INSTITUTO DE BIOCIÊNCIAS
PROGRAMA DE PÓS-GRADUAÇÃO EM BIOLOGIA ANIMAL

ELISA BERLITZ ILHA

ODONTOCETES DISTRIBUTION AND MARINE PROTECTED AREAS: HOW FAR IS BRAZIL TO IMPROVE THE CONSERVATION OF THESE FAR-RANGING MARINE TOP PREDATORS?

PORTO ALEGRE
2020

ELISA BERLITZ ILHA

ODONTOCETES DISTRIBUTION AND MARINE PROTECTED AREAS: HOW FAR IS BRAZIL TO IMPROVE THE CONSERVATION OF THESE FAR-RANGING MARINE TOP PREDATORS?

Dissertação apresentada ao Programa de Pós-Graduação em Biologia Animal, Instituto de Biociências da Universidade Federal do Rio Grande do Sul, como requisito parcial à obtenção do título de Mestra em Biologia Animal.

Área de concentração: Biodiversidade, Conservação e Manejo

Orientador: Prof. Dr. Ignacio Benites Moreno

Coorientadora: Dra. Karina Bohrer do Amaral

PORTO ALEGRE

2020

ELISA BERLITZ ILHA

ODONTOCETES DISTRIBUTION AND MARINE PROTECTED AREAS: HOW FAR IS BRAZIL TO IMPROVE THE CONSERVATION OF THESE FAR-RANGING MARINE TOP PREDATORS?

Aprovada em 29 de junho de 2020.

BANCA EXAMINADORA

Avaliadora: Dra. Flávia Pereira Tirelli,
Universidade Federal do Rio Grande do Sul / Instituto Pró-Carnívoros

Avaliadora: Dra. Ana Bertoldi Carneiro,
BirdLife International

Avaliadora: Dra. Manuela Bassoi,
Universidade Federal do Rio Grande do Norte / Scientific Committee on Antarctic Research - Expert Group on Birds and Marine Mammals

Agradecimentos

Há – nesta constante desassociação da história humana à Terra – uma lógica civilizatória[1] que violenta a Natureza e suas tantas formas de vida. E há neste insaciável "progresso" que existe à luz desta civilização um esgotamento da vida. Vida que o próprio desenvolvimento ensinou a chamar de "recurso". A dissociação do *estar* e do *sentir-se parte* – impulsionada por uma forma de estrutura político-desenvolvimentista que vem sendo brutalmente imposta – emprega a urgência de diversas reações mínimas a favor da vida e, dentre elas, a ciência-utópica, me parece ter nome comum de conservação.

Mas, dentre todas nossas utopias – enquanto cientistas ou mesmo como população civil – há o ímpeto de um presente mais inacreditável que um futuro distópico. Há um Brazil que não conhece o Brasil, que não merece o Brasil e que vem matando o Brasil[2]. E é, portanto, extremamente difícil expressar qualquer utopia nos dias de hoje sem denunciar. Denunciar que tal crise é um projeto[3], ora, Darcy Ribeiro já o fez há muito tempo. Mas há também que denunciar o desmonte, o descrédito, o desamparo, o ecocídio. O que se assiste hoje, na contramão de todos os futuros imaginados, é a ampliação deste projeto. Um projeto exaustivo e violento, que assegura a concentração de bens (sejam eles de estar e até mesmo financiáveis) e que gera cada vez mais pobreza. Um projeto monocultural e patriarcal, contrário à diversidade que é inerente a vida, a vida aquela que nunca existirá como recurso; a vida que intrinsecamente tem valor e direito ancestral.

Enquanto a presente dissertação foi escrita, passaram as motosserras, as boiadas, as queimadas e a violência pela Amazônia. Ampliaram-se flexibilizações das leis ambientais, se ausentaram as fiscalizações e as multas aos grileiros, ruralistas e garimpeiros ilegais. Mais de 474 novos agrotóxicos foram permitidos (com a certeza de que muitos outros venenos ainda serão). Intensificou-se o projeto de desmonte do Sistema Nacional do Meio Ambiente. Ameaçaram-se os Conselhos e reduziu-se a participação da sociedade civil junto à conservação. Introduziu-se policiais militares não qualificados para a diretoria do Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio). Se expôs a Mata Atlântica, as restingas e os mangues ao eminente risco de extinção. Se ignorou o maior vazamento de óleo já registrado na costa marinha brasileira (e também nos oceanos tropicais!), enquanto cidadãs/ãos limpavam ecossistemas marinhos e costeiros com as próprias mãos. Não se cobrou nem um só real, nem

---

[1] Tão potentemente discutidas por Ailton Krenak em Ideias para Adiar o Fim do Mundo (2019) e por Davi Kopenawa em A Queda do Céu: Palavras de um Xamã Yanomami (2016).
[2] Querelas do Brasil, Adir Blanc & Maurício Tapajós, 1978.
[3] "*A crise da educação no Brasil não é uma crise; é um projeto*".

uma só vida perdida pelo rompimento criminoso da barragem da Mina Córrego do Feijão controlada pela criminosa Vale S.A. Reduziu-se drasticamente as verbas e os incentivos à pesquisa científica. Se apresentou um projeto de Future-se, que mais parece um túnel no tempo direto para um passado que ninguém imaginou voltar – principalmente após anos de uma Educação Pública, Gratuita e de Qualidade, que se tornava, ainda que lentamente, cada vez mais plural e afirmativa (como plenamente deverá vir a ser!). E, aos que tiveram, assim como eu, o privilégio deste acesso à educação (ou a tantos outros) – denunciar formal ou informalmente tamanho desaforo e posicionar-se contra ele, é o mínimo – o mínimo – a se fazer nos dias de hoje.

Mesmo assim, e felizmente, há quem – em afeto e em luta – nos faça lembrar de acreditar, também, nas utopias. E a todos/as esses *quems*, agradeço pro-fun-da-men-te. Aqui, por esta etapa, em especial:

À Karina do Amaral, minha querida coorientadora formalmente informal, pelo apoio, pela escuta, pelas trocas. Por todo o aprendizado, mas principalmente, por toda amizade. Agradeço de coração tua presença nesta etapa;

Ao Ignacio Moreno, pelas tantas oportunidades ao longo desses quase dez anos, pela confiança no meu trabalho, pela amizade e pela sempre grande empolgação que tens com as nossas alegrias e vitórias – sejam elas acadêmicas ou não;

À Maria João Ramos Pereira, que tem o coração tão aberto quanto a porta da sala, pelos conselhos, pelo apoio e pela força da mulher acadêmica que inspira;

Aos queridos/as amigos/as do LABSMAR, em todas as suas temporadas desde 2011, que cheios de carinho e afeto fizeram deste laboratório uma segunda casa, repleta de acolhimento e aprendizados;

Aos amigos Diego Janisch e Luiz Esser, pelas trocas e conversas do mundo dos modelos de distribuição e da vida;

Ao Dr. Alexandre Schiavetti, pela solicitude e por compartilhar uma compilação cuidadosa das Unidades de Conservação brasileiras;

Ao Dr. André Barreto, pelos dados do Sistema de Apoio ao Monitoramento de Mamíferos Marinhos (SIMMAM) e pelo grande esforço em tornar a informação de ocorrência de cetáceos pública e de qualidade;

Ao Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) pela bolsa concedida;

À minha querida família, a que nasceu comigo e a que escolhi ao longo do caminho, em especial à Glorinha e ao Pepo, por todo incentivo, companheirismo e infindo amor.

“Somos mesmo uma humanidade? Pensemos em nossas instituições mais bem consolidadas, como as universidades ou os organismos multilaterais, que surgiram no século XX: Banco Mundial, Organização dos Estados Americanos (OEA), Organização das Nações Unidas (ONU), Organização das Nações Unidas para a Educação (Unesco). Quando a gente quis criar uma reserva da biosfera em uma região do Brasil, foi preciso justificar para a Unesco porque era importante que o planeta não fosse devorado pela mineração. Para essa instituição, é como se bastasse manter apenas alguns lugares como amostra grátis da Terra. Se sobrevivermos, vamos brigar pelos pedaços de planeta que a gente não comeu, e os nossos netos e tataranetos – ou os netos dos nossos tataranetos- vão poder passear para ver como era a Terra no passado. Essas agências e instituições foram configuradas e mantidas como estruturas dessa humanidade. E nós, legitimamos sua perpetuação, aceitamos suas decisões, que muitas vezes são ruins e nos causam perdas, porque estão a serviço da humanidade que pensamos ser. (...) Enquanto isso, a humanidade vai sendo descolada de maneira tão absoluta desse organismo que é a terra. (...) Recurso natural para quem? Desenvolvimento sustentável para quê? O que é preciso sustentar?”

Ailton Krenak, em
Ideias para adiar o fim do mundo (2019)

“*E ele disse: que sabes do mar. Ela respondeu: o que imagino.*
Apenas o que imagino. E gosto.”

Valter Hugo Mãe, em
Homens imprudentemente poéticos (2016)

APRESENTAÇÃO

Esta dissertação de mestrado foi redigida conforme Resolução Nº37/2018 do Programa de Pós-Graduação em Biologia Animal (PPGBan) da Universidade Federal do Rio Grande do Sul. O texto principal está estruturado sob a forma de artigo científico, redigido em língua inglesa, visando a submissão no periódico *Frontiers in Marine Science* (seção *Marine Conservation and Sustainability*), e de acordo com as normas aos autores do referido periódico (https://www.frontiersin.org/about/author-guidelines). De acordo com o Artigo 43º do Regimento do PPGBan, o artigo está acompanhado de dois capítulos extras em português, sendo um introdutório e um conclusivo. O introdutório deve conter, de forma sucinta, uma descrição geral dos objetivos, uma revisão bibliográfica ampla e uma síntese dos resultados gerais; enquanto o conclusivo deve apresentar as principias conclusões do trabalho.

SUMÁRIO

Resumo: A conservação in situ de predadores de topo altamente móveis – como os cetáceos odontocetos – não é uma tarefa fácil e depende, também, da identificação e da preservação dos habitats onde (uma ou mais espécies) preferencialmente ocorrem. As áreas marinhas protegidas (MPAs), por sua vez, têm sido impulsionadas como a estratégia mais importante para mitigar os crescentes impactos antrópicos nos oceanos. Existem, contudo, poucas evidências empíricas da sua contribuição para os odontocetos e, no Brasil, a atual cobertura de MPAs tem sido atribuída a políticas públicas insidiosas. Nesta dissertação, buscamos entender o papel das características oceanográficas na distribuição da biodiversidade de odontocetos em águas brasileiras, bem como avaliar a contribuição da cobertura de MPAs e identificar áreas importantes para priorizações espaciais para a conservação dos odontocetos no Oceano Atlântico Sul Ocidental (SWA). A modelagem de distribuição de espécies (SDM) baseada no princípio da máxima entropia (MaxEnt) foi escolhida para gerar modelos para 17 espécies de odontocetos (15 Deficientes em Dados e duas Vulneráveis à ameaça de extinção) na Zona Econômica Exclusiva brasileira (EEZ) e águas adjacentes. A melhor configuração do modelo ($\Delta AICc = 0$) para cada espécie (SDM-individuais) foi projetada usando a função *complementary log-log* (cloglog) para produzir uma estimativa de probabilidade de ocorrência. Todos os modelos individuais apresentaram excelente desempenho preditivo (AUC> 0,9 e TSS> 0,7). Os SDM-individuais foram combinados para produzir um *stack-species distribution model* (S-SDM), onde os modelos individuais são sobrepostos em um contexto multi-espécie, permitindo a identificação de habitats críticos para as espécies. Duas áreas de maior probabilidade de ocorrência foram identificadas: uma em áreas neríticas e oceânicas profundas além da quebra da plataforma continental ao sul da Cadeia-Vitória Trindade e do Banco de Abrolhos até a área de influência da Convergência Subtropical (hotspot oceânico); e outra em uma área influenciada principalmente por ressurgências costeiras na zona urbana mais populosa do país (hotspot costeiro). Por meio de uma análise de lacunas, os modelos foram sobrepostos às atuais medidas de gestão espacial (cobertura de MPAs e Áreas Prioritárias para Conservação – PAC), bem como as ameaças antrópicas mapeadas (pesca comercial, indústrias marinhas de petróleo e gás e os portos). Apesar da alta porcentagem de cobertura de MPAs na EEZ brasileira (28%), esta é desigualmente distribuída entre as três províncias biogeográficas marinhas (Spanding et al., 2007) e é concentrada em águas costeiras – não cumprindo os requisitos estabelecidos pelas Metas de Aichi e representando, ainda, importantes lacunas para a conservação da maioria das espécies incluídas. Muitas MPAs ainda carecem de instrumentos necessários para garantir uma contribuição efetiva e, sozinhas (sem os recursos financeiros e logísticos necessários), parecem ser insuficientes para garantir a conservação da biodiversidade de odontocetos e de seus habitats críticos em águas brasileiras. Já o zoneamento proposto pelo PAC parece abranger áreas de alta probabilidade de ocorrência de odontocetos e poderia motivar um debate inicial sobre estratégias de manejo dinâmicas e/ou sobre o conceito das *Areas of Interest*, o primeiro estágio das *Important Marine Mammals Areas* (IMMAs) no contexto do planejamento espacial marinho brasileiro.

Palavras-chave: habitats críticos, análise de lacuna, áreas marinhas protegidas, modelos de distribuição de espécie, odontocetos, planejamento espacial marinho.

ABSTRACT: Cetaceans in situ conservation requires the preservation of species or populations, as well as the preservation of their preferred habitats. An important step towards this is to understand which habitats are used with higher frequency (for one or more species), and where environmental features (abiotic and biotic) are required to maintain a favorable conservation status. Here, we aimed to understand the role that oceanographic features play on odontocete distribution in the Western South Atlantic Ocean (SWA) to evaluate the suitability of existing Brazilian MPA policy and to identify areas of biological importance to spatial prioritizations for odontocete conservation. Species distribution modelling (SDM) based on the maximum entropy principle (MaxEnt) was chosen to generate models for 17 taxa of odontocete species in the Brazilian Economic Exclusive Zone. The best-fit model configuration (ΔAICc=0) for each species (individual-SDM) was projected using the complementary log-log link function to produce an estimate of occurrence probability. All individual-SDM presented an excellent predictive performance (AUC> 0.9 and TSS> 0.7). Individual-SDMs were combined to produce a Stacked-species distribution model (S-SDM) to identify odontocete ecological hotspots across multiple species, as well as the role of environmental features in driving odontocetes distribution patterns in the SWA. Two areas of major probability of occurrence were identified and can be understood as critical habitats. One is in neritic and deeper waters outer the continental shelf break south of Vitoria-Trindade seamount and the Abrolhos Bank until the Subtropical Convergence zone (offshore hotspot area); and other is in nearshore waters influenced by coastal upwellings in the most populous urbanized coastal region of Brazil (nearshore hotspot area). Through a gap analysis, the S-SDM was overlapped with the current spatial management measures (MPAs coverage and priority areas for conservation) and with the mapped anthropic threats (commercial fishing, oil and gas marine industries and ports). Both offshore and nearshore hotspot areas are under main anthropic threats. Despite the high percentage of coverage (28%), the current MPA policy is unevenly distributed among three marine biogeographical provinces and is most concentrated among the contiguous zone limits (24 nm). It highlights the Brazilian failure to meet Aichi Biodiversity Targets as well as important conservation gaps for most included species. The current MPA policy alone seems to be insufficient to guarantee the conservation of these far-ranging odontocetes and their preferred habitats over time.

Keywords: critical habitats, gap analysis, marine protected areas, marine spatial planning, odontocetes, species distribution model (SDM).

CAPÍTULO INTRODUTÓRIO

CONSERVAÇÃO *IN SITU* DE CETÁCEOS

Ao pretender a conservação *in situ* dos cetáceos (ordem Cetartiodactyla) é preciso considerar a preservação de estoques, populações e/ou espécies de cetáceos selvagens, assim como dos ambientes onde elas preferencialmente ocorrem (Reeves, 2018). Isso significa não apenas a proteção dos organismos em si, mas também dos ambientes – habitats e ecossistemas – que sustentam as comunidades bióticas às quais pertencem (Reeves, 2018). Nesse sentido, um passo importante é entender quais habitats são usados com maior frequência (por uma ou mais espécies) e onde as características ambientais (bióticas e abióticas) são necessárias para manter um *status* de conservação mais favorável ao longo do tempo (Cañadas et al., 2005; Pérez-Jorge et al., 2015).

A conservação *in situ* de predadores de topo altamente móveis como os cetáceos não é, contudo, uma tarefa fácil. As ocorrências em alto mar e/ou através de fronteiras políticas nacionais, as migrações de amplo alcance e a associação desses organismos com características oceanográficas dinâmicas em um ambiente tridimensional são alguns dos principais desafios atribuídos (Clark et al., 2010; Hoyt, 2018). Entre as baleias-verdadeiras (Mysticeti), por exemplo, a maioria das espécies migra por milhares de quilômetros duas vezes por ano entre áreas reprodutivas mais próximas aos trópicos e áreas de alimentação próximas aos polos (Hoyt, 2018; Stern & Friedlaender, 2018). Já entre os botos e golfinhos (Odontoceti), a maioria não apresenta padrões migratórios tão bem definidos e está ativamente buscando formas de atingir seus requerimentos energéticos. Para isso, costumam associar-se a características oceanográficas bem definidas e espacialmente dinâmicas que influenciam na distribuição e na agregação de suas presas (Hooker et al., 1999; Cañadas et al., 2002; Mannocci et al., 2017). A distribuição dos cetáceos portanto não é aleatória. É influenciada por características oceanográficas topográficas (como a batimetria) e hidrográficas persistentes (como correntes oceânicas e sistemas frontais) e efêmeras (como ressurgências ocasionadas por sistemas de ventos) (Hyrenbach et al., 2000; Forcada, 2018); assim como pela temperatura superficial da água do mar, a salinidade, a concentração de clorofila e a disponibilidade de produção primária (Baumgartner et al., 2001; Cañadas et al., 2002).

Além disso, devido a suas características de vida (como a longevidade, a maturidade tardia e as baixas taxas reprodutivas) os cetáceos são particularmente suscetíveis aos impactos antrópicos (Ballance, 2018; Passadore et al., 2018). A conservação desses organismos está em debate desde, pelo menos, meados do século XX, quando a caça comercial moderna levou diversas espécies –

especialmente de grandes cetáceos[4] – à beira da extinção (Zacharias et al., 2006; Reeves, 2018). Nas últimas décadas, contudo, outros desafios têm sido somados, ameaçando amplamente pequenos odontocetos em regiões costeiras e estuarinas (Secchi et al., 2003; Turvey et al., 2007; Rojas-Bracho & Reeves, 2013; Hamner et al., 2014; Azevedo et al., 2017; da Silva & Martin, 2018). Mapas de risco atuais para mamíferos marinhos, indicam que os odontocetos representam a maior parte das espécies em áreas de alto risco e que os impactos antrópicos atualmente existentes nas zonas costeiras acumulam níveis de ameaças nunca antes vistos (Avila et al., 2018). Por outro lado, muito menos se sabe sobre os níveis de ameaça sofridos por odontocetos de hábitos oceânicos, com ocorrência para além das águas nacionais de cada país.

As principais ameaças antropogênicas para a sobrevivência dos cetáceos são relacionadas à conflitos pesqueiros (como a sobrepesca, a captura incidental e o emaranhamento em redes fantasmas) – sobretudo aqueles de escala industrial (Fruet et al., 2012; Prado et al., 2013; Di Tullio et al., 2015; Avila et al., 2018). Entretanto, outras ameaças também têm sido frequentemente relatadas e se intensificam rapidamente, como: o aumento no tráfego de navios e a colisão com embarcações, a poluição sonora crônica, a poluição residual, a poluição química e as consequências das mudanças climáticas (Yogui et al., 2010; Bittencourt et al., 2014; Di Beneditto & Ramos, 2014; Rossi-Santos, 2014; Wedekin et al., 2014; Bezamat et al., 2015; Méndez-Fernandez et al., 2018; Moore, 2018).

ODONTOCETOS E AS ÁREAS MARINHAS PROTEGIDAS

Nas últimas décadas, as áreas marinhas protegidas[5] (MPAs) foram amplamente reconhecidas como uma das estratégias de conservação *in situ* mais importantes para mitigar os crescentes impactos antrópicos sobre os oceanos e as espécies marinhas (Agardy et al., 2011; Hilborn, 2016). Houve, por exemplo, um aumento de 2 milhões de km^2 cobertos por MPAs em 2000 (0,7% do oceano) para mais 26 milhões de km^2 em 2020 (7% do oceano) (UNEP-WCMC & IUCN, 2020). Esse grande aumento é atribuído, principalmente, ao surgimento de metas internacionais de conservação propostas por organizações multilaterais, como as Metas de Aichi, vinculadas à Convenção da Diversidade Biológica (CBD). As Metas de Aichi apresentam um plano estratégico para 2011-2020[6]

---

[4] Em inglês, o termo *great whales* refere-se às baleias-verdadeiras (Mysticeti) e ao cachalote (Odontoceti), cetáceos de grande porte amplamente explorados durante o período da caça comercial.
[5] O termo áreas marinhas protegidas é utilizado para se referir, simplesmente, a áreas protegidas (conhecidas no Brasil, também, como Unidades de Conservação – Brasil, 2000) que estão presentes no ecossistema marinho, que se estende desde a zona intertidal até o oceano profundo (Hoyt, 2018).
[6] O não cumprimento internacional das Metas de Aichi no período inicialmente determinado (2011-2020) levou a extensão das mesmas para 2030 (https://www.bioversityinternational.org/cbd/).

e estabelecem ações concretas a serem realizadas pelos governos signatários, como o Brasil. Entre as metas atreladas ao Objetivo Estratégico C, a Meta 11 definiu que:

> "Até 2020, pelo menos 17% das zonas terrestres e de águas continentais, e **10% das zonas costeiras e marinhas**, especialmente áreas de importância particular para biodiversidade e serviços ecossistêmicos, devem estar conservadas por meio de **gerenciamento eficiente e equitativo**, **ecologicamente representadas**, com **sistemas bem conectados de áreas protegidas** e outras medidas eficientes de conservação baseadas em área, e integradas em mais amplas paisagens terrestres e marinhas" (https://www.cbd.int/sp/targets/).

Entretanto, diversas evidências sugerem que a maioria das MPAs têm falhado em fornecer resultados ecológicos e sociais positivos (Hilborn, 2016; Gill et al., 2017) e que algumas das deficiências frequentemente relatadas (como tamanhos reduzidos e designs inapropriados, planejamentos e/ou gerenciamentos inadequados e, até mesmo, a degradação dos ecossistemas circundantes) podem resultar em MPAs ecologicamente insuficientes ou, até mesmo, criar perigosas ilusões de proteção (Agardy et al., 2011; 2016).

No que diz respeito aos cetáceos odontocetos, existem de fato poucos exemplos empíricos da eficiência das MPAs em contribuir para a sua conservação[7] (Gormley et al., 2012; O'Brien & Whitehead, 2013; Mintzer et al., 2015; Pinn, 2018). Há, entretanto, diversos insucessos que relatam: mudanças na distribuição de populações em relação aos limites das MPAs definidos (La Manna et al., 2014; Hartel et al., 2015); a falta de cumprimento ou da necessidade de medidas de conservação adicionais (Steckenreuter et al., 2012; Fossi et al., 2013); ou de decisões políticas que prevaleceram sobre considerações ecológicas (Notarbartolo Di Sciara et al., 2008; Agardy et al., 2011; Rojas-Bracho & Reeves, 2013; Pinn, 2018). Entre os odontocetos, há dois exemplos emblemáticos de MPAs que falharam em garantir a conservação das espécies as quais foram designadas para proteger (Agardy et al., 2011; Pinn, 2018) – a criticamente ameaçada vaquita (*Phocoena sinus*) no México (Rojas-Bracho et al., 2006; Rojas-Bracho & Reeves, 2013) e o possivelmente extinto baiji (*Lipotes vexillifer*) na China (Turvey et al., 2007, 2010) – evidenciando os enormes desafios que podem ser atribuídos à eficiência deste tipo de estratégia (Agardy et al., 2011; Pinn, 2018).

Não obstante – e considerando os avanços conceituais sobre o tema – tanto a identificação de habitats críticos como a aplicação de medidas de manejo dinâmicas parecem ter um papel

[7] Um importante questionamento a se fazer é: como, a partir de delimitações que são principalmente baseadas em limites fixos (forma através da qual são desenhadas a maioria das áreas protegidas em vigor, inclusive no Brasil), em um ambiente tridimensional, é possível contribuir para conservação de espécies amplamente móveis e que tem sua distribuição principalmente associada a características oceanográficas dinâmicas?

importante a desempenhar (Hooker et al., 2011; Becker et al., 2016; Notarbartolo di Sciara et al., 2016; Hoyt, 2018; Pinn, 2018; Agardy et al., 2019; Maxwell et al., 2020). Os habitats críticos[8] são locais ou condições oceanográficas que as populações (ou espécies ou estoques) de cetáceos utilizam regularmente para se alimentar, se reproduzir e socializar, incluindo, também, rotas migratórias e áreas fundamentais para a agregação de suas presas (Clark et al., 2010; Hoyt, 2011; Hoyt, 2018).

Áreas reprodutivas como o banco de Abrolhos para as baleias-jubarte (*Megaptera novaeangliae*) no Oceano Atlântico Sul Ocidental (Bortolotto et al., 2017), são um exemplo de habitats crítico mais facilmente identificável. Isso porque, todos os anos, uma das populações da espécie migra até a costa brasileira durante os meses de inverno e encontra as condições ambientais adequadas (águas protegidas e mais cálidas próximas da costa, geralmente associadas a ambientes coralíneos) para seu período reprodutivo (Bortolotto et al., 2017).

Contudo, condições oceanográficas que resultam em alta produtividade primária e, portanto, permitem a agregação de várias espécies, são também áreas essenciais de serem protegidas (Hyrenbach et al., 2000; Clark et al., 2010; Hoyt, 2018). Um exemplo disto é o *Ligurian Front*, no Mar Mediterrâneo, um sistema frontal permanente que resulta em uma importante área de alimentação e de reprodução para 13 espécies de cetáceos e que influenciou na criação do Santuário de Pelagos (Notarbartolo Di Sciara et al., 2008; Notarbartolo di Sciara et al., 2016; Pennino et al., 2017). A importância dessa condição oceanográfica para a conservação dos cetáceos no mar Mediterrâneo (em uma região pressionada por ações antrópicas) influenciou na criação deste santuário, que é reconhecido como um marco entre as MPAs, uma vez que: foi criado considerando a natureza dinâmica dos sistemas marinhos, por sua escala espacial ter sido definida em base a considerações oceanográficas (especificamente a localização do sistema frontal permanente da Ligúria) e, ainda, expandir as medidas protetivas para além das águas nacionais (abrindo um precedente para a implementação de áreas protegidas em alto mar, com uma administração compartilhada entre países) (Notarbartolo Di Sciara et al., 2008; Notarbartolo di Sciara et al., 2016; Pennino et al., 2017).

Entretanto, é preciso reconhecer, também, que o processo de demarcação espacial dos limites do santuário demorou uma década para ser estabelecido e que, ao final, prevaleceram decisões políticas (como haver uma divisão equitativa entre as águas territoriais dos países) sobre

---

[8] Os hábitos críticos não possuem, necessariamente, *status* regulatório de área protegida. Eles podem apenas reconhecer a importância de uma área e a necessidade de aplicar medidas de proteção (Pinn, 2018); ou também ser entendidos como o estágio inicial para a definição de futuras áreas protegidas (Clark et al., 2010).

considerações ecológicas (como abranger apropriadamente os limites do santuário sobre o habitat crítico desses cetáceos) (Notar artolo di Sciara et al., 2008; Agardy et al., 2011). Assim, uma grande zona com baixa densidade de cetáceos acabou sendo incluída nos limites desta MPA, enquanto uma parte do habitat crítico das espécies na zona pelágica foi deixada sem qualquer proteção, mesmo sendo esta uma zona de alto risco devido a constante circulação de frotas navais e navios de sísmica (Agardy et al., 2011). Além disso, mesmo com uma ampla área restritiva, o Santuário de Pelagos – assim como toda MPA existente – tão pouco é capaz de, isoladamente, proteger o ecossistema e as espécies marinhas[9] de todos os demais impactos que cada vez mais atingem os oceanos (como as consequências das mudanças climáticas, possíveis derramamentos de óleo, a contaminação por resíduos plásticos, a contaminação pelo escoamento terrestre e/ou por produtos químicos oriundos dos continentes).

DIVERSIDADE DE ODONTOCETOS E ÁREAS MARINHAS PROTEGIDAS NO BRASIL

Até o momento no Brasil foram registradas 49 espécies de cetáceos, sendo 40 odontocetos (Tabela 1) (Hrbek et al., 2014; Wickert et al., 2016; Cypriano-Souza et al., 2017; Bastida et al., 2018). Das oito espécies que estão incluídas na Lista Vermelha da Fauna Ameaçada de Extinção (MMA, 2014a), quatro[10] são odontocetos: os vulneráveis (VU) boto-cinza (*Sotalia guianensis*) e cachalote (*Physeter macrocephalus*), a criticamente ameaçada (CR) toninha (*Pontoporia blainvillei*) e o boto-da-Amazônia (*Inia geoffrensis*) em perigo de extinção (EN). As porcentagens mais alarmantes, no entanto, dizem respeito às espécies avaliadas como Deficientes em Dados (DD) (62,5%) e Não Avaliadas (NE) (25%) (Rocha-Campos et al., 2011a,b) – que não contam com nenhuma medida específica de proteção ou de manejo.

No que se refere às MPAs[11] brasileiras, em 2018, o governo brasileiro anunciou o aumento de 1,5% de MPAs marinhas de administração Federal para 25%, com a criação de dois conjuntos de MPAs nos arquipélagos oceânicos de São Pedro São Paulo e de Trindade e Martim-Vaz (Brasil, 2018a,b). Cada conjunto incluiu uma grande área de uso sustentável (na categoria Área de Proteção

---

[9] Já existem, inclusive, evidências de estresse toxicológico em odontocetos presentes no Santuário de Pélagos (golfinho-listrado *Stenella coeruleoalba*), testado para produtos químicos persistentes, bioacumuláveis e tóxicos (Fossi et al., 2013) – revelando uma das deficiências comumente atribuídas às MPAs: a degradação dos ecossistemas circundantes (Agardy et al., 2011; 2016).

[10] O boto-de-Lahille (*Tursiops gephyreus*) é uma espécie recentemente revalidada (Wickert et al., 2016) que deverá entrar na próxima lista de espécies ameaçadas, classificada como vulnerável.

[11] No Brasil, poucas MPAs foram designadas com o propósito explícito de proteger espécies cetáceos. Estas cobrem apenas proporções de alguns habitat críticos de três espécies costeiras (boto-cinza, baleia-jubarte e baleia-franca), sendo: Área de Proteção Ambiental (APA) Anhatomirim (SC), Reserva de Fauna Tibau do Sul (RN), APA boto-cinza (RJ), APA Ponta da Baleia (BA) e APA da baleia-franca (SC).

Ambiental, equivalente a categoria V da IUCN) cobrindo mais de 800,000 km^2 (representando 87,4% das áreas de proteção), ao redor de uma área de proteção integral menor (na categoria Monumento Natural, equivalente a categoria III da IUCN), cobrindo mais de 116.000 km^2 (representando apenas 12,6% das áreas de proteção) (Giglio et al., 2018).

Entretanto, aquilo que poderia ter sido um importante avanço na conservação marinha do país, revelou-se como mais uma política insidiosa quando os decretos de criação das áreas protegidas foram publicados (Brasil, 2018a, b; Magris & Pressey, 2018). Mudanças de cima para baixo foram feitas pelo governo federal em conjunto com a Marinha do Brasil, tanto nas categorias de manejo quanto no desenho das MPAs, ignorando as recomendações feitas por técnicos, por especialistas e pela população civil durante as etapas consultivas obrigatórias por lei (Giglio et al., 2018). Ainda, por decreto, foi mantida a permissão de pesca de "subsistência"[12] dentro das áreas de proteção integral e algumas das áreas ricas em biodiversidade e endemismos foram eliminadas, inclusive, dos limites de proteção de uso sustentável (Giglio et al., 2018; Magris & Pressey, 2018).

Uma vez que estas porcentagens de cobertura se anunciaram como perigosas ilusões de proteção (Agardy et al., 2003; 2016) e que estes arquipélagos são reconhecidamente importantes, também, para os cetáceos (Ott et al., 2009; Moreno et al., 2017; Ilha, 2018), questionou-se, então, qual era, de fato, a contribuição das áreas marinhas protegidas existentes no Brasil para os cetáceos odontocetos no Oceano Atlântico Sul Ocidental.

Descrição geral dos objetivos e metodologias utilizadas

O objetivo geral desta dissertação foi avaliar a cobertura e a contribuição das áreas marinhas protegidas (MPAs) brasileiras para a conservação da biodiversidade de cetáceos odontocetos no Oceano Atlântico Sul Ocidental (SWA). Tal delineamento baseou-se na Legislação Nacional sobre a prioridade de pesquisa para espécies Deficientes em Dados (MMA, 2014b); e nos compromissos assumidos pelo país enquanto signatário da Convenção sobre a Diversidade Biológica (Brasil, 1998); considerando os princípios e as diretrizes para a implementação da Política Nacional da Biodiversidade (Brasil, 2002; 2003) e as decisões sobre o Plano Estratégico de Biodiversidade 2011-

[12] Nenhuma destas ilhas têm uma população civil permanente ou populações tradicionais que dependem da pesca de subsistência. Em vez disso, existe a presença de atividades de pesca comercial a partir de embarcações industriais de empresas de pesca regionais (Giglio et al., 2018); e a pesca de "subsistência" referida é, de fato, mantida apenas para validar a pesca recreativa realizada por funcionários da Marinha do Brasil, mesmo com evidências de que esta prática já causou mudanças na estrutura da comunidade de peixes e no declínio de algumas das principais espécies-alvo de conservação (Pinheiro et al., 2010, 2015; Giglio et al., 2018).

2020, as Metas de Aichi e as Metas Nacionais de Biodiversidade 2011-2020 (CONABIO, 2013; MMA, 2014b).

Para tanto, foram compilados dados de ocorrência disponíveis de todas as espécies de odontocetos marinhas (n=36) registradas na costa brasileira, na Zona Econômica Exclusiva (EEZ) e em águas adjacentes (Tabela 1). A compilação dos dados foi realizada em bancos de dados públicos específicos para cetáceos[13], dados de pesquisa não publicados e em uma extensa revisão de artigos científicos. Tal revisão, permitiu a inclusão de 17 espécies de odontocetos nas análises[14], das quais duas estão nacionalmente classificadas como Vulneráveis (VU) e as outras 15 como Deficientes em Dados (DD) (Tabela 1).

Foram utilizadas duas abordagens principais: a) modelos de distribuição de espécies (s*pecies distribution modelling*, SDM) baseados no princípio de máxima entropia (MaxEnt) (Phillips et al., 2006; 2017); e b) análise de lacuna (*gap analysis*) (Hooker et al., 2011) envolvendo dados espaciais referentes à cobertura de MPAs, algumas das principais ameaças antrópicas identificadas e uma extensa revisão da legislação nacional associada às MPAs brasileiras.

Os SDMs são ferramentas amplamente utilizadas para prever a distribuição potencial das espécies (Elith & Leathwick, 2009) e identificar áreas de importância biológica visando a priorização espacial da conservação (Guisan & Thuiller, 2005). A implementação dessa abordagem no ecossistema marinho têm aumentado (Robinson et al., 2017) e contribuído para a identificação de habitats críticos (Cañadas et al., 2005; Gomez et al., 2017); de hotspots ecológicos (Tobeña et al., 2016; Zellmer et al., 2019); e para direcionar medidas de conservação e manejo para espécies de cetáceos (Bombosch et al., 2014; Zanardo et al., 2017; Passadore et al., 2018).

Dentre os vários algoritmos atualmente existentes (Elith & Leathwick, 2009) – para os cetáceos – o MaxEnt é conhecido por apresentar bom desempenho preditivo quando comparado à modelos de presença-ausência (Derville et al., 2018; Passadore et al., 2018), além de demonstrar ser capaz de gerar modelos com um nível relativamente alto de complexidade e precisão (do Amaral et al., 2015; Tobeña et al., 2016; Barragán-Barrera et al., 2019). No presente trabalho, este algoritmo foi escolhido por seu desempenho preditivo (Elith et al., 2006, 2011) e, ainda, por ser menos sensível ao tamanho amostral pequeno (Pearson et al., 2007; Wisz et al., 2008).

---

[13] O Sistema de Apoio ao Monitoramento de Mamíferos Marinhos (SIMMAM) (http://simmam.acad.univali.br/webgis/) e o Projeto de Monitoramento de Cetáceos na Bacia de Santos (PMC-BS) (http://sispmcprd.petrobras.com.br/sispmc). No que se refere ao SIMMAM (que contêm categorias de confiança para cada registro inserido), foram utilizados apenas aqueles registros catalogados como "certeza".

[14] Considerando a utilização estrita de dados de avistagem e um número mínimo de 10 registros de ocorrência por espécie após a verificação e limpeza dos dados (ver *Material and Methods*).

Foram gerados modelos individuais para cada uma das espécies incluídas. O melhor modelo para cada espécie (ΔAICc = 0) teve o output projetado a partir da função *complementary log-log link* (cloglog) de modo a produzir uma estimativa de probabilidade de ocorrência (Phillips et al., 2017). Os modelos individuais foram, então, combinados através do *Stack-species distribution model* (S-SDM), de modo a identificar áreas onde a probabilidade de ocorrência de várias espécies é maior quando comparada à áreas adjacentes (Calabrese et al., 2014; D'Amen et al., 2015; Phillips et al., 2017; Zellmer et al., 2019). Os objetivos específicos desta etapa foram: i) a identificação de áreas ecologicamente importantes para diversas espécies de odontocetos (hotspots ecológicos); e ii) compreender o papel das características oceanográficas na influência dos padrões de distribuição dos odontocetos no SWA.

A abordagem do S-SDM foi utilizada para identificar áreas de maior adequabilidade ambiental em um contexto multi-espécie (Calabrese et al., 2014; Tobeña et al., 2016; Phillips et al., 2017; Zellmer et al., 2019). Optou-se por essa abordagem em oposição à combinação de mapas binários (ou seja, de presença e ausência) já que, apesar de amplamente utilizados, estes podem ser tendenciosos ou enviesados uma vez que dependem da definição arbitrária de limiares de corte (*threshold*) (Calabrese et al., 2014; D'Amen et al., 2015; Zellmer et al., 2019).

Já no que diz respeito a análise de lacunas, esta é considerada uma estratégia importante para apoiar o planejamento espacial marinho (*marine spatial planning*), de modo a facilitar a priorização de medidas de conservação e melhorar a representatividade de áreas protegidas já existentes (Hooker et al., 2011; Gomez et al., 2017). O objetivo específico foi, portanto, identificar correspondências e/ou incompatibilidades entre: as ameaças antrópicas mapeadas, a cobertura de estratégias de conservação *in situ* (com ênfase nas MPAs, mas considerando, também, a política das Áreas Prioritárias para a Conservação) e os hotspots ecológicos resultantes do S-SDM.

Dentre os impactos mapeados estão: o esforço da pesca comercial mapeada por satélites, a partir da plataforma *Global Fishing Watch* (https://globalfishingwatch.org/); da localização das bacias de extração e de processamento de petróleo e gás a partir da Agencia Nacional de Petróleo e Gás (http://www.anp.gov.br/); e, ainda, dos maiores portos costeiros nacionais através da Agência Nacional de Transportes Aquaviários (http://portal.antaq.gov.br/).

Tabela 1. Revisão das informações sobre a ocorrência de cetáceos odontocetos no Brasil. Compilação dos dados de ocorrência (avistagens e encalhes) das espécies de odontocetos já registradas na costa brasileira, na Zona Econômica Exclusiva e em águas adjacentes. É apresentado: o *status* de conservação à nível global (IUCN) e nacional (Rocha-Campos et al., 2011a; 2011b; MMA, 2014b) e a presença destas espécies em relação às províncias biogeográficas (*sensu* Spalding et al., 2007) presentes na área de estudo. PNBS = Província do Norte do Brasil (PNBS); PTSA = Província do Atlântico Sul Ocidental Tropical; PWTSA = Província do Atlântico Sul Ocidental Temperado-Quente. Aquelas espécies que constam como "incluídas nas análises" são as que compõem as análises realizadas para este estudo e mais informações são encontradas sobre elas no segundo capítulo.

Espécies	Nome comum	IUCN	BRASIL	Informação compilada	PNBS	PTSA	PWTSA
DELPHINIDAE							
Cephalorhynchus commersonii	Golfinho-de-Commerson	LC	NE	Um registro encalhe (Pinedo et al., 2002a)	-	-	**X**
Delphinus sp.	Golfinho-comum	DD	DD	Incluída nas análises	**X**	**X**	**X**
Feresa attenuata	Orca-pigmeia	LC	DD	Incluída nas análises	**X**	**X**	**X**
Globicephala macrorhynchus	Baleia-piloto-de-peitorais-curtas	LC	DD	Incluída nas análises	**X**	**X**	**X**
Globicephala melas	Baleia-piloto-de-peitorais-longas	LC	DD	Incluída nas análises	-	-	**X**
Grampus griseus	Golfinho-de-Risso	LC	DD	Incluída nas análises	**X**	**X**	**X**
Lagenodelphis hosei	Golfinho-de-Fraser	LC	DD	Encalhes registrados ao longo da costa brasileira (Haimovici & Aguiar dos Santos, 2001; Pinedo et al., 2001; Moreno et al., 2003; Dorneles et al., 2007; Siciliano et al., 2008; Meirelles et al., 2009; Santos et al., 2010b; Melo et al., 2010; Lailson-Brito et al., 2012; Santos-Neto et al., 2014; Costa et al., 2017); e duas avistagens oriundas de bancos de dados públicos (SIMMAM e PMC-BS)	**X**	**X**	**X**
Lagenorhynchus australis	Golfinho-de-Peale	LC	NE	Um registro de encalhe (Pinedo et al., 2002a)	-	-	**X**
Lissodelphis peronii	Golfinho-liso-do-sul	LC	NE	Um espécime encalhado vivo (Martuscelli et al., 1995)	-	-	**X**
Orcinus orca	Orca	DD	DD	Incluída nas análises	-	**X**	**X**
Peponocephala electra	Golfinho-cabeça-de-melão	LC	DD	Incluída nas análises	**X**	**X**	**X**
Pseudorca crassidens	Falsa-orca	NT	DD	Incluída nas análises	**X**	**X**	**X**
Sotalia fluviatilis	Tucuxi	DD	**NT***	Espécie não marinha	-	-	-
Sotalia guianensis	Boto-cinza	NT	**VU***	Incluída nas análises	**X**	**X**	**X**
Stenella attenuata	Golfinho-pintado-pantropical	LC	DD	Incluída nas análises	**X**	**X**	**X**
Stenella clymene	Golfinho-de-Clymene	LC	DD	Incluída nas análises	**X**	**X**	**X**
Stenella coeruleoalba	Golfinho-listrado	LC	DD	Incluída nas análises	-	**X**	**X**

Stenella frontalis	Golfinho-pintado-do-Atlântico	LC	DD	Incluída nas análises	**X**	**X**	**X**
Stenella longirostris	Golfinho-rotador	LC	DD	Incluída nas análises	**X**	**X**	**X**
Steno bredanensis	Golfinho-de-dentes-rugosos	LC	DD	Incluída nas análises	**X**	**X**	**X**
Tursiops truncatus	Golfinho-nariz-de-garrafa	LC	DD	Incluída nas análises (como *Tursiops* spp.)	**X**	**X**	**X**
Tursiops gephyreus	Boto-de-Lahille	VU	NE	Incluída nas análises (como *Tursiops* spp.)	-	-	**X**
PHYSETERIDAE							
Physeter macrocephalus	Cachalote	VU	**VU***	Incluída nas análises	**X**	**X**	**X**
KOGIIDAE							
Kogia sima	Cachalote-anão	DD	DD	Encalhes reportados ao longo da costa brasileira (Soto et al., 1999, Maia Nogueira & Serra., 2001; Dorneles et al., 2008; Siciliano et al., 2008; Souto et al., 2009; Santos et al., 2010; Ott et al., 2013; Di Azevedo et al., 2015, 2017; Moura et al., 2016); e duas avistagens confirmadas oriundas de bancos de dados públicos (PMC-BS) e de dados não publicados (LABSMAR)	**X**	**X**	**X**
Kogia breviceps	Cachalote-pigmeu	DD	DD	Encalhes reportados ao longo da costa brasileira e ilhas oceânicas (Carvalho, 1966; Geise & Borobia, 1987; Soto et al., 1999; Maia Nogueira & Serra., 2001; Gurjão et al., 2003; Bloodworth & Odell, 2008; Dorneles et al., 2008; Siciliano et al., 2008; Souto et al., 2009; Santos et al., 2010; Ott et al., 2013; Di Azevedo et al., 2017; Moura et al., 2016; Prado et al., 2016)	-	**X**	**X**
ZIPHIIDAE							
Berardius arnuxii	Baleia-bicuda-de-Arnoux	DD	DD	Um espécime boiando morto (Siciliano & De Oliveira Santos, 2003) e poucos encalhados (Ott et al., 2013; Prado et al., 2016)	-	-	**X**
Hyperoodon planifrons	Baleia-bicuda-do-sul	LC	DD	Três encalhes (Gianuca & Castello, 1976; Soto & Vega, 1997; Cimardi, 1996) e uma avistagem reportada (Santos & Figueiredo, 2016)	-	-	**X**
Mesoplodon densirostris	Baleia-bicuda-de-Blainville	DD	DD	Quatro registros de encalhe (Castello & Pinedo, 1980; Lichter, 1986; Simões-Lopes & Ximenez, 1993; Secchi & Zarzur, 1999; Bastida et al., 2018)	-	**X**	**X**
Mesoplodon europaeus	Baleia-bicuda-de-Gervais	DD	NE	Alguns registros de encalhe (Martins et al., 2004; Santos et al., 2005; Meirelles et al., 2009; de Oliveira Santos et al., 2010b; Di Azevedo et al., 2016)	-	**X**	**X**

Mesoplodon grayi	Baleia-bicuda-de-Gray	DD	DD	Quatro registros de encalhe (Soto & Vega, 1997; Pinedo et al., 2001; Di Tullio, 2005; Ott et al., 2013)	-	-	**X**
Mesoplodon hectori	Baleia-bicuda-de-Hector	DD	DD	Um registro de encalhe (Zerbini & Secchi, 2001; Prado et al., 2016)	-	-	**X**
Mesoplodon layardii	Baleia-bicuda-de-Layard	DD	DD	Três registros de encalhe (Pinedo et al., 2002; Siciliano & Franco, 2005; Maia-Nogueira & Nunes, 2005; Prado et al., 2016)	-	**X**	**X**
Mesoplodon mirus	Baleia-bicuda-de-True	DD	NE	Um registro de encalhe (Souza et al., 2005)	-	-	**X**
Ziphius cavirostris	Baleia-bicuda-de-Cuvier	LC	DD	Encalhes registrados ao longo da costa brasileira e ilhas oceânicas (Zanelatto et al., 1995; Alves-Júnior et al., 1996; Pinedo et al., 2001; Macleod et al., 2005; Di Tullio, 2005; Santos et al., 2010b; Mayorga et al., 2010; Fisch & Port, 2013; Ott et al., 2013; Bortolotto et al., 2016; Prado et al., 2016)	-	**X**	**X**
INIIDAE							
Inia geoffrensis	Boto-cor-de-rosa	EN	**EN***	Espécie não marinha	-	-	-
Inia boliviensis	Boto	NE	NE	Espécie não marinha	-	-	-
Inia araguaiaensis	Boto	NE	NE	Espécie não marinha	-	-	-
PONTOPORIDAE							
Pontoporia blainvillei	Toninha	VU	CR*	Incluída e retirada das análises	-	**X**	**X**
PHOCIIDAE							
Phocoena spinipinnis	Boto-de-Burmeister	NT	NE	Encalhes registrados na costa brasileira (Simões-Lopes & Ximenez, 1989; Pinedo, 1989; Molina-Schiller et al., 2005; Ott et al., 2013; Prado et al., 2016)	-	-	**X**
Phocoena dioptrica	Boto-de-óculos	LC	NE	Um registro de encalhe (Pinedo et al., 2002a)	-	-	**X**

SÍNTESE DOS RESULTADOS GERAIS

Na presente dissertação, modelos de distribuição potencial para 17 espécies de odontocetos foram aplicados em um contexto de multi-espécie (S-SDM) para a identificação de áreas ecologicamente importantes. No que se refere aos modelos individuais (individual-SDM), todos apresentaram um excelente desempenho preditivo (AUC> 0.9 e TSS> 0.7) indicando robustez. A topografia batimétrica foi a variável que mais contribuiu para os modelos. Os mapas de distribuição potencial para cada espécie são discutidos individualmente no Material Suplementar (Figuras Suplementares 3 – 19), enquanto o artigo discute os resultados em base a grupos funcionais, definidos de acordo com a filogenia conhecida e as informações ecológicas obtidas.

Dentre os odontocetos oceânicos estão: i) os “*black-fishes*“ e o golfinho-de-Risso (*Globicephala melas*, *G. macrorhynchus*, *Feresa attenuata*, *Pseudorca crassidens*, *Peponocephala electra* e *Grampus griseus*) com preferências por águas oceânicas e profundas (<1.000 m) e pertencentes a subfamília Globicephalinae; ii) pequenos golfinhos oceânicos do gênero *Stenella* (*S. attenuata*, *S. longirostris*, *S. coeruleoalba* e *S. clymene*) que pertencem a subfamília Delphininae; e iii) o cachalote (*Physeter macrocephalus*) com preferência por águas profundas ao longo da borda externa da plataforma continental.

Entre os odontocetos considerados de "ampla distribuição" (*wide-ranging*) estão espécies da subfamília Delphininae que têm registros em águas costeiras, neríticas e oceânicas (*Delphinus* sp., *Orcinus orca*, *Tursiops* spp. e *Steno bredanensis*). A faixa batimétrica que essas espécies são observadas pode variar, por exemplo, de poucos metros há 3.000 m de profundidade. Já as espécies costeiras mostraram preferências por águas costeiras e neríticas rasas e são também da subfamília Delphininae (*Sotalia guianensis* e *S. frontalis*). Dentre as últimas, o boto-cinza (*S. guianensis*) foi a única espécie estritamente costeira incluída nas análises; enquanto o golfinho-pintado-do-Atlântico (*S. frontalis*) – apesar de ter registros, também, em águas mais profundas – parece ter preferência por águas mais quentes e com até 200 m de profundidade.

O S-SDM identificou duas áreas de maior probabilidade de ocorrência para várias espécies, sendo: uma em regiões neríticas e oceânicas além da plataforma continental (*offshore hotspot area*) ao sul da Cadeia Vitória-Trindade e do Banco de Abrolhos até a zona de influência da Convergência Subtropical; e outra próxima da costa na região sudeste do país em uma área influenciada principalmente por ressurgências costeiras (*nearshore hotspot area*) (Figura 1). Ambas as áreas podem ser entendidas como hábitats críticos para várias espécies, devido a frequência com que as espécies ocorrem e a alta produtividade primária associada a características oceanográficas bem definidas e que podem proporcionar a agregação de suas presas.

Através da análise de lacunas, identificou-se que mais de 28% da EEZ é coberta por MPAs, mas que essa porcentagem é desigualmente distribuída entre as províncias biogeográficas (Figura 2). A província do Norte do Brasil (PNBS) tem 3% de cobertura por MPAs, a província do Atlântico Sul Ocidental Tropical (PTSA) 25% e a província do Atlântico Sul Ocidental Temperado-Quente (PWTSA) 0,4%. Entretanto, no que se refere às porcentagens presentes na PTSA, apenas os dois conjuntos de MPAs ao redor dos arquipélagos oceânicos de São Pedro e São Paulo e de Trindade e Martim-Vaz são responsáveis por quase 24%.

A partir de um ranking gerado através da sobreposição dos polígonos das MPAs aos valores resultantes do S-SDM, pode-se observar que: as MPAs com maior potencial de abrigar áreas costeiras ecologicamente importantes para várias espécies estão presentes no sudeste do Brasil; enquanto às áreas neríticas e oceânicas ecologicamente importantes carecem de quaisquer medidas protetivas de forma geral. Dentre as MPAs que podem influenciar diretamente na conservação de odontocetos (tipos I e II), 70 são de administração federal, 75 estaduais e 15 municipais. Dentre as federais – as quais esses documentos estão disponibilizados de forma padronizada na página do ICMBio – só 47% apresentam planos de manejo aprovados e, dentre essa porcentagem, apenas 27% citam alguma medida diretamente vinculada aos odontocetos (e.g., monitoramento acústico, avançar no conhecimento científico, regular áreas de pesca, não-molestamento de espécies durante o turismo, etc.).

A categoria de gestão mais frequente é a Área de Proteção Ambiental, que representa a categoria de gestão menos restritiva do país (Schiavetti et al., 2013). Com exceção daquelas ao redor das ilhas oceânicas brasileiras (Atol das Rocas, Fernando de Noronha, São Pedro e São Paulo e Trindade e Martim-Vaz) e uma na costa nordeste (Parque Estadual Marinho Manuel Luís), as demais MPAs estão situadas em águas costeiras. Não há áreas protegidas após a Zona Contígua (até 24 nm), nem outras em águas oceânicas, sendo essa uma importante lacuna de proteção para espécies oceânicas e de ampla distribuição. Ambas as áreas identificadas como ecologicamente importantes estão, também, sob constante pressão dos principais impactos antrópicos mapeados (Figura 2).

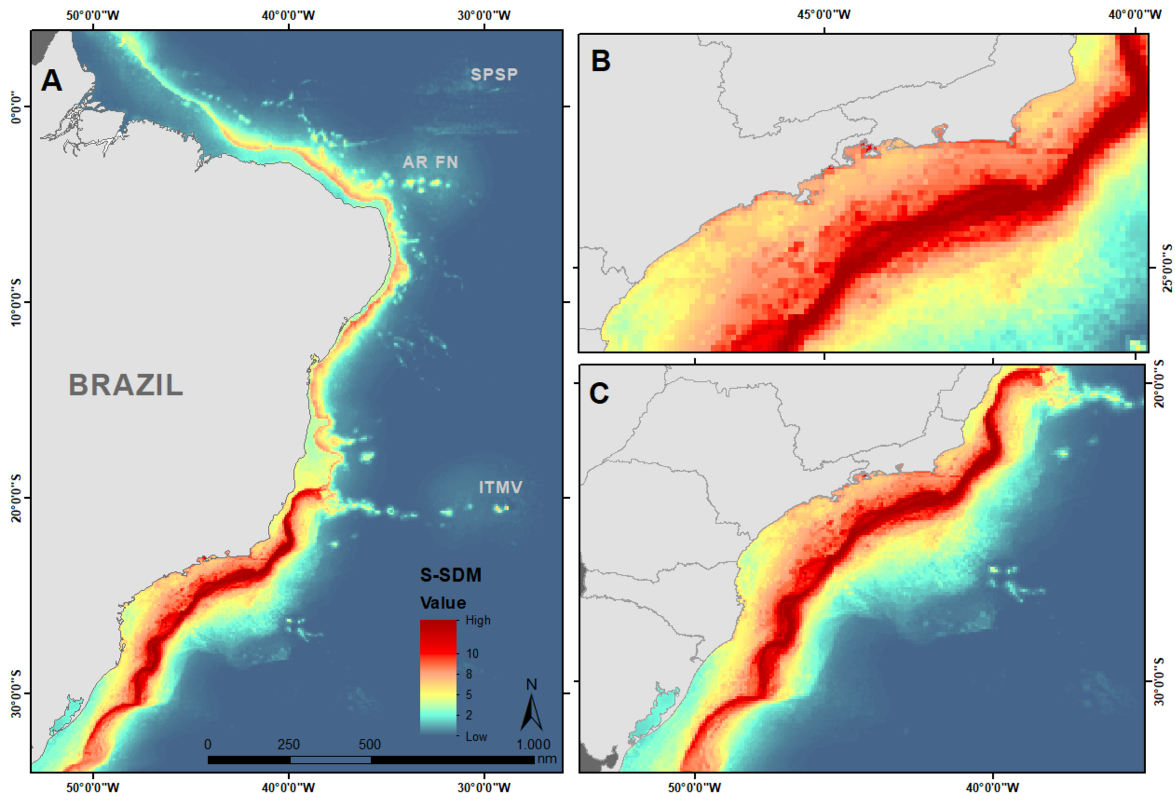


FIGURA 1. *STACK-SPECIES DISTRIBUTION MODELS* (S-SDM) MOSTRANDO ÁREAS DE MAIOR PROBABILIDADE DE OCORRÊNCIA PARA ODONTOCETOS NO BRASIL. Individual-SDM foram gerados para 17 espécies e então combinados através do S-SDM: A) resultado geral; B) aproximação para o hotspot costeiro; e C) aproximação para o hotspot oceânico. Escala de cores mostra os scores do S-SDM pela probabilidade de ocorrência predita (cloglog).

A primeira parte da discussão foi estruturada no papel das características oceanográficas na influência dos padrões de distribuição dos odontocetos no SWA, considerando os hotspots ecológicos identificados pelo S-SDM. Já a segunda, se baseia na análise de lacunas para discutir a conservação dos odontocetos em águas jurisdicionais brasileiras – a partir de estratégias de conservação baseadas em limites fixos (MPAs) e a potencial contribuição das Áreas Prioritárias para a Conservação (PAC) motivando o debate inicial sobre estratégias de manejo dinâmicas e sobre o conceito das *Areas of Interest* (AoIs), o primeiro estágio das *Important Marine Mammals Areas* (IMMAs) (https://www.marinemammalhabitat.org/).

Os resultados foram interpretados à luz das províncias biogeográficas marinhas (*Marine Ecoregions of the Word* - MEOW) (Spalding et al., 2007), uma vez que estas são consideradas importantes para o desenvolvimento de sistemas ecologicamente representativos de áreas protegidas (Spalding et al., 2007) e entendendo a natureza heterogênea da área de estudo.

Por último – e entendendo o contexto de pós-verdade em que estamos globalmente inseridos – destaca-se que esta dissertação não tem como objetivo invalidar ou desacreditar as áreas marinhas protegidas como estratégias de gestão, ou tão pouco atribuir a falta de eficácia das MPAs aos gestores/as desses espaços que são, sem dúvida alguma, de existência fundamental. Qualquer um/uma que se interesse pela conservação marinha sabe, aliás, que tais profissionais, equipes e comunidades se esforçam diária e amplamente em prol da conservação, mesmo com recursos humanos e financeiros extremamente limitados, com pessoal reduzido e a falta de apoio logístico e financeiro por parte dos governos Federal, estaduais e municipais.

Esta dissertação busca apenas incentivar a discussão sobre o papel das áreas marinhas protegidas no que se refere a conservação dos cetáceos odontocetos (em base aos avanços teóricos na área) e como nós – enquanto pesquisadores/as, educadores/as, gestores/as e ambientalistas – podemos contribuir para uma política de conservação mais eficaz, avaliando quais são os principais desafios para a efetividade das MPAs e como poderíamos superá-los, repensando estratégias e imaginando novas possibilidades nos caminhos da conservação.

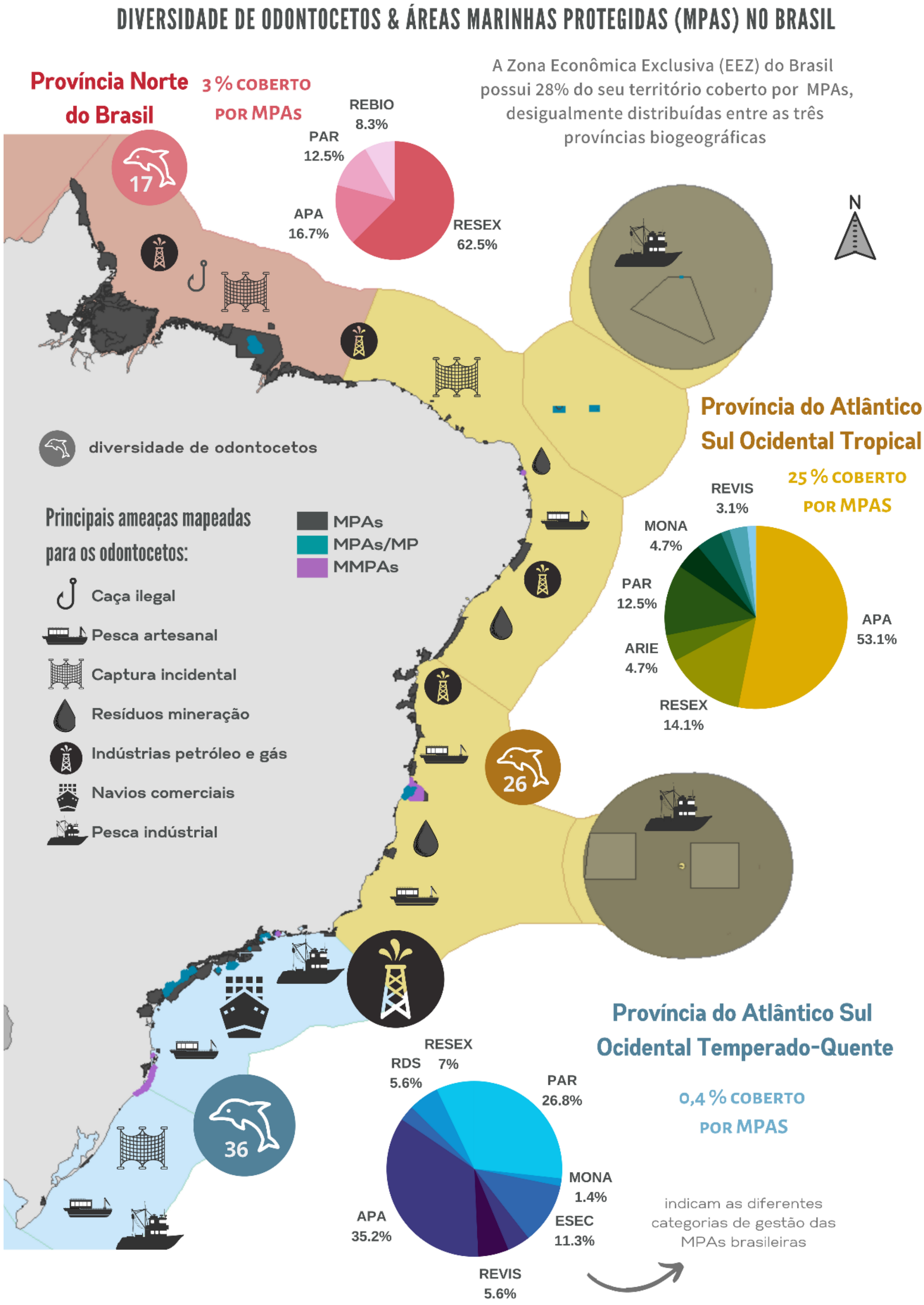


FIGURA 2. DIVERSIDADE DE ODONTOCETOS E AS ÁREAS MARINHAS PROTEGIDAS NO BRASIL. MPAs = áreas marinhas protegidas (também conhecidas como Unidades de Conservação); MPAs/MP = MPAs em que o Plano de Manejo contém estratégias direcionadas aos cetáceos (ainda que estes não sejam seu objetivo central); MMPAs = MPAs criadas com cetáceos como seu objetivo central de conservação.

Referências

Alves-Júnior, T. T., Ávila, F. J., de Oliveira, J. A., Furtado-Neto, M. A., and Monteiro-Neto, C. (1996). Registros de cetáceos para o litoral do estado do Ceará, Brasil. *Arq. Ciên. Mar* 30, 79–92. doi:10.32360/acmar.v30i1-2.31398.

Agardy, T., Claudet, J., and Day, J. C. (2016). 'Dangerous Targets' revisited: Old dangers in new contexts plague marine protected areas. *Aquat. Conserv. Mar. Freshw. Ecosyst*. 26, 7–23. doi:10.1002/aqc.2675.

Agardy, T., Cody, M., Hastings, S., Hoyt, E., Nelson, A., Tetley, M., et al. (2019). Looking beyond the horizon: An early warning system to keep marine mammal information relevant for conservation. *Aquat. Conserv. Mar. Freshw. Ecosyst.* 29, 71–83. doi:10.1002/aqc.3072.

Agardy, T., di Sciara, G. N., and Christie, P. (2011). Mind the gap: Addressing the shortcomings of marine protected areas through large scale marine spatial planning. *Mar. Policy* 35, 226–232. doi:10.1016/j.marpol.2010.10.006.

Agardy, T., Bridgewater, P., Crosby, M.P., Day, J., Dayton, P.K., et al. 2003. Dangerous targets?: Unresolved issues and ideological clashes around marine protected areas. Aquat. Conserv. Mar. Freshw. Ecosyst., 13: 353–367.

Avila, I. C., Kaschner, K., and Dormann, C. F. (2018). Current global risks to marine mammals: Taking stock of the threats. *Biol. Conserv*. 221, 44–58. doi:10.1016/j.biocon.2018.02.021.

Azevedo, A. de F., Carvalho, R. R., Kajin, M., Van Sluys, M., Bisi, T. L., Chunha, H. A., et al. (2017). The first confirmed decline of a delphinid population from Brazilian waters : 2000 – 2015 abundance of Sotalia guianensis in Guanabara Bay , South-eastern Brazil. *Ecol. Indic*. 79, 1–10. doi:10.1016/j.ecolind.2017.03.045.

Ballance, L. T. (2018). Cetacean Ecology. Encycl. Mar. Mamm., 172–180. doi:10.1016/b978-0-12-804327-1.00087-x.

Barragán-Barrera, D. C., do Amaral, K. B., Chávez-Carreño, P. A., Farías-Curtidor, N., Lancheros-Neva, R., Botero-Acosta, N., et al. (2019). Ecological niche modeling of three species of stenella dolphins in the Caribbean basin, with application to the seaflower biosphere reserve. Front. Mar. Sci. 6, 1–17. doi:10.3389/fmars.2019.00010.

Baumgartner, M. F., Mullin, K. D., May, L. N., and Leming, T. D. (2001). Cetacean habitats in the northern Gulf of Mexico. *Fish. Bull.* 99, 219–239.

Becker, E. A., Forney, K. A., Fiedler, P. C., Barlow, J., Chivers, S. J., Edwards, C. A., et al. (2016). Moving towards dynamic ocean management: How well do modeled ocean products predict species distributions? *Remote Sens*. 8, 1–26. doi:10.3390/rs8020149.

Bloodworth, B.E., Odell, D.K. (2008) *Kogia breviceps*. *Mamm. Spec.* 819:1–12. DOI: 10.1644/819.1

Brasil. (1998). Decreto Nº 2.519, de 16 de março de 1998. Promulga a Convenção sobre Diversidade Biológica, assinada no Rio de Janeiro, em 05 de junho de 1992. Disponível em: https://www.planalto.gov.br/ccivil_03/decreto/d2519.htm

Brasil. (2000). Sistema Nacional de Unidades de Conservação da Natureza. Lei nº 9.985, de 18 de julho de (2000). Disponível em: http://www.planalto.gov.br/ccivil_03/leis/l9985.htm

Brasil. (2002). Decreto Nº 4.339, de 22 de agosto de 2002. Institui princípios e diretrizes para a implementação da Política Nacional da Biodiversidade. Disponível em: http://www.planalto.gov.br/ccivil_03/decreto/2002/D4339.htm

Brasil. (2003). Decreto Nº 4.703, de 21 de maio de 2003. Dispõe sobre o Programa Nacional da Diversidade Biológica - PRONABIO e a Comissão Nacional da Biodiversidade, e dá outras providências. Disponível em: https://www.mma.gov.br/estruturas/conabio/_arquivos/dec4703_03conabio.pdf

Bombosch, A., Zitterbart, D. P., Van Opzeeland, I., Frickenhaus, S., Burkhardt, E., Wisz, M. S., et al. (2014). Predictive habitat modelling of humpback (Megaptera novaeangliae) and Antarctic minke (*Balaenoptera bonaerensis*) whales in the Southern Ocean as a planning tool for seismic surveys. *Deep. Res. Part I Oceanogr. Res. Pap.* 91, 101–114. doi:10.1016/j.dsr.2014.05.017.

Bortolotto, G. A., Danilewicz, D., Hammond, P. S., Thomas, L., and Zerbini, A. N. (2017). Whale distribution in a breeding area: Spatial models of habitat use and abundance of western South Atlantic humpback whales. *Mar. Ecol. Prog. Ser.* 585, 213–227. doi:10.3354/meps12393.

Bortolotto, G. A., Morais, I. O. B., Ferreira, P. R. B., Dos Reis, M. D. S. S., and Souto, L. R. A. (2016). Anthropogenic impact on a pregnant Cuvier's beaked whale (*Ziphius cavirostris*) stranded in Brazil. *Mar. Biodivers. Rec.* 9, 1–5. doi:10.1186/s41200-016-0055-0.

Calabrese, J. M., Certain, G., Kraan, C., and Dormann, C. F. (2014). Stacking species distribution models and adjusting bias by linking them to macroecological models. *Glob. Ecol. Biogeogr*. 23, 99–112. doi:10.1111/geb.12102.

Cañadas, A., Sagarminaga, R., De Stephanis, R., Urquiola, E., and Hammond, P. S. (2005). Habitat preference modelling as a conservation tool: Proposals for marine protected areas for cetaceans in southern Spanish waters. *Aquat. Conserv. Mar. Freshw. Ecosyst.* 15, 495–521. doi:10.1002/aqc.689.

Cañadas, A., Sagarminaga, R., and García-Tiscar, S. (2002). Cetacean distribution related with depth and slope in the Mediterranean waters off southern Spain. *Deep. Res. Part I Oceanogr. Res. Pap.* 49, 2053–2073. doi:10.1016/S0967-0637(02)00123-1.

Carvalho, C.T. (1966). Notas sobre *Kogia breviceps* (Cetacea: Physeteridae). *Rev. Biol. Trop.* 14 (2): 169-181

Castello, H. P., and Pinedo, M. C. (1980). *Mesoplodon densirostris* (Cetacea, Ziphiidae), primeiro registro para o Atlântico Sul Ocidental. *Brazilian J. Oceanogr.* 29, 91–94. doi:10.1590/s1679-87591980000200020.

Clark, J., Dolman, S. J., and Hoyt, E. (2010). Towards Marine Protected Areas for Cetaceans in Scotland, England and Wales: A scientific review identifying critical habitat with key recommendations.

Cimardi, A.V. Mamíferos de Santa Catarina. Florianópolis: FATMA, 1996. 302 p.

Conabio. (2013). Resolução CONABIO Nº 06, de 03 de setembro de 2013. Dispõe sobre as Metas Nacionais de Biodiversidade para 2020. Disponível em: http://www.rbma.org.br/anuariomataatlantica/pdf/metas_nacionais_biodiversidade_cdb_2020.pdf

Costa, A. F., Siciliano, S., Emin-Lima, R., Martins, B. M. L., Sousa, M. E. M., Giarrizzo, T., et al. (2017). Stranding survey as a framework to investigate rare cetacean records of the north and north-eastern Brazilian coasts. *Zookeys* 2017, 111–134. doi:10.3897/zookeys.688.12636.

Cypriano-Souza, A. L., de Meirelles, A. C. O., Carvalho, V. L., and Bonatto, S. L. (2017). Rare or cryptic? The first report of an Omura's whale (Balaenoptera omurai) in the South Atlantic Ocean. *Mar. Mammal Sci.* 33, 80–95. doi:10.1111/mms.12348.

D'Amen, M., Dubuis, A., Fernandes, R. F., Pottier, J., Pellissier, L., and Guisan, A. (2015). Using species richness and functional traits predictions to constrain assemblage predictions from stacked species distribution models. *J. Biogeogr.* 42, 1255–1266. doi:10.1111/jbi.12485.

da Silva, V. M. F., and Martin, A. R. (2018). "Amazon River Dolphin," in Encyclopedia of Marine Mammals, 21–24. doi:10.1016/b978-0-12-804327-1.00044-3.

Derville, S., Torres, L. G., Iovan, C., and Garrigue, C. (2018). Finding the right fit: Comparative cetacean distribution models using multiple data sources and statistical approaches. *Divers. Distrib.* 24, 1657–1673. doi:10.1111/ddi.12782.

Di Azevedo, M. I. N., Carvalho, V. L., and Iñiguez, A. M. (2016). First record of the anisakid nematode Anisakis nascettii in the Gervais' beaked whale *Mesoplodon europaeus* from Brazil. *J. Helminthol.* 90, 48–53. doi:10.1017/S0022149X14000765.

Di Azevedo, M. I. N., Carvalho, V. L., and Iñiguez, A. M. (2017). Integrative taxonomy of anisakid nematodes in stranded cetaceans from Brazilian waters: an update on parasite's hosts and geographical records. *Parasitol. Res.* 116, 3105–3116. doi:10.1007/s00436-017-5622-8.

Di Azevedo, M. I. N., Knoff, M., Carvalho, V. L., Mello, W. N., Lopes Torres, E. J., Gomes, D. C., et al. (2015). Morphological and genetic identification of *Anisakis paggiae* (Nematoda: Anisakidae) in dwarf sperm whale *Kogia sima* from Brazilian waters. *Dis. Aquat. Organ.* 113, 103–111. doi:10.3354/dao02831.

Di Tullio, J. C., Goodall, N., Secchi, E. R., de Oliveira, M. C. and Siciliano, S. (2005). Strandings of beaked whales along the western South Atlantic: relative frequency of species, seasonality and zoogeography. In: *16th Biennial Conference on the Biology of Marine Mammals*, 2005, San Diego, 2005.

do Amaral, K. B., Alvares, D. J., Heinzelmann, L., Borges-Martins, M., Siciliano, S., and Moreno, I. B. (2015). Ecological niche modeling of Stenella dolphins (Cetartiodactyla: Delphinidae) in the southwestern Atlantic Ocean. *J. Exp. Mar. Bio. Ecol.* 472, 166–179. doi:10.1016/j.jembe.2015.07.013.

Dorneles, P. R., Lailson-Brito, J., dos Santos, R. A., Silva da Costa, P. A., Malm, O., Azevedo, A. F., et al. (2007). Cephalopods and cetaceans as indicators of offshore bioavailability of cadmium off Central South Brazil Bight. *Environ. Pollut.* 148, 352–359. doi:10.1016/j.envpol.2006.09.022.

Dorneles, P. R., Lailson-Brito, J., Fernandez, M. A. S., Vidal, L. G., Barbosa, L. A., Azevedo, A. F., et al. (2008). Evaluation of cetacean exposure to organotin compounds in Brazilian waters through hepatic total tin concentrations. *Environ. Pollut.* 156, 1268–1276. doi:10.1016/j.envpol.2008.03.007.

Elith, J., Graham, C. H., Anderson, R. P., Dudı´k, M., Ferrier, S., Guisan, A., et al. (2006). Novel methods improve prediction of species' distributions from occurrence data. *Ecography,* 29, 129–151. doi:10.1111/j.1432-1033.1987.tb13499.x.

Elith, J., and Leathwick, J. R. (2009). Species Distribution Models: Ecological Explanation and Prediction Across Space and Time. *Annu. Rev. Ecol. Evol. Syst.* 40, 677–697. doi:10.1146/annurev.ecolsys.110308.120159.

Elith, J., Phillips, S. J., Hastie, T., Dudík, M., Chee, Y. E., and Yates, C. J. (2011). A statistical explanation of MaxEnt for ecologists. *Divers. Distrib.* 17, 43–57. doi:10.1111/j.1472-4642.2010.00725.x.

Fisch, F., and Port, D. (2013). New stranding record of *Ziphius cavirostris* (Cuvier, 1823) (Cetacea: Ziphiidae) at Trindade Island, Brazil. *Rev. Eletrônica Biol.* 6, 286–291.

Forcada, J. (2018). "Distribution," in Encyclopedia of Marine Mammals, 259–262. doi:10.1016/B978-0-12-804327-1.00106-0.

Fossi, M. C., Panti, C., Marsili, L., Maltese, S., Spinsanti, G., Casini, S., et al. (2013). The Pelagos Sanctuary for Mediterranean marine mammals: Marine Protected Area (MPA) or marine polluted area? The case study of the striped dolphin (*Stenella coeruleoalba*). *Mar. Pollut. Bull.* 70, 64–72. doi:10.1016/j.marpolbul.2013.02.013.

Geise, B, Borobia, M (1987) New brazilian records for *Kogia*, *Pontoporia*, *Grampus* and *Sotalia* (Cetacea, Physeteridae, Platanistidae and Delphinidae). *J. Mamm.*, 68(4):873-875.

Gianuca, N. M., and Castello, H. P. (1976). First record of the southern bottlenose whale, *Hyperoodon planifrons*, from Brazil. Sci. *Reports Whales Res. Inst.* 28, 119–126.

Giglio, V. J., Pinheiro, H. T., Bender, M. G., Bonaldo, R. M., Costa-Lotufo, L. V., Ferreira, C. E. L., et al. (2018). Large and remote marine protected areas in the South Atlantic Ocean are flawed and raise concerns: Comments on Soares and Lucas (2018). *Mar. Policy* 96, 13–17. doi:10.1016/j.marpol.2018.07.017.

Gill, D. A., Mascia, M. B., Ahmadia, G. N., Glew, L., Lester, S. E., Barnes, M., et al. (2017). Capacity shortfalls hinder the performance of marine protected areas globally. *Nature* 543, 665–669. doi:10.1038/nature21708.

Gomez, C., Lawson, J., Kouwenberg, A. L., Moors-Murphy, H., Buren, A., Fuentes-Yaco, C., et al. (2017). Predicted distribution of whales at risk: Identifying priority areas to enhance cetacean monitoring in the Northwest Atlantic Ocean. *Endanger. Species Res*. 32, 437–458. doi:10.3354/esr00823.

Gormley, A. M., Slooten, E., Dawson, S., Barker, R. J., Rayment, W., Du Fresne, S., et al. (2012). First evidence that marine protected areas can work for marine mammals. *J. Appl. Ecol.* 49, 474–480. doi:10.1111/j.1365-2664.2012.02121.x.

Guisan, A., and Thuiller, W. (2005). Predicting species distribution: Offering more than simple habitat models. Ecol. Lett. 8, 993–1009. doi:10.1111/j.1461-0248.2005.00792.x.

Gurjão, L.M., Furtado-Neto, M.A., dos Santos, R.A., Cascon, P. (2003) Notes on diet of sperm whales (Cetacea: Physeteroidea), stranded in Ceará State, Northeastern Brazil. *Arq. Ciên. Mar*, 36: 67-75.

Haimovici, M., and Aguiar dos Santos, R. (2001). Cephalopods in the diet of marine mammals stranded or incidentally caught along southeastern and southern Brazil (21–34°S). *Fish. Res.* 52, 99–112.

Hamner, R. M., Wade, P., Oremus, M., Stanley, M., Brown, P., Constantine, R., et al. (2014). Critically low abundance and limits to humanrelated mortality for the Maui's dolphin. *Endanger. Species Res.* 26, 87–92. doi:10.3354/esr00621.

Hartel, E. F., Constantine, R., and Torres, L. G. (2015). Changes in habitat use patterns by bottlenose dolphins over a 10-year period render static management boundaries ineffective. *Aquat. Conserv. Mar. Freshw. Ecosyst.* 25, 562–572. doi:10.1002/aqc.2465.

Hilborn, R. (2016). Policy: Marine biodiversity needs more than protection. Nature 535, 224–226. doi:10.1038/535224a.

Hooker, S. K., Cañadas, A., Hyrenbach, K. D., Corrigan, C., Polovina, J. J., and Reeves, R. R. (2011). Making protected area networks effective for marine top predators. Endanger. *Species Res.* 13, 203–218. doi:10.3354/esr00322.

Hooker, S. K., Whitehead, H., and Gowans, S. (1999). Marine protected area design and the spatial and temporal distribution of cetaceans in a submarine canyon. *Conserv. Biol.* 13, 592–602. doi:10.1046/j.1523-1739.1999.98099.x.

Hoyt, E. (2011). Marine Protected Areas for Whales, Dolphins and Porpoises. Earthscan, 464p.

Hoyt, E. (2018). "Marine Protected Areas," in Encyclopedia of Marine Mammals, eds. B. Würsig, J. G. M. Thewissen, and K. M. Kovacs (Academic Press), 569–580. doi:https://doi.org/10.1016/C2015-0-00820-6.

Hrbek, T., Da Silva, V. M. F., Dutra, N., Gravena, W., Martin, A. R., and Farias, I. P. (2014). A new species of river dolphin from Brazil or: How little do we know our biodiversity. *PLoS One* 9. doi:10.1371/journal.pone.0083623.
Hyrenbach, D. K., Forney, K. A., and Dayton, P. K. (2000). Viewpoint: Marine protected areas and ocean basin management. *Aquat. Conserv. Mar. Freshw. Ecosyst*. 10, 437–458. doi:10.1002/1099-0755(200011/12)10:6<437::AID-AQC425>3.0.CO;2-Q.
Ilha, E.B. (2018). Cetáceos da Cadeia Vitória-Trindade e áreas adjacentes. Trabalho de Conclusão de Curso apresentado à Comissão de Graduação de Ciências Biológicas da Universidade Federal do Rio Grande do Sul como requisito obrigatório para obtenção do grau de Bacharela em Ciências Biológicas. Disponível em: https://www.lume.ufrgs.br/handle/10183/230442
Lailson-Brito, J., Dorneles, P. R., Azevedo-Silva, C. E., Bisi, T. L., Vidal, L. G., Legat, L. N., et al. (2012). Organochlorine compound accumulation in delphinids from Rio de Janeiro State, southeastern Brazilian coast. *Sci. Total Environ.* 433, 123–131. doi:10.1016/j.scitotenv.2012.06.030.
La Manna, G., Manghi, M., and Sarà, G. (2014). Monitoring the habitat use of common bottlenose dolphins (Tursiops truncatus) using passive acoustics in a Mediterranean marine protected area. *Mediterr. Mar. Sci.* 15, 327–337. doi:10.12681/mms.561.
Lichter, A. A. (1986). Records of beaked whales (Ziphiidae) from the Western South Atlantic. *Sci. Reports Whales Res. Inst.* 46, 109–127.
Macleod, C., Perrin, W., Pitman, R., Barlow, J., Ballance, L., D Amico, A., et al. (2005). Known and inferred distributions of beaked whale species (Cetacea: Ziphiidae). *J. Cetacean Res. Manag.* 7, 271.
Magris, R. A., and Pressey, R. L. (2018). Marine protected areas: Just for show? *Science*, 360, 723–724. doi:10.1126/science.aat6215.
Maia-Nogueira, R., and Nunes, J. A. A. C. (2005). Record of the Layard's beaked whale, *Mesoplodon layardii* (Gray, 1856), in northeastern Brazil. *Lat. Am. J. Aquat. Mamm.* 4, 137–139. doi:10.5597/lajam00082.
Maia Nogueira, R., and Serra., C. G. B. and S. D. (2001). Revisão dos registros do gênero *Kogia* (Gray, 1846) (Cetacea, Physeteridae, Kogiinae) no litoral do nordeste do Brasil, incluindo dados osteológicos. *Bioikos* 15 (1): 50-59.
Mannocci, L., Boustany, A. M., Roberts, J. J., Palacios, D. M., Dunn, D. C., Halpin, P. N., et al. (2017). Temporal resolutions in species distribution models of highly mobile marine animals: Recommendations for ecologists and managers. *Divers. Distrib.* 23, 1098–1109. doi:10.1111/ddi.12609.
Martins, A. M. A., Alves, Jr., T. J., Furtado Neto, M. A. A., and Lien, J. (2004). The most northern record of Gervais' beaked whale, *Mesoplodon europaeus* (Gervais, 1855), for the Southern Hemisphere. *Lat. Am. J. Aquat. Mamm*. 3, 151–155. doi:10.5597/lajam00059.
Martuscelli, P.; Milanelo, M.; Olmos, F. 1995. First record of Arnoux's beaked whale (*Berardius arnuxii*) and southern right-whale dolphin (*Lissodelphis peronii*) from *Brazil. Mammalia.*, 59 (2): 274-275.
Mayorga, L. F. S. P., Barbosa, L. A., and Bhering, R. C. C. (2010). Primeiros registros de encalhe de *Ziphius cavirostris* (Cetacea, Odontoceti) na costa do Espírito Santo, Brasil Luis. *Biotemas* 23, 223–226.
Maxwell, S. M., Gjerde, K. M., Conners, M. G., and Crowder, L. B. (2020). Mobile protected areas for biodiversity on the high seas. *Science*, 367, 252–254. doi:10.1126/science.aaz9327.
MMA. (2006a). Deliberação CONABIO No 40, de 07 de fevereiro de 2006. Available at: https://www.mma.gov.br/estruturas/conabio/_arquivos/Delib_040.pdf
MMA, (2006b). Decreto No 5.758, de 13 de abril de 2006. Available at: https://www.mma.gov.br/estruturas/240/_arquivos/decreto_5758_2006_pnap_240.pdf
MMA. (2014a). Portaria MMA No 444, de 17 de dezembro de 2014. Available at: http://pesquisa.in.gov.br/imprensa/jsp/visualiza/index.jsp?jornal=1&pagina=121&data=18/12/2014
MMA. (2014b). Portaria MMA No 43, de 31 de janeiro de 2014. Available at: http://www.dados.gov.br/dataset/123123
MMA. (2018). Portaria nº 463 de 18 de dezembro de 2018. Available at: http://areasprioritarias.mma.gov.br/.
Meirelles, A. C. O., Monteiro-Neto, C., Martins, A. M. A., Costa, A. F., Barros, H. M. D. R., and Alves, M. D. O. (2009). Cetacean strandings on the coast of Ceará, North-eastern Brazil. *J. Mar. Biol. Assoc. United Kingdom* 89, 1083–1090. doi:10.1017/S0025315409002215.
Melo, C. L. C., Santos, R. A., Bassoi, M., Araújo, A. C., Lailson-Brito, J., Dorneles, P. R., et al. (2010). Feeding habits of delphinids (Mammalia: Cetacea) from Rio de Janeiro State, *Brazil. J. Mar. Biol. Assoc. United Kingdom* 90, 1509–1515. doi:10.1017/S0025315409991639.

Mintzer, V. J., Schmink, M., Lorenzen, K., Frazer, T. K., Martin, A. R., and da Silva, V. M. F. (2015). Attitudes and behaviors toward Amazon River dolphins (*Inia geoffrensis*) in a sustainable use protected area. Biodivers. Conserv. 24, 247–269. doi:10.1007/s10531-014-0805-4.

Molina-Schiller, D., Rosales, S. A., and Freitas, T. R. O. (2005). Oceanographic conditions off coastal South America in relation to the distribution of Burmeister's porpoise, *Phocoena spinipinnis*. *Lat. Am. J. Aquat. Mamm.* 4, 141–156. doi:http://dx.doi.org/10.5597/lajam00078.

Moore, S.E. 2018. Climate Change. in Encyclopedia of Marine Mammals, 194-197. doi:10.1016/B978-0-12-804327-1.00106-0.

Moreno, I. B., Danilewicz, D., Borges-Martins, M., Ott, P. H., Caon, G., and Oliveira, L. R. (2003). Fraser's dolphin (*Lagenodelphis hosei* Fraser, 1956) in southern Brazil. *Lat. Am. J. Aquat. Mamm.* 2, 39–46. doi:10.5597/lajam00029

Moreno I.B., Amaral K.B., Camargo Y.R., Dorneles D.R., Frainer G. et al (2017) Cetáceos da Ilha da Trindade e Arquipélago de Martin Vaz. In: PROTRINDADE: programa de pesquisas científicas na Ilha da Trindade: 10 anos de pesquisas / SECIRM – Brasília, 200 p.

Moura, J. F., Acevedo-Trejos, E., Tavares, D. C., Meirelles, A. C. O., Silva, C. P. N., Oliveira, L. R., et al. (2016). Stranding events of *Kogia* whales along the Brazilian coast. *PLoS One* 11, 1–15. doi:10.1371/journal.pone.0146108.

Notarbartolo Di Sciara, G., Agardy, T., Hyrenbach, D., Scovazzi, T., and Van Klaveren, P. (2008). The Pelagos Sanctuary for Mediterranean marine mammals. Aquat. Conserv. Mar. Freshw. Ecosyst. 18, 367–391. doi:10.1002/aqc.855.

Notarbartolo di Sciara, G., Hoyt, E., Reeves, R., Ardron, J., Marsh, H., Vongraven, D., et al. (2016). Place-based approaches to marine mammal conservation. Aquat. Conserv. Mar. Freshw. Ecosyst. 26, 85–100. doi:10.1002/aqc.2642.

O'Brien, K., and Whitehead, H. (2013). Population analysis of Endangered northern bottlenose whales on the Scotian Shelf seven years after the establishment of a Marine Protected Area. Endanger. Species Res. 21, 273–284. doi:10.3354/esr00533.

Ott P.H., Tavares M., Secchi E.R., Di Tullio J.C. (2013) Cetacea. Mamíferos do Rio Grande do Sul, Editora UFSM, 457-550p.

Ott, P.H.,Tavares, M., Moreno, I.B., Oliveira, L.R., Danilewicz, D. (2009) Os Cetáceos do Arquipélago de São Pedro e São Paulo, Brasil. In: Ilhas Oceânicas Brasileiras: da pesquisa ao manejo volume II / Editors: Mohr, L.V. et al. Brasília: MMA/Secretaria de Biodiversidade e Florestas, 283-300p.

Passadore, C., Möller, L. M., Diaz-Aguirre, F., and Parra, G. J. (2018). Modelling Dolphin Distribution to Inform Future Spatial Conservation Decisions in a Marine Protected Area. *Sci. Rep.* 8, 1–14. doi:10.1038/s41598-018-34095-2.

Pearson, R. G., Raxworthy, C. J., Nakamura, M., and Townsend Peterson, A. (2007). Predicting species distributions from small numbers of occurrence records: A test case using cryptic geckos in Madagascar. *J. Biogeogr.* 34, 102–117. doi:10.1111/j.1365-2699.2006.01594.x.

Pennino, M. G., Mérigot, B., Fonseca, V. P., Monni, V., and Rotta, A. (2017). Habitat modeling for cetacean management: Spatial distribution in the southern Pelagos Sanctuary (Mediterranean Sea). *Deep. Res. Part II Top. Stud. Oceanogr.* 141, 203–211. doi:10.1016/j.dsr2.2016.07.006.

Pérez-Jorge, S., Pereira, T., Corne, C., Wijtten, Z., Omar, M., Katello, J., et al. (2015). Can static habitat protection encompass critical areas for highly mobile marine top predators? Insights from coastal East Africa*. PLoS One* 10, 1–16. doi:10.1371/journal.pone.0133265.

Phillips, S. J., Anderson, R. P., Dudík, M., Schapire, R. E., and Blair, M. E. (2017). Opening the black box: an open-source release of Maxent. *Ecography* 40, 887–893. doi:10.1111/ecog.03049.

Phillips, S. J., Anderson, R. P., and Schapire, R. E. (2006). Maximum entropy modeling of species geographic distributions. *Int. J. Glob. Environ.* 190, 231–259. doi:10.1016/j.ecolmodel.2005.03.026.

Pinedo, M. C., Barreto, A. B., Lammardo, M. P., Andrade, A. L., and Geracitano, L. (2002a). Northernmost records of the spectacled porpoise, Layard's beaked whale, Commerson's dolphin, and Peale's dolphin in the southwestern Atlantic Ocean. *Aquat. Mamm.* 28, 32–37.

Pinedo, M. C., Lammardo, M. P., and Barreto, A. S. (2001). Review of Ziphius cavirostris, Mesoplodon grayi and *Lagenodelphis hosei* (Cetacea: Ziphiidae and Delphinidae) in Brazilian waters, with new records from southern Brazil. *Atlantica* 23, 67–76. Available at: http://www.lei.furg.br/atlantica/vol23/G2399.pdf.

Pinedo, M. C., Polacheck, T., Barreto, A. S., and Lammardo, M. P. (2002b). A note on vessel of opportunity sighting surveys for cetaceans in the shelf edge region off the southern coast of Brazil. *J. Cetacean Res. Manag.* 4, 323–329.

Pinedo, M.C. (1989). Primeiro registro de *Phocoena spinipinnis* (Cetacea, Phocoenidae) para o litoral do Rio Grande do Sul, Brasil, com medidas osteológicas e análise do conteúdo estomacal. *Atlântica*, 11(1): 85-99.

Pinn, E. H. (2018). "Protected Areas: The False Hope for Cetacean Conservation?" in Oceanography and Marine Biology: An Annual Review, eds. S. J. Hawkins, A. J. Evans, A. C. Dale, L. B. Firth, I. P. Smith (Taylor & Francis).

Pinheiro, H. T., Martins, A. S., and Gasparini, J. L. (2010). Impact of commercial fishing on Trindade Island and Martin Vaz Archipelago, Brazil: Characteristics, conservation status of the species involved and prospects for preservation. *Brazilian Arch. Biol. Technol*. 53, 1417–1423. doi:10.1590/S1516-89132010000600018.

Pinheiro, H. T., Mazzei, E., Moura, R. L., Amado-Filho, G. M., Carvalho-Filho, A., Braga, A. C., et al. (2015). Fish biodiversity of the Vitória-Trindade seamount chain, southwestern Atlantic: An updated database. *PLoS One* 10, 1–17. doi:10.1371/journal.pone.0118180.

Prado, J. H. F., Mattos, P. H., Silva, K. G., and Secchi, E. R. (2016). Long-term seasonal and interannual patterns of marine mammal strandings in subtropical western South Atlantic. *PLoS One* 11, 1–23. doi:10.1371/journal.pone.0146339.

Reeves, R. R. (2018). "Conservation," in Encyclopedia of Marine Mammals, 215–229. doi:10.1108/S2051-503020170000021003.

Robinson, N. M., Nelson, W. A., Costello, M. J., Sutherland, J. E., and Lundquist, C. J. (2017). A systematic review of marine-based Species Distribution Models (SDMs) with recommendations for best practice. *Front. Mar. Sci.* 4, 1–11. doi:10.3389/fmars.2017.00421.

Rocha-Campos, C. C., Moreno, I.B., Rocha, J. M. et al. 2011a. Plano de Ação Nacional para a conservação de mamíferos aquáticos: grandes cetáceos e pinípedes. ICMBio, Brasília.

Rocha-Campos, C. C., Moreno, I.B., Rocha, J. M. et al. 2011b. Plano de Ação Nacional para a conservação de mamíferos aquáticos: grandes cetáceos e pinípedes. ICMBio, Brasília. doi:10.3389/fmars.2017.00421.

Rojas-Bracho, L., and Reeves, R. (2013). Vaquitas and gillnets: Mexico's ultimate cetacean conservation challenge. Endanger. Species Res. 21, 77–87. doi:10.3354/esr00501.

Rojas-Bracho, L., Reeves, R. R., and Jaramillo-legorreta, A. (2006). Conservation of the vaquita *Phocoena sinus*. *Mamm. Rev.* 36, 179–216. doi:10.1111/j.1365-2907.2006.00088.x.

Santos-Neto, E. B., Azevedo-Silva, C. E., Bisi, T. L., Santos, J., Meirelles, A. C. O., Carvalho, V. L., et al. (2014). Organochlorine concentrations (PCBs, DDTs, HCHs, HCB and MIREX) in delphinids stranded at the northeastern Brazil. *Sci. Total Environ.* 472, 194–203. doi:10.1016/j.scitotenv.2013.10.117.

Santos, M. C. de O., and Figueiredo, G. C. (2016). A rare sighting of a bottlenose whale (*Hyperoodon planifrons*, Flower 1882) in shallow waters off southeastern Brazil. *Brazilian J. Oceanogr*. 64, 105–110. doi: http://dx.doi.org/10.1590/S1679-87592016108006401.

Santos, M. C. de O., Zampirolli, É., de, A. F. V., and Alvarenga, F. S. (2005). A Gervais' beaked whale (*Mesoplodon europaeus*) washed ashore in southeastern Brazil: extra limital record? *Aquat. Mamm.* 29, 404–410. doi:10.1578/01675420360736604.

Santos, M. C. de O., Lailson-Brito, J., Flach, L., Oshima, J. F., Figueiredo, G. C. et al., (2019). Cetacean movements in coastal waters of the southwestern Atlantic Ocean. Bio. *Neotrop*. 19, e20180670. doi:http://dx.doi.org/10.1590/1676-0611-BN-2018-0670.

Santos, M. C. de O., Siciliano, S., de Castro Vicente, A. F., Alvarenga, F. S., Zampirolli, É., de Souza, S. P., et al. (2010a). Cetacean records along São Paulo State Coast, Southeastern Brazil. *Brazilian J. Oceanogr*. 58, 123–142. doi:10.1590/s1679-87592010000200004.

Santos, M. C. de O., Siciliano, S., Vicente, A. F., Alvarenga, F. S., Zampirolli, É., de Souza, S. P., et al. (2010b). Cetacean Records Along São Paulo State Coast. *Brazilian J. Oceanogr.* 58, 123–142.

Secchi, E. R., Danilewicz, D., and Ott, P. H. (2003). Applying the phylogeographic concept to identify franciscana dolphin stocks: implications to meet management objectives. *J. Cetacean Res. Manag*. 5, 61–68.

Secchi, E. R., and Zarzur, S. (1999). Plastic debris ingested by a Blainville's beaked whale, *Mesoplodon densirostris*, washed ashore in Brazil. *Aquat. Mamm*. 25, 21–24.

Siciliano, S., and Santos, M. C. O. (2003). On the occurrence of the Arnoux's beaked whale (*Berardius arnuxii*) in Brazil. *J. Mar. Biol. Assoc. United Kingdom* 83, 887–888. doi:10.1017/S0025315403007999h.

Siciliano, S. and Franco, S.M.S. (2005) Catálogo da Coleção de Mamíferos Aquáticos do Museu Nacional. FIOCRUZ/ENSP. 44p., il.

Siciliano, S., Emin-lima, N. R., Costa, A. F., Magalhães, F. A., Tosi, C. H., Garri, R. G., et al. (2008). Revisão do Conhecimento sobre os Mamíferos Aquáticos da Costa Norte do Brasil. *Arq. do Mus. Nac.* 66, 381–401.
Simões-Lopes, P. C., and Ximenez, A. (1989). *Phocoena spinipinnis* Burmeister, 1865, na costal sul do Brasil (Cetacea - Phocoenidae). *Biotemas* 2, 83–89.
Soto J. M., Montibeller, A., Santos, R.A. (1999). Análise do conteúdo estomacal de *Kogia breviceps* e *Kogia simus* (Cetacea, Physeteridae), coletados em Santa Catarina, Brasil. XII Semana Nacional de Oceanografia. Rio de Janeiro. pp. 319–321.
Soto, J. M. and Vega, S. S. (1977). Primeiro registro de baleia bicuda de Gray, *Mesoplodon grayi* Haast 1876, (Cetacea, Ziphiidae) para o Brasil, com referências osteológicas e a revisão de citações de zifídeos em águas brasileiras. *Biociências*, 5(1): 69-89.
Souto, L. R. A., Lemos, L. M., Violante, T. H. A. S., and Maia-Nogueira, R. (2009). Record of a neonate dwarf sperm whale, *Kogia sima* (Owen, 1866) stranded on the coast of Bahia, northeastern Brazil. Lat. Am. J. *Aquat. Mamm.* 7, 105–106. doi:10.5597/lajam00146.
Souza, S. P., Siciliano, S., Cuenca, S., and Sanctis, B. (2005). A True's beaked whale (*Mesoplodon mirus*) on the coast of Brazil: adding a new beaked whale species to the Western Tropical Atlantic and South America. *Lat. Am. J. Aquat. Mamm.* 4, 129–136. doi:10.5597/lajam00077.
Spalding, M. D., Agostini, V. N., Rice, J., and Grant, S. M. (2012). Pelagic provinces of the world: A biogeographic classification of the world's surface pelagic waters. *Ocean Coast. Manag.* 60, 19–30. doi:10.1016/j.ocecoaman.2011.12.016.
Spalding, M. D., Fox, H. E., Allen, G. R., Davidson, N., Ferdaña, Z. A., Finlayson, M., et al. (2007). Marine Ecoregions of the World: A Bioregionalization of Coastal and Shelf Areas. *Bioscience* 57, 573–583. doi:10.1641/b570707.
Steckenreuter, A., Harcourt, R., and Möller, L. (2012). Are speed restriction zones an effective management tool for minimising impacts of boats on dolphins in an australian marine park? *Mar. Policy* 36, 258–264. doi:10.1016/j.marpol.2011.05.013.
Stern, S. J., and Friedlaender, A. S. (2018). Migration and Movement. Encycl. Mar. Mamm., 602–606. doi:10.1016/b978-0-12-804327-1.00173-4.
Tobeña, M., Prieto, R., Machete, M., and Silva, M. A. (2016). Modeling the potential distribution and richness of cetaceans in the Azores from fisheries observer program data. *Front. Mar. Sci.* 3. doi:10.3389/fmars.2016.00202.
Turvey, S. T., Barrett, L. A., Hart, T., Collen, B., Yujiang, H., Lei, Z., et al. (2010). Spatial and temporal extinction dynamics in a freshwater cetacean. Proc. R. Soc. B Biol. Sci. 277, 3139–3147. doi:10.1098/rspb.2010.0584.
Turvey, S. T., Pitman, R. L., Taylor, B. L., Barlow, J., Akamatsu, T., Barrett, L. A., et al. (2007). First human-caused extinction of a cetacean species? Biol. Lett. 3, 537–540. doi:10.1098/rsbl.2007.0292.
Wickert, J. C., Von Eye, S. M., Oliveira, L. R., and Moreno, I. B. (2016). Revalidation of *Tursiops gephyreus* Lahille's, 1908 (Cetartiodactyla: Delphinidae) from the southwestern Atlantic Ocean. J. Mammal. 97, 1728–1737. doi:10.1093/jmammal/gyw139.
Wisz, M. S., Hijmans, R. J., Li, J., Peterson, A. T., Graham, C. H., Guisan, A., et al. (2008). Effects of sample size on the performance of species distribution models. Divers. Distrib. 14, 763–773. doi:10.1111/j.1472-4642.2008.00482.x.
Zanardo, N., Parra, G. J., Passadore, C., and Möller, L. M. (2017). Ensemble modelling of southern Australian bottlenose dolphin *Tursiops* sp. distribution reveals important habitats and their potential ecological function. Mar. Ecol. Prog. Ser. 569, 253–266. doi:10.3354/meps12091.
Zanelatto, R.C., Bittencourt, M.L., Corrêa, M.F.M., and Domit, L.G. (1995). *Ziphius cavirostris* Cuvier, 1823 (Cetacea, Ziphiidae) on the Brazilian coast, with notes on biometry. *Iheringia*, (79): 141-147.
Zellmer, A. J., Claisse, J. T., Williams, C. M., Schwab, S., and Pondella, D. J. (2019). Predicting optimal sites for ecosystem restoration using stacked-species distribution modeling. *Front. Mar. Sci.* 6, 1–12. doi:10.3389/fmars.2019.00003.
Zerbini, A. N., and Secchi, E. R. (2001). Occurrence of Hector 's beaked whale, *Mesoplodon hectori*, in Southern Brazil. *Aquat. Mamm.* 27, 149–153. Available at: http://aquaticmammalsjournal.org/share/AquaticMammalsIssueArchives/2001/AquaticMammals_27-02/27-02_Zerbini.PDF.

ODONTOCETES DISTRIBUTION AND MARINE PROTECTED AREAS: HOW FAR IS BRAZIL TO IMPROVE THE CONSERVATION OF THESE FAR-RANGING MARINE TOP PREDATORS?

Elisa Berlitz Ilha[1,2]*, Karina Bohrer do Amaral[1,3], Ignacio Benites Moreno[1,2,4]

1 – Laboratório de Sistemática e Ecologia de Aves e Mamíferos Marinhos, Departamento de Zoologia, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil

2 - Programa de Pós-Graduação em Biologia Animal, Instituto de Biociências, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil

3 – Programa de Monitoramento da Biodiversidade Aquática na Área Ambiental I, Rede Rio Doce Mar, Rio Grande, Brazil

4 – Centro de Estudos Costeiros, Limnológicos e Marinhos, Campus Litoral Norte, Universidade Federal do Rio Grande do Sul, Imbé, Brazil

*** Correspondence:**
Elisa Berlitz Ilha
elisaberlitz@gmail.com

Key words: critical habitats[1], gap analysis[2], marine protected areas[3], marine spatial planning[4], odontocetes[5], species distribution model[6].

Abstract: Cetaceans in situ conservation requires the preservation of species or populations, as well as the preservation of their preferred habitats. An important step towards this is to understand which habitats are used with higher frequency (for one or more species), and where environmental features (abiotic and biotic) are required to maintain a favorable conservation status. Here, we aimed to understand the role that oceanographic features play on odontocete distribution in the Western South Atlantic Ocean (SWA) to evaluate the suitability of existing Brazilian MPA policy and to identify areas of biological importance to spatial prioritizations for odontocete conservation. Species distribution modelling (SDM) based on the maximum entropy principle (MaxEnt) was chosen to generate models for 17 taxa of odontocete species in the Brazilian Economic Exclusive Zone. The best-fit model configuration ($\Delta AICc=0$) for each species (individual-SDM) was projected using the complementary log-log link function to produce an estimate of occurrence probability. All individual-SDM presented an excellent predictive performance ($AUC > 0.9$ and $TSS > 0.7$). Individual-SDMs were combined to produce a Stacked-species distribution model (S-SDM) to identify odontocete ecological hotspots across multiple species, as well as the role of environmental features in driving odontocetes distribution patterns in the SWA. Two areas of major probability of occurrence were identified and can be understood as critical habitats. One is in neritic and deeper waters outer the continental shelf break south of Vitoria-Trindade seamount and the Abrolhos Bank until the Subtropical Convergence zone (offshore hotspot area); and other is in nearshore waters influenced by coastal upwellings in the most populous urbanized coastal region of Brazil (nearshore hotspot area). Through a gap analysis, the S-SDM was overlapped with the current spatial management measures (MPAs coverage and priority areas for conservation) and with the mapped anthropic threats (commercial fishing, oil and gas marine industries and ports). Both offshore and nearshore hotspot areas are under main anthropic threats. Despite the high percentage of coverage (28%), the current MPA policy is unevenly distributed among three marine biogeographical provinces and is most concentrated among the contiguous zone limits (24 nm). It highlights the Brazilian failure to meet Aichi Biodiversity Targets as well as important conservation gaps for most included species. The current MPA policy alone seems to be insufficient to guarantee the conservation of these far-ranging odontocetes and their preferred habitats over time.

1 INTRODUCTION

Cetaceans *in situ* conservation requires the preservation of wild species or populations themselves, as well as the preservation of environments (habitats and ecosystems) that support them and the biotic communities to which they belong (Reeves, 2018). Therefore, an important step towards this is to understand which habitats are used with higher frequency (for one or more species), and where environmental features (abiotic and biotic) are required to maintain a favorable conservation status through time (Cañadas et al., 2005; Pérez-Jorge et al., 2015).

Given their life-history traits (such as longevity, late maturity and low reproductive rates) cetaceans are particularly susceptible to human stressors (Ballance, 2018; Evans, 2018; Passadore et al., 2018). These stressors have been increasing on oceans in recent decades, bound to globalization and the massive industrial production scales required by capitalism (Clausen & Clark, 2005; Burns, 2017). Among marine mammals, risk maps suggested that odontocetes currently represented the majority of species in the high-risk areas, and that threats in coastal waters worldwide impose previously unrecognized levels of cumulative risk for most coastal marine mammals (Avila et al., 2018). Meanwhile, little is known about the extent of threats suffered by oceanic odontocetes, where the high seas impose great logistic challenges to research, management, and surveillance (Mannocci et al., 2017).

Marine protected areas (MPAs) were widely recognized as one of the most important management tools to mitigate over-exploitation of marine resources, degradation of ocean habitats and improve conservation (Agardy et al., 2011; Hoyt, 2011; Trathan et al., 2014; Handley et al., 2020). In Brazil – as well as most occidental countries – the process of demarcating MPAs is increasingly driven by global targets tied to multilateral agreements, as the Convention on Biological Diversity (CBD) (Brazil, 1998; Agardy et al., 2016). Among Aichi Biodiversity Targets[15], for example, Target 11 defines to protect 10% of the world's oceans by 2020 safeguarding areas of particular importance for biodiversity and ecosystem services, through an effectively managed, ecologically representative, and well-connected systems of protected areas.

Nevertheless, the efficacy of many MPAs remain uncertain and evidence suggests that MPAs often fail to deliver positive ecological and social outcomes (Agardy et al., 2016; Hilborn, 2016; Gill et al., 2017; Handley et al., 2020). The effectiveness of MPAs also differs among scenarios, being more complex to protect high-mobile and migratory top-predators – as cetaceans – with distribution ranges associated with dynamic oceanographical features in pelagic systems (Hyrenbach et al., 2000).

[15] Established concrete actions to be taken by the signatory governments through twenty targets divided into five strategic goals (https://www.cbd.int/sp/targets/).

Though the role of MPAs for cetaceans conservation is constantly under debate (Hooker et al., 2011; Notarbartolo di Sciara et al., 2016; Hoyt, 2018; Agardy et al., 2019), there is few empirical evidence that MPAs can improve odontocetes conservation (Gormley et al., 2012; O'Brien and Whitehead, 2013; Mintzer et al., 2015; Pinn, 2018). Besides, beyond the most common MPAs shortcomings (see Agardy et al., 2011), the lack of information about most odontocetes distribution range and their critical habitats are also a great challenge for MPAs efficiency (Hoyt, 2011; Zanardo et al., 2017).

The critical habitats do not necessarily have regulatory status as a protected area (Pinn, 2018) but seems to play a role for cetacean place-based conservation (Notarbartolo di Sciara et al., 2016; Gomez et al., 2017; Hoyt, 2018). Critical habitats are places or conditions where populations or species regularly use for feed, socialize, rest, breed and raise their young (Hoyt, 2018); as well as migration routes, areas that protect essential ecosystem functions and the habitat that cetacean prey depend upon (Hoyt 2011; Hoyt, 2018). Therefore – although feeding, breeding and calving grounds are most critical to protect – it is also essential to protect cetacean key oceanographic processes (as upwellings, ocean fronts or ephemeral habitats) and topographic features (as seamounts and canyons) (Hyrenbach et al., 2000; Clark et al., 2010; Pompa et al., 2011; Hoyt, 2018).

To date, 36 marine odontocetes have been recorded in the Brazilian territory and jurisdictional waters (Wickert et al., 2016; Cypriano-Souza et al., 2017; Bastida et al., 2018). Three marine species are included in the Brazil Red List of Threatened Species (MMA, 2014a): both Vulnerable sperm whale (*Physeter macrocephalus*) and the Guiana dolphin (*Sotalia guianensis*) and the Critically Endangered Franciscana dolphin (*Pontoporia blainvillei*). Most species are still classified as Data Deficient (62.5%) or even as Not Evaluated (25%) (Rocha-Campos et al., 2011a; 2011b). The main anthropogenic threats are mainly related to fishing conflicts (such as overfishing, bycatch and entanglement) (Fruet et al., 2012; Prado et al., 2013; Di Tullio et al., 2015), vessel traffic (Marega-Imamura et al., 2020), chronic high noise pollution (Bittencourt et al., 2014; Rossi-Santos, 2014), debris and chemical pollution (Yogui et al., 2010; Di Beneditto and Ramos, 2014; Méndez-Fernandez et al., 2018).

Regard to Brazilian MPAs, in 2018 the government announced the "accomplishment of Aichi Target 11", by increasing the jurisdictional waters covered by federal MPAs from 1.5% to more than 25% by the creation of two new sets of protected areas (Brazil, 2018a,b; Magris and Pressey, 2018). However, top-down changes in the original design and categories proposed by technical assessments as well as the maintenance of fishing permission inside no-take areas (see Giglio et al., 2018), alerted civil and scientific communities to another insidious policy bring to a dangerous illusion of protection (Agardy et al., 2011; Giglio et al., 2018; Magris and Pressey, 2018).

Based on the national legislation in accordance with CBD commitments on research priority for data deficient species (Brazil, 1998; MMA, 2014b) – this study aims to assess the contribution of Brazilian MPAs to the odontocete biodiversity conservation in the Southwestern Atlantic Ocean (SWA). Understanding the role that habitat features play on cetacean distribution is a crucial step to evaluate the suitability of existing MPAs (Pérez-Jorge et al., 2015) and to identify areas of biological importance to spatial prioritizations for conservation (Guisan and Thuiller, 2005; Zanardo et al., 2017).

Species distribution modelling (SDM) is a valuable tool for predicting the distribution of cetacean species and can be used to support management initiatives, such identifying critical habitats (Cañadas et al., 2005; Gomez et al., 2017), ecological hotspots (Tobeña et al., 2016), and help with the management actions or planning of MPA networks (Bombosch et al., 2014; Gomez et al., 2017; Zanardo et al., 2017; Passadore et al., 2018). A presence-only modeling approach based on the maximum entropy principle (Phillips et al., 2006; Phillips, 2017) was chosen to generate occurrence probability models for 17 taxa of odontocete species in Brazilian Exclusive Economic Zone (EEZ). The individual-SDMs were then combined in order to produce a Stacked-Species Distribution Models (S-SDM) (Calabrese et al., 2014; D'Amen et al., 2015; Zellmer et al., 2019). The aim was to identify odontocete hotspot areas, as well as the role of environmental features in driving odontocetes distribution patterns in the SWA. Through a gap analysis, individual-SDM and multi-species S-SDM were overlapped with the current spatial management measures by the MPAs coverage and the priority areas for conservation (PAC), analyzing the associated legislation, the main coverage gaps, and the principal anthropic pressures through Brazilian EEZ. The predicted maps of both individual-SDM and S-SDM were interpreted in the light of marine biogeographic provinces which are thought to contribute to marine spatial planning (MSP) (Spalding et al., 2007; Robinson et al., 2017).

2 MATERIAL AND METHODS

2.1. Study Area

The Brazilian coastline has approximately 10,800 km, including the cutouts along the coastline, such as bays and gulfs (Schiavetti et al., 2013). The geographical extent of study area was designed to include Brazilian Economic Exclusive Zone (EEZ) which extends 200 nautical miles from the coastline, as well as adjacent waters from Southwestern Atlantic Ocean (SWA) (55ºS-25ºS, 4ºW-34ºW) covering a heterogeneous and complex ecosystem (Figure 1).

In general, the SWA is under influence of three major water masses: The North Brazil Current (NBC) and the Brazil Current (BC) which splits from the tropical South Equatorial Current (SEC), and the subantarctic Malvinas Current (MC) (Stramma et al., 1990; Da Silveira et al., 1994; Spalding et al., 2012) (Figure 1). Beginning at about 10°S, the NBC flows northward, transporting an important amount of water along the coastal waters of northern Brazil (including freshwater from the Amazon basin). The NBC is characterized by Sea Surface Temperature (SST) ranging between 22°C and 29°C and Sea Surface Salinity (SSS) ranging from 35 to 36.75 psu (Da Silveira et al., 1994; Bourlès et al., 1999; Garzoli et al., 2004). The warm tropical and oligotrophic BC flows southward along the coast of Brazil from approximately 10°S to 38°S, where it collides with the north-flowing MC between 33-38°S (Stramma et al., 1990) (Figure 1). On average, the SST and SSS in the BC is about 18°C-28°C and 35-36.2 psu, with maximums commonly found at around 20°S (Mémery et al., 2000; Willson and Rees, 2000). The cooler MC had mean SST of 6°C (Brandini et al., 2000), with a sharp gradient in SST and SSS observed when it meets the BC in the South Atlantic Subtropical Convergence (SASC) (Garzoli, 1993; Goni et al., 1996).

To refer to the study area a global system of marine biogeography as natural frameworks for marine zoning was chosen rather than political demarcations based on land. The use of a biogeographical classification intends to contribute with conservation planning efforts (Spalding et al., 2012), and are considered essential for the development of ecologically representative systems of Protected Areas as is required by international agreements, such as the CBD (Spalding et al., 2007; CBD, 2010). According to the Marine Ecoregions of the Word (MEOW), the study area comprises three marine provinces: **North Shelf Brazil** (PNSB), **Tropical Southwestern Atlantic** (PTSA) and **Warm-Temperate Southwestern Atlantic** (PWTSA) (Figure 1). Provinces are cohesive units defined by the presence of distinct biotas (including the presence of mobile and endemic species), with some cohesion over evolutionary time frames, and which have arisen as a result of distinctive abiotic features that circumscribe their boundaries (Spalding et al., 2007). In the study area, the MEOW limits are similar to those limits proposed by the Large Marine Ecosystems of the Word (LMEs), other proposal for space units which is often cited by the Brazilian Institute of Geography and Statistics (*Instituto Brasileiro de Geografia e Estatística*).

In relation to its environmental features, the PNSB is mainly influenced by the warm NBC. This province is characterized by a smooth topography and a large continental shelf (from 146 to 292 km), climatic stability, high tidal ranges and high rates of primary production influenced by Amazon River Basin (and the Orinoco River in Venezuela) as an external source of organic matter (Figure 1c) (Ekau and Knoppers, 1999; MMA, 2010; Schiavetti et al., 2013).

The PTSA is principally influenced by the warm tropical BC, and is characterized by a narrow continental shelf (from 20 to 55 km), with the exception of the Abrolhos Bank (240 km), and has oligotrophic waters with low primary productivity and little organic matter input (Figure 1c) (Ekau and Knoppers, 1999; Knoppers et al., 2010; Schiavetti et al., 2013). From Cabo de São

Roque (5°S) to about 16°S the shelf is narrow and the slope is relatively steep (Moreno et al., 2005). At about 20.5°S, the BC encounters the Vitoria-Trindade seamount chain (VTC), which demarcates the transition between tropical (PTSA) and subtropical waters (PTWSA) in the SWA (Amado-Filho et al., 2007; Moreno et al., 2017). The VTC in combination with Abrolhos Bank act as a topographic barrier to BC flow (Ekau and Knoppers, 1999; Knoppers et al., 2010; Lemos et al., 2018), however can also provide a horizontal connectivity between the continental shelf and its isolated oceanic islands at the end of the VTC (Pinheiro et al., 2017).

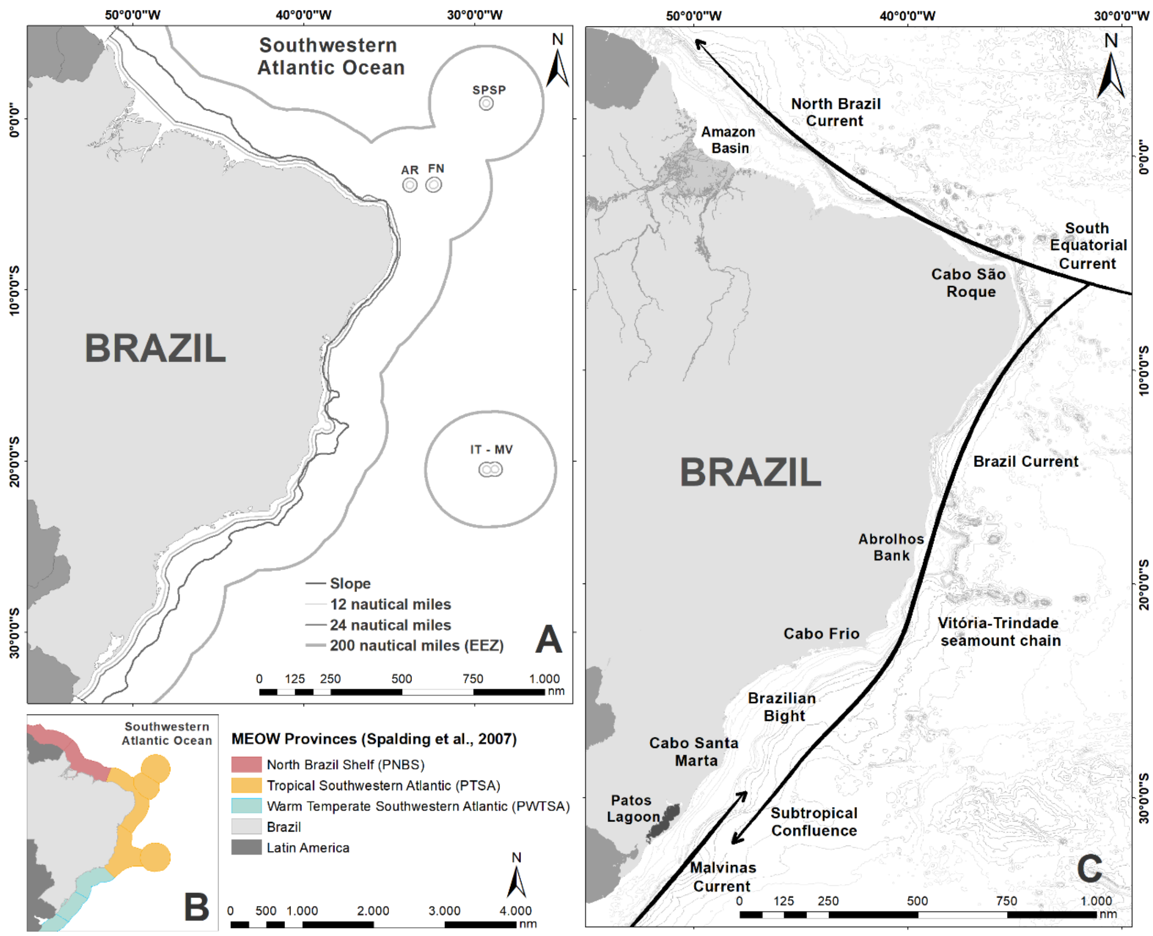


FIGURE 1. STUDY AREA: POLITICAL BOUNDARIES, OCEANOGRAPHIC FEATURES AND BIOGEOGRAPHICAL PROVINCES. A) Political boundaries based on the United Nations Convention on the Law of the Sea (CNUDM, 1992), that defines the limits of the Territorial Sea (12 nautical miles), the Contiguous Zone (24 nautical miles) and the EEZ (200 nautical miles). Letters correspond to the oceanic islands: AR = Atol das Rocas; FN = Fernando de Noronha Island; SPSP = São Pedro São Paulo archipelago; IT-MV = Trindade Island and Martin-Vaz. B) Biogeographical boundaries of Marine Ecoregions of the Word (MEOW) (Spalding et al., 2007). C) Main oceanographical features driving odontocete distribution in the SWA.

The PWTSA is characterized by different dominant hydrographic dynamics, seasonal climate, coastal and shelf break upwellings, smooth topography, a large continental shelf (until 220 km) and medium to high primary production (Brandini, 1990; Schiavetti et al., 2013; Di

Tullio et al., 2016). At its northern limit (about 23ºS) the Brazilian coast undergoes a sudden change in its orientation from North-South to East-West (Mata et al., 2017). The warm and resource-depleted BC encounters the deeper South Atlantic Central Water (SACW), that is pumped to superficial layers, bringing low-temperatures (<18°C) and nutrient-rich waters nearshore (Brandini, 1990; Tavares et al., 2010; Coelho-Souza et al., 2012). The change in the coastline orientation, a steep slope and the occurrence of these two water masses, associated with the prevailing winds, generates a strong upwelling in the continental shelf. The coastal upwellings from SACW occur with greater intensity on the continental shelf south of Abrolhos Bank, mainly in the Cabo Frio where it takes place nearshore and in the Cabo de Santa Marta (Knoppers et al., 2010). The region between Cabo Frio and Cabo de Santa Marta is named South Brazilian Bight (23–28.5°S; SBB), and is a typical western boundary current system (Castro and Miranda, 1998; Nogueira Jr. and Brandini, 2018) (Figure 1c). The SBB is strongly influenced by upwelling and presents dynamic hydrographic variation (Moreno et al., 2005). From Cabo de Santa Marta the continental shelf widens progressively to the southern end of the continent (Bisbal, 1995; Tavares et al., 2010).

At its southern limit, the PWTSA is under influence of the South Atlantic Subtropical Convergence (SASC) and the two-external sources of organic matter: the Patos Lagoon (30º 32ºS – 51º 53ºW) and the La Plata river (Uruguay) (Figure 1c) (Ciotti et al., 1995). During austral winter this input of organic matter extends further than Santa Marta Cape (28°S) while in austral summer it retracts to 32°S (Piola et al., 2005; Prado et al., 2016). In this mixing zone subantarctic waters slope downwards extending northwards below the tropical waters and reaching offshore areas of southern and southeastern Brazil as part of the SACW (Brandini, 1990). This is one of the most energetic regions in all the oceans (Saraceno et al., 2004).

2.2. Environmental data, odontocete occurrences and background

Data processing and statistical analysis were performed with R (version 3.5.3, R Core Team, 2016) and ArcMap (version 10.3.1 ESRI). Environmental layers were selected based on their ecological relevance for cetaceans (Baumgartner et al., 2001; Cañadas et al., 2002; do Amaral et al., 2015; Derville et al., 2018; Passadore et al., 2018; Barragán-Barrera et al., 2019; Becker et al., 2019). A set of 22 environmental variables were selected to be candidates (Supplementary Table 1). These environmental variables are raster layers of dynamic and static information data and were gathered from public databases, such as Bio-Oracle (http://www.bio-oracle.org/) (Tyberghein et al., 2012) and MARSPEC (http://www.marspec.org/) (Sbrocco and Barber, 2013) at a 5-arcmin resolution (~10km). All environmental layers were processed to encompass the same extension and resolution.

Variable selection was conservative in order to build ecologically meaningful models. Therefore, the correlation among layers was investigated using correlation coefficients (<0.7, Dormann et al., 2013) and variance inflation factors (vif) to identify highly collinear variables (<10, Marquaridt, 1970). The 'vifcor' finds a pair of variables which has the maximum linear correlation and excludes the one which has greater vif, and 'vifstep' calculates vif for all variables and excludes the variables with vif greater than threshold (=10) (Naimi, 2017; Passadore et al., 2018). These steps were repeated until there are no variables remaining with a vif greater than thresholds using the usdm package (Naimi, 2017; Passadore et al., 2018). The Pearson correlation among remaining layers after vif steps was investigated using the function 'pairs' from raster package (Hijmans et al., 2015) (Supplementary Figure 1). Finally, static layers used in this study included bathymetry (bathy), bathymetry slope (slope) and distance to shore (distoshore); and dynamic layers included annual range chlorophyll-a concentration (Chlora_R), range and maximum annual Sea Surface Salinity (SSS_R and SSS_Ma) and annual range Sea Surface Temperature (SST_R) (Table 1).

Georeferenced data for 36 species of odontocetes were compiled from published records, unpublished scientific data, and Brazilian public databases of marine mammals in the study area (i.e., SIMMAM and PMC-BS). These occurrences were collected through different years and seasons, during both opportunistic and systematic marine wildlife observations. In order to perform species distribution models (SDM), species with less than 10 records were excluded (Pearson et al., 2007; Wisz et al., 2008). Therefore, occurrence data from 17 species were used to build individual-SDMs (Table 2), after scrutinizing and removing duplicate records (Supplementary Table 3). The distribution of covariates in the landscape is a finite sample known as background (Elith et al., 2011). We used the function randomPoints from dismo to sample background data from the study area using 10,000 random points as default setting (Phillips and Dudík, 2008; Liu et al., 2018). The random points were used as the "absence" component of the evaluation data in addition to the known presences (Liu et al., 2016).

2.2. Species Distribution Models (SDM)

The maximum entropy principle was used to estimate the potential distribution of odontocetes in the study area (Phillips et al., 2006, 2017). The MaxEnt algorithm estimates the geographic range of a species by finding the distribution closest to geographically uniform, subject to constraints defined in terms of 'features' (as environmental variables) derived from environmental conditions at recorded occurrence locations (Phillips et al., 2017). It quantifies a statistical relationships between predictor variables at occurrence locations and 'background' locations (Phillips et al., 2006; Phillips and Dudík, 2008; Muscarella et al., 2014), and produces a continuously varying, nonnegative suitability scores for each cell in a specified geographic region (Warren et al., 2008).

Nowadays, several algorithms are available to perform spatial distribution models (Elith and Leathwick, 2009). The MaxEnt was chosen because its predictive performance is consistently competitive with the highest performing methods (Elith et al., 2006, 2011), and is less sensitive to small sample sizes than other algorithms available (Pearson et al., 2007; Wisz et al., 2008). Usually, small samples sizes are a recurrent issue for cetaceans occurrence data due to their wide-ranging and high mobile characteristics, the rarity for some species, the observational challenges in field and the difficult to access some remote habitats they can live in (Redfern et al., 2006; Derville et al., 2018). Moreover, for cetacean species this algorithm performs well when compared to presence-absence models (Derville et al., 2018; Passadore et al., 2018), and has been shown to be able of modelling species habitats with a relatively high level of complexity and accuracy (Bombosch et al., 2014; Tobeña et al., 2016; Derville et al., 2018; Barragán-Barrera et al., 2019).

Individual-SDMs were developed for each species using MaxEnt v. 3.4.1 implemented in the dismo package v. 1.1.4 called through the R programming language (Hijmans et al., 2017; Phillips et al., 2017). For model calibration, MaxEnt model settings were defined through the ENMevaluate function available in the ENMeval package (Muscarella et al., 2014). The ENMeval facilitates increased rigor in the development of MaxEnt models, providing species-specific tuning of settings to improve model performance and reduce the degree to which models overfit (Muscarella et al., 2014). The block approach was used as data partitioning method, in which it partitions data into four bins based on the lines of latitude and longitude that divide occurrences localities as equally as possible (Muscarella et al., 2014; Barragán-Barrera et al., 2019). Occurrences and background localities are assigned to each of the four bins based on their position with respect to these lines (Muscarella et al., 2014). The model runs four times with three blocks set as training data and one block set as test data for each iteration, so then evaluation metrics are summed across the iterations (Zellmer et al., 2019). Moreover, ENMevaluate function processes six feature classes and the combinations between them (Linear, Quadratic, Product, Threshold, Hinge, Category), and standardized values of Regularization Multipliers (0.5, 4, 0.5) to evaluate the best model for each species. The Akaike's Information Criterion (ΔAICc) reflects both model's goodness-fit and complexity using an unpartitioned data set (Muscarella et al., 2014). The model with the lowest value of ΔAICc (=0) was considered the best model out of the current suite of models (Warren and Seifert, 2011; Muscarella et al., 2014). The best-fit model for each species (individual-SDM) was projected using the complementary log-log link (cloglog) function to produce an estimate of occurrence probability (Phillips et al., 2017). The cloglog is more appropriate for estimating probability of occurrence than the logistic transformation, a previous MaxEnt default (Phillips et al., 2017; Zellmer et al., 2019).

2.3. Validation model and prediction

For each species 80% of the sightings were randomly selected as training data sets ('kfold' function in dismo package) and the remaining (20%) was used as testing data, to evaluate the fit of the model and its predictive power ('evaluate' function in dismo package). We used the threshold-independent area under the curve (AUC) of receiver operating characteristic (ROC) curve as indicators of the predictive skill of the model (Phillips et al., 2006). An AUC closer to 1 is considered a good model, while close to 0.5 to 0 would indicate that the model performed it's not better than random (Phillips et al., 2006). Complementary, the performance of models was also assessed by the true skill statistic (TSS) (Allouche et al., 2006), which reflects the rate of false positive and negative predictions but is not sensitive to the frequency of presence points (Allouche et al., 2006). As TSS is a threshold-dependent metric, we calculated the threshold value that maximized specificity (true negative rate) and sensitivity (true positive rate) over the evaluation dataset predictions (spec_sens) (Liu et al., 2013, 2016; Derville et al., 2018). This threshold is one of the best selection methods for when only presence data are available (Liu et al., 2013) and seems to produce consistent results (Liu et al., 2016). Values of TSS < 0.4 reflecting poor model predictive performance, 0.4 – 0.6 moderate, and TSS 0.6 – 0.8 good, and > 0.8 excellent performance (González-Ferreras et al., 2016; Tobeña et al., 2016) (Table 2).

2.4. Stack-Species Distribution Models (S-SDM)

To identify areas with conditions for increased odontocete biodiversity we produced a Stacked-Species Distribution Model (S-SDM) (Calabrese et al., 2014; D'Amen et al., 2015; Zellmer et al., 2019). The S-SDMs were built by combining each of the individual-SDMs in order to provide an opportunity to identify suitable habitat across multiple species (Zellmer et al., 2019). As Tobeña et al. (2016), the S-SDM map was created to investigate where cetacean richness is expected to be higher when compared with adjacent occurrence areas, given a greater environmental suitability.

2.5. Marine Protected Area Gap Analysis

The MPAs data were gathered from the World Database of Protected Areas (www.protectedplanet.net) (UNEP-WCMC, 2019) and from Chico Mendes Institute for Biodiversity Conservation (*Instituto Chico Mendes Chico Mendes de Conservação da Biodiversidade*) (http://www.icmbio.gov.br/portal/) (ICMBio, 2019) in shapefile format. In Brazil, the Coastal-Marine system is understood as one Biome and the protected areas are known as Conservation Units (UCs) (Brazil, 2000; Schiavetti et al., 2013). The National System of Protected Areas (*Sistema Nacional de Unidades de Conservação*) (Brazil, 2000; 2002) defined two classes of protection areas and comprises 12 management categories. The Integral Protection Protected Areas are no-take protected areas and comprises: Ecological Stations (ESEC - IUCN[16] Ia), Biological Reserves (REBIO - IUCN Ia), National Parks (PARK – IUCN II), Natural Monuments (MONA – IUCN III) and Wildlife Refuges (REVIS – IUCN III). The Sustainable Use Protected Areas are areas with multiple uses and comprises: Environmental Protection Areas (APA – IUCN V), Areas of Relevant Ecological Interest (ARIE – IUCN IV), Extractive Reserves (RESEX – IUCN VI), Sustainable Development Reserves (RDS – IUCN VI), Private Natural Heritage Reserve (RPPN – IUCN IV), Wildlife Reserves (REFAU – IUCN VI) and National Forest (FLONA – IUCN VI) (Supplementary Table 4).

All marine and coastal UCs with available information were included in Coastal-Marine biome were considered. For discussion of coverage, the coastal and marine UCs (keeping the 'MPA' term for all of them) were classified in three types: I – MPAs with total or main area (>50%) at sea and/or ocean island (direct influence on odontocetes); II – MPAs mainly in coastal areas (>50%), but with some extent at sea and/or ocean islands (direct influence on odontocetes); and III – MPAs in terrestrial coastal areas (100%), which contribute indirectly by conserving adjacent coastal areas (indirect influence on odontocetes) (Supplementary Figure 2). Nevertheless, only those with direct influence will be discussed here. To evaluate the coverage of the current zoning of the MPAs related with odontocete probability of occurrence, the MPAs polygons were overlapped with the S-SDM raster. The maximum value from the S-SDM raster was extracted and this value was used to rank MPAs according to higher richness coverage.

Main anthropogenic threats in the EEZ were mapped through public databases: ports, with data obtained from the National Waterway Transport Agency (ANTAQ) (http://portal.antaq.gov.br/); oil and gas extraction basins by the Brazilian National Petroleum Agency[17] (ANP) (http://www.anp.gov.br/); and commercial fishing[18] effort database from Global Fishing Watching (GFW) (https://globalfishingwatch.org/). The first two were obtained as polygons in shapefile format, whilst the GFW dataset contains the original release of the GFW fishing effort data and includes commercial fishing effort binned into grid cells 0.1 degrees and measured in units of hours (see Kroodsma et al., 2018). The GFW dataset from 2012-2016 was

[16] Equivalence of each Brazilian category (Brazil, 2000) with the six management categories for protected areas suggested by the International Union for Conservation of Nature (IUCN) (IUCN, 1994) (for more details see Dudley, 2008).
[17] Provides shapefiles of exploration blocks and production fields, that is, locations of hydrocarbon exploration which encompass seismic, performance and production stages.
[18] Included industrial fishing vessels tracked from 2012 to 2016, by Automatic Identification System (AIS) satellite signals. These vessels are mostly trawler, drifting long liners and purse seiners active vessels, larger than 24m and 36m, the size which most vessels are mandated by the International Maritime Organization to transmit AIS signals. For more information see Kroodsma et al., (2018) and https://globalfishingwatch.org/.

obtained in csv format and pooled together into a raster file through the 'rasterize' function of raster (Hijmans et al., 2017) in log scale.

One crucial step of spatial planning is revisiting the efficacy of existing area-based protection measures in light of new information on species distribution (Gomez et al., 2017). Therefore, marine spatial prioritizations that are part of Brazilian policy were overlapped with S-SDM raster to investigate if those marine priority areas recently evaluated by experts to several marine organisms encompass the resulting areas of high odontocete richness. The Priority Areas for Conservation, Sustainable Use and Sharing of Biodiversity Benefits (PAC) is an instrument created to support decision making in Brazilian conservation planning, instituted by federal decree Nº 5.092 (Brazil, 2004) in line with the strategies recommended by the CBD and other national instruments (as MMA, 2006a; 2006b). The PAC was last updated in 2018 (MMA, 2018), by several experts and using the most widely used decision support software for conservation planning (MARXAN; http://marxan.net/). Polygons in shapefile format were disponible in the Ministry of the Environment website (http://areasprioritarias.mma.gov.br/).

3 RESULTS

3.1. Species Distribution Models (SDM)

After running correlation coefficients and variance inflation factors ('vifstep' and 'vifcor') individual-SDMs were built based on seven uncorrelated environmental layers (Table 1). From 3.710 compiled records, 2.192 were retained after scrutinizing data (Supplementary Table 2). All models presented an excellent predictive performance, with AUC scores > 0.9 and TSS scores > 0.7 indicating model robustness (Table 2). The best model configuration for each species is presented in Table 2. The variable that most contributed to models was bathy (retained the higher % in 15 models), followed by distance to shore, SST_R, Chlora_R and SSS_R, and in lower percentages by slope and SSS_Ma (Table 2). The final individual-SDM with predicted potential distribution map for each species is shown and shortly commented on Supplementary Material (Supplementary Figures 3-19). The results are discussed by functional groups according to phylogeny and ecological information.

TABLE 1. List of environmental variables used in this study and their respective source, unit, resolution, codes and final values of variance inflation factors (vif).

	Environmental variables	Source	Unit	Resolution	Codes	vif
static	**Bathymetry (depth of the seafloor)**	MARSPEC	m	0.0833333	bathy	1.838427
	Distance to shore	MARSPEC	km	0.0833333	distoshore	2.048749
	Bathymetric slope	MARSPEC	degrees	0.0833333	slope	1.092413

dynamic	**Range annual chlorophyll-a concentration**	Bio-Oracle	mg.m-3	0.0833333	Chlora_R	2.115702
	Annual range sea surface salinity	Bio-Oracle	psu	0.0833333	SSS_R	2.278154
	Maximum annual sea surface salinity	Bio-Oracle	psu	0.0833333	SSS_Ma	2.277576
	Annual range sea surface temperature	Bio-Oracle	ºC	0.0833333	SST_R	1.803802

TABLE 2. Best fit MaxEnt model selected for each of the 17 species. TRD = Training Data; TED = Test Data; FC = Feature Classes; RMV = Regularization Multipliers Value; TrAUC = Train AUC; TeAUC = Test AUC; TSS = True Skill Statistic; spec_spe = threshold value that maximized specificity (true negative rate) and sensitivity (true positive rate).

Species	TRD	TED	FC	RMV	TrAUC	TeAUC	TSS	spec_spe	Variable contribution (%)
Black-fishes and Risso's dolphin (preference by oceanic and deeper waters < 1000m) (Globicephalinae)									
Globicephala macrorhynchus	22	5	LQH	3.5	0.94	0.92	0.875	0.48	bathy (49.0046); distoshore (47.0841); SST_R (2.8734); SSS_R (1.0321); Chlora_R (0.0058); SSS_Ma (0.0000); slope (0.0000)
Globicephala melas	11	3	LQ	0.5	0.99	1.00	0.995	0.88	bathy (51.8492); slope (17.2355); distoshore (15.4489); SST_R (11.1901); SSS_R (3.5279); SSS_Ma (0.5884); Chlora_R (0.1601)
Feresa attenuata	13	4	LQ	2.5	0.97	0.96	0.912	0.35	bathy (68.7248); SSS_R (18.5290); distoshore (10.6295); Chlora_R (2.1167); SSS_Ma (0.0000); slope (0.0000); SST_R (0.0000)
Pseudorca crassidens	17	5	LQ	2	0.96	0.97	0.898	0.31	bathy (52.6529); SST_R (19.8771); distoshore (14.4445); slope (6.5713); SSS_R (3.8052); Chlora_R (2.6138); SSS_Ma (0.0353)
Peponocephala electra	18	5	LQ	0.5	0.98	0.98	0.937	0.36	bathy (41.7004); distoshore (35.3369); SSS_R (12.1249); Chora_R (5.9294); slope (4.2404); SST_R (0.6681); SSS_Ma (0.0000)
Grampus griseus	62	15	LQH	3	0.99	0.98	0.898	0.15	bathy (33.7648); Chlora_R (23.2116); distoshore (13.7001); SST_R (12.3341); SSS_R (6.4821); slope (5.5739); SSS_Ma (4.9335)
Wide-ranging delphinids (inhabits coastal, neritic and oceanic waters) (Delphininae)									
Orcinus orca	74	17	LQH	4	0.97	0.97	0.887	0.32	bathy (41.1717); Chlora_R (25.0864); SST_R (18.5905); distoshore (7.9474); SSS_Ma (0.0000); slope (3.9140); SSS_R (3.2900)
Tursiops spp.	313	78	LQHP	2	0.97	0.96	0.830	0.09	bathy (68.1620); SST_R (7.8012); SSS_R (6.7152); distoshore (6.4131); Chlora_R (4.0346); SSS_Ma (1.9535); slope (1.8292);

Steno bredanensis	76	18	LQ	0.5	0.95	0.96	0.822	0.08	bathy (69.9517); distoshore (14.0927); SST_R (6.0778); SSS_R (5.6761); slope (2.1845); Chlora_R (1.7340); SSS_Ma (0.2831)
Delphinus sp.	67	17	LQ	0.5	0.97	0.99	0.97	0.27	bathy (55.6522); SST_R (14.9061); Chlora_R (13.4154); slope (5.3143); SSS_R (6.3284); distoshore (3.8305); SSS_Ma (0.5532)
Small coastal delphinids (preference by coastal and neritic shallower waters) (Delphininae)									
Sotalia guianensis	66	16	LQ	0.5	1.00	0.99	0.98	0.04	bathy (58.6082); distoshore (30.5362); SST_R (4.3242); SSS_R (2.5736); Chlora_R (2.5569); SSS_Ma (1.1812); slope (0.2197)
Stenella frontalis	236	59	LQ	0.5	0.98	0.98	0.92	0.05	bathy (70.0346); SSS_R (14.7802); SST_R (5.4201); distoshore (4.8228); Chlora_R (4.6430); slope (0.2994); SSS_Ma (0.0000)
Small oceanic delphinids (stenellids with preference by oceanic and deeper waters) (Delphininae)									
Stenella attenuata	288	71	LQ HP	4	0.96	0.95	0.81	0.24	distoshore (49.1505); bathy (35.8162); slope (6.4053); Chlora_R (3.6383); SSS_Ma (2.6322); SST_R (2.0055); SSS_R (0.3519)
Stenella clymene	44	11	LQ	0.5	0.94	0.95	0.85	0.26	distoshore (42.1503); bathy (33.2319); SSS_R (12.2193); Chlora_R (7.2613); SST_R (4.6052); slope (0.5188); SSS_Ma (0.0132)
Stenella coeruleoalba	19	5	LQ H	4	0.98	0.99	0.98	0.81	bathy (56.6403); Chlora_R (26.5399); SST_R (9.0020); distoshore (4.7730); slope (3.0448); SSS_Ma (0.0000); SSS_R (0.0000)
Stenella longirostris	147	36	LQ H	2	0.98	0.96	0.81	0.03	bathy (45.6137); slope (22.4061); distoshore (13.9059); SSS_R (8.4264); Chlora_R (5.4356); SST_R (3.1442); SSS_Ma (1.0683)
Sperm whale (preference by deep waters along the edges of continental shelf) (Physeteridae)									
Physeter macrocephalus	283	71	LQ HP	1.5	0.97	0.96	0.83	0.04	bathy (63.0813); distoshore (17.0180); slope (10.2997); SST_R (5.3201); Chlora_R (2.5931); SSS_Ma (1.3796); SSS_R (0.3082)

3.2. Stack-Species Distribution Models (S-SDM)

The S-SDM showed predicted multi-species habitat suitability across the Brazilian EEZ and adjacent waters from SWA for 17 odontocete species. Two areas of major probability of occurrence given a greater environmental suitability across multiple species was indicated: one in neritic and deeper waters outer of the continental shelf break through the PWTSA and southern PTSA (offshore hotspot area); and one in nearshore waters influenced by coastal upwellings in the northern PWTSA (nearshore hotspot area) (Figure 2). In general, average occurrence probability was lower in coastal and oligotrophic warm waters, especially along the narrow continental shelf in the PTSA and through PBNS and increases south of Abrolhos Bank and the Vitória-Trindade Chain. Except for the model generated for the Guiana dolphin (the only strictly coastal and estuarine species included), all individual-SDM indicated environmental suitability on this offshore area (see Supplementary Figures 3-19). Meanwhile, nearshore waters with great environmental suitability were influenced by individual-SDMs from wide-ranging delphinids (killer whale, bottlenose dolphins, rough-toothed dolphin, and common dolphin) and small coastal delphinids (Atlantic-spotted dolphin and Guiana dolphin) (Table 2). This coastal area, besides being a higher productive zone, is also a metropolitan area where the odontocetes are under threat from high anthropogenic pressures from increasing activities and developments (adjacent areas of southeastern Brazil).

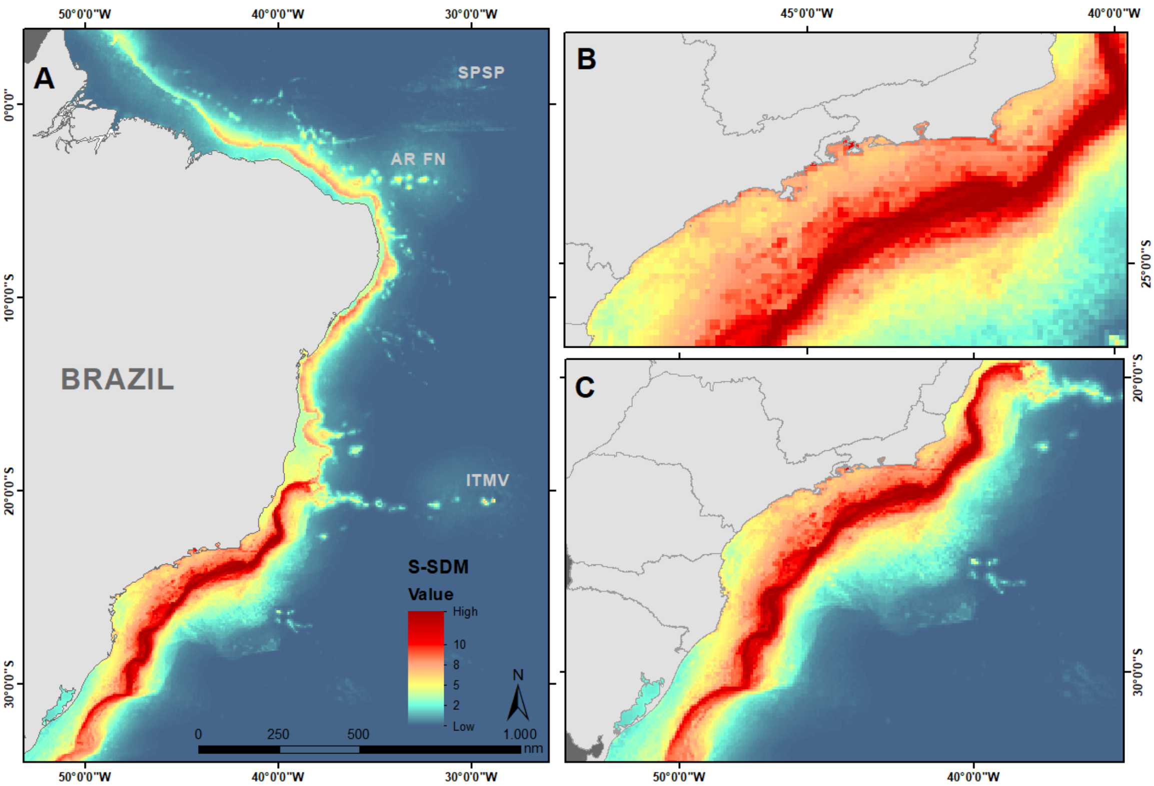


FIGURE 2. STACK-SPECIES DISTRIBUTION MODELS (S-SDM) SHOWING PREDICTED MULTI-SPECIES PROBABILITY OF OCCURRENCE. Individual-SDMs were created for 17 odontocete species and then added together to create an S-SDM. A) S-SDM general result; B) zoom to the nearshore hotspot area; and C) zoom to the offshore hotspot area. Color ramp shows S-SDM scores by predicted probability of occurrence.

3. 3. Gap Analysis

Regarding to MPAs the current percentage of coverage in the Brazilian EEZ is the 28%, unevenly distributed among the three marine provinces (Figure 3A) (Supplementary Table 4). Among

MPAs that could directly influence the marine odontocetes conservation (type I and II), 70 MPAs are from federal administration, 75 state administration and 15 municipal administration (Supplementary Table 4). Among those from federal[19] administration, only 47% have approved management plans and, among these, only 27% cited some management measures specifically for odontocetes (e.g., acoustic monitoring, advances in scientific knowledge, regulates the gillnets fisheries and diving interactions with dolphins).

Almost all MPAs type I and II are distributed in the Contiguous Zone (until 24 nm from the coastline). The exceptions are those MPAs around oceanic islands of the PTSA (Atol das Rocas, Fernando de Noronha, São Pedro São Paulo and Trindade and Martim-Vaz Archipelagos) and one small and no-take MPA in the PNBS (Marine State Park Manuel Luís). The absence of other MPAs up to 24 nm is an important protection gap to wide-ranging and oceanic odontocetes in the Brazilian EEZ (Figure 3B).

The predicted areas of greatest occurrence probability across multiple species, are also those with the highest concentration of mapped anthropic pressures (Figure 3C). In offshore waters, the biggest exploration blocks and production fields of oil and gas industries are found between southern PTSA and northern PWTSA, while the highest concentration of ports is found in the northern PWTSA. Regarding commercial fishing, the effort at EEZ was concentrated in coastal and neritic waters through the PWTSA and widely in offshore waters after 200 nm (mainly by non-Brazilian vessels).

Lastly, when the S-SDM was overlapped with the PAC spatial prioritizations, were observed that it encompasses most of the resulting areas of high odontocete probability of occurrence (Figure 3D). As based in the EBSAs concept, the PAC harbors areas of high, very high and extremely high biological importance, identified through high, very high and extremely high action priority (Figure 3D). It could be useful for determining and prioritizing dynamic management areas, incorporating other in situ strategies beyond the MPA model based on fixed boundaries used in Brazil. The area of high probability of occurrence of odontocetes and without any coverage by MPAs or PAC, for example, is the same area with the highest activity by the oil and gas industry – an activity that imposes direct threats to odontocetes (Figure 3C).

The marine province with the highest odontocete species richness (PWTSA) has the lowest MPA coverage (Figure 4). The species with the highest MPA coverage along its potential distribution is the Guiana dolphin. Meanwhile, there are species with no coverage of MPA at all along its potential distribution, such as the long-finned pilot whale (*Globicephala melas*). The most frequent management category is Environmental Protection Area (APA) (category V –

---

[19] Only the federal MPAs could be evaluated by the standardizing information from ICMBio platform (http://www.icmbio.gov.br/).

IUCN) (more than 50%), the least restrictive multiple-use management category (Supplementary Table 4).

Among marine provinces, the PNBS has 3% covered by MPAs type I and II (11,115,821.55 ha) (Figure 4). Two large multiple-use MPAs increase this percentage (APA Reentrâncias Maranhenses and APA Arquipélago do Marajó). All other MPAs type I and II are classified as small[20] and medium sizes (Supplementary Table 4). The PNBS has the lowest diversity of odontocete species (17 species), and the lowest diversity of MPAs management categories (Figure 4). The Extractive Reserves (RESEX) (category VI – IUCN) is the most frequent management category. The RESEX is associated with a large presence of mangroves in this region and, as well as the traditional populations that depend on these natural resources and is based on co-management.

The PTSA has the highest percentage of covered area by MPAs, reaching more than 25% (93,628,999.24 ha) (Figure 4). However, only the two newly implemented sets of MPAs around São Pedro São Paulo archipelago (SPSP) and Trindade and Martin-Vaz islands (ITMV) cover together almost 24%. Of this percentage, 87.5% are from multiple-use APAs and 12.5% from no-take MONAs (category III – IUCN) that do not sustain the no-take requirements. Besides the newly implemented large MPAs, all other MPAs are classified as medium and small sizes. The PTSA has 26 odontocete species registered.

The PWTSA has the lowest percentage of coverage (0.4%, about 2.159.119,54 ha) (Figure 4). Besides three medium size MPAs, all other MPAs are classified with small sizes. The northern PWTSA has the greatest number of MPAs with direct influence on odontocetes (type I and II) (Supplementary Table 4) and the largest amount of “ranked” MPAs as capable to cover preferred habitats for small coastal and wide-ranging delphinids in this highly threatened area (Figure 3). This province also has the highest odontocete diversity, with 36 marine species registered. The species composition differs from other provinces, mainly for the presence of many temperate species recorded in the southern PWTSA, as porpoises (Phocoenidae) and beaked whales (Ziphiidae) that could not be directly included in the analyses. This province has a diverse management category, but the most frequent category is also APA (category V – IUCN) (Figure 4). Further, the PWTSA has the highest concentration of anthropic threats in the areas of greatest occurrence probability for several species, in both coastal and offshore zones (Figure 4).

[20] Interpretation of the size of the MPAs for cetaceans as a feature follows Pinn (2018): small (<1000 km^2), medium (>1000 km^2 to 10,000 km^2), large (10,000 km^2 to 100,000 km^2) and very large (>10,000 km^2).

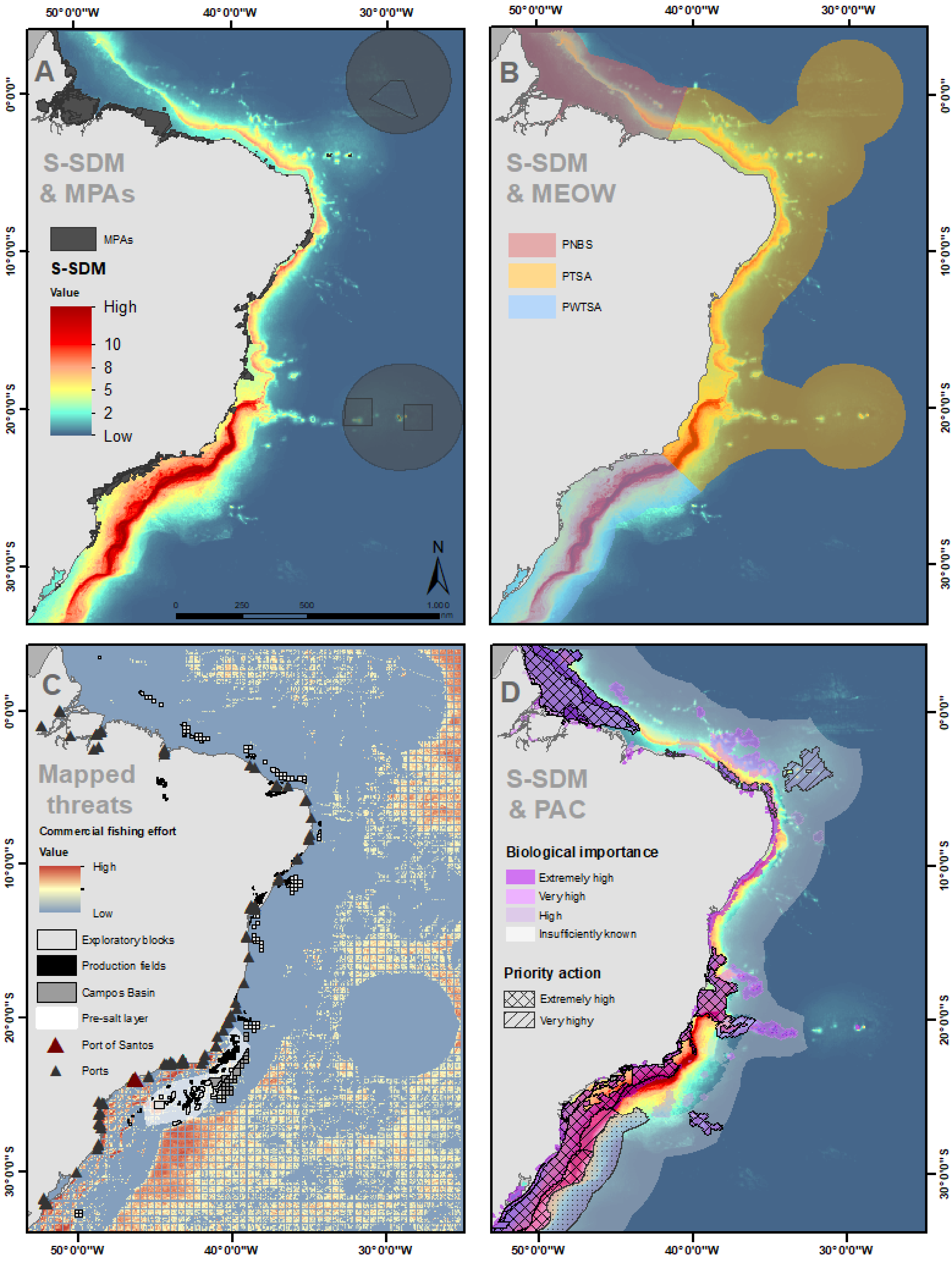


FIGURE 3. GAP ANALYSIS FROM ODONTOCETE CONSERVATION THROUGH BRAZILIAN JURISDICTIONAL WATERS. A) Marine protected areas coverage and S-SDM scores by predicted probability of occurrence across multi-species; B) S-SDM scores through the three marine biogeographic provinces (Spalding et al., 2007); C) Main mapped threats identified as ports (considering the intense shipping traffic), the oil and gas industries represented by exploratory blocks and production fields and the commercial fishing effort (log) between 2012-2016; and D) Priority Areas for Conservation (PAC) overlapped with the S-SDM scores (MMA, 2018).

4 DISCUSSION

Here, for the first time individual-SDM associated with spatial maps for multiple species (S-SDM approach) were applied to identify ecologically important areas for odontocetes in the SWA. Based on this approach were identified preferred habitats for 17 odontocete species; and odontocetes hotspots zones in an almost contiguous nearshore and offshore waters. Both areas could be understood as critical habitats across multiple species, mainly attributed to the frequency of occurrence of the species and by the high primary production related to well-defined oceanographic features. In the context of gap analysis, were identified matches and mismatches of MPAs coverage and odontocetes potential distribution; and where are three main anthropic pressures in relation to these ecological important areas to odontocetes.

4.1. The role of environmental features in driving odontocetes distribution patterns in the SWA

The results obtained here are very similar to the pattern of diversity for cetaceans find worldwide by Tittensor et al. (2010), in which odontocetes were influenced mainly by optimal SST at mid-latitudes (20º-40º) and high oceanic productivity (Tittensor et al., 2010; Whitehead et al., 2010). The S-SDMs was useful to identify areas with high probability of occurrence for a majority of the odontocetes in a transitional zone between tropical and subtropical biotas, south of the Abrolhos Bank and the VCT (Figure 2). Neritic and offshore waters outer of the continental slope are under influence of the upwellings from SACW that rise south of the Abrolhos Bank, the movements of the two main currents BC and MC and, consequently, the SASC. Meanwhile, the great occurrence probability in urbanized nearshore waters occurs in the northern PWTSA, in or near Cabo Frio upwellings zone and decreasing towards the SBB. Understanding the physical mechanisms that influence the formation and the persistence of predictable critical habitats is essential in order to define conservation management strategies for far-ranging top-marine predators (Hyrenbach et al., 2000).

4.1.1. The offshore hotspot area

Odontocete cetaceans do not have well-defined migratory patterns and their critical habitats are most subject to well-defined but spatially dynamic ocean features associated with their energy requirements (Mannocci et al., 2017; Forcada, 2018). Among the included oceanic dolphins, the commonly called black fishes (the pygmy killer whale *Feresa attenuata*, the melon-headed whale *Peponocephala electra*, the short-finned pilot whale *Globicephala macrorhynchus*, the long-finned pilot whale and the false killer whale *Pseudorca crassidens*) and the Risso's dolphin (*Grampus griseus*), the oceanic stenellids (the pantropical-spotted dolphin *Stenella attenuata*, the

Clymene dolphin *S. clymene*, the striped dolphin *S. coeruleoalba*, and the spinner dolphin *S. longirostris*), and the sperm whale shown high occurrence probability in offshore and deeper waters (>1,000m) in step shelf edge areas outer of continental slope (Supplementary Figures 3-19). Most oceanic top-predators are known to prefer heterogeneous habitats, such as shelf breaks and submarine canyons (Hooker et al., 1999; Bouchet et al., 2015). The increase of productivity is determined by static bathymetric features and hydrographic features (as persistent currents and frontal systems and ephemeral habitats generated by wind and/or current-driven upwellings and eddies) (Hyrenbach et al., 2000; Forcada, 2018), concentrating prey for deep divers (Davis et al., 2001; Cañadas et al., 2002; Notarbartolo Di Sciara et al., 2008). In fact, habitat features that enhance local productivity and the aggregation of prey species are widely described as the primary influence of the physical environment over cetacean distributions (Davis et al., 2001; Cañadas et al., 2002; Di Tullio et al., 2016). The seafloor depth and relief, combined with temperature and other oceanographic features affect the occurrence of prey and, therefore, influence odontocetes distribution (Baumgartner et al., 2001; Davis et al., 2001).

The offshore hotspot area predicted with high occurrence probability across multi-species (Figure 2) is characterized by shelf break upwellings from SACW that take place along continental slope and the seasonal movements of BC and MC, altering water compositions and enhancing densities of autotrophic communities of upper layers (Brandini, 1990; Di Tullio et al., 2016). The primary production rates in the northern PWTSA are greater during austral summer and spring months, when upwellings from SACW are more intense (Knoppers et al., 2010; Tardin et al., 2019b). Meanwhile, in the southern PWTSA the interaction between BC and MC over the shelf produce a northward and onshore flow during austral winter (with subantarctic, nutrient-rich and lower salinity waters) and a southward and offshore flow during austral summer (with warm, nutrient-poor coastal waters) (Moreno et al., 2005; Prado et al., 2016). The latitude of SASC determines where the BC will separate from the continent (usually about 36°S), and is farther north during austral winter and spring (Olson et al., 1988; Podestá et al., 1991; Moreno et al., 2005). The increase of phytoplankton biomass during austral winter and spring has also been related to nutrient supply from La Plata River and Patos Lagoon (Ciotti et al., 1995; Prado et al., 2016).

The "black fishes", the Risso's dolphin and the sperm whale have principally a teutophagic diet ("squid-eaters"), whereas the oceanic stenellids have a wider spectrum of target prey of fishes and squids (Davis et al., 2001; Cañadas et al., 2002). Di Tullio et al., (2016) indicates that most large and small delphinids have higher densities in the southern PWTSA during spring season, when compared with autumn. Prado et al., (2016) also reported an increase in the number of strandings of these species during late winter and earlier spring in this area. This is probably associated with the increasing in high primary productivity and, consequently, a high biomass of demersal and pelagic fish and squid in the vicinity of shelf breaks that moving from the south in association with the SASC (Haimovici and Perez, 1991; Haimovici and Aguiar dos Santos, 2001; Dos Santos and Haimovici, 2002; Haimovici et al., 2009). For the same reason, the industrial fishing effort has been concentrated in this province (Figure 3C). The PWTSA is responsible for more than 50% of industrial and commercial fishery production in Brazil (Knoppers et al., 2010). This also results in an overexploitation of several fishery stocks and high bycatch rates of several marine top-predators (Zerbini and Kotas, 1998; Bugoni et al., 2008; Prado et al., 2016). The commercial fishing effort data presented here are underestimated, since Brazil is one of the countries with a poor satellite coverage for both artisanal and commercial fishing (Kroodsma et al., 2018). Moreover, the coastal artisanal gillnet fishery is also recognized as a threat to several odontocete species (Prado et al., 2013; Di Tullio et al., 2015) and were not included.

The seasonal changes in well-defined oceanographic features and prey availability can cause changes in odontocete distribution. For example, the long-finned pilot whale appears to be associated with colder waters from MC, reaching lower latitudes by the influence of the SACS (Supplementary Figure 6). Meanwhile, more tropical species (as the pygmy killer whale, the long-finned pilot whale, the melon-headed whale, the pantropical-spotted dolphin, the Clymene dolphin and the spinner dolphin) seem to have their movements associated with the warm BC through Brazilian continental slope, following its boundaries seasonally (Supplementary Figures 4, 5, 9, 12, 13) (Secchi, 1995; do Amaral et al., 2015). The dynamic nature of pelagic systems reinforces the need to include dynamic management measures (Hyrenbach et al., 2000) and also the biological importance of the SACS as a limit range for several species in the SWA (Moreno et al., 2005).

4.1.2. The nearshore hotspot area

The wide-ranging delphinids, the killer whales (*Orcinus orca*), the rough-toothed dolphin (*Steno bredanensis*), the bottlenose dolphins (*Tursiops* spp.) and the common dolphin (*Delphinus* sp.), showed higher occurrence probability in neritic habitats over the continental shelf, but also in both predicted areas for coastal and oceanic species.

In Brazilian waters two bottlenose dolphins (*Tursiops* spp.) are recognized: The Lahille's bottlenose dolphin (*T. gephyreus)* a recently revalidated species (Wickert et al., 2016) and the common bottlenose dolphin (*T. truncatus*). Despite the full taxonomic status of the Lahille's bottlenose dolphin is still under debate (Fruet et al., 2017; Simões-Lopes et al., 2019; Genoves et al., 2020), here we assumed the existence of two different species (Hohl et al., 2020; Machado et al., 2020). The Lahille's bottlenose dolphin occur in inshore waters close to the surf zone, coastal bays, and adjacent waters from coastal estuaries and lagoons of southern PWTSA, Uruguay and

Argentina (Wickert et al., 2016; Simões-Lopes et al., 2019). The Lahille's bottlenose dolphin present site fidelity in the Patos Lagoon (Genoves et al., 2020), Laguna river estuary and in the Tramandaí river estuary (Daura-Jorge et al., 2012; Di Giacomo and Ott, 2016; Ilha et al., 2018). In these estuaries, the Lahille's bottlenose dolphin is known for perform a cooperative fishing carried out with traditional fishermen, an interspecific and cultural relationship (Pryor et al., 1990; Simões-Lopes et al., 1998; Daura-Jorge et al., 2012). This interaction is recognized as local cultural heritage by municipal legislations (Imbé, 1990; Laguna, 1997). Recently, the IUCN listed the Lahille's Bottlenose dolphin as Vulnerable (VU) (Vermeulen, et al., 2019).

Conversely, the common bottlenose dolphin (*T. truncatus*) is widely distributed along the Brazilian coast (Wickert et al., 2016; Simões-Lopes et al., 2019). The common bottlenose dolphin occur in the three marine provinces, in coastal and offshore waters and also around all oceanic islands (Rossi-Santos et al., 2006; Baracho et al., 2008; De Carvalho and Rossi-Santos, 2011; Meirelles et al., 2016; Milmann et al., 2017). The common bottlenose dolphin has known site fidelity around SPSP archipelago (Milmann et al., 2017); and is frequently sighted closer to coast in the Cagarras Archipelago (Lodi et al., 2014; Lodi, 2016; Lodi and Tardin, 2018) and in the Cabo Frio region (Tardin et al., 2013, 2019b). Nevertheless, Tardin et al., (2019b) indicates that this species does not seem to be resident in the Cabo Frio region, using it as a passing area influenced by prey availability. Further, common bottlenose dolphins have also been sighted in all seasons around Trindade Island (De Carvalho and Rossi-Santos, 2011; Moreno et al., 2017; Ilha, 2018). The core observation occurs mainly inside the 12 nm around Trindade Island, which was removed from any type of protection by the top-down changes in the MPA design (Ilha, 2018; Giglio et al., 2018).

The rough-toothed dolphin, despite being recorded along the three marine provinces, is all year sighted only in coastal waters from Abrolhos Bank and northern PWTSA (Lodi and Hetzel, 1998; Rossi-Santos et al., 2006; Lodi et al., 2012; Santos et al., 2019). Lodi et al. (2012) suggest a possible instance of site fidelity in coastal waters between Cabo Frio and Rio de Janeiro cities, but also indicate the need to better understand the home range of this species. Santos et al. (2019), for example, reveal that some individuals of rough-toothed dolphins first seen in Guanabara Bay (Rio de Janeiro state) were sighted 240 km southwards in coastal waters from São Paulo state three years later. The presence of the rough-toothed dolphin around the Abrolhos Archipelago and the coral reef surroundings, can be association with their potential prey items, some of which occur in shallow reef sites such as those found in the Abrolhos area (Lodi and Hetzel, 1999; Wedekin et al., 2005; Rossi-Santos et al., 2006).

As observed for the wide-ranging odontocetes, the coastal small delphinids, the Atlantic-spotted dolphin (*Stenella frontalis*) and the Guiana dolphin are frequent species in the nearshore hotspot area (Tavares et al., 2010; do Amaral et al., 2015; Santos et al., 2017, 2019). This seems to be an important cetaceans hotspots, where dolphins and whales find a prey-rich region (Santos et al., 2019; Tardin et al., 2019a). The upwelling phenomena replenishes surface nutrients and enhances primary production (Hyrenbach et al., 2000), rich fishing grounds and increased biomass of some of potential main prey such some squids and small pelagic fishes (Bakun and Parrish, 1990; Haimovici and Perez, 1991; Paiva and Motta, 2000).

The Atlantic-spotted dolphin showed a discontinuous distribution range in the SWA (between 6º and 18ºS) (Moreno et al., 2005; Danilewicz et al., 2013; do Amaral et al., 2015). Low occurrence probability occurs in the PTSA, where the continental shelf is narrow (6° to 16°S) and the total estimated fish biomass is 77% lower than the estimated biomass of the shelf located between 20° and 34°S (Moreno et al., 2005; Paiva 1997). Morphological, molecular and environmental data suggests an isolated population in southeastern Brazil (Moreno et al., 2005; Caballero et al., 2013; do Amaral et al., 2015), where this species is frequently sighted in coastal waters (Zerbini et al 2004). Santos et al., (2017) indicates that the Atlantic-spotted dolphin is the commonest sighted species surrounding the no-take PARK Laje de Santos all year round (category II – IUCN), which seems to be a critical habitat for the species. This is especially relevant if this southern population is, indeed, isolated as proposed by Moreno et al., (2005).

The Guiana dolphin is the most common cetacean species found within Brazilian waters (Santos et al., 2019) and yet is one of the species with the highest population decline recorded (Azevedo et al., 2017) (Supplementary Figure 17). The Guiana dolphin is one of the most studied coastal species, with several research mainly conducted in protected bays and estuaries (Santos et al., 2019). The Guiana dolphin is considered to be resident in several bays and estuaries, such as the Paranaguá Estuarine Complex, Norte Bay, Babitonga Bay, Sepetiba Bay, Cananéia Estuary, Ilha Grande and Guanabara Bay and the adjacent coastal waters in the PWTSA (Wedekin et al., 2007; Dias et al., 2009; Espécie et al., 2010; Santos et al., 2010; Cremer et al., 2011; Oshima and Santos, 2016; Azevedo et al., 2017); Caravelas and Paragaçu river estuary, Todos os Santos Bay, Abrolhos Bank and around Fortaleza in the PTSA (Rossi-Santos et al., 2006; Cantor et al., 2012; Batista et al., 2014; Flores et al., 2018). The Guiana dolphin is also frequently reported in the PNBS (Rosas et al., 2018). The Guanabara bay is one of the most degraded water bodies in the Guiana dolphin range, and is a critical habitat for a resident population that declined about 37% in 16 years (Azevedo et al., 2017).

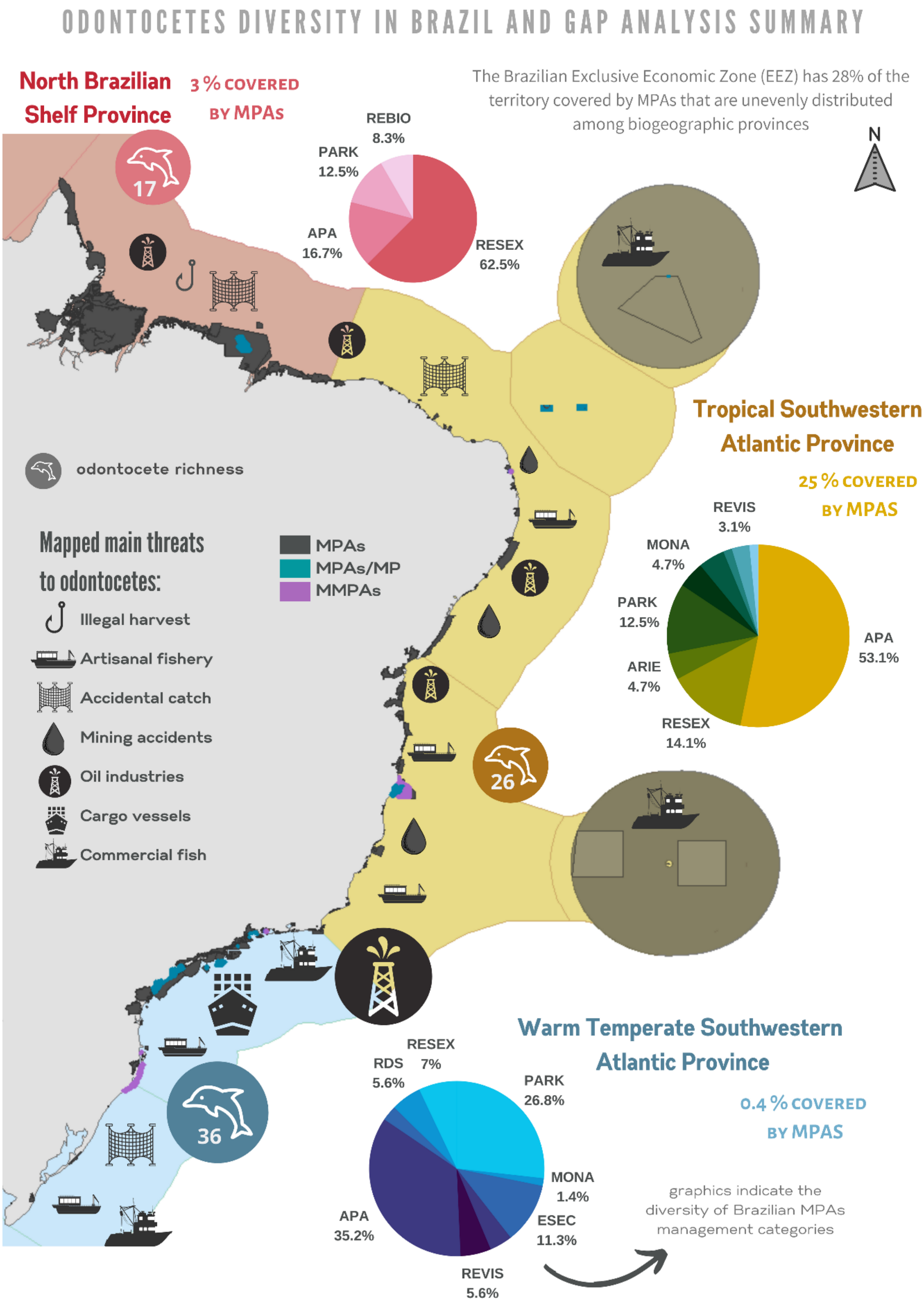


FIGURE 4. ODONTOCETES DIVERSITY IN BRAZIL AND GAP ANALYSIS SUMMARY. Percentage of MPA coverage and management categories among marine biogeographic provinces and the mapped main threats to odontocete conservation. MPA = marine protected area; MPAs/MP = MPAs that the management plan address management measures for cetaceans; MMPAs = MPAs created with cetacean-species as a conservation main-target.

4.2. Gap Analysis for odontocete conservation

Despite the high percentage of MPAs coverage in the Brazilian EEZ (28%), the current MPA policy alone seems to be insufficient to guarantee the odontocetes conservation and their preferred habitats over the time. Most Brazilian MPAs do not provide any specific management measures for odontocete conservation and a high percentage of MPAs do not even have a management plan, although this is a mandatory step by the SNUC (Brazil, 2000) as well as is considered as the "heart" of success or failure of MPAs (Hoyt, 2018). Several Brazilian MPAs still work as "paper MPAs" (Gill et al., 2017), and have no effective management as demanded by CBD/Aichi goals. Further, considering the IUCN definition for MPA networks (see Hooker et al., 2011), it's not possible to understand Brazilian MPAs as a well-connected system of MPAs; and neither as being ecologically representative given their unevenly coverage through the three biogeographical provinces (Figure 4) – and these characteristics are also requested by CBD/Aichi goals to achieve Target 11.

However, this does not mean that MPAs cannot be a powerful tool to achieve conservation goals in the marine ecosystem. Some MPAs are able to contribute to the protection of fixed habitats responsible for maintaining marine biodiversity (such as mangroves and coral reefs) (ICMMPA, 2011; Rotjan et al., 2014; Obura, 2018), which also contribute to protect cetacean habitats and ecosystems. Instead, most of Brazilian MPAs failures are associated to the lack of commitment by governments (from Federal, state, and municipal administrations) to provide the necessary subsidies for the correctly management of the MPAs, by the non-compliance of the steps established by the SNUC and by the imposing top-down approaches in the management spaces.

Thereby, as anthropic activities in the ocean increase, it is fundamental to manage human pressures on cetaceans both within and outside MPAs (ICMMPA, 2011). The MSP with integrated surveillance may offer a potential strategy to ensure suitable management of activities and to evidence to policy makers a clear view of environmental impacts (Pinn, 2018). The gap analysis can facilitate the spatial prioritization once identified unprotected and susceptible important ecological features and habitats (Hooker et al., 2011; Hoyt, 2018).

The concept of place-based conservation of cetaceans has been promoted as an effective tool in the last few years (ICMMPA, 2014; Notarbartolo di Sciara et al., 2016; Reeves, 2018). Other tools as the Ecologically or Biologically Significant Areas (EBSAs) set up under the CBD and the Important Marine Mammals areas (IMMAs) a new concept proposed by the IUCN Marine Mammal Protected Areas Task Force, can help policymakers to identifying appropriate areas for place-based cetacean conservation (Notarbartolo di Sciara et al., 2016). According to Pinn (2018), within the framework of MSP, cetacean place-based conservation could be pursued through the identification of critical habitats (preferably without the MPA label) combined with a sectoral management. A critical habitat is not necessarily a protected area, as neither IMMAs nor EBSAs. Instead, they are scientific tools that have the potential to support area-based management strategies (ICMMPA, 2014; Kot, 2014). Other space-based management tools can be integrated, such as environmental impact assessments, MPA networks, ecosystem-based management or even checking existing MPAs or zoning designations (ICMMPA, 2014; Hoyt, 2018). Following the ICMMPA (2014), MSP initiatives ought to focus on identifying areas of potentially high threat to cetaceans, to further improve modeling data, along with real data acquisition from surveys and applied research.

4.2.1. Within fixed boundaries: Marine Protected Areas (MPAs)

Overcoming current shortcomings, several MPAs could contribute to odontocete conservation. Around Fernando de Noronha Island, spinner dolphins have been recorded for decades resting, mating, nursing and also sheltering against predators (Silva-jr et al., 2005; Tischer et al., 2017). The set of MPAs around this island were not designed with the spinner dolphin as a target-specie. Nevertheless, the spinner dolphin critical habitat (Dolphin's Bay) is surrounding by the no-take PARK Fernando de Noronha (Category II – IUCN), while the displacement area is within the APA Fernando de Noronha – Atol das Rocas – SPSP boundaries (category V – IUCN) (ICMBio, 2017). However, recent studies indicate that the growth of tourism and dolphin watching are altering the area of occupation of this population (see Tischer et al., 2017). This emphasizes the importance of adaptive measures, as well as the fulfillment of supposedly already existing ones. The APA current management plan implements some nuisance restrictions (e.g., as noise, active chasing, and diving with dolphins) and is architected through zoning areas (ICMBio, 2017). Among oceanic species, the spinner dolphin is the only one with an identified critical habitat - in addition to the potential ones identified in this study. Meanwhile, for the sperm whale two concentration areas have already been suggested: the Camamu-Almada basin (about 13ºS) (Ramos et al., 2010) and the shelf border of the southern PWTSA (Pinedo et al., 2002; Di Tullio et al., 2016). The first is an area of constant exploration of oil and natural gas (Ramos et al., 2010), and the second one is under pressure from extensive commercial fishing areas (Knoppers et al., 2010). So far in Brazilian waters, there are no addressed management measures specifically to sperm whales that might be capable of contributing to changing their threatened status.

Through the nearshore hotspot area, Santos et al., (2019) reported movements of wide-ranging and coastal small delphinids, reinforcing the use of this area by several odontocete species. However, it's also one of the regions under the greatest impact of coastal urbanization, tourism, and marine industries in the EEZ (Figure 3C). The port of Santos, for example, is the largest port complex of Latin America (Santos et al., 2017). It's responsible for a quarter of Brazilian trade, and widely increases the marine traffic in this region. Further, according to the

ANP, the Campos basin extends over 100 km^2 from southern PTSA (Espírito Santo state) to northern PWTSA (Rio de Janeiro state) and together with pre-salt layer is responsible for 80% of national production of oil and gas. According to IBGE, this region also has the highest population density in the coastal zone and increases disorderly in the austral summer months. The only two nuclear power plants in Brazil are also located in the coastal city of Angra dos Reis, in the Rio de Janeiro state. The ESEC Tamoios (Category Ia – IUCN), ranked with the greatest odontocete probability of occurrence (Supplementary Table 4), was created to comply legal provisions which determine that nuclear power plants must be located in areas delimited by the ESEC category and to protect biodiversity-rich oceanic islands (Brazil, 1990). This management plan has few actions addressed for cetaceans (e.g., intensify enforcement during migratory periods) (ICMBio, 2006) and species such as the Guiana and the Atlantic-spotted dolphins are frequent in its surroundings. Nevertheless, this MPA is currently under severe pressure from real estate speculation, being considered as a "special area of tourist interest" (PL 6.479/2019).

The northern PWTSA has the largest number of "ranked" MPAs capable of covering preferred habitats for small coastal and wide-ranging delphinids in this highly threatened area (Figure 3) (Supplementary Table 4). The nearshore hotspot area can be both understood as a representative ecological area as well as an area of greatest concern (Hooker et al., 2011). Some of these MPAs have recent management plans that directly address strategies for odontocetes, such as the ESEC Tupinambás and the REVIS Alcatrazes (ICMBio, 2018). As the PARK Laje de Santos, these MPAs also were not created specifically for cetaceans' benefit. Nevertheless, they include concern about the migratory fauna and the current management plans addressing some important management measures (PEMLS, 2018; ICMBio 2018). Either by identifying surrounding main threats (such as the presence of large cargo vessels assigned to the Port of Santos in the areas where the Atlantic-spotted dolphin occurs) (PEMLS, 2018); or by include cetacean monitoring and/or fishing fleet regulations (such as cetacean acoustic monitoring and regulation of gillnet fisheries in important Francisca dolphin feeding areas) (ICMBio, 2018). Through a multi-specie management context (Hooker et al., 2011), these mosaics of small MPAs should be thought of as a local network of MPAs – especially because most of them alone are too small to contribute for cetacean conservation. This area encompasses important ocean processes that provide high biological diversity nearshore. It should be used to involve precautionary measures aimed at curtailing the principal anthropic pressures (Hooker et al., 2011).

For the threatened Guiana dolphin, three MPAs were created to protect resident populations: the federal APA Anhatomirim (Brazil, 1992), and the both municipal APA Boto-cinza (Mangaratiba, 2015) and the REFAU Tibau do Sul (Tibau do Sul, 2006). Together with the APA Baleia-franca for the southern-right whale (*Eubalaena australis*) and the APA Ponta da Baleia for the humpback whales, these are the only MPAs specially created with cetacean species as a main-target. The APA Anhatomirim harbor a critical habitat for the resident population of the Guiana dolphin in the Norte Bay (Wedekin et al., 2007, 2010). The management plan presents a marine zoning defined together with local artisanal fishermen and managers, with specific rules for each zone (ICMBio, 2013). The "Dolphin Protection Zone", for example, allows monitoring and research, professional artisanal fishing (except trawl gear), tourism and recreational vessels registered and authorized by MPA (with predefined speed limits) and non-motorized vessels, and prohibits mariculture and dredging construction (ICMBio, 2013). Conversely, the REFAU Tibau do Sul has no management plan or monitoring and surveillance programs (de Freitas et al., 2016), and the APA Boto-cinza in the Sepetiba Bay is being newly implemented. However, to obtain some level effectiveness within MPAs boundaries, especially considering the great amount of multiple-use MPAs, would be essential that those already implemented MPAs include at least: newly identified critical habitats, an adequacy of zoning architecture within MPAs boundaries, an explicit assessment of threats, clear management goals and monitoring plans allowing retrospective evaluation of MPA effectiveness (Hooker et al., 2011; Hoyt, 2018; Reeves, 2018).

Among the other marine provinces, the PNBS contains the largest number of MPAs based on co-management with local communities (RESEX[21] category). The large number of coral reefs in the PTSA are associated with the great number of MPAs (Schiavetti et al., 2013). Although for odontocetes this province does not predict a high probability of occurrence across multiple species, the PTSA is recognized as an important concentration area for most baleen whales in the SWA (Andriolo et al., 2010). Furthermore – and despite being increasing – it is also recognized that this region historically has a smaller sampling effort. Over the past five years, this province has suffered with some of the biggest Brazilian environmental crimes resulting from mining activities (the rupture of the Mariana dam and the biggest oil spill already registered in tropical waters) (Sánchez et al., 2018; Pinheiro et al., 2019; Soares et al., 2020; do Carmo and Lombardi, 2020). The dimensions of impacts on cetaceans and their habitats are still unknown, but this is an example of damage that cannot be controlled by MPAs (Agardy et al., 2011), reinforcing the need for an integrated MSP with surveillance as well as a governmental commitment to respond adequately to mitigate economic, social, and biological impacts (Soares et al., 2020).

[21] The co-management has the potential to improve conservation actions, based in community-based enforcement as is indicated by Mitzer et al (2015). This study - performed in continental waters in the Amazon - revealed empirical success strategies in the RDS Mamirauá (category IUCN – IV) where, influenced by participation in the RDS activities (such as research and ecotourism), the local fishers have positive attitudes toward Amazon River dolphin, increasing enforcement of illegal harvest and limiting dolphin mortality. These strategies could be applied among the coastal and marine RESEXs, acting pro-actively toward the illegal and accidental capture of the Guiana dolphin, threats often identified within MPAs boundaries.

4.2.2. Without legal boundaries: Priority Areas for Conservation (PAC)

The priority areas proposed by the PAC (MMA, 2018) encompasses most of the resulting areas of high odontocete probability of occurrence (Figure 3D). The PAC effectively does not provide legal protection, but is proposed as an approach to guide future public policies (Castro et al., 2014). Since the PAC is sectorized, it would be possible to develop a focus management on where it is most needed, when it is most needed. Although this is not an easy task, especially when financial resources for surveillance are scarce, some strategies could be incorporated. Some strategies emerge, such as define fixed routes to commercial vessels (Hazen et al., 2017); the commitment and the regulation of commercial fishing vessels to adopt mitigation measures already recognized to fishing in extremely and very high action priority areas (Hall et al., 2000; Hamilton and Baker, 2019); fishing exclusion areas and/or seasons (Di Tullio et al., 2015); the consideration of movement corridors connecting ecological important areas (Clark et al., 2010); spatial restrictions according to oceanographic features (Howell et al., 2008); or even deepen studies on assessment of the temporal nature of threats to the odontocetes and incorporating them through dynamic management measures (Hyrenbach et al., 2000; Hooker et al., 2011; Becker et al., 2016; Agardy et al., 2019).

Moreover, it would be possible to use PAC sectors with high and extremely high priority action to identify potential Areas of Interest (AoIs) for several odontocete species – the first stage of IMMAs select process (see Agardy et al., 2019; IUCN Marine Mammal Protected Areas Task Force, 2018) to motivate this initial debate to the SWA. The zones “area of coastal resurgence” and the “Ilha Grande bay” in the nearshore hotspot or the “south shelf”, the “upper slope of the Santos basin” or the “south slope”, for example, overlap the S-SDM areas with greater probability of occurrence (Supplementary Figure 20). Among the criteria for AoIs, for example, the PWTSA holds: vulnerable species (since encompass most of the distribution of range of the Francisca dolphin in Brazilian waters, several resident populations of the Guiana dolphin, and migration routes and feeding grounds of the sperm whales); nearshore and offshore aggregation and feeding areas (with high biological productivity associated with coastal and shelf break upwellings, confluence zone and fronts); distinctiveness by harbor populations with genetic, behavior, and/or ecologically distinctive characteristics (as the populations of the Lahille’s bottlenose dolphin and the Atlantic-spotted dolphin); and high cetacean diversity (with 36 species of odontocetes and eight species of baleen whales).

4.3. Model performance and occurrence data

Besides model robustness and statistical performance, models also should be evaluated in relation to existing knowledge, that is, what is known about the biology and ecology of the species (Fiedler et al., 2018). Ideally, the data used for cetacean SDMs should come from systematic surveys designed to estimate abundance and distribution (Fiedler et al., 2018) and preferably using presence-absence data (Tardin et al., 2019a). However, these studies are cost-demanding (Tardin et al., 2019b). Most cetacean data are conducted using opportunistic sightings or non-systematic surveys (Redfern et al., 2006; do Amaral et al., 2015) and are still limited for many cetaceans species (Redfern et al., 2017). While the increase of anthropic pressures increases conservation challenges for cetaceans (Redfern et al., 2017), many management measures end up neglected by Data Deficient limitations. Conversely, the precautionary approach understands that the lack of full scientific certainty should not be used as a reason for postponing conservation measures (FAO, 1996; CBD, 2010).

Heterogeneous data collection has led to large gaps in scientific knowledge of most cetaceans distributions (Mannocci et al., 2017). In the Brazilian EEZ, most cetacean information is still resulting of stranding data (Meirelles et al., 2009; Moura et al., 2016; Prado et al., 2016) and survey efforts dedicated to coastal areas (Santos and Figueiredo, 2016; Lodi and Tardin, 2018; Santos et al., 2019). New information about offshore odontocetes are still rarely found scientific papers (Pinedo et al., 2002; Zerbini et al., 2004; Wedekin et al., 2014; Di Tullio et al., 2016); and mainly obtained from reports of areas of economic interest that monitored effects of oil and gas exploration (Parente et al., 2007; Ramos et al., 2010; PMC-BS, 2019; SIMMAM, 2019). The availability of these report data in public databases are understood as a counterpart to civilian society (Barbosa and Owes, 2020). This type of data, obtained on a broader scale and through different collection methods, allows building macroscale studies, such as investigating biogeographic provinces (Mannocci et al., 2017).

Despite recognizing the strengths and limitations of the SDM approaches (Merow et al., 2013; Gomez et al., 2017), here were presented useful data on the occurrence and distribution of two threatened odontocetes and 15 evaluated as Data Deficient. With exception of common bottlenose dolphin (Tardin et al., 2019a;b), the Franciscana dolphin (do Amaral et al., 2018) and dolphins from genus *Stenella* (do Amaral et al., 2015), this is the first time that individual-SDM are presented for several odontocete species in the Brazilian EEZ. Plausive species distribution models using scientific and public data-base-information were generated (Supplementary Figures 3-19). For some species, such as the pygmy-killer whale and the Risso's dolphin, essentially nothing is known about population trends or suitable habitats in both Brazilian waters or even worldwide (Baird, 2018b; Hartman, 2018). Meanwhile, species with relatively known distribution areas that have their distribution ranges expanded by the new records included (such as the pantropical-spotted dolphin and the Clymene dolphin), should be considered with caution. Thus, even with few data records for some species as the black-fishes, individual-SDM provided relevant information on preferred habitats, especially when combined in the S-SDM. The importance of specific public databases for cetaceans, with degrees of reliability and completed data information is highlighted, especially considering the need of this information for conservation actions. Quite often, simple data such as latitude and longitude coordinates are not available in the scientific papers, making the information access difficult for managers and decision makers.

5 CONCLUSIONS

The first International Conference on Marine Mammal Protected Areas (ICMMPA) recommended as a priority that concerted effort be made to assemble cetacean critical habitat data to then identify and fill the considerable knowledge gaps (ICMMPA, 2009; Hoyt, 2011). The SDM is an important tool to highlight priority areas that warrant increased attention and monitoring efforts (Gomez et al., 2017), allowing that place-based conservation efforts can be directed most effectively (Hoyt, 2011; di Sciara et al., 2016). Meanwhile, the S-SDM was useful to identify commonalities between species and ecologically important areas (Tobeña et al., 2016; Zellmer et al., 2019).

Here were presented two potential critical habitats resulting from S-SDM models for multiple species, attributed to feeding grounds and aggregation areas by the frequency of occurrence of the species and by the high primary production related to well-defined oceanographic features. Both offshore and nearshore hotspot areas are under main anthropic threats. However, the offshore one is under any kind of conservation measure. Further, other potential critical habitat are also cited in relation to existing scientific knowledge and – for all of them – broad-based ecological information (as behavioral, social and movement data) should support information from critical habitats (Hooker et al., 2011). The wide-dimension of the study area is recognized and wherefore its strongly recommended that fine-scale studies within identified critical habitat are necessary (such as done by Tardin et al. 2019a; 2019b and Bortolotto et al., 2017) – but it must start somehow.

The increase in activities of Brazilian marine industries is notable, and so far, it is not possible to count on the actual MPA policy for odontocete conservation. Most MPAs were designated to meet other objectives that are not necessarily cetaceans' benefit. Besides, under economic and political pressures, most of MPAs are under insidious political effects (Giglio et al., 2018; Magris and Pressey, 2018). Finally, it is essential to keep in mind that conservation efforts are multidisciplinary and involve conscientious daily efforts of many people (from bureaucrats and political, scientists and educators, to fisherman and activists) (Reeves, 2018) and most of the they start with strategies to raise awareness with civil society (Hall et al., 2000; Pinn, 2018). This study looking-for encourages the discussion on the role of Brazilian MPAs for odontocetes conservation and how can we – as scientists, educators, managers, and environmentalists – build a more proactive and effective conservation policy to these species and their environment (Hoyt, 2018; Reeves, 2018).

REFERENCES

Agardy, T., Claudet, J., and Day, J. C. (2016). 'Dangerous Targets' revisited: Old dangers in new contexts plague marine protected areas. *Aquat. Conserv. Mar.* Freshw. *Ecosyst.* 26, 7–23. doi:10.1002/aqc.2675.

Agardy, T., Cody, M., Hastings, S., Hoyt, E., Nelson, A., Tetley, M., et al. (2019). Looking beyond the horizon: An early warning system to keep marine mammal information relevant for conservation. *Aquat. Conserv. Mar. Freshw. Ecosyst.* 29, 71–83. doi:10.1002/aqc.3072.

Agardy, T., di Sciara, G. N., and Christie, P. (2011). Mind the gap: Addressing the shortcomings of marine protected areas through large scale marine spatial planning. *Mar. Policy* 35, 226–232. doi:10.1016/j.marpol.2010.10.006.

Allouche, O., Tsoar, A., and Kadmon, R. (2006). Assessing the accuracy of species distribution models: prevalence, kappa and the true skill statistic (TSS). *J. Appl. Ecol.* 43, 1223–1232. doi:10.1111/j.1365-2664.2006.01214.x.

Amado-Filho, G. M., Maneveldt, G., Manso, R. C. C., Marins-Rosa, B. V., Pacheco, M. R., and Guimarães, S. M. P. B. (2007). Estructura de los mantos de rodolitos de 4 a 55 metros de profundidad en la costa sur del estado de Espírito Santo, Brazil. *Ciências Mar.* 33, 399–410. doi:10.7773/cm.v33i4.1148.

Andriolo, A., da Rocha, J. M., Zerbini, A. N., Simões-Lopes, P. C., Moreno, I. B., Lucena, A., et al. (2010). Distribution and relative abundance of large whales in a former whaling ground off eastern South America. *Zoologia* 27, 741–750. doi:10.1590/S1984-46702010000500011.

Avila, I. C., Kaschner, K., and Dormann, C. F. (2018). Current global risks to marine mammals: Taking stock of the threats. *Biol. Conserv.* 221, 44–58. doi:10.1016/j.biocon.2018.02.021.

Azevedo, A. de F., Carvalho, R. R., Kajin, M., Van Sluys, M., Bisi, T. L., Chunha, H. A., et al. (2017). The first confirmed decline of a delphinid population from Brazilian waters: 2000 – 2015 abundance of *Sotalia guianensis* in Guanabara Bay, Southeastern Brazil. *Ecol. Indic.* 79, 1–10. doi:10.1016/j.ecolind.2017.03.045.

Baird, R. W. (2018). Pygmy Killer Whale. in *Encyclopedia of Marine Mammals*, eds. B. Würsig, J. G. M. Thewissen, and K. M. Kovacs (Academic Press), 788-790 doi:10.1016/b978-0-12-804327-1.00210-7.

Bakun, A., and Parrish, R. H. (1990). Comparative studies of coastal pelagic fish reproductive habitats: the Brazilian sardine (*Sardinella aurita*). *ICES J. Mar. Sci.* 46, 269–283. doi:10.1093/icesjms/46.3.269.

Ballance, L. T. (2018). Cetacean Ecology. in *Encyclopedia of Marine Mammals*, eds. B. Würsig, J. G. M. Thewissen, and K. M. Kovacs (Academic Press), 172–180. doi:10.1016/b978-0-12-804327-1.00087-x.

Barbosa, A.F. and Owes, A.L. (2020). IBAMA e Indústria de Pesquisa Sísmica: em busca do conhecimento e sustentabilidade do licenciamento ambiental. Mind Duet Comunicação e Marketing.

Baracho, C., Cipolotti, S., Marcovaldi, E., Apolinário, M., and Silva, M. B. (2008). The occurrence of bottlenose dolphins (*Tursiops truncatus*) in the biological reserve of Atol das Rocas in north-eastern Brazil. *Mar. Biodivers. Rec. 1.* doi:10.1017/s1755267207007920.

Barragán-Barrera, D. C., do Amaral, K. B., Chávez-Carreño, P. A., Farías-Curtidor, N., Lancheros-Neva, R., Botero-Acosta, N., et al. (2019). Ecological niche modeling of three species of *Stenella* dolphins in the Caribbean basin, with application to the seaflower biosphere reserve. *Front. Mar. Sci.* 6, 1–17. doi:10.3389/fmars.2019.00010.

Bastida, R., Rodríguez, D., Secchi, E., da Silva, V. (2018). Mamíferos aquáticos da América do Sul e da Antártica. 1rst Edn, Vazquez Mazzini Editores, 368p.

Batista, R. L. G., Alvarez, M. R., dos Reis, M. do S. S., Cremer, M. J., and Schiavetti, A. (2014). Site fidelity and habitat use of the Guiana dolphin, *Sotalia guianensis* (Cetacea: Delphinidae), in the estuary of the Paraguaçú River, northeastern Brazil. North. *West. J. Zool.* 10, 93–100.

Baumgartner, M. F., Mullin, K. D., May, L. N., and Leming, T. D. (2001). Cetacean habitats in the northern Gulf of Mexico. *Fish. Bull.* 99, 219–239.

Becker, E. A., Forney, K. A., Fiedler, P. C., Barlow, J., Chivers, S. J., Edwards, C. A., et al. (2016). Moving towards dynamic ocean management: How well do modeled ocean products predict species distributions? *Remote Sens.* 8, 1–26. doi:10.3390/rs8020149.

Becker, E. A., Forney, K. A., Redfern, J. V., Barlow, J., Jacox, M. G., Roberts, J. J., et al. (2019). Predicting cetacean abundance and distribution in a changing climate. *Divers. Distrib.* 25, 626–643. doi:10.1111/ddi.12867.

Bisbal, G. A. (1995). The Southeast South American shelf large marine ecosystem. Evolution and components. *Mar. Policy* 19, 21–38. doi:10.1016/0308-597X(95)92570-W.

Bittencourt, L., Carvalho, R. R., Lailson-Brito, J., and Azevedo, A. F. (2014). Underwater noise pollution in a coastal tropical environment. *Mar. Pollut. Bull.* 83, 331–336. doi:10.1016/j.marpolbul.2014.04.026.

Bombosch, A., Zitterbart, D. P., Van Opzeeland, I., Frickenhaus, S., Burkhardt, E., Wisz, M. S., et al. (2014). Predictive habitat modelling of humpback (Megaptera novaeangliae) and Antarctic minke (*Balaenoptera bonaerensis*) whales in the Southern Ocean as a planning tool for seismic surveys. *Deep. Res. Part I Oceanogr. Res. Pap.* 91, 101–114. doi:10.1016/j.dsr.2014.05.017.

Bouchet, P. J., Meeuwig, J. J., Salgado Kent, C. P., Letessier, T. B., and Jenner, C. K. (2015). Topographic determinants of mobile vertebrate predator hotspots: Current knowledge and future directions. *Biol. Rev.* 90, 699–728. doi:10.1111/brv.12130.

Bourlès, B., Gouriou, Y., and Chuchla, R. (1999). On the circulation in the upper layer of the western equatorial Atlantic. *J. Geophys. Res. Ocean.* 104, 21151–21170. doi:10.1029/1999jc900058.

Brandini, F. P. (1990). Hydrography and characteristics of the phytoplankton in shelf and oceanic waters off southeastern Brazil during winter (July/August 1982) and summer (February/March 1984). *Hydrobiologia* 196, 111–148. doi:10.1007/BF00006105.

Brandini, F. P., Boltovskoy, D., Piola, A., Kocmur, S., Röttgers, R., Cesar Abreu, P., et al. (2000). Multiannual trends in fronts and distribution of nutrients and chlorophyll in the southwestern Atlantic (30-62°S). *Deep. Res. Part I Oceanogr. Res. Pap.* 47, 1015–1033. doi:10.1016/S0967-0637(99)00075-8.

Brazil. (1987). Lei Federal No 7.643, de 18 de dezembro de 1987. Available at: https://www.icmbio.gov.br/cma/images/stories/Legislacao/Leis/Lei_Federal_n_7.643_pro%C3%ADbe_a_ca%C3%A7a_de_baleias_-_Pro%C3%ADbe_a_ca%C3%A7a_de_baleias.pdf

Brazil. (1992). Decreto No528, de 20 de maio de 1992. Available at: http://www.planalto.gov.br/ccivil_03/decreto/1990-1994/D0528.htm

Brazil. (2000). Lei nº 9.985, de 18 de julho de 2000. Available at: http://www.planalto.gov.br/ccivil_03/leis/l9985.htm.

Brazil. (2002). Decreto Nº 4.340, de 22 de agosto de 2002. Available at: http://www2.mma.gov.br/port/conama/legiabre.cfm?codlegi=374.

Brazil (2004). Decreto Nº 5.092, de 21 de maio de 2004. Available at: https://www.planalto.gov.br/ccivil_03/_Ato2004-2006/2004/Decreto/D5092.htm

Brazil. (2008). Decreto No 6.698, de 17 de dezembro de 2008. Available at: https://www.icmbio.gov.br/cma/images/stories/Legislacao/Decretos/decreto_Cria%C3%A7%C3%A3o_do_Santu%C3%A1rio_das_Baleias_-_Santu%C3%A1rio_das_Baleias.pdf

Brazil (2018a). Decreto Nº 9.312, de 19 de março de 2018. Avalilable at: http://www.planalto.gov.br/CCIVIL_03/_Ato2015-2018/2018/Decreto/D9312.htm

Brazil (2018b). Decreto Nº 9.313, de 19 de março de 2018. Available at: http://www.planalto.gov.br/ccivil_03/_ato2015-2018/2018/Decreto/D9313.htm

Bugoni, L., Mancini, P. L., Monteiro, D. S., Nascimento, L., and Neves, T. S. (2008). Seabird bycatch in the Brazilian pelagic longline fishery and a review of capture rates in the southwestern Atlantic Ocean. *Endanger. Species Res.* 5, 137–147. doi:10.3354/esr00115.

Caballero, S., Marcos, M. C., Sanches, A., and Mignucci-Giannoni, A. A. (2013). Initial description of the phylogeography, population structure and genetic diversity of Atlantic spotted dolphins from Brazil and the Caribbean, inferred from analyses of mitochondrial and nuclear DNA. *Biochem. Syst. Ecol.* 48, 263–270. doi:10.1016/j.bse.2012.12.016.

Calabrese, J. M., Certain, G., Kraan, C., and Dormann, C. F. (2014). Stacking species distribution models and adjusting bias by linking them to macroecological models. *Glob. Ecol. Biogeogr.* 23, 99–112. doi:10.1111/geb.12102.

Cañadas, A., Sagarminaga, R., De Stephanis, R., Urquiola, E., and Hammond, P. S. (2005). Habitat preference modelling as a conservation tool: Proposals for marine protected areas for cetaceans in southern Spanish waters. *Aquat. Conserv. Mar. Freshw. Ecosyst.* 15, 495–521. doi:10.1002/aqc.689.

Cañadas, A., Sagarminaga, R., and García-Tiscar, S. (2002). Cetacean distribution related with depth and slope in the Mediterranean waters off southern Spain. *Deep. Res. Part I Oceanogr. Res. Pap.* 49, 2053–2073. doi:10.1016/S0967-0637(02)00123-1.

Cantor, 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. Mammal Sci.* 28, 63–83. doi:10.1111/j.1748-7692.2010.00456.x.

Castro, B. M., and Miranda, L. B. (1998). "Physical oceanography of the western Atlantic continental shelf located between 4N and 34S coastal segment (4W)," in *The Sea*, eds. A. R. Robinson and K. H. Brink (John Wiley & Sons, Inc), 209–250.

Castro, F. R., Mamede, N., Danilewicz, D., Geyer, Y., Pizzorno, J. L. A., Zerbini, A. N., et al. (2014). Are marine protected areas and priority areas for conservation representative of humpback whale breeding habitats in the western South Atlantic? *Biol. Conserv.* 179, 106–114. doi:10.1016/j.biocon.2014.09.013.

CBD, 2010. COP Decision X/2. Strategic Plan for Biodiversity 2011–2020. Available at: https://www.cbd.int/doc/decisions/cop-10/cop-10-dec-02-en.pdf.

Ciotti, Á. M., Odebrecht, C., Fillmann, G., and Moller, O. O. (1995). Freshwater outflow and Subtropical Convergence influence on phytoplankton biomass on the southern Brazilian continental shelf. *Cont. Shelf Res.* 15, 1737–1756. doi:10.1016/0278-4343(94)00091-Z.

Clark, J., Dolman, S. J., and Hoyt, E. (2010). Towards Marine Protected Areas for Cetaceans in Scotland, England and Wales: A scientific review identifying critical habitat with key recommendations.

Coelho-Souza, S. A., López, M. S., Guimarães, J. R. D., Coutinho, R., and Candella, R. N. (2012). Biophysical interactions in the cabo frio upwelling system, Southeastern Brazil. *Brazilian J. Oceanogr.* 60, 353–365. doi:10.1590/S1679-87592012000300008.

Costa, A. P. B., Rosel, P. E., Daura-Jorge, F. G., and Simões-Lopes, P. C. (2016). Offshore and coastal common bottlenose dolphins of the western South Atlantic face-to-face: What the skull and the spine can tell us. *Mar. Mammal Sci.* 32, 1433–1457. doi:10.1111/mms.12342.

Cremer, M. J., Hardt, F. A. S., Tonello, A. J., and Simões-Lopes, P. C. (2011). Distribution and status of the Guiana dolphin *Sotalia guianensis* (Cetacea, Delphinidae) population in Babitonga Bay, Southern Brazil. Zool. Stud. 50, 327–337.

Cypriano-Souza, A. L., de Meirelles, A. C. O., Carvalho, V. L., and Bonatto, S. L. (2017). Rare or cryptic? The first report of an Omura's whale (*Balaenoptera omurai*) in the South Atlantic Ocean. *Mar. Mammal Sci.* 33, 80–95. doi:10.1111/mms.12348.

D'Amen, M., Dubuis, A., Fernandes, R. F., Pottier, J., Pellissier, L., and Guisan, A. (2015). Using species richness and functional traits predictions to constrain assemblage predictions from stacked species distribution models. *J. Biogeogr.* 42, 1255–1266. doi:10.1111/jbi.12485.

da Silva, V. M. F., and Martin, A. R. (2018). "Amazon River Dolphin," in *Encyclopedia of Marine Mammals*, 21–24. doi:10.1016/b978-0-12-804327-1.00044-3.

Da Silveira, I. C. A., De Miranda, L. B., and Brown, W. S. (1994). On the origins of the North Brazil Current. *J. Geophys. Res.* 99. doi:10.1029/94jc01776.

Danilewicz, D., Ott, P. H., Secchi, E., Andriolo, A., and Zerbini, A. (2013). Occurrence of the Atlantic spotted dolphin, *Stenella frontalis*, in southern Abrolhos Bank, Brazil. *Mar. Biodivers. Rec.* 6, 1–3. doi:10.1017/S1755267212000929.

Daura-Jorge, F. G., Cantor, M., Ingram, S. N., Lusseau, D., and Simões-Lopes, P. C. (2012). The structure of a bottlenose dolphin society is coupled to a unique foraging cooperation with artisanal fishermen. *Biol. Lett.* 8, 702–705. doi:10.1098/rsbl.2012.0174.

Davis, R. W., Ortega-ortiz, J. G., Ribic, C. A., Evans, W. E., Biggs, D. C., Ressler, P. H., et al. (2001). Cetacean habitat in the northern oceanic Gulf of Mexico Randall. *Deep. Res. Part I* 0, 1–22.

De Carvalho, M. S., and Rossi-Santos, M. R. (2011). Sightings of the bottlenose dolphins (*Tursiops truncatus*) in the Trindade Island, Brazil, South Atlantic Ocean. *Mar. Biodivers. Rec.* 4, 2009–2011. doi:10.1017/S1755267211000029.

de Freitas, D. C., da Silva, P. C. M., Lunardi, V. de O., dos Santos, J. E. A., and Lunardi, D. G. (2016). Uso e ocupação do solo na Reserva Faunística Costeira de Tibau do Sul (REFAUTS), Rio Grande do Norte, Brasil (1984 - 2015). *Rev. Bras. Geogr. Física* 9, 1880–1887.

Derville, S., Torres, L. G., Iovan, C., and Garrigue, C. (2018). Finding the right fit: Comparative cetacean distribution models using multiple data sources and statistical approaches. *Divers. Distrib.* 24, 1657–1673. doi:10.1111/ddi.12782.

Di Beneditto, A. P., and Ramos, R. M. A. (2014). Marine debris ingestion by coastal dolphins: What drives differences between sympatric species? *Mar. Pollut. Bull.* xxx, xxx. doi:http://dx.doi.org/10.1016/j.marpolbul.2014.03.057.

Di Giacomo, A. B., and Ott, P. H. (2016). Long-term site fidelity and residency patterns of bottlenose dolphins (*Tursiops truncatus*) in the Tramandaí Estuary, southern Brazil. *Am. J. Lat. Am. J. Aquat. Mamm.* 11, 155–161. doi:http://dx.doi.org/10.5597/lajam00224.

di Sciara, G. N., Hoyt, E., Reeves, R., Ardron, J., Marsh, H., Vongraven, D., et al. (2016). Place-based approaches to marine mammal conservation. *Aquat. Conserv. Mar. Freshw. Ecosyst.* 26, 85–100. doi:10.1002/aqc.2642.

Di Tullio, J. C., Fruet, P. F., and Secchi, E. R. (2015). Identifying critical areas to reduce bycatch of coastal common bottlenose dolphins *Tursiops truncatus* in artisanal fisheries of the subtropical western South Atlantic. *Endanger. Species Res.* 29, 35–50. doi:doi: 10.3354/esr0069.

Di Tullio, J. C., Gandra, T. B. R., Zerbini, A. N., and Secchi, E. R. (2016). Diversity and distribution patterns of cetaceans in the subtropical Southwestern Atlantic outer continental shelf and slope. *PLoS One* 11, 1–24. doi:10.1371/journal.pone.0155841.

Dias, L. A., Herzing, D., and Flach, L. (2009). Aggregations of guiana dolphins (*Sotalia guianensis*) in Sepetiba bay, Rio de Janeiro, Southeastern Brazil: Distribution patterns and ecological characteristics. *J. Mar. Biol. Assoc. United Kingdom* 89, 967–973. doi:10.1017/S0025315409000782.

do Amaral, K. B., Alvares, D. J., Heinzelmann, L., Borges-Martins, M., Siciliano, S., and Moreno, I. B. (2015). Ecological niche modeling of *Stenella* dolphins (Cetartiodactyla: Delphinidae) in the southwestern Atlantic Ocean. *J. Exp. Mar. Bio. Ecol.* 472, 166–179. doi:10.1016/j.jembe.2015.07.013.

do Amaral, K. B., Danilewicz, D., Zerbini, A., Di Beneditto, A. P., Andriolo, A., Alvares, D. J., et al. (2018). Reassessment of the Franciscana *Pontoporia blainvillei* (Gervais & d'Orbigny, 1844) distribution and niche characteristics in Brazil. *J. Exp. Mar. Bio. Ecol.* 508, 1–12. doi:10.1016/j.jembe.2018.07.010.

do Carmo, W. P. D., and Lombardi, P. M. (2020). Oil Spill on Brazilian Coast and the Lack of Answers. *Oceanogr. Fish.* 11, 74–76. doi:10.19080/OFOAJ.2020.11.555820.

Dormann, C. F., Elith, J., Bacher, S., Buchmann, C., Carl, G., Carré, G., et al. (2013). Collinearity: A review of methods to deal with it and a simulation study evaluating their performance. *Ecography* 36, 027–046. doi:10.1111/j.1600-0587.2012.07348.x.

Dos Santos, R. A., and Haimovici, M. (2002). Cephalopods in the trophic relations off southern Brazil. *Bull. Mar. Sci.* 71, 753–770.

Dudley, N. (2008). Guidelines for applying protected area management categories. Glan, Switzerland: IUCN.

Ekau, W., and Knoppers, B. (1999). An introduction to the pelagic system of the North-East and East Brazilian shelf. *Arch. Fish. Mar. Res.* 47, 113–132.

Elith, J., Graham, C. H., Anderson, R. P., Dudı´k, M., Ferrier, S., Guisan, A., et al. (2006). Novel methods improve prediction of species' distributions from occurrence data. *Ecography* 29, 129–151. doi:10.1111/j.1432-1033.1987.tb13499.x.

Elith, J., and Leathwick, J. R. (2009). Species Distribution Models: Ecological Explanation and Prediction Across Space and Time. *Annu. Rev. Ecol. Evol. Syst.* 40, 677–697. doi:10.1146/annurev.ecolsys.110308.120159.

Elith, J., Phillips, S. J., Hastie, T., Dudík, M., Chee, Y. E., and Yates, C. J. (2011). A statistical explanation of MaxEnt for ecologists. *Divers. Distrib.* 17, 43–57. doi:10.1111/j.1472-4642.2010.00725.x.

Espécie, M. D. A., Tardin, R. H. O., and Simão, S. M. (2010). Degrees of residence of Guiana dolphins (*Sotalia guianensis*) in Ilha Grande Bay, south-eastern Brazil: A preliminary assessment. *J. Mar. Biol. Assoc. United Kingdom* 90, 1633–1639. doi:10.1017/S0025315410001256.

FAO. 1996. Precautionary approach to capture fisheries and species introductions. FAO Technical Guidelines for Responsible Fisheries. No. 2. FAO, Roma. 54 pp.

Fiedler, P. C., Redfern, J. V., Forney, K. A., Palacios, D. M., Sheredy, C., Rasmussen, K., et al. (2018). Prediction of large whale distributions: A comparison of presence-absence and presence-only modeling techniques. *Front. Mar. Sci.* 5, 1–15. doi:10.3389/fmars.2018.00419.

Flores, P. A. C., da Silva, V. M. F., and Fettuccia, D. de C. (2018). "Tucuxi and Guiana Dolphins," in *Encyclopedia of Marine Mammals*, eds. B. Würsig, J. G. M. Thewissen, and K. M. Kovacs (Academic Press), 1024–1027. doi:10.1016/b978-0-12-804327-1.00264-8.

Forcada, J. (2018). "Distribution," in in *Encyclopedia of Marine Mammals*, eds. B. Würsig, J. G. M. Thewissen, and K. M. Kovacs (Academic Press), 259–262. doi:10.1016/B978-0-12-804327-1.00106-0.

Fossi, M. C., Panti, C., Marsili, L., Maltese, S., Spinsanti, G., Casini, S., et al. (2013). The Pelagos Sanctuary for Mediterranean marine mammals: Marine Protected Area (MPA) or marine polluted area? The case study of the striped dolphin (*Stenella coeruleoalba*). *Mar. Pollut. Bull.* 70, 64–72. doi:10.1016/j.marpolbul.2013.02.013.

Fruet, P. F., Kinas, P. G., Da Silva, K. G., Di Tullio, J. C., Monteiro, D. S., Rosa, L. D., et al. (2012). Temporal trends in mortality and effects of by-catch on common bottlenose dolphins, *Tursiops truncatus*, in southern Brazil. *J. Mar. Biol. Assoc. United Kingdom* 92, 1865–1876. doi:10.1017/S0025315410001888.

Fruet, P. F., Secchi, E. R., Di Tullio, J. C., Simões-Lopes, P. C., Daura-Jorge, F., Costa, A. P. B., et al. (2017). Genetic divergence between two phenotypically distinct bottlenose dolphin ecotypes suggests separate evolutionary trajectories. *Ecol. Evol.,* 1–13. doi:10.1002/ece3.3335.

Garzoli, S. L. (1993). Geostrophic velocity and transport variability in the Brazil-Malvinas Confluence. *Deep. Res. Part I* 40, 1379–1403. doi:10.1016/0967-0637(93)90118-M.

Garzoli, S. L., Ffield, A., Johns, W. E., and Yao, Q. (2004). North Brazil Current retroflection and transports. *J. Geophys. Res. C Ocean.* 109, 1–14. doi:10.1029/2003jc001775.

Genoves, R. C., Fruet, P. F., Botta, S., Beheregaray, L. B., Möller, L. M., and Secchi, E. R. (2020). Fine-scale genetic structure in Lahille's bottlenose dolphins (*Tursiops truncatus gephyreus*) is associated with social structure and feeding ecology. *Mar. Biol.* 167. doi:10.1007/s00227-019-3638-6.

Giglio, V. J., Pinheiro, H. T., Bender, M. G., Bonaldo, R. M., Costa-Lotufo, L. V., Ferreira, C. E. L., et al. (2018). Large and remote marine protected areas in the South Atlantic Ocean are flawed and raise concerns: Comments on Soares and Lucas (2018). *Mar. Policy* 96, 13–17. doi:10.1016/j.marpol.2018.07.017.

Gill, D. A., Mascia, M. B., Ahmadia, G. N., Glew, L., Lester, S. E., Barnes, M., et al. (2017). Capacity shortfalls hinder the performance of marine protected areas globally. *Nature* 543, 665–669. doi:10.1038/nature21708.

Gomez, C., Lawson, J., Kouwenberg, A. L., Moors-Murphy, H., Buren, A., Fuentes-Yaco, C., et al. (2017). Predicted distribution of whales at risk: Identifying priority areas to enhance cetacean monitoring in the Northwest Atlantic Ocean. *Endanger. Species Res.* 32, 437–458. doi:10.3354/esr00823.

Goni, G., Kamholz, S., Garzoli, S., and Olson, D. (1996). Dynamics of the Brazil-Malvinas confluence based on inverted echo sounders and altimetry. *J. Geophys. Res. C Ocean.* 101, 16273–16289. doi:10.1029/96JC01146.

González-Ferreras, A. M., Barquín, J., and Peñas, F. J. (2016). Integration of habitat models to predict fish distributions in several watersheds of Northern Spain. *J. Appl. Ichthyol.* 32, 204–216. doi:10.1111/jai.13024.

Gormley, A. M., Slooten, E., Dawson, S., Barker, R. J., Rayment, W., Du Fresne, S., et al. (2012). First evidence that marine protected areas can work for marine mammals. *J. Appl. Ecol.* 49, 474–480. doi:10.1111/j.1365-2664.2012.02121.x.

Guisan, A., and Thuiller, W. (2005). Predicting species distribution: Offering more than simple habitat models. *Ecol. Lett.* 8, 993–1009. doi:10.1111/j.1461-0248.2005.00792.x.

Haimovici, M., and Aguiar dos Santos, R. (2001). Cephalopods in the diet of marine mammals stranded or incidentally caught along southeastern and southern Brazil (21–34°S). *Fish. Res.* 52, 99–112.

Haimovici, M., Fischer, L. G., Rossi-Wongtschowski, C. L. D. B. S., Bernardes, R. Á., and dos Santos, R. A. (2009). Biomass and fishing potential yield of demersal resources from the outer shelf and upper slope of southern Brazil. *Lat. Am. J. Aquat. Res.* 37, 395–408. doi:10.3856/vol37-issue3-fulltext-10.

Haimovici, M., and Perez, J. A. A. (1991). Coastal cephalopod fauna of Southern Brazil. *Bull. Mar. Sci.* 49, 221–230.

Hall, M. A., Alverson, D. L., and Metuzals, K. I. (2000). By-Catch: Problems and Solutions. *Mar. Pollut. Bull*. 41, 204–219.

Hamilton, S., and Baker, G. B. (2019). Technical mitigation to reduce marine mammal bycatch and entanglement in commercial fishing gear: lessons learnt and future directions. *Rev. Fish Biol. Fish.* 29, 223–247. doi:10.1007/s11160-019-09550-6.

Hamner, R. M., Wade, P., Oremus, M., Stanley, M., Brown, P., Constantine, R., et al. (2014). Critically low abundance and limits to humanrelated mortality for the Maui’s dolphin. *Endanger. Species Res.* 26, 87–92. doi:10.3354/esr00621.

Handley, J. M., Pearmain, E. J., Oppel, S., Carneiro, A. P. B., Hazin, C., Phillips, R. A., et al. (2020). Evaluating the effectiveness of a large multi-use MPA in protecting Key Biodiversity Areas for marine predators. *Divers. Distrib.* 2020, 1–15. doi:10.1111/ddi.13041.

Hartman, K. L. (2018). Risso’s Dolphin. in *Encyclopedia of Marine Mammals*, eds. B. Würsig, J. G. M. Thewissen, and K. M. Kovacs (Academic Press), 824-827. doi:10.1016/b978-0-12-804327-1.00219-3.

Hazen, E. L., Palacios, D. M., Forney, K. A., Howell, E. A., Becker, E., Hoover, A. L., et al. (2017). WhaleWatch: a dynamic management tool for predicting blue whale density in the California Current. *J. Appl. Ecol.* 54, 1415–1428. doi:10.1111/1365-2664.12820.

Hijmans, R. J., Phillips, S., Leathwick, J. R., and Elith, J. (2017). Package “dismo.” *Ref. Modul. Life Sci.* doi:10.1016/b978-0-12-809633-8.02390-6.

Hijmans, R. J., van Etten, J., Cheng, J., Mattiuzzi, M., Sumner, M., Greenberg, J. A., et al. (2015). R: Package “raster.” Cran, 203. Available at: https://cran.r-project.org/web/packages/raster/raster.pdf.

Hilborn, R. (2016). Policy: Marine biodiversity needs more than protection. *Nature* 535, 224–226. doi:10.1038/535224a.

Hohl, L. S. L., Sicuro, F. L., Wickert, J. C., Moreno, I. B., Rocha-Barbosa, O., and Barreto, A. S. (2020). Skull morphology of bottlenose dolphins from different ocean populations with emphasis on South America. *J. Morphol.*, 1–14. doi:10.1002/jmor.21121.

Hooker, S. K., Cañadas, A., Hyrenbach, K. D., Corrigan, C., Polovina, J. J., and Reeves, R. R. (2011). Making protected area networks effective for marine top predators. *Endanger. Species Res.* 13, 203–218. doi:10.3354/esr00322.

Hooker, S. K., Whitehead, H., and Gowans, S. (1999). Marine protected area design and the spatial and temporal distribution of cetaceans in a submarine canyon. *Conserv. Biol.* 13, 592–602. doi:10.1046/j.1523-1739.1999.98099.x.

Howell, E. A., Kobayashi, D. R., Parker, D. M., Balazs, G. H., and Polovina, J. J. (2008). TurtleWatch: A tool to aid in the bycatch reduction of loggerhead turtles Caretta caretta in the Hawaii-based pelagic longline fishery. *Endanger. Species Res.* 5, 267–278. doi:10.3354/esr00096.

Hoyt, E. (2018). “Marine Protected Areas,” in *Encyclopedia of Marine Mammals*, eds. B. Würsig, J. G. M. Thewissen, and K. M. Kovacs (Academic Press), 569–580. doi:https://doi.org/10.1016/C2015-0-00820-6.

Hoyt E (2011) Marine Protected Areas for whales, dolphins and porpoises: a world handbook for cetacean habitat conservation and planning. Earthscan, London

Hrbek, T., Da Silva, V. M. F., Dutra, N., Gravena, W., Martin, A. R., and Farias, I. P. (2014). A new species of river dolphin from Brazil or: How little do we know our biodiversity. *PLoS One* 9. doi:10.1371/journal.pone.0083623.

Hyrenbach, D. K., Forney, K. A., and Dayton, P. K. (2000). Viewpoint: Marine protected areas and ocean basin management. *Aquat. Conserv. Mar. Freshw. Ecosyst*. 10, 437–458. doi:10.1002/1099-0755(200011/12)10:6<437::AID-AQC425>3.0.CO;2-Q.

IBAMA. (1996). Portaria No 117, de 26 de dezembro. Available at: https://www.icmbio.gov.br/cma/images/stories/Legislacao/Portarias/Proibi%C3%A7%C3%A3o_de_molestamento_de_cet%C3%A1ceos_-_PORTARIA_N%C2%BA_117_DE_26_DE_DEZEMBRO_DE_1996.pdf

ICMBio. (2006). Plano de Manejo Estação Ecológica de Tamoios. ICMBio/MMA.

ICMBio. (2013). Plano de Manejo Área de Proteção Ambiental do Anhatomirim. ICMBio/MMA.

ICMBio. (2018). Plano de Manejo da Estação Ecológica Tupinambás e do Refúgio de Vida Silvestre do Arquipélago de Alcatrazes. ICMBio/MMA.

ICMMPA. (2009). International Committee on Marine Mammals Protected Areas. *Proceedings of the First International Conference on Marine Mammal Protected Ares*, Reeves, R.R. (ed.). Available at: www.icmmpa.org.

ICMMPA. (2011). Endangered Spaces, Endangered Species. *Proceedings of the Second International Conference on Marine Mammal Protected Ares*, Hoyt, E. (ed.). Available at: www.icmmpa.org.

ICMMPA. (2014). Important Marine Mammal Areas - A Sense of Place, a Question of Size. *Proceedings of the Third International Conference on Marine Mammal Protected Ares*, Hoyt, E. (ed.). Available at: www.icmmpa.org.

ICMMPA. (2016).

Ilha, E. B.; Serpa, N.B., dos Santos, P.F., Heissler, V.L., Dorneles, D.R. et al. (2018). Interação entre pescadores, botos e tainhas: Aprendizados sobre cooperação, tradição e cultura. Editora UFRGS.

Imbé (1990). Decreto Nº 049, de 31 de janeiro de 1990. Available at: https://leismunicipais.com.br/a1/rs/i/imbe/decreto/1990/5/49/decreto-n-49-1990-declara-os-botos-golfinhos-da-barra-do-rio-tramandai-como-patrimonio-do-municipio

IUCN, 1994. Guidelines for Protected Areas Management Categories. IUCN, Gland, Switzerland.

Katona, S., and Whitehead, H. (1988). Are Cetacea ecologically important? Oceanogr. Mar. Biol. Annu. Rev. 26, 553–568.

Knoppers, B., de Souza, W. F., Ekau, W., Figueiredo, A. G., and Soares-Gomes, A. (2010). “A interface Terra-Mar do Brasil,” in *Biologia Marinha*, eds. E. Interciência (Rio de Janeiro), 529–552.

Kroodsma, D. A., Mayorga, J., Hochberg, T., Miller, N. A., Boerder, K., Ferretti, F., et al. (2018). Tracking the global footprint of fisheries. *Scien* 359, 904–908. DOI: 10.1126/science.aao5646.

Kot, C.Y., P. Halpin, J. Cleary and D. Dunn. (2014). "A Review of Marine Migratory Species and the Information Used to Describe Ecologically or Biologically Significant Areas (EBSAS)” by *Global Ocean Biodiversity Initiative (GOBI) for the Convention on Migratory Species*. Assessment conducted by Marine Geospatial Ecology Lab, Duke University.

Laguna. (1997). Lei Nº 521 de 10 de Novembro de 1997. Available at: https://camara-municipal-da-laguna.jusbrasil.com.br/legislacao/1019502/lei-521-97#

Lemos, A. T., Ghisolfi, R. D. R., and Mazzini, P. L. F. (2018). Annual phytoplankton blooming using satellite-derived chlorophyll-a data around the Vitória-Trindade Chain, Southeastern Brazil. *Deep. Res. Part I Oceanogr. Res. Pap.* 136, 62–71. doi:10.1016/j.dsr.2018.04.005.

Liu, C., Newell, G., and White, M. (2016). On the selection of thresholds for predicting species occurrence with presence-only data. *Ecol. Evol.* 6, 337–348. doi:10.1002/ece3.1878.

Liu, C., White, M., and Newell, G. (2013). Selecting thresholds for the prediction of species occurrence with presence-only data. *J. Biogeogr.* 40, 778–789. doi:10.1111/jbi.12058.

Lodi, L. (2016). Update on the current occurrence of Tursiops truncatus (Montagu, 1821) in Rio de Janeiro State. *Lat. Am. J. Aquat. Mamm.* 11, 220–226. doi:http://dx.doi.org/10.5597/lajam00231.

Lodi, L., Cantor, M., Daura-Jorge, F. G., and Monteiro-Neto, C. (2014). A missing piece from a bigger puzzle: Declining occurrence of a transient group of bottlenose dolphins off Southeastern Brazil. *Mar. Ecol.* 35, 516–527. doi:10.1111/maec.12108.

Lodi, L., and Hetzel, B. (1998). O golfinho-de-dentes-rugosos (*Steno Bredanensis*) no Brasil. *Bioikos* 12, 29–45.

Lodi, L., and Hetzel, B. (1999). Rough-toothed dolphin, *Steno bredanensis*, feeding behaviors in Ilha Grande bay, Brazil. *Biociências* 7, 29–42.

Lodi, L., Oliveira, R. H. T., Figueiredo, L. D., and Simão, S. M. (2012). Movements of the rough-toothed dolphin (*Steno bredanensis*) in Rio de Janeiro State, south-eastern Brazil. *Mar. Biod. Rec.* J. 5, 8–11. doi:10.1017/S1755267212000322.

Lodi, L., and Tardin, R. (2018). Site fidelity and residency of common bottlenose dolphins (Cetartiodactyla: Delphinidae) in a coastal insular habitat off southeastern Brazil. *Panam. J. Aquat. Sci*. 13, 53–63.

Magris, R. A., and Pressey, R. L. (2018). Marine protected areas: Just for show? *Science Com.*. 360, 723–724. doi:10.1126/science.aat6215.

Mangaratiba. (2015). Lei No 962, de 10 de abril de 2015. Available at: http://www.mangaratiba.rj.gov.br/portal/arquivos/atos-oficiais/leis-2015/pmm-lei-9622015.pdf

Mannocci, L., Boustany, A. M., Roberts, J. J., Palacios, D. M., Dunn, D. C., Halpin, P. N., et al. (2017). Temporal resolutions in species distribution models of highly mobile marine animals: Recommendations for ecologists and managers. *Divers. Distrib.* 23, 1098–1109. doi:10.1111/ddi.12609.

Marega-Imamura, M., Michalski, F., Silva, K., Schiavetti, A., Le Pendu, Y., and de Carvalho Oliveira, L. (2020). Scientific collaboration networks in research on human threats to cetaceans in Brazil. *Mar. Policy* 112. doi:10.1016/j.marpol.2019.103738.

Marquaridt, D. W. (1970). Generalized inverses, ridge regression, biased linear estimation, and nonlinear estimation. *Technometrics* 12, 591–612. doi:10.1080/00401706.1970.10488699.

Mata M.M., Cirano M., Van Caspel M. (2017) Aspectos da circulação oceânica e sua variabilidade no entorno da cadeia submarina vitória-trindade. In: *PROTRINDADE: programa de pesquisas científicas na Ilha da Trindade: 10 anos de pesquisas / SECIRM* – Brasília, 200 p.

Meirelles, A. C. O., Campos, T. M., Marcondes, M. C., Groch, K. R., Souto, L. R., Reis, M. do S. S., et al. (2016). Reports of strandings and sightings of bottlenose dolphins (*Tursiops truncatus*) in northeastern Brazil and Brazilian oceanic islands. *Am. J. Lat. Am. J. Aquat. Mamm.* 11, 178–190. doi:http://dx.doi.org/10.5597/lajam00227.

Meirelles, A. C. O., Monteiro-Neto, C., Martins, A. M. A., Costa, A. F., Barros, H. M. D. R., and Alves, M. D. O. (2009). Cetacean strandings on the coast of Ceará, North-eastern Brazil. *J. Mar. Biol. Assoc*. United Kingdom 89, 1083–1090. doi:10.1017/S0025315409002215.

Mémery, L., Arhan, M., Alvarez-Salgado, X. A., Messias, M. J., Mercier, H., Castro, C. G., et al. (2000). The water masses along the western boundary of the south and equatorial Atlantic. *Prog. Oceanogr.* 47, 69–98. doi:10.1016/S0079-6611(00)00032-X.

Méndez-Fernandez, P., Taniguchi, S., Santos, M. C. O., Cascão, I., Quérouil, S., Martín, V., et al. (2018). Contamination status by persistent organic pollutants of the Atlantic spotted dolphin

(*Stenella frontalis*) at the metapopulation level. *Environ. Pollut.* 236, 785–794. doi:10.1016/j.envpol.2018.02.009.

Merow, C., Smith, M. J., and Silander, J. A. (2013). A practical guide to MaxEnt for modeling species' distributions: What it does, and why inputs and settings matter. *Ecography* 36, 1058–1069. doi:10.1111/j.1600-0587.2013.07872.x.

Milmann, L. C., Danilewicz, D., Baumgarten, J., and Ott, P. H. (2017). Temporal–spatial distribution of an island-based offshore population of common bottlenose dolphins (*Tursiops truncatus*) in the equatorial Atlantic. *Mar. Mammal Sci*. 33, 496–519. doi:10.1111/mms.12380.

Mintzer, V. J., Schmink, M., Lorenzen, K., Frazer, T. K., Martin, A. R., and da Silva, V. M. F. (2015). Attitudes and behaviors toward Amazon River dolphins (*Inia geoffrensis*) in a sustainable use protected area. Biodivers. Conserv. 24, 247–269. doi:10.1007/s10531-014-0805-4.

MMA. (2006a). Deliberação CONABIO No 40, de 07 de fevereiro de 2006. Available at: https://www.mma.gov.br/estruturas/conabio/_arquivos/Delib_040.pdf

MMA, (2006b). Decreto No 5.758, de 13 de abril de 2006. Available at: https://www.mma.gov.br/estruturas/240/_arquivos/decreto_5758_2006_pnap_240.pdf

MMA. (2014a). Portaria MMA Nº 444, de 17 de dezembro de 2014. Available at: http://pesquisa.in.gov.br/imprensa/jsp/visualiza/index.jsp?jornal=1&pagina=121&data=18/12/2014

MMA. (2014b). Portaria MMA Nº 43, de 31 de janeiro de 2014. Available at: http://www.dados.gov.br/dataset/123123

MMA. (2018). Portaria nº 463 de 18 de dezembro de 2018. Available at: http://areasprioritarias.mma.gov.br/.

MMA. (2010). Panorama da Conservação dos Ecossistemas Costeiros e Marinhos no Brasil. Secretária de Biodiversidade e Florestas/Gerência de Biodiversidade Aquática e Recursos Pesqueiros. MMA/SBF/GBA.

Moreno, I. B., Zerbini, A. N., Danilewicz, D., De Oliveira Santos, M. C., Simões-Lopes, P. C., Lailson-Brito, J., et al. (2005). Distribution and habitat characteristics of dolphins of the genus *Stenella* (Cetacea: Delphinidae) in the southwest Atlantic Ocean. *Mar. Ecol. Prog. Ser.* 300, 229–240. doi:10.3354/meps300229.

Moreno I.B., Amaral K.B., Camargo Y.R., Dorneles D.R., Frainer G. et al (2017) Cetáceos da Ilha da Trindade e Arquipélago de Martin Vaz. In: *PROTRINDADE: programa de pesquisas científicas na Ilha da Trindade: 10 anos de pesquisas / SECIRM* – Brasília, 200 p.

Moura, J. F., Acevedo-Trejos, E., Tavares, D. C., Meirelles, A. C. O., Silva, C. P. N., Oliveira, L. R., et al. (2016). Stranding events of *Kogia* whales along the Brazilian coast. PLoS One 11, 1–15. doi:10.1371/journal.pone.0146108.

Muscarella, R., Galante, P. J., Soley-Guardia, M., Boria, R. A., Kass, J. M., Uriarte, M., et al. (2014). ENMeval: An R package for conducting spatially independent evaluations and estimating optimal model complexity for Maxent ecological niche models. *Methods Ecol. Evol*. 5, 1198–1205. doi:10.1111/2041-210x.12261.

Naimi, B. (2017). Package "usdm". Uncertainty Analysis for Species Distribution Models. R- Cran, 18.

Nogueira Jr., M., and Brandini, F. P. (2018). Community Structure and Spatiotemporal Dynamics of the Zooplankton in the South Brazilian Bight: A Review. *Plankt. Ecol. Southwest. Atl. From Subtrop. to Subantarctic Realm*, 149–169. doi:https://doi.org/10.1007/978-3-319-77869-3_8.

Notarbartolo Di Sciara, G., Agardy, T., Hyrenbach, D., Scovazzi, T., and Van Klaveren, P. (2008). The Pelagos Sanctuary for Mediterranean marine mammals. *Aquat. Conserv. Mar. Freshw. Ecosyst*. 18, 367–391. doi:DOI: 10.1002/aqc.855.

Notarbartolo di Sciara, G., Hoyt, E., Reeves, R., Ardron, J., Marsh, H., Vongraven, D., et al. (2016). Place-based approaches to marine mammal conservation. *Aquat. Conserv. Mar. Freshw. Ecosyst*. 26, 85–100. doi:10.1002/aqc.2642.

O'Brien, K., and Whitehead, H. (2013). Population analysis of Endangered northern bottlenose whales on the Scotian Shelf seven years after the establishment of a Marine Protected Area. *Endanger. Species Res*. 21, 273–284. doi:10.3354/esr00533.

Obura, D. O. (2018). On being effective, and the other 90%. *ICES J. Mar. Sci.* 75, 1198–1199. doi:10.1093/icesjms/fsx096.

Olson, D. B., Podestá, G. P., Evans, R. H., and Brown, O. B. (1988). Temporal variations in the separation of Brazil and Malvinas Currents. *Deep Sea Res. Part A, Oceanogr. Res. Pap.* 35, 1971–1990. doi:10.1016/0198-0149(88)90120-3.

Oshima, J. E. de F., and Santos, M. C. de O. (2016). Guiana dolphin home range analysis based on 11 years of photo-identification research in a tropical estuary. *J. Mammal*. 97, 599–610. doi:10.1093/jmammal/gyv207.

Paiva, M.P. (1997). Recursos pesqueiros estuarinos e marinhos do Brasil. Universidade Federal do Ceará Edições, Fortaleza.

Paiva, M. P., and Motta, P. C. S. da (2000). Cardumes da sardinha-verdadeira, *Sardinella brasiliensis* (Steindachner), em águas costeiras do estado do Rio de Janeiro, *Brasil. Rev. Bras. Zool.* 17, 339–346. doi:10.1590/s0101-81752000000200004.

Parente, C. L., Araújo, J. P. de, and Araújo, M. E. de (2007). Diversity of cetaceans as tool in monitoring environmental impacts of seismic surveys. *Biota Neotrop*. 7, 49–56. doi:10.1590/s1676-06032007000100007.

PEMLS. (2018). Plano de Manejo Parque Estadual Marinho da Laje de Santos. Fundação Floresta/Estado São Paulo.

Passadore, C., Möller, L. M., Diaz-Aguirre, F., and Parra, G. J. (2018). Modelling Dolphin Distribution to Inform Future Spatial Conservation Decisions in a Marine Protected Area. *Sci. Rep.* 8, 1–14. doi:10.1038/s41598-018-34095-2.

Pearson, R. G., Raxworthy, C. J., Nakamura, M., and Townsend Peterson, A. (2007). Predicting species distributions from small numbers of occurrence records: A test case using cryptic geckos in Madagascar. *J. Biogeogr*. 34, 102–117. doi:10.1111/j.1365-2699.2006.01594.x.

Pérez-Jorge, S., Pereira, T., Corne, C., Wijtten, Z., Omar, M., Katello, J., et al. (2015). Can static habitat protection encompass critical areas for highly mobile marine top predators? Insights from coastal East Africa. *PLoS One* 10, 1–16. doi:10.1371/journal.pone.0133265.

Phillips, S. (2017). maxnet: Fitting ‘Maxent’ Species Distribution Models with “glmnet.” R Packag., version 0.1.

Phillips, S. J., Anderson, R. P., Dudík, M., Schapire, R. E., and Blair, M. E. (2017). Opening the black box: an open-source release of Maxent. *Ecography* 40, 887–893. doi:10.1111/ecog.03049.

Phillips, S. J., Anderson, R. P., and Schapire, R. E. (2006). Maximum entropy modeling of species geographic distributions. *Int. J. Glob. Environ. Issues* 190, 231–259. doi:10.1016/j.ecolmodel.2005.03.026.

Phillips, S. J., and Dudík, M. (2008). Modeling of species distributions with Maxent: new extensions and a comprehensive evaluation. *Ecography* 31, 161–175. doi:10.1111/j.2007.0906-7590.05203.x.

Pinedo, M. C., Polacheck, T., Barreto, A. S., and Lammardo, M. P. (2002). A note on vessel of opportunity sighting surveys for cetaceans in the shelf edge region off the southern coast of Brazil. *J. Cetacean Res. Manag*. 4, 323–329.

Pinn, E. H. (2018). "Protected Areas: The False Hope for Cetacean Conservation?" in Oceanography and Marine Biology: An Annual Review, eds. S. J. Hawkins, A. J. Evans, A. C. Dale, L. B. Firth, I. P. Smith (Taylor & Francis).

Pinheiro, F. C. F., Pinheiro, H. T., Teixeira, J. B., Martins, A. S., and Cremer, M. J. (2019). Opportunistic Development and Environmental Disaster Threat Franciscana Dolphins in the Southeast of Brazil. *Trop. Conserv. Sci.* 12, 1–7. doi:10.1177/1940082919847886.

Pinheiro, H. T., Bernardi, G., Simon, T., Joyeux, J. C., Macieira, R. M., Gasparini, J. L., et al. (2017). Island biogeography of marine organisms. *Nature* 549, 82–85. doi:10.1038/nature23680.

Pinheiro, H. T., and Joyeux, J. C. (2015). The role of recreational fishermen in the removal of target reef fishes. *Ocean Coast. Manag.* 112, 12–17. doi:10.1016/j.ocecoaman.2015.04.015.

Pinheiro, H. T., Martins, A. S., and Gasparini, J. L. (2010). Impact of commercial fishing on Trindade Island and Martin Vaz Archipelago, Brazil: Characteristics, conservation status of the species involved and prospects for preservation. *Brazilian Arch. Biol. Technol.* 53, 1417–1423. doi:10.1590/S1516-89132010000600018.

Piola, A. R., Matano, R. P., Palma, E. D., Möller, O. O., and Campos, E. J. D. (2005). The influence of the Plata River discharge on the western South Atlantic shelf. *Geophys. Res. Lett.* 32, 1–4. doi:10.1029/2004GL021638.

PL. (6479/2019). Institui a região da Costa Verde, nos termos que especifica, como Área Especial de Interesse Turístico. Available at: https://www25.senado.leg.br/web/atividade/materias/-/materia/140268.

PMC-BS. (2019). Projeto de Monitoramento de Cetáceos na Bacia de Santos. Available at: http://sispmcprd.petrobras.com.br/sispmc

Podestá, G. P., Brown, O. B., and Evans, R. H. (1991). The annual cycle of satellite-derived sea surface temperature in the southwestern Atlantic ocean. *J. Clim.* 4, 457–467.

Pompa, S., Ehrlich, P. R., and Ceballos, G. (2011). Global distribution and conservation of marine mammals. Proc. Natl. Acad. Sci. U.S.A. 108, 13600–13605. www.pnas.org/cgi/doi/10.1073/pnas.1101525108

Prado, J. H. F., Mattos, P. H., Silva, K. G., and Secchi, E. R. (2016). Long-term seasonal and interannual patterns of marine mammal strandings in subtropical western South Atlantic. *PLoS One* 11, 1–23. doi:10.1371/journal.pone.0146339.

Prado, J. H. F., Secchi, E. R., and Kinas, P. G. (2013). Mark-recapture of the endangered Franciscana dolphin (*Pontoporia blainvillei*) killed in gillnet fisheries to estimate past bycatch from time series of stranded carcasses in southern Brazil. *Ecol. Indic.* 32, 35–41. doi:10.1016/j.ecolind.2013.03.005.

Pryor, K., Lindbergh, J., Lindbergh, S., and Milano, R. (1990). A Dolphin-Human fishing cooperative in Brazil. *Mar. Mammal Sci*. 6, 77–82.

Ramos, R. M. A., Siciliano, S., Ribeiro, R. (2010). Monitoramento da Biota Marinha em Navios de Sísmica: seis anos de pesquisa (2001-2007). Everest Tecnologia em Serviços.

Redfern, J. V., Fergunson, M. C., Becker, E. A., Hyrenbach, K. D., Good, C., Barlow, J., et al. (2006). Techniques for cetacean–habitat modeling. *Mar. Ecol. Prog. Ser.* 310, 271–295. doi:10.3354/meps310271.

Redfern, J. V., Moore, T. J., Fiedler, P. C., de Vos, A., Brownell, R. L., Forney, K. A., et al. (2017). Predicting cetacean distributions in data-poor marine ecosystems. *Divers. Distrib.* 23, 394–408. doi:10.1111/ddi.12537.

Reeves, R. R. (2018). "Conservation," in *Encyclopedia of Marine Mammals*, eds. B. Würsig, J. G. M. Thewissen, and K. M. Kovacs (Academic Press), 215–229. doi:10.1108/S2051-503020170000021003.

Robinson, N. M., Nelson, W. A., Costello, M. J., Sutherland, J. E., and Lundquist, C. J. (2017). A systematic review of marine-based Species Distribution Models (SDMs) with recommendations for best practice. *Front. Mar. Sci.* 4, 1–11.

Rocha-Campos, C. C., Moreno, I.B., Rocha, J. M. et al. 2011a. Plano de Ação Nacional para a conservação de mamíferos aquáticos: grandes cetáceos e pinípedes. ICMBio, Brasília.

Rocha-Campos, C. C., Moreno, I.B., Rocha, J. M. et al. 2011b. Plano de Ação Nacional para a conservação de mamíferos aquáticos: grandes cetáceos e pinípedes. ICMBio, Brasília. doi:10.3389/fmars.2017.00421.

Rojas-Bracho, L., and Reeves, R. (2013). Vaquitas and gillnets: Mexico's ultimate cetacean conservation challenge. *Endanger. Species Res.* 21, 77–87. doi:10.3354/esr00501.

Rojas-Bracho, L., Reeves, R. R., and Jaramillo-legorreta, A. (2006). Conservation of the vaquita Phocoena sinus. *Mamm. Rev.* 36, 179–216. doi:10.1111/j.1365-2907.2006.00088.x.

Roman, J., Estes, J. A., Morissette, L., Smith, C., Costa, D., McCarthy, J., et al. (2014). Whales as marine ecosystem engineers. *Front. Ecol. Environ.* 12, 377–385. doi:10.1890/130220.

Rossi-Santos, M. R. (2014). Oil Industry and Noise Pollution in the Humpback Whale (*Megaptera novaeangliae*) Soundscape Ecology of the Southwestern Atlantic Breeding Ground. *J. Coast. Reserach* 0, 00–00. doi:10.2112/JCOASTRES-D-13-00195.1.

Rossi-Santos, M., Wedekin, L. L., and Sousa-Lima, R. S. (2006). Distribution and habitat use of small cetaceans off Abrolhos Bank, eastern Brazil. *Lat. Am. J. Aquat. Mamm.* 5, 23–28. doi:10.5597/lajam00088.

Rotjan, R., Jamieson, R., Carr, B., Kaufman, L., Mangubhai, S., Obura, D., et al. (2014). Establishment, Management, and Maintenance of the Phoenix Islands Protected Area. 1st ed. *Elsevier Ltd*. doi:10.1016/B978-0-12-800214-8.00008-6.

Sánchez, L. E., Alger, K., Alonso, L., Francisco, B., Brito, M. C., Laureano, F., et al. (2018). Impacts of the Fundão Dam failure: a pathway to sustainable and resilient mitigation. Gland, Switzerland doi:https://doi.org/10.2305/IUCN.CH.2018.18.en.

Santos, M. C. d. O., Laílson-Brito, J., Flach, L., Oshima, J. E. F., Figueiredo, G. C., Carvalho, R. R., et al. (2019). Cetacean movements in coastal waters of the southwestern Atlantic Ocean. *Biota Neotrop*. 19. doi:10.1590/1676-0611-BN-2018-0670.

Santos, M. C. de O., and Figueiredo, G. C. e (2016). A rare sighting of a bottlenose whale (Hyperoodon planifrons, Flower 1882) in shallow waters off southeastern Brazil. *Brazilian J. Oceanogr.* 64, 105–110. doi:http://dx.doi.org/10.1590/S1679-87592016108006401.

Santos, M. C. de O., Figueiredo, G. C., and Van Bressem, M.-F. (2017). Cetaceans using the marine protected area of “Parque Estadual Marinho da Laje de Santos”, Southeastern Brazil. *Brazilian J. Oceanogr.* 65, 605–613. doi:http://dx.doi.org/10.1590/S1679-87592017130606504.

Santos, M. C. de O., Oshima, J. E. F., Pacífico, E. dos S., and Silva, E. (2010). Guiana dolphins, *Sotalia guianensis* (Cetacea: Delphinidae), in the Paranaguá Estuarine Complex: Insights on the use of area based on the photo-identification technique. Zoologia 27, 324–330. doi:10.1590/S1984-46702010000300002.

Saraceno, M., Provost, C., Piola, A., Bava, J., and Gagliardini, A. (2004). Brazil Malvinas Frontal System as seen from 9 years of advanced very high-resolution radiometer data. 109, 1–14. doi: 10.1029/2003JC002127.

Sbrocco, E. J., and Barber, P. H. (2013). MARSPEC: ocean climate layers for marine spatial ecology. *Ecology* 94, 979–979. doi:10.1890/12-1358.1.

Schiavetti, A., Manz, J., Zapelini, C., Cristina, T., and Inez, M. (2013). Ocean & Coastal Management Marine Protected Areas in Brazil: An ecological approach regarding the large marine ecosystems. *Ocean Coast. Manag.* 76, 96–104. doi:10.1016/j.ocecoaman.2013.02.003.

Secchi, E. R., Danilewicz, D., and Ott, P. H. (2003). Applying the phylogeographic concept to identify franciscana dolphin stocks: implications to meet management objectives. *J. Cetacean Res. Manag.* 5, 61–68.

Secchi, E. S. S. (1995). Comments on the southern range of the spinner dolphin (Stenella longirostris) in the western South Atlantic. *Aquat. Mamm*. 21, 105–108.

Silva-jr, J. M., Silva, F. J. L., and Sazima, I. (2005). Rest, nurture , sex , release , and play : diurnal underwater behaviour of the spinner dolphin at Fernando de Noronha Archipelago , SW Atlantic. *J. Ichthyol. Aquat. Biol.* 9, 161–176.

SIMMAM. (2019). Sistema de Apoio ao Monitoramento de Mamíferos Marinhos. Available at: http://simmam.acad.univali.br/webgis/

Simões-Lopes, P. C., Daura-Jorge, F. G., Lodi, L., Bezamat, C., Costa, A. P. B., and Wedekin, L. L. (2019). Bottlenose dolphin ecotypes of the western south Atlantic: The puzzle of habitats, coloration patterns and dorsal fin shapes. *Aquat. Biol.* 28, 101–111. doi:10.3354/ab00712.

Simões-Lopes, P. C., Fabián, M. E., and Menegheti, J. O. (1998). Dolphin interactions with the mullet artisanal fishing on southern Brazil: a qualitative and quantitative approach. *Rev. Bras. Zool.* 15, 709–726. doi:10.1017/CBO9781107415324.004.

Spalding, M. D., Agostini, V. N., Rice, J., and Grant, S. M. (2012). Pelagic provinces of the world: A biogeographic classification of the world’s surface pelagic waters. *Ocean Coast. Manag.* 60, 19–30. doi:10.1016/j.ocecoaman.2011.12.016.

Spalding, M. D., Fox, H. E., Allen, G. R., Davidson, N., Ferdaña, Z. A., Finlayson, M., et al. (2007). Marine Ecoregions of the World: A Bioregionalization of Coastal and Shelf Areas. *Bioscience* 57, 573–583. doi:10.1641/b570707.

Soares, M.O., Teixeira, C.E., Bezerra, L.E.A., Paiva, S.V., Tavares, T.C.L. et al. (2020) Oil spill in South Atlantic (Brazil): Environmental and governmental disaster. *Marine Policy,* 115(2020): 103879. https://doi.org/10.1016/j.marpol.2020.103879

Stramma, L., Ikeda, Y., and Peterson, R. G. (1990). Geostrophic transport in the Brazil current region north of 20°S. *Deep Sea Res. Part A, Oceanogr. Res. Pap.* 37, 1875–1886. doi:10.1016/0198-0149(90)90083-8.

Tardin, R. H., Chun, Y., Jenkins, C. N., Maciel, I. S., Simão, S. M., and Alves, M. A. S. (2019a). Environment and anthropogenic activities influence cetacean habitat use in southeastern Brazil. *Mar. Ecol. Prog. Ser.* 616, 197–210. doi:10.3354/meps12937.

Tardin, R. H., Chun, Y., Simão, S. M., and Alves, M. A. S. (2019b). Habitat use models of spatially auto-correlated data: a case study of the common bottlenose dolphin, *Tursiops truncatus truncatus*, in southeastern Brazil. *Mar. Biol. Res.* 15, 305–316. doi:10.1080/17451000.2019.1644773.

Tardin, R. H., Simão, S. M., and Alves, M. A. S. (2013). Distribution of *Tursiops truncatus* in Southeastern Brazil: A modeling approach for summer sampling. *Nat. Conserv.* 11, 65–74. doi:10.4322/natcon.2013.011.

Tavares, M., Moreno, I. B., Siciliano, S., Rodrguez, D., Marcos, M. C., Lailson-Brito, J., et al. (2010). Biogeography of common dolphins (genus *Delphinus*) in the southwestern Atlantic Ocean. *Mamm. Rev.* 40, 40–64. doi:10.1111/j.1365-2907.2009.00154.x.

Tibau do Sul. (2006). Decreto Nº 014 de 2006. Available at: https://refauts.webnode.com/_files/200000034- 33cd634c7f/ decreto%20refauts% 20014_2006.pdf

Tischer, M. C., de Carli, R. de C., Silva, F. J. de L., and da Silva, J. M. (2017). Tourism growth altering spinner dolphins' area of occupation in Fernando de Noronha archipelago, Brazil. *Lat. Am. J. Aquat. Res.* 45, 807–813. doi:10.3856/vol45-issue4-fulltext-16.

Tittensor, D. P., Mora, C., Jetz, W., Lotze, H. K., Ricard, D., Berghe, E. Vanden, et al. (2010). Global patterns and predictors of marine biodiversity across taxa. *Nature* 466, 1098–1101. doi:10.1038/nature09329.

Tobeña, M., Prieto, R., Machete, M., and Silva, M. A. (2016). Modeling the potential distribution and richness of cetaceans in the Azores from fisheries observer program data. *Front. Mar. Sci.* 3: 1-19. doi:10.3389/fmars.2016.00202.

Trathan, P. N., Collins, M. A., Grant, S. M., Belchier, M., Barnes, D. K. A., Brown, J., et al. (2014). "The South Georgia and the South Sandwich Islands MPA: Protecting A Biodiverse Oceanic Island Chain Situated in the Flow of the Antarctic Circumpolar Current," *in Advances in Marine Biology (Elsevier Ltd.)*, 15–78. doi:10.1016/B978-0-12-800214-8.00002-5.

Turvey, S. T., Pitman, R. L., Taylor, B. L., Barlow, J., Akamatsu, T., Barrett, L. A., et al. (2007). First human-caused extinction of a cetacean species? *Biol. Lett.* 3, 537–540. doi:10.1098/rsbl.2007.0292.

Tyberghein, L., Verbruggen, H., Pauly, K., Troupin, C., Mineur, F., and De Clerck, O. (2012). Bio-ORACLE: A global environmental dataset for marine species distribution modelling. *Glob. Ecol. Biogeogr.* 21, 272–281. doi:10.1111/j.1466-8238.2011.00656.x.

Warren, D. L., Glor, R. E., and Turelli, M. (2008). Environmental niche equivalency versus conservatism: Quantitative approaches to niche evolution. Evolution (N. Y). 62, 2868–2883. doi:10.1111/j.1558-5646.2008.00482.x.

Warren, D. L., and Seifert, S. N. (2011). Ecological niche modeling in Maxent: the importance of model complexity and the performance of model selection criteria. *Ecol. Appl.* 21, 335–342.

Vermeulen, E., Fruet, P., Costa, A., Coscarella, M. and Laporta, P. (2019). *Tursiops truncatus ssp. gephyreus*. The IUCN Red List of Threatened Species 2019: e.T134822416A135190824.

Wedekin, L. L., Daura-Jorge, F. G., Piacentini, V. Q., and Simões-Lopes, P. C. (2007). Seasonal variations in spatial usage by the estuarine dolphin, *Sotalia guianensis* (van Bénéden, 1864) (Cetacea; Delphinidae) at its southern limit of distribution. Brazilian J. Biol. 67, 1–8. doi:10.1590/S1519-69842007000100002.

Wedekin, L. L., Daura-Jorge, F. G., and Simões-Lopes, P. C. (2010). Habitat preferences of Guiana dolphins, *Sotalia guianensis* (Cetacea: Delphinidae), in Norte Bay, southern Brazil. *J. Mar. Biol. Assoc. United Kingdom* 90, 1561–1570. doi:10.1017/S0025315410001414.

Wedekin, L. L., Freitas, A., Engel, M. H., and Sazima, I. (2005). Rough-Toothed Dolphins (*Steno bredanensis*) Catch Diskfishes while Interacting with Humpback Whales (*Megaptera novaeangliae*) off Abrolhos Bank Breeding Ground, Southwest Atlantic. *Aquat. Mamm*. 30, 327–329. doi:10.1578/am.30.2.2004.327.

Wedekin, L., Rossi-Santos, M., Baracho, C., Cypriano-Souza, A., and Simões-Lopes, P. (2014). Cetacean records along a coastal-offshore gradient in the Vitória-Trindade Chain, western South Atlantic Ocean. *Brazilian J. Biol.* 74, 137–144. doi:10.1590/1519-6984.21812.

Whitehead, H., O'Brien, K., and Worm, B. (2010). Diversity of deep-water cetaceans and primary productivity. *Mar. Ecol. Prog. Ser.* 408, 1–5. doi:10.3354/meps08619.

Wickert, J. C., Von Eye, S. M., Oliveira, L. R., and Moreno, I. B. (2016). Revalidation of *Tursiops gephyreus* lahille, 1908 (Cetartiodactyla: Delphinidae) from the southwestern Atlantic Ocean. *J. Mammal.* 97, 1728–1737. doi:10.1093/jmammal/gyw139.

Willson, H. R., and Rees, N. W. (2000). Classification of mesoscale features in the Brazil-Falkland Current confluence zone. *Prog. Oceanogr.* 45, 415–426. doi:10.1016/S0079-6611(00)00011-2.

Wisz, M. S., Hijmans, R. J., Li, J., Peterson, A. T., Graham, C. H., Guisan, A., et al. (2008). Effects of sample size on the performance of species distribution models. *Divers. Distrib.* 14, 763–773. doi:10.1111/j.1472-4642.2008.00482.x.

Yogui, G. T., de Oliveira Santos, M. C., 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 Atlantic Ocean. *Mar. Pollut. Bull.* 60, 1862–1867. doi:10.1016/j.marpolbul.2010.07.022.

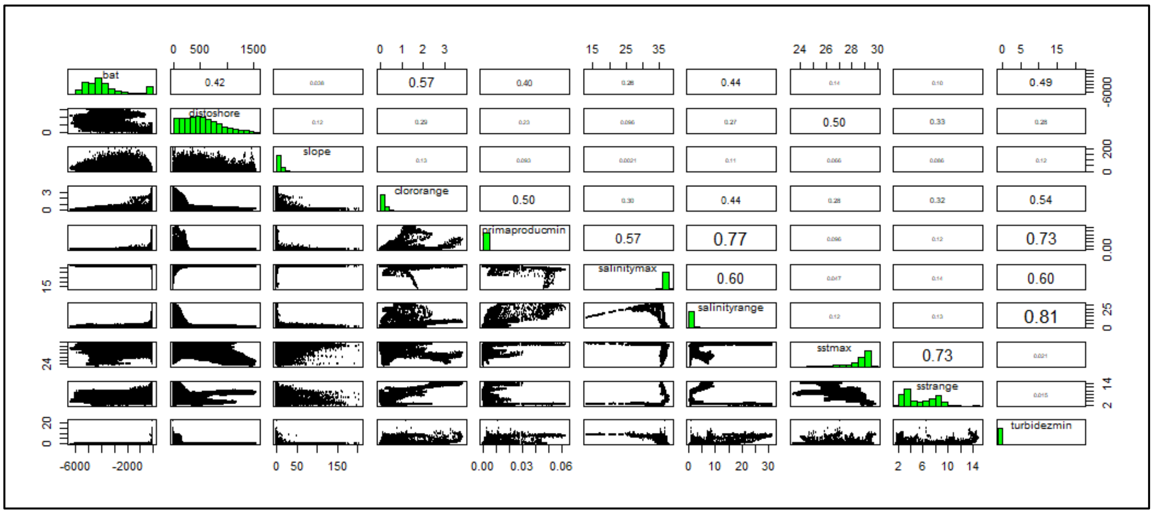
Zacharias, M. a, Gerber, L. R., and Hyrenbach, K. D. (2006). Review of the Southern Ocean Sanctuary: Marine Protected Areas in the context of the International Whaling Commission Sanctuary Programme. *J. Cetacean Res. Manag.* 8, 1–12.

Zanardo, N., Parra, G. J., Passadore, C., and Möller, L. M. (2017). Ensemble modelling of southern Australian bottlenose dolphin *Tursiops* sp. distribution reveals important habitats and their potential ecological function. *Mar. Ecol. Prog. Ser.* 569, 253–266. doi:10.3354/meps12091.

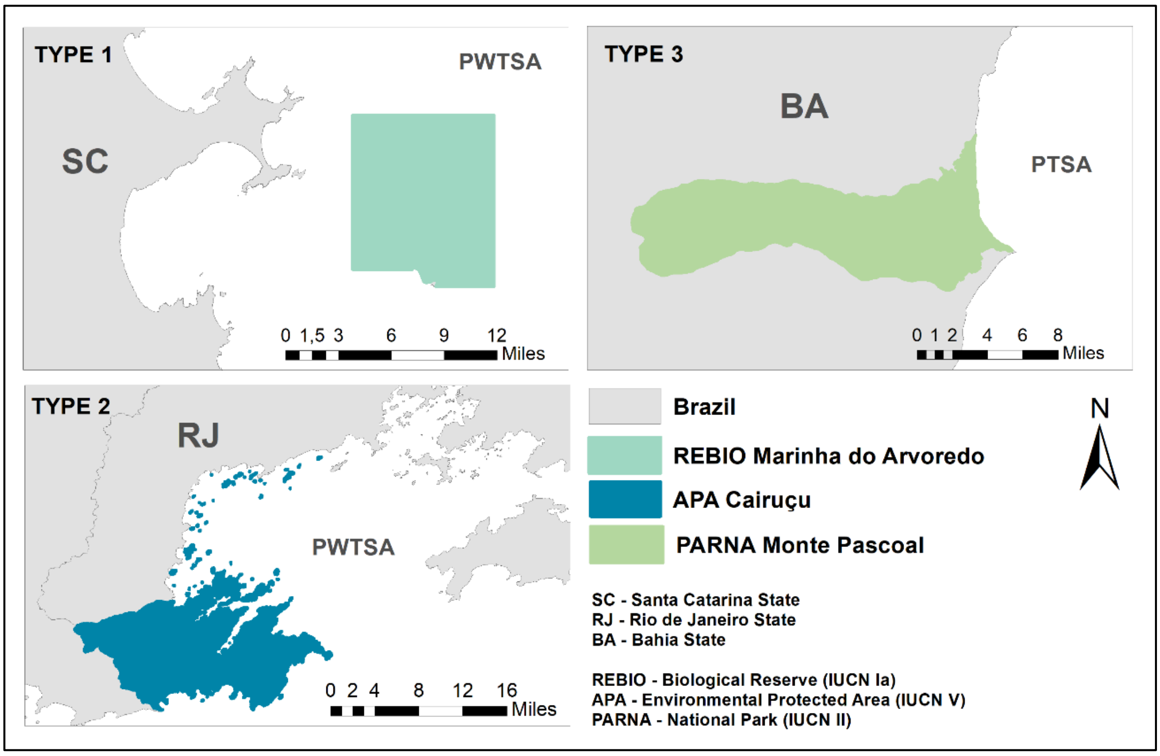
Zellmer, A. J., Claisse, J. T., Williams, C. M., Schwab, S., and Pondella, D. J. (2019). Predicting optimal sites for ecosystem restoration using stacked-species distribution modeling. *Front. Mar. Sci.* 6, 1–12. doi:10.3389/fmars.2019.00003.

Zerbini, A. N., and Kotas, J. E. (1998). A Note on Cetacean Bycatch in Pelagic Driftnetting off Southern Brazil. *Reports Int. Whal. Comm.* 48, 519–524. doi:10.1017/CBO9781107415324.004.

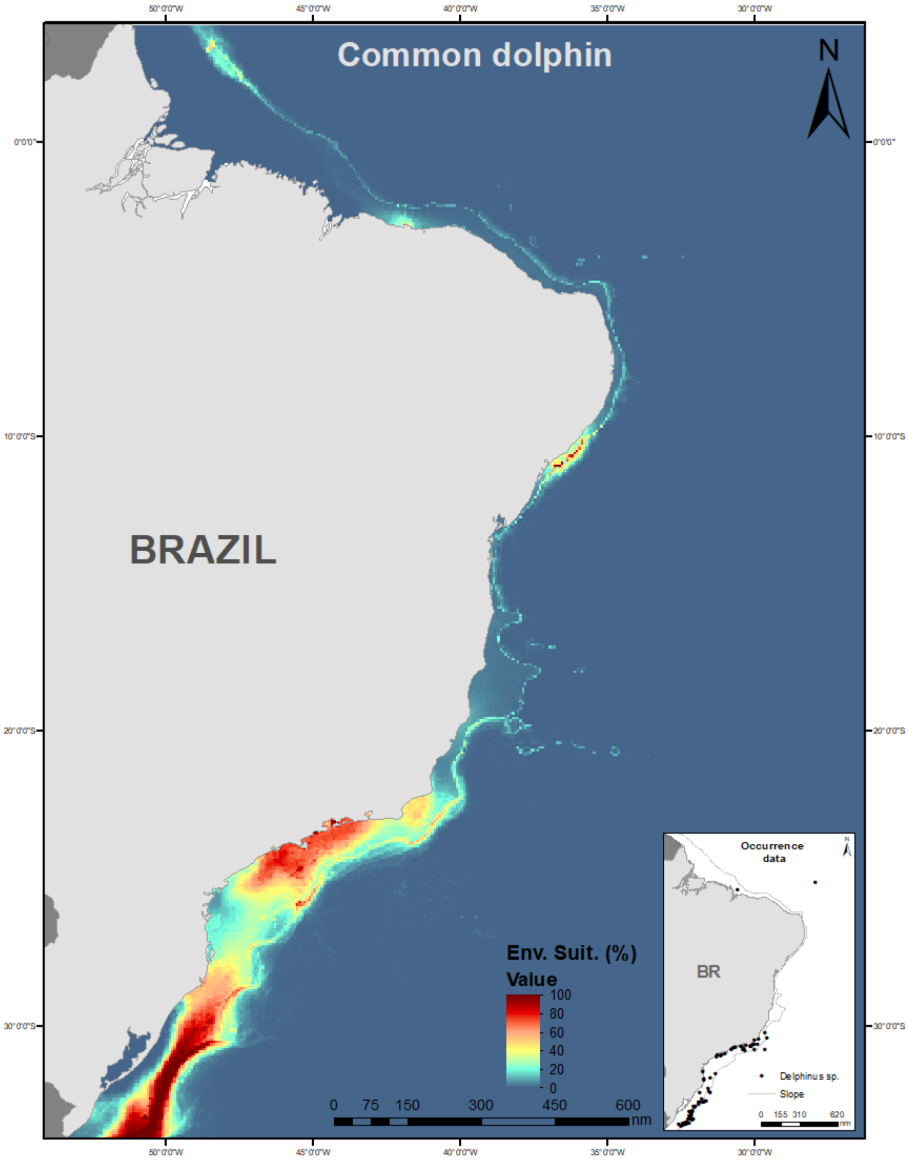
Supplementary Material



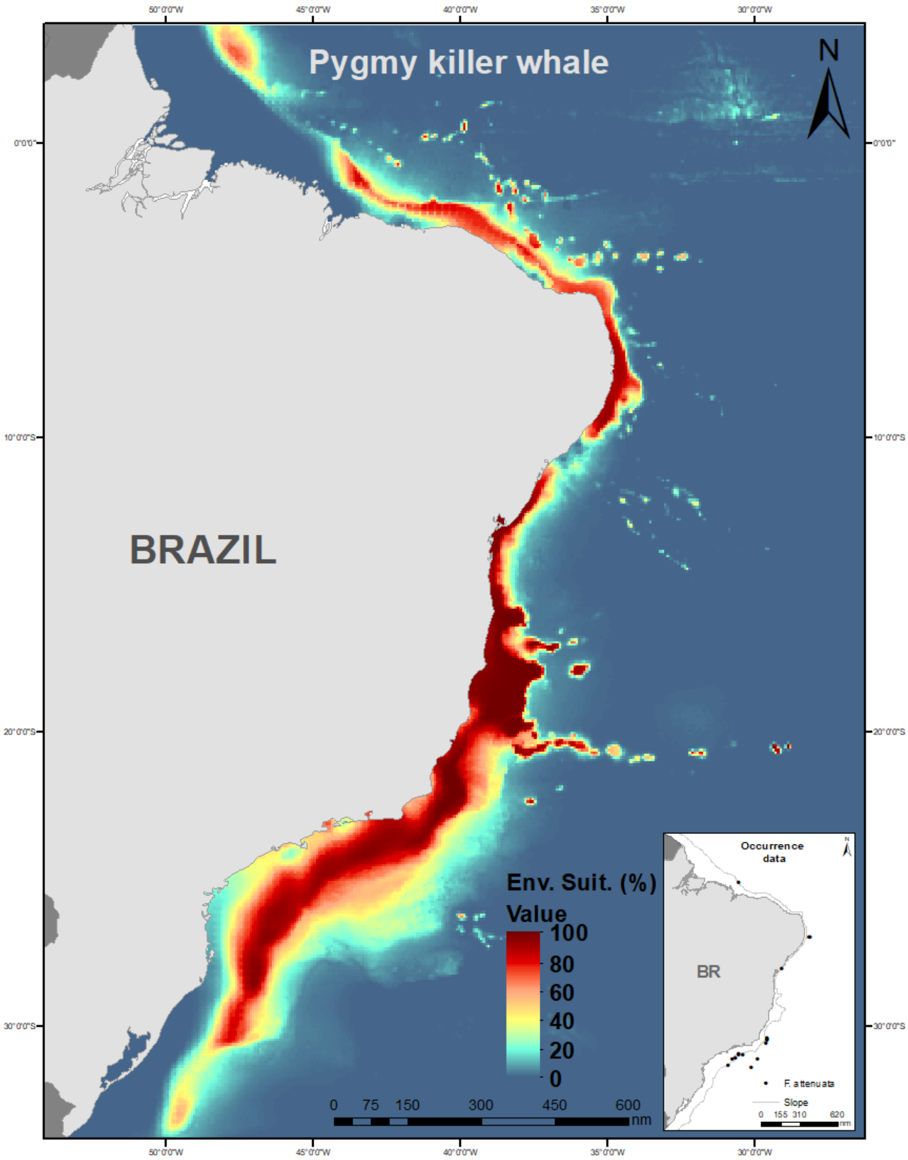
Supplementary Figure 1. Correlation matrix of 12 environmental layers used in the species distribution models. These layers were selected after a procedure of selection using vif from a pre-selected set of 22 candidates (see Material and Methods).



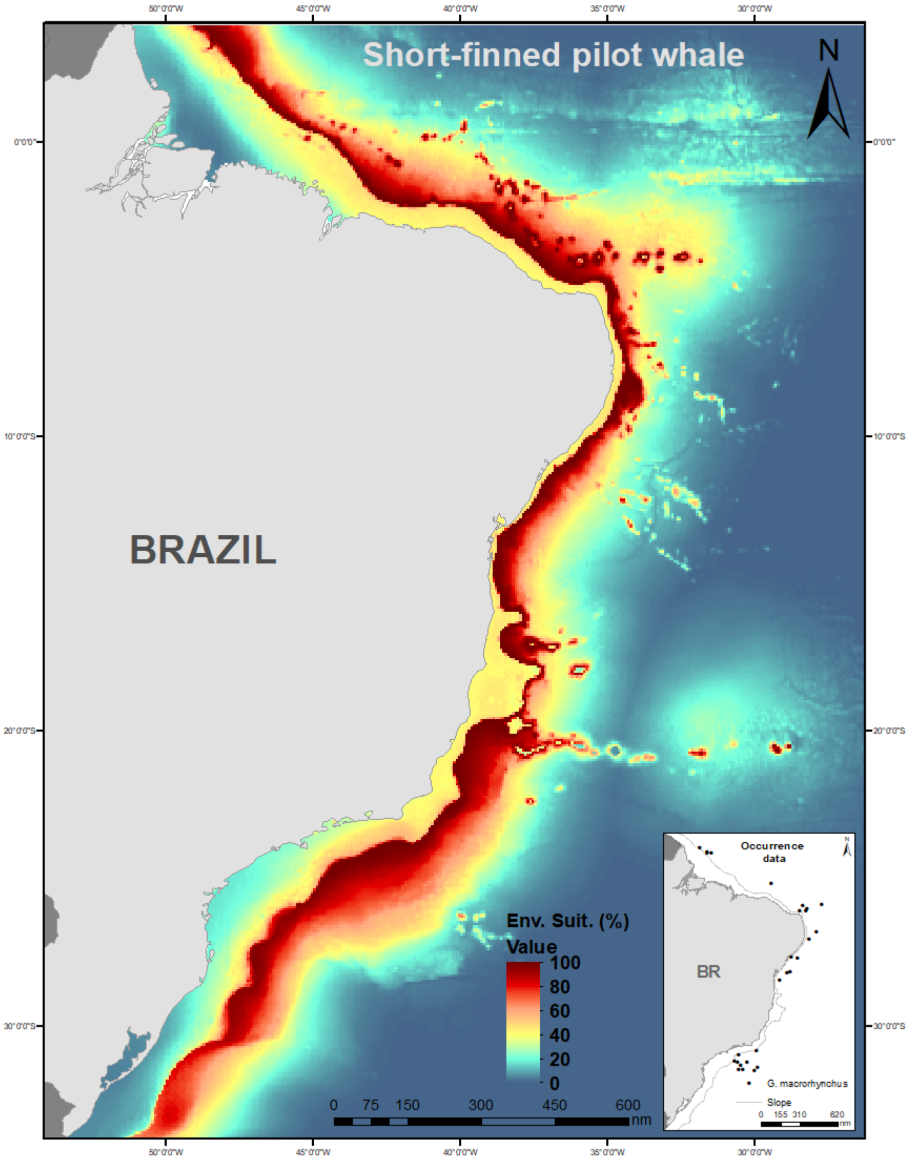
Supplementary Figure 2. Classification of Brazilian Marine Protected Areas adopted in this study. Three types of MPAS are shown: type I – MPAs completely or partially (>50%) at sea or covering oceanic islands, which are considered to have direct influence on odontocetes; type II – MPAs designed mainly covering coastal areas (>50%), but with some extent at sea and/or oceanic islands (direct influence on odontocetes); and type III – MPAs designed exclusively in terrestrial coastal areas (100%), contributing indirectly in the conservation of adjacent coastal areas (indirect influence on odontocetes).



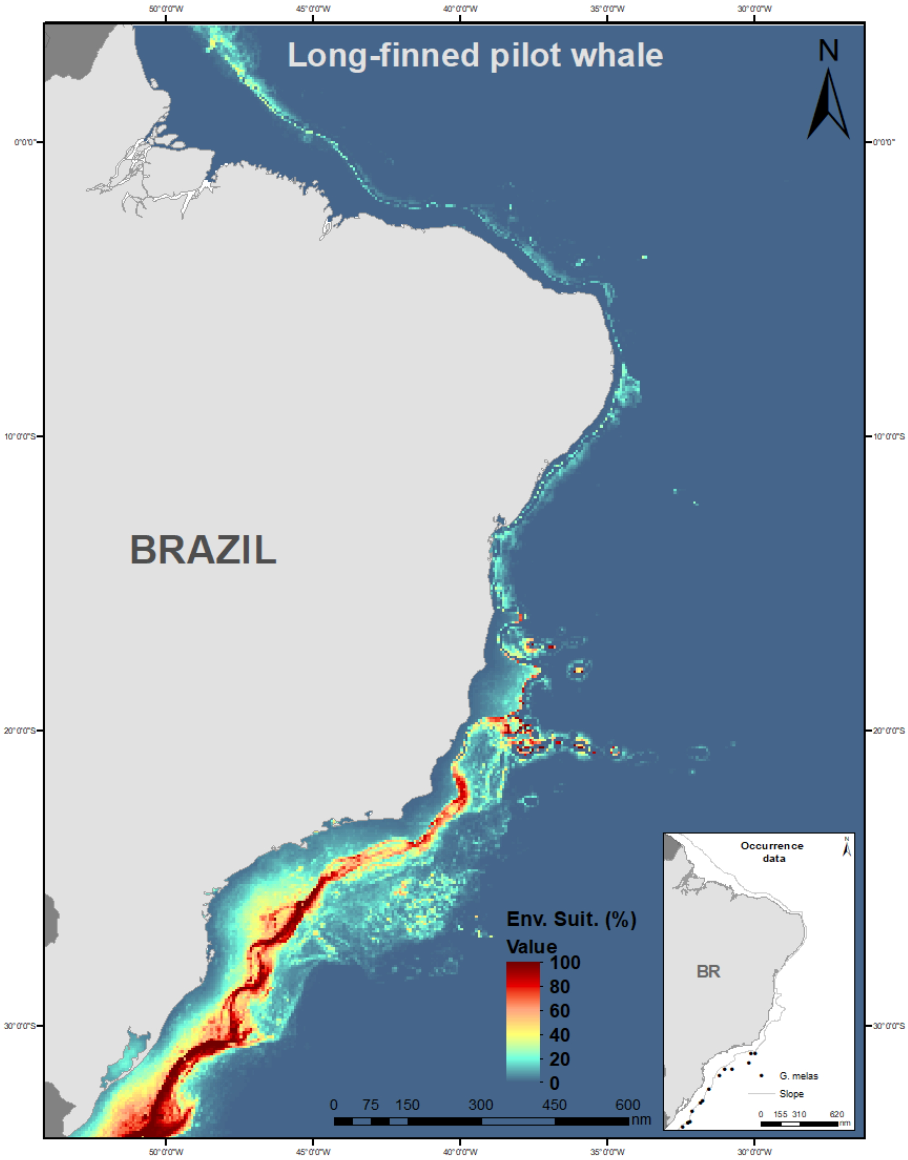
SUPPLEMENTARY FIGURE 3. MAP REPRESENTING THE POTENTIAL DISTRIBUTION FOR COMMON DOLPHIN (*DELPHINUS* SP.) IN THE SOUTHWESTERN ATLANTIC OCEAN (SWA). The predicted potential distribution for common dolphins shows high occurrence probability in neritic waters in highly productive areas influenced by the upwelling and confluence systems in the Warm-Temperate Southern Atlantic Ocean Province (PWTSA). The variable bathy ranging from 4m to 4,658m (mean = 356.50 m); distoshore between 1km and 351km (mean = 110.23 km); slope ranging from 0º to 50º (mean = 9.51º); Chlora_R between 0.119 and 2.88mg/m^3 (mean = 1.37 mg/m^3); SSS_Ma between 35.95 and 37.52 psu (mean = 36.79 psu); SSS_R ranging from 0.89 to 5.85 psu (mean = 3.06 psu); and SST_R between 2.42 and 14.27ºC (mean = 9.53ºC). The model suggests two different areas with high occurrence probability, one of them it is places at shallow and nearshore waters in the South Brazilian Bight (SBB) (22° to 28°S); and other area with it is placed over the continental shelf in the southern PWTSA, mainly in deeper waters along the continental shelf break. The potential distribution is consistent with previous studies, where its distribution at southeastern and south Brazilian areas is well documented (Tavares et al. 2010, Di Tullio et al. 2016). For the North Brazilian Shelf Province (PNBS) are a few records of strandings, incidental catch and reports of areas of economic interest that monitored effects of oil and gas exploration (Asano-filho et al., 2007; Magalhães et al., 2007; Siciliano et al., 2008; Jefferson et al., 2009; Tavares et al., 2010; Costa et al., 2017). There are no published scientific sightings, being more likely that the species is not common in this area (Asano-filho et al., 2007; Magalhães et al., 2007; Siciliano et al., 2008; Jefferson et al., 2009; Costa et al., 2017). The genus have no clarified taxonomic status on SWA (Jefferson et al., 2009; Tavares et al., 2010); but recent studies suggest that common dolphins in the SWA all belong to a single species (Cunha et al., 2015).



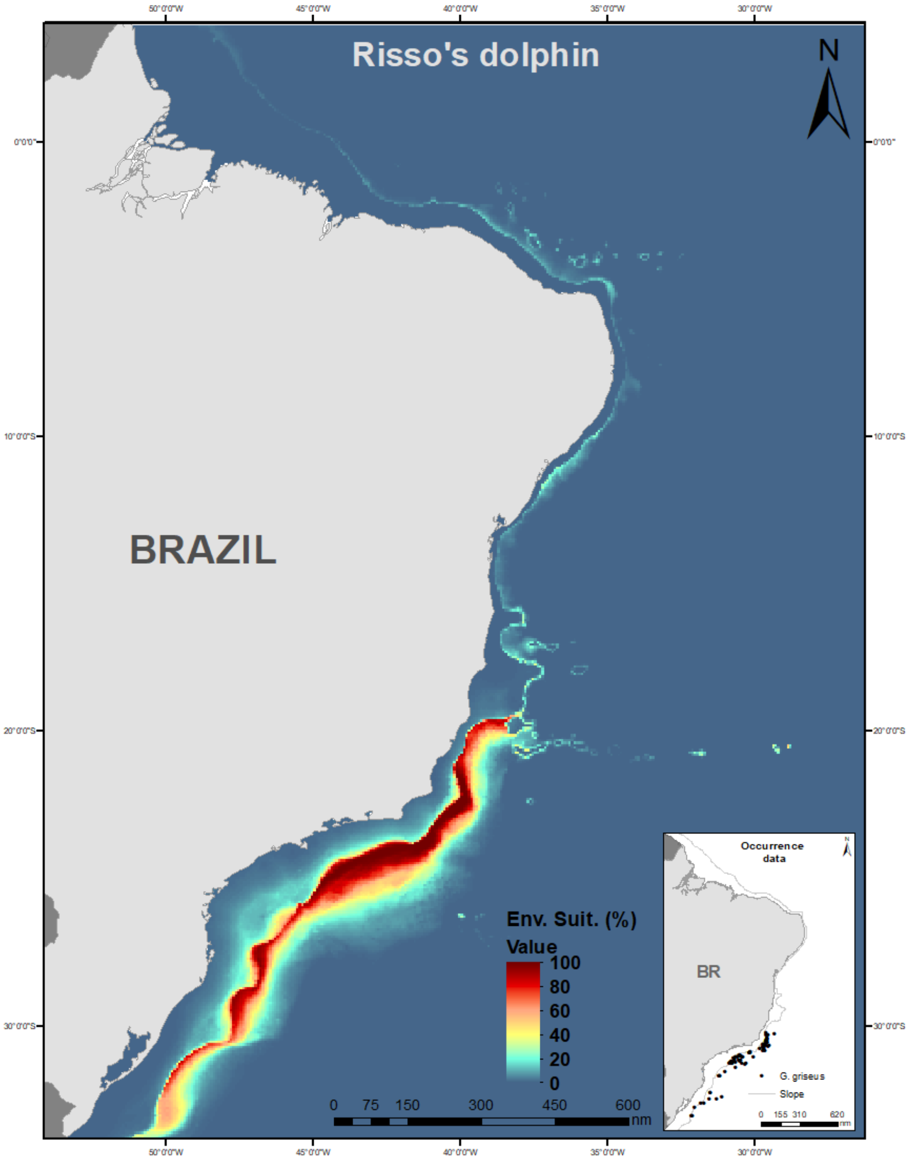
SUPPLEMENTARY FIGURE 4. MAP REPRESENTING THE POTENTIAL DISTRIBUTION FOR PYGMY KILLER WHALE (*FERESA ATTENUATA*) IN THE SOUTHWESTERN ATLANTIC OCEAN (SWA). The predicted potential distribution for the pygmy killer whale shows high occurrence probability in waters with low temperatures range and higher depths along continental shelf break in PWTSA, and over all the continental shelf in the Tropical Southern Atlantic Ocean Province (PTSA). The variable bathy ranging from 67m to 2,639m (mean = 1,118.19 m); distoshore between 11km and 328km (mean = 139 km); slope ranging from 3º to 86º (mean = 23.25º); Chlora_R between 0.08 and 0.78 mg/m^3 (mean = 0.34 mg/m^3); SSS_Ma between 36.42 and 37.57 psu (mean = 37.32 psu); SSS_R ranging from 0.89 to 1.85 psu (mean = 1.17 psu); and SST_R between 2.59 and 6.79ºC (mean = 5.32ºC). The pygmy killer whale, is one of the least-known Delphinidae members, and are distributed in tropical open-ocean waters worldwide (Baird, 2018a). Although the model suggests a wide area of high environmental suitability, the pygmy killer whale is rare throughout all their distribution range. There are few strandings records in the PTSA and the PWTSA (Zerbini and de Oliveira Santos, 1997; Magalhães et al., 2007, 2008; Batista et al., 2012; Lemos et al., 2013), and few confirmed sightings. This is the first model proposed for pygmy killer whale in the study area and it seems to agree with what is known for the species worldwide. However, the interpretation of potential distribution presented here should be taken with caution because the small sample size (n=16) used to perform the model. In this sense, the predict distribution could be just a reflect of the data used restricted to the observational efforts focused on Brazilian Economic Exclusive Zone (Br-EEZ).



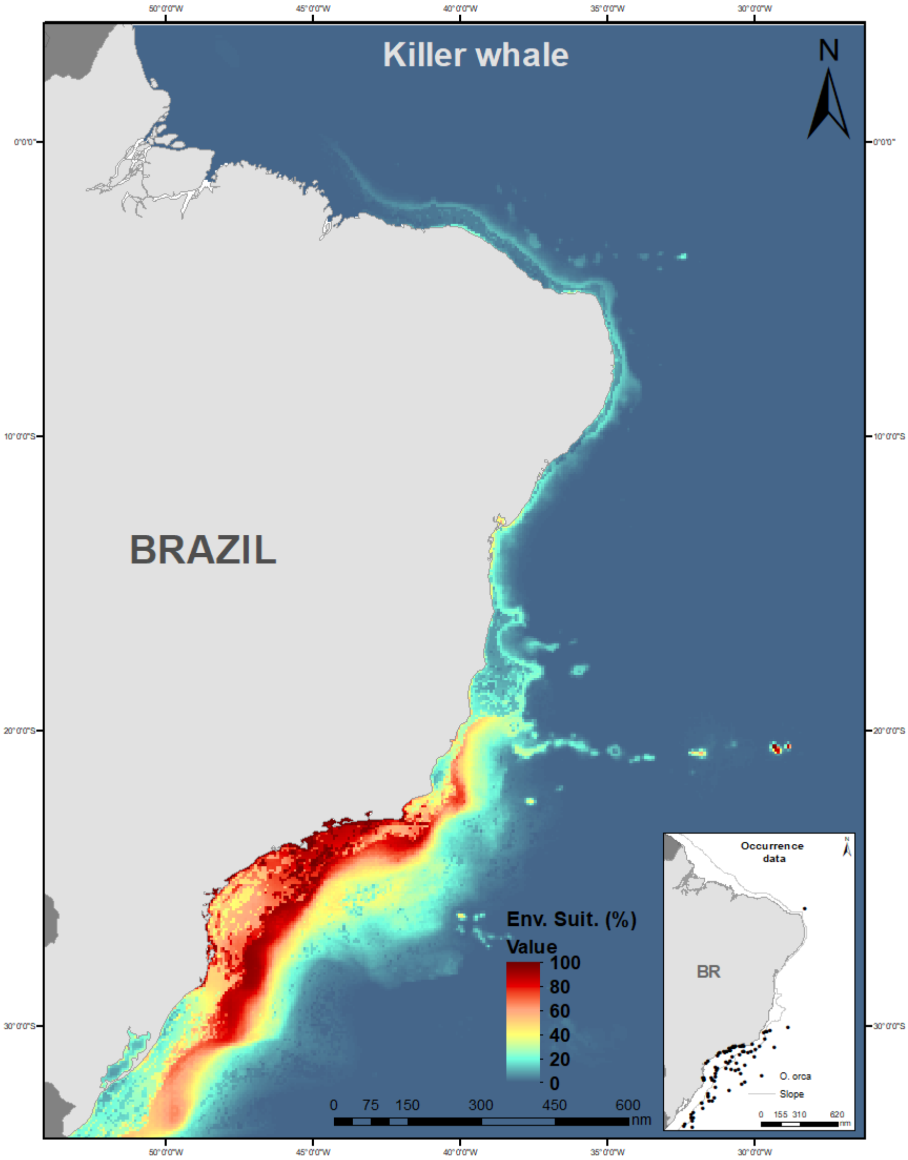
Supplementary Figure 5. Map representing the potential distribution for short-finned pilot whale (*Globicephala macrorhynchus*) in the Southwestern Atlantic Ocean (SWA). The predicted potential distribution for the short-finned pilot whale indicates a wide area of high occurrence probability beyond continental shelf break in all three marine provinces. The variable bathy ranging from 190m to 3,988m (mean = 2,087.64 m); distoshore between 5km and 369km (mean = 180.93 km); slope ranging from 2º to 158º (mean = 23.36º); Chlora_R between 0.04 and 0.69 mg/m^3 (mean = 0.29 mg/m^3); SSS_Ma between 36.24 and 37.62 psu (mean = 36.97 psu); SSS_R ranging from 0.88 to 5.65 psu (mean = 1.74 psu); and SST_R between 2.29 and 7.16ºC (mean = 4.29ºC). This species is found worldwide in tropical, subtropical, and warm temperate waters, and occurs in nearshore and pelagic environments (Olson, 2018). High environmental suitability was predicted in deeper waters (>2,000m) along continental shelf break and surrounding oceanic islands and seamounts, corroborating preferences already described for this species (Olson, 2018). The short-finned pilot whale inhabiting nearshore areas only where the continental shelf is narrow as in the PTSA. Most sightings and strandings are reported for the PTSA, corroborating the preference for warm tropical waters with low temperatures ranges (Alves-Júnior et al., 1996; Magalhães et al., 2007; Meirelles et al., 2009; Carvalho et al., 2010; Batista et al., 2012; Costa et al., 2017). Further, the PWTSA seems to be the southern limit for the species in the SWA.



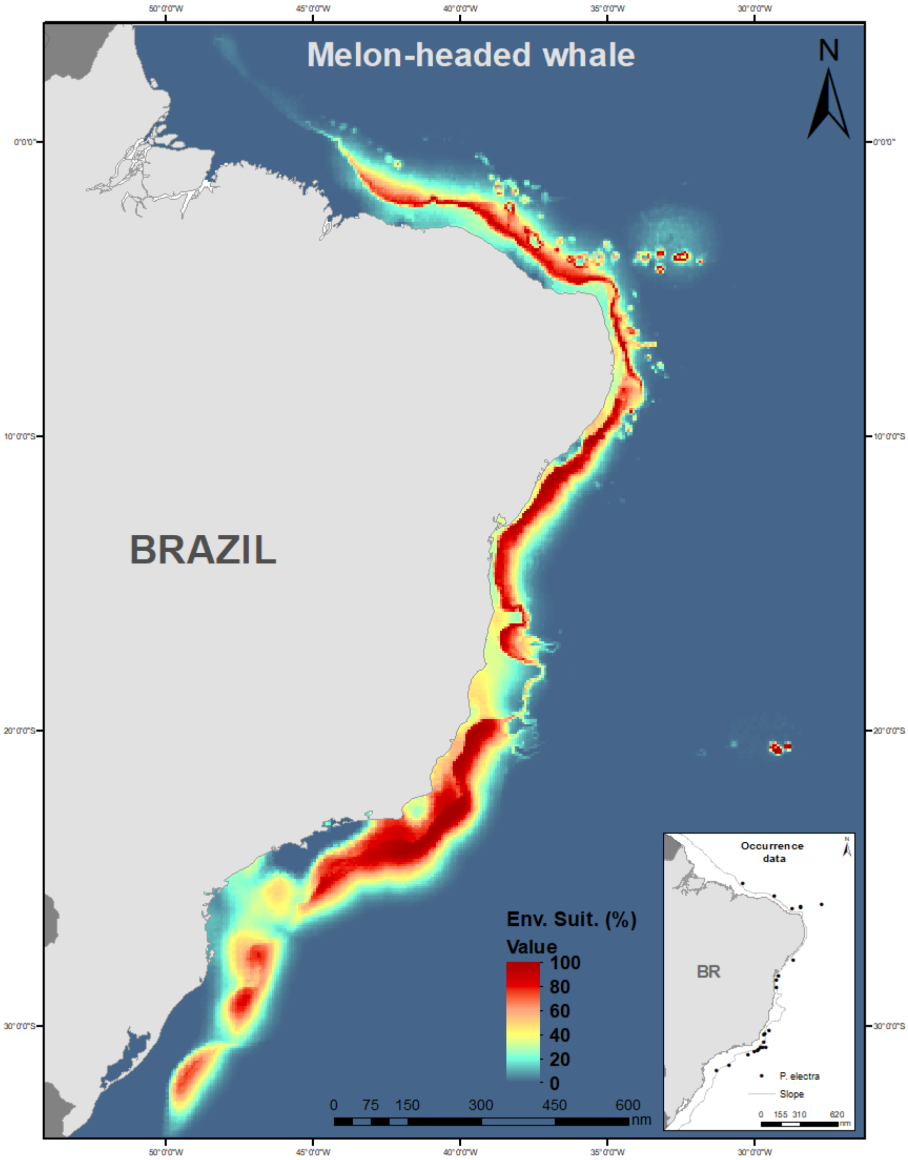
Supplementary Figure 6. Map representing the potential distribution for long-finned pilot whale (*Globicephala melas*) in the Southwestern Atlantic Ocean (SWA). The predicted potential distribution for the long-finned pilot whale shows highest occurrence probability in colder, oceanic deeper waters beyond slope. The variable bathy ranging from 181m to 2,207m (mean = 987.28 m); distoshore between 117km and 265km (mean = 190.93 km); slope ranging from 6º to 46º (mean = 19.28º); Chlora_R between 0.32 and 2.27 mg/m^3 (mean = 1.01 mg/m^3); SSS_Ma between 36.61 and 37.44 psu (mean = 37.08 psu); SSS_R ranging from 0.92 to 4.39 psu (mean = 2.39 psu); and SST_R between 6.10 and 12.30ºC (mean = 8.89ºC). The long-finned pilot whale has an antitropical distribution range, inhabiting mainly cold temperate waters of both the North Atlantic and the Southern Ocean (Olson, 2018). In the SWA, there are overlap areas with the short-finned pilot whale in subtropical waters (Olson, 2018), probably in northern PWTSA. As opposed to the short-finned pilot whale, the long-finned pilot whale seems to prefer coolest waters with depth up to 1,000m. The long-finned pilot whale has sightings and strandings records only in PWTSA (Petry and Fonseca, 2001; Dos Santos and Haimovici, 2002; Santos et al., 2010). Di Tullio et al. (2016) reported this species as the second most frequent large delphinid sighted outer continental shelf and slope in the southern PWTSA. There are no public records of the long-finned pilot whale in the PTSA, even though the predicted potential distribution map has shown high environmental suitability in the Vitoria-Trindade Chain (VTC) seamounts.



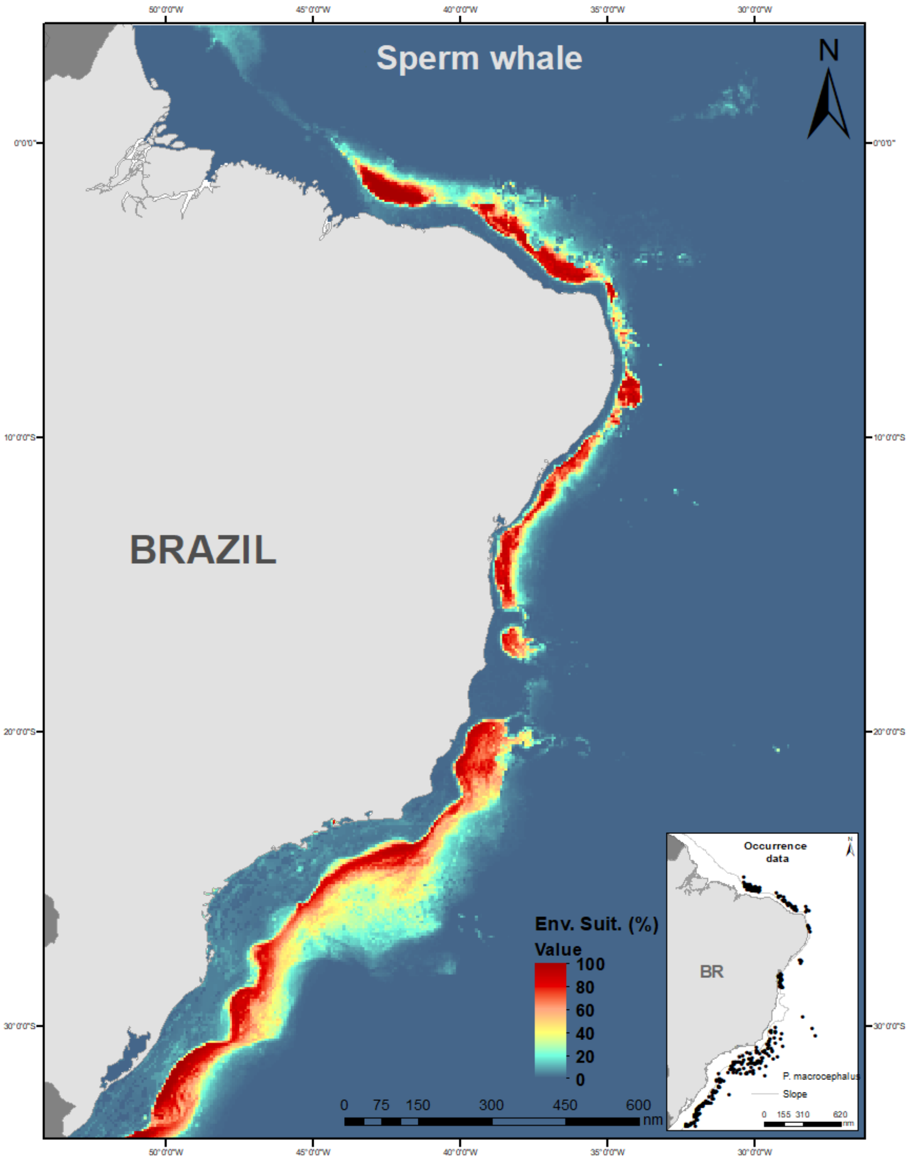
SUPPLEMENTARY FIGURE 7. MAP REPRESENTING THE POTENTIAL DISTRIBUTION FOR RISSO'S DOLPHIN (*GRAMPUS GRISEUS*) IN THE SOUTHWESTERN ATLANTIC OCEAN (SWA). The predicted potential distribution for the Risso's dolphin indicated high occurrence probability in deep and offshore waters (>1000m), concentrated over continental slope and steep shelf-edge areas. The variable bathy ranging from 10m to 2,943m (mean = 1401.11 m); distoshore between 2km and 350km (mean = 159.68 km); slope ranging from 1º to 46º (mean = 16.37º); Chlora_R between 0.05 and 1.57 mg/m^3 (mean = 0.43 mg/m^3); SSS_Ma between 35.99 and 37.63 psu (mean = 37.37 psu); SSS_R ranging from 0.87 to 4.27 psu (mean = 1.18 psu); and SST_R between 4.26 and 11.07ºC (mean = 6.38ºC). Di Tullio et al., (2016) indicate that the Risso's dolphin has higher densities beyond the 600m isobath in PWTSA. The Risso's dolphin sightings are concentrated in southern PTSA and PWTSA, corroborating their preference for waters warmer than 12ºC (Hartman, 2018). These records come almost exclusively from public databases, except for two published accidental catches. Few strandings are recorded in the three marine provinces (summarized by Toledo et al., 2015). Although described as a widely distributed species, the Risso's dolphin has some few populations with known site fidelity, but are isolated from each other, or have shown no evidence of exchange between them, suggesting little long-range dispersal (Gaspari et al., 2007; Chen et al., 2011; Hartman, 2018).



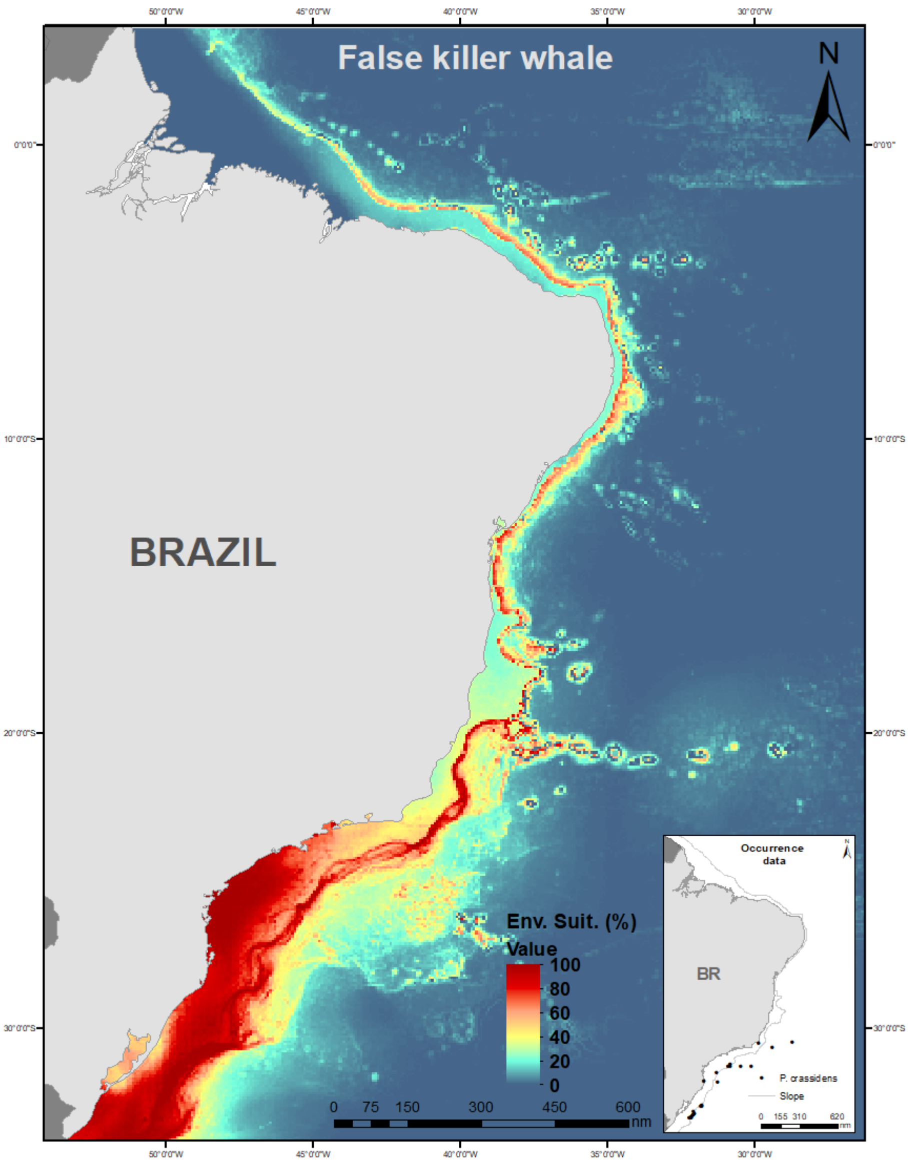
Supplementary Figure 8. Map representing the potential distribution for killer whale (*Orcinus orca*) in the Southwestern Atlantic Ocean (SWA). The predicted potential distribution for the killer whale indicates high occurrence probability in coastal and over continental shelf from PWTSA, mainly in colder and productivity areas influenced by SBB upwellings and the Subtropical Confluence (SASC). The variable bathy ranging from 2m to 3,676m (mean = 750.098 m); distoshore between 1km and 515km (mean = 121.935 km); slope ranging from 0° to 112° (mean = 8.402°); Chlora_R between 0.040 and 2.135 mg/m^3 (mean = 0.875 mg/m^3); SSS_Ma between 35.929 and 37.773 psu (mean = 36.984 psu); SSS_R ranging from 0.859 to 4.674 psu (mean = 1.743 psu); and SST_R between 3.171 and 12.227°C (mean = 7.932°C). Killer whales inhabits all oceans and most seas, but is more frequent in productive and colder waters (Ford, 2018). Although there is no such information about killer whales that occurs in Brazilian waters, is currently recognized the existence of morphologically, ecologically, and genetically distinct populations (LeDuc et al., 2008; Morin et al., 2010; Ford, 2018). Killer whale populations may exhibit seasonal shifts in distribution related to prey availability. Killer whales are sighted mainly in coastal areas from SBB between November and February (Santos et al., 2019), and further south in deeper waters between spring and winter (Lodi and Borobia, 2013). High suitable areas predicted areas through PWTSA where killer whales are frequently sighted (see Discussion). Killer whale sightings are rare northern of the PTWSA (Bastida et al., 2018). In fact, warmer waters of middle-latitudes (30°S) in the SWA are suggested as secondary range for killer whales (Ford, 2018).



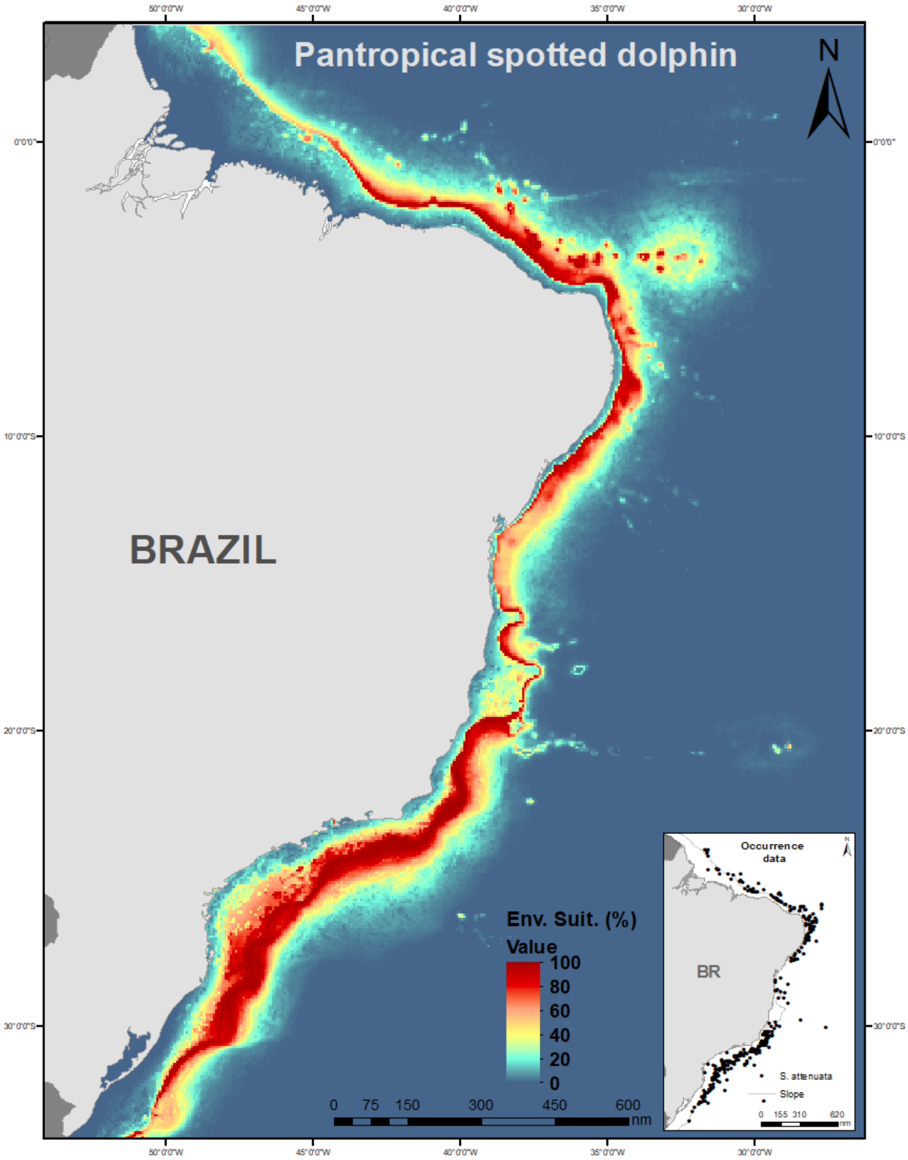
Supplementary Figure 9. Map representing the potential distribution for melon-headed whale (*Peponocephala electra*) in the Southwestern Atlantic Ocean (SWA). The predicted potential distribution for the melon-headed whale indicates high occurrence probability along deeper waters (<1000m) from continental shelf break. The variable bathy ranging from 109m to 2,908m (mean = 1576.17 m); distoshore between 3km and 184km (mean = 105.56 km); slope ranging from 4º to 117º (mean = 25º); Chlora_R between 0.07 and 0.68 mg/m^3 (mean = 0.32 mg/m^3); SSS_Ma between 36.39 and 37.66 psu (mean = 37.21 psu); SSS_R ranging from 0.88 to 2.64 psu (mean = 1.37 psu); and SST_R between 2.55 and 8.84ºC (mean = 4.85ºC). The oceanic islands, namely Trindade, Atol das Rocas and Fernando de Noronha, are also indicated with high environmental suitability, and the last two islands has confirmed sighting (Baracho et al., 2005; Rocha-Campos et al., 2007). Nearshore sightings only occur in PTSA, where the continental shelf is narrow. Most strandings are record in PTSA (Lodi et al., 1990; Batista et al., 2012; Toledo et al., 2015) but also in PNBS (Costa et al., 2017). Melon-headed whales are found worldwide in tropical to subtropical waters, and sightings are often associated with incursions of warm water currents (Perryman and Danil, 2018). May the melon-headed whales dwell the equatorial North Brazilian Current (NBC) and the tropical BC waters masses (which separates from the continental shelf about 36°S), moving seasonally between its boundaries. Further, the absence in Abrolhos Bank may are related with shallower topography in this region.



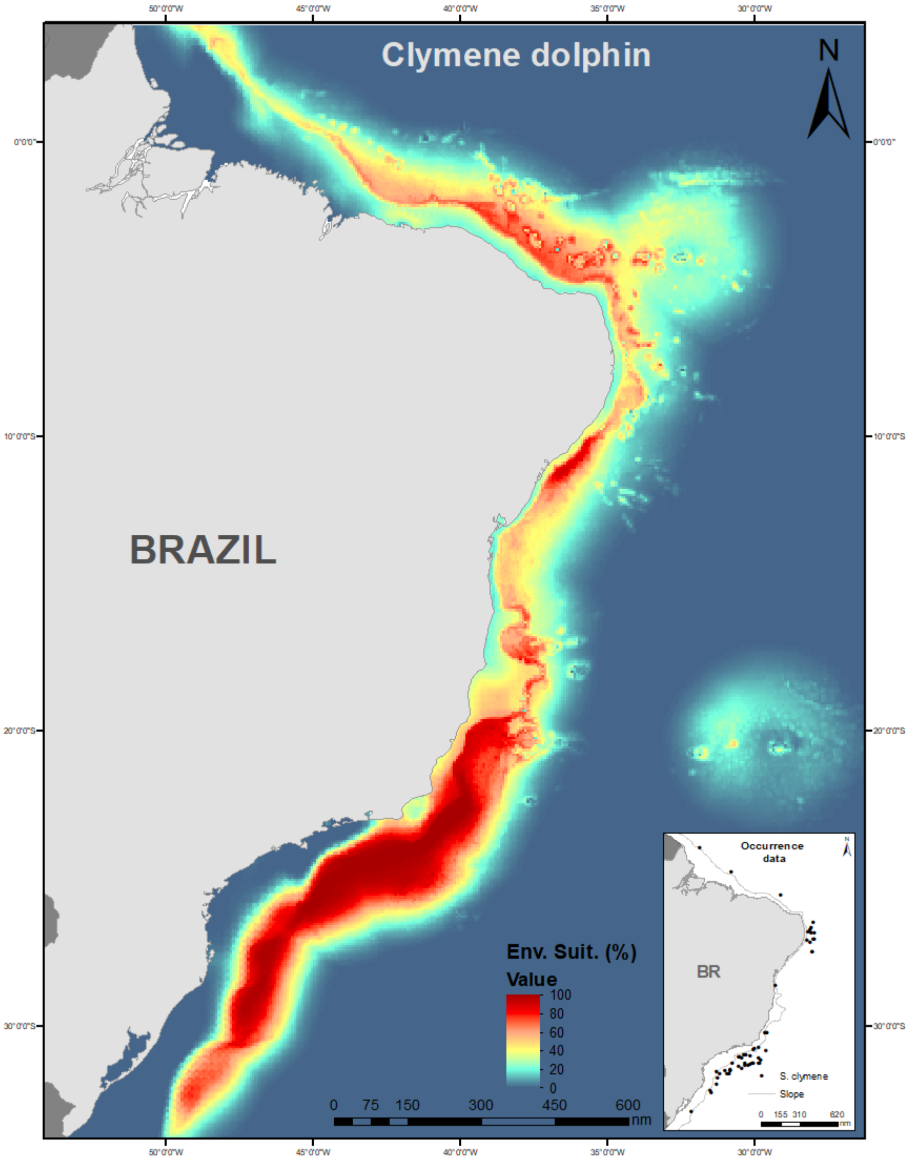
Supplementary Figure 10. **Map representing the potential distribution for sperm whale (*Physeter macrocephalus*) in the Southwestern Atlantic Ocean (SWA).** The predicted potential distribution for the sperm whale indicates high environmental suitability in deeper waters (around 2000m) along the edges of continental shelf in PTSA and PWTSA. The variable bathy ranging from 7m to 4,395m (mean = 1,911.17 m); distoshore between 2km and 542km (mean = 158.53 km); slope ranging from 1º to 87º (mean = 17.39º); Chlora_R between 0.02 and 2.37 mg/m^3 (mean = 0.44 mg/m^3); SSS_Ma between 36.37 and 38.01 psu (mean = 37.04 psu); SSS_R ranging from 0.85 to 4.91 psu (mean = 1.68 psu); and SST_R between 2.45 and 13.31ºC (mean = 5.92ºC). Sightings in offshore waters reach depths greater than 4000 m, and topographic features seems to be an important factor in their ranges. Strandings are recorded through all three marine provinces, with greatest incidence in PTSA (Ramos et al., 2001; Lodi & Borobia, 2013; Costa et al., 2017). The PTSA was a major whaling ground off the eastern coast of South America in the 20th century (Andriolo et al., 2010), where the sperm whale was intensely hunted (Toledo and Langguth, 2009), but also in Cabo Frio region (Ramos et al., 2010). Moreover, in the PTSA the sperm whale has been observed throughout all the year (Andriolo et al., 2010; Ramos et al., 2010), but sightings nearshore occur only where the continental shelf is narrow. Meanwhile, the southern PTWSA have the highest frequency of sightings in the last years (Bastida et al., 2018), principally in the spring season and in deeper waters over the continental slope (Di Tullio et al., 2016). The importance of slope topography for sperm whales has been recorded in this area (Pinedo et al., 2002).



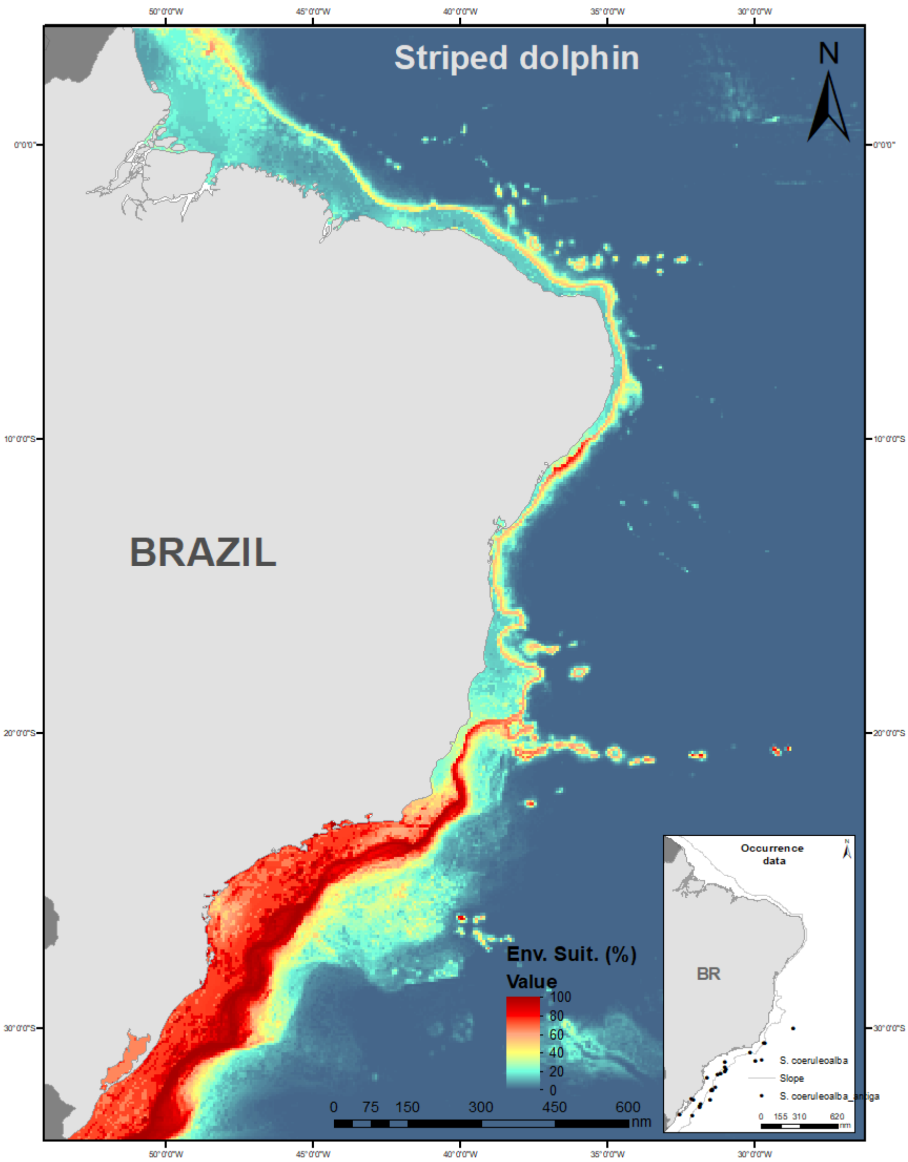
SUPPLEMENTARY FIGURE 11. MAP REPRESENTING THE POTENTIAL DISTRIBUTION FOR FALSE KILLER WHALE (*PSEUDORCA CRASSIDENS*) IN THE SOUTHWESTERN ATLANTIC OCEAN (SWA). The predicted potential distribution for the false killer whale indicates high environmental suitability in coastal and deeper waters (<1000m) over the large continental shelf, and along the slope in the PWTSA. The variable bathy ranging from 15m to 4,117m (mean = 1,227.565 m); distoshore between 2km and 477km (mean = 174.82 km); slope ranging from 1º to 40º (mean = 17.39º); Chlora_R between 0.041 and 2.546 mg/m^3 (mean = 0.773 mg/m^3); SSS_Ma between 36.062 and 37.697 psu (mean = 37.062 psu); SSS_R ranging from 0.888 to 4.964 psu (mean = 2.290 psu); and SST_R between 3.178 and 12.194ºC (mean = 8.438ºC). Great environmental suitability also was predicted to VCT and steep shelf-edge areas along PTSA, where sightings and strandings often occurs (Baracho et al., 2005; Batista et al., 2012). The false killer whale are found worldwide throughout the tropics and subtropics, with greater density in lower latitudes (Baird, 2018b). In Brazil, In southern PWTSA, the false killer whale has been observed in coastal areas (LTMM-IO-FURG, unpublished data cited in Botta et al., 2012), where two groups of divergent trophic level and/or habitats could be identified isotopically (Botta et al., 2012). One group seems to have a more coastal piscivorous feeding habit (Botta et al., 2012), whereas the other group consumes mainly oceanic cephalopods (Andrade et al., 2001), which can indicate longitudinal movements according with prey availability among coastal and pelagic waters (Lodi and Borobia, 2013). Further, strandings of false killer whales in southern PWTSA are more frequent in spring/winter and might be related to the higher productivity in this area which could attract individuals to this area (Prado et al., 2016).



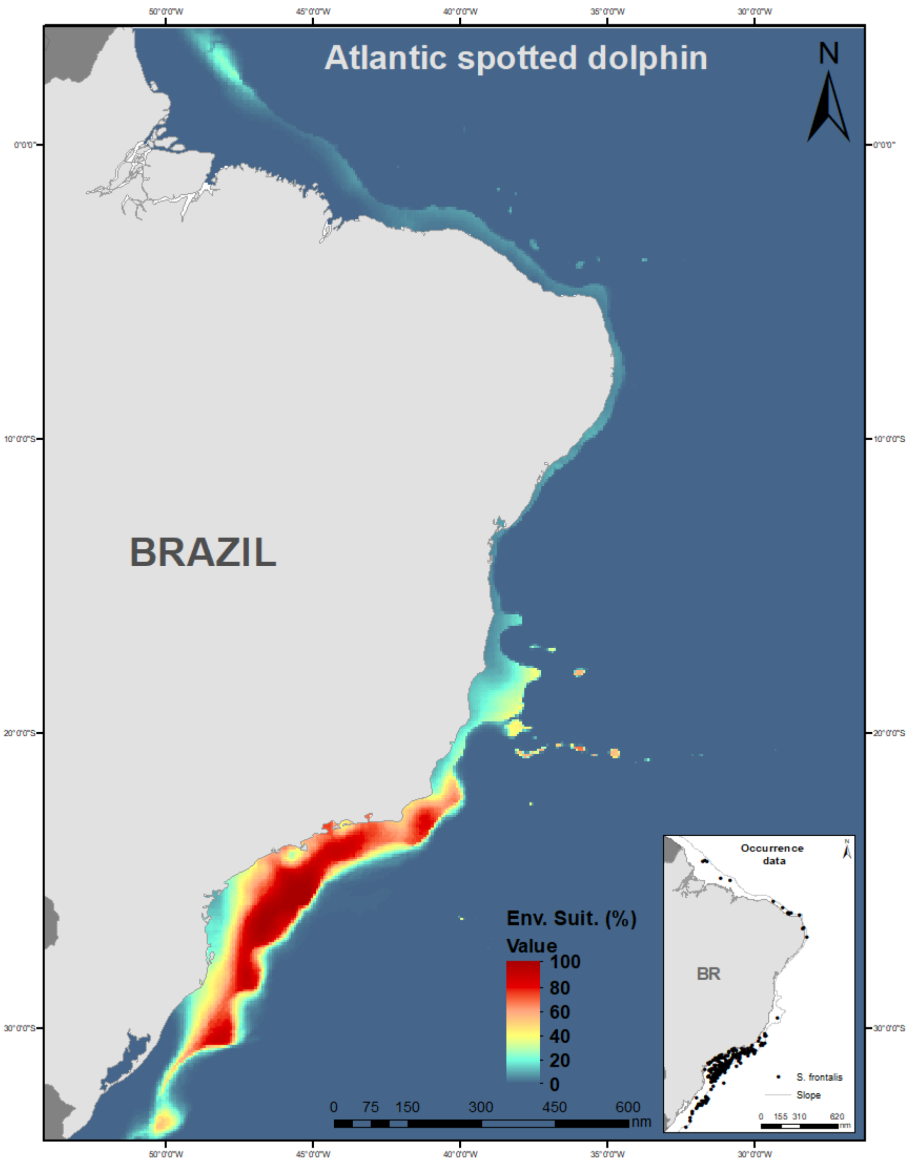
Supplementary Figure 12. Map representing the potential distribution for pantropical spotted dolphin (*Stenella attenuata*) in the Southwestern Atlantic Ocean (SWA). The predicted potential distribution for the pantropical spotted dolphin indicates high occurrence probability in deep waters (>1000m) along the continental shelf break and around tropical oceanic island. The variable bathy ranging from 5m to 4633m (mean = 1379.422 m); distoshore between 1km and 860km (mean = 127.031 km); slope ranging from 1º to 158º (mean = 22.136º); Chlora_R between 0.024 and 2.085 mg/m^3 (mean = 0.406 mg/m^3); SSS_Ma between 35.223 and 38.059 psu (mean = 37.106 psu); SSS_R ranging from 0.859 to 16.730 psu (mean = 1.678 psu); and SST_R between 2.162 and 11.355ºC (mean = 5.416ºC). In Brazilian waters, the pantropical spotted dolphin ecological niche have been associated with warm (>27ºC) and deep waters beyond slope (Moreno et al., 2005; do Amaral et al., 2015). In fact, until recently, most sighting were concentrated in the PTSA (do Amaral et al., 2015). The new sightings data presented here are mainly from public databases and were obtained principally in areas of economic interest monitored systematically (oil exploration). These records extending the pantropical spotted dolphin range southward and seem to corroborate the abundant status described for this species in other ocean basins (Perrin, 2018). Rice (1998) suggest that southern distribution range for this species in the SWA is close to Uruguay (34ºS). Further, also as described for major water masses in the eastern Pacific (Perrin, 2018), may the pantropical spotted dolphin inhabits the equatorial North Brazilian Current (NBC) and the tropical Brazilian Current (BC) waters masses.



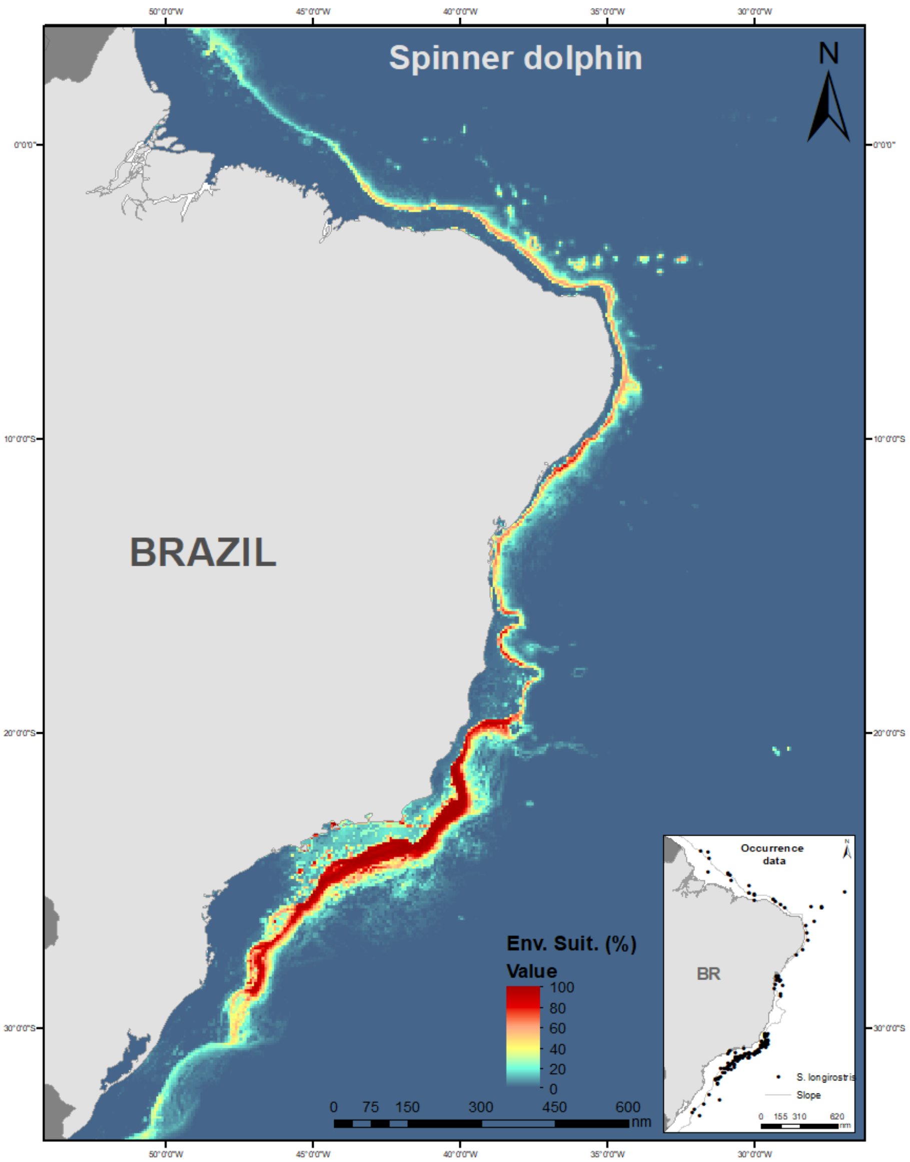
SUPPLEMENTARY FIGURE 13. MAP REPRESENTING THE POTENTIAL DISTRIBUTION FOR CLYMENE DOLPHIN (*STENELLA CLYMENE*) IN THE SOUTHWESTERN ATLANTIC OCEAN (SWA). The predicted potential distribution for the Clymene dolphin indicates a wide area of high occurrence probability in offshore and deeper waters over and beyond continental shelf break from PTSA to PWTSA. The variable bathy ranging from 7m to 4,769m (mean = 2,033.18 m); distoshore between 2km and 318km (mean = 180.82 km); slope ranging from 1º to 104º (mean = 14.75º); Chlora_R between 0.020 and 0.80 mg/m^3 (mean = 0.33 mg/m^3); SSS_Ma between 36.25 and 37.64 psu (mean = 37.20 psu); SSS_R ranging from 0.90 to 5.64 psu (mean = 1.34 psu); and SST_R between 2.34 and 8.27ºC (mean = 5.49ºC). The Clymene dolphin is endemic from Atlantic Ocean (Fertl et al., 2003), and is often observed nearshore where deep water approaches the coast (Jefferson, 2018a). Most records are reported to the PTSA (Fertl et al., 2003; Moreno et al., 2005), where Clymene dolphin is considered be more frequent (Moreno et al., 2005; do Amaral et al., 2015). However, this may be more related to the narrowing of the continental shelf than to a greater abundance of the species. As for the pantropical spotted dolphin, the new sightings presented here are mainly from public databases and were obtained in offshore areas of economic interest monitored systematically. The absence of records in PWTSA until them, could be related to the widening of the continental shelf, the separation of the warm BC from coast, and/or the increase of environmental suitability in open-ocean waters.



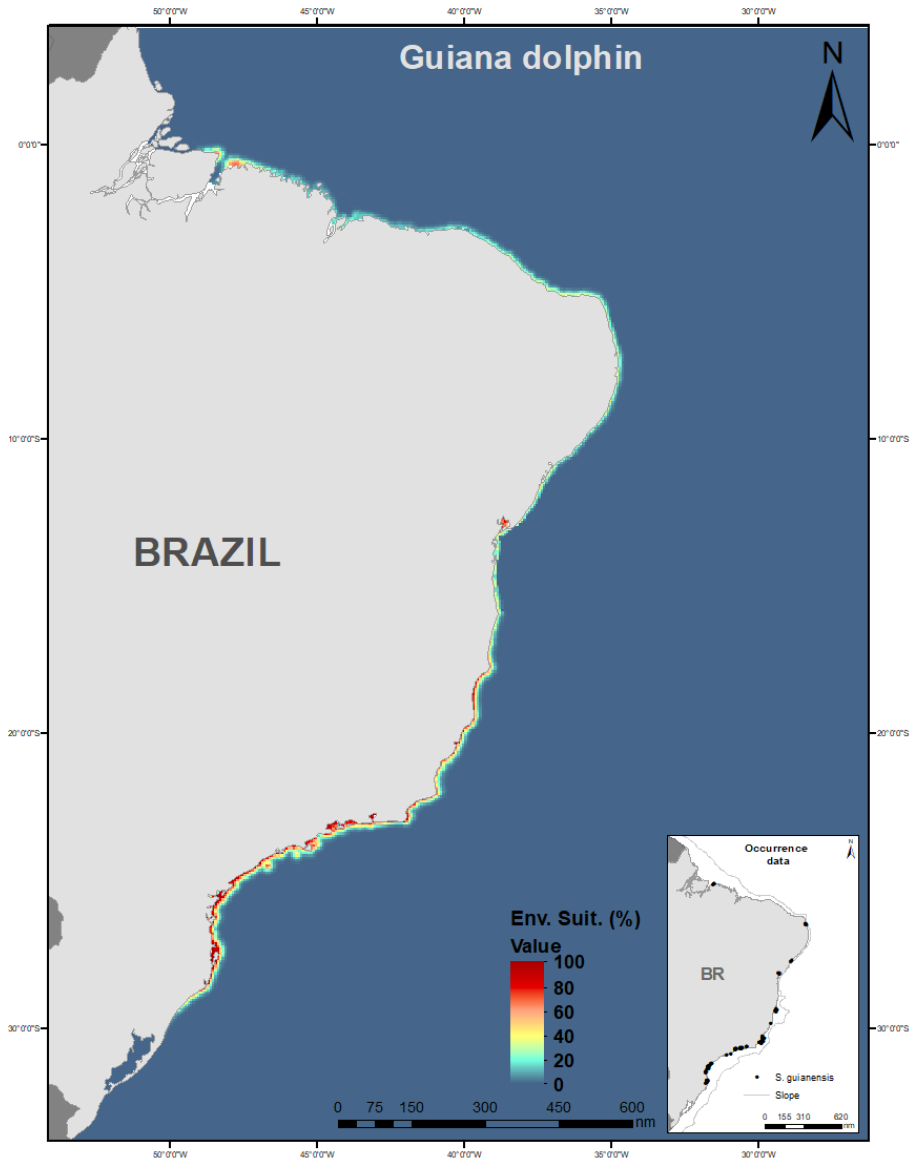
SUPPLEMENTARY FIGURE 14. MAP REPRESENTING THE POTENTIAL DISTRIBUTION FOR THE STRIPED DOLPHIN (*STENELLA COERULEOALBA*) IN THE SOUTHWESTERN ATLANTIC OCEAN (SWA). The predicted potential distribution for the striped dolphin shows high occurrence probability southern of the VTC, in coolest waters across continental shelf and upper slope from PWTSA. The variable bathy ranging from 9m to 2,515m (mean = 640.82 m); distoshore between 2km and 396km (mean = 148.69 km); slope ranging from 1º to 94º (mean = 19.09º); Chlora_R between 0.04 and 3.37 mg/m^3 (mean = 0.94 mg/m^3); SSS_Ma between 35.48 and 37.77 psu (mean = 37.00 psu); SSS_R ranging from 0.88 to 9.48 psu (mean = 2.54 psu); and SST_R between 3.35 and 14.49ºC (mean = 8.52ºC). The striped dolphin is a pelagic small delphinid common in warm-temperate to tropical waters in all ocean basins (Archer, 2018), and are often associated with convergence zones and waters influenced by upwelling (Ballance et al., 2006). In the SWA, striped dolphins seems to prefer subtropical and warm temperate regions, although there are few sightings in tropical waters (Moreno et al., 2005; Carvalho et al., 2010; de Santos et al., 2010; do Amaral et al., 2015). Furthermore, strandings are more frequent in the PWTSA, and even further south in Uruguayan and Argentinean waters (do Amaral et al., 2015). Stomach content analysis of stranded individuals in PWTSA shows cephalopods beaks of oceanic species, corroborating the pelagic habits of striped dolphins (Rosas et al., 2002). Although some sightings reach 2,000 m depth, on average, the striped dolphins seems to prefer waters up to 600m and colder waters than others oceanic stenellids (*S. attenuata*, *S. clymene* and *S. longirostris*).



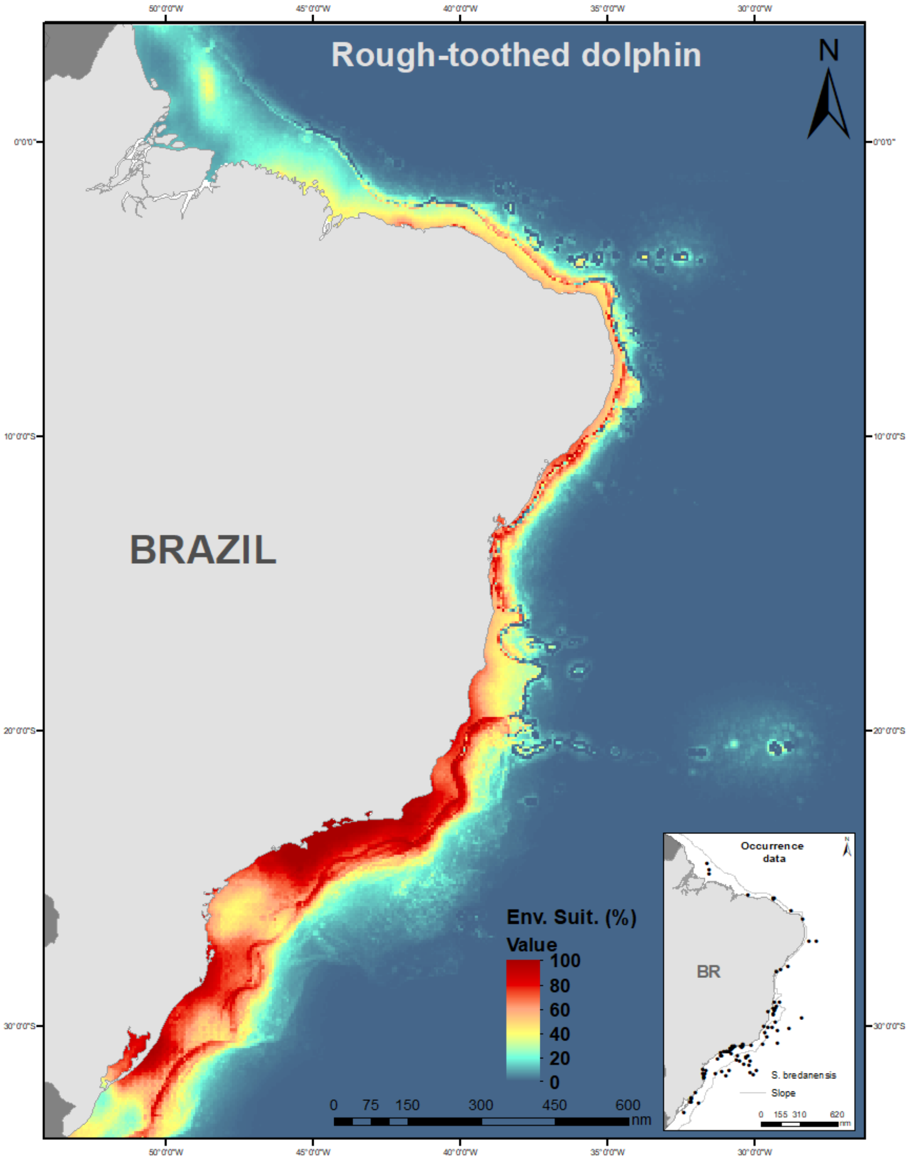
SUPPLEMENTARY FIGURE 15. MAP REPRESENTING THE POTENTIAL DISTRIBUTION FOR ATLANTIC SPOTTED DOLPHIN (*STENELLA FRONTALIS*) IN THE SOUTHWESTERN ATLANTIC OCEAN (SWA). The predicted potential distribution for the Atlantic spotted dolphin indicates high occurrence probability in coastal and neritic waters over the continental shelf in northern PWTSA and beyond the shelf break in southern PWTSA. The variable bathy ranging from 2m to 2,574m (mean = 224.77 m); distoshore between 1km and 307km (mean = 114.27 km); slope ranging from 0º to 65º (mean = 5.22º); Chlora_R between 0.09 and 2.22 mg/m^3 (mean = 0.85 mg/m^3); SSS_Ma between 35.14 and 37.57 psu (mean = 37.007 psu); SSS_R ranging from 0.86 to 13.15 psu (mean = 1.729 psu); and SST_R between 2.280 and 11.79ºC (mean = 7.76ºC). The Atlantic-spotted dolphin is endemic from Atlantic Ocean, Gulf of Mexico and Caribbean, and its southern range corresponds to the region influenced by the SASC (Moreno et al., 2005; Paro et al., 2014). The model corroborates the distribution previously described by Moreno et al., (2005) and do Amaral et al., (2015). The Atlantic spotted dolphin is the only species among the genera with coastal habitats in the SWA (about 200m depth), although they are also sighted in deeper waters (Moreno et al., 2005; Di Tullio et al., 2016). The environmental suitably increase southward, following the widening of the continental shelf. Sightings concur with the area of the SASC, what seems to influence the distribution range of the Atlantic spotted dolphin seasonally by the drift of the BC, trough PTSA/PWTSA and Uruguayan coast (Moreno et al., 2005; do Amaral et al., 2015). The increase of sightings appears to corroborate the proposed discontinuous distribution along the Brazilian coast proposed by Moreno et al. (2005). Despite a considerable number of records at northern Brazil, the model indicated low occurrence probability for the species in this marine province.



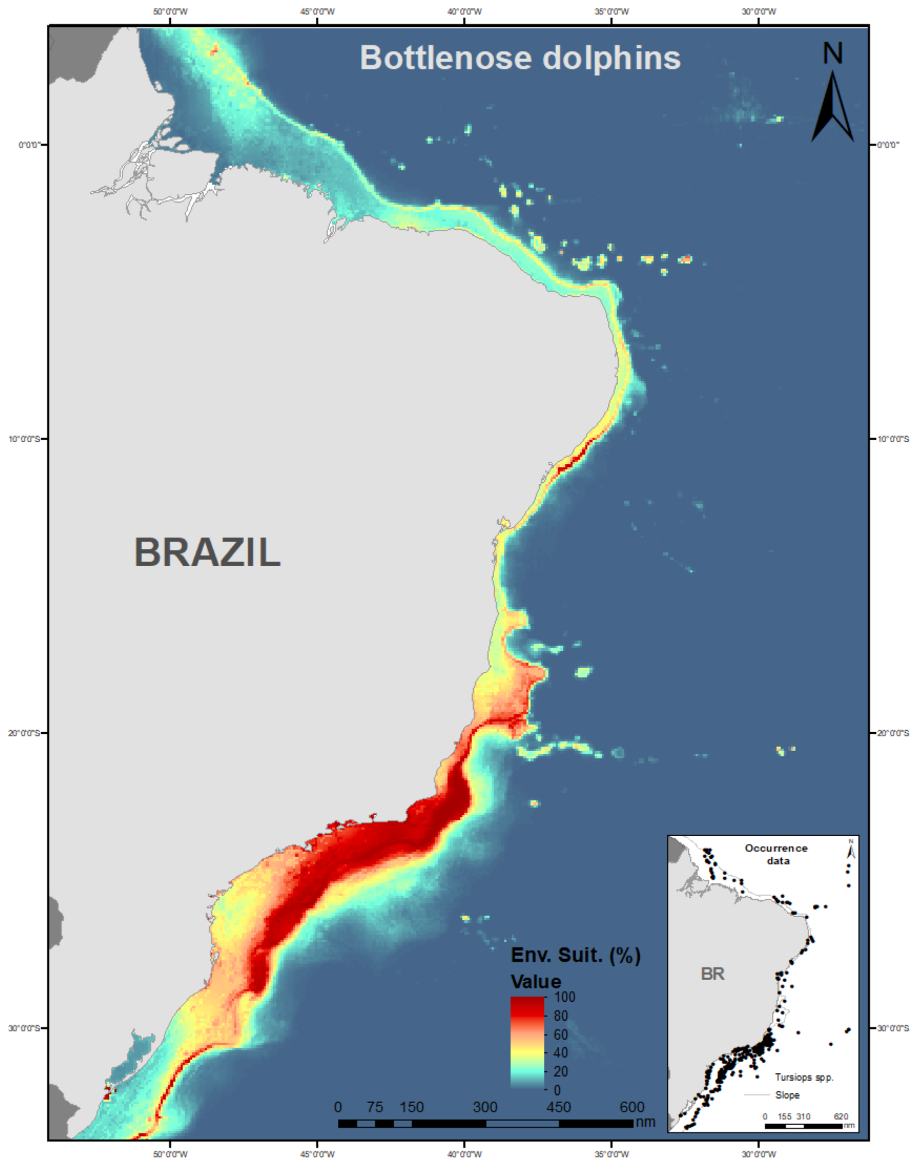
Supplementary Figure 16. Map representing the potential distribution for the spinner dolphin (*Stenella longirostris*) in the Southwestern Atlantic Ocean (SWA). The predicted potential distribution for the spinner dolphin indicates high occurrence probability in deeper waters over the continental shelf break through PTSA and northern PWTSA. The variable bathy ranging from 14m to 4,785m (mean = 997.22 m); distoshore between 2km and 412km (mean = 119.88 km); slope ranging from 1º to 158º (mean = 24.21º); Chlora_R between 0.04 and 1.77 mg/m^3 (mean = 0.47 mg/m^3); SSS_Ma between 35.223 and 37.69 psu (mean = 37.24 psu); SSS_R ranging from 0.86 to 16.73 psu (mean = 1.40 psu); and SST_R between 2.30 and 11.08ºC (mean = 5.51ºC). The environmental suitability decreases south of 30ºS. Despite the increase of sightings, the model to the spinner dolphin is similar to the generated by do Amaral et al., (2015), which suggest preferences for deep and warmer waters (<25ºC). Large groups with many individuals are recorded in the northern PWTSA (Bastida et al., 2018), mainly in spring, corroborating the preference for a more tropical habitat and seasonal movements (Di Tullio et al., 2016). Site fidelity for spinner dolphins is only known around Fernando de Noronha Island, where they are sighting all year round and is a critical area for the species in the SWA. Less frequently, spinner dolphins are also sighted around Atol das Rocas and São Pedro São Paulo archipelago (Bastida et al., 2018).



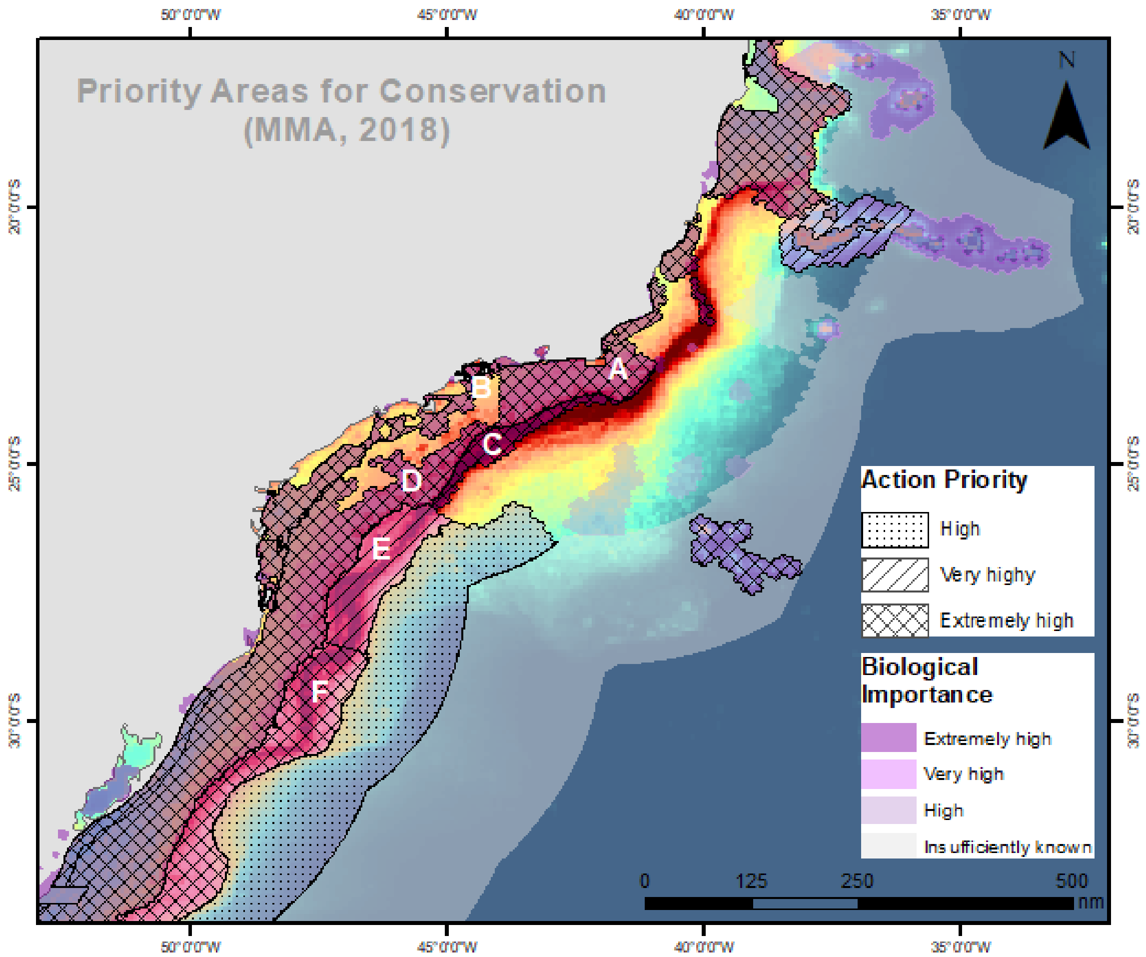
SUPPLEMENTARY FIGURE 17. MAP REPRESENTING THE POTENTIAL DISTRIBUTION FOR THE GUIANA DOLPHIN (*SOTALIA GUIANENSIS*) IN THE SOUTHWESTERN ATLANTIC OCEAN (SWA). The predicted potential distribution for the Guiana dolphin indicates high occurrence probability in warmer, shallow, and coastal waters between northern PWTSA and southern PTSA. The variable bathy ranging from 1m to 49m (mean = 12.404 m); distoshore between 1km and 34km (mean = 5.428 km); slope ranging from 0º to 13º (mean = 2.071º); Chlora_R between 0.1154 to 2.0404 mg/m^3 (mean = 0.7647 mg/m^3); SSS_Ma between 35.937 and 37.588 psu (mean = 36.720 psu); SSS_R ranging from 1.241 to 27.899 psu (mean = 3.708 psu); and SST_R between 1.939 and 11.175ºC (mean = 7.111ºC). Areas with no occurrence data (e.g., PNBS and PTSA coast) are mainly related to missing geographic coordinates in published studies, and not reflect the absence of the species. The Guiana dolphin is a strictly coastal species, endemic from Atlantic Ocean, from southern Brazil to Honduras (Azevedo et al., 2017). The Guiana dolphin occurs throughout all three marine provinces (see Discussion), including waters close to the Amazon basin until the southernmost point at 27º35'S. Further, the Guiana dolphin is the odontocete most frequently sighted shallow waters from Abrolhos Bank, and this is the population that inhabits waters with the longest distance from the coast (Rossi-Santos et al., 2006). The Abrolhos Banks are predominantly formed by coral reefs, and in this area the 200 m isobath is located up to 250 km from the shore (Floeter et al., 2001; Moreno et al., 2005).



Supplementary Figure 18. Map representing the potential distribution for the rough-toothed dolphin (*Steno bredanensis*) in the Southwestern Atlantic Ocean (SWA). The predicted potential distribution for the rough-toothed dolphin shows high occurrence probability along continental shelf from PWTSA and PTSA. The variable bathy ranging from 3m to 4,318m (mean = 666.84 m); distoshore between 1km and 486km (mean = 83.71 km); slope ranging from 0º to 47º (mean = 8.04º); Chlora_R between 0.03 to 3.45 mg/m^3 (mean = 0.90 mg/m^3); SSS_Ma between 34.90 and 37.86 psu (mean = 36.87 psu); SSS_R ranging from 0.88 to 19.66 psu (mean = 2.66 psu); and SST_R between 2.28 and 13.96ºC (mean = 7.08ºC). The rough-toothed dolphin is known to prefer deep pelagic waters in most parts of its worldwide range (Jefferson, 2018b). In Brazilian waters, however, this species are recorded mainly in coastal waters (Lodi and Hetzel, 1998; Santos et al., 2019), but also in deep waters, suggesting a wide distribution range. In fact, populations of rough-toothed dolphins in Hawaii are described to has large home ranges (Baird et al., 2008). The rough-toothed dolphin is record throughout all three marine provinces, but most frequently in PWTSA, which is also its southern distribution limit in the SWA. The rough-toothed dolphin are sighted in all seasons in the northern PWTSA, where they may present site fidelity in these high productivity coastal waters (Lodi et al., 2012; de Oliveira Santos et al., 2019). This species are also often record in shallow waters from Abrolhos Bank (about 12 km from shore), and coral reef surroundings (Rossi-Santos et al., 2006).



SUPPLEMENTARY FIGURE 19. MAP REPRESENTING THE POTENTIAL DISTRIBUTION FOR BOTTLENOSE DOLPHINS (*TURSIOPS* SPP.) IN THE SOUTHWESTERN ATLANTIC OCEAN (SWA). The predicted potential distribution for bottlenose dolphins indicates high occurrence probability in coastal waters from SBB, over the continental shelf and upper slope from PTSA and PWTSA, and around oceanic islands (Trindade and Martin-Vaz, Atol das Rocas and Fernando de Noronha). The bathy ranging from 2m to 4,896m (mean = 518.9m); distoshore between 1km and 713km (mean = 110.3 km); slope ranging from 0º to 198º (mean = 13.01º); Chlora_R between 0.020 and 3.738 mg/m^3 (mean = 0.712 mg/m^3); SSS_Ma between 34.99 and 37.91 psu (mean = 37.018 psu); SSS_R ranging from 0.828 to 24.858 psu (mean = 2.282 psu); and SST_R between 2.142 and 15.050ºC (mean = 6.485ºC). Despite the low suitability in the model, bottlenose dolphins are frequent in São Pedro São Paula archipelago. The Lahille's bottlenose dolphin (*Tursiops gephyreus*) (see Wickert et al., 2016) occur in shallow coastal and estuarine waters from PWTSA, while the common bottlenose dolphin (*Tursiops truncatus*) has a widely rage and inhabiting coastal, offshore, and oceanic island through all three marine provinces (see Discussion). Together with Guiana-dolphin, bottlenose dolphins are probably the most common dolphins on the Brazilian coast. Although they are phenotypically distinct, they may occur in sympatry in some regions and distinguishing them in the field is still not straightforward (Wickert et al., 2016; Simões-Lopes et al., 2019), reason why they were maintained here as *Tursiops* spp. and all records from the possible two species were pooled together.



Supplementary Figure 20. Priority Areas for Conservation (PAC) overlapped with S-SDM results. The letters indicate PAC zones: A - Area of coastal resurgence; B - Ilha Grande bay; C – Upper slope of the Santos basin; D - South shelf; E – North slope; F – South slope.

SUPPLEMENTARY TABLE 1. A set of 22 environmental variables (included static and dynamic variables) selected to be candidates, their respective source, unit, original resolution, and abbreviation in this study.

	Environmental variables	Source	Unit	Resolution	Codes
static	Bathymetry (Depth of the seafloor)	MARSPEC	m	1 km	bathy
	Distance to shore	MARSPEC	km	1 km	distoshore
	Bathymetric slope	MARSPEC	degrees	1 km	slope
dynamic	Chlorophyll-a concentration (Max, Min, Mean, Range)	Bio-Oracle	mg.m-3	9 km	Chlora
	Sea Surface Salinity (Max, Min, Mean, Range)	Bio-Oracle	psu	9 km	SSS
	Sea Surface Temperature (Max, Min, Mean, Range)	Bio-Oracle	ºC	9 km	SST
	Primary Productivity (Max, Min, Mean, Range)	Bio-Oracle	g.m-3.day-1	9 km	pr_prod
	Diffuse attenuation (Max, Min, Mean)	Bio-Oracle	m-1	9 km	DifAtte

SUPPLEMENTARY TABLE 2. Occurrence data from 17 species used to build individual-SDMs. Is the result data of scrutinizing and removing duplicate records on the same pixel. All data were collected from scientific publication and downloaded from public databases until November 2019. SCI = Published and unpublished scientific data; PUB = Public report and public databases for cetaceans in Brazil; SCI/PUB = Published scientific data also available in public databases[22].

https://drive.google.com/drive/folders/1c2RFuW54j1T7tLuo_cc17y0JC79KN40z

SUPPLEMENTARY TABLE 3. Ranking of MPAS according to Stack-Species Distribution Model (S-SDM). The rank is based on the maximum pixel value from S-SDM raster recorded inside the polygon representing each MPA. Abbreviations are **SO** = Source of MPA shapefile; **CAT** = Brazilian category (Brazil, 2000); **CLA** = Brazilian classes of protection (Brazil, 2000); **LOC** = State location in Brazilian territory; **ADM** = Type of administration (federal, state or private); **RAN** = "Ranking" of the maximum pixel value from S-SDM raster to each MPA polygon (greater probability of occurrence of a greater number of species); **IUCN =** equivalence of each Brazilian category with the six management categories for protected areas defined by IUCN (IUCN, 1994); **ha** = MPA area in hectares; **TP** = types of classification of this study based on influence in odontocete species (I, II or III) (see Supplementary Figure 2); **PRO** = MEOW provinces (Spalding et al., 2007).

SO	NAME	CAT	CLA	LOC	ADM	IUCN	RANK	AREA	TP	PRO
	Direct influence on odontocete									
PrPl	**Estação Ecológica De Tamoios**	ESEC	PI	BR-RJ	FED	Ia	11.50	8660.35	I	PWTSA
PrPl	Área de Proteção Ambiental Marinha Do Litoral Norte	APA	US	BR-SP	STA	V	10.82	236047.00	I	PWTSA
PrPl	Área de Proteção Ambiental Costa Das Algas	APA	US	BR-ES	FED	V	10.29	115001.92	I	PTSA
PrPl	Reserva Extrativista Marinha Arraial Do Cabo	RESEX	US	BR-RJ	FED	VI	10.06	51601.46	I	PWTSA
PrPl	Área de Proteção Ambiental Marinha Do Litoral Centro	APA	US	BR-SP	STA	V	9.90	2463.59	I	PWTSA
PrPl	**Estação Ecológica Tupinambás**	ESEC	PI	BR-SP	FED	Ia	9.52	2463.59	I	PWTSA
PrPl	Parque Estadual Da Ilha Anchieta	PARK	PI	BR-SP	STA	II	9.52	828.08	I	PWTSA
PrPl	Monumento Natural Das Ilhas Cagarras	MONA	PI	BR-RJ	FED	III	9.40	105.93	I	PWTSA
PrPl	Reserva de Desenvolvimento Sustentável Do Aventureiro	RDS	US	BR-RJ	STA	VI	9.39	1910.00	I	PWTSA
PrPl	Parque Natural Municipal Dos Corais De Armação Dos Búzios	PARK	PI	BR-RJ	STA	II	9.35	5.70	I	PWTSA
PrPl	Parque Estadual Ilha Grande	PARK	PI	BR-RJ	STA	II	9.09	12052.00	I	PWTSA
PrPl	Parque Estadual Ilhabela	PARK	PI	BR-SP	STA	II	9.08	27025.00	I	PWTSA
PrPl	Reserva Biológica Estadual da Praia do Sul	REBIO	PI	BR-RJ	STA	Ia	9.04	3600.00	I	PWTSA

[22] For a reason of dimension and file size this supplementary table was kept in a link. If you would like access it, request access directly from the link or by the e-mail: elisaberlitz@gmail.com.

PrPl	Área de Proteção Ambiental Marinha Do Litoral Sul	APA	US	BR-SP	STA	V	8.38	1091.09	I	PWTSA
PrPl	Monumento Natural Das Ilhas de Trindade e Martim Vaz e Do Monte Columbia	MONA	PI	BR-ES	FED	III	8.24	6796771.75	I	PTSA
PrPl	Área de Relevante Interesse Ecológico Ilhas Queimada Grande e Queimada Pequena	ARIE	US	BR-SP	FED	IV	8.23	65.17	I	PWTSA
PrPl	**Área de Proteção Ambiental Da Baleia Franca**	APA	US	BR-SC	FED	V	7.99	154867.40	I	PWTSA
PrPl	Estação Ecológica Dos Tupiniquins	ESEC	PI	BR-SP	FED	Ia	7.95	1727.71	I	PWTSA
PrPl	Refúgio da Vida Silvestre Das Ilhas Do Abrigo e Guararitama	REVIS	PI	BR-SP	STA	III	7.95	481.00	I	PWTSA
PrPl	Reserva Biológica Marinha Do Arvoredo	REBIO	PI	BR-SC	FED	Ia	7.85	17104.60	I	PWTSA
PrPl	**Refúgio da Vida Silvestre Do Arquipélago De Alcatrazes**	REVIS	PI	BR-RJ	FED	III	7.84	67479.29	I	PWTSA
PrPl	Área de Proteção Ambiental Plataforma Continental Do Litoral Norte	APA	US	BR-BA	STA	V	7.43	236047.00	I	PTSA
PrPl	Reserva Extrativista Marinha Pirajubaé	RESEX	US	BR-SC	FED	VI	7.25	1712.08	I	PWTSA
PrPl	Área de Proteção Ambiental De Setiba	APA	US	BR-ES	STA	V	7.17	12960.00	I	PTSA
PrPl	Área de Proteção Ambiental do Arquipélago de Trindade e Martim Vaz	APA	US	BR-ES	FED	V	7.16	40385419.59	I	PTSA
PrPl	Refúgio da Vida Silvestre De Santa Cruz	REVIS	PI	BR-ES	FED	III	7.00	17709.39	I	PTSA
PrPl	Reserva Extrativista De Canavieiras	RESEX	US	BR-BA	FED	VI	6.82	100726.36	I	PTSA
PrPl	**Parque Estadual Marinho Da Laje De Santos**	PARK	PI	BR-SP	STA	II	6.77	5000.00	I	PWTSA
PrPl	Área de Proteção Ambiental Municipal Tartarugas	APA	US	BR-ES	MUN	V	6.64	109200.00	I	PTSA
PrPl	Parque Nacional Marinho De Fernando De Noronha	PARK / Ramsar Site	PI	BR-PE	FED	II	6.26	10929.47	I	PTSA

PrPl	**Área de Proteção Ambiental De Fernando De Noronha - Rocas - São Pedro São Paulo**	APA	US	BR-PE	FED	V	6.26	154409.03	I	PTSA
PrPl	Área de Proteção Ambiental Baía de Todos os Santos	APA	US	BR-BA	STA	V	6.05	80000.00	I	PTSA
PrPl	Parque Nacional Marinho Das Ilhas Dos Currais	PARK	PI	BR-PR	FED	II	5.72	1359.70	I	PWTSA
PrPl	Refúgio De Vida Silvestre Ilha Dos Lobos	REVIS	PI	BR-RS	FED	III	5.63	142.39	I	PWTSA
PrPl	**Área de Proteção Ambiental Ponta Da Baleia / Abrolhos**	APA	US	BR-BA	STA	V	5.42	34600.00	I	PTSA
PrPl	Reserva Extrativista De Cassurubá	RESEX	US	BR-BA	FED	VI	5.35	100578.38	I	PTSA
PrPl	Reserva Biológica Atol Das Rocas	REBIO / Ramsar Site	PI	BR-PE	FED	Ia	5.32	35186.41	I	PTSA
PrPl	Área de Proteção Ambiental Costa Dos Corais	APA	US	BR-AL	FED	V	5.12	406085.93	I	PTSA
PrPl	Parque Natural Municipal do Forte de Tamandaré	PARK	PI	BR-PE	MUN	II	4.99	34700.00	I	PTSA
PrPl	Área de Proteção Ambiental Barra do Rio Mamanguape	APA	US	BR-PB	FED	V	4.81	14917.79	I	PTSA
PrPl	Área de Proteção Ambiental Caraíva/Trancoso	APA	US	BR-BA	STA	V	4.76	31900.00	I	PTSA
PrPl	Reserva Extrativista Corumbau	RESEX	US	BR-BA	FED	VI	4.70	89996.76	I	PTSA
PrPl	Reserva Extrativista Marinha Da Lagoa do Jequiá	RESEX	US	BR-AL	FED	VI	4.24	10203.79	I	PTSA
PrPl	**Parque Nacional Marinho dos Abrolhos**	PARK	PI	BR-BA	FED	II	4.17	87943.14	I	PTSA
PrPl	Refúgio da Vida Silvestre do Molhe Leste	REVIS	PI	BR-RS	MUN	III	3.71	30.00	I	PWTSA
PrPl	Área de Proteção Ambiental Da Praia De Ponta Grossa	APA	US	BR-CE	MUN	V	3.14	558.67	I	PTSA
PrPl	Parque Estadual Marinho Da Pedra Da Risca Do Meio	PARK	PI	BR-CE	STA	II	3.03	3320.00	I	PTSA
PrPl	Reserva Extrativista Prainha Do Canto Verde	RESEX	US	BR-CE	FED	VI	2.63	29804.99	I	PTSA
PrPl	Área de Proteção Ambiental do Manguezal da Barra Grande	APA	US	BR-CE	MUN	V	2.54	181100.00	I	PTSA
PrPl	Área de Proteção Ambiental Reentrâncias Maranhenses	APA / Ramsar Site	US	BR-MA	STA	V	2.11	2680910.00	I	PNBS
PrPl	**Reserva Extrativista de**	RESEX	US	BR-MA	FED	VI	1.99	186053.87	I	PNBS

	Cururupu									
PrPl	Parque Estadual Marinho d o Parcel de Manuel Luís	PARK / Ramsar Site	PI	BR-MA	STA	II	1.86	45237.00	I	PNBS
ICM Bio	Reserva Extrativista Baía do Tubarão	RESEX	US	BR-MA	FED	VI	1.75	223888.98	I	PNBS
PrPl	Monumento Natural do Ar quipélago de São Pedro e S ão Paulo	MONA	PI	BR-PE	FED	III	1.73	4726317.84	I	PTSA
PrPl	Reserva Extrativista Marin ha de Gurupi-Piriá	RESEX	US	BR-PA	FED	VI	1.68	74081.81	I	PNBS
PrPl	Área de Proteção Ambiental do Arquipélago de São Pedro e São Paulo	APA	US	BR-PE	FED	V	1.68	38450193.81	I	PTSA
PrPl	Reserva Extrativista Marinha Araí-Peroba	RESEX	US	BR-PA	FED	VI	1.49	11549.73	I	PNBS
PrPl	Reserva Extrativista Marin ha Caeté-Taperaçu	RESEX	US	BR-PA	FED	VI	1.48	42489.17	I	PNBS
ICM Bio	Reserva Extrativista de Arapiranga-Tromaí	RESEX	US	BR-PA	FED	VI	1.46	186909.14	I	PNBS
PrPl	Reserva Extrativista Marinha Tracuateua	RESEX	US	BR-PA	FED	VI	1.38	27864.08	I	PNBS
PrPl	Reserva Extrativista Maracanã	RESEX	US	BR-PA	FED	VI	1.32	30179.20	I	PNBS
PrPl	Reserva Biológica do Parazinho	REBIO	PI	BR-AP	STA	Ia	0.54	111.31	I	PNBS
PrPl	Área de Proteção Ambiental de Maricá	APA	US	BR-RJ	STA	V	10.36	500.00	II	PWTSA
PrPl	Área de Proteção Ambiental Massambaba	APA	US	BR-RJ	STA	V	10.06	7630.60	II	PWTSA
PrPl	Área de Proteção Ambiental do Pau Brasil	APA	US	BR-RJ	STA	V	9.95	9940.00	II	PWTSA
PrPl	Parque Estadual da Costa do Sol	PARK	PI	BR-RJ	STA	II	9.95	9841.90	II	PWTSA
PrPl	Área de Proteção Ambiental Paisagem Carioca	APA	US	BR-RJ	MUN	V	9.90	204.00	II	PWTSA
PrPl	Área de Proteção Ambiental da Orla Marítima	APA	US	BR-RJ	MUN	V	9.90	248.00	II	PWTSA
PrPl	Área de Proteção Ambiental das Po ntas de Copacabana, Arpoador e Seus Entornos	APA	US	BR-RJ	MUN	V	9.90	300.00	II	PWTSA
PrPl	Parque Natural Municipal da Prainha	PARK	PI	BR-RJ	MUN	II	9.63	126.30	II	PWTSA
PrPl	Área de Proteção Ambiental da Prainha	APA	US	BR-RJ	MUN	V	9.63	157.08	II	PWTSA
PrPl	Parque Natural Municipal de Grumari	PARK	PI	BR-RJ	MUN	II	9.63	805.00	II	PWTSA
PrPl	Área de Proteção Ambiental de Grumari	APA	US	BR-RJ	MUN	V	9.63	966.32	II	PWTSA

PrPl	Área de Proteção Ambiental dos Morros do Leme e do Urubu	APA	US	BR-RJ	MUN	V	9.63	127.00	II	PWTSA
ICM Bio	Área de Proteção Ambiental Cairuçu	APA	US	BR-RJ	FED	V	9.43	32610.78	II	PWTSA
PrPl	Área de Proteção Ambiental de Guapimirim	APA	US	BR-RJ	FED	V	9.37	13890.54	II	PWTSA
PrPl	Estação Ecológica da Guanabara	ESEC	PI	BR-RJ	FED	Ia	9.37	1936.25	II	PWTSA
PrPl	Área de Proteção Ambiental da Paisagem e do Areal da Praia Do Ponta l	APA	US	BR-RJ	STA	V	9.05	2400.00	II	PWTSA
PrPl	Área de Proteção Ambiental de Guaraqueçaba	APA	US	BR-PR	FED	V	9.01	282446.3 6	II	PWTSA
PrPl	Estação Ecológica de Guaraqueçaba	ESEC / Ramsar Site	PI	BR-PR	FED	Ia	8.70	4370.15	II	PWTSA
PrPl	Reserva Extrativista Mandira	RESEX	US	BR-SP	FED	VI	8.67	1177.80	II	PWTSA
PrPl	Reserva Extrativista Taquari	RESEX	US	BR-SP	STA	VI	8.67	1662.20	II	PWTSA
PrPl	Estação Ecológica Juréia-Itatins	ESEC	PI	BR-SP	STA	Ia	8.60	79.27	II	PWTSA
PrPl	Área de Relevante Interesse Ecológico de São Sebastião	APA	US	BR-SP	STA	V	8.59	608.00	II	PWTSA
PrPl	Reserva de Desenvolvimen to Sustentável da Ilha do M orro do Amaral	RDS	US	BR-SC	MUN	VI	8.58	335.77	II	PWTSA
PrPl	Reserva Biológica Estadual e Arqueológica de Guaratiba	REBIO	PI	BR-RJ	STA	Ia	8.58	3600.00	II	PWTSA
PrPl	Parque Estadual do Prelado	PARK	PI	BR-SP	STA	II	8.38	1828.22	II	PWTSA
ICM Bio	Parque Nacional do Superagui	PARK	PI	BR-PR	FED	V	8.36	33860.36	II	PWTSA
ICM Bio	Área de Relevante Interesse Ecológico Ilha do Ameixal	ARIE	US	BR-SP	FED	IV	8.32	400.00	II	PWTSA
PrPl	Reserva de Desenvolvimento Sustentável Barra do Una	RDS	US	BR-SP	STA	VI	8.32	1487.00	II	PWTSA
PrPl	Parque Estadual Xixová-Japuí	PARK	PI	BR-SP	STA	II	8.18	901.00	II	PWTSA
PrPl	Área de Relevante Interesse Ecológico do Degredo	ARIE	US	BR-ES	STA	IV	8.10	235700.0 0	II	PTSA
PrPl	Área de Proteção Ambiental de Mangaratiba	APA	US	BR-RJ	STA	V	8.02	25239.00	II	PWTSA
ICM Bio	Estação Ecológica de Carijós	ESEC	PI	BR-SC	FED	Ia	7.92	759.34	II	PWTSA
PrPl	**Área de Proteção Ambiental Anhatomirim**	APA	US	BR-SC	FED	V	7.91	4436.59	II	PWTSA
ICM Bio	**Área de Proteção Ambiental Cananéia - Iguape - Peruíbe**	APA / Ramsar Site	US	BR-SP	FED	V	7.86	202309.5 8	II	PWTSA
PrPl	Área de Proteção Ambiental da Ilha Comprida	APA	US	BR-PR	STA	V	7.86	18907.60	II	PWTSA

PrPl	Parque Estadual Ilha do Cardoso	PARK	PI	BR-PR	STA	II	7.86	13500.00	II	PWTSA
PrPl	Área de Proteção Ambiental da Orla Marítima da Baía de Sepetiba	APA	US	BR-RJ	STA	V	7.69	172.00	II	PWTSA
PrPl	Parque Nacional Restinga de Jurubatiba	PARK	PI	BR-RJ	FED	II	7.69	14922.39	II	PWTSA
PrPl	Área de Proteção Ambiental Guaratuba	APA	US	BR-PR	STA	V	7.67	199587.0 0	II	PWTSA
PrPl	Parque Estadual do Rio Vermelho	PARK	PI	BR-SC	STA	II	7.67	1532.00	II	PWTSA
PrPl	Reserva de Desenvolvimento Sustentável Itapanhapima	RDS	US	BR-SP	STA	VI	7.59	1242.70	II	PWTSA
PrPl	Parque Estadual da Serra do Tabuleiro	PARK	PI	BR-SC	STA	II	7.52	84130.00	II	PWTSA
PrPl	Estação Ecológica da Ilha do Mel	ESEC	PI	BR-PR	STA	Ia	7.45	2240.68	II	PWTSA
PrPl	Parque Natural Municipal de Jacarenema	PARK	PI	BR-ES	STA	II	7.37	307.00	II	PTSA
PrPl	Área de Proteção Ambiental Baía de Camamu	APA	US	BR-BA	STA	V	7.27	118000.0 0	II	PTSA
PrPl	Reserva Extrativista Ilha do Tumba	RESEX	US	BR-SP	STA	VI	7.27	1128.26	II	PWTSA
ICM Bio	Parque Nacional da Restinga de Jurubatiba	PARK	PI	BR-RJ	FED	II	7.24	14919.46	II	PWTSA
PrPl	Parque Estadual do Acaraí	PARK	PI	BR-SC	STA	II	7.16	6667.00	II	PWTSA
PrPl	Reserva Biológica de Comboios	REBIO	PI	BR-ES	FED	Ia	6.85	784.63	II	PTSA
PrPl	Parque Estadual da Ilha do Mel	PARK	PI	BR-PR	STA	II	6.61	337.84	II	PWTSA
PrPl	Área Preservação Ambiental do Pratigi	APA	US	BR-BA	STA	V	6.21	32000.00	II	PTSA
PrPl	Área Preservação Ambiental de Guaibim	APA	US	BR-BA	STA	V	6.13	2000.00	II	PTSA
PrPl	Parque Estadual de Itaúnas	PARK	PI	BR-ES	STA	II	6.03	353600.0 0	II	PTSA
PrPl	Área de Proteção Ambiental Costa de Itacaré/Serra Grande	APA	US	BR-BA	STA	V	5.54	62960.00	II	PTSA
PrPl	Área de Proteção Ambiental Lagoas de Guarajuba	APA	US	BR-BA	STA	V	5.45	230.00	II	PTSA
PrPl	Área Preservação Ambiental Coroa Vermelha	APA	US	BR-BA	STA	V	5.44	4100.00	II	PTSA
PrPl	Reserva Extrativista Acaú-Goiana	RESEX	US	BR-PB	FED	VI	5.09	6676.69	II	PTSA
PrPl	Área de Proteção Ambiental de Guadalupe	APA	US	BR-PB	STA	V	4.99	44799.00	II	PTSA
PrPl	Área Preservação Ambiental do Estuário do Rio Mundaú	APA	US	BR-CE	STA	V	4.87	1596.36	II	PTSA
PrPl	Área de Proteção Ambiental de Santa Cruz	APA	US	BR-PB	STA	V	4.82	38962.00	II	PTSA

ICM Bio	Refúgio de Vida Silvestre do Rio dos Frades	REVIS	PI	BR-BA	FED	III	4.76	898.67	II	PTSA
PrPl	Reserva Biológica de Santa Isabel	REBIO	PI	BR-SE	FED	Ia	4.59	4109.88	II	PTSA
PrPl	Área de Proteção Ambiental Delta do Parnaí ba	APA	US	BR-CE	FED	V	4.57	309593.7 7	II	PTSA
PrPl	Área de Proteção Ambiental Santo Antônio	APA	US	BR-BA	STA	V	4.50	23000.00	II	PTSA
PrPl	Área de Relevante Interesse Ecológico Manguezais da Foz do Rio Mamanguape	ARIE	US	BR-PB	STA	IV	4.41	5721.00	II	PTSA
PrPl	Área de Relevante Interesse Ecológico Barra do Rio Camaratuba	ARIE	US	BR-PB	STA	IV	4.36	160.00	II	PTSA
PrPl	Área de Proteção Ambiental Bonfim/Guaraíra	APA	US	BR-RN	STA	V	4.20	42.00	II	PTSA
ICM Bio	Parque Nacional da Lagoa do Peixe	PARK / Ramsar Site	PI	BR-RS	FED	II	4.13	36721.71	II	PWTSA
PrPl	Reserva de Desenvolvimento Sustentá vel Estadual Ponta do Tubarão	RDS	US	BR-RN	STA	VI	4.09	9723.78	II	PTSA
PrPl	Área de Proteção Ambiental Jenipabu	APA	US	BR-RN	STA	V	4.07	1881.00	II	PTSA
PrPl	Área de Proteção Ambiental das Dunas da Lagoinha	APA	US	BR-CE	STA	V	4.03	523.48	II	PTSA
PrPl	Área de Proteção Ambiental de Santa Rita	APA	US	BR-AL	STA	V	4.01	8800.00	II	PTSA
PrPl	Área de Proteção Ambiental do Lagamar do Cauípe	APA	US	BR-CE	STA	V	3.85	1884.45	II	PTSA
PrPl	Área de Proteção Ambiental de Piaçabuçu	APA	US	BR-AL	FED	V	3.64	9107.01	II	PTSA
PrPl	Parque Natural Municipal das Dunas da Sabiaguaba	PARK	PI	BR-CE	MUN	II	3.49	460.70	II	PTSA
PrPl	Monumento Natural das Fa lésias de Beberibe	MONA	PI	BR-CE	STA	III	3.09	31.00	II	PTSA
PrPl	Área de Proteção Ambiental da Lagoa do Uruaú	APA	US	BR-CE	STA	V	3.01	2672.58	II	PTSA
PrPl	Parque Nacional De Jerico acoara	PARK	PI	BR-CE	FED	II	2.99	8863.03	II	PTSA
PrPl	Área Preservação Ambiental do Rio Pacoti	APA	US	BR-CE	STA	V	2.92	2914.92	II	PTSA
PrPl	Área de Proteção Ambiental Da Foz do Rio Das Preguiças - Pequenos Lençóis - Região Lagunar Adjacente	APA	US	BR-MA	STA	V	2.90	269684.0 0	II	PNBS
ICM Bio	Reserva Extrativista Chocoaré - Mato Grosso	RESEX	US	BR-CE	FED	VI	2.79	2783.16	II	PTSA
ICM Bio	Reserva Extrativista do Batoque	RESEX	US	BR-CE	FED	VI	2.79	601.44	II	PTSA

ICM Bio	Reserva Extrativista Marinha do delta do Parnaíba	RESEX	US	BR-MA	FED	VI	2.70	27022.07	II	PNBS
ICM Bio	Parque Nacional Lençóis Maranhenses	PARK	PI	BR-MA	FED	II	1.82	156608.16	II	PNBS
ICM Bio	Reserva Extrativista Itapetininga	RESEX	US	BR-MA	FED	VI	1.62	16294.64	II	PNBS
PrPl	Reserva Extrativista Mãe Grande De Curuça	RESEX	US	BR-PA	FED	VI	1.48	36678.24	II	PNBS
PrPl	Reserva Extrativista Marinha Cuinarana	RESEX	US	BR-PA	FED	VI	1.45	11036.41	II	PNBS
PrPl	Reserva Extrativista Marinha Mestre Lucindo	RESEX	US	BR-PA	FED	VI	1.43	26465.00	II	PNBS
PrPl	Reserva Extrativista Marinha De Soure	RESEX	US	BR-PA	FED	VI	1.29	26464.88	II	PNBS
PrPl	Área de Proteção Ambiental Algodoal-Maiandeua	APA	US	BR-PA	STA	V	1.10	2378.00	II	PNBS
PrPl	Reserva Extrativista Marinha Mocapajuba	RESEX	US	BR-PA	FED	VI	1.06	21027.80	II	PNBS
PrPl	Área de Proteção Ambiental Arquipélago do Marajó	APA	US	BR-PA	STA	V	0.69	5998570.00	II	PNBS
PrPl	Parque Nacional do Cabo Orange	PARK	PI	BR-AP	FED	II	0.63	657318.06	II	PNBS
PrPl	Reserva Biológica do Lago de Piratuba	REBIO	PI	BR-AP	STA	Ia	0.56	357000.00	II	PNBS
ICM Bio	Estação Ecológica de Maracá-Jipioca	ESEC	PI	BR-AM	FED	Ia	0.53	58756.95	II	PTSA
PrPl	Área de Proteção Ambiental Conceição da Barra	APA	US	BR-ES	STA	V	0.00	7728.00	II	PTSA
PrPl	Reserva Extrativista Marinha da Baía do Iguape	RESEX	US	BR-BA	FED	VI	0.00	10074.00	II	PTSA
PrPl	Área de Proteção Ambiental Morro do Silvério	APA	US	BR-RJ	STA	V	0.00	150.12	II	PWTSA
	Indirect influence on odontocetes									
PrPl	Parque Estadual do Itinguçu	PARK	PI	BR-SP	STA	II	8.72	5040.00	III	PWTSA
PrPl	Parque Natural Municipal da Galheta	PARK	PI	BR-SC	MUN	II	8.10	149.30	III	PWTSA
PrPl	Área de Proteção Ambiental da Lagoa Grande	APA	US	BR-ES	MUN	V	7.99	261200.00	III	PTSA
ICM Bio	Reserva Particular Patrimônio Natural Araçari	RPPN	US	BR-BA	PRI	IV	5.54	110.00	III	PTSA
PrPl	Parque Estadual de Itapeva	PARK	PI	BR-RS	STA	II	5.63	1000.00	III	PWTSA
ICM Bio	Reserva Particular Patrimônio Natural Fazenda Avaí	RPPN	US	BR-BA	PRI	IV	4.62	469.10	III	PTSA
PrPl	Reserva do Particular do Patrimônio Natural Mata Estrela	RPPN	US	BR-RN	PRI	IV	4.13	2039.93	III	PTSA

PrPl	Área Preservação Ambiental do Pecém	APA	US	BR-CE	STA	V	3.41	122.79	III	PTSA
PrPl	Parque Estadual Serra da Tiririca	PARK	PI	BR-RJ	STA	II	10.24	3493.00	III	PWTSA
PrPl	Parque Estadual Restinga de Bertioga	PARK	PI	BR-SP	STA	II	9.69	9317.69	III	PWTSA
PrPl	Parque Estadual Serra do Mar	PARK	PI	BR-SP	STA	II	9.51	332000.00	III	PWTSA
PrPl	Parque Nacional da Serra da Bocaina	PARK	PI	BR-RJ	FED	II	9.23	100000.00	III	PWTSA
PrPl	Área de Relevante Interesse Ecológico Do Guará	ARIE	US	BR-SP	STA	IV	8.03	455.00	III	PWTSA
PrPl	Área de Proteção Ambiental de Praia Mole	APA	US	BR-ES	STA	V	7.96	400.00	III	PTSA
PrPl	Parque Nacional de Saint-Hilaire/Lange	PARK	PI	BR-PR	FED	II	7.67	25119.00	III	PWTSA
PrPl	Parque Estadual Lagoa do Açu	PARK	PI	BR-RJ	STA	II	6.48	8276.67	III	PWTSA
PrPl	Área de Proteção Ambiental das Lagoas e Dunas do Abaeté	APA	US	BR-BA	STA	V	6.27	1800.00	III	PTSA
PrPl	Área de Proteção Ambiental Caminhos Ecológicos da Boa Esperança	APA	US	BR-BA	STA	V	6.14	230296.00	III	PTSA
PrPl	Área Preservação Ambiental do Rio Capivara	APA	US	BR-BA	STA	V	5.80	1800.00	III	PTSA
ICM Bio	Reserva Particular Patrimônio Natural das Dunas de Santo Antônio	RPPN	US	BR-BA	PRI	IV	5.61	370.72	III	PTSA
PrPl	Reserva Particular do Patrimônio Natural Dunas de Santo Antônio	RPPN	US	BR-BA	PRI	VI	5.60	370.72	III	PTSA
PrPl	Refúgio de Vida Silvestre de Uma	REVIS	PI	BR-BA	FED	III	5.49	23404.00	III	PTSA
PrPl	Área de Proteção Ambiental do Estuário do Rio Mundaú	APA	US	BR-CE	STA	V	4.87	1596.36	III	PTSA
PrPl	Área de Proteção Ambiental da Lagoa Encantada	APA	US	BR-BA	STA	V	4.40	11800.00	III	PTSA
PrPl	Área de Relevante Interesse Ecológico da Barra do Rio Camaratuba	ARIE	US	BR-PB	STA	IV	4.36	16800.00	III	PTSA
PrPl	Parque Nacional do Monte Pascoal	PARK	PI	BR-RJ	FED	II	4.31	22.50	III	PWTSA
PrPl	Área de Proteção Ambiental do Rio Pacoti	APA	US	BR-CE	STA	V	2.92	2914.92	III	PTSA
ICM Bio	Reserva Particular do Patrimônio Natural Ilha do Caju	RPPN	US	BR-MA	PRI	VI	2.81	102.00	III	PNBS
ICM Bio	Reserva Particular do Patrimônio Natural Sítio Jaquarema	RPPN	US	BR-MA	PRI	VI	1.77	7.68	III	PNBS
PrPl	Área de Proteção Ambiental da Ilha do Combu	APA	US	BR-PA	STA	V	0.00	1597.00	III	PNBS
ICM Bio	Estação Ecológica do Taim	ESEC / Ramsar Site	PI	BR-RS	FED	Ia	0.00	32806.31	III	PWTSA

PrPl	Área de Proteção Ambiental da Região de Maracanã	APA	US	BR-MA	STA	V	0.00	1831.00	III	PNBS
PrPl	Reserva Extrativista de São João da Ponta	RESEX	US	BR-PA	STA	VI	0.00	3203.00	III	PNBS
PrPl	Área de Proteção Ambiental Bacia do Cobre/São Bartolomeu	APA	US	BR-BA	STA	V	0.00	2260.00	III	PTSA
PrPl	Parque Estadual do Bacanga	PARK	PI	BR-MA	STA	II	0.00	2634.00	III	PNBS
PrPl	Reserva Extrativista Quilombo do Frechal	RESEX	US	BR-MA	STA	VI	0.00	2634.00	III	PNBS
PrPl	Área Preservação Ambiental da Lagoa do Jijoca	APA	US	BR-CE	STA	V	0.00	3995.61	III	PTSA
PrPl	Reserva Biológica de Una	REBIO	PI	BR-BA	FED	Ia	0.00	18500.00	III	PTSA
ICM Bio	Reserva Particular Patrimônio Natural Carroula	RPPN	US	BR-BA	PRI	IV	0.00	14.73	III	PTSA
ICM Bio	Reserva Particular Patrimônio Natural das Dunas	RPPN	US	BR-BA	PRI	IV	0.00	78.00	III	PTSA
ICM Bio	Reserva Particular Patrimônio Natural Mercês Sabiaquaba e Nazário	RPPN	US	BR-CE	PRI	IV	0.00	50.00	III	PTSA
ICM Bio	Reserva Particular Patrimônio Natural Sítio Ameixas - Poço Velho	RPPN	US	BR-CE	PRI	IV	0.00	464.33	III	PTSA
PrPl	Parque Natural Municipal de Marapendi	PARK	PI	BR-RJ	STA	II	0.00	247.00	III	PWTSA
ICM Bio	Reserva Particular Patrimônio Natural Gleba O Saquinho de Itapirapuá	RPPN	US	BR-RJ	PRI	IV	0.00	3.97	III	PWTSA
ICM Bio	Reserva Particular Patrimônio Natural Morro do Curussu Mirim	RPPN	US	BR-RJ	PRI	IV	-	22.80	III	PWTSA

SO: PrPl = Protected Planet; ICMBio = Chico Mendes Institute for Biodiversity Conservation;
CAT: ESEC = Ecological Stations; REBIO = Biological Reserves; PARK = National, State or Municipal Parks; MONA = Natural Monuments; REVIS = Wildlife Refuges; APA = Environmental Protection; ARIE = Areas of Relevant Ecological Interest; RESEX = Extractive Reserves; RDS = Sustainable Development Reserves; RPPN = PRIte Natural Heritage Reserve; PI = Integral Protection Protected Areas; US = Sustainable Use Protected Areas;
CLA: PI = Full protection (no-take MPAs); US = sustainable use (multiple-use MPAs)
LOC: RJ = Rio de Janeiro; SP = São Paulo; ES = Espirito Santo; SC = Santa Catarina; RS = Rio Grande do Sul; BA = Bahia; PE = Pernambuco; PB = Paraíba; PR = Paraá; AL = Alagoas; CE = Ceará; MA = Maranhão; PA = Pará; RN = Rio Grande do Norte
PRO: PNBS = North Brazilian Shelf Province; PTSA = Tropical Southern Atlantic Ocean Province; PWTSA = Warm-Temperate Southern Atlantic Ocean Province

References

Alves-Júnior, T. T., Ávila, F. J., de Oliveira, J. A., Furtado-Neto, M. A., and Monteiro-Neto, C. (1996). Registros de cetáceos para o litoral do estado do Ceará, Brasil. *Arq. Ciên. Mar* 30, 79–92. doi:10.32360/acmar.v30i1-2.31398.

Andrade, A. L., Pinedo, M. C., and Barreto, A. S. (2001). Gastrointestinal parasites and prey items from a mass stranding of false killer whales, *Pseudorca crassidens*, in Rio Grande do Sul, Southern Brazil. *Braz. J. Biol*. 61, 55–61. doi:10.1590/s0034-71082001000100008.

Andriolo, A., da Rocha, J. M., Zerbini, A. N., Simões-Lopes, P. C., Moreno, I. B., Lucena, A., et al. (2010). Distribution and relative abundance of large whales in a former whaling ground off eastern South America. *Zoologia* 27, 741–750. doi:10.1590/S1984-46702010000500011.

Archer, F. I. (2018). Striped Dolphin. Encycl. in *Encyclopedia of Marine Mammals*, eds. B. Würsig, J. G. M. Thewissen, and K. M. Kovacs (Academic Press), 954–956. doi:10.1016/b978-0-12-804327-1.00251-x.

Asano-filho, M., José, F., and Alberto, F. C. (2007). Composição da fauna nas pescarias realizadas com espinhel pelágico na costa norte do Brasil durante a execução do Projeto Protuna. 40, 58–64. doi:10.32360/acmar.v40i1.6145.

Azevedo, A. de F., Carvalho, R. R., Kajin, M., Van Sluys, M., Bisi, T. L., Chunha, H. A., et al. (2017). The first confirmed decline of a delphinid population from Brazilian waters: 2000 – 2015 abundance of *Sotalia guianensis* in Guanabara Bay, South-eastern *Brazil. Ecol. Indic*. 79, 1–10. doi:10.1016/j.ecolind.2017.03.045.

Baird, R. W. (2018a). False Killer Whale. *Encyclopedia of Marine Mammals*, eds. B. Würsig, J. G. M. Thewissen, and K. M. Kovacs (Academic Press), 347-349, doi:10.1016/b978-0-12-804327-1.00006-6.

Baird, R. W. (2018b). Pygmy Killer Whale. *Encyclopedia of Marine Mammals*, eds. B. Würsig, J. G. M. Thewissen, and K. M. Kovacs (Academic Press), 788-790, doi:10.1016/b978-0-12-804327-1.00210-7.

Baird, R. W., Webster, D. L., Mahaffy, S. D., McSweeney, D. J., Schorr, G. S., and Ligon, A. D. (2008). Site fidelity and association patterns in a deep-water dolphin: Rough-toothed dolphins (*Steno bredanensis*) in the Hawaiian Archipelago. *Mar. Mammal Sci.* 24, 535–553. doi:10.1111/j.1748-7692.2008.00201.x.

Ballance, L. T., Pitman, R. L., and Fiedler, P. C. (2006). Oceanographic influences on seabirds and cetaceans of the eastern tropical Pacific: A review. *Prog. Oceanogr.* 69, 360–390. doi:10.1016/j.pocean.2006.03.013.

Batista, R. L. G., Schiavetti, A., Santos, U. A. dos, and Reis, M. do S. S. dos (2012). Cetaceans registered on the coast of Ilhéus (Bahia), northeastern Brazil. *Biota Neotrop.* 12, 31–38. doi:10.1590/s1676-06032012000100003.

Bastida, R., Rodríguez, D., Secchi, E., da Silva, V. (2018). Mamíferos aquáticos da América do Sul e da Antártica. 1rst Edn, Vazquez Mazzini Editores, 368p.

Baracho, C., Cipolotti, S., Marcovaldi, E., Rossi-Santos, M. et al. (2005). Viabilidade de estudos de foto e video-identificação de cetáceos oceânicos na Rebio Atol das Rocas. *Workshop "Ilhas Oceânicas Brasileiras – da pesquisa ao manejo"*, Museu Nacional, UFRJ.

Brazil. 2000. Lei Nº 9.985/00 que institui o Sistema Nacional de Unidade de Conservação da Natureza. http://www.planalto.gov.br/ccivil_03/leis/l9985.htm.

Botta, S., Hohn, A. A., MacKo, S. A., and Secchi, E. R. (2012). Isotopic variation in delphinids from the subtropical western South Atlantic. *J. Mar. Biol. Assoc. United Kingdom* 92, 1689–1698. doi:10.1017/S0025315411000610.

Bracho, C., Cipolotti, S., Marcovaldi, E., Rossi-Santos, M., Silva, M.B., Apolinário, M. (2005). Viabilidade de estudos de foto e vídeo-identificação de cetáceos oceânicos na Rebio Atol das Rocas. Workshop "Ilhas Oceânica Brasileiras da Pesquisa ao Manejo", Museu Nacional, Universidade Federal do Rio de Janeiro.

Carvalho, V. L., Bevilaqua, C. M. L., Iñiguez, A. M., Mathews-Cascon, H., Ribeiro, F. B., Pessoa, L. M. B., et al. (2010). Metazoan parasites of cetaceans off the northeastern coast of Brazil. *Vet. Parasitol.* 173, 116–122. doi:10.1016/j.vetpar.2010.06.023.

Chen, I., Watson, A., and Chou, L. S. (2011). Insights from life history traits of Risso's dolphins (*Grampus griseus*) in Taiwanese waters: Shorter body length characterizes northwest Pacific population. *Mar. Mammal Sci.* 27, E43–E64. doi:10.1111/j.1748-7692.2010.00429.x.

Costa, A. F., Siciliano, S., Emin-Lima, R., Martins, B. M. L., Sousa, M. E. M., Giarrizzo, T., et al. (2017). Stranding survey as a framework to investigate rare cetacean records of the north and north-eastern Brazilian coasts. *Zookeys* 2017, 111–134. doi:10.3897/zookeys.688.12636.

Cunha, H. A., De Castro, R. L., Secchi, E. R., Crespo, E. A., Lailson-Brito, J., Azevedo, A. F., et al. (2015). Molecular and morphological differentiation of common dolphins (*Delphinus* sp.) in the Southwestern Atlantic: Testing the two species hypothesis in sympatry. *PLoS One* 10. doi:10.1371/journal.pone.0140251.

Di Tullio, J. C., Gandra, T. B. R., Zerbini, A. N., and Secchi, E. R. (2016). Diversity and distribution patterns of cetaceans in the subtropical Southwestern Atlantic outer continental shelf and slope. *PLoS One* 11, 1–24. doi:10.1371/journal.pone.0155841.

do Amaral, K. B., Alvares, D. J., Heinzelmann, L., Borges-Martins, M., Siciliano, S., and Moreno, I. B. (2015). Ecological niche modeling of *Stenella* dolphins (Cetartiodactyla: Delphinidae) in the southwestern Atlantic Ocean. *J. Exp. Mar. Bio. Ecol.* 472, 166–179. doi:10.1016/j.jembe.2015.07.013.

Dos Santos, R. A., and Haimovici, M. (2002). Cephalopods in the trophic relations off southern Brazil. Bull. *Mar. Sci.* 71, 753–770.

Fertl, D., Jefferson, T. A., Moreno, I. B., Zerbini, A. N., and Mullin, K. D. (2003). Distribution of the Clymene dolphin *Stenella clymene*. *Mamm. Rev.* 33, 253–271. doi:10.1046/j.1365-2907.2003.00033.x.

Floeter, S. R., Guimarães, R. Z. P., Rocha, L. A., Ferreira, C. E. L., Rangel, C. A., and Gasparini, J. L. (2001). Geographic variation in reef-fish assemblages along the Brazilian coast. *Glob. Ecol. Biogeogr.* 10, 423–431. doi:10.1046/j.1466-822X.2001.00245.x.

Ford, J. K. B. (2018). Killer Whale. *Encyclopedia of Marine Mammals*, eds. B. Würsig, J. G. M. Thewissen, and K. M. Kovacs (Academic Press), 531–537. doi:10.1016/b978-0-12-804327-1.00010-8.

Gaspari, S., Airoldi, S., and Hoelzel, A. R. (2007). Risso's dolphins (*Grampus griseus*) in UK waters are differentiated from a population in the Mediterranean Sea and genetically less diverse. *Conserv. Genet.* 8, 727–732. doi:10.1007/s10592-006-9205-y.

Hartman, K. L. (2018). Risso's Dolphin. *Encyclopedia of Marine Mammals*, eds. B. Würsig, J. G. M. Thewissen, and K. M. Kovacs (Academic Press), 824-827, doi:10.1016/b978-0-12-804327-1.00219-3.

IUCN (1994). Red List Categories and Criteria. Gland, IUCN.

Jefferson, T. A. (2018a). Clymene Dolphin. *Encyclopedia of Marine Mammals*, eds. B. Würsig, J. G. M. Thewissen, and K. M. Kovacs (Academic Press), 197–200. doi:10.1016/b978-0-12-804327-1.00093-5.

Jefferson, T. A. (2018b). Rough-Toothed Dolphin. *Encyclopedia of Marine Mammals*, eds. B. Würsig, J. G. M. Thewissen, and K. M. Kovacs (Academic Press), 838–840. doi:10.1016/b978-0-12-804327-1.00223-5.

Jefferson, T. A., Fertl, D., Bolaños-Jiménez, J., and Zerbini, A. N. (2009). Distribution of common dolphins (*Delphinus* spp.) in the western atlantic ocean: A critical re-examination. *Mar. Biol.* 156, 1109–1124. doi:10.1007/s00227-009-1152-y.

LeDuc, R. G., Robertson, K. M., and Pitman, R. L. (2008). Mitochondrial sequence divergence among Antarctic killer whale ecotypes is consistent with multiple species. *Biol. Lett.* 4, 426–429. doi:10.1098/rsbl.2008.0168.

Lemos, L. S., de Moura, J. F., Hauser-Davis, R. A., de 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. *Ecotoxicol. Environ. Saf.* 97, 166–175. doi:10.1016/j.ecoenv.2013.07.025.

Lodi, L. and Borobia, M. (2013). Botos, baleias e golfinhos do Brasil: Guia de Identificação. 1rst Edn, Technical Books, 479p.

Lodi, L., and Hetzel, B. (1998). O golfinho-de-dentes-rugosos (*Steno Bredanensis*) no Brasil. *Bioikos* 12, 29–45.

Lodi, L., Oliveira, R. H. T., Figueiredo, L. D., and Simão, S. M. (2012). Movements of the rough-toothed dolphin (*Steno bredanensis*) in Rio de Janeiro State, south-eastern Brazil. *Marin. Biod. Recor.* 5, 8–11. doi:10.1017/S1755267212000322.

Lodi, L., Siciliano, S., and Capistrano, L. (1990). Mass stranding of *Peponocephala electra* (Cetacea, Globicephalinae) on Piracanga Beach, Bahia, Northern Brazil. *Sci. Reports Cetacean Res.* 1, 79–84.

Magalhães, F. A. de, Garri, R. G., Tosi, C. H., Siciliano, S., Chellappa, S., and Silva, F. J. de L. (2007). First confirmed record of *Feresa attenuata* (Delphinidae) for the Northern Brazilian Coast. *Biota Neotrop.* 7, 313–315. doi:10.1590/s1676-06032007000200036.

Meirelles, A. C. O., Monteiro-Neto, C., Martins, A. M. A., Costa, A. F., Barros, H. M. D. R., and Alves, M. D. O. (2009). Cetacean strandings on the coast of Ceará, North-eastern Brazil. *J. Mar. Biol. Assoc. United Kingdom* 89, 1083–1090. doi:10.1017/S0025315409002215.

Moreno, I. B., Zerbini, A. N., Danilewicz, D., De Oliveira Santos, M. C., Simões-Lopes, P. C., Lailson-Brito, J., et al. (2005). Distribution and habitat characteristics of dolphins of the genus *Stenella* (Cetacea: Delphinidae) in the southwest Atlantic Ocean. *Mar. Ecol. Prog. Ser.* 300, 229–240. doi:10.3354/meps300229.

Morin, P. A., Archer, F. I., Foote, A. D., Vilstrup, J., Allen, E. E., Wade, P., et al. (2010). Complete mitochondrial genome phylogeographic analysis of killer whales (*Orcinus orca*) indicates multiple species. *Genome Res.* 20, 908–916. doi:10.1101/gr.102954.109.

Olson, P. A. (2018). Pilot Whales. *Encyclopedia of Marine Mammals*, eds. B. Würsig, J. G. M. Thewissen, and K. M. Kovacs (Academic Press), 701–705. doi:10.1016/b978-0-12-804327-1.00194-1.

Paro, A. D., Rojas, E., and Wedekin, L. L. (2014). Southernmost record of the Atlantic spotted dolphin, *Stenella frontalis* in the south-west Atlantic Ocean. *Mar. Biodivers. Rec.* 7, 2–4. doi:10.1017/S1755267214000517.

Perrin, W. F. (2018). Pantropical Spotted Dolphin. *Encyclopedia of Marine Mammals*, eds. B. Würsig, J. G. M. Thewissen, and K. M. Kovacs (Academic Press), 676–678. doi:10.1016/b978-0-12-804327-1.00189-8.

Perryman, W. L., and Danil, K. (2018). Melon-Headed Whale. *Encyclopedia of Marine Mammals*, eds. B. Würsig, J. G. M. Thewissen, and K. M. Kovacs (Academic Press), 593–595. doi:10.1016/b978-0-12-804327-1.00171-0.

Petry, M. V., and Fonseca, V. S. (2001). Mamíferos Marinhos Encontrados Mortos no Litoral do Rio Grande do Sul de 1997 a 1998. *Acta Biol. Leopoldensia* 23, 225–235.

Pinedo, M. C., Polacheck, T., Barreto, A. S., and Lammardo, M. P. (2002). A note on vessel of opportunity sighting surveys for cetaceans in the shelf edge region off the southern coast of Brazil. *J. Cetacean Res. Manag.* 4, 323–329.

Ramos, R. M. A., Siciliano, S., Borobia, M., Zerbini, A. Z., Pizzorno, J. L. A., Fragoso, A. B. L., et al. (2001). A note on strandings and age of sperm whales (*Physeter macrocephalus*) on the Brazilian coast. *J. Cetacean Res. Manag.* 3, 321–327.

Ramos, R. M. A., Siciliano, S., Ribeiro, R. (2010). Monitoramento da Biota Marinha em Navios de Sísmica: seis anos de pesquisa (2001-2007). Everest Tecnologia em Serviços.

Rice DW (1998) Marine mammals of the world: systematics and distribution. Special Publication Number 4. Society for Marine Mammalogy, Lawrence, KS

Rocha-Campos, C., Marini-Filho, O.J., Engel, M. (2007). Brazil Progress report on cetacean research, March 2006 to February 2007, with statistical data for the calendar year 2006 or season 2006/2007.

Rosas, F. C. W., Monteiro-Filho, E. L. A., Marigo, J., Santos, R. A., Andrade, A. L. V., Rautenberg, M., et al. (2002). The striped dolphin, *Stenella coeruleoalba* (Cetacea: Delphinidae), on the coast of São Paulo State, Southern Brazil. *Aquat. Mamm*. 28, 60–66.

Rossi-Santos, M., Wedekin, L. L., and Sousa-Lima, R. S. (2006). Distribution and habitat use of small cetaceans off Abrolhos Bank, eastern Brazil. *Lat. Am. J. Aquat. Mamm.* 5, 23–28. doi:10.5597/lajam00088.

Santos, M. C. de O., Laílson-Brito, J., Flach, L., Oshima, J. E. F., Figueiredo, G. C., Carvalho, R. R., et al. (2019). Cetacean movements in coastal waters of the southwestern Atlantic Ocean. *Biota*

Santos, M. C. de O., Siciliano, S., de Castro Vicente, A. F., Alvarenga, F. S., Zampirolli, É., de Souza, S. P., et al. (2010). Cetacean records along São Paulo State Coast, Southeastern Brazil. *Brazilian J. Oceanogr*. 58, 123–142. doi:10.1590/s1679-87592010000200004.

Santos, M. C. de O., Siciliano, S., Vicente, A. F., Alvarenga, F. S., Zampirolli, É., de Souza, S. P., et al. (2010). Cetacean Records Along São Paulo State Coast,. *Brazilian J. Oceanogr.* 58, 123–142.

Siciliano, S., Emin-lima, N. R., Costa, A. F., Magalhães, F. A., Tosi, C. H., Garri, R. G., et al. (2008). Revisão do Conhecimento sobre os Mamíferos Aquáticos da Costa Norte do Brasil. *Arq. do Mus. Nac.* 66, 381–401.

Simões-Lopes, P. C., Daura-Jorge, F. G., Lodi, L., Bezamat, C., Costa, A. P. B., and Wedekin, L. L. (2019). Bottlenose dolphin ecotypes of the western South Atlantic: The puzzle of habitats, coloration patterns and dorsal fin shapes. *Aquat. Biol.* 28, 101–111. doi:10.3354/ab00712.

Spalding, M. D., Fox, H. E., Allen, G. R., Davidson, N., Ferdaña, Z. A., Finlayson, M., et al. (2007). Marine Ecoregions of the World: A Bioregionalization of Coastal and Shelf Areas. *Bioscience* 57, 573–583. doi:10.1641/b570707.

Tavares, M., Moreno, I. B., Siciliano, S., Rodrguez, D., Marcos, M. C., Lailson-Brito, J., et al. (2010). Biogeography of common dolphins (genus *Delphinus*) in the southwestern Atlantic Ocean. *Mamm. Rev.* 40, 40–64. doi:10.1111/j.1365-2907.2009.00154.x.

Toledo, G. A. D. C., Gurgel Filho, N. M., Brito, J. L. D. S., and Langguth, A. (2015). Stranding of a Risso's dolphin (Cetacea, Delphinidae) on the north-eastern coast of Brazil, with comments on its distribution and threats in the Western South Atlantic. *Mar. Biodivers. Rec.* 8, 1–7. doi:10.1017/S1755267215000408.

Toledo, G., and Langguth, A. (2009). Data on biology and exploitation of west atlantic sperm whales, *Physeter macrocephalus* (Cetacea: Physeteridae) off the coast of paraíba, *Brazil. Zoologia* 26, 663–673. doi:10.1590/S1984-46702009000400011.

Zerbini, A. N., and de Oliveira Santos, M. C. (1997). First Record of the Pygmy Killer Whale *Feresa attenuata* (Gray, 1874) for the Brazilian coast. *Aquat. Mamm*. 23, 105–109.

Wickert, J. C., Von Eye, S. M., Oliveira, L. R., and Moreno, I. B. (2016). Revalidation of tursiops gephyreus lahille, 1908 (Cetartiodactyla: Delphinidae) from the southwestern Atlantic Ocean. J. Mammal. 97, 1728–1737. doi:10.1093/jmammal/gyw139.

CONCLUSÕES GERAIS

- Esta dissertação apresenta modelos de distribuição potencial para 17 espécies de odontocetos, aplicados em um contexto multi-espécie (S-SDM) para a identificação de áreas ecologicamente importantes. Tanto a área costeira (*nearshore hotspot area*) como a oceânica (*offshore hotspot area*) podem ser entendidas como habitat críticos para várias espécies de odontocetos, devido a frequência com que as espécies ocorrem e a alta produtividade primária associada a características oceanográficas bem definidas e que influenciam a agregação de suas presas.
- A topografia batimétrica foi um dos fatores que mais influenciou na distribuição das espécies de odontocetos incluídas. Quando combinada com características hidrográficas, como ressurgências, correntes marinhas e sistemas frontais, o aumento na produtividade local influência na agregação de presas e, portanto, influencia na distribuição dos odontocetos, corroborando o que já é amplamente descrito na literatura.
- Em relação às espécies de odontocetos incluídas, o hotspot oceânico foi influenciado principalmente pelos modelos de distribuição potencial de espécies oceânicas (*oceanic dolphins*), como os popularmente conhecidos "black-fishes" (*F. attenuata, P. electra, G. macrorhynchus, G. melas, P. crassidens*) e golfinho-de-Risso (*G. griseus*) da família Globicephalidae; por quatro espécies do gênero *Stenella* (*S. attenuata, S. longirostris, S. coeruleoalba, S. clymene*) da família Delphinidae; e o cachalote (*P. macrocephalus*) da família Physeteridae. Os modelos individuais apontam que essas espécies têm maior probabilidade de ocorrência em águas profundas (1.000 m) na borda externa da plataforma continental.
- O hotspot costeiro é influenciado principalmente pelos modelos de distribuição potencial de odontocetos de ampla distribuição (*wide-ranging delphinids*) e por pequenos golfinhos costeiros (*costal small delphinids*) da família Delphinidae. O golfinho-comum (*Delphinus* sp.), a baleia-orca (*O. orca*), o golfinho-de-dentes-rugosos (*S. bredanensis*) e o golfinho-nariz-de-garrafa (*Tursiops* spp.) fazem parte do primeiro grupo. Essas espécies apresentaram alta probabilidade de ocorrência em áreas neríticas da plataforma continental, mas também em ambas as áreas costeiras e oceânicas preditas como ecologicamente importantes para várias espécies. A faixa batimétrica em que essas espécies são observadas varia consideravelmente. A baleia-orca e o golfinho-de-dentes-rugosos, por exemplo, variam de poucos metros a mais de 3.000 metros de profundidade. Já as espécies costeiras são representadas pelo boto-cinza (*S. guianensis*) e pelo golfinho-pintado-do-Atlântico (*S. frontalis*). O boto-cinza foi a única espécie estritamente costeira incluída nas análises (registros até 49m profundidade); enquanto o golfinho-pintado-do-Atlântico parecem preferir águas mais quentes com até 200 metros de profundidade.

- No contexto da análise de lacunas, pode-se observar que há uma alta porcentagem de cobertura (28%) da EEZ por MPAs. Contudo, apesar do anúncio feito pelo governo brasileiro em 2018, não é possível considerar que elas atinjam os requerimentos exigidos para cumprir a Meta 11 de Aichi. Diversas MPAs ainda não possuem planos de manejo, mesmo que esse seja um passo mandatório da legislação brasileira. Desta forma, é difícil entendê-las como efetivamente manejadas. Além disso, como estão desigualmente distribuídas entre as províncias biogeográficas (que abrangem características oceanográficas heterogêneas), tão pouco podem ser entendidas como ecologicamente representativas. Apenas uma das províncias (PTSA) tem mais de 24% de cobertura e se referem quase exclusivamente aos dois novos conjuntos de MPAs criados em 2018. As principais falhas das MPAs como estratégia de gestão são, contudo, atribuídas a intenções políticas insidiosas e a falta de responsabilidade e de fornecimento de subsídios por parte dos governos (Federal, municipais e estaduais), o que seria fundamental para que profissionais, comunidades, estudantes e voluntários/as pudessem executar de forma adequada a administração e a operacionalização de cada MPA, ampliando sua efetividade de conservação.
- Considerando o aumento dos impactos antrópicos em águas brasileiras, atribuídos a pesca comercial, a indústria marinha de petróleo e gás e o tráfego de embarcações cargueiras entre os maiores portos do país, se evidencia a necessidade ampliar as estratégias de conservação *in situ* marinhas para além dos limites fixos que são proporcionados pelas MPAs. Isso significa que – ademais das MPAs e em conjunto com elas – deveríamos estar discutindo e articulando outras estratégias de manejo e de gestão *in situ* para garantir a conservação dos cetáceos odontocetos e dos ecossistemas marinhos.
- Uma vez que as duas áreas identificadas como de maior importância ecológica para várias espécies de odontocetos estão inseridas próximas às zonas de maior pressão, indica-se, também, a importância de aplicar o enfoque precautório, ou seja, a deficiência em dados não pode ser um argumento utilizado para postergar ações concretadas de conservação e manejo. Além disso, o planejamento espacial marinho, poderia contribuir amplamente para a priorização de áreas que deveriam estar sob uma mitigação responsável destes impactos através de medidas de manejo dinâmicas a serem incorporadas (e isso poderia ser baseado, inclusive, no zoneamento das Áreas Prioritárias para a Conservação). Uma das maiores contribuições feitas pela análise de lacunas é, de fato, a identificação de locais que deveriam ser priorizados em futuras ações e estratégias de manejo.
- Os tipos de dados de ocorrência utilizados e a ampla escala da área de estudo, permitiram a construção de modelos e a inferência dos resultados em uma macroescala. Reconhecendo as forças e as limitações das abordagens utilizadas, considera-se que os modelos individuais trouxeram

informações pertinentes sobre a distribuição das espécies, mas são especialmente relevantes quando combinados no S-SDM. Para alguma das espécies incluídas, essa é a primeira vez que modelos de distribuição potencial são gerados. As lacunas de conhecimento existentes, principalmente no que diz respeito às espécies oceânicas, dificultam o desenvolvimento de estratégias de conservação para essas espécies. Desta forma, se reforça a importância da publicação dos dados completos de ocorrência das espécies – tanto de relatórios vinculados à monitoramentos das indústrias marinhas quanto de pesquisas científicas executadas – em bancos de dados públicos (como, por exemplo, o SIMMAM) e nas mesmas publicações endereçadas às revistas científicas. Os dados de ocorrência, principalmente para espécies oceânicas, são uma das ferramentas mais importantes para prever medidas de manejo e gestão que possam contribuir para o conhecimento e a conservação dessas espécies, mesmo quando se entende que há uma deficiência de dados (reforçando a importância do enfoque precautório).

- Entende-se que a padronização das informações das MPAs de administração estadual e municipal deveriam ser realizadas no mesmo padrão existente para as de administração Federal. Isso também contribuiria para a tomada de decisões e ampliaria a possibilidade de gerir as MPAs como redes. Ainda, no contexto brasileiro que é tão rico em categorias de gestão como em povos e comunidades tradicionais historicamente vinculados ao mar, faz-se imprescindível superar "o mito moderno da natureza intocada", vinculado às noções ambientalistas vigentes a partir da década de 80. O co-manejo dos recursos a partir de estratégias desde as bases (*bottom-up*), representa maiores oportunidades de eficácia nas gestões das MPAs. Além disso, mesmo que haja uma extensa e qualificada bibliografia sobre as MPAs, muitas delas são, ainda, baseadas em contextos e experiências internacionais, extremamente diferentes do contexto nacional e latino-americano. É importante que comecemos a contextualizar nossos desafios e discutir, em conjunto com todos/as que diariamente esforçam-se pela conservação, como poderemos ser mais proativos, efetivos e socialmente justos para a conservação da sociobiodiversidade.
- É fundamental investir em estratégias de conservação *in situ* e mitigar os impactos antrópicos existentes sobre os cetáceos se quisermos garantir sua sobrevivência. Entretanto, repensar o modelo político e socioeconômico que nos trouxe até aqui é, também, essencial para que possamos atuar na raiz dos nossos problemas socioambientais e não apenas atenuar suas consequências. A integração das MPAs a outras estratégias e esforços (como o planejamento espacial marinho e/ou a incorporação de medidas de manejo dinâmicas) poderá, sem dúvida, contribuir para mitigar os impactos identificáveis e muitas das deficiências que são comumente atribuídas às MPAs. Porém – e apesar dos imensuráveis esforços daqueles/as que atuam para a conservação – a proteção socioambiental no Brasil têm se tornado uma tarefa cada vez mais difícil. E isso é culpa do modelo

político e socioeconômico em vigor e da falta de responsabilidade e de compromisso daqueles que se dispõe a governar em favor da acumulação de renda de poucos, de forma contrária à justiça socioambiental e ao bem comum. Dessa forma, se de fato, quisermos garantir a conservação dos cetáceos – e de toda a biodiversidade marinha e terrestre – o que precisamos, urgentemente, é mudar nossos modos de produção e de consumo, optar e batalhar por um outro sistema político e socioeconômico (diferente deste que vivemos) e, principalmente, transformar a forma como nos relacionamos com a Natureza. Precisamos eleger representantes que apoiem (e não desmontem) a ciência, a pesquisa e a educação; que respeitem as normativas ambientais vigentes e que façam que estas sejam cumpridas (ao invés de destruí-las ou enfraquecê-las); e que se comprometam com uma sociedade mais justa, equitativa e ambientalmente saudável. A redução de apoios logísticos e financeiros nessas áreas não apenas inviabiliza as operações de fiscalização pelo país (seja dentro ou fora das áreas protegidas), como, também, inviabiliza as pesquisas, os monitoramentos, as avaliações, as interações com a sociedade civil e, consequentemente, a eficiência dos instrumentos e das políticas de conservação.