-48; Melo, 2018) and for another in BRNE1 (26-64; Meirelles, 2013). In BRNE2 there is only one study available (Paro, 2010) and in BRNE3 no effort has been conducted yet.

BRNO

No effort has been conducted in this MU.

French Guiana

FRGU

Guiana dolphin abundance/density was estimated in the FRGU by two recent studies. Mannocci *et al.* (2012) and Laran *et al.* (2019) conducted aerial surveys in the EEZ coastal waters from French Guiana and estimated 2,076 and 1,764 Guiana dolphins in the area, respectively.

Surinam and Guyana

FRGU

No effort has been conducted in these countries.

Venezuela

VEOR

Two studies were conducted in the Orinoco River by line-transectss. Abundance estimates point out to thousands of individuals: Gomez-Salazar *et al.* (2012) estimated 2,205 and Herrera (2013) estimated 4,451 Guiana dolphins. This MU seems well studied, but it represents only the Orinoco River and the whole coast from this MU to VEML (1,500km of coastline) has not been sampled. Therefore, information about abundance/density estimates cover a small extension of Venezuela coast.

VEML

This MU has been poorly studied in its total area for abundance/density of Guiana dolphins. Two studies were conducted at Maracaibo Lake (a total area about 13,000km^2), but only 900km^2 were sampled (Briceño *et al.*, 2017). At the Gulf of Venezuela two other studies estimated abundance/density in about 6km^2 (Carrasquero, 2010; Espinoza-Rodríguez *et al.*, 2019).

Trinidad and Tobago

No effort has been conducted in this country.

Colombia and northern areas

CCOL

Two mark-recapture studies were conducted in the Gulf of Morrosquilo. Abundance estimates point to hundreds of individuals (118-426; Dussán-Duque, 2013), but the sampling area was small and covered about 300km^2. This MU seems under sampled and is the only site sampled along the Colombia coast. As a consequence, information about abundance/density estimates covered a small extension of the CCOL.

There is currently one PhD thesis study ongoing in Uraba Gulf, which one of its objectives is to estimate abundance of Guiana dolphin in this region (Trujillo and Rosso-Londoño, pers. comm.).

Costa Rica/Panama

Efforts are incipient. Only one study covered 10km^2 (Gamboa-Poveda, 2009).

Nicaragua and Honduras

No effort has been conducted in these countries.

Research priorities and recommendations

The literature review stresses out some critical gaps regarding population abundance estimates and trends.

- Sampling effort must be extended along coastal areas, where abundance data are lacking for most MUs and where opportunistic sightings and strandings usually record Guiana dolphins. Aerial surveys seem to be adequate for this purpose (Mannocci *et al.*, 2012; Laran *et al.*, 2019) and can be complementary to effort already applied in sheltered waters.

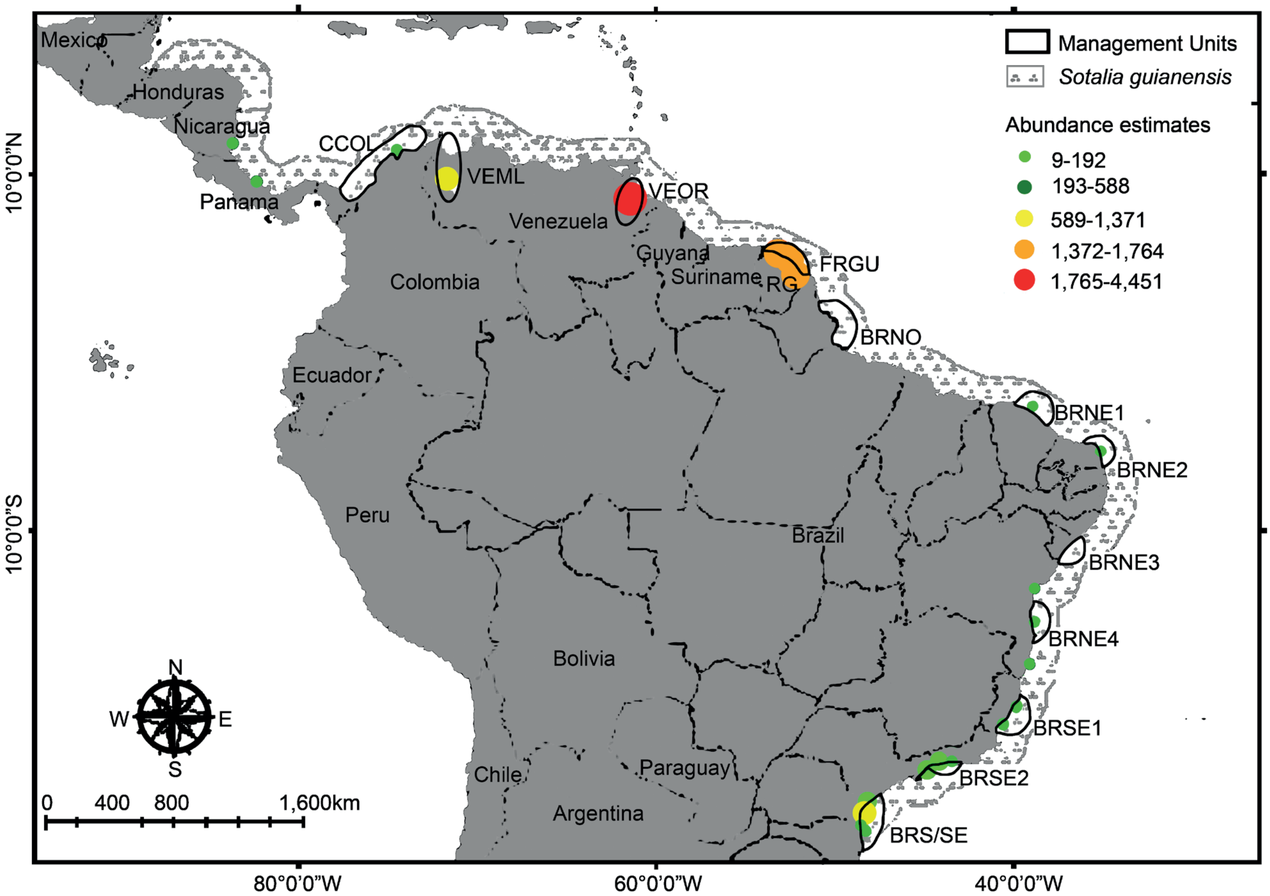

Fig. 4. Map of management units defined during the SG Workshop (2019) and their respective abundance/density estimates of Guiana dolphin (*Sotalia guianensis*), obtained from studies conducted between 2000 and 2019.

- In the sites in which continuous monitoring has been conducted, as in Guanabara, Ilha Grande and Sepetiba Bay (Rio de Janeiro state), Cananéia Estuarine Complex (São Paulo state), Paranaguá Estuarine Complex (Paraná state) and Babitonga Bay (Santa Catarina state), in southern and southeastern Brazil, it is highly recommended to assess trends in abundance/densities.
- Comparable methods and appropriate correction factors should be used to estimate abundance in areas where previous estimates are available.
- Improve the protocol for abundance estimation methodologies and to obtain estimates of trends in abundance, encouraging new technics for this purpose (e.g. passive acoustic monitoring, Unmanned Aircraft Systems – UAS, etc.).
- Foster international cooperation and conducted an integrated workshop to enhance the scientific approach concatenating protocols for data collection and analysis in abundance estimates.

4.3 Biological parameters

General characteristics

This report provides a summary of information on life history and population parameters available for the Guiana dolphin, particularly related to body size, age and reproduction (see Table 2). We compiled the information available from peer-reviewed scientific articles, masters and doctoral theses as well as working papers presented during the Workshop. Personal communications and unpublished data provided by specialists during the meeting were also included to complement this report.

Information about biological parameters for the Guiana dolphins is available mainly for the southern part of its distribution, in southeastern and southern Brazil (Table 2; Fig. 5). However, even in these areas, the information is still elementary, fragmented and, in some cases, based on reduced sample sizes. Most information listed here originated from stranding data (see below), but for some local population, information from long-term mark-recapture studies are also available, particularly regarding the estimation of reproductive output and survival rates.

Table 1

Summary of abundance/density estimates of Guiana dolphin (*Sotalia guianensis*) from 2000 to 2019. Management Units were defined during the *Sotalia guianensis* pre-assessment Workshop (2019). Methods: Mark-recapture (1) and Line-transect (2).

Management Unit	Area (km^2)	Period	Estimates	Source
BRS/SE - Brazil				
Babitonga Bay (SC)[2]	160	2001-03	147-365	Cremer (2007)
Babitonga Bay (SC)[1]	160	2010-11	174-252	Schulze (2012)
Guaratuba Bay (PR)[2]	40	2002-03	0.15/km^2	Filla (2004)
Antonina Bay (PR)[2]	28	2003-04	23.1 ind/km^2	Japp (2004)
Paranaguá Estuarine Complex (PR)[2]	600	2012-13	1,371-2,393	Miranda (2017)
Cananéia Estuarine Complex (SP)[1]	125	2000-03	290-360	Santos and Zerbini (2006)
Cananéia Estuarine Complex (SP)[2]	106	2001	0.15/km^2	Bisi (2001)
Cananéia Estuarine Complex (SP)[1]	132	2007	697-730	Pacífico (2008)
Cananéia Estuarine Complex (SP)[1]	132	2016	392-438	Mello *et al.* (2019)
BRSE2 - Brazil				
Ilha Grande Bay (RJ) [1]	550	2005-09	602-1,296	Souza (2013)
Ilha Grande Bay(RJ) [1]	550	2007-10	1,232-1,389	Espécie (2011)
Ilha Grande Bay (RJ)[1]	550	2007-13	482-757	Espécie (2015)
Sepetiba Bay (RJ) [2]	526	2002-03	739-2,196	Flach *et al.* (2008)
Sepetiba Bay (RJ) [1]	145	2006-07	1,004-1,117	Nery *et al.* (2008)
Sepetiba Bay (RJ) [1]	520	2012	588-1,004	Flach (2015)
Guanabara Bay (RJ) [1]	280	2015	37-40	Azevedo *et al.* (2017)
BRSE1 - Brazil				
Benevente Bay (ES) [1]	---	2014	59-78	Mamede (2015)
Regência (ES) [1]	235	2007	81-141	Cepile (2008)
Espírito Santo state (costal zone)	3,319	Summer 2019	393-1,256	RRDM – Rede Rio Doce Mar – FEST (2019)
Espírito Santo state (costal zone)	9,305	Winter 2019	137-840	RRDR as above
BRNE4 - Brazil				
Canavieiras Estuarine Complex (BA) [1]	---	2016-17	28-48	Melo (2018)
Ilhéus (BA) [2]	30	2014-15	133-343	Rosa (2016)
Caravelas River Estuary (BA) [1]	700	2009	83-182	Cantor *et al.* (2012)
BRNE3 - Brazil				
No effort	---	---	---	-
BRNE2 - Brazil				
Southern Coast of RN State [1]	22.3	2008-09	192-297	Paro (2010)
BRNE1 - Brazil				
Fortaleza city (CE) [1]	16	2009-11	26-64	Meirelles (2013)
BRNO - Brazil				
No effort	---	---	---	-
FRGU - French Guiana				
EEZ, coastal stratum [2]	39,409	2008	2,076	Mannocci *et al.* (2012)
EEZ, coastal stratum [2]	61,465	2017	1,764	Laran *et al.* (2019)
Surinam				
---	---	---	---	-
Guyana				
---	---	---	---	-
VEOR - Venezuela				
Orinoco River [2]	5,078	2006-07	2,205	Gomez-Salazar *et al.* (2012)
Orinoco River [2]		2008, 2012-13	4,451	Herrera-Trujillo (pers. comm.)
VEML - Venezuela				
Zapara Is. Southern Gulf of Venezuela[1]	6.33	2008-09	5.62 ind/km^2	Carrasquero (2010)
Barranquitas, Maracaibo Lake System[1]	249.2	2011-12	1.66 ind/km^2	Delgado-Ortega (2012)
Maracaibo Lake System[2]	900	2017	1.25 ind/km^2	Briceño *et al.* (2017)
Zapara Is. Southern Gulf of Venezuela[1]	6.33	2009-11	150-573	Espinoza-Rodríguez *et al.* (2019)
Trinidad and Tobago				
---	---	---	---	-
CCOL – Colombia				
Golfo de Morrosquilo [1]	310	2002-06	70-90	Dussán-Duque *et al.* (2006)
Golfo de Morrosquilo [1]	310	2009-10	118-426	Dussán-Duque (2013)
Costa Rica/Panama [1]				
Coastal region	10	2003-05	81-100	Gamboa-Poveda (2009)
Nicaragua				
---	---	---	---	-
Honduras				
---	---	---	---	-

Guiana dolphin can reach up to 230cm in total length and weight 150kg (PMP-BS[3]). The maximum estimated age was 33yr (Lima *et al.*, 2017). The species is not sexually dimorphic, but slight variation in maximum total lengths and sexual maturity was observed within and between some regions. Male maximum total length varied between 179cm, in northeastern Brazil (Meirelles *et al.*, 2010), and 230cm in south Brazil (PMP-BS[1]). Female maximum total length varied between 174.5cm in Espírito Santo, southeastern Brazil (Ramos *et al.*, 2010), and 230cm in south Brazil (PMP-BS[1]). Sexual maturity is reached between 170-180cm in males and 160-169cm in females, and age of sexual maturity was estimated between 6-7 yr in males and 5-7yr in females (Ramos *et al.*, 2010; Rosas and Monteiro-Filho, 2002). Seasonality in testicular activity was not detected, but adult males have large testes, estimated in 3.3% of the total body weight (Rosas and Monteiro-Filho, 2002). Both ovaries are functional (Rosas and Monteiro-Filho, 2002) but a slight variation is recorded for birth periods. Births on the Rio de Janeiro coast, southeastern Brazil, occurs from spring to autumn, with a peak during the autumn (Ramos *et al.*, 2010). On the Paraná coast, southern Brazil, no defined seasonality was recorded (Rosas and Monteiro-Filho, 2002). Lactation period, estimated between 8.7 and 9.4 months, was estimated only for Paraná (Rosas and Monteiro-Filho, 2002). Reproductive senescence was detected for females older than 25 years (Rosas and Monteiro-Filho, 2002). Information provided by relative size and histological inspection of tastes, and reinforced by behaviour analysis of wild populations, indicate that the species has a promiscuous mating system (Rosas and Monteiro-Filho, 2002; Santos and Rosso, 2008).

Research priorities and recommendations

The literature review stresses some critical gaps regarding biological parameters.

- Studies addressing aspects of reproduction and growth should be carried out, particularly for populations in the north and northeast of Brazil (BRNO, BRNE1-4), and in Central America (regions where there is no information).
- Considering the high degree of dependence of the populations of the south and southeast regions in Brazil on the environments of bays and estuaries, where the anthropogenic pressure is intensive, efforts must be made to obtain survival estimates for the different populations.
- Information on reproductive biology and growth needs to be updated and/or carried out for the entire southern and southeastern regions of Brazil, mainly for estimation of age and length at sexual maturity, annual pregnancy rate and calving interval.

4.4 Threats

Multiple activities are potentially sources of impacts on various Guiana dolphin local populaitons within the defined Management Units. These activities were listed and discussed by expert researchers during the intersessional Workshop held during the Latin American Society of Aquatic Mammals (RT) meeting in Peru, 2018. The survey resulted in 11 anthropogenic activities to which Guiana dolphins are exposed: fishing activities (gill, trawl and longline) (PI); development of coastal infrastructure (DI); port activities (including dredging (DRMultiple activities are potentially sources of impacts on various Guiana dolphin local populations within the defined Management Units. These activities were listed and discussed by expert researchers during the intersessional Workshop), underwater explosions (EX), vessel traffic (TE), environmental disasters (AA); mining (M); oil exploration (PG); aquaculture/fish farming (MA); industrial activities (IN); agricultural activities (AG); nautical activities (AN); and nautical tourism (TU) (Fig. 5). This list was used as a basis for the assessment of impacts and threats by Workshop participants, which evaluated the existing studies that addressed the impacts and their potential effects on dolphins considering the study areas, but also the management units proposed (see Annex E).

Human-induced mortality

Mortality Rates and Strandings Events

In 1994, the Scientific Committee of the International Whaling Commission (IWC) urged that steps should be taken by member states to reduce incidental mortality of genus *Sotalia*, while at the same time establishing better systems of recording and monitoring take levels (IWC, 1995). Since then, anthropogenic activities and habitat loss have increased probably faster than the scientific knowledge about their effects on population conservation status and health.

At the moment, there are estimates of total mortality rates only for specific populations such as Cananéia Estuarine Complex (BRS/SE; Mello *et al.*, 2019), Guanabara Bay (BRSE2; Azevedo *et al.*, 2017) and Caravelas River (BRNE4; Cantor *et al.*, 2012) in Brazil, and Gulf of Morrosquillo, Colombia (Dussán-Duque, 2013). More detailed information and studies come from southeastern Brazil. While the Caravelas, Cananéia and Gulf of Morrosquillo mark-recapture studies estimated relatively high survival rates (0.88, 0.86 and 0.95, respectively), in Guanabara Bay it was much lower (from 0.427 to 0.551, depending on the period). In the latter, it was observed a fast decline in the population, probably related to mortality and not related to emigration (Azevedo *et al.*, 2017). Guanabara Bay is a human-densely region and is environmentally degraded, with different threats potentially contributing to this decline in the Guiana dolphin population.

[3]The PMP-BS is an intense beach monitoring program that has been underway since 2015 along the coasts of São Paulo, Paraná and Santa Catarina, including the southern limit of the Guiana dolphin distribution. All data collected is available at *http://simba.petrobras.com.br*.

Table 2

Summary of the current knowledge on biological parameters of Guiana dolphin (*Sotalia guianensis*).

Area	Parameter		References
Venezuela			
Maracaibo Lake (VEML)			
	Maximum length	Male: 200cm	
		Female: 222cm	
	Maximum age	31 years	
Brazil - Northeastern			
Ceará State (BRNE1)			
	Maximum length	Males: 210cm	Meirelles *et al.* (2010)
		Females: 208cm	
		Males: 189cm	Spinelli (2017)
		Females: 208cm	
	Reproduction	Female length of sexual maturity: 165-208cm	Spinelli (2017)
		Male length of sexual maturity: 164-189cm	
		Length at birth: 97cm	
	Survival (Macuripe)	2009-11: Adult survival=0.88 (95% CI: 0.69-0.96)	Meirelles (2013)
Rio Grande do Norte State (BRNE2)			
	Maximum length	Male: 200cm	
		Female: 197cm	
		Male: 200cm	
		Female 196cm	
		Male: 220cm	
		Female: 194cm	
	Length at physical maturity	Male: 200cm	
		Male: 200cm	
		Female: 194.2-196cm	
		Male: 220cm	
		Female 194cm	
Bahia State (BRNE4)			
	Survival rate	CJS=0.88 ± 0.07 SE, 95% CI=0.67-0.96	Cantor *et al.* (2012)
		RD=0.89 ± 0.03 SE, 95% CI=0.82-0.94	
Brazil - Southeastern			
Espírito Santo (BRSE1)			
	Maximum age	20 years	Carvalho *et al.* (2012)
		33 years	Lima *et al.* (2017)
	Maximum length	Male: 222cm	Ramos *et al.* (2010)
		Female: 184.5cm	
	Age at asymptotic length	6 years	Ramos *et al.* (2010)
	Asymptotic length	Males: 176cm	Lima *et al.* (2017)
		Females: 191cm	
	Length at physical maturity	187.5cm	Carvalho *et al.* (2012)
	Reproduction	Length at birth: 92.96-122cm (Mean=103.3cm)	Carvalho *et al.* (2012)
		Age at female sexual maturity: 7 years	Lima *et al.* (2017)
		Age at male sexual maturity: 8 years	
		Length of female sexual maturity: 191cm (SD=7.12)	
		Length of male sexual maturity: 190.2cm (SD=158.75)	
Rio de Janeiro – (BRSE1)			
	Maximum age	30 years	Arruda Ramos *et al.* (2000); Di Beneditto and Ramos (2004)
	Maximum length	Males: 200cm	Ramos *et al.* (2010)
		Females: 198cm	Ramos *et al.* (2010)
	Age at asymptotic length	6 years	Ramos *et al.* (2010)
	Asymptotic length	Males: 191.7cm	Arruda Ramos *et al.* (2000)
		Females: 191.7cm	
	Age at physical maturity	Males: 7 years	Arruda Ramos *et al.* (2000)
		Females: 7 years	
	Length at physical maturity	Males: 185cm	Arruda Ramos *et al.* (2000)
		Females: 185cm	
	Reproduction	Gestation period: 11.6 months	Arruda Ramos *et al.* (2000)
		Length at birth: 97-106cm	
		86-117.5cm	Di Beneditto and Ramos (2004);
		Age at female sexual maturity: 6 years	Arruda Ramos *et al.* (2000)
		Age at male sexual maturity: 6 years	
		Length at female sexual maturity: 160cm	
		Length at male sexual maturity: 180cm	

Cont.

Area	Parameter		References
Rio de Janeiro – (BRSE2)			
	Maximum length	Males: 210cm Females: 198cm	Ramos *et al.* (2010)
	Age at asymptotic length	6 years	Ramos *et al.* (2010)
	Survival	Calf survival=0.75 (SE=0.02) Juvenile survival=0.89 (SE=0.02) Adult survival=0.89 (SE=0.02)	Flach, unpublished data
		2007-10=0,97 (SE=0.01)	Espécie (2011)
	Reproduction	Calving interval: 2-3 years Fecundity: 0.20 (min: 0.17-max: 0.25)	Flach, unpublished data
Brazil - Guanabara Bay (BRSE2)			
	Survival rate	2000-05=0.43 (95% CI 0.28-0.59) 2005-10=0.55 (95% CI 0.40-0.70) 2010-15=0.55 (95% CI 0.37–0.72)	Azevedo *et al.* (2017)
Brazil - São Paulo – North (BRS/SE)			
	Maximum length	Males: 200cm Females: 200cm	Ramos *et al.* (2010)
	Age at asymptotic length	6 years	Ramos *et al.* (2010)
Brazil - São Paulo – South (BRS/SE)			
	Maximum age	29 years	Santos *et al.* (2003)
	Maximum length	Male: 200cm Female: 200cm	Santos *et al.* (2003)
	Age at asymptotic length	7 years	Santos *et al.* (2003)
	Asymptotic length	179.8cm	Santos *et al.* (2003)
	Reproduction	Length at birth: 97.8cm	Santos *et al.* (2003)
		Calving interval: 2-3 years	Santos *et al.* (2001)
	Survival	2015-16: 0.86 (SE=0.06)	Mello (2016)
Brazil - São Paulo (BRS/SE)			
	Maximum age	Male: 9.7 years Female: 9 years	PMP/BS
	Maximum length	Male: 230cm Female: 206cm	PMP/BS
	Reproduction	Female age at sexual maturity: 6.5 years Male age at sexual maturity: 7.3 years Female length at sexual maturity: 165-208cm Male length at sexual maturity: 164-189cm	Santos Neto (2017)
Brazil - South			
Paraná (BRS/SE)			
	Maximum age	Male: 30 years Female: 24 years	PMP/BS
	Maximum length	Male: 208cm Female: 197cm	PMP/BS
	Maximum age	30 years	Rosas *et al.* (2003)
	Asymptotic length	Males <5 years: 159.6cm Males >5 years: 186.4cm Females: 177.3cm	Rosas *et al.* (2003)
	Maximum weight	121kg	Rosas and Monteiro-Filho (2002)
	Reproduction	Reproductive cycle: 2 years Senescence: females older than 25 years Gestation period: 11.6 months Length at birth: 89.1 to 95cm (92.2 ± 2.7cm) Lactation period: 8.7 months Age at female sexual maturity: between 5 and 8 years Age at male sexual maturity: 7 years Length at female sexual maturity: between 164 to 169cm Length at male sexual maturity: between 170 and 175cm	Rosas and Monteiro-Filho (2002)
Santa Catarina (BRS/SE)			
	Maximum age	Male: 25 years Female: 25 years	PMP/BS
	Maximum length	Male: 212cm Female: 230cm	PMP/BS

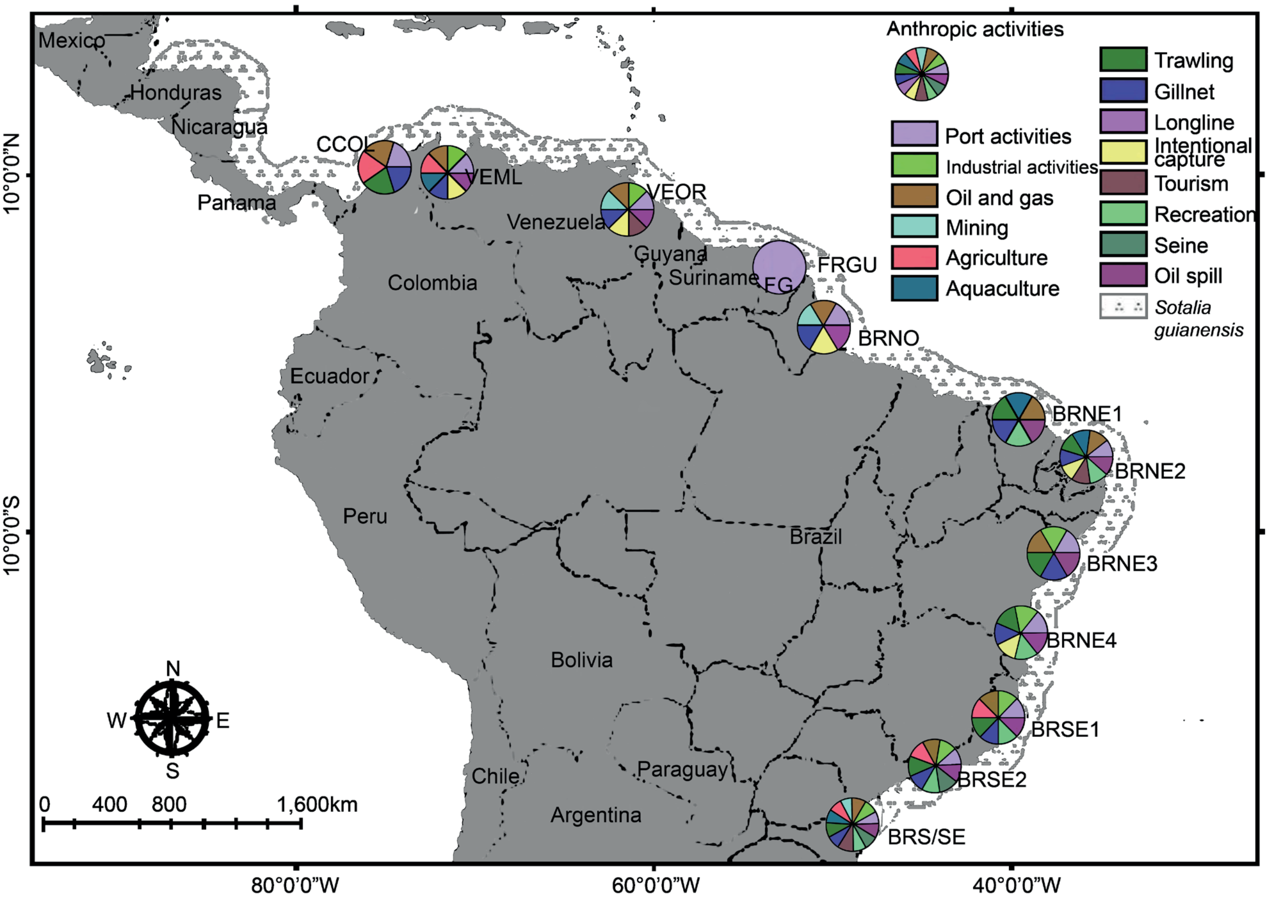

Fig. 5. Map of anthropogenic activities potentially impacting Guiana dolphins identified for each management unit during the Workshop in 2019 (map based on Annex E).

However, even in the absence of direct estimates of injuries caused by human activities, suggestive marks of trauma have been observed on live animals (Azevedo *et al.*, 2009; Flach, 2015; Nery *et al.*, 2008) and stranded individuals. Information collected from stranding programmes between 2015 and 2019, recorded 832 Guiana dolphin carcasses during daily beaching monitoring, along approximately 1,500km of the southeast and south Brazilian coast (data available at: *http://simba.petrobras.com.br*). Considering only fresh or in early decomposition carcasses (*n*=328), signs of fishery interactions were seen in 42% (*n*=138) of them, but in some areas signs of fishery interactions were observed in almost 75% of the carcasses (see Fig. 6).

Other negative interactions, such as vessel collision, marine debris ingestion and aggression are rare, but also recorded during necropsy (details provided in specific topics below). Additionally, juvenile/calves stranded more frequently (~50%) than adults (33%) or undetermined individuals (17%), and this proportion is similar for animals with (juveniles=55.8%; adults=33.3%) or without (juveniles=45.4%; adults=31.9%) suggestive marks of fishing interaction.

Bycatch

Fisheries bycatch of marine mammals are regulated throughout the Guiana dolphin distribution, but are poorly monitored. Therefore, impacts of bycatch on these populations are not well understood. The lack of data on fishing effort, particularly for small-scale fisheries, bycatch rates, and which Guiana dolphin population are affected remain as critical barriers for assessing risks from individual fisheries or cumulative impacts from fisheries that overlap with the population distribution.

Nevertheless, the high number of Guiana dolphins found stranded along the coast and information from the literature inform the species is one of the most commonly caught small cetaceans in Brazilian coastal gillnet fisheries (Di Beneditto, 2003; Emin-Lima *et al.*, 2008; Lodi and Capistrano, 1990; Meirelles *et al.*, 2010; Siciliano, 1994; Sidou, 2008). The same impact was reported for other regions in South and Central America (Vidal *et al.*, 1994). For example, in Colombia, at least six mortality events related with entanglement in nets are reported yearly for the last five years (Trujillo, pers. comm.). Although gillnets appear to be the most important fisheries in terms of threats, interactions also include incidental mortality in other types of nets, artisanal longline fisheries, the use of dynamite in fishing operations, direct catches for meat consumption and bait, and competition with fisheries for fishing resources (Crespo *et al.*, 2010; Delgado-Ortega,

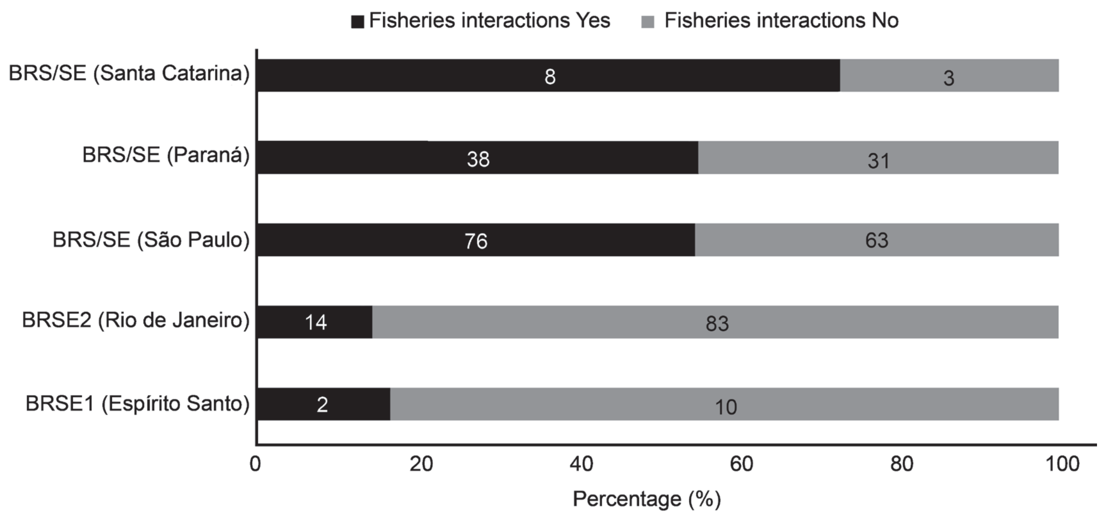

Fig. 6. Guiana dolphin carcasses with or without suggestive marks of fishery interactions detected during necropsies. The analysed individuals were found stranded along the Brazilian states of Espirito Santo, Rio de Janeiro, São Paulo, Paraná and Santa Catarina. The number within columns indicates the absolute number of dolphins. Only fresh and early decomposition stages were considered (codes 2 and 3, *sensu* Geraci and Lounsbury, 2005).

2012; Di Beneditto *et al.*, 1998; Loch *et al.*, 2009; Lodi and Capistrano, 1990; Monteiro-Neto *et al.*, 2000; Nery *et al.*, 2008; Pinheiro and Cremer, 2003; Rosas *et al.*, 2010). The review contributions in understanding Guiana dolphin bycatch are summarised by management units in Table 3.

In general, few initiatives and experiments have been carried out on Guiana dolphins to mitigate fisheries interactions. Crespo *et al.* (2010) cited just one experimental test with pingers carried out in Iracema Beach, Fortaleza, Brazil, from 1996 to 1998 (Monteiro-Neto *et al.*, 2004). Experiments with functional, dummy and control trials were tested in a sheltered area where dolphin groups were monitored. The results suggested that functional pingers affect dolphin distribution, but side effects in population parameters and its prey were not cited.

Summarised by management units

BRS/SE

In the central coastal area of São Paulo state, Guiana dolphins represented 5.4% of the incidental capture records during the over 20 years of monitoring artisanal fishing (Bertozzi *et al*., unpublished data). On the southern area in the same state, in Cananéia Estuarine Complex, fisheries interactions were observed between 2004 and 2007 and Guiana dolphins represented 11.5% of no-target species captured. On the coast of Paraná state, the monitoring of fisheries recorded the incidental capture of 45 Guiana dolphins between 1997 and 1999 (Rosas, 2000).

BRSE1

In the region of Atafona, north of Rio de Janeiro state, Guiana dolphin has historically represented one of the species most vulnerable to fishing activities. Between 1987-88 Lodi and Capistrano (1990) recorded the incidental capture of 33 specimens; later, between 1989 and 1996, Di Beneditto *et al.* (1998) registered 78 individual incidental captures. Between 2001 and 2002, monitoring of 374 sets of gillnets resulted in the bycatch of 20 individuals (Di Beneditto, 2003).

BRNE (1-4)

In the northeast of Brazil, an ethnobiology study carried out in Pernambuco state showed that 44% of the fishermen confirmed that have incidental capture individual of Guiana dolphins, but the mortality rate and the threat to the population are still unknown (Araújo, 2008). For Ceará state (BRNE1) mortality due to incidental captures was estimated at 4 to 11 individuals per year (Monteiro-Neto *et al.*, 2000). In Rio Grande do Norte state (BRNE2) the mortality recorded for small-scale fisheries was 29 individuals over three years (Attademo, 2007).

BRNO

The mortality of Guiana dolphin by interactions with small-scale fisheries was evaluated in Pará, from August 2006 to May 2007, and 166 Guiana dolphins were captured; an average of 5.35 dolphins per fishing sets (Emin-Lima *et al.*, 2008). This number is larger than for other regions of Brazil.

Additionally, Guiana dolphin can be severely injured, due to trauma related to net entanglements resulting in partial or complete amputations and deformations. Remains of nylon gillnets were found around the body of Guiana dolphins (Azevedo *et al.*, 2009; Domiciano *et al.*, 2016). As cited by Rosas *et al.* (2010) this might result in severe injuries and traumas, high-stress levels and secondary mortality, which goes unaccounted for in Guiana dolphins (Van Bressem *et al.*, 2007).

Bycatch and intentional captures – Venezuela cases

Historically in Maracaibo Lake there has been a use of Guiana dolphin when it is incidentally captured. The meat is used for human consumption or as bait for shark fishing (Barrios-Garrido *et al.*, 2015; Ramírez, 2005; Sánchez and Briceño, 2017). In the last four years, there has been an increase in beached individuals of Guiana dolphins in Lake Maracaibo with signs of anthropogenic injuries, such as suggestive marks of fisheries interactions. The bycatch rates were estimated per region (North, Center and South of the Lake Maracaibo) for 3 to 5 months (Briceño *et al.*, unpublished data; see Table 3). Recently, direct hunting has been reported: between July 2019 and January 2020, about 100 individuals were captured for consumption and these data have been collected through interviews conducted at the main fishing ports and with local informants. In a single hunting event in the north of the lake in January 2020, 17 animals were killed and consumed, including pregnant females (Briceño, pers. comm.). Considering the data collected between 2016 and 2020, an estimated bycatch and directed hunting mortality is estimated at almost 180 individuals/year, one of the highest rates in the species entire distribution (Briceño *et al*., unpublished data; Sánchez and Briceño, 2017).

Environmental concerns

Chemical Contaminants

Guiana dolphin is a marine ecosystem sentinel (Moura *et al.*, 2013) as the species is particularly sensitive to environmental changes and the spatially and temporally pollution signals of the environment might be detected throughout their life parameters. Guiana dolphins are exposed to a range of human-induced impacts that include persistent environmental pollution and emerging diseases. Its coastal distribution, high residency and site fidelity, high trophic level and long lifespan (about 30 years) complicate the exposition to these pollutants and disturbances (Bisi *et al.*, 2012; de Freitas Azevedo *et al.*, 2004). For instance, Guiana dolphin can present high concentrations of xenobiotics with potential for bioaccumulation and biomagnification (e.g. mercury and persistent organic compounds). These processes have been reported for populations in the south and southeastern Brazil (Kajiwara *et al.*, 2004; Lailson-Brito *et al.*, 2010; 2012; Yogui *et al.*, 2003). Many of these contaminants can lead to harmful effects on the health conditions, such as altering hormonal cycles and acting as an immunosuppressant. Although the Guiana dolphin is the most studied delphinid in the coast of Brazil regarding bioaccumulation of contaminants, the vast majority of investigations were carried out in the southeastern region, and no available studies were found on Guiana dolphin populations from other countries along its distribution.

Trace Elements

Most studies published regarding trace element levels in Guiana dolphins were carried out in the southeastern region of Brazil, mainly along the coast of Rio de Janeiro State (Bisi *et al.*, 2012; Carvalho *et al.*, 2008; Kunito *et al.*, 2004; Lailson-Brito *et al.*, 2012; see Table 4). In other regions, studies are still scarce (Monteiro-Neto *et al.*, 2003; Moura *et al.*, 2012a).

The highest concentrations of mercury have been reported in specimens from Rio de Janeiro, with values ranging from 0.17 to 132 $\mu g.g^{-1}$ wet weight (w.w) in liver tissue (Lailson-Brito *et al.*, 2012; Lemos *et al.*, 2013). The population of Guanabara Bay had the highest mean concentration, 19.9 µg.g-1 w.w. (Lailson-Brito *et al.*, 2012). This study found a positive correlation between mercury concentrations and the total length, probably because of the accumulation of this trace element over the life of the Guiana dolphin, a pattern widely reported in studies with marine mammals throughout the world (Lailson-Brito *et al.*, 2012). In the south/southeast region of Brazil, there is a single study which analysed individuals collected from the south coast of São Paulo State to the north coast of Paraná State, that reported similar values to those reported in Guanabara Bay, varying between 1.4 and 380$\mu g.g^{-1}$ dry weight (d.w.; 0.35 to 95$\mu g.g^{-1}$ w.w.; Kunito *et al.*, 2004). The only two studies published in the north and northeastern regions of Brazil found the lowest concentrations of mercury in Guiana dolphin, with values ranging between 0.10 and 29.5 $\mu g.g^{-1}$ w.w. in the liver of individuals from Ceará (Monteiro-Neto *et al.*, 2003) and between 0.07 and 0.79 $\mu g.g^{-1}$ w.w. in the muscle of individuals from Amapá (Moura *et al.*, 2012a). In a preliminary study in the south of Maracaibo Lake (Venezuela), it was found a mean mercury concentration of 2.96 ± 0.16$\mu g.g^{-1}$ w.w. in the liver (*n*=2) and 0.69 ± 0.01$\mu g.g^{-1}$ w.w. in the muscle (*n*=6; Yurasi Briceño, pers. comm.).

Investigations on the bioaccumulation of other trace elements, such as cadmium (Cd) and lead (Pb), are even scarcer in Guiana dolphin and the tissues analysed vary between them (see Table 4). In northeastern Brazil, two studies reported cadmium values ranging from <0.002$\mu g.g^{-1}$ w.w. in liver to 4.1$\mu g.g^{-1}$ w.w. in kidney (Korn *et al.*, 2010; Monteiro-Neto *et al.*, 2003). Most studies have been carried out along the coast of Rio de Janeiro state, with cadmium concentrations ranging from <0.047$\mu g.g^{-1}$ w.w. in the liver of Guiana dolphins from northern region to 3.29$\mu g.g^{-1}$ w.w. in the kidney of individuals from the central-southern region of the state (Dorneles *et al.*, 2007; Lemos *et al.*, 2013). Between the south coast of São Paulo and the north of Paraná state, it has been reported cadmium concentrations ranging from 0.19 to 2.9$\mu g.g^{-1}$ d.w. in liver (Kunito *et al.*, 2004). Regarding lead, only four published articles were found, with the highest mean concentration reported in the liver of Guiana dolphins from Cananéia, São Paulo state (3.2$\mu g.g^{-1}$ w.w.; Salgado *et al.*, 2018).

Persistent Organic Pollutants

Most published studies about persistent organic pollutants (e.g. organochlorine compounds and organobromine compounds) in Guiana dolphins are from the southeastern and southern of Brazil (Dorneles *et al.*, 2010; Kajiwara *et al.*,

Table 3

Summary of the current knowledge on fisheries interactions and Guiana dolphin bycatch.
Information were collected from stranding events and interviews with fishermen.

Location	Years	Fishing gear	% of carcasses or bycatch rates*	Seasonal capture	Information from
Venezuela					
Maracaibo Lake, (west-central coast) – (VEML)	2018-20	Gillnet	21 individuals/year	No seasonal difference detected	Yurasi Briceño, pers. comm.
Maracaibo Lake (west-central coast) – (VEML)	2011-12	Artisanal longline	5 individuals/year	No seasonal difference detected	Delgado-Ortega (2012)
Maracaibo Lake, Zulia state (southern portion) – (VEML)	2016-20	Gillnet	144 individuals 36 individuals/year	No seasonal difference detected	Yurasi Briceño, pers. comm. Sánchez and Briceño (2017)
Maracaibo Lake, Zulia state (northern portion) – (VEML)	2007-13 2017-20* 2005*	Gillnet	91 individuals registered 15 individuals per year (only one artisanel port) *52 individuals 17 per year *-30 individuals that year	Wet season (Aug.-Nov.) *not seasonal difference	H. Barrios-Garrido, pers.comm. Yurasi Briceño* Sánchez and Briceño (2017) Ramírez (2005)
Brazil - North					
Pará – (BRNO)	2006-07	Gillnet	166 individuals 5.35 individuals/sets	No seasonal difference	Emin-Lima *et al.* (2008)
Northeastern Brazil					
Ceará (BRNE1)	1992-98		4-11 individuals/year (30#)	Spring	Monteiro-Neto *et al.* (2000)
Ceará (BRNE1)	1992-2005	Gillnet and trawling	30.6% of stranded individuals	Winter and spring	Meirelles *et al.* (2010)
Southeastern Brazil					
North of Rio de Janeiro (BRSE1)	1987-88	Gillnet	33 individuals$	-	Lodi and Capistrano (1990)
North of Rio de Janeiro (BRSE1)	2001-02	Gillnet	0.031 (km of net.day)$^{-1}$	No seasonal difference	Di Beneditto (2003)
North of Rio de Janeiro (BRSE1)	2001-07	Gillnet	~33% of stranded individuals	Winter and spring	Moura *et al.* (2009)
Sepetiba Bay, Rio de Janeira (BRSE2)	2005-16	Gillnet	75% of stranded individuals	-	Flach (2015)
Central São Paulo State (BRS/SE)	1999-19	Gillnet	19 individuals	Not evaluated	Bertozzi, pers. comm.
South of São Paulo State (BRS/SE)	2004-07	Gillnet	18 individuals	Not evaluated	Sidou (2008)
Southern Brazil					
Paraná (BRS/SE)	1997-99	Gillnet	45 individuals	-	Rosas (2000)
Paraná (BRS/SE)	2007-12	Gillnet	~61% of stranded individuals	-	Domiciano *et al.* (2016)
Babitonga Bay, Santa Catarina (BRS/SE)		Gillnet		Spring and summer	Pinheiro and Cremer (2003)
Baía Norte, Ilha de Santa Catarina - Santa Catarina (BRS/SE)	1983-2014	-	-	Winter	Vianna *et al.* (2016)
North and Central Santa Catarina (BRS/SE)	1983-2014	-	-	Autumn	Vianna *et al.* (2016)

*Percentage of carcasses found with evidence of bycatch; # number of dolphins bycaught in 1996; $between 1987 and 1988, blank=not available.

2004; Lailson-Brito *et al.*, 2010; Lavandier *et al.*, 2015; Yogui *et al.*, 2003; 2011), except a study carried out in the northeast of Brazil (Santos-Neto *et al.*, 2014). See Table 5 for details. Regarding organochlorine compounds, the highest concentrations of PCBs were reported for Guiana dolphins from Guanabara Bay (RJ; 6.7-99.0µg.g^{-1} lipid weight; lw), an area with a high degree of industrialisation. The highest concentrations of DDT and its metabolites were recorded in specimens collected in areas with greater agricultural influence, in the south coast of São Paulo and in the coast of Paraná state (0.54-150µg.g^{-1} lw; Alonso *et al.*, 2010; Kajiwara *et al.*, 2004; Lailson-Brito *et al.*, 2010; Yogui *et al.*, 2003). The lowest concentrations, both for PCBs and DDTs, were reported in Guiana dolphins collected along the coast of Ceará, with mean values of 1.1µg.g^{-1} lw and 0.3µg.g^{-1} lw, respectively (Santos-Neto *et al.*, 2014). The other chlorinated pesticides (HCH and its isomers, HCB and Mirex) bioaccumulated in lower concentrations in Guiana dolphins from all studies (see Table 5).

Studies on the bioaccumulation of organobrominated compounds (polybrominated diphenyl ethers - PBDEs) in Guiana dolphins are quite scarce and without standardisation regarding the tissue analysed (subcutaneous adipose tissue, liver and muscle; Dorneles *et al.*, 2010; Lavandier *et al.*, 2015; Yogui *et al.*, 2003; see Table 6). Thus, it is difficult to compare the results and limits the understanding of the bioaccumulation potential of these compounds in Guiana dolphin along its distribution.

Table 4

Mean±SD, minimum and maximum concentrations of total mercury (HgT), cadmium (Cd) and lead (Pb) in Guiana dolphin (*Sotalia guianensis*) from the Brazilian coast. The concentrations were expressed as μg.g^{-1} wet weight.

		THg			Cd			Pb			
Regions	N	Liver	Muscle	Kidney	Liver	Muscle	Kidney	Liver	Muscle	Kidney	References
Brazil											
Northern											
Amapá (BRNO)	27	-	0.4 ± 0.16 0.07-0.79	-	-	-	-	-	-	-	Moura *et al.* (2012a)
Northeastern											
Ceará (BRNE1)	11	4.62 0.10-29.51	-	1,24 0,06-5,63	0,22 0,01-1,32		0,78 0,01-4,09	0,11 0,10-0.12	-	0.11 0.11-1.28	Monteiro-Neto *et al.* (2003)
Bahia (BRNE4)	3	-	-	-	<0.002-1.2	4.9°	2.10-3.31	0.04-0.36	0.02°	<0.001-0.32	Korn *et al.* (2010)
Southeastern											
North coast of Rio de Janeiro (BRSE1)	29	8.67ª# 0.84-87.92	-	-	-	-	-	-	-	-	Kehrig *et al.* (2008)
North coast of Rio de Janeiro (BRSE1)	6	9.98 1.10-21.7	0.73 0.34-1.42	-	0.34 0.18-0.56	0.10 0.07-0.18	-	-	-	-	Carvalho *et al.* (2008)
North coast of Rio de Janeiro (BRSE1)	19	27.8 ± 24.7ª 3.60-72.98	-	-	0.41ª 0.01-1.48	-	-	-	-	-	Seixas *et al.* (2009)
North coast of Rio de Janeiro (BRSE1)	20	1.07 ± 0.35 (0.2-1.66)	-	-	-	-	-	-	-	-	Moura *et al.* (2012b)
North coast of Rio de Janeiro (BRSE1)	11	15.4 ± 20.1 0.17-58.77	-	-	<0.047 <0.047-0.97	-	-	-	-	-	Lemos *et al.* (2013)
North coast of Rio de Janeiro (BRSE1)	21	-	3.28±1.69ª	-	-	-	-	-	-	-	Kehrig *et al.* (2013)
North coast of Rio de Janeiro (BRSE1)	14	4.1 ± 2.8 (Imaturos) 12.7 ± 7.1 (Maduros)	0.6 ± 0.1 (Imaturos) 1.3 ± 0.3 (Maduros)	-	-	-	-	-	-	-	Kehrig *et al.* (2016)
North coast of Rio de Janeiro (BRSE1)	28	-	3.91±2.16ª	-	-	-	-	-	-	-	Baptista *et al.* (2016)
Guanabara Bay, RJ (BRSE2)	NI	17.44	-	-	-	-	-	-	-	-	Lailson-Brito *et al.* (2002)
Guanabara Bay, RJ (BRSE2)	19	19.9 ± 32.3 (0.35-132)	-	-	-	-	-	-	-	-	Lailson-Brito *et al.* (2012)
Guanabara Bay, RJ (BRSE2)	12	-	0.92±0.65	-	-	-	-	-	-	-	Bisi *et al.* (2012)
Sepetiba Bay, RJ (BRSE2)	42	-	0.26±0.33	-	-	-	-	-	-	-	Bisi *et al.* (2012)
Ilha Grande bay, RJ (BRSE2)	6	8.8 ± 2.1ª	1.9 ± 0.8ª	-	-	-	-	-	-	-	Seixas *et al.* (2014)
Ilha Grande bay, RJ (BRSE2)	9	-	0.68±0.22	-	-	-	-	-	-	-	Bisi *et al.* (2012)
Central-south area of Rio de Janeiro (BRSE2)	5	-	-	-	-	-	1.18±1.10 0.04-3.29	-	-	-	Dorneles *et al.* (2007)
São Paulo State and Paraná State* (BRS/SE)	20	77 ± 107ª (1.4-380)	-	-	0.65±0.75ª (0.19-2.9)	-	-	0.07±0.053ª 0.028-0.19	-	-	Kunito *et al.* (2004)
Cananéia, SP (BRS/SE)	21	-	-	-	-	-	-	3.17 ± 2.84 <DL-9.62	-	-	Salgado *et al.* (2018)

NI: data not informed; *authors did not differentiate individuals from the two states; ªvalues expressed on dry weight; #median values; °n=1; DL=detection limit; dash=not analysed.

Noise Pollution and Collisions

Only four studies have been published regarding the impact of noise pollution on the acoustic behaviour of the Guiana dolphin in Brazil: (i) one in Guanabara Bay, Rio de Janeiro state BRSE2 (Bittencourt *et al.*, 2017); (ii) one in Cananéia, São Paulo state - BRS/SE (Resende, 2008); (iii) one in Caravelas estuary, Bahia state - BRNE4 (Pais *et al.*, 2018); and (iv) one in the district of Pipa, Rio Grande do Norte state – BRNE2 (Martins *et al.*, 2018). Changes in the whistles acoustic parameters were recorded for some studies and suggested as a response to the high underwater noise. However, Bittencourt *et al.* (2017) found that the Guiana dolphins produced whistles of shorter duration; conversely, (Martins *et al.*, 2018) reported a reduction in the number of clicks in noisy conditions. Stutz Reis (2013) observed different responses in Bevenuete bay, in Espirito Santo's state (BRS1), where Guiana dolphins produced longer whistles in a noisy habitat.

Table 5

Mean±SD, minimum and maximum concentrations of the organochlorine compounds (ΣPCB, ΣDDT, ΣHCH, HCB e Mirex) in blubber of Guiana dolphins (*Sotalia guianensis*) from the Brazilian coast. The concentrations were expressed as $\mu g.g^{-1}$ lipid weight.

Regions	N	ΣPCB	ΣDDT	ΣHCH	HCB	Mirex	References
Brazil							
Northeastern							
North region of Ceará (BRNE1)	4	2.23±1.17 0.02-3.85	0.33±0.26 0.006-0.63	NA	0.02±0.02 0.003-0.04	0.08±0.04 0.02-0.12	Santos-Neto *et al.* (2014)
Metropolitan region of Ceará (BRNE1)	8	7.35±6.27 0.04-17.3	1.11±0.66 0.06-1.91	0.04±0.01 0.04-0.05	0.007±0.004 0.002-0.01	0.09±0.03 0.04-0.15	Santos-Neto *et al.* (2014)
South region of Ceará (BRNE1)	13	1.12±1.32 0.03-0.82	0.30±0.28 0.003-0.82	0.03±0.03 0.005-0.08	0.07±0.05 0.02-0.16	0.07±0.05 0.02-0.16	Santos-Neto *et al.* (2014)
Southeastern							
Guanabara Bay, RJ (BRSE2)	12	34.8±26.3 6.7-99.2	7.9±6.9 2.1-21.5	NA	0.046±0.04 <0.004-0.11	NA	Lailson-Brito *et al.* (2010)
Sepetiba Bay, RJ (BRSE2)	5	12.3±11.7 1.7-25.5	3.9±3.9 0.65-9.99	NA	0.029±0.028 0.013-0.08	NA	Lailson-Brito *et al.* (2010)
Ubatuba, SP (BRS/SE)	3	47.78 (25.87-66.03)	34.03 16.91-48.08	0.07 0.06-0.07	0.11 (0.08-0.14)	1.26 0.57-1.87	Alonso *et al.* (2010)
Baixada Santista, SP (BRS/SE)	3	39.69 27.86-61.34	36.98 24.57-55.91	0.09 0.03-0.21	0.12 0.07-0.17	0.76 0.24-1.04	Alonso *et al.* (2010)
Cananéia, SP (BRS/SE)	9	4.61±3.31 0.2-9.22	35.9±46.8 0.54-125	0.016± 0.02 <0.003-0.04	0.015±0.009	0.15±0.08 0.01-0.32	Yogui *et al.* (2003)
São Paulo state (BRS/SE)	1	1.97	5.87	0.011	0.067	0.046	Yogui *et al.* (2010)
São Paulo and Paraná states* (BRS/SE)	26	1.3-79	1-150	<0.001-0.061	0.0016-0.40	NA	Kajiwara *et al.* (2004)
				NA		NA	
Southern							
Paranaguá Estuarine Complex, PR (BRS/SE)	15	4.6±4 0.76-14.3	5.7±5.8 0.98-23.5	NA	0.041±0.040 <0.004-0.16	NA	Lailson-Brito *et al.* (2010)

*Authors did not differentiate individuals from the two states; NA=not analysed.

Table 6

Mean±SD, minimum and maximum concentrations of the organobrominated compounds (ΣPBDE) in Guiana dolphins (*Sotalia guianensis*) from the Brazilian coast. The concentrations were expressed as $\mu g.g^{-1}$ lipid weight.

Local	N	Sex	ΣPBDE			Reference
			Blubber	Liver	Muscle	
BRSE1						
North-central region, RJ	10	M/F	NA	53*	NA	Quinete *et al.* (2011)
North-central region, RJ	3	F	NA	0.20 ± 0.12 (0.07-0.29)	0.10 ± 0.06 (0.03-0.14)	Lavandier *et al.* (2015)
North-central region, RJ	5	M	NA	0.12 ± 0.045 (0.07 -0.17)	0.06 ± 0.02 (0.04-0.08)	Lavandier *et al.* (2015)
Metropolitan region and 'Região dos Lagos', RJ	6	F	NA	0.16 ±0.15 (0.01–0.45)	NA	Dorneles *et al.* (2010)
Metropolitan region and 'Região dos Lagos', RJ	13	M	NA	0.67 ±0.43 (0.26–1.62)	NA	Dorneles *et al.* (2010)
BR S/SE						
São Paulo state	4	F	73.2 ± 79.1	NA	NA	Yogui *et al.* (2011)
São Paulo state	5	M	59.5 ± 47.1	NA	NA	Yogui *et al.* (2011)

M: male; F: female; *values expressed wet weight; NA= not analysed.

In general, published and unpublished data (grey literature) from different areas along the Brazilian coast highlighted potential communication masking of Guiana dolphin acoustic signals when they are using noise areas (Alburquerque and Souto, 2013; Domit *et al.*, 2018; Martins *et al.*, 2018; Pais *et al.*, 2018; Resende, 2008; Rossi-Santos, pers. comm.). In a recent study, 20 years of acoustic data were analysed for Guiana dolphin population from Sepetiba Bay, Rio de Janeiro state (BRSE2). Changes in the spatial and temporal structure of Guiana dolphin repertoire potentially have been induced for noise pollution. In general, whistle diversity, duration and rate decreased significantly thought the years, whereas maximum and minimum frequencies increased. Spatially, Guiana dolphins emitted longer and more complex whistles in less noisy habitats (Maciel, 2020).

In the case of Venezuela, Barrios-Garrido *et al.* (2016) found that the significant amount of ambient noise produced by boats, ships, and tankers for the transportation of tourists, goods, and oil products may be affecting the whistle structure of Guiana Dolphin in the southern portion of the Gulf of Venezuela, specifically between Zapara Island and San Bernardo Bay. In Colombia, distribution of Guiana dolphins overlaps with ports, so the potential for negative interaction exists but has not been measured up to date (Trujillo, pers. comm.).

There is no specific study being conducted evaluating rates of vessels collisions in Guiana dolphins. Nevertheless, the systematic beach monitoring program (PMP-BS[1]) conducted along the beaches in southern and southeastern Brazil (BRS/SE and BRSE2 and BRSE1) recorded 832 Guiana dolphins stranded which eleven carcasses were reported with suggestive marks of vessel collisions. Moreover, alive and dead stranded individuals were recorded with marks suggesting traumatic injuries probably caused by boat propeller (Domiciano *et al.*, 2016; Paulo André Flores, pers. comm.).

Dolphin Watching and Recreational Nautical Tourism Activities

Nautical tourism activities are an increasingly significant threat to marine mammals worldwide, resulting in a billionaire industry (O'Connor *et al.*, 2009). Nautical tourism is a significant economic activity along the South and Central America; however, few studies have investigated the potential impact on Guiana dolphins population.

'Commercial dolphin-watching programs are reported for Maracaibo Lake, Venezuela (VEML) and in Brazilian waters, such as Baía Norte in Santa Catarina state, Cananéia in São Paulo state (both under BRS/SE) and at Pipa beach in Rio Grande do Norte state (BRNE2). In Baía Norte, commercial dolphin-watching tourism resulted in behavioural changes and long and short-term habitat displacement by Guiana dolphins (Pereira *et al.*, 2007). Similar results were reported in Cananéia instantly after boat approximation (Filla and Monteiro-Filho, 2009). In Pipa beach, behavioural changes were reported in groups with calves, particularly during resting and socialising (Santos *et al.*, 2006).

In Maracaibo Lake (VELM), Venezuela, commercial dolphin-watching tourism is reported to occur sporadically; however, no study investigated the potential impacts on Guiana dolphin ecology and behaviour (Hoyt and Iñíguez, 2008). In Colombia, small dolphin watching ventures exist in Morosquillo Gulf, but there is no information about the level of interaction and the number of boats pursuing this activity in the area (Trujillo, pers. comm.).

Recreational nautical tourism exists along the entire Guiana dolphin distribution. Behaviour categorised as negative reactions were reported in some areas in Sergipe state (BRNE 3; Marega-Imamura *et al.*, 2018; Nunes *et al.*, 2014), in Ilhéus, Bahia state (BRNE4; Marega-Imamura *et al.*, 2018; Santos *et al.*, 2013), Cananéia, São Paulo state (Filla and Monteiro-Filho, 2009), Paranaguá Estuarine Complex, Paraná state (Gaudard, 2011) and in Baía Norte, Santa Catarina State (Pereira *et al.*, 2007).

Diseases

Cetaceans are considered environmental sentinels and their health often reflects either anthropogenic or natural spatio-temporal disturbances. Over the years, several pathogens have been identified as the cause of stranding episodes and mortality and, in fact, represent a potential risk to the life and conservation of cetaceans and at least for Guiana dolphin (Groch *et al.*, 2018). Several diseases have been documented in Guiana dolphins such as herpesvirus in general (Sacristán *et al.*, 2019), generalised poxvirus infection (Crespo *et al.*, 2010; Sacristán *et al.*, 2018; Van Bressem *et al.*, 2009), morbillivirus (Domiciano *et al.*, 2016; Groch *et al.*, 2014; Groch *et al.*, 2018; Marutani, 2020), *Toxoplasma gondii* (Bandoli and De Oliviera, 1977), Brucella spp. (Sánchez-Sarmiento *et al.*, 2018), and also lobomycosis and lobomycosis-like disease in Guiana dolphins from several localities (Van Bressem *et al.*, 2009). Many bacterial pathogens from the family Aeromonadaceae and Vibrionaceae have been isolated from Guiana dolphins. In addition, systemic infections caused by fungi of the genus *Aspergillus* spp., considered rare, have been reported more frequently (Groch *et al.*, 2018). Cases of toxoplasmosis and systemic aspergillosis have been observed in Guiana dolphins in Paraná state (PMP-BS[1]).

Studies investigating pathological findings are increasing, particularly along the Brazilian coastal area, due to an intense beach monitoring program that has been underway (Projeto de Monitoramento de Praias) and all fresh and early decomposed carcasses have been submitted for necropsy. Although some of the results of this program are unpublished, other studies have disclosed important results in terms of Guiana dolphin health status. Hepatic degeneration, lung problems and severe vascular thrombosis in Guiana dolphins caught on the Caribbean coast of Colombia were mentioned by Bössenecker (1978). Ruoppolo (2003), Marigo *et al.* (2010) and Domiciano *et al.* (2016) revealed parasitic pneumonia caused by the presence of *Halocercus brasiliensis* as one of the main causes of mortality of Guiana dolphin from the coasts of São Paulo and Paraná States (southeast and southern Brazil, respectively).

A study investigated the pathological findings and mortality of 50 Guiana dolphins from Paraná state (BRSE/S) and suggested major cause of death were ascribed to anthropogenic activities, including fisheries bycatch and trauma. However, the natural mortality, irrespective of the cause, were related to bronchointerstitial pneumonia, associated with parasitism, lymphadenitis and membranous glomerulonephritis. These results suggest, that while anthropogenic activities are a leading cause of cetacean strandings in Paraná, and probably in other regions, underlying pre-existing diseases may contribute towards deaths (Domiciano *et al.*, 2016). In the last years (2015-19) the main histological findings observed in Guiana dolphins evaluated in PMP-BS[1] in a specific area (Paraná state) were pneumonia (56%) (interstitial, granulomatous, chronic bronchopneumonia), lymphadenopathy (44%) (lymphoid depletion and lymphadenitis), hepatitis (20%), nephritis (16%) and lymphocytic encephalitis (8%). Granulomatous dermatitis was also observed in association with fungal infection. Interstitial pneumonia and lymphoid depletion were associated with morbillivirus infection in 11 animals. Also, coinfection with *Toxoplasma gondii* or *Aspergillus* spp. was detected.

The data compiled by Rosas *et al.* (2010) present a case of osteomyelitis reported by Furtado and Simões-Lopes (1999) in Guiana dolphins from Santa Catarina coast, in southern Brazil, and a case related to periodontal disease seen in the mandible of one individual from Venezuela. They also cited lesions potentially caused by *Crassicauda* sp. seen in the pterygoids of Guiana dolphins from Rio de Janeiro coast (Van Bressem *et al.*, 2007), which are also recorded in skulls of individuals found stranded in the Paraná coast (Domit, pers. comm.). Chronic bone lesions, degenerative infections, traumatic bone lesions and developmental bone anomalies in specimens from Rio de Janeiro state were reported by Ramos *et al.* (2001).

These results suggest a vulnerability of this species to environmental disturbances. Threats, including chemical contamination, underwater noise and habitat degradation are potential impacts evoking the types of stress, immunosuppression and diseases observed in different Guiana dolphin population along the species entire distribution.

Marine Debris

There is no specific study being conducted focusing on interactions with Guiana dolphins and marine debris. Nevertheless, the systematic beach monitoring program (PMP-BS) recorded 832 individuals stranded on the beaches in southern and southeastern Brazil and debris were observed in four of 328 Guiana dolphins evaluated by necropsy. The interaction includes ingestion and entanglement. In several occasions, Guiana dolphins have been recorded entangled to discarded artisanal longlines in the Maracaibo Lake, specifically to fishing gear design to capture blue crabs (*Callinectes* spp.) (H. Barrios-Garrido, pers.comm.).

Reduction of Prey Availability Due to Overfishing

The overlap of fisheries target species/food resources is an indirect interaction between marine mammals and fisheries. This interaction could increase the vulnerability of this dolphin species by reducing food availability, while also increasing their exposure to direct fisheries interactions, such as bycatch. Few studies have been conducted to assess the potential effect of overfishing Guiana dolphin prey along the entire species distribution. The most frequent fish consumed by Guiana dolphins range 3.2cm to 16.2cm, suggesting that the species does not compete directly with the fisheries (Di Beneditto, 2000; Oliveira, 2003; Santos *et al.*, 2002). However, de Gurjao *et al.* (2003) suggested that the Guiana dolphin might compete with the artisanal fisheries on the Ceará coast (northern Brazil – BRNE1), based on the fish families consumed by species and those which are most commonly captured in this region.

Available information on the diet suggests that many important prey for Guiana dolphins are of commercial interest (e.g. *Harengula clupeola, Pomadasys corvinaeformes*, *Thichiurus lepturus, Sardinella brasiliensis*, *Pellona harroweri*, *Isopisthus parvipinnis*, *Centropomus* sp., *Cetengraulis edentulus*, *Mugil* sp., *Lycengraulis grossidens*, and *Micropogonias furnieri*; Madeira di Beneditto and Siciliano, 2007; Oliveira *et al.*, 2008; Rodrigues *et al.*, 2020). Additionally, some fishes preyed by Guiana dolphins are bycatch of artisanal trawls, suggesting that Guiana dolphins could be feeding following fishing boats and exposed for threats.

Coastal Development (e.g. Port Activities)

Along the entire distribution of Guiana dolphin, the presence of coastal and maritime infrastructure, including ports, windy farms and oil platforms, are generating an array of anthropogenic activities, such as vessel traffic, dredging, pile driving, underwater explosions, environmental accidents and others. These activities might generate a wide range of direct and indirect impacts on Guiana dolphin populations (Domit *et al.*, 2009; Van Belleghem and Domit, 2017). Port areas harbour high levels of noise and chemical pollution, for example, tin occurs in antifouling paints used in ship hulls and port structures and has been found in elevated concentrations in tissues of Guiana dolphin (Dorneles *et al.*, 2008). However, even the impacts of all those activities on Guiana dolphins remain underestimated, changes in behaviour and habitat use patterns were observed for the population in Babitonga Bay affected by a port development (Santa Catarina State) (Cremer, 2011; Cremer *et al.*, 2009). Moreover, ports and other coastal and maritime development infrastructure could be responsible for synergetic and additive impacts. The cumulative effects of stress can lead to immunodepression, leaving the Guiana dolphin populations susceptible to diseases and other threats (Domiciano *et al.*, 2016; Groch *et al.*, 2018; Van Bressem *et al.*, 2009).

In Colombia, an ongoing study on mapping the distribution of Guiana dolphins and port infrastructure shows an overlap for at least four of the five regions along the Colombian Caribbean where these dolphins appear to have resident populations. The overlap implies that there are probably negative interactions due to ship traffic and noise, affecting the dolphins in these areas, but no regular study is currently being conducted to determine the potential effects of this interaction on Guiana dolphins populations (Trujillo, pers. comm.).

In the Gulf of Venezuela (VEML), Espinoza-Rodríguez *et al.* (2019) found that the area where most of the sightings of Guiana dolphins occurred were overlapped with the navigation channel used to transport multiple products, including oil tankers and other boats. Observations carried out for years in this area shown that the presence and abundance of Guiana dolphins on this area are likely related to dredging frequency and intensity. Further research in needed to improve our understanding on this potential threat in that area (Barrios-Garrido *et al.*, 2015).

Climate Change

Empirical and modelled studies indicate climate change will likely result in abundance and distribution shifts for marine mammals (Becker *et al.*, 2019; Derville *et al.*, 2019; Hamilton *et al.*, 2019; MacLeod, 2009). However, even though modelled predictions for Guiana dolphins do not exist yet, a study is ongoing in Brazil (Rodrigo Tardin, pers. comm.).

Research priorities and recommendations

Bycatch is a critical conservation problem faced by the Guiana dolphin, however other potential threats are also important and reported. Limited studies on habitat degradation, fisheries interactions and exposure to threats have been carried out along the entire distribution area. Several knowledge gaps must still be filled to appraise better their potential for short- and long-term synergistic and cumulative effects to the Guiana dolphin. Fitness, health and population viability should be addressed for monitoring anthropogenic impacts on Guiana dolphin population. The literature review stresses out some critical gaps and priorities on threats assessment and mitigation.

- Develop spatial planning and threats exposure analysis, integrating layers of Guiana dolphins occurrence and anthropogenic activities, such as: (a) fisheries; (b) sources pf chemical and noise contamination; (c) coastal and maritime development activities associated with potential threats (e.g. ports; oil/gas; mining); and (d) tourism.
- Assess the effect of cumulative and synergistic impacts of anthropogenic activities on Guiana dolphins, especially in critical areas from south and southeast Brazil, but also in Maracaibo Lake and other areas exposed to high-level of contaminates.
- Improve stranding networks and sampling programs in order to collect samples of Guiana dolphins as well as biopsies for integrated broad ecological studies.
- Develop habitat preference modelling (HPM) to quantify and qualify the relationship between species presence or abundance and environmental processes (including natural and anthropogenic factors). This model enhances the ability to predict distributions and must facilitate dynamic management strategies.
- Investigate the potential effects of anthropogenic noise (including dredging, vessels traffic, seismic and other port activities) on behaviour, habitat use, acoustic parameters and health condition of Guiana dolphins.
- Increase the geographic extent of ecotoxicological investigations, increasing the effort on determination of highly toxic emerging compounds (e.g. persistent organic pollutants, POPs).
- Conduct studies on trophic transfer of pollutants in ecosystems used by Guiana dolphins, especially in critical areas from south and southeast Brazil, but also in Maracaibo Lake and other areas exposed to high-level of contaminates.
- Strength studies with contaminant-specific biomarker assays of exposure and effects.
- Perform pollutant level monitoring of most threatened populations a through remote biopsy sampling of skin and blubber.
- Implement protocols and initiatives of health assessment for Guiana dolphins, including: (1) metal, organic and emerging composts (nanoparticles, hormones, pharmaceuticals); (2) exposure biomarkers; and (3) the presence of diseases through extensive pathological assessments (histological, bacteriological, fungal and/or virologic).
- Implement government policies and regulation (e.g. through environmental licenses) to straight monitoring and mitigation actions, regarding noise and acoustic pollution effects.
- Strengthen recommendations for mitigating impacts related to the establishment of new port areas along the coast.
- Evaluate the effects of ports and other coastal development infrastructure in the health and habitat quality of entire Guiana dolphins distribution.
- Develop measures to improve tourism management, especially attention for dolphin watching activities and in engaging the stakeholders (public and private sector, academia, etc.).
- Define areas of great relevance for the conservation of the species aiming the definition of new protected areas or other measures to reduce the impacts on important habitats for Guiana dolphins.
- Develop management plans for protected areas of relevance to Guiana dolphins along with monitoring of potential benefits generated by economic and ecosystem services might be provided by the species.
- Enforce regulations where protected areas already exist.
- Strengthen international scientific and political cooperation among the countries that comprise Guiana dolphin occurrence, encouraging conservation strategies, edu-communication and outreach campaign.
- Further, despite the recognition of the unequivocal responsibility of local governments, coordinate international efforts and multiple governance strategies towards the reduction of threats/stressors sources, particularly fisheries interactions, pollution and emergent diseases.

In terms of assessing and mitigating Guiana dolphins bycatch the most import recommendations, include specific actions considered a priority by the IWC Bycatch Mitigation Initiative Workplan 2018-2020 (e.g. Objectives 2, 3 and 4 in the work plan).

- Conduct a bycatch assessment (e.g. rapid assessment as suggested by FAO; Lee *et al.*, 2020), particularly for small-scale fisheries, estimating fishing effort, existing bycatch data, and also the challenges and opportunities for co-management initiatives to mitigate fishing interaction.
- Identify specific fisheries where achievable bycatch mitigation strategies could be tested and introduced.
- Build capacity and methods to design alternative approaches to achieve effective bycatch mitigation and monitoring solutions, if possible, in partnership with fishing communities.
- Perform experiments to evaluate the effectiveness of methods already known for reducing bycatch, such as pingers.
- Engage communities participating in pilot and affiliated projects to mitigate fishing mortality.
- Develop a 'toolbox' of socio-economic incentive-based approaches for small-scale fisheries.
- Strengthen the maintenance of the beach monitoring project as a strategy to assess species mortality, including assessing the effectiveness of mitigation methods.

Management and conservation issues

To achieve the objectives of species conservation, monitoring populations is a central activity, which is generally expensive and depends on baseline knowledge of the species or species involved (Danielsen *et al.*, 2019; Marsh and Trenham, 2008). In general, management and conservation actions are a way to minimise, mitigate and regulate human activities that directly or indirectly affect valued sites and/or valued species, with the goal of sustaining existence of specific species or of biodiversity in general. Examples of these actions are the establishment of regulations on boat traffic and fisheries, elaboration of action plans, creation of protected areas, evaluation of species on the red lists, among others.

In the world, there are many effective example of management strategies and conservation actions to mitigate adverse effects on cetacean populations, but the initial planning, development and final effectiveness of these actions depends on how much is known about what is expected to protect (Heywood, 2006). In the case of Guiana dolphin the scarce of biological and ecological data limits the establishment of management and conservation actions throughout its distribution. Furthermore, the methods applied by different research groups are not standardised and, thus, the results are often incomparable.

Currently, Guiana dolphin is classified as Near Threatened by IUCN (Secchi *et al.*, 2018) and is listed in Appendix II of the Convention on the Conservation of Migratory Species and in the Convention on International Trade in Endangered Species (CITES). The few data available on population abundance and trends, the impact of threats, identification of the critical areas for the conservation of the species influences the creation and execution of conservation actions along its distribution.

Nicaragua

The species has been evaluated and classified as 'Data Deficient' according to the national red list, following IUCN criteria.

Honduras

No data available.

Costa Rica

No data available.

Panamá

No data available.

Colombia

There is 'The Action Plan for South American river dolphins 2010-2020'. In 2006, the Red Book of Threatened Mammals of Colombia was published, where Guiana dolphin was included as 'Vulnerable' (Vu) (Trujillo *et al.*, 2006). A diagnosis of aquatic mammals in Colombia was published presenting all the knowledge about the species in each region of the country (Trujillo *et al.*, 2013). In addition, a work on the ecology of Guiana dolphins resulted in the creation of area with special management for the species in the gulf of Morrosquillo (Dussán-Duque, 2013). In 2014, the Management Plan for aquatic mammals in Colombia was published (Trujillo *et al.*, 2014) and endorsed by the Ministry of Environment. In addition to the strategic lines of research, management, education and communications, specific recommendations were made for the *ex situ* management issue, given that Colombia is one of the countries in which specimens of Guiana dolphin i have been held in aquariums for long periods. Likewise, in 2017 the Plan for the Conservation and Management of Aquatic Mammals (cetaceans, manatees and otters) of the department of Magdalena (Trujillo *et al.*, 2017) was published, where one of the species of greatest interest is Guiana dolphin.

Venezuela

In 2017, the Guiana dolphin was considered in the action plan elaborated with the purpose of systematising and orienting the management and conservation actions of aquatic mammals (Plan de acción para la conservación de los mamíferos acuáticos de Venezuela: delfines de agua dulce, nutrias y manatíes 2017-27). It is important to highlight that in 1992 the

'Cienagas de Juan Manuel, Aguas Blancas y Aguas Negras' National Park was created, which covers 150km² of water in the south of Lake Maracaibo. Although it was not created for the specific protection of this species, it is an important area of resting and feeding for Guiana dolphins. Currently, some progress has been made in Lake Maracaibo, in the southern region, population estimates, and threat identification were made, but it deserves more effort to meet the proposed goals. In addition, the species has been evaluated in the national red list of endangered species following IUCN criteria.

Guyana
The species has been classified as 'Endangered' according to the National Red List, following IUCN criteria.

Suriname
No data available.

French Guiana
The species has been evaluated and classified as 'Endangered' according to the National Red List following IUCN criteria.

Brazil
Accounting for the Conservation Units with a considerable marine portion, there are 92 protected areas along the Guiana dolphin distribution in the country. These Conservation Units are divided into eight different protection categories considering the Brazilian System of National Conservation Units. Also, there are areas within the categories Ia, II, III, IV and V established by the IUCN Protected Areas Categories System, however none of the category IV (Habitat/Species Management Area) have been decreed considering the species. Of those 92 areas throughout the distribution of the species in Brazil, 32 correspond to federal areas, while 50 and 11 correspond to state and municipal areas, respectively. Although it has many protected areas, only a total of 40 areas have management plans, and less than a quarter of them, mentioned the species in its plans.

The species is listed as Near Threatened in the IUCN Red List (Secchi *et al.*, 2018) and as Vulnerable in the Brazilian National Biodiversity Red list of Threatened Species, which also used the IUCN criterion (Directive MMA 444/2014). The species has, also, been considered in different federal government conservation tools such as: National Conservation Plan for Marine Cetaceans, National Action Plan for the Conservation of Threatened Species and of Socioeconomic Importance of the Mangrove Ecosystem (Directive ICMBio 500/2019), Impact Reduction Plan of oil and gas exploration, Impact Reduction Plan of mining and also the species has been taken into account in the ordinance which aims to establish the Marine Priority Areas for Brazilian Coast (Decree MMA 5092-2004, Directive MMA 9/2007).

In some Brazilian states, there has been created specific tools for the conservation of the species. In Santa Catarina State the species has been classified in the 'endangered - EN' category in the Official List of Endangered Species of Fauna (Resolution CONSEMA 02/2011). The Conservation Plan for Marine Tetrapods in Paraná was elaborated to ensure the maintenance of Guiana dolphin populations in the state and preserve their natural habitat. Also in Paraná state, the species has been cited in the Paraná Book of Fauna in Extinction. In São Paulo State, the species has been classified as 'Near Threatened' under the Endangered and Probably Endangered Species of Wild Fauna list of the state (Decree 63.8532/2018). In Rio de Janeiro state the species is not listed into the Threatened Fauna Species list (Decree 15.793/1997), however more recently the species has been mentioned as one of the top 10 priorities species for conservation in this state and a public awareness campaign has begun (Defending Endangered Species Embrace These Ten). In Sepetiba Bay, municipality of Mangaratiba, also in Rio de Janeiro state, the Law 940/2014 established the creation of the Área de Proteção Ambiental Marinha Boto cinza (APA Marinha Boto Cinza), however, this area is not part of the National System of Conservation Units mentioned above. The species is list as 'Vulnerable' in the Bahia State threatened species list.

Regulations, legislations, a list of conservation units and other important information are presented in Annexes F, G and H.

RECOMMENDATIONS

Recently, the IUCN category for the species changed to Near Threatened, which implies that the existing data are not sufficient to qualify to one of the threat categories (Secchi *et al.*, 2018). Despite of the few known of population parameters (i.e. abundance estimates, trends and mortality levels) in most of its distribution, this coastal species faces numerous threats along its habitat. The Guiana dolphin inhabits a diverse number of habitats, however, the knowledge about the species is not homogeneous throughout its distribution. Therefore, one of the research priorities should identify areas of higher concentrations in places where there is no information and use standardised methodologies to estimate population parameters and mortality rates in the main areas. Notwithstanding and although the species is globally considered as Neat Threatened, there are some countries along its distribution that considered it in another category (e.g. Brazil, Colombia, Venezuela=Vulnerable, Guyana=Endangered), bear out the importance of regional as well as globally assessments.

Although the existence of a large system of Marine Protected Areas along the species distribution (e.g. Brazil), it has been shown that these areas design are not necessarily protecting the most vulnerable populations (e.g. ESEC Tamoios in Brazil; Tardin, 2020). Thus, new studies should focus in the understanding of human activities and its interaction with the species, to allocate better Conservation Units along the range of the species. Moreover, and to support the previous, it should be highlight that although some regions show many conservation units (e.g. Rio de Janeiro state *n*=19), there are a lack of Conservation Units as well as management actions in areas with a high human pressure (Guanabara Bay) which certainly could take the population to extinction in a short time (Azevedo *et al.*, 2017).

5. EXPERT ELICITATION: PERCEPTIONS ON CURRENT KNOWLEDGE AND RESEARCH PRIORITIES TO ASSESS AND IMPROVE THE CONSERVATION STATUS OF GUIANA DOLPHINS

To assess the current knowledge and perceived research priorities to assess and improve the conservation status of the Guiana dolphins, an expert elicitation was conducted in 2019, through an online questionnaire (Google Forms; see Annex I). Experts were identified through a web-based survey of the literature (including grey literature) and consisted of both senior and early-career scientists with knowledge on Guiana dolphins and its habitat conservation. These experts were contacted by email and were provided with information on the aims and objectives of the assessment. The survey was conducted online using the Google Form platform, in Portuguese and Spanish. The survey was available for five weeks, and the selected experts received up to two reminders by e-mail. A correspondence e-mail address was provided to be used to solve any doubts.

Experts filled an online survey of 19 questions (open and multiple-choice questions), consisting of five parts: (1) characterising the experts in terms of the study area, institution, experience time and themes; (2) perceived conservation status of Guiana dolphins and their habitat; and research priorities to improve the conservation status assessment; (3) perceived threats to the Guiana dolphin populations and research priorities to reduce these threats; (4) the current knowledge gaps on Guiana dolphin populations; (5) priorities for management actions to address the conservation of the species.

The 35 experts that contributed to the survey have been working with Guiana dolphins in seven different countries which included Nicaragua (3%), Panama (3%), Costa Rica (5%), Venezuela (10%), Colombia (8%), French Guinea (3%), and Brazil [southern (28%), south-eastern (33%) and north-eastern (10%) Brazil]; the respondents could choose more than one location. Most respondents represent Universities (73%), some of them are working for NGOs (15%) or in Scientific institutions (6%), and a few work as independent consultants. About 47% have more than 12 years' experience studying dolphin ecology and conservation issues (21% of them >20 years), and only 6% are early-career scientists (≤3yrs). Concerning scientific topics, a total of 39% of the respondents have experience with population parameters (e.g. demography), 29% with impact assessment, 14% with biological parameters, 11% with conservation policies, and only 7% with population structure analysis. The respondents have a wide background experience with impact assessment on Guiana dolphins, highlighted by the similar percentage of experience in assessing impacts from bycatch (19%), noise pollution (18%), coastal infrastructure development (16%), chemical pollution (14%), marine/vessel traffic (14%), and also 'multiple-impacts' (19%); the respondents could indicate more than one impact.

Based on the experience and perception of the respondents, the most threatened Guiana dolphins populations are the ones from Guanabara Bay (*n*=13) and Sepetiba Bay (*n*=7), both in the state of Rio de Janeiro in Brazil, followed by the population in the Paranaguá Estuarine Complex (*n*=5) in the state of Paraná in Brazil and in the Maracaibo Lake in Venezuela (*n*=4). However, another 18 areas were cited, covering almost the entire Guiana dolphin distribution. In general, the respondents suggest that all populations occurring in areas with ports and industrial activities are the most impacted ones, thus being conservation priorities areas due to the risk for the populations.

To obtain insights on which research lines and topics should be prioritised now, and during the next five years, the respondents were asked open-ended questions on current knowledge gaps, the conservation status of the species and how status assessment can be improved, current threats and how the risks for the species can be mitigated. Word clouds of the responses of each open-ended question (see Fig.7) reveal the most common topics that emerged within the answers of the respondents.

Considering the question 'What are research priorities to evaluate the conservation status of the species?' the majority of the respondents (88%, see Fig.8) indicated that research on population dynamics should be prioritised both now and during the coming 5 years. These studies include: (i) abundance and population size estimates; (ii) population structure over time with long term monitoring and estimates of both population and biological parameters, such as reproduction, growth and mortality rates (e.g. supporting Population Viability Analysis); (iii) genetic flow and connectivity among the populations; and (iv) population ecology and demographic analyses, considering intrapopulation variations such as residence patterns, behaviour, habitat use, social structure and organisation.

More than half of the respondents pointed out that both now and during the coming five years, the assessment of anthropogenic impacts to Guiana dolphins is crucial to evaluate its' conservation status (see Fig.8). The anthropogenic activities that raised most concerns in the light of the conservation status are fisheries, port activities and tourism, which generate bycatch, pollution, vessel traffic, acoustic pollution and habitat degradation. The cumulative and synergic impacts, including climate change, should be spatially evaluated along the entire distribution of Guiana dolphin.

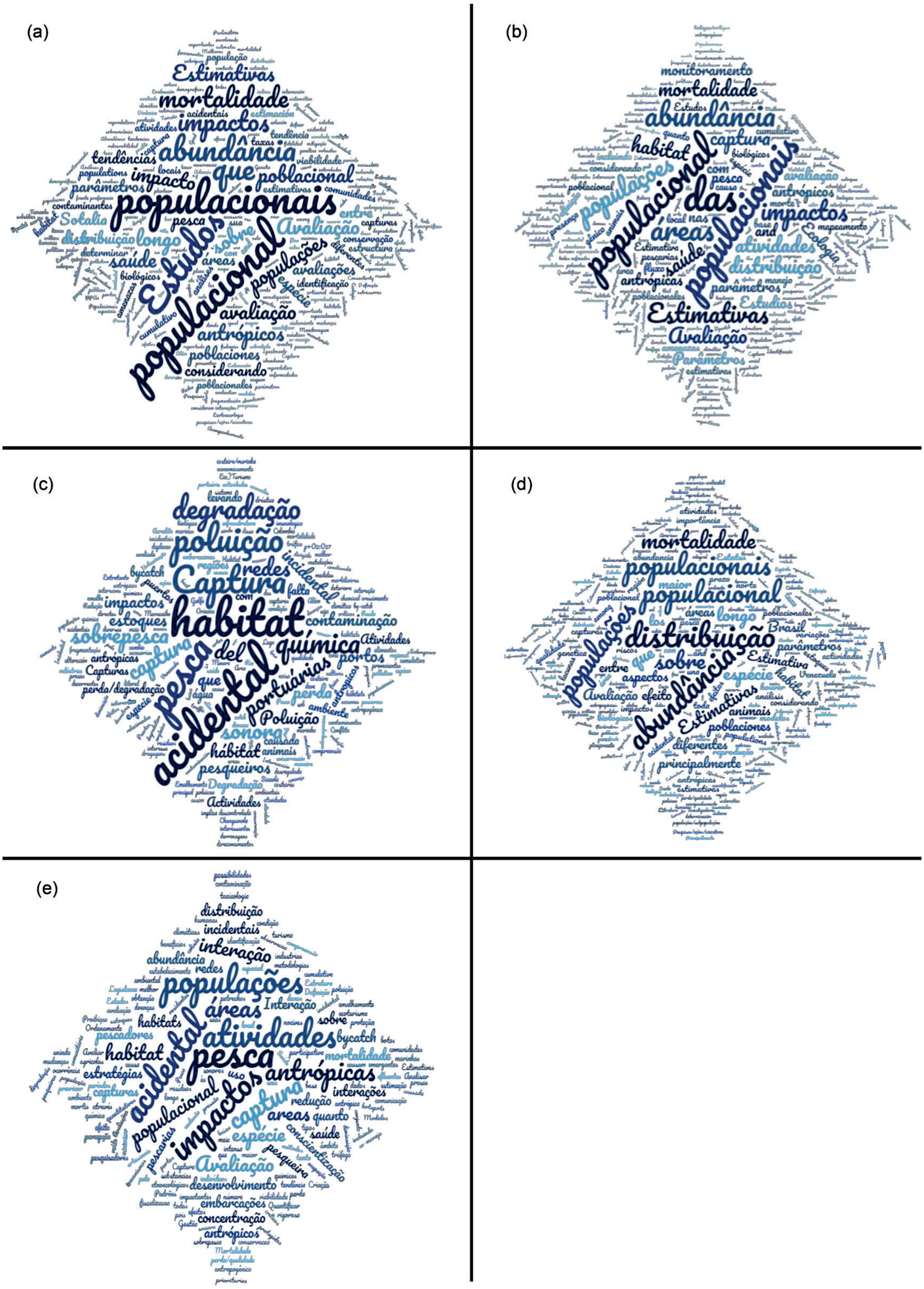

Fig. 7. Word clouds of the answers of the open questions:
(a) What are research priorities to evaluate the conservation status of the species?
(b) Which research lines should be prioritised over the next 5 years, to evaluate the conservation status of the species?
(c) What are the main threats to the conservation of *S. guianensis*?
(d) What are the main knowledge gaps about this species, considering the priorities to evaluate extinction risk?
(e) Which research lines should be prioritised over the next 5 years, to reduce the threats to this species?]

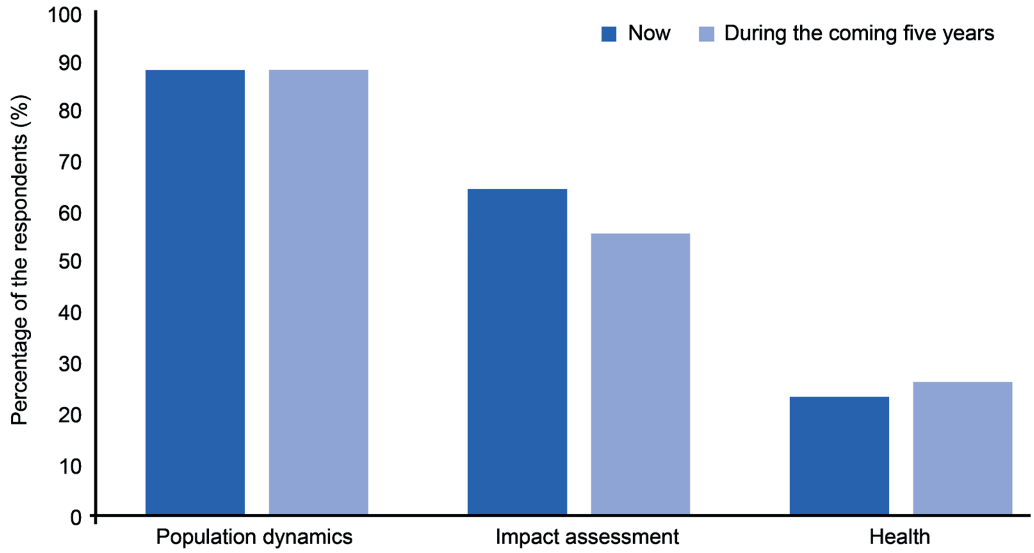

Fig. 8. The respondents were asked the open-ended question 'What are research priorities to evaluate the conservation status of the *S. guianensis*?' twice, once investigating research priorities right now, and once investigating research priorities to evaluate the conservation status during the next five years. The answers were categorised in three categories: those which mentioned research on: (i) population dynamics; (ii) impact assessment; and (iii) health.

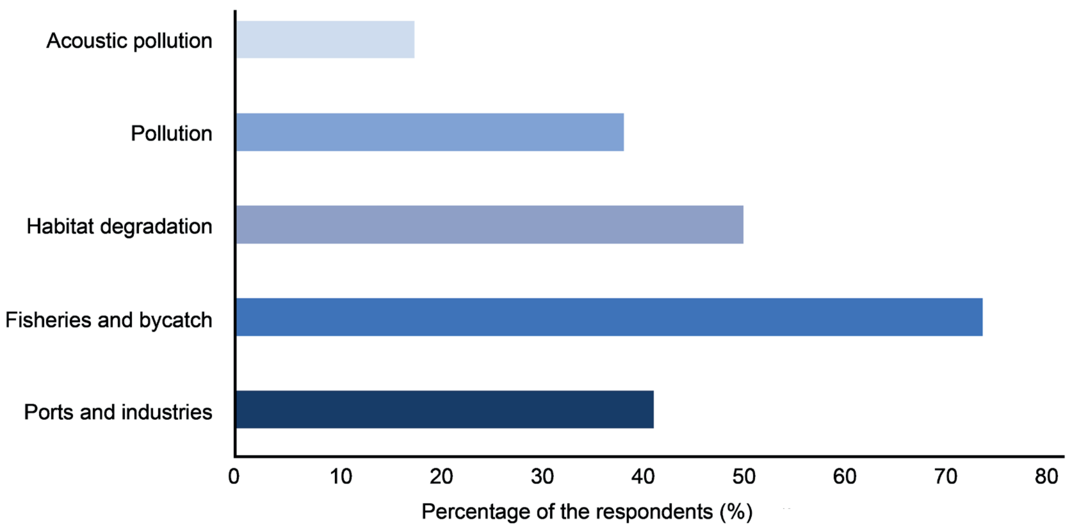

Fig. 9. The respondents were asked the open-ended question 'What are the current main threats to the conservation of *S. guianensis*?' The answers were categorised in five not mutually exclusive categories: 'ports and industries', 'fisheries and bycatch', 'habitat degradation', 'pollution and contamination' and 'acoustic pollution'.

A quarter of the respondents mentioned the importance of health assessment of population and individuals, as a priority to evaluate the conservation status of the species (for now and the next 5 years) (see Fig.8). This includes ecotoxicology and contaminants (such as trace elements and organic persistence) analysis, but also the evaluation of causes of mortalities, particularly considering the significant mortality event in Rio de Janeiro in 2018, caused by morbillivirus (Groch *et al.*, 2018). Other research priorities that were mentioned to improve the evaluation of the conservation status of the species are outreach and stakeholder involvement (with the fisheries, port and tourism sector) and initiatives related to public policies and co-management.

When asked 'What are the current main threats to the conservation of *S. guianensis*?', most of the respondents (73.5%; see Fig.9) indicate fisheries interactions and consequently bycatch as the main threat to Guiana dolphins. Secondly, habitat degradation and loss are mentioned by half of the respondents, which might be caused by pollution/contamination (mentioned by 38% of the respondents in Fig.9). Pollution (chemical and acoustic) might be caused by the presence of ports, industries or other coastal infrastructure, which was mentioned by 41% of the respondents as important threats (Fig.9).

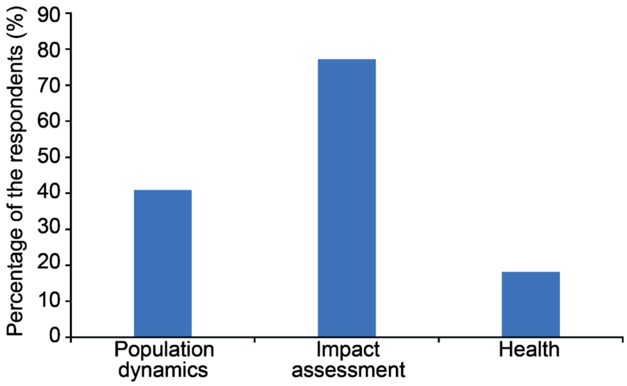

Fig. 10. The respondents were asked the open-ended question 'Which research lines should be prioritised over the next 5 years, to reduce the threats to this species?' The answers were categorised in nine not mutually exclusive categories: 'stakeholder involvement and management', 'health', 'impact assessment, 'population dynamics', 'ports and industries', 'fisheries and bycatch', 'habitat degradation', 'pollution and contamination' and 'acoustic pollution'.

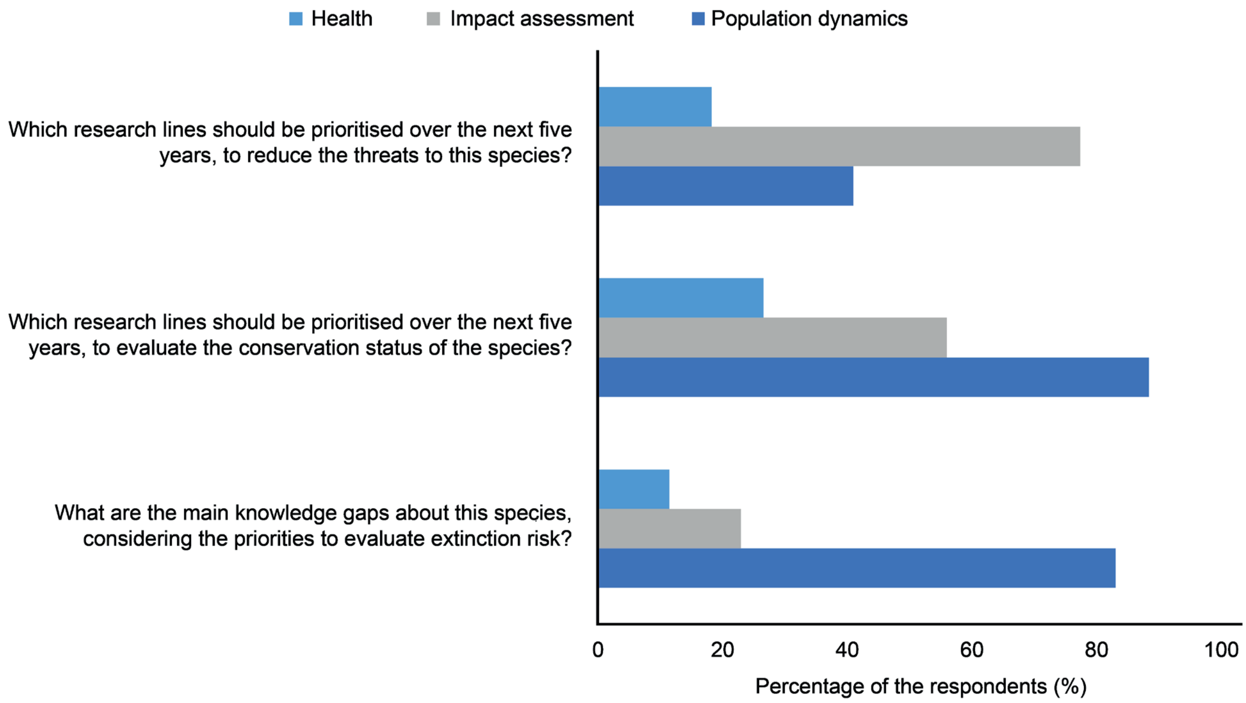

Fig. 11. The responses to the following three open-ended questions 'What are the main knowledge gaps about this species, considering the priorities to evaluate extinction risk?', 'Which research lines should be prioritised over the next 5 years, to reduce the threats to this species?', 'Which research lines should be prioritised over the next 5 years, to evaluate the conservation status of the species?' were categorised in 9 not mutually exclusive categories: 'stakeholder involvement and management', 'health', 'impact assessment', 'population dynamics', 'ports and industries', 'fisheries and bycatch', 'habitat degradation', 'pollution and contamination' and 'acoustic pollution'.

The respondents were also queried about 'Which research lines should be prioritised over the next 5 years, to reduce the threats to this species?'. Most of the respondents (77%; see Fig.10) mentioned impact assessment as a priority, especially considering fisheries and bycatch (63.6%), for example, mortality rate estimates and research on strategies to reduce bycatch considering different types of fishing gear. A significant part (40.9%) of the respondents pointed out that accurate population dynamic studies are crucial to reduce the threats to Guiana dolphins along the species distribution. Over a quarter (31.8%) of the respondents highlighted the importance to work on stakeholder involvement in research and management, especially co-management with artisanal fisheries communities and ports and industries. Lastly, the development of management and mitigation actions and policies, such as protection of critical habitats, also emerged as a priority to reduce the threats to Guiana dolphins during the coming 5 years.

The respondents were also asked 'What are the main knowledge gaps about this species, considering the priorities to evaluate extinction risk?'. There was a very high level of consensus among the respondents (82.9%; Fig.11) that there exists a significant lack of knowledge on population dynamics, especially population parameters such as growth, mortality and reproductive rates, but also distribution, abundance and connectivity. Moreover, other knowledge gaps that were pointed out are the cumulative and synergistic impacts caused by fisheries, ports, industries and tourism; and in what different ways degraded habitats might affect the populations of Guiana dolphins. The knowledge gap on the population in Maracaibo lake in Venezuela, and the connectivity among populations of Venezuela, Colombia and Central American countries were also mentioned as important topics to be addressed during the next years.

Throughout all five of the open-questions, respondents reinforced the importance of outreach and stakeholder involvement, and initiatives related to public policies and co-management. The results highlight that the experts consider management actions and conservation policies as a crucial part of the efforts to support species conservation. A total of 47% of the respondents have been involved in some level (regional, national, international) in action plans for Guiana dolphin conservation; however, is important to highlight that another 47% of the respondents have never been involved in conservation policies or in developing tools or plans focusing on the conservation of Guiana dolphins.

The integrated analysis of this online questionnaire provided insights in the conservation status of Guiana dolphins, stressing that future research on both short and long term should be focused on population dynamics and impact assessment. These efforts will not only improve the accuracy of the conservation status, but they will also provide crucial baseline information to reduce the impacts caused by anthropogenic activities, particularly in fisheries, ports and industries. It is also essential to reach out and involve stakeholders, such as artisanal fishermen and port management, in research, management and public policies, in order to improve the conservation context of Guiana dolphins.

6. CONCLUSION

Almost all marine mammal species have been reported to face at least one threat and many populations have experienced significant declines due to cumulative impacts of anthropogenic activities. Bycatch in artisanal gillnets is one of the most important concerns for the conservation of most Guiana dolphins populations (Di Beneditto, 2003; Monteiro-Neto *et al.*, 2000; Cremer *et al.*, 2018). However, there is critical information on the harmful effects of noise pollution, high levels of contaminant loads and emerging diseases (MeCV, herpesvirus, skin diseases of unknown aetiology) affecting diverse populations throughout its range (Barrios-Garrido *et al.*, 2016; Bittencourt *et al.*, 2014; 2017; Cremer *et al.*, 2009; Dorneles *et al.*, 2010; Espinoza-Rodríguez *et al.*, 2019; Filla and Monteiro-Filho, 2009; Groch *et al.*, 2018; Kunito *et al.*, 2004; Lailson-Brito *et al.*, 2010; 2012). Conversely, there is a striking lack of data on population and biological parameters for most areas of the species' distribution range.

Combined effects of the dense human-population on coastal areas, fisheries, ports, agriculture and industrial activities, and emergent diseases are rapidly driving Guiana dolphins to many uncertainties regarding its future (Azevedo *et al.*, 2017; Cremer *et al.*, 2018). Also, some of the new threats for this species are of great concern, particularly disease by exposure to viruses and other etiological pathogens, and the uses of their meat for human consumption in Maracaibo Lake or also used as fish bait in northern Brazil (Cunha *et al.*, In prep; Flores and Da Silva, 2009; Briceño, pers. comm.).

Guiana dolphins are considered 'Vulnerable' in Brazil, Colombia and Venezuela, and there is an urgent need for conservation action for this species. Management units (MU) of *Guiana* dolphins that occur in areas with high human population densities are exposed to multiple and cumulative impacts that affect their conservation and resilience. In this context, the management units BRSE1, BRSE2, BRS/SE in Brazil, and the ones placed on Maracaibo lake MU (Venezuela), and stand out, in particular the resident populations of Guanabara and Sepetiba Bays (both in Rio de Janeiro State), Paranaguá and Babitonga (Paraná and Santa Catarina State). Guanabara Bay (RJ) is a region with a high degree of environmental degradation, where Guiana dolphin population has shown a continuous decline over the years (Azevedo *et al.*, 2017).

7. GENERAL INFORMATION

The Workshop steering group was composed by Camila Domit (CEM/UFPR, Brazil), Fábia Luna (ICMBIO/CMA, Brazil), Adriana Miranda (ICMBIO/CMA, Brazil) , Juan Pablo Torres-Flores (ICMBIO/CMA, Brazil), Susana Caballero (Universidad de los Andes, Colombia), and also Alexandre Zerbini (NOAA, USA) and Lindsay Porter (IWC, small cetacean sub-committee).

Point of contact (POCs) by priorities topics

Management and conservation

Yurasi Briceño Reina (Instituto Venezolano de Investigaciones Científicas/IVIC, Centro de Ecologia, Venezuela).

Population structure

Susana Caballero (Universidad de los Andes, Colombia)
Haydée Cunha (MAQUA/UERJ, Brazil).

Abundance and trends

Alexandre Azevedo (MAQUA/UERJ, Brazil).

Biological parameters
Marta Cremer (UNIVILLE, Brazil).

Threats
Tatiana Bisi (MAQUA/UERJ, Brazil)
José Lailson Brito Junior (MAQUA/UERJ, Brazil).

8. REFERENCES

Legal Framework Cited

Brazil 2004. Decreto MMA no 5.092, de 21 de maio de 2004. Regras e identificação de áreas prioritárias para conservação. [Available at: *http://www.planalto.gov.br/ccivil_03/_Ato2004-2006/2004/Decreto/D5092.htm*].

Portaria MMA no 9, de 23 de janeiro de 2007. Reconhece como áreas prioritárias, utilização sustentável e repartição de benefícios da biodiversidade brasileira. [Available at: *https://www.icmbio.gov.br/cepsul/images/stories/legislacao/Portaria/2007/p_mma_09_2007_areaprioritariaparabiodiversidade_revgd_p_126_2004.pdf*].

Portaria MMA no 444, de 17 de dezembro de 2014. Reconhecer como espécies da fauna brasileira ameaçadas de extinção aquelas constantes da 'Lista Nacional Oficial de Espécies da Fauna Ameaçadas de Extinção'. [Available at: *https://www.icmbio.gov.br/portal/images/stories/docs-plano-de-acao/00-saiba-mais/04_-_PORTARIA_MMA_Nº_444_DE_17_DE_DEZ_DE_2014.pdf*].

Instituto Chico Mendes de Conservação da Biodiversidade – ICMBio. Portaria ICMBio nº 91, de 27 de agosto de 2010. Plano Nacional de Ação para Conservação das Espécies Ameaçadas e de Importância Socioeconômica do Ecossistema Manguezal - PAN Manguezal. [Available at: *https://www.icmbio.gov.br/portal/images/stories/docs-pan/pan-manguezal/1-ciclo/pan-manguezal-portaria-aprova-cao-e-gat.pdf*].

Prefeitura da Cidade do Rio de Janeiro. Decreto no 15.793, de 4 de junho de 1997. Criação do Programa Rio- Diversidade - Programa de Conservação das Espécies Raras e Ameaçadas de Extinção. [Available at: *https://leismunicipais.com.br/a/rj/r/rio-de-janeiro/decre-to/1997/1580/15793/lei-organica-rio-de-janeiro-rj*].

Prefeitura do Município de Mangaratiba. Lei no 940, de 8 de outubro de 2014. Cria a área de proteção ambiental marinha Boto Cinza. [Available at: *http://www.mangaratiba.rj.gov.br/portal/arquivos/atos-oficiais/leis-2014/pmm-lei-9402014.pdf*].

Conselho Estadual do Meio Ambiente de Santa Catarina – CONSEMA. Resolução no 2, de 6 se dezembro de 2011. [Available at: *http://www.fatma.sc.gov.br/upload/Fauna/resolucao_fauna__002_11_fauna.pdf*].

Governo do Estado de São Paulo. Decreto 63.853, de novembro de 2018. Declara as espécies da fauna silvestre no Estado de São Paulo regionalmente extintas, as ameaçadas de extinção, as quase ameaçadas e as com dados insuficientes para avaliação, e dá providências correlatas. [Available at: *https://www.al.sp.gov.br/repositorio/legislacao/decreto/2018/decreto-63853-27.11.2018.html*].

Trujillo, F., Diazgranados, M. C., Garcia, C. and Dussan, S. 2006. *Sotalia guianensis*. En: Libro Rojo de los Mamíferos de Colombia. Bogotá: Conservación Internacional, Ministerio de Medio Ambiente y Desarrollo Territorial, pp. 273-277.

References

Alburquerque, N.D.S. and Souto, A.D.S. 2013. The underwater noise from motor boats can potentially mask the whistle sound of estuarine dolphins (*Sotalia guianensis*). *Ethnobiology and Conservation* 2. [Available at: *https://doi.org/10.15451/ec2013-8-2.5-1-15*].

Alonso, M.B., Marigo, J., Bertozzi, C.P., Santos, M.C.O., Taniguchi, S. and Montone, R.C. 2010. Occurrence of chlorinated pesticides and polychlorinated biphenyls (PCBs) in Guiana dolphins (*Sotalia guianensis*) from Ubatuba and Baixada Santista, São Paulo, Brazil. *Latin Am. J. Aquat. Mamm.* 8: 123-30.

Araújo, J.P. 2008. Influência das condições ambientais sobre o comportamento do boto-cinza (*Sotalia guianensis*) e sua interação com as atividades antrópicas em Pernambuco. Thesis (Doutorado em Oceanografia biológica), Universidade de Pernambuco, Recife. 74pp.

Araujo, J.P., Souto, A., Geise, L. and Araujo, M.E. 2008. The behavior of *Sotalia guianensis* (Van Bénéden) in Pernambuco coastal waters, Brazil, and a further analysis of its reaction to boat traffic. *Revista Brasileira de Zoologia* 25 (1): 1-9.

Arruda Ramos, R.M., Madeira di Beneditto, A.P. and Wille Lima, N.R. 2000. Growth parameters of *Pontoporia blainvillei* and *Sotalia fluviatilis* (Cetacea) in northern Rio de Janeiro, Brazil. *Aquat. Mamm.* 26(1): 65-75.

Attademo, F.L.N. 2007. Caracteriazção da pesca artesanale e interação com mamíferos marinhos na região da Costa Branca do Rio Grande do Norte. Dissertação (Mestrado em Meio Ambiente e Desenvolvimento), Universidade do Estado do Rio Grande do Norte (UERN), Mossoró. 45pp.

Azevedo, A.F., Carvalho, R.R., Kajin, M., Van Sluys, M., Bisi, T.L. and Cunha, H.A. 2017. The first confirmed decline of a delphinid population from Brazilian waters: 2000-2015 abundance of *Sotalia guianensis* in Guanabara Bay, South-eastern Brazil. *Ecological Indicators* 79: 1-10. [Available at: *https://doi.org/10.1016/j.ecolind.2017.03.045*].

Avila, I.C., Kaschner, K. and Dormann, C.F. 2018. Current global risks to marine mammals: taking stock of the threats. *Biol. Cons.* 221: 44-58. [Available at: *https://doi.org/10.1016/biocon.2018.02.021*].

Azevedo, A.F., Lailson-Brito, J., Dorneles, P.R., Sluys, M., van, C., H.A. and Fragoso, A.B.L. 2009. Human-induced injuries to marine tucuxis (*Sotalia guianensis*) (Cetacea: Delphinidae) in Brazil. *Mar. Biodivers. Rec.* 2. [Available at: *https://doi.org/10.1017/S1755267208000262*].

Bandoli, J.G. and De Oliviera, C.B. 1977. Toxoplasmose em *Sotalia guianensis* (Van Beneden, 1863), Cetacea - Delphinidae. *Folha Médica* 75: 459-68.

Baptista, G., Kehrig, H.A., Di Beneditto, A.P.M., Hauser-Davis, R.E., Almeida, M.G., Rezende, C.E., Siciliano, S., De Moura, J.F. and Moreira, I. 2016. Mercury, selenium and stable isotopes in four small cetaceans from the Southeastern Brazilian coast: Influence of feeding strategy. *Environ. Poll.* 218: 1298-307.

Barrios-Garrido, H., Boher-Bentti, S., De Turris-Morales, K., Espinoza-Rodriguez, N., Ferrer-Pérez, A., Herrera-Trujillo, O.L. and Bolaños-Jiménez, J. 2015. Tonina costera, Sotalia guianensis. *In*: Rodriguez, J.P., Garcia-Rawlins, A. and Rojas-Suarez, F. (eds). *Libro Rojo de la Fauna Venezolana*. Provita, Fundacion Empresas Polar, Caracas, Venezuela. [Available from: *http://wikieva.org.ve/index.php/Sotalia_guianensis*].

Barrios-Garrido, H.A., De Turris-Morales, K., Delgado-Ortega, G., Nash, C.M. and Espinoza-Rodriguez, N. 2016. Acoustic parameters of Guiana Dolphin (*Sotalia guianensis*) whistles in the southern Gulf of Venezuela. *Aquat. Mamm.* 42(2): 127-36. [Available at: *https://doi.org/10.1578/AM.42.2.2016.127*].

Becker, E.A., Forney, K.A., Redfern, J.V., Barlow, J., Jacox, M.G., Roberts, J.J. and Palacios, D.M. 2019. Predicting cetacean abundance and distribution in a changing climate. *Divers. Distrib.* 25(4): 626-43.

Bisi, T., Lepoint, G., Azevedo, A., Dorneles, P., Flach, L., Das, K., Malm, O. and Lailson-Brito, J. 2012. Trophic relationships and mercury biomagnification in Brazilian tropical coastal food webs. *Ecol. Indicators* 18: 291-302.

Bisi, T.L. 2001. Estimativa de densidade populacional do boto-cinza *Sotalia guianensis* (Cetacea, Delphinidae) na regiao Estuarina Lagunar de Cananéia, SP. Bachelor Thesis, Universidade Estadual Paulista Júlio de Mesquita Filho, Rio Claro, Brazil. 35pp.

Bittencourt, L., Carvalho, R.R., Lailson-Brito, J. and Azevedo, A.F. 2014. Underwater noise pollution in a coastal tropical environment. *Mar. Poll. Bull.* 83: 331-36.

Bittencourt, L., Lima, I.M.S., Andrade, L.G., Carvalho, R.R., Bisi, T.L., Lailson-Brito, J. and Azevedo, A.F. 2017. Underwater noise in an impacted environment can affect Guiana dolphin communication. *Mar. Poll. Bull.* 114: 1130-34.

Borobia, M., Siciliano, S., Lodi, L. and Hock, W. 1991. On the distribution of South American dolphins, *Sotalia fluviatilis*. *Can. J. Zool./Revue Canadienne de Zoologie* 69: 1025-39.

Bössenecker. 1978. Capture and care of *Sotalia guianensis*. *J. Aquat. Mamm.* 691: 13-17.

Briceño, Y., Sánchez, L., Herrera, O., Ferrer, A., Bolaños, J., Ramírez, S., Villaroel, A. and González, M. 2017. Chapter: *Tonina costera*, *Sotalia guianensis* (Van Bénedén, 1864). Plan de acción para la conservación de los mamíferos acuáticos de Venezuela: delfines de agua dulce, nutrias y manatíes.

Buckland, S.T., Anderson, D.R., Burnham, K.P., Laake, J.L., Borchers, D.L. and Thomas, L. 2004. *Advanced Distance Sampling*. Oxford University Press, New York, USA. 416pp.

Caballero, S., Hollatz, C., Rodríguez, S., Trujillo, F. and Baker, C.S. 2018. Population structure of riverine and coastal dolphins *Sotalia fluviatilis* and *Sotalia guianensis:* patterns of nuclear and mitochondrial diversity and implications for conservation. *J. Heredity:* 757-770.

Caballero, S., Trujillo, F., Vianna, J.A., Barrios-Garrido, H., Montiel, M.G., Beltrán-Pedreros, S., Marmontel, M., Santos, C.O.M., Rossi-Santos, M., Santos, F.R. and Baker, C.S. 2010. Mitochondrial DNA diversity, differentiation and phylogeography of the South American riverine and coastal dolphins *Sotalia fluviatilis* and *Sotalia guianensis*. *Latin Am. J. Aquat. Mamm.* 8: 69-79.

Cantor, M.M., Wedekin, L.L., Daura-Jorge, F.G., Rossi-Santos, M.R. and Simões-Lopes, P.C. 2012. Assessing population parameters and trends of Guiana dolphins (*Sotalia guianensis*): an eight-year mark-recapture study. *Mar. Mamm. Sci.* 28: 63-83. [Available at: *https://doi.org/10.1111/j.1748-7692.2010.00456.x*].

Carrasquero, J. 2010. Estimación de la densidad poblacional del delfín estuarino (*Sotalia guianensis*) en al sur del Golfo de Venezuela, estado zulia [Population density estimates Guiana dolphin (*Sotalia guianensis*) in southern Gulf of Venezuela] (Tesis de Licenciatura), Universidad del Zulia, Maracaibo, Zulia, Venezuela.

Carvalho, A.P.M., Ywasaki, J., Azevedo, C.T., Campos, A.S., Queiroz, F.F., Pontes, L.A.E., Barbosa, L.A. and Silveira, L.S. 2012. Crescimento e desenvolvimento do boto-cinza (*Sotalia guianensis*) do litoral do Espírito Santo. *Arquivo Brasileiro de Medicina Veterinária e Zootecnia* 64(1): 205-08.

Carvalho, C.E.V., Di Beneditto, A.P.M., Souza, C.M.M., Ramos, R.M.A. and Rezende, C.E. 2008. Heavy metal distribution in two cetaceans species from Rio de Janeiro State, south-eastern Brazil. *J. Mar. Biol. Assoc. UK* 88(6): 1117-20.

Cepile, A.R. 2008. Estimativa populacional por marcąção-recaptura e padŗão de atividade do boto-cinza, *Sotalia guianensis* (Cetacean, Delphindae) em Regéncia, ES. Dissertação (Programa de Pós-graduação em Comportamento e Biologia Animal), Universidade Federal de Juiz de Fora, Minas Gerais.

Cremer, M.J. 2007. Ecologia a conservação de populaçoes simpátricas de pequenos cetáceos em ambiente estuarino no sul do Brasil. Ph.D. Thesis, Universidade Federal do Paraná, Curitiba, Brazil. 232pp.

Cremer, M.J. 2011. Distribution and status of the Guiana dolphin *Sotalia guianensis* (Cetacea, Delphinidae) population in Babitonga Bay, southern Brazil. *Zoological Studies* 50(3): 327-37.

Cremer, M.J., Simões-Lopes, P.C. and Pires, J.S.R. 2009. Occupation pattern of a harbor inlet by the estuarine dolphin, *Sotalia guianensis* (Van Bénéden, 1864) (Cetacea, Delphinidae). *Brazilian Archives of Biology and Technology* 52(3): 765-74.

Cremer, M., Holz, A., Sartori, C.M., Schulze, B., Paitach, R.L. and Simões-Lopes. 2018. Behavior and ecology of endangered species living together: long term monitoring of resident sympatric dolphin populations. Pp. 477-508. In: M.R. Rossi-Santos and C.W. Finkl (eds): *Advances in Marine Vertebrate Research in Latin America*. Springer. 521pp. [Available at: *https://doi.org/10.007/978-3-319-56985-7_17*].

Crespo, E.A., Alarcon, D., Alonso, M., Bazzalo, M., Borobia, M., Cremer, M., Filla, G., Lodi, L., Magalhães, F.A., Marigo, J., Lima de Queiroz, H., Reynolds, J.E.I., Schaeffer, Y., Dorneles, P.R., Lailson-Brito, J. and Wetzel, D.L. 2010. Report on the working group on major threats and conservation. *Latin Am. J. Aquat. Mamm.* 8(1-2): 47-56.

Cunha, H.A., da Silva, V.M.F., Lailson-Brito, J., Jr., Flores, P.A.C., Azevedo, A.F., Reis, M.S., Barbosa, L.A., Silva, F.J.L., Zanelatto, R.C., Meirelles, A.C., Santos, M.C.O., Watts, P.C. and Solé-Cava, A.M. In prep. Population structure of the dolphin *Sotalia guianensis* in the Southwestern Atlantic: stock delimitation through multi-locus analyses. [Available from the author].

Cunha, H.A. 2007. Sistemática molecular e filogeografia do género *Sotalia* (Gray, 1866) (Delphinidae) no Brasil. Thesis (Doutorado em Genética), Universidade Federal do Rio de Janeiro, Rio de Janeiro. 182pp.

Cunha, H.A., daSilva, V.M.F., Lailson-Brito, J.J.R., Santos, M.C.O., Flores, P.A.C., Martin, A.R., Azevedo, A.F., Fragoso, A.B.L., Zanelatto, R.C. and Sole-Cava, A.M. 2005. Riverine and marine ecotypes of *Sotalia* dolphina are different species. *Mar. Biol.* 148: 449-57.

Da Silva, V.M.F., Fettuccia, D., Rodrigues, E.S., Edwards, H., Moreno, I.B., Moura, J.F., Wedekin, L.L., Bazzalo, M., Emin-Lima, N.R., Carmo, N.A.S., Siciliano, S. and Utreras, V.B. 2010. Report of the Working Group on Distribution, Habitat Characteristics and Preferences, and Group Size. *Latin Am. J. Aquat. Mamm.* 8(31-38). [Available at: *https://doi.org/10.5597/lajam00151*].

Danielsen, F., Burgess, N.D., Balmford, A., Donald, P.F., Funder, M., Jones, J.P., Alviola, P., Balete, D.S., Blomley, T., Brashares, J., Child, B., Enghoff, M., Fjeldså, J. and Holt, S. 2019. *Monitoring of Areas and Species/Populations*. 311 ES_CWR_30-11 30/11/10 14:33. 311pp.

Deecke, V.B. and Janik, V.M. 2006. Automated categorization of bioacoustic signals: Avoiding perceptual pitfalls. *J. Acoust. Soc. Am.* 119(1): 645-53.

de Freitas Azevedo, A., Lailson-Britto, J., Jr., Cunha, H.A. and Van Sluys, M. 2004. A note on site fidelity of marine tucuxis (*Sotalia fluviatilis*) in Guanabara Bay, southeastern Brazil. *J. Cetacean Res. Manage.* 6(3): 265-68.

de Gurjao, L.M., de Andrade Furtado Neto, M., dos Santos, R. and Cascon, P. 2003. Feeding habits of marine tucuxi, *Sotalia fluviatilis*, at Ceara State, northeastern Brazil. *Latin Am. J. Aquat. Mamm.* 2(2): 117-22.

Delgado-Ortega, G. 2012. Distribución espacial y temporal de la tonina del lago (*Sotalia guianensis*) en el costa occidental del sistema de Maracaibo. (Biologist Research). Supervisor: H. Barrios-Garrido, University of Zulia, Maracaibo, Venezuela.

Derville, S., Torres, L.G., Albertson, R., Andrews, O., Baker, C.S., Carzon, P., Constantine, R., Donoghue, M., Dutheil, C., Gannier, A., Oremus, M., Poole, M., Robbins, J. and Garrigue, C. 2019. Whales in warming water: Assessing breeding habitat diversity and adaptability in Oceania's changing climate. *Glob. Change Biol.* 25(4): 1466-81.

Di Beneditto, A.P. 2000. Ecologia alimentar de *Pontoporia blainvillei* e *Sotalia fluviatilis* (Cetacea) na costa norte do Estado do Rio de Janeiro. PhD Thesis. Universidade Estadual do Norte Fluminense, RJ, Brazil. 173pp. [In Portuguese].

Di Beneditto, A.P.M. 2003. Interactions between gillnet fisheries and small cetaceans in northern Rio de Janeiro, Brazil: 2001-2002. *Latin Am. J. Aquat. Mamm.* 2(2): 79-86.

Di Beneditto, A.P., Ramos, R., Lima, N.R. and Santos, R.A. 1998. Feeding ecology of *Pontoporia blainvillei* and *Sotalia fluviatilis* in northen Rio de Janeiro, Brazil: a preliminary analysis. Abstracts, VIII Reunião de Trabalhos de Especialistas em Mamíferos Aquáticos da América do Sul: 25-29.

Di Beneditto, A.P.M. and Ramos, R.M.A. 2004. Biology of the marine tucuxi dolphin (*Sotalia fluviatilis*) in south-eastern Brazil. *J. Mar. Biol. Assoc. UK* 84(6): 1245-50.

Domiciano, I.G., Domit, C., Broadhurst, M.K., Koch, M.S. and Bracarense, A.P.F. 2016. Assessing disease and mortality among small cetaceans stranded at a world heritage site in southern Brazil. *PloS ONE* 11(2): e0149295.

Domit, C., Sasaki, G., Rosa, L. and Rosso-Londono, M.C. 2009. Cetáceos no monitoramento ambiental de atividades portuárias: sentinelas do ambiente marinho. *In*: Boldrini (eds). *Dragagens portuárias no Brasil: licenciamento e monitoramento ambiental*. Ademadan, Antonina, PR.

Domit, C., L., R., Moura, S. and Rodrigues, G. 2018. Relatório técnico do monitoramento da atividade de dragagem e potenciais efeitos em cetáceos e quelônios na baía de Paranaguá, Paraná, Brasil, Universidade Federal Fluminense, Brasil.

Dorneles, P.R., Lailson-Brito, J., Azevedo, A.F., Meyer, J.A., Vidal, L.G., Fragoso, A.B., Torres, J.P., Malm, O., Blust, R. and Das, K. 2008. High accumulation of perfluorooctane sulfonate (PFOS) in marine tucuxi dolphins (*Sotalia guianensis*) from the Brazilian coast. *Environ. Sci. Technol.* 42: 5363-73.

Dorneles, P.R., Lailson-Brito, J., Dirtu, A.C., Weijs, L., Azevedo, A.F., Torres, J.P.M., Malm, O., Neels, H., Blust, R., Das, K. and Covaci, A. 2010. Anthropogenic and naturally-produced organobrominated compounds in marine mammals from Brazil. *Environment International* 36: 60-67.

Dorneles, P.R., Lailson-Brito, J., dos Santos, R.A., Silva da Costa, P.A., Malm, O., Azevedo, A.F. and Torres, J.P.M. 2007. Cephalopods and cetaceans as indicators of offshore bioavailability of cadmium off Central South Brazil Bight. *Enviro. Poll.* 148: 352-59.

Dussán-Duque, B.S. 2013. Ecology of the Guiana dolphin (*Sotalia guianensis*) in the southern area of the Gulf of Morrosquillo, Colombia: implcations for conservation. Doctoral dissertation, University of St Andrews, St. Andrews, Scotland, UK.

Dussán-Duque, S., Wells, R.S. and Bassos-Hull, K. 2006. Distribución, uso de habitat y abundancia de *Sotalia guianensis* en el Golfo de Morrosquillo, Colombia. Workshop on Research and Conservation of the Genus Sotalia, 2006, Armação dos Búzios. Abstracts of workshop on research and conservation of the genus *Sotalia*. p.15. Armação dos Búzios.

Edwards, H.H. and Schnell, E.G.D. 2001. Status and ecology of *Sotalia fluviatilis* in the Cayos Miskito Reserve, Nicaragua. *Mar. Mamm. Sci.* 17: 445-72.

Emin-Lima, N.R., Costa, A.F., Rodrigues, A.L.F., Souza, R.F.C. and Siciliano, S. 2008. Capturas acidentais de *Sotalia guianensis* na costa norte do Brasil: análises preliminares. Anais XIII Reunión de Trabajo de Especialistas en Mamíferos Acuáticos de América del Sur y 7o. Congresso SOLAMAC, Montevideo, Uruguai.

Espécie, M. 2011. Tamanho populacional e estimativa da sobrevivência relativa de *S. guianensis* na parte Oeste da baía de Ilha Grande-RJ. 13.

Espécie, M. 2015. O que seis anos de marcação-recaptura revelam sobre a população de boto-cinza da parte oeste da baía da Ilha Grande, Litoral sul do Rio de Janeiro. 2.

Espinoza-Rodríguez, N., De Turris-Morales, K., Shimada, T. and Barrios-Garrido, H. 2019. Guiana dolphin (*Sotalia guianensis*) in the southern Gulf of Venezuela: Seasonal distribution, group size, and habitat use. *Regional Studies in Marine Science* 32: 100874.

Filla, F.G. and Monteiro-Filho, E.L.A. 2009. O desenvolvimento do turismo náutico e a sua ligação com a observação do boto-cinza (*Sotalia guianensis*) na região de Cananéia, litoral sul do Estado de São Paulo. *Revista Turismo em Análise* 20(2): 282-301.

Filla, G.F. 2004. Estimativa da densidade populacional e estrurura de agrupamento do boto-cinza, *Sotalia guianensis* (Cetacea, Delphinidae), na Baia de Guaratuba e na Porção norte do complexo estuarino de Baia de Paranagua, PR. Dissertação de Mestrado, Universidade Federal do Paraná, Curitiba.

Flach, L. 2015. Estimativa de parametros populacionais, area de vida, mortalidade e interaçoes da atividade pesquiera sobre a população de botos-cinza (*Sotalia guianensis*) (Van Beneden, 1864) (Cetacea, Delphinidae) na Baia de Sepetiba (RJ). Tese (Doutorado em Ecologia e Evolução), Universidade do Estado do Rio de Janeiro, Rio de Janeiro, RJ.

Flach, L., Flach, P.A. and Chiarello, A.G. 2008. Density, abundance and distribution of the guiana dolphin (*Sotalia guianensis* van Benéden, 1864) in Sepitiba Bazy, southeast Brazil. *J. Cetacean Res. Manage.* 10(1): 31-36.

Flores, P.A.C. and Bazzalo, M. 2004. Home ranges and movement patterns of the marine tucuxi dolphin, *Sotalia fluviatilis*, in the Baia Norte, Southern Brazil. *Latin Am. J. Aquat. Mamm.* 3(1): 37-52.

Flores, P.A.C. and Da Silva, V.M.F. 2009. Tucuxi and Guiana Dolphin (*Sotalia fluviatilis* and *S. guianensis*). pp.1188- 92. *In*: W.F. Perrin, B. Würsig and J.G.M. Thewissen (eds). *Encyclopedia of Marine Mammals*. Elsevier, Amsterdam. 2nd ed., 1352pp. ISBN-13: 978-0-120373553-9.

Furtado, M.H.B.C. and Simões-Lopes, P.C. 1999. Alterações senil-degenerativas e anomalias anatômicas na coluna vertebral de pequenos cetáceos. *Biotemas* 12(4): 133-47.

Gamboa-Poveda, M. 2009. Tamano poblacional, distribucion, y uso de habitat de dos species simpatricas de delfines en el refugio nacional de vida silvestre Gand-Oca_Manzanillo, Costa Rica. Programa de Maestria en Ciencias Marinas y Costeras, Escuela de Ciencias Biologicas, Universidad Nacional de Costa Rica. 105pp.
Gaudard Oliveira, A. 2011. Ecologia comportamental de interações entre boto-cinza, *Sotalia guianensis* (van Béneden, 1864) e embarcações no litoral paranaense. Dissertation (Mestrado em Ecologia e Conservação de Recursos Naturais), Universidade Federal de Uberlândia, Uberlândia, Minas Gerais, Brazil. 51pp.
Geraci, J.R. and Lounsbury, V.J. 2005. *Marine Mammals Ashore: a Field Guide for Strandings*. 2nd ed. National Aquarium in Baltimore, Baltimore, MD. 371pp.
Gomez-Salazar, C., Trujillo, F., Portocarrero-Aya, M. and Whitehead, H. 2012. Population, density estimates, and conservation of river dolphins (Inia and Sotalia) in the Amazon and Orinoco river basins. *Mar. Mamm. Sci.* 281: 124-53.
Groch, K.R., Colosio, A.C., Marcondes, M.C.C., Zucca, D., Díaz-Delgado, J., Niemeyer, C., Marigo, J., Brandão, P.E., Fernandez, A.Z. and Catão-Dias, J.L. 2014. Novel cetacean morbillivirus in Guiana dolphin, Brazil. *Emerg. Infect. Dis.* 20: 511-13.
Groch, K.R., Santos-Neto, E.B., Díaz-Delgado, J., Ikeda, J.M.P., Carvalho, R.R., Oliveira, R.B., Guari, E.B., Bisi, T.L., Azevedo, A.F., Lailson-Brito, J. and Catão-Dias, J.L. 2018. Guiana dolphin unusual mortality event and link to cetacean morbillivirus, Brazil. *Emerg. Infect. Dis.* 24(7): 1349-54.
Hamilton, C.D., J., V.-G., Kovacs, K.M., Ims, R.A., Kohler, J. and Lydersen, C. 2019. Contrasting changes in space use induced by climate change in two Arctic marine mammal species. *Biol. Lett.* 15: 20180834. [Available at: *http://dx.doi.org/10.1098/rsbl.2018.0834*].
Herrera, O. 2013. Estatus de los delfines de rio *Sotalia* sp. e *Inia geoffrensis* en la cuenca del Orinoco. Tesis. Master Universitario en Biodiversidad en Areas Trilopicales y su Conservacion, Universidad Internacional Menéndez Pelayo. 103pp.
Heywood, V. 2006. Monitoring of areas and species/populations to assess effectiveness of conservation/management actions. pp.295-313. In: *Crop Wild Relatives. A Manual of in situ Conservation*. Earthscan, London.
Hoyt, E. and Iñíguez, M. 2008. *Estado del Avistamiento de Cetáceos en América Latina*. WDCS, Chippenham, UK, Global Ocean, London, IFAW, East Falmouth. 60pp.
International Whaling Commission. 1995. Report of the Scientific Committee, Annex G. Report of the sub-committee on small cetaceans. *Rep. Int. Whal. Comm.* 45:165-86.
International Whaling Commission. 2019. Report of the Scientific Committee. Annex M. Report of the Sub-Committee on Small Cetaceans. *J. Cetacean Res. Manage. (Suppl.)* 20:320-45.
Japp, A.K. 2004. Estimativa da densidade populacional do boto-cinza *Sotalia guianensis* na Baia de Antonina, Paraná. Monografia de Graduação, Pontifício Universidade Católica do Paraná, Curitiba.
Kajiwara, N., Matsuoka, S., Iwata, H., Tanabe, S., Rosas, F.C.W., Fillmann, G. and Readman, J.W. 2004. Contamination by persistent organochlorines in cetaceans incidentally caught along Brazilian coastal waters. *Arch. Environ. Contam. Toxicol.* 46: 124-34.
Kehrig, H.A., Hauser-Davis, R.A., Seixas, T.G., Pinheiro, A.B. and Di Beneditto, A.P.M. 2016. Mercury species, selenium, metallothioneins and glutathione in two dolphins from the southeastern Brazilian coast: mercury detoxification and physiological differences in diving capacity. *Environ. Poll.* 213: 785-92.
Kehrig, H.A., Seixas, T.G., Malm, O., Di Beneditto, A.P.M. and Rezende, C.E. 2013. Mercury and selenium biomagnification in a Brazilian coastal food web using nitrogen stable isotope analysis: A case study in an area under the influence of the Paraiba do Sul River plume. *Mar. Poll. Bull.* 75: 283-90.
Kehrig, H.A., Seixas, T.G., Palermo, E.A., Di Beneditto, A.P.M., Souza, C.M.M. and Malm, O. 2008. Different species of mercury in the livers of tropical dolphins. *Analytical Letters* 41: 1690-98.
Korn, M.G.A., Santos, G.L.D., Rosa, S.M., Teixeira, L.S.G. and Oliveira, P.V.D. 2010. Determination of cadmium and lead in cetacean Dolphinidae tissue from the coast of Bahia state in Brazil by GFAAS. *Microchemical Journal* 96: 12-16.
Kunito, T., Nakamura, S., Ikemoto, T., Anan, Y., Kubota, R., Tanabe, S., Rosas, F.C.W., FIllmann, G. and Readman, J.W. 2004. Concentration and subcellular distribution of trace elements in liver of small cetaceans incidentally caught along the Brazilian coast. *Mar. Poll. Bull.* 49: 574-87.
Lailson-Brito, J., Dorneles, P.R., Azevedo-Silva, C.E., Azevedo, A.F., Vidal, L.G., Zanelatto, R.C., Loziniski, C.P.C., Azeredo, A., Fragoso, A.B., Cunha, H.A., Torres, J.P.M. and Malm, O. 2010. High organochlorine accumulation in blubber of Guiana dolphin, *Sotalia guianensis*, from Brazilian coast and its use to establish geographical differences among populations. *Environ. Poll.* 158: 1800-08.
Lailson-Brito, J., Jr., Cruz, R., Dorneles, P.R., Andrade, L., Azevedo, A.F., Fragoso, A.B., Vidal, L.G., Costa, M.B., Bisi, T.L., Almeida, R., Carvalho, D.P., Bastos, W.R. and Malm, O. 2012. Mercury-selenium relationships in liver of Guiana dolphin: The possible role of kupffer cells in the detoxification process by tiemannite formation. *PLoS ONE* 7(7): 1-10.
Lailson-Brito, J., Kehrig, H.A. and Malm, O. 2002. Mercúrio total nos tecidos do Boto-Cinza, *Sotalia fluviatilis* (Cetácea, Delphinidae), da Baía de Guanabara, Rio de Janeiro, Brazil. pp.291-300. *In*: Prego, R., Duarte, A., Panteleitchouk, A.V. and Santos, T.R. (eds). *Estudos sobre Contaminação*. Piaget, Viseu.
Laran, S., Bassols, N., Doremus, G., Authrer, M., Ridoux, V. and Van Canneyt, O. 2019. *Distribution et abondonce de la mégafauna marine aux Petit Antilles et an Guyana (REMMOA-II Petit Antilles and Guyana 2017)*. Rapport final pour l'Agence Francaise pour la Biodiversité. 80+xxxiipp.
Lavandier, R., Arêas, J., Dias, P.S., Taniguchi, S., Montone, R., Moura, J.F., Quinete, N., Siciliano, S. and Moreira, I. 2015. An assessment of PCB and PBDE contamination in two tropical dolphin species from the Southeastern Brazilian coast. *Mar. Poll. Bull.* 101: 947-53.
Lee, R.U., Read, A., Marttin, F., Poulain, F. and Funge-Smith, S. 2020. Fisheries Emergency Report Assessment Tool (FERAT). FAO, Rome. [Available at: *https://doi.org/10.4060/ca826/en*].
Lemos, L.L., De Moura, J.F., Hauser-Davis, R.A., Campos, R.C. and Siciliano, S. 2013. Small cetaceans found stranded or accidentally captured in southeastern Brazil: Bioindicators of essential and non-essential trace elements in the environment. *Ecotoxicology and Environmental Safety* 97: 166-75.
Lima, J.Y., Carvalho, A.P.M., Azevedo, C.T., Barbosa, L.A. and Silveira, L.S. 2017. Variation of age and total length in *Sotalia guianensis* (Van Bénéden, 1864) (Cetacea, Delphinidae), on the coast of Espírito Santo state, Brazil. *Brazilian J. Biology* 77: 437-43.
Loch, C., Marmontel, M. and Simões-Lopes, P.C. 2009. Conflicts with fisheries and intentional killing of freshwater dolphins (*Cetacea: Odontoceti*) in the Western Brazilian Amazon. *Biodivers. Cons.* 18(14): 3,979-88. [Available at: *https://doi.org/10.1007/s10531-009-9693-4*].

Lodi, L. and Capistrano, L. 1990. Capturas acidentais de pequenos cetáceos no litoral norte do Estado do Rio de Janeiro. *Biotemas* 3(1): 47-65. [In Portuguese].
Maciel, I.S. 2020. Ecologia acustica do boto-cinza nas Baias de Sepetiba e Ilha Grande. Tese (doutorado em biologia animal), Instituto de Ciências Biológicas e da Saúde, Universidade Federal Rural do Rio de Janeiro, Seropédica, RJ.
MacLeod, C.D. 2009. Global climate change, range changes and potential implications for the conservation of marine cetaceans: a review and synthesis. *Endang. Spec. Res.* 7: 125-36.
Madeira di Beneditto, A.P. and Siciliano, S. 2007. Stomach contents of the marine tucuxi dolphin (*Sotalia guianensis*) from Rio de Janeiro, south-eastern Brazil. *J. Mar. Biol. Assoc. UK* 87: 253-54.
Mamede, N.S. 2015. Caracterização espaço-temporal da população de boto-cinza, *Sotalia guianensis* Van Beneden, 1864 (Cetacea: Delphinidae) na Baia de Benevente, Espirito Santo, e implcações para a conservação. Dissertação (Mestrado em Ecologia), Universidade Federal de Juiz de Fora, Juiz de Fora, MG.
Mannocci, L., Monestiez, P., Bolanos-Jiminez, J., Doremus, G., Jeremie, S., Laran, S., Rinaldi, R., van Canneyt, O. and Ridoux, V. 2012. Megavertebrate communities from two contrasting ecosystems in the western tropical Atlantic. *J. Mar. Syst.* 111-112: 208-22.
Marega-Imamura, M., de Carvalho, G.H., Le Pendu, Y., Silva, P.S. and Schiavetti, A. 2018. Behavioral responses of *Sotalia guianensis* (Cetartiodactyla, Delphinidae) to boat approaches in northeast Brazil. *Lat. Am. J. Aquat. Res.* 46(2): 268-79.
Marigo, J., Ruoppolo, V., Rosas, F.C.W., Valente, A.L.S., Oliveira, M.R., Dias, R.A. and Catãodias, J.L. 2010. Helminths of *Sotalia guianensis* (Cetacea: Delphinidae) from the south and southeastern coasts of Brazil. *J. Wildl. Dis.* 46(2): 599-602.
Marsh, D. and Trenham, P.C. 2008. Tracking current trends in plant and animal population monitoring. *Cons. Biol.* 22: 647-55.
Martins, D.T.L., Rossi-Santos, M.R. and Lima, F.J. 2008. Effects of anthropogenic noise on the acoustic behaviour of *Sotalia guianensis* (Van Bénéden, 1864) in Pipa, North-eastern Brazil. *J. Mar. Biol. Assoc. UK* 98: 215-22. [Available at: *https://doi.org/10.1017/S0025315416001338*].
Marutani, V.H.B., Miyabe; F.M., Alfieri, A.F, Domit; C., de Matos, A.M.R.N., Filho, M.R.C.M. and Bracarense, A.P.F.R.L. 2021. Systematic beach monitoring as a health assessment tool: cetacean morbillivirus under non-epizootic circumstances in stranded dolphins. *bioRxiv – Pathology,* Early view. [Available from: *https://doi.org/10.1101/2021.02.13.431109*]
Meirelles, A.C., Silva, C.P.N., Ribeiro, A.C. and Filho, A.S. 2010. Records of Guiana dolphin, *Stalia guianensis*, in the state of Ceara, north-eastern Brazil. *Latin Am. J. Aquat. Mamm.* 8(1-2): 97-102.
Meirelles, A.C.O. 2013. Ecologia populacional e comportamental do boto-cinza, *Sotalia guianensis* (Van Beneden, 1864), na enseada do Mucuripe, Fortaleza, Estado do Ceara. Tese (Doutorado em Ciencias Marinhas Tropicais), Universidade Federal do Ceara, Fortaleza, CE.
Mello, A.B. 2016. Parametros populacionais do boto-cinza, *Sotalia guianensis* (Cetartiodactyla: Delphinidae), no estuario de Cananeia entre 2015 e 2016. Dissertação de Mestrado, Universidade de São Paulo, São Paulo. 59pp.
Mello, A.B., de Molina, J.M.B., Kajin, M. and Santos, M.C.d.O. 2019. Abundance estimates of Guiana dolphins (*Sotalia guianensis*; Van Bénéden, 1864) inhabiting an estuarine system in southeastern Brazil. *Aquat. Mamm.* 45: 56-65.
Melo, D.M. 2018. Ecologia populacional de *Sotalia guianensis* no complexo estuarino de Canavieiras - Bahia, Brasil. Dissertação (Mestrado em Sistemas Aquáticos Tropicais), Universidade Estadual de Santa Cruz, Ilhéus, BA.
Miranda, A.V. 2017. Estimativa de densidade e tamanho populacional de botos-cinza, *Sotalia guianensis* (Van Beneden, 1864) no complexo estuarino de Paranaguá, Paraná. Dissertação (Mestrado em Sistemas Costeiros e Oceânicos), Universidade Federal do Paraná, Pontal do Sul, PR.
Monteiro-Neto, C., Alves-Junior, T.T., Capibaribe Avila, F.J., Campos, A.A., Fernandes Costa, A., Negrao Silva, C.P. and Furtado-Neto, M.A.A. 2000. Impact of fisheries on the tucuxi (*Sotalia fluviatilis*) and rough-toothed dolphin (*Steno bredanensis*) populations off Ceara state, northeastern Brazil. *J. Aquat. Mamm*. 26: 49-56.
Monteiro-Neto, C., Itavo, R.V. and Moraes, L.E.S. 2003. Concentrations of heavy metals in *Sotalia fluviatilis* (Cetacea: Delphinidae) off the coast of Ceará, northeast Brazil. *Environ. Poll.* 123: 319-24.
Monteiro-Neto, C., Avila, F.J.C., Alves, T.T., Jr., Araújo, D.S., Campos, A.A., Martins, A.M.A., Parente, C.L., Andrade Furtado-Neto, M.A. and Lien, J. 2004. Behavioural responses of *Sotalia fluviatilis* (Cetacea, Delphinidae) to acoustic pingers, Fortaleza, Brazil. *Mar. Mamm. Sci.* 21(1): 145-51.
Moura, J.F., Sholl, T.G.C., Rodrigues, E.S., Hacon, S. and Siciliano, S. 2009. Marine tucuxi dolphin (*Sotalia guianensis*) and its interaction with passive gillnet fisheries along the northern coast of the Rio de Janeiro state, Brazil. *Mar. Biodivers. Rec.* 2/e82: 1-4.
Moura, J.F., Emim-Lima, R., Hacon, S.S., Vega, C.M., Campos, R.C. and Siciliano, S. 2012a. Guiana dolphins (*Sotalia guianensis*, Van Benédén, 1864) as indicators of the bioaccumulation of total mercury along the coast of Rio de Janeiro State, Southeastern Brazil. *Bull. Environ. Contamin. Toxicol.* 88: 54-59.
Moura, J.F., Emim-Lima, R., Hacon, S.S., Vega, C.M., Campos, R.C. and Siciliano, S. 2012b. Mercury status of the Amazon Continental Shelf: Guiana dolphins (*Sotalia guianensis*, Van Benéden, 1864) as a bioindicator. *Bull. Environ. Contamin. Toxicol.* 89: 412-18.
Moura, J.F., Hauser-Davis, R.A., Lemos, L.L. and Siciliano, S. 2013. Guiana dolphins (*Sotalia guianensis*) as marine ecosystem sentinels: ecotoxicology and emerging diseases. *Reviews of Environmental Contamination and Toxicology* 228: 1-29. [Available at: *https://doi.org/10.1007/978-3-319-01619-1_1*].
Nery, M.F., Espécie, M.d.A. and Simão, S.M. 2008. Marine tucuxi dolphin (*Sotalia guianensis*) injuries as a possible indicator of fisheries interaction in southeastern Brazil. *Brazilian J. Oceanog.* 56: 313-16.
Nunes, E.S., Carvalho, G. and Silva, M.N. 2014. Reações comportamentais de *Sotalia guianensi*s, (boto-cinza), durante encontro com embarcações no Estuário do Rio Sergipe e Foz do Rio Poxim, Aracaju, Sergipe. *Cadernos de Graduação - Ciências biológicas e da saúde Unit* 2(1):111-129.
O'Connor, S., Campbell, R., Cortez, H. and Knowles, T. 2009. Whale Watching Worldwide: Tourism Numbers, Expenditures and Expanding Economic Benefits. A special report from the International Fund for Animal Welfare, Yarmouth, MA, USA, prepared by Economists at Large. 295pp.
Oliveira, M.R. 2003. Ecologia alimentar de *Sotalia fluviatilis* e *Pontoporia blainvillei* (Cetacea: Delphinidae e Pontoporidae) no litoral sul do Estado de São Paulo e litoral do Estado do Paraná. Dissertação (Mestrado em Ciências Biológicas) - Universidade Federal do Paraná, Cutitiba.
Oliveira, M.R., Rosas, F.C.W., Pinheiro, P.C. and Santos, R.A. 2008. Alimentação de *Sotalia guianensis*. pp.91-101. *In*: Monteiro Filho, E.L.A. and Monteiro, K.D.K.A. (eds). *Biologia, Ecologia e Conservação do Boto-cinza*. Páginas & Letras Editora e Gráfica, São Paulo, Brazil.

Oshima, J.E.d.F. and Santos, M.C.O. 2016. Guiana dolphin home range analysis based on 11 years of photo-identification research in a tropical estuary. *J. Mammal.* 97(2): 599-610. [Available from*: https://www.jstor.org/stable/26373078*].

Pacífico, E.d.S. 2008. Estimativa de abundancia do boto-cinza, *Sotalia guianensis*, no complexo estuarino-lagunar de Cananeia (SP): gerando subsidios para a carta sao. 2008. Trabalho de Conclusão de Curso (Bacharel em Ecologia). Curso de Ecologia, Universidade Estadual Paulista 'Júlio de Mesquita Filho', Rio Claro, SP. 68pp.

Paro, A.D. 2010. Estimativa populacional e uso do habitat do boto-cinza (*Sotalia guianensis*) no litoral sul do Rio Grande do Norte. Dissertação (Mestrado em Psicobiologia), Universidade Federal do Rio Grande do Norte, Natal, RN.

Pais, F.S., Cardoso, R. P., Rossi-Santos, M.R., Wedekin, L.L., Silva, F.J.L., Monteiro-Filho, E.L.A. and Leão, D.T.M. 2018. Anthropogenic noise and Guiana dolphins (*Sotalia guianensis*) in Brazil: Ecological and Conservation Concerns. pp.321-367. *In*: M.R. Rossi-Santos and C.W. Finkl (eds.). *Advances in Marine Vertebrate Research in Latin America.* Springer International Publishing, 2018.

Pereira, M.G., Bazzalo, M. and de Carvalho Flores, P.A. 2007. Reacoes comportamentais na superficie de *Sotalia guianensis* (Cetacea, Delphinidae) durante encontros com embaracoes na Baia Norte de Santa Catarina. *Zoociencias* 9(2): 123-35.

Pinheiro, A.B. and Cremer, M. 2004. Etnoecologia e captura acidental de golfinhos (Cetacea: Pontoporiidae e Delphinidae) na Baía de Babitonga, Santa Catarina. *Desenvolvimento e Meio Ambiente* 8: 69-75.

Quinete, N., Lavandier, R., Dias, P., Montone, R. and Moreira, I. 2011. Specific profiles of polybrominated diphenylethers (PBDEs) and polychlorinated biphenyls (PCBs) in fish and tucuxi dolphins from the estuary of Paraíba do Sul River, Southeastern Brazil. *Mar. Poll. Bull.* 62(2): 440-46.

Ramírez, S. 2005. Interacción de cetáceos con la pesquería artesanal de la zona suroccidental del golfo de Venezuela, estado Zulia. Iniciativa de Especies Amenazadas. Libro Una Mano a la Naturaleza, Proyecto 123.

Ramírez, S. 2005. Bases ecologicas para la conservación del delfín estuarino (*Sotalia fluviatilis*) en el Golfo de Venezuela. [Abstract available at: *http://www.cdc.fonacit.gov.ve/cgi-win/be_alex.exe?Acceso=T052100016892/0&Nombrebd=Conicit*].

Ramos, R.M.A., Di Beneditto, A.P.M. and Lima, N.R.W. 2000. Growth parameters of *Pontoporia blainvillei* and *Sotalia fluviatilis* (Cetacea) in northern Rio de Janeiro, Brazil. *Aquat. Mamm.* 26: 67-75.

Ramos, R.M.A., Di Beneditto, A.P.M. and Souza, S.M.D. 2001. Bone lesions in *Sotalia fluviatilis* (Cetacea) as a consequence of entanglement: Case report. *Brazilian J. Veterinary Research and Animal Science* 38(4): 192-195.

Ramos, R.M.A., Di Beneditto, A.P.M., Siciliano, S., Santos, M.C.O., Zerbini, A.N., Vicente, A.F.C., Zampirolli, E., Alvarenga, F.S., Fragoso, A.B., Lailson-Brito Jr., J., Azevedo, A.F., Barbosa, L. and Lima, N.R.W. 2010. Morphology of the Guiana dolphin (*Sotalia guianensis*) off southeastern Brazil: growth and geographic variation. *Latin Am. J. Aquat. Mamm.* 8(1-2): 137-49.

Resende, F. 2008. Alterações acústico comportamentais. pp.165-76. *In*: Monteiro-Filho, E.L.A. and Monteiro, K.D.K.A. (eds). *Biologia, ecoogia e conservação do Boto-cinza*. Páginas e Letras Editora e Gráfica, São Paulo.

Rodrigues, V.L.A., Wedekin, L.L., Marcondes, M.C.C., Barbosa, L. and Farro, A.P.C. 2020. Diet and foraging opportunism of the Guiana Dolphin (*Sotalia guianensis*) in the Abrolhos Bank, Brazil. *Mar. Mamm. Sci.* 36(2): 436-50.

Rosa, G.A. 2016. Ecologia populacional do boto-cinza, *Sotalia guianensis* (Van Bénéden, 1864): Paramatros populacionais, comportamento a distribuição na costa de Ilhéus, nordeste do Brasil. Dissertação (Mestrado em Sistemas Aquáticos Tropicais), Universidade Estadual de Santa Cruz, Ilhéus, BA.

Rosas, F.C.W. 2000. Interaçoes com a pesca, mortalidade, idade, reprodução e crescimento de *Sotalia guianensis* e *Pontoporia blainvillei* no litoral sul do Estado de São Paulo e litoral do Estado do Paraná, Brasil, Universidade de Paraná, Curitiba, Brasil. 145pp. [In Portuguese].

Rosas, F.C.W., Barreto, A.S. and Monteiro-Filho, E.L.A. 2003. Age and growth of the estuarine dolphin (*Sotalia guianensis*) (Cetacea, Delphinidae) on the Paraná coast, Southern Brazil. *Fish. Bull.* 101: 377-83.

Rosas, F.C.W., Marigo, J., Laeta, M. and Rossi-Santos, M.R. 2010. Natural history of dolphins of the genus *Sotalia*. *Latin Am. J. Aquat. Mamm.* 8(1-2): 57-68.

Rosas, F.C.W. and Monteiro-Filho, E.L.A. 2002. Reproduction of the estuarine dolphin (*Sotalia guianensis*) on the coast of Parana, southern Brazil. *J. Mamm.* 83: 507-15.

RRDM – Rede Rio Doce Mar – FEST. 2019. Relatório Anual: Anexo 6 – Monitoramento de mamíferos, tartarugas e aves marinhas associados à foz do Rio Doce, lataforma continental e áreas protegidas adjacentes.

Ruopollo, V. 2003. Patologia comparada de cetáceos e pinípedes. 2003. Dissertação (Mestrado em Patologia Experimental e Comparada) – Universidade de São Paulo, São Paulo. 136pp.

Sacristan, C., Esperon, F., Marigo, J., Ewbank, A.C., De Carvalho, R.R., Groch, K.R., De Castilho, P.V., Sanchez-Sarmiento, A.M., Costa-Silva, S., Ferreira-Machado, E., Gonzales-Viera, O.A., Daura-Jorge, F. G., Santos-Neto, E.B., Lailson Brito, J., De Freitas Azevedo, A., Simões-Lopes, P.C., Neves, C.G. and Catao-Dias, J.L. 2018. Molecular identification and microscopic characterization of poxvirus in a Guiana dolphin and a common bottlenose dolphin, Brazil. *Dis. Aquat. Organ.* 130(3) 177-185.

Sacristan, C., Esperon, F., Ewbank, A.C., Diazdelgado, J., Ferreira-Machado, E., Costa Silva, S., Sanchez-Sarmiento, A.M., Groch, K.R., Neves, E., Pereira Dutra, G.H., Gravena, W., Ferreira Da Silva, V.M., Marcondes, M.C.C., Castaldo Colosio, A., Cremer, M.J., Carvalho, V.L., Ac, O.M., Marigo, J. and Catao-Dias, J.L. 2019. Novel herpesviruses in riverine and marine cetaceans from South America. *Acta Tropica* 190: 220-227, 2019.

Salgado, L.D., Más-Rosa, S. and Azevedo, J.C.R. 2018. Concentrations of metals in liver of Guiana dolphins (*Sotalia guianensis*) from an estuary in Southeast of Brazil. *Ecotoxicology Environmental Contamination* 13(1): 51-61.

Sánchez, L. and Briceño, Y. 2017. Anthropogenic interactions increasing mortality of cetaceans in the Maracaibo Lake, Venezuela. 28th International Congress Conservation Biology (ICCB 2017), Cartagena.

Sanchez-Sarmiento, A.M., Carvalho, V.L., Diazdelgado, J., Ressio, R.A., Fernandes, N., Guerra, J.M., Sacristan, C., Groch, K.R., Silvestreperez, N., Ferreira-Machado, E., Costa-Silva, S., Navas-Suarez, P., Meirelles, A.C.O., Favero, C., Marigo, J., Bertozzi, C.P., Colosio, A.C., Marcondes, M.C.C., Cremer, M.J., Silva, N.D.S., Ferreira Neto, J.S., Keid, L.B., Soares, R., Sierra, E., Fernandez, A. and Catao-Dias, J.L. 2019. Molecular, serological, pathological, immunohistochemical and microbiological investigation of Brucella spp. in marine mammals of Brazil reveals new cetacean hosts. *Transboundary Emerging Diseases* 66(4): 1674-1692.

Santos, M.C.O., Rosso, S., Santos, R.A, Lucato, S.H.B. and Bassoi, M. 2002. Insights on small cetacean feeding habits in southeastern Brazil. *Aquat. Mamm.* 28: 38-45.

Santos, E., Pansard, K.C., Yamamoto, M.E. and Chellappa, S. 2006. Comportamento do boto-cinza, *Sotalia guianensis* (Van Beneden) (Cetacea, Delphinidae) na presence de barcos de tourismo na Praia de Pipa, Rio Grande do Norte, Brasil. *Rev. Bras. Zool* 23(3): 661-66. [In Portugese].

Santos, M.C.O., Barão-Acuña, L. and Rosso, S. 2001. Insights on site fidelity and calving intervals of the marine tucuxi dolphin (*Sotalia fluviatilis*) in south-eastern Brazil. *J. Mar. Biol. Assoc. UK* 81: 1049-52.

Santos, M.C.O., Cremer, M.J., Secchi, E.R., Flach, L., Filla, G., Hubner, A. and Dussan-Duque, S. 2010. Report of the Working group on population abundance and density estimation. *Latin Am. J. Aquat. Mamm.* 8: 39-45.

Santos, M.S., Schiavetti, A. and Alvarez, M.R. 2013. Surface patterns of *Sotalia guianensis* (Cetacea: Delphinidae) in the presence of boats in Port of Malhado, Ilhéus, Bahia, Brazil. *Latin Am. J. Aquat. Res.* 41(1): 80-88.

Santos, M.C.O. and Rosso, S. 2008. Social organization of marine tucuxi dolphins, *Sotalia guianensis*, in the Cananéia estuary of south-eastern Brazil. *J. Mammal.* 89(2): 347-55.

Santos, M.C.O., Rosso, S. and Ramos, R.M.A. 2003. Age estimation of marine tucuxi (*Sotalia fluviatilis*) in South-eastern Brazil. *J. Mar. Biol. Assoc. UK* 83: 233-36.

Santos, M.D.O. and Zerbini, A.N. 2006. Abundance estimates of the marine tucuxi dolphin (*Sotalia guianensis*) in the Cananéia Estuary, southeastern Brazil. pp.51. Workshop on Research and Conservation of the Genus *Sotalia*, Armação de Búzios, Rio de Janeiro, Brazil. Edil Artes Gráficas, Rio de Janeiro.

Santos-Neto, E., Azevedo-Silva, C.E., Bisi, T.L., Santos, J., Meirelles, A.C.O., Carvalho, V.L., Azevedo, A.F. and Lailson-Brito, J. 2014. Organochlorine concentrations (PCBs, DDTs, HCHs, HCB and Mirex) in delphinids stranded at the northeastern Brazil. *Sci. Total Environ.* 472: 194-203.

Santos-Neto, E.B. 2017. Influência de parâmetros de história natural (sexo, idade e maturidade sexual) nos padrões de acumulação de compostos organobromados do boto-cinza (*Sotalia guianensis*) da Baía de Sepetiba, Rio de Janeiro, Brasil. 2017. Tese (Doutorado em Ecologia e Evolução) - Universidade do Estado do Rio de Janeiro, Rio de Janeiro.

Schulze, B. 2012. Estimativa populacional e area de vida do boto-cinza, *Sotalia guianensis* (Cetacea, Delphindae) na Baia da Babitonga, Santa Caterina, Brasil. Dissertação de Mestrado, USFC, Programa de Pós-Graduação em Ecologia. 119pp.

Secchi, E. 2012. *Sotalia fluviatilis*. 2013 IUCN Red List of Threatened Species, Version 2013.2. [Available from: *https://www.iucnredlist.org*].

Secchi, E., Santos, M.P. and Reeves, R. 2018. *Sotalia guianensis*. The IUCN Red List of Threatened Species 2018: e.T181359A50386256. [Available at: *https://dx.doi.org/10.2305/IUCN.UK.2018-2.RLTS.T181359A50386256.en*]. [Downloaded on 22 June 2020].

Seixas, T.G., Kehrig, H.A., Di Beneditto, A.P.M., Souza, C.M.M., Malm, O. and Moreira, I. 2009. Essential (Se, Cu) and non-essential (Ag, Hg, Cd) elements: what are their relationships in liver of *Sotalia guianensis* (Cetacea, Delphinidae)? *Mar. Poll. Bull.* 58: 601-34.

Seixas, T.G., Moreira, I., Siciliano, S., Malm, O. and Kehrig, H.A. 2014. Differences in methylmercury and inorganic mercury biomagnification in a tropical marine food web. *Bull. Environ. Contamin. Toxicol.* 92(3): 274-78.

Siciliano, S. 1994. Review of small cetaceans and fishery interactions in coastal waters of Brazil. *Rep. Int. Whal. Comm. (special issue)* 15: 241-50.

Sidou, S.A. 2008. Capturas acidentais de pequenos cetaceos pela frota pesqueira do Porto de Cananeia, SP. Trabalho de Conclusão de Curso (Bacharelado em Ciências Biológicas), Universidade Estadual Paulista, UNESP, câmpus de Rio Claro, São Paulo. 126pp.

Souza, S.C.P. 2013. Estimativa de parametros populacionais do boto-cinza, *Sotalia guianensis* (Van Beneden, 1864) (Cetacea, Delphinidae) na Baia de Paraty (RJ). Dissertação (Mestrado em Ecologia e Evolução), Universidade do Estado do Rio de Janeiro, Rio de Janeiro, RJ.

Spinelli, L.G. 2017. Avaliação da biologia reprodutiva de *Sotalia guianensis* (Van Bénéden, 1864), na costa leste do Estado do Ceará e centro do Estado de SãoPaulo. 2017. Monografia (Bacharelado em Ciências Biológicas com habilitação em Gerenciamento Costeiro) - Universidade Estadual Paulista, São Vicente.

Stutz Reis, S. 2013. Uso do hábitat pelo boto-cinza *Sotalia guianensis* (Van Benédén, 1864) (Cetacea: delphinidae) na Baía de Benevente, ES, Brasil. Dissertation, Programa de Pós-Graduação em Ciências Biológicas, Universidade Federal de Juiz de Fora.

Tardin, R. 2020. Modelling habitat use by the Guiana dolphin, *Sotalia guianensis*, in south-eastern Brazil: Effects of environmental and anthropogenic variables, and the adequacy of current management measures. *Aquatic Conservation: Marine and Freshwater Ecosystems* 30: 775-86.

Trujillo, F., Diazgranados, M.C., Garcia, C. and Dussan, S. 2006. *Sotalia guianensis*. pp.273-77. *Libro Rojo de los Mamíferos de Colombia*. Bogotá, Conservación Internacional, Ministerio de Medio Ambiente y Desarrollo Territorial.

Trujillo, F., Gartner, A., Caicedo, D. and Diazgranados, M. 2013. Diagnostico del Estado de Conocimiento y Conservacion de los Mamiferos Acuaticos en Colombia. Ministerio de Ambiente y Desarrollo Sostenible, Fundacion Omacha.

Trujillo, F., Caicedo-Herrera, D. and Diazgranados, M.C. 2014. Plan de acción nacional para la conservación de los mamiferos acuáticos en Colombia (PAN Mamiferos Colombia). Ministerio de Ambiente y Desarollo Territorial, Bogotá, Colombia.

Trujillo, F., Ortiz, E., Mosquera-Guerra, F., Prieto, J., Jauregui, A. and Pabon, K. 2017. Plan de conservacion y manejo de mamiferos acuaticos en el departamento del Magdalena. Corpamag, Fundacion Omacha, Fundacion Museo del Mar y Acuario y Museo del Mar Fospina S.A.S. Santa Marta, Colombia. 112pp.

Van Belleghem, T. and Domit, C. 2017. Which port activities pose the highest threats to coastal dolphins? Prioritization based on expert elicitation. Abstract SMM - Society for Marine Mammalogy's 22nd Biennial Conference of the Biology of Marine Mammals, Halifax, Nova Scotia, Canada.

Van Bressem, M.F., Raga, J.A., DiGuardo, G., Jepson, P.D. and Duignan, P.J. 2009. Emerging infectious diseases in cetaceans worldwide and the possible role of environmental stressors. *Dis. Aquat. Organ.* 86: 143-57. [Available at: *https://doi.org/10.3354/dao02101*].

Van Bressem, M.F., Van Waerebeek, K., Reyes, J., Félix, F., Echegaray, M., Siciliano, S., Di Beneditto, A.P., Flach, L., Viddi, F., Avila, I.C., Bolaños, J., Castineira, E., Montes, D., Crespo, E., Flores, P.A.C., Haase, B., Mendonca de Souza, S.M.F., Laeta, M. and Fragoso, A.B. 2007. A preliminary overview of skin and skeletal diseases and traumata in small cetaceans from South American waters. *Latin Am. J. Aquat. Mamm.* 6(1): 7-42.

Vianna, T.D.S., Loch, C., Castilho, P.V.D., Gaidzinski, M.C., Cremer, M.J. and Simões-Lopes, P.C. 2016. Review of thirty-two years of toothed whale strandings in Santa Catarina, southern Brazil (Cetacea: Odontoceti). *Zoologia* (*Curitiba*) 33(5): 1-11.

Vidal, O., Van Waerebeek, K. and Findley, L.T. 1994. Cetaceans and gillnet fisheries in Mexico, Central America and the wider Caribbean: a preliminary review. *Rep. Int. Whal. Comm. (special issue)* 15: 221-33.

Yogui, G.T., Santos, M.C.O., Bertozzi, C.P. and Montone, R.C. 2010. Levels of persistent organic pollutants and residual pattern of DDTs in small cetaceans from the coast of São Paulo, Brazil. *Mar. Poll. Bull.* 60: 1862-67.
Yogui, G.T., Santos, M.C.O., Bertozzi, C.P., Sericano, J.L. and Montone, R.C. 2011. PBDEs in the blubber of marine mammals from coastal areas of São Paulo, Brazil, southwestern Atlantic. *Mar. Poll. Bull.* 62: 2666-70.
Yogui, G.T., Santos, M.C.O. and Montone, R.C. 2003. Chlorinated pesticides and polychlorinated biphenyls in marine tucuxi dolphins (*Sotalia fluviatilis*) from the Cananéia estuary, southeastern Brazil. *Sci. Total Environ.* 312: 67-78.

Annex A

List of Participants

Alexandre Azevedo
UERJ, Brazil

André Barreto
UNIVALI, Brazil

Artur Andriolo
UFJF/Instituto Aqualie, Brazil

Camila Domit
UFPR, Brazil

Carolina Bertozzi
Instituto Biopesca, UNIFESP, Brazil

Leonardo Flach
IBC, Brazil

Marcos Rossi-Santos
UESC, Brazil

Rodrigo Tardin
UFRJ, Brazil

Haydée Cunha
UERJ, Brazil

Paulo Flores
ICMBio

Pedro Fruet
FURG

Flávio Lima
CEMAM/UERN

Susana Caballero
Universidad de los Andes, Colombia

Yurasi Briceño
Proyecto Sotalia - Instituto Venezolano de Investigaciones Científicas/IVIC, Centro de Ecologia, Venezuela

Annex B

Google Forms Participants

(Represented by their respective e-mails)

turtle.ste@gmail.com
caio.noritake@gmail.com
sj.caballero26@uniandes.edu.co
vridoux@univ-lr.fr
megapterax@yahoo.com
hbarriosg@gmail.com
yurasialejandra@gmail.com
mario.rollo@unesp.br
sousalima.renata@gmail.com
Holly.Edwards@myfwc.com
jjessicap@gmail.com
liboutros@gmail.com
monicagamboapo@gmail.com
fernando@omacha.org
abarreto@univali.br
mauriciocantor@yahoo.com
jdick@univali.br
contato@r3animal.org
oceanmaciel@gmail.com
guilherme.713@gmail.com
taihoppe@gmail.com
vitorluz@aquasis.org
renan_ptch@hotmail.com
lwedekin@yahoo.com.br
camilahaz@yahoo.com.br
alonso.mb@gmail.com
pedro.castilho@udesc.br
aleschi@uesc.br
mjc2209@yahoo.com.br
aazaccaron@gmail.com
anapaula@uenf.br
artur.andriolo@ufjf.edu.br
azevedo.alex@uol.com.br
rhtardin@gmail.com

Annex C

Agenda

Day 1 (25 November 2019)
Afternoon (14:00-18:30)
Welcome and participants presentation (14:00)
Proposed agenda (14:30)
IWC and Scientific Committee Guiana dolphin pre-assessment – Workshop objectives and future steps (15:00)

Coffee break (15:30)
Management and Conservation – Main results, data gaps and topic discussion (16:30)

Day 2 (26 November 2019)
Morning (08:30-12:30)
Population structure - Main results, data gaps and topic discussion (08:30)

Coffee break (10:30)
Proposal of population units (11:00)

Afternoon (14:00-18:30)
Abundance and trends - Main results, data gaps and topic discussion (14:00)

Coffee break (16:00)
Biological parameters - Main results, data gaps and topic discussion (16:30)

Day 3 (27 November 2019)
Morning (08:30-12:30)
Threats - Main results, data gaps and topic discussion (08:30)

Coffee break (10:30)
Threats - Main results, data gaps and topic discussion (11:00)

Afternoon (14:00-17:00)
Discussion about further issues (14:00)
Google forms: the researchers' perspectives (16:00)

Coffee break and meeting closing (16:30)

Day 4 (28 November 2019)
Morning and afternoon
Report compilation (08:30-12:00; 14:00-16:00)

Annex D

Scientific Paper Submitted to the IWC Scientific Committee (SC68B), Concerning the Review of Genetic Analysis and the Population Structure Proposal for Guiana Dolphin

SC/68B/SDDNA/06rev1. Cunha, H.A., Farro, A.P.C. and Caballero, S. Review of population structure studies for *Sotalia guianensis* and a proposal for Management Units. 9pp.
Document can be found at: *https://archive.iwc.int/?r=17367&k=3f8a29cf34.*

Annex E

Table Presenting the Anthropogenic Activities Potentially Impacting Guiana Dolphins Identified for Each Management Unit During the Workshop

Threat	BRS/SE	BRSE2	BRSE1	BRNE4	BRNE3	BRNE2	BRNE1	BRNO	FRGU	VEOR	VEML	CCOL
Port activities	1	1	1	1	1	1	0	1	1	1	1	1
Industrial activities	1	1	1	1	1	0	0	0	NA	1	1	0
Oil and gas exploration/ exploitation	1	1	1	0	1	1	1	1	NA	1	1	1
Mining	1 (Dragagem de areia para exploração)	0	0	0	NA	0	0	1	NA	1	1	1
Agriculture	1	1	1	0	0	0	0	0	NA	0	1	1
Aquaculture	1	0	0	0	0	1	1	NA	NA	0	1	0
Trawling	1	1	1	1	1	1	1	NA	NA	0	0	1
Gillnets	1	1	1	1	1	1	1	1	NA	1	1	1
Longlines	0	0	0	0	0	0	0	0	NA	0	0	0
Direct captures	0	0	0	1	0	1	0	1 (fish bait)	NA	1	1	0
Tourism	1	0	0	0	0	1	0	0	NA	0	1	0
Water sports	1	1	1	1	NA	1	1	NA	NA	0	0	0
Purse seines	1	1	NA	0	0	0	0	0	NA	0	0	0
Oil spills	1	1	1	1	1	1	1	1	NA	1	1	NA
Multi-activities	10	8	7	6	5	8	5	4	1	6	7	5
Recognised habitat loss	1	1	1	1	1	1	1	NA	NA	1	1	1

Annex F

Management and Conservation Actions by Country

Country	Specific management or conservation action (protected area, action plan, status evaluation, among others)	Law	Regional status (Red List)
Nicaragua	1	Yes	Deficient data
Honduras	0	Yes	Not evaluated
Costa Rica	0	Yes	Not evaluated
Panama	0	Yes	Not evaluated
Colombia	5	Yes	Vulnerable
Venezuela	3	Yes	Vulnerable
Guyana	1	Yes	Endangered
Suriname	1	Yes	Not evaluated
French Guiana	1	Yes	Endangered
Brazil	27	Yes	Vulnerable

Annex G

Existing Laws by Country Granting Some Protection to Guiana Dolphin Populations

Honduras
Gazzette No. 34,000 Decree No 115-2015. 2016. Animal Protection and Welfare Law.

Nicaragua
Presidential Decree (1991) - Create Cayos Miskito Reserve.

Costa Rica
Regulamento para la Operación de Actividades Relacionadas con Cetáceos en Costa Rica Nº 32495 its breach is punishable by Ley Orgánica del Ambiente Nº 7554, la Ley de Conservación de Vida Silvestre Nº 7317 y La Ley de Pesca y Acuacultura Nº 8436.

Panama
Gazette No. 28389-B Resolution 0530-2017. Whale watching in the jurisdictional waters of the Republic of Panama.

Colombia
Law (2005) from the Ministry of Environment and Territorial Development of Colombia.

Venezuela
Presidential Decree No. 1485 (1996). Species protected from hunting.

Presidential Decree No. 1486 (1996). On endangered species.

Ley de Protección de la Fauna Silvestre y su Reglamento No. 29.289/No. 4.925.

Guyana
Environmental Protection Agency (EPA) Act, 1996 [general protection of wildlife].

Suriname
Nature Protection Act 1954 and the Game Act 1954.

French Guiana
Law Arrêté du 1er juillet 2011 fixant la liste des mammifères marins protégés sur le territoire national et les modalités de leur protection.

Brazil
Nº 5197 (03 Jan. 1967). Protection of Fauna. Modifications: Nº 7653 (17 Feb. 1988) and Nº 9111 (10 Oct. 1995).

Nº 6938 (31 Aug. 1981). National Environmental Policy, its objectives and implementation mechanisms.

Nº 7643 (18 Dec. 1987). Prohibition of hunting or any form of intentional harassment of cetaceans in national jurisdiction waters.

Nº 9605 (12 Feb. 1998). Penal and administrative sanctions from detrimental behavior and activities to the environment (a.k.a. Environmental Crimes Law).

Nº 9985 (18 Jul. 2000) – National System of Protected Areas Federal Decrees.

Nº 88218 (06 Apr. 1983). Create the Abrolhos National Marine Park.

Nº 528 (20 May 1992). Create and define the limits of the Anhatomirim Environmental Protection Area, specially created to protect the local population of Sotalia fluviatilis.

Nº 3179 (21 Oct. 1999). Regulations pertaining to the Environmental Crimes Law. Regulations.

IBAMA (Instituto Brasileiro de Meio Ambiente e Recursos Naturais Renováveis). Nº 117 (26 Dec. 1996). Regulations to prevent harassment in national jurisdictional waters.

IBAMA Nº 05-N (20 Jan. 1998. Establish regulations to safeguard the reproduction, resting, and calving of *Sotalia fluviatilis* in the Anhatomirim Environmental Protection Area, Santa Catarina.

IBAMA Nº 98 (14 Apr. 2000). Regulations for the maintenance and management of aquatic mammals in captivity with the objectives of rehabilitation, research, education and public display.

Licenciamento Ambiental de atividades potencialmente poluidoras.

Lei de molestamento de cetáceos de 1987.

Annex H

Table Compiling Information on Management and Conservation Actions for Guiana Dolphins by Country

Protected area (national park, reserve, refuge)	Action Plan	National Red List*	Other
Brazil			
Área de Protección Ambiental de Anhatomirim (APAA), Baia Norte de la Isla de Santa Catarina	Action Plan for Aquatic Mammals of Brazil (IBAMA 1997, 2001, 2011, 2019)	Yes	Lista Oficial de Espécies da Fauna Ameaçada de Extinção do Estado de Santa Catarina, 2011
Plano de manejo da UC e seu zoneamento incluindo zona de proteção do golfinho *Sotalia guianensis*, Florianopolis on the coast of Santa Catarina	Plano de Conservação para Tetrápodes Marinhos no Paraná		Livro da Fauna do Paraná em Extinção, 2007
Decree nº 6698 17, December de 2008. Sanctuary	Plano de manejo da UC e seu zoneamento incluindo zona de proteção do golfinho Sotalia guianensis, Florianopolis on the coast of Santa Catarina		
Zoning with regulation of use in the Cananéia estuarine-lagoon complex			
Santuário as águas jurisdicionais marinhas brasileiras de baleias e golfinhos, Decreto nº 6698 17 de Dezembro de 2008			
APA Baía de Todos os Santos, 1999, Bahia State/Northeast Brazil			
Parque Nacional Marinho de Abrolhos, Abrolhos Bank. 1986			
APA Ponta da Baleia, Bahia State. 1993			
Reserva Faunística Costeira de Tibau do Sul, Rio Grande do Norte State/ Northeast Brazil. 2006			
Área de Proteção Ambiental (APA) Dunas do Rosado, Rio Grande do Norte State/Northeast Brazil. 2018			
Apa Marinha Boto-Cinza, Baia de Sepetiba/Mangaratiba (RJ).2015			
ESEC Tamoios, Baía de Ilha Grande/Paraty e Angra dos Reis (RJ). 1990			
Parque Estadual da Ilha Grande, Insular Baía de Ilha Grande (RJ). 1971			
APA Cairuçu, Baía de Ilha Grande e Paraty (RJ).			
APA de Setiba, Guarapari, Vila Velha (ES). 1994			
Parque Estadual Ilha do Cardoso, Cananéia (SP). 1962			
Parque Estadual Xixová-Japuí, São Vicente, Praia Grande/Litoral Central (SP). 1993			
Parque Estadual Marinho da Laje de Santos, Santos (SP). 1993			
Apa Marinha do Litoral Centro, Bertioga, Guarujá, Santos, São Vicente, Praia Grande, Mongaguá, Itanhaém, Peruíbe (SP). 2008			
Apa Marinha Litoral Norte. 2008			
APA Marinha Litoral Sul, Cananéia (SP). 2008			
Nicaragua			
No	No	Yes	-
Honduras			
No	No	No	-
Costa Rica			
No	No	No	-
Panama			
No	No	No	-

Protected area (national park, reserve, refuge)	Action Plan	National Red List*	Other
Colombia			
Protected area: Gulf of Morrosquillo	The action plan for South American river dolphins 2010-20; Management Plan for aquatic mammals in Colombia; Plan for the conservation and management of aquatic mammals (cetaceans, manatees and otters) of the department of Magdalena	Yes	-
Venezuela			
National Park: Ciénagas de Juan Manuel, Aguas Blancas y Aguas Negras, south of Lake Maracaibo	Plan de acción para la conservación de los mamíferos acuáticos de Venezuela: delfines de agua dulce, nutrias y manatíes 2017-27	Yes	-
Guyana			
No	No	Yes	-
Suriname			
No	No	No	Previously the Marine Mammals Conservation Corridor for Northern South America proposal; since 2015 no more activities undertaken
French Guiana			
No	No	Yes	

*following the IUCN criteria.

Annex I

Google Forms Questionnaire

Guiana dolphin pre-assessment - IWC.SC

Levantamento de trabalhos, dados e demais informações sobre o status de conhecimento sobre_Sotalia guianensis_

*Obrigatório

Endereço de e-mail *

Seu e-mail

Qual é a sua área de atuação? *