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Where the wild things are: First dedicated vessel-based expedition of marine mammals in Belize

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Abstract: Baseline data on the distribution and occurrence of marine mammals are needed to better understand their role in marine ecosystems and to protect them from the negative impacts of climate change and human activity. Here, we report the results of vessel-based surveys to document marine mammals throughout the territorial waters of Belize in the Western Caribbean Sea. In 2016 and 2017, 543 km of transects (85 h of survey effort) aboard a 14-m catamaran resulted in 17 sightings of four species of marine mammal: inshore and offshore bottlenose dolphins *Tursiops truncatus*, Atlantic spotted dolphins *Stenella frontalis*, pantropical spotted dolphins *Stenella attenuata*, and Antillean manatees *Trichechus manatus manatus*. Coastal manatees and bottlenose dolphins were found in shallow waters and all other species exclusively in deep waters east of the Mesoamerican Barrier Reef System. These preliminary findings suggest there is a low density of marine mammals in the offshore habitats of Belize. Future studies should employ vessel-based distance sampling techniques and passive acoustic monitoring to reliably track the occurrence of marine mammals in this region and assess their distribution and abundance.

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Résumé : *Là où sont les choses sauvages : première expédition sur un navire dédié aux mammifères marins du Belize.* Des données de base sur la répartition et l'abondance des mammifères marins sont nécessaires pour mieux comprendre leur rôle dans les écosystèmes marins et afin de les protéger des impacts négatifs du changement climatique et de l'activité humaine. Nous rapportons ici les résultats d'enquêtes visant à récolter des données sur les mammifères marins dans les eaux territoriales du Belize, en Mer des Caraïbes occidentale. En 2016 et 2017, 543 km de transects (soit 85 heures de relevés) à bord d'un catamaran de 14 m ont permis d'effectuer 17 observations de quatre espèces de mammifères marins : le grand dauphin *Tursiops truncatus* à la côte et au large, le dauphin tacheté de l'Atlantique *Stenella frontalis*, le dauphin tacheté pantropical *Stenella attenuata* et le lamantin des Caraïbes *Trichechus manatus manatus*. Les lamantins et les grands dauphins côtiers ont été observés dans les eaux peu profondes et toutes les autres espèces exclusivement dans les eaux profondes à l'est du système de récifs coralliens mésoaméricain. Ces résultats préliminaires suggèrent une faible densité de mammifères marins dans les eaux profondes du Belize. Les futures études devraient utiliser des techniques d'échantillonnage à distance basées sur les navires et une surveillance acoustique passive afin de suivre de manière fiable la présence de mammifères marins dans cette région et d'évaluer leur répartition et leur abondance.

Keywords: Belize ● Cetaceans ● Manatee ● Distribution ● Caribbean Sea ● Offshore surveys

Introduction

Due to their high metabolic demands, marine mammals have strong influences on the structure and function of the world's oceans and play an important role as consumers of fish and invertebrates, as reservoirs for nutrients, and as detrital sources of energy and habitat (Roman et al., 2014). Marine mammals serve as sentinels in aquatic and coastal environments as they are long lived, exhibiting a high trophic level of the ecosystem, and have dense physiology (i.e. high fat storage) in which they can accumulate anthropogenic toxins lending insight into factors which may impact human health as well (Wells et al., 2004). Most marine mammals are particularly vulnerable to increasing anthropogenic impacts and have been heavily exploited throughout human history from factors such as direct hunting and bycatch associated with fishing gear (Mast et al., 2014). The consequences of human impacts on marine mammal biodiversity remains poorly understood both regionally and globally (Davidson et al., 2012).

Regional patterns of marine species richness and composition can frame a critical context for their management and conservation (Tittensor et al., 2010). Also, knowing the occurrence and spatial distribution of marine mammals is an important prerequisite for their preservation (Kaschner et al., 2011), and can provide a baseline against which to measure the impacts of climate change, seismic activity, pollution levels, fisheries and boat traffic, among others. Information on which species are present and how they use regional habitats is often expensive and challenging to gather (Alves et al., 2018). In many areas of the Caribbean, there is a lack of resources and funding necessary to effectively survey marine megafauna across large areas of remote coastlines, reefs, or offshore waters (Castelblanco-Martínez et al., 2019).

In the Western Caribbean Sea, the status of marine mammals remains poorly understood due to their occurrence in vast and uninhabited regions, and a lack of dedicated study effort. Most of our knowledge of marine mammal species in Belize comes from strandings and opportunistic sightings (Ramos et al., 2016). Belize is home to at least 17 species of aquatic mammals inhabiting the shallow water coastline and coastal lagoon, and its offshore deep-sea ecosystems (Ramos et al., 2016), including 15 species of whales and dolphins: *Tursiops truncatus* (Montagu, 1821), *Stenella attenuata* (Gray 1846), *Stenella clymene* (Gray 1850), *Stenella frontalis* (Cuvier, 1829), *Stenella longirostris* (Gray, 1828), *Steno bredanensis* (G. Cuvier in Lesson, 1828), *Physeter macrocephalus* Linnaeus, 1758, *Globicephala macrorhynchus* Gray, 1846, *Peponocephala electra* (Gray, 1846), *Pseudorca crassidens* (Owen, 1846), *Orcinus orca* (Linnaeus, 1758), *Kogia breviceps* (de Blainville, 1838), *Ziphius cavirostris* Cuvier 1823, *Megaptera novaeangliae* (Borowski, 1781), *Balaenoptera*

physalus (Linnaeus, 1758), the Antillean manatee *Trichechus manatus manatus* Linnaeus, 1758, and the Neotropical river otter *Lontra longicaudis annectens* (Major, 1897). Manatees are the only marine mammal species for which extensive long-term studies have been conducted in the region, revealing high densities and wide-ranging distributions in shallow water habitats nationwide (Morales-Vela et al., 2000; Castelblanco-Martínez et al., 2013; Ramos et al., 2016).

Boat-based surveys are an effective way to evaluate the presence of marine mammal species in a region (Mullin & Fulling, 2004), and are useful for baseline estimates of their relative abundance and distribution (Dawson et al., 2004). Sightings of marine mammals obtained during dedicated or opportunistic boat-based surveys at the northern (Roden & Mullin, 2000), western (Pardo et al., 2009), eastern (Gero & Whitehead, 2006), southwestern (Farías-Curtidor et al., 2017) and southeastern (Smultea et al., 2013) Caribbean Sea, suggest marine mammal diversity, abundance, and distribution can vary dramatically throughout the basin. Dedicated monitoring of marine mammals provides data necessary to study the distribution patterns and trends in relative abundance species, and provide relevant baseline data to inform management decisions (e.g. Correia et al., 2019). To date, no systematic boat-based studies have been carried out to assess the status or abundance of most cetacean species found in Belize or the adjacent Caribbean waters of Mexico, Guatemala, and Honduras (Castelblanco-Martínez et al., 2019).

In this study, we conducted the first dedicated boat-based survey in the territorial and deep-sea waters of Belize, with the aim to documenting the diversity of marine mammals.

Methods

Two six-day-long surveys were conducted aboard a 14-m long Leopard Catamaran: one in May 2016 and another in May 2017. The catamaran traveled at an average speed of 13.5 km.h^{-1} with a team of 8 to 10 observers with previous experience in sighting marine megafauna. The 2016 surveys followed a predetermined route through the shallow lagoon system into the deep-sea, starting in Placencia and traveling north to the northern tip of Turneffe Atoll, then back south past Lighthouse Reef Atoll and Glover's Reef Atoll (Fig. 1). The 2017 survey reversed the 2016 route. Survey data were collected in two modes: 1) on-effort searching, and 2) off-effort "closing" to approach a school (Kinzey et al., 2000). A transect was defined as the pathway covered during on-effort searching, in which four observers stood watch during daylight hours (07:00 to 17:30), two on the bow and two in the stern, from a sighting platform giving observers an eye-height of 6 m. Each observer worked shifts of two hours on and two hours off (6 h per person, per day), using a 7× binocular scanned out to the horizon from 180° abeam of his/her side of the ship. GPS tracks of vessel movements were recorded on an iPhone 6 (Apple Inc.) with the application Navionics, and also verified via the shipboard navigation equipment. Survey data including observers on duty, survey effort, vessel speed, and weather conditions throughout the survey (i.e. cloud cover and Beaufort Seastates) were recorded to a datasheet. Observers also kept records of the survey effort restricted to optimal sea conditions (Beaufort 3 or less), and swell heights of less than 2 meters.

Once a marine mammal was detected, the catamaran's speed was reduced and we approached the animals (off-effort closing mode), following regional guidelines to maintain an appropriate distance and reduce disturbance (Marine Mammal Protected Areas Task Force, 2018). Observers focused on gathering information to taxonomically identify species, estimate group size and composition, record predominant behavioral activity, and collect ancillary data. Attempts were made to take photos of all sighted animals with several DSLR cameras equipped with telephoto lenses (50-400 mm) for species identification and possible photo-identification of individuals through scarring of the dorsal fin (Würsig & Jefferson, 1990). Photos of bottlenose dolphins were used to attempt to distinguish coastal and offshore ecotypes using several characteristics: the offshore has darker coloration, is larger in size, is whiter on the dorsal surface of the peduncle, and was only found in deep waters of depths > 100 m (Ramos et al., 2016) similar to those reported in the Gulf of Mexico (Wells & Scott, 2018). When possible, behavioral data were collected with *ad libitum* sampling on the behavior of sighted animals (Altmann, 1974). Data were collected from the vessel in-movement and attempts were made to stop the vessel to gather additional information.

Coastal lagoon was defined as shallow water (1-25 m depth) habitats within the boundary of the lagoon system dominated by a variety of microhabitats including seagrass beds, coral reef, mud and silt, algae, and rock. Deep sea was defined as water depths of 50 m at the edge of the lagoon and reef system, in depths up to 2,000 m beyond the Mesoamerican barrier reef. Shallow water habitats were typically dramatically different from deep water habitats.

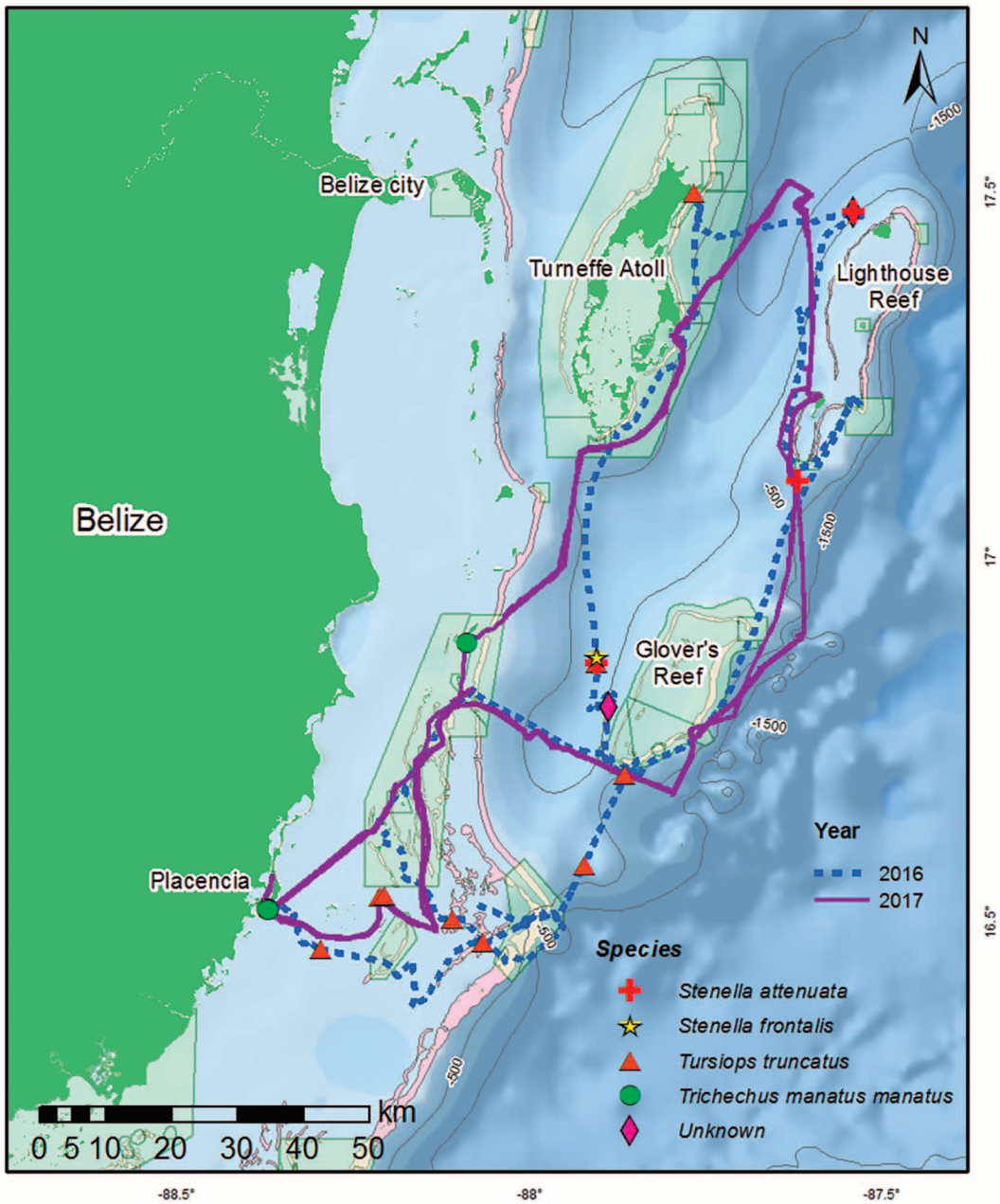

Figure 1. Map of the vessel survey routes taken during each week-long trip in the territorial waters of Belize in 2016 and 2017 and sighting locations of marine mammals. Sightings of marine mammals are represented with symbols. Pink areas show coral reefs. Green areas represent Marine Protected Areas.

A DJI Phantom 3 Professional quadcopter was flown opportunistically to record fine-scale behaviors, to supplement vessel-based group size estimates in dolphins and manatees, and to locate and observe the behavior of manatees. These observations served to enhance our ability to see animals under the water's surface but were not included in on-effort search boat from the vessel. The aircraft was hand-launched from the boat and flown over animals at altitudes of 30-100 m for and durations of up to 12 minutes. The drone was only flown in non-rainy conditions and winds < 35 km/h. Aerial observations from our small drone allowed us to verify our group size estimates by comparing our boat-based

estimates to more reliable aerial counts of the number of individual dolphins present.

Results

Boat-based transects

A total of 85 h of survey effort was completed in 12 days. Boat-based transects resulted in travel distances of 223 km (12 transects) in 2016 and 241 km (12 transects) in 2017 (Fig. 1), and 17 sightings of four different marine mammal species (Fig. 1 & Table 1). The majority of our effort was in search of animals, and only 2 boat-based sightings of marine mammals occurred when effort was ended or when the boat was stationary and anchored to the seabed at the end or beginning of the day.

Tursiops truncatus

Bottlenose dolphins were the most frequently sighted species (8 sightings in 2016, 1 sighting in 2017), with an encounter rate (ER) of 0.068 ind.km^{-1}. Group sizes ranged from one to eight individuals. From these observations, 37.5% of sightings (n = 3) were of the coastal ecotype (Fig. 2A) sighted within the coastal lagoon near the mainland coast or close to mangrove islands in water depths ranging from 1-15 m. Coastal bottlenose dolphins traveled and rested in small groups or alone in all sightings. Bottlenose dolphins (most likely of the offshore ecotype) were found exclusively in deep waters between Lighthouse Reef Atoll and Turneffe Atoll, and further south near Glover's Reef Atoll. Several of the dolphins continued to swim bow-riding with the vessel while it was in motion, but they quickly departed when the vessel slowed down or stopped moving.

Table 1. Sightings of marine mammals during two, one-week long surveys in the Caribbean Sea of Belize in 2016 and 2017. *Tursiops truncatus* (*Tt*), *Stenella attenuata* (*Sa*), *S. frontalis* (*Sf*), *Trichechus manatus manatus* (*Tmm*), and Unknown (Un). On: On-effort searching, Off: Off-effort "closing" to approach the school, Opp.: opportunistic sighting (see methods for details).

Sighting No.	Date	Time	Vessel/ Drone	Species	Group size	Effort	Depth (m)	Habitat type	Location
1	2016-May-01	9:35	V	*Tt*	1	On	< 5	Coastal lagoon	Placencia
2	2016-May-01	13:00	V	*Tt*	2	On	< 3	Coastal lagoon	Laughing Bird Caye
3	2016-May-01	17:50	V	*Tt*	6	On	< 3	Coastal lagoon	Laughing Bird Caye
4	2016-May-02	24:30	V	*Tt*	5	On	< 4	Coastal lagoon	Gladden Spit
5	2016-May-03	8:30	V	*Tt*	3	On	400	Deep sea	East of Glover's Reef Atoll
6	2016-May-03	9:36	V	Un	1	On	260	Coral reef	Southern tip of Glover's Reef Atoll
7	2016-May-03	9:48	V	*Tt*	8	On	1800	Deep sea	East of Lighthouse Reef Atoll
8	2016-May-03	9:48	V	*Sa*	6	On	1800	Deep sea	East of Lighthouse Reef Atoll
9	2016-May-03	11:30	V	*Sf*	20	On	2000	Deep sea	East of Glover's Reef Atoll
10	2016-May-04	5:45	D	*Tt*	1	Off	< 4	Coastal lagoon	Cockroach Caye, northeast Turneffe Atoll
11	2016-May-04	10:29	V	Un	1	On	960	Deep sea	Northeast tip of Lighthouse Reef Atoll
12	2016-May-04	11:42	V	*Sa*	40	On	1200	Deep sea	East of Lighthouse Reef Atoll
13	2016-May-05	14:19	V	*Tt*	6	On	240	Deep sea	South of Glover's Reef Atoll
14	2017-May-18	15:36	V	*Sa*	100-150	On	300	Deep sea	Northeast of Glover's Reef Atoll
15	2017-May-20	15:12	D	*Tmm*	2	On	< 8	Coastal lagoon	Man O' War Caye
16	2017-May-21	13:26	V	*Tt*	2	On	< 6	Coastal lagoon	Coastal lagoon
17	2017-May-22	15:34	V	*Tmm*	1	On	< 3	Coastal lagoon	Placencia Lagoon
18	2017-May-21	18:09	D	*Tmm*	2	Opp.	< 3	Coastal lagoon	Placencia Lagoon
19	2017-May-22	6:43	V, D	*Tmm*	3	Opp.	< 3	Coastal lagoon	Placencia Lagoon
20	2017-May-22	7:18	V, D	*Tmm*	4	Opp.	< 3	Coastal lagoon	Placencia Lagoon
21	2017-May-22	9:08	V, D	*Tmm*	1	Opp.	< 3	Coastal lagoon	Placencia Lagoon

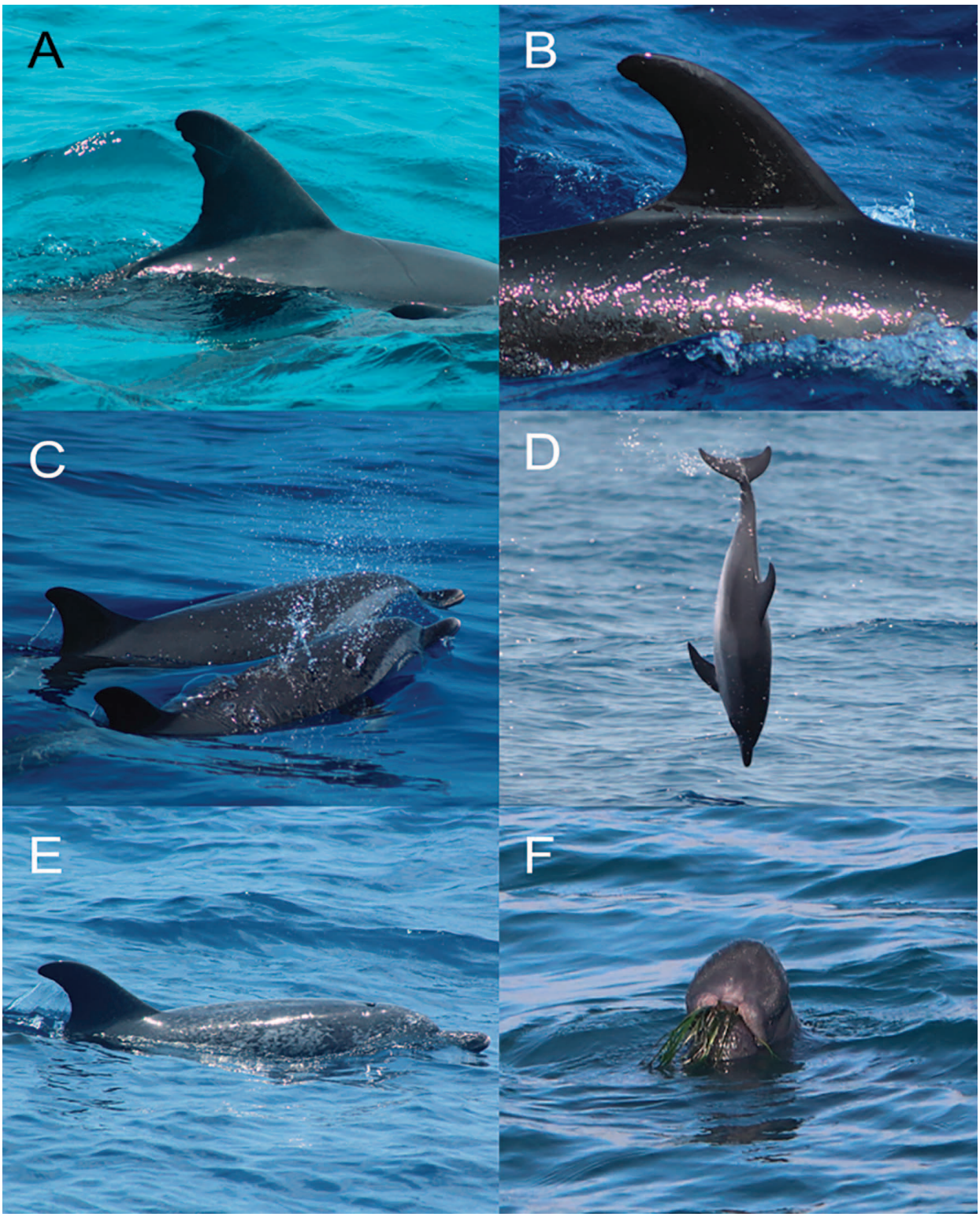

Figure 2. Images of marine mammals taken during coastal and offshore vessel-based surveys in Belize. **A.** A bottlenose dolphin *Tursiops truncatus* (likely of the coastal ecotype) sighted near Placencia. **B.** A bottlenose dolphin (likely of the offshore ecotype) encountered near Lighthouse Reef Atoll. **C.** Two juvenile pantropical spotted dolphins *Stenella attenuata* in a large group sighted near Lighthouse Reef Atoll. **D.** An Atlantic spotted dolphin *Stenella frontalis* calf reentering the water following a 2-m high leap. **E.** Its mother surfacing for a breath. **F.** A young Antillean manatee *Trichechus manatus manatus* feeding on a mouth full of seagrass in Placencia Lagoon.

Stenella attenuata

Three groups of Pantropical spotted dolphins (Fig. 2C) were sighted traveling in group sizes of 6, 40, and approximately 125 individuals (Fig. 3 & Table 1). Due to the average group size of the species, *S. attenuata* showed the highest ER (0.27 ind.km^{-1}) among the observed species. The two larger dolphin groups were typically dispersed over an expansive area making group size estimates challenging (Fig. 3A-C). Groups were observed resting, traveling, and socializing, oftentimes with subgroups exhibiting distinct behavioral states. Pantropical spotted dolphin groups were sighted northeast of Lighthouse Atoll and east of Glover's Reef Atoll.

Stenella frontalis

There was one sighting of *S. frontalis* east of Glover's Reef in during the 2016 survey (Table 1). The group consisted of 20 or more individuals (ER = 0.27 ind.km^{-1}) traveling with *S. attenuata.* One mother-calf pair (Fig. 2D-E) remained bow-riding and socializing near the vessel for 32 min with the calf displaying numerous in-air leaps (Fig. 2D).

Trichechus manatus manatus

Antillean manatees were sighted twice during the 2017 survey, from the boat in shallow lagoon waters (~ 3 m depth) within 30 m of mangrove habitats (Fig. 2F) in Placencia Lagoon, southern Belize (Fig. 1).

Photo-identification

All dolphins photographed in each encounter were used to create a catalog for *S. attenuata* (n = 20) in Belize, and match *S. frontalis* (n = 2) and *T. truncatus* (n = 9) to existing catalogs for the species (E.A. Ramos, *Unpublished data*).

Drone observations

We deployed the P3 in encounters with bottlenose dolphins (2 flights) and pantropical spotted dolphins (3 flights) (Fig. 3). In pantropical spotted dolphins, we noted the distribution of animals in the group staggered across sizes suggesting divisible social ranks in their groups with mother and calf pairs placed in the back of the group, apparently to benefit from the hydrodynamic pull from other animals in the formation rear placement of mother/calf pairs (Fig. 3). In review of aerial drone observations, Antillean manatees remained largely stationary with few movements and long (> 5 min) inter-breath intervals, indicating they were likely resting in these turbid lagoon waters.

Occurrence relative to protected areas

The majority (74%) of sightings occurred outside of protected areas. Sightings of marine mammals in protected areas occurred exclusively in shallow waters and in the waters surrounding the barrier reef of each of the offshore atolls.

Discussion

In this study, we conducted boat-based surveys in the southern end of the coastal lagoon of Belize and the deep sea. Our surveys resulted in little detection of marine mammals. About 30% of the reported species for Belize (Ramos et al., 2016) were detected during the boat-based surveys, primarily in small groups and infrequently. The low occurrence for most species suggests the region hosts a low density and number of whale and dolphin species present in its territorial waters. Additionally, poor weather conditions restricted sightings in 2017, likely contributing to the low detection rate during surveys (0.05 sightings.km^{-1} in 2016 *vs* 0.02 sightings.km^{-1} in 2017).

In our surveys, coastal *T. truncatus* were regularly found along the entire coast and in offshore lagoons supporting previous research demonstrating their nationwide distribution (Coastal Zone Management Authority & Institute, 2014; Campbell et al., 2002; Kerr et al., 2005; Ramos et al., 2018). The probable offshore ecotype of this species was only found in Belizean deep-water ecosystems; however, more data including genetic information and body size measurements are needed to confirm the different ecotypes in this region. There were few sightings of *S. attenuata* and *S. frontalis* in our surveys, and no encounters with a variety of other delphinids that occur in the area (e.g., *S. clymene*, *Steno bredanensis*), indicating there are unlikely to be large populations of these species inhabiting the deep-water and coastal ecosystems in Belize year-round, and/or they may occur seasonally. Both species of spotted dolphin sighted during these surveys (*S. frontalis* and *S. attenuata*) were encountered in water depths ranging between 1500-2000 m where they are more often reported (Ramos et al., 2016). While our dataset is small for these species, ecological niche models in the Caribbean Sea and Atlantic Ocean partially support our findings, since it has been suggested that *S. attenuata* prefers deeper areas in contrast to *S. frontalis*, which appear to distribute mainly within shallow water habitats (do Amaral et al., 2015; Barragán-Barrera et al., 2019). For example, the only region where *S. frontalis* have been sighted

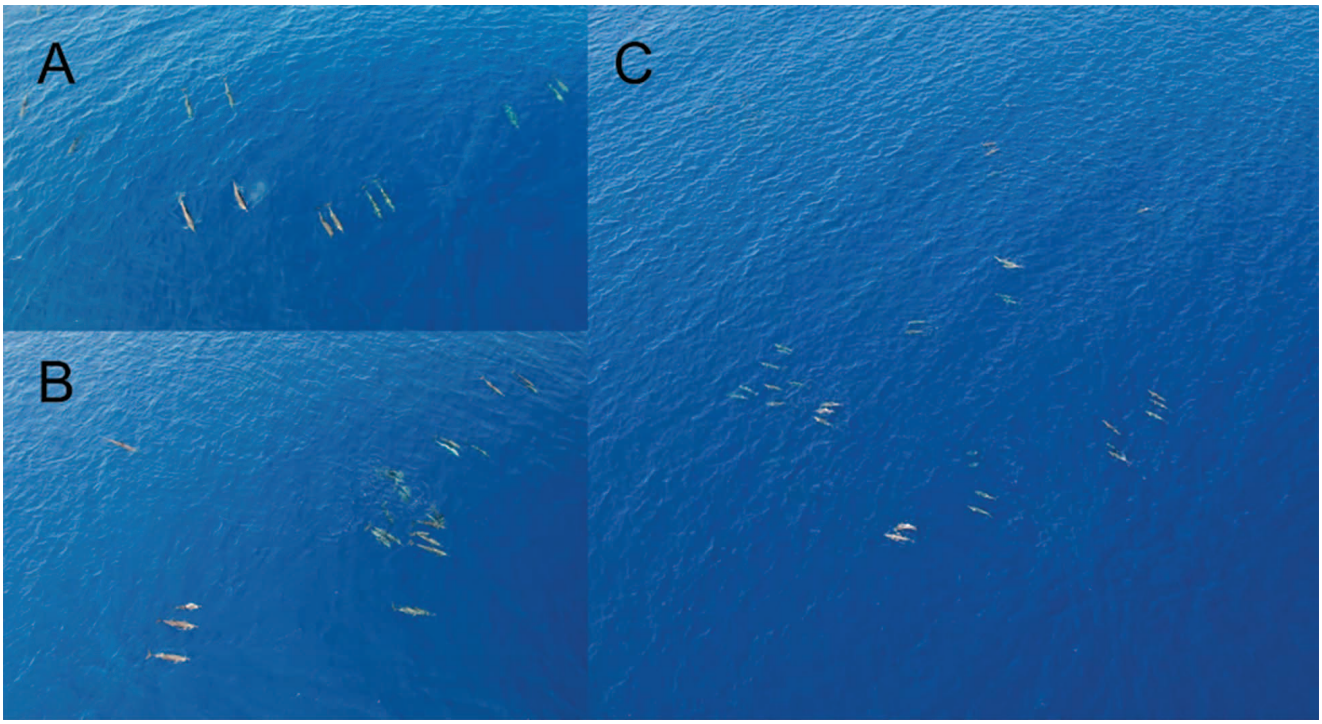

Figure 3. Aerial drone-based observations of a group of pantropical spotted dolphins *Stenella attenuata* in the pelagic waters east of Lighthouse Reef Atoll. **A.** Lower altitude flights provided a more suitable perspective for behavioral observations of individual animals within the group traveling and **B.** Socializing. **C.** Higher altitude observations were most valuable for group size verifications. Footage gathered with a DJI Phantom 3 quadcopter.

regularly in Belize is in Punta Gorda within hundreds of meters of the coast.

Drone observations enabled improved counts of the group sizes of dolphins and coastal manatees, and the tracking of their movement and behavior. Overhead counts revealed many more individual dolphins in encounters with *Stenella* spp. and allowed us to distinguish several manatees in one location that were not easily sighted from the boat. Future observations with drones show great promise to improve data collection and monitoring capacity for marine mammal research in Belize and Caribbean.

No large cetaceans were found during these surveys. Sightings of large baleen whales in Belize are rare yet stranding events indicate that *Megaptera novaeangliae*, *Balaenoptera physalus*, and possibly other unidentified species of baleen whale may be present in the region in low numbers (Ramos et al., 2016). Sperm whales (*Physeter macrocephalus*) are the most commonly sighted species of large toothed whale reported in the deep-sea (Coastal Zone Management Authority & Institute, 2014; Ramos et al., 2016). Two sperm whales and 33 dolphins were sighted in 2012 during the first cetacean aerial survey in Belize (Coastal Zone Management Authority & Institute, 2014). Less frequent accounts of *Globicephala macrorhynchus*, *Peponocephala electra, Pseudorca crassidens*, and *Orcinus orca* (Bolaños-Jiménez et al., 2014) suggest these species likely pass through Belizean waters at different times of year but may not exhibit site-fidelity or year-round occurrence (Ramos et al., 2016).

Seventy-four percent of the marine mammal sightings recorded during our surveys was located outside Marine Protected Areas, suggesting that some critical habitats for cetaceans are not under protection, and further emphasizing the importance of a country-wide protection strategy of these species in non-protected marine areas. Although 23 areas within the territorial seas of Belize are considered protected (McField et al., 2018), marine mammals are highly mobile species creating challenges for guaranteeing that protected area designations adequately consider the broad range and daily movements of some species (Wilson, 2016). Therefore, we recommend performing an analysis of critical areas along with the assessment of the adequacy of existent MPAs, which will be necessary to inform management and conservation decisions.

Limited information on the regional status of marine mammals and their importance to marine ecosystems hinders the development of effective regulations to mitigate threats to their populations. The role that cetaceans play in marine ecosystems east of the Mesoamerican Barrier Reef System (MBRS) or the consequences that they face from anthropogenic impacts are largely unknown. The MBRS faces threats related to the removal of mangrove coverage, unsustainable coastal development, and offshore oil exploration (Verutes et al., 2017), and more broadly, the global threats of climate change and natural disasters, primarily hurricanes (Taylor & Jones, 2016). Additionally, plans to begin deep-sea seismic exploration for oil reserves threaten the entire MBRS and the aquatic habitats of Belize. Offshore exploration for petroleum deposits in the deep-sea depends on seismic air guns to produce loud pulses directly into the seafloor that can have long-term consequences for the wellbeing of marine mammals, potentially causing damage to the inner ears of whales and dolphins and disturbing behavior and communication with conspecifics, critical to their survival (Kavanagh et al., 2019). In December 2017, the Government of Belize (GOB) officially banned exploration for offshore oil deposits in all protected areas and within < 1 km of their borders (Government of Belize, 2018). Other threats include large ships traveling through shipping lanes offshore that not only imply collisions with cetaceans (Van Waerebeek et al., 2007), but also produce engine noise capable of limiting the effectiveness of whale calls and impacting their behavior (Tyack, 2008).

Most of our sightings occurred at depths of > 200 m or < 10 m. The territorial waters of Belize are largely comprised of habitats > 500 m in depth generally located far from the coast and becoming deeper further away from the coast. It is unclear if animals aggregate at specific depths in the areas surrounding the oceanic atolls where productivity may be highest or where the prey of the different dolphin species aggregate. Future marine mammal monitoring efforts in Belize should implement a combination of vessel-based visual distance sampling techniques (Thomas et al., 2010) and acoustic methods (*e.g.*, Barlow & Taylor, 2005). Deploying numerous passive acoustic recorders to effectively document cetacean presence over time and across the different seasons would ensure limited disturbance while being a cost-effective long-term approach for continued monitoring. Aerial and vessel-based research efforts should be repeated on a regular basis to properly monitor marine mammals in the offshore and deep-sea areas of Belize.

Understanding geographical variation in species richness is needed to establish global-scale conservation priorities (Pompa et al., 2011). Many of the whale and dolphin species found in Belize could have an extensive home range in which the MBRS could be a sojourn in their home range. Several studies have demonstrated adaptive movements over a wide latitudinal and longitudinal range in marine mammal species including pilot whales (e.g. Alves et al., 2019), Atlantic spotted dolphins (Herzing et al., 2017), bottlenose dolphins (Nykänen et al., 2018), and Antillean manatees (Castelblanco-Martínez et al., 2013). Although the country-based monitoring of marine megafauna is valuable, it is advisable to implement monitoring protocols on a regional scale in order to understand the distribution, occurrence and status of those populations (Castelblanco-Martínez et al., 2019). In the Caribbean, most marine mammal sightings in deep waters have been recorded during opportunistic surveys, while few surveys have been exclusively dedicated to monitoring cetaceans. To the best of our knowledge, long-distance boat-based surveys have not been attempted in the offshore areas of the Caribbean in Mexico, Guatemala, or Honduras. Hence, agreements between nations and transboundary collaboration are urgent to implement marine mammal conservation programs. A future aim for marine mammal management should be to create a roadmap for an effective international collaboration to develop systematic and dedicated monitoring across the Mesoamerican Reef region.

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