

## A Review of the Aquatic Mammals of Belize

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### Abstract

Characterizing species occurrence, abundance, and distribution is critical to the management of natural resources and the conservation of biodiversity. In the Western Caribbean, little information exists on the occurrence of aquatic mammals along the Mesoamerican Barrier Reef System and adjacent aquatic ecosystems. Herein, we present the first comprehensive review of aquatic mammals encountered in the marine and freshwater habitats of Belize. To determine which aquatic mammal species occur in Belizean waters, we conducted an extensive review of published and unpublished reports of aquatic mammals. We located 163 unique reports from museum and animal collections, journal articles, theses, news reports, conference proceedings, institutional reports, and verified accounts from personal observations. Our review confirms the presence of 17 aquatic mammal species in Belize: 15 cetaceans (*Megaptera novaeangliae*, *Balaenoptera physalus*, *Ziphius cavirostris*, *Physeter macrocephalus*, *Kogia breviceps*, *Orcinus orca*, *Pseudorca crassidens*, *Globicephala macrorhynchus*, *Peponocephala electra*, *Stenella attenuata*, *S. clymene*, *S. frontalis*, *S. longirostris*, *Steno bredanensis*, and *Tursiops truncatus*), one sirenian (*Trichechus manatus manatus*), and one carnivore (*Lontra longicaudis annectens*). Our findings provide the most up-to-date list of aquatic mammal presence in Belize. Given the limited data points obtained for most identified species, we recommend that systematic studies be conducted to investigate the status of the variety of aquatic mammals

in the region to effectively monitor populations and devise strategies to mitigate the negative impacts of anthropogenic activity and climate change-related ecosystem shifts.

**Key Words:** aquatic mammals, Belize, Western Caribbean, marine mammals, species distribution

### Introduction

Human activities and the widespread effects of accelerated global climate change threaten most marine and freshwater ecosystems (Schipper et al., 2008; Estes et al., 2011; May-Collado & Agnarsson, 2011). An understanding of the composition and diversity of species in aquatic ecosystems is crucial to identifying the status of aquatic mammals and enacting effective regulatory measures for their protection. *Aquatic mammals* are defined as all mammals that spend the majority of their lives in water and are dependent on aquatic ecosystems to conduct activities critical to their survival and reproduction (e.g., foraging and breeding). This term includes marine mammals (most of which inhabit oceanic habitats but can also inhabit coasts and rivers) and freshwater dependent mammals that include, but are not limited to, more than 129 species from the following clades: Cetaceans (Suborders Mysticeti: baleen whales; Odontoceti: toothed whales), Sirenians (Trichechidae: manatees; Dugongidae: dugongs), Pinnipeds (Otoriidae: sea lions; Phocidae: seals; Odobenidae: walruses), and Carnivores (Mustelidae: otters; Ursidae: polar bears).

Aquatic mammals play key roles in their ecosystems, ranging from primary consumers to top predators to ecosystem engineers (Roman et al., 2014; Kiszka et al., 2015). Population declines and extinctions of top marine predators result in trophic cascades capable of impacting a broad range of ecological processes (Heithaus et al., 2008; Kiszka et al., 2015). Most aquatic mammal species have endured major exploitation by humans. In the past three centuries, a combination of hunting, habitat loss, and other anthropogenic impacts have resulted in major population declines; loss of genetic diversity (Chapin et al., 2000); and the extinction of the baiji (*Lipotes vexillifer*), Steller's sea cow (*Hydrodamalis gigas*), Japanese sea lion (*Zalophus japonicus*), Caribbean monk seal (*Monachus tropicalis*), Japanese river otter (*Lutra lutra whiteleyi*), and sea mink (*Neovision macrodon*) (International Union for Conservation of Nature [IUCN], 2015). Evidence from the fossil record coupled with projections of extinction risk indicates extinction rates for terrestrial and marine fauna has increased several-fold compared to historical rates (Ricciardi & Rasmussen, 1999; Davidson et al., 2012). Identifying the potential impacts of the loss of aquatic mammal species, their risk of extinction, and determining their functional roles within aquatic ecosystems requires baseline data on species presence and distribution that is often lacking in regions with limited resources to conduct wide-scale studies.

Information is limited on the status of aquatic mammals across the riverine systems, coastal habitats, and oceanic cays and atolls in Belize, which form the heart of the Mesoamerican Barrier Reef System (MBRS). Reliable assessments of the status of populations of aquatic mammal species found in this region are currently infeasible due to the absence of data on their occurrence, demographics, abundance, and distribution. The Belizean government and a variety of national and international nongovernmental organizations (NGOs) are heavily invested in the conservation of Belizean biodiversity and natural resources. Almost a third of the Belizean territorial area is protected by 103 protected areas, including 17 forest reserves, four nature reserves, 18 national parks, nine marine reserves (MR), five natural monuments, 15 archaeological reserves, seven bird sanctuaries, 12 spawning aggregation reserves (National Protected Area System [NPAS], 2015), and two regions protected by the Ramsar Conventions on Wetlands (locations designated for the protection and effective management of wetlands) (Ramsar Convention Secretariat, 2013). Aquatic mammals are protected from extraction and hunting under the *Wildlife Protection Act of 1981*. However, despite nationwide effort to protect wildlife, systematic investigations of most

of the country's aquatic mammals have not been conducted due largely to limited resources and the absence of dedicated in-country research institutions for aquatic mammal research. The Antillean manatee (*Trichechus manatus manatus*) and certain populations of bottlenose dolphin (*Tursiops truncatus*) are well studied in the region, both having been the focus of numerous short- and long-term studies across the coastal and oceanic cays of Belize. However, due to the diverse ecological requirements and life histories of aquatic mammals, managers and stakeholders should be cautious in generalizing potential threats and effective protection measures to other species based on these findings.

The aim of this study is to present the first comprehensive review of aquatic mammal occurrence in Belize and this region of the western Caribbean Sea. We conducted an extensive review of published and unpublished records of aquatic mammals, verifying unpublished accounts when possible; mapped occurrence records in relation to protected regions to provide the first cohesive record of aquatic mammals in Belize; and then discussed the extent of knowledge of each aquatic mammal species in this region.

## Methods

### *Study Region*

We investigated all occurrences of aquatic mammals throughout Belize from its northern border with Quintana Roo, Mexico (N 18° 29' 58", W 088° 13' 44") to its southern border with Guatemala (N 15° 38' 45", W 088° 11' 15"). Our study region extended to the maritime borders of Belize's Exclusive Economic Zone (EEZ) and included 313 km of coastline and 35,905 km<sup>2</sup> of territorial sea (Figure 1). Belize is comprised of six districts, numerous coastal and pelagic cays, three oceanic atolls, and 35 river catchments or watersheds that drain into the Caribbean Sea. Its three oceanic atolls are separated from the mainland by deep water channels characterized by depths greater than 1,000 m (Stoddart, 1962; Stoddart et al., 1982).

### *Compilation and Review of Records*

We conducted an extensive search for sighting records within our study region. The source of each aquatic mammal record was classified into the following eight categories: (1) collection/museum (specimens held in museums, animal collections, or online databases), (2) peer-reviewed article, (3) book/book chapter, (4) personal observation (unpublished sightings cited here as personal communications), (5) dissertation/thesis, (6) institutional report (e.g., governmental, NGO, institutional), (7) conference proceedings, and (8) local news. In addition to the database search,



**Figure 1.** Map of the study region in Belize showing its districts, relevant locations, and the boundary of Belize's Exclusive Economic Zone

we conducted online searches, contacted NGOs and governmental organizations throughout Belize to acquire sighting and stranding records, and collected personal observations with accompanying data that were examined by the authors of this review before verifying species identifications. Reports from local news were only accepted if accompanied by images that could be used for verification. To find articles reporting occurrences of aquatic mammals in Belize, we examined a variety of scientific databases (e.g., Elsevier, Springerlink, Web of Science) and consulted various scientific collections and museums (e.g., Smithsonian Institution National Museum of Natural History) using numerous relevant key words and the scientific and common names of 33 aquatic mammal species previously reported in the Caribbean (e.g., Jefferson & Lynn, 1994; Ward et al., 2001; Platt & Rainwater, 2011).

When a confirmed occurrence of an aquatic mammal species was represented in more than one source (e.g., in an online database and as a specimen in a collection), we included only the original report if it was available. For unpublished accounts, we attempted to contact the authors to seek additional evidence of verification if the species in question could be easily misidentified (e.g., species of *Stenella*) or if the species is outside of its reported range (e.g., baleen whales). When animal photos accompanied occurrence records, we attempted to identify the species in question by

referring to marine mammal identification guides (e.g., Jefferson et al., 2008) and consulting with expert colleagues if species identification was challenging, especially when distinguishing between *Peponocephala electra* and *Pseudorca crassidens*.

### Mapping of Records

We mapped aquatic mammal occurrences where coordinates were available or if a description of the geographic sighting location was reported. If latitude and longitude were available, coordinates were plotted on a map using *ArcGIS 10.3* (ESRI, St. Charles, MO, USA). If coordinates were unavailable but data points were depicted on a map, we georeferenced points using *ArcGIS* by overlaying records with maps of Belize and identifying the approximate coordinates of each point. Records that lacked geographic data or were only associated with a broad region were not plotted in the map. When data were available, one point was generated for each reported sighting of groups and/or individuals; thus, each mapped point may represent the sighting of more than one animal. Aquatic mammal occurrence records were overlaid with the protected regions (NPAS, 2015) in Belize, and we calculated the percentage of reports that fell within these areas.

## Results

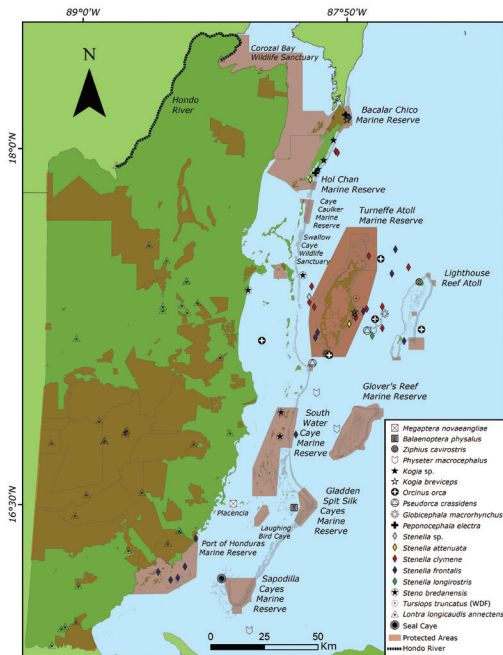
Following our review of thousands of sources and 203 potential records, we compiled 163 unique records of 17 aquatic mammal species in Belize. Identified species include 15 cetaceans (two mysticetes; 13 odontocetes), one sirenian, and one carnivore. Strandings consisted of 10.3% ( $n = 17$ ) of all reports, but this does not reflect actual stranding frequencies for species given we considered only individual reports of a stranding event and not the total number of stranded animals. In order from sources with the most to the least records, sources came from collections/museums, personal observations, institutional reports, peer-reviewed articles, theses, conference proceedings, local news, and no unique records from books/book chapters (Table 1). The Antillean manatee was the most commonly reported species, followed closely by the neotropical river otter (*Lontra longicaudis annectens*) and bottlenose dolphin (Table 1). Of the 17 verified species, eight are classified as *Data Deficient*, six of *Least Concern*, one is *Vulnerable*, and two are *Endangered* (IUCN, 2015).

All verified records of aquatic mammals with accompanying geographic data were mapped in relation to all protected regions in Belize as of 2016 (Figure 2). There are thousands of individual sighting records for coastal bottlenose dolphins and manatees that have been observed in many

**Table 1.** Number for each verified aquatic mammal species listed according to species common name, Latin name, IUCN status, source, and the percentage of reports for each species of all verified records. "Strandings" indicates the number of records from stranding events and WDF = worldwide distributed form.

Common name	Scientific name	IUCN status	Collection/ museum	Peer- reviewed article	Personal observation	Thesis	Institutional report	Conference proceedings	Local news	Total records	% of total	Strandings
Humpback whale	<i>Megaptera novaeangliae</i>	Least Concern			1					1	0.6	
Fin whale	<i>Balaenoptera physalus</i>	Endangered	1							1	0.6	1
Cuvier's beaked whale	<i>Ziphius cavirostris</i>	Least Concern				1				1	0.6	1
Sperm whale	<i>Physeter macrocephalus</i>	Vulnerable	1		5		1			7	4.3	
Pygmy or dwarf sperm whale	<i>Kogia sp.*</i>								3	3	1.8	3
Pygmy sperm whale	<i>Kogia breviceps</i>	Data Deficient				2				2	1.2	2
Killer whale	<i>Orcinus orca</i>	Data Deficient		2	2		1			5	3.1	
False killer whale	<i>Pseudorca crassidens</i>	Data Deficient			2					2	1.2	
Short-finned pilot whale	<i>Globicephala macrorhynchus</i>	Data Deficient	1		3					4	2.5	
Melon-headed whale	<i>Peponocephala electra</i>	Data Deficient				1			1	2	1.2	2
Unidentified stenellid	<i>Stenella sp.*</i>				4					4	2.5	
Pan-tropical spotted dolphin	<i>Stenella attenuata</i>	Least Concern		1	2		1			4	2.5	2
Clymene dolphin	<i>Stenella clymene</i>	Data Deficient		1			1			2	1.2	1
Atlantic spotted dolphin	<i>Stenella frontalis</i>	Data Deficient	1			1	2			4	2.5	1
Spinner dolphin	<i>Stenella longirostris</i>	Data Deficient			1					1	0.6	
Rough-toothed dolphin	<i>Steno bredanensis</i>	Least Concern	1	1	3					5	3.1	2
Bottlenose dolphin	<i>Tursiops truncatus</i> (coastal)	Least Concern	8	6		8	4	4		30	18.6	1
Bottlenose dolphin	<i>Tursiops truncatus</i> (WDF)	Least Concern			4		2			6	3.7	
Antillean manatee	<i>Trichechus manatus manatus</i>	Endangered	15	13	1	5	7	1	1	43	26.3	1
Neotropical river otter	<i>Lontra longicaudis annectens</i>	Data Deficient	31		1		3	1		36	21.6	
Totals			59	24	30	14	26	6	5	163		17

\* Indicates species could only be identified to the genus level.



**Figure 2.** Map of aquatic mammal reports throughout Belize. Records were mapped according to species name in Latin, alongside protected regions with relevant site locations named. All reports with accompanying geographic location data are depicted, with the exception of Antillean manatees and coastal bottlenose dolphins. WDF = worldwide distributed form.

coastal and oceanic protected areas, including the Port of Honduras MR, Glover's Reef MR, Swallow Caye Wildlife Sanctuary (WS), Bacalar Chico MR and National Park, and Turneffe Atoll MR. These records were not mapped. Of the 105 mapped records, 40% ( $n = 42$ ) fell within all protected areas, of which 16.2% ( $n = 17$ ) represent strandings. In the following section, we provide a brief overview of each species in the Wider Caribbean and discuss the occurrence records and extent of knowledge of each verified species in Belize according to their taxonomic order, genus (where relevant), and species classification.

#### *Order Cetacea, Suborder Mysticeti*

**Humpback Whale** (*Megaptera novaeangliae*; Gray, 1846)—Humpback whales are reported extensively throughout much of the Caribbean Sea (e.g., Winn et al., 1975; Levenson & Leapley, 1978; Mignucci-Giannoni, 1998; Swartz et al., 2003; Whitt et al., 2011); however, to the best of our knowledge, they have not been reported in the western Caribbean Sea. There is a single verified sighting of an emaciated lone individual, likely ill or disoriented, which was observed in the Victoria Channel near

Placencia in the south of Belize on 24 February 2016 (A. Hagan, pers. comm., 24 February 2016) (Figures 1 & 2) and for some weeks in Amatique Bay, Guatemala, according to local news reports. The animal was observed days later in the region, eventually stranding and dying in the Toledo District in southern Belize on 25 April 2016. Reports indicate the individual had a gillnet attached to it at the time of death but whether this was the cause of death is unclear. The necropsy performed by the Toledo Institute for Development and Environment (TIDE) did not reveal cause of death (J. R. Foley, pers. comm., 20 June 2016).

**Fin Whale** (*Balenoptera physalus*; Linnaeus, 1758)—Across the Caribbean, groups of free-ranging fin whales have been reported in Puerto Rico (Mignucci-Giannoni, 1998), and strandings have occurred near Venezuela (Lira et al., 1995) and the Colombian Caribbean (Muñoz-Hincapié et al., 1998), but they have not been observed in the western Caribbean Sea (Archer et al., 2013). On 28 April 1986, a single live adult female fin whale stranded in Placencia near Buttonwood Caye, but attempts to guide it into deep water were unsuccessful (Figure 2) (Sanders et al., 1997).

#### *Suborder Odontoceti*

**Cuvier's Beaked Whale** (*Ziphius cavirostris*; G. Cuvier, 1823)—Cuvier's beaked whales have been documented throughout the Caribbean (e.g., Caldwell et al., 1971a; Mignucci-Giannoni, 1998; Rinaldi et al., 2006; Whitt et al., 2011). Near Belize, the skeletal remains of several stranded *Z. cavirostris* have been recovered along the coast of the Mexican Caribbean (Niño-Torres et al., 2015). The only record of a beaked whale in Belizean waters is a single *Z. cavirostris* that stranded on Northern Cay on Lighthouse Reef Atoll (LHR) in 1988 (Figure 2) (Sanders et al., 1997). The specimen's skull and vertebrae were used to verify the species by D. Perrin (Sanders et al., 1997).

**Sperm Whale** (*Physeter macrocephalus*; Linnaeus, 1758)—Sperm whales are broadly distributed throughout most of the Caribbean (e.g., Watkins & Moore, 1982; Watkins et al., 1985; Carlson et al., 1995; Gordon et al., 1998; Cardona-Maldonado & Mignucci-Giannoni, 1999; Boisseau et al., 2000; Pardo et al., 2009b). In the Mexican Caribbean, there are six confirmed reports of stranded sperm whales, with the nearest stranding to Belize reported in the Yucatan Peninsula (Ortega-Argueta & Morales-Vela, 1998), near Cozumel and Isla Mujeres (Xacur Maiza et al., 1998; Niño-Torres et al., 2015), and Espíritu Santo Bay (Navarro et al., 1990). *P. macrocephalus* is the



most commonly sighted large-toothed whale in Belize, with seven confirmed sightings in pelagic waters, most between Turneffe Atoll (TA) and LHR (Table 1; Figure 2). In mid-April of 2010, two sightings were reported between TA and LHR (T. Rath, pers. comm., 30 June 2014; J. Romero, pers. comm., 14 December 2014). During marine mammal aerial surveys in April of 2012, two individuals were sighted in the southern region of the MBRS near the Sapodilla Cayes (Coastal Zone Management Authority & Institute of Belize [CZMAI], 2014) and one individual outside the reef at Glover's Reef Atoll (Figure 2). On 5 May 2015, M. Leslie (pers. comm., 6 May 2015) encountered a single sperm whale near South Water Caye. Anecdotal reports of *P. macrocephalus* throughout Belize were frequent in our review, and three sightings found online were verified with video and photo data.

*Pygmy* (*Kogia breviceps*; *Blainville, 1838*) and *Dwarf Sperm Whales* (*K. sima*; *Owen, 1866*)—Pygmy and dwarf sperm whales have been reported in deep waters throughout the Caribbean, primarily from stranding records (e.g., Cardona-Maldonado & Mignucci-Giannoni, 1999; Boisseau et al., 2000). Morphological similarities between the two species and their cryptic lifestyles make accurate species identification of individuals at sea challenging. Numerous strandings of *K. breviceps* (e.g., De la Parra Venegas, 1998; Ortega-Argueta & Morales-Vela, 1998; González Solís et al., 2006) and *K. sima* (e.g., Sánchez-Okrucky, 1997; Xacur Maiza et al., 1998; Niño-Torres et al., 2015) have been reported north of Belize in the neighboring Mexican Caribbean. On 27 February 2009, a single *K. breviceps* stranded on a beach of Blackbird Caye at TA (Figure 2) (Szczepaniak & Cure, 2009). In August 2013, K. Jenko (pers. obs., 25 August 2013) encountered a single highly decomposed carcass of a stranded *K. breviceps* on a beach in Bacalar Chico MR and National Park on Ambergris Caye (Figure 2). We were unable to verify specimens of *K. sima*; however, we identified three separate news reports of three stranded *Kogia* sp. on Ambergris Caye (Figure 2). These included a live stranding on 30 August 2008 and two separate strandings of deceased individuals on 11 June 2009 and 12 June 2009, respectively. The live-stranded animal presented with large wounds on the flukes and shark bites, and eventually succumbed to its injuries. Due to a lack of high-quality pictures, these records could not be verified to the species level.

*Killer Whale* (*Orcinus orca*; *Fitzinger, 1860*)—Killer whales have been reported throughout the Caribbean, with most sightings in the eastern Caribbean (Bolaños-Jiménez et al., 2014) and

one report from the Mexican Caribbean (Niño-Torres et al., 2015). Five sightings of *O. orca* have been documented in Belizean waters (Table 1; Figure 2). In 1992, a group of two adult females and a calf were observed south of TA (Figure 2) (Sanders et al., 1997). Bolaños-Jiménez et al. (2014) reported a single individual from the 1980s and a group of 15 animals in July of 1992. In 2006, J. Robinson (pers. comm., 15 September 2013) encountered a group of *O. orca* between TA and LHR (Figure 2) composed of a male, three other likely females, and a calf. In December 2013, a commercial dive boat observed a group near Mauger Caye northeast of TA (J. Romero, pers. comm., 15 December 2014).

*False Killer Whale* (*Pseudorca crassidens*; *Owen, 1846*)—False killer whales have been extensively reported throughout the Caribbean (e.g., Mörzer Bruyns, 1969; Caldwell & Caldwell, 1975; Mignucci-Giannoni, 1998; Romero et al., 2001; Boisseau et al., 2006; Rinaldi et al., 2006; Pardo et al., 2009a, 2009b; Whitt et al., 2011) and north of Belize in Quintana Roo and the coastal Mexican Caribbean (e.g., García-Rivas, 1999; Delgado Estrella et al., 2004; Niño-Torres et al., 2015). There are two confirmed sightings of *P. crassidens* in Belize: a group of more than eight animals observed on 3 May 2015 in pelagic waters between TA and LHR (T. Sagee, pers. comm., 30 May 2015) and a group of six or more animals encountered southwest of TA on 5 May 2015 (M. Leslie, pers. comm., 6 May 2015).

*Short-Finned Pilot Whale* (*Globicephala macrorhynchus*; *Gray, 1846*)—Short-finned pilot whales are found throughout the Caribbean, typically in deep waters and at the edge of the continental shelf (Jérémie, 2005; Boisseau et al., 2006; Whitt et al., 2011). Numerous strandings have been reported throughout the Mexican Caribbean (Morales-Vela & Olivera-Gómez, 1993; Niño-Torres et al., 2015). Groups of *G. macrorhynchus* were observed on scuba dive trips at the southern tip of TA on 1 April 2011 (E. A. Ramos, pers. obs., 4 April 2012) and 8 December 2011 (Biodiversity and Environmental Resource Data System [BERDS], 2015) (Figure 2). On 16 November 2009, a group of more than 50 *G. macrorhynchus* were observed in pelagic waters on ecotourism boat trips from TA to LHR (A. N. Jeffords, pers. comm., 30 April 2015). We located one online video of people swimming with a small group of *G. macrorhynchus* in Southern Belize in 2014. This species is one of the most frequently reported in Belize; however, most observations could not be verified.

*Melon-Headed Whale* (*Peponocephala electra*; Gray, 1846)—In the Caribbean, melon-headed whales have been observed in Dominica, St. Vincent, Venezuela, and Puerto Rico (Caldwell et al., 1976; Watkins et al., 1997; Mignucci-Giannoni et al., 1998; Bolaños & Villarroel-Marin, 2003). Niño-Torres et al. (2015) reported the stranding of a live *P. electra* calf near Playa del Carmen, Mexico. On 28 May 2014, a recently deceased male neonate *P. electra* stranded on a beach at the Bacalar Chico MR and National Park in northern Belize (Figure 2) (Courtene-Jones, 2014). On 30 July 2014, a juvenile individual was observed disoriented and injured in the shallow waters of San Pedro, Ambergris Caye; it died the following day (Figure 2) (J. Galves, pers. comm., 20 September 2014). The animal had lacerations along its head and right pectoral flipper and a deeper wound on the front of its head, potentially the result of a collision with a boat propeller. A necropsy revealed large quantities of stomach parasites, but the cause of death could not be determined.

*Pantropical Spotted Dolphin* (*Stenella attenuata*; Gray, 1846)—Pantropical spotted dolphins have been reported throughout the Caribbean (e.g., Caldwell et al., 1971b; Roden & Mullin, 2000; Mignucci-Giannoni et al., 2003). Jefferson & Lynn (1994) sighted two groups of four *S. attenuata* in pelagic waters more than 100 km east of Belize's EEZ. On 3 August 2015, a single female *S. attenuata* live-stranded on TA (E. A. Ramos, pers. obs.) and survived for approximately 8 h before passing. The necropsy revealed cysts (possible pannicular parasitic cysts) located extensively throughout the body, but the cause of stranding and death could not be determined. On 15 December 2015, a single deceased animal stranded at Hol Chan MR (K. F. Castillo, pers. comm., 16 December 2015).

*Clymene Dolphin* (*Stenella clymene*; Gray, 1850)—In the Caribbean, Clymene dolphins have been reported in the Windward Islands (Perrin & Mead, 1994) and in Carriacou, north of Grenada (Perrin et al., 1981). There are several stranding reports for *S. clymene* in the Mexican Caribbean near Cancun from 1991 to 2013 and one stranding in Mahahual (Delgado Estrella et al., 1998; Aguilar-Aguilar et al., 2010). Niño-Torres et al. (2015) reported the sighting of an interspecific group of *S. clymene* and *S. frontalis* near Xcalak. In Belize, a single animal stranded on Ambergris Caye in 1991 (Figure 2) (Fertl et al., 2003; Jefferson & Curry, 2003). Sanders et al. (1997) reported 15 sightings of *S. clymene* in deep water channels in Belize, with an average group size of 10.6 dolphins and a range of one to 35 dolphins.

Three of these observations occurred between TA and the Belize Barrier Reef and 12 between TA and LHR (Figure 2).

*Atlantic Spotted Dolphin* (*Stenella frontalis*; G. Cuvier, 1829)—Atlantic spotted dolphins are found throughout the Wider Caribbean (e.g., Mignucci-Giannoni, 1998), with strandings and sightings of free-ranging individuals reported in the Mexican Caribbean (Niño-Torres et al., 2015). In Belize, one stranded individual was reported along the Monkey River on 15 August 1985 (BERDS, 2015). Groups of *S. frontalis* are regularly observed ranging from Bacalar Chico in northern Belize (Ateweberhan et al., 2011; Chapman, 2012) to Port of Honduras in southern Belize (Rojas-Arias, 2013). Sanders et al. (1997) reported seven observations of *S. frontalis*, primarily along the fringing reef of TA and LHR, and neighboring deep water channels, including the sighting of a neonate and a mixed-species group with two unidentified stenellid dolphins. Rojas-Arias (2013) identified 24 individuals throughout the Port of Honduras MR (Figure 2).

*Spinner Dolphin* (*Stenella longirostris*; Gray, 1828)—Spinner dolphins have been documented throughout the Caribbean (e.g., Caldwell et al., 1971b; Jefferson & Lynn, 1994; Mignucci-Giannoni, 1998; Rinaldi et al., 2006). Niño-Torres et al. (2015) reported groups of up to 15 spinner dolphins 15 km east/northeast of Isla Mujeres in the Mexican Caribbean. Although we located numerous anecdotal observations of *S. longirostris* in Belizean waters, we could verify only one sighting of this species between the mainland and TA (Figure 2) (D. N. Castelblanco-Martínez, pers. obs., 25 January 2015).

*Rough-Toothed Dolphin* (*Steno bredanensis*; G. Cuvier in Lesson, 1828)—In the Caribbean, rough-toothed dolphins have been reported off Guadeloupe (Boisseau et al., 2000), Colombia (Prieto-Rodríguez, 1988), Honduras (Kuczaj & Yeater, 2007), Venezuela (Bolaños & Boher, 1996), Puerto Rico, and Virgin Bank (Mattila & Clapham, 1989). Groups of *S. bredanensis* have been observed north of Belize near Isla Mujeres, Mexico (Delgado Estrella et al., 2002; Niño-Torres et al., 2015). Perkins & Miller (1983) reported a mass-stranding event on 11 November 1981 of 13 *S. bredanensis*, found across a 60 to 90 m stretch of shore 30.5 m north of the Sibun River (Figure 2). The causes of death could not be determined due to the states of decomposition, but sex was identified for seven males and five females. On 15 December 2008, a single individual stranded between Wee-Wee Caye and

Twin Caye (U.S. National Museum [USNM], 2015). Groups of *S. bredanensis* are frequently sighted in the South Water Caye MR near Tobacco Caye and Twin Cayes (Figure 2) (L. Kaufman, pers. comm., 3 March 2015) and once in 2008 at Glover's Reef Atoll by T. McClanahan of the Wildlife Conservation Society (WCS) (L. Searle, pers. comm., 11 March 2016). On 8 February 2015, two *S. bredanensis* were encountered east of TA (Figure 2) (S. Teixeira Santos, pers. comm., 8 February 2015). This species is regularly reported in Placencia and southern Belize (Hines, 2011) but with few existing verifiable records.

**Bottlenose Dolphin** (*Tursiops truncatus*; *Montagu, 1821*)—In the Caribbean, bottlenose dolphins occur in two distinct ecotypes or forms: (1) an inshore or coastal ecotype and (2) an offshore ecotype or worldwide distributed form (Caballero et al., 2012). Both types occur regularly in Belize, with each appearing distinct: the coastal form is lighter in color, smaller in size, travels in smaller groups, and inhabits shallow water ecosystems; while the worldwide distributed form is darker, larger, and is generally found in large groups in pelagic waters. Minimal habitat overlap has been observed between these types of *T. truncatus* near the coasts, barrier reef, and fringing reefs of oceanic cayes and atolls. The genetic and species distinction between these types remains unresolved.

**Coastal Ecotype**—Coastal bottlenose dolphins are one of the most well-studied marine mammals in Belize. They are found in shallow bodies of water, including river mouths, estuaries, and lagoons, along the coasts, around cayes, and in the countries' three oceanic atolls. Anecdotal reports suggest that strandings of this species may be common throughout Belize but remain largely unreported and/or undiscovered. Oceanic Society (OS), an NGO based out of California, USA, has logged over 1,500 sightings of coastal *T. truncatus* at TA and the Drowned Cayes (DC) in Belize, with 783 reported on OBIS-SEAMAP (Ocean Biogeographic Information System—Spatial Ecological Analysis of Megavertebrate Populations) by E. A. Ramos. A small population of coastal bottlenose dolphins at TA composed of resident and transient animals (Campbell et al., 2002; Dick & Hines, 2011) has been the subject of long-term study since 1992. Abundance estimates and long-term photo-identification indicates a population size of 108 to 261 individuals (Campbell et al., 2002; Hancock, 2007; Dick & Hines, 2011) and suggests that TA serves as the core area of a much larger home range, likely including the DC and the coast of mainland Belize. Approximately 170 bottlenose dolphins have been

photo-identified to date, with 16 demonstrating a site fidelity of more than 22 y. Numerous other studies have been conducted on this population since 1992, including investigations of their behavior, group size, habitat preference (Grigg & Markowitz, 1997), social affiliations and site fidelity (Bilgre, 1998; Hancock & Oliver, 2001; Hancock, 2007), foraging and microhabitat use (Hinderstein, 1998; Eierman & Connor, 2014), and sound production (Campbell, 2004; Ramos, 2014).

In the DC, several kilometers east of Belize City (Figure 1), a photo-identification study from 1997 to 2002 revealed a population of 128 bottlenose dolphins with similar group sizes and site fidelities as the population at TA (Kerr et al., 2005), and continued photo-identification work at TA found an overlap of three individuals between the two regions (Hancock, 2007). Short-term studies of this population have included investigations of their occurrence, distribution, group size dynamics, habitat use, behavior, and affiliation patterns (e.g., Sanders & Grigg, 1998; Sanders, 1999; Petersen, 2001; Kerr et al., 2005; Alongi, 2007). In the Port of Honduras MR in the Toledo district of southern Belize (Figures 1 & 2), Rojas-Arias (2013) identified 29 different individuals across 67 sightings of dolphin groups (Figure 2). One lone sociable dolphin was observed for many years inhabiting the shallow waters of LHR and the Blue Hole in the 1990s to early 2000s (Dudzinski et al., 1995; Bilgre et al., 1999). Although the population of bottlenose dolphins at TA has been well studied, and populations have been briefly studied in DC and PHR, in most areas of Belize, crucial information is lacking on their movement patterns, ecology, and susceptibility to negative impacts from anthropogenic sources.

**Worldwide Distributed Form**—Only six records were obtained for this form of *T. truncatus* in Belize, more representative of a lack of reports than a genuine absence given the frequent anecdotal reports of their occurrence. Scuba dive boats in pelagic waters and shallow regions near the reef regularly encounter groups, but most sightings could not be verified or distinguished from the coastal ecotype. Off TA, the worldwide distributed form has been observed periodically traveling along the fringing reef since 1994 (Sanders et al., 1997) and traveling in deep waters between LHR and TA. Two individuals were resighted several months apart in the same location in front of Blackbird Caye, TA (Figure 2) (E. A. Ramos, pers. obs., 28 February 2013), suggesting the possibility of site fidelity to specific regions for the worldwide distributed form in Belize.



### Order Sirenia

*West Indian Manatee; Antillean Subspecies* (*Trichechus manatus manatus*; *Linnaeus, 1758*)—Antillean manatees inhabit coasts throughout the Gulf of Mexico and Caribbean Sea (Husar, 1977; Lefebvre et al., 1989; Fertl et al., 2005). This species is the most extensively studied aquatic mammal in Belize, with 43 reports of the species along the rivers, coastal waters, and oceanic atolls, and consistent monitoring in Belize since the late 1960s (e.g., Charnock-Wilson, 1970; Bengtson & Magor, 1979; McCarthy, 1986; Gibson, 1995; Auil, 2004). Our review of records of *T. m. manatus*—hereafter “manatees”—underestimates their actual prevalence (Table 1) as they are the most commonly sighted marine mammal in Belize, with dozens of strandings per year (E. A. Ramos, pers. comm., 14 February 2016). O’Shea & Salisbury (1991) reported Belize as having the highest number of manatees identified in any aerial survey conducted in the Caribbean region, possibly due to the high quality of habitat and low level of killing. Manatees consistently travel along much of the Belizean coast from north to south (Auil, 1988) across Belize and are estimated to have a population size of 700 to 900 animals (Galvez et al., 2013). Year-round presence of this species also has been established in Bacalar Chico in northern Belize (Jenko et al., 2014). Three protected areas in Belize were created specifically to protect manatees: (1) Gales Point WS, (2) Swallow Caye WS, and (3) Corozal Bay WS. Aerial surveys have shown that inshore habitats (e.g., estuaries, lagoons, and rivers) are preferred to offshore ones (i.e., cayes and coasts) (Morales-Vela et al., 2000, 2007; Auil, 2004).

Turneffe Atoll is also the only entirely offshore marine area reported as part of the distribution of the species (Platt et al., 2000; Holguin, 2004; Edwards et al., 2014), monitored primarily by OS. Satellite tracking of manatees captured at TA showed regular trips to the mainland, suggesting a foraging strategy that guarantees necessary freshwater intake while maintaining use of the atoll as a feeding area (Castelblanco-Martínez et al., 2012). Self-Sullivan et al. (2003) documented the seasonal occurrence and behavior of male manatees between 1995 and 2001 at breaks in the northern Belize Barrier Reef. Other studies included testing manatee photo-identification as a tool to study wild manatees in the Caribbean (Self-Sullivan, 2007), descriptions of their distribution and habitat use in the DC (LaCommare et al., 2008), and their use of resting holes (Bacchus et al., 2009).

In 1997, the Belizean government, various NGOs, and U.S. agencies began a long-term research project to study the population of manatees in Belize (Bonde et al., 2001; Auil et al.,

2007). Manatees are caught twice per year as part of a larger tagging and tracking project that started in Southern Lagoon and expanded to New River Lagoon, Placencia Lagoon, Belize City cayes (Auil et al., 2007), and TA (Castelblanco-Martínez et al., 2013). With routinely conducted health assessments on their physiological state, and employing various kinds of radio-tracking devices and passive integrative transponder (PIT) tags, this project has yielded extensive insights on the biology, genetics, health, diet, and physiology of manatees in Belize (e.g., Harr et al., 2006; Siegal-Willott et al., 2006; Vianna et al., 2006; Alves-Stanley et al., 2010; Hunter et al., 2010; Ramey, 2010; Wong et al., 2012; Flores-Cascante et al., 2013; Allen, 2014). In January 2014, a manatee monitoring program was implemented in Bacalar Chico MR and National Park aimed at providing information on the abundance trends, distribution, habitat preferences, and habitat use patterns of manatees encountered in the protected area (Courtene-Jones et al., 2015).

### Order Carnivora

*Neotropical River Otter* (*Lontra longicaudis annectens*; *Major, 1897*)—The neotropical river otter regularly occurs north of Belize in Quintana Roo and Chetumal Bay, Mexico (Morales-Vela & Olivera-Gómez, 1994; Gallo-Reynoso, 1997; Calmé & Sanvincente, 2009). The Hondo River, which borders Belize and Mexico, seems to be an important area for the species: Morales-Vela & Olivera-Gómez (1994) reported five sightings of *L. l. annectens* on this river, and Orozco-Meyer (1998) collected 42 samples of otter scat and reported one sighting. Platt & Rainwater (2011) observed a single individual preying upon turtles along Cox Lagoon (Figure 2). Minty et al. (2001) reported 15 sightings of this species on mainland Belize: seven in the Rascapulo River, five at the Macal & Rascapulo Impoundment Area, and three in the Chiquibul Forest (Figure 2). BERDS (2015) contained over 31 records from across the country (Figure 2). Santiago-Plata et al. (2014) used sightings from BERDS and an additional 69 unreported sightings to build a predictive model of habitat suitability for *L. l. annectens* in Belize.

*Unconfirmed Species*—Numerous additional reports were located for several species, but they could not be verified. Historical records indicate the distribution of the extinct Caribbean monk seal (*Monachus tropicalis*; Gray, 1850) included regions of southern Belize neighboring Guatemala and Honduras (Timm et al., 1997; Kovacs, 2008). Seal Caye, within the Sapodilla Caye MR, suggests a historical connection with *M. tropicalis* (Figure 2). USNM (2015) contained

five skeletal specimens from the neighboring Yucatan Peninsula. We located four additional records of *Stenella* sp.; however, accurate identification of species of the genus *Stenella* is challenging because of the physical similarities among species, so they could not be verified (Table 1; Figure 2). Similar issues arise in the identification of pelagic species of “blackfish” toothed whales (e.g., *G. macrorhynchus* and *P. electra*) and both species of *Kogia*. We identified a single record of a stranded Fraser’s dolphin (*Lagenodelphis hosei*; Fraser, 1956) in Belize at Hol Chan MR but were unable to verify this report. Sanders et al. (1997) reported the sighting of a group of eight common dolphins (*Delphinus delphis*; Linnaeus, 1758) in July of 1997 between Laughing Bird Caye and Point Placencia along the mainland coast; however, given a lack of reliable evidence for short-beaked common dolphins in the Gulf of Mexico or the Wider Caribbean and their common misidentification (Jefferson et al., 2009), we could not verify this record in absence of photo data.

### Discussion

In this review, we confirm the presence of 17 aquatic mammal species across the freshwater and marine habitats of Belize and provide the most comprehensive review of aquatic mammal occurrences in this region of the western Caribbean Sea. The list is comprised of 16 obligate marine mammals (15 completely marine) and one freshwater dependent carnivore. With the exception of the Antillean manatee and coastal bottlenose dolphin, no systematic data have previously been gathered regarding the distribution and abundance of aquatic mammal species in Belize. Records were sparse for most identified cetaceans in our review. The number of aquatic mammals reported in Belize is similar to the Mexican Caribbean bordering the north/northwest border of Belize (18 species; Niño-Torres et al., 2015) and Cuba (19 species; Whitt et al., 2011). This review provides primarily presence-only records of species occurrence; thus, these data should not be used to indicate the absence of unidentified species.

Systematic studies characterizing the status, distribution, and abundance of the aquatic mammals identified in Belize are desperately needed for the management of protected areas and the protection of biodiversity. While many of the mapped records were located within protected areas, nongovernmental and governmental organizations expend significant effort patrolling these regions, translating to higher probabilities of opportunistically encountering free-ranging and stranded animals. The high density of sightings in certain pelagic areas (e.g., between TA

and LHR) may represent a true density of species in the region but is likely partially explained by visitation bias as a result of common boat routes. Frequent sightings of rough-toothed dolphins near the southern coast, sperm whales throughout pelagic waters, baleen whales near Placencia, and Kogiidae strandings on Ambergris Caye suggest some regularity of occurrence in these species and warrant further investigation. The single *B. physalus* that stranded at Buttonwood Caye and the single *M. novaeangliae* that stranded in the Toledo District in southern Belize indicate baleen whales occur within the Belizean EEZ; however, a paucity of occurrence records suggests their presence has gone undetected or is infrequent in the region.

Records of stranded animals should be evaluated critically when identifying the presence of a particular species; most marine mammals that were recorded as stranding in Belize inhabit pelagic habitats (e.g., Kogiidae), and individuals of these species may strand on coasts distant from their habitat. Cetaceans are not often found stranded in Belize as they may wash up in inaccessible regions (CZMAI, 2014) like TA that are also inhabited by a large population of scavenging American crocodiles (*Crocodylus acutus*), or along the many kilometers of uninhabited cays and coast. Manatee strandings are frequent along the Belizean coast (132 records between 2003 and 2011; Galves, 2012; CZMAI, 2014), with sublethal and fatal injuries primarily caused by watercraft collision that are increasing in rate throughout the nation (Galvez et al., 2013).

All aquatic mammal species in Belize must contend with the negative impacts of anthropogenic activity such as risk of injury from bycatch, disturbance from human activity, habitat loss to development, and exposure to pollutants. Current levels of protection and enforcement of regulations in marine habitats are insufficient to protect the diverse ecological needs of aquatic mammals in Belize’s waters. Most cetaceans reported in this review inhabit poorly understood deep water ecosystems, considered a major gap in national protection measures, which are unlikely candidates for intensive conservation efforts and are at risk of the impacts of exploration and drilling for offshore oil reserves. Proposals to commence these activities in the coastal and offshore waters of Belize were temporarily halted following public outcry; these activities were permanently banned from World Heritage Sites and within 1 km around reef systems, and temporarily banned by moratorium from seven marine protected areas. Marine dredging can be a significant threat to coastal marine mammals in Belize if its impacts are not considered in environmental impact assessments (Todd et al., 2015). The ongoing State Bank Project

entails the construction of a bridge through the Swallow Caye WS for the benefit of visiting cruise ships in habitats crucial for the continued survival of Belize's diminishing manatee population (Auil Gomez, 2011) and a small bottlenose dolphin population (Kerr et al., 2005). The most potent threat to manatees is watercraft collision, resulting in injuries and high mortality rates. These interactions are partially due to high densities of vessels in manatee habitat. Vessels also pose significant threats to all marine mammals in their nonlethal impacts. For example, repeated behavioral disruption can result in declines in reproductive success and population size (Bejder et al., 2006). Human activities are restricted in certain protected areas and regions of high manatee density through the establishment of no-wake zones, but data to inform the development of regulations for interactions with other marine mammals is lacking. Baseline studies of species status and impact studies on the effects of anthropogenic threats are crucial to mitigate the impacts of anthropogenic pressures on marine mammals and to reduce human-wildlife conflicts.

Improving our understanding of aquatic mammal species' ranges and distributions in the Caribbean is crucial for monitoring the impacts of climate change. These changes include shifts in species' ranges and changes in biodiversity associated with tracking of optimal temperature conditions and shifts in prey distribution (Learmonth et al., 2006), declines in reproductive success (Forcada et al., 2005), and increases in disease transmission and toxicant exposure (Harvell et al., 1999; Burek et al., 2008). Increased water temperatures in the Caribbean could influence populations of the patchily distributed prey of pelagic marine animals and have been associated with cetacean mortality events (International Whaling Commission [IWC], 1997; Learmonth et al., 2006). Tropical delphinids may face challenges relocating due to thermoregulatory needs or ecological specialization to current habitats and prey, and effects will vary depending on species habitat and migratory behavior (Learmonth et al., 2006). Changes in sea surface temperature, pH, CO<sub>2</sub>, and salinity may result in increased algal blooms associated with fertilizer and nutrient runoff that can cause major harm to marine mammals (Scholin et al., 2000). For example, in 2015, massive amounts of sargassum seaweed inundated the coast across Belize and the Mexican Caribbean, in some locations resulting in ecological shifts in shore and reef habitat (E. A. Ramos, pers. obs., 14 February 2016) whose effects on aquatic mammals is unknown.

Data aggregated during this review can be used to guide baseline data collection on marine mammals in the Belizean EEZ such as vessel-based

surveys. Passive acoustic monitoring using stationary recorders can be used as a tool for identifying both broad- and fine-scale movement patterns of a range of cetacean species (Risch et al., 2013), and acoustic records could be used to derive species' density and abundance (Marques et al., 2009). Methods of modelling the ecological niche or spatial distribution of a species could be used to identify regions of probable species occurrence that warrant investigation as well as areas in need of protection (Thorne et al., 2012). With the high levels of nature-based marine tourism throughout the coastal and pelagic habitats of Belize, publicly reported sightings of cetacean species could provide managing authorities with valuable data. For example, Bruce et al. (2014) identified preferred resting locations for humpback whale mother-calf pairs using citizen/science-based data gathered aboard commercial whale-watching vessels. Citizen science programs to gather publicly reported data through reports on Web platforms and mobile phone applications are already in use in Belize (e.g., ECOMAR's Whale Watch; L. Searle, pers. comm., 11 March 2016). Investigations of the impacts of nature-based tourism (e.g., whale watching) should be conducted given their potential for harmful impacts. Identifying and comparing the genetic structure and diversity of aquatic animal populations throughout Belize to other regions will facilitate improvements to regional management strategies.

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## Literature Cited

- Aguilar-Aguilar, R., Delgado-Estrella, A., & Moreno-Navarrete, R. G. (2010). New host report for nematodes in a stranded short-snouted spinner dolphin *Stenella clymene* (Cetacea: Delphinidae) from the Mexican Caribbean coast. *Helminthologia*, 47(2), 136-138. <http://dx.doi.org/10.2478/s11687-010-0020-0>
- Allen, A. C. (2014). *Diet of the Antillean manatee (Trichechus manatus manatus) in Belize, Central America* (Master's thesis). Nova Southeastern University Oceanographic Center, Dania Beach, FL. Retrieved from [http://nsuworks.nova.edu/cgi/viewcontent.cgi?article=1002&context=occ\\_stuetd](http://nsuworks.nova.edu/cgi/viewcontent.cgi?article=1002&context=occ_stuetd)
- Alongi, J. T. (2007). *Group characteristics and social affiliation patterns of bottlenose dolphins (Tursiops truncatus) in the Drowned Cayes, Belize, Central America* (Master's thesis). San Diego State University, San Diego, CA.
- Alves-Stanley, C. D., Worthy, G. A. J., & Bonde, R. K. (2010). Feeding preferences of the West Indian manatee in Florida, Belize, and Puerto Rico as indicated by stable isotope analysis. *Marine Ecology Progress Series*, 402, 255-267. <http://dx.doi.org/10.3354/meps08450>
- Archer, F. I., Morin, P. A., Hancock-Hanser, B. L., Robertson, K. M., Leslie, M. S., Bérubé, M., . . . Taylor, B. L. (2013). Mitogenomic phylogenetics of fin whales (*Balaenoptera physalus* spp.): Genetic evidence for revision of subspecies. *PLOS ONE*, 8(5), e63396. <http://dx.doi.org/10.1371/journal.pone.0063396>
- Ateweberhan, M., Chapman, J., Humber, F., Harris, A., & Jones, N. (2011). Bacalar Chico Marine Reserve: Ecological status of Belize Barrier Reef's northernmost reserve. In M. L. D. Palomares & D. Pauly (Eds.), *Too precious to drill: The marine biodiversity of Belize* (pp. 112-118). Vancouver: Fisheries Centre, University of British Columbia. Retrieved from [http://aerl06.aerl.ubc.ca/conference/belize/FCRR\\_Belize.pdf#page=118](http://aerl06.aerl.ubc.ca/conference/belize/FCRR_Belize.pdf#page=118)
- Auil, N. E. (1988). *Belize manatee recovery plan*. Kingston, Jamaica: UNDP/GEF Coastal Zone Management Project, Belize/UNEP Caribbean Environment Programme. Retrieved from [www.cep.unep.org/meetings-events/4th-spaw-stac-1/WG31-inf20en%20.pdf/at\\_download/file](http://www.cep.unep.org/meetings-events/4th-spaw-stac-1/WG31-inf20en%20.pdf/at_download/file)
- Auil, N. E. (2004). *Abundance and distribution trends of the West Indian manatee in the coastal zone of Belize: Implications for conservation* (Master's thesis). Texas A&M University, College Station. Retrieved from [www.sirenian.org/PDFs/auil2004.pdf](http://www.sirenian.org/PDFs/auil2004.pdf)
- Auil, N. E., Powell, J. A., Bonde, R. K., Andrewin, K., & Galves, J. (2007). *Belize Conservation Programme 10 year summary* (Report to Liz Claiborne Art Ortenberg Foundation). New York: Wildlife Trust.
- Auil Gomez, N. (2011). The fate of manatees in Belize. In M. L. D. Palomares & D. Pauly (Eds.), *Too precious to drill: The marine biodiversity of Belize* (pp. 19-24). Vancouver: Fisheries Centre, University of British Columbia. Retrieved from [http://aerl06.aerl.ubc.ca/conference/belize/FCRR\\_Belize.pdf#page=118](http://aerl06.aerl.ubc.ca/conference/belize/FCRR_Belize.pdf#page=118)
- Bacchus, M. L. C., Dunbar, S. G., & Self-Sullivan, C. (2009). Characterization of resting holes and their use by the Antillean manatee (*Trichechus manatus manatus*) in the Drowned Cayes, Belize. *Aquatic Mammals*, 35(1), 62-71. <http://dx.doi.org/10.1578/AM.35.1.2009.62>
- Bejder, L., Samuels, A., Whitehead, H., Gales, N., Mann, J., Connor, R., . . . Krützen, M. (2006). Decline in relative abundance of bottlenose dolphins exposed to long-term disturbance. *Conservation Biology*, 20(6), 1791-1798. <http://dx.doi.org/10.1111/j.1523-1739.2006.00540.x>
- Bengtson, J. L., & Magor, D. (1979). A survey of manatees in Belize. *Journal of Mammalogy*, 60, 230-232. <http://dx.doi.org/10.2307/1379785>
- Bilgre, B. A. (1998). *Occurrence, site fidelity, distributions and association patterns of bottlenose dolphins (Tursiops truncatus) in the southern portion of Turneffe Reef Atoll, Belize* (Master's thesis). San Diego State University, San Diego, CA. Retrieved from [www.worldcat.org/title/occurrence-site-fidelity-distributions-and-association-patterns-of-bottlenose-dolphins-tursiops-truncatus-in-the-southern-portion-of-turneffe-reef-atoll-belize/oclc/39344304](http://www.worldcat.org/title/occurrence-site-fidelity-distributions-and-association-patterns-of-bottlenose-dolphins-tursiops-truncatus-in-the-southern-portion-of-turneffe-reef-atoll-belize/oclc/39344304)
- Bilgre, B., Frohoff, T., Sanders, A., & Dudzinski, K. (1999, November). *Observations of a lone sociable dolphin in Belize*. Proceedings of the Thirteenth Biennial Conference on the Biology of Marine Mammals, Maui, HI. Retrieved from [www.worldcat.org/title/occurrence-site-fidelity-distributions-and-association-patterns-of-bottlenose-dolphins-tursiops-truncatus-in-the-southern-portion-of-turneffe-reef-atoll-belize/oclc/39344304](http://www.worldcat.org/title/occurrence-site-fidelity-distributions-and-association-patterns-of-bottlenose-dolphins-tursiops-truncatus-in-the-southern-portion-of-turneffe-reef-atoll-belize/oclc/39344304)
- Biodiversity and Environmental Resource Data System (BERDS). (2015). *Biodiversity and environmental resource data system of Belize*. Retrieved from [www.biodiversity.bz/find/species/checklists](http://www.biodiversity.bz/find/species/checklists)
- Boisseau, O., Carlson, C. A., & Seipt, I. (2000). *A report on cetacean research conducted by the International Fund for Animal Welfare (IFAW) off Guadeloupe, Dominica, Martinique, Grenada and Tobago from 12 January to 30 March 2000*. Unpublished Report to the IFAW, Yarmouth Port, MA.
- Boisseau, O., Leaper, R., & Moscrop, A. (2006, June). *Observations of small cetaceans in the Eastern Caribbean* (Paper SC/58/SM24). Presented to the Scientific Committee, 58th Annual Meeting of the International Whaling Commission (IWC), St. Kitts and Nevis.
- Bolaños, J., & Boher, S. (1996). Cetáceos de Venezuela. Lista actualizada [Cetaceans of Venezuela: Updated list]. *Natura*, 104, 51-53.
- Bolaños, J., & Villarroel-Marin, A. (2003). Three new records of cetacean species for Venezuelan waters. *Caribbean Journal of Science*, 39(2), 230-232.
- Bolaños-Jiménez, J., Mignucci-Giannoni, A. A., Blumenthal, J., Bogomolni, A., Casas, J. J., Henríquez, A., . . . Luksenburg, J. A. (2014). Distribution, feeding habits and morphology of killer whales *Orcinus orca* in



- the Caribbean Sea. *Mammal Review*, 44, 177-189. <http://dx.doi.org/10.1111/mam.12021>
- Bonde, R. K., Aguirre, A. A., & Powell, J. A. (2001, December). *Biological assessment and handling of captured free-ranging manatees in Belize*. Proceedings of the Fourteenth Annual Conference on the Biology of Marine Mammals, Vancouver, BC, Canada.
- Bruce, E., Albright, L., Sheehan, S., & Blewitt, M. (2014). Distribution patterns of migrating humpback whales (*Megaptera novaeangliae*) in Jervis Bay, Australia: A spatial analysis using geographical citizen science data. *Applied Geography*, 54, 83-95. <http://dx.doi.org/10.1016/j.apgeog.2014.06.014>.
- Burek, K. A., Gulland, F. M. D., & O'Hara, T. M. (2008). Effects of climate change on Arctic marine mammal health. *Ecological Applications*, 18(Special Issue 2), S126-S134. <http://dx.doi.org/10.1890/06-0553.1>
- Caballero, S., Islas-Villanueva, V., Tezanos-Pinto, G., Duchene, S., Delgado-Estrella, A., Sanchez-Okrucky, R., & Mignucci-Giannoni, A. A. (2012). Phylogeography, genetic diversity and population structure of common bottlenose dolphins in the Wider Caribbean inferred from analyses of mitochondrial DNA control region sequences and microsatellite loci: Conservation and management implications. *Animal Conservation*, 15(1), 95-112. <http://dx.doi.org/10.1111/j.1469-1795.2011.00493.x>
- Caldwell, D. K., & Caldwell, M. C. (1975). Dolphin and small whale fisheries of the Caribbean and West Indies: Occurrence, history, and catch statistics—with special reference to the Lesser Antillean Island of St. Vincent. *Journal of the Fisheries Research Board of Canada*, 32(7), 1105-1110. <http://dx.doi.org/10.1139/f75-132>
- Caldwell, D. K., Caldwell, M. C., & Walker, R. V. (1976) First records for Fraser's dolphin (*Lagenodelphis hosei*) in the Atlantic and the melon-headed whale (*Peponocephala electra*) in the western Atlantic. *Cetology*, 25, 1-4.
- Caldwell, D. K., Rathjen, W. F., & Caldwell, M. C. (1971a). Cuvier's beaked whale, *Ziphius cavirostris*, from Barbados. *Bulletin of the Southern California Academy of Sciences*, 70(1), 52-53.
- Caldwell, D. K., Caldwell, M. C., Rathjen, W. F., & Sullivan, J. R. (1971b). Cetaceans from the Lesser Antillean island of St. Vincent. *Fisheries Bulletin*, 69, 303-312.
- Calmé, S., & Sanvicente, M. (2009). *Distribución, uso de hábitat y amenazas para la nutria neotropical* (Lontra longicaudis annectens): *Un enfoque etnozoológico* [Distribution, habitat use, and threats to the neotropical river otter]. In J. Espinoza Avalos, I. Islebe, & H. Hernández Arana (Eds.), *El sistema ecológico de la Bahía de Chetumal, costa del Caribe Mexicano* [The ecological system of the Bay of Chetumal, Mexico's Caribbean coast] (pp. 124-130). Chetumal, Quintana Roo, México: The College of the Southern Border.
- Campbell, G. S. (2004). *Quantitative comparison of bottlenose dolphin (Tursiops spp.) whistles from three geographic regions* (Master's thesis). San Diego State University, San Diego, CA. Retrieved from [cetus.ucsd.edu/CVs/GCampbell\\_MSthesis.pdf](http://cetus.ucsd.edu/CVs/GCampbell_MSthesis.pdf)
- Campbell, G. S., Bilgre, B., & Defran, R. H. (2002). Bottlenose dolphins (*Tursiops truncatus*) in Turneffe Atoll, Belize: Occurrence, site fidelity, group size, and abundance. *Aquatic Mammals*, 28(2), 170-180.
- Cardona-Maldonado, M. A., & Mignucci-Giannoni, A. A. (1999). Pygmy and dwarf sperm whales in Puerto Rico and the Virgin Islands, with a review of *Kogia* in the Caribbean. *Caribbean Journal of Science*, 35, 29-37.
- Carlson, C. A., Seipt, I., Brown, R., Lewis, E., & Moscrop, A. (1995). *Report on a project by the International Fund for Animal Welfare (IFAW) to enhance public awareness and promote the appropriate development of whale watching in Dominica* (An Information Paper). Gland, Switzerland: International Whaling Commission, Working Group on Whale Watching.
- Castelblanco-Martínez, D. N., Powell, J., Galves, J., & Auil Gomez, N. (2013). Preliminary information from first tagged manatees in Turneffe Atoll (Belize) reveal regular travel patterns to the mainland. *Sirenews*, 60, 12-13.
- Castelblanco-Martínez, D. N., Padilla-Sáldivar, J., Hernández-Arana, H. A., Slone, D., Reid, J., & Morales-Vela, B. (2012). Movement patterns of Antillean manatees in Chetumal Bay (Mexico) and coastal Belize: A challenge for regional conservation. *Marine Mammal Science*, 29(2), E166-E182. <http://dx.doi.org/10.1111/j.1748-7692.2012.00602.x>.
- Chapin III, F. S., Zavaleta, E. S., Eviner, V. T., Naylor, R. L., Vitousek, P. M., Reynolds, H. L., . . . Mack, M. C. (2000). Consequences of changing biodiversity. *Nature*, 405(6783), 234-242. <http://dx.doi.org/10.1038/35012241>
- Chapman, J. K. (2012). *Status of marine resources in Bacalar Chico Marine Reserve 2011* (Annual report). London: Blue Ventures.
- Charnock-Wilson, J. (1970). Manatees and crocodiles. *Oryx*, 10, 236-238. <http://dx.doi.org/10.1017/S0030605300008498>
- Coastal Zone Management Authority & Institute (CZMAI). (2014). *State of the Belize Coastal Zone Report 2003-2013: Coastal Zone Management Authority & Institute (CZMAI)*. Belize City, Belize: CMZAI. Retrieved from [www.coastalzonebelize.org/wp-content/uploads/2014/10/State-of-the-Belize-Coastal-Zone-Report-2003-20134.pdf](http://www.coastalzonebelize.org/wp-content/uploads/2014/10/State-of-the-Belize-Coastal-Zone-Report-2003-20134.pdf)
- Courtene-Jones, W. (2014). *Blue Ventures stranding report*. London: Blue Ventures.
- Courtene-Jones, W., Rubin, J., Jenko, K., Gough, C. L. A., & Chapman, J. K. (2015). *Bacalar Chico manatee monitoring project summary 2014* (Blue Ventures Conservation Report). London: Blue Ventures.
- Davidson, A. D., Boyer, A. G., Kim, H., Pompa-Mansilla, S., Hamilton, M. J., Costa, D. P., . . . Brown, J. H. (2012). Drivers and hotspots of extinction risk in marine mammals. *Proceedings of the National Academy of Sciences*, 109(9), 3395-3400. <http://dx.doi.org/10.1073/pnas.1121469109>

- De la Parra Venegas, R. (1998, April). *Registros se dos varamientos: Stenella clymene y Kogia breviceps en la costa de Cancún, Quintana Roo* [Stranding records: *Stenella clymene* and *Kogia breviceps* on the coast of Cancún, Quintana Roo]. XXIII Reunión Internacional para el Estudio de los Mamíferos Marinos, Xcarat, Quintana Roo, México.
- Delgado Estrella, A., López-Hernandez, I., & Vazques Maldonado, L. E. (1998, April). *Registro de varamientos en las costa sureste del golfo de México (estados de Veracruz, Tabasco, Campeche y Quintana Roo)* [Registration strandings on the southeast coast of the Gulf of Mexico (states of Veracruz, Tabasco, Campeche, and Quintana Roo)]. XXIII Reunión Internacional para el Estudio de los Mamíferos Marinos, Xcarat, Quintana Roo, México.
- Delgado Estrella, A., Ibarra, L., Romero-Tenorio, A., & De la Torre, A. (2004, May). *Varamiento de una hembra de delfín clymene Stenella clymene y una cría de Falsa Orca Pseudorca crassidens, en la Costa de Quintana Roo, México. Notas sobre la Biología reproductiva y salud* [Stranding of a female *Stenella clymene* and a False killer whale *Pseudorca crassidens* on the coast of Quintana Roo, México]. XXIX Reunión Internacional para el Estudio de los Mamíferos Marinos, La Paz, México.
- Delgado Estrella, A., Romero-Tenorio, A., Ibarra-Vargas, L., & Torres-Salcedo, R. (2002, May). *Rescate y rehabilitación de una hembra varada de delfín de dientes rugosos, Steno bredanensis, varada en la costa de Cancún, Quintana Roo* [Rescue and rehabilitation of a female rough-toothed dolphin, *Steno bredanensis*, stranded on the coast of Cancun]. XXVII Reunión Internacional para el Estudio de los Mamíferos Marinos, Veracruz, México.
- Dick, D. M., & Hines, E. M. (2011). Using distance sampling techniques to estimate bottlenose dolphin (*Tursiops truncatus*) abundance at Turneffe Atoll, Belize. *Marine Mammal Science*, 27(3), 606-621. <http://dx.doi.org/10.1111/j.1748-7692.2010.00435.x>
- Dudzinski, K. M., Frohoff, T. G., & Crane, N. L. (1995). Behavior of a lone female bottlenose dolphin (*Tursiops truncatus*) with humans off the coast of Belize. *Aquatic Mammals*, 21, 149-153.
- Edwards, H. H., Stone, S. B., Hines, E. M., Auil Gomez, N., & Winning, B. E. (2014). Documenting manatee (*Trichechus manatus manatus*) presence at Turneffe Atoll, Belize, Central America and its conservation significance. *Caribbean Journal of Science*, 48, 71-75. <http://dx.doi.org/10.18475/cjos.v48i1.a12>
- Eierman, L. E., & Connor, R. C. (2014). Foraging behavior, prey distribution, and microhabitat use by bottlenose dolphins *Tursiops truncatus* in a tropical atoll. *Marine Ecology Progress Series*, 503, 279-288. <http://dx.doi.org/10.3354/meps10721>
- Estes, J. A., Terborgh, J., Brashares, J. S., Power, M. E., Berger, J., Bond, W. J., . . . Wardle, D. A. (2011). Trophic downgrading of planet Earth. *Science*, 333(6040), 301-306. <http://dx.doi.org/10.1126/science.1205106>
- Fertl, D., Jefferson, T. A., Moreno, I. B., Zerbini, A. N., & Mulin, K. D. (2003). Distribution of the Clymene dolphin *Stenella clymene*. *Mammal Review*, 33(3-4), 253-271. <http://dx.doi.org/10.1046/j.1365-2907.2003.00033.x>
- Fertl, D., Schiro, A. J., Regan, G. T., Beck, C. A., Adimey, N., Price-May, L., . . . Crossland, R. (2005). Manatee occurrence in the northern Gulf of Mexico, west of Florida. *Gulf and Caribbean Research*, 17, 69-94. <http://dx.doi.org/10.18785/gcr.1701.07>
- Flores-Cascante, L., Morales-Vela, B., Castelblanco-Martínez, D. N., Padilla-Saldivar, J., & Auil Gomez, N. (2013). Elementos de la dieta del manatí *Trichechus manatus manatus* en tres sitios importantes para la especie en México y Belice [Dietary elements of the manatee *Trichechus manatus* in three important sites for the species in Mexico and Belize]. *Revista Ciencias Marinas y Costeras*, 5, 25-36.
- Forcada, J., Trathan, P., Reid, K., & Murray, E. (2005). The effects of global climate variability in pup production of Antarctic fur seals. *Ecology*, 86(9), 2408-2417. <http://dx.doi.org/10.1890/04-1153>
- Gallo-Reynoso, J. P. (1997). Situación y distribución de las nutrias en México, con énfasis en *Lontra longicaudis annectens* Major [Situation and distribution of river otters in Mexico, with an emphasis on *Lontra longicaudis annectens* Major]. *Revista Mexicana de Mastozoología*, 2, 10-32.
- Galves, J. (2012). *Manatee carcass stranding along the coastal zone of Belize – 2005-2010* (Report for Coastal Zone Management Authority & Institute/Sea to Shore Alliance). Belize: Belize Marine Mammal Stranding Network.
- Galvez, J., Clarke, C. J., & Rosado, S. K. (2013). *Ameliorating threats to manatees in the heart of Belize*. Report for Sea to Shore Alliance/Coastal Zone Management Authority & Institute/Swallow Caye Wildlife Sanctuary. Retrieved from [www.conservation-leadershipprogramme.org/media/2014/12/02107412\\_Belize\\_FinalReport\\_Manatees.pdf](http://www.conservation-leadershipprogramme.org/media/2014/12/02107412_Belize_FinalReport_Manatees.pdf)
- García-Rivas, M. del C. (1999, April). *Registro de nado con Orcas falsas Pseudorca crassidens en el Caribe Mexicano* [Sightings of false killer whales *Pseudorca crassidens* in the Mexican Caribbean]. XXIV Reunión Internacional para el Estudio de los Mamíferos Marinos, La Paz, Mexico.
- Gibson, J. (1995). *Managing manatees in Belize* (Master's thesis). University of Newcastle, NSW, Australia.
- González Solís, D. G., Vidal-Martínez, V. M., Antochiw-Alonso, D. M., & Ortega-Argueta, A. (2006). Anisakid nematodes from stranded pygmy sperm whales, *Kogia breviceps* (Kogiidae), in three localities of the Yucatan Peninsula, Mexico. *Journal of Parasitology*, 92(5), 1120-1122. <http://dx.doi.org/10.1645/GE-3553RN.1>
- Gordon, J., Moscrop, A., Carlson, C., Ingram, S., Leaper, R., Matthews, J., & Young, K. (1998). Distribution, movements and residency of sperm whales off the Commonwealth of Dominica, Eastern Caribbean: Implications for the development and regulation

- of the local whalewatching industry. *Report of the International Whaling Commission*, 48, 551-558.
- Grigg, E., & Markowitz, H. (1997). Habitat use by bottlenose dolphins (*Tursiops truncatus*) at Turneffe Atoll, Belize. *Aquatic Mammals*, 23(3), 163-170.
- Hancock, B. L. (2007). *Group characteristics, site fidelity, and social affiliation patterns of bottlenose dolphins (Tursiops truncatus) in Turneffe Atoll, Belize* (Master's thesis). San Diego State University, San Diego, CA.
- Hancock, B. L., & Oliver, G. W. (2001). *The social and behavioral ecology of bottlenose dolphins (Tursiops truncatus) in the coastal waters of Belize* (Oceanic Society Institutional Report). San Francisco: Oceanic Society. Retrieved from <http://eprints.uberibz.org/1199/1/doc20101210152021.pdf>
- Harr, K., Harvey, J., Bonde, R., Murphy, D., Lowe, M., Menchaca, M., . . . Francis-Floyd, R. (2006). Comparison of methods used to diagnose generalized inflammatory disease in manatees (*Trichechus manatus latirostris*). *Journal of Zoological Wildlife Medicine*, 37, 151-159. <http://dx.doi.org/10.1638/05-023.1>
- Harvell, C. D., Kim, K., Burkholder, J. M., Colwell, R. R., Epstein, P. R., Grimes, D. J., . . . Porter, J. W. (1999). Emerging marine diseases—Climate links and anthropogenic factors. *Science*, 285(5433), 1505-1510. <http://dx.doi.org/10.1126/science.285.5433.1505>
- Heithaus, M. R., Frid, A., Wirsing, A. J., & Worm, B. (2008). Predicting ecological consequences of marine top predator declines. *Trends in Ecology and Evolution*, 23, 202-210. <http://dx.doi.org/10.1016/j.tree.2008.01.003>
- Hinderstein, L. M. (1998). *The feeding ecology of the bottlenose dolphins (Tursiops truncatus) off the coast of Belize* (Master's thesis). San Francisco State University, San Francisco, CA.
- Hines, E. M. (2011). Threats to coastal dolphins from oil exploration, drilling and spills off the coast of Belize. In M. L. D. Palomares & D. Pauly (Eds.), *Too precious to drill: The marine biodiversity of Belize* (pp. 14-18). Vancouver: Fisheries Centre, University of British Columbia. Retrieved from [http://aerl06.aerl.ubc.ca/conference/belize/FCRR\\_Belize.pdf#page=118](http://aerl06.aerl.ubc.ca/conference/belize/FCRR_Belize.pdf#page=118)
- Holguin, S. B. P. (2004). *Contextual conservation: Antillean manatees (Trichechus manatus manatus) of Turneffe Atoll, Belize* (Master's thesis). San Francisco State University, San Francisco, CA. Retrieved from [www.turneffeatollmarinereserve.org/app/webroot/userfiles/214/File/Science/Holguin.pdf](http://www.turneffeatollmarinereserve.org/app/webroot/userfiles/214/File/Science/Holguin.pdf)
- Hunter, M. E., Auil Gomez, N. E., Tucker, K. P., Bonde, R. K., Powell, J., & McGuire, P. M. (2010). Low genetic variation and evidence of limited dispersal in the regionally important Belize manatee. *Animal Conservation*, 13, 592-602. <http://dx.doi.org/10.1111/j.1469-1795.2010.00383.x>
- Husar, S. L. (1977). *The West Indian manatee (Trichechus manatus)*. *Wildlife Research Report*, 7. Washington, DC: U.S. Department of Interior, Fish and Wildlife Service.
- International Union for Conservation of Nature (IUCN). (2015). *2015 IUCN red list of threatened species*. Retrieved from [www.iucnredlist.org](http://www.iucnredlist.org)
- International Whaling Commission (IWC). (1997). Report of the IWC workshop on climate change and cetaceans. *Report of the International Whaling Commission*, 47, 293-313.
- Jefferson, T. A., & Curry, B. E. (2003). *Stenella clymene*. *Mammalian Species*, 726, 1-5. <http://dx.doi.org/10.1644/726>
- Jefferson, T. A., & Lynn, S. K. (1994). Marine mammal sightings in the Caribbean Sea and Gulf of Mexico, summer 1991. *Caribbean Journal of Sciences*, 83-89.
- Jefferson, T. A., Webber, M. A., & Pitman, R. L. (2008). *Marine mammals of the world: A comprehensive guide to their identification*. San Diego: Academic Press/Elsevier.
- Jefferson, T. A., Fertl, D., Bolaños-Jiménez, J., & Zerbini, A. N. (2009). Distribution of common dolphins (*Delphinus* spp.) in the western Atlantic Ocean: A critical re-examination. *Marine Biology*, 156, 1109-1124. <http://dx.doi.org/10.1007/s00227-009-1152-y>
- Jenko, K., Castelblanco-Martínez, N., Chapman, J., & Gough, C. (2014, December). *Preliminary analysis of opportunistic sightings data shows year-round presence and seasonality in habitat use by manatees in Bacalar Chico, Belize*. Proceedings of the IV Congreso Colombiano de Zoología, Cartagena, Colombia.
- Jérémie, S. (2005, July). *Synthesis of cetaceans off the island of Martinique, French West Indies (UNEP/DEC)/CAR WG.27/REF.7*. Presented at the United Nations Environment Programme Regional Workshop of Experts on the Development of the Marine Mammal Action Plan for the Wider Caribbean Region, United Nations Environment Programme, Bridgetown, Barbados. Retrieved from [www.cep.unep.org/pubs/meetingreports/MMAP](http://www.cep.unep.org/pubs/meetingreports/MMAP)
- Kerr, K. A., Campbell, C. G., & Defran, R. H. (2005). Bottlenose dolphins (*Tursiops truncatus*) in the Drowned Cayes, Belize: Group size, site fidelity and abundance. *Caribbean Journal of Science*, 411, 172-177.
- Kiszka, J. J., Heithaus, M. R., & Wirsing, A. J. (2015). Behavioural drives of the ecological roles and importance of marine mammals. *Marine Ecology Progress Series*, 523, 267-281. <http://dx.doi.org/10.3354/meps11180>
- Kovacs, K. (2008). *Monachus tropicalis*. In International Union for Conservation of Nature (Ed.), *2011 IUCN red list of threatened species, Version 2011.2*. Retrieved from [www.iucnredlist.org](http://www.iucnredlist.org)
- Kuczaj II, S. A., & Yeater, D. B. (2007). Observations of rough-toothed dolphins (*Steno bredanensis*) off the coast of Utila, Honduras. *Journal of the Marine Biological Association of the United Kingdom*, 87(01), 141-148. <http://dx.doi.org/10.1017/S0025315407054999>
- LaCommare, K. S., Self-Sullivan, C., & Brault, S. (2008). Distribution and habitat use of Antillean manatees (*Trichechus manatus manatus*) in the Drowned

- Cayes area of Belize, Central America. *Aquatic Mammals*, 34(1), 35-43. <http://dx.doi.org/10.1578/AM.34.1.2008.35>
- Learmonth, J. A., MacLeod, C. D., Santos, M. B., Pierce, G. J., Crick, H. Q. P., & Robinson, R. A. (2006). Potential effects of climate change on marine mammals. *Oceanography and Marine Biology: An Annual Review*, 44, 431-464. <http://dx.doi.org/10.1201/9781420006391.ch8>
- Lefebvre, L. W., O'Shea, T. J., Rathbun, G. B., & Best, R. C. (1989). Distribution, status, and biogeography of the West Indian manatee. In C. A. Wood (Ed.), *Biogeography of the West Indies* (pp. 567-610). Gainesville, FL: Sandhill Crane Press.
- Levenson, C., & Leapley, W. T. (1978). Distribution of humpback whales (*Megaptera novaeangliae*) in the Caribbean determined by a rapid acoustic method. *Journal of the Fisheries Board of Canada*, 35(8), 1150-1152. <http://dx.doi.org/10.1139/f78-180>
- Lira, C., Bolaños, J., & Mondolfi, E. (1995, December). *On two strandings of fin whale (Balaenoptera physalus) and its presence in Venezuelan waters*. Proceedings of the Eleventh Biennial Conference on the Biology of Marine Mammals, Orlando, FL.
- Marques, T. A., Thomas, L., Ward, J., DiMarzio, N., & Tyack, P. L. (2009). Estimating cetacean population density using fixed passive acoustic sensors: An example with Blainville's beaked whales. *The Journal of the Acoustical Society of America*, 125(4), 1982-1994. <http://dx.doi.org/10.1121/1.3089590>
- Mattila, D. K., & Clapham, P. J. (1989). Humpback whales, *Megaptera novaeangliae*, and other cetaceans on Virgin Bank and in the northern Leeward Islands, 1985 and 1986. *Canadian Journal of Zoology*, 67, 2201-2211. <http://dx.doi.org/10.1139/z89-31>
- May-Collado, L. J., & Agnarsson, I. (2011). Phylogenetic analysis of conservation priorities for aquatic mammals and their terrestrial relatives, with a comparison of methods. *PLOS ONE*, 6(7), e22562. <http://dx.doi.org/10.1371/journal.pone.0022562>
- McCarthy, T. J. (1986). The gentle giants of Belize. Part II: Distribution of manatees. *Belize Audubon Society Bulletin*, 18(7), 1-4.
- Mignucci-Giannoni, A. A. (1998). Zoogeography of cetaceans off Puerto Rico and the Virgin Islands. *Caribbean Journal of Science*, 34(3-4), 173-190.
- Mignucci-Giannoni, A. A., Rodríguez-López, M. A., Perez-Zayas, J. J., Montoya-Ospina, R. A., & Williams, E. H., Jr. (1998). First record of the melonhead whale (*Peponocephala electra*) for Puerto Rico. *Mammalia*, 62(3), 452-457.
- Mignucci-Giannoni, A., Swartz, S. L., Martínez, A., Burks, C. M., & Watkins, W. A. (2003). First records of the pantropical spotted dolphin (*Stenella attenuata*) for the Puerto Rican Bank, with a review of the species in the Caribbean. *Caribbean Journal of Science*, 39(3), 381-391.
- Minty, C. D., Sutton, D. A., Rogers, A. D. F., Bateman, R. M., Penn, M. G., Stafford, P. J., & Sanders, L. M. (2001). *Preliminary report on the scientific and biodiversity value of the Macal and Raspaculo Catchment, Belize: A wildlife impact assessment for the proposed Macal River Upper storage facility*. London: Natural History Museum. Retrieved from [http://eprints.uberibz.org/784/1/NHM9\\_05\\_01Wia15.pdf.m](http://eprints.uberibz.org/784/1/NHM9_05_01Wia15.pdf.m)
- Morales-Vela, B., & Olivera-Gómez, L. D. (1993). Varamiento de calderones *Globicephala macrorhynchus* (Cetacea: Delphinidae) en la Isla de Cozumel, Quintana Roo, México [Strandings of short-finned pilot whales *Globicephala macrorhynchus* (Cetacea: Delphinidae) at Cozumel Island, Quintana Roo, Mexico]. *Anales del Instituto de Biología Serie Zoológica*, 64, 177-180.
- Morales-Vela, B., & Olivera-Gómez, L. D. (1994). Mamíferos acuáticos y su protección en la zona fronteriza México-Belice [Aquatic mammals and their protection in the border zone between Mexico and Belize]. In E. Suárez-Morales (Ed.), *Estudio integral de la frontera México-Belice: Recursos naturales* [Comprehensive study of the Mexico-Belize border: Natural resources]. Chetumal, Quintana Roo, México: CIQRO.
- Morales-Vela, B., Olivera-Gómez, D., Reynolds III, J. E., & Rathbun, G. B. (2000). Distribution and habitat use by manatees (*Trichechus manatus manatus*) in Belize and Chetumal Bay, Mexico. *Biological Conservation*, 95, 67-75. [http://dx.doi.org/10.1016/S0006-3207\(00\)00009-4](http://dx.doi.org/10.1016/S0006-3207(00)00009-4)
- Morales-Vela, B., Padilla-Saldívar, J. A., Reid, J., & Butler, S. (2007). First records of long-distance manatee movements between Mexico and Belize. *Sirenews*, 47, 12-14.
- Mörzer Bruyns, W. F. J. (1969). Sight records and notes on the false killer whale, *Pseudorca crassidens* (Owen, 1846). *Säugetierkundliche Mitteilungen*, 17(4), 351-356.
- Muñoz-Hincapié, M. F., Mora-Pinto, D. M., Montoya-Ospina, R. A., & Mignucci-Giannoni, A. A. (1998, January). *Records of cetacean mortality and strandings from the Colombian Caribbean*. Proceedings of the World Marine Mammal Science Conference, Monte Carlo, Monaco.
- National Protected Area System (NPAS). (2015). *National Protected Areas Secretariat Ministry of Forestry Fisheries and Sustainable Development*. Retrieved from <http://protectedareas.gov.bz/us>
- Navarro, D., Jimenez, A., & Juárez, J. (1990). Los mamíferos de Quintana Roo [Mammals of Quintana Roo]. In *Diversidad biológica en la biosfera de Sian ka'an Quintana Roo* [Biological diversity in the biosphere of Sian Ka'an Quintana Roo] (pp. 371-450). Chetumal, Quintana Roo, México: Centro de Investigaciones de Quintana Roo/University of Florida.
- Niño-Torres, C. A., García-Rivas, M. del C., Castelblanco-Martínez, D. N., Padilla-Saldívar, J. A., Blanco-Parra, M. del P., & de la Parra-Venegas, R. (2015). Aquatic mammals from the Mexican Caribbean: A review. *Hidrobiologica*, 25(1), 143-154.



- Orozco-Meyer, A. (1998). *Tendencia de la distribución y abundancia de la nutria de río* (*Lontra longicaudis annectens Major, 1897*), en la ribera del Río Hondo [Distribution and abundance trends of neotropical river otters (*Lontra longicaudis annectens Major, 1897*), in the basin of the River Hondo] (Master's thesis). Instituto Tecnológico de Chetumal, Quintana Roo, México.
- Ortega-Argueta, A., & Morales-Vela, B. (1998). *Registro de cetáceos en Campeche, Yucatan y Quintana Roo, México* [Strandings of cetaceans in Campeche, Yucatan and Quintana Roo, Mexico] (Informe Técnico MM-03).
- O'Shea, T. J., & Salisbury, C. A. (1991). Belize: A last stronghold for manatees in the Caribbean. *Oryx*, 25(3), 156-164.
- Pardo, M., Jiménez-Pinedo, C., & Palacios, D. (2009a). The false killer whale (*Pseudorca crassidens*) in the south-western Caribbean: First stranding record in Colombian waters. *Latin American Journal of Aquatic Mammals*, 7(1-2), 63-67. <http://dx.doi.org/10.5597/lajam00136>
- Pardo, M. A., Mejía-Fajardo, A., Beltrán-Pedrerros, S., Trujillo, F., Kerr, I., & Palacios, D. M. (2009b). Odontocete sightings collected during offshore cruises in the western and southwestern Caribbean Sea. *Latin American Journal of Aquatic Mammals*, 7(1-2), 57-62. <http://dx.doi.org/10.5597/lajam00135>
- Perkins, J. S., & Miller, G. W. (1983). Mass stranding of *Steno bredanensis* in Belize. *Biotropica*, 15(3), 235-236. <http://dx.doi.org/10.2307/2387835>
- Perrin, W. F., & Mead, J. G. (1994). Clymene dolphin – *Stenella clymene* (Gray, 1846). In S. H. Ridgeway & R. Harrison (Eds.), *Handbook of marine mammals: Volume 5. First book of dolphins* (pp. 161-171). San Diego: Academic Press.
- Perrin, W. F., Mitchell, E. D., Mead, J. G., Caldwell, D. K., & van Bree, P. J. H. (1981). *Stenella clymene*, a rediscovered tropical dolphin of the Atlantic. *Journal of Mammalogy*, 62, 583-598. <http://dx.doi.org/10.2307/1380405>
- Petersen, H. (2001). *Habitat use and behavior of the bottlenose dolphin (Tursiops truncatus) in the Drowned Cayes, Belize* (Master's thesis). San Francisco State University, San Francisco, CA.
- Platt, S. G., & Rainwater, T. R. (2011). Predation by neotropical otters (*Lontra longicaudis*) on turtles in Belize. *IUCN Otter Specialist Group Bulletin*, 28(1). Retrieved from [www.otterspecialistgroup.org/Bulletin/Volume28/Platt\\_Rainwater\\_2011.pdf](http://www.otterspecialistgroup.org/Bulletin/Volume28/Platt_Rainwater_2011.pdf)
- Platt, S. G., Rainwater, T. R., Miller, B. W., & Miller, C. M. (2000). Notes on the mammals of Turneffe Atoll, Belize. *Caribbean Journal of Science*, 36(1-2), 166-168.
- Prieto-Rodríguez, M. (1988). Reporte de algunos cetáceos del Caribe Colombiano [Report on cetaceans in the Colombian Caribbean]. *Boletín de Facultad de Biología Marina*, 8, 30-40.
- Ramey, T. L. (2010). *Trace element concentrations in red blood cells of Antillean manatees (Trichechus manatus manatus) in Belize* (Master's thesis). New York: Columbia University.
- Ramos, E. A. (2014). *Foraging-related calls produced by bottlenose dolphins (Tursiops truncatus) at Turneffe Atoll, Belize* (Master's thesis). New York: Hunter College, The City University of New York.
- Ramsar Convention Secretariat. (2013). *The Ramsar Convention manual: A guide to the Convention on Wetlands (Ramsar, Iran, 1971)* (6th ed.). Gland, Switzerland: Ramsar Convention Secretariat.
- Ricciardi, A., & Rasmussen, J. B. (1999). Extinction rates of North American freshwater fauna. *Conservation Biology*, 13(5), 1220-1222. <http://dx.doi.org/10.1046/j.1523-1739.1999.98380.x>
- Rinaldi, C., Rinaldi, R., & Sahagian, P. (2006). *Report of surveys conducted on small cetaceans off Guadeloupe 1998 to 2005* (Working document SC/58/SM17). Presented to the International Whaling Commission Scientific Committee, St. Kitts and Nevis.
- Risch, D., Clark, C. W., Dugan, P. J., Popescu, M., Siebert, U., & Van Parijs, S. M. (2013). Minke whale acoustic behavior and multi-year seasonal and diel vocalization patterns in Massachusetts Bay, USA. *Marine Ecology Progress Series*, 489, 279-295. <http://dx.doi.org/10.3354/meps10426>
- Roden, C. L., & Mullin, K. D. (2000). Sightings of cetaceans in the northern Caribbean Sea and adjacent waters, winter 1995. *Caribbean Journal of Science*, 36(3-4), 280-288.
- Rojas-Arias, J. (2013). *Establecimiento de la línea de información de base para la especie Tursiops truncatus en la reserva marina de Puerto Honduras, Belice* [Establishing a baseline for the species *Tursiops truncatus* in the Port of Honduras Marine Reserve in Belize] (Master's thesis). The College of the Southern Border, Chetumal, México.
- Roman, J., Estes, J. A., Morissette, L., Smith, C., Costa, D., McCarthy, J., . . . Smetacek, V. (2014). Whales as marine ecosystem engineers. *Frontiers in Ecology and the Environment*, 12(7), 377-385. <http://dx.doi.org/10.1890/130220>
- Romero, A., Agudo, A. I., Green, S. M., & Notarbartolo di Sciara, G. (2001). *Cetaceans of Venezuela: Their distribution and conservation status* (NOAA Technical Report NMFS 151). Washington, DC: National Oceanic and Atmospheric Administration.
- Sánchez-Okruky, R. (1997, April). *Atención de mamíferos marinos varados en las costas de Quintana Roo* [Care of marine mammals stranded on the coast of Quintana Roo]. XXIII Reunion International para el Estudio de los Mammíferos Marinos, Xcarat, Quintana Roo, México.
- Sanders, A. M. (1999). *Behavioral patterns and group size dynamics of bottlenose dolphins (Tursiops truncatus) in Belize, Central America* (Master's thesis). San Francisco State University, San Francisco, CA.
- Sanders, A. M., & Grigg, E. K. (1998, January). *Behavioral patterns of bottlenose dolphins (Tursiops truncatus) at Turneffe Atoll, Belize*. Proceedings of the World Marine Mammal Science Conference, Monte Carlo, Monaco.
- Sanders, A. M., Bilgic, B. A., & Markowitz, H. (1997). *Annotated checklist of cetaceans in Belize, Central*

- America (Oceanic Society Institutional Report). Ross, CA: Oceanic Society.
- Santiago-Plata, V. M., Lloyd, A., Walker, P., & Walker, Z. (2014, August). *Predicting the occurrence of the neotropical otter (Lontra longicaudis) in Belize*. Proceedings of XIII IUCN OSG International Otter Congress, Quintana Roo, México.
- Schipper, J., Chanson, J. S., Chiozza, F., Cox, N. A., Hoffmann, M., Katariya, V., . . . Young, B. E. (2008). The status of the world's land and marine mammals: Diversity, threat, and knowledge. *Science*, 322, 225-230. <http://dx.doi.org/10.1126/science.1165115>
- Scholín, C. A., Gulland, F. M. D., Doucette, G. J., Benson, S., Busman, M., Chavez, F. P., . . . Haulena, M. (2000). Mortality of sea lions along the central California coast linked to a toxic diatom bloom. *Nature*, 403(6765), 80-84. <http://dx.doi.org/10.1038/47481>
- Self-Sullivan, C. (2007). Non-lethal boat scars on manatees in Belize as a tool for evaluation of a Marine Protected Area – Preliminary results. *Gulf and Caribbean Fisheries Institute*, 59, 465-470.
- Self-Sullivan, C., Smith, G. W., Packard, J. M., & LaCommare, K. S. (2003). Seasonal occurrence of male Antillean manatees (*Trichechus manatus manatus*) on the Belize barrier reef. *Aquatic Mammals*, 29(3), 342-354. <http://dx.doi.org/10.1578/01675420360736514>
- Siegal-Willott, J., Estrada, A., Bonde, R., Wong, A., Estrada, D. J., & Harr, K. (2006). Electrocardiography in two subspecies of manatee (*Trichechus manatus latirostris* and *T. m. manatus*). *Journal of Zoological Wildlife Medicine*, 37, 447-453. <http://dx.doi.org/10.1638/05-086.1>
- Stoddart, D. R. (1962). Three Caribbean atolls: Turneffe Islands, Lighthouse Reef, and Glover's Reef, British Honduras. *Atoll Research Bulletin*, 87, 1-147. <http://dx.doi.org/10.5479/si.00775630.87.1>
- Stoddart, D. R., Fosberg, F. R., & Spellman, D. L. (1982). Cays of the Belize barrier reef and lagoon. *Atoll Research Bulletin*, 256, 1-75. <http://dx.doi.org/10.5479/si.00775630.257.1>
- Swartz, S. L., Cole, T., McDonald, M. A., Hildebrand, J. A., Oleson, E. M., Martinez, A., . . . Jones, M. L. (2003). Acoustic and visual survey of humpback whale (*Megaptera novaeangliae*) distribution in the eastern and southeastern Caribbean Sea. *Caribbean Journal of Science*, 39(2), 195-208.
- Szczepaniak, I., & Cure, K. (2009). *First record of a pygmy sperm whale (Kogia breviceps) in Belize* (Oceanic Society Institutional Report). Ross, CA: Oceanic Society.
- Thorne, L. H., Johnston, D. W., Urban, D. L., Tyne, J., Bejder, L., Baird, R. W., . . . Chapla Hill, M. (2012). Predictive modeling of spinner dolphin (*Stenella longirostris*) resting habitat in the main Hawaiian Islands. *PLOS ONE*, 7(8), e43167. <http://dx.doi.org/10.1371/journal.pone.0043167>
- Timm, R. M., Salazar, R. M., & Peterson, A. T. (1997). Historical distribution of the extinct tropical seal, *Monachus tropicalis* (Carnivora: Phocidae). *Conservation Biology*, 11, 549-551. <http://dx.doi.org/10.1046/j.1523-1739.1997.96035.x>
- Todd, V. L., Todd, I. B., Gardiner, J. C., Morrin, E. C., MacPherson, N. A., DiMarzio, N. A., & Thomsen, F. (2015). A review of impacts of marine dredging activities on marine mammals. *ICES Journal of Marine Science: Journal du Conseil*, 72(2), 328-340. <http://dx.doi.org/10.1093/icesjms/fsu187>
- U.S. National Museum (USNM). (2015). *Smithsonian Institution, National Museum of Natural History*. Retrieved from <http://collections.mnh.si.edu/search>
- Vianna, J. A., Bonde, R. K., Caballero, S., Giraldo, J. P., Lima, R. P., Clark, A., . . . Santos, F. R. (2006). Phylogeography, phylogeny and hybridization in trichechid sirenians: Implications for manatee conservation. *Molecular Ecology*, 15, 433-447. <http://dx.doi.org/10.1111/j.1365-294X.2005.02771.x>
- Ward, N., Moscrop, A., & Carlson, C. (2001). *Elements for the development of a marine mammal action plan for the Wider Caribbean: A review of marine mammal distribution*. Havana, Cuba: United Nations Environment Programme.
- Watkins, W. A., & Moore, K. E. (1982). An underwater acoustic survey for sperm whales (*Physeter catodon*) and other cetaceans in the southeast Caribbean. *Cetology*, 46, 1-7.
- Watkins, W. A., Moore, K. E., & Tyack, P. (1985). Sperm whale acoustic behaviours in the southeast Caribbean. *Cetology*, 49, 1-15.
- Watkins, W. A., Daher, M. A., Samuels, A., & Gannon, D. P. (1997). Observations of *Peponocephala electra*, the melon-headed whale, in the southeastern Caribbean. *Caribbean Journal of Science*, 33(1-2), 34-40.
- Whitt, A. D., Jefferson, T. A., Blanco, M., Fertl, D., & Rees, D. (2011). A review of marine mammal records of Cuba. *Latin American Journal of Aquatic Mammals*, 9(2), 65-122. <http://dx.doi.org/10.5597/lajam00175>
- Winn, H. E., Edell, R. K., & Taruski, A. G. (1975). Population estimate of the humpback whale (*Megaptera novaeangliae*) in the West Indies by visual and acoustic techniques. *Journal of the Fisheries Research Board of Canada*, 32(4), 499-506. <http://dx.doi.org/10.1139/f75-061>
- Wong, A. W., Bonde, R. K., Siegal-Willott, J., Stamper, M. A., Colee, J., Powell, J. A., . . . Harr, K. E. (2012). Monitoring oral temperature, heart rate, and respiration rate of West Indian manatees during capture and handling in the field. *Aquatic Mammals*, 38(1), 1-16. <http://dx.doi.org/10.1578/AM.38.1.2012.1>
- Xacur Maiza, J. Á., Torres, M. C. L., Carlos, E. V., Vélez, L. C. V., & Viliesid, L. C. (1998). *Enciclopedia de Quintana Roo* [Encyclopedia of Quintana Roo], 7. Verdehalago, México.