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DISTRIBUTION AND POTENTIAL CAUSES OF SEA TURTLE STRANDINGS IN THE STATE OF RIO DE JANEIRO, SOUTHERN BRAZIL

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Abstract.—**Sea turtles are subject to a wide range of human threats. Information collected from sea turtles found dead or debilitated (termed strandings) can provide valuable insights into these threats. In recent years, extensive beach monitoring projects implemented along the entire coast of Brazil (7,367 km) have facilitated data collection on regional sea turtle strandings. Here, we compiled stranding data from the Santos Basin in the state of Rio de Janeiro, Brazil, from 19 September 2016 to 19 September 2019. During this period, we recorded 3,957 sea turtle strandings of which 3,508 were dead turtles. We recorded five turtle species including 3,587 Green Turtles (*Chelonia mydas*), 242 Loggerhead Turtles (*Caretta caretta*), 76 Olive Ridley Turtles (*Lepidochelys olivacea*), 18 Leatherback Turtles (*Dermochelys coriacea*), eight Hawksbill Turtles (*Eretmochelys imbricata*), and 26 unidentified individuals. From all species, 12 were oceanic-stage juveniles, 3,663 were neritic-stage juveniles, and 147 were adults. A total of 539 strandings (13.6%) showed signs of anthropogenic interactions: 318 involved fishing gear, 125 involved watercrafts, 90 showed evidence of direct injuries from humans, four involved plastic items, and two involved oil pollution. Our results suggest that fisheries bycatch and watercraft collisions (mainly in bays) are the predominant threats to Green Turtles in the state Rio de Janeiro. It also appears that mortality of Loggerhead, Olive Ridley, and adult Leatherback Turtles is associated with fishing activities in feeding areas or in migratory corridors between feeding and breeding areas.**

Key Words.—anthropogenic impacts; *Caretta caretta*; *Chelonia mydas*; *Dermochelys coriacea*; *Eretmochelys imbricata*; *Lepidochelys olivacea*; mortality; threats

INTRODUCTION

Sea turtles are subject to a wide range of threats, including many associated with human activities. These anthropogenic threats include boat strikes, fisheries bycatch, dredge operations, habitat loss, and both chemical and plastic pollution (Oravetz 2000; Bugoni et al. 2003; Schuyler et al. 2014; Jerdy et al. 2017). Knowledge of the spatial, temporal, and demographic risk posed by these factors on sea turtles is key to developing conservation actions to mitigate these threats.

Beach monitoring projects that collect information from sea turtles found dead or debilitated in a study area (termed strandings) can provide critical information on sea turtle populations in adjacent marine habitats (e.g., species, sex, life stage, diet, etc.; Epperly et al. 1996; Tomás et al. 2008; Reis et al. 2017; Vélez-Rubio et al. 2017), as well as sources of anthropogenic interactions and mortality (Vélez-Rubio et al. 2013; Goldberg et al. 2016; Reis et al. 2017). In Brazil, data collection on sea turtle strandings has intensified in the last 10 y due to beach monitoring projects implemented along the entire coast (Werneck et al. 2018). Such projects are mandated by the Brazilian Institute of the Environment and Renewable Resources (IBAMA) to evaluate the effects of offshore activities related to the discovery and extraction of petroleum and natural gas. This effort aims to improve the environmental and social responsibilities of these operations through the implementation of mitigating or compensatory measures (Werneck et al. 2018).

In September 2016, the Santos Basin Beach Monitoring Project (SB-BMP) began monitoring the beaches and nearshore waters in the state of Rio de Janeiro to document strandings of sea turtles, as well as seabirds and marine mammals. Sea turtle strandings include the five species that occur in Brazilian waters: Green Turtle (*Chelonia mydas*), Loggerhead Turtle (*Caretta caretta*), Hawksbill Turtle (*Eretmochelys imbricata*), Olive Ridley

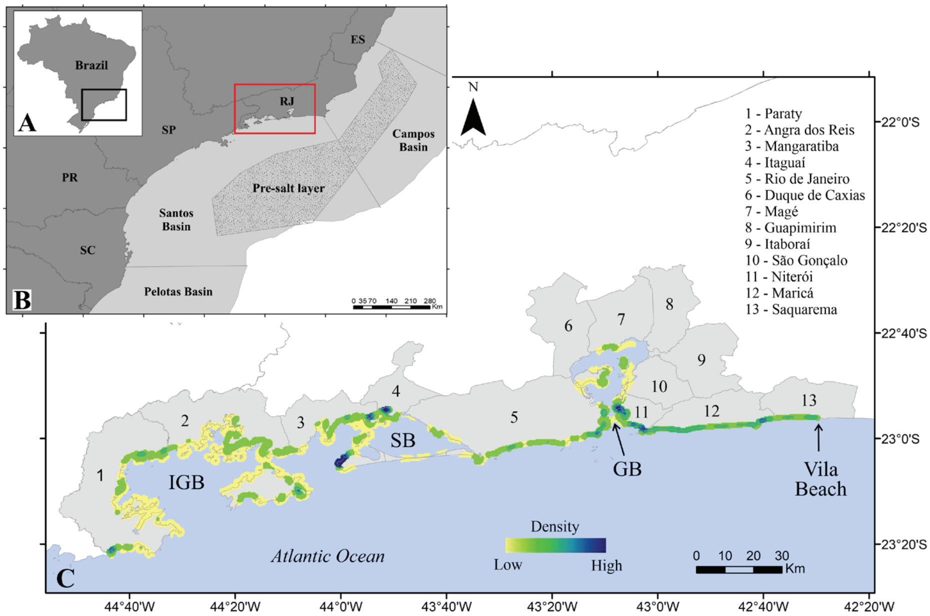

Figure 1. (A) Location of the Santos Basin in southern Brazil. (B) Location of the study area within the Santos Basin relative to the states of Santa Catarina (SC), Paraná (PR), São Paulo (SP), Rio de Janeiro (RJ), and Espírito Santo (ES), as well as the Pelotas and Campos basins and Pre-salt layer (hatched area; see text for description). (C) The 13 municipalities between Saquarema (Vila Beach) to Paraty (Caixa D'Aço Beach) in state of Rio de Janeiro, where the Santos Basin Beach Monitoring Project documented sea turtle strandings from 19 September 2016 and 19 September 2019. Colored areas along the coastline indicate the density of sea turtles strandings for all species combined. Abbreviations are IGB = Ilha Grande Bay, IS = Sepetiba Bay, and GB = Guanabara Bay.

Turtle (*Lepidochelys olivacea*) and Leatherback Turtle (*Dermochelys coriacea*; Marcovaldi and Marcovaldi 1999). Currently, all five species are listed in the Red Book of Threatened Brazilian Fauna (Instituto Chico Mendes de Conservação da Biodiversidade/Ministério do Meio Ambiente 2018). In this study, we analyzed data collected from sea turtle strandings found along the southern and central portion of the coast of the state of Rio de Janeiro in the Santos Basin between September 2016 and September 2019. The goals of this study were to (1) determine the spatial distribution of strandings, (2) identify the species and life stages of strandings, and (3) infer the primary sources of mortality.

Materials and Methods

Study site.—The Santos Basin is located in the southern portion of the Brazilian continental margin along the states of Santa Catarina, Paraná, São Paulo, and Rio de Janeiro (Fig. 1). While the SB-BMP covers all states within the basin, our study area was located on the northern portion of the Santos Basin between Saquarema (Vila Beach; 22º56'08"S, 42º29'44"W) and Paraty (23º22'07"S, 44º43'31"W) in the state of Rio de Janeiro, Brazil (Fig. 1). This area contains three main bays (Guanabara Bay, Sepetiba Bay, and Ilha Grande Bay), which host many economic activities of considerable importance to the state, including different industrial complexes, shipping ports, tourist activities, a large concentration of urban areas, and intensive artisanal fishing activities (Freitas and Rodrigues 2014; Johnsson and Ikemoto 2015). Moreover, there are considerable oil reserves in the Santos Basin, in a region called Pre-salt Layer (Fig. 1). The exploration of these reserves can only be carried out if the exploration company (in this case PETROBRAS) executes a mitigation plan for marine fauna, a condition required by IBAMA.

Data collection.—We compiled data on sea turtle strandings found during the SB-BMP in the state of Rio de Janeiro from 19 September 2016 to 19 September 2019. We further extracted only those stranding records documented between Vila Beach in Saquarema and Caixa D'Aço Beach in Paraty in Rio de Janeiro state. Data were collected using three different monitoring strategies: daily monitoring on the beaches (by car, foot, or bicycle), monitoring by watercraft (near the coast), and opportunistic reports made by the public. The monitoring protocol can be found in Werneck et al. (2018).

For each stranding event, we recorded the date and time, location (GPS coordinates), species, body size (curved carapace length; CCL), condition (alive or dead and stage of decomposition adapted from Geraci and Lounsbury 2005; Table 1), evidence of anthropogenic interactions, and presence of fibropapillomatosis. We

Table 1. Classification system used to determine the condition of sea turtles found debilitated or dead (termed strandings) during Santos Basin Beach Monitoring Project between Saquarema (Vila Beach) and Paraty in the state of Rio de Janeiro (adapted from Geraci and Lounsbury 2005).

Code	Condition	Characteristics (external examination only)
1	Alive	—
2	Carcass in good condition	Normal appearance, little action of necrophagous animals, little skin loss, firm musculature and fat, intact organs, intestine with little quantity of gas
3	Moderate decomposition	Carcass intact, protrusion of tongue and genital organ, eyes dry or absent, skin loss, hemolyzed blood, fat affected, muscles brittle, intestine dilated with gas.
4	Advanced decomposition	Considerable skin loss, intensive action of necrophagous animals, strong odor, smooth fat with gas bubbles, muscles nearly liquified, viscera brittle, intestine filled with gas
5	Carcass mummified or skeletal remains	—

used body size measurements to classify each turtle into a life stage using reference values for each species in Brazil (Santos et al. 2011a). For all species, we classified individuals with CCL < 30 cm to be oceanic-stage juveniles (Bjorndal 1996). We classified neritic-stage juveniles differently for each species: 30–96 cm for Green Turtles (Colman et al. 2014), 30–82 cm for Loggerhead Turtles (Marcovaldi and Chaloupka 2007), 30–62 cm for Olive Ridley Turtles (Silva et al. 2007), 30–139 cm for Leatherback Turtles (Thomé et al 2007), and 30–82 cm for Hawksbill Turtles (Marcovaldi et al. 2007). We classified individuals with CCL equal to or greater than the maximum values described for neritic-stage juveniles as adults. We only conducted external assessments for each stranding (i.e., we did not conduct necropsies to assess maturity and/or reproductive status, or cause of death).

When we encountered external evidence of anthropogenic interactions, we separated each observation into one of five categories: (1) Fishing gear, indicated by any type of fishing gear found on the animal (hook, nylon line, net, etc.) or marks suggestive of an interaction with such gear, (2) Watercraft, indicated by superficial or deep cuts or irregular fractures in bone or soft parts typical of collision with propellers or the hulls of boats, (3) Injuries, indicated by occurrences of physical aggression by humans on turtles, including knife cuts, blows to the head, fractured bones, and other signs of unnatural trauma or laceration, (4) Plastic debris, indicated by external interaction with any type of plastic item, such as soft plastic, packaging, polystyrene foam, etc., or (5) Oil, indicated by the presence of oil residues. We also assigned each interaction with a relative ranking score based on the strength of evidence: strong, moderate, or weak. A strong interaction was one in which the causal agent was found on the animal or when the interaction was obvious despite not finding the causal agent (e.g., collision with watercraft). We recorded an interaction as moderate when the causal agent was not found but there was strong evidence of the type of interaction. A weak interaction was one in the absence of a causal agent and absence of strong evidence of the type of interaction. For the oiled category, we categorized body coverage as either < 25%, 25–50%, 50–75%, or > 75%.

Data analysis.—To determine spatial patterns of strandings, we processed the georeferenced data points for each stranding and created maps using the software ArcGIS 10 (Esri, Redlands, California USA). We combined stranding data from the municipalities of Saquarema and Maricá because monitoring in Saquarema was only performed until Vila Beach and did not extend over the entire coastline of the municipality. Using Spatial Analysis in ArcGIS 10, we aimed to test if there were any spatial differences in the density of strandings. For density maps, we used a kernel density calculation tool. First, we used Standard Deviation classification with five classes for the density map of the occurrences of strandings. Second, we used Equal Interval classification with 10 classes for the maps of the spatial distribution of strandings per species and spatial distribution of strandings per anthropogenic impact. Density was calculated based on the number of points (strandings) in a location (i.e., the greater the number of points grouped within a cell, the greater the kernel density estimate). We evaluated stranding data by species per month using Data Dispersion Analysis to identify temporal variation.

RESULTS

During the study period, we recorded 3,957 sea turtle strandings between Saquarema (Vila Beach) and Paraty: 3,587 Green Turtles (90.6%), 242 Loggerhead Turtles (6.1%), 76 Olive Ridley Turtles (1.9%), 18 Leatherback Turtles (0.5%), eight Hawksbill Turtles (0.2%), and 26 with undetermined species (0.7%; Table 2). We determined the life stage for 3,822 individuals: 12 oceanic-stage juveniles, 3,663 neritic-stage juveniles, and 147 adults (Table 2). We found 449 animals alive (Code 1) and 3,508 dead. Of these dead individuals, most were in an advanced stage of decomposition: 256 in Code 2 (7.3%), 618 in Code 3 (17.6%), 2,169 in

Table 2. Sea turtle strandings (n = number) recorded from 19 September 2016 to 19 September 2019 between Saquarema (Vila Beach) and Paraty in the state of Rio de Janeiro, Brazil, for Green Turtles (*Chelonia mydas*), Loggerhead Turtles (*Caretta caretta*), Olive Ridley Turtles (*Lepidochelys olivacea*), Hawksbill Turtles (*Eretmochelys imbricata*), and Leatherback Turtles (*Dermochelys coriacea*). Information includes life stage, body size (curved carapace length; CCL), and external condition (see text for descriptions of Codes 1-5).

			Life stage			CCL (cm)			Condition (Code)				
Species	n	%	Oceanic juvenile	Neritic juvenile	Adult	Mean	SD	Range	1	2	3	4	5
Green Turtle	3,587	90.6	12	3,515	7	35.9	14.2	24.1–98.6	438	251	594	1,925	379
Loggerhead Turtle	242	6.1	-	128	73	77.3	11.3	50.2–137.6	8	4	19	163	48
Olive Ridley Turtle	76	1.9	-	11	53	65.3	4.3	33.4–75.3	2	1	4	54	15
Leatherback Turtle	18	0.5	-	2	14	140.5	12.3	114.0–155.5	-	-	1	16	1
Hawksbill Turtle	8	0.2	-	7	-	59.5	4.9	55.0–64.9	1	-	-	5	2
Undetermined	26	0.7	-	-	-	-	-	-	-	-	-	6	20
Total	3,957	100	12	3,663	147				449	256	618	2,169	465

Code 4 (61.8%), and 465 in Code 5 (13.3%; Table 2). Live animals were sent to the SB-BMP rehabilitation centers. Most occurrences were notified through reports from general population/partnership network (51.2%), followed by active monitoring on land (44.1%), and monitoring by watercraft (4.7%).

For all species combined, we found the greatest density of strandings around Marambaia Island in the municipality of Mangaratiba (Fig. 1); however, this pattern was primarily driven by the high concentration of Green Turtle strandings at Marambaia Island (Fig. 2). Stranding densities were greatest in the central and eastern municipalities for Loggerhead and Olive Ridley Turtles (Fig. 2). We found that strandings of Leatherback Turtles were concentrated in the eastern municipalities, especially Saquarema, while strandings of Hawksbill Turtles were concentrated near the mouth of Guanabara Bay (Fig. 2).

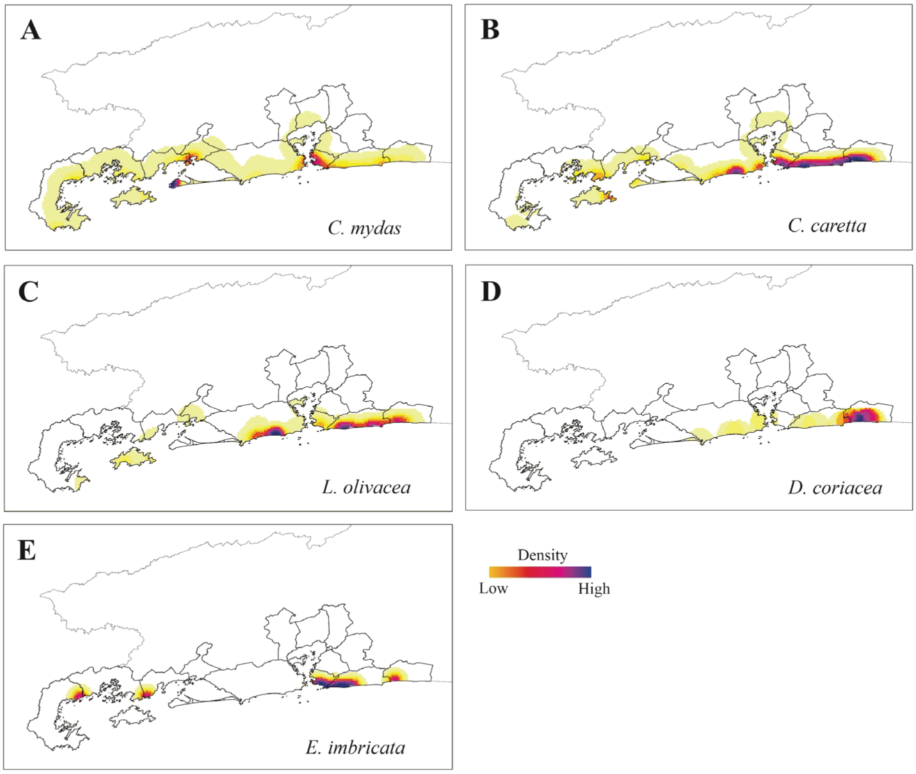

Figure 2. Spatial distribution of sea turtle strandings recorded for each species from 19 September 2016 to 19 September 2019 between Saquarema (Vila Beach) and Paraty (Caixa D'Aço Beach) in the state of Rio de Janeiro, Brazil. (A) Green Turtles (*Chelonia mydas*), (B) Loggerhead Turtles (*Caretta caretta*), (C) Olive Ridley Turtles (*Lepidochelys olivacea*), (D) Leatherback Turtles (*Dermochelys coriacea*), and (E) Hawksbill Turtles (*Eretmochelys imbricata*).

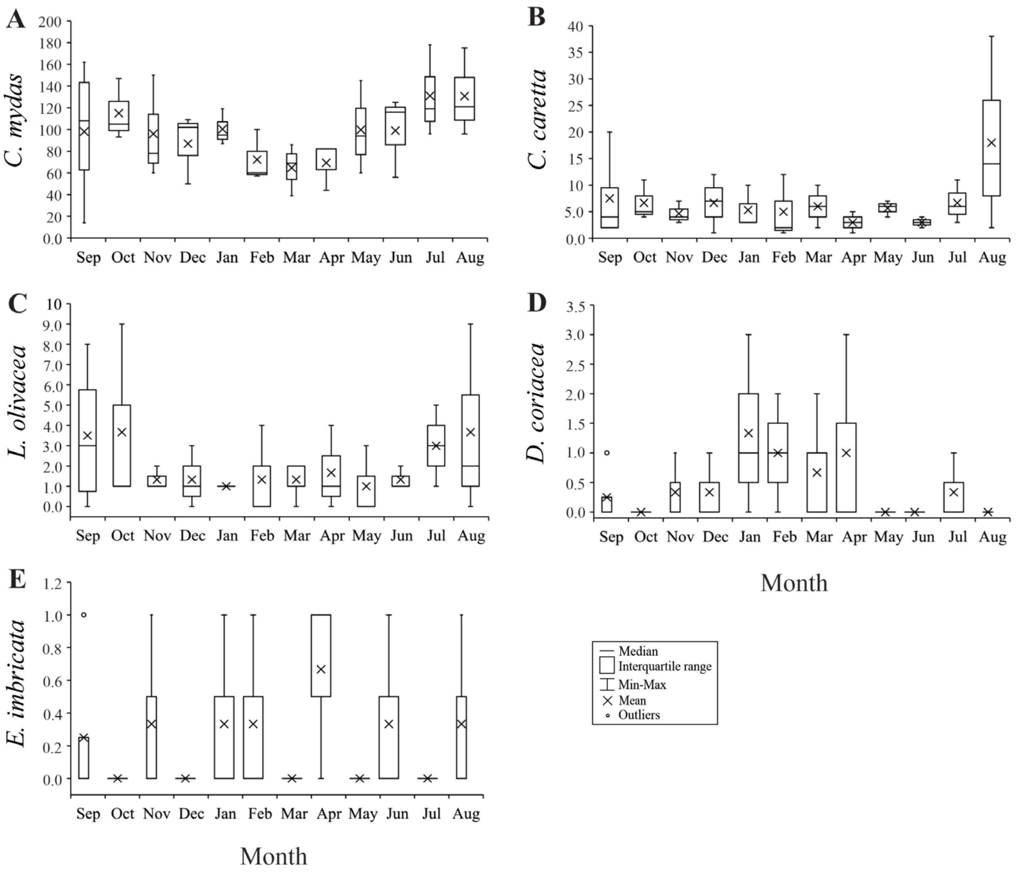

FIGURE 3. Average monthly distribution of sea turtle strandings for each species recorded from 19 September 2016 to 19 September 2019 between Saquarema (Vila Beach) and Paraty (Caixa D'Aço Beach) in the state of Rio de Janeiro, Brazil. (A) Green Turtles (*Chelonia mydas*), (B) Loggerhead Turtles (*Caretta caretta*), (C) Olive Ridley Turtles (*Lepidochelys olivacea*), (D) Leatherback Turtles (*Dermochelys coriacea*), and (E) Hawksbill Turtles (*Eretmochelys imbricata*).

We found that the average number of strandings per month over the 3 y varied among species (Fig. 3). For Green and Loggerhead Turtles, we recorded the highest number of strandings between July and September (winter and early spring), with a maximum in July for Green Turtles (n = 393, with 178 in 2018) and in August for Loggerhead Turtles (n = 54, with 38 occurrences in 2018; Fig. 3). For Olive Ridley Turtles, we recorded the highest number of standings in September when all years were combined (n = 14) even though the highest occurrence in a single month was in October 2018 (n = 9). For Leatherback Turtles, strandings occurred between January and April (summer and early autumn), with a maximum in April 2017 (n = 5). For Hawksbill Turtles, isolated occurrences were scattered throughout the year (Fig. 3).

Regarding strandings with evidence of anthropogenic interactions, we documented 500 individuals with one type of anthropogenic interactions: 476 Green Turtles, 18 Loggerhead Turtles, five Olive Ridley Turtles, and one for Leatherback Turtle. Additionally, we recorded 39 individuals with more than one type of interaction: 38 Green Turtles and one Olive Ridley Turtle. Of these 539 anthropogenic interactions, we categorized 59.0% as Fishing gear, 23.2% as Watercraft, 16.7% as Injuries, 0.7% as Plastic debris, and 0.4% as Oil with body coverage <25% (Table 3). Among all interactions with fishing gear, 68 (21.4%) occurred on Marambaia Island (Fig. 4). Records of watercraft collisions (n = 125) were most dense at the entrance of Guabanara Bay and in the port area of Sepetiba Bay, with Green Turtles being the most affected (n = 120; Fig. 4, Table 3). Injuries related to physical aggression by humans on turtles were most dense inside Sepetiba Bay near the town of Itacuruça (Fig. 4). Fibropapillomatosis (FP) was documented in 493 Green Turtles (12.5 %) and one Hawksbill Turtle. FP was not documented in any Loggerhead, Olive Ridley, or Leatherback Turtles. We found 54.8% of turtles exhibiting FP during on-beach and in-water monitoring of Guanabara (n = 145) and Sepetiba Bays (n = 131).

DISCUSSION

Green Turtle.—Green Turtle strandings have been recorded with greater frequency than other species in all regions of Brazil (southeast: Reis et al. 2009; Reis

Table 3. Frequency of each documented anthropogenic interaction for each species, separated by strength of evidence (see text), recorded from 19 September 2016 and 19 September 2019 between Saquarema (Vila Beach) and Paraty in the state of Rio de Janeiro, Brazil. Species abbreviations are CM = Green Turtle (*Chelonia mydas*); CC = Loggerhead Turtle (*Caretta caretta*; LO = Olive Ridley Turtle (*Lepidochelys olivacea*); DC = Leatherback Turtle (*Dermochelys coriacea*). Total number of strandings = 3,957. The abbreviations TAI = Types of anthropogenic interactions and SOE = Strength of evidence; W = weak, M = moderate, S = strong.

		Species				
TAI	SOE	CM	CC	LO	DC	Total
Fishing gear	W	25	7	3		35
	M	47	1			48
	S	234		1		235
Watercraft	W	95	3	1		99
	M	16				16
	S	9		1		10
Injuries	W	63	5	1	1	70
	M	10	2			12
	S	8				8
Plastic debris	W					0
	M					0
	S	4				4
Oil	W					0
	M					0
	S	2				2
Total		513	18	7	1	539

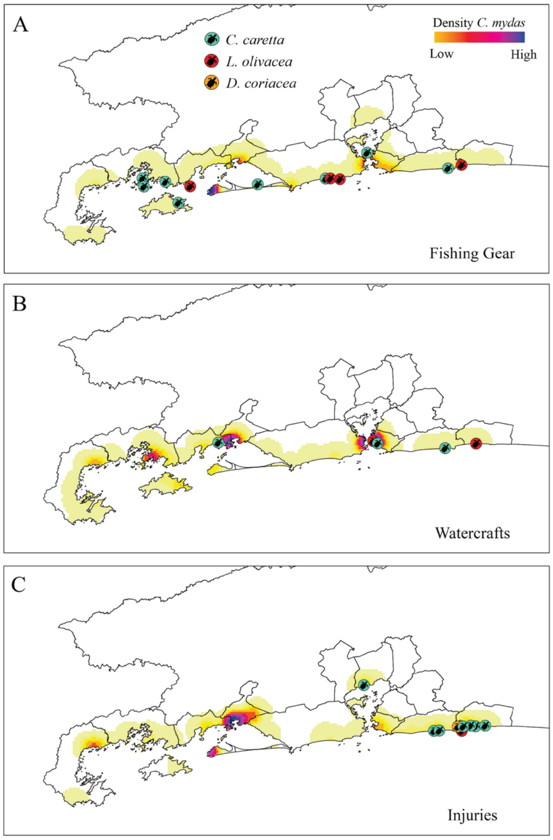

Figure 4. Density map of the three predominate anthropogenic interactions: (A) Fishing gear, (B) watercrafts, and (C) injuries caused by human aggression documented for Green Turtles (*Chelonia mydas*) from 19 September 2016 to 19 September 2019 between Saquarema (Vila Beach) and Paraty (Caixa D'Aço Beach) in the state of Rio de Janeiro, Brazil. Anthropogenic interactions documented for other species are represented by icons on maps: Loggerhead Turtles (*Caretta caretta*), Olive Ridley Turtles (*Lepidochelys olivacea*), and Leatherback Turtles (*Dermochelys coriacea*).

et al. 2017; Tagliolatto et al. 2019b; this study; south: Monteiro et al. 2016; Cantor et al. 2020; northeast: Poli et al. 2014; Farias et al. 2019). In addition to supporting several important nesting sites that are concentrated on oceanic islands, the entire coastline of Brazil constitutes an important feeding area for Green Turtles in the Atlantic Ocean. These individuals comprise a mixed-genetic stock originating from multiple rookeries, including Brazil, Ascension Island, Costa Rica, Suriname, and numerous Caribbean and west African countries (Marcovaldi and Marcovaldi 1999; Mascarenhas et al. 2005; Almeida et al. 2011; Santos et al. 2011a; Naro-Maciel et al. 2012).

We found the greatest density of Green Turtle strandings on Marambaia Island, where 21.4% of strandings with documented anthropogenic interactions were with fishing gear. Marambaia, despite being called an island, is a point of land connected to the mainland through extensive sandbanks, coastal vegetation, and mangrove areas. These habitats constitute a natural breeding ground for fishes, crustaceans, and mollusks that attracts Green Turtles and also fishermen (Almeida et al. 2011; Cardoso et al. 2011). The high number of Green Turtles that we found dead in this area may be attributed to the intensive artisanal fishing practiced by local community. Artisanal fishing, especially using gillnets, is considered a significant threat to populations of Green Turtles around the world because it is widely practiced and frequently overlaps with the feeding and resting grounds of juveniles of this species (Alfaro-Shigueto et al. 2011; Almeida et al. 2011; Senko et al. 2014).

Following interactions with fishing gear, the next most common anthropogenic interaction we documented for Green Turtles was from watercraft collisions and injuries related to human aggression. Most stranded individuals with marks suggestive of collisions with watercrafts occurred in the Guanabara and Sepetiba Bays, corresponding to 55% of all anthropogenic interactions documented in these areas. These bays are characterized by extensive urban, industrial, and tourist activities, and have considerable boat and industrial ship traffic (Instituto Políticas Alternativas para o Cone Sul

[PACS] 2015). In Australia, most records of watercraft collisions involving Green Turtles were also in bays of commercial and recreational importance (Hazel and Gyuris 2006). Collectively, these patterns demonstrate that Green Turtles continue to use urbanized habitats following development, but that watercraft interactions can cause significant sea turtle mortality in these areas.

Regarding injuries caused by human aggression on turtles, most records were consistent with traumatic blows to the head, causing skull fractures, and knife cuts. For Green Turtles found on Marambaia Island, we observed spatial overlap between the density of interactions involving such injuries and those involving fishing gear. These individuals may have become victims of aggression after being caught incidentally during fishing activities. While we do not have information on local consumption of turtle meat, the reports obtained about these injuries suggest that they occur when animals are removed from nets and discarded. Monteiro (2004) also attributed signs, such as the cutting or the removal of the shell and meat, to interactions with fishing activities. Another high density area for such injuries was found in Sepetiba Bay at Itacuruça (PACS 2015).

Despite the relatively small number of Green Turtle strandings that were attributed to plastic pollution and oil, we obtained data only from external evaluations of the stranded animals, which may have caused these threats to be underrepresented. Entanglement in plastic debris or extensive oil exposure would be visible externally; however, mortality associated with the ingestion of plastic debris or oil would have been missed in our stranding assessments. Nevertheless, ocean pollution is one of the greatest threats to the marine environment and the organisms that depend on it (Sutherland et al. 2010; Vegter et al. 2014; Gall and Thompson 2015). Plastics are frequently found in the digestive tract of sea turtles, especially Green Turtles, which has been widely documented in the South Atlantic (Bugoni et al. 2001; Tourinho et al. 2010; Jerdy et al. 2017; Vélez-Rubio et al. 2018; Rizzi et al. 2019). Although this threat may have been underrepresented in our study, recent studies suggest that plastic pollution is a significant threat to this mixed foraging aggregation.

We documented 493 Green Turtles with fibropapillomatosis (FP), a disease caused by a herpesvirus and characterized by the development of single or multiple skin tumors occurring both externally and internally. Depending on the severity of the disease, it can result in death (Herbst and Klein 1995). Most cases of FP in marine turtles have been recorded in Green Turtles and occur in areas close to large urban centers, including industrialized bays, suggesting a positive relationship between the prevalence of this disease and human activities (Aguirre and Lutz 2004). On Itaipu Beach in the municipality of Niterói, Rio de Janeiro State, studies of FP on resident juveniles Green Turtles indicated a high incidence of this disease in comparison with other data collected in Brazil (Guimarães et al. 2013; Tagliolatto et al. 2016). The proximity of this in-water site to Guanabara Bay further supports the connection between human activity and FP in Green Turtles.

Loggerhead Turtle.—Loggerheads Turtles accounted for the second highest percentage of strandings after Green Turtles (6.1%). Loggerheads have the largest number of breeding grounds on the coast of Brazil and one of the largest populations in the Atlantic Ocean (Santos et al. 2011a). The northern portion of the state of Rio de Janeiro is one of the major breeding areas for this species in Brazil (Santos et al. 2011b). According to Tagliolatto et al. (2019a), incidental bycatch of Loggerhead Turtles by industrial bottom trawl fishery is significantly higher in winter and around the geographic coordinates 23° S and 42° W, which corresponds with the temporal and spatial patterns of loggerhead strandings found in the present study. Although we found only eight individuals with external evidence of interaction with fishing gear, both this species and Olive Ridley Turtles are known to interact with bottom trawlers without incurring external injuries (Guimarães et al. 2018; Tagliolatto et al. 2019a). In addition to trawling, pelagic longline fishing may also be a source of loggerhead mortality. Sales et al. (2008), in an extensive monitoring work of this fishery in the southwest Atlantic, recorded 789 Loggerhead Turtles between 2001 and 2005, which represents 56.8% of the total turtles incidentally captured.

Olive Ridley Turtle.—Olive Ridley Turtles were the third most frequent species found as strandings in this study (n = 76) and most individuals were adults. This species is considered the least abundant sea turtle in the waters off southern Brazil (Da Silva et al. 2007). The reproduction and nesting areas for Olive Ridley Turtles in Brazil are concentrated in the state of Sergipe (northeastern region; Castilhos et al. 2011), but studies have confirmed that some individuals migrate to feeding grounds in the southern region between breeding seasons (Reis et al. 2010; Petitet and Bugoni 2017; Reis et al. 2017; Guimarães et al. 2018).

In Brazil, the reproductive season of Olive Ridley Turtles is from September to March (Silva et al. 2007), while strandings in this study were most frequent between July and October (winter and early spring). Tagliolatto et al. (2019b) reported a higher rate of incidental bycatch of Olive Ridley Turtles in the bottom trawl fishery during the winter and spring. Thus, our stranding data are consistent with data from these previous studies indicating that adult Olive Ridley Turtles may be dying primarily from interactions with industrialscale fishing activities during their migrations between feeding and reproduction areas. Although only seven individuals were found with external evidence of interaction with fishing gear, this species is known to interact mainly with bottom trawling fisheries in Brazil, similar to Loggerhead Turtles, but also with longline fishery (Sales et al. 2008).

Leatherback Turtle.—Leatherback Turtle strandings are rare throughout the entire coast of Brazil. We recorded 18 individuals, with most occurring between January and April. In a large survey conducted between 1969 and 2001, Barata et al. (2004) recorded only five leatherback strandings in the state of Rio de Janeiro. Up to 2016, however, there were no studies in the region involving the SB-BMP in Rio de Janeiro state, which may have generated underestimated data on the number of strandings in the region. Once again, this demonstrates the importance of maintaining monitoring programs along the coast.

Of the five species nesting in Brazil, Leatherback Turtles deposit the fewest number of clutches (Thomé et al. 2007). Leatherbacks are primarily oceanic, in which their migratory movements are mainly related to seasonal concentrations of their preferred prey (gelatinous zooplankton), but their use of nearshore habitats has been described in several studies as well (Houghton et al. 2006; Doyle et al. 2008; López-Mendilaharsu et al. 2009; Robinson et al. 2016). López-Mendilaharsu et al. (2009) identified feeding grounds used by Leatherback Turtles in the southwest Atlantic, which were predominantly on the continental shelf and break, including the Santos Basin. In the spring and summer in the central northern region of the state of Rio de Janeiro, regular upwellings occur at the narrow continental margin (Valentin 2001). This upwelling leads to a significant increase in phytoplankton and zooplankton from February to April, which can attract leatherbacks closer to the shore as they follow increases in food availability, specifically jellyfish. In turn, this leads to more leatherbacks being caught accidentally by coastal fisheries (Guimaraens et al. 2005; Sales et al. 2008; Schroeder et al. 2014). The increase in the number of leatherback strandings in the month of April in our study coincides with these aspects of their foraging biology, but also with their breeding season in Brazil (September to March; Thomé et al. 2007). Most leatherback strandings we found were adult individuals, but we did not assess reproductive status. Nevertheless, this species is classified as Critically Endangered in Brazil, making the loss of adult individuals worrisome in the long term.

Colman et al. (2019) recorded an increase in the average annual number of leatherback nests in Brazil between 1988 and 2017 when comparing the average over the first 5 y with that of the last 5 y. The authors highlighted the absence of adult mortality estimates for Leatherback Turtles in Brazil, indicating that a low mortality of adults and large juveniles is required to maintain viable marine turtle populations. Therefore, documenting leatherback strandings and determining causes of mortality, along with the continuation of long-term monitoring and genetic studies, can provide important information for evaluating the impacts of mortality threats and elucidating the population stock structure in Brazil.

Hawksbill Turtle.—The low frequency of hawksbill strandings that we found (n = 8) was expected, as this species occurs less frequently in the southern and southeastern regions of Brazil and is more abundant throughout the northern-northeastern coast (Marcovaldi et al. 2007). The primary nesting sites for Hawksbill Turtles are in northeastern Brazil, as well as two of the most important feeding grounds in the country: Fernando de Noronha Archipelago (Sanches and Bellini 1999) and Rocas Atoll (Marcovaldi et al. 1998). Seven Hawksbill Turtles that we found were neritic-stage juveniles, suggesting that the coast of Rio de Janeiro supports a small foraging aggregation; however, more work is needed to understand their foraging ecology and genetic origins.

Spatial distribution of strandings.—We recorded the greatest number of strandings in the municipalities of Maricá (including western Saquarema), Mangaratiba, and Rio de Janeiro. Maricá (and western Saquarema) represent a long coastline that runs in an east-west direction, meaning that it is facing the southern quadrant and is exposed to high-energy waves (Muehe and Valentini 1998). The size and orientation of these municipalities may therefore contribute to the stranding of carcasses on beaches. In addition, Maricá and western Saquarema are closer to the central northern region of the state of Rio de Janeiro, where the number of strandings is higher than the more southern municipalities surveyed in our study (Tagliolatto et al. 2019b). Reis et al. (2017) also identified an important concentration of strandings in Saquarema and the municipalities to the north of our study area: Arraial do Cabo, Cabo Frio, and Búzios. Collectively, these results suggest that standings in this area are influenced by local winds, the coast orientation, and upwelling events (as we described in the Leatherback Turtle section). Eastern Saquarema and the municipalities to the north are monitored by another beach monitoring project (BMP), the Campos Basin - BMP, so the strandings we recorded only correspond to those strandings that occur in the west/south of Saquarema. Mangaratiba had the second greatest number of strandings and these records are possibly associated with interactions with fisheries in Sepetiba Bay, as we described in the Green Turtle section.

Conservation concerns.—Intensive monitoring in this area has provided important and unprecedented information on sea turtle stranding events. These include the discovery of areas with high rates of interactions with fishing gear, as well as injuries associated with human aggression towards turtles that accidentally captured during fishing activities near urban areas (Marambaia and Itacuruça, Sepetiba Bay). These finding reveal local problems that need to be mitigated through environmental awareness projects and increased local inspection and enforcement. The confirmation that Guanabara and Sepetiba Bay are likely places for sea turtles to be struck by boats demonstrated that this type of interaction can cause significant sea turtle mortality in these areas. The finding that leatherback strandings coincide, in part, with their breeding season in Brazil, suggested that coastal fisheries may pose the major threat to Leatherback Turtles in the region. These occurrences are worrisome in the long term and point to the need for mitigation measures in fisheries that incidentally catch leatherbacks in Brazil.

High rates of mortality for juvenile Green Turtles have been reported by stranding studies in Brazil. This species is considered Endangered worldwide (Seminoff 2004), and both the uncontrolled development of coastal habitats and fisheries bycatch represent significant concerns regarding the maintenance of stocks in the long term (Hamann et al. 2010). In Brazil, studies investigating the interaction between Green Turtles and artisanal fishing activities have increased in the past 10 y and there has been a strong effort to reduce incidental bycatch (Sales et al. 2010; Santos et al. 2011a; López-Barrera et al. 2012). Measures aimed to mitigate bycatch mortality include the development of more efficient fishing gears in reducing bycatches, mainly in industrial fisheries (Hamann et al. 2010; Sales et al. 2010). Tackling the issue of sea turtle bycatch in small-scale artisanal fisheries is intrinsically more difficult due to the greater diversity of gear used in these fisheries and to the dispersed and decentralized nature of fishing communities (Dutton and Squires 2008). In Brazil, three Regional Management Units for Green Turtles have been identified based on demographic, spatial, and genetic information about geographic distributions of populations. This area represents important habitats of high-use and connectivity between breeding and feeding areas and could be integrated with other georeferenced data of human activities subject to management, such as fisheries, oil and gas extraction, coastal development, and others, thereby helping to design appropriate management strategies for this species (Wallace et al. 2010).

As in all stranding studies, the number of animals washed ashore and detected by surveys represents only a small proportion of all mortality events. The main reasons for underestimating mortality rates from stranding data are (1) oceanographic characteristics, such as distance from beach, currents, wind, and season, (2) the consumption of the carcasses by other animals, (3) missed carcasses by monitoring, and (4) possible local consumption (Senko et al. 2014). As these stranding rates simply depict the minimum mortality occurring in an area, the actual scenario is frequently much worse. As the degradation of the coastal environment continues to increase, we can expect mortality and stranding rates to increase as well (Cantor et al. 2020). The potential impact of anthropogenic threats on these populations, as revealed through stranding records of SB-BMP, underscores the urgent need to implement conservation actions, such as mitigation measures for bycatch and targeted environmental awareness campaigns in specific communities. The continued monitoring of stranding events in the region will enable a long-term assessment of the impacts of different threats in the region of the Santos Basin in the state of Rio de Janeiro.

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LITERATURE CITED

Aguirre, A.A., and P.L. Lutz. 2004. Marine turtles as sentinels of ecosystem health: is fibropapillomatosis an indicator? EcoHealth 1:275−283.

Alfaro-Shigueto, J., J. Mangel, F. Bernedo, P.H. Dutton, J.A. Seminoff, and B.J. Godley. 2011. Small-scale fisheries of Peru: a major sink for marine turtles in the Pacific. Journal of Applied Ecology 48:1432−1440.

Almeida, A.P., A.J.B. Santos, J.C.A. Thomé, C. Bellini,

C. Baptistotte, M.A. Marcovaldi, A.S. dos Santos, and M. Lopez. 2011. Avaliação do estado de conservação da tartaruga marinha *Chelonia mydas* (Linnaeus, 1758) no Brasil. Pp. 12–19 *In* Biodiversidade Brasileira. Perez, M.B., R.A Magris, and K.T. Ribeiro (Eds.). Tamar/ICMBio, Bahia, Brasil.

Barata, C.R., E.H.S.M. Lima, M. Borges-Martins, J.T. Scalfoni, C. Bellini, and S. Siciliano. 2004. Records of the Leatherback Sea Turtle (*Dermochelys coriacea*) on the Brazilian coast, 1969–2001. Journal of the Marine Biological Association of the United Kingdom 84:1233–1240.

Bjorndal, K.A. 1996. Foraging ecology and nutrition of sea turtles. Pp. 199–231 *In* The Biology of Sea Turtles. Volume I. Lutz, P.L., and J.A. Musick (Eds.). CRC Press, Boca Raton, Florida, USA.

Bugoni, L., L. Krause, and M.V. Petry. 2001. Marine debris and human impacts on sea turtles in southern Brazil. Marine Pollution Bulletin 42:1330–1334.

Bugoni, L., L. Krause, and M.V. Petry. 2003. Diet of sea turtles in southern Brazil. Chelonian Conservation and Biology 4:685–688.

Cantor, M., A.S. Barreto, R.M. Taufer, B. Giffoni, P.V. Castilho, A. Maranho, C. Beatriz, C. Kolesnikovas, D. Godoy, D.W. Rogério, et al. 2020. High incidence of sea turtle stranding in the southwestern Atlantic Ocean. ICES Journal of Marine Science 77:1864–1878.

Cardoso R.S., G. Mattos, C.H.S. Caetano, T.M.B. Cabrini, L.B. Galhardo, and F. Meireis. 2011. Effects of environmental gradients on sandy beach macrofauna of a semi-enclosed bay. Marine Ecology 33:106–116.

Castilhos, J.C., C.A. Coelho, J.F. Argolo, E.A.P. Santos, A. Marcovaldi, A.S. Santos, and M. Lopez. 2011. Avaliação do estado de conservação da tartaruga marinha *Lepidochelys olivacea* (Eschscholtz, 1829) no Brasil. Pp. 26–36 *In* Biodiversidade Brasileira. Perez, M.B., R.A Magris, and K.T. Ribeiro (Eds.). Tamar/ICMBio, Bahia, Brazil.

Colman, L.P., A.R.C. Patrício, A. McGowan, A.J.B. Santos, M.A. Marcovaldi, C. Bellini, and B. Godley. 2014. Long term growth and survival dynamics of Green Turtles (*Chelonia mydas*) at an isolated tropical archipelago in Brazil. Marine Biology 162:111–122.

Colman, L.P., J.C.A Thomé, A.P. Almeida, C. Baptistotte, P.C.R. Barata, A.C. Broderick, F.A. Ribeiro, L. Vila-Verde, and B.J. Godley. 2019. Thirty years of Leatherback Turtle *Dermochelys coriacea* nesting in Espírito Santo, Brazil, 1988−2017: reproductive biology and conservation. Endangered Species Research 39:147–158.

Da Silva, A.C.C.D., J.C. Castilhos, G.G. Lopez, and P.C.R. Barata. 2007. Nesting biology and conservation of the Olive Ridley Sea Turtle (*Lepidochelys olivacea*) in Brazil, 1991/1992 to 2002/2003. Journal of the Marine Biological Association of the United Kingdom 87:1047–1056.

Doyle, T.K., J.D. Houghton, P.F. O'Súilleabháin, V.J. Hobson, F. Marnell, J. Davenport, and G.C. Hays. 2008. Leatherback Turtles satellite-tagged in European waters. Endangered Species Research 4:23–31.

Dutton, P.H., and D. Squires. 2008. Reconciling biodiversity with fishing: a holistic strategy for Pacific sea turtle recovery. Ocean Development & International Law 39:200–222.

Epperly, S.P., J. Braun, A.J. Chester, F.A. Cross, J.V. Merriner, P.A., and J.H. Churchill. 1996. Beach strandings as an indicator of at-sea mortality of sea turtles. Bulletin of Marine Science 59:289–297.

Farias, D.S.D., A.E.B. Alencar, A.C. Bomfim, A.B.L. Fragoso, S. Rossi, G.J.B. Moura, S.A. Gavilan, and F.J.L. Silva. 2019. Marine turtles stranded in northeastern Brazil: composition, spatio-temporal distribution, and anthropogenic interactions. Chelonian Conservation and Biology 18:105–111.

Freitas, M.B., and S.C.A. Rodrigues. 2014. As consequências do processo de desterritorialização da pesca artesanal na Baía de Sepetiba (RJ, Brasil): um olhar sobre as questões de saúde do trabalhador e o ambiente. Ciência & Saúde Coletiva 19:4001–4009.

Gall, S.C., and R.C. Thompson. 2015. The impact of debris on marine life. Marine Pollution Bulletin 92:170–179.

Geraci, J.R., and V.J. Lounsbury. 2005. Specimen and data collection. Pp 176–228 *In* Marine Mammals Ashore: A Field Guide for Strandings. 2nd Edition. Geraci, J.R., and V.J. Lounsbury (Eds.). National Aquarium in Baltimore, Baltimore, Maryland, USA.

Goldberg, D.W., C. Cegoni, D.W. Rogério, J. Wanderlinde, E.P. Lima, R.L. Silveira, H. Jerdy, and E.C.Q. Carvalho. 2016. Fatal *Citrobacter* coelomitis in a juvenile Green Turtle (*Chelonia mydas*): a case report. Marine Turtle Newsletter 150:10–13.

Guimaraens, M.A., A.M. Paiva., and R. Coutinho. 2005. Modeling *Ulva* spp. dynamics in a tropical upwelling region. Ecological Modelling 188:448–460.

Guimarães, S.M., H.M. Gitirana, A.V. Wanderley, C. Monteiro-Neto, and G. Lobo-Hajdu. 2013. Evidence of regression of fibropapillomas in juvenile Green Turtles *Chelonia mydas* caught in Niterói, southeast Brazil. Diseases of Aquatic Organisms 102:243–247.

Guimarães, S.M., D.C. Tavares, and C. Monteiro-Neto. 2018. Incidental capture of sea turtles by industrial bottom trawl fishery in the Tropical South-western Atlantic. Journal of Marine Biological Association of the United Kingdom 98:1525–1531.

Hamann, M., M.H. Godfrey, J.A. Seminoff, K. Arthur, P.C.R. Barata, K.A. Bjorndal, A.B. Bolten, A.C.

Broderick, L.M. Campbell, C. Carreras, et al. 2010. Global research priorities for sea turtles: informing management and conservation in the 21st century. Endangered Species Research 11:245–269.

Hazel, J., and E. Gyuris. 2006. Vessel-related mortality of sea turtles in Queensland, Australia. Wildlife Research 33:149–154.

Herbst, L.H., and P.A. Klein. 1995. Green Turtle fibropapillomatosis: challenges to assessing the role of environmental cofactors. Environmental Health Perspectives 103:27−30.

Houghton, J.D., T.K. Doyle, M.W. Wilson, J. Davenport, and G.C. Hays. 2006. Jellyfish aggregations and Leatherback Turtle foraging patterns in a temperate coastal environment. Ecology 87:1967–1972.

Instituto Chico Mendes de Conservação da Biodiversidade/Ministério do Meio Ambiente (ICMBio/MMA). 2018. Livro vermelho da fauna Brasileira ameaçada de extinção (Brazil Red Book of Threatened Species of Fauna). ICMBio/MMA, Brasília, Brazil. 76 p.

Instituto Políticas Alternativas para o Cone Sul (PACS). 2015. Baía de Sepetiba: fronteira do desenvolvimentismo e os limites para a construção de alternativas. PACS, Rio de Janeiro, Brazil. 126 p.

Jerdy, H., M.R. Werneck, M.A. da Silva, R.B. Ribeiro, M. Bianchi, E. Shimoda, and E.C.Q. de Carvalho. 2017. Pathologies of the digestive system caused by marine debris in *Chelonia mydas*. Marine Pollution Bulletin 116:192–195.

Johnsson, R.M.F., and S.M. Ikemoto. 2015. Diagnóstico do setor costeiro da Baía da Ilha Grande: Subsídios à elaboração do zoneamento ecológico-econômico costeiro. Instituto Estadual do Ambiente, Rio de Janeiro, Brazil. 242 p.

López-Barrera, E.A., G.O. Longo, and E.L.A. Monteiro-Filho. 2012. Incidental capture of Green Turtle (*Chelonia mydas*) in gillnets of small-scale fisheries in the Paranaguá Bay, Southern Brazil. Ocean & Coastal Management 60:11–18.

López-Mendilaharsu, M., C.F.D. Rocha, P. Miller, A. Domingo, and L. Prosdocimi. 2009. Insights on Leatherback Turtle movements and high use areas in the southwest Atlantic Ocean. Journal of Experimental Marine Biology and Ecology 378:31–39.

Marcovaldi M.A., and M. Chaloupka. 2007. Conservation status of the Loggerhead Sea Turtle in Brazil: an encouraging outlook. Endangered Species Research 3:133–143.

Marcovaldi, M.A., and G.G. Marcovaldi. 1999. Marine turtles of Brazil: the history and structure of Projeto TAMAR-IBAMA. Biological Conservation 91:35–41.

Marcovaldi, M.A., C. Baptistotte, J.C. De Castilhos, B.M.G. Gallo, E.H.S.M. Lima, T.M. Sanches, and C.F. Vieitas. 1998. Activities by Project TAMAR in Brazilian sea turtle feeding grounds. Marine Turtle Newsletter 80:5–7.

Marcovaldi, M.A., G.G. Lopez, L.S. Soares, A.J.B. Santos, C. Bellini, and P.C.R. Barata. 2007. Fifteen years of Hawksbill Sea Turtle (*Eretmochelys imbricata*) nesting in Northern Brazil. Chelonian Conservation and Biology 6:223–228.

Mascarenhas, R., R. Santos, and D. Zeppelini. 2005. Stranded sea turtles on the coast of Paraíba, Brazil. Marine Turtle Newsletter 107:13–14.

Monteiro, D.S. 2004 Encalhes e interação de tartarugas marinhas com a pesca no litoral do Rio Grande do Sul. Monografia. M.Sc. Thesis, Universidade Federal do Rio Grande, Rio Grande, Rio Grande do Sul, Brazil. 63 p.

Monteiro, D.S., S.C. Estima, T.B.R. Gandra, A.P. Silva, L. Bugoni, Y. Swimmer, J.A. Seminoff, and E.R. Secchi. 2016. Long-term spatial and temporal patterns of sea turtle strandings in southern Brazil. Marine Biology 163:1–19.

Muehe, D., and E. Valentini. 1998. O litoral do estado do Rio de Janeiro: uma caracterização físico-ambiental. Fundação de Estudos do Mar (FEMAR), Rio de Janeiro, Brazil. 123 p.

Naro-Maciel, E., A.C.V. Bondioli, M. Martin, A.P. Almeida, C. Baptistotte, C. Bellini, M.A. Marcovaldi, A.J.B. Santos, and G. Amato. 2012. The interplay of homing and dispersal in Green Turtles: a focus on the southwestern Atlantic. Journal of Heredity 103:792–805.

Oravetz, C.A. 2000. Reducción de la captura incidental en las pesquerías. Pp. 217–222 *In* Técnicas de Investigación y Manejo para la Conservación de Tortugas Marinas. (Traducción al español). Eckert, K.L., K.A. Bjorndal, F.A. Abreu-Grobois, and M. Donnelly (Eds.). Publicación no. 4, Grupo de Especialistas en Tortugas Marinas de la Unión Internacional de Conservación de la Naturaleza/ Comisión para la Supervivencia de las Especies. Washington, D.C., USA.

Petitet, R., and L. Bugoni. 2017. High habitat use plasticity by female Olive Ridley Sea Turtles (*Lepidochelys olivacea*) revealed by stable isotope analysis in multiple tissues. Marine Biology 164:134.

Poli, C., L.C.S. Lopez, D.O. Mesquita, C. Saska, and R. Mascarenhas. 2014. Patterns and inferred processes associated with sea turtle strandings in Paraíba State, Northeast Brazil. Brazilian Journal of Biology 74:283–289.

Reis, E.C., D.W. Goldberg, and G.G. Lopez. 2017. Diversidade e distribuição de tartarugas marinhas na área de influência das atividades de E&P na Bacia de Campos, Rio de Janeiro. Pp. 121–159 *In* Mamíferos, Quelônios e Aves: Caracterização Ambiental Regional da Bacia de Campos, Atlântico Sudoeste. Reis, E.C., and M.P. Curbelo-Fernandez (Eds.). Elsevier, Rio de Janeiro, Brazil.

Reis, E.C., J.F. Moura, L.M. Lima, B. Rennó, and S. Siciliano. 2010. Evidence of migratory movements of Olive Ridley Turtles (*Lepidochelys olivacea*) along the Brazilian coast. Brazilian Journal of Oceanography 58:255–259.

Reis, E.C., V.V. Silveira, and S. Siciliano. 2009. Records of stranded sea turtles on the coast of Rio de Janeiro State, Brazil. Marine Biodiversity Records 2:1–4.

Rizzi, M., F.L. Rodrigues, L. Medeiros, I. Ortega, L. Rodrigues, D.S. Monteiro, F. Kessler, and M.C. Proietti. 2019. Ingestion of plastic marine litter by sea turtles in southern Brazil: abundance, characteristics and potential selectivity. Marine Pollution Bulletin 140:536–548.

Robinson, N.J., S.J. Morreale, R. Nel, and F.V. Paladino. 2016. Coastal Leatherback Turtles reveal conservation hotspot. Scientific Reports 6:1–9.

Sales, G., B.B. Giffoni, and P.C.R. Barata. 2008. Incidental catch of sea turtles by the Brazilian pelagic longline fishery. Journal of the Marine Biological Association of the United Kingdom 88:853–864.

Sales, G., B.B. Giffoni, F.N. Fiedler, V.G. Azevedo, J.E. Kotas, Y. Swimmer, and L. Bugoni. 2010. Circle hook effectiveness for the mitigation of sea turtle bycatch and capture of target species in a Brazilian pelagic longline fishery. Aquatic Conservation 20:428–436.

Sanches, T.M., and C. Bellini. 1999. Juvenile *Eretmochelys imbricata* and *Chelonia mydas* in the Archipelago of Fernando de Noronha, Brazil. Chelonian Conservation and Biology 3:308–311.

Santos, A.S.D., A.D.P. Almeida, A.J.B. Santos, B.M.G. Gallo, B. Giffoni, C. Baptistotte, C.A. Coelho, E.H.S.M. Lima, G. Sales, G.G. Lopez, et al. 2011a. Plano de Ação Nacional para a Conservação das Tartarugas Marinhas. Instituto Chico Mendes de Conservação da Biodiversidade, Brasilia, Brazil. Série Espécies Ameaçadas 25:25–47.

Santos, A.S.D, L.S. Soares, M.A. Marcovaldi, D.S. Monteiro, B. Giffoni, and A.P. Almeida. 2011b. Avaliação do estado de conservação da tartaruga marinha *Caretta caretta* Linnaeus, 1758 no Brasil. Pp. 1–9 *In* Avaliação do Estado de Conservação das Tartarugas Marinhas. Biodiversidade Brasileira. Perez, M.B., R.A Magris, and K.T. Ribeiro (Eds.) Tamar/ICMBio, Bahia, Brazil.

Schroeder, R., J.O. Branco, F. Freitas, Jr, and C. Resgalla, Jr. 2014. Preliminary assessment of the jellyfish bycatch captured off southern and southeastern Brazil. Latin American Journal of Aquatic Research 42:289–300.

Schuyler, Q., B.D. Hardesty, C. Wilcox, and K. Townsend. 2014. Global analysis of anthropogenic debris ingestion by sea turtles. Conservation Biology 28:129–139.

Seminoff, J.A. 2004. *Chelonia mydas*. The IUCN Red List of Threatened Species 2004. https://www.iucnredlist.org.

Senko J., A. Mancini, J.A. Seminoff, and V. Koch V. 2014. Bycatch and directed harvest drive high Green Turtle mortality at Baja California Sur, Mexico. Biological Conservation 169:24–30.

Silva, A.C.C.D., J.C. Castilhos, G.G. Lopez, and P.C.R. Barata. 2007. Nesting biology and conservation of the Olive Ridley Sea Turtle (*Lepidochelys olivacea*) in Brazil, 1991/1992 to 2002/2003. Journal of the Marine Biology Association of the United Kingdom 87:1047–1056.

Sutherland, W.J., M. Clout, I.M. Côté, P. Daszak, M.H. Depledge, L. Fellman, E. Fleishman, R. Garthwaite, D.W. Gibbons, J. De Lurio, et al. 2010. A horizon scan of global conservation issues for 2010. Trends in Ecology & Evolution 25:1–7.

Tagliolatto, A.B., B. Giffoni, S.M. Guimarães, M.H. Godfrey, and C. Monteiro-Neto. 2019a. Incidental capture and mortality of sea turtles in the industrial double-rig-bottom trawl fishery in south-eastern Brazil. Aquatic Conservation: Marine and Freshwater Ecosystems 30:351–363.

Tagliolatto A.B., D.W. Goldberg, M.H. Godfrey, and C. Monteiro-Neto. 2019b. Spatio-temporal distribution of sea turtle strandings and factors contributing to their mortality in south-eastern Brazil. Aquatic Conservation: Marine and Freshwater Ecosystems 30:331–350.

Tagliolatto, A.B., S.M. Guimarães, G. Lobo-Hadju, and C. Monteiro-Neto. 2016. Characterization of fibropapillomatosis in Green Turtles *Chelonia mydas* (Cheloniidae) captured in a foraging area in southeastern Brazil. Diseases of Aquatic Organisms 121:233–240.

Thomé, J.C.A., C. Baptistotte, L.M.P. Moreira, J.T. Scalfoni, A.P. Almeida, D.B Rieth, and P.C.R. Barata. 2007. Nesting biology and conservation of the Leatherback Sea Turtle (*Dermochelys coriacea*) in the State of Espírito Santo, Brazil, 1988-1989 to 2003-2004. Chelonian Conservation Biology 6:15–27.

Tomás, J., P. Gozalbes, J.A. Raga, and B.J. Godley. 2008. Bycatch of Loggerhead Sea Turtles: insights from 14 years of stranding data. Endangered Species Research 5:161–169.

Tourinho, P.S., J.A. Ivar do Sul, and G. Fillmann. 2010. Is marine debris ingestion still a problem for the coastal marine biota of southern Brazil? Marine Pollution Bulletin 60:396–401.

Valentin, J.L. 2001. The Cabo Frio upwelling system, Brazil. Pp. 97–105 *In* Ecological Studies: Coastal Marine Ecosystems of Latin America. Seeliger, U., and B. Kjerfve (Eds.). Springer-Verlag, Berlin, Heidelberg, Germany.

Vegter, A.C., M. Barletta, C. Beck, J. Borrero, H. Burton, M.L. Campbell, M.F. Costa, M. Eriksen, C. Eriksson, A. Estrades, et al. 2014. Global research priorities to mitigate plastic pollution impacts on marine wildlife. Endanger Species Research 25:225–247.

Vélez-Rubio, G.M., A. Estrades, A. Fallabrino, and J. Tomás. 2013. Marine turtle threats in Uruguayan waters: insights from 12 years of stranding data. Marine Biology 160:2797–2811.

Vélez-Rubio, G.M., N. Teryda, P.E. Asaroff, A. Estrades, D. Rodriguez, and J. Tomás. 2018. Differential impact of marine debris ingestion during ontogenetic dietary shift of Green Turtles in Uruguayan waters. Marine Pollution Bulletin 127:603–611.

Vélez-Rubio, G.M., R. Trinchin, A. Estrades, V. Ferrando, and J. Tomás. 2017. Hypothermic stunning in juvenile Green Turtles (*Chelonia mydas*) in Uruguayan coastal waters: learning for future events. Chelonian Conservation and Biology 16:151–158.

Wallace, B.P., A.D. DiMatteo, B.J. Hurley, E.M. Finkbeiner, A.B. Bolten, M.Y. Chaloupka, B.J. Hutchinson, F.A. Abreu-Grobois, D. Amorocho, K.A. Bjorndal, et al. 2010. Regional management units for marine turtles: a novel framework for prioritizing conservation and research across multiple scales. PLoS ONE 5:1–11. https://doi.org/10.1371/journal.pone.0015465

Werneck, M.R., L.G. Almeida, P. Baldassin, S. Guimarães, L.A. Nunes, P. Lacerda, and A.L. Oliveira. 2018. Sea turtle beach monitoring program in Brazil. Pp. 23–47 *In* Reptiles and Amphibians. Gutiérrez, D.R.A. (Ed.). IntechOpen, London, UK.

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