MANATEE WATCHING IS WIDESPREAD AND SEASONALLY AFFECTED IN NORTHEAST BRAZIL: A CASE OF THE ENDANGERED *TRICHECHUS MANATUS MANATUS* (SIRENIA: TRICHECHIDAE)

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Marine mammal watching is a non-consumptive wildlife-oriented tourism practice. *Trichechus manatus manatus* (hereinafter – **Antillean manatee**) belongs to the charismatic marine megafauna and is subject to this practice at many places. Here we investigated the Antillean manatee watching in Brazil, focusing on mapping this activity across the country, identifying hotspot areas, analysing the potential seasonality of this practice, and assessing the interactions between people and Antillean manatees. We used a social network as data source since this species often appears on social media. The species is charismatic and have characteristics, which attract public affection such as large body size, gentle behaviour, and distinct physical appearance. We detected Antillean manatee watching in 91 localities distributed across 19 municipalities and nine states in northern and north-eastern Brazil. We considered six localities as Antillean manatee watching hotspots because of their high number of associated images. Five of the hotspots were located within three Protected Areas for sustainable use. We found up to 23 people depicted in a single manatee-related picture posted on social network, but up to five people appeared in most posts (photos and videos). Furthermore, images were significantly posted mostly during the summer months, indicating seasonality in Antillean manatee watching. We classified the manatee-watching interactions collected as either prohibited or permitted by the Brazilian law. Permitted interactions were significantly more frequent, but the occurrence of prohibited interactions reveals the current lack of compliance with Brazilian regulations. We suggest that tourism management strategies prioritise Antillean manatee watching hotspot areas, focusing on reinforcing compliance with local regulations and preferably involving local residents to ensure the sustainability of this practice in Brazil.

Key words: ecotourism, human-wildlife interaction, sirenians, tourism sustainability, travel behaviour, wildlife

Introduction

Non-consumptive wildlife-oriented recreation is defined as a human recreational activity focusing on interacting with nature and wildlife, wherein the focal organisms are not purposefully removed or have their well-being affected by the engagement (Duffus & Dearden, 1990; Bejder et al., 2022). If conducted properly and in a sustainable non-invasive manner, such tourism practices can provide economic benefits to local communities (O'Connor et al., 2009; Hunt et al., 2015; Zimmerhackel et al., 2019; Dembovska & Zvaigzne, 2021), promote habitat conservation (Thurstan et al., 2012; Hunt et al., 2015; Stronza et al., 2019), and wildlife protection (Tisdell & Wilson, 2005; Ballantyne et al., 2011; Lin & Kuo, 2016; Fumagalli et al., 2021).

Wildlife watching is nowadays intrinsically linked to taking photographs and/or videos with the option of posting them on social media. Photographs and videos that have been posted on social media platforms have been widely explored to trace practices and interactions related to various species. The combination of smartphone availability, built in

Global Positioning Systems (GPS), high-resolution cameras, and internet connectivity, with social media usage, has introduced a new range of data to be explored, spontaneously generated by social media (Hamme et al., 2021; Kroetz et al., 2021). Social media have also created an opportunity to collect data on human-nature interactions on both spatial and temporal scales (Dickison et al., 2012; Toivonen et al., 2019; Papafitsoros et al., 2021; Cheung et al., 2022), allowing the collection of large volumes of location-based ecological data (Dickison et al., 2012). For example, social media data, such as data extracted from Instagram, have answered questions regarding wildlife trade (Di Minin et al., 2019; Wyatt et al., 2022), wildlife distribution, monitoring of rare and data deficient populations (Jeawak et al., 2018; Sullivan et al., 2019; Cranswick et al., 2022), visitation patterns in conservation areas (Tenkanen et al., 2017), tourist preferences (Hausmann et al., 2018; Kroetz et al., 2021), and tourist sentiments and perceptions of the environment (Becken et al., 2017; Kroetz et al., 2021; Palazzo et al., 2021; Šmelhausová et al., 2022), in addition to visitor pressure on wildlife

welfare (Sullivan et al., 2019; Papafitsoros et al., 2021, 2023; Hamme et al., 2021).

The rapid uncoordinated growth of tourist practices involving marine mammals can cause short-term or immediate effects (Cecchetti et al., 2018; Machernis et al., 2018). For instance, animals may demonstrate behavioural changes in response to approaching boats, such as changing orientation, depth and fluking behaviour (Rycyk et al., 2018), increasing swimming speed (Nowacek et al., 2004), performing fewer surface, social, resting and forage-feeding behaviours (Marega-Imamura et al., 2018), and changing respiration rates (Christiansen et al., 2014; Fiori et al., 2019). Short-term behavioural responses can lead to long-term biological consequences for individuals and populations, such as habitat abandonment, reduced reproductive success, a decrease in growth rate, and, consequently, population decline (Bejder et al., 2006; Lusseau & Bejder, 2007; Higham et al., 2008; Mortensen et al., 2021).

In Brazil, *Trichechus manatus manatus* Linnaeus, 1758 (hereinafter – Antillean manatee; Fig. 1) is targeted by animal-watching tourism practices (Izidoro & Shiavetti, 2022). Such practices are often related to community-based tourism (Braga & Selva, 2016; Lepre, 2018). The Brazilian federal government regulates Antillean manatee watching through Conservation Action Plans and local legislation (ICMBio, 2013, 2018a,b, 2021; Luna et al., 2022). Such regulations focus on determining the organisations that can practice Antillean manatee watching, the type of vessels allowed, the carrying capacity of the vessels, the minimum distance from the animals, and the duration of the observation time. But there is limited information about where this practice occurs and the pressure it may put on the animals. The Antillean manatee has a disjointed distribution throughout northern and north-eastern Brazil, extending from Amapá to Alagoas states (Luna et al., 2008; Lima et al., 2011; Alves et al., 2016; Favero et al., 2020), where warm waters and rich biodiversity often attract tourists from around the world. *Trichechus manatus* Linnaeus, 1758 is globally classified as Vulnerable by the IUCN (Deutsch et al., 2008). Its subspecies, *Trichechus manatus manatus*, is classified as Endangered on the Brazilian list of threatened species and on the IUCN Red List (Self-Sullivan & Mignucci-Giannoni, 2008; MMA, 2022). Thus, any practice related to this subspecies should be well-tracked and regulated to guarantee its long-term survival in the wild.

Fig. 1. Male Antillean manatee (*Trichechus manatus manatus*) at a soft-release (acclimatisation) facility situated in the mangrove area of the River Tatuamunha in the Costa dos Corais Protected Area, Porto de Pedras municipality, Alagoas state, Brazil (Author: Paula D. F. Coutinho).

In the present study, we aimed to assess Antillean manatee watching in Brazil, focusing on: 1) mapping the areas where it occurs in Brazil; 2) comparing the incidence of Antillean manatee watching per municipality and state; 3) identifying potential hotspot areas; 4) investigating the temporal and seasonal patterns of this activity; and 5) investigating manatee-watching interactions to assess how Antillean manatee watching may impact Antillean manatee behaviour. We used a social media platform to obtain such information. We expected to find Antillean manatee watching hotspots (estimated by a high number of Instagram posts) in Alagoas and Paraíba states, where Antillean manatee watching and the presence of native and reintroduced Antillean manatees have been previously reported in Brazil (e.g. Luna et al., 2008; Lima et al., 2011; Alves et al., 2016; Favero et al., 2020; Izidoro & Shiavetti, 2022; Santos et al., 2022). We also expected Antillean manatee watch-

ing to be more frequent during the summer, when the temperature is higher, and the water turbidity is lower in north-eastern Brazil (Garcia, 2017; Favero et al., 2020), thereby attracting more tourists. Furthermore, considering that Antillean manatees are relatively calm and curious animals (Gomes et al., 2008; Charles et al., 2022; Ponnampalam et al., 2022), we expected a wide range of spontaneous close contact manatee-watching interactions to be depicted on the Instagram social media platform, as previously observed for other marine mega-fauna, such as seals (Sullivan et al., 2019) or sea turtles (Leitão et al., 2022).

Material and Methods
Ethical note

No specific licence is required for the data mining of publicly available social media data. We gathered data by inspecting publicly available images (photos and videos) on the Instagram platform. We followed the terms and conditions of the platform to protect their users' identity. We concealed the identity of the users that posted the inspected images in our study and only considered the relevant information to avoid image duplication during data compilation.

Data collection

We obtained data from publicly available photos and videos posted on the Instagram platform (Meta, California, USA) from October 2010 to August 2022. We chose the platform because of its growing use for obtaining wildlife data for several purposes (e.g. Sullivan et al., 2019; Hamme et al., 2021; Papafitsoros et al., 2021; Barros et al., 2022; Leitão et al., 2022). We used the hashtag search tool, where a word or phrase is preceded by the hash sign (#) to identify specific topics. We used the hashtag tool combined with the Geotag tool to facilitate data mining, which has previously allowed scientists to search and filter for posts specific to a species or region (e.g. Sullivan et al., 2019; Papafitsoros et al., 2021, 2023; Palazzo et al., 2021; Leitão et al., 2022). We then used the website https://snapinsta.app/pt to download the available images depicting Antillean manatees and Antillean manatee watching to create our image bank for the detailed analysis and extraction of our data.

Data processing

From each image (photos and videos), we compiled information on the Instagram user pro-file, image inspection date, the original date of the post, locality, municipality, state (the latter three were obtained from geotags and post caption information), Antillean manatee presence and absence, number of Antillean manatees and number of people. We also compiled data on Antillean manatee behaviour and the interactions between humans and Antillean manatees. We followed the data mining methodology of Leitão et al. (2022), adapted to our target species (Fig. 2).

We classified manatee-watching interactions as «Prohibited» and «Permitted» according to the current Brazilian legislation. Prohibited interactions included when a person was in the water with a Antillean manatee but not fully submerged, swam underwater with an Antillean manatee (when the person's body was fully submerged), collected underwater footage and/or underwater photos, touched an Antillean manatee, chased an Antillean manatee, tried to attract an Antillean manatee, posed for a photo with an Antillean manatee, kissed an Antillean manatee, or provided water and/or food to an Antillean manatee (for complete regulation, see Federal Law №9.605/1988 and Decree №6.514/2008, article 30; https://www.planalto.gov.br/ccivil_03/_ato2007-2010/2008/decreto/d6514.htm). Permitted interactions included behaviours such as when a person approached and retreated from the Antillean manatee without direct physical contact and when the person passively observed an Antillean manatee from land or boat. Such interactions are not prohibited by the Brazilian law.

Mapping the distribution of Antillean manatee watching

To construct the map of Antillean manatee watching locations in Brazil, we used ArcGIS 10.4 (ESRI, Redlands, USA). We plotted the municipalities and specific localities whenever available (i.e. the name of the beach where an Antillean manatee was observed) that were geotagged or specified in the captions of the Instagram posts depicting Antillean manatees. To obtain the municipalities' central locations (geographic co-ordinates), we considered the IBGE 2021 municipality data (IBGE, 2021). To obtain specific localities (e.g. beaches, river mouths), we used Google Earth to extract the geographic co-ordinates of the location. Finally, we assigned the number of posts depicting Antillean manatees and Antillean manatee watching for each location.
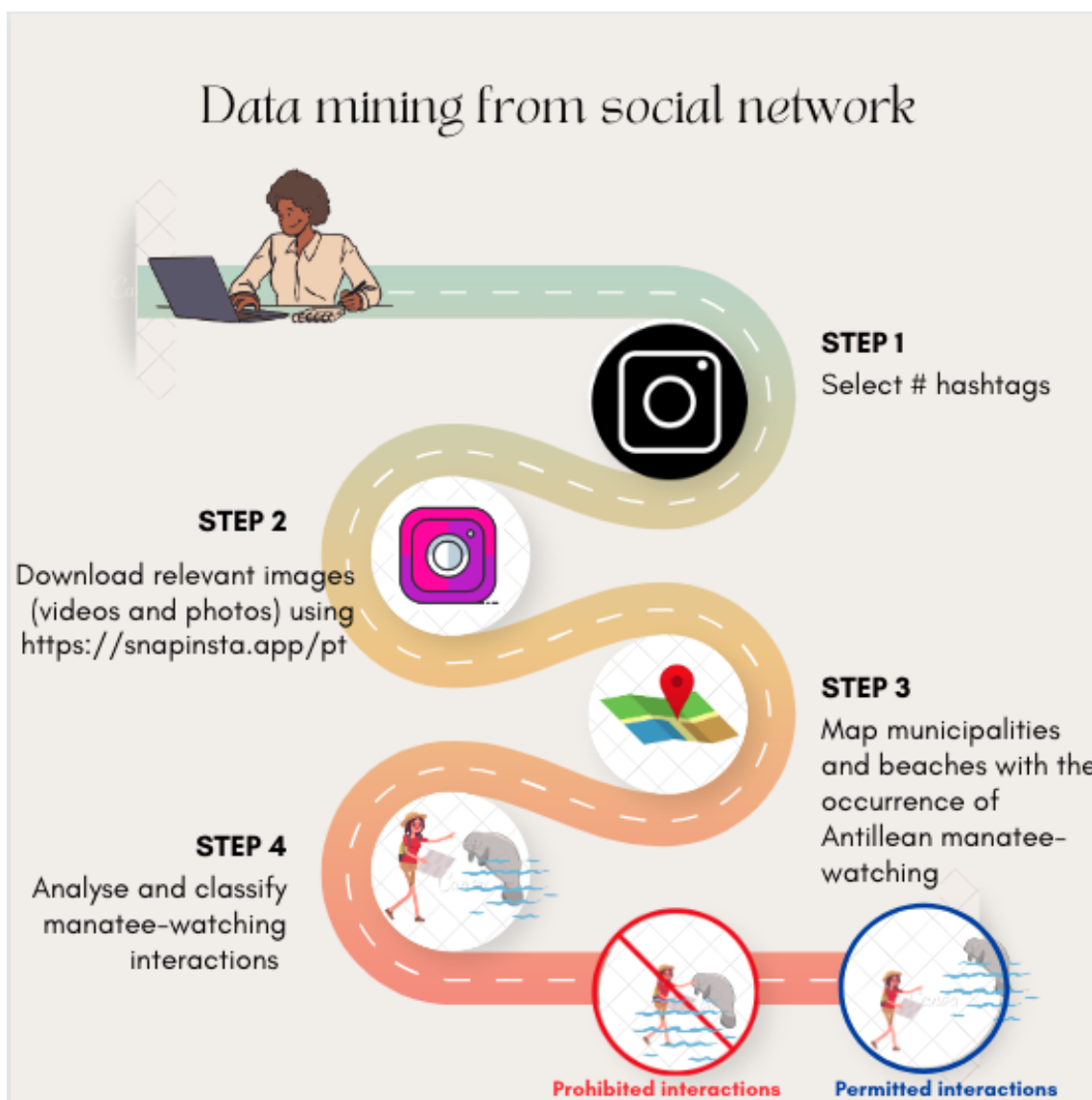
Fig. 2. Data mining method used to obtain data on the distribution of Antillean manatee (*Trichechus manatus manatus*) watching and the manatee-watching interactions from October 2010 to August 2022.

Behavioural data collection

We obtained human and Antillean manatee behavioural data from the video posts on Instagram. We considered the all-occurrence method (Altmann, 1974) when extracting behavioural data from the videos. We scored the behaviours in these videos using Datavyu 1.5.3 software (Datavyu Team, 2014). Furthermore, we considered additional data from photo posts to complement information from the list of manatee-watching interactions and to compare the incidence of prohibited and permitted interactions.

Data analysis

Considering that the number of posts reflects the popularity of places on Instagram (e.g. Shuqair & Cragg, 2017; Kroetz et al., 2021; Asdecker, 2022), we used the number of Instagram posts depicting Antillean manatees in the area to determine Antillean manatee watching hotspots. Areas with over 25 posts were considered hotspots. We used a Chi-Square test to investigate whether the incidence of Antillean manatee watching (estimated from the frequency of Instagram posts depicting Antillean manatees) was evenly distributed across the municipalities and states where this practice occurs in Brazil, accessing the significance of differences among independent categories. We conducted the Kruskal-Wallis test to compare the incidence of Instagram posts depicting Antillean manatee watching between years since this test is indicated to test for differences among three or more independent samples. We excluded the years 2010, 2011, 2012 and 2022 from the comparison between years because there were no complete data for the years 2010 and 2022 (since the Instagram platform was launched in October 2010, and we concluded our data mining in August 2022), and there were no Antillean manatee watching-related images for the years 2011 and 2012 (see result

section). We kept the COVID-19 lockdown period because we expected a variation due to the pandemic restrictions (Vărzaru et al., 2021) and wanted to confirm this variation through the Instagram platform. We conducted the Mann-Whitney U-test, comparing two independent groups, to verify whether Antillean manatee watching was more frequent in the summer months compared to other months to investigate whether this practice was seasonally oriented or not. We considered December, January, February and March as the summer months in the north-eastern and northern coastal areas of Brazil (CPTEC/INPE, 2022), where Antillean manatees are known to occur. We conducted the Chi-square test to identify whether the number of people depicted in Antillean manatee-related Instagram posts varied per post, i.e. to test if the categories of number of people varied per post. We used the Chi-square test with Yates correction due to the small degree of freedom, to test whether the number of posts depicting prohibited interactions and permitted interactions was evenly distributed in these two categories of manatee-watching interactions. The Kruskal-Wallis and Mann-Whitney U test were performed using GraphPad Prism 9 software (https://www.graphpad.com/company). The Chi-Square test was conducted using Microsoft Excel 365 software. Significance was attained at $p < 0.05$.

Results
Antillean manatee watching hotspots in Brazil
We obtained 1819 images using 21 hashtags (1374 photos and 445 videos). From these images, Antillean manatee watching was registered on 91 locali-ties (including indigenous villages, islands, beaches, mangroves, and river mouths), distributed across 19 municipalities (Fig. 3) and nine states in northern and north-eastern Brazil (Electronic Supplement 1, Electronic Supplement 2). Six of the 91 localities presented more than 25 Instagram posts depicting Antillean manatees. Therefore, we considered these areas as Antillean manatee watching hotspots. Five of the hotspots are included in three Protected Areas, namely Costas dos Corais Environmental Protected Area, Alagoas State (N = 2), Barra de Mamanguape Environmental Protected Area, Paraíba State (N = 2), and Delta do Parnaíba Environmental Protected Area, Piauí State (N = 1). These Protected Areas permit the sustainable use of resources. The number of Instagram posts depicting Antillean manatees was not evenly distributed across the different Brazilian States ($\chi^2 = 658.8$, df = 8, $p < 0.001$) and municipalities ($\chi^2 = 83$, df = 18, $p < 0.001$).

Temporal evaluation of Antillean manatee watching
We only found Instagram posts depicting Antillean manatee watching from April 2013 to August 2022 (the month we ended data collection). There were no such Instagram posts in 2010, 2011, and 2012. Instagram posts depicting Antillean manatee watching varied between years (Kruskal Wallis, H(8): 66.56, $p < 0.001$), increasing from 2013 to 2021 (Fig. 4, Fig. 5). There was a slight decrease in Instagram posts in 2020, i.e. at the first year of the COVID-19 pandemic in Brazil. Furthermore, since our analysis only included data up to August 2022, the number of posts for this year was slightly lower than for the previous five years (Fig. 4).
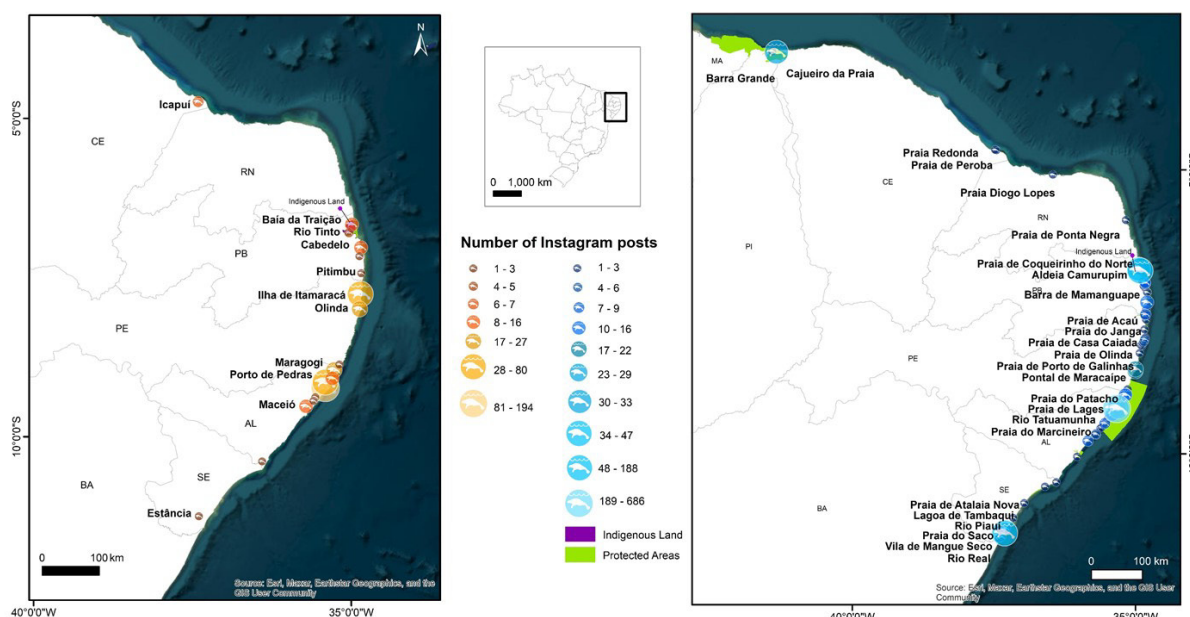

Fig. 3. Municipalities (on the left) and specific localities (i.e. beaches, mangroves, rivers, and estuaries) (on the right), where Antillean manatee (*Trichechus manatus manatus*) watching was detected in social network posts from October 2010 to August 2022.

Most Instagram posts depicting Antillean manatees were detected in January (234), March (233), and November (200). We found a significant difference in the incidence of Antillean manatee watching when comparing the average number of Instagram posts between the summer months (December, January, February and March) and the other months of the year (Mann Whitney U test, $N_1 = 4$, $N_2 = 8$, $U = 2$ $p = 0.017$) (Fig. 5).

Manatee-watching interactions

From the 1819 images collected, Antillean manatees were present in 1222 and absent in 597 ones. People were present in 1791 images and absent in 28. Of the 1791 images with people, 1353 were photos and 438 were videos. In 606 photos, we could not assess the number of people because they were outside the photo's frame. However, in the remaining photos, the number of people ranged from one to twenty-three per photo. In 259 videos, we could not assess the number of people because they were outside the video frame. In the remaining videos, the total number of people per video ranged from one to twenty. However, there were only up to five people (total number) in most of the images (photos and videos) ($\chi^2 = 420.7$, df = 2, p < 0.001; Fig. 6).

We found 1206 images featuring people and Antillean manatees simultaneously including 399 videos and 807 photos. From these images, it was possible to detect 29 types of Antillean manatee-watching interactions. People initiated 16 types of interactions, which we classified into three categories (Table 1). Antillean manatees initiated 13 types of interactions, which we also classified into three categories (Table 2).

From the inspection of 399 videos (people and Antillean manatees present at the same time), we observed a higher number of permitted (N = 268) than prohibited interactions (N = 178) ($\chi^2 = 9.1$, df = 1, p < 0.01). When inspecting all 807 photos (people and Antillean manatees present at the same time), we observed the same pattern, where most of the images depicted permitted interactions (N = 602) compared to prohibited interactions (N = 298), $\chi^2 = 51.3$, df = 1, p < 0.001.

Antillean manatee behaviours when not depicted in direct contact with people

When there was no direct contact with people (i.e. no physical interaction between Antillean manatees and people or their objects), it was possible to detect 16 behaviour types performed by the Antillean manatees (Table 3).
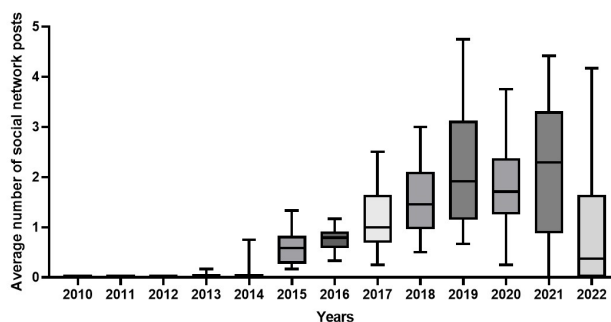

Fig. 4. Average number of social network posts (bars indicate the standard errors) related to Antillean manatee (*Trichechus manatus manatus*) watching per year in Brazil from 2010 to 2022.
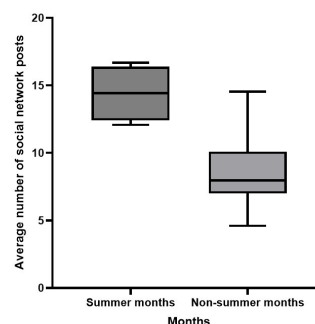

Fig. 5. Distribution of social network posts related to Antillean manatee (*Trichechus manatus manatus*) watching in Brazil between 2013 and 2022 during summer months (i.e. December, January, February, and March) and non-summer months (i.e. April to November) in northern and north-eastern Brazil (mean and standard error).
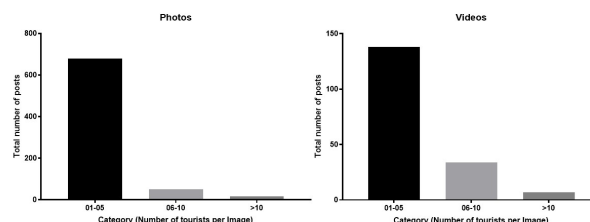

Fig. 6. Social network posts and the number of people depicted in the images from April 2013 to August 2022. Designations: A – the number of social network photos depicting Antillean manatee-watching interactions; B – the number of social network videos depicting Antillean manatee-watching interactions.

Discussion

The images obtained through Instagram posts evidenced Antillean manatee watching practices in the north-eastern region of Brazil, in the states of Alagoas, Paraíba, Pernambuco, Piauí, and Sergipe. The municipalities and localities obtained from Instagram posts matched previously recorded Antillean manatee distributions (Luna et al., 2008; Lima et al., 2011; Alves et al., 2016; Favero et al., 2020). An aerial survey of Antillean manatees from Piauí to Alagoas states revealed that the state of Piauí supported

the highest Antillean manatee population density (Alves et al., 2016). This survey also revealed a discontinuity in Antillean manatee sightings in the states of Pernambuco, Rio Grande do Norte, and Ceará. Land-based and boat surveys in Piauí state revealed that **Antillean manatee distribution** is intrinsically related to the availability of natural resources, e.g. fresh water and food (Favero et al., 2020). Santos et al. (2022) monitored the home ranges of Antillean manatees, which were reintroduced in the states of Alagoas and Paraíba, and found that Astro, an **Antillean manatee** released in Alagoas state, was the only individual, which used the areas of the states of Sergipe and Bahia. Astro's home range comprised the River Vaza Barris and the estuarine complex of the Piauí/Fundo/Real Rivers. This could explain the Instagram posts depicting Antillean manatees in Sergipe and Bahia states, despite the lack of known native individuals.

Table 1. Categorisation and description of Antillean manatee-watching interactions initiated by people, collected from social network posts from April 2013 to August 2022

Behavioural category	Prohibited?	Behaviour (n)	Description
Passive observation	No	Observe from land (video = 41, photo = 50)	The person passively observes the Antillean manatee from the land
	No	Observe from the motorboat (video = 32, photo = 37)	The person passively observes the Antillean manatee from a small motorboat
	No	Observe from a non-motorised boat (video = 184, photo = 165)	The person passively observes the Antillean manatee from a raft, a kayak or a stand-up board
	No	Approach (video = 4, photo = 0)	The person moves towards the Antillean manatee
	No	Retreat (video = 1, photo = 0)	The person moves in the opposite direction of the Antillean manatee
Active interaction with manatee	Yes	In the water with manatee (video = 54, photo = 128)	The person approaches the Antillean manatee and gets into the water with the animal but does not dive
	Yes	Swim with manatee (video = 22, photo = 36)	The person swims with the Antillean manatee, i.e. their entire body is in the water with the animal
	Yes	Underwater footage (video = 5, photo = 0)	The person puts the camera into the water or is diving with an Antillean manatee and records underwater footage
	Yes	Underwater photo (video = 0, photo = 9)	The person puts the camera into the water or is diving with an Antillean manatee and takes underwater photos
	Yes	Touch the manatee (video = 73, photo = 87)	The person touches and rubs the Antillean manatee gently
	Yes	Chase (video = 6, photo = 0)	The person actively swims or moves towards the Antillean manatee that is swimming away
	Yes	Try to attract the manatee (video = 5, photo = 0)	The person puts their hand or an object into the water and splashes the water, trying to attract the Antillean manatee
	Yes	Posing (video = 2, photo = 18)	The person positions themselves so that the manatee is visible in the image background. The person does not touch the Antillean manatee
	Yes	Kiss (video = 1, photo = 1)	The person stays in the water with the manatee and kisses the Antillean manatee
Nutrition	Yes	Feed (video = 3, photo = 2)	The person actively attempts to/or feeds the Antillean manatee
	Yes	Provide water (video = 5, photo = 8)	The person actively attempts to/or provides water to the Antillean manatee

Table 2. Categorisation and description of the Antillean manatee-watching interactions initiated by the Antillean manatees, collected from social network posts from April 2013 to August 2022

Behavioural category	Behaviour (n)	Description
Boat interaction	Approach boat (video = 69, photo = 0)	The animal swims towards boat
	Retreat from boat (video = 2, photo = 0)	The animal swims in the opposite direction of the boat
	Circle the boat (video = 6, photo = 0)	The animal swims around the boat
	Flipper (forelimb) on the boat (video = 8, photo = 0)	The animal uses its flipper (forelimb) to touch the boat
	Snout on the boat (video = 20, photo = 14)	The animal uses its snout to touch the boat
	Hug the boat (video = 84, photo = 86)	The animal uses both flippers (forelimbs) to hold the boat
	Exposure of the penis on the boat (video = 1, photo = 0)	The animal exposes its penis and makes copulatory movements on the boat
	Swim under the boat (video = 1, photo = 0)	The animal swims under the boat
	Chase the boat (video = 4, photo = 0)	The animal actively swims after the boat
Observer interaction	Approach observer (video = 9, photo = 0)	The animal swims towards the person
	Observer contact (video = 46, photo = 110)	The animal is in direct physical contact with the observer
	Retreat observer (video = 1, photo = 0)	The animal swims in the opposite direction to the person
Object interaction	Interaction with an underwater camera (video = 2, photo = 11)	The animal approaches and touches the person's underwater camera

Table 3. Antillean manatee behaviours in the absence of direct physical interaction with people collected from social network posts from April 2013 to August 2022

Behaviour (n)	Description
Surface swim (vídeo = 78, photo = 40)	The animal swims slowly at the surface
Water column swim (video = 38, photo = 0)	The animal swims slowly in the water column
Shallow swim (video = 20, photo = 15)	The animal swims slowly in shallow water
Spinning swim (video = 2, photo = 0)	The animal pivots in the water by using its flippers
Inverted swim (video = 2, photo = 1)	The animal turns upside down and swims
Surface rest (video = 10, photo = 3)	The animal remains with its eyes closed, positioned at the surface of the water, performing breathing movements
Inverted rest (video = 0, photo = 9)	The animal stays with its ventral region facing upwards, keeping its body positioned on the surface of the water or the substrate, with its eyes closed, performing breathing movements
Shallow rest (video = 5, photo = 11)	The animal is in shallow waters and maintains its eyes closed, positioned at the surface of the water, performing breathing movements
Walk to the bottom (video = 8, photo = 0)	The animal uses both flippers to pull itself through the substrate as if walking using its upper limbs
Float (video = 1, photo = 0)	The animal maintains its eyes closed, positioned in the water column, performing only unconscious breathing movements
Dive (video = 2, photo = 0)	The animal swims in deeper waters
Surface feed (video = 30, photo = 1)	The animal eats at the surface, including foraging (searching for food) and grazing (consumption) behaviours
Touch another Antillean manatee (video = 8, photo = 2)	The animal uses its snout to have direct physical contact with another Antillean manatee
Embrace another Antillean manatee (video = 0, photo = 3)	The animal uses both flippers (forelimbs) to embrace another Antillean manatee
Embrace semi-captive (vídeo = 3, photo = 1)	The animal uses both flippers (forelimbs) to embrace the semi-captive Antillean manatee reintroduction structure
Copulation attempt (video = 4, photo = 1)	The animal tries to attach its body to another individual, but there is no penetration

Of the 91 localities mapped in our study, six could be considered potential Antillean manatee watching hotspots, based on the high number of Instagram posts. The incidence of social media posts in a region can often indicate its touristic popularity (Orsi & Geneletti, 2013; Hausmann et al., 2018; Kim et al., 2021). For instance, areas used for recreational bluefish angling have been identified from videos posted on the YouTube platform (Eryaşar & Saygu, 2022). Such hotspot areas may be important for local economies. Antillean manatees are charismatic animals, and its native and reintroduced individuals seem to attract visitors to natural areas and, thus, may contribute to the development of local community economies, if tourism is performed responsibly and sustainably (Stronza & Pêgas, 2008; Lebrão et al., 2021; Ventura et al., 2022). This pattern of animal-watching associated with the development of local community economies has been observed for other species, such as primates at the Mamirauá Sustainable Development Reserve in Brazilian Amazon (Lebrão et al., 2021), reintroduced *Castor fiber* Linnaeus, 1758 in the River Otter (Denver, England) (Auster et al., 2020), and sea turtles in the fishing village of Praia do Forte, Bahia state, Brazil (Pegas et al., 2013). Considering that five of the six hotspots for Antillean manatee watching were within Protected Areas of sustainable use, governments could formally consider Antillean man-

atee watching as one of the official non-consumptive wildlife-oriented recreations of the regions to attract tourists. Nevertheless, the practice should be supervised to guarantee its sustainability.

The hotspot municipalities and localities have varied tourism capacities, access difficulties and economic-related metrics (Electronic Supplement 3). For instance, Patacho Beach was indicated as a hotspot for Antillean manatee watching tourism in Alagoas state being located in Porto de Pedras municipality within the Costas dos Corais Environmental Protected Area. The estuary of the River Tatuamunha in Porto de Pedras municipality seems to be the only place in Alagoas state, where Antillean manatee watching is allowed, and it is considered community-based tourism (Lepre, 2018; Izidoro & Schiavetti, 2022). Locals take visitors to see Antillean manatees in rehabilitation enclosures using a raft steered by rowers (Braga & Selva, 2016). For the state of Pernambuco, Olinda municipality was considered a hotspot. This is a very surprising result since Olinda is a large city (population size: 393 734; Human Development Indices (2010): 0.735; population density (inhabitant/km^2) (2010): 9063.58; IBGE, 2021) and the beaches are not a main tourist attraction since they are highly polluted. Thus, we suspected that interactions with Antillean manatees were most likely performed by residents. In the Paraíba state, the indigenous villages of Camurupim and Barra de

Mamanguape are hotspots in the Mamanguape municipality within the Barra de Mamanguape Environmental Protected Area, where visitors need to use a dirt road to access these areas (Silvestre et al., 2011). Tourism in the area has increased in recent years, with local communities constructing accommodation and developing ecotourism, like Antillean manatee watching (Barbosa & Crispim, 2015; Temoteo et al., 2018). In Cajueiro da Praia municipality, which falls within the Delta do Parnaíba Environmental Protected Area (in Piauí state), the presence of the Projeto Peixe-Boi Marinho, under the responsibility of the Aquatic Mammals Centre and ICMBio, allowed for the development of Antillean manatee watching in this area. Fishermen perform this activity during boat trips (Perinotto et al., 2008; Carvalho, 2010).

From a temporal perspective, we observed an increase in posts depicting Antillean manatees and Antillean manatee watching over the years. This finding matches the increase of Instagram users each year (Statista, 2022), the growing popularity of Antillean manatee watching (Normande et al., 2015; Braga & Selva, 2016), increasing access to mobile phones, and the development of new mobile phone camera and internet coverage technologies (Blahnik & Schindelbeck, 2021; Techterms, 2021). Thus, it is unlikely that the increase in posts depicting Antillean manatees reflects an increase in Antillean manatee population size. As expected, we observed a higher average number of manatee-related Instagram posts during the summer months compared to the other months of the year, suggesting seasonality in Antillean manatee watching in Brazil. Climate is among the factors that strongly motivate and determine tourist flow and trends (Scott & Lemieux, 2010). Thus, it is worth pointing out the potential effects of climate change on Antillean manatee watching. Climate changes may result in extreme climate events, changes in rainfall patterns, biodiversity loss, sea-level rise, beach erosion, vector-borne diseases, and insect or water-born pests (UNWTO, 2016). Consequently, these changes may cause shifts in tourism flow in north-eastern Brazil since this area may be prone to some of these events. The seasonality of Antillean manatee watching may also be affected by the Antillean manatee reproductive season in north-eastern Brazil. This season (mating and birth season) starts in October and finishes in March in north-eastern Brazil (O'Shea et al., 2022). During this period, the Antillean manatees search for places with calm water, such as channels, lakes and rivers, to reproduce and give birth to their young ones (Hartman, 1979; O'Shea et al., 2022). During the

reproduction season, more attention must be given to possible encounters with females and their newborn calves. Although Antillean manatee strandings have been recorded during all months of the year, the highest frequency has been recorded during the summer (Balensiefer et al., 2017), matching the Antillean manatee reproductive season (O'Shea et al., 2022) and our findings of the highest frequencies of Antillean manatee watching-related Instagram posts.

Overcrowding is a consequence of tourism seasonality and can affect the target animals of this study. In most of the Instagram photo and video posts, we observed a small number of people per photo and video (i.e. 1–5 individuals). Nonetheless, these data can be underestimated as it is possible that there were more people out of the photo and video frames. The number of tourists strongly influences visitors' satisfaction, with regards to tourism practices, where tourists are less likely to return to a destination that experiences excessive levels of use (Avila-Foucat et al., 2013; Fernandes & Rossi-Santos, 2018; Dogru-Dastan, 2022; Nie et al., 2022). The number of tourists also influences marine mammal welfare and behaviour. For instance, *Trichechus manatus* ssp. *latirostris* (Harlan, 1824) spent less time nursing and bottom-resting and more time milling when the number of swimmers and boats increased (King & Heinen, 2004). Furthermore, *T. m.* ssp. *latirostris* use protected (no-entry) sanctuaries more often when the number of swimmers and boats increases (King & Heinen, 2004). Therefore, a higher number of tourists can lead to habitat abandonment (Christiansen et al., 2014; Fiori et al., 2019). Thus, understanding how the number of people impacts Antillean manatee behaviour, and determine the maximum number of people that could cause less effects on Antillean manatee behaviour for a specific time period, may help to establish guidelines for the sustainability of this practice in Brazil and could, therefore, be the subject of future studies.

We observed several interactions between Antillean manatees and people in Brazil. At least 11 interaction types could be classified as prohibited by the Brazilian law. Even though permitted interactions were more frequent, the fact that prohibited interactions were recorded in a considerable number of photos and videos is very alarming. We observed interactions where people were in the water with the animal and even kissed and provided food and water to the Antillean manatees. This proximity is known to be dangerous as it can be the source of several diseases (Orams, 2002; Borges et al., 2009; Glasser et al., 2021; Hamme et al., 2021; Melo et al., 2022),

changes in vocal and postural behaviours (Nowacek et al., 2004; Borges et al., 2007; Rycyk et al., 2018; Brady et al., 2020; Toro et al., 2021; Umeed et al., 2018, 2022) and unwanted habituation to humans (Bach & Burton, 2017; Hutschenreiter et al., 2022; Simmonds & Nunny, 2022). As such, we believe that social media data are a key to obtain information on spontaneous interactions between people and Antillean manatees, as previously observed for other marine mammals. For instance, Sullivan et al. (2019) found a significant discrepancy when comparing the level of human-seal major disturbances between social media data and traditional datasets, where disturbance was detected 20 times more frequently in Instagram posts. Thus, we also recommend the use of the Instagram platform as a source of data on spontaneous human-manatee interactions.

We registered behaviours that can be considered as habituation, such as approaching the boat, embracing the boat and putting a flipper (forelimb) on the boat (Sorice et al., 2003; Simmonds & Nunny, 2022). Such behaviours could also be a consequence of the role of tactile signals in Antillean manatees. Antillean manatee's tactile behaviours play an important role in environmental exploration, mother-calf cohesion, and self-maintenance (Lucchini et al., 2021, 2023). Understanding the effects of viewing pressure on individual animals within a population can help manage tourist practices and ensure that target individuals or groups are protected. Papafitsoros et al. (2021) used social media data to quantify whether tourism pressure varied in *Caretta caretta* (Linnaeus, 1758) population in Laganas Bay (Greece), a loggerhead sea turtle breeding area and a popular summer tourism destination. They found that even during the breeding season, resident turtles represented most of the social media entries, indicating that operators are targeting a specific area of the bay where these individuals are more likely to be found, representing a higher risk of trauma or mortality to these animals, as the authors observed through photo-identification of carapace damage.

Conclusions

Our study detected the occurrence of Antillean manatee watching in Brazil in 91 locations, six of which could be considered hotspots for this economically positive activity for local communities. We also detected several prohibited interactions between humans and Antillean manatees at these localities, revealing a lack of compliance with existing Brazilian regulations. The mapped locations, especially the hotspot areas, should be the target of environmental education campaigns and good-conduct

recycling courses for local guides to assure the long-term sustainability of Antillean manatee watching. We recommend that good-conduct recycling courses focus on human-animal proximity and the behaviour of tour guide operators. We suggest periodical data mining from the Instagram platform to evaluate public attitudes towards threatened species, such as Antillean manatees, to guide management strategies, such as expand protection and inspection actions in the most affected areas. Areas with high incidence of prohibited behaviour should be targeted by government inspections and environmental education actions. This may allow for the monitoring of Antillean manatee watching tourism in near real-time, providing updated information for decision-makers.

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Supporting Information

Municipalities (Electronic Supplement 1. Municipalities reported in social network posts depicting Antillean manatees and manatee-watching in northern and north-eastern Brazil from April 2013 to August 2022) and specific localities (Electronic Supplement 2. Specific localities reported in social network posts depicting Antillean manatees and manatee-watching in northern and north-eastern Brazil from April 2013 to August 2022) reported in social network posts depicting *Trichechus manatus manatus* in northern and north-eastern Brazil, together with characteristics of the manatee-watching hotspots municipalities (Electronic Supplement 3. Characteristics of the manatee-watching hotspots municipalities) may be found in the **Supporting Information**.

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НАБЛЮДЕНИЯ ЗА ЛАМАНТИНАМИ ШИРОКО РАСПРОСТРАНЕНЫ И ПОДВЕРЖЕНЫ СЕЗОННЫМ ИЗМЕНЕНИЯМ НА СЕВЕРО-ВОСТОКЕ БРАЗИЛИИ НА ПРИМЕРЕ ИСЧЕЗАЮЩЕГО (EN) *TRICHECHUS MANATUS MANATUS* (SIRENIA: TRICHECHIDAE)

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Наблюдение за морскими млекопитающими является рациональным туристическим подходом, ориентированным на дикую природу. *Trichechus manatus manatus* (далее – ламантин) являются примером харизматических видов морской мегафауны, являясь объектом наблюдений во многих пунктах, где вид встречается. В данной работе были изучены наблюдения за ламантинами в Бразилии, сосредоточив внимание на картографировании наблюдений в стране, выявлении горячих точек, анализе потенциальной сезонности этой практики и оценке взаимодействия между людьми и ламантинами. В качестве источника данных мы использовали одну из широко используемых социальных сетей, поскольку этот вид часто появляется в ее постах. Ламантин харизматичен и обладает характеристиками, которые привлекают публичное внимание, такими как большой размер тела, нежное поведение и привлекательный внешний вид. Наблюдения за ламантинами были отмечены в 91 локалитете, расположенном в 19 муниципалитетах и девяти штатах севера и северо-востока Бразилии. Шесть локалитетов были приняты за горячие точки наблюдений за ламантинами из-за большого количества связанных с ними изображений. Пять горячих точек были расположены на трех особо охраняемых природных территориях для устойчивого использования. Было отмечено до 23 человек на одной фотографии, связанной с ламантином, размещенной в социальной сети; но в большинстве постов (фото и видео) фигурировало до пяти человек. Кроме того, изображения значимо чаще публиковались в летние месяцы, что указывает на сезонность наблюдений за ламантинами. Собранные наблюдения за ламантинами были классифицированы как запрещенные или разрешенные законодательством Бразилии. Разрешенные взаимодействия происходили значимо чаще, но возникновение запрещенных взаимодействий свидетельствует о текущем несоблюдении природоохранных законов Бразилии. Мы предлагаем, чтобы в стратегиях управления туризмом приоритет отдавался наблюдению за ламантинами в горячих точках, уделяя особое внимание усилению соблюдения местного законодательства и предпочтительному привлечению местных жителей для обеспечения устойчивости этой практики в Бразилии.

Ключевые слова: взаимодействие человека и дикой природы, дикая природа, поведение в путешествии, сирены, устойчивое развитие туризма, экотуризм