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The Antillean manatee (*Trichechus manatus manatus*) in the southern Caribbean: A compilation and review of records for the Dutch Leeward islands and the central Venezuelan coast

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The Antillean manatee (*Trichechus manatus manatus*) is a subspecies of the West Indian manatee and is found from Mexico and the Bahamas south to Brazil. It is listed as Endangered by the IUCN (Self-Sullivan & Mignucci-Giannoni, 2008). Population estimation is very difficult in this species but more recently Castelblanco-Martínez, Nourisson, Quintana-Rizzo, Padilla-Saldivar & Schmitter-Soto, 2012) compiled expert estimates to suggest a total meta-population size of 6,700 animals. There is a Venezuelan regional population stretching from the Orinoco to the Guajira peninsula that was estimated to be about 400 animals (Castelblanco-Martínez et al., 2012). This population is precariously hanging on to existence along the northern Caribbean coast of South America and the species is listed as critically endangered according to the IUCN in Venezuela and locally endangered in Colombia (Boede et al., 2015; Caicedo-Herrera, Trujillo, Rodríguez & Rivera, 2004). In recent decades, very few sightings of manatees along the coast of Venezuela have been recorded.

The most recent population assessment (O'Shea, Correa-Viana, Ludlow & Robinson, 1988) and archaeological review (McKillop, 1985) of manatee occurrence along the central Venezuelan mainland coast are quite dated. Furthermore, neither produced any records for this area, suggesting that the central Caribbean coast of Venezuela (Paria Peninsula to Paraguaná Peninsula) and adjacent islands have long been practically devoid of manatees. However, since then, eight sightings and other records were compiled by Debrot, van Buurt, Caballero and Antczak (2006). Among these were three sightings of manatees reported for the island of Curaçao, dating from the late 1970s, 2001, and 2005 (Figure 1a and b) and a place name (not an actual sighting) "Manparía Kutu" from Bonaire

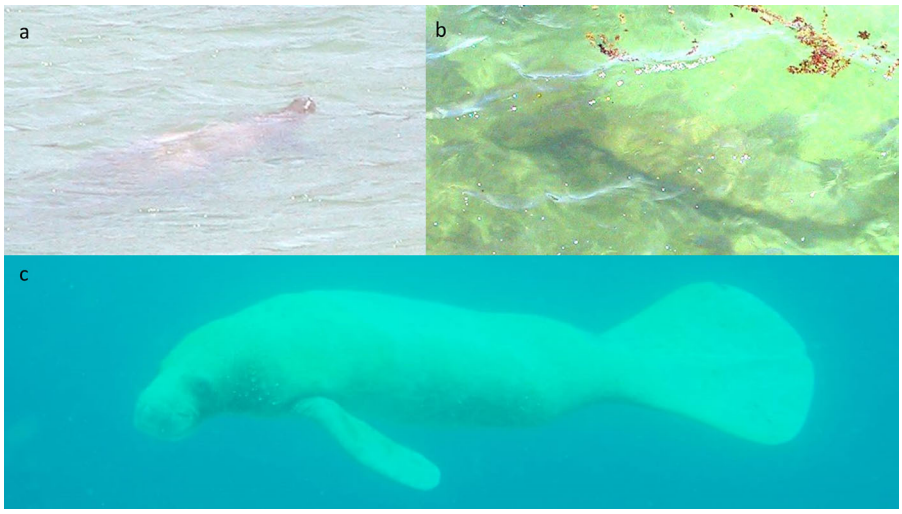

FIGURE 1 Photographic documentation of two manatees for the southern Caribbean Dutcj Leeward islands. Manatee surfacing to breathe (a) and the same individual underwater (b) in the Ascención lagoon on the northeast coast of Curaçao, 12 September 2005. (Photos by A. O. Debrot). (c) Manatee on the fringing reef at Saliña Vleit Bonaire, 10 July 2018. (Photo by L. Eybrecht).

suggesting the former occurrence of this species in Bonaire (Debrot et al., 2006). In this study our first purpose was to report the first-known manatee sighting record for Bonaire, which dates from July 2018 (Figure 1c), and an early colonial reference to this species for Curaçao. The second objective was to update manatee records for the adjacent central coast of Venezuela. For this, we conducted an Internet search of manatee mention in published and online sources for all cities and rivers of the central Venezuelan coast, in both Spanish and English. This literature search allowed us to add five previously unrecorded manatee records for the central coast of Venezuela. The third objective was to combine all manatee records for the areas considered (Table 1) and assess the Dutch Leeward records in the context of what is known about manatee occurrence along the central Venezuelan coast.

The compiled records come from numerous informal and formal published sources, so the type and quality of the information varied significantly. Our compiled records involving Bonaire (n = 2), Curaçao (n = 4), and Venezuela (n = 9) included two manatee toponyms. Toponyms are essentially place names. When these are based on animal names they are taken to suggest the species' former presence at the location. Even though they cannot be considered unequivocal proof of a species' former presence, toponyms are still considered valuable because they can provide clues about the historical biogeography of rare species (Adam & Garcia, 2003). Paleontological records of unidentified sirenians (such as listed by Debrot et al., 2006) were excluded as they could have involved any of several other sirenian genera (e.g., Vélez-Juarbe & Domning, 2015).

The two new Dutch Leeward island records reported here are for Bonaire and Curaçao. These islands form part of an island chain parallel to the mainland coast of Venezuela. Moving from west to east, Aruba, Curaçao, and Bonaire form the Dutch Leeward islands, while the more easterly island groups, such as Las Aves, Los Roques, and others belong to Venezuela. Curaçao is located 65 km from the mainland and Bonaire is 85 km from the mainland (Figure 2). Both islands are oceanic in nature and separated from the mainland by water depths exceeding 1,000 m and the strong westward-flowing Caribbean Current (Larue, Smith & Schellekens, 1991). The islands further possess significant mangrove and seagrass lagoon habitats (Debrot & Sybesma, 2000) but lie in a uniquely arid area of the Caribbean (Sarmiento, 1976).

The first manatee sighting documented for Bonaire dates from 10 July 2018, when a single, extremely emaciated, man-sized manatee was observed and photographed at close range during a morning recreational dive on the reef

TABLE 1 Overview of supporting information on 15 manatee records for the central Venezuelan coast and offshore islands, as discussed in the text and mapped in Figure 2. Sources listed are the first mention in the manatee literature and if different, followed by the original source document.

Record no.	Area/island	Location	Date	Habitat	Type of record	Coordinates	Source	Documentation	Comments
1	Bonaire	Saliña Vleit	10 July 2018	Reef at seasonal stream	Sighting	12°09′49″N, 68°17′14″W	This paper	Photo, Figure 1c	Emaciated, not wary
2	Bonaire	Manparía Kutu	Prehistoric	Reef	Toponym	12°03′40″N, 68°13′27″W	Debrot et al. (2006)	Buurt (2014)	
3	Curaçao	Boka Ascención	12 September 2005	Lagoon	Sighting	12°18′52″N, 69°03′18″W	Debrot et al., (2006)	Photo, Figure 1a and b	Rotund, wary
4	Curaçao	Caracasbaai	1 February 2001	Reef	Sighting	12°03′N 68°51′W	Debrot et al. (2006)	Experienced diver account	
5	Curaçao	Boka Wandòmi	Late 1970s	Reef near embayment	Sighting	12°22′20″N, 69°07′20″W	Debrot et al. (2006)	Experienced diver account	
6	Curaçao	Unknown	1655	Unspecified	Historical mention	—	This paper; Stuyvesant (1655)	Colonial archives	
7	Venezuela, central coast	Off Cubagua	~1520	Marine	Legend (or sighting)	—	This paper; López de Gomara (1954)	None	"Fishes as men with beards, hair and arms"
8	Venezuela, central coast	Across form Cubagua	1514–1541	Unspecified	Historical mention	—	This paper; Torres Merino (2018)	None	Object of trade
9	Venezuela, central coast	Mochima Park	June 2012	Reef	Sighting	10°19′N, 64°30′W	This paper; public site https://nl.pinterest.com/pin/396176098446420549	Photo G. Carias-Tucker	Not wary
10	Venezuela, central coast	Neveri river	1990	Fresh water	Sighting	10°10′N, 68°42′W	UNEP (1995)	Expert account	
11	Venezuela, central coast	Puerto Cabello	1991	Marine	Sighting	10°29′N, 68°00′N	UNEP (1995)	Expert account	
12	Venezuela, central coast	El Palito	Prehistoric	NA	Archaeological site	10°28′N, 68°07′W	This paper; Cruxent & Rouse (1958)	Bone	From published map[a]

(Continues)

TABLE 1 (Continued)

Record no.	Area/island	Location	Date	Habitat	Type of record	Coordinates	Source	Documentation	Comments
13	Venezuela, central coast	Trompis	Prehistoric	NA	Archaeological site	10°29′N, 68°10′W	Debrot et al. (2006); Rouse & Cruxent (1963)	Bone	From published map[a]
14	Venezuela, central coast	Palmasola	Prehistoric	NA	Archaeological site	10°31′N, 68°11′W	Debrot et al., 2006; Sýkora, 2005	Bone	From published map[a]
15	Venezuela, central coast	Punta Manatí	Early/ precolonial	Lagoon	Toponym	11°11′27″N, 68°24′36″W	This paper; map of Venezuela	Bitter & Martínez (2001)	

[a]See Antczak & Antczak (2006).

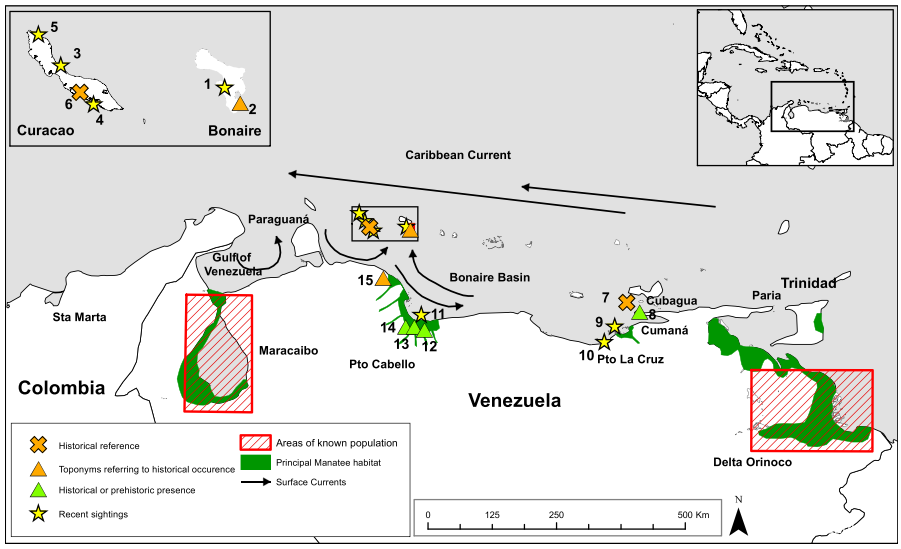

FIGURE 2 Map of manatee records (as listed in Table 1) and main potential population sources along the southern Caribbean coast of Venezuela. Red dashes: areas of known populations; green: areas of key current habitat; orange cross: early colonial written references to the manatee; orange triangles: toponyms referring to likely historical occurrence; green triangles: pre-Hispanic or early colonial presence based on bone specimens or documented trade; yellow stars: recent (i.e., late 20th and early 21st century) sighting records; arrows: documented sea surface current flows in the southern Caribbean and along the Venezuelan coast.

slope on the sheltered west coast of Bonaire (Figure 1c). The location of the sighting lies at the mouth of Saliña Vleit, one of the larger seasonal gullies of the island, which at the time was discharging freshwater runoff from unusual July rains. The underweight condition of the manatee (see Figure 1c) suggests the animal was wandering in search of foraging habitat for a considerable time and that it could have come from far away. Sea conditions were normal to calm, visibility was about 10 m and current direction was slow and to the south. The manatee was swimming steadily in waters of 17–18 m deep and about 3 m above the bottom, in a southerly direction.

A second Dutch Leeward manatee record comes from a letter dated 8 June 1655 from Petrus Stuyvesant, director-general of New Netherlands to Matthias Beck, the vice-director of Curaçao. The letter stated that "Any turtle catchers, also those who ship manatee or sea cow meat, ought to be charged no less than 5 to 6 pounds Flemish for a last of salt, as well as those who intend to ship it to N. Nederlandt or the Verginies, however, …" (Stuyvesant, 1655). This letter, deposited in the New York State Archives, suggests that these instructions were based on actual activities taking place at the time. Salt was locally used for preservation of manatee meat but it is clear from the communications that the Dutch West India Company gave preference to shipping salt to the Netherlands for preservation of the strategically important North Sea herring catch (Israel, 1989; Prins, 2013). While a single reference such as this must be interpreted cautiously, it does suggest that manatees were common enough in the surrounding seas to challenge the salt supply.

For the central Venezuelan coast, our literature search uncovered one early colonial mention of the inhabitants of Nueva Cádiz on Cubagua trading with the mainland tribes for supplies that included manatee meat (Torres Merino, 2018) and one that recounted the presumed presence of "fish with beards, hair and arms like men" in the waters around Cubagua (López de Gómara, 1954). This record refers to either a mermaid legend or actual sightings of manatees. Manzanilla-Fuentes (2007) reported two single stranding records for dead manatees in the Gulf of Venezuela, 7 km east from the entrance of Lake Maracaibo (March and July 2003). While these records are notable in being the first documented manatee records for the Gulf of Venezuela and offer support for the idea that manatees also move out of Lake Maracaibo, they were not included in our assessment for the central Venezuelan coast.

An account by Colón (1837), in which Spanish explorers survived partially on rotten manatee skins while traveling to Cubagua from eastern Venezuela in 1535, was also not included as a relevant record as those skins likely originated from the Orinoco. From the same area of Cubagua we can further report one recent sighting dating from June 2012 (https://nl.pinterest.com/pin/396176098446420549, see Table 1). An additional archaeological record was found for El Palito near Puerto Cabello on the Venezuelan mainland coast (Cruxent & Rouse, 1958) and the place name Punta Manatí was found for a coastal promontory 55 km north of Puerto Cabello (Bitter & Martínez, 2001). All these five and the other four records for the central Venezuelan coast are concentrated in two coastal areas that today still possess viable manatee habitat (Figure 2). These are the areas around Puerto La Cruz and Cumaná to the east, and the areas around Puerto Cabello to the west, which lies almost directly opposite the Dutch Leeward islands. Both areas have a number of rivers discharging fresh water from the hinterlands and possess relatively extensive mangrove lagoons and sheltered embayments. Both areas are further connected to other potential Venezuelan coastal source areas for wandering manatees by shallow coastal habitat. The occurrence of manatees in these two areas requires no special explanation other than that animals would need to move alongshore for considerable distances to reach these areas. Neither area today possesses resident manatee populations.

Explaining manatee occurrence in both Bonaire and Curaçao, is more problematic as today these islands also have no resident manatee population and are a lot more isolated. Similar to the Bahamas, where freshwater is scarce (Quintana-Rizzo & Reynolds, 2010), manatees are unlikely to ever have been abundant in the Dutch Leeward islands. Moreover, deep waters and strong currents separate these islands from mainland Venezuelan population sources, which mean that repeated movements back and forth between these islands and the mainland seem unlikely. Therefore, we surmise that the animals seen in these islands most probably accidentally drifted away from their mainland source area and perchance encountered these islands ("waifs"), similar to what is believed to be the case for manatees in the Bahamas (Quintana-Rizzo & Reynolds, 2010). The seeming recent increase in manatee presence in the Dutch Leeward islands is not likely due to any actual recent increase in abundance but most likely an artifact caused by lack of awareness and underreporting in the past.

With a total of four recent sightings in the Dutch Leeward islands in the last decades, all within 125 km from each other (3.2 manatee sightings/100 km), and only three sightings (Table 1, records 9, 10, and 11) along 1,050 km of the central coast of Venezuela (0.29 manatee sightings/100 km) from the Gulf of Venezuela to the tip of the Paria Peninsula, the Dutch Leeward islands appear to display an unusual concentration of marine manatee records. This begs the question from where did these recent manatees originate? While manatees can move great distances (Deutsch et al., 2003; Satizábal et al. 2012), and can even move across the open sea to reach oceanic island groups (Alvarez-Alemán, Beck & Powell, 2010; Holguin, 2004), their movements are generally restricted and their populations relatively strongly separated (Barros et al., 2017; Garcia-Rodriquez et al., 1998; Vianna et al., 2006). This means that the first place to consider when manatees are abnormally "frequent" in an area outside their normal range would be the most-nearby population source.

The absolute nearest potential manatee habitat along the Venezuelan mainland coast that could have served as a source of manatees to these islands in the past, are the rivers and mangrove lagoons in and around Puerto Cabello (150 km away from Bonaire). From Puerto Cabello northwards to Punta Manatí (95 km away) there is suitable manatee habitat (Figure 2). This is also a portion of the Venezuelan coast where predominant westerly currents are deflected offshore towards the Dutch Leeward islands partly due to the curvature of the coast and partly due to upwelling-induced Ekman advection that transports surface waters offshore and to the north (Andrade, Barton & Mooers, 2003; Muller-Karger & Castro, 1994). However, based on the paucity of recent sightings in this area, it currently does not support a population that could serve as a significant source of manatees.

The current nearest population of manatees is located in Lake Maracaibo. Relatively high daytime sightings by boat survey in different sectors of the lake (e.g., an average of one sighting per 56 survey hours by Montiel-Villalobos and Barrios-Garrido, 2005 and one sighting per 12 survey hours by Manzanilla-Fuentes, 2007) suggest fairly high manatee densities particularly near the mouth of the lake. Nevertheless, the species' conservation status in the lake remains grave and the size of the manatee population is unknown (Boede et al., 2015). Lake Maracaibo is only

400 km away from Bonaire but located downstream from the island based on the predominant direction of the Caribbean Current. However, both the Gulf of Venezuela and the central Venezuelan coast in the Bonaire basin lie off-set from the main flow of the Caribbean Current which causes complex eddy phenomena. For instance, the area has well-documented seasonally strong off-shore currents associated with upwelling (Muller-Karger & Castro, 1994), coastal undercurrents (Andrade et al., 2003) and nearshore currents flowing towards the east, opposite to the general direction of the Caribbean Current (Joyce, Hernandez-Guerra & Smethie, 2001; Zeigler, 1964). Based on this, we suggest that the recent Bonaire and Curaçao manatee records most likely originate from the Lake Maracaibo manatee population and that periodic eastwards-flowing and seasonal offshore surface current patterns could be the mechanism by which manatees may stray over to these islands.

The largest locus of concentration of manatees in the southern Caribbean and about 900 km upstream from the Dutch islands is the Orinoco River and its delta area, including the small population at Trinidad (Boede et al., 2015; Romero & Creswell, 2005). Such distances are not insurmountable for a species known elsewhere to make seasonal migrations of hundreds of kilometers (Deutsch et al., 2003). Furthermore, the prevailing strong currents flowing westward (Andrade et al., 2003) could explain manatees being transported passively across open waters, even from more distant sources as far away as Brazil (Balensiefer et al., 2017). To reach Bonaire and Curaçao this way, the animals involved would first need to bypass a whole chain of small Venezuelan islands. If so, one could expect there to be some sightings or capture records for those intervening islands, particularly for Margarita or the Los Roques archipelago. Both of these areas are important tourist and dive destinations where sightings of any stray manatees would be unlikely to go unnoticed. However, there are no known sightings or even any archaeological records of the species for either Margarita or Los Roques, notwithstanding the considerable body of archaeological and biological research (Antczak, 1991, 1998; Antczak & Antczak 1993, 2006, 2015; Antczak, Antczak & Lentino, 2019; Antczak, Buitrago, Mackowiak de Antczak & Guada, 2007; Debrot, Yranzo & Arocha, 2019; Schapira, Montano, Antczak & Posada, 2009). Therefore, transport from the distant eastern Caribbean coast of Venezuela via the deep waters is possible but is not currently supported based on the actual distribution of records. A distant Colombian origin for the manatees seen in the Dutch islands cannot be ruled out but is very unlikely. Not only is the nearest possible source of manatees in Colombia (Ciénaga Grande de Sta. Marta) substantially farther (690 km) than Lake Maracaibo but it only has a small and threatened population where the species is only sporadically reported. Also, between the Colombian and Venezuelan areas of distribution, there is a large section of coast with unsuitable habitat conditions and which likely forms a natural barrier to long-shore manatee dispersal (Montoya-Ospina, Caicedo-Herrera, Millán-Sánchez, Mignucci-Giannoni & Lefebvre, 2001).

We conclude that compared to the central Venezuelan coast, the relatively high concentration of manatee records in the Dutch Leeward islands suggests nonrandom dispersal of straying animals. Long-distance dispersal from distant upstream sources is not currently supported by the distribution of records. The Lake Maracaibo population appears to be the most likely nearby source of manatees straying to the Dutch Leeward islands. Finally, the existence of documented counter currents and off-shore transport of surface waters due to coastal topography and wind-induced upwelling could be the mechanism facilitating manatee movement to these off-shore islands.

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