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Pancho (PE424), A Florida manatee in Mexico
 Pancho in Xel-Há, natural cave in the Riviera Maya coast.
 Photo: Staff of Xel-Ha Marine Park

UNION INTERNATIONALE POUR LA CONSERVATION DE LA NATURE ET DE SES RESSOURCES
 INTERNATIONAL UNION FOR CONSERVATION OF NATURE AND NATURAL RESOURCES

Commission de la sauvegarde des espèces - Species Survival Commission



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Note from Sirenia Specialist Group Co-Chairs:

In February, the IUCN SSC Sirenia Specialist Group updated the list of members for the period 2021-24. New members were invited to join the Commission on the basis of their expertise on the biology and conservation of manatees and dugongs and their habitats. The official list will be updated by IUCN in September 2021.

You can check on the status of your membership on: URL: IUCN - Commission System
<https://portals.iucn.org/commissions/>

Please let us know if you have problems updating your details as the process can be complicated. We are willing to work with you to fix any issues if you reach out to us.

Regards,

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Co-Chairs of the Sirenia Specialist Group-SSC-IUCN

Editor's Note: The editors apologize for the delay in publishing this issue, there were articles we wanted to make sure would be included.

LOCAL NEWS

BRAZIL

On a newborn Antillean manatee (*Trichechus manatus manatus*) recently found at Baía do Tubarão Extractive Reserve, eastern coast of Maranhão state

On 22 January 2021, a dead newborn Antillean manatee (*T. m. manatus*) was found floating at Mapari River, Humberto de Campos municipality, eastern Maranhão, Northeast of Brazil. The site is part of the Baía do Tubarão Extractive Reserve, a protected area established in April 2018 which comprises 223,889 hectares of marine and coastal habitats (Brasil, 2018).

A visual assessment of the animal's body showed blood plaques around the nasal orifices and bruises in the fluke and pectoral fins (Figure 1), which might suggest entanglement in a fishing net. Through morphometric procedures (Figure 2) and an observation of the animal's belly, it was found to be a male, measuring 123 cm in length by 85 cm of maximum circumference in the thoracic region. Aiming at characterization and genetic sequencing, biological material (muscle and skin) was collected and sent to the Centro Nacional de Pesquisa e Conservação de Mamíferos Aquáticos (CMA/ICMBio) and to the Fundação Oswaldo Cruz, Rio de Janeiro.



Figure 1. Bruise detail in the left pectoral fin of newborn Antillean manatee (*T. m. manatus*) found at Baía do Tubarão Extractive Reserve, east coast of Maranhão state, Northeastern Brazil.



Figure 2. ICMBio technicians performing biometrics on the newborn Antillean manatee (*Trichechus m. manatus*) found at Baía do Tubarão Extractive Reserve, east coast of Maranhão state, Northeastern Brazil.

With the help of residents, the carcass was buried (Figure 3) in a georeferenced location so that, within a few months, its bones will be recollected, assembled, exposed, and used in environmental education and awareness raising activities for residents and visitors of the Baía do Tubarão Extractive Reserve.

According to the CMA/ICMBio database, there has been 14 records of manatees along the Maranhão coastline since 2008. Of those records with available locality data, five occurred in Humberto de Campos, three in São José de Ribamar, two in Icatu and one in São Luís (Figure 4). One additional stranding record of an adult male in the locality of Panaquatira, São José do Ribamar, has been recently published (Conceição et al., 2020).



Figure 3. Procedures for burying the newborn Antillean manatee (*T. m. manatus*) found at Baía do Tubarão Extractive Reserve, east coast of Maranhão state, Northeastern Brazil.

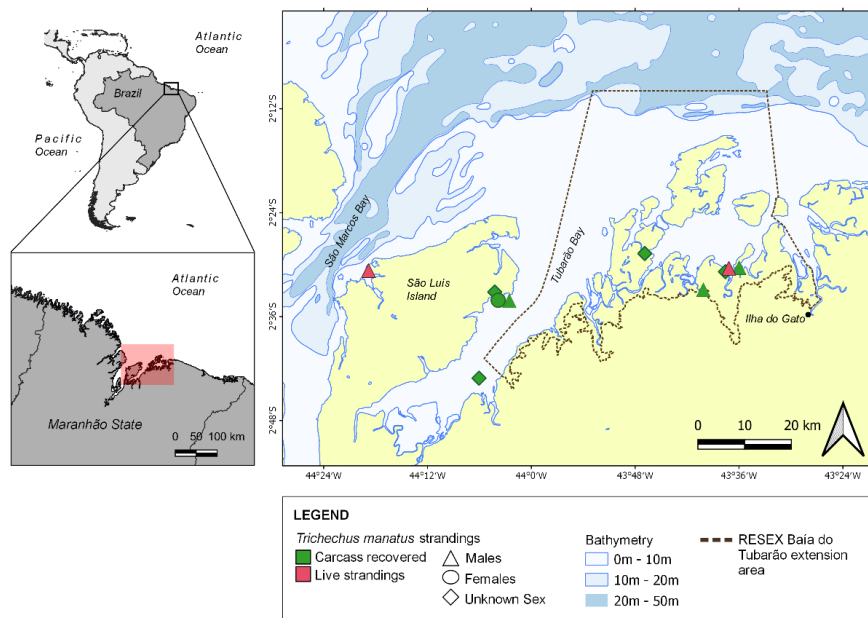


Figure 4. Locations of manatee records along Maranhão coastline, Northeastern Brazil, and indication of the boundaries of Baía do Tubarão Marine Extractive Reserve. Source: CMA/ICMBio. Figure prepared by G.F. Ruenes.

This present record adds a sixth specimen spotted in Humberto de Campos and a third newborn recorded in the Mapari River, which suggests that the large Tubarão Bay and its impressive mangroves are ecologically relevant to predict suitable areas for manatees. According to Luna et al. (2008a), Tubarão Bay recorded one of the highest numbers of Antillean manatees in Brazil. In contrast, the far eastern coastline of Maranhão has been considered an unsuitable habitat for manatees due to its vast open sand beaches (Luna et al., 2008b; Bonvicino et al., 2020). But, on the other hand, the Reentrâncias Maranhenses still remains a primarily unsurveyed area, with numbers of thriving manatees still undetermined.

According to Balensiefer et al. (2017), the state of Maranhão is the third location of the largest Antillean manatee stranding in Brazil. One of the manatees rescued in Maranhão, in 2010, remains in rehabilitation facilities at the CMA/ICMBio. This specimen (Daniel) is part of the manatee release program and his release in the stranded region, could highly contribute to the conservation of the species in the state.

Studies of population, genetics, and health of manatees in Maranhão must be carried out, and residents of Baía do Tubarão Extractive Reserve, who basically live from fishing and subsistence agriculture, have a fundamental role in the monitoring and protection of the fauna that inhabits the region, considered of high biological value and unquestionable for the preservation of the endangered Antillean manatees along South America.

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Manatees in the Tico-Tico comic book, Rio de Janeiro, Brazil: 1905 – 1977

From the early 1500s European travelers described manatees in the waters of Northeastern and Northern Brazil. These accounts include the southernmost records of the Antillean manatee provided by Father José de Anchieta (1533-1597) to the waters near Vila Velha (20°23'S) in Espírito Santo state (Whitehead, 1977). In the first centuries of colonization (1500-1800), the main reports covered manatee hunting and selling of their products: oil, meat, skin, and others. Interestingly, in the 1900s, manatees also became part of a diverse literature, such as comic books and popular Brazilian magazines. In this context, 'O Tico-Tico' was a comic book created and published in Rio de Janeiro, from 1905 to 1977 (Biblioteca Nacional, 2021). It was indeed the very first comic book published in the country (Velasquez, 2021). More than that, Tico-Tico is considered a deep change in the structure of the rigid patterns of education at that time. As more children learned to read it soon increased its coverage with a variety of educative issues. By 1940, Tico-Tico regularly published sections on botany and natural history, among others.

Here we present a few pages selected from this comic book covering the issue of 'manatees' (peixe-boi, in Brazilian Portuguese). We present here four of these pages, reporting on basic aspects of their behavior and biology (Figures 1 and 2). More interesting is the page published in 1946 presenting the 'Production of Brazil, North Region'. In this page, the section of 'fishing production' shows the illustration of a 'peixe boi' as an important source of income in the whole region (Figure 2B). This is a clear message that manatees were valued solely as a product to be explored and consumed. For several decades, thousands of Amazonian manatees were hunted and parts of these animals, such as

blubber and skin, were exported to Europe every year. Nowadays, manatees are still poached in the most remote areas of the country. There are national protection laws to curb the hunting of wildlife in Brazil, but the consumption of manatees, and other wildlife species, is still very traditional in the Amazon basin. The practice of hunting manatees is truly reminiscence of recent past beliefs that perceive manatees as food.



Figure 1: Pages of the “Tico-Tico” comic book depicting manatees. (A) O Peixe-boi, 1935; (B) Almanach do Tico-Tico, 1937.

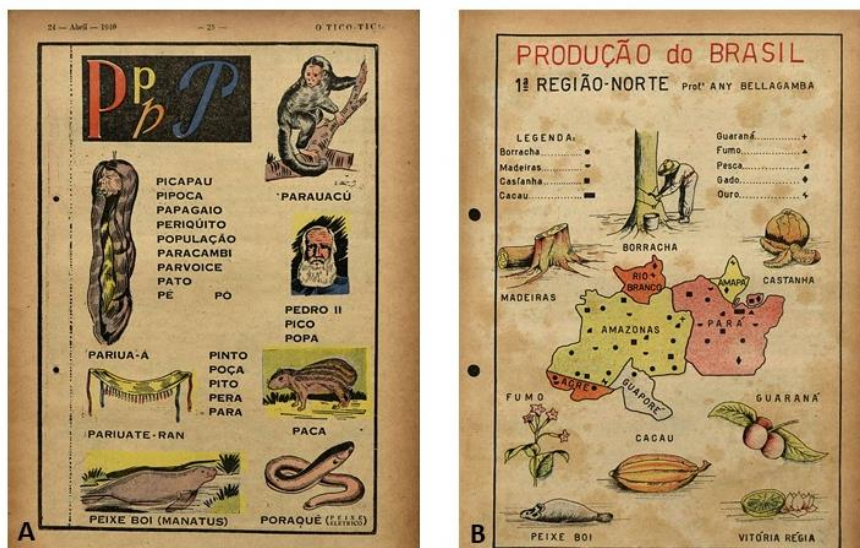


Figure 2: Continuing... Pages of the “Tico-Tico” comic book depicting manatees. (A) O Peixe-boi (Manatus); (B) Produção do Brasil, 1a. Região Norte, 1946.

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Genetics as a tool for conservation and management of West Indian manatee populations in Brazil.

A study conducted by the National Center for Research and Conservation of Aquatic Mammals (CMA), United States Geological Survey Wetland and Aquatic Research Center, and partner researchers found that the marine Antillean manatee (*Trichechus manatus manatus*) has low genetic diversity in regions where there are territorial interfaces with the Amazonian manatee (*Trichechus inunguis*). The study was published as an article in the journal, *Frontiers in Marine Science*.

For the first time, nuclear genetic diversity of manatees along the southern extent of the species' distribution and the suspected hybrid zone was surveyed (including coastlines of Venezuela, Guyana, and Brazil).

Our results show that the Antillean manatee subspecies forms a single non-continuous population along the Brazilian coast. Our analyses showed that this population occasionally interbreeds with the populations located further north and west, between Venezuela and Guyana, demonstrating that the mouth of the Amazon River would not be a strong enough barrier to isolate the subpopulations of Brazil north and south of the Amazon River mouth (Amapá and Pará to Alagoas). Overall, low genetic variation was found for Brazilian manatees but the gene flow with the Venezuela

and Guyana coastlines reduces the likelihood of inbreeding and fixation of deleterious alleles within the two populations. Habitat restoration and travel corridors could help facilitate more gene flow, increase genetic variation, and provide long-term population stability to create more resilience to stochastic events or diseases.

Moreover, the Antillean and Amazonian species' distributions overlap at the Amazon River plume, but we found no further evidence of natural hybridization. Considering that hybrids tend to become unviable in nature, large instances of hybridization could potentially reduce fitness and ultimately reduce the breeding population size. Further, hybridization could result in outbreeding depression of resultant offspring. The low evidence of hybrids is encouraging for the conservation of these species, as a high occurrence of hybrids could have a detrimental impact on the survival of both species in Brazil.

Genetic studies can contribute to the adoption of new conservation strategies, like habitat restoration in areas with low genetic diversity or the creation of migratory corridors. Moreover, genetics can guide fundamental activities such as the release of rehabilitated and captive animals in order to avoid inbreeding and outbreeding depression.

The Aquatic Mammals Center (CMA) in Brazil has made use of tools and genetic data to implement conservation actions throughout the southern range of the species' distribution in Brazil. An example of this are the rescued and rehabilitated manatees that were released in the Environmental Protected Area "APA Costa dos Corais", north coast of Alagoas, Brazil, where the species was extirpated more than half a century ago by anthropogenic factors (Figure 1). The release in this region (APA Costa dos Corais) may allow for connectivity in southern Alagoas and other states of Brazil where manatee occurrence is fragmented (Pernambuco to Rio Grande do Norte).

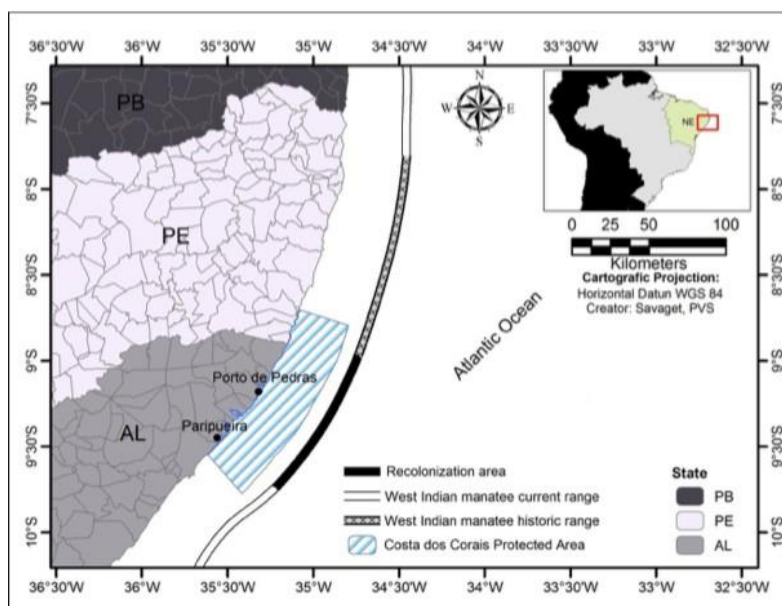


Figure 1. Recolonization area in Alagoas state, on the northeast coast of Brazil (map from: Fábila de Oliveira Luna - Phd thesis).

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ICMBio/CMA remotely holds a second monitoring meeting of the Antillean manatee Conservation Action Plan (PAN).

Brazil has as one of the most important tools for the conservation of species: National Action Plans for the Conservation of Endangered Species or Speleological Heritage (PANs). PANs are public policies, agreed with society, that identify and guide as priority actions to fight like viruses that endanger populations of species and thus protect them. The Antillean manatee, an endangered species in the country, has a specific PAN.

The preparation of the Antillean manatee PAN took place in August 2016 at ICMBio/CEPENE. Thirty-two participants attended the workshop, a representation of government agencies, civil societies, NGOs and universities. At the time, a Technical Advisory Group (GAT), was created composed of manatee specialists. The group monitors the implementation and realization of annual monitoring and evaluations of the PAN, also coordinated by the National Center for Research and Conservation of Aquatic Mammals - ICMBio/CMA.

In 2020, with the COVID-19 pandemic, ICMBio/CMA faced the challenge of how to conduct the second PAN monitoring workshop. To maintain the schedule of the annual PAN monitoring, ICMBio/CMA carried out the monitoring with the partners of the GAT in a virtual way; the meeting exceeded expectations, making possible a valuable group discussion on the progress of the actions to be carried out.

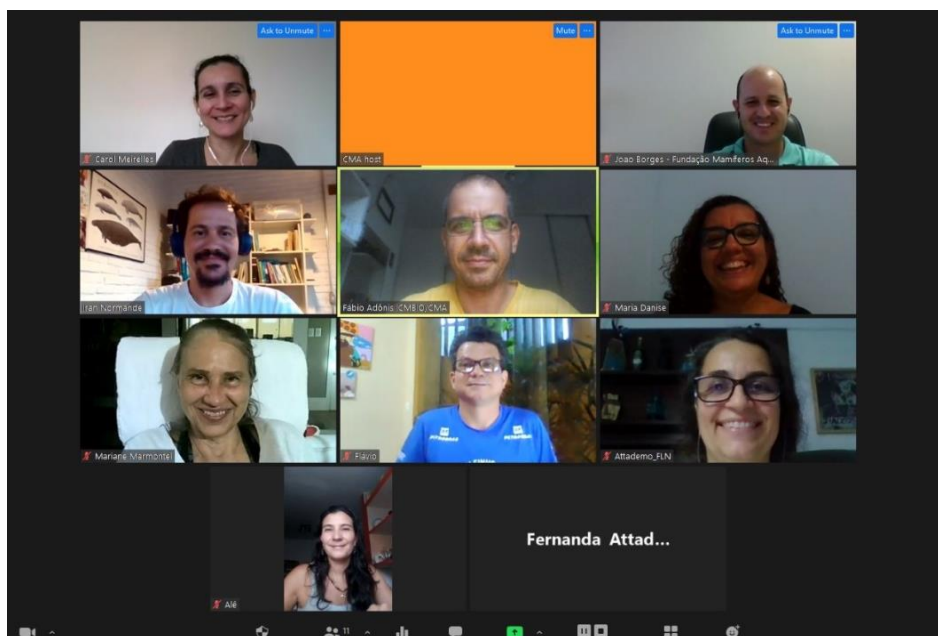


Figure 1: Workshop photo and participants of Technical Advisory Group

The products achieved by the PAN represent advances in manatee conservation. The meeting highlighted the releases and systematic monitoring of manatees, the construction of new acclimatization and release captivity in Ceará and progress on arrangements for the construction of the new captivity center in Rio Grande do Norte, as well as the creation of the Manatee Environmental Education Network - REAMP. The GAT also ratified the importance of a new population estimate of manatees in Brazil, as stated by ICMBio/CMA.

The GAT is also concerned about the compromise in the progress of PAN actions in 2021 caused by the pandemic, while reinforcing the need to guarantee financial resources and to have greater articulation between the actors and institutions that make the PAN, as a way to improve execution of the actions this year.

The Management Panel of the second Monitoring of Antillean Manatee PAN was the product of the workshop. The graph below shows the status of the actions progress:

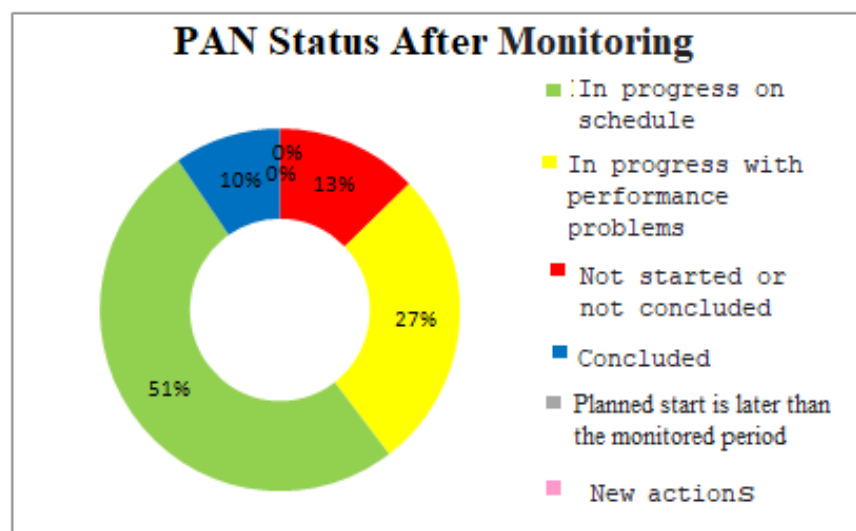


Figure 2: Manatee action plan management panel

In order to continue the good progress of the PAN, it is recommended to maintain partnerships with NGOs, educational and research institutions, which support Antillean manatee conservation actions. Technical Cooperation Agreements are important and are being signed with partners: Instituto Bicho d'Água, Instituto Biota and Aquasis. This will facilitate the implementation of joint activities in great part of the manatee range in Brazil.

For more information about the PAN, visit:

www.icmbio.gov.br/portal/faunabrasileira/planos-de-acao/9327-plano-de-acao-nacional-para-a-conservacao-peixe-boi-marinho.

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Projeto Peixe-boi (Manatee Project) - 40 years of research and conservation of Antillean manatee in Brazil

In 1980, oceanographers Catuête Albuquerque and Guy Marcovaldi traveled the Brazilian coast from the state of Rio de Janeiro to Amapá, conducting interviews in several locations, in search of information about the occurrence of manatees and sea turtles (Albuquerque and Marcovaldi, 1982). During the expedition, the researchers found that both groups, the species were under great threat, giving rise to the Peixe-boi Project and to the Tamar Project, created by the Brazilian Institute called IBDF. For the manatee, it was found that in many of the locations visited, the occurrence of the species was only historical, as in the states of Espírito Santo and Bahia (Albuquerque and Marcovaldi, 1982). In addition to extinction in this region, oceanographers also found that in the rest of the distribution area

there were areas of discontinuity. After verifying an important population in the region of Barra do Rio Mamanguape, State of Paraíba, Catuête installed the first Brazilian base to research ecology of the Antillean manatee in Brazil.

The more they went deeper into the studies, the greater the concerns about the species. As the search information was systematized, some problems were identified, including the stranding of manatee calves, the existence of animals in inadequate enclosures and the loss of habitat (Luna and Passavante, 2010). Due to the need for ample space to receive the animals, a new project base was created on Itamaracá Island, State of Pernambuco, where the project's main office was installed and transformed into a Peixe-boi Center (IBAMA, 1990). Animals in need of clinical assistance, either due to stranding or because they were in inadequate enclosures, started to be transferred for this location (Luna and Passavante, 2010).

Over the years, the Projeto Peixe-boi - ICMBio/CMA and partners, has been able to contribute to the conservation of the species through the rescue, rehabilitation and release of manatees in Brazil, the elaboration of public policies, incentive to the formation of and conducting research. In the 1980s, when the project started, the manatee was the most endangered aquatic mammal in the country and categorized as “critically endangered (CR)”. Currently, the species remains threatened with extinction, however with the status of endangered (EN). Concerns about the species are still great and that is why the ICMBio/CMA has been strengthening the conservation actions of the species.

ICMBio/CMA planned to celebrate the 40th anniversary of the project, highlighting the actions and results in this period. However, due to the COVID-19 pandemic, this celebration needed to be postponed, but not forgotten. In this way, ICMBio/CMA thanks this news to all the institutions, researchers, collaborators and partners that were part of the 40-year history of Projeto Peixe-boi. We have certainty that without the presence of any of these, this story would not have the success that today celebrates.

When security measures for the pandemic allow, ICMBio/CMA intends to celebrate in honor of history, as well as for the victory of having overcome this difficult moment for the entire planet.

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During the COVID-19 pandemic, ICMBio/CMA publishes two children's books.

The entire planet has been facing COVID-19 and there was a need to readjust activities during this pandemic period. One of the works carried out by Chico Mendes Institute for Biodiversity Conservation/National Aquatic Mammals Center (ICMBio/CMA) is environmental education, through lectures and courses, among other activities. With the closure of schools, ICMBio/CMA was concerned with children and how to bring awareness of manatee conservation to them. In order to bring extracurricular activities to children, allowing a better entertainment and at the same time enabling them to learn a little more about manatees, the Center launched two children's books: “Sou Xica, o peixe-boi da praça do Derby” (I’m Xica - the manatee from Derby Square) and “Vamos aprender com o peixe-boi?” (Let’s learn with manatees?) (Figure 1).

Xica's book, with illustrations of the Spanish artist Andrés Serna, tells the story of the most famous Brazilian manatee. Xica was considered a “celebrity” and mascot of Pernambuco State, where she lived all her 53 years. She was the oldest known Brazilian manatee. She spent more than 20 years living in a small tank, in a public square in Recife, being one of the main attractions of the city. During that period, residents and tourists went to that square to visit Xica, being part of the family leisure. However, she suffered from being in an inadequate enclosure and with inappropriate food, among other things. For this reason, she acquired scoliosis. After two decades in that place, Xica was transferred to ICMBio/CMA, where she continued to be the main attraction for visitors. Even with Xica's death in 2015, she remains in people's imagination, being one of the main references of manatees when it comes to conservation. Through the story of this charming manatee, we present the importance of conservation of the species, in addition to a loving tribute to the “grandma” manatee.



Figure 1. Children’s books published by ICMBio/CMA.

The book “Let’s learn with manatees?” uses playful language, which brings children closer to the manatee, through photos of the animals. The authors teach the biology of the species, talk about the importance of habitat preservation, explain about manatee rescue, rehabilitation and release and elucidate that in Brazil there are two species of manatees and that both are cared for by ICMBio/CMA. All teaching is carried out as if it was the manatee itself talking to the child, which facilitates the understanding of the information brought to this audience.

The two children's books can be accessed at the links below:

https://www.icmbio.gov.br/cma/images/stories/Publica%C3%A7%C3%B5es/Livro_Xica.pdf

[https://www.icmbio.gov.br/cma/images/stories/Publica%C3%A7%C3%B5es/Livro_infantil_Aprendendo com o peixe-boi ICMBio CMA.pdf](https://www.icmbio.gov.br/cma/images/stories/Publica%C3%A7%C3%B5es/Livro_infantil_Aprendendo_com_o_peixe-boi_ICMBio_CMA.pdf)

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State of Rio Grande do Norte, northeastern Brazil, as an important area to release Antillean manatee.

The coastline of Rio Grande do Norte (RN) State is an area with a large number of Antillean manatee calves stranding in Brazil, being only behind Ceará State (Balensiefer et al., 2017). Animals rescued in this location have been part of the national reintroduction program since 1994 (Luna and Passavante, 2010), with a high success rate (Normande et al., 2015). Recent studies show that animals rehabilitated in captivity, when released, use discontinuous occurrence areas of the species, such as Pernambuco State (Attademo et al., 2020) including where they are considered as extinct (e.g, Sergipe and Bahia States; IUCN, 2020).

Actions for the conservation of the Antillean manatee in RN can positively influence the other adjacent areas of occurrence of the species, since the State is located between the region with the greatest (Ceará) and the third (Paraíba) number of strandings. In Paraíba there is a release site for the species (Attademo et al, 2021).

In 1980 the Brazilian Government initiated actions for the conservation of the species, and in 1998 the Cetáceos da Costa Branca Project, through the State University of Rio Grande do Norte (PCCB/UERN) started studies on the RN’s manatee population and their potential threats. The stranded animals rescued in RN were not released in the area of origin but were released in an important restocking area in the extreme south of the species’ range.

In RN, captive rescue and rehabilitation programs were maintained, but if there is permanence of sending animals to other locations, the region may suffer from a decrease in population, and even extinction in some areas, in the medium-term.

Attademo et al. (2021) highlighted the importance of implementing the acclimatization enclosure for released manatees in the RN, also including as a priority action of the species National Conservation Action Plan (PAN).

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COLOMBIA

Uncontrolled invasive hippos in the Magdalena River basin: An emergent threat to Antillean manatees in Colombia?

The Antillean manatee (*Trichechus manatus manatus*) inhabits wetlands and tributaries of the lower and middle Magdalena River basin (Colombia), including rivers, swamps (locally known as

'cienagas'), and floodplains. The species range encompasses parts of the Antioquia, Santander, Bolivar, Cesar and Magdalena departments. Key areas for manatees include several rivers (Sogamoso, Lebrija, Cimitarra, Simití, Cesar, Cauca, and San Jorge) as well as wetland areas (Depresión Momposina, Canal del Dique, and Ciénaga Grande de Santa Marta). The subspecies is regarded as Endangered and protected by Colombian law. However, many aspects of the abundance, ecology, behavior, and conservation status of Antillean manatees in the Magdalena River basin are still poorly known (Castelblanco-Martínez et al. 2015). The species faces multiple threats, mostly of anthropic origin. Manatee habitats experience intense transformation caused by cattle ranching, deforestation, illegal fishing, fish farming, monoculture farming, road development, and the expansion of human populations. These activities have rapidly increased sedimentation, hydrodynamic cycle modifications, and pollution, among other processes, which are in turn exacerbated by climate change (Aguilar-Rodríguez et al. 2004; Restrepo A 2013). In addition, the presence of cattle together with the recent introduction of Asian water buffalo (Ángel-Marín et al. 2010) have impacted wetlands and rivers via soil compaction and changes in water quality, also potentially excluding manatees from food resources and critical areas for survival.

Since the early decade of 1990, the Middle Magdalena River basin of Colombia harbors an introduced population of free-ranging, reproducing hippos (*Hippopotamus amphibius*) (Subalusky et al. 2019). All individuals descend from one male and three females, initially introduced by drug lord Pablo Escobar for his private zoo. The lack of intense droughts and of large social mammalian carnivores in the region results in reduced mortality and high birth rates for hippos, and the population now comprise several tens of individuals. Hippos have currently expanded into two thousand square kilometers of the Middle Magdalena River basin, an area spanning across several departments of Colombia (Jiménez et al. 2018). In addition, there are unconfirmed hippo sightings in two localities of the Lower Magdalena River basin, raising concerns of further range expansion. The spread of this introduced population has ecological and socio-economic effects (Monsalve-Buriticá & Ramírez-Guerra 2018; Subalusky et al. 2019), including decreased water quality in seasonal marshes associated to the river (Shurin et al. 2020), and attacks to people and livestock (Valderrama 2012). Due to their uncontrolled growth, range expansion, and negative effects, hippos in Colombia have been regarded as an invasive species (Shurin et al. 2020; Castelblanco-Martínez et al. 2021).

A recent study indicates that the introduced hippo population has been exponentially increasing, likely due to its tolerance to degraded and fragmented landscapes in the region (Castelblanco-Martínez et al. 2021). In the near future, range expansion is projected to occupy many important areas for manatees, such as ciénagas, flooded areas and rivers of the Magdalena river Basin. The imminent use area overlap between both species poses a serious risk due to their contrasting behavioral traits. The manatee is a cryptic, stealthy species, whereas hippos are highly aggressive and territorial. Since both species are aquatic herbivores, they occupy similar ecological niches, and will potentially compete for food and space.

The most significant impacts of hippos on Colombian manatee populations, however, are likely those related to their deleterious effect on habitats. Hippo movements significantly affect geomorphology, hydrology and connectivity of water bodies (Subalusky et al. 2019). Due to their amphibious habits, hippos are an important factor of water quality modification, producing shifts in

nutrient and oxygen levels, water biogeochemical variables, and transparency, among others (Stears et al. 2018). These changes can potentially impact the abundance and quality of food resources available to manatees, and favor the growth of potentially toxic cyanobacteria (Bengis et al. 2016; Shurin et al. 2020). In addition, hippos may act as vectors for pathogens that can affect other mammal species (see Dudley et al. 2016 for a review).

Habitat selection by manatees adapts in response to water level pulses in river ecosystems and associated floodplains (e.g. Jimenez-Dominguez & Olivera Gómez 2014). Even though the details of this habitat use dynamic are poorly known for the Magdalena River Basin, we hypothesize that hippo population increase may impact manatee occupation and movements in several ways. First, hippos may eventually occupy perennial water bodies used by manatees as refuge areas during the dry season, reducing the chances of manatee survival, particularly for vulnerable individuals such as mom-calf pairs. Second, hippos may disrupt manatee migratory routes by occupying watercourses that serve as crucial transit corridors. Third, hippos can exacerbate sedimentation processes within the Magdalena River basin, which can be critical for manatees particularly during the dry season. Hippos are considered ecological engineers, due to their capacity to mobilize large volumes of sediment, leading to soil colmation (Moore 2006). Death records indicate that wetland sedimentation creates bottlenecks in manatee migratory paths, resulting in stranding, trapping, vulnerability to poaching, and increased mortality (Arraut et al. 2017; Aguilar-Rodríguez & Castelblanco-Martínez 2019). In the mid-term, disruption of migratory paths may lead to the isolation of manatee groups, thus affecting population genetics in the long-term.

As hippos expand over the Magdalena River floodplains, interactions between this species and human communities become increasingly complex. People perceptions confront hippos and manatees in a particular way. The hippo is seen as an opportunity for extra income thanks to their potential as a tourist attraction, whereas the manatee is perceived as a little-known species, which has become irrelevant to communities because they cannot make a profit from it. Therefore, the promise of short-term benefits for some inhabitants builds positive perceptions and attitudes towards invasive hippos, disguising the potential risk of problematic interactions with local peoples all over the basin. At the same time, some rural communities have to deal with the harmful effect of hippos: increased risk of attacks on humans, unexpected impacts on their livelihoods (e.g., fishing, crops, and livestock), and negative consequences for traditional riverine cultures.

The rapid growth of the hippo population, projected to reach approximately 1500 individuals in 2030 (Castelblanco-Martínez et al 2021), highlights the urgent need to implement cost-efficient management actions in order to control this invasion. Accordingly, the precautionary principle should be taken into account, starting with management actions implemented at the local scale. Correlative and dynamic spatial modeling approaches indicate that if no action is taken, either by strict enclosing of sterilized animals, culling, or a combination of both, hippos will likely colonize the extensive wetland network in the Caribbean Region of Colombia, which includes several key areas for manatees. In this unfortunate scenario, we think that hippos will eventually outnumber manatees in the following years, mostly due to their negative impact on habitat structure, integrity, and function. This represents an additional major threat to an already endangered native aquatic mammal.

Demographic and geographical scenarios indicate that introduced hippos might promote a widespread population decline in Colombian native aquatic species, including Antillean manatees. However, the response of the national authorities to the expansion of invasive hippos has not been effective in promptly controlling this population. The interface between science and policy seems to be entangled between evidence and the political burden resulting from implementing those urgently required management actions. Animal rights activists have influenced some local communities and pushed for a political debate centered on the rights and interests of individual hippos. This point of view promotes compassionate conservation approaches to tackle the invasion (e.g. Dembitzer 2018). Ethical debates should be more focused on the impacts of hippos on hundreds of native, threatened species such as manatees, rather than on the individuals of an invasive introduced species. We want to stress our concern at the way in which Colombian national authorities are prioritizing efforts and resources towards an ineffective way to control this invasion. Therefore, we urge for decisive actions in order to protect Antillean manatees, and many other native species and habitats in the Magdalena River basin, which could be jeopardized by the unaddressed threat of introduced hippos.

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EAST AFRICA

The past informs the future: A recent genetic study of museum held samples shows Indian Ocean dugongs are vulnerable – We need future genetic studies for the management and conservation of critically small dugong populations off East Africa

The Dugongidae family consists of only one extant member, the dugong (*Dugong dugon*), which is classified as ‘vulnerable’ on the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species (IUCN Red List, 2019), but may be ‘endangered’ in parts of its range (Marsh et al., 2012). Dugongs have already disappeared from some localities, including Mauritius, western Sri Lanka, the Maldives, Japan’s Sakishima Chains, Hong Kong’s Pearl River Estuary, several islands in the Philippines, Cambodia, and Vietnam (Lawler et al., 2002). The remaining main populations have been reported off Australia, in the Persian Gulf, and in parts of the Red Sea, off the coast of east Africa, the west coast of Sri Lanka, Indonesia and, the Pacific islands (Nasr et al., 2019). There have been numerous regional studies on dugong populations, for example off Australia (e.g., Marsh et al., 1982), but until recently no range-wide studies of dugong populations encompassing their entire historical distribution range had been conducted. Due to their conservation status, such studies are often hindered by a paucity of contemporary samples, making museum collections a valuable resource to help us better understand such vulnerable marine mammals.

Thus, Plön et al. (2019) were able to source a total of 172 historical dugong skeletal samples, such as teeth, tusks and bone, from 14 collections (11 European and one African museum collection, and two European university collections). Samples represented individuals from populations throughout the dugongs’ historical range and ranged in date from 1827 to 1996. The mtDNA was successfully amplified from these samples to investigate the population genetic structure of the species. The results revealed new and divergent mtDNA lineages within the Indian Ocean, but also provided new and exciting results. While most specimens were contained under one mtDNA lineage, the Western Indian Ocean (WIO) lineage, another distinct lineage was found to be isolated to the nearby Madagascar and Comores islands. This suggests that the poorly understood, now small population off Madagascar, is genetically important and requires a higher conservation priority. In addition, genetic diversity within the Indian Ocean lineages was found to have severely dropped in samples collected after the 1950s. Thus, the discovery of new lineages (e.g. Madagascar) and the overall reduction in genetic diversity indicated a need for further study to highlight the vulnerability of the Indian Ocean dugong to extinction and the need for its conservation. Plön et al.’s (2019) findings were supported by a previous study examining historical changes in dugong distribution and perceived changes in their abundance in the Persian/Arabian Gulf, which found that since the 1950s, the dugong’s range in the region may have contracted by one quarter. In addition, despite its large population in the Gulf, overall densities were far lower than in other areas of their distribution range (Al-Abdulrazzak and Pauly, 2017).

Furthermore, two recent Global Environment Fund (GEF) projects suggest dugongs remain only in scattered, isolated small groups in the WIO. Dugong sightings off Madagascar are rare, with younger fishermen never having encountered these animals and being unaware of their name in their local language (Cockcroft and Young, 1998; <https://www.dugongconservation.org/where-we->

work/madagascar/). Off East Africa, a series of questionnaire surveys showed similar results and aerial surveys of 'hotspots' suggested dugongs are all but extirpated off East Africa, other than from the Bazaruto Archipelago (Cockcroft et al., 2018). Numbers off Kenya and Tanzania are almost certainly in the tens and not hundreds.

These studies employed different methodologies (genetic studies versus abundance estimates), but came to the same conclusion – dugong population numbers have dropped since the 1950s. Ultimately, the exceptionally low numbers of dugongs off East Africa may warrant the recognition of this population (especially those within the Bazaruto area) as isolated and vulnerable, with a change in their conservation status from "vulnerable" to "endangered" or, more probably, "critically endangered". The analyses of any existing genetic samples are critical in establishing the isolation and conservation status of East Africa's dugongs and in the management and conservation of the remaining animals.

Sirenian populations for which we have the most scientific data – Florida manatees and Australian dugongs – have stronger management programs and are more likely to survive extinction. This warrants further efforts in regions like the Western Indian Ocean. Dugongs are already a priority for conservation in Bazaruto, Mozambique, which is believed to house the last viable population in the Western Indian Ocean region (Findlay et al., 2011). However, outside of Bazaruto and in other places off East Africa, like off Tanzania and Kenya, the species is showing a major decline and only remnant numbers remain. Here, historical data, for example further access to museum samples, is imperative for dugong conservation.

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FLORIDA

Unprecedented Mortality of Florida Manatees along the Atlantic Coast

An unprecedented number of manatee carcasses have been documented by the Florida Fish and Wildlife Conservation Commission along Florida's Atlantic coast during the winter and spring of 2020-2021. During the four-month period from December 1, 2020 to March 31, 2021, a total of 582 manatee carcasses have been verified in this region, and the die-off is still ongoing at the time this article was submitted. Most carcasses were reported in the Indian River Lagoon (IRL) of the central-east coast, which Reynolds et al. (2015) referred to as "the world's most important habitat" for the West Indian manatee, but substantially elevated numbers also occurred in southeast Florida during the winter months. Adults have made up approximately 40% of cases, which is much higher than normal. The US federal Working Group for Marine Mammal Unusual Mortality Events agreed that this event meets the criteria of an unusual mortality event (UME); with US Fish and Wildlife Service concurrence, the event was officially declared on 22 March 2021.

The investigation into this UME is ongoing, so all data and conclusions should be considered preliminary. The primary cause has been identified as starvation, but other contributing factors have not been ruled out. Necropsies on a subset of carcasses recovered in early to mid-winter have the following common findings: emaciation with substantial atrophy of fat, muscle, and organs; little or no filling of the gastrointestinal tract in most cases; poor body condition indicative of severe malnourishment; and little or no evidence of cold exposure on the skin. Initial pathology findings were remarkable in the extent of tissue atrophy observed at the microscopic level, underscoring how far the health of these animals had deteriorated prior to death. Some manatee carcasses found later in the winter showed gastrointestinal filling indicative of recent feeding, but tissue atrophy remained profound and apparently the detrimental effects of prolonged starvation could not be reversed. Evaluation of temperature data indicates that the winter was not sufficiently cold to result in this level of mortality, and many carcasses were found near or within warm-water habitat. A synergistic interaction between cold and malnutrition is possible, however.

Seagrass in the IRL has been devastated by repeated, long-lasting phytoplankton blooms since 2011 (Morris et al. 2018), and it now appears to have nearly disappeared in many areas, leaving bare substrate where formerly extensive and lush meadows of submerged aquatic vegetation had recently formed foundational communities. Between 2009 and 2019, the areal extent of seagrass decreased by 58%, and by 2020, the percent seagrass cover within that footprint had declined by 89% (from ~20% to ~2%, on average) (St. Johns River Water Management District, unpublished data). For years ecologists have expressed concern that this biologically diverse estuary may undergo a regime shift from a macrophyte-dominated ecosystem (seagrass, macroalgae) to one in which phytoplankton dominate primary productivity (Phlips et al. 2014). The IRL is at risk of ecosystem collapse (Adams et al. 2019), and this manatee UME is the latest manifestation of the lagoon's ill health. Fortunately, manatees are dietary generalists and have the ability to feed on a wide variety of other vegetation found in freshwater systems, along shorelines, and in salt marshes. Now that temperatures are warming and manatees are not constrained to remain close to warm-water sites, they are dispersing to other habitats.

FWC staff and our partners continue to respond to higher levels of public reports of manatees in distress; 57 manatees have been rescued in the Atlantic region in the 4 months since December 1 (93 statewide), pushing manatee critical care facilities to capacity. A large number of small lone calves (21 <200 cm SL statewide) have been among those rescued, possibly orphaned by the deaths of their mothers; the rearing of more orphans in oceanaria will add further strain to the rehabilitation program, as such calves typically remain in managed care for about 2 years.

Along the Atlantic coast of the United States, the northern IRL stands out as "...a major hub of manatee activity in all seasons..." (Deutsch et al. 2003, p. 62), supporting up to 70% of the east coast population present in the spring (Martin et al. 2015), which was last estimated at 4,000 animals (95% CRI, 3,240–4,910) in 2016 (Hostetler et al. 2018). Therefore, the consequences for manatees of seagrass loss in the IRL extend well beyond the physical limits of the lagoon. For example, it appears that in winter manatees migrated south from that region in a malnourished state, many of them dying in southeast Florida. As the weather warms, carcasses with similar poor body condition and tissue atrophy have been found as far as north as Georgia (Clay George, Georgia DNR, pers. comm.). This underscores the concern for long-term health effects from this event even after manatees disperse to other feeding areas. It is too early to quantify the effect of the ongoing die-off on the Atlantic population, but it appears that the impact will be considerable. If this major loss of environmental carrying capacity is long-lasting (i.e., the seagrass does not recover), it will likely have profound effects on future manatee population status on the Atlantic coast.

For updates on this event, please see our web site:

<https://myfwc.com/research/manatee/rescue-mortality-response/ume/>

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-Charles J. Deutsch¹, Martine de Wit¹, Margaret E. Barlas¹, William Greer¹, Amber R. Howell¹, Andrew Garrett¹, and Leslie I. Ward-Geiger¹

¹Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, United States

MEXICO

Pancho and Moon, two wintering resident manatees of the Atlantic Coast of Florida in Mexico

In November 2020, a Florida manatee arrived at the coast of Cancun. By December 8th, there were photos and videos on social media from an adult manatee with unusual scars on his tail and a white scar on his right side (Figure. 1). These scar patterns revealed that this male manatee had a Florida identification record number PE424. PE code corresponds to Port Everglades power plant, Ft. Lauderdale, New River (Beck and Reid 1995).

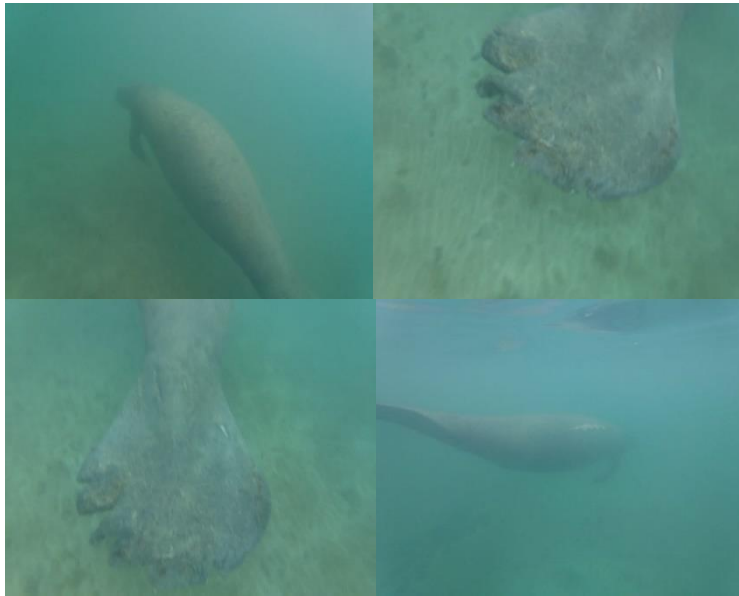


Figure 1. Scar pattern used to identify PE424 from Florida, locally known as "Pancho" (Photo: Anonymous).

This manatee was named Pancho by the local people in Isla Mujeres, Mexico. Because of his scars and long trip, Roberto Sánchez, a veterinarian from the Mexican Association of Habitats for the Interaction and Protection of Marine Mammals (AMHMAR), recommended to the Mexican government the need for a clinical assessment. The evaluation stated that Pancho is a healthy and strong adult of 3.3 m long and weighing an estimated 600-700 kg.

Considering Pancho's healthy condition, the Mexican government authorized his release after putting on a satellite transmitter to monitor his movements and assess him remotely. Benjamín Morales from El Colegio de la Frontera Sur (ECOSUR) assumed responsibility with the support of the project "Conservation assessment of the manatee population in Quintana Roo, Mexico and their connectivity in the coastal zones, 2019-2021", funded by the Sac-Tun Company, together with Roberto Sánchez as the veterinarian responsible and operational fieldwork support of Directors and staff from The National Commission of Natural Protected Areas (CONANP).

Preparations for tagging and working groups.

Because of Pancho's big size, a custom belt was built for him following the protocols developed in the 90s by the Sirenia Project of the United States National Biological Service and used in Mexico since 1994 (Morales-Vela et al. 1995). Also, a satellite transmitter was prepared (Telonics Inc). Pancho was released with an Iridium manatee tag on January 26 (Figures 2 and 3) in Isla Mujeres after his second clinical assessment. During this evaluation, his skin appeared to us to be that of an old manatee.



Figure 2. AMHMAR and ECOSUR staff handling Pancho in Isla Mujeres for a second clinical assessment and tagging with a Telonics-Iridium transmitter and a Hobo-temp sensor installed in the belt. (Photos: B. Morales and AMHMAR).

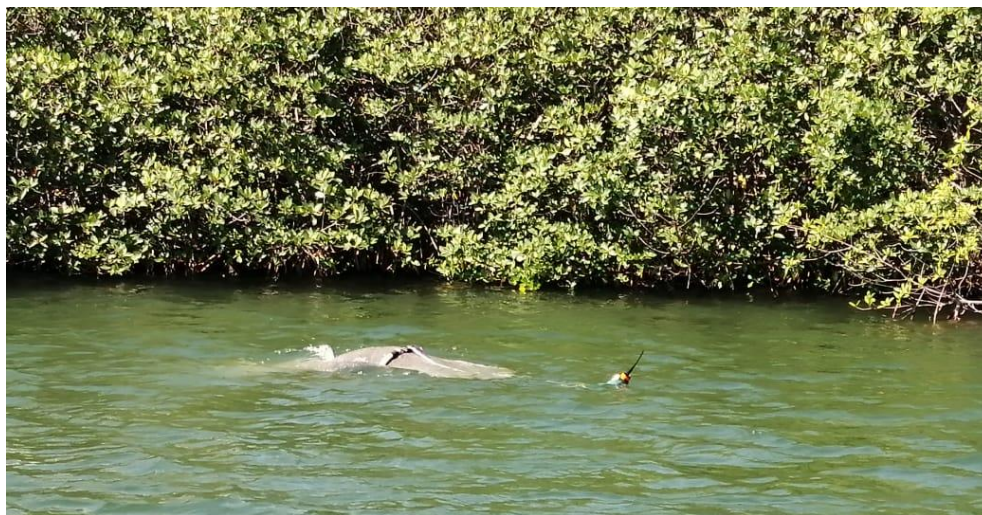


Figure 3. Pancho with tagging system attached and touring the shores of the Nichupté Lagoon, Quintana Roo (Photo: B. Morales).

A Facebook fan page was created (<https://www.facebook.com/Pancho-el-manat%C3%AD-de-Florida-105246348272183>) for the interested public to know about Pancho and participate in his care and monitoring.

Pancho's first movements and general behavior in Mexican waters.

During his first month of monitoring, Pancho showed three different behavioral patterns. The first one was after tagging and releasing him in Isla Mujeres (Figure. 4, a) he crossed from Isla Mujeres to Cancun coast directly to Puerto Cancun Marina, staying there for five days. He has been there before several times, feeling comfortable and safe for resting (Figure. 4, b). During a second moment, after these days, he went out of the marina to the south, entering the Nichupte Lagoon system (NLS) through the main navigation channel and staying all day long in the lagoon, showing short movements less than 2 kilometers. NLS has seagrasses, mangroves, and lacking docks and hotels, and surely Pancho spent most of the time feeding (Figure. 4, c). Later, he moved to the lagoon's northeast side, spending time between continuous traffic boat and dock zones and low human activity zones with seagrasses and mangrove channels, resting and feeding. At the marinas, he was observed resting under the boats' shadows and pleasantly accepting the freshwater offered by people to drink. It was requested that Marina administration not offer him water since there are a lot of natural freshwater sources available in the lagoon. During a third moment, within days, Pancho extended his exploring movements to the NLS southside.



Pancho and Moon

- a) Pancho releasing place (Isla Mujeres)
- b) Puerto Cancun Marina
- c) Nichupté Lagoon
- d) Southern limit Pancho's movements (Xel-Ha)
- e) Northwestern limit Pancho's movements (Ría Lagartos)
- f) Moon on April 16th
- g) Moon on April 14th

Figure 4. The area where Pancho is moving, as well Moon sight places.

On February 12, we noticed that the buoy was damaged, so we changed the transmitter on February 24. Fortunately, the entire process was carried out in the water with the support of divers from AMHMAR. We confirmed that Pancho was in good condition, strong and active. After recovering the tag, we noted that a crocodile did the damage; Jim Reid (formerly from United States Geological Service, United States) and Mexican experts working with crocodiles corroborated this by analyzing the marks in the tag (Figure. 5). There are two important populations of crocodile species at Nichupte Lagoon, the American crocodile (*Crocodylus acutus*) and crocodile Moreletii (*C. moreletii*). Therefore, following Jim's comment that in these cases, the only thing we can do is have a new tag ready to replace.

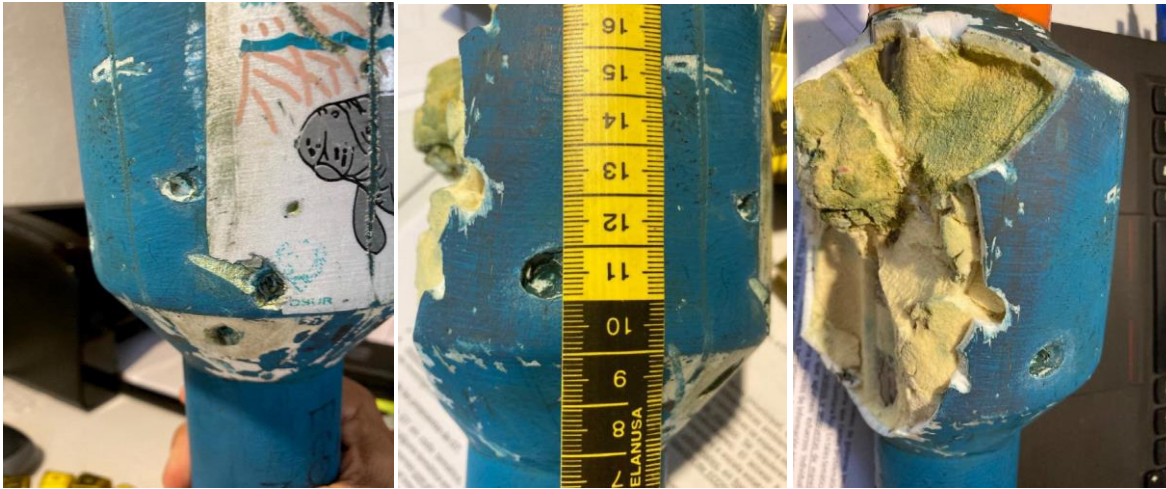


Figure 5. Transmitter floating chamber damaged by a crocodile bite. Teeth patterns are seen at the breaking line in the floating section of the tag (Photos: B. Morales).

By the end of March, he changed the pattern of his movements completely, going out of the NLS to travel the south coast of Quintana Roo, stopping temporarily by marinas and touristic ports on his way, and exploring every cove and cenote, most of them with tourist activity. This trip along the coast ended at Xel-Ha Cove, traveling almost 107 kilometers in few days (fig. 4, d). Later, he returned to the north with faster movements reaching NLS again and spending some days there. In early April, again, Pancho went out of the NLS, this time to the north side of Quintana Roo with faster movements, along the coast, and stopping in several places to feed on the abundant seagrasses. He traveled about 95 kilometers, reaching near Holbox town and returning with slower movements taking 4 to 5 days to arrive at NLS. Three days later, he went out to the north again and traveled 180 kilometers, arriving at Ría Lagartos Natural Protected Area in Yucatan State (fig. 4, e). After one or two days, he returned to NLS with slower movements exploring places with natural freshwater sources, streams, and abundant seagrass areas, where free manatees are regularly sighted.

Pancho is a very dynamic manatee with recurrent round-trip excursions. His movement pattern suggests that NLS and Puerto Cancun Marina serve as reliable sites, of which he goes out to explore surroundings and then returning there. The exploratory behavior that Pancho showed on the north coast of Quintana Roo and part of Yucatan suggests that Pancho was not in this region before. So, this would suggest that he probably traveled from Florida crossing the Yucatan Channel rather than up along the coast. Still, we must wait for more signals from Pancho to answer this question.

We were analyzing this data when we receive unexpected news. On April 16, professor Raúl Díaz-Gamboa from the Yucatan Autonomous University received photos and videos of an adult manatee with a conspicuous dorsal scar spotted in Telchac Port Town, Yucatan state (Figure. 4, f) displaying a calm and docile behavior (Figure. 6).

Given the presence of Pancho, we sent the photos to Florida. A few hours later, Amy Teague of the Wetland and Aquatic Research Center Sirenia Project USGS identified this manatee as an adult female known as Moon MIPS ID RB358.



Figure 6. Moon sighted near Telchac Port, Yucatan, on April 16, 2021. Moon's photos also are shown in Beck and Reid (1995) (Photo: Fishermen of Telchac, Yucatan).

Moon's first record was at Riviera Beach in 1982, with regular yearly sightings. Chip Deutsch commented that Moon was radio-tracked along the Atlantic coast from 1986 to 1994, and she figured prominently (TBC-03) in his monograph analysis (Deutsch et al. 2003) with 1724 days tracked.

Although manatee genetic studies in the Mexican Caribbean have proved genetic flow from Floridian individuals along the time (Nourisson et al. 2011), those long-distance migrants had not been physically detected until now.

Moon was defined as an adult manatee in 1986 (Deutsch et al. 2003), so now she is an older female, and Pancho also looks old, which is surprising. There is the possibility that Pancho and Moon may decide to return to Florida and show us their return route, either crossing the open sea and taking advantage of the Island of Cuba or traveling along the Yucatan coast and Gulf of Mexico getting to the USA by Texas and arriving at home on Florida's east coast. For the first option, there is clear evidence of an important demographic manatee connection between Cuba and Florida (Alvarez-Alemán et al. 2018), and there is also evidence that one winter male manatee traveled on the Atlantic Ocean at a rate of 87 km per day in Florida (Deutsch et al 2003). There is only 200 linear km between Cuba and the Yucatan coasts, very convenient in distance. In support of the second option, we have only the two early records of Moon on the central coast of Yucatán, first in Chicxulub Port Town (Figure. 4, g) at 35 km west of Telchac Port Town two days before, where the photo was taken by fishermen in Telchac. Also, it is known that long-distance coastal movements of manatees are associated with meeting their physiological

requirements of access to freshwater and regular food consumption for health and maintaining body conditions, as Pancho has and probably also Moon, but in this case, would represent a long trip near to 4,800 kilometers, but not impossible. Currently, the long-distance travel record in a Florida manatee is 2,360 km in an adult male (Deutsch et al. 2003).

In the search for a possible answer to the question, why two wintering adult manatees from the east coast of Florida are in Mexico in such a short time? Chip Deutsch comments that this may reflect the dire habitat situation on Florida's east coast. Probably also combined with the winter migratory stimulus of long distances behavior in some Florida manatees (Deutsch et al. 2003).

But now, we will have to replace Pancho's tag again because it is failing, and we are looking to tag Moon. Cathy Beck commented that in 1986 Moon was tagged by Bob Bonde and Tom O'Shea in the water, and both said she is a very calm manatee, easy to tag while in the water. We are already looking forward to meeting Moon!

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PHILIPPINES

Notes on dugong calf occurrence in the Busuanga-Calait-Coron-Culion Island complex of Palawan, Philippines before and after Supertyphoon Haiyan

Many write-ups about dugong calves in the Philippines mention the northeastern Palawan islands of Busuanga, Calait, Coron and Culion (11.983268°N; 120.101709°E), where documentation spans 33 years (Table 1) and also includes adult dugong sightings (*e.g.* PCSDS 2006a, 2006b; SEAMAM III 2015).

Table 1. Initial list of reported dugong calves from the Busuanga-Calait-Coron-Culion island complex, 1987 to 2019.

Month	Year	Given "Name"	Adult/ Calves	Island	Source	Notes
Sep	1987		4/1	Calauit	Kataoka et al. 1995	Aerial survey
Apr	1988		6/2	Busuanga		
May	1992		7/2			
Jun-08	1992	"Joanna"	0/1	Culion		Died after 16 weeks in facility
March	2017		1/1	Busuanga	Tripadvisor 2021	Photograph of mother and calf swimming together uploaded to website
June	2018		1/1		Kim 2018	
Apr-07	2019	"Bughaw"	0/1		Ibañez 2019	Died after 1 week in facility

Aerial surveyors in 1987, 1988 and 1992 detected dugong calves in Busuanga and Calait Islands. Orphaned calves (*i.e.* "Joanna" from Culion in 1992; "Bughaw" from west Busuanga in 2019) died despite the care provided. Mother-and-calf photos from Busuanga are regularly uploaded (Kim 2018; Tripadvisor 2017; Dugongdivecenter-ph 2016). In February 2020, Ms. Erina Molina shared her observations of mothers-and-calves in a location within this island complex.

A "calving area" along western Culion mentioned by some PCSDS (2006b) interviewees hints at a mechanism enabling persistence of this dugong population despite Supertyphoon Haiyan's 2013 direct hit on Busuanga (Figure 1).

After COVID-19-related restrictions eased, one of us (MS) tested a visit to Busuanga and Coron Islands on mid-March 2021. Lockdowns reimposed on March 29 presents travel-related challenges.



Figure 1. Approximate locations of dugong calves and “calving area” in the Busuanga-Calauit-Coron-Culion island complex. Inset indicates the area relative to the Philippines.

Acknowledgement: Thanks to MS. Erina Molina for sharing observations of mother-and-calf pairs.

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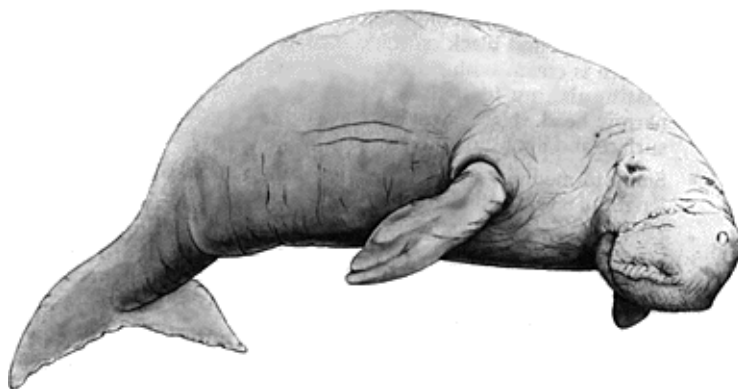
Report of the Third Southeast Asian Marine Mammal Symposium (SEAMAM III). 2015. UNEP/CMS Secretariat, Bonn, Germany. 643 pages. CMS Technical Series No. 32. Accessed at URL: https://www.cms.int/sites/default/files/publication/SEAMAM_smallfilesize.pdf

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Sirenews – Dugong
(End of local news)

UPCOMING SYMPOSIA/CONFERENCES

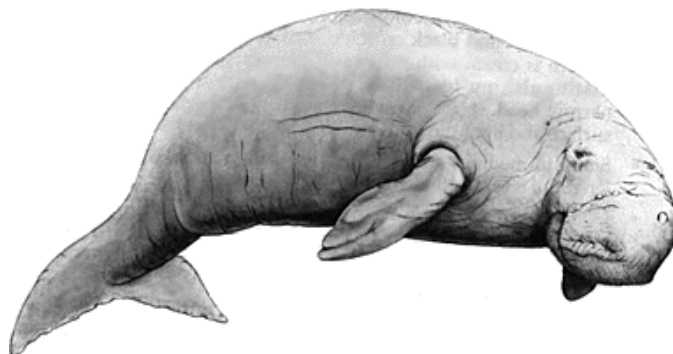
TENTH INTERNATIONAL SIRENIAN SYMPOSIUM

HOLD THE DATE!

The 10th International Sirenian Symposium is tentatively to be held in Palm Beach, Florida in conjunction with the 24th Biennial Conference on the Biology of Marine Mammals.

Further details are forthcoming upon approval by the Society.

For questions, please contact Nicole Adimey (adimey22@gmail.com)



Sirenews – Dugong

UPCOMING SYMPOSIA/CONFERENCES

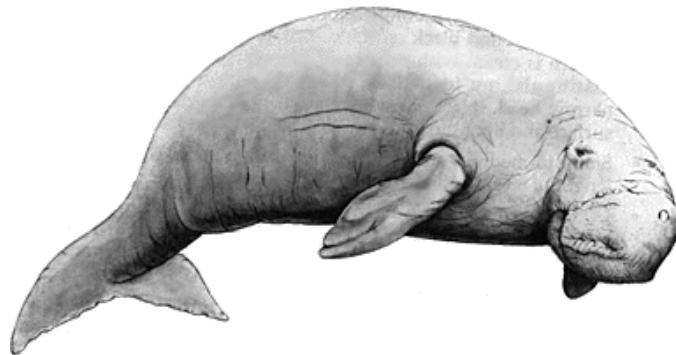
SMM2021

HOLD THE DATE!

A SEA CHANGE: Transforming Science into Stewardship

December 13th-17th, 2021

conference website (smmconference.org)



Sirenews – Dugong
(End of upcoming conferences)

CALL FOR CONCEPT NOTES LAUNCHED BY THE CMS DUGONG MOU SECRETARIAT

The CMS Dugong MoU Secretariat is excited to announce the launch of a new call for concept notes to support community-led activities that address key threats to dugongs and seagrass.

The CMS Dugong MOU to promote internationally coordinated actions to ensure the long-term survival of dugongs and their seagrass habitats throughout their extensive range.

This new initiative will work with selected applicants to develop and fund projects of up to **25,000 USD** that aim to improve community-led dugong and seagrass conservation activities through one or more of the following priority approaches:

- Participatory research and primary data collection, including monitoring;
- Conservation actions, management frameworks and policies;
- Development of business models in support of coastal communities and marine conservation;
- Communication tools and awareness raising.

This opportunity is open to non-governmental organizations or governmental agencies in the country of project implementation. Applicants must have existing relationships with local stakeholders, including local communities.

Eligible organizations are invited to submit a concept note using the attached application form by **17 May 2021** with a view to launching the projects in September 2021.

Further details, including eligibility requirements and selection criteria can be found in the attached guidelines. For any questions, contact: seagrass-ecosystems@cms.int



CMS Dugong MOU Secretariat

Memorandum of Understanding on the Conservation and Management of Dugongs and their Habitats throughout their Range (Dugong MOU)

Convention on Migratory Species Office - Abu Dhabi • United Nations Environment Programme
c/o Environment Agency - Abu Dhabi • PO Box 45553 • Abu Dhabi • United Arab Emirates
www.cms.int/dugong • www.dugongseagrass.org • @DugongHub

SYMPOSIA/CONFERENCES

THE FIRST AFRICAN MANATEE SYMPOSIUM

JANUARY 18-21, 2021

The First African Manatee Symposium, held online from January 18-21, 2021, brought together African manatee researchers and students, conservationists, resource managers, and educators, as well as sirenian experts from other parts of the world. Eighty attendees represented 17 countries, including 11 African nations. Thirty-three spoken presentations of African manatee research and conservation results from across the species range, presented in English and French, highlighted work that has been accomplished mostly over the past fifteen years, as well as presentations on specific topics by sirenian experts from other parts of the world that are applicable to African manatees. The workshop also included round tables to update the Convention of Migratory Species Action Plan for the African Manatee which was originally written in 2008. Recommended updates to the Action Plan will be published in the next edition of Sirenews. This symposium shared important knowledge gained about African manatees, introduced attendees to sirenian research and conservation activities occurring in other parts of the world, and allowed for discussions and planning for research and conservation actions needed in the next ten years and beyond. Lucy Keith-Diagne (lkd@africanaquaticconservation.org)

ABSTRACTS

ORAL PRESENTATIONS

(in alphabetical order)

Veterinary Considerations for the Conservation of African Manatees (*Trichechus senegalensis*)

Ashley Barratclough, Cynthia R. Smith, Forrest M. Gomez and Sam H. Ridgway

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Growing pressures on natural resources and human population expansion are accelerating the sixth mass extinction. Numerous marine mammal species are threatened or endangered, including the four remaining sirenian species. The West African manatee (*Trichechus senegalensis*) is currently the least studied sirenian species, making documentation of species decline and conservation planning challenging. The primary threats to African manatees - habitat loss, bycatch, and hunting - are mirrored in other endangered marine mammals such as vaquita porpoise (*Phocoena sinus*) bycatch and Indus river dolphin (*Platanista gangetica minor*) habitat fragmentation by dams.^{1,2} Insurance of species survival while anthropogenic causes are being addressed warrants increased interdisciplinary collaboration and application of a broad range of conservation tools. Conservation veterinarians can assist in identifying and filling critical data gaps, including the collection of baseline health data, to determine which actions are feasible and most suitable for each species. ³ Applying techniques and knowledge gained from health evaluations of other threatened sirenian and cetacean species globally to

the African manatee can help bridge data gaps.⁴ Similar challenges are occurring with the Amazonian manatee (*Trichechus inunguis*).⁵ Capacity building in Iquitos, Peru has enabled improved local education in addition to manatee rescue and rehabilitation.⁶ Sharing successful sirenian *in situ* conservation actions, including veterinary techniques, treatment plans (e.g. of harpoon injuries), and pathologic findings, can inform further development of African manatee health assessment and rehabilitation protocols. Early integration of veterinary considerations into conservation planning and local capacity building can help build a holistic, step-wise approach to saving species.

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Manatee Diet Studies

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As opportunistic herbivores it seems that manatees will eat almost anything! Manatees have been known to consume fish, taken deliberately from fisherman's nets, as well as invertebrates, eaten both intentionally and incidentally while feeding on vegetation. However, vegetation that is present in their habitat, be it coastal or riverine, makes up the bulk of their diet. Different techniques to determine the diet of an individual manatee include: (1) direct observation of feeding, (2) field observation of feeding "scars" that remain after manatees have fed, (3) microhistological examination of ingesta or fecal samples, (4) stable isotope analyses of tissues, (5) genetic analysis of ingesta or fecal samples, and (6) near-infrared reflectance spectroscopy (NIRS) of plant samples compared to gastrointestinal tract samples. The method chosen will depend on the objectives of the study, samples available, and budgetary constraints. I will present a brief review of each of these methods, with some practical tips for field research.

Survey of Manatee Threats and Killing in Southwest Lagoons of Nigeria

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In Nigeria, African Manatee (*Trichechus senegalensis*) is one of the marine mammals that is protected by law and concerns of many governmental agencies. Manatee is distributed throughout Nigerian lagoons and connecting rivers with growing threats from communities fishing on the water bodies. Survey conducted in 2018 – 2019 in Lagos, Ogun and Ondo States indicated target hunting of Manatee in Lekki Lagoon, Imakun River, and Mahin Lagoon across these states. Lagos had 78% of Manatee Killed, Ogun 18% and Ondo 6% with two manatee killing gears used Manatee box trap 71% and Manatee gill net 21% of the killings. The killings are not accidental as 94% were direct hunting with only 6% as bycatch in gill net. Majority of the sex killed could not be determined as 63% were unknown sex, 25% male and 12% female. Manatee killings are associated with need to provide for the family a form of livelihood with income ranging \$450 to \$600 per manatee caught. Manatee is highly hunted are target species in southwest Nigerian for income generation because of various reasons ranging from taste, oil and aphrodisiac believe of some parts of the organ. In order to end manatee hunting and reduce killing to a barest minimal, there is need for enforcement of the enact laws on conservation of endangered species 2016 with dear consequences, provision of alternative livelihood that is sustainable with multi-level funding till the livelihood is self-sufficiency. A cage culture of African catfish or dominant fast growing aquaculture practice might provide a suitable alternative.

Manatee Research and Conservation: Where Does One Start?

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Over the years, scientists have been confronted with the complicated task of how best to successfully study imperiled, cryptic megafauna. To conduct a new study, it is best to start with a review of pertinent literature and conduct a background check for any available useful data. This would include historical documents, publications, maps, accounts, and ancillary data sets. As manatees are an internationally protected species, before you begin your project you will also need to check to see what wildlife permits are needed from your governmental agency to authorize your research. Using the experiences gained over the last 50 years, we will examine some of the most useful modalities that researchers have employed for better understanding manatees and how best to address their long-term conservation concerns. We will track the usefulness of detailed examination of opportunistic carcass collection, establishing rescue/rehabilitation programs when necessary, conducting direct observations in the field, employing aerial survey techniques and utilizing remote drone operation, determining fitness and health of individuals in the population, and using radio-tracking and remote monitoring tools. We will apply these methods to addressing the fundamental questions about the impact of both natural and anthropogenic threats, interpreting basic manatee biology and behavior, determining their population status, evaluating critical habitat, and moving ahead despite limited budget constraints. We will course through the possible questions scientists are faced with for these concerns and how best to approach and implement possible management mitigation avenues. The future of research lies on the shoulders of young scientists today, and coupled with their enthusiasm for conducting novel approaches to traditional methods, we hope they will lead us towards a helpful approach for the management of our precious natural resources for future generations to enjoy.

African Manatee Age Determination Using Earbones

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Life history is a key component in manatee research and it helps address important management needs, particularly of endangered populations. Tools to collect this information include growth-layer counts from earbones, these layers have been shown to reflect the age in years for manatees. Manatees are polyphyodont; therefore, teeth are not adequate for ageing manatees. Instead of a tooth, part of the earbone complex is used to count growth-layers to determine postmortem manatee age. With increasing awareness of the importance of sample collection from manatee carcasses, a skillful earbone removal will be helpful. Improved knowledge of the skull anatomy will facilitate extraction of the earbone. Unfortunately, it is easy to recover the wrong bone or break/chip the portion to be aged. Thus, having familiarity with landmarks and orientation will assure the collection of the correct earbone piece (periotic bone rostral - "dome portion"). This presentation will discuss the techniques for earbone removal from the skull, as well as preservation of the bone until it can be sent to a laboratory for analysis. It is essential for all stranding members to receive earbone removal training to increase the number and quality of earbones collected. This enables more manatee carcasses to be aged from all regions. To date, only 34 African manatee earbones from Benin, Mali, Angola, Cameroon, Ghana, Gabon, and Senegal have been aged. It is imperative to understand how crucial it is in collecting these samples that provide insight in understanding African manatee life history and management needs.

Determinants of African Manatee (*Trichechus senegalensis*, link 1795) bycatch and fishing effort in Lake Ossa Wildlife Reserve: Perspectives for Human Wildlife Conflict Mitigation

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When people and wildlife species share the same natural resources, it may lead to human wildlife-conflict with consequences on human livelihoods and survival of the threatened species. Accidental capture of African manatees by artisanal gillnets in Lake Ossa Wildlife Reserve, Cameroon, is a major conservation issue. This study sought to understand the relationship between gillnet placement method and manatee conflict. We address this gap by investigating on whether (1) there is any association between gillnets spatial deployments method and manatee nets destruction, and (2) there is any seasonal difference on manatee bycatch or net destruction. Five focus-group and 150-interviews with local fishers were conducted in June 2019 to map fishing-manatee conflict areas. We conducted an experiment testing different gillnet placement and their likelihood of being destroyed by a manatee. We deployed nets a) parallel to the manatee feeding shoreline, b) perpendicularly across channels, c) circularly in open water and d) linearly in open water, all (four gillnets) equidistantly separated, with a 12 hour observation time frame for five days/month over six months. Net destruction was recorded according to the likely species involved. We measured water quality and fish catch (kg)/net every 12hours. We found an association between gillnet deployment and destruction by manatees. Deploying gillnets linearly appear to be the most desirable technique as it yielded highest fish catch (mass=1.35±0.5kg) and least (14.81%) destroyed by manatee. Comparatively, most destroyed gillnet where those along feeding shoreline and across channels and yielded lowest mean catch of 1.06±0.89kg. Also, deploying nets linearly experienced the least destruction (25%), while configurations along feeding shorelines and parallel to vegetation, recorded the highest mixed destruction (33.39% and 31.25%) respectively. We recommend setting gillnets linearly or circularly in open water, as they have little interaction with manatee, navigation boats, and little deployment effort; preventing further manatee entanglement.

Human-manatee conflicts: fish species plundered from gillnets by the African manatee (*Trichechus senegalensis*) and hunting of manatees in the Southern Korup, Cameroon

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The African manatee has been poorly studied, though it is Red-Listed “Vulnerable” by the IUCN and heavily hunted. Nutritionally, African manatees are mostly known for herbivory diet. There is little information about fish diet, though fish robbery by manatees from gillnets is a threat to this mammal. This feeding behaviour is known to drive negative perceptions and attitudes of fishers towards manatees, thereby exacerbating the already existing heavy hunting and bycatch in the species home range. From December 2015 to October 2016 and August 2016 to May 2017, respectively, we quantified fish prey species plundered from gillnets by manatees and documented the number of manatees hunted in Moko River in the Southern Korup Park, Cameroon. We partnered with two local fishers and collected carcasses of fish left in gillnets by manatees during their normal fishing activities. Also, through a network of five local informants, we recorded real-time incidences of poaching. A total of 260 fish carcasses of seven fish species were collected from gillnets, with catfish *Chrysichthys sp.* the most represented preyed species. Apart from its economic importance in the capture fisheries (a catfish is twice as expensive as a cichlid of about the same sizes in the local market), catfish is a valuable cultural fish in the area and Central Africa as a whole. Hence, fish theft is an important driving force for human-manatee conflicts. A total of five manatees (four females and one male) were killed using harpoons during the study period, with most killing in early wet season. These findings have implications for community outreach and education on the conservation of manatees, generation of alternative livelihood programs, production of a formal legal instrument (absent in Cameroon) for human-wildlife conflict management and compensation for wildlife-related losses, and advocate strongly for government responsiveness to manatee hunting.

L'éducation Environnementale au Coeur de la Conservation du Lamantin

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Notre travail s'appuie sur l'éducation environnementale (EE) comme méthode pour atteindre le changement de mentalités sur la consommation de viande d'espèces menacées. Grâce à la formation MENTOR Manatee, nous avons développé une thématique de sensibilisation focalisée sur le lamantin d'Afrique, une espèce emblématique de cette région qui est menacée par le commerce illégal. Nos discussions sur les thématiques environnementales avec les élèves et enseignants, nous ont permis de comprendre leur perception des espèces animales qu'ils chassent ou consomment. Chaque année nous ciblons environ 5000 élèves des écoles primaires et secondaires avec les cours sur le lamantin. En plus nous créons des dizaines de clubs de la nature, avec plus de 600 membres chaque année. Nous formons aussi des encadreurs parmi les enseignants de chaque établissement partenaire pour gérer les clubs. Chaque club nature propose un plan d'action annuel avec des activités de nettoyage des cours d'eaux et places publiques proches de leurs établissements, ainsi que des programmes de sensibilisation diverses. Pour revaloriser le lamantin, les jeunes ont fabriqué des sculptures, des costumes, des tableaux, des mascottes et des jeux de lamantin. L'ONG OELO soutient les projets des clubs et les accompagne dans l'exécution de leurs travaux. Les membres des clubs les plus engagés sont soutenus par des bourses d'études, pour leur permettre de poursuivre leur cursus scolaire. Chaque année nous célébrons plusieurs événements communautaires, pendant lesquels les élèves sensibilisent des milliers de membres de la communauté. En outre, nous organisons un campement de leadership environnemental avec les membres des

clubs nature les plus motivés. Ces efforts n'auraient pas été possible sans l'adhésion des autorités administratives de la ville (dont le Maire centrale) et du corps enseignant ; que nous remercions pour leur franche collaboration.

Gestion Intégrée du Lamantin d'Afrique dans la Vallée de l'Ouémé au Bénin

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Le lamantin Africain (*Trichechus senegalensis*) est classé espèce « vulnérable » selon l'Union Internationale pour la Conservation de la Nature depuis 1986. Bien que signalée au Bénin, l'espèce est très peu étudiée. Entre 1999 et 2006, Nature Tropicale a réalisé des travaux de terrain pour conformer sa présence dans différents écosystèmes humides du Bénin ; mais aussi pour identifier les menaces qui pèsent sur l'espèce. Ainsi, tous les villages des communes de Ouinhi, Bonou, Adjohoun, Dangbo, Aguégus et Porto-Novo établis le long du fleuve Ouémé, ont été parcourus et plus de 2000 personnes interrogées. Les résultats montrent que l'espèce est présente dans les complexes fluvio-lagunaires des vallées de l'Ouémé, du Mono et du Niger. Actuellement, la répartition spatio-temporelle et la taille de la population du lamantin sont peu connues. Grâce aux actions de conservation entreprises sur le terrain, les couloirs de migration sont de plus en plus connus. Plusieurs menaces ont été identifiées dont les plus importantes sont le braconnage, les collisions avec les navires en mer côtière, la destruction de l'habitat, le piégeage dans des poches du cours d'eau en saison sèche. Le nombre annuel de lamantins braconnés reste inconnu, mais six villages sont réputés pour cette activité. De 2014 à 2019, quatre lamantins ont été tués ; dont un en mer par l'hélice d'un remorqueur du Port de Cotonou. En plus des actions de sensibilisation des communautés locales riveraines de l'habitat du lamantin, des mesures sont prises pour appuyer l'application effective des lois relatives à la protection de cette espèce au Bénin. Grâce aux résultats obtenus, les recherches sur l'espèce se poursuivent dans le complexe fluvio-lagunaire du fleuve Mono, et le fleuve Niger.

An Appraisal of the threats to African Manatees in Nigeria: Preliminary Results from Southern Nigeria

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An appraisal of threats to African manatees' populations in southern Nigeria was embarked upon to understand their prospects for survival in the region and make recommendations for conservation. Ten rivers, the Abakpa, Eniong-Creek, Calabar, Cross, Ikpa, Ikpan, Imo, Niger, Qua Iboe and Kwa, were surveyed in dry and rainy seasons together with contact visits, clandestine investigations, use of informants and interviews of hunters and fisher-folks for 10 years (2009 – 2019) within known manatee habitats in five states of southern Nigeria. The goals of the project, which is part of an African manatee range-wide project, were to quantify threats and numbers of

manatees captured or killed annually and work to reduce them, to build African manatee research and conservation capacity in West and Central Africa, and to increase knowledge of African manatee biology and ecology to foster effective conservation. Our results show that African manatees face diverse threats from intense hunting for bushmeat trade, traditional medicine, juju animism, habitat destruction, fisheries-bycatch, infrastructural development and petroleum based pollution. During the project period, we documented over 500 manatees killed or captured alive as well as documented licensed hunting of manatees as rogue animals over two decades. Overall, documented threats differed significantly by rivers and states and included illegal hunting using traps, harpoons, specialized nets, pit-traps, as well as fisheries-bycatch and manatee mortality due to entrainment in infrastructural construction. An illegal manatee trade network and routes where manatee carcasses are stockpiled and transported to other parts of Nigeria and sold for higher prices are documented. There are imperatives to form synergy with governments, regulatory authorities and NGOs to increase public awareness and law enforcement. Finally, feasible locations for Marine / Estuarine Protected Areas and alternative livelihood programs to reduce manatee hunting, bycatch and habitat destruction need to be identified in southern Nigeria.

Involving local communities into the conservation of the African manatee within the Lake Ossa Wildlife Reserve (LOWR) and the Douala-Edea National Park (DENP), Cameroon

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The African manatee is distributed in 21 African countries, including Cameroon. In this country, Lake Ossa (LOWR) and Lake Tisongo (DENP) are considered as important manatee sites as they inhabit a relatively high manatee abundance with regard to other manatee habitats in Cameroon. However, in the LOWR and the DENP as well as in most of its distribution range, the African manatee is threatened by poaching, incidental catch in fishing nets and habitat degradation. To mitigate threats on manatees in the two protected areas, we sensitized fishermen, women and high schools students (through short lectures of 30 minutes per class and the distribution of booklets) and implicated them into the restoration of manatees' habitat through their participation on both the creation of plant nurseries and the planting of young trees in some degraded banks of Lake Ossa; we also improved and diversified alternative livelihoods for the fishermen, women and youths, through training sessions on activities like bee farming, ecoguide service, clothes sewing, homemade soap and vinegar manufacturing, etc. Thus, between April 2017 and December 2018, 2500 students from three secondary schools (two within the LOWR and 1 within the DENP) received environmental education lessons; 51 fishermen were trained in bee farming, 60 women in homemade soap and vinegar manufacturing, 15 youths as ecoguides and 15 youths in plant nursery creation. In addition, two nurseries of 5000 seedlings were constructed by fishermen and students and 4000 young trees were subsequently planted by the same team. In the short and medium-term, we expect through the alternative livelihood activities to reduce the intensity of fishing activities and accidental catch. The environmental education would improve the perception of the next generation of fishermen towards manatees, and the reforestation would decrease erosion and the siltation of the Lake.

The Use of a Small Multirotor Drone to Survey the African Manatee (*Trichechus senegalensis*)

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Increasingly, drones have been used to overcome the challenges of detecting marine mammals. The African manatee's elusive behavior and adaptability make the species exceptionally difficult to detect. The goal of this research is to compare traditional survey methods (visual observations and the presence of feeding signs) with the use of a small multirotor drone. Study sites include water bodies frequented by manatees in southwest and southeast Nigeria. Sites are repeatedly sampled from December 2019 to August 2020 to account for movement of manatees within a water body. Visual observations are conducted aboard a stationary motorboat while a drone flies a series of parallel line transects overhead. The transects were designed to optimize the battery potential of the drone, focusing on flight time rather than area covered with each flight lasting 35 minutes. Approximately 1,600 visual and thermal high-resolution images are generated per site and analyzed post-flight for manatee sightings. We also search for feeding signs to confirm large scale occupancy (ψ) at each site. A single-season multi-method model variant in PRESENCE 12.37 is used to determine differences in detection between methods. The first set of models vary small-scale occupancy (θ_i) with time and detection (p) with method, while the null model assumes θ_i to be constant across surveys and p equal for all sampling methods. Models are ranked using the Akaike information criterion adjusted for sample size (AIC_c), with the most supported model used to determine the influence of environmental covariates (depth, turbidity, water body, sea state, sun glitter, and floating vegetation density) on detection probabilities. This study confirms the value of remote sensing as a cost-effective and safe alternative to gaining an overhead viewpoint often required to study marine mammals. We suggest the use of drones as an innovative method to observe, monitor, and predict where manatees are located.

Le lamantin d'Afrique dans le Lac de Guiers : Aire de distribution, Alimentation et Menaces

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Situé dans le haut delta du fleuve Sénégal, le Lac de Guiers est le plus grand lac au Sénégal. Par son étendu, la pêche étant la plus grande activité, ce qui est souvent lié à une menace pour les animaux aquatiques tel que le lamantin d'Afrique. Entre Octobre 2018 et Février 2019, nous avons fait des enquêtes sur 161 personnes réparties dans 22 villages au tour du lac, ce qui nous a permis de connaître plusieurs informations sur le lamantin. L'interview portait sur la connaissance du lamantin d'Afrique, sa distribution dans le lac pendant la journée et dans l'année, les menaces qui pèsent sur cette espèce mais aussi d'autres informations sur le lamantin dans le Lac de Guiers. Après les enquêtes, 63% des pêcheurs nous font part que les lamantins sont abondants dans le lac en saison des pluies et augmentent chaque année parce qu'ils sont beaucoup plus tranquilles dans le lac que dans les autres zones de son aire de distribution. Mais aussi la rareté de certaines plantes que mangeaient les lamantins ; a fait que ce dernier change son monde d'alimentation par les herbiers et les poissons qu'ils prennent directement dans les filets des pêcheurs. Pour les menaces, nous avons enregistré cinq prises accessoires durant ces sept dernières années, le barrage de Richard Toll qui permet au lamantin d'entrer et de sortir du lac a causé cinq morts ces dernières années. L'augmentation récente des pirogues motorisées est une menace émergente qui peut causer des blessures par impact et leurs hélices. Au cours de ces enquêtes nous avons également sensibilisé les populations de certains villages qui ne connaissaient même pas que le lamantin est une espèce à protéger. Ces résultats permettront une meilleure prise en charge de la protection du lamantin dans le lac, aussi d'avoir plus d'information sur son écologie.

African Manatee (*Trichechus senegalensis*) Threat Assessments in Liberia

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The African Manatee (*Trichechus senegalensis*) has not been documented with any evidential evidence before in Liberia.

Geographical Range: The species occurs in coastal, estuarine and river waters on the west coast of Africa [5]. The species occur in some of the major estuarine and river systems of Liberia and we have documented it at Lake Piso surrounding tributaries.

Habitat and Ecology: The habitat requirements of the species are thought to include sheltered water and access to freshwater. The species feeds primarily in rivers especially over swamped agricultural land.

Threats: Unregulated hunting and traps have been witnessed as the main of threats. The level of these threats is thought to be increasing. Other threats include the destruction of habitat by palm oil companies.

Methodology: *Trichechus senegalensis* occurs in Liberia this is an undocumented species and no previous research of value has been conducted. 54 Interviews with local fishermen and interviewed two Manatee hunters collection of evidence were conducted during 2016-2018 during the dry and rainy seasons. Madiana and Jorini Sambolah are two target villages situated along the Mafa river these are two identified areas for *Trichechus senegalensis*.

Results: -Confirmation *Trichechus senegalensis* exists in Liberia. -Collection of bones, skull, penises handed to Wildlife Dept FDA. -Photographic/ Video evidence of hunting and killing of the African Manatee.

Conservation effort proved successful in the villages of Madiana and Jorini Sambolah predominately Muslim villages. I discussed with the Chief Imam and villagers that eating Sea Pig is Haram in Islam. There is also a verse in the Koran which states Muslims should not eat anything that has a skin that comes from the sea. The women especially agreed never to cook the Manatee ever again.

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Charismatic microflora: what manatee-associated diatoms can tell us about their hosts

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Investigations of endo- and epibiotic microbial communities demonstrate that microbiome research provides novel and valuable insights into the host animal health and behaviour. Increasing understanding of the microbiome composition and function changes how various diseases and disorders are perceived. In many cases, the origin of illness or debility is not necessarily linked to the presence of pathogens, but rather the lack of some of the native microbiome components. This is clearly extremely relevant in the context of the biodiversity crisis and environmental protection. However, little has yet been done to implement the recent ideas and new knowledge to improve either the overall condition and wellbeing of captive animals or the effectiveness of ecosystem management projects in the natural environment. Although photosynthetic microorganisms, such as diatoms, are rarely considered an essential element of any animal microbiome, there is consistent evidence that some diatom species are highly specialised and adapted to the epizotic lifestyle, and their survival may depend on the survival of their hosts. This is plausible as specific ecological requirements of many diatom species, as well as their inability to exist in non-preferred habitats where they are outcompeted by more tolerant and better-adapted taxa, are well known and have long been used in various biomonitoring applications. This presentation will discuss why manatee-associated diatoms may represent an as-yet unaddressed group of potential bioindicators and how they could be used to enhance and improve the environmental management and wildlife conservation practices as well as captive breeding and reintroduction programmes of endangered and threatened sirenians.

Manatee Calf Rescue and Rehabilitation

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Mother-dependent manatee calves, whether West Indian, Amazonian or African, are vulnerable or endangered from anthropogenic pressures. Some calves are abandoned or separated from their mothers, but others are captured after the mother is hunted, and the calves are taken for future use as food or as part of the illegal pet trade. As part of the species' recovery, rescuing these calves is essential for the species protection and enhancing genetic diversity by re-introducing them later into the wild population. Manatee calf rehabilitation and raising them to releasable age is a joint and balanced effort between the fields of veterinary medicine and zootechnics. Many calves suffer from malnourishment, colic, and necrotizing enterocolitis, which need to be treated immediately and aggressively. Calf rehabilitation involves intensive supervision, hydration, and feeding through a calculated and balanced formula of electrolytes, elemental amino acid-based milk, protein, and medium-chain triglyceride oils. Vegetables and fruits are introduced at an early age, and manatees are progressively weaned until they reach 1.5 years. At which time, their diet consists solely of a variety of aquatic plants, lettuces, fruits, and tuberous roots. Successful rehabilitation protocols include frequent health assessments and morphometrics, hematology, and blood chemistry history to document development and health parameters. Preparing to release a rehabilitated manatee back to the wild includes feeding at the bottom through weighted PVC feeders, presentation of seagrasses, water hyacinths, and water lettuce prior to release, and progressive acclimation to a natural habitat. Following the release, manatees are monitored for one year via radio-tracking with periodic health assessments. A release is considered successful when the manatee is observed feeding on wild vegetation and drinking fresh water from a natural source, interacting with other manatees, avoiding human-related hazards, repeatedly found medically stable, and surviving for a full year after release.

Reducing commerce of African manatee (*Trichechus senegalensis*) bushmeat in the Bas Ogooué of Gabon

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The Bas Ogooué is Gabon's largest wetland of international importance, covering 1,370,000 hectares along the Ogooué River. It is an important habitat for the African manatee, yet little is known about their population. The region has long been known for the availability of manatee bushmeat at markets and restaurants. When OELO began market studies, manatee meat was present in 27% of our market surveys and 22% of restaurant surveys. Between 2012 and 2019, we led 740 market and restaurant surveys at the largest bushmeat market of the Bas Ogooué. We created an Environmental Education program with a manatee lesson plan in 30 schools reaching tens of thousands of students, led manatee outreach days and activities with youth clubs reaching thousands of youth, and created collaborations with community leaders and partners. We led key informant interviews with 5 known manatee hunters and 50 fishers to better understand the trade and threats to manatees. Over the seven-year period, we recorded a drastic decline in the open trade of manatee meat in restaurants and in the market, with only one observation recorded since 2014. Our interviews signaled the importance of bycatch of manatee calves in certain types of fishing gear (with 75 percent of *Heterotis niloticus* fishers reporting bycatch), shed light a network of for hire manatee hunters, and uncovered a trade in manatee penis. Additionally, we collected 20 genetic samples from manatee tissue and bones for future analysis. We have begun working with national government and conservation partners to include techniques to reduce bycatch in fisheries management plans and continue our outreach and EE efforts, including creating the country's first restaurant coop of responsible vendors who have pledged to no longer sell illegal bushmeat from protected species.

Réduire le commerce de viande de brousse de lamantin africain (*Trichechus senegalensis*) dans le Bas Ogooué au Gabon

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Organisation Ecologique des Lacs et de l'Ogooué (OELO). Sahoty derriere Adiwa, Lambaréné, Gabon.

Le Bas Ogooué est la plus grande zone humide d'importance internationale au Gabon, couvrant 1 370 000 hectares le long du fleuve Ogooué. C'est un habitat important pour le lamantin africain, mais on en sait peu sur sa population. La région est connue depuis longtemps pour la disponibilité de viande de brousse de lamantin dans les marchés et les restaurants. Lorsque OELO a commencé les études de marché, la viande de lamantin était présente dans 27% de nos enquêtes de marché et 22% des enquêtes des restaurants. Entre 2012 et 2019, nous avons mené 740 enquêtes de marché au plus grand marché de viande de brousse du Bas Ogooué. Nous avons créé un programme d'éducation environnementale, y compris un cours sur le lamantin, dans 30 écoles atteignant des dizaines de milliers d'élèves, organisé des journées de sensibilisation et des activités avec des clubs de jeunes auprès de milliers de jeunes, et créé des collaborations avec des dirigeants et des partenaires communautaires. Nous avons mené des entretiens avec des informateurs clés avec 5 chasseurs connus de lamantins et 50 pêcheurs pour mieux comprendre le commerce et les menaces pesant sur les lamantins. Nous avons enregistré une baisse drastique du commerce ouvert de viande de lamantin dans les restaurants et au marché, avec une seule observation enregistrée depuis 2014. Nos entretiens ont montré l'importance des prises accidentelles de veaux de lamantins dans certains types d'engins de pêche (avec 75 pour cent des pêcheurs d'*Heterotis niloticus* déclarant des prises accidentelles), ont mis en lumière un réseau de chasseurs de lamantins sur commande et ont découvert un commerce de pénis de lamantin. De plus, nous avons collecté 20 échantillons génétiques de chair et d'os de lamantins pour une analyse future. Nous travaillons avec le gouvernement national et les partenaires de conservation pour inclure des techniques de réduction des prises accidentelles dans les plans d'aménagement des pêches et poursuivons nos efforts de sensibilisation et d'EE, notamment en créant la première coopérative de

restaurateurs du pays de vendeurs responsables qui se sont engagés à ne plus vendre de viande de brousse illégale provenant d'espèces protégées.

Evaluation des menaces pesant sur la survie des lamantins vivant a l'estuaire du fleuve de la R. D. Congo

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Le lamantin a une distribution qui s'étend Kimwabi, Kizunga Manianga, Nteva, Katala jusqu'aux alentours de l'île de Boma, sans oublier l'axe qui remonte la rivière Lukunga où certains trouvent des endroits propices pour leur reproduction. La détermination de son abondance dans ce biotope n'a pas encore été réalisée ; toutefois, ce mammifère a fait l'objet d'une chasse massive dans un passé récent. Sa viande est toujours très recherchée par les populations de cet estuaire. Suite aux efforts de sensibilisation menés depuis 2012, l'abattage du lamantin est considéré désormais comme une infraction punissable par la loi. Au cours de cinq dernières années, le braconnage du lamantin a sensiblement baissé. Les méthodes d'enquête par interview et la mise en place d'un réseau d'informateurs nous ont permis d'identifier les principales menaces qui pèsent sur ces lamantins. Par ordre d'importance, trois menaces pèsent sur ces mammifères : 50% des cas sont imputables au braconnage, 35% des cas résultant des captures intentionnelles par des filets à poche, et 15% des cas de piégeage au niveau de rencontre des affluents et bras du fleuve. Les cas d'échouage et des décès suite aux travaux de dragage sont représentés une mortalité accessoire. A court terme, le renforcement de l'Education environnementale et de la Sensibilisation des communautés riveraines sur l'importance de la conservation des lamantins, la Dénonciation des cas de braconnage, de Capture intentionnelle ou de Piégeage auprès des agents de l'ICCN et la Surveillance des petites rivières, criques sont les activités à mener. A moyen terme la Délimitation des zones de pêche, l'Implication des communautés riveraines aux activités de conservation du lamantin et la création des AGR sont à recommander. La Mise en place d'un mécanisme de redistribution des revenus de l'écotourisme est à encourager.

Fishery-Manatee interaction in Lake Ossa Wildlife Reserve, Douala-Edea National Park and Nkam River, Cameroon

Constant Ndjassi¹, Santiago Ormeno², Christian Kongte³, Alvine Ebenye⁴, Alex Tamo³, and Lucy Keith-Diagne⁵

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The African manatee is an endangered aquatic mammal. It frequents coastal waters along the Atlantic coast from Mauritania to Angola. In Cameroon it can be found in lakes, streams, rivers and along the coast, in estuarine waters. These environments represent excellent fishing areas for artisanal fishermen. With the increasingly low fishing yields many fishermen are becoming manatee hunters. To this end, a study to assess the cohabitation between manatee and artisanal fishing was carried out from 2015 to 2018 within the framework of the MENTOR-Manatee program in the Lake Ossa Faunal Reserve and the Douala - Edea National Park and also along the Nkam

River near to Douala city. During this study we carried out surveys on manatee consumption of fish in fishing nets at Lake Ossa and also collected data on manatee mortality. The monitoring of fishermen's landing sites around the Lake Ossa Faunal Reserve allowed us to document the frequency of fish consumption and to identify the fish species consumed. Five species were regularly documented: *Tilapia zillii*, *Sarotherodon melanoteron*, *Chrysichthis* sp., *Odaxothrisa* sp., and *Schilbe mystus*. Documentation of cases of manatee mortality were carried out with the help of a community informant network. Thirty-five cases of manatee deaths were reported by the network during the study period. Among these cases, many cases of poaching were reported. These cases call for a strong attention from the authorities in charge of wildlife protection in these protected freshwater aquatic areas, which are very often neglected. These data have been shared with the authorities in order to set up an effective anti-poaching system. Also, educational talks were given to educate fishermen on manatee conservation and the role it plays in water bodies for greater fishing productivity.

Une saison de pluie avec les lamantins au site Ramsar de Petit Loango, Gabon

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Le Petit Loango fait partie du complexe lagunaire d'Iguéla. C'est une plaine côtière légèrement ondulante avec plusieurs lacs, entrecoupée de petites rivières et de marais temporaires et permanents, dans un décor de savanes, de mangroves et de forêts pluviales. Le site joue un rôle important dans la maîtrise des crues, la capture des sédiments et la stabilisation des berges avec la végétation riveraine. Compte tenu de la très faible densité de population et du classement du site comme réserve de faune sauvage en 1956, ce dernier est très peu utilisé même s'il accueille à ses abords des activités d'exploitation pétrolière. Le recouvrement avec le Parc national de Loango a été établi en 2002. Il abrite des espèces vulnérables telles que l'hippopotame, le gorille, l'éléphant et bien entendu : le lamantin. Selon Powell (1996), le Gabon jouit d'une très bonne population de lamantin avec une particularité exceptionnelle à la lagune Ndougou, la voisine immédiate de la lagune Iguéla. Par leurs bassins hydrographiques, elles sont distantes à peine d'une dizaine de kilomètres. Le complexe lagunaire d'Iguéla, bénéficie-t-elle de ce même attribut que Ndougou ? C'est à partir de transect tout au long de la lagune que les données d'observation présence/absence ont été relevées ainsi que des prélèvements fixe par mois des données de pH, salinité, TDS. Pour cette première phase, la détermination de la répartition basique des zones d'observations se dessine. De même que celle des zonages des paramètres physico-chimique.

Monitoring of the African manatee (*Trichechus senegalensis*) population for adaptive conservation in the Lac Ossa Wildlife Reserve, Cameroon

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Ecological monitoring is a powerful adaptive management tool in the field of conservation. It allows answering questions related to the abundance, distribution, and population dynamics of a species, which will help guide appropriate conservation actions. Although the African manatee has been surveyed in several locations across their distribution areas, no long-term monitoring has been established. Therefore, a silent disappearance risk is possible. This study presents a five-year-period manatee monitoring data in Lac Ossa Wildlife Reserve (LOWR). A 30-min point scan method was used to visually detect manatee presence and estimate their relative abundance and distribution in the LOWR. Thus, six permanent sites were established and visited four times per

month, where direct and indirect manatee observations were recorded. The monitoring period was executed over 05 consecutive years. The one-factor ANOVA test was used to compare yearly average observation frequencies. Thus, years 2015 (n= 65 scans), 2016 (n= 300 scans) and 2017 (n= 353 scans) yielded average frequencies of 15.05, 14.78 and 16.64 respectively; and there was no significant difference in average frequency between the three years. Years 2018 (n= 217 scans) and 2019 (n= 89 scans) on the other hand yielded average frequencies of 5.2 and 1.33 and were significantly lower to those from the first three years ($F= 3.466$; $P= 0.018$). These results show clearly a sharp decrease in manatee observation frequency starting in 2018. The decrease might be attributed to the massive proliferation of *Salvinia molesta*, an invasive aquatic plant, which started in 2017. The presumptive impact of *Salvinia* on manatee abundance in lake Ossa would not have been detected if not our manatee monitoring program. We suggest that African manatee long-term monitoring be established throughout their distribution range to quantify and follow up the level of human impact on their population.

Proximate and Mineral Composition of African Manatee Food Resources Along Ipore River in Ondo State, Nigeria

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This study assessed the African manatee food resources, and their nutritive quality along Ipore River, Ondo State, between April and July 2018 for effective conservation of the animal in the area. Questionnaire administration (A total of 135 questionnaires were distributed to the fishermen in the seven villages along Ipore River), field identification of the food resources and laboratory analysis was adopted. Seven samples (six food resources and one non-food) were collected for laboratory analysis (proximate composition using AOAC methods and mineral contents using atomic absorption spectrometry). ANOVA was used to test for significant differences in the samples. The respondents stated that manatee feed on six plant species (*Ceratophyllum demersum*, *Manihot esculenta* leaves and soaked tuber, *Vossia cuspidata*, *Echinocloa spp*, and *Polygonum salicifolium*). Also, the result of the proximate analysis showed that the highest crude protein ranges from 2.28 ± 0.20 to 23.95 ± 0.25 , crude fibre from 8.23 ± 0.04 to 17.80 ± 0.20 both in soaked cassava tuber and leaves respectively. The mineral composition also varies with *cd* having the highest Na (3.46 ± 0.18), *Drypteris spp* (non-food resource) has the highest K (4.17 ± 0.16) and Ca (5.23 ± 4.46) while soaked cassava tuber has the highest Fe (7.5 ± 0.02). There were significant differences in these values ($p < 0.05$). It has been confirmed that manatee feed on soaked cassava tuber in the study area. Also, the food preference of West African manatee could be dependent on proximate and mineral composition on one hand while other factors (such as availability, taste and other anti-nutritional factors present in plants) may also play a part. It is concluded that conservation of African manatee in Ipore River cannot be hindered by food as there are diverse food resources to select from. It is suggested that issues of water quality and conflict with humans be researched into.

How are you dugong? Using a multi-pronged approach to study and conserve endangered dugongs in Malaysia

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The dugong (*Dugong dugon*) is listed as Vulnerable on the IUCN Red List of Threatened Species, but certain populations of dugongs are critically endangered and could disappear in the near future due to a combination of small population size and the effects of one or more risk factors. In Malaysia, dugongs are protected by law and

listed as a marine endangered species under various Federal and State laws. The vicinity of the Johor east coast of Peninsular Malaysia, particularly around the Sibu-Tinggi Archipelago, is inhabited by a small local population of dugongs whereby the area appears to be a promising stronghold for the species in the country. In 2010, a systematic distributional line transect aerial survey of dugongs was conducted from the south of Sibu Hujung Island, north to Setindan Island over a span of eight days. The survey found that the distribution of dugongs were concentrated to off the southwest area of the Sibu Archipelago, with mother-calf pairs of dugongs distributed mainly off the southwest of Sibu Hujung Island, extending into areas beyond the boundary of the existing Marine Park. Results of the 2010 survey led to concerns that the protection for dugongs in the area was inadequate, rendering the animals vulnerable to human threats in unprotected areas outside the Marine Park. Further comprehensive research on dugongs and their seagrass habitats around the Johor east coast islands has been ongoing since 2014, using a combination of systematic aerial surveys, acoustic surveys, contaminants analyses, seagrass mapping and dugong feeding ecology surveys, and social science studies to assess local stakeholders' perceptions of dugongs and willingness to participate in conservation. In 2015, the Johor state government announced a RM1,000,000 (~USD240,000) commitment towards the establishment of a dugong sanctuary, in line with its 5-year development plan for the state. This initiative was timely as there were observed significant overlaps between dugong and seagrass distribution with human activities. At least 18 dugong deaths were recorded in the area between 2015 and 2019. All incidents of dugong deaths involved immature individuals, some of which showed clear signs of interactions with human activities as the cause of fatality. A management plan for the proposed Johor Dugong Sanctuary was subsequently drafted, and can serve as the way forward for dugong conservation in the area, by having an appropriate balance between conservation needs of the dugongs and their seagrass habitats, and economic needs of the area and local stakeholders at large. The area of the proposed dugong sanctuary is now internationally designated as the Mersing Archipelago Important Marine Mammal Area (IMMA) under the IUCN. Using a multi-pronged approach to study locally endangered dugongs provided a well-rounded and strong basis for conservationists to push for urgently needed enhanced protection measures for the animals and their habitats.

African manatee research: a historical perspective and personal journey

Dr. James A Powell

Executive Director, Clearwater Marine Aquarium Research Institute

In the 1980s, compared to its cousins the West Indian and Amazonian manatees, there was very little known about the African manatee. We knew the species was found in 21 countries from Mauritania to Angola and inhabited the upper reaches of the Niger River in Mali. We were unsure whether they could still be found in Lake Chad, though there were reports of manatees living in other Chadian lakes. There were no qualitative population estimates, scarce observational data and we speculated about their basic biology primarily from what was known about other manatee species. We did know that though protected, hunting manatees for food and traditional medicines persisted throughout the species' range. In 1984 I had the opportunity to travel to The Gambia to assess the potential impact of a proposed Balingho Antisalt Dam on manatees. While in Africa, I traveled to Senegal and Côte d'Ivoire to reconnoiter those areas to determine the feasibility of conducting the first in-depth field study of the African manatee. I returned to Côte d'Ivoire in 1986 to assess the behavioral ecology, status, distribution and threats to manatees in the country the work included the first radio tracking of the species. This study was the start of nearly 10 years of research on African manatees and forest elephants in the region. Since then and over these past four decades, the great work of incredible biologists have contributed greatly to our

understanding of both species. This presentation provides a historical perspective and touches on my own journey of discovery.

Passive Acoustic Monitoring and Characterization of African Manatee Vocalizations

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We recorded the first vocalizations of African manatees (*Trichechus senegalensis*) in the wild (Lake Ossa, Cameroon) and compared them to other manatee species. Within a six-day period we detected over 3,300 African manatee vocalizations and characterized 303 high-quality vocalizations. Structurally, their vocalizations are similar to other manatee species. Specifically, African manatee vocalizations are short (mean duration = 0.179 sec), have a mean fundamental frequency of 4.66 kHz, are harmonically rich (median number of harmonics = 3), can have an emphasized band that is not the fundamental (27%), can be frequency modulated (mean bandwidth of the fundamental = 406 Hz), and can contain subharmonics (22%). African manatees are difficult to visually detect in the wild however, we found they commonly produce vocalizations and suggest passive acoustic monitoring techniques are valuable for studying their distribution, habitat preferences, and seasonal behavior.

African Manatee (*Trichechus senegalensis*) Threats Survey in The Gambia

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In The Gambia, manatees were previously highly hunted before the introduction of protective legal instruments in 2003, thus indicating reduction in their population. We conducted surveys of manatee along the River Gambia and coastal areas where they exist. Between 2018 - 2019, seventy interviews were conducted in 10 villages which involved identification and quantification of threats with fishermen and longtime hunters on Gambia's North, Central, Lower, Upper River and West Coast regions along the River Gambia. Survey techniques addressed frequency of manatee sightings, presence of threats and poachers, knowledge of manatees killed, injured or caught, and other sighting information. Threats identified by this study included (in order of significance) unintended catch in fishing nets (n = 32), illegal poaching (n = 4) and tidal stranding (n = 2). Samples such as skull, skin, tissue, vibrissae, and rib bones were collected. It was found that unintended catch in fishing gears was the highest in all survey areas. In Sinchu Janu, in the Lower River Region, a manatee was tidally stranded, found alive, killed and then sold for consumption. As this study is preliminary, results have not been shared with the Department of Parks and Wildlife Management and Ministry of Fisheries and Water Resources. Upon completion, results will be presented to the said institutions as data and information evidence, to help develop a multi-institutional arrangement and sensitization to fishermen to prevent, deter and eliminate or reduce manatee unintended catches as well reporting obligations.

Assessment of the effectiveness of noninvasive free-floating fecal samples of the African manatee as a source of DNA for genetic analysis using mitochondrial, microsatellite, and sex identification markers

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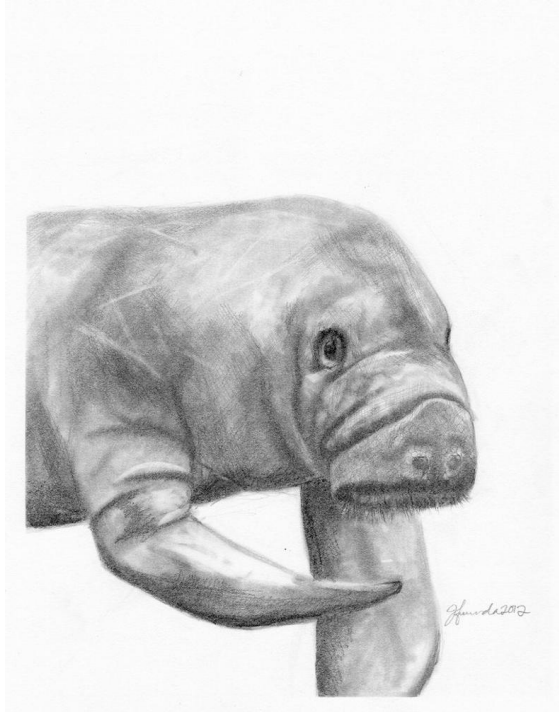
The African manatee is the least known of sirenian species and their cryptic nature hampers direct observational studies. We investigated the reliability of DNA isolated from free-floating manatee feces for genetic analysis using mitochondrial, microsatellite and sex-specific DNA markers. We also assessed the effect of habitat on the quality and quantity of fecal DNA yields. We optimized the QIAmp Fast DNA Stool Kit protocol to isolate DNA from 235 free-floating African manatee feces collected in lakes Ossa (n=93), Tisongo (n=60) and Sanaga River (n=82), Cameroon, between 2016-2017. We selected 110 isolates with a total DNA concentration (t[DNA]) >10ng/μl, DNA was purified from possible PCR inhibitors, and we amplified a 410-bp segment of the mitochondrial Control Region (CR). We used the pre-amplification PCR approach to amplify 13 microsatellites and three sex-specific loci in four to eight PCR replicates per individual and constructed a consensus genotype. Overall, t[DNA] averaged 15.3ng/μl, and about 92% of the samples yielded adequate CR sequence lengths with an average HQ% of 94.6%. The PCR success rate was high (80%) and allelic dropout rate moderate (ADO=24%). We successfully assigned sex to 86% of the isolates. Total DNA concentration and PCR success were significantly (P=0.0002) higher for samples from rivers (21.9ng/μl, 87.5%) than lake's (11.8ng/μl, 79.4%). Also, ADO was significantly (P=0.006) lower in rivers as compared to lakes (18.5% versus 29.1%, respectively). This suggests that fecal samples from rivers are fresher than those found in lakes, where the water can be stagnant and feces can remain in the system for a much longer time, allowing for a greater chance of collecting older fecal samples. For the first time, noninvasive manatee fecal DNA was used to generate reliable microsatellite and sex genotypic profiles. This approach is cost-effective and would make the genetic sampling of the imperiled elusive manatee more accessible.

African Manatee Conservation in Angola- Measures implemented and Challenges

Miguel Xavier

National Institute of Biodiversity and Protected Areas of Angola

The African Manatee (*Trichechus Senegalensis*) has a wide range of distribution in Angola, being found in several Angolan rivers such as Cuanza, Dande, Longa, Nzenza and Loge. The current status of this animal is still not well known despite some studies already carried out by some researchers. Fieldwork shows that the state of the animal remains critical in Angola given the anthropogenic pressure. The Manatee is hunted for its meat, but also because of the conflict that exists between this mammal and the fishermen who accuse it of destroying their nets. In this way, our efforts are focused on raising the awareness and sensitization of fishermen and riverside populations to safeguard this animal that represents one of the main important of the Angolan biodiversity. Since 2010, a conservation program has been started on the different rivers that make up its distribution area, mainly on the Cuanza and Dande rivers and recently on the Nzenza river. The 2010 conservation work culminated in the publication of a book on environmental awareness and awareness "Salvemos o Manatim" which addressed the issues related to the biology of the species, its distribution, its status and the conservation efforts that must be provided for the conservation of the species. awareness of the riverside populations about the danger of the "Fish woman".



***Sirenews* – Florida manatee**
(End of abstracts)

RECENT GRADUATE STUDENTS COMPLETED PROJECTS

Vocal variation of the two subspecies of the West Indian manatee in three geographically isolated regions

Jessica D. Reyes-Arias

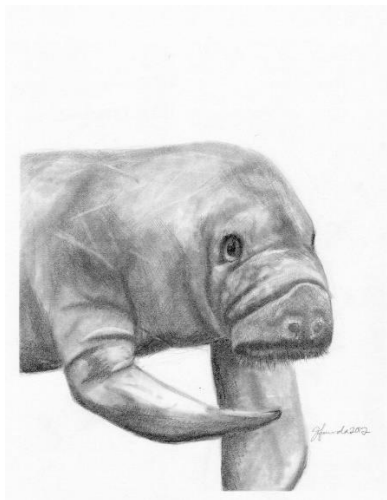
Master of Science in Natural Resources and rural development.

Departamento de conservación de la biodiversidad, El Colegio de la Frontera Sur (ECOSUR)
2021

Abstract: Geographic variation in the vocal behavior of manatees has been reported but is largely unexplored. Vocalizations of West Indian manatees (*Trichechus manatus*) from Belize, Mexico, and Florida were analyzed and compared to determine if calls varied between subspecies and geographic region. Six parameters were measured from the fundamental frequency of 3,859 manatee calls obtained from wild and captive animals. Discriminant function and cluster analysis revealed similarities and differences in measured frequency values and duration of calls among the three groups. Overall, findings suggest that the acoustics parameters of the West Indian manatee differ between different study groups and geographic origin. Due to the inability to identify manatees producing the vocalization during recordings, it is unclear if variation is related to age, gender, individual variation, environmental conditions, and other factors. Our findings highlight the need for further study of the vocal behavior of manatees throughout their range and provides critical information needed for improved automated detection of manatee calls for wildlife monitoring.

Reyes-Arias, Jessica Dayanh. 2021. Vocal variation of the two subspecies of the West Indian manatee in three geographically isolated regions. MS Thesis, El Colegio de la Frontera Sur (ECOSUR), Chetumal - México. 38 pp.

Recent and future plans: After my master's degree I will try to find an investigate job to improve my professional development and i plan to enroll in a PhD program in bioacoustics in mammals 2022-2023.



Sirenews – Florida manatee
(End of graduate students completed projects)

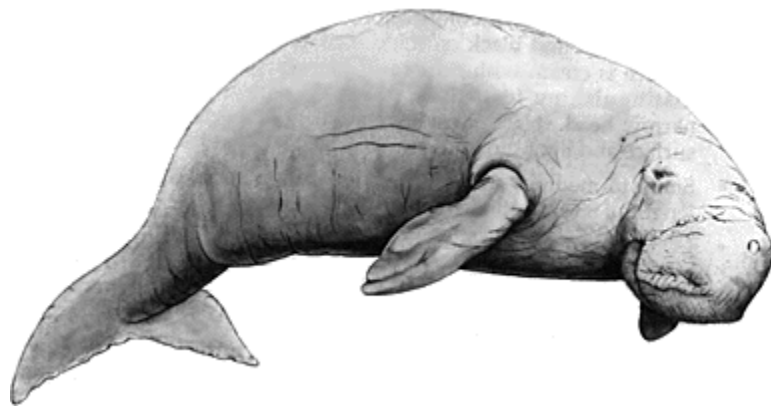
RECENT LITERATURE

The Bibliography and Index of the Sirenia and Desmostylia now has a new domain name and is accessible via the following link: <http://sirendom.org/biblio/> This resource is a comprehensive, annotated bibliography and index of technical and popular literature that encompasses over 500 years of published information on sirenians, now with over 6,500 separate references."

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Sirenews – Dugong

NOTES FROM THE EDITORS: We would like to thank all of those who have contributed articles for *Sirennews*. On occasion, we have taken the liberty to make minor edits in an effort to accommodate our formatting style and provide clarity for our readership. However, we have restrained from making all grammatical edits in an effort to preserve the original intent of the submitting author.

We would also like to encourage you to submit any manatee and dugong sketches or old-time prints for publication in future issues!



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