

Perceptions on the distribution, threats, strandings, and conservation of the Antillean manatee (*Trichechus manatus manatus*) in the Río Dulce National Park, Izabal, Guatemala

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Abstract

The Antillean manatee in Guatemala faces multiple threats resulting from habitat loss and human interactions such as motorboat collisions and poaching. While some conservation efforts have been initiated in Río Dulce National Park (RDNP), there is a lack of studies examining the current perceptions of threats to the species. This knowledge gap may hinder the development of effective conservation strategies that consider both the species and local communities. Our objective was to analyze the perceptions of key local stakeholders concerning the Antillean manatee, including its distribution, threats, attention to strandings, and the current status of conservation in the protected area of RDNP. From July to October 2019, we conducted 50 semi-structured interviews with technicians and river users, such as fishermen and boat captains. Additionally, we held two workshops: one aimed at developing a participatory mapping exercise and another to validate the information. Each workshop

Keywords:

Central America, local knowledge, protected area, river users, Trichechidae

was divided into two groups: one for technicians and another for river users. A total of 68 people participated in the workshops, the majority of respondents were male (n = 47), ranging in age from 19 to 71, and predominantly local to the area. Their activities in the river included fishing, biological monitoring, transportation, and providing tourism services. Perceived threats to the Antillean manatee included motorboat collisions, poaching, bycatch, habitat degradation, and water pollution. The focus groups also identified key observations, such as mother-calf sightings, specific areas of risk for manatee-boat collisions, areas with a higher presence of aquatic vegetation, and additional threats such as habitat degradation and poaching. Our results demonstrate that stakeholders possess a fundamental understanding of the manatee, its threats, and its distribution. They also highlight a noticeable lack of knowledge, specifically regarding the attention given to manatee strandings. It is recommended that conservation strategies include environmental education adapted to local conditions, as well as the promotion of manatee studies and their dissemination at the local level, including attention to strandings in the area.

Introduction

The Antillean manatee (*Trichechus manatus manatus*) is a subspecies of the West Indian manatee (*Trichechus manatus*) an aquatic mammal belonging to the Order Sirenia and the Family Trichechidae. Its distribution ranges from the Gulf of Mexico to northern Brazil, encompassing the Caribbean coasts of Central and South America and the islands of the Greater Antilles (Reynolds III et al., 2002). In Guatemala, the Antillean manatee is found in the department of Izabal, in the water bodies of the Lago de Izabal-Río Dulce system, the Sarstoon River, the Amatique and La Graciosa bays, and the coastal area of Punta de Manabique (Quintana-Rizzo, 1993). Currently, the Antillean manatee is classified as Category No. 1 (species in danger of extinction) in the List of Threatened Species of Guatemala (DCA, 2021). According to the International Union for Conservation of Nature (IUCN), this subspecies is classified as Threatened (Self-

ARTICLE INFO

Manuscript type: Article

Article History

Received: 25 July 2023

Received in revised form: 4 January 2024

Accepted: 12 January 2024

Available online: 12 April 2024

Handling Editor: João Carlos Gomes Borges

Citation:

Corona-Figueroa, M. F., & Cifuentes-Espinosa, J. A. (2024). Perceptions on the distribution, threats, strandings, and conservation of the Antillean manatee (*Trichechus manatus manatus*) in the Río Dulce National Park, Izabal, Guatemala. *Latin American Journal of Aquatic Mammals*, 19(1), 61-71. <https://doi.org/10.5597/lajam00328>

Sullivan & Mignucci-Giannoni, 2008) and cataloged in Appendix I of the International Convention on Endangered Species of Wild Fauna and Flora (CITES, 2019).

In Guatemala, the Antillean manatee faces anthropogenic threats, such as poaching, bycatch resulting from the use of illegal fishing gear, collisions with vessels transiting at high speeds, as well as environmental deterioration (CONAP, 2004a; Machuca-Coronado & Corona-Figueroa, 2019; Machuca-Coronado et al., 2023). However, in addition to existing legislation prohibiting manatee hunting, there are several conservation efforts aimed at protecting the manatee, such as the National Strategy for Manatee Conservation. This includes actions to cover needs on research, conservation, management, and mitigation of impacts on the species and its habitat in Guatemala (CONAP, 2004a). Likewise, in Izabal Department (hereafter Izabal), there are five protected areas where the manatee is one of the conservation elements, included in the management plans. Consequently, monitoring for manatee sightings are priority activities. These areas are managed by the National Council of Protected Areas (CONAP, by its acronym in Spanish) and co-managed by different non-governmental organizations (Machuca-Coronado & Corona-Figueroa, 2019).

Río Dulce and El Golfete are part of the RDNP. According to the current legal instruments, this protected area is governed by management regulations that outline certain prohibitions and permitted activities. Among these, the management plan has a navigation regulation indicating the speed limit at which motorized vessels must navigate according to the zones of the protected area (CONAP, 2019). Despite being designated as a protected area with controlled tourism, Izabal remains one of the most frequented destinations for both residents and foreign tourists. In fact, it recorded approximately 118,800 visitors during the 2019 Easter holidays (INGUAT, 2019); consequently, boat traffic increases during these holiday periods.

On the other hand, previous ethnographic studies demonstrated local communities of El Estor and Livingston do not have an identity link around the Antillean manatee due to the constant migrations occurring in Izabal. Besides, hunting has existed since ancient times in this region, and meat consumption is the principal use of the manatee (Del Valle, 2001; Ruiz et al., 2008). However, the communities perceived that trawling fishing nets are the main threat to the manatees, evidencing a scarce control and surveillance in the permitted use of fishing gear in the area (Ruiz et al., 2008). Currently, the fishing gear allowed in the Lago de Izabal and the RDNP are the traditional hook fishing, cast nets, gill nets and pot traps. However, lengths and measurements of the mesh size vary according to the water body (MAGA, 2002).

Conservation of the species in freshwater systems is facilitated by the establishment of protected areas, which are based on environmental and ecological considerations such as integrated watershed management (Saunders et al., 2002). However, it is essential to consider not only environmental factors but also local adaptation and contextualization of conservation programs, especially in remote areas or complex systems where the state may lack effective control (Lejano et al., 2007). Community-based conservation projects have revealed that certain characteristics linked to socio-cultural aspects, such as land tenure systems, cultural beliefs, and institutions, can positively influence the success of conservation processes (Brooks et al., 2013).

For the success of conservation strategies, it is paramount considering the local knowledge and the participation of the inhabitants of the area (Rodas-Trejo et al., 2012; Brooks et al., 2013; Ladrón de Guevara-Porras et al., 2019). Given that local people promote, implement, and/or respect the actions of conservation processes, their active participation holds great significance (Brooks et al., 2013). In this sense, the objective of our study was to analyze the perceptions of key local people, such as field technicians (e.g., natural resources technicians, environmental educators, park rangers, control and surveillance agents) and river users, concerning the distribution of the Antillean manatee, its threats, attention to stranding events, and its conservation within the protected area of the RDNP.

In this study, we employ a conceptual approach primarily rooted in ethnoecology and conservation. Ethnoecology, defined as the study of local knowledge systems and their relationship with biotic and abiotic components of nature, has evolved to encompass not only the relationship between ecosystem components (or a part thereof) but also their connection to societal well-being (Reyes-García & Martí Sanz, 2007). Similar approaches have been utilized, for instance, to emphasize how local resource management contributes to the generation and preservation of the Amazonian manatee (Gutiérrez Barreto, 2019). This approach has also been utilized to compare various monitoring methods, including qualitative approaches that can complement one another and potentially reveal population trends of the Amazonian manatee (Oshita et al., 2022). Finally, it has shed light on the perception and local knowledge regarding the Antillean manatee in unprotected areas. In these areas, people acknowledge the challenges faced by the Antillean manatee and consider the species as a potential flagship species, thereby enhancing its value for ecotourism (Corona-Figueroa et al., 2022).

Materials and Methods

Study Area

The RDNP is one of the five protected areas of Izabal, Guatemala. The area covers a 1 km wide strip on both banks along the Río Dulce and El Golfete (CONAP, 2019). Río Dulce is a 41 km long navigable river that stretches from San Felipe Castle to its mouth at the Amatique Bay, in the Guatemalan Caribbean (Fig. 1). It is part of the Lago de Izabal and Río Dulce basin, on the Atlantic slope (Suárez, 2011). This region has a tropical rainy climate with two climatic periods, the rainy one, which extends from June to September, and the dry one, from October to May (Yáñez-Arancibia et al., 1999). It also presents a dominant period of north-northwest trade winds. In Río Dulce and El Golfete, mangrove forests, floodplain forests, and areas with wetlands predominate, combined with other intensive land uses, such as banana plantations, oil palms, and cattle pastures (Yáñez-Arancibia et al., 1999; Dix & Hernández, 2001).

Within the protected area are 17 communities with 15,073 inhabitants registered in 2014 (CONAP, 2019), in which the Mayan Q'eqchi' ethnic group predominates, followed by the Ladino (INE, 2018). The main economic activities are agriculture, livestock, subsistence hunting, forestry, fishing, and the provision of tourism services (CONAP, 2004b). CONAP, or Consejo Nacional de Áreas Protegidas, is the institution that manages the RDNP,

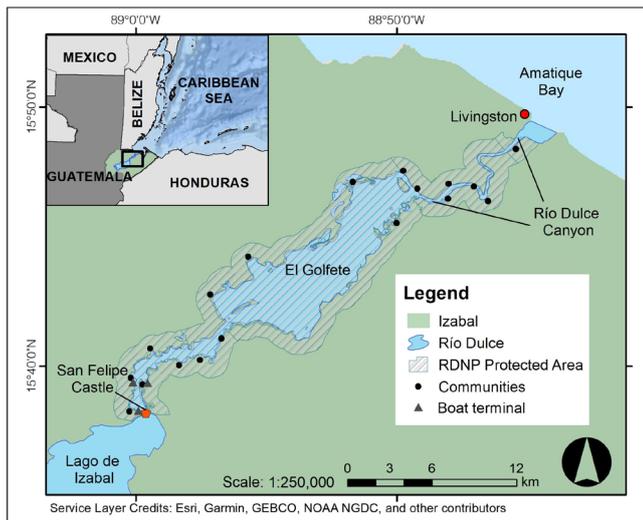


Figure 1. Location of the study area: the Río Dulce National Park (RDNP) in Izabal department, Guatemala. Settled communities, boat terminals, San Felipe de Lara Castle and the municipality of Livingston are marked.

in collaboration with other government, academic, and civil institutions. Likewise, CONAP has a close relationship with different groups organized within the communities settled in the protected area, such as the Community Development Councils (COCODES, by its acronym in Spanish), the Tourist Self-Management Committees (CAT, by its acronym in Spanish) and the boaters and fishermen associations (Machuca-Coronado & Corona-Figueroa, 2019).

Methodology

Between July and October 2019, we conducted 50 semi-structured interviews, one participatory mapping workshop, and one information validation workshop. We conducted the workshops separately, one with field technicians or park rangers who carry out biological monitoring in the protected area and the other with local people whose main livelihood depended on the river or who carried out secondary activities on the river. Permits issued by community representatives to carry out studies that involve local knowledge about biodiversity in Guatemala are not required if these were carried out before June 2020 (CONAP, 2020; DCA, 2020), as is the case of our study.

For the semi-structured interviews, we used a non-probabilistic convenience sampling, which is frequently used for exploratory qualitative studies (Newing, 2011). The selection criteria to apply the interviews were people over 18 years old considered users of the river, that is, who carried out some activity in the river, such as fishing and transport and tourism service providers, as well as field technicians or park rangers of the protected area.

Some of the interviews were carried out from a boat in the morning, looking directly for the users who were in the river at that moment, while others were carried out at the municipal docks or in the institutions of the area (Fig. 2A and 2B). The structure of the interview included a section on prior, free, and informed consent, another on information about the interviewee (age, gender, livelihood, activity carried out in the river, schooling level) and others on the distribution, threats, attention of strandings and conservation of the manatee (Supplementary Material

1). Although we had the support of a Maya Q'eqchi' language translator, the interviews were conducted in Spanish, as the interviewees understood and spoke this language.

For the workshops, we convened field technicians or park rangers from public, civil and academic organizations in the protected area. In addition, with the support of the community leaders of the protected area, we carried out a call to the users of the river. In each workshop we followed a free, prior and informed consent guide that consisted of verbally informing the participants about the research team, the objectives of the workshop and the research, as well as voluntary participation and the anonymity of their participation. During these workshops we conducted a participatory mapping to discuss manatee and calf sighting areas, potential feeding areas or aquatic vegetation areas, and perceived anthropogenic threats to the manatee (Supplementary Material 2; Fig. 2C and 2D).

In November 2019, we held two more workshops to validate the information obtained in the previous workshops in order to reach a consensus on the results. Likewise, we used the criterion of triangulation to ensure the quality of the information obtained from the methods used (Newing, 2011; Seid, 2017). Again, the intervention of the Maya Q'eqchi' translator was not necessary during the workshops with community members, since the participants understood and spoke the Spanish language.

Data Analysis

The information obtained from the interviews was organized into a database. In addition, we coded the information using the following categories: threats, procedures for attention to strandings, and manatee conservation (Table 1). Additionally, we used a contextualization of some of these topics through the use of contextual quotes (Coffey & Atkinson, 2003; Enguix, 2013). Then, we performed a descriptive analysis (relative frequencies)



Figure 2. Methodologies applied in this study. Interviews conducted with: A) river users, such as fishers and B) boat transport service providers. Participatory mapping was carried out during the workshops with: C) technicians and D) community members of the protected area. Photo credits: F. Corona, M. de León and H. Tiul.

Table 1. Description of the coding used to classify threats, attention to strandings, and manatee (*Trichechus manatus*) conservation.

Threats of the manatee and its habitat (CONAP, 2004a)	
Poaching	It is carried out due to the consumption of manatee meat. Manatee meat is sometimes sold in local markets. It seems that strangers poach manatees near the borders.
Bycatch	It occurs due to the illegal use of fishing gear such as trawling nets. Manatees can become entangled and die from suffocation or acquired injuries.
Motorboat collision	It occurs in places where the traffic of motorized vessels at high speeds is frequent. Manatees can also be injured by cuts from propellers. Also, strong collisions can cause the death of a manatee.
Habitat degradation	It refers to the loss of habitat due to deforestation, sedimentation, bank erosion, removal of aquatic grasses, land use change around the water body.
Water pollution	It is pollution from municipal waste, agro-industrial waste, discharges from ships and pipelines, etc.
Attention to manatee strandings	
Procedure for stranding attention	The report of a stranded manatee, alive or dead, is a fundamental step for the manatee to be attended by the authorities. Attention to stranding refers to the location of the animal, capture of morphometric data, investigation of possible causes of death and, if possible a necropsy. Finally, the animal is buried to prevent infections of domestic animals and/or humans by pathogens.
No procedure	In this study we define it as the situation in which a manatee is stranded but is not reported to the authorities. Depending on the cause of death and state of the animal, the person decides to use its meat, take it out of the water, set it adrift, bury it or sink it.
Manatee conservation (Corona-Figueroa et al., 2022)	
Existence value	It is assigned to a species when its existence is appreciated, thus it would feel a loss if that species disappeared.
Ecological value	It is assigned to a species when its role in the ecosystem is known, regardless of whether it has a direct benefit for people.
Economic value	It is assigned to a species when some direct or indirect economic return is obtained from it. In this study, we identified this value for manatees' potential attraction for tourism.

of the answers obtained according to the coded themes. For responses to perceived threats to manatees, we calculated the mention percentage as the number of respondents who mentioned threat *i* among the total responses obtained (*sensu* Franzini et al., 2013).

In addition, we performed contingency tables with the maximum likelihood chi-square analysis with a 90% confidence level to determine associations between the characteristics of the interviewees (education level and activity carried out in the river) and the responses obtained on the number of perceived threats to the manatee and awareness of the procedures for the attention of strandings. While higher confidence level is commonly set, particularly in trials and experimental studies, due to the exploratory nature of this research, we considered it appropriate to assign a confidence level of 90%. This confidence level has been widely used in qualitative studies for instance in studies that documented the local perception and traditional ecological knowledge from riverside communities in Hondo River, Mexico (Corona-Figueroa et al., 2022).

We then performed a correspondence analysis to visualize the associations between the variables that were significant, indicating the percentage of the variance explained in the first two axes of the graph. All statistical analyses were performed using the InfoStat program (Di Rienzo et al., 2018). Finally, we carried out a comparative analysis of the information provided during the participatory mapping workshops and digitized the maps with Google Earth Pro and ArcGIS 10.3 programs.

Results

Characteristics of the Interviewees

We conducted 50 semi-structured interviews in total. Most of the interviewees were men (Table 2). The age range of the interviewees was between 19 and 71 years, distributed into the following age groups: G-A (19 - 32 years): 36%; G-B (33 - 45 years): 28%; G-C (46 - 58 years): 26%; and G-D (59 - 71 years): 10%. Most of the respondents (68%) were natives of the area that corresponds to Río Dulce, while 26% indicated that they come from other parts of the country; 6% did not specify their

Table 2. Details about the methods used and number of participants by gender in the activities.

Methods	No. of interviewees and workshop attendees	Gender	
		Male	Female
Semi-structured interview	50	47	3
Participatory mapping workshop for technicians	24	17	7
Participatory mapping workshop for community members	17	13	4
Validation workshop for technicians	12	10	2
Validation workshop for community members	15	12	3

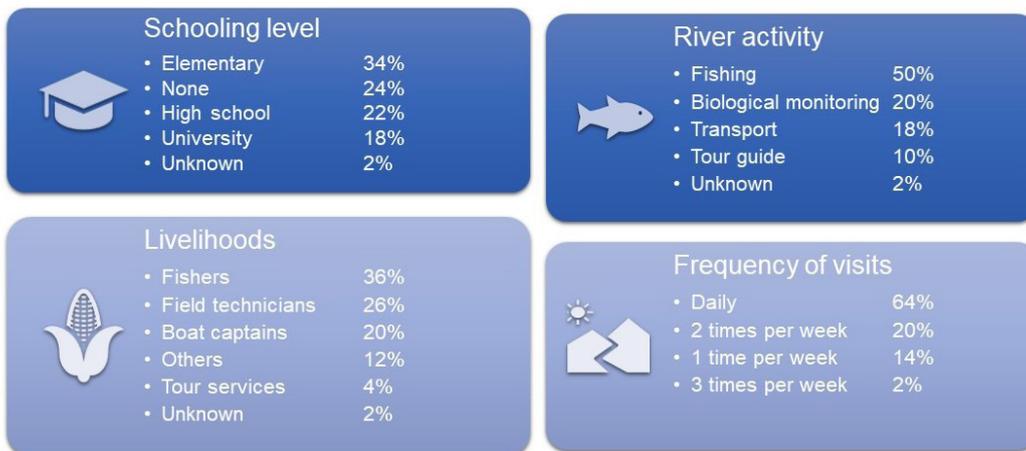


Figure 3. Characteristics of the river users interviewed in the RDNP.

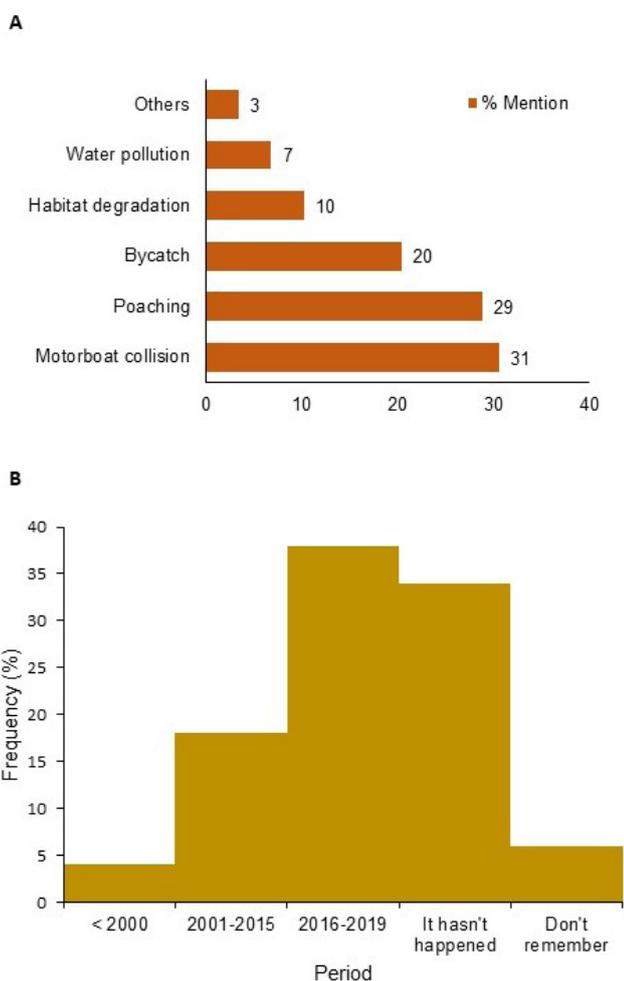


Figure 4. Responses from river users interviewed: A) Percentage of mention of perceived threats to the manatee. B) Last period in which the interviewee heard about manatee poaching activities in Izabal.

origin. Of the non-native respondents, only eight indicated that they had lived in Río Dulce for more than ten years, and five less than ten years.

Most of the interviewees have only the elementary schooling level, followed by none, high school, and university level (Fig. 3). Among the livelihoods of the interviewees, the majority are fishers,

followed by field technicians and boat captains (Fig. 3). Most of the activities carried out by the interviewees in the river are fishing, biological monitoring, transport by boat, and the provision of tourism services (e.g., tour guides) (Fig. 3). In relation to the frequency with which they visit the river, the majority mentioned that they do so daily, followed by twice a week (Fig. 3).

Perceptions of the Distribution, Threats, and Attention to Manatee Strandings

All interviewees have sighted at least one manatee in Río Dulce. All mentioned seeing them alive, but 20% reported finding dead manatees in Río Dulce. As for the current situation of the manatee population in the area compared to 10 years ago, 62% of the interviewees mentioned that there are more manatees now than in the past, 28% mentioned that the number of manatees remains the same, and only 10% perceived it as less. A technician from the protected area argued that this perceived increase in the number of manatees may be a result of increased human activities and habitat fragmentation, which causes the manatees to move more for feeding and shelter, therefore manatees are more exposed and sighted by people.

Perceived threats to the manatee were related to human activities, such as motorboat collisions, poaching, bycatch, habitat degradation, and water pollution (Fig. 4A). Threats considered natural, such as American crocodile (*Crocodylus acutus*) predation and mortality associated with giving birth, were mentioned less (3%). However, 28% of those interviewed stated that the manatee does not present any type of threat because it is a protected species. In terms of motorboat collision, some interviewees (40%) mentioned that between one and two motorboat collisions with adult manatees may occur per year. They further argued that this is due to two main factors; the first is the high speed at which the motorboats travel, which causes direct collisions with manatees, and which are usually not reported for fear of sanctions and, therefore, are not attended to by the authorities. And the other reason is due to the increase of traffic, from both boats and yachts, in the protected area, which prevents the free movement of the manatees, especially in the shallow and narrow areas of the river.

As for poaching, the interviewees indicated that they have heard both recent and past hunting events throughout the entire range

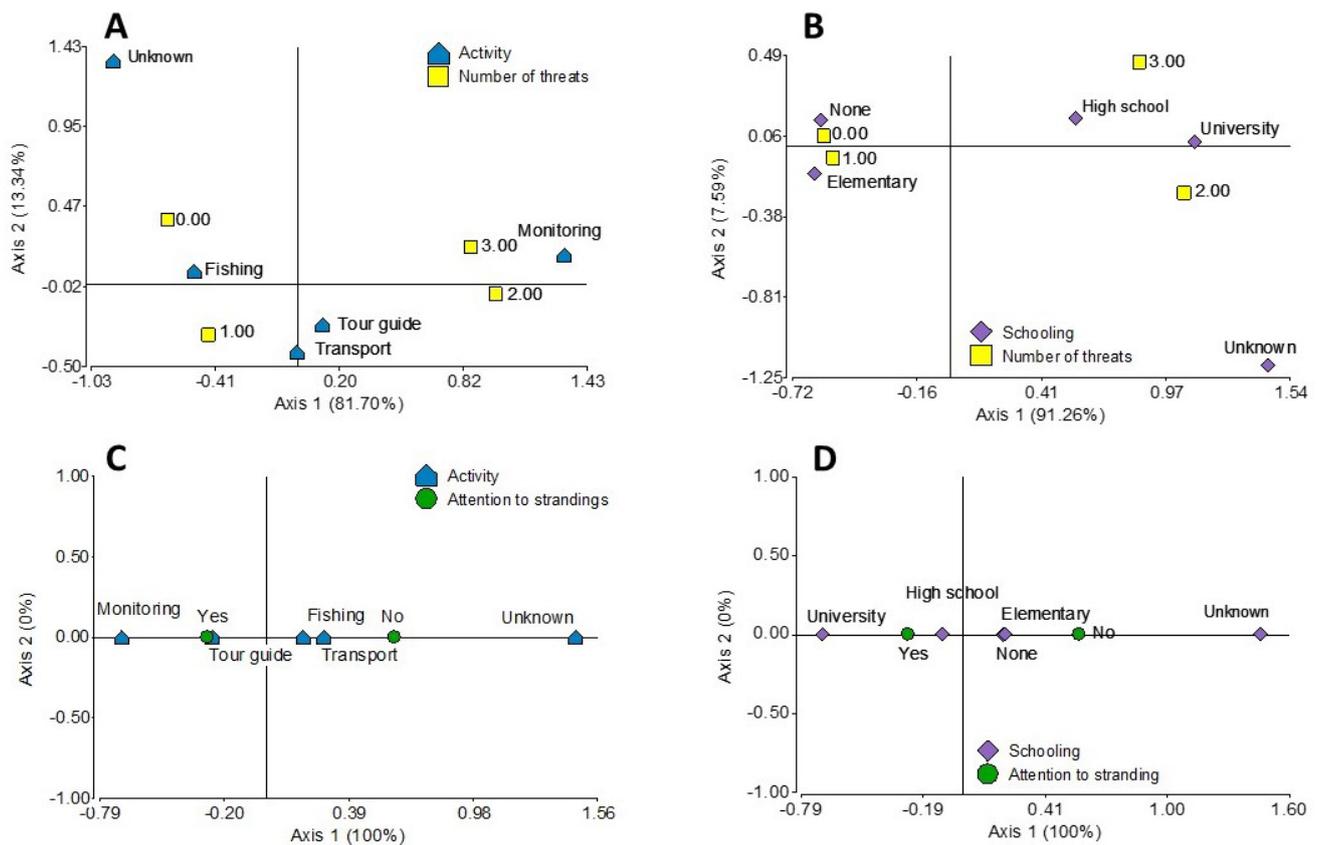


Figure 5. Correspondence analysis for: A) Activities carried out by interviewees in the river and the number of recognized threats to the manatee; B) Schooling level of the interviewees and the number of recognized threats; C) Activities carried out in the river and the recognized procedures for the attention of manatee strandings; and D) Schooling level and the recognized procedures for the attention of strandings.

of the manatee in Guatemala (Fig. 4B). However, 34% mentioned that poaching does not occur within the area. Among the reasons why people usually engage in this illegal activity, they mentioned that it is for food, particularly due to the taste of manatee meat; in this regard some people commented: *"There are people who do harm them [manatees] because they have tried them, but we protect the area from La Angostura to the San Felipe Castle"*. They also mentioned a cultural reason, related to their belief in protection against unspecified evils. Some comments were: *"The manatee has a bone in its ear with a hole like an eye, which serves to avoid the evil eye"*; *"In the past, it was customary for people to give a manatee ear bone to newborn children. On the positive side, it is good that certain habits have been lost"*.

About bycatch, some interviewees (20%) indicated that this threat is related to the use of large fishing nets, such as trammel nets. In this regard, some technicians mentioned that during these events, manatees get entangled and drown because they cannot break the nets. In addition, they mentioned that in this situation three scenarios typically occur: 1) notify the authorities, 2) bury it, and 3) take advantage of the meat as food. As for habitat degradation, the interviewees commented that this threat is related to the change in land use, the removal of aquatic grasses, and the dredging or filling of some streams. In the case of water pollution, they mentioned that it is related to the inadequate management of liquid and solid wastes coming from the upper and middle part of the basin.

The number of threats to the manatee identified by respondents was associated with the activities they performed in the river

(p value = 0.0004) and with their schooling level (p value < 0.0001). People who engaged in fishing, tourism services, and transportation activities frequently identified at least one threat to the manatee, while those who carried out monitoring activities in the river identified between two and three threats (Fig. 5A). Individuals with higher schooling levels identified a greater number of threats, while those with lower schooling levels recognized at least one threat (Fig. 5B).

Most of the interviewees (66%) indicated that they have some procedure for attending stranded manatees in the protected area. However, when we asked for details of the procedure they followed, we found different answers, such as using meat if the animal was dead; reporting the event to the local authorities such as the Nature Protection Division (DIPRONA, by its the acronym in Spanish), the Center for Conservation Studies (CECON, by its the acronym in Spanish), or CONAP; or just burying it or taking it out of the water towards the shore (Table 1). In contrast, 34% of the respondents did not know what to do in the event of a manatee stranding, mainly due to the lack of a clear procedure. In this regard, some commented, *"I did not know where to report, whether to the COCODE or to the authorities."*

The responses of the technicians about the attention to manatee strandings were quite similar to each other, indicating that during these events data should be collected on the individual (e.g., male or female, morphometry, probable cause of death, etc.), as well as bury it in a nearby area. In addition, they mentioned that this data is collected to make it available for investigations. However, there were emerging issues about situations that prevent

or slow down successful stranding attention. Among these, they mentioned having a limited budget and a lack of personnel, since the institutions in the area do not have the fuel to travel to the sites or the people to attend to the cases. Among other emerging issues, some mentioned that social networks have been a good tool for reporting deaths or reporting manatee strandings, since it makes it easier for the information to reach the institutions.

In relation to the procedure for the attention of stranded manatees, an association was found between the activities carried out in the river (p value = 0.02) and the level of schooling (p value = 0.03). People who carry out monitoring and tourism activities frequently recognize a procedure to attend to a manatee stranding, while people who are dedicated to fishing and transport did not always mention knowing about any procedure for the attention of stranded manatees (Fig. 5C). Additionally, it was found that the interviewees with a high educational level usually identify the existence of a procedure for the attention of stranded manatees (Fig. 5D).

Perception of the importance of manatee conservation

Most of the interviewees (90%) agreed that the manatee should be conserved in the protected area; the remaining 10% commented that they did not know the reason for its conservation. Perceptions about conserving this species were mixed. For example, some are related to the value of existence, indicating happiness or curiosity when observing manatees, that the species does not represent a threat to people, respect for all forms of life, and the need to share the space where it lives with human activities.

Other arguments were those related to economic value, focused on tourism activities and as an emblematic species for the region. Some commented *"It [the manatee] is Izabal's icon; it is attractive to tourists. It sinks its head and then its fins, people are happy to see, even if it is that"*. The arguments related to the ecosystem value of the species came mainly from the technicians who mentioned the manatee as an indicator species of ecosystem quality and as a controller of aquatic grasses: *"The mere fact of calling it an indicator species suggests that there are optimal conditions, which indicates that the system is healthy"*.

Participatory mapping

We had 41 participants during the workshops to carry out the participatory mapping and 27 participants for the validation (Table 2). The maps show the areas where the participants commonly sighted manatees (singles and in groups) and the mother-calf dyad. The technicians were the ones who located the most manatee sighting areas throughout the protected area. They also noted that the mother-calf dyad has been sighted mainly in the southwestern area of Río Dulce and in the northeast of El Golfete (Fig. 6A). The community members reported sightings of manatees and calves mainly in the northeast area of El Golfete and in the adjoining lagoons (Fig. 6B). On both maps, the participants also located areas with the presence of aquatic grasses as possible feeding areas for manatees.

In relation to the areas where stranded manatees have been found, with cause of death unknown, the technicians indicated two areas of El Golfete, one located in the northeast area and the other at the beginning of the section of the river canyon. Technicians also located fishing nets (e.g., robber trammel nets,

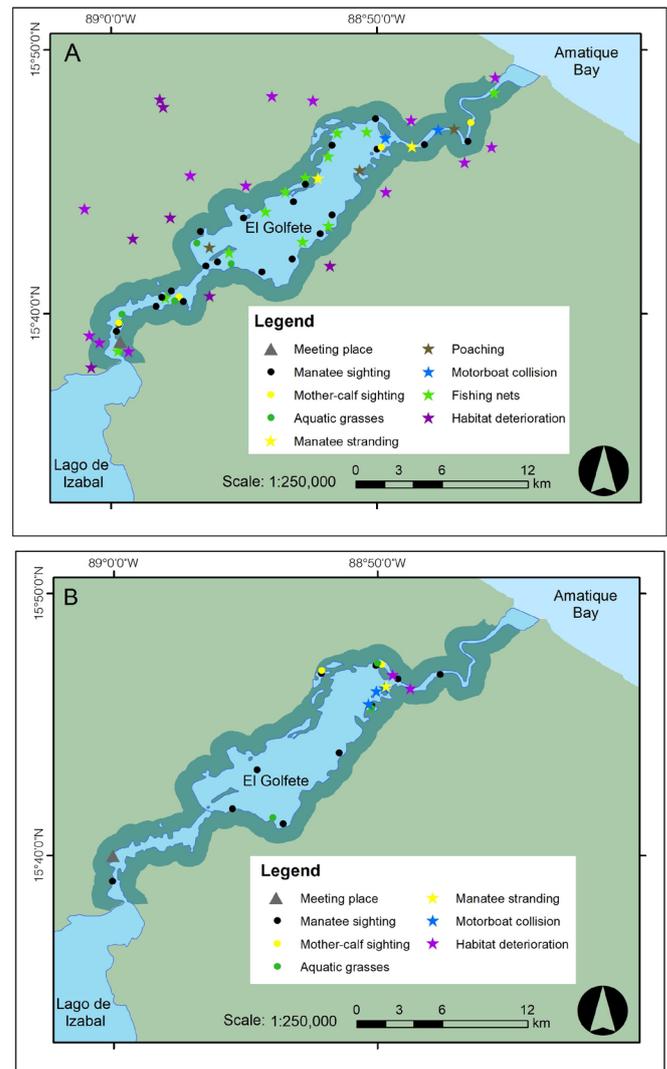


Figure 6. Participatory mapping showing manatee (*Trichechus manatus*) sightings, potential feeders (presence of aquatic grasses), manatee stranding sites and threats perceived by: A) technicians and B) community members.

‘mojarrero’ trammel nets for mojarra fish) throughout the protected area, mainly in El Golfete, mentioning that these are threats to the species. In addition, they located sites where manatee poaching has been reported. The identified boat collision areas were narrow places, such as the section of the Río Dulce canyon. Finally, the technicians located other threats related to human activities, such as habitat deterioration due to the change in land use (e.g., oil palm monocultures, cattle pastures), located mainly outside the limits of the protected area.

The community members also identified the beginning of the section of the river canyon as an area where a stranded manatee was found. Likewise, in that part of El Golfete they pointed out the motorboat collisions. And as another threat related to the habitat deterioration linked to human activities, the community members identified water contamination in the eastern end of El Golfete. In this regard, they agreed that this part of El Golfe had been affected by the inadequate management of solid waste: *"This part of El Golfete is a funnel. All the garbage that comes from the upper [portion] of the basin accumulates here"*.

Discussion

The manatee sighting sites reported by technicians and river users as well as the presence of the mother-calf dyad in the RDNP are consistent with findings from previous studies. These studies utilized aerial surveys (Quintana-Rizzo et al., 2023) and sightings at fixed points from a boat (Corona-Figueroa, 2012). In general, Río Dulce and El Golfete are areas where manatee presence reports are fewer compared to those of Lago de Izabal and La Graciosa Bay (Quintana-Rizzo & Machuca-Coronado, 2008). Additionally, it has been identified as a corridor that manatees use to move between the Lago de Izabal and the Amatique Bay (Quintana-Rizzo, 1993).

However, the aquatic habitat offered by the RDNP exhibits characteristics associated with the presence of manatees, particularly in the El Golfete area. These characteristics include shallow areas, the presence of aquatic vegetation, river confluences providing heterogeneous habitat conditions, such as fresh waters, feeding sites and refuge (Axis-Arroyo et al., 1998; Jiménez-Domínguez & Olivera-Gómez, 2014; Corona-Figueroa et al., 2021). The north side of El Golfete has minimal anthropogenic disturbance, such as low motor vessel traffic, where it has been evident that manatees prefer (Corona-Figueroa, 2012). In addition, the presence of the mother-calf dyad in some sites within El Golfete suggests that this area may serve as a refuge for manatees (Morales-Vela & Olivera-Gómez, 1992; Corona-Figueroa, 2012, 2013). These sites may play a role in the philopatric behavior displayed by females with calves (Rathbun et al., 1990; Morales-Vela et al., 1999; Gannon et al., 2007).

Most of the interviewees perceived either an increase in the manatee population or a stable population compared to ten years ago. In Guatemala, the estimated population was 150 manatees (Quintana-Rizzo & Reynolds, 2010) and according to recent aerial surveys, the authors support that the manatee population has remained stable in the last two decades (Quintana-Rizzo et al., 2023). Although manatee population monitoring was paused for a few years due to funding limitations (Machuca-Coronado & Corona-Figueroa, 2019), aerial surveys have been conducted since October 2021 to monitor the species in the Cuyamel-Omoa Punta de Manabique Sustainable Biological Corridor (ORMACC, 2022). Other aerial surveys have also been conducted only for the Lago de Izabal, since August 2022 (R. Paz, Fundación Defensores de la Naturaleza, pers. comm., 17 July 2023).

The threats identified by technicians and river users (*i.e.*, motorboat collision, poaching, bycatch, habitat degradation, and pollution) have been previously identified in Izabal (Del Valle, 2001; Ruiz et al., 2008; Machuca-Coronado & Corona-Figueroa, 2019). Among the threats, poaching and bycatch were recognized in the participatory mapping only by the technicians working in the protected area. Community members only identified contamination threats and motorboat collisions during the participatory mapping. The lack of mention of the other threats by community members might be attributed to the fear of being implicated (Rodas-Trejo et al., 2012; Alvarez-Alemán et al., 2021; Corona-Figueroa et al., 2022).

Our study identified a potential link between the number of recognized threats to the species, and the schooling level, and the activities carried out by people in the river. A similar link

was identified between the procedures for attending strandings events. A study on the African manatee (*T. senegalensis*) found that human-manatee conflicts decrease with increased knowledge about the species. It also showed a positive correlation with age and level of education (Mayaka et al., 2019).

Technicians and park rangers of the protected area acknowledged the existence of procedures for the attention of manatee strandings. The procedures for the attention of stranded manatees consist of recording data on the location, the state of decomposition, recognition of the possible cause of death, taking morphometric measurements, and the disposal of the stranded manatee (Table 1). However, records are only carried out by field technicians and park rangers from protected areas trained by CONAP. The Fundación Defensores de la Naturaleza (FDN) made the first efforts to train technicians, park rangers, and key people in the communities in responding to the manatee strandings that occurred in the Lago de Izabal. However, training has been suspended for several years (Machuca-Coronado et al., 2023).

The river users interviewed were unaware of these procedures or mentioned incorrect actions when strandings occur. This has also been reported in Río Hondo, Mexico (Corona-Figueroa et al., 2022). The lack of knowledge about reporting and attending to manatee strandings (see Table 1) may be due to the limited information that is shared, especially in remote areas far from the urban center of the protected area (Silva & Araújo, 2001); or when trying to communicate with the authorities by cellphone the phone numbers are outdated (M. F. Corona-Figueroa, pers. obs.). Additionally, river users may be afraid of being associated negatively with the event that led to the manatee stranding (Alvarez-Alemán et al., 2021).

Although the manatee is considered a symbol at the administrative level, this species does not hold a prominent place in the worldview of the ethnic groups of Izabal due to the constant migrations that occur in this region. Manatee meat as food is the main use that people perceive for the species (Del Valle, 2001; Ruiz et al., 2008). Likewise, it has been reported that the ear bone of manatees is used as an amulet for newborns to prevent them from the evil eye (Ruiz et al., 2008). In our study, most people agreed that it is important to conserve the manatee, primarily attributing value to its existence (*e.g.*, the species exists in the ecosystem and because it is a harmless species) and economic potential (*e.g.*, the species is an attraction for tourists). Similar results are also evident in other studies conducted in Mexico (Rodas-Trejo et al., 2012; Corona-Figueroa et al., 2022), and Peru, with the Amazonian manatee (Silva et al., 2014). Instead, in this study the ecosystem value of the species, that is, the role the manatee plays in the ecosystem, was only recognized by the field technicians of the protected area.

In other countries, the manatee has been identified as a potential umbrella species due to its unique biological and ecological characteristics, potentially contributing to the protection of other species (Daniel-Rentería et al., 2010). These characteristics, in addition to the positive attitudes that local people have about the manatee, are essential to recognize it as a flagship species in this region (Bowen-Jones & Entlewestle, 2002). To foster a greater understanding and appreciation of the manatee and its role in environmental conservation, it is essential for people to recognize these characteristics. This can be achieved through various

means, such as environmental education, training processes, and community participation in sighting activities. By developing respectful attitudes and appreciation towards the species, local people can play an active role in its conservation (Ruiz et al., 2008; Rodas-Trejo et al., 2012; Ladrón de Guevara-Porras et al., 2019).

Our study summarizes the perceptions of technicians and river users on the distribution, threats, strandings, and conservation of the Antillean manatee in the RDNP. While the study's scope was primarily qualitative, the methodology applied here can be useful in other contexts especially in areas where information about the perception of the species is scarce. However, caution should be exercised when attempting to generalize the information presented here, since it corresponds to a specific timeframe and the insights of the technicians and river users available during that period. Future research could benefit from a quantitative assessment and long-term monitoring efforts, in combination with ethnoecological studies, to provide a more comprehensive understanding of the threats, manatee population, and the effectiveness of conservation strategies.

Such studies would generate up-to-date information about the perception of the species and its habitat, covering sites adjacent to the protected area and the tributary rivers of Río Dulce, such as Ciénega, Chocón Machacas, Tatín rivers. We consider it is essential to actively involve river users and local communities as allies in reporting and attending manatee strandings. Even local key actors could be part of the manatee stranding network in Izabal (Machuca-Coronado et al., 2023), particularly when government institutions, such as CONAP, DIPRONA, and the Ministry of Agriculture, Livestock and Food (MAGA for its acronym in Spanish) are faced with staff shortages or limited budgets to carry out these activities (Ruiz et al., 2008; Machuca-Coronado & Corona-Figueroa, 2019; this study). Their participation can play a crucial role in enhancing conservation efforts, as has successfully occurred in other regions, such as Laguna Guerrero, Mexico (Romero, 2019).

Río Dulce and El Golfete are completely navigable by motorized vessels, being the outboard motorboats the most common, however, yachts, sailboats, catamarans, jet-skis, paddle kayaks, and motorized canoes can also be found on the river (M. F. Corona-Figueroa, pers. obs.). Currently, there are 1,134 motorboats, 280 jet-skis, 30 sailboats, and 76 yachts registered just in the Livingston Harbor Master's Office (DGAMDN, 2023). Previous studies suggest that motorboat traffic influences the presence of the manatee in the RDNP (Corona-Figueroa, 2012), where a high number of motorboats and kayaks has been recorded compared to other protected areas (Quintana-Rizzo et al., 2023). This is worrying given that the death of manatees due to boat collision has only been recorded in this protected area (Machuca-Coronado et al., 2023). Therefore, we recommend that the authorities of the protected area install warning signs and enforce reduced speed for motorized vessels in narrow and shallow areas of the river. Additionally, it is essential to outreach information at the speeds recommended in the navigation regulation of the management plan of the protected area (CONAP, 2019), particularly when tourism intensifies during vacation periods.

We suggest closely linking conservation efforts with long-term environmental education and awareness strategies. When disclosing information about threats, reporting procedures, and

attending strandings, it is essential to consider the specific context of the area and the institutions involved (Lejano et al., 2007). This includes factors such as schooling level, language (Q'eqchi', Spanish, and English), and the various user groups addressed, such as field technicians, park rangers, fishers, boat captains, and tourists. For this, different outreach forms should be considered to ensure that the information is available to the target audience effectively. Finally, we highlight the importance of implementing effective control and surveillance measures by the authorities to ensure compliance with current regulations, such as the prohibition of manatee hunting, the use of permitted fishing gear, and the navigation regulations. Both environmental education and control, and surveillance measures will foster public awareness and positive attitudes to protect this endangered species and its habitat.

Acknowledgments

This study is part of Project No. F17/2019/FONACON, which was funded by Fideicomiso de Administración e Inversión del Fondo Nacional para la Conservación de la Naturaleza (FONACON), of the Consejo Nacional de Áreas Protegidas (CONAP) and administered by Asociación Movimiento Brazos Solidarios ASOMBRAS ONG, in 2019. We thank the technical staff and park rangers of the Río Dulce National Park, from CONAP, mainly Andrés Caal, Hugo Tiul, and Ariel Saavedra for the support provided during this study; Marllory De León, for her assistance in the workshops carried out, and Rocío Paz, Tannia Sandoval, Victor Gudiel, and Maynor Tut, for their assistance, supervision, and recommendations during this project. We thank the staff of the Autoridad para el Manejo Sustentable de la Cuenca del Lago de Izabal y Río Dulce (AMASURLI) for the logistical support provided during the workshops. We also thank the people who participated in the interviews and workshops for the information provided. We thank Andrea Cabrera for reviewing the first English version of our manuscript. Finally, we thank the anonymous reviewers for their valuable comments and suggestions to improve our manuscript.

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Supplementary material

Supplementary Material 1 - Interview guide.

Supplementary Material 2 - Participatory mapping guide.