



Bycatch assessment of the West Indian manatee (*Trichechus manatus*) and other megafauna in artisanal fisheries of the Caribbean



Photo credit: Patrick Rose

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Summary

Within the framework of the Action Plan for the Conservation of Marine Mammals (MMAP) in the Wider Caribbean Region and the Regional Management Plan for the West Indian Manatee, the SPAW-RAC has initiated a study on one of the main threat region-wide for the West Indian manatee: bycatch and vessel strikes. This study, the “Manatee Bycatch Pilot Project”, consists in a questionnaire that has been submitted to fishermen in Belize, Colombia, the Dominican Republic, Haiti and Mexico. The aim of this study was to investigate bycatch and use of West Indian manatees (*Trichechus manatus*), cetaceans (essentially delphinids) and sea turtles. A total of 610 interviews was collected in the sampled countries, and provide new information on bycatch, hunting of manatees and other vulnerable megafauna in this region. Overall, this preliminary study highlights that manatees and sea turtles are still hunted in the region, despite the prohibition of their capture in most of the sampled countries and the decline of the consumption of manatee and sea turtle meat. Bycatch occurs in most countries, but at a relatively low level. However, given the low size of manatee populations in the region, captures may not be sustainable but more quantitative data are actually needed. Cetacean bycatch occurs in the region too, but in low numbers. Fishermen perceive an increasing occurrence of either incidental or intentional captures in Belize. This pattern seems to be opposite in Colombia and Dominican Republic, where captures are perceived as decreasing. The perception of the trend in manatee abundance is contrasted between Hispaniola Island (Haiti and Dominican Republic) and the mainland, where populations are believed to decrease for the former and increase for the later. In order to better understand the effect of artisanal fishing on vulnerable megafauna, specific recommendations are provided, such as the improvement of fishing effort/practices data.

Background and terms of reference

Within the framework of the Action Plan for the Conservation of Marine Mammals (MMAP) in the Wider Caribbean Region (UNEP, 2008) and the Regional Management Plan for the West Indian Manatee (CEP Technical Report 48, 2010), the SPAW-RAC has initiated a study on one of the main threats region-wide for the West Indian manatee: bycatch and vessel strikes. This study, the “Manatee Bycatch Pilot Project”, consists in a questionnaire that has been submitted to a number of stakeholders (mostly fishermen) in each country. As a start and in order to assess the effectiveness and relevance of the approach, only a small number of countries have participated in the project: Belize, Colombia, the Dominican Republic, Haiti and Mexico. The five countries have been chosen based on the interest of local partners to participate in the project and because of bycatch and vessel strikes representing the principal threats for manatees as reported in the Regional Manatee Management Plan.

Dr. Jeremy Kiszka has been in charge of processing and analyzing the questionnaires in order to assess spatial and temporal variations of incidental catches of manatees and other species (sea turtles and cetaceans), as well as to identify factors responsible for the occurrence of bycatch.

Acknowledgments

The author would like to thank all contributors (interviewers, field technicians, national coordinators) for collecting interview survey data in order to assess bycatch of manatees, cetaceans and sea turtles in Dominican Republic, Mexico, Belize, Haiti and Colombia. Special thanks are addressed to national coordinators who supervised data collection in their countries, especially Haydee Dominguez (Dominican Republic), Benjamin Morales (Mexico), Nicole Auil (Belize), Jean Wiener (Haiti) and Dalila Caicedo (Colombia). Special thanks are addressed to Dr. Nicolas Pilcher for elaborating the questionnaire survey.

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1. Introduction

Large long-lived marine vertebrates, such as marine mammals, seabirds and sea turtles, are highly vulnerable to additional mortalities due to fisheries for biological reasons, such as late maturity and low reproduction rates. A large number of species (both protected and unprotected), are severely threatened due to unmanaged fisheries (Lewison *et al.*, 2004). While the issue of bycatch in fisheries is a major risk factor, it has to date primarily been investigated in industrial fisheries, and very little attention has been given to the extent of bycatch in artisanal fisheries (Moore *et al.*, 2010). Artisanal fisheries account for more than 95% of fishers in the world, especially in developing countries (Pauly, 2006). Their impact on vulnerable megafauna may thus be significant, either as bycatch or as target species (Moore *et al.*, 2010). However, detailed information on fisheries catch composition is limited due to a lack of monitoring and reporting as a result of restricted financial and logistical capacity. In developing countries, artisanal fisheries is the principal fishing practice and are consequently of considerable social and economic importance to regional human populations. These fisheries, however, can negatively impact the abundance and species composition of vulnerable taxa (Pinnegar & Engelhard 2008), with continued unregulated exploitation potentially leading to declines of key species with consequences not only for those species, but also the broader food web including commercial species that are critical to the livelihoods of local populations. The flexible and informal nature of most artisanal fisheries (broad range of target species, diversity of gears used, occurrence in multiple marine habitats, general absence of seasonality, etc.) make them very difficult to study, both in term of catch statistics and bycatch. In addition, for most artisanal fisheries (except some gillnet fisheries), observer programs are very difficult to implement, due to logistical constraints such as small boat size. Therefore, in absence of data collected at sea on fishing vessels by observers, researchers have increasingly used social sciences to better understand the interactions between artisanal fisheries and marine ecosystems (Johannes *et al.*, 2000; Close & Hall, 2006), particularly charismatic species such as marine mammals, elasmobranchs and sea turtles (e.g. Moore *et al.*, 2010; Kiszka, 2012; Leeney & Poncelet, 2013; Turvey *et al.*, 2013).

The Wider Caribbean Region (WCR; Fig. 1) is characterized by a diversity of marine habitats, including coral reefs, seagrasses, mangroves, and other environments, such as sandy beaches and rocky shores. So far, more than 10,000 marine species have been recorded in this region (Miloslavich *et al.*, 2010), including a diversity of sea turtle and marine mammal species occurring from inshore to deep oceanic waters. Despite the high value of this region as a breeding and feeding ground for cetaceans, sea turtles

and the Antillean subspecies of the West Indian manatee (*Trichechus manatus manatus*), very little is known on the magnitude of their interactions with human activities, especially fisheries (artisanal fisheries in particular) as one of their most potential source of additional mortality (Lewison *et al.*, 2004). Artisanal fisheries in the Caribbean are also poorly known, and as elsewhere around the world, they target multiple species using a diversity of gears, including gillnets, beach and seine nets, hand- and longlines. Caribbean small-scale fisheries also face common issues including resource overexploitation, fleet conflicts (with industrial and recreational fisheries) and lack of management that could be due to weak institutions, unclear legal management instruments, lack of capacity and enforcement and limited involvement of fishermen in management process (Salas *et al.*, 2007). Due to the widespread distribution and the major social and economic importance of artisanal fisheries in the WCR and their potential for interacting with vulnerable megafauna, bycatch may be a major issue in the region.

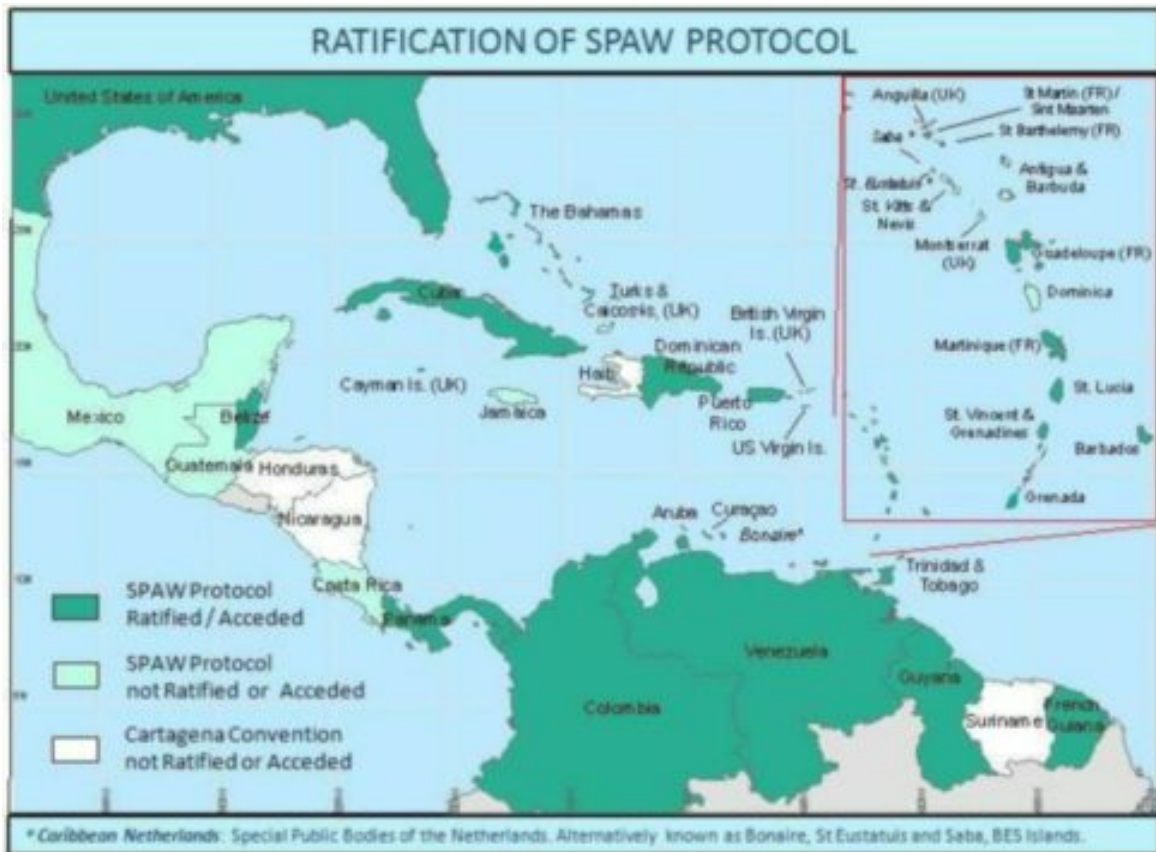


Fig. 1: Map of the Wider Caribbean region (<http://www.cep.unep.org/>).

Marine mammal and sea turtle fisheries have significantly declined for economic reasons in the West Indies and Caribbean (Caldwell and Caldwell, 1975). However, very limited information exists on the extent of bycatch in artisanal fisheries of the region. So far, sea turtle bycatch has only been documented in industrial longline, trawl and gillnet fisheries in the WCR and adjacent waters (Wallace *et al.*, 2010). Marine mammal bycatch in gillnets has also been documented in the region, including Belize (West Indian manatee), Colombia (West Indian manatee, mysticetes and odontocetes), Mexico (West Indian manatee, mysticetes and odontocetes) and Venezuela (West Indian manatee and odontocetes; Reeves *et al.*, 2013 for a review). However, information is almost anecdotal and qualitative.

The Antillean subspecies of the West Indian manatee (hereafter the West Indian manatee) is one of the most charismatic marine species in the Caribbean and is classified as “Endangered” on the IUCN Red List of Threatened Species. Actual population size is probably less than 2,500 remaining mature individuals throughout its range. In absence of immediate conservation and management actions, it has been hypothesized that West Indian manatees could undergo a decline of more than 20% over the next two generations (Self-Sullivan and Mignucci-Giannoni, 2008, 2012). This species is particularly vulnerable to anthropogenic threats (both lethal and non-lethal) due to its narrow coastal range, but also for its needs for freshwater for osmoregulation and warm water for thermoregulation. Just as all sirenian species around the globe, the main origin of the present status (especially low numbers) of West Indian manatees in the WCR is past hunting, notably for oil, meat and bones since the pre-Colombian period (Domning, 1982; Self-Sullivan and Mignucci-Giannoni, 2012). Intrinsic factors such as low fecundity, slow growth and maturation most likely limited the recovery of manatee populations throughout the region. Current threats of the West Indian manatee in the WCR include illegal hunting (e.g. Colombia, Mexico, Costa Rica, Cuba, Dominican Republic and Honduras), as well as watercraft collisions and bycatch (Self-Sullivan and Mignucci-Giannoni, 2012). Nowadays, it is still difficult to distinguish intentional and incidental captures, and reporting by fishermen is very rare (Quintana-Rizzo and Reynolds, 2008). Except for Haiti, West Indian manatees are protected by law throughout the WCR. However, baseline information on their abundance and population trends is still lacking in most countries of the species range (Table 1.1).

Within the framework of the Action Plan for the Conservation of Marine Mammals (MMAP) in the WCR (UNEP, 2008) and the Regional Management Plan for the West Indian Manatee (CEP Technical Report 48, 2010), the SPAW-RAC has initiated a study on manatee bycatch in the region. This study, the

“Manatee Bycatch Pilot Project”, consists in a questionnaire that has been submitted to several hundreds of stakeholders (mostly fishermen) in each country. As a start and in order to assess the effectiveness and relevance of the approach, only a small number of countries have participated in the project: Belize, Colombia, Dominican Republic, Haiti and Mexico. The five countries have been chosen based on the interest of local partners to participate in the project and because of bycatch and vessel strikes representing the principal threats for manatees as reported in the Regional Manatee Management Plan. This report presents the results of this preliminary study, highlights strengths and limitations and proposes future directions.

Table 1.1: Overview of status, abundance and legal protection for West Indian manatees in Mexico, Belize, Colombia, Haiti and the Dominican Republic (references: Morales-Vela *et al.*, 2000, 2003; Montoya-Ospina *et al.*, 2001; Quintana-Rizzo and Reynolds, 2008; Self-Sullivan and Mignucci-Giannoni, 2012).

Country	Population Estimate	Population Trend	Date of Habitat/species protection	Core distribution	Threats
Mexico	1,500	Unknown (data deficient)	1921	Veracruz, Tabasco, Chiapas, Campeche (Gulf of Mexico), Quintana Roo	Bycatch, poaching, disturbance from tourism, vessel collisions
Belize	1,000	Probable decline (data deficient)	1933	Entire coast, particularly east of Belize city	Bycatch, poaching, disturbances from tourism, vessel collisions
Colombia	500	Probable decline (data deficient)	1969	Atrato, Sinú, San Jorge, Cauca, Cesar and Magdalena rivers, Ciénaga Grande de Santa Marta	Bycatch and poaching
Haiti	100	Unknown (data deficient)	-	North coast	Unknown
Dominican Republic	100	Probable decline (data deficient)	1938	South and north-east coast	Unknown

2. Methodology

This study aimed at investigating interactions between fisheries (including targeted captures and bycatch) and marine megafauna (marine mammals and sea turtles), with a particular focus on the West Indian manatee. In order to estimate the magnitude of fisheries mortality on West Indian manatees and other megafauna, a measure of fishing effort and a catch (or bycatch) rate are needed. It is widely accepted that the most accurate method to assess bycatch rates is using independent fisheries observers on board fishing vessels (Alverson *et al.*, 1994). However, when data collected on fishing vessels is unavailable or impossible to collect (artisanal fisheries vessels are generally too small to put observers on them), the knowledge of fishermen can be exploited from structured questionnaire surveys (Johannes *et al.*, 2000). Despite limitations of social survey data (data are generally more qualitative than quantitative, information provided is often inaccurate), this methodology enables assessing the relative importance (spatial and temporal) of fisheries on coastal ecosystems, including large marine vertebrates such as marine mammals and sea turtles. This method has been previously used in the WCR to investigate the past and present status of West Indian manatees, including in Mexico and Belize (Morales-Vela *et al.*, 2000, 2003) and Colombia (Montoya-Ospina *et al.*, 2001).

In-person interview surveys, which forms the basis of this study, consists of questionnaire surveys that were conducted in Haiti, Dominican Republic, Colombia, Mexico and Belize. A single questionnaire form was used, based on the methodology described by Pilcher and Kwan (2011). After an introductory statement, the questionnaire (a questionnaire was generally completed in about 30 minutes) included mostly closed questions allowing collecting quantified and factual information. Each questionnaire was completed in-person with fishermen or other stakeholders. Firstly, questions included interviewee's characteristics: age, gender, previous involvement in interview surveys, occupation and fishing background, fishing practice (monthly "effort") and fishing boat characteristics. Questions on their level of knowledge on manatees, cetaceans and sea turtles were asked, including on sighting frequency and seasonality, existence of hotspots and abundance of animals. Then, the core of the questionnaire on captures was conducted. Questions were asked on manatee, cetacean and sea turtle captures at different spatial and temporal levels: captures in neighboring villages and own experience (lifetime, 5 last years and last year). Perception questions were also asked, especially to investigate manatee, cetacean and sea turtle population trends, their importance in the ecosystem and in the local culture,

for example. Finally, questions on fishing gear used were asked (Appendix 1). For each country, a national coordinator was designated. He/she led training activities, supervised interviewers and collated data to fill in the national database (Excel table). National coordinators were permanent citizens/residents of the study countries and were experienced working with fishing communities and bycatch issues. Training of the interviewers included explaining the purpose of the study, survey protocol and design.

Here, analyses of the questionnaire focused on assessing spatial and temporal variations of megafauna and other species (sea turtles and cetaceans) bycatch as well as to identify factors responsible for the occurrence of captures.



Questionnaire survey training workshop (Holbox, Mexico) conducted in June 2012 (top left) and questionnaire surveys conducted with local fishermen.

3. Results

3.1 Sampling

A total of **896** interview surveys were conducted in the studied region, including 55 from Belize, 40 from Mexico, 192 from Haiti, 508 from Colombia and 101 from the Dominican Republic. For Haiti, 369 fishermen were interviewed, but no information on bycatch/deliberate captures of manatees (or any other species) were documented in almost half the cases ($n = 177$ interviewees), therefore only 192 surveys were selected to the analysis of results. The questionnaire data for the other 177 were discarded from the analysis.

3.2 Belize

General and interviewee characteristics

Questionnaire surveys were conducted from December 2012 to March 2013. A total number of 55 interviews was conducted in three districts, including Corozal ($n=20$), Toledo ($n=26$) and Stann Creek ($n=9$) by six interviewers (Fig. 2). Age of sampled interviewees ranged from 20 to 66 (mean=43). 95% of interviewees were males. Only 31% of fishermen did not participate in previous interview surveys. For those who participated in previous surveys (not exclusive), fisheries (49%), marine protected areas (MPAs; 29%) and marine mammals (25%) were the main focus of these questionnaires. For 82% of interviewed fishermen, fishing was their primary activity. Their mean fishing experience was 22.5 years (Range=5-51). 48% of fishermen declared fishing every month of the year. For others, no seasonal pattern was found. The mean number of fishing days per week varied from 5.1 (low season) to 5.4 (high season) and ranged from 1 to 7 (mode=7). Among interviewed fishermen, boat length ranged from 2.4 to 27 meters (mean=17) and 96% were using motorized boats (mean HP=40, range=6-120). Gillnets are mostly used by interviewed fishermen, on a year-round basis. Fishermen use them to catch fish. They are set close to shore close to mangroves and on seagrass beds (in less than 10 meters deep) during 6-12 hours (modal soak time). The modal length of nets is 100 meters, but they can reach up to 400 meters.



Fig. 2: Location of the sampled district in Belize

(from left to right: Corozal, Stann Creek and Toledo, www.wikipedia.org)

Megafauna' sightings

100% of fishermen declared they already sighted manatees in varying circumstances, including during their fishing operations (65%) and traveling (59%; typically during transit to fishing sites; Fig. 3). In other cases, fishermen observed manatees stranded (4%, 2 cases), hunted (1 case) or caught in nets (8%; Fig. 3). For dolphins (only 16 respondents), two species were reported as observed, including the bottlenose dolphin (*Tursiops truncatus*) and the Atlantic spotted dolphin (*Stenella frontalis*), mostly observed during traveling (63%) and fishing (50%; Fig. 3).

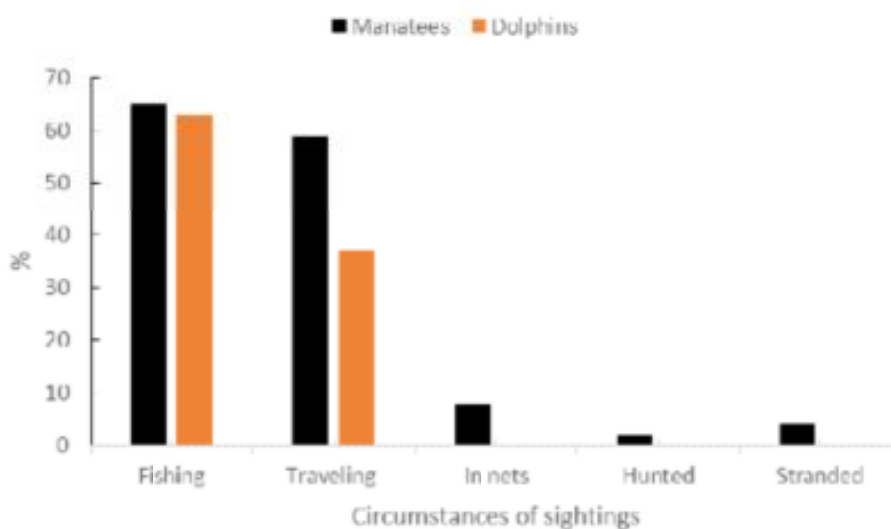


Fig. 3: Circumstances of manatee and dolphin sightings in Belize.

No seasonal patterns of sightings were consistently reported for both manatees and dolphins, suggesting a year-round presence of these species along the coast of Belize. For 68% of interviewed fishermen, manatee hotspots exist along the coast. However, the location of these hotspots has not been provided. Calves have been observed by at least 58% of interviewees.

Megafauna' captures

According to interviewed fishermen, captures of manatees in other villages than theirs occur for 24% of them (49% declared no and 27% did not know about it; Fig. 4). For a slight majority of them (58%), the deliberate killing of manatees does not occur in their own village, whereas that all interviewed fishermen did not declare any manatee capture during the last year (Fig. 4). However, during the last 5 years, one fisherman declared the incidental catch of three manatees. Finally, 33% of fishermen declared manatee captures during their career (Fig. 4) in numbers varying between 1 (n=4 fishermen) and 3 individuals (n=2). Manatee captures (either intentional or incidental) were reported in Corozal (n=1 fisherman), Toledo (n=2) and Stann Creek (n=1). A case of manatee poaching has been reported by one interviewee in Toledo. No spatial patterns of captures were investigated due to limited sample size and the low levels of captures reported by interviewees.

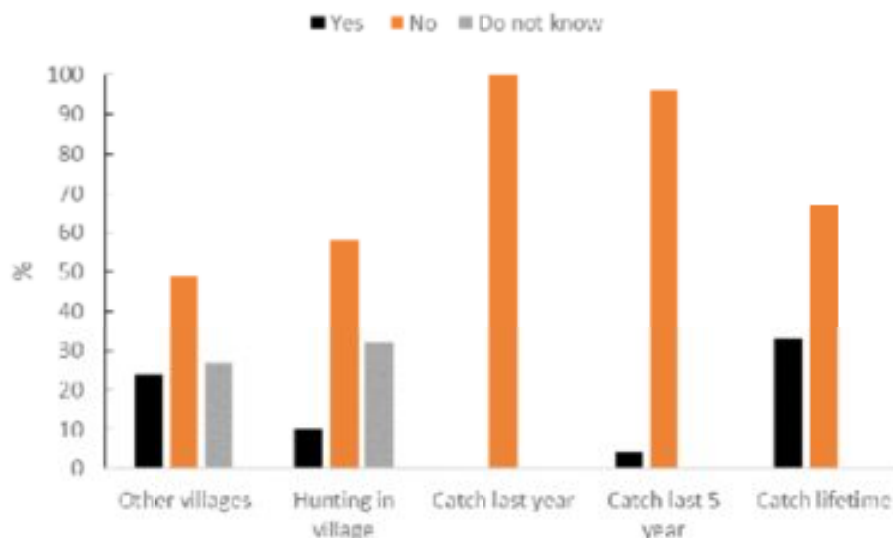


Fig. 4: Declaration of manatee captures by interviewed fishermen in Belize (from left to right: 1- Do manatee captures occur in other villages?; 2- Does manatee hunting occur in your village?; 3- Did you

catch a manatee during the last year?; 4- Did you catch a manatee during the last 5 years?; 5- Did you catch a manatee during your lifetime?).

Concerning dolphin and sea turtle captures, very little information was provided (only 16 and 12 respondents, respectively). 63% of interviewed fishermen declared dolphin catches (all incidentals) occur in other villages (no location provided). No dolphin catches were reported by any interviewee. For sea turtles, fishermen declared green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*) turtles are the most common species in Belize. 42% reported that captures occur in other villages, and only 18% declared that captures occur in their own village. A single fisherman reported two sea turtle captures during the last year (no species identity provided).

Factors affecting catches and use of caught megafauna

No information on habitat-specific characteristics of captures was provided. On 8 reported captures of manatees, 6 were made with gillnets and 4 with a harpoon (intentional captures). Very limited information was provided on the use of caught manatees, dolphins or sea turtles. Once a manatee is caught on purpose, interviewed fishermen declared they eat or sell the animal. When caught by accident, 75% of them declared their release or discard (if dead).

Perceptions of catch and population trends

For a majority of interviewed fishermen (42%), there is an increase of manatee captures in Belize, either incidental or intentional (unclear from data collected). Moreover, fishermen also perceive an increasing number of manatees along the coast of Belize (Fig. 5). According to them, the increasing number of manatees is most likely due to the protection of this species in their country.

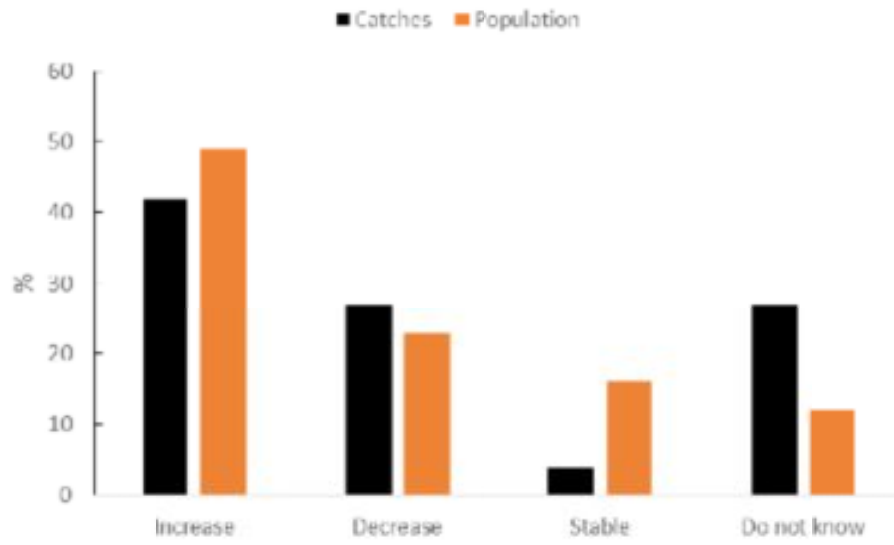


Fig. 5: Perception of catch and population trends of manatees in Belize.

3.3 Mexico

General and interviewee characteristics

Questionnaire surveys were conducted between January and May 2013 by four interviewers in the state of Quintana Roo (southeastern Mexico; Fig. 6). 40 interviews were conducted in 14 villages. All interviewees were males, and their age ranged from 20 to 74 (mean=42). For 63% of interviewed fishermen, fishing was their main occupation. Their mean fishing experience was 21 years (Range=2-45). Nearly 89% of interviewed fishermen did participate in previous interview surveys. For those whom participated in previous surveys (not exclusive), fisheries (74%), MPAs (36%), marine mammals (10%), ecotourism (8%) and sea turtles (5%) were the focus of previous studies. 76% of fishermen declared fishing every month of the year. For others, their effort was higher during summer, especially in July and August. The mean number of fishing days per week did not vary with seasons (mean=6; mode=7; range=1-7).



Fig. 6: Location of the state of Quintana Roo (southeastern Mexico, www.wikipedia.org).

Among interviewed fishermen, mean boat length was 7.4 meters (mode=60) and 86% of them have motorized boats (mode HP=60). 65% of fishermen provided information on fishing gear used. Surprisingly, no fishermen have declared the use of gillnets or seines (such as purse and beach seines). All interviewees declared the use of longline and hook and lines to target fish mostly in deep waters from March to July.

Megafauna' sightings

100% of fishermen declared they already sighted manatees in varying circumstances, including when transiting to fishing spots (68%) and during fishing (40%). In one occasion, a fisherman observed a stranded manatee (Fig. 7). Only 17% of fishermen declared manatees occur on a year round basis along the coast of Quintana Roo. For dolphins (33 respondents), encounters were essentially made during fishing or when traveling (Fig. 7). The identification of species encountered was not consistent, so information provided was discarded. For 78% of interviewed fishermen, manatee hotspots exist along the coast. However, the location of these hotspots was not provided. Calves have been observed by at least 28% of interviewees.

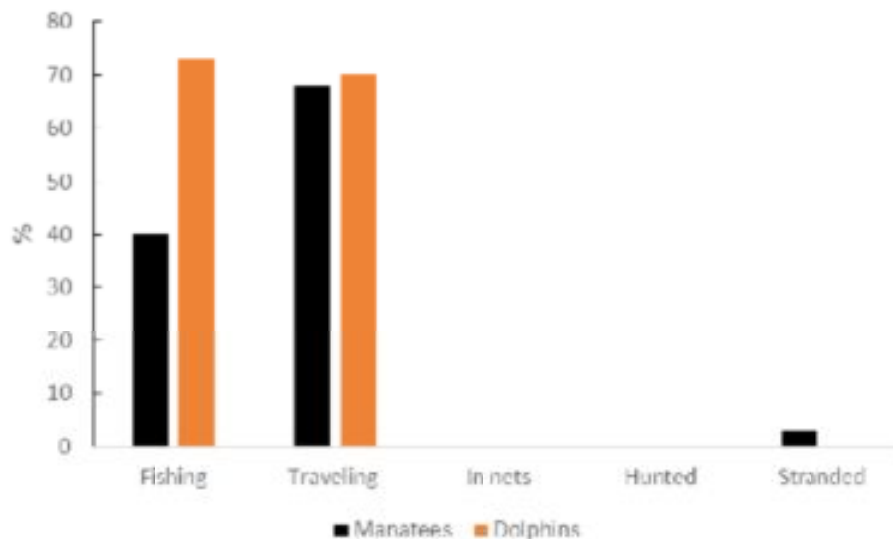


Fig. 7: Circumstances of manatee and dolphin sightings along the coast of Quintana Roo (SE Mexico).

Megafauna' captures

Manatee captures occur in other villages for only 11% of interviewed fishermen (78% declared no and 9% did not know about it; Fig. 8).

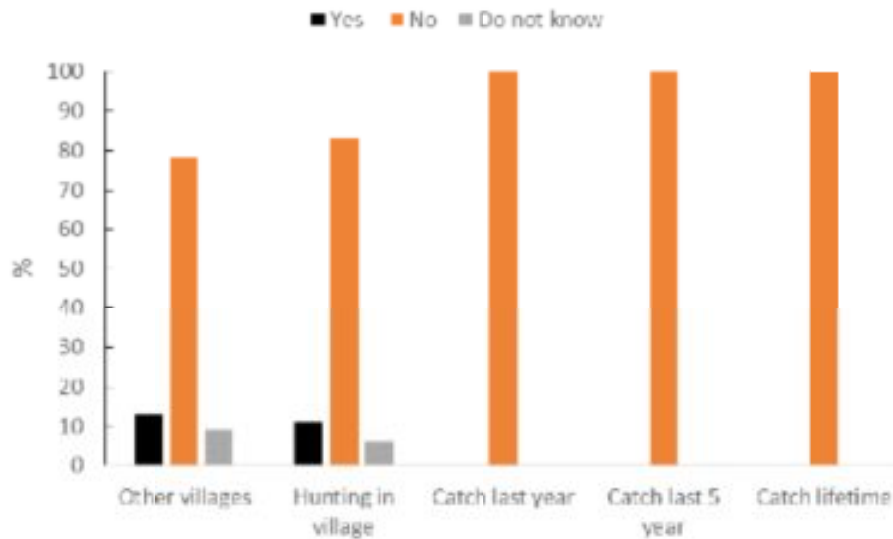


Fig. 8: Declaration of manatee captures by interviewed fishermen in Mexico (from left to right: 1- Do manatee captures occur in other villages?; 2- Does manatee hunting occur in your village?; 3- Did you catch a manatee during the last year?; 4- Did you catch a manatee during the last 5 years?; 5- Did you catch a manatee during your lifetime?).

For only 11% of them, the deliberate killing of manatees occurs in their own village. No manatee capture was declared by any fisherman in Quintana Roo, neither during the last year, last five year or during their career (Fig. 8). No deliberate nor incidental captures of dolphins were reported by fishermen. No information on sea turtle captures were provided at all (no interviews for sea turtles has been conducted in Mexico).

Factors affecting catches and use of caught megafauna

No information on habitat- nor gear-specific characteristics of captures was provided. Once a manatee is caught, interviewed fishermen declared the animal is eaten and eventually sold (2 cases). However, it is unclear whether this fate applies for them and their village, or for fishermen from other villages.

Perceptions of catch and population trends

No trend of captures or population size was provided by interviewed fishermen. However, a majority of them (88%) consider manatees will persist in the Quintana Roo region in the future, as this species is currently protected (all fishermen are aware that killing a manatee is illegal in Mexico).

3.4 Colombia

General and interviewee characteristics

In Colombia, questionnaire surveys were conducted from May to July 2013. A total number of 508 interviews was conducted in two major river basins: including Magdalena (n = 177) and Sinú (n=331) river basins. Magdalena river basin includes six departments that were sampled: Magdalena (n=72), Bolivar (n=41), Cesar (n=29), Antioquia (n=23), Atlántico (n=20) and Santander (n=13, Fig. 9). Sinú river basin was sampled in Córdoba department. In total, interviews were conducted in 28 villages. The age of sampled interviewees ranged from 16 to 85 (mean=44), and 65% of interviewees were males.

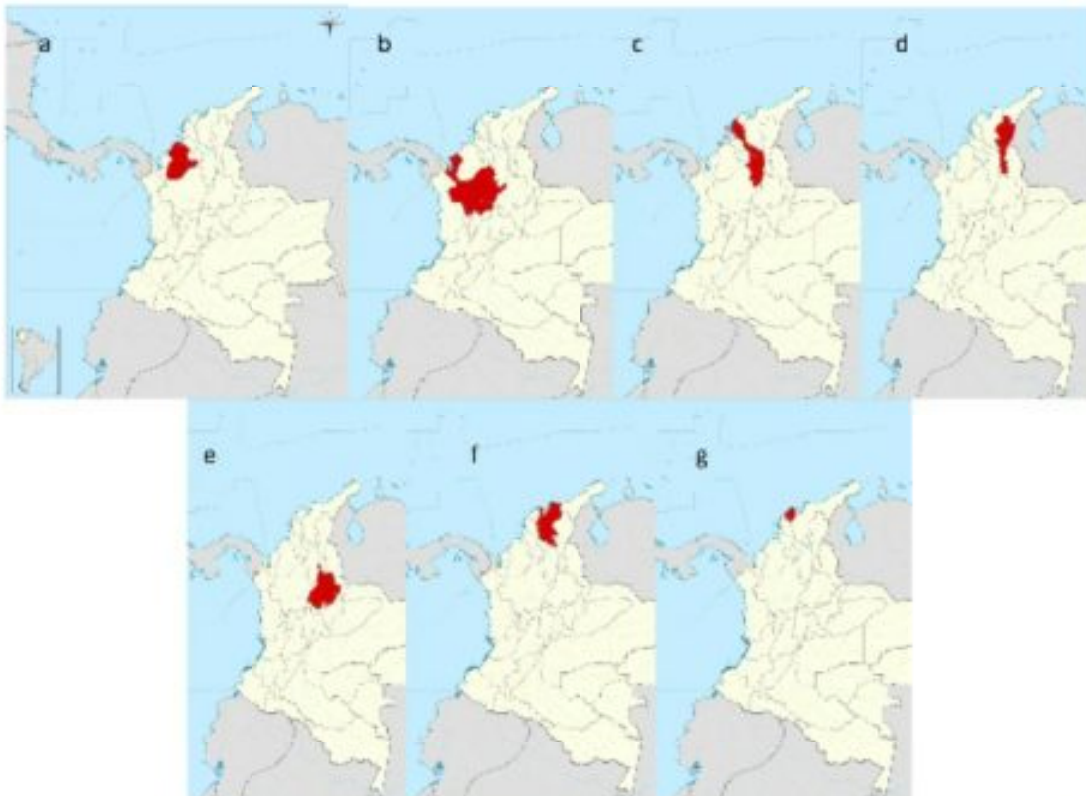


Fig. 9: Location of the sampled departments in Colombia (a- Córdoba, b- Antioquia, c- Bolívar, d- Cesar, e- Santander, f- Magdalena, g- Atlántico ; www.wikipedia.org).

For 72% of interviewed fishermen, fishing was their primary activity and their only professional activity for 47% of them. Their mean fishing experience was 27 years (range=1-70). More than 62% of interviewed fishermen have previously been involved in questionnaire surveys. For those whom

participated in previous surveys (not exclusive), fisheries (33%), sea turtles (14%), marine mammals (7%) and marine protected areas (4%) were the main focus of previous studies. 61% of fishermen declared fishing every month of the year. The number of fishing days per week ranged from 1 to 7 (mean=4.6; mode=3). Among interviewed fishermen, boat length ranged from 2 to 10 meters (mean=6.6 m) and only 23% use motorized boats. Among fishing gears used, the most detailed information was provided on gillnets. These gillnets are used in multiple habitats, including coastal (estuaries, mangroves) and deep water and target fish in large majority (>95%). However, the relative use of each habitat could not be estimated. Soak time was highly variable among interviewed fishermen (from < 2 hours to >24 hours: modal range=6-12 hours). Mean net size was 154 m and modal size was 100 m (range=10-1000 m).

Manatee sightings

Information on sightings were only provided for manatees, but not for cetaceans and sea turtles. 85% of fishermen declared they had already sighted manatees in varying circumstances, but essentially fishing (73%). No differences in sighting reporting rates between the two main river basins (Fig. 10).

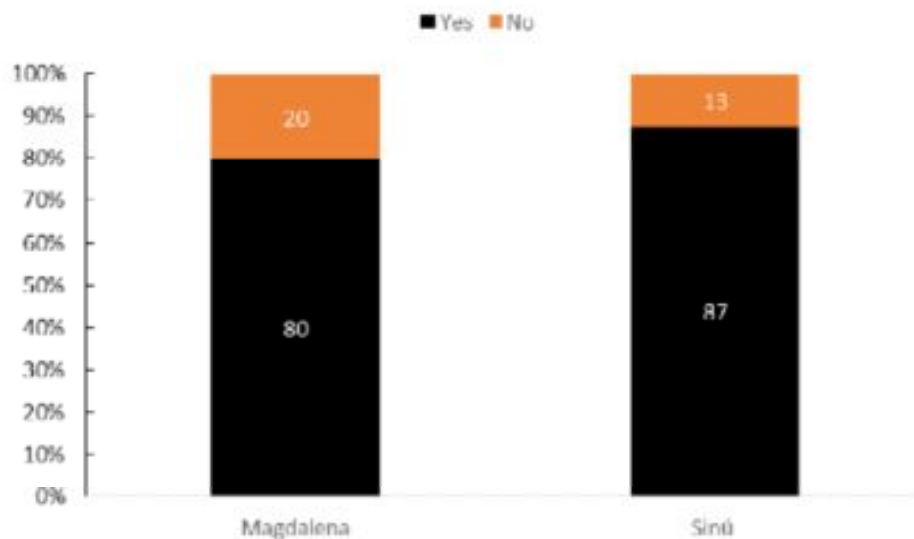


Fig. 10: Proportion of fishermen having previously observed manatees in Magdalena and Sinú river basins.

Seasonality of observations was inconsistent among interviewed fishermen, and manatees are seen all year round along the coast of Colombia. For 93% of interviewed fishermen, manatee hotspots exist along the coast of Colombia. However, the location of these hotspots was not provided.

Manatee captures

For 70% of interviewed fishermen throughout the country, captures of manatees do not occur in other villages (Fig. 11). For 90% of fishermen, hunting for manatees does not occur in their own village. Only 3% of interviewed fishermen declared captures of manatees (Fig. 11), both incidentally using gillnets (n=7 interviewees) but also intentionally using a harpoon (n=9). These captures were reported in both Sinú (n=9 interviewees) and Magdalena river basins (n=7). Catches over the last 5 years were reported by 11 fishermen (6%). However, nearly 10% (n=18) of interviewed fishermen declared a capture of manatee during their entire fishing career (Fig. 11).

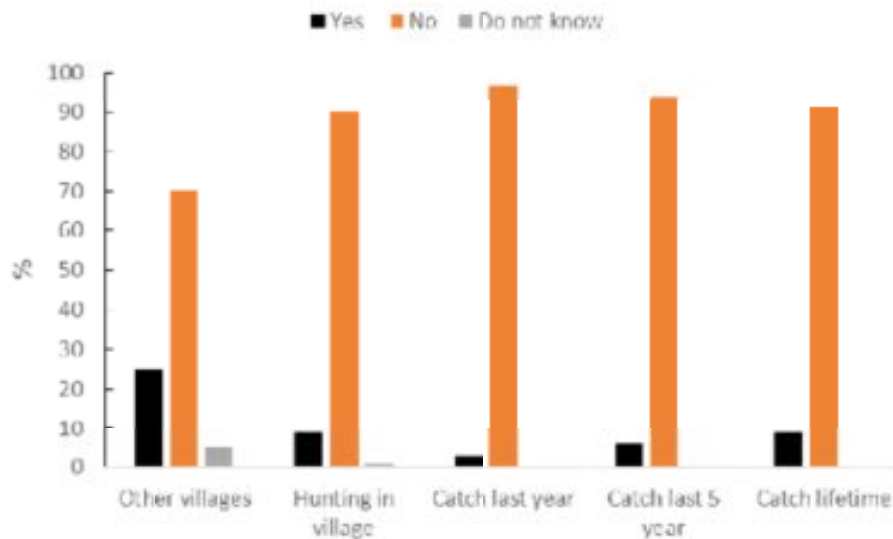


Fig. 11: Declaration of manatee captures by interviewed fishermen in Colombia (from left to right: 1- Do manatee captures occur in other villages?; 2- Does manatee hunting occur in your village?; 3- Did you catch a manatee during the last year?; 4- Did you catch a manatee during the last 5 years?; 5- Did you catch a manatee during your lifetime?).

Only three fishermen reported the capture of manatees during the last year, all in Magdalena department. Captures reported during the last 5 years have occurred in both Magdalena (n=4 cases) and Sinú river basins (n=7). Captures reported during fishermen's career also occurred in Sinú (9 cases) and Magdalena (n=9) basins. When reporting catches, fishermen mostly declared the capture of a single individual, including at the scale of their lifetime. However, multiple captures were reported by two interviewees (4 individuals each) in Sinú river basin.

Factors affecting catches and use of caught manatees

As we could expect, if caught on purpose, manatees are either eaten or sold for meat consumption, in almost all cases. If caught by accident, 58% of interviewed fishermen declared they would release the animal. We can certainly add to this 7% of them who would discard a caught animal. 13% of fishermen would consume the meat of caught manatees, and 3% would sell it. About 18% of interviewees did not respond to the question of the use of manatees if caught by accident. No detailed analyses on habitat- or gear-specific characteristics of captures could be conducted due to limited data and sample size. However, fishermen that have already made incidental captures were using gillnets in shallow waters, mostly targeting fish.

Perceptions of catch and population trends

No clear pattern could be found at the national level on trends of manatee numbers in Colombia. Overall, increase of manatee abundance was reported for 39.8% of interviewed fishermen, whereas 47.6% reported a decrease of the number of manatees. However, some variations were found among the sampled departments (Fig. 12).

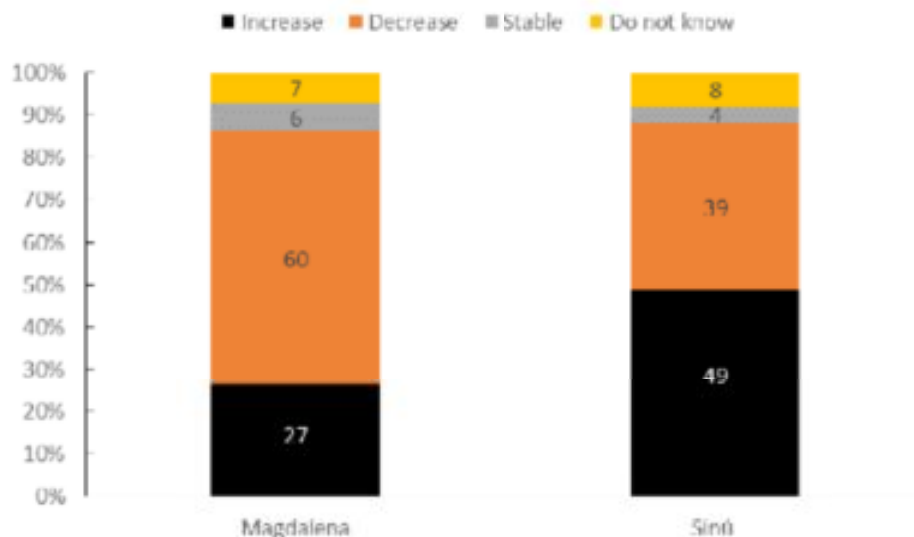


Fig. 12: Perception of population trends of manatees in Colombia (in %).

The decline of manatees seems to be perceived differently among the two main river basins. In the Magdalena river basin, fishermen mainly perceive a decrease of manatee numbers, whereas fishermen from the Sinú basin mostly report an increasing abundance of manatees (Fig. 12).

3.5 Haiti

General and interviewee characteristics

Questionnaire surveys were conducted from March to May 2013 in Haiti. A total number of 369 interviews was conducted in 32 villages belonging to 10 departments located all around the country. However, only 192 surveys from 9 departments contained information on manatee captures and fishing practices (Fig. 13). The age of sampled interviewees ranged from 19 to 90, and 95% of interviewees were males. For 89% of interviewed fishermen, fishing was their main occupation. 87% of fishermen declared fishing every month of the year. The number of fishing days per week ranged from 1 to 7 (mode=6). Boat length ranged from 1.5 to 7.6 meters (mean=3.8 m) and only 15% use motorized boats (HP range=8-40). In Haiti, multiple fishing gears (targeting multiple taxa, but mostly fish) are used by artisanal fishermen, including gill/trammel nets, pelagic and bottom longlines, purse and beach seines, traps and hand lines. Fishing occurs all year round in a diversity of coastal habitats. However, nets are mainly used in seagrass (43%) and deep water (42%) habitats. The relative importance of fishing gear used could not be evaluated due to lack of data. Soak time was highly variable among interviewed fishermen (from < 2 hours to > 24 hours), but the modal soak time was atypically long (> 24 hours). The mean length of nets used is 372 m, but varies considerably among respondents (SD=265; range=20-1580 m).

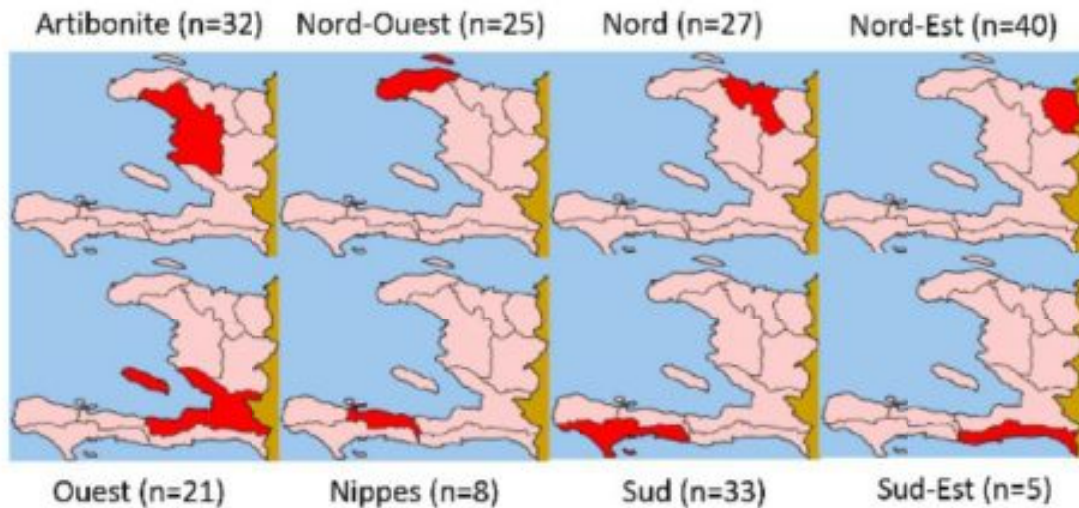


Fig. 13: Number of interviews conducted in Haiti for each department (Grand'Anse excepted, n=1, www.wikipedia.org).

Manatee sightings

Information on sightings were only provided for manatees only (no information for cetaceans and sea turtles). 95% of fishermen declared they already observed manatees. However, circumstances of observations were not provided. There were strong differences on the rate of manatee sighting reporting among the sampled departments. Indeed, fishermen from the north coast mostly observe manatees (Nord, Nord-Est and Nord-Ouest departments), whereas observations in the south of the country are significantly rarer (manatees are rarely reported by fishermen from the Ouest department; Fig. 14). Circumstances of manatee sightings were not provided.

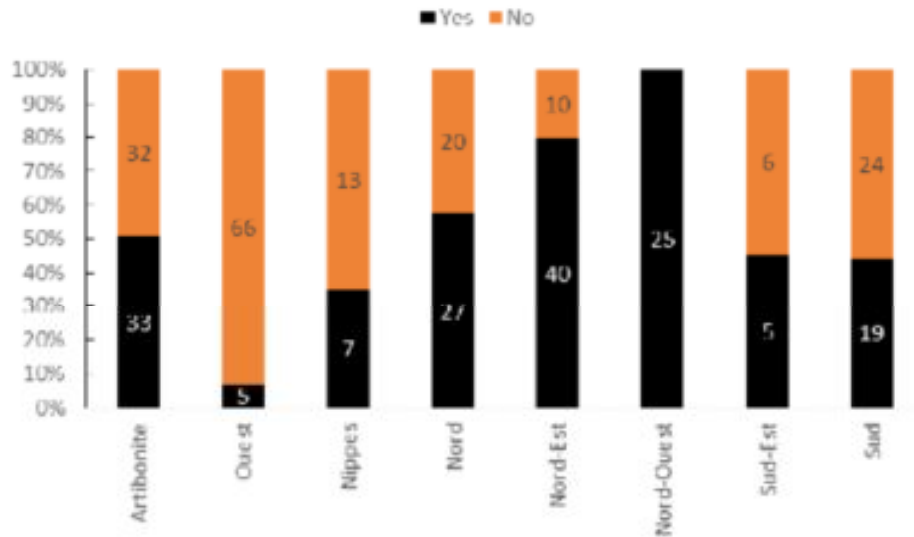


Fig. 14: Proportion and numbers of fishermen having previously observed manatees from the nine sampled departements of Haiti.

Manatee captures

A large proportion of Haitian fishermen declared that manatee hunting occurs in their village (44%). However, they rarely declared captures made by themselves. As expected, there is an increasing number of manatee captures reported by interviewed fishermen over time (Fig. 15). Captures of manatees in other villages was mostly reported by interviewed fishermen from Nippes, Sud-Est and Sud departments (Fig. 16). According to a large proportion of them, hunting for manatees occurs all around Haiti, especially Artibonite, Nord, Nord-Est (Fig. 17). However, only 2% of interviewees declared catching manatees themselves during the last year, including in Sud-Est (n=1 interviewee), Nippes (n=1) and Nord (n=1) departments. Number of captured manatees for each fisherman varied between 1 (n=2) and 2 (n=1). Captures of manatees during the last 5 years and during their lifetime were declared by 3% and 10% of respondents, respectively.

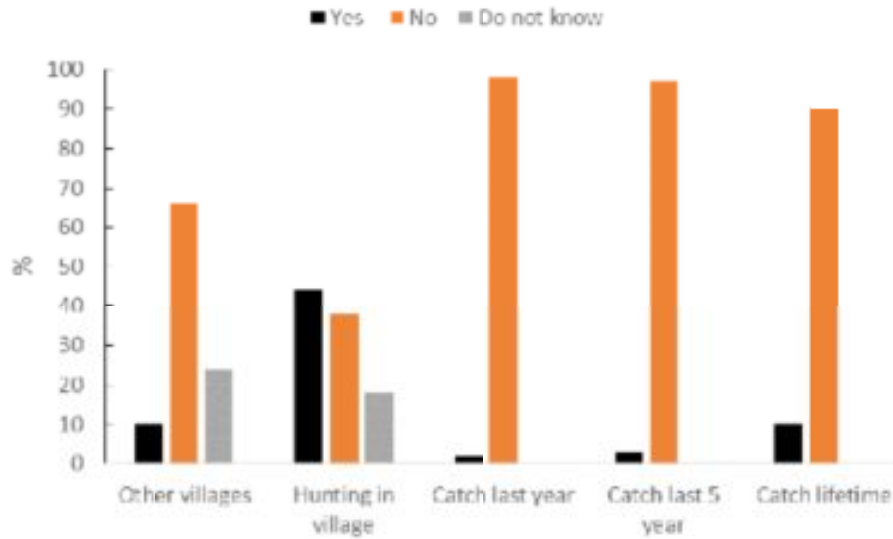


Fig. 15: Declaration of manatee captures by interviewed fishermen in Haiti (from left to right: 1- Do manatee captures occur in other villages?; 2- Does manatee hunting occur in your village?; 3- Did you catch a manatee during the last year?; 4- Did you catch a manatee during the last 5 years?; 5- Did you catch a manatee during your lifetime?).

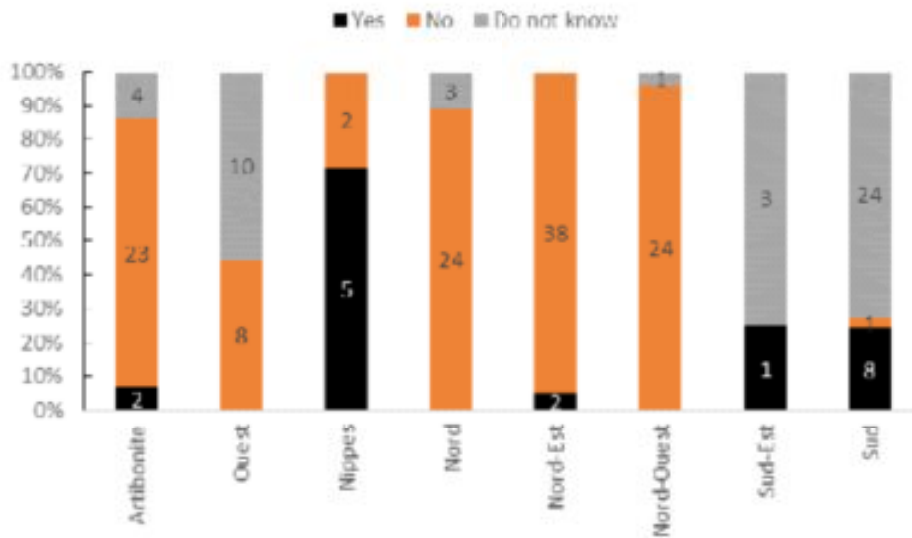


Fig. 16: Proportions and numbers of fishermen who reported captures of manatees in other villages for each sampled department in Haiti.

Captures reported during the last 5 years have occurred in Sud-Est (n=1 case), Nippes (n=2), Artibonite (n=1) and Nord (n=1) departments. Interestingly, captures reported during their career mostly occurred

in Artinonite (50% of fishermen), Nippes (12%, n=2), Nord-est (n=1), Nord (n=1), Sud (n=1) and Sud-Est (n=2) departments. When capture occurred over a lifetime, fishermen reported a single captured individual on 88% of cases. Otherwise, fishermen declared the capture of 3 (2 cases) and 4 (2 cases) individuals in total.

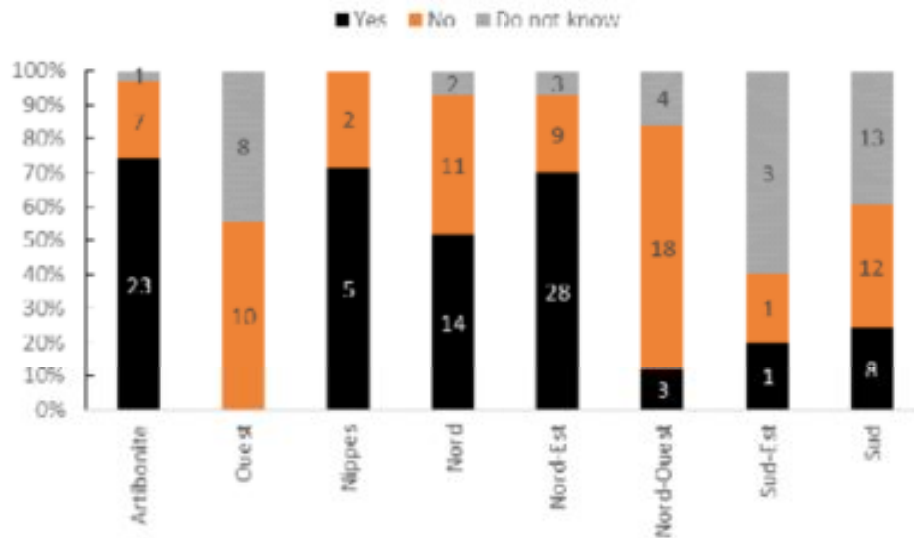


Fig. 17: Proportions and numbers of fishermen who reported manatee hunting in their own village for each sampled department in Haiti.

Factors affecting catches and use of caught manatees

No analyses on habitat- or gear-specific characteristics of captures could be conducted due to limited data and sample size. If caught either on purpose or by accident, manatees are eaten and/or sold.

Perceptions of catch and population trends

No trends of manatee catch or bycatch was provided by interviewed fishermen. However, for more than 40% of them, there is a decreasing abundance of manatees off Haiti (28% think there is an increase; Fig. 18).

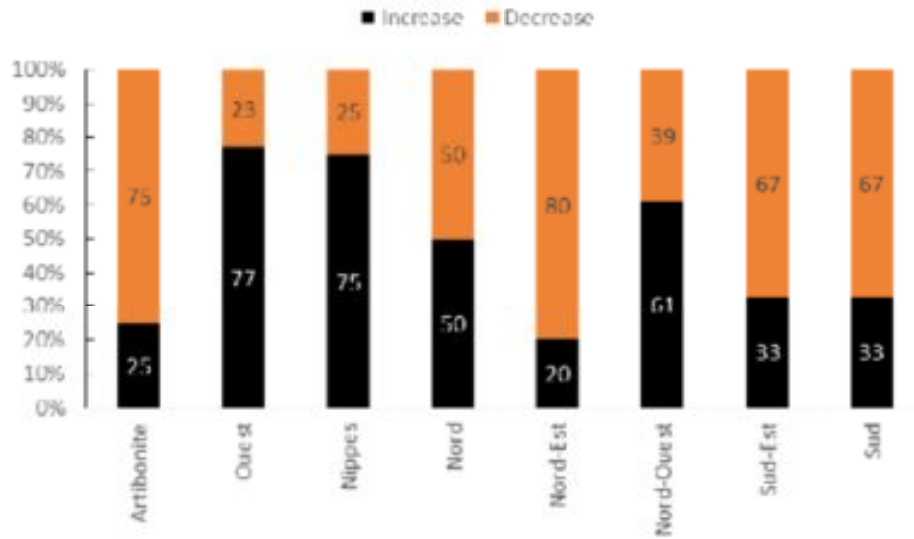


Fig. 18: Perception of manatee population trends of manatees in Haiti.

There were spatial variations of the perception of population trends of manatees in Haiti. Fishermen perceive a decline of manatees in Artibonite and Nord-Est departments (the decreasing pattern observed in Sud and Sud-Est department is based on a very small sample size). Conversely, a population increase is perceived by fishermen from Ouest, Nord-Ouest and Nippes.

3.6 Dominican Republic

General and interviewee characteristics

Questionnaire surveys were conducted from August to December 2012. A total number of 101 interviews was conducted in the Samana province, located in the northeastern part of the country (Fig. 19). Eleven interviewers conducted the survey in five towns. The age of sampled interviewees ranged from 19 to 89 (mean=43), and 100% of interviewees were males.



Fig. 19: Location of the Samana province (Dominican Republic, www.wikipedia.org).

For 86% of interviewed fishermen, fishing was their main occupation and their only professional activity for 50% of them. Their mean fishing experience was 25 years (range=3-68). 78% of fishermen declared fishing every months of the year. The number of fishing days per week ranged from 1 to 7 (mean=5.5; mode=7). Boat length of interviewed fishermen ranged from 3 to 10 meters (mean=5.45 m) and 80% use motorized boats (mean HP=18; mode=15). Among respondents, multiple fishing gears (targeting multiple taxa, but mostly fish) are used, especially gill/trammel nets, hand lines and beach seines. Fishing occurs all year round in a diversity of coastal habitats. However, the relative importance of fishing gear used could not be evaluated due to lack of data. For nets, their mean length was 272 m (range=19-600 m). Soak time did not vary among interviewed fishermen (mode= < 2 hours).

Megafauna' sightings

Information on sightings were provided for manatees, dolphins and sea turtles. 71% of fishermen declared they already observed manatees in varying circumstances, including during fishing operations (47%) and traveling (47%; Fig. 20). In other cases, fishermen caught manatees on purpose (6%, 4 cases). For 71% of interviewed fishermen, manatee hotspots exist in Dominican Republic. However, the location of these hotspots was not provided. Calves have been observed by at least 32% of interviewees (mostly between May and September). Dolphins have been observed by over 95% of interviewed fishermen, including bottlenose dolphins (>90% of respondents), but also spotted dolphins, short-finned pilot whales (*Globicephala macrorhynchus*) and killer whales (*Orcinus orca*). For 64% of them, there are preferential hotspots for dolphins off Dominican Republic. Among marine megafauna, sea turtles was the most commonly known taxa among interviewed fishermen (98%). Most commonly seen species are hawksbills (74% of interviewees), loggerheads (*Caretta caretta*; 60%), greens (46%) and leatherbacks (*Dermochelys coriacea*; 34%). As for cetaceans and manatees, sea turtles were mostly observed during fishing and traveling. However, nesting turtles have been observed by 6% of interviewees. About 67% of respondents think sea turtle hotspots exist in the region.

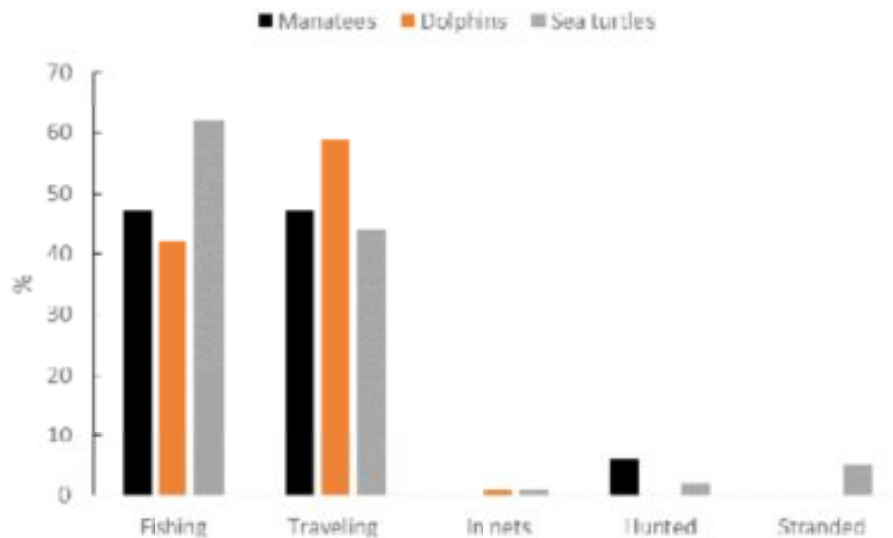


Fig. 20: Circumstances of manatee, dolphin and sea turtle sightings off Samana province (Dominican Republic).

Megafauna' captures

According to interviewed fishermen, captures of manatees in other villages occur for 18% of them (53% declared no and 29% did not know about it). However, 21% of them reported that manatee hunting occurs in their villages, while 100% of them declared no manatee capture either during the last year or the last five years (Fig. 21). Only two fishermen reported incidental captures, including one in a seine net (either beach or seine).

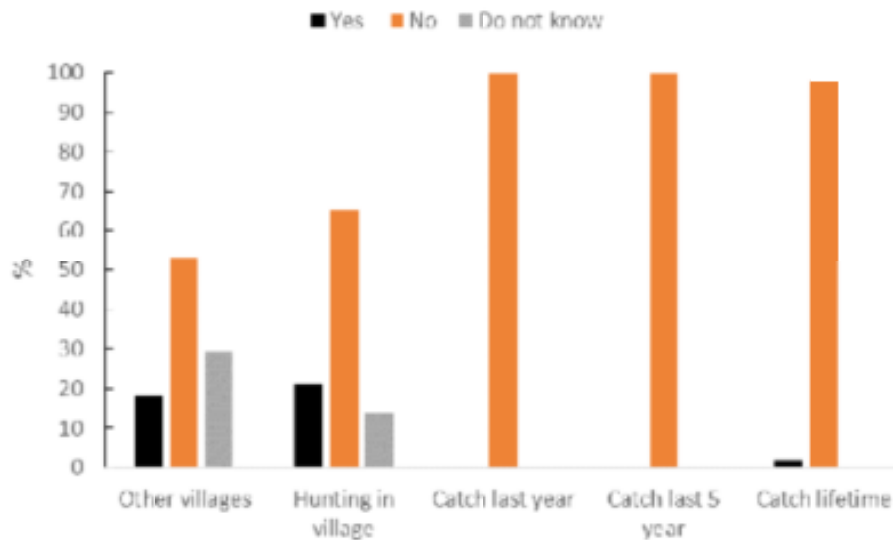


Fig. 21: Declaration of manatee captures by interviewed fishermen in Dominican Republic (from left to right: 1- Do manatee captures occur in other villages?; 2- Does manatee hunting occur in your village?; 3- Did you catch a manatee during the last year?; 4- Did you catch a manatee during the last 5 years?; 5- Did you catch a manatee during your lifetime?).

For dolphins, respondents did not know if captures occur in other villages. Two fishermen (7%) declared incidental captures of single individuals in gillnets during the last year. Sea turtle captures were more frequently reported by interviewed fishermen (Fig. 22). According to them, sea turtle captures occur in other villages (13%), such as in Puerta Plata, Los Cacaos and Sabana de la Mar. They also declared turtle hunting occurs in their own village for 33% of them (Fig. 23). However, only 9% of interviewees declared a sea turtle capture during the last year, while 12% and 21% made captures during the last five years (mean=1.3; range=1-3 individuals; mode=1) and during their lifetime (mean=1.5; range=1-3 individuals; mode=1), respectively (Fig. 22).

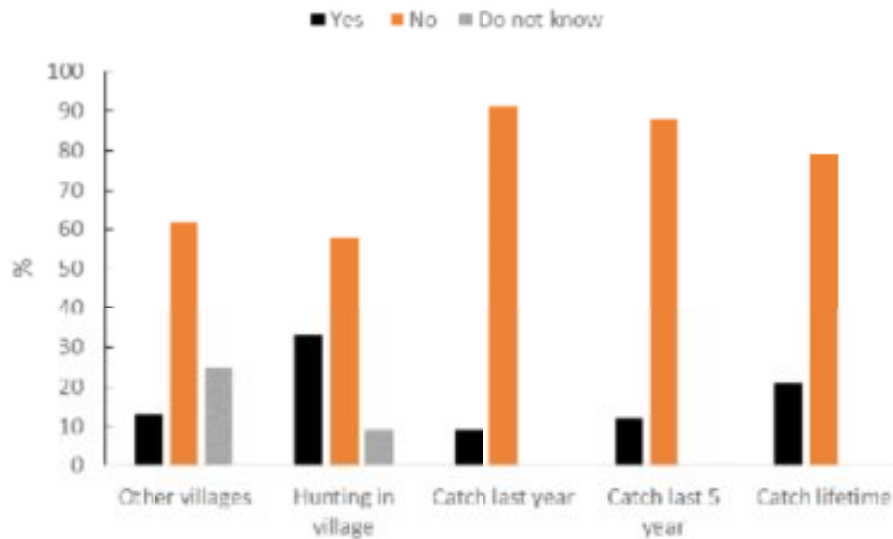


Fig. 22: Declaration of sea turtle captures by interviewed fishermen in Dominican Republic (from left to right: 1- Do sea turtle captures occur in other villages?; 2- Does sea turtle hunting occur in your village?; 3- Did you catch a sea turtle during the last year?; 4- Did you catch a sea turtle during the last 5 years?; 5- Did you catch a sea turtle during your lifetime?).

Factors affecting catches and use of caught megafauna

No gear-species characteristics of captures could be conducted due to limited sample size for manatees. For sea turtles, 41% of gears involved in captures were gillnets, 35% were either beach or purse seines and 18% were hook and lines. The identity of species involved could not be provided by respondents. In one case, a fisherman declared an intentional capture using a harpoon. When caught on purpose, manatees were eaten (36%) and/or sold (13%). However, data were not reliable as a large proportion of fishermen declared the release of caught animals. When incidentally caught, fishermen declared they release manatees (61%, when presumably alive) or discarded them (18%, when presumably dead). For 11% of them, they are eaten or sold (2%). When dolphins are captured, fishermen all declared they release or discard them. For sea turtles, when caught incidentally (89 respondents), the animal is released (66%), discarded (12%) or eaten (27%). The use of sea turtles as bait has been reported by one fisherman.

Perceptions of catch and population trends

For a majority of respondents from Samana province (42%), there is a decrease of manatee catches in Dominican Republic (9% only think captures are increasing; Fig. 23). They also perceive a decrease of

manatee numbers in their region (54%), while only 17% of them consider there is an increasing abundance of manatees. Trends in captures were not documented for dolphins. However, most fishermen perceive an increase of their number off Dominican Republic (75%). Finally, there is a perceived decreasing number of sea turtle captures, while their numbers are perceived as either increasing (42%) or decreasing (48%, Fig. 24).

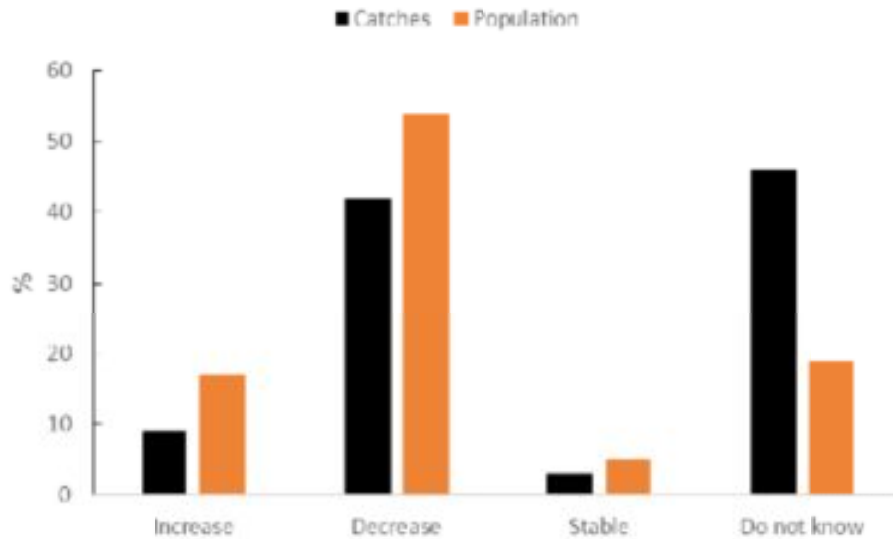


Fig. 23: Perception of catch and population trends of manatees in Samana province (Dominican Republic).

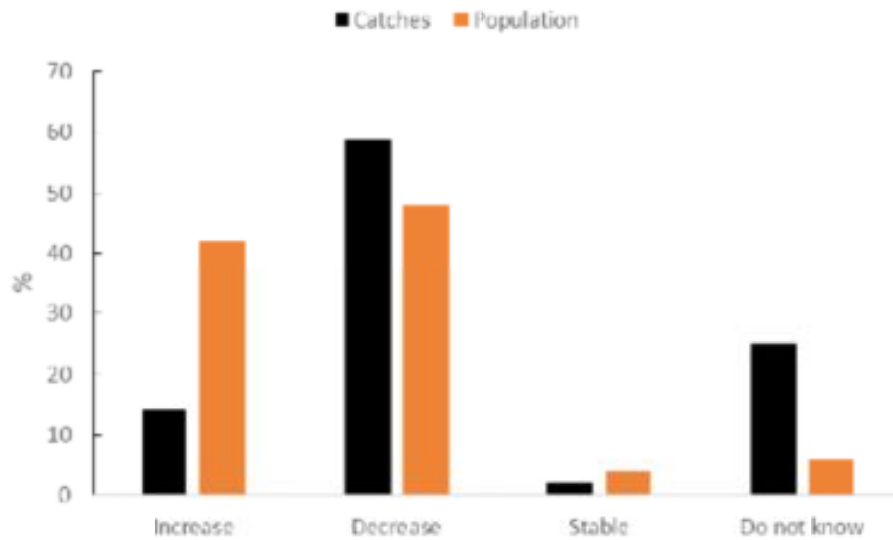


Fig. 24: Perception of catch and population trends of sea turtles in Samana province (Dominican Republic).

4. Conclusions and Recommendations

4.1 Major findings

For the first time in the WCR, a regional-wide study investigated the interactions between artisanal fisheries and vulnerable megafauna, including marine mammals (especially the Caribbean subspecies of the West Indian manatee), and sea turtles. Previous studies have been mainly conducted at the national level, especially on manatee bycatch and poaching (see for a review Self-Sullivan and Mignucci-Giannoni, 2012), but no previous studies exist on cetacean and sea turtle bycatch, exploitation and use in these small-scale fisheries. Interview surveys are probably the least expensive method to study the status and conservation issues of sirenians. They are noninvasive and enable to collect detailed information on small and elusive populations, including on their interaction with human activities such as fisheries. This pilot project is based on nearly 900 interviews collected in Belize, Mexico, Colombia, Haiti and Dominican Republic, and provide some new information on the incidental, and intentional catch of manatees, cetaceans and sea turtles in this region, their use as well as some factual information on trends of their abundance as perceived by fishermen.

Overall, this preliminary study highlights that manatees and sea turtles are still hunted in the region, despite the prohibition of their capture in most of the target countries and the decline of the consumption of manatee and sea turtle meat. It also underlines that bycatch occurs in most countries, but at a relatively low level. However, given the low size of manatee populations in the region (especially around insular states; Quintana-Rizzo and Reynolds, 2008; Self-Sullivan and Mignucci-Giannoni, 2008, 2012), combined to the fact that bycatch reporting is likely to be underestimated from interview surveys, captures may not be sustainable. However, more quantitative data on the abundance of manatees and bycatch rates are needed at the regional level. In Belize, both manatees, dolphins and sea turtles incidental and intentional catches have been reported, but the occurrence of captures seems relatively low. In Mexico (Quintana Roo), fishermen rarely reported bycatch events and it seems that the deliberate killing of manatees is extremely rare too. A relatively similar situation was found in Colombia. Conversely, intentional and accidental captures appear to be very common in Haiti, and fishermen declared on multiple occasions the importance of manatees as a resource (particularly for meat). However, there was some discrepancy between general statements (existence of hunting and bycatch in their village, for example) and number of catches declared by interviewed fishermen, which probably

suggests that respondents do not report their own catches. The perception of catch trends varied according to sampled countries, especially for manatees. In Belize, fishermen perceive an increasing occurrence of either incidental or intentional captures. Conversely, this pattern seems to be opposite in Colombia and Dominican Republic, where captures are perceived as decreasing. Interestingly, the perception of the trend in manatee abundance is contrasted between Hispaniola Island (Haiti and Dominican Republic) and the mainland (Mexico, Belize and Colombia), where populations are believed to decrease for the former and increase for the latter. However, some contrasted situations were found in Colombia. The decline of manatees seems to be perceived differently among the sampled regions. Indeed, the majority of fishermen from Cesar, Atlántico, Magdalena and Santander reported a decline of manatees. Conversely, fishermen from Antioquia, Bolivar and Córdoba reported an increasing abundance of manatees. In Haiti, data collected may indicate some level of continued bycatch and a marked decline of manatees off the island. Therefore, urgent studies are needed to complement questionnaire data, such as using abundance surveys (e.g. transect surveys), particularly in the most poorly known areas such as Hispaniola Island. Spatial trends of bycatch within sampled countries was not possible due to either limited sample size (e.g. Belize, Mexico) or the restriction of the interview survey effort to a single province or state (all other countries, except Haiti and Colombia). In Haiti, questionnaires have been distributed throughout most coastal departments around the country. Manatee sightings were reported by fishermen from all coastal departments that were sampled. However, areas where most manatee sightings were reported are Nord-Ouest, Nord-Est, Nord and Artibonite departments. Despite the absence of data on the current distribution of manatees around Haiti, it seems that this species may be more widely distributed than previously thought (Rathbun *et al.*, 1985). However, more data are needed to document the current distribution and abundance of manatees in Haiti. Even if bycatch data were not provided for this country, it seems that manatee hunting widely occurs, especially in Artibonite, Nippes, Nord and Nord-Est departments, where manatees are most likely to occur (Quintana-Rizzo and Reynolds, 2008). As manatees are considered as an important resource in Haiti (at least culturally), it appears that future studies and management measures are critically needed in this country.

4.2 Data limitations

In this preliminary study, we used a relatively large dataset, in comparison to most other studies conducted locally (e.g. Morales-Vela *et al.*, 2000; Montoya-Ospina *et al.*, 2001; Quintana-Rizzo and

Reynolds, 2008). However, data were lacking in order to better characterize bycatch and hunting/poaching. Qualitative and quantitative information on fishing practices were poorly provided but are extremely important, especially to calculate a fishing effort. Moreover, from the data collected, no bycatch rates could be calculated. However, in order to spatially and temporally estimate fisheries captures (including targeted species and bycatch), two types of information are needed: a measure of fishing effort and a bycatch rate (e.g. number of individuals caught per unit of effort). The most basic, easy and widespread metrics of fishing effort is the number of boats, particularly from rapid and low-cost methods such as questionnaire surveys (López *et al.*, 2003; McCluskey and Lewison 2008; Moore *et al.*, 2010). Fishing effort and bycatch rates expressed in terms of more specific effort metrics (e.g., number of boat-days, number of fishing trips) can typically be reduced to values expressed in terms of boat numbers, facilitating comparison with other studies (Moore *et al.*, 2010). For future surveys in the WCR, it is critical that information on fishing effort (port characteristics, number of boats) is collected. It is also important to consider that an analysis of the effect of gears used or habitat (especially to conduct a risk assessment) is only possible if detailed questions on fishing practices are asked to interviewees (see for example Kiszka, 2012 for a risk assessment for each gear used). More detailed information on the identity of species caught is also important (using simplified species identification guides), such as in the case of sea turtles, where a diversity of species (but not necessarily several nor all) can be potentially caught and impacted by small-scale fisheries. In the present study, a recurrent problem was also the difficulty to distinguish incidental and intentional catches, an issue that has already been identified in the region from other studies (Self-Sullivan and Mignucci-Giannoni, 2012). Therefore, a clearer distinction should be made in questionnaires for future surveys. Moreover, in some cases, information was not reliable, which was most likely related to the fact that questions were not clear enough for respondents or that they were reluctant to really answer them in spite of the survey being anonymous. For example, it was reported on several occasions that the fate of intentionally caught specimens could be either their release or discard, which appears unlikely.

4.3 Recommendations

Overall, a list of recommendations for future activities can be proposed:

- A critical brainstorming session (workshop) with interviewers, country coordinators, project participants and other interested parties should be organized in order to quantify the limits,

weaknesses and the strengths of this interview survey protocol (based on comments made above), as well as to identify priority questions. For example, some information collected during this preliminary questionnaire survey might not necessarily be relevant (and may jeopardize attention of interviewees). Therefore, a clearer delineation of survey objectives and scientific questions will help to elaborate a more focused questionnaire (which does not prevent to include new questions) that will enable to collect more reliable data.

- Data collection on fishing practices and effort needs to be improved (e.g. number of gears used by boat, number of boats, gear utilization in relation to habitats), especially to calculate a fishing effort and bycatch rates for each country/region/state and each gear used. These data will be also critical for a risk assessment analysis (see below).
- No accurate analysis of spatial and temporal patterns on bycatch and hunting (except for Haiti) could be conducted (which was an important assignment for this preliminary study). In future surveys, it is strongly recommended to better document the location of fishing grounds used by fishermen to order to identify and map areas and habitats where captures most likely occur.
- The extension of the bycatch assessment throughout the region should include other vulnerable and threatened species, especially elasmobranchs (sharks and rays), facing a major decline in the WCR. Elasmobranchs are particularly vulnerable to fishery bycatch because of their life history traits including low fecundity, slow growth, late age at maturity and large size. Despite conservation efforts undertaken in various regions over the world, shark bycatch and exploitation for the fin trade have increased over the last years and a number of species are listed as Near Threatened, Vulnerable or Endangered on the IUCN Red List. In the WCR, sharks from coastal and reef-associated ecosystems have significantly declined over the last decades (Ward-Paige *et al.*, 2010). An understanding of the exploitation, use and bycatch of elasmobranchs will enable to understand the level of vulnerability of these vulnerable species in the Caribbean. In the frame of the *South-West Indian Ocean Fisheries Project (SWIOFP)*, 20-30 minutes questionnaires enabled the calculation of bycatch rates and a specific risk assessment analysis for marine mammals, sea turtles and elasmobranchs along the east coast of Africa, including Mozambique, Tanzania and Kenya (Kiszka, 2012)
- As mentioned earlier, it is recommended to conduct an Ecological Risk Assessment for the Effects of Fishing (ERA) based on interview surveys collected at the regional level in the WCR. An ERA method examines the likely consequences of removals through fishing mortality on populations (their susceptibility to population effects of fishing) and recognizes that the differing fecundity and life-history attributes of populations (their productivity) play a role in determining

likely population responses. It is based on a framework that involves a hierarchical approach that moves from a comprehensive but largely qualitative analysis of risk, through a more focused and semi-quantitative approach, to a highly focused and fully quantitative “model-based” approach (Hobday *et al.*, 2011). Three levels of ERA have been identified but based on interview survey data, only two levels can be used: Level 1 analysis (Scale Intensity Consequence Analysis, SICA) is designed to identify hazards to species and systems using qualitative data and expert opinion; Level 2 (Productivity-Susceptibility Analysis, PSA) is based on the biological characteristics of species caught in the fishery concerned (Productivity), and the degree of interaction between that fishery and those species (Susceptibility). The Level 2 methodology considered to be the most appropriate and robust for fisheries ERA is termed Productivity-Susceptibility Analysis (PSA) (Hobday *et al.*, 2011). Five general ecological components are evaluated: a- target species; b- by-product and bycatch species, c- threatened, endangered and protected species (TEP), d- habitats and e- ecological communities. Based on interview survey data conducted in the WCR, a PSA could be conducted based on scoring methods provided by Hobday *et al.* (2011) and adapted for vulnerable megafauna of the region, including marine mammals, sea turtles and elasmobranchs. This approach would be beneficial to identify the most impacting fishing practices and gears and focus management efforts.

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