

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

Delma Nataly Castelblanco-Martínez^{1, 2, 3, *}, Daniel Gonzalez-Socoloske^{3, 4}, Leslie Cabrias⁵, Natalia Garcés-Cuartas², Gloria Katerin Arévalo-González^{2, 3}, João Carlos Gomes Borges^{3, 6, 7}, and Miriam Marmontel^{3, 7}

¹Conacyt/Universidad Autónoma del Estado de Quintana Roo. Mexico

²Fundación Internacional para la Naturaleza y la Sustentabilidad (FINS). Mexico

³IUCN Species Survival Commission Sirenian Specialist Group

⁴Department of Biology, Andrews University. Berrien Springs, USA

⁵Caribbean Manatee Conservation Center, Inter American University of Puerto Rico. Puerto Rico

⁶Projeto Viva o Peixe-Boi-Marinho. Fundação Mamíferos Aquáticos. Recife, Brazil

⁷Instituto de Desenvolvimento Sustentável Mamirauá. Tefé, Brazil

*Corresponding author: castelblanco.nataly@gmail.com

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

Keywords:

Sirenia, *Trichechus manatus manatus*, endangered species

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,

ARTICLE INFO

Manuscript type: Review

Article History

Received: 02 October 2022

Received in revised form: 30 November 2022

Accepted: 02 December 2022

Available online: 27 January 2023

Handling Editor: Aldo S. Pacheco

Citation:

Castelblanco-Martínez, D. N., Gonzalez-Socoloske, D., Cabrias, L., Garcés-Cuartas, N., Arévalo-González, G. K., Borges, J. C. G., & Marmontel, M. (2023). Accomplishments and challenges of research on the Antillean manatee: A bibliometric analysis. *Latin American Journal of Aquatic Mammals*, 18(1), 158-166. <https://doi.org/10.5597/lajam00297>

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.

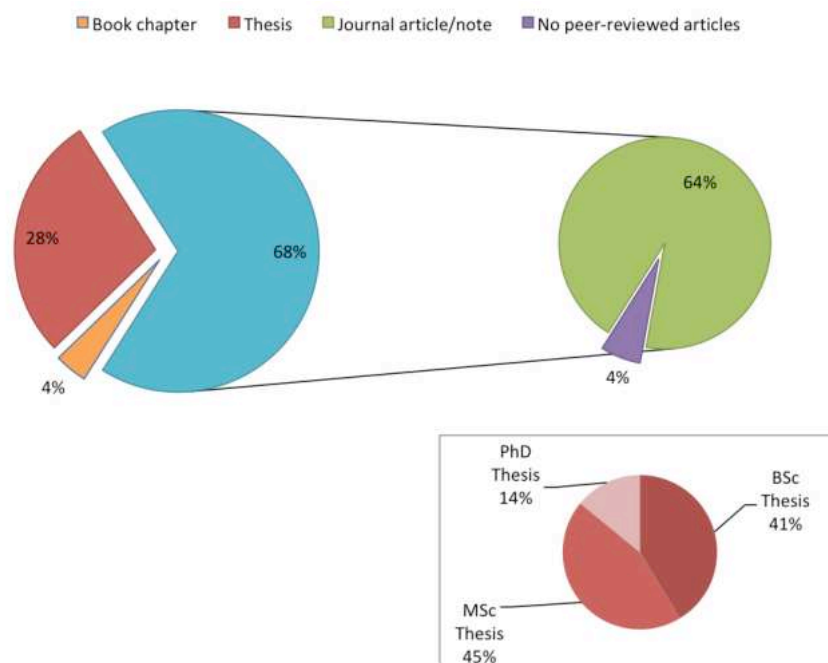


Figure 1. Proportion of publication type related to Antillean manatees (1935 - 2022). The types 'book' (n = 2) and 'report' (n = 1) were excluded for visualization purposes.

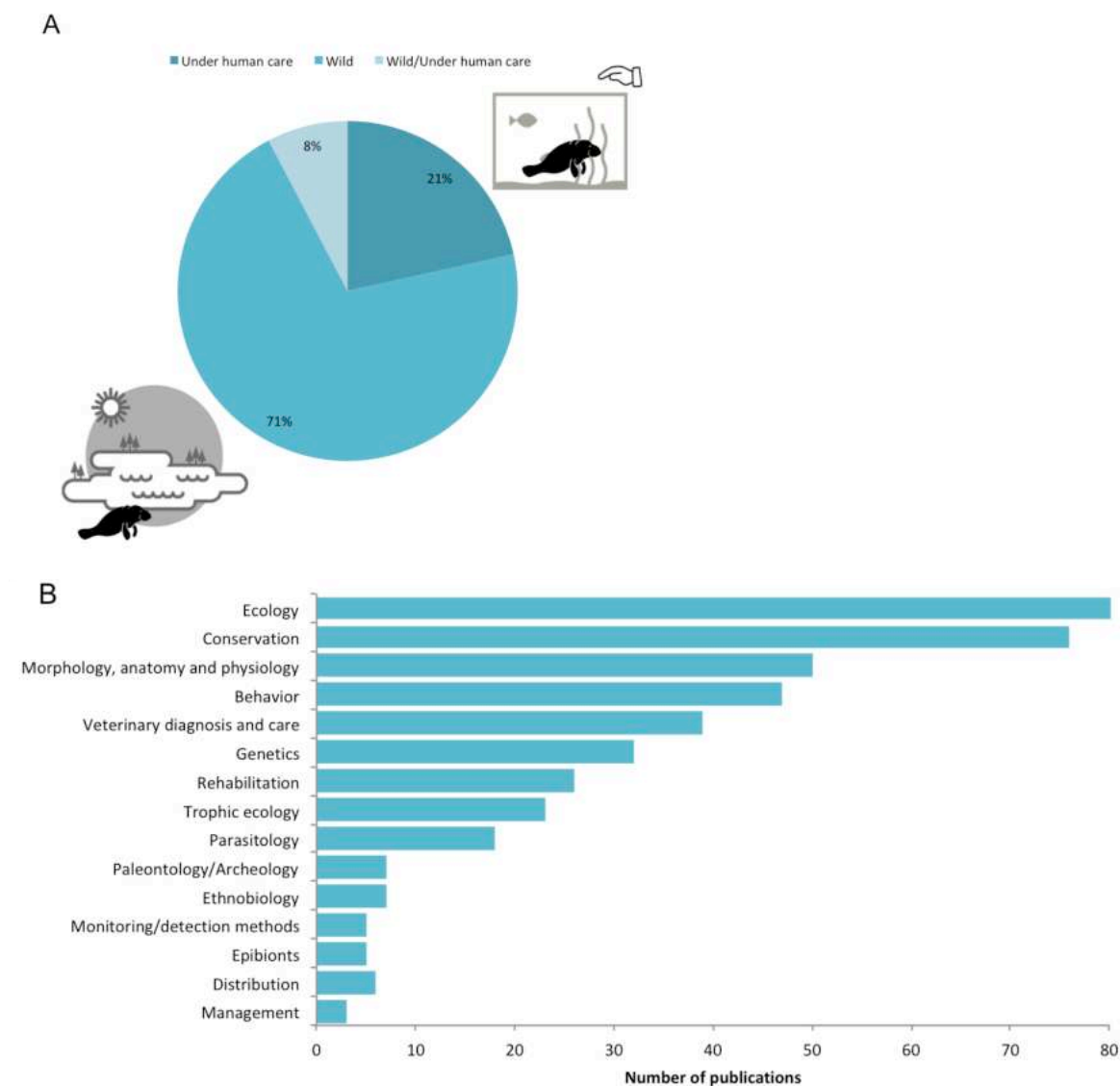


Figure 2. A) Type of setting under which manatees have been studied [year range]. B) Number of published works according to research topic [year range].

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

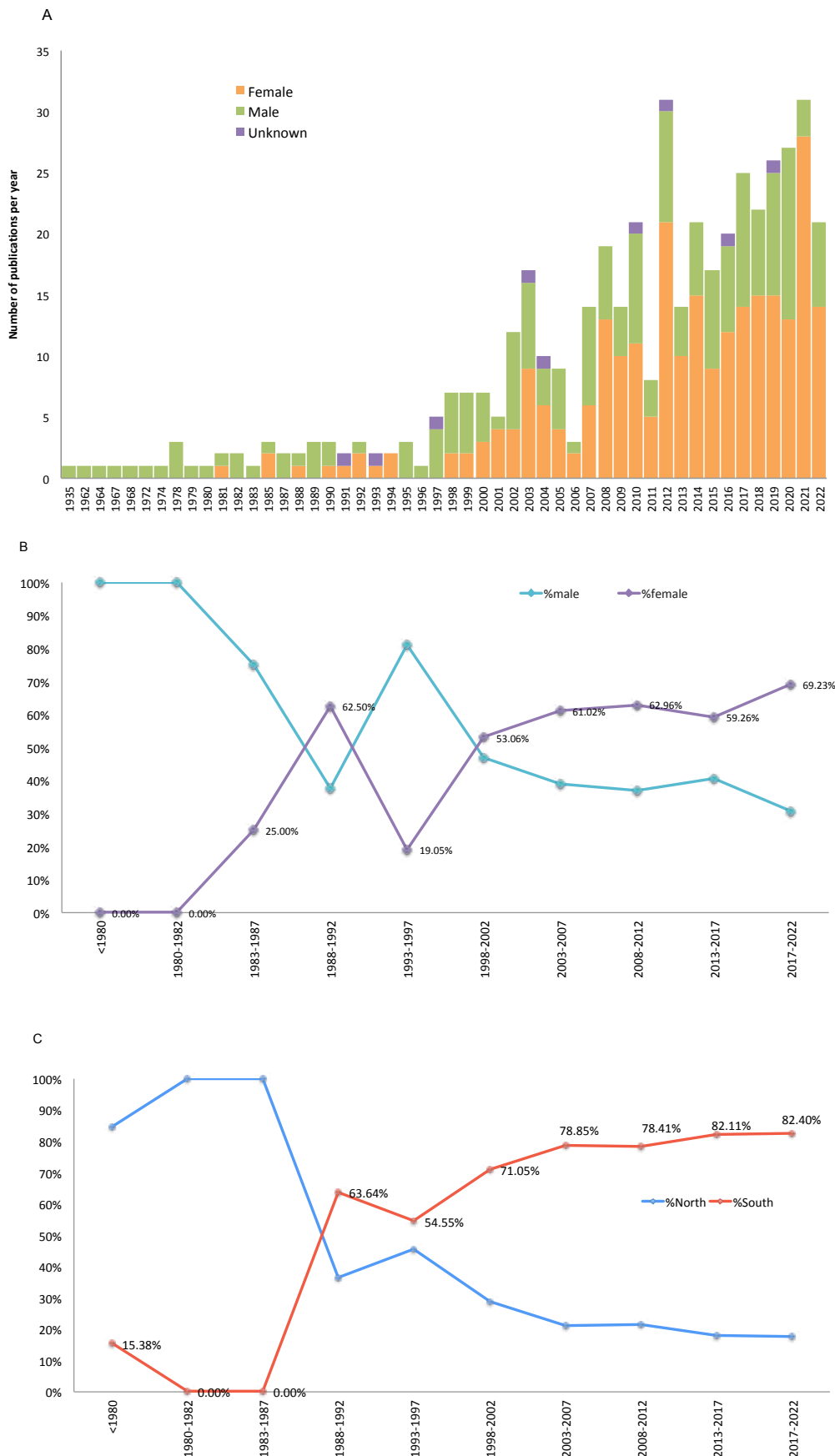


Figure 3. A) Temporal trends on scientific production related to Antillean manatees, discriminated by gender of the first author. The number of publications for 2022 (Jan. – Aug.) was extrapolated for 12 months; B) Temporal trends of first author's gender; C) Temporal trends of the first author's origin.

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.

Acknowledgments

We acknowledge three anonymous reviewers and the editor for the insightful comments on the manuscript.

References

- Alicca, J. A., Harvey, J., & Mignucci Giannoni, A. (1997). Variations in the vocal repertoire of the manatee in the Caribbean (*Trichechus manatus manatus*). *Journal of the Acoustical Society of America*, 102(3179). <https://doi.org/10.1121/1.420831>
- Alvarez-Alemán, A., García-Alfonso, E., Forneiro-Martin, V. Y., Hernández-Gonzalez, Z., Escalona-Domenech, R., Hurtado, A., Powel, J. A., Jacoby, C. A., & Frazer, T. K. (2018). Status and conservation of manatees in Cuba: historical observations and recent insights. *Bulletin of Marine Science*, 94(2), 313-327. <https://doi.org/10.5343/bms.2016.1132>
- Alvarez-Alemán, A., García Alfonso, E., Powell, J. A., Jacoby, C. A., Austin, J. D., & Frazer, T. K. (2021). Causes of mortality for endangered Antillean manatees in Cuba. *Frontiers in Marine Science*, 8, 646021. <https://doi.org/10.3389/fmars.2021.646021>
- Anzolin, D. G., Sarkis, J. E. de S., Diaz, E., Soares, D. G., Serrano, I. L., Borges, J. C. G., Souto, A. S., Taniguchi, S., Montone, R. C., & Bainy, A. C. D. (2012). Contaminant concentrations, biochemical and hematological biomarkers in blood of West Indian manatees *Trichechus manatus* from Brazil. *Marine Pollution Bulletin*, 64(7), 1402–1408. <https://doi.org/10.1016/j.marpolbul.2012.04.018>
- Arévalo-González, G. K., Castelblanco-Martínez, D. N., Sánchez-Palomino, P., López-Arévalo, H. F., & Marmontel, M. (2014). Complementary methods to estimate population size of Antillean manatees (Sirenia: Trichechidae) at Ciénaga de Paredes, Santander, Colombia. *Journal of Threatened Taxa*, 6(6), 5830–5837. <https://doi.org/10.11609/JoTT.o3156.5830-7>
- Attademo, F. L. N., Normande, I. C., Sousa, G. P., Costa, A. F., Borges, J. C. G., de Alencar, A. E. B., da Costa Foppel, E. F., & de Oliveira Luna, F. (2022). Reproductive success of Antillean manatees released in Brazil: implications for conservation. *Journal of the Marine Biological Association of the United Kingdom*, 1–8. <https://doi.org/10.1017/S0025315422000443>
- 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].
- Balensiefer, D. C., Attademo, F. L. N., Sousa, G. P., Freire, A. C. da B., da Cunha, F. A. G. C., Alencar, A. E. B., Silva, F. J. de L., & Luna, F. de O. (2017). Three decades of Antillean manatee (*Trichechus manatus manatus*) stranding along the Brazilian coast. *Tropical Conservation Science*, 10, 1940082917728375. <https://doi.org/10.1017/S0025315422000443>
- Bezerra, A. R., Salmito-Vanderley, C. S. B., Bersano, P. R. O., Carvalho, V. L., Meirelles, A. C. O., Attademo, F. L. N., Luna, F. O., & Silva, L. D. M. (2018). Histological characterization of reproductive tract and fetal annexes of the West Indian manatee (*Trichechus manatus*) from Brazil. *Pesquisa Veterinária Brasileira*, 38, 2166–2174. <https://doi.org/10.1590/1678-5150-PVB-5707>
- Borges, J. C. G., da Bôaviagem Freire, A. C., Attademo, F. L. N., de Lima Serrano, I., Anzolin, D. G., De Carvalho, P. S. M., & Vergara-Parente, J. E. (2012). Growth pattern differences of captive born Antillean manatee (*Trichechus manatus*) calves and those rescued in the Brazilian northeastern coast. *Journal of Zoo and Wildlife Medicine*, 43(3), 494–500. <https://doi.org/10.1638/2011-0199R.1>
- Borges, J. C. G., Vergara-Parente, J. E., Alvite, C. M. de C., Marcondes, M. C. C., & Lima, R. P. (2007). Embarcações motorizadas: uma ameaça aos peixes-boi marinhos (*Trichechus manatus*) no Brasil. *Biota Neotropica*, 7(3), 199–204. <https://doi.org/10.1590/S1676-06032007000300021>
- Cabrias-Contreras, L. J., Sánchez-Okrucky, R., Caicedo-Herrera, D., Jaramillo-Ortiz, L., de la Rosa, F., Negrete-Philippe, A. C., Cruz-Martínez, D., Rivera-Guzmán, A. L., & Mignucci-Giannoni, A. (2021). Baseline urinalysis results in 32 healthy Antillean manatees (*Trichechus manatus manatus*). *Journal of the American Veterinary Medical Association*, 258(4), 416–424. <https://doi.org/10.2460/javma.258.4.416>
- Casad, B. J., Franks, J. E., Garasky, C. E., Kittleman, M. M., Roesler, A. C., Hall, D. Y., & Petzel, Z. W. (2021). Gender inequality in academia: Problems and solutions for women faculty in STEM. *Journal of Neuroscience Research*, 99(1), 13–23. <https://doi.org/10.1002/jnr.24631>
- Castelblanco-Martínez, D. N., Bermúdez-Romero, A. L., Gómez-Camelo, I. V., Rosas, F. C. W., Trujillo, F., & Zerda-Ordoñez, E. (2009). Seasonality of habitat use, mortality and reproduction of the vulnerable Antillean manatee *Trichechus manatus manatus* in the Orinoco River, Colombia: implications for conservation. *Oryx*, 43(02), 235. <https://doi.org/10.1017/S0030605307000944>
- Castelblanco-Martínez, D. N., Nourisson, C., Quintana-Rizzo, E., Padilla-Saldivar, J., & Schmitter-Soto, J. (2012). Potential effects of human pressure and habitat fragmentation on population viability of the Antillean manatee *Trichechus manatus manatus*: a predictive model. *Endangered Species Research*, 18, 129–145. <https://doi.org/10.3354/esr00439>
- Castelblanco-Martínez, D. N., Padilla-Saldivar, J., Hernández-Arana, H. A., Slone, D., Reid, J., & Morales-Vela, B. (2013). Movement patterns of Antillean manatees in Chetumal Bay (Mexico) and coastal Belize: A challenge for regional conservation. *Marine Mammal Science*, 29(2), 166–182. <https://doi.org/10.1111/j.1748-7692.2012.00602.x>
- Castelblanco-Martínez, D. N., dos Reis, V., & de Thoisy, B. (2018). How to detect an elusive aquatic mammal in complex environments? A study of the endangered Antillean manatee *Trichechus manatus manatus* in French Guiana. *Oryx*, 52(2), 382–392. <https://doi.org/10.1017/S0030605316000922>
- Castelblanco-Martínez, D. N., Slone, D. H., Landeo-Yauri, S. S., Ramos, E. A., Alvarez-Alemán, A., Attademo, F. L. N., Beck, C. A., Bonde, R. K., Butler, S. M., Cabrias-Contreras, L. J., Caicedo-Herrera, D., Galves, J., Gómez-Camelo, I. V., Gonzalez-Socoloske, D., Jiménez-Domínguez, D., Luna, F. O., Mona-Sanabria, Y., Morales-Vela, J. B., Olivera-Gómez, L. D., Padilla, Saldivar, J.

- A., Mignucci-Giannoni, A. A. (2021). Analysis of body condition indices reveals different ecotypes of the Antillean manatee. *Scientific Reports*, 11(1), 1–14. <https://doi.org/10.1038/s41598-021-98890-0>
- Collyer, F. M. (2018). Global patterns in the publishing of academic knowledge: Global North, global South. *Current Sociology*, 66(1), 56–73. <https://doi.org/10.1177/0011392116680020>
- Corona-Figueroa, M. F., Ríos, N., Castelblanco-Martínez, D. N., Vilchez-Mendoza, S., Delgado-Rodríguez, D., & Niño-Torres, C. A. (2021). Searching for manatees in the dark waters of a transboundary river between Mexico and Belize: a predictive distribution model. *Aquatic Ecology*, 55(1), 59–74. <https://doi.org/10.1007/s10452-020-09810-9>
- de Meirelles, A. C. O. (2008). Mortality of the Antillean manatee, *Trichechus manatus manatus*, in Ceará State, north-eastern Brazil. *Journal of the Marine Biological Association of the United Kingdom*, 88(6), 1133–1137. <https://doi.org/10.1017/S0025315408000817>
- de Meirelles, A. C. O., dos Santos Lima, D., de Oliveira Alves, M. D., Borges, J. C. G., Marmontel, M., Carvalho, V. L., & dos Santos, F. R. (2022). Don't let me down: West Indian manatee, *Trichechus manatus*, is still critically endangered in Brazil. *Journal for Nature Conservation*, 67, 126169. <https://doi.org/10.1016/j.jnc.2022.126169>
- de Thoisy, B., Spiegelberger, T., Rousseau, S., Talvy, G., Vogel, I., & Vie, J. C. (2003). Distribution, habitat, and conservation status of the West Indian manatee *Trichechus manatus* in French Guiana. *Oryx*, 37(4), 431–436. <https://doi.org/10.1017/S0030605303000796>
- Deutsch, C. J., Self-Sullivan, C., & Mignucci-Giannoni, A. (2008). *Trichechus manatus*. *The IUCN Red List of Threatened Species 2008*. E.T22103A9356917. <https://doi.org/10.2305/IUCN.UK.2008.RLTS.T22103A9356917>
- Domínguez-Tejo, H. M. (2021). History and conservation status of the Antillean manatee *Trichechus manatus manatus* in Hispaniola. *Oryx*, 55(2), 284–293. <https://doi.org/10.1017/S0030605319000140>
- dos Santos, S. S., dos Santos Medeiros, I., Rebelo, V. A., Carvalho, A. O. B., Dubut, J. P., Mantovani, J. E., Círiaco, R. D., dos Santos, R. E. G., Marmontel, M., & Normande, I. C. (2022). Home ranges of released West Indian manatees *Trichechus manatus* in Brazil. *Oryx*, 56(6), 939–946. <https://doi.org/10.1017/S003060532100079X>
- Galves, J., Guy-Galves, C., Auil-Gomez, N., Bonde, R. K., Powell, J., Alvarez-Alemán, A., & Castelblanco-Martínez, N. (2022). Analysis of a long-term dataset of Antillean manatee strandings in Belize: implications for conservation. *Oryx*, 1–9. <https://doi.org/10.1017/S0030605321000983>
- Garcés-Cuartas, N., Niño-Torres, C. A., & Castelblanco-Martínez, D. N. (2020). Vibrissae growth rate of captive Antillean manatees (*Trichechus manatus manatus* Linnaeus, 1758). *Marine Mammal Science*, 36(1), 344–353. <https://doi.org/10.1111/mms.12638>
- Gonzalez-Socoloske, D., & Olivera-Gómez, L. D. (2012). Gentle giants in dark waters: using side-scan sonar for manatee research. *The Open Remote Sensing Journal*, 5, 1–14. <https://doi.org/10.2174/1875413901205010001>
- Gonzalez-Socoloske, D., Olivera-Gómez, L. D., & Ford, R. E. (2009). Detection of free-ranging West Indian manatees *Trichechus manatus* using side-scan sonar. *Endangered Species Research*, 8(3), 249–257. <https://doi.org/10.3354/esr00232>
- Gonzalez-Socoloske, D., Taylor, C. A., & Rendon, O. R. (2011). Distribution and conservation status of the Antillean manatee (*Trichechus manatus manatus*) in Honduras. *Latin American Journal of Aquatic Mammals*, 9(2), 123–131. <https://doi.org/10.5597/lajam00176>
- Gonzalez-Socoloske, D., Olivera-Gómez, L. D., Reid, J. P., Espinoza-Marin, C., Ruiz, K. E., & Glander, K. E. (2015). First successful capture and satellite tracking of a West Indian manatee (*Trichechus manatus*) in Panama: feasibility of capture and telemetry techniques. *Latin American Journal of Aquatic Mammals*, 10(1), 52–57. <https://doi.org/10.5597/lajam00194>
- Good, T. P., Beechie, T. J., McElhany, P., McClure, M. M., & Ruckelshaus, M. H. (2007). Recovery planning for Endangered Species Act-listed Pacific salmon: Using science to inform goals and strategies. *Fisheries*, 32(9), 426–440. [https://doi.org/10.1577/1548-8446\(2007\)32\[426:rfpes\]2.0.co;2](https://doi.org/10.1577/1548-8446(2007)32[426:rfpes]2.0.co;2)
- Guzman, H. M., & Condit, R. (2017). Abundance of manatees in Panama estimated from side-scan sonar. *Wildlife Society Bulletin*, 41(3), 556–565. <https://doi.org/10.1002/wsb.793>
- Hénaut, Y., Lara-Sánchez, L. E., Morales-Vela, B., & Machkour-M'Rabet, S. (2020). Learning capacities and welfare in an Antillean manatee, *Trichechus manatus manatus*. *Comptes Rendus - Biologies*, 343(1), 73–87. <https://doi.org/10.5802/crbiol.6>
- Hermes-Lima, M., Santos, N. C. F., Alencastro, A. C. R., & Ferreira, S. T. (2007). Whither Latin America? Trends and challenges of science in Latin America. *IUBMB Life*, 59(4–5), 199–210. <https://doi.org/10.1080/15216540701258751>
- Holguin-Medina, V. E., Fontenele-Araujo, J., Alcaraz-Romero, V. M., Cortes, J. F., & Muñoz-Delgado, J. (2015). Circadian and ultradian activity rhythms in manatee (*Trichechus manatus manatus*) in captivity. *Biological Rhythm Research*, 46(5), 631–645. <https://doi.org/10.1080/09291016.2015.1046244>
- Jiménez-Pérez, I. (2002). Heavy poaching in prime habitat: the conservation status of the West Indian manatee in Nicaragua. *Oryx*, 36(3), 272–278. <https://doi.org/10.1017/S0030605302000492>
- Kikuchi, M., Akamatsu, T., Gonzalez-Socoloske, D., de Souza, D. A., Olivera-Gomez, L. D., & da Silva, V. M. F. (2014). Detection of manatee feeding events by animal-borne underwater sound recorders. *Journal of the Marine Biological Association of the United Kingdom*, 94(6), 1139–1146. <https://doi.org/10.1017/S0025315413001343>
- Kiszka, J. (2014). Bycatch assessment of the West Indian manatee (*Trichechus manatus*) and other megafauna in artisanal fisheries of the Caribbean. *Report to SPAW-RAC*, 41.
- Landeo-Yauri, S. S., Ramos, E. A., Castelblanco-Martínez, D. N., Niño-Torres, C. A., & Searle, L. (2020). Using small drones to photo-identify Antillean manatees: A novel method for monitoring an endangered marine mammal in the Caribbean Sea. *Endangered Species Research*, 41, 79–90. <https://doi.org/10.3354/ESR01007>
- Landeo-Yauri, S. S., Castelblanco-Martínez, D. N., Hénaut, Y., Arreola, M. R., & Ramos, E. A. (2022). Behavioural and physiological responses of captive Antillean manatees to small aerial drones. *Wildlife Research*, 49(1), 24–33. <https://doi.org/10.1071/WR20159>

- Lima, D. S., Vergara-Parente, J. E., Young, R. J., & Paszkiewicz, E. (2005). Training of Antillean manatee *Trichechus manatus manatus* Linnaeus, 1758 as a management technique for individual welfare. *Latin American Journal of Aquatic Mammals*, 4(1), 61–68. <https://doi.org/10.5597/lajam00071>
- McLarty, M. J., Gonzalez-Socoloske, D., Alvarez-Alemán, A., & Angulo-Valdés, J. (2020). Manatee habitat characterization using side-scan sonar. *Journal of the Marine Biological Association of the United Kingdom*, 100(1), 173–179. <https://doi.org/10.1017/S0025315419000973>
- McKillop, H. I. (1985). Prehistoric exploitation of the manatee in the Maya and circum-Caribbean areas. *World Archaeology*, 16(3), 337–353. <https://doi.org/10.1080/00438243.1985.9979939>
- Medeiros, I. D. S., Rebelo, V. A., dos Santos, S. S., Menezes, R., Almeida, N. V., Messias, L. T., do Nascimento J. L. X., Luna, F. O., Marmontel, M. & Borges, J. C. G. (2021). Spatiotemporal dynamics of mangrove forest and association with strandings of Antillean manatee (*Trichechus manatus*) calves in Paraíba, Brazil. *Journal of the Marine Biological Association of the United Kingdom*, 101(3), 503–510. <https://doi.org/10.1017/S002531542100045X>
- Merchan, F., Echevers, G., Poveda, H., Sanchez-Galan, J. E., & Guzman, H. M. (2019). Detection and identification of manatee individual vocalizations in Panamanian wetlands using spectrogram clustering. *Journal of the Acoustical Society of America*, 146(3), 1745–1757. <https://doi.org/10.1121/1.5126504>
- Mignucci-Giannoni, A. A., Montoya-Ospina, R. A., Jiménez-Marrero, N. M., Rodríguez-López, M. A., Williams Jr, E. H., & Bonde, R. K. (2000). Manatee mortality in Puerto Rico. *Environmental Management*, 25(2), 189–198. <https://doi.org/10.1007/s002679910015>
- Morales-Vela, B., Padilla-Saldivar, J. A., & Mignucci-Giannoni, A. A. (2003). Status of the manatee (*Trichechus manatus*) along the northern and western coasts of the Yucatan Peninsula, Mexico. *Caribbean Journal of Science*, 39(1), 42–49.
- Normande, I. C., Malhado, A. C. M., Reid, J., Viana, P. C., Savaget, P. V. S., Correia, R. A., Luna, F. O., & Ladle, R. J. (2016). Post-release monitoring of Antillean manatees: an assessment of the Brazilian rehabilitation and release programme. *Animal Conservation*, 19(3), 235–246. <https://doi.org/10.1111/acv.12236>
- Panyawai, J., & Prathep, A. (2022). A systematic review of the status, knowledge, and research gaps of dugong in Southeast Asia. *Aquatic Mammals*, 48(3), 203–222. <https://doi.org/10.1578/AM.48.3.2022.203>
- Pires, J. M. L., Moreira, A. B., & Rocha, A. (2016). Parasitological research in urine from marine manatees (*Trichechus manatus manatus*) maintained in captivity in Brazil. *Scientific Electronic Archives*, 9(1), 47–52. <https://doi.org/10.36560/942016341>
- Quintana-Rizzo, E., & Reynolds III, J. (2010). *Regional management plan for the West Indian manatee* (*Trichechus manatus*). Kingston: UNEP Caribbean Environment Programme.
- Ramírez-Jiménez, H. H., Olivera-Gómez, L. D., & De La Cueva, H. (2017). Habitat use by the Antillean manatee (*Trichechus manatus*) during an extreme dry season in an urban lake in Tabasco, Mexico. *Therya*, 8(1), 19–26. <https://doi.org/10.12933/therya-17-411>
- Ramos, E. A., Maloney, B., Magnasco, M. O., & Reiss, D. (2018). Bottlenose dolphins and Antillean manatees respond to small multi-rotor unmanned aerial systems. *Frontiers in Marine Science*, 5, 316. <https://doi.org/10.3389/fmars.2018.00316>
- Ramos, E. A., Maust-Mohl, M., Collom, K. A., Brady, B., Gerstein, E. R., Magnasco, M. O., & Reiss, D. (2020). The Antillean manatee produces broadband vocalizations with ultrasonic frequencies. *Journal of the Acoustical Society of America*, 147(2), EL80–EL86. <https://doi.org/10.1121/10.0000602>
- Ramos, E. A., Landeo-Yauri, S., Castelblanco-Martínez, N., Arreola, M. R., Quade, A. H., & Rieucan, G. (2022). Drone-based photogrammetry assessments of body size and body condition of Antillean manatees. *Mammalian Biology*, 1–15. <https://doi.org/10.1007/s42991-022-00228-4>
- Reynolds III, J. E., Powell, J. A., Keith Diagne, L. W., Barton, S. L., & Scolardi, K. M. (2018). Manatees: *Trichechus manatus*, *T. senegalensis*, and *T. inunguis*. In B. Würsig, J. G. M. Thewissen, & K. M. Kovacs (Eds.), *Encyclopedia of Marine Mammals* (pp. 558–566). Academic Press. <https://doi.org/10.1016/b978-0-12-804327-1.00165-5>
- Rivera-Chavarría, M., Castro, J., & Camacho, A. (2015). The relationship between acoustic habitat, hearing and tonal vocalizations in the Antillean manatee (*Trichechus manatus manatus*, Linnaeus, 1758). *Biology Open*, 4(10), 1237–1242. <https://doi.org/10.1242/bio.013631>
- Romero-Calderón, A. G., Morales-Vela, B., Rosiles-Martínez, R., Olivera-Gómez, L. D., & Delgado-Estrella. (2016). Metals in bone tissue of Antillean manatees from the Gulf of Mexico and Chetumal Bay, Mexico. *Springer*, 96(1), 9–14. <https://doi.org/10.1007/s00128-015-1674-6>
- Siegel-Willott, J. L., 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 Zoo and Wildlife Medicine*, 37(4), 447–453. <https://doi.org/10.1638/05-086.1>
- Silva, F. M. O., Vergara-Parente, J. E., Gomes, J. K. N., Teixeira, M. N., Attademo, F. L. N., & Silva, J. C. R. (2009). Blood chemistry of Antillean manatees (*Trichechus manatus manatus*): Age variations. *Aquatic Mammals*, 35(2), 253–258. <https://doi.org/10.1578/AM.35.2.2009.253>
- Sousa-Lima, R. S., Paglia, A. P., & da Fonseca, G. A. B. (2008). Gender, age, and identity in the isolation calls of Antillean manatees (*Trichechus manatus manatus*). *Aquatic Mammals*, 34(1), 109–122. <https://doi.org/10.1578/AM.34.1.2008.109>
- Takeuchi, N. Y., Walsh, M. T., Bonde, R. K., Powell, J. A., Bass, D. A., Gaspard, J. C., & Barber, D. S. (2016). Baseline reference range for trace metal concentrations in whole blood of wild and managed West Indian manatees (*Trichechus manatus*) in Florida and Belize. *Aquatic Mammals*, 42(4), 440–453. <https://doi.org/10.1578/AM.42.4.2016.440>
- Umeed, R., Niemeyer Attademo, F. L., & Bezerra, B. (2018). The influence of age and sex on the vocal repertoire of the Antillean manatee (*Trichechus manatus manatus*) and their responses to call playback. *Marine Mammal Science*, 34(3), 577–594. <https://doi.org/10.1111/mms.12467>
- Vanoye, F. F. L. (2002). *Constantes hemáticas para crías de manatí* (*Trichechus manatus manatus*) *de hasta dos años de edad en cautiverio* [BSc. thesis, Universidad Veracruzana. Veracruz, México].

Supplementary material

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

