South Atlantic Cetacean Project (SACET)

The Gulf of Guinea Expedition 2025

Summary Report

Key Findings and Insights into the Humpback Whale Breeding Season

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Surveys conducted in São Tomé and Príncipe, between August and October 2025

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Introduction

São Tomé and Príncipe is a biologically rich tropical archipelago, located on the equator, close to the west African shoreline, in the Gulf of Guinea. Since 2012 São Tomé and Príncipe have been part of the UNESCO World Network of Biosphere Reserve (Ceríaco et al., 2022). Despite this designation, its marine habitats remain relatively understudied. The earliest information on cetaceans in the region originated from historical whaling records (Carvalho et al., 2022; Townsend, 1935). Dedicated scientific research did not begin until the early 2000s, and initially focused exclusively on the waters surrounding São Tomé Island (Brito et al., 2010; Carvalho et al., 2011, 2022; Carvalho Ines, 2004; Pereira et al., 2013; Picanço et al., 2009). In 2020, the first scientific surveys were conducted around Príncipe Island within the framework of the SACET project's first expedition (Sesani et al., 2020). As the only dedicated scientific effort targeting Príncipe, this initiative represents the first confirmation of cetacean presence around the island. Consequently, all current species descriptions for waters surrounding Príncipe derive from the SACET project. Through all the previously mentioned studies, a total of 11 cetacean species have been recorded in the waters of São Tomé and Príncipe, including the Humpback whale (*Megaptera novaeangliae*), Sperm whale (*Physeter macrocephalus*), Dwarf sperm whale (*Kogia sima*), Short-finned pilot whale (*Globicephala macrorhynchus*), Killer whale (*Orcinus orca*), Pygmy killer whale (*Feresa attenuata*), Risso's dolphin (*Grampus griseus*), Bottlenose dolphin (*Tursiops truncatus*), Pantropical-spotted dolphin (*Stenella attenuata*), Rough-toothed dolphin (*Steno bredanensis*), and Striped dolphin (*Stenella coeruleoalba*) (Carvalho et al., 2022; Picanço et al., 2009). Additionally, during the first SACET expedition in 2020, a 12th species, the False killer whale (*Pseudorca crassidens*) was added to the regional species list, marking the first documented occurrence of this species in the waters of São Tomé and Príncipe (Sesani et al., 2020). However, research efforts in the region have been limited and sporadic, resulting in data that remain insufficient to fully assess cetacean diversity, distribution, and population trends. Continuous and systematic monitoring is therefore essential to improve understanding of the occurrence patterns, habitat use, and potential threats faced by these species within the São Tomé and Príncipe Exclusive Economic Zone.

The SACET (South Atlantic Cetacean) Project is a research and conservation initiative led by the EDMAKTUB Association, dedicated primarily to the study of cetaceans in the South Atlantic Ocean. The project's first expedition took place in the Gulf of Guinea in 2020, focusing survey efforts on the waters surrounding São Tomé and Príncipe (Sesani et al., 2020), with a particular focus on Humpback whales that migrate to the region to breed (Carvalho et al., 2011; Ramos et al., 2023). Building on that campaign, the 2025 expedition returned to São Tomé and Príncipe to further assess the marine biodiversity of the archipelago and to continue studying humpback whales that use these waters as calving and breeding grounds. The data collected during this expedition provide an opportunity to compare findings with those from the 2020 campaign, thereby contributing to the development of a comprehensive baseline for future ecological and conservation research in the region.

Research Objectives

This initiative aimed to assess local marine biodiversity, especially cetaceans and other marine fauna in the Gulf of Guinea, with a particular focus around the islands of São Tomé and Principe. Research activities were primarily concentrated around Príncipe Island, as this area remains comparatively the most understudied. The goal is to address existing knowledge gaps and enhance understanding to support conservation efforts and the sustainable use of the country's coastal marine ecosystems. Fostering community-driven marine biodiversity management.

The research program is structured around four primary objectives, each contributing to a comprehensive understanding of marine ecosystems and the promotion of effective conservation strategies.

(1) Cetacean Research serves as the cornerstone of the program, with a primary emphasis on southern hemisphere humpback whales (*Megaptera novaeangliae*) that migrate to the region to breed. This research encompasses a range of sub-disciplines, including photo-identification for individual recognition and tracking, behavioral investigation, habitat use studies to elucidate spatial and temporal distribution patterns, and body condition assessments to evaluate individual and overall population health. On a broader scale, the expedition also monitors the presence, diversity, and distribution of other cetacean species within the study area, contributing to a more comprehensive understanding of the region’s marine mammal community.

(2) Megafauna Monitoring expands the research scope to include other large marine taxa, such as sharks, rays, large bony fishes, sea turtles and sea birds, thereby facilitating an integrated understanding of the local biodiversity.

(3) Habitat Assessment aims to evaluate the composition and condition of marine habitats while identifying key human impacts such as pollution, unsustainable fishing practices, and illegal fisheries. This objective seeks to understand how these anthropogenic pressures affect ecosystem health, species distribution, and habitat quality within the study area.

(4) Collaboration and Outreach emphasize the importance of interdisciplinary partnerships and stakeholder engagement. Through collaboration with academic institutions, conservation organizations, and local communities, this pillar promotes data sharing, capacity building, and public awareness, thereby strengthening collective efforts toward evidence-based and sustainable marine resource management.

Research activities were approved and licensed by the Ministério de Agricoltura, Pesca e Desenvolvimento Rural, Direcção das Pescas, under the Autorização n°02/DP/MAPDR/2025.

Methods

Study Area

São Tomé and Príncipe are young, volcanic, oceanic islands located near the equator as part of the Gulf of Guinea island system. São Tomé rises sharply from the surrounding ocean and is encircled by an extensive submarine platform of approximately 450 km², bounded by the 200 m isobath (Henriques and Neto, 2023). Príncipe features steep topography with a relatively narrow littoral zone of about 86 km², with depths generally less than 25 m, beyond which waters drop rapidly to over 2,000 m (Cowburn, 2019). Both islands are accompanied by multiple smaller islets: São Tomé's largest are Cabras, Santana, Sete Pedras, and Rolas, while Príncipe comprises six islets, including Bom-Bom, Caroco (Jockey's Cap), Tinhosa Grande, and Tinhosa Pequena (Figure 1). The region is influenced by four major ocean currents; the Guinea Current, Benguela Current, Angola Current, and South Equatorial Current, which shape local oceanographic conditions (Ceríaco et al., 2022). The bathymetric and geomorphological features of the islands, shaped by their volcanic origin along the Cameroon Volcanic Line, play a major role in determining local habitat distribution, water circulation, and nutrient availability. These factors are essential for understanding the structure and functioning of the surrounding marine ecosystem. (Ceríaco et al., 2022).

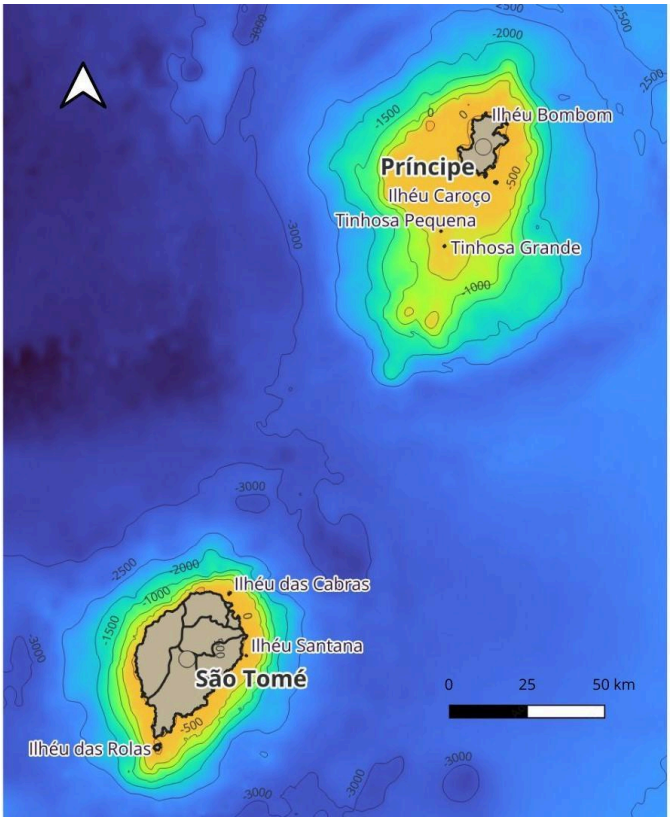


Figure 1: Map of the study area

Data Collection

Fieldwork was conducted aboard MAKTUB, a 14.15 meter, well-equipped research catamaran (Figure 2), which served both as the primary research platform and as a liveaboard for the crew. The expedition set sail on the 10th of July from Santiago Island, Cabo Verde following the west African coast line till Ivory coast and then crossed the Gulf of Guinea to arrive in Sao Tomé and Príncipe on the 25th of July. Surveys commenced in São Tomé on August 1st and ceased on the 26th of October. were carried out across and around the islands, with survey routes largely dictated by prevailing weather conditions. Randomized transects were conducted in shallow coastal waters surrounding the islands and islets, as well as in the pelagic zones between the two main islands. The vessel anchored overnight in various sheltered bays, resulting in transects starting and ending from multiple locations. Longer transects were undertaken during crossings between the islands, providing extended survey effort.

Figure 2: Research vessel, the MAKTUB, in front of the south coast of Príncipe

Daily surveys were conducted when weather conditions permitted (sea state < Beaufort 4, visibility > 2 km). Minimum of two observers were positioned on both sides of the vessel, covering approximately 180° each to maximize visual coverage. During the survey effort, data on weather conditions, sightings of cetaceans, fish, turtles, birds, other marine fauna, and marine debris were recorded using LOGGER2010 software, including GPS coordinates. For cetacean sightings, the following information was collected: date, start and end time, coordinates, species, group size, behavior, presence of parasites, reactions to the vessel, and any sample collection. For other megafauna, size, density, and behavior were recorded, while for marine debris, type, size, and density were documented.

Upon encountering cetaceans, particularly humpback whales, the vessel transitioned from sailing to engine power to facilitate smoother maneuvering during data collection. The approach was conducted under 5 knots, to minimise disturbance. Vessel operations in cetacean proximity and scientific work was conducted in accordance with the local Law on Fauna, Flora and Protected Areas (Law No. 11/99) and the Marine Resource/EEZ Law (Decreto-Lei No. 63/81). The vessel followed the animals' movements, maintaining a parallel or diagonal position relative to the posterior of the whale at a distance of 100-300 meters. When in close proximity, the engine was either switched off or placed in neutral to minimize disturbance.

Equipment

Three DJI drone models (Mavic 2 Pro, Mavic 3, Mavic 3 classic) were deployed when whales were observed within 500 meters of the vessel to capture video footage for photo-identification, behavioral observations, and body condition assessments. The drones were remotely operated using the DJI app on an Apple iPad Air and recorded high-resolution video, with a maximum of 4K at 120 frames per second.

Two Nikon D7100 digital SLPR cameras were employed, one equipped with an AF-S 75-300 mm VR Nikon lens, and the other with a 150-600 mm Sigma lens.

An Aquarian audio H2D hydrophone, coupled with a ZOOM H4N audio recorder, was used for occasional acoustic monitoring.

Flight Procedure

Drones were launched from the stern of the vessel to minimize the risk of collisions with external structures. The primary objective of each flight was photo-identification. For this purpose, drones were flown over whales to capture the entire body and obtain close views of the head, maintaining an altitude of approximately 5–30 meters. Camera orientation was adjusted to optimize lighting conditions, minimizing glare and other visual obstructions.

During diving sequences, drones were positioned at a lower angle behind the whale to capture clear images of the ventral side of the fluke, increasing the likelihood of obtaining still frames suitable for assessing fluke shape and coloration. To complement conventional photo-identification, drones were also flown alongside the animal at a lower angle to capture the dorsal fin from a 90° perspective.

For body condition assessments and behavioral observations, drones were maintained above the whale with the entire body in the field of view, following the animal's movements. This flexible positioning allowed comprehensive documentation of individual identification features as well as natural behaviors.

During sightings, breathing patterns, including the number of breaths and dive durations, were recorded to optimize the positioning of both the vessel and drone for subsequent surfacing, maximizing the likelihood of obtaining high-quality footage. Additionally, the drone's position served as a visual cue to aid the maneuvering of the research vessel.

Conventional Photo-Identification

Photographs were captured using Nikon D7100 digital SLR cameras for species recognition and photo-identification. For the prior clear images were obtained of cetaceans and other marine megafauna, focusing on the frontal region and, when possible, the entire body, to facilitate species identification based on general morphology and coloration patterns.

For individual photo-identification, particular attention was given to the dorsal fin and fluke, as well as any distinctive features such as notches, lesions, or scars. Efforts were made to capture dorsal fins from both sides at a 90° angle, although this was not always achievable, and flukes were photographed from behind during diving sequences at a 0° angle.

Acoustic monitoring

Occasional acoustic monitoring was conducted to detect cetacean presence in the study area during both day and night. The Aquarian audio H2D hydrophone, connected to a Zoom H4N audio recorder, was deployed in the water at depths of 1–5 meters while the vessel engine was turned off and the boat remained stationary.

Data Processing

The datasets generated during the expedition were processed, visualized, and analyzed using R (version 4.0.3) and RStudio (Version: 2023.03.1+446 (R Core Team, 2023)), using the following packages: ggplot, sf, dplyr, naturalearth, naturalearth data, marmap (H. Wickham, 2016; H. Wickham et al., 2022; Kelso & Patterson, 2010; Pante & Simon-Bouhet, 2013; Pebesma, 2018). Marine megafauna sighting data, marine debris and research effort were compiled and summarized to quantify survey coverage and encounter rates. Sighting frequencies for cetaceans were calculated and tabulated, while the number of individuals encountered was visualized for cetaceans, seabirds, and other marine fauna (e.g., fish). For humpback whales, group composition metrics and behavioral states were systematically assessed, and the occurrence and composition of encountered marine debris was visualized. Maps, both distribution and track maps were created in QGIS (Version: 3.40.5 (QGIS Development Team)).

Photo-identification processing

For each observed animal, photographs underwent a quality control process through visual assessment, during which images of low resolution or with inadequate angles were discarded. Dorsal fin shapes were categorized into types 1 to 5 following categorization created by Mizroch in 1990. Fluke images were similarly categorized into groups 1 to 5, where 1 represents a completely white fluke and 5 a completely black fluke (Mizroch et al., 1990), when applicable, to serve as baseline criteria. Individual animals were then separated, and the best images of the dorsal fin, fluke, and vertical drone shots were collected.

These images were subsequently compared to the existing catalogue from the 2020 expedition. If no matches were found, a new entry was created in the catalogue, recording the animal's identification, date, fluke and fin categories, any associated animals, and all relevant images.

Drone footage was also assessed visually in Adobe Lightroom, from which still images of the head, entire body, dorsal fin, and fluke (when available) were extracted for each individual. Animals were compared to previously catalogued individuals, and unmatched animals were added to a dedicated drone ID catalogue, including the drone ID, date, and footage filenames.

Finally, the drone catalogue was integrated with the general photographic catalogue to complete each animal's information sheet, ensuring the compilation of all available data for each individual.

Additionally, fluke images were submitted to the HappyWhale platform, a global citizen-science database employing artificial intelligence to identify and track individual whales, allowing verification of matches and evaluation of population connectivity across ocean basins.

Results and Discussion

The crossing between the two archipelagos, from Cabo Verde to São Tomé and Príncipe took 15 days under harsh weather conditions, which accelerated the journey; however, strong winds and high waves made visual monitoring challenging, resulting in only a small number of cetacean sightings.

The research vessel and team first arrived at the waters of the island nation at the end of July, approaching from the northwest of São Tomé, and commenced surveys on the 1st of August and ceased on the 26th of October. Survey effort was concentrated around both islands; in the case of São Tomé, most effort focused on the northwestern coast, while in Príncipe surveys were concentrated along the northwestern and southern coasts.

Occasional extended surveys were conducted around the entire islands, and offshore areas during inter-island crossings (Figure 3). Survey operations were primarily dependent on weather conditions, and secondarily on cetacean sightings and logistical considerations. The survey covered a total of 71 days and 2,379 nautical miles.

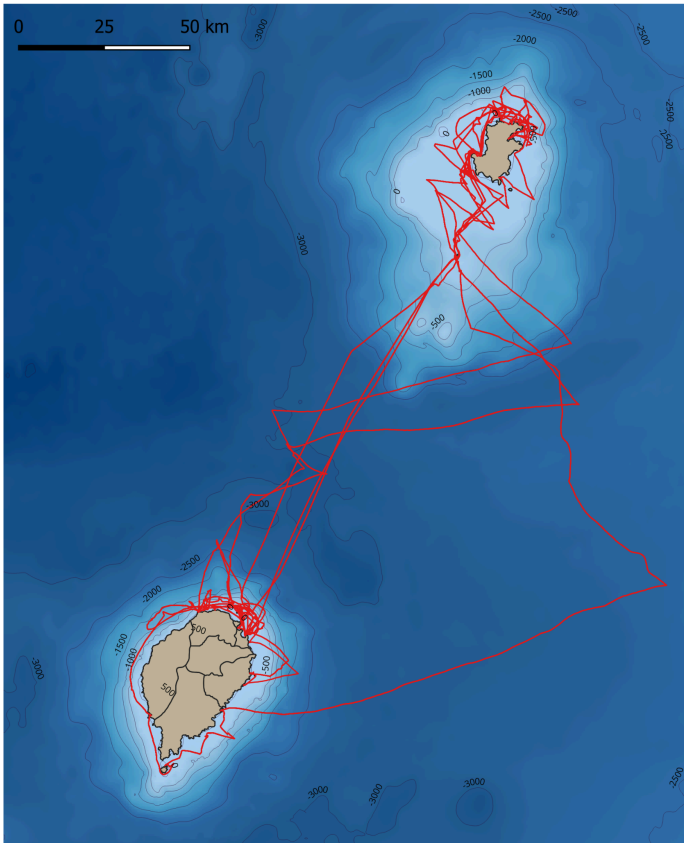


Figure 3: Map showcasing the survey track of the research vessel around São Tomé and Príncipe

Species Presence

During the 15 day crossing from Cabo Verde to São Tomé and Príncipe, a total of 11 brief cetacean encounters were documented (Table 1), primarily at the beginning of the journey near Cabo Verde. Observed species included short-finned pilot whales (*Globicephala macrorhynchus*), large sized, oceanic ecotype of bottlenose dolphins (*Tursiops truncatus*), pantropical-spotted dolphins (*Stenella attenuata*), spinner dolphins (*Stenella longirostris*), Clymene dolphins (*Stenella clymene*) (Figure 4), rough-toothed dolphins (*Steno bredanensis*) (Figure 5), and other dolphin species, which could not be identified due to the harsh weather conditions, distance, and briefness of the sightings.

Table 1. Species sightings recorded during the crossing between the two archipelagos. Abbreviations: Gma = short-finned pilot whale, Tt = bottlenose dolphin, Sa = pantropical spotted dolphin, Sl = spinner dolphin, Sb = rough-toothed dolphin, Sc = Clymene dolphin, DSp = unidentified dolphin species (unidentified due to harsh weather conditions, distance, and briefness of the sightings).

Species	Gma	Tt	Sa	Sl	Sb	Sc	DSp	Total
Number of Encounters	3	1	2	1	1	1	2	10
Number of Animals	30	6	230	100	20	150	22	658

Figure 4: Clymene dolphins (Stenella clymene)

Figure 5: Rough-toothed dolphins (Steno bredanensis)

Around São Tomé and Príncipe a total of 63 surveys, encompassing 372 hours of effort, were conducted in the waters surrounding São Tomé and Príncipe (Table 2). During these surveys, a total of 98 cetacean sightings were recorded. Out of these sightings 63 were Humpback whales, comprising a total of 113 individuals. The first encounter occurred on 1 August. The average depth of Humpback whale encounters was 39 meters, with a maximum recorded depth of 77 meters and a minimum of 4 meters.

Table 2: Detailed sampling effort, cetacean and out of that only humpback whale (Mn) sighting numbers during the surveillance.

Month	Search Effort (h)	Number of surveys	Number of all Cetacean Sightings	Number of Mn sightings	Mean Group Size ± SD
August	121	22	46	34	1.67 ± 0.63
September	142	21	35	21	2.14 ± 1.42
October	109	20	17	6	1.83 ± 0.40
Total	372	63	98	63	1.88 ± 0.81

During the surveys around the island nation, six cetacean species were recorded (Table 3), including Humpback whales (*Megaptera novaeangliae*), Pantropical-spotted dolphins (*Stenella attenuata*), Bottlenose dolphins (*Tursiops truncatus*), and Short-finned pilot whales (*Globicephala macrorhynchus*). In addition, single sighting of a lone Killer whale (*Orcinus orca*), and a group of Sperm whales (*Physeter macrocephalus*) were documented during the survey period (Figure 6). Moreover, during several dolphin encounters, the species identification was not possible, due to poor sighting conditions such as long observation distance, unfavorable weather, or brief encounter duration.

The number of species sightings and the number of individuals encountered per species varied notably, reflecting differences in group size preferences among species. Abundance and occurrence rates were calculated for all recorded species, revealing that Pantropical-spotted dolphins (*Stenella attenuata*) had the highest number of individuals, while Humpback whales (*Megaptera novaeangliae*) exhibited the highest occurrence rate within the area during the study period.

Table 3: Number of sightings and total number of individuals recorded per species, along with their respective abundance and occurrence rates.

Species	Number of Sightings	Number of Individuals	Occurrence Rate
Humpback whale (Mn)	63	113	61.76%
Bottlenose dolphin (Tt)	8	472	7.84%
Pantropical spotted dolphin (Sa)	22	2112	21.56%
Short-finned pilot whale (Gma)	4	28	3.92%
Killer whale (Oo)	1	1	0.98%
Sperm whale (Pm)	1	10	0.98%
Unidentified dolphin species (DSp)	3	135	2.94%
Total	102	2871	100%

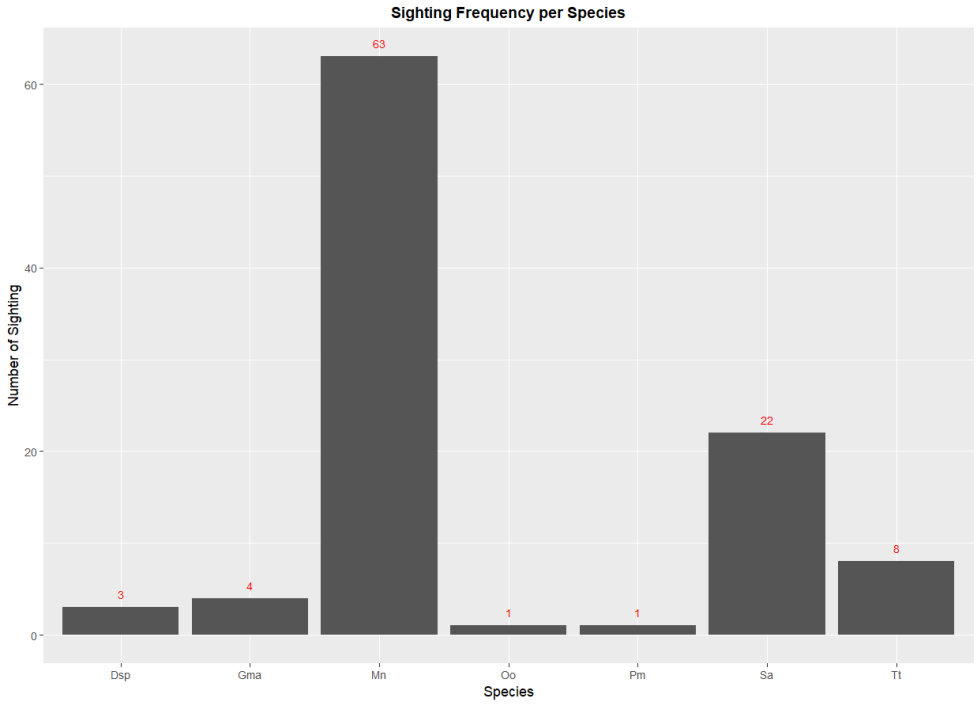


Figure 6: Frequency of cetacean species encountered during surveys. Species abbreviations: DSp = unidentified dolphin species, Gma = short-finned pilot whale (Globicephala macrorhynchus), Mn = humpback whale (Megaptera novaeangliae,), Oo = killer whale (Orcinus orca), Pm = sperm whale (Physeter macrocephalus), Sa = pantropical spotted dolphin (Stenella attenuata), Tt = bottlenose dolphin (Tursiops truncatus).

In total, an estimated 2.871 individual cetaceans were recorded during the surveys around São Tomé and Príncipe (Figure 7). Pantropical-spotted dolphins (*Stenella attenuata*) were the most numerous, observed in large pods of around 100+ individuals, with approximately 2.112 individuals sighted in total. Bottlenose dolphins (*Tursiops truncatus*) were the second most numerous species, with 472 individuals recorded, followed by Humpback whales (*Megaptera novaeangliae*), with a total of 113 individuals. Unidentified dolphin species accounted for 135 individuals, while Short-finned pilot whales (*Globicephala macrorhynchus*) were represented by 78 individuals. Single sightings of a group of Sperm whales (*Physeter macrocephalus*) contributed 10 individuals to the total count. And lastly, a single Killer whale (*Orcinus orca*) was also documented during the study period.

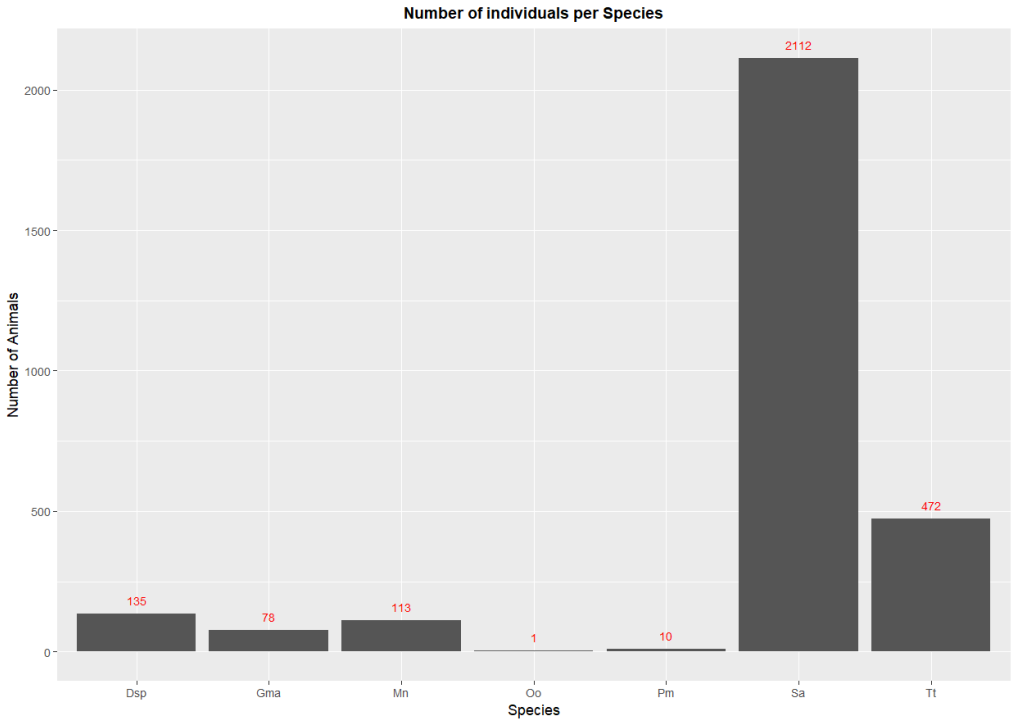


Figure 7: Number of encountered individuals per species. Species abbreviations: DSp = unidentified dolphin species, Gma = short-finned pilot whale (Globicephala macrorhynchus), humpback whale (Megaptera novaeangliae), Oo = killer whale (Orcinus orca), Pm = sperm whale (Physeter macrocephalus), Sa = pantropical spotted dolphin (Stenella attenuata), Tt = bottlenose dolphin (Tursiops truncatus)

The distribution map (Figure 8, 9) of cetacean sightings (excluding humpback whales) shows that most observations were concentrated in the northern waters of both São Tomé and Príncipe. However, this pattern likely reflects the higher survey effort in these areas rather than a true ecological preference. Sporadic sightings were documented elsewhere around the islands, and between islands during inter-island crossings. Another notable area of encounters was around the small islets south of Príncipe (Tinhosas), where three species were recorded: Pantropical-spotted dolphins (*Stenella attenuata*), Killer whales (*Orcinus orca*), and Sperm whales (*Physeter macrocephalus*). Pantropical-spotted dolphins (*Stenella attenuata*) were the most frequently observed species, predominantly occurring along the northeastern coast of Príncipe, followed by the northern region of São Tomé, with occasional sightings in the open waters between the islands. Bottlenose dolphins (*Tursiops truncatus*) were primarily recorded in the northern waters of São Tomé, with isolated observations in the southern region, as well as a single sighting in the northern waters of Príncipe. In contrast, short-finned pilot whales (*Globicephala macrorhynchus*) were observed exclusively in the northern waters of São Tomé.

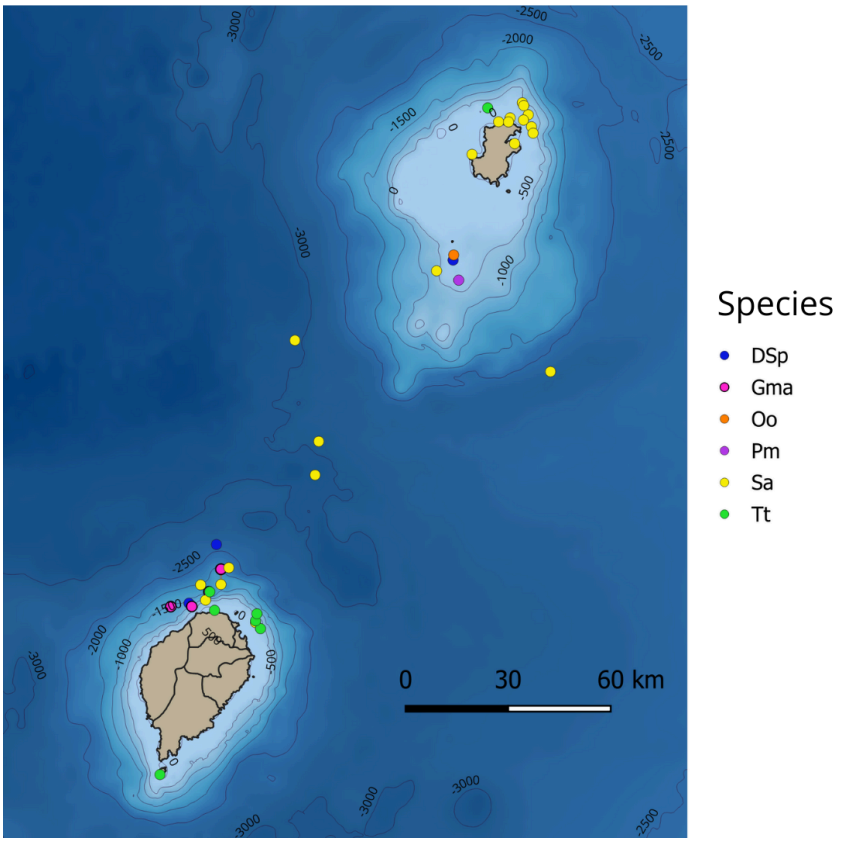


Figure 8: Map illustrating cetacean sightings recorded during the study period in the waters surrounding São Tomé and Príncipe. Different colors represent the various species observed

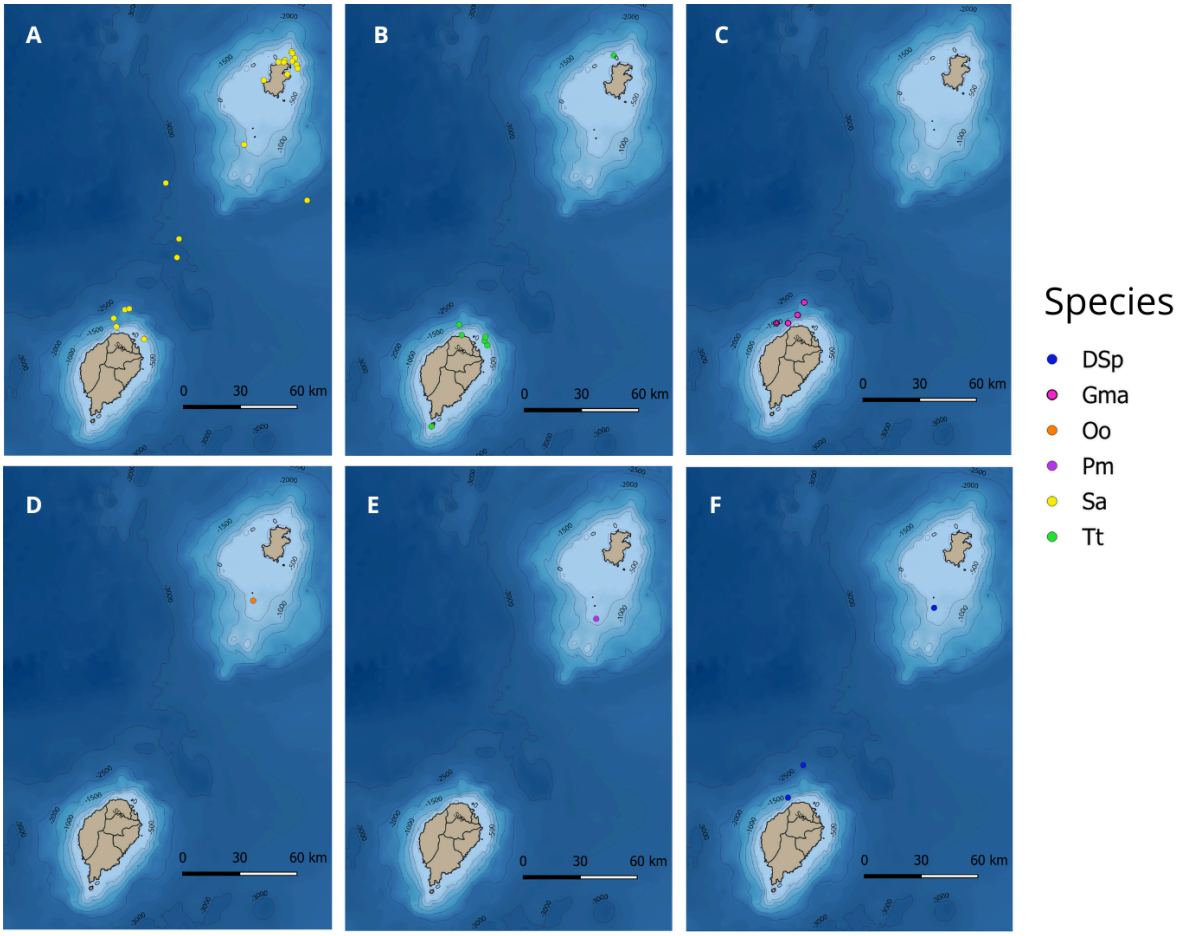


Figure 9: Distribution maps of the recorded cetacean species. Graph A shows pantropical-spotted dolphins (Stenella attenuata), B depicts bottlenose dolphins (Tursiops truncatus), C represents short-finned pilot whales (Globicephala macrorhynchus), D shows killer whales (Orcinus orca), E depicts sperm whales (Physeter macrocephalus), and F displays unidentified dolphin species.

Near the Tinhosas islets, in the south of Príncipe, a single Killer whale (*Orcinus orca*), identified as a lone male, was observed in September (Figure 10). The animal was travelling, swimming fast north towards Príncipe Island. On the same day, a group of 10 Sperm whales (*Physeter macrocephalus*), including a calf, was also recorded in the same general area (Figure 11), however, unlike the orca these whales were swimming slowly, resting at the surface.

Figure 10: Male killer whale in the south of Príncipe

Figure 11: Sperm whales resting at the surface

Short-finned pilot whales (*Globicephala macrorhynchus*) (Figure 12) were recorded on four occasions, primarily within the same area in the northwestern waters of São Tomé. The group size on three occasions was small with a mean of 9 individuals, however on a single occasion 50 pilot whales were encountered. In three of these four encounters, the animals were observed exhibiting travelling behavior, while socializing was recorded during the remaining encounter. Overall, a total of 78 animals were counted throughout the study period.

Figure 12: Short-finned pilot whales (Globicephala macrorhynchus)

Pantropical spotted dolphins (*Stenella attenuata*) (Figure 13) were typically observed in large groups, with a mean group size of 111 individuals. A total of 22 sightings were recorded, encompassing approximately 2112 individuals. They were recorded around both islands in coastal and offshore waters. This species was the most frequently encountered dolphin species and the most abundant in the study area, often exhibiting active surface behaviors, including jumping, and leaping out of the water.

Figure 13: Pantropical-spotted dolphin (Stenella attenuata)

Bottlenose dolphins (*Tursiops truncatus*) (Figure 14) were recorded on six occasions, in all of which the animals were exhibiting travelling behavior. On three occasions, the pod size was small, with a mean group size of 14 individuals. One encounter involved a medium-sized pod of approximately 60 animals, and two encounters involved large pods ranging from 150 to 200 individuals. In total, 472 individuals were recorded, predominantly around São Tomé, particularly along the northern coast, with a single sighting near Príncipe. All encounters were observed within the littoral zone.

Figure 14: Bottlenose dolphin (Tursiops truncatus)

Humpback whales

Occurrence and Occupancy

Humpback whales (*Megaptera novaeangliae*) were observed throughout all three surveyed months (Figure 15). The majority of encounters occurred in August, with 35 sightings comprising 57 individuals, followed by September with 22 sightings of 45 animals. Additionally, 6 sightings of 11 individuals have been recorded in October.

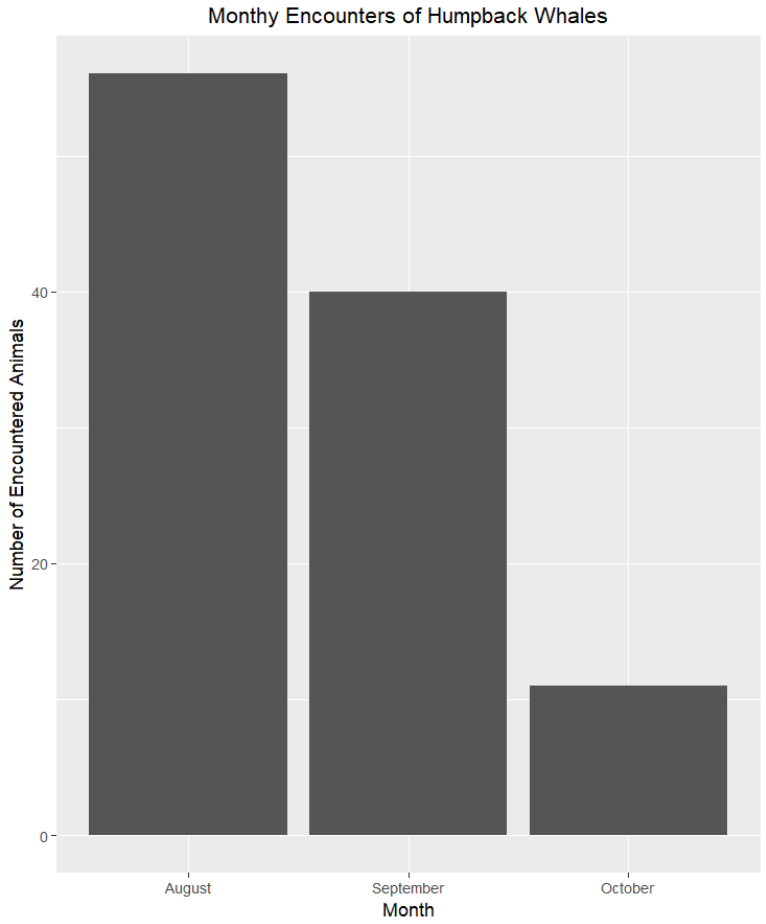


Figure 15: Distribution of Humpback whale (Megaptera novaeangliae) encounters over the three-month survey period. The x-axis represents the survey month, and the y-axis indicates the number of individuals recorded

Humpback whales were documented around both islands and near the southern islets of Príncipe, particularly around the Tinhosas group (Figure 16). Most sightings were recorded in shallow waters above the littoral zone of the islands. Exceptions included a few encounters in deeper waters, where animals were observed moving northwards from São Tomé towards Príncipe, or conversely, south of Príncipe moving in the opposite direction. This pattern suggests that while humpback whales primarily utilize nearshore habitats, they also traverse deeper offshore areas during transit between the islands.

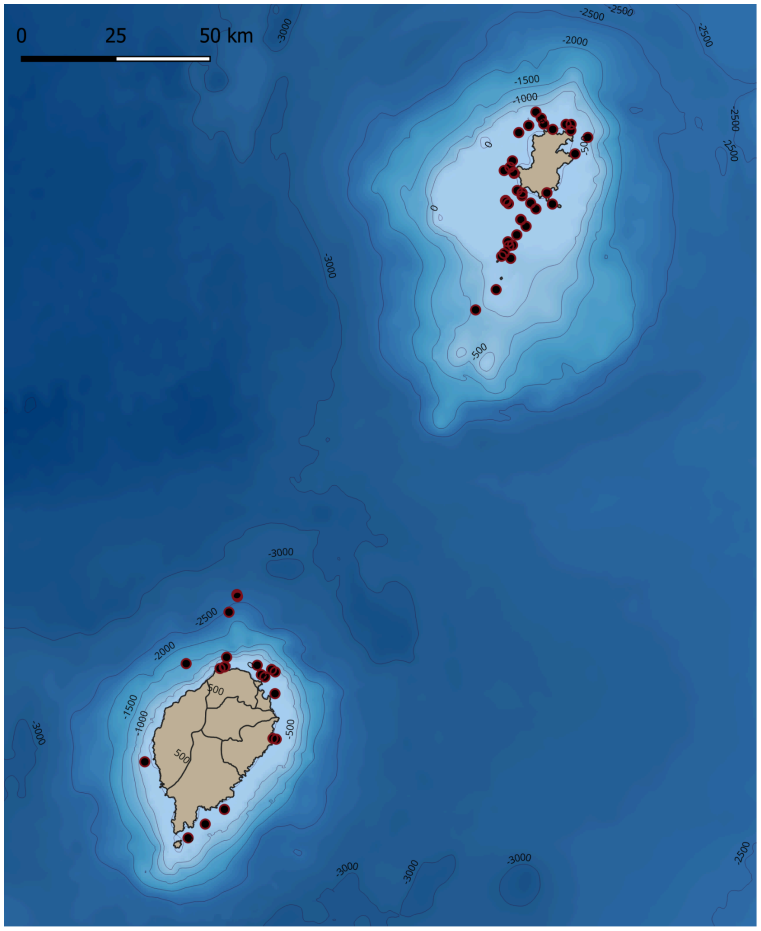


Figure 16: Map showing Humpback whale (Megaptera novaeangliae) sightings recorded during the study period in the waters surrounding São Tomé and Príncipe

Throughout the three surveyed months, the spatial distribution of humpback whale encounters exhibited variability, primarily due to randomized transects that were constrained by weather conditions and logistical considerations. Figure 17 presents this variation through three graphs, corresponding to August, September, and October, illustrating how sightings were distributed across the survey area over time. Generally, animals were encountered in near shore, shallow waters with only a few exceptions. In all three months a higher number of whales were recorded around Príncipe island. In August and October multiple encounters were documented in the south of Príncipe, near Tinhosas, above the littoral zone, which seemed to be a transitional area between the islands.

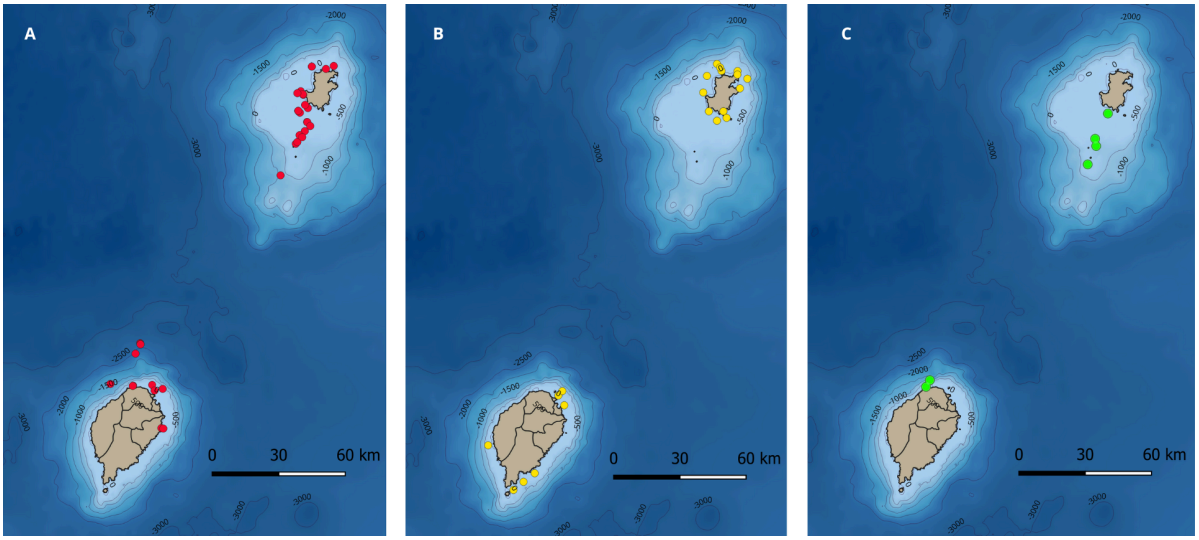


Figure 17: Humpback whale encounters across the three surveyed months, with graph A showing August, graph B showing September, and graphD showing October

Group Composition

The observed animals were categorized based on group size, with individuals considered associated if they remained within close proximity (<100 m) of each other, engaged in interactions, and or moved together. Group classifications, established during the first expedition, included: singletons, duos, mother and calf pairs (MCP), and trios (Sesani et al., 2020).

Most animals observed were adults, primarily forming duos, followed by single adult individuals (singletons) and mother and calf pairs, of which 11 were recorded. The least frequently encountered categories were trios, with only one group documented in the north of Príncipe (Figure 18).

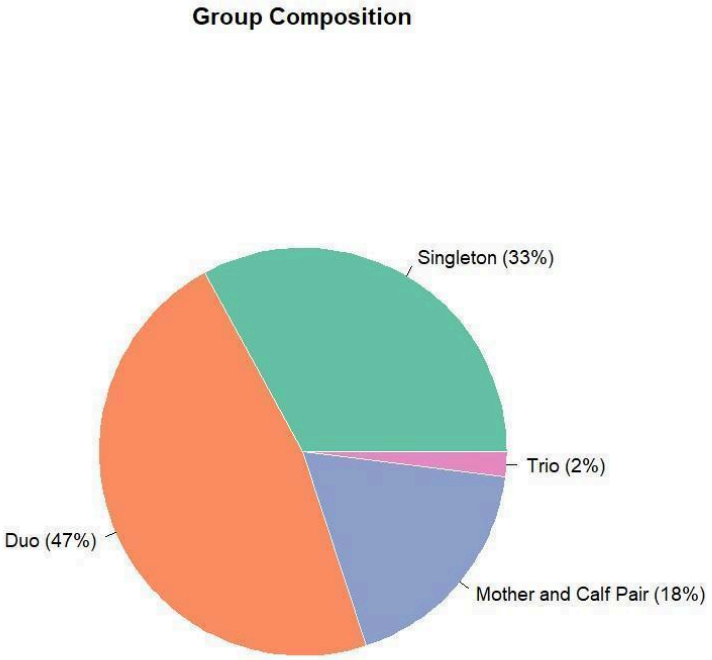


Figure 18: Group composition of encountered humpback whales. The number of observed group classes was as follows: singleton (n = 26), duo (n = 28), mother and calf pair (MCP; n = 14), trio (n = 1)

Figure 19 illustrates the spatial distribution of these encounters across four maps, highlighting mother and calf pairs (graph A), duos (graph B), trios (graph C), and singletons (graph D). Duos and singletons were the most frequently recorded group compositions and were distributed across the study area, with the highest concentrations observed along the western and southern coasts of Príncipe. A total of 14 mother and calf pairs were recorded, primarily around São Tomé, 6 pairs in the northern region and only 2 pairs were sighted in the southeast. While 6 pairs were seen around Príncipe, with equal distribution, three of them sighted in the north and three in the south. These mother and calf pairs were generally observed in shallow coastal waters between 6 and 10 meters depth, with a three exception in the south of Principe, near Tinhosas, recorded at an approximate 45 meters. Overall, the mean depth was 22 meters in case of calves. Additionally, a trio was observed in the northern region of Príncipe, near Bom Bom. The individuals remained in close proximity, moved synchronously, and exhibited socializing behavior.

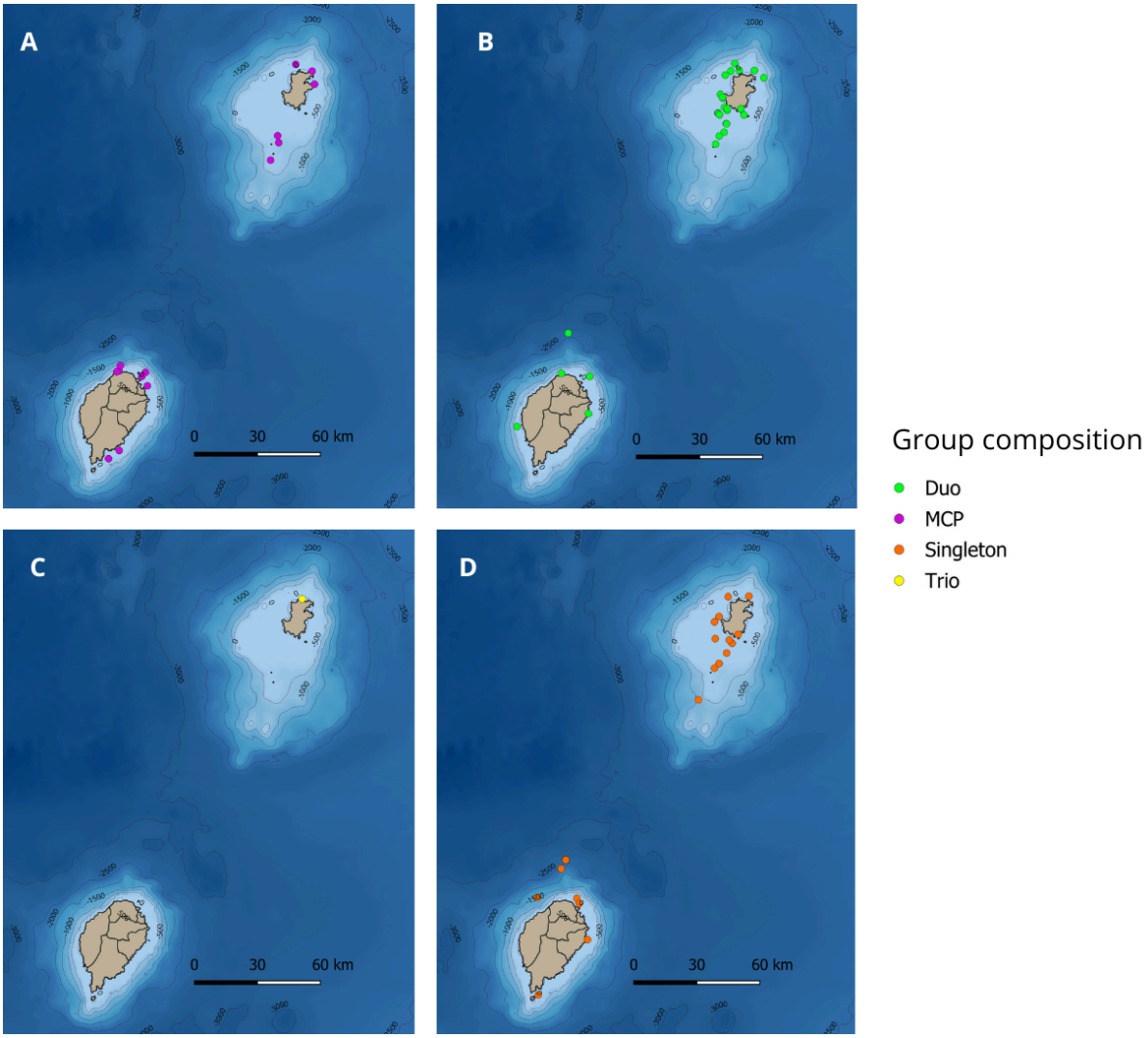


Figure 19: Humpback whale encounters by group composition: Figure A shows mother–calf pairs, Figure B shows duos, Figure C shows trios, and Figure D shows singletons.

The frequency of different group compositions varied across the surveyed months (Figure 20). In the first two months, August and September, duos were the most commonly observed group type, while in October no duos were recorded. Mother and calf pairs were predominantly recorded in September, followed by October, and lastly August with only a single observation. Singletons were encountered throughout the entire research period, with descending frequency. One trio was observed during August.

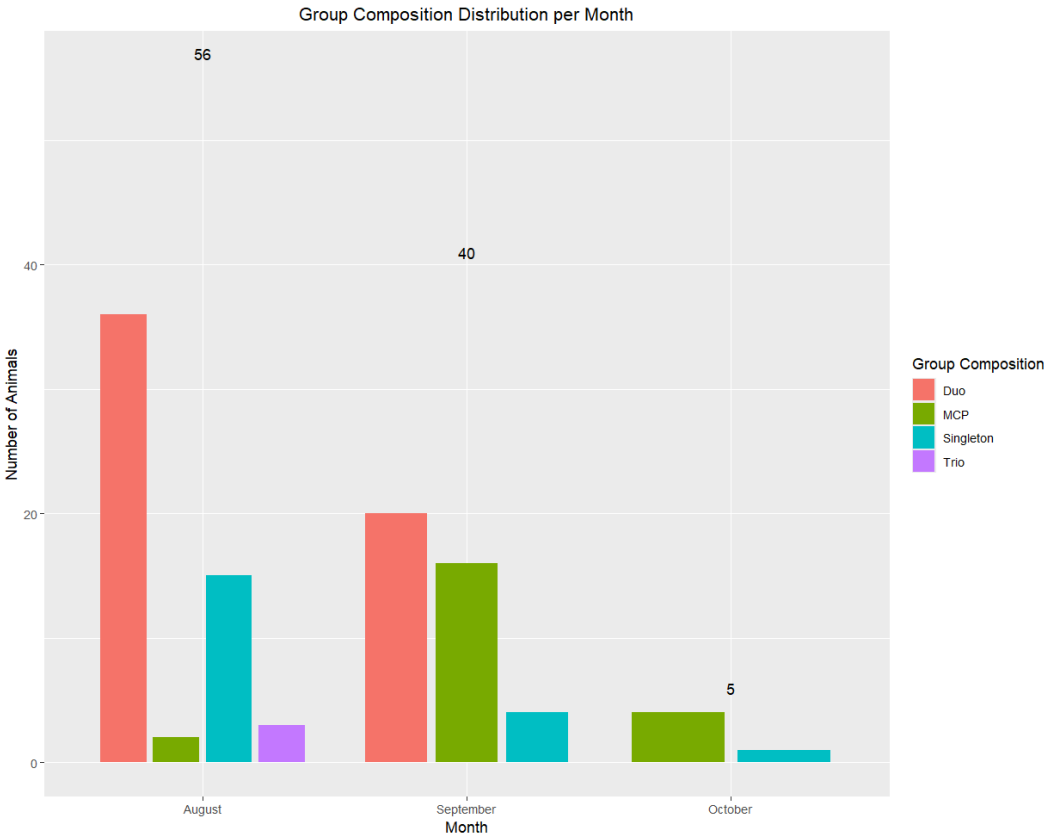


Figure 20: Distribution of group compositions across the surveyed months. The x-axis represents the month, and the y-axis indicates the number of animals per group composition. Numbers above each month denote the total number of individual whales observed during that month

Several whale groups were encountered on multiple occasions throughout the survey period, counting a total of 13 individuals being observed twice or even three times (Table 4). Three different pairs of whales were resighted twice, one of which occurred on the same day, on the 15th of August. On that exact day, one other pair was encountered on three occasions. Additionally, two mother and calf pairs were also observed three times during the survey period. One of these pairs was sighted in September, on the 10th, 14th, and 15th, exclusively in the northwest of São Tomé. The other mother and calf pair was observed twice toward the end of September (on the 21st and 24th) and once at the beginning of October (on the 3rd). This latter pair was sighted in the waters surrounding Príncipe, at multiple locations, including Pedra Galé, Mosteiros, and Thinosas. Additionally, one mother and calf pair was encountered twice on the same day of October 18.

Table 4: Frequency of cetacean encounters by group composition

	Singleton	Duo	MCP	Trio
Single sighted	19	24	11	1
Resighted once	1	3	1	0
Resighted twice	0	1	2	0

Photo-Identification

To maximize the likelihood of documenting each individual, both aerial and conventional photo-identification methods were employed. Drone-based photo-identification proved particularly effective for intra-annual individual recognition, especially through the identification of temporary features such as cookie-cutter shark (*Isistius brasiliensis*) bite marks, that appear as white, circular wounds (Figure 21). These distinctive scars facilitated the rapid and reliable identification of animals within a short time frame, although they gradually heal and may become less visible over time.

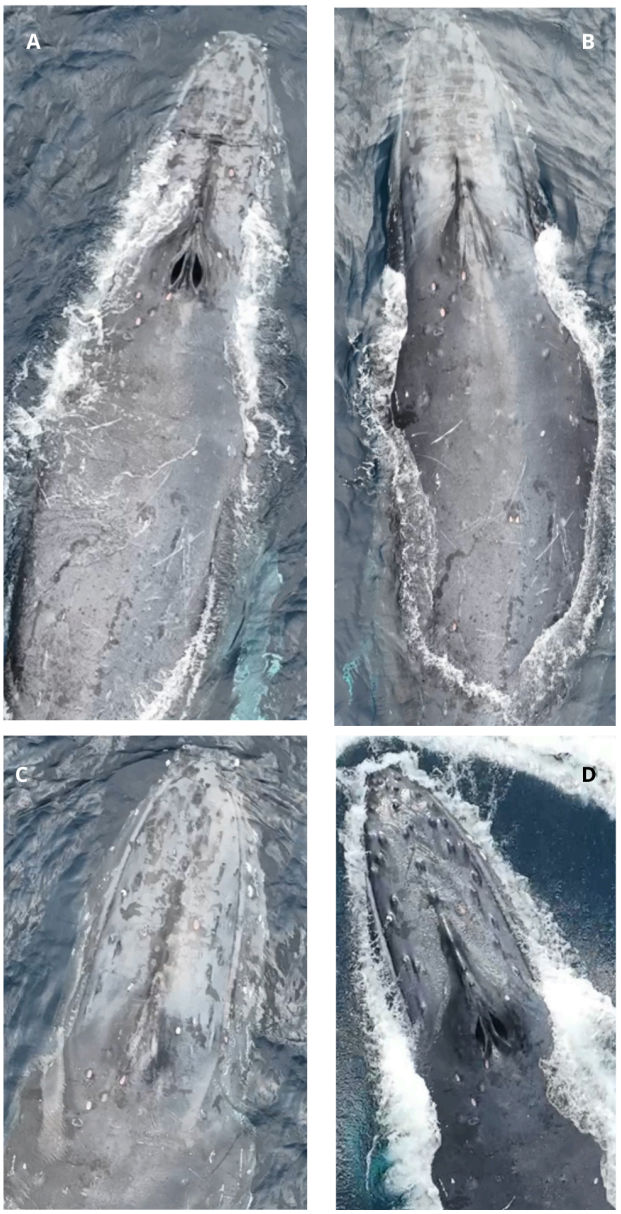


Figure 21: Same humpback whale sighted on multiple occasions. Image A shows the frontal left region of the body from the first sighting, while image C provides a close-up of the head area. The right panels (image B and D) display corresponding views from the second sighting. These images illustrate how aerial footage can support photo-identification based on scars, wounds, and other distinctive or temporary markings.

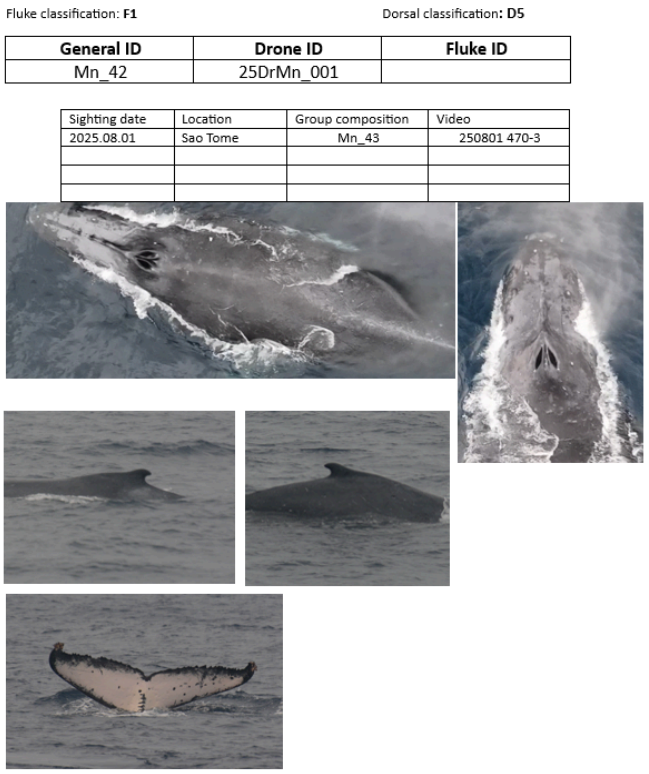
Conversely, conventionally used dorsal fin and or fluke images remains more reliable for inter-annual identification, as it is based on stable morphological characteristics such as the shape of the dorsal fin (Figure 22) and the shape and pigmentation pattern of the fluke (Figure 23), although marks, nicks, and scars may develop or change over time on these features.

The use of drones also increased the number of successful fluke captures, as the aircraft could often reach the animals more quickly than the vessel before the whale dives away. Drones provided enhanced maneuverability and speed around the animals, while conventional photo-identification was more dependent on vessel positioning and the animals' behavior and movement patterns. Each encounter is a completely different situation therefore the data collection technique has to be adjusted. As a result there were 3 whales who were only documented with digital cameras and 11 which only with the use of a drone, the remaining were captured with both methods.

Figure 22: Image of a humpback whale's dorsal fin captured by digital camera

Figure 23: Image of a humpback whale's fluke captured by digital camera

Using both aerial and conventional photo-identification techniques, individual humpback whales were catalogued based on distinct morphological, pigmentation and scarring features. Aerial photo-identification, derived from drone imagery, resulted in the identification of 70 individual whales, while conventional photo-identification, based on photographs of dorsal fins and flukes taken from the vessel, yielded 62 identified individuals. Following cross-comparison and verification of matching individuals between the two datasets, a combined catalogue was compiled containing 73 unique humpback whales (Figure 24). This integrated catalogue provides a robust baseline for future population monitoring, facilitating both intra- and inter-annual resightings and contributing to the long-term understanding of the regional breeding population.


Fluke classification: **F1**

Dorsal classification: **D5**

General ID	Drone ID	Fluke ID
Mn_42	25DrMn_001	

Sighting date	Location	Group composition	Video
2025.08.01	Sao Tome	Mn_43	250801 470-3

Figure 24: Example of an individual record in the joint photo-identification catalogue

Three international resightings were confirmed through Happywhale, a global citizen science platform that employs artificial intelligence to identify and track individual whales by comparing photographs of their unique tail flukes (Figure 25, 26, 27). The first individual in question, an adult humpback whale, was first documented on 8 August 2020 in the Western Cape, South Africa, by the Sea Search Research & Conservation Association (Figure 26), and was subsequently resighted almost exactly three years later, on 9 August 2025, in Príncipe, São Tomé and Príncipe, by EDMAKTUB (Figure 27).

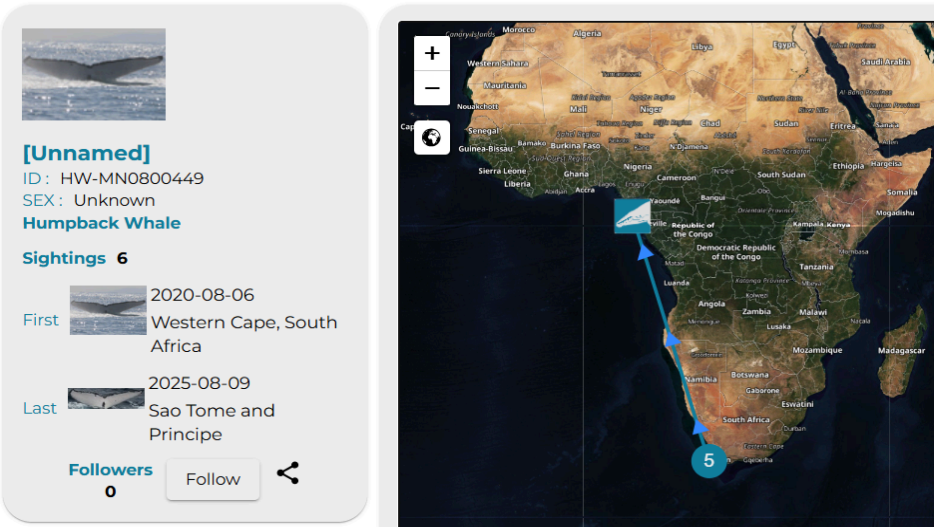


Figure 25: Official match in HappyWhale website. The blue arrow is provided only to illustrate the spatial separation between the two sites and should not be interpreted as the whale's true path of travel.

Figure 26: Fluke ID picture from the first encounter of the animal in South Africa, in 2020, by Sea Search

Figure 27: Fluke ID from the last encounter of the animal, in São Tomé and Príncipe, in 2025, by EDMAKTUB

The second matched individual (Figure 28) was first recorded in the waters near Réunion Island in 2012 by Violaine Dulau (Figure 29) and subsequently resighted in São Tomé and Príncipe in 2025 by the EDMAKTUB research team (Figure 30). This interoceanic encounter provides remarkable evidence of long-distance movement across the Indian and Atlantic Oceans, suggesting potential connectivity between populations.

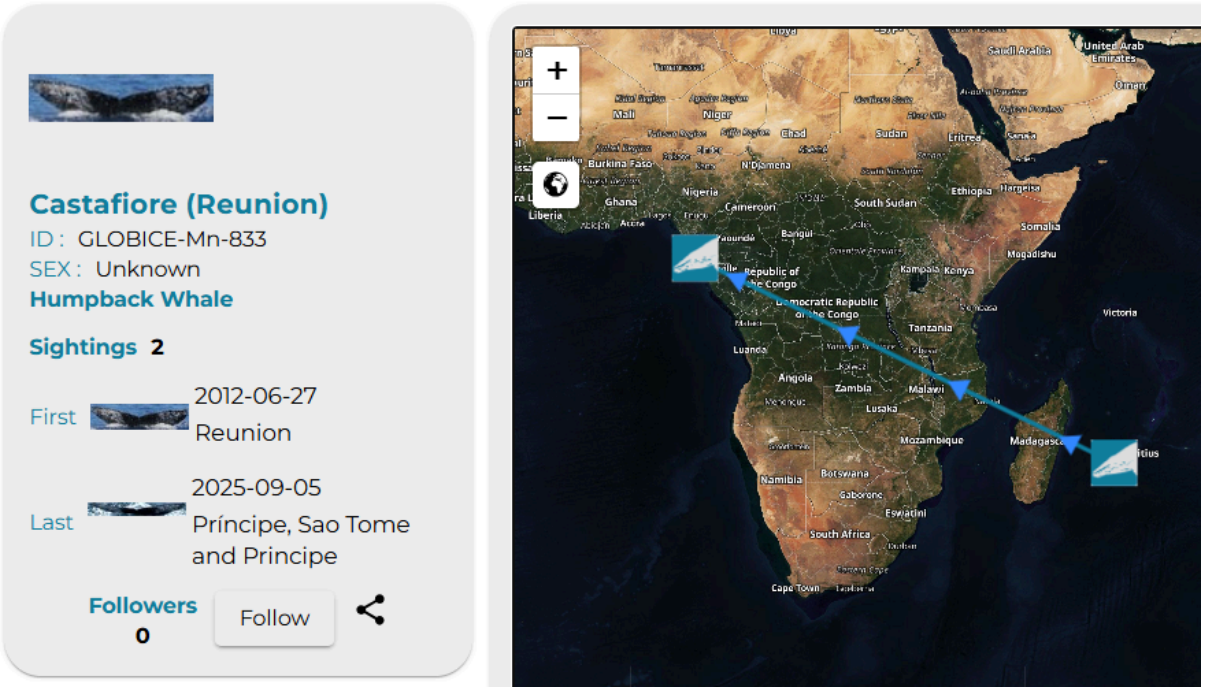


Figure 28: Official match in HappyWhale website. The blue arrow is provided only to illustrate the spatial separation between the two sites and should not be interpreted as the whale's true path of travel.

Figure 29: Fluke ID picture from the first encounter of the animal in la Reunion, in 2012, by Violaine Dulau

Figure 30: Fluke ID from the last encounter of the animal, in São Tomé and Príncipe, in 2025, by EDMAKTUB

The final matched humpback whale (Figure 31) was identified on both sides of the South Atlantic Ocean, providing further evidence of transoceanic movements within the species' migratory range. This individual was first recorded off the coast of Brazil in 2018 by the Humpback Whale Institute (Figure 32) and was subsequently re-sighted in the waters of São Tomé and Príncipe in 2025 by the EDMAKTUB research team (Figure 32).

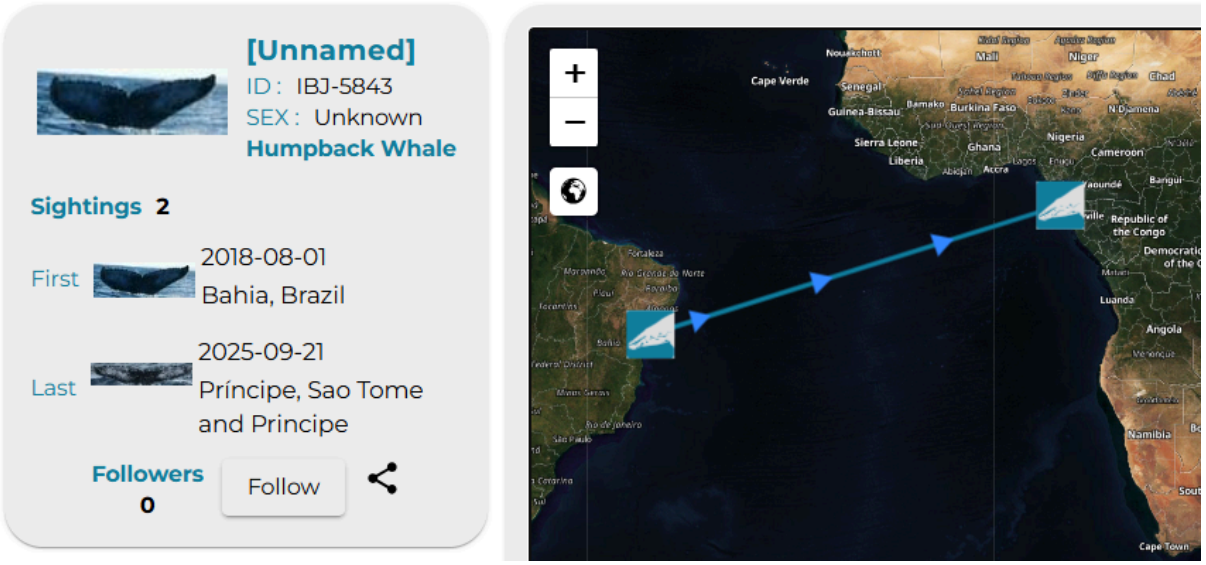


Figure 31: Official match in HappyWhale website. The blue arrow is provided only to illustrate the spatial separation between the two sites and should not be interpreted as the whale's true path of travel.

Figure 32: Fluke ID picture from the first encounter of the animal in Brazil, in 2018, by the Humpback Whale Institute

Figure 33: Fluke ID from the last encounter of the animal, in São Tomé and Príncipe, in 2025, by EDMAKTUB

Collectively, these observations provide valuable evidence of connectivity between breeding and feeding grounds across ocean basins and underscore the critical importance of international collaboration, long-term monitoring, and standardized photo-identification programs to enhance our understanding of humpback whale migratory ecology and the underlying transoceanic and interoceanic movements.

Behavior

The most frequently observed behaviors of the encountered humpback whales, in decreasing order, were travelling, milling, and socializing, with resting being the least commonly recorded (Figure 34). Travelling behavior was characterized by steady, directional movement, often with consistent surfacing intervals, suggesting migration or transit between areas. Milling described non-directional, slow swimming in a general area with frequent changes of direction or circular movement, typically interpreted as an intermediate or exploratory behavior. Socializing involves physical or acoustic interactions among individuals, including close contact, pectoral fin slapping, or breaching, often indicative of reproductive or communicative activities. Resting was rarely observed and was characterized by minimal movement and extended surfacing intervals, usually in calm, shallow waters.

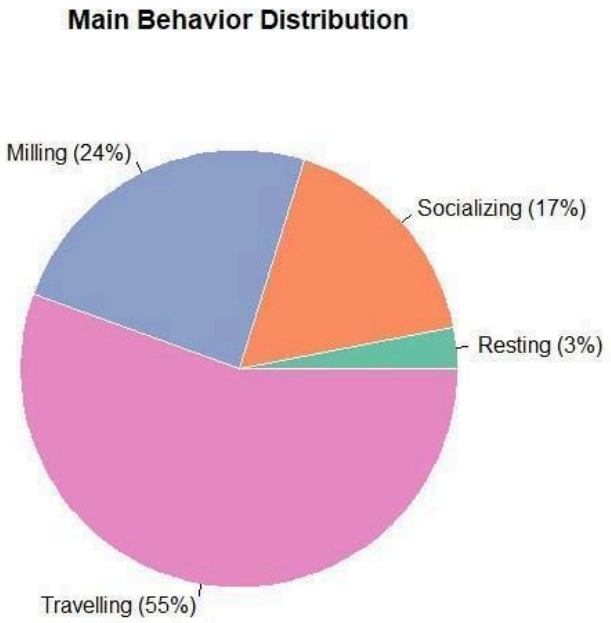


Figure 34: The distribution of encountered main behaviors of humpback whales

Humpback whales are well known for their acrobatic surface behaviors, which were evident during the surveys through a variety of minor behaviors. The most commonly observed acrobatics included breaching (Figure 35), fluking, pectoral slaps, tail slaps, wake riding, and sharking, among others.

Figure 35: Adult humpback whale breaching

The distribution of Humpback whale (*Megaptera novaeangliae*) behaviors varied across the survey months (Figure 36). In August, milling was the most frequently observed behavior, followed by travelling. In September, travelling emerged as the dominant behavior, occurring substantially more frequently than other behavioral types. While in October, only two behavior types were recorded, which were travelling and socializing, the prior remaining the most commonly recorded.

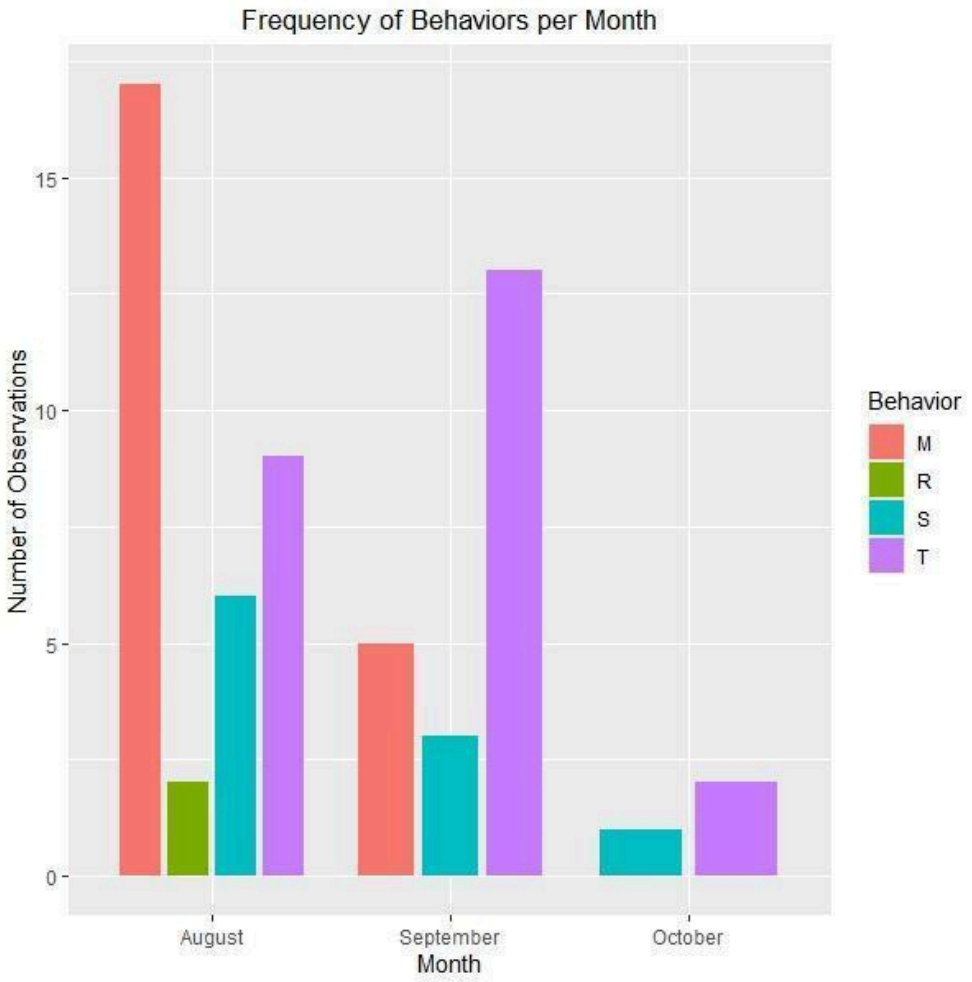


Figure 36: Distribution of Humpback whale (Megaptera novaeangliae) main behaviors across the surveyed months. The x-axis represents the month, and the y-axis shows the number of behavior occurrences. Main behaviors are coded as follows: M = Milling, R = Resting, S = Socializing, T = Travelling

A unique inter-species interaction (Figure 37) was observed in August between an adult Humpback whale (*Megaptera novaeangliae*) and a pod of short-finned pilot whales (*Globicephala macrorhynchus*). The Humpback whale was observed surfing the waves while the pilot whales remained in close proximity, surrounding the individual. Subsequently, the Humpback whale twisted and turned around while the pilot whales swam around it and exhibited active surfacing behavior, displaying dynamic and coordinated movement.

Figure 37: Aerial footage of an interspecies interaction of an adult humpback whale surrounded by short-finned pilot whales

Body Assessment

Body condition of the encountered humpback whales was visually assessed through external indicators, including the presence of fresh scars, open wounds, epibiotic parasites, deformities, and signs of reduced body fat reserves. These indicators provide valuable insights into the overall health status and potential exposure to environmental or anthropogenic stressors. The majority of individuals (96.6%) exhibited circular wounds consistent with cookie-cutter shark (*Isistius brasiliensis*) bites (Figure 38, 39), which are common in cetaceans inhabiting tropical and subtropical waters. These lesions were predominantly concentrated around the head region (Figure 21). Cookie-cutter shark bites were observed not only on humpback whales but also on other cetacean species, including pantropical spotted dolphins (Figure 40).

Figure 38: Healing cookie-cutter shark bite on an adult humpback whale

Figure 39: Healed cookie-cutter shark bites on an adult humpback whale

Figure 40: Pantropical spotted dolphin with fresh cookie-cutter shark bites

One individual humpback whale exhibited an unusually pale coloration**,** markedly lighter than the typical dark grey pigmentation of humpback whales. Photographic documentation revealed that the whale's body was extensively covered with long linear scars, deep lacerations, and irregular white patches, some of which appeared to be areas of healed or healing tissue. These white extended patches were particularly prominent along the flanks and dorsal region, suggesting tissue regeneration following significant injury. Several wounds were deep and recent, exposing pink subdermal tissue, while others appeared older and partially healed, indicating multiple episodes of trauma over time. (Figure 41, 42).

Figure 41: photo of a highly scared and wounded individual, taken with digital camera

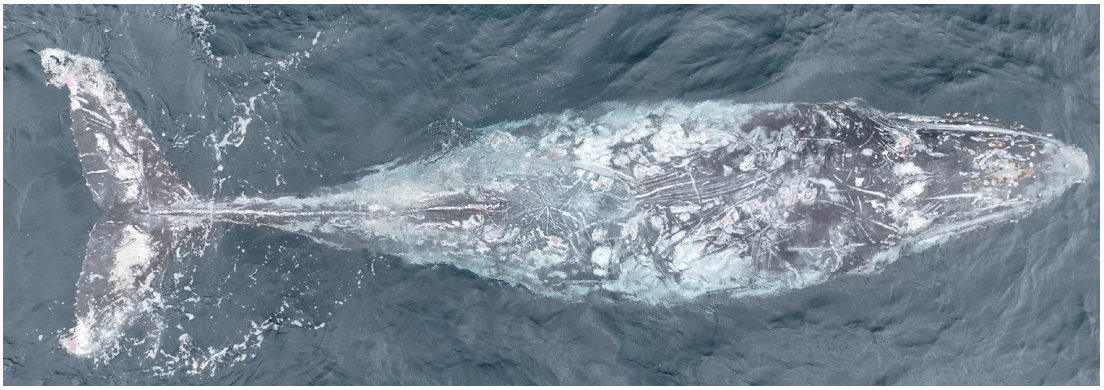


Figure 42: aerial footage if the same animal showing the extent of the injuries, covering the entire dorsal side of the animal (ventral was not evaluated)

Overall, no external parasites, deformities, or abnormal growths were detected on any of the observed individuals. All whales appeared to have normal body morphology, with no visible indications of skeletal malformations, ectoparasites, or other physical anomalies that might suggest compromised health or developmental abnormalities. The absence of such external indicators may reflect generally favorable health conditions within the local population; however, subtle, or internal pathologies cannot be excluded without closer examination or necropsy data. Continued visual monitoring of external health parameters can provide valuable insight into the overall well-being and environmental pressures affecting humpback whales in the region.

Comparison of expedition outcomes

Comparing the first SACET expedition conducted in 2020 with the second survey period in 2025, it is important to note that the two field campaigns took place during slightly different phases of the humpback whale breeding season. The 2020 expedition began on 26 August, with only four surveys conducted that month, and continued through the end of November, resulting in a total of 51 surveys. In contrast, the 2025 expedition started earlier, on 1 August, and concluded at the end of October, yielding 63 surveys in total (Table 5).

Table 5: Comparison table of the first (2020) and second (2025) expedition, regarding search effort and humpback whale (Mn) sightings.

Expedition	Search Effort (h)	Number of Mn sightings	Number of Individuals	Number of Singletons	Number of Duos	Number of Mother and calf pairs	Number of Trios
2020	402	59	94	25	5	28	1
2025	372	63	113	24	29	14	1

In 2025, a higher number of sightings and individuals was recorded. However, group composition differed between the two expeditions. In 2020, mother and calf pairs (MCP) were the most frequently encountered group type, followed by singletons, duos, and trios. In the 2025 expedition, duos were the most common group composition, closely followed by singletons, with MCPs and trios occurring less frequently.

Group composition also varied between months (Figure 43). In August 2020, singletons and MCPs were observed in equal numbers (4 each), whereas in 2025 almost exclusively adult animals were encountered, with one exception. All four group types were present in August 2025, with duos being most frequent, followed by singletons, and only one MCP and one trio recorded. In September 2020, 16 MCPs and 21 singletons were sighted alongside several duos. In 2025, duos remained the most common group type, followed by eight MCPs and several singletons. In October, the two periods were most similar: in 2020, 9 MCPs and 3 singletons were recorded, compared with 4 MCPs and 1 singleton in 2025. Although surveys continued into November 2020, no humpback whale encounters were documented during that month.

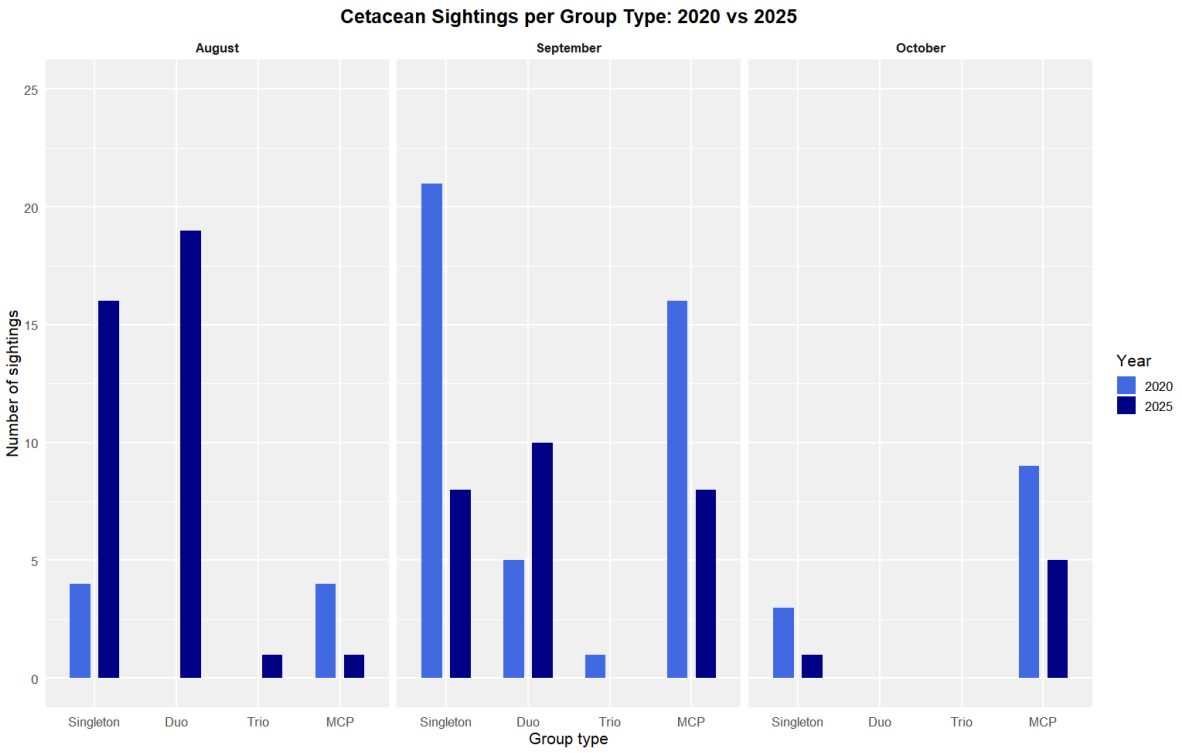


Figure 43: Humpback Whale Group Composition Across Months: Comparison Between Two Expeditions

Overall, while the number of trios and singletons remained nearly unchanged (1–1 and 24–25, respectively), duos increased markedly from 5 in 2020 to 29 in 2025. The most notable change, however, was the substantial decline in mother and calf pair encounters, decreasing from 28 in 2020 to 14 in 2025.

The underlying causes of this pattern cannot be inferred from the two field seasons alone. Several potential explanations may account for the observed decline. First, seasonal variability in migration timing may reflect natural cyclical fluctuations in breeding behaviour and habitat use. Second, broader environmental changes, including climate-driven alterations in sea temperature, prey availability, or oceanographic conditions, may influence reproductive success or distribution. Third, increasing anthropogenic pressures in the Gulf of Guinea, such as offshore oil exploration and extraction, vessel traffic, and associated noise pollution, could disrupt breeding activities or displace whales from preferred habitats.

Marine Megafauna Monitoring

Summary of avian biodiversity observations confirmed exceptionally high avian biodiversity and abundance across São Tomé and Príncipe. Sooty Terns (Onychoprion fuscatus) were the most frequently observed species, particularly around the Tinhosas islets, which serve as major nesting sites.

Other tern species were also common in this area. The Black Kite (*Milvus migrans*) was notably abundant on São Tomé but much less frequent on Príncipe. Tropicbirds (*Phaenthonidae*) showed a wider spatial distribution throughout the study area.

Additional seabird species recorded included (Figure 44) the Brown Booby (*Sula leucogaster*), Bridled Tern (*Onychoprion anaethetus*), Wilson's Storm-Petrel (*Oceanites oceanicus*), Skuas (*Stercorariidae*), and the Brown Noddy (*Anous stolidus*). Occasional marine bird sightings included Cory's Shearwater (*Calonectris borealis*), other shearwater species (*Procellariidae*), Sandwich Tern (*Thalasseus sandvicensis*), Gannet (*Morus bassanus*), Great Skua (*Stercorarius skua*), and Cormorants (*Phalacrocoracidae*). Overall, the findings highlight a rich and dynamic seabird community associated with the coastal and offshore ecosystems of São Tomé and Príncipe, underscoring the ecological importance of these islands as key habitats for regional avifauna.

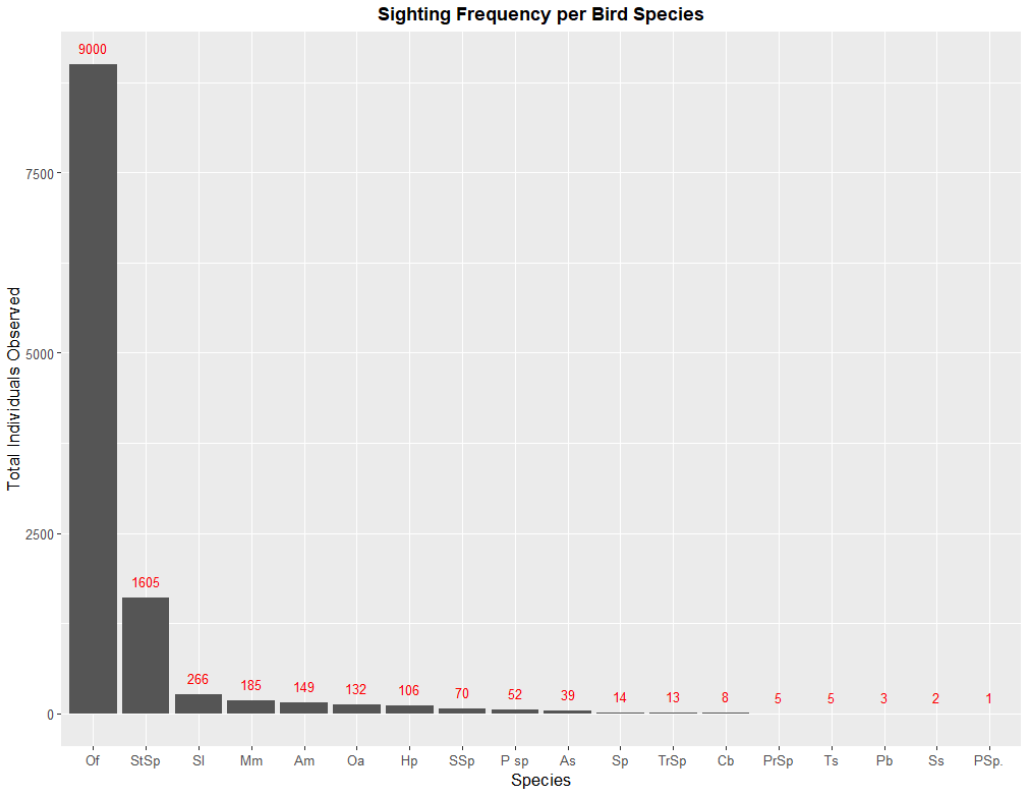


Figure 44: Total amount of encountered birds per species, where Of: Scooty tern (Onychoporion Fuscatus), StSp: tern species (Sterninae), Sl: Brown booby (Sula leucogaster), Mm: Black kite (Milvus migrans), Am: Black nobby (Anous minutus), Oa: Bridled tern (Onychorion anaethetus), Hp: Storm petrel (Hydrobates pelagicus, Wilson's (Oceanites oceanicus)), SSp: Skua sp. (Stecorariidae), P sp: Tropic bird (Phaenthonidae), As: Brown nooby (Anous stolidus), Sp: Pomarine skua (Stercorarius pomarinus), TrSp: Terrestrial species, Vb: Cory's shearwater (Calonectris borealis), PrSp: Shearwater species (Procellariidae), Ts: Sandwich tern (Onchoprion anaethetus), Pb: Gannet (Pelecanus bassnus), Ss: Great skua (Stercorarius skua), PSp: Cormorant (Phalacrocoracidae).

Regarding fish observations, flying fish (*Exocoetidae*) were consistently abundant throughout the surveys, being recorded on every survey day. In addition, occasional sightings included tuna (observed five times), three shark species sightings, ocean sunfish (*Mola mola*), swordfish (*Xiphias gladius*) and mahi-mahi (*Coryphaena hippurus*), highlighting the presence of various large sized fish in the waters surrounding São Tomé and Príncipe (Figure 45).

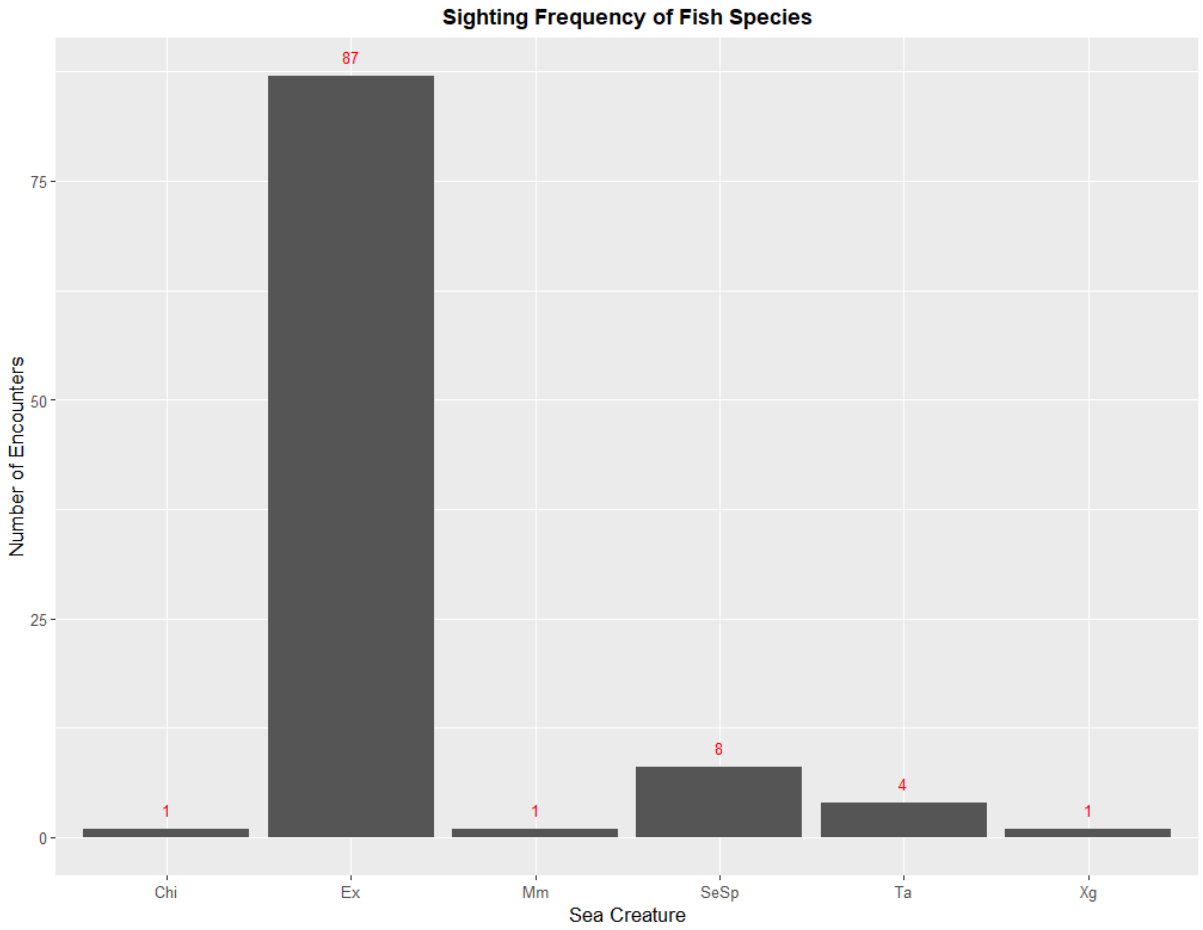


Figure 45: Total amount of encountered marine species, where Chi: Mahi mahi (Coryphaeba hippurus), Ex: Flying fish (Exocoetidea), Mm: Sunfish (Moal mola), SeSp: Shark species (Selachi), Ta: Yellow-fined tuna (Thunnus albacares), Xg: Swordfish (Xiphias gladius).

Furthermore, Green Sea turtles (*Chelonia mydas*) were observed on three occasions exclusively in the bay of São Tomé.

Habitat Assessment

The coastal and marine habitats of São Tomé and Príncipe were generally characterized by clear waters, healthy small coral, and productive nearshore ecosystems, particularly in areas with limited anthropogenic influence. Shallow coastal zones, especially those with sandy or mixed substrates, provided suitable breeding and calving grounds for humpback. However, localized pressures such as fishing activity, marine litter accumulation near urbanized bays, and boat traffic were observed, indicating areas where human impact may be affecting habitat quality. Overall, the region maintains a high ecological value, warranting continued monitoring to detect and mitigate potential degradation from expanding coastal and maritime activities.

Fishing activities were highly concentrated within limited coastal zones, particularly near populated regions and accessible bays. This spatial concentration of effort raises concerns about the long-term sustainability of local fisheries and the potential for overexploitation of nearshore resources. Suggesting that fishing pressure may be increasing, emphasizing the need for future collaborative assessments involving local communities, fisheries authorities, and conservation organizations to evaluate the ecological impact of current practices and to promote sustainable management of marine resources.

Owing to limited stakeholder interest and engagement, a comprehensive or in-depth assessment of the fisheries was not undertaken.

Pollution

Marine litter was observed throughout the study area, with notably higher concentrations near the main bay of São Tomé, where human activity and coastal runoff are most pronounced. The majority of the debris consisted of plastic materials, including packaging of various sizes, small plastic fragments such as pellets and micro-debris, and discarded plastic bottles (Figure 46). Abandoned fishing gear, such as ropes and nets, was also recorded, though less frequently, while balloons and other floating waste were occasionally sighted drifting offshore. The predominance of plastic waste reflects global trends in marine pollution, underscoring the need for improved waste management and awareness initiatives to mitigate its impact on the local marine ecosystem and the species that inhabit it.

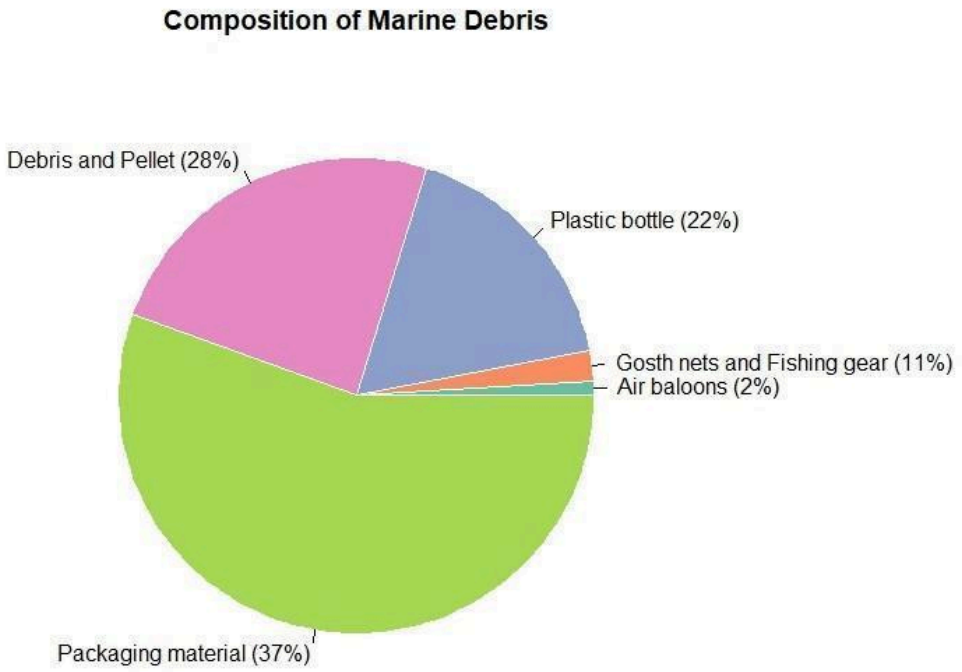


Figure 46: Composition of encountered marine debris

On one occasion in August, an adult Humpback whale was observed with a fishing line entangled on its fluke (Figure 43, 44). Fortunately, the line was only caught among barnacles at the tip of the fluke. Nonetheless, this observation highlights the risks posed by ghost nets and discarded fishing gear, which present a significant threat to cetaceans, particularly to calves that are highly active and more susceptible to entanglement in marine debris.

Figure 47: Humpback whale dragging a fishing line

Figure 48: Humpback whale fluke with a fishing line stuck to its right tip

Oil exploration activities

In recent years, São Tomé and Príncipe has intensified its deepwater oil exploration activities, driven by interest from large international companies and the country's strategy to diversify its economy and generate new sources of income. The National Petroleum Agency (ANP-STP) has led this process, overseeing several exploration contracts in the Exclusive Economic Zone. Companies such as TotalEnergies, Shell, Galp and Petrobras are currently participating in various offshore blocks, contributing investment, technology and expertise in deepwater operations.

For São Tomé and Príncipe, these activities represent an opportunity for growth, with the potential to attract investment, develop local capacity and strengthen the country's economic stability.

However, deepwater exploration also poses significant challenges. Protecting the marine environment, managing environmental risks, and ensuring transparency in revenue management are essential to ensuring that the oil industry contributes to sustainable development. Environmental and social impact assessments (ESHIAs) and mitigation measures, such as monitoring marine fauna during seismic operations, are part of the regulatory framework that the country applies to preserve its ecosystems.

Despite the environmental impact assessments (ESHIAs) and mitigation measures, the negative effects on wildlife, and specifically on marine mammals, are based mainly on theoretical calculations and behavioral studies in other regions. However, it is very difficult to assess this without adequate knowledge of the situation of cetacean populations both before and after the work, as is the case in São Tomé and Príncipe.

Among oil-related activities, the main threat under normal conditions, especially for cetaceans, is the noise generated. Within these activities, seismic surveys pose the greatest risk due to their characteristics in terms of explosions using air guns, their duration, and the extent of the areas to be surveyed. During the campaigns, we were able to obtain acoustic recordings in the vicinity of a drilling ship, which produces lower-intensity and more localized sounds compared to seismic surveys.

The recordings showed that at 8.5 nautical miles (15.742 km), the noise was intense, masking any other noise within the recording frequencies of our equipment, but covering, for example, the songs of humpback whales as well as the clicks of sperm whales. Even without being able to determine the intensity due to equipment limitations, it is noticeable at such a distance how any other type of sound is covered by the predominant noise. To a lesser extent and with some sound, specifically humpback whale song at 15.6 nautical miles (27.78 km) and finally at about 18 nautical miles (33.34 km), other vocalizations such as sperm whale clicks and dolphin whistles could be heard.

This shows that although they may not cause damage, they will certainly cause disturbances that may affect the presence of certain populations to a greater or lesser

extent and directly affect their conservation. These parameters are not taken into account in impact studies.

Oil exploitation should be a good justification and impetus for in-depth study of marine life, and in this case cetaceans.

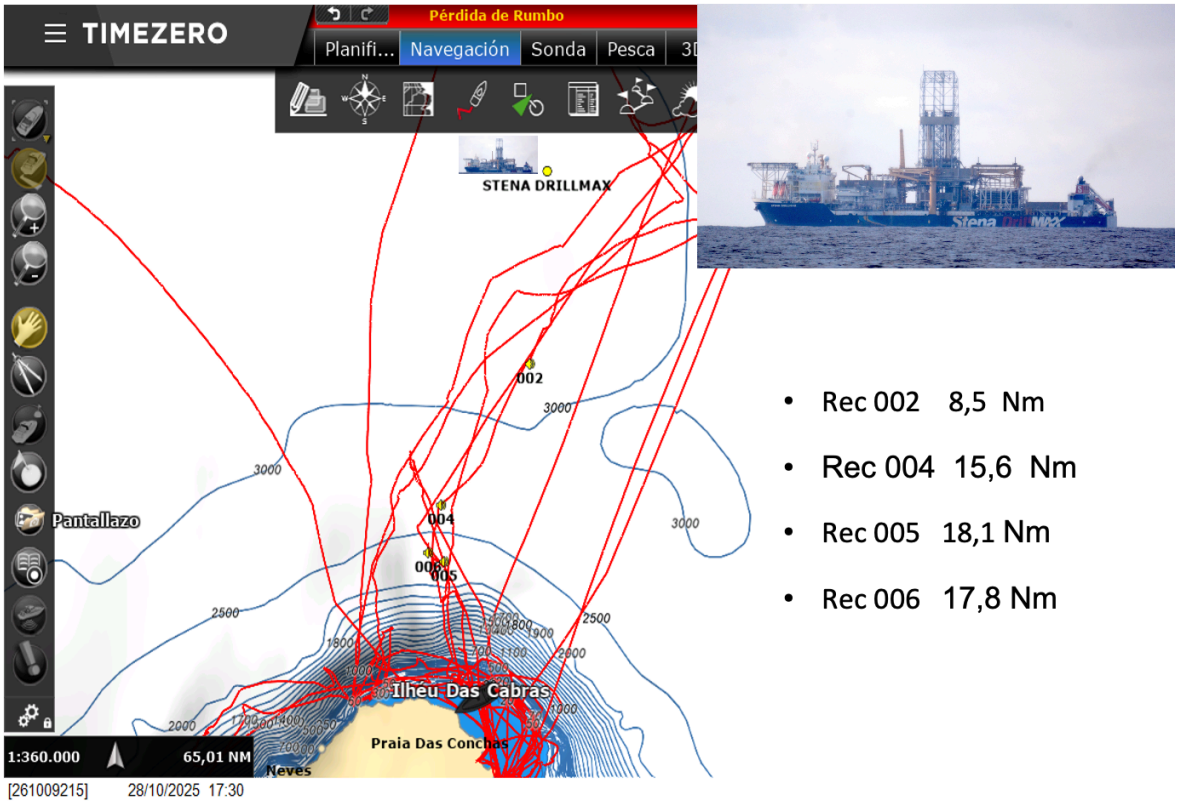


Figure 49: map and photo of the drilling vessel showing the locations where the recordings were made and the distances between them

Conclusion

The present study documented a comprehensive effort to document the occurrence, distribution and behavior of cetaceans and other marine megafauna in the waters of the Gulf of Guinea, particularly surrounding São Tomé and Príncipe. The findings contribute valuable data to the limited existing knowledge of the region. During the crossing from Cabo Verde to São Tomé and Príncipe, eleven brief cetacean encounters were recorded, despite harsh weather conditions that limited visual detectability. The observed species including short-finned pilot whales (*Globicephala macrorhynchus*), large oceanic bottlenose dolphins (*Tursiops truncatus*), pantropical spotted dolphins (*Stenella attenuata*), spinner dolphins (*Stenella longirostris*), rough-toothed dolphins (*Steno bredanensis*), Clymene

dolphins (*Stenella clymene*), and unidentified dolphin species. Illustrating the diversity of pelagic odontocetes inhabiting this transition zone between the eastern tropical Atlantic and the Gulf of Guinea.

Around São Tomé and Príncipe, a total of 98 cetacean sightings were recorded over 63 surveys, comprising six confirmed species. The waters supported multiple cetacean species, with the humpback whale (*Megaptera novaeangliae*) being the dominant species observed. Other documented species included the pantropical-spotted dolphin (*Stenella attenuata*), bottlenose dolphin (*Tursiops truncatus*), short-finned pilot whale (*Globicephala macrorhynchus*), sperm whale (*Physeter macrocephalus*), and killer whale (*Orcinus orca*). The pantropical spotted dolphin was the most abundant species in terms of total numbers of individuals recorded. While humpback whales displayed the highest sighting frequency, reflecting their seasonal occurrence in the region's shallow coastal habitats during the breeding season. These findings are consistent with previous regional studies, which identified the same assemblage of species in adjacent West African waters (Brito et al., 2010; Carvalho et al., 2022; Weir, 2010).

Humpback whales were encountered throughout all three surveyed months, with a clear concentration of sightings in shallow nearshore waters surrounding both islands and the southern islets of Príncipe (Tinhosas). These areas appear to serve as suitable calving and breeding grounds, offering calm, warm, and protected environments typical of humpback whale nursery habitats (Carvalho et al., 2011; Sesani et al., 2020). The repeated occurrence of mother and calf pairs across the study period, predominantly in shallow waters between 6 and 10 meters deep, reinforces the critical reproductive significance of these coastal waters. A total of 14 mother and calf pairs were recorded, all observed in isolation, which aligns with well documented behavioral patterns in humpback whales whereby females with dependent calves avoid other individuals to reduce energy expenditure, minimize predation risk, and prevent harassment by males (Clapham, 1996; Tyack & Whitehead, 1983; Cartwright & Sullivan, 2009).

Behavioral observations indicated that calves frequently engaged in playful activities near their mothers, including rolling, tail slapping, and short breaches. Such behaviors are known to contribute to the development of motor coordination and muscle strength essential for survival and future migratory performance (Cartwright & Sullivan, 2009; Bauer et al., 1993; Bercovitch, 2019). The predominance of social and traveling behaviors among adult whales suggests that the population utilizes the islands both as a breeding site and as part of their migratory route within the South Atlantic population (Ramos et al., 2023).

Photo-identification efforts, combining both aerial (drone) and vessel-based photography resulted in the identification of 73 unique individual humpback whales, providing the foundation for the first dedicated regional catalogue. This catalogue represents an essential baseline for future monitoring, enabling both intra and inter-annual resighting comparisons. Notably, three individuals were matched through the global Happywhale database, confirming connections between São Tomé and Príncipe and other regions of the South Atlantic and Indian Oceans, including South Africa, Réunion, and Brazil. These

matches provide rare but valuable evidence of long-distance transoceanic movement and population connectivity among humpback whale stocks, emphasizing the ecological and conservation relevance of São Tomé and Príncipe within the broader migratory network of the species. While the whales observed are generally associated with the B1 substock of the South Atlantic population, which feeds in Antarctic waters, genetic and movement data indicate some degree of connectivity among adjacent stocks, preventing the definitive assignment of all individuals to the B1 substock (Ramos et al., 2023).

Beyond cetaceans, the surveys documented a rich diversity of associated marine megafauna, including seabirds, large pelagic fishes, and sea turtles, underscoring the high productivity and ecological significance of the region. The Tinhosas islets, in particular, were confirmed as a hotspot of biodiversity, supporting major seabird colonies.

Despite the overall health of the marine environment, several anthropogenic threats were identified. The expansion of offshore oil exploration activities introduces increasing pressures, especially through underwater noise generated by drilling and seismic surveys, which can disrupt cetacean communication, behavior, and habitat use in this critical breeding area. Furthermore, the presence of marine litter, primarily plastic debris, was widespread, especially near populated bays around São Tomé. An incident involving a humpback whale entangled in a fishing line, although not life-threatening, exemplifies the ongoing risks posed by ghost nets and discarded fishing gear. Additionally, concentrated nearshore fishing effort may increase the potential for resource competition and habitat degradation, particularly within the same shallow areas used by breeding cetaceans. These findings underscore the urgent need for enhanced waste management, responsible fishing practices, and marine spatial planning to balance conservation and human livelihoods.

The results of this study confirm that the coastal and offshore waters of São Tomé and Príncipe constitute an ecologically important area for multiple cetacean species, including the humpback whale, which uses the region as a breeding and calving ground. The observed species diversity, behavioral data, and preliminary photo-identification results provide a crucial foundation for long-term monitoring and conservation planning. Continued research is essential to refine population estimates, understand seasonal movements, population trends and assess anthropogenic threats. Establishing sustained collaborative programs between local authorities, conservation organizations, and international research institutions will be vital to ensure the protection of this biologically rich and strategically located marine habitat.

A comparison with the 2020 SACET expedition revealed important interannual differences. Notably, there was a substantial decline in mother and calf pair encounters in 2025. Mother and calf pairs are crucial for population recruitment, a continued decrease may indicate emerging reproductive or survival challenges for the local humpback population. The causes of this pattern cannot be determined from the available data, but potential explanations include natural interannual variability, climate-driven habitat changes, or increasing anthropogenic pressures such as offshore oil activities and noise pollution. These findings highlight the necessity of sustained monitoring and expanded research efforts to

determine whether this decline reflects a temporary fluctuation or a more persistent trend, and to identify the specific threats affecting the long-term viability of humpback whales in the region.

Overall, the results of this study confirm that the coastal and offshore waters of São Tomé and Príncipe represent an ecologically important area for multiple cetacean species, including humpback whales that rely on the region for breeding and calving. The documented species diversity, behavioral observations, and preliminary photo-identification dataset establish a strong foundation for long-term monitoring and conservation planning. Continued research will be essential to refine population estimates, understand seasonal movements, and quantify anthropogenic threats. Building sustained partnerships among local authorities, conservation organizations, and international research institutions will be crucial for ensuring the long-term protection of this biologically rich marine habitat.

In conclusion, the present expedition, together with the 2020 SACET survey, advances our scientific understanding of cetaceans in the Gulf of Guinea and underscores the strategic importance of São Tomé and Príncipe within the South Atlantic humpback whale migratory network. Long-term monitoring, habitat protection, and international data sharing remain essential pillars for conserving marine megafauna in the region. Safeguarding these waters will contribute not only to national biodiversity priorities but also to broader regional conservation objectives across the tropical eastern Atlantic.

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Logger 2010 software was developed by the International Fund for Animal Welfare to assist with benign research on cetaceans and is available to download from http://www.ifaw.org/sotw

Appendix

Links to further information on oil exploration in São Tomé and Príncipe:

https://totalenergies.com/news/press-releases/sao-tome-principe-totalenergies-acquires-offshore-exploration-license

https://www.offshore-mag.com/regional-reports/africa/article/55091419/totalenergies-totalenergies-takes-helm-at-second-exploration-block-offshore-sao-tome-and-principe

https://worldoil.com/news/2024/6/26/totalenergies-joins-promising-deepwater-exploration-block-offshore-sao-tome-and-principe-africa

https://www.anp-stp.gov.st/wp-content/uploads/2025/06/ESHIA-STP-02-PT_FINAL-COMPLETE.pdf

https://www.galp.com/corp/en/media/press-releases/press-release/id/1631/galp-expands-exploration-interest-in-sao-tome-with-275-stake-in-shells-offshore-block-4

https://www.telanon.info/economia/2023/12/28/42808/petrobras-compra-participacao-em-ativos-da-shell-em-sao-tome-e-principe

https://agenciagov.ebc.com.br/noticias/202312/petrobras-informa-sobre-a-atuacao-em-blocos-exploratorios-em-sao-tome-e-principe

https://www.galp.com/sobre-nos/o-que-fazemos/upstream/sao-tome-e-principe