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Accomplishments and challenges of the research on Antillean manatee: A bibliometric analysis

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Abstract

The Antillean manatee (*Trichechus manatus manatus*) is an endangered subspecies of the West Indian manatee inhabiting countries of South America, Meso America and the Caribbean. Basic and applied research is necessary to inform management plans for the effective recovery of this subspecies. The purpose of this study was to systematically review literature regarding Antillean manatees, without restriction of the research topic. Article selection and screening process are described. Our final database consisted of 456 publications, of which peer-reviewed literature (articles, reviews, and notes in research journals) represent the most important type (63.4%), followed by BSc, MSc, and PhD theses (28.1%). Most of the research (70%) was

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conducted on wild manatees, 21,5% under human care conditions, and the rest a combination of both; the most common topics of study were 'ecology', 'conservation', 'morphology, anatomy and physiology', and 'behavior'. The literature on Antillean manatee has expanded significantly over the last two decades across the region, with most of the research published in just the last five (25.4%) to 10 (44.6%) years. Most of the published work has been by Brazilian, Mexican, and Colombian researchers. However, an important amount of research remains as theses in Portuguese or Spanish limiting the dissemination of results. Relevant limitations for research and publication in Latin American countries may have an impact on the published literature on Antillean manatees, including scarce funding, poor facilities, language-related difficulties, and lack of a culture of publication. Avenues to melt scientific barriers may include increasing governmental investment on research, strengthening international networks, and improving the support to publish in high-impact journals.

Introduction

The Antillean manatee (*Trichechus manatus manatus*) is a subspecies of the West Indian (*Trichechus manatus*) manatee, and occupies coastal areas, estuaries, rivers, and lagoons of more than twenty countries from the Greater Antilles, Meso America and South America (Quintana-Rizzo & Reynolds, 2010; Reynolds et al., 2018). The subspecies shows the highest environmental plasticity among sirenians, and recent research on the body condition of wild Antillean manatees suggests the distinction of coastal and freshwater ecotypes (Castelblanco-Martínez et al., 2021).

Historical hunting of Antillean manatees is reported in almost all of the areas where the subspecies is distributed (e.g., McKillop, 1985; Jiménez-Pérez, 2002; de Thoisy et al., 2003; Morales-Vela et al., 2003; Alvarez-Alemán et al., 2018; Domínguez-Tejo,

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2021), and in some developing countries manatees continue to be killed for food (e.g., de Thoisy et al., 2003; Castelblanco-Martínez et al., 2018). The collisions with outboard vessels are relatively common in Puerto Rico, Brazil, and Belize (Mignucci-Giannoni et al., 2000; Galves et al., 2022; Borges et al., 2007), and bycatch of Antillean manatee occurs in most countries, but at a relatively low level (Kiszka, 2014). Habitat loss and degradation is the most common threat to manatee coastal populations, including removal of littoral forests, seagrass destruction by the dredging of canals, and mangrove destruction by the construction of seawalls (Auil, 2004). Commercial cultivation, logging and ranching have led to increased sediment build-up along rivers, modification of river pathways, and the destruction of shore vegetation (Medeiros et al., 2001). The Antillean manatee's distribution area is wide but highly fragmented, and the lack of connectivity along with low reproductive rates has important implications on the viability of its population.

Although the West Indian manatee is vulnerable according to the Red Data Book (Deutsch et al., 2008), the Antillean subspecies is listed as endangered due to the cumulative impacts of natural catastrophes, anthropogenic disturbances, and low recovery rates, which have caused a progressive decrease in the population throughout its range (Castelblanco-Martínez et al., 2012). Additionally, wild populations of the subspecies are facing an extremely high risk of local extinction in many countries. For example, Antillean manatees are currently considered as critically endangered in Dominican Republic (Dominguez-Tejo, 2021) and in Brazil (de Meirelles et al., 2022).

Under this conservation scenario, scientific research is necessary to create a baseline of information on the biology, distribution, abundance, ecology, and behavior, among other subjects relative to Antillean manatees (Good et al., 2007). Also, studies aiming to evaluate natural and anthropogenic

threats on the subspecies are urgently required in order to guide management plans for recovery at local and regional scales (Panyawai & Prathep, 2022). Reviewing of current state-of-the-art of knowledge on Antillean manatees is critical to identify the main research areas, highlight research gaps, and describe past and emergent trends in publication related to this study subject. This information can be useful to guide current and future research efforts in Latin America and the Caribbean. The purposes of this article are to describe the current state of the research on Antillean manatees, to identify gaps in knowledge regarding this endangered subspecies, and to elucidate possible gender/nationality trends in authorship.

Methods

Systematic review was adopted as the research method. We used search engines (e.g., GoogleScholar, Scopus, ResearchGate, Academia) applying combinations of key words, e.g., "Antillean manatee" + "Brazil", "*Trichechus manatus manatus*" + "Panama". After an exhaustive search, a database was created including the following information for each reference: author, year, title, country, type of publication, topic, gender/nationality of first author, and language. A careful treatment was conducted to discard duplicates; conference proceedings were excluded, as they were considered gray literature.

We used a binary distinction of gender (male vs. female) based on the first name of the primary author and/or our knowledge of the person. We are aware that personal gender identity is more complex than our designation, but for the purposes of our analysis we used the binary distinction. Nationality was determined by our personal knowledge of the first author or the institutional affiliation.

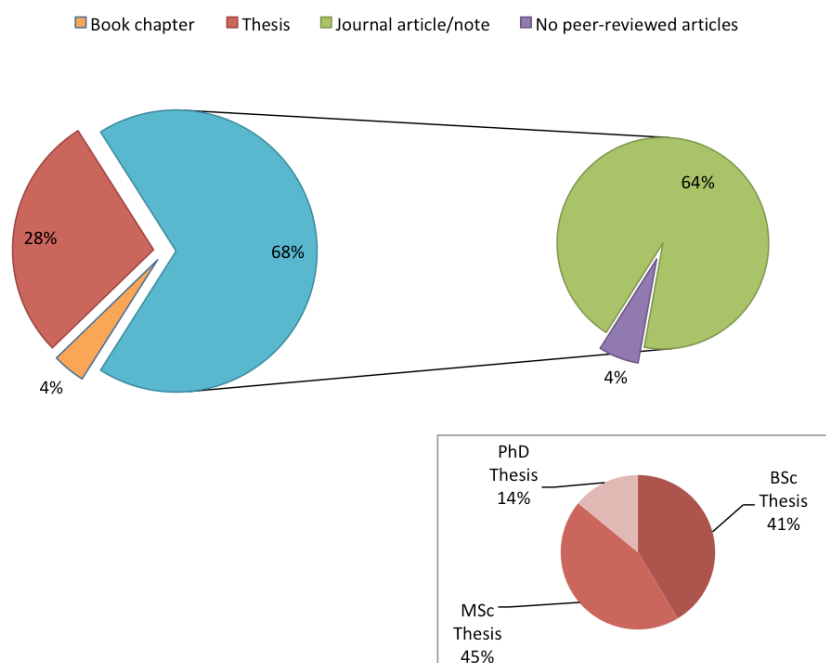


Figure 1. Proportion of publication type related to Antillean manatees (1935 - 2022). The types 'book' (n = 2) and 'report' (n = 1) were excluded for visualization purposes.

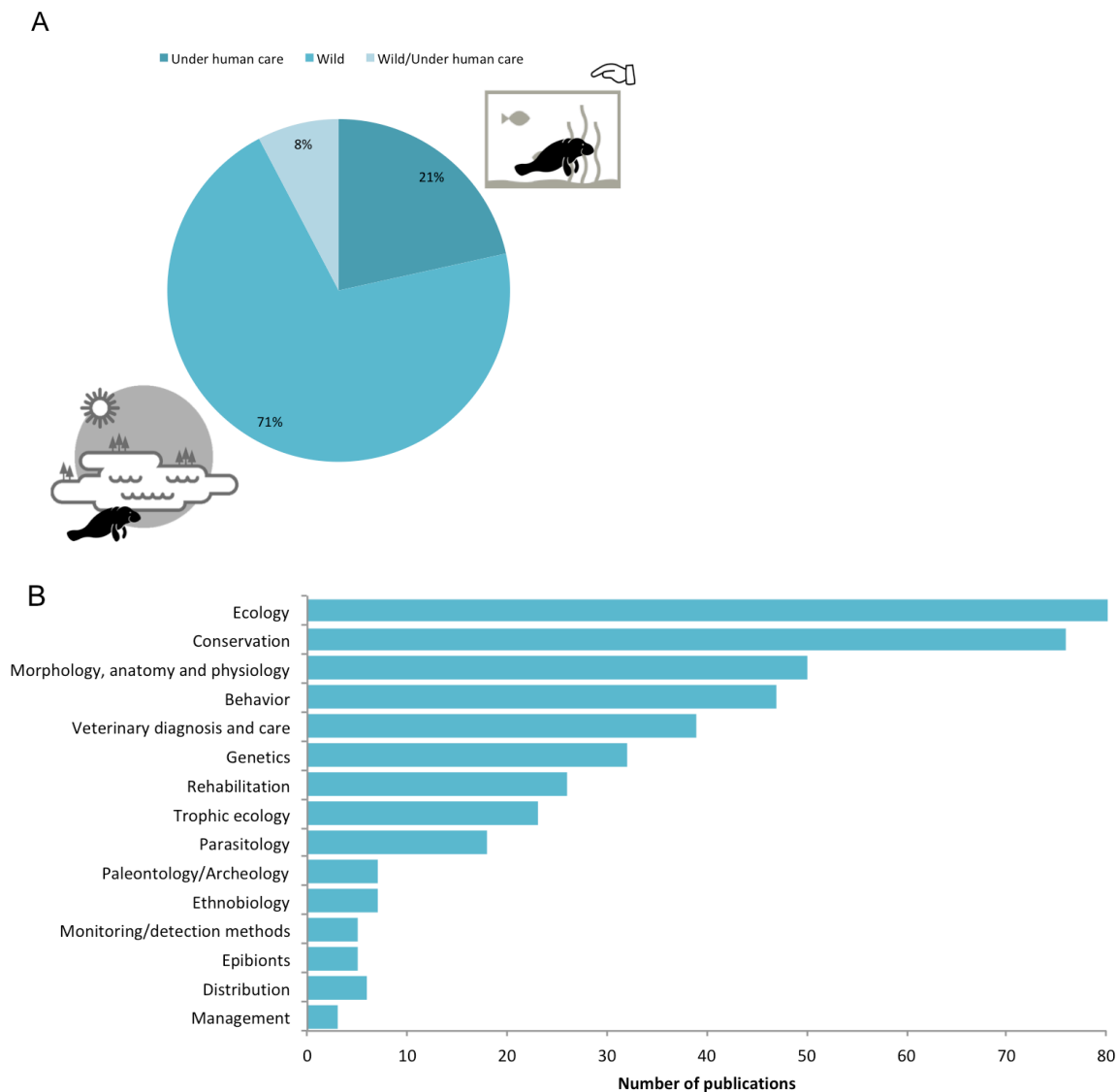


Figure 2. A) Type of setting under which manatees have been studied [year range]. B) Number of published works according to research topic [year range].

Several authors have coupled the sociology of knowledge with elements of postcolonial and Southern theories to demonstrate evidence of an international division in knowledge-making between nations and regions. These approaches indicate that national wealth and many of the ways of academic publishing are implicated in the maintenance of North-South inequalities in academic production (Collyer, 2018). We divided nationalities of the first authors into the ‘Global North’ and ‘Global South’ (Collyer, 2018), to analyze trends in respective contributions. Herein, these terms broadly refer to a socio-economic division rather than a strictly geographical one.

Results

The search in online databases yielded 456 documents (1935 – August 2022), which were included for a detailed analysis and synthesis (see Supplementary Material 1 for complete database). The most frequent type of publication consisted of peer-reviewed

literature (articles, reviews, and notes in research journals, $n = 289$, 63.4%), followed by MSc, BSc and PhD theses ($n = 128$, 28.1%). Of the total of theses, only a small proportion corresponded to doctoral dissertations ($n = 18$, 14.1%) (Fig. 1).

Most of the research (70.6%) was conducted under wild conditions and 21.5% under human care. The rest of the studies used combined or comparative data from free-ranging manatees and manatees under human care (Fig. 2A). The published research on Antillean manatees has been focused on a variety of topics (Fig. 2B). The most important subject was ‘ecology’ (24.5%), which includes a relatively large amount of preliminary, low-budget assessments of manatee occurrence, distribution, and conservation status in particular territories/countries (e.g., Castelblanco-Martínez et al., 2009; Gonzalez-Socoloske et al., 2011; Arévalo-González et al., 2014). Another relevant category is ‘Conservation’ (16.6%), which includes quantitative or qualitative descriptions of threats to manatee viability/health such as boat collisions (e.g., Borges et al., 2007), poaching (e.g., Jiménez-Pérez, 2002), contaminants (e.g., Anzolin et al., 2012; Romero-Calderón et

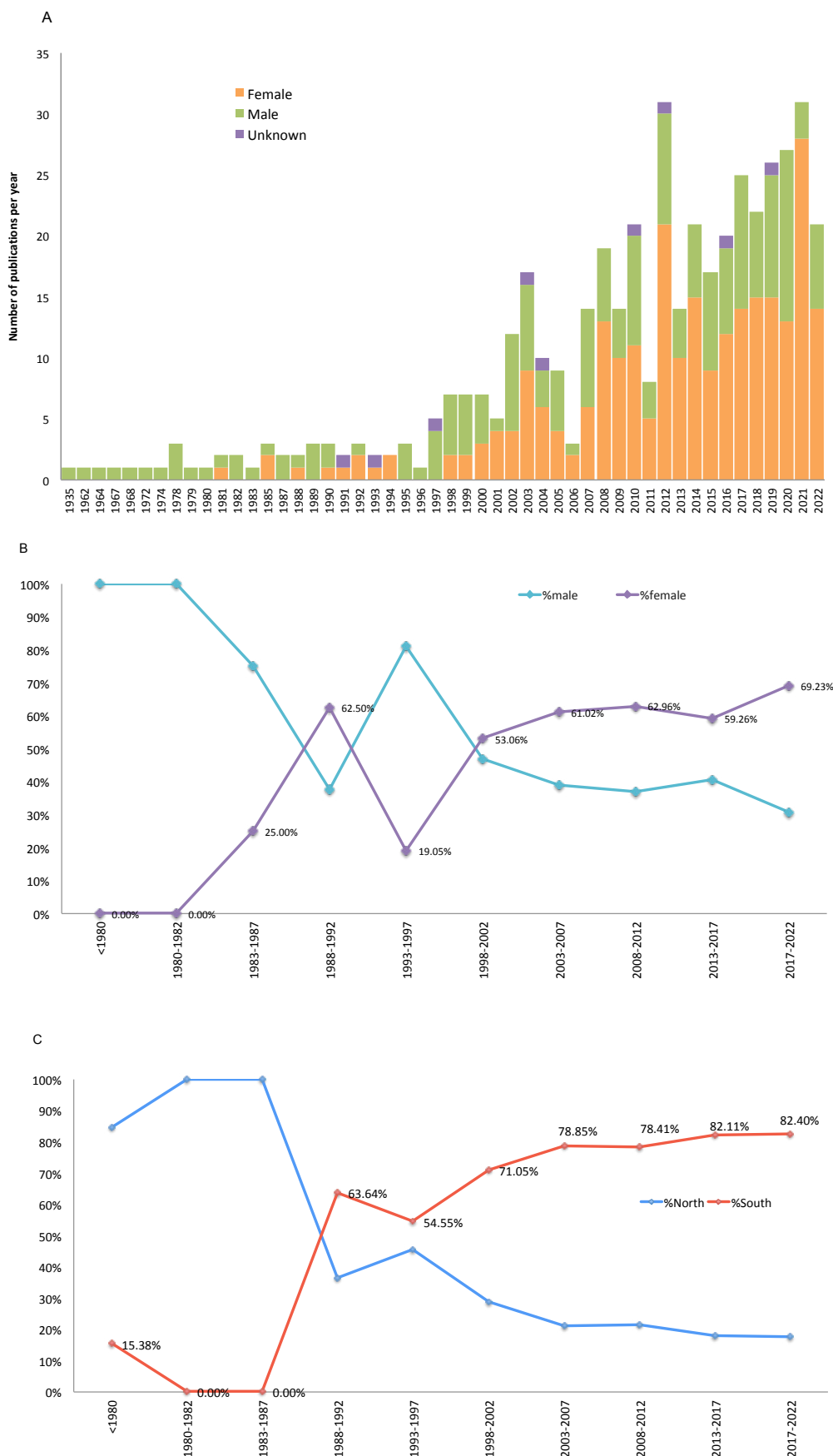


Figure 3. A) Temporal trends on scientific production related to Antillean manatees, discriminated by gender of the first author. The number of publications for 2022 (Jan. – Aug.) was extrapolated for 12 months; B) Temporal trends of first author's gender; C) Temporal trends of the first author's origin.

al., 2016), among others. Datasets obtained from local stranding networks have provided relatively consistent information to develop long-term and large-scale analysis on manatee mortality in Brazil (de Meirelles, 2008; Balensiefer et al., 2017), Belize (Galves et al., 2022), Puerto Rico (Mignucci-Giannoni et al., 2000), Cuba (Alvarez-Alemán et al., 2021), and Dominican Republic (Dominguez-Tejo, 2021). The topic morphology, anatomy and physiology (10.9%) covers many aspects of Antillean manatee's biology such as age and growth (e.g., Borges et al., 2012), body condition (Castelblanco-Martínez et al., 2021), histology (e.g., Bezerra et al., 2018), cardiology (e.g., Siegal-Willott et al., 2006), and others. Several documents informing reference values of serum, urine and hormones are also included in this category (e.g., Vanoye, 2002; Silva et al., 2009; Takeuchi et al., 2016). In the topic behavior (10.3%), papers approaching aspects on manatee communication (e.g., Alicca et al., 1997; Sousa-Lima et al., 2008; Umeed et al., 2018; Merchan et al., 2019; Ramos et al., 2020), learning and welfare (e.g., Hénaut et al., 2020), husbandry (Lima et al., 2005), circadian rhythm (Holguin-Medina et al., 2015), habitat preferences (e.g., Ramírez-Jiménez et al., 2017), and movements and migrations (e.g., Castelblanco-Martínez et al., 2013) were found.

The literature on Antillean manatees has expanded over the last two decades (Fig. 3A). We found a significant positive correlation between the number of publications and year (Pearson's $r = 0.77$, $DF = 88$, $p < 0.001$), with most production occurring during the last five (25.4%) to 10 (44.6%) years. Brazilian, Mexican, and Colombian researchers have led most of the published work. However, an important amount of research remains as theses in Portuguese or Spanish, limiting the dissemination of results. Overall, 56.6% of first authors were female, with female first authorship exhibiting a significant upward trend from 1997 (Fig. 3B). Also, first authors were predominantly from the 'Global North' until 1990 - 1994, but during the last 25 years more than 80% of publications were first-authored by Latin American researchers (Global South) (Fig. 3C).

Discussion

Relevant barriers for research and publication in Latin American countries may have an impact on the published literature on Antillean manatees, including scarce funding, poor facilities, language-related difficulties, and lack of a culture of publication. However, our study suggests that, during the last decade, developing countries in Latin America are making substantial contributions to sirenian research, with results not limited to Antillean manatees, but also applicable to other populations in the Order. These research efforts are occurring despite the low average proportion of gross domestic product (GDP) invested in science and technology in the region throughout the last 10-year period (Hermes-Lima et al., 2007).

Although several studies on the subspecies have a regional approach (e.g. Castelblanco-Martínez et al., 2012, 2021), it is noticeable that the relatively higher scientific literature production is led by researchers from Mexico and Brazil. A system of governmental funding of domestic research, public universities, and research centers in those countries, although imperfect, may have resulted in a positive impact on manatee research, especially in the form of undergraduate and graduate theses.

The published literature on the subspecies includes a relatively large amount of preliminary, low-budget assessments of manatee occurrence, distribution, and conservation status in particular territories/countries. These studies represent important baseline information for monitoring and management and are often based on simple methods to collect manatee information such as interviews of local inhabitants, detection of indirect signs of presence (feeding signs, feces), or fixed-point visual surveys from shore or floating platforms. Nevertheless, during the last decade, there has been an important increase of documents describing the utilization of more sophisticated monitoring tools, such as telemetry (e.g., Castelblanco-Martínez et al., 2013; Gonzalez-Socoloske et al., 2015; Normande et al., 2016; Attademo et al., 2022; dos Santos et al., 2022), side-scan sonars (e.g., Gonzalez-Socoloske et al., 2009; Gonzalez-Socoloske & Olivera-Gómez, 2012; Arévalo-González et al., 2014; Guzman & Condit, 2017; Castelblanco-Martínez et al., 2018; McLarty et al., 2020; Corona-Figueroa et al., 2021), drones (e.g., Ramos et al., 2018, 2022; Landeo-Yauri et al., 2020, 2022), and hydrophones (e.g., Kikuchi et al., 2014; Rivera-Chavarría et al., 2015; Merchan et al., 2019). Likely, in the upcoming years, the rapid evolution of detection and tracking devices – and the increase in their affordability – will have a positive impact on the amount and quality of data about Antillean manatee presence, movements, and habitat use in developing countries. International networking and governmental investment are desirable to accelerate this process.

Studies conducted under human care of Antillean manatees have yielded an important amount of information on the behavior, physiology, morphology and health of the subspecies (e.g., Garcés-Pires et al., 2016; Cuartas et al., 2020; Cabrias-Contreras et al., 2021). Currently, several dozen Antillean manatees are held in facilities in Brazil, Mexico, Puerto Rico, Belize, Guyana, and Colombia, in many cases for rehabilitation and release purposes.

Gender bias against female researchers has been widely documented for other research topics (Casad et al., 2021), however despite these obstacles, female senior authors have dominated literature on Antillean manatee, particularly during the last 15 - 20 years. It is encouraging to see this trend. Similarly, the vast majority of the Antillean manatee literature in the last 20 years has been produced by senior authors from Latin America (the 'Global South'), which is an important shift from the earliest work on the subspecies.

Recommendations

Based on the results of our literature review, we recommend the following actions:

- Strengthen national science and technology systems in the Global South to secure funding for manatee research. This includes creating mechanisms to facilitate publication in well-ranked journals by Latin American researchers;
- Several routes to overcome language barriers including peer language-proofing and translation systems in preprint platforms, and free translation/language proofing resources provided by universities and scientific institutes;
- Improve strategies of international cooperation to monitor and research manatees at a regional level. Manatees, like many other aquatic mammals, make long-distance movements and have large home ranges, often traveling through several countries;

- Implement, improve, or extend stranding networks to collect long-term data and samples;
- Standardize sampling methodology to allow comparisons across studies.

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Supplementary material

Supplementary Material 1 - Database of scientific literature related to Antillean manatees (1935-2022).

