

Manatees across borders: Introduction to the special issue on the biology and conservation of manatees

Ana Carolina O. de Meirelles^{1, 2, 3, 4,*}, Rodrigo Amaral^{5, 6}, João Carlos G. Borges^{3, 4, 7, 8},
and Nataly Castelblanco-Martínez^{3, 9, 10}

¹Alliance for Manatees, Marine Mammal Research Unit, Institute for the Oceans and Fisheries, University of British Columbia, Vancouver, Canada

²Associação de Pesquisa e Preservação de Ecossistemas Aquáticos – Aquasis, Caucaia, Brazil

³Sirenia Specialist Group, Species Survival Commission, The International Union for Conservation of Nature

⁴Research and Conservation Network for Sirenians in the Amazon Estuary (SEA), Instituto de Desenvolvimento Sustentável Mamirauá, Tefé, Brazil

⁵Instituto Federal de Educação, Ciência e Tecnologia do Amazonas (IFAM), Manaus, Brazil

⁶Associação Amigos do Peixe-boi (AMPA), Manaus, Brazil

⁷Fundação Mamíferos Aquáticos, São Cristóvão, Brazil

⁸Programa de Pós-Graduação em Ecologia e Monitoramento Ambiental, Universidade Federal da Paraíba, Rio Tinto, Brazil

⁹El Colegio de la Frontera Sur, Departamento de Sistemática y Ecología Acuática, Laboratorio de Mamíferos Acuáticos, Chetumal, Mexico

¹⁰Fundación Internacional para la Naturaleza y la Sustentabilidad, Chetumal, Mexico

*Corresponding author: caomeirelles@gmail.com

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Introduction

Manatees (Family Trichechidae) belong to the order Sirenia and, together with the dugongs (Family Dugongidae), are the only fully-aquatic mammals with herbivorous habits. There are three recognized manatee species: the Amazonian manatee, *Trichechus inunguis*, occupying the Amazon River Basin; the African manatee, *T. senegalensis*, found in lakes, rivers and estuaries of West Africa; and the West Indian manatee, *T. manatus*, distributed in islands, coasts and rivers of the American continent. Two subspecies of *T. manatus* are currently recognized: the Florida manatee (*T. m. latirostris*), found in the southeastern United States, particularly in Florida; and the Antillean manatee (*T. m. manatus*), which occupies coastal areas, rivers and lagoons of Mesoamerica, the Antilles, and South America. However, this subspecific classification is not supported by genetic (García-Rodríguez et al., 1998; Vianna et al., 2006; Santos et al., 2016) and morphological (Barros et al., 2017) evidence, and needs to be revisited. A recent publication found significant differences in body condition indexes among Antillean manatees inhabiting freshwater systems and coastal areas, suggesting the presence of ecotypes (Castelblanco-Martínez et al., 2021).

Due to their need to consume large amounts of vegetation (Bengtson, 1983) and their low tolerance to cold waters (Irvine, 1983), manatees are restricted to shallow tropical and subtropical waters. Although West Indian and African manatees inhabit marine and brackish environments, they rely on freshwater intake to

maintain the osmotic balance (Ortiz et al., 1998). Therefore, they tend to seek out inland freshwater resources or coastal freshwater springs (Favero et al., 2020; Keith-Diagne et al., 2022), a behavior that significantly influences their distribution and movements. The availability of resources will ultimately shape the utilization of these environments according to the energy requirements of each individual (Deutsch et al., 2022).

Because of their habitat preferences, manatees often use areas near human settlements, and consequently face several anthropogenic impacts such as hunting (Calvimontes & Marmontel, 2022), incidental capture (Meirelles, 2008; Brum et al., 2021; Debrot et al., 2023), habitat loss and fragmentation (Marmontel et al., 2012; Lazenski et al., 2021), boat traffic and collision (Basset et al., 2020; Galves et al., 2023), and contaminants (Castañheda-Chávez et al., 2020; Silva Junior et al., 2022; Lemos et al., 2024). Unravel manatees' biological and ecological aspects can help to identify priority research subjects, actions, and areas for conservation. Even though the majority of published information about manatees originates from the United States, the number of publications resulting from studies in Latin America has been experiencing significant growth (see Amaral et al., 2023 and Castelblanco-Martínez et al., 2023 for a review). However, a wealth of information from this region remains undiscovered in unpublished documents.

To this end, this Special Issue aims to bring together a body of research about manatee biology and conservation, focusing on West Indian and Amazonian manatees, considering the scope

of the *Latin American Journal of Aquatic Mammals*. To the best of our knowledge, this marks the inaugural issue in any scientific journal exclusively dedicated to manatees.

Historical Perspective

Manatees are widely acknowledged as gentle, slow, and inquisitive aquatic mammals across much of their habitat. Regrettably, due to hunting in certain regions, these graceful creatures have adapted by adopting a more secretive behavior as a means of self-protection. Consequently, manatees can be perceived as shy, almost mysterious beings, a testament to their resilience in the face of human-induced challenges.

European explorers were the first to document the presence of manatees in the Americas. Christopher Columbus, a prominent figure among these explorers, was likely one of the first ones to encounter these animals, in 1493 (Janson, 1980). The sailors, possibly fatigued from their long voyages, mistook the manatees for mermaids (or sirens), as noted in Columbus' journal, where he described them as 'not as pretty as they are said to be' (Dunn & Kelley et al., 1989).

However, way before the explorers arrived in the Americas, indigenous peoples were familiar with manatees. Historical records and archaeological evidence suggest that manatees played a role in the cultures of indigenous communities. Native tribes and communities in Florida, the Caribbean islands, and Central and South America often depicted manatees in their art, and manatee bones have been found in archaeological sites, indicating their use for tools and materials (McKilop, 1985; Gotz et al., 2014). Additionally, explorers, historians, religious, and naturalists also reported manatee meat was an important food source for native peoples (Whitehead, 1978; O'Donnell, 1981; Osborn, 2016).

Some of these characters were the first to describe the West Indian manatee morphology, habitat, and behavior in America's coastal waters. These descriptions usually had some information about how they were hunted and recipes prepared with manatee meat (see Whitehead, 1978; Harris, 2020). However, it was only in 1758 that the species was officially described by the Swedish naturalist Carl Linnaeus in the 10th edition of his influential work, 'Systema Naturae'. Remarkably, Linnaeus did not assign a specific specimen as the type specimen (holotype). There is a widespread belief that he drew upon diverse sources of information, potentially incorporating preserved specimens from other collections during the process of characterizing the species. The common name of the species is derived from the region where it was initially observed - the West Indies, encompassing the Greater Antilles and the Lesser Antilles. Interestingly, the term itself originated from Christopher Columbus, who, upon arriving in the Caribbean, mistakenly believed he had reached the Indies (East Asia) (Bourne, 1904). However, it is also unknown who was the first one to assign this common name to the species. What is known is that after Linnaeus formally described the species, interest in these creatures grew, and several naturalists started to study and write about the West Indian manatee in several places, such as in the USA (Bartram, 1791), South America (d'Orbigny, A., 1835–1847), and Nicaragua (Belt, 1874).

Concerning the Amazonian manatee, Gaspar de Carvajal, a Spanish Dominican missionary who participated in the famous expedition led by Francisco de Orellana, wrote about the discovery of the Amazon River and manatees as a food source for indigenous people in 1541-1542. The British naturalists Alfred Russel Wallace, Henry Walter Bates, and Richard Spruce also visited the Amazon region between 1848 and 1852 (Wallace, 1853), and reported the presence of the species (called cow-fish by him) in the Negro River, state of Amazonas, which meat they used to eat during dinner. The author reported the species was common in the lakes of the region and provided information about its anatomy and behavior. However, the first recognized description of the Amazonian manatee came only in 1883, when von Pelzeln published in German the findings of the Swiss naturalist Johann Baptist Ritter von Natterer in an expedition to Brazil between 1817 and 1835. The description was based on five animals collected in Borba, Madeira River, in the state of Amazonas. In the report, the author pointed out the differences between the studied specimens and the other known manatee species in the Americas, called *Manatus americanus* at that time, such as the absence of nails, and longer head and flippers.

What both species have in common, besides anatomy and behavior, is the fact they have been hunted everywhere they were, first by native people, then by explorers and new settlers (Domning, 1982; Harris, 2020). In fact, hunting extirpated West Indian manatees from the Lesser Antilles (Lefebvre et al., 2001) and the southernmost area of the species distribution (Espírito Santo, Bahia, and Sergipe states, northeastern Brazil) (Albuquerque & Marcovaldi, 1982). Intensive hunting for commercialization took place in Brazil, Guyana, and Suriname [see a detailed review about hunting in Lefebvre et al. (2001)], and probably extirpated the species from the southernmost part of its distribution in the 1950s (Domning, 1982). Hunting also resulted in low densities and patchy distribution for manatee, increasing the species extinction risk. At those hunting levels, it is not surprising that the West Indian manatee was one of the species included in Allen's book (1942) 'Extinct and vanishing mammals of the western hemisphere'. Actually, the species is still hunted for subsistence and local commerce in several countries (Morales-Vela et al., 2003; Luna et al., 2008; Domínguez Tejo, 2021; Izidoro et al., 2022; Jiménez, 2022; Debro et al., 2023).

The situation was not different for Amazonian manatees. The species was intensely hunted during the colonial period until 1973, when manatee poaching was banned in Brazil. During this long period, Amazonian manatees were hunted for their meat and later also for hide, with peaks of thousands of animals per year (Domning, 1982; Antunes et al., 2016). Although protected by laws in most countries along its distributional area, the hunting of Amazonian manatee is a deeply embedded cultural practice and remains widespread throughout its range (Brum et al., 2021).

From the first description of the manatees until now, research has increased to understand the biological aspects of these species, including morphology, physiology, behavior, and ecology, and to investigate the main and potential threats to the species, supporting the conservation efforts on their distribution (see Amaral et al., 2023 and Castelblanco-Martínez et al., 2023 for a review). Additionally, scientific meetings and collaborative networks have been carried out to share strategies and results among institutions for species conservation.

Marine mammalogists have been reunited to discuss aspects of the biology and conservation of aquatic mammals, including manatees, since the 1970s. The Mexican Society of Marine Mammalogy (*Sociedad Mexicana de Mastozoología Marina* - SOMEMMA) was created in La Paz, in 1979, and holds biennial meetings. However, before this, experts had the 1st International Meeting about the Baja California Marine Mammals. In 1996, the scientific community within Central America formed the Mesoamerican Society for Biology and Conservation (*La Sociedad Mesoamericana para la Biología y Conservación* - SMBC), which has held meetings annually. Within the SMBC, the 1st Symposium for the Biology and Conservation of Antillean manatees in Mesoamerica was held in 2006 in Guatemala (Gonzalez-Socoloske et al., 2007). In South America, since 1984, the scientific community has met biennially to discuss aspects of biology and conservation of aquatic mammals during the Working Meetings of South American Specialists in Aquatic Mammals (RTs). During these meetings, experts discussed the creation of a society. Thus, in 1996, in Chile, the Latin American Society of Specialists in Aquatic Mammals (*Sociedade Latino-Americana de Especialistas em Mamíferos Aquáticos* - SOLAMAC) was created. In 1981, the Society for Marine Mammalogy (SMM) was founded in California, USA, and holds biennial meetings all over the world. The International Sirenian Symposium is usually held in conjunction with the SMM meetings as an all-day meeting that fosters communication between researchers, managers, and policy makers on all aspects of Sirenian conservation. Additionally, annually, the University of Florida Aquatic Animal Health Program organizes the Manatee Research Symposium to bring researchers, professionals, and students together from universities and animal care facilities around the world to share current research findings related to manatee biology, health, care, and conservation.

The International Union for the Conservation of Nature (IUCN) Sirenia Specialist group aims to study, assess extinction risk, and facilitate conservation actions for sirenian species. In 2013, to promote the communication and to better coordinate conservation actions at a regional level, the Sirenia Specialist Group created six regional groups. In the Americas, there are three groups: the South American (SAR), the Meso-American (MAR), and the Southeast United States. In 2014, the regional co-chairs of the SAR established the Latin American Symposium for Manatee Research and Conservation (SILAMA) (Castelblanco-Martínez & Marmontel, 2015). One of the objectives of the SILAMA is to gather sirenian specialists to exchange experiences and advances on the biology and conservation of manatee species.

Contents of the Special Issue

We are pleased to introduce the special issue devoted to the gentle and vulnerable manatees. This special issue brings you ten articles and three notes covering the following main topics: morphology, feeding habits and behavior, health, abundance, distribution, threats, and conservation. Pinheiro et al. describe the gross anatomy and histological aspects of the digestive tract of *T. m. manatus* showing similarities with other species of the order Sirenia.

Manatees are generalist herbivores, and their diet includes many species of subaquatic, emergent, floating, and riparian vegetation. In this issue, Ramos et al. report the direct observation of consumption of *Halophila baillonii* by *T. m. manatus* in Belize, adding this item to the diet of the species. Val and colleagues describe the behavior richness of released *T. m. manatus* in Brazil, demonstrating the positive influence of the home range size on ethological aspects of rehabilitated and released manatees.

Many of the manatee anatomy and health aspects have been described during the handling of manatees under human care, for example, in rescue and rehabilitation centers. This includes rare events such as the first occurrence of oral cleft in an Amazonian manatee addressed in this issue by da Silva et al., who describe a unique clinical case and discuss its potential causes.

Manatees are in general shy and cryptic species, and many of them inhabit waters with limited visibility. In many areas, particularly in rivers and lagoons of Meso and South America, the low detection rates have always been a critical challenge for researchers, as this limits the estimations of abundance and density, both necessary to monitor the populations' status, to propose protected areas, and to plan management strategies. Techniques for abundance estimations were addressed in this issue to survey *T. m. manatus* and *T. inunguis*. Choi-Lima et al. propose a new protocol to detect and estimate the abundance of *T. m. manatus* using active acoustics (side-scan sonar), showing successful results in Brazil. A review of the application of this technique in manatee research was recently published in LAJAM (see Gonzalez-Socoloske & Olivera-Gomez, 2023). Farinelli et al. evaluate the use of unmanned aerial vehicles for detecting Amazonian manatees, showing the challenges and future directions of the technique. The distribution of West Indian manatees was the main topic of the two articles. Cubero-Pardo et al. describe the distribution and use of the area of the Antillean manatee in three protected areas in Costa Rica, demonstrating the relationships between environmental factors and food availability. Deeks et al. evaluate the relationship between the distribution of the West Indian manatee and freshwater and seagrass availability considering the impacts of climate change, and the authors indicate the significant effect of the decline in seagrass coverage on manatee distribution.

Following the topics of conservation and threats, Allen et al. provide an overview of the current conservation status of the West Indian manatee in Florida and Puerto Rico, highlighting the emerging threats, such as reduction of food availability and emerging diseases, and conservation challenges for that region. Corona-Figueroa and Cifuentes-Espinosa evaluate the perception of threats and conservation of *T. m. manatus* in Rio Dulce National Park in Guatemala by the park users, recommending the increase of research and action on awareness to improve the conservation efforts in the area. The stranding of West Indian manatee calves was the main theme of three studies. Moreira-Lima et al. demonstrate the correlation between the increasing calf stranding and environmental degradation from salt and shrimp production in two Northeastern Brazil estuaries. Meirelles et al. provide an overview of calf stranding on the Brazilian semi-arid coast and discuss some hypotheses that can explain this unusually high incidence. Arévalo-González et al. evaluate twelve years of stranding reports in the middle Magdalena River basin in Colombia,

showing the necessity of improvement on the stranding network as an action for the conservation of the species in the region.

This issue represents the tireless effort of many researchers along manatee distribution areas, and their devotion to investigate various aspects of some of the most elusive and endangered aquatic mammals. We believe that this compilation is an important contribution for manatee research, management, and conservation.

Good reading!

The Guest Editors

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