Research Article

Distribution and conservation of the West Indian manatee (*Trichechus manatus manatus*) in the Catazajá wetlands of northeast Chiapas, México.

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Abstract

Tropical coastal wetlands have a rich biodiversity, a restricted geographic distribution and are a prime habitat for manatees in the regions where they occur in the Neotropics. Human pressures affect the persistence of tropical wetland ecosystems and hence of manatees. In the continental Neotropics, the West Indian manatee (*Trichechus manatus*) is represented in Mexico by the subspecies *T. m. manatus.* Lack of information regarding the current distribution of manatees in Mexico hampers conservation approaches of this marine mammal. In this paper we present information on a survey of a population of manatees found in the Catazajá wetlands (*ca* 60,000ha) in northeast Chiapas, Mexico. We additionally report on manatee conservation efforts spanning seven years aimed at involving the participation of local rural communities. Systematic surveys for the presence of manatees were conducted between Feb-Nov, 2007 by sightings along sampling transects in waterways, recording of manatee presence as evidenced by recently browsed aquatic vegetation, presence of stranded individuals and presence of deceased manatees. Additionally, some records of manatee presence underwater were obtained by using a side-scan sonar system. Lastly, interviews with 120 individuals from 10 local communities also yielded information on manatee presence in the wetland system. A map of the study area divided into a grid of 50 ha cells was used to plot and quantify the records of manatee presence obtained with the above procedures. Results indicated presence of manatees in 11% (*ca* 4,850 ha) of the 50 ha cells into which the study area was divided. Records indicate presence of manatees throughout the wetland, but with concentration in particular sectors. Involvement of local communities in manatee conservation has resulted in designating the Catazajá wetlands as a natural protected area.

Keywords: *Trichechus manatus*, West Indian manatee, wetlands, Neotropics, manatee conservation, Mexico

Los humedales costeros del Neotrópico son ricos en biodiversidad, presentan una distribución geográfica restringida y son los hábitats principales para poblaciones de manatíes en las regiones en donde estos ocurren. Los humedales costeros están bajo riesgo debido a presiones humanas, impactando la persistencia de poblaciones de manatíes. En la región continental del Neotrópico, el manatí esta representado por la especie *Trichechus manatus* y en México por la subespecie *T. m. manatus.* La falta de información básica sobre la distribución actual de poblaciones de manatíes en México dificulta acciones de conservación de este mamífero marino. En este trabajo presentamos los resultados de un reconocimiento de la población de manatíes en los humedales de Catazajá (*ca* 60,000 ha) en la región noreste del estado de Chiapas, cercana al Golfo de México. También reportamos avances en programas de conservación de los manatíes que involucran a las comunidades locales. Entre Febrero y Noviembre del 2007 se efectuaron reconocimientos sobre presencia de manatíes en el humedal a través de avistamientos a lo largo de trayectos de muestreo, de evidencia de ramoneo de la vegetación acuática, de presencia de individuos varados y de detección de cadáveres. Ocasionalmente usamos un sonar para detectar presencia de manatíes bajo la superficie del agua. Asimismo, llevamos a cabo entrevistas con 120 personas de 10 comunidades locales acerca de áreas del humedal con presencia de manatíes. La información de presencia de manatíes derivada de estos registros fue ubicada en un mapa geográfico del humedal dividido en celdas de 50 ha. Estas fueron usadas para cuantificar los registros. Los resultados indicaron la presencia de manatíes en el 11% (*ca* 4,850 ha) de las celdas de 50 ha en que fue dividida el área de estudio. Los registros también indicaron áreas de concentración de presencia de manatíes en algunos sectores del humedal. Los programas comunitarios mostraron un incremento acentuado entre el 2005 y 2007 en la participación por los pobladores locales en acciones de conservación de los manatíes y del humedal, resultado en la consolidación del humedal como un área natural protegida.

Palabras clave: *Trichechus manatus*, manatí, humedales tropicales, Neotrópico, Catazajá, México

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Introduction

The order Sirenia is represented by three species of manatees (*Trichechus senegalensis* in West Arfrica*, T. inunguis* in the eastern coast and Amazon river of South America, and *T. manatus* in the Antilles and rivers and estuaries of the Gulf of Mexico and the Caribbean) and one species of dugong distributed in tropical and subtropical regions of the Indo-Pacific. In the Neotropics the West Indian manatee (*Trichechus manatus*) is represented in Florida by the subspecies *T. m. latirostris* and in Mexico by the subspecies *T. m. manatus* [1]. Adults may be 3.5 meters in length and weight 1000 kgs, making it the largest continental mammal in Latin America. They inhabit the coastal and inland waterways of southern Mexico, Central America, the Greater Antilles, and the northern coast of South America [1-2].

Manatees are robust, long-lived species and appear remarkably resilient to natural disease and the effects of human-related injury and trauma [3]. These characteristics might be the result of an efficient and responsive immune system compared to other marine mammals. Although relatively immune to infectious agents, manatees face other potentially serious threats, including epizootic diseases and pollution while in large aggregations [4]. Threats to manatees world-wide are habitat loss, illegal hunting and boat collisions [2,4]. These pressures endanger the persistence of manatees worldwide and the full effects of these and uncontrolled human population growth on the species are unknown [5-7].

Manatees inhabit salt, fresh, and brackish waters, they feed on marine, estuarine, and fresh water vegetation [8]. They play an important role recycling nutrients and stimulating primary productivity in nitrogen-poor aquatic ecosystems and may be used as health indicators of their habitat [4,9]. Small numbers, the species´ very slow breeding cycle, together with habitat destruction and fragmentation, accidental deaths and poaching are the main reasons why the Antillean manatee is listed as vulnerable in IUCN´s Red Data Book [10] and in CITES Appendix I as threatened with extinction.

In Mexico, information is limited regarding current distribution of populations, although historical accounts indicate they were once more common [11]. Available information about the current distribution of manatees (*T. m. manatus*) and some aspects of its ecology in Mexico is available only for two localities, one in the coastal state of Tabasco (southeast Gulf of Mexico) [5,12] and the other along the eastern Caribbean coast of the Yucatan peninsula [13-14]. Historically, manatees have been reported in coastal lagoons in Los Tuxtlas, Veracruz (north of Tabasco state), but these populations have been extirpated [15]. Manatee populations are reported for the Alvarado lagoon about 150km north of Los Tuxtlas [16] and there is a report of the existence of manatee population as far north as the Mexican state of Tamaulipas by the Gulf of Mexico coast [17]. Environmental legislation in Mexico forbids hunting of manatees and the official Mexican environmental norm (NOM-

ECOL-059-1994) [6,11] considers the manatee as a mammal species in danger of extinction.

Scarcity of data on the manatee populations in Mexico makes it difficult to craft well informed conservation and management decisions both regionally and locally about the species and its habitat. In this paper we report the results of a survey of a population of manatees in the wetlands of Catazajá in northeast Chiapas, Mexico. We additionally report the unfolding of an initiative aimed at integrating the local communities in a program of conservation of the manatee population and its habitats.

Methods

Study area

The wetland system of Catazajá is found in northeast Chiapas, Mexico (17º44 N, 92º01 W) (Fig. 1). Average elevation above sea level is 10 m and average annual precipitation and temperature are 2322 mm and 26.4 ºC, respectively. Rainfall is distributed seasonally with a "dry seaton" between November and May, with precipitation ranging from 500 to 700 mm, and a rainy season from June to October, with precipitation ranging from 1,400 to 1,700 mm. The wetland is an extensive flooded flatland encompassing about 60,000ha and is part of a larger wetland system connected to the Gulf of Mexico and in which the Pantanos de Centla Biosphere Reserve (300,000 ha) is found (see http://www.parkswatch.org/parkprofile.php?l=eng&country=mex&park=pcbr) (Fig. 2).

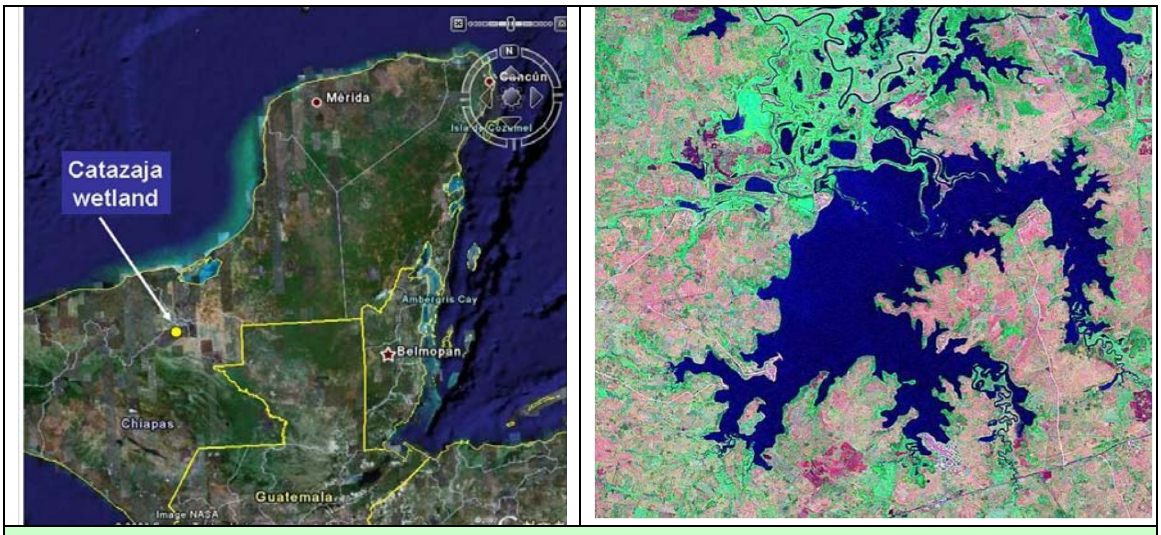

Fig. 1. Left: location of the Catazajá wetlands in the northeast corner of the state of Chiapas, Mexico and about 110 km from the Gulf of Mexico coast (map modified after Google Earth). Right: satellite image of the Catazajá wetland system showing the major lagoon of Catazajá as well as smaller seasonal and permanent lagoons and a system of canals and rivers. Image: Landsat ETM Pancromica 3 bands. N-15-15-2000.

The Catazajá wetland subsystem contains 112 seasonal and 10 permanent lagoons as well as several streams and small rivers that traverse its flatlands. Bordering the northeastern boundary of the Catazajá wetland system is the Usumacinta river, the 2nd largest river in Mexico. The wetlands are rich in aquatic and terrestrial wildlife. There are about 134 bird species, aquatic mammals such as the manatee and river otter (*Lontra longicaudis*), terrestrial mammals such as the black howler monkey (*Alouatta pigra*) and felids such as the Ocelot (*Felis pardalis*). Reptiles such as Moreletti's crocrodyle (*Crocodylus moreletti*), the green iguana (*Iguana iguana*) and the white turtle (*Dermatemys mawii*) are common as well in the wetlands [18].

Fig. 2. Views of landscapes in the Catazajá wetlands in northeast Chiapas, Mexico. Third photo from left to right shows a view of the town of Catazajá.

The area of the Catazajá wetlands is inhabited by about 55,000 people, most of them concentrated in the towns of Catazajá, La Libertad and E. Zapata. Major economic activities are cattle ranching, agriculture (corn, chili, beans and bananas) and fishing [19,20]. More recent agricultural developments are the establishment of rubber and palm oil plantations in the dry land areas [21] as well as ecotourism (Fig.3).

Fig. 3. Fishing is an important subsistence activity amongst the population in the wetlands area. An initiative that is gaining momentum in the area is ecotourism.

Population surveys

To gather information on the distribution of the population of manatees in the Catazajá wetland we used three procedures:

(1) Direct sightings from a boat as manatees came up to the surface for air and detection of water surface movements of individuals. These surveys were conducted along the length of seven transects of variable length (7-16 km) (Fig. 4). Transects were located in areas assumed to be favored by manatees (edge of lakes and along canals and streams). Between February and November 2007 each waterway was traversed once a month with a motor boat at a speed of 5 km/hr. When manatees were sighted, the boat was stopped to obtain a count of individuals sighted. Transects surveys were conducted from 0700 to 1100 hrs and 1600-1900 hrs.

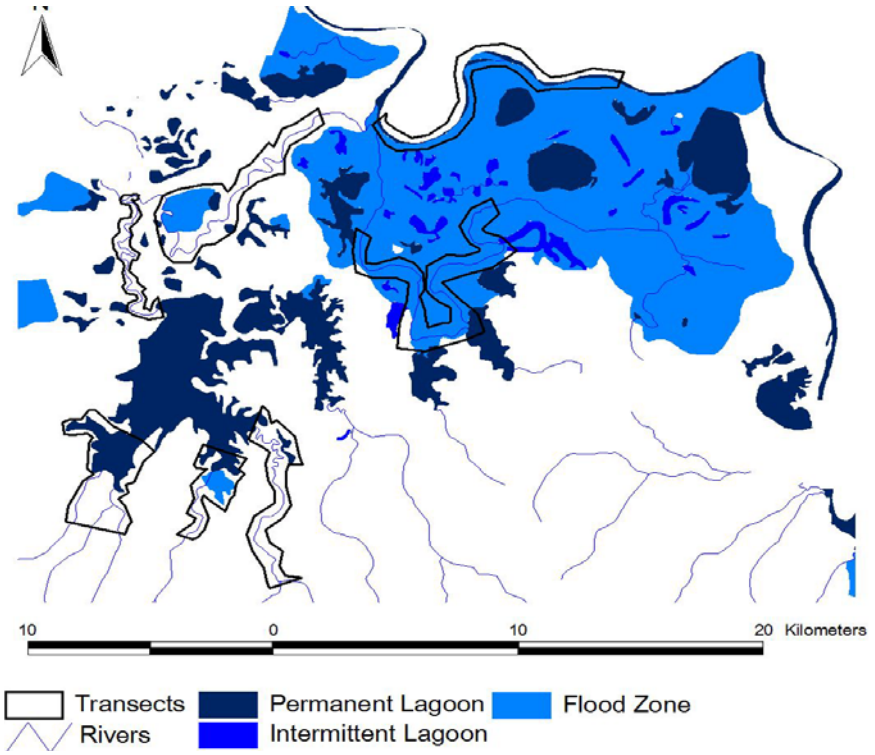

Fig. 4. Study area and location of sampling transects. These are shown as black contour lines along streams, edges of lagoons and seasonally flooded areas. The thick sinuous black line in the upper left area of the map and adjacent to the area in blue is the Usumacinta river.

(2) Indirect indication of presence and activity of manatees was recorded while sampling transects were traversed by noting the presence of aquatic vegetation on the water surface that had evidence of having been recently browsed by manatees (Fig. 5). Other evidence of manatees were the presence of stranded individuals in very low water and the sporadic presence of carcasses of recently deceased individuals (Fig. 5)

Fig.5. Upper row from left to right: Sighting of manatee, head and dorsum of manatee (the two orifices are the nose nostrils) and area of aquatic vegetation recently browsed by manatees. Lower row from left to right first two images: stranded manatee in low water in the dry season, stranded manatee rescued and ready to be transferred to another location within the wetland. Far right: floating manatee carcass.

(3) In addition to recording of sighting of manatees along water courses, a few records (N = 17) of presence of manatees were obtained under water using a side scan sonar system (997c SI Combo, Humminbird) which had been proven to detect manatees as far as up to 10 m from each side of the boat (Fig 6). It is possible that multiple counts of the same manatees was possible, but only presence rather than number of individuals was scored.

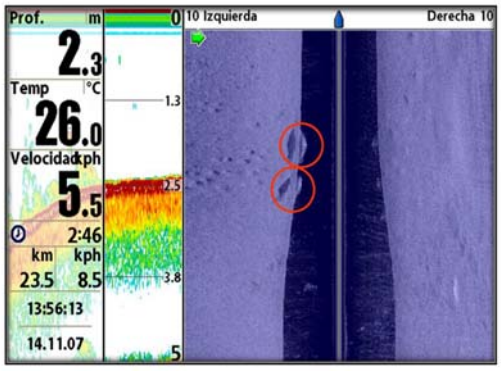

Fig. 6. Example of two manatees detected underwater by the sonar, at 2.3 m in depth.

Each of the above records was geo-referenced (UTM coordinates) with a hand-held GPS or with the GPS integrated to the sonar scanner. GPS records were then placed in a gridded map (50 ha cells) of the study area constructed with ArcView software (version 3.2).

Interviews with local inhabitants and fishermen

Between April and August we conducted semi-structured interviews with local fishermen ≥ 18 years of age to obtain information of sightings or evidence of presence of manatees in the wetland. The individuals interviewed were inhabitants of 10 small communities distributed throughout the study area and involved in fishing activities throughout the year. This type of approach has given successful and reliable results in manatee survey work in the Caribbean side of the Yucatan peninsula [22] and in Cuba [23]. Informants were shown a detailed map (see Fig. 4)) of the study area and were asked to indicate where they had sighted manatees and when in the recent past (24 months) or if they had seen evidence of manatee presence (e.g. recent browsing of surface vegetation). Informants were asked to describe the manatee to ensure that the right mammal was being identified. Once the informant had identified the location in the map a note was made of the identity of the cell in the grid.

Other records of presence of manatees

Discovery of stranded individuals and/or carcasses found floating were also used as evidence of presence of manatees and the location of these records was recorded in the gridded map of the study area.

Data processing

All records of presence of manatees were transferred to the gridded map and each 50 ha cell was color coded depending on whether they referred to sightings, sonar scanning, stranded individuals, carcasses and records from interviews or to combinations of these. Color coded cells were counted for each category and the total number of coded cells and their equivalence in ha was calculated for all presence records per category. The gridded map was further divided into four quadrants (500 cell each) following the four cardinal points and cell occupancy was quantified for each quadrat.

Community participation in manatee conservation

Participation by local inhabitants in conservation of manatees and their habitats in the Catazajá wetlands was achieved by launching a series of workshops and public talks and discussion with local people and community authorities in the municipal headquarters of the region (town of Catazajá). These activities, conducted intermittently from 2003-2007, were aimed at informing local fishermen, young students and local government officials about the value of preserving the manatees and their habitats and about how such actions could also result in benefit to the communities (preservation of native vegetation, sustainability of fishing activities, conservation of sources of fresh water and diminished erosion, among others, including the possibility of developing ecotourism projects that could involve the native vegetation and the fauna existing in the wetlands, including the manatees.

Results

Sampling effort

We completed 70 runs and a total of 420 hours searching for manatees along the sampling transects and 120 individual interviews with local fishermen from the 10 communities about presence of manatees throughout the study area.

Data on presence of manatees showed positive scores for 97 cells or 11% of the total number of cells potentially available to manatees The 97 cells accounted for about 4,850 ha of wetland waterways in which manatees were present (Table 1; Fig 7).

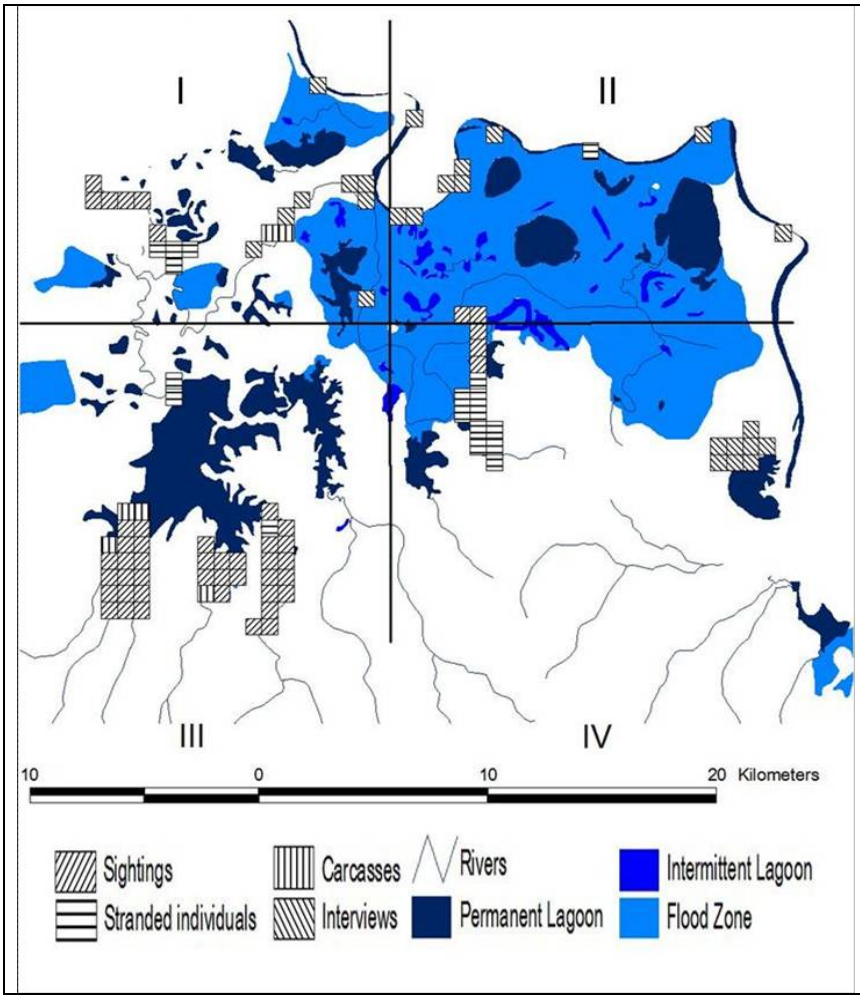

Fig. 7. Records of manatee presence in the Catazajá wetlands. The shaded cells (50 ha each) indicate positive records based on the categories shown at the bottom of the map.

Quadrat III had the highest occupancy (45%) by manatees followed by quadrats IV and I (Table 1; Fig 4). The quadrat with the least occupancy was quadrat II (12%) (Table 1). Fifty five percent of stranded individuals were recorded in quadrat IV (Table 1)

Table 1. Number of records based on sightings, stranded individuals and carcasses as indicators of manatee presence and corresponding number of 50 ha cells in each of the four quadrats into which the study area was divided. In the case of the interviews the numbers refer to the number of 50 ha cells in which positive records for manatee presence fell, and they are based on the results of 120 individual interviews. Also shown is the total estimated number of ha accumulated by positively scored cells for manatee presence in each category.

	Quadrats						
CATEGORIES	I	II	III	IV	Number of cells	%	ha
Sightings	6	2	37	3	48	49	2,400
Stranded individuals	4	1	3	10	18	19	900
Carcasses	2	-	4	-	6	6	300
Interviews (N = 120)	8	9	-	8	25	26	1,250
Total	20	12	44	21	97	100	4,850
%	21	12	45	22			

Community participation in manatee conservation

Between August of 2001 and December of 2007 we conducted 23 workshops with the participation of local inhabitants and imparted 80 public talks to people of the communities of the Catazajá municipality. These initiatives were aimed at stimulating community participation regarding the importance of preserving the manatee population in the Catazajá wetlands. About 4,540 people participated in these activities and individuals participation in general increased from year to year (Fig. 8).

Complimentary to this, we produced four posters stressing manatee conservation, five video programs about the manatees, one booklet and two leaflets that were distributed in the local communities, both through the local schools and through the community government officials.

Discussion

Although our initial survey of the distribution of manatee presence in the Catazajá wetland was not exhaustive, with some areas still pending additional or first time surveys (e.g. areas in quadrat II and IV), the survey showed the existence of an important population of manatees as attested by the numerous sightings in many localities within the wetland system. The survey also showed that while these mammals seem to be distributed throughout the wetlands, that they also tend to concentrate their presence and activities in particular areas.

Habitat preference

Direct and/or indirect presence of manatees was more often recorded in the small rivers, canals and at the edges of the permanent and semipermanent lagoons. Manatees sightings in these areas were usually associated to concentrations of floating aquatic vegetation (e.g *Eichornia crassipes* and *Salvinia auriculata*), to tree cover along the edges, to a mild underwater current and depths of about 3 m, features that seem to be associated to manatee presence in other localities in Mesoamerica [24]. Our survey also showed that manatees also seem to move into areas that are seasonally flooded (mainly quadrat II), probably the result of presence of food resources and less human disturbance.

Quadrat occupancy

The highest number of records (45%) for manatee presence were scored for quadrat III. While the largest permanent lagoon ("Laguna Grande") is found in this quadrat, manatee presence was mainly recorded at the southern edges of the lagoon and along the small rivers and streams that flow into it from the south. Three factors may explain the high concentration of records of manatee presence in this area of quadrat III. **First**, a historical one. In 1992 local fishermen with assistance from the local government built seven embankments in the northern part of the lagoon to stop drainage during the dry season (March-June), with the purpose of sustaining fishing activities [25]. These embankments effectively isolated the lagoon, possibly isolating the manatee population that moved seasonally into this quadrat. However, during the peak of the rainy season (Sept-Oct) the lagoon's water level raises above the embankments and the system is again connected with the rest to the north and manatees have the possibility of dispersing beyond. **Second**, it could be that legislation regulating fishing activity in that area of the lagoon restricts the transit of motorboats in those areas, which are also known to be important areas of reproduction for commercially important fish species. This may benefit manatees by resulting in fewer collisions with motor boats and preservation of useful resources. **Third**, it could also be the result of the recent interest (see Implications for conservation below) by the local population in protecting the manatees, resulting also in reports of sightings. The southern edge of the lagoon is not only an area preferred by manatees, but it also harbors the largest human settlement, the town of Catazajá, with a population of 17,881 inhabitants.

Manatee dispersal and migration

Results from the interviews indicated presence of manatees in the four quadrats into which the study area was divided. People also recognized rivers as major waterways for manatees to access other rivers, canals and seasonally flooded areas in the wetland. High dispersal of manatees in the study area was recorded by the discovery of two stranded individuals (an adult male and an adult female) in November 2007 as we surveyed the Chacamax river, 35km southeast of Catazajá. An additional record was also obtained along the same river, but at 45 km southeast of Catazajá where two manatees were sighted swimming upriver.

Our survey also showed presence of manatees along the Usumacinta River, possibly a major waterway used in seasonal migrations by manatees to reach the Catazajá wetlands from other wetland areas found closer to the Gulf of Mexico coast. It has been documented that manatees can traverse long distances during seasonal migrations involving hundred of km along coastal water ways and from dozens to up to 100 of km inland [26-27].

Stranded individuals

The use of seasonally flooded areas by manatees may explain the presence of stranded individuals in the dry season in all four quadrats. In one instance in 1995, there were 17 individuals stranded in various localities in quadrat IV. All 17 were rescued and relocated into deeper waters (see Fig. 5).

Causes of death

Causes of death for the six carcasses recorded in our survey showed that three of these were directly related to human activity and all took place in river waters. In quadrat III, one case was the result of a collision with a motor boat. Two deaths in quadrat III were caused by entanglement in fishing nets which were being operated illegally. The rest were individuals that were stranded in very low water, but died before they were discovered.

Implications for conservation

Human pressures leading to increasing biological impoverishment, habitat fragmentation, and modification of ecological processes affect the persistence of tropical wetland ecosystems. Further, increasing regional, local and global spread of hazardous wastes and toxic substances together with global climate change and ozone depletion and an increasing human ''ecological footprint'' resulting from an exponentially growing population and use of natural resources puts ecosystems and plant and animal species at further risk [28]. Tropical coastal wetlands are biodiversity rich, have a restricted geographic distribution and are a prime habitat for manatees in the regions where they occur in the Neotropics [29].

The wetlands in which the Catazajá wetland subsystem is found is an extensive system of wetlands encompassing more than 500,000 ha and it is mainly formed by the convergence of two major rivers: the Usumacinta and the Grijalva, as well as by several medium size and small rivers that flow toward and merge near the Gulf of Mexico coast. Such a scenario provides manatees with a huge wetland landscape also penetrating inland about 40-50 km. The coastal wetland system has been heavily transformed (destruction and fragmentation of native habitats) by human activity involving cattle ranching and petroleum exploration and extraction and the area harbors many human settlements. About 300,000 ha of this major wetland system has been protected (Pantanos de Centla biosphere reserve - see study area in Methods). While the reserve protects many pristine areas, segments of the wetland existing beyond the boundaries of the biosphere reserve do not enjoy such protection. Because of the mobility of manatees throughout the wetland system, populations may be at risk from human activity in these other localities. In these cases, efforts to involve local communities are essential to ensure the conservation of the wetlands and of the manatee populations existing within. In this context, the Catazajá wetland is a case in point.

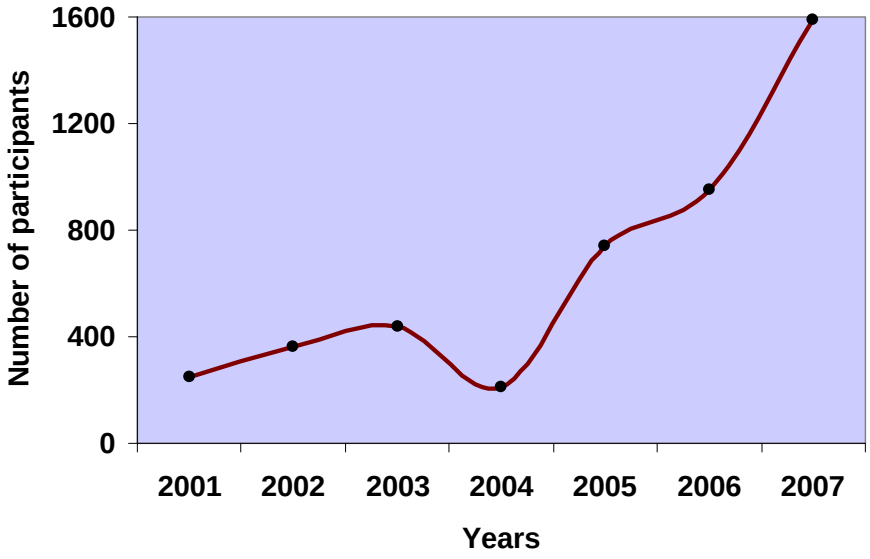

Fig. 8. Number of people participating in the manatee conservation workshops for the period 2001-2007. Increasing participation reflects increasing interest by the local population in protecting the manatees and their habitats in the Catazajá wetlands.

Since 2001, we have gradually involved the local communities in the conservation of manatees and the wetland ecosystem. Local people participation has been gradual and more recently accelerated (Fig. 8). While still in progress, tangible outcomes of community involvement in conservation are the following: protection by the local community of manatee preferred gathering areas in the wetland is gaining strength, hunting of manatees is now almost non existent, local people trained by us now assist in keeping track of manatee sightings and local community members actively become involved in the rescue of

stranded individuals. Importantly, the manatee has now become the animal emblem for the communities in the study area (Fig. 9). A manatee festival is held once a year, with intensive participation by local inhabitants, including adults of all ages and school children.

Fig. 9. The manatee has become the animal emblem in the major town of Catazajá. Community members actively participate in protection of manatees. An annual manatee festival involves people from all local communities and school children actively participate in conservation-oriented drawing contests and other activities. For more information http://www.primatesmx.com/manateewebfntpgxpress1english.htm

The growing interest by the communities in the development of the manatee project and in becoming involved in the conservation of the manatees and the Catazajá wetlands has gone beyond expectations. In November of 2006, through an initiative by the municipality of Catazajá and the state of Chiapas governments, the Catazajá wetlands were decreed as a natural protected area [30]. The area under protection encompasses 41,058 ha of the Catazajá wetlands and it includes most of the segments of the wetlands where we have obtained records of presence and activity of manatees. To further ensure the protection and in view of the high relevance of the Catazajá wetlands for the conservation of manatees and of local biodiversity, in February of 2008, the Catazajá wetlands reserve was incorporated as a RAMSAR site [31] by the Ramsar Convention on Wetlands (see http://www.ramsar.org/ and http://www.ramsar.org/wn/w.n.mexico_april08_s.htm). The protected area has also been classified as a natural protected area category IV by the International Union on the Conservation of Nature (IUCN) of the United Nations.

Further work needs to be done to complete the population surveys in the entire Catazajá wetland reserve and in immediate and intermediate areas beyond its boundaries. Information is also needed on the demographic structure of the population to assess its size and seasonal distribution throughout the Catazajá wetland. With this information at hand, population viability projections can be produced under different hypothetical scenarios of wetland management.

Detailed monitoring of manatee movements and migratory behavior needs to be carried out using sonar and radiotelemetry technology as well as basic studies of the foraging ecology and of the social and reproductive behavior of manatees in the wetland. Further needed are investigations - using molecular techniques - on population genetics to assess variability, gene flow and genetic bottlenecks in the manatee population. These efforts will not only provide new information on basic aspects of the ecology and biology of the manatee population present in the Catazajá wetlands, but also the empirical and technical tools to ensure its conservation.

Acknowledgements

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