



Evidence of Leatherback Turtles (*Dermochelys coriacea*) in Brazilian Subtropical Coastal Waters

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Little is known about the range, distribution, and seasonal movements of many pelagic megafauna (Hays et al. 2016). The constraints are intrinsic to animals' remote and sparse distributions (Hays et al. 2009). Paradoxically, some of these large pelagic species are easily recognized and charismatic (Houghton et al. 2006). The Leatherback Turtle (*Dermochelys coriacea*) is the largest and most widely distributed extant sea turtle (López-Mendilaharsu et al. 2009). Leatherback Turtles are highly migratory, traveling thousands of kilometers

between tropical coastal nesting beaches and remote foraging habitats in search of gelatinous macrozooplankton (e.g., salps, Scyphomedusae, Siphonophora) (López-Mendilaharsu et al. 2009; Fossette et al. 2010; Almeida et al. 2011).

Some studies have been conducted on the distribution and movement patterns of the Leatherback Turtle, with information on the migration and foraging along the Brazilian coast (Almeida et al. 2011; Billes et al., 2006; Lopes et al. 2004; López-Mendilaharsu, 2009; Witt et al., 2011).

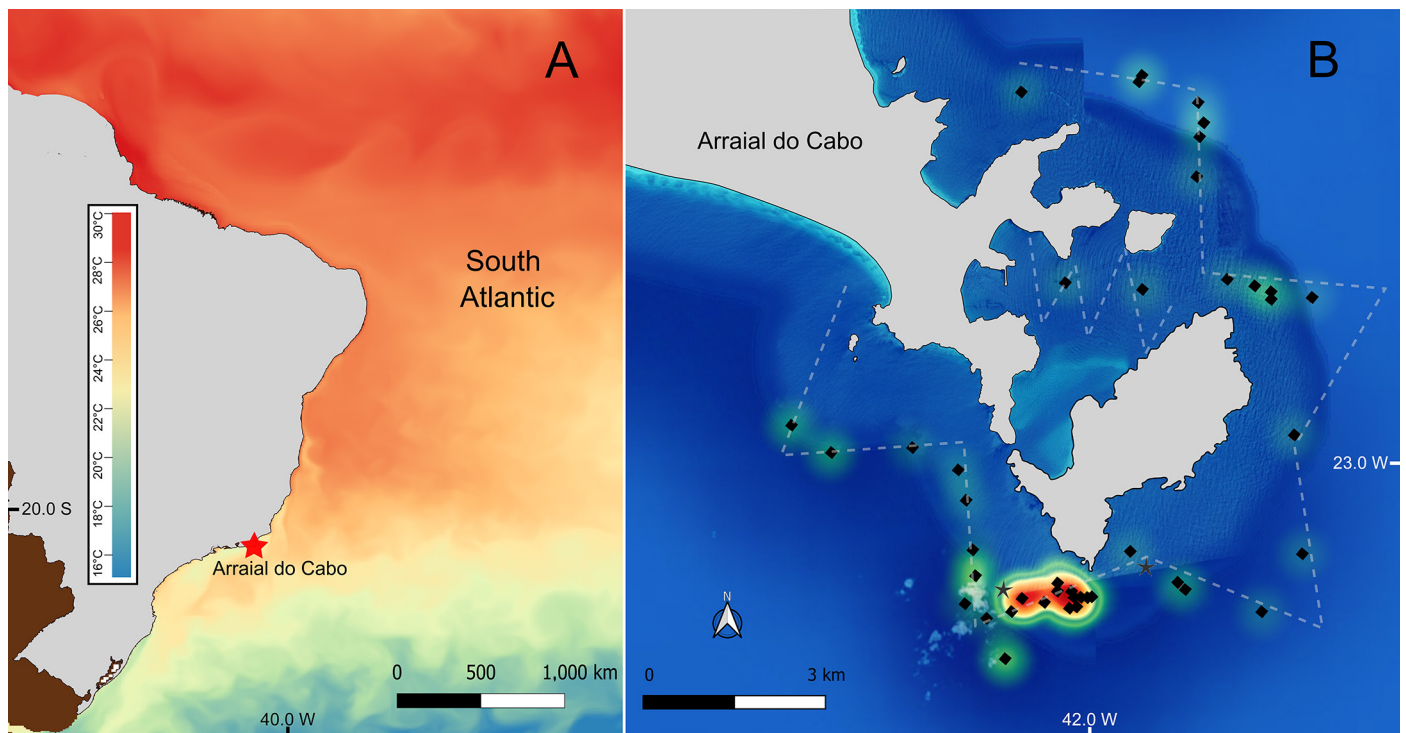


Figure 1. Location of Arraial do Cabo in the Brazilian coast (A). Spatial distribution of Leatherback Turtles (*Dermochelys coriacea*; black diamonds) and Ocean Sunfish (*Mola mola*; gray stars) sightings in the study area at Arraial do Cabo from November to December 2019 (B). The heat map, based on number of sightings of *D. coriacea*, was created with the kernel density function of ArcGIS. Brightness of red shading corresponds to higher relative density of sightings. Dashed lines indicate transect routes.

The Leatherback has a complex behavior, with transoceanic (Africa-Brazil) and latitudinal (South America coast) migrations between nesting and feeding areas (López-Mendilaharsu et al. 2009; Almeida et al. 2011). In the southwestern Atlantic Ocean, Leatherback Turtles are only known to regularly nest in eastern Brazil. This is a population of conservation concern due to small population size, restricted nesting geographical distribution, and its susceptibility to threats (e.g., climate change, bycatch, and pollution) (Colman et al. 2019).

Herein we report direct observations of a Leatherback Turtle coastal aggregation in the southwest Atlantic Ocean. Although records of Leatherback Turtle movement throughout the Brazilian coast are existent, this is the first time that a high number of individuals has been observed less than 3 km from the continent. This report provides additional information about their distribution and the possible dispersal patterns of the species.

The study area is located off the coast of Arraial do Cabo (-22.950000 S, -42.016667 W), on the south-eastern coast of Brazil. The Arraial do Cabo Coast is marked by a change in the shoreline orientation from north-south to northeast-southwest (Fig. 1), and it has a narrow continental shelf. During the austral spring and summer, the prevailing winds (north-northeast) combined with the geomorphology of the coast, result in upwelling (Valentin 2001; Coelho-Souza et al. 2012). Upwelling events bring nutrient-rich, deep, and cold waters (<18 °C) to the surface of the South Atlantic Central Waters (SACW) (Valentin 2001). This phenomenon boosts primary productivity, supporting high fish density (Coelho-Souza et al. 2012). The study area is located within a highly touristic marine protected area with a recently elaborated management plan lacking no-take zones. This region has great ecological and biogeographic importance, harboring tropical and subtropical species, including other species of sea turtles (Mello-Fonseca et al. 2021).

We conducted bimonthly surveys with a mean duration of 5 h (range: 4–6 h) from March 2019 to March 2020 (34 research days) in a 9.6 m wooden vessel with a 3-cylinder WMW engine. The surveys followed a line transect route at approximately 6 km/h to maximize study area coverage (Fig. 1b). When an animal was spotted, geographic coordinates were recorded with a GPS (GARMIN eTrex 10). We collected superficial sea water temperature (analog thermometer), wind direction/speed (<https://portal.inmet.gov.br/>), and salinity (Portable refractometer with automatic temperature compensation). Photographic records were made using DSLR (Nikon D3100) and underwater cameras (X-TRAX EVO). The fieldwork was part of a Cetaceans and Turtles Monitoring Project (conducted by Instituto SENAI de Tecnologia Química e Meio Ambiente da Firjan) linked to the environmental permitting and licensing requirements of the local port (Porto do Forno) activities (Abio 892/2009).

Between November and December 2019, we observed a total of 67 Leatherback Turtles (Figs. 1b, 2a), a species not encountered in the region before or after this period. A maximum of 20 individuals were recorded in a single day (Table 1). Leatherbacks were observed feeding on jellyfish (Cnidaria, Medusae) patches. Moreover, we also encountered two Ocean Sunfish (*Mola mola*) (Figs. 1b & 2b). Leatherback Turtles and Ocean Sunfish were in an area with maximum depths of 60–87 m. The prevalence of strong northeasterly winds and low temperature (<18 °C) regimes were an indication of the upwelling typical of the austral spring. Salinity was constant throughout the observations. We highlight that both species were observed at distances not much more than 3 km from the coast.

The Leatherback Turtle is an oceanic species crossing ocean basins between Brazil and Africa (Almeida et al. 2011). Although evidence exists of Leatherbacks foraging in southwestern Atlantic coastal waters (López-Mendilaharsu

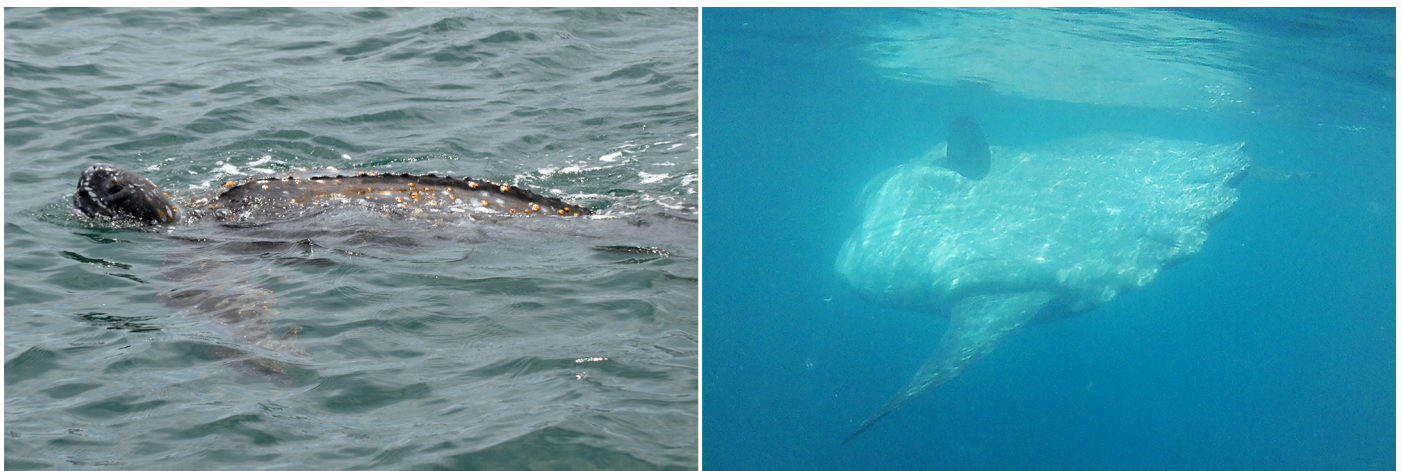


Figure 2. Leatherback Turtle (*Dermochelys coriacea*) (left) and Ocean Sunfish (*Mola mola*) (right) at Arraial do Cabo, Brazil. Photographs by Fabio Cruz (left) and Raquel Muniz (right).

Table 1. Summary of Leatherback Turtle (*Dermochelys coriacea*) and Ocean Sunfish (*Mola mola*) sightings and corresponding abiotic data in Arraial do Cabo, Brazil.

Specie	Day	Sightings	Wind speed (kts)	Wind direction	Temperature (°C)	Salinity (ppm)
<i>Dermochelys coriacea</i>	03 Nov 2019	13	12	NE	15	35
<i>Dermochelys coriacea</i>	20 Nov 2019	4	11	NE	22	35
<i>Dermochelys coriacea</i>	21 Nov 2019	12	17	NE	19	35
<i>Mola mola</i>	21 Nov 2019	2	17	NE	19	35
<i>Dermochelys coriacea</i>	22 Nov 2019	20	20	NE	18	35
<i>Dermochelys coriacea</i>	30 Nov 2019	1	6	NE	17	35
<i>Dermochelys coriacea</i>	01 Dec 2019	17	8	NE	13	35

et al. 2009), most reports come from dead and injured turtles, stranded or bycaught in fisheries (Barata et al. 2004; Monteiro et al. 2016). Therefore, the novelty of this record is the high number of individuals aggregated near the Brazilian coast (< 1 km to 3 km) for multiple days. The presence of a coastal aggregation of Leatherback Turtles not only presents a unique opportunity for conservation, but also highlights the importance of this area as a marine biodiversity hotspot for oceanic fauna.

The observation of Leatherback Turtles in Arraial do Cabo waters occurred during austral spring corresponding to a period when the upwelling has a higher prevalence. The upwelling nutrient-rich waters increase the productivity of phytoplankton and zooplankton communities (Valentin 2001; Coelho-Souza et al. 2012). The high levels of primary productivity and food availability due to the upwelling attracts a wide range of large pelagic consumers. For instance, the Arraial do Cabo region hosts Bryde's Whales (*Balaenoptera brydei*), Dwarf Minke Whales (*B. acutorostrata*), and Shark Whales (*Rhincodon typus*) (Hassel et al. 2003; Maciel et al. 2016; Di Benedetto et al. 2021). These species' prey items (e.g., copepods, jellyfish, squids, and small fishes) are present in considerable numbers under the influence of the upwelling, suggesting that the coast of Arraial do Cabo is possibly an important seasonal feeding ground for large pelagic animals (Valentin 2001; Coelho-Souza et al. 2012). However, determining the long-term influence of environmental factors on Leatherback Turtle sightings in Arraial do Cabo requires further investigation.

Telemetry studies indicate that the southeast Brazilian coast (including Arraial do Cabo) is likely a migratory corridor for nesting Leatherback Turtles (Almeida et al. 2011). Local artisanal fishermen indicated that the Leatherback is the second most captured species in Arraial do Cabo (Awabdi, 2019). Furthermore, stranding events of Leatherback Turtles are common in the study area (Tagliolatto et al. 2020). Less is known about Ocean Sunfish in Brazilian coastal waters and reports for Arraial do Cabo are concentrated on social media (JGF pers. comm.). While the occurrence of Ocean Sunfish

reported here is low, both species show similar distribution elsewhere (see Mosnier et al. 2019). The distribution of Leatherback Turtles and Ocean Sunfish species is influenced by sea surface temperature, food availability, and currents (Pope et al. 2010; Mosnier et al. 2019). However, physiological differences between species result in finer-scale niche segregation, and density extrapolations are likely to be inaccurate.

At first the remarkable number of recorded Leatherback Turtles may seem related to the migration to the reproductive area (September to March) about 200 km from the study site (Almeida et al. 2011; Vargas et al. 2017). However, the annual Brazilian nesting population consists of between 15 and 18 females (Colman et al. 2019). It is possible that individuals sighted are from different nesting colonies. The southwestern Atlantic is a mixed foraging area for Leatherback Turtles from different rookeries (West Africa and North Atlantic) (Vargas et al. 2017). Indeed, part of the largest nesting rookery for Leatherback Turtles in the world feeds in the Brazilian coast (Witt et al. 2011). The proximity of the coast and accessibility of the study area may facilitate further studies to elucidate the genetic composition of individuals using the Brazilian coast.

Although globally classified as vulnerable (Wallace et al. 2013), the Leatherback Turtle is critically endangered on the Brazil list (ICMBio 2018). Species at coastal waters are exposed to multiple threats (Monteiro et al. 2016; Tagliolatto et al., 2020). Evidence and reports of incidental catches and sea turtle-fishery interactions are known in Arraial do Cabo (Reis et al. 2017; Awabdi 2019). Moreover, port activity, and an intense aquatic tourism are a matter of concern as both may negatively affect sea turtle populations through boat strikes, plus acoustic and other pollution sources (Giglio et al. 2017; Reis et al. 2017; Campbell et al. 2019; Tagliolatto et al. 2020). The foraging aggregations are formed by individuals from several rookeries (Vargas et al. 2017), and thus the potential impacts on Leatherback Turtles using the waters of Arraial do Cabo may have widespread consequences.

This study provides new information on Leatherback Turtle distribution, at a location that was not previously

known to have a large number of sightings. Although preliminary, our findings identify Arraial do Cabo as a foraging ground for Leatherback Turtles. Therefore, the occurrence of Leatherbacks in the region may provide baseline information for guiding management strategies. The finding of Leatherback Turtle aggregations requires investigation to provide information on habitat use, seasonality, and ecological drivers. Additional spatiotemporal study is needed to understand the frequency and size of the area for this sea turtle species. Also, artisanal fishermen could be involved in the conservation of the species as habitat-overlap is possible (Awabdi 2019). Identifying specific key coastal habitats might provide opportunities to impact mitigation and protection of endangered populations.

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