Sirenews

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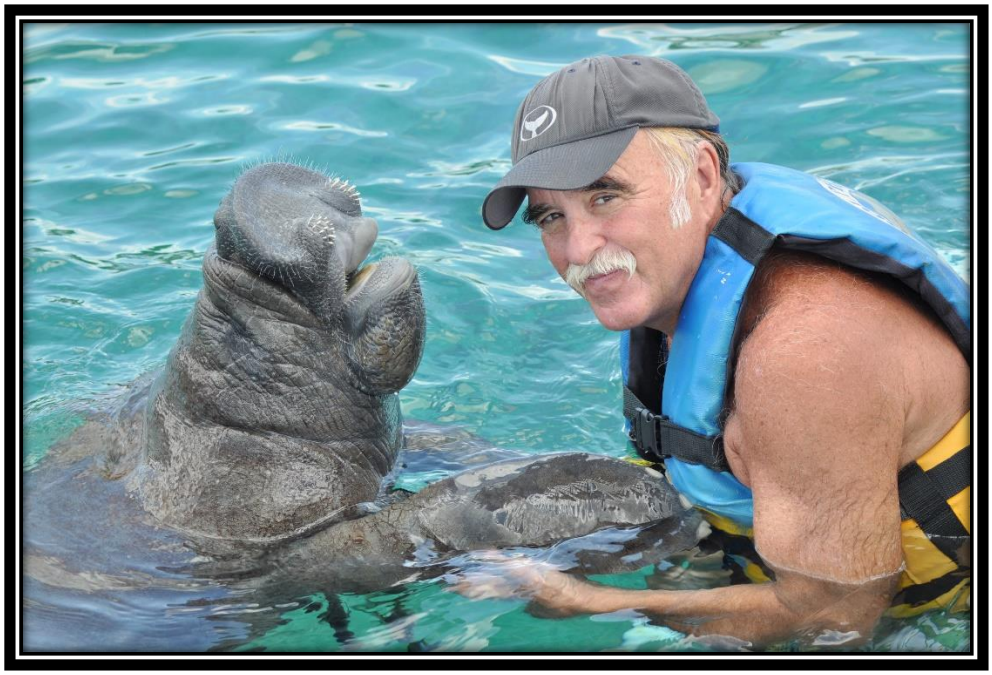
IN THIS ISSUE:

IN MEMORY OF DR. GREGORY BOSSART



Gregory Bossart (1951-2019)

UNION INTERNATIONALE POUR LA CONSERVATION DE LA NATURE ET DE SES RESOURCES

INTERNATIONAL UNION FOR CONSERVATION OF NATURE AND NATURAL RESOURCES

Commission de la souvegarde des especes - Species Survival Commission

SSC Species Survival Commission

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CLEARWATER MARINE AQUARIUM RESEARCH INSTITUTE

Dr. Gregory Bossart passed away in November 2019 after a courageous battle with pancreatic cancer. He was a world renowned and respected veterinarian and scientist and prominent in the One Health movement. Most recently he was the Senior Vice President of Research, Conservation and Animal Health at Georgia Aquarium, but his commitment to veterinary medicine and research spans over three decades. His intelligence, passion, and dedication to furthering marine animal research and knowledge has changed our understanding of marine mammals and how to care for them in our facilities and in our oceans. During Greg's career, he helped characterize the first viral disease in manatees, developed the first immunohistochemical technique for diagnosing brevetoxicosis in marine mammals and birds, and documented resurging and emerging diseases in manatees, cetaceans, and birds. He led the Health and Environmental Risk Assessment (HERA) research project on bottlenose dolphins in the Indian River Lagoon in Florida and founded the Avian and Wildlife Laboratory at the University of Miami. He framed much of his research after the One Ocean, One Health initiative, wherein he examined the role of aquatic species as sentinels for the effects of environmental change, on animal, ecosystem, and human health. He authored over 150 peer reviewed publications in addition to numerous book chapters. Greg was not only a mentor and collaborator to many people in the aquatic animal community, he was also a friend. He was a caring person and exceptionally dedicated to his family and his faith. He is survived by his wife of 22 years, Jennifer and their three children, Ansley, 16, Hayden, 13 and Charlie, 2.

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Editor's Note: It is with a heavy heart that we report the passing of another charter member from the sirenian community, Dr. Greg Bossart. Greg's life and determination as a pathologist, veterinarian, and conservationist extended beyond the bounds and borders of most in this field. He leaves a legacy of decades of work that has advanced our knowledge of manatee health. As we all get older this passing of the leaders has become more evident, but we also have learned to value the contributions of capable young scientists who are eager to carry the torch that Greg held. We will miss Greg's insights, mentorships, and consistent willingness to help marine mammals.

LOCAL NEWS

BRAZIL

2019 Northeast Brazil oil spill: how Antillean manatees (*Trichechus manatus manatus*) were affected along the coast of Maranhão, Brazil

Starting in late August 2019, beaches of Brazil were washed by crude oil of unknown origin, spilling over 3,000 km of the northeastern coast in the next months. Almost a thousand beaches were affected, reaching as far the Maranhão state coastline. This oil spill is considered the most extensive and severe environmental disaster ever recorded in Brazilian history (Soares *et al*., 2020). For Antillean manatees (*T. m. manatus*), the coastline of Maranhão can be considered their last major stronghold in Brazil. But these important populations and related habitats were significantly affected by the oil spill as suggested by Magris and Giarrizzo (2020). According to the Ibama (Brazilian Environment Institute) website (http://www.ibama.gov.br/manchasdeoleo-localidades-atingidas) and ICICT/Fiocruz sources, almost 13 tons of crude oil were cleaned off along 47 affected beaches of Maranhão. These include several municipalities along the coast, such as: Tutóia (Ilha da Melancieira and Arpoador); São Luís (city coast); Alcântara (Ilha do Livramento, Praia da Mamuna and Praia do Itinga); Araioses (Ilha dos Poldros and Ilha do Caju, the mangroves of Canárias); Barreirinhas (Praia do Caburé and Praia Canto do Atins); Cururupu (Ilha de Maiaú and Ilha de Caçacueira); Humberto de Campos (Ilha de Santana); Paulino Neves (Praia do Barro Vermelho); and Santo Amaro (Travosa and Praia dos Lençóis) (Figure 1). Considering the amount of crude oil recorded and the remaining yet not fully dimensioned, it is highly recommended the evaluation of concentration of petroleum hydrocarbons and its contaminants such as metals, benzene, toluene, ethyl benzene and xylene in manatees living in Maranhão.

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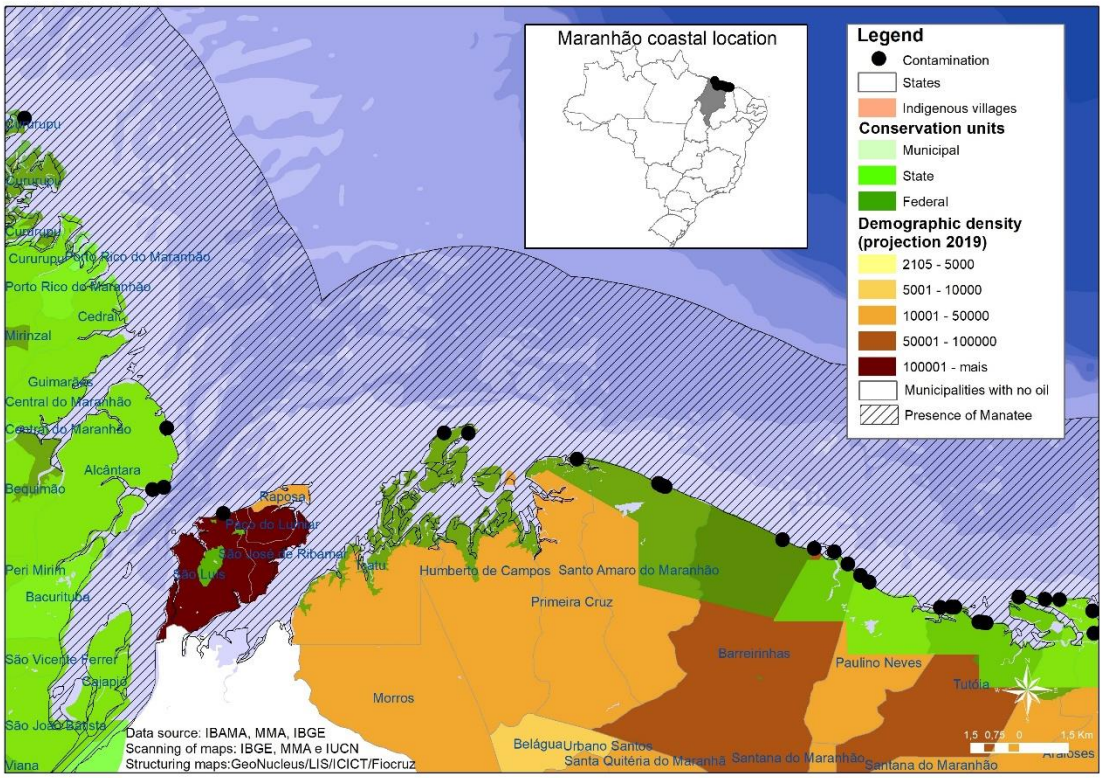

Figure 1. Crude oil contamination along Maranhão state coast, Brazil, since late August 2019 and the indication of Antillean manatee (*T. m. manatus*) distribution. Sources: Ibama (MMA) and ICICT/Fiocruz. Original shape of manatee distribution from: Deutsch, C.J., Self-Sullivan, C. & Mignucci-Giannoni, A. 2008. *Trichechus manatus*. *The IUCN Red List of Threatened Species* 2008: e.T22103A9356917. https://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T22103A9356917.en. Downloaded on 23 March 2020.

Successful recaptures of released Amazonian manatees in Brazil

Since 2008, the Aquatic Mammals Laboratory of INPA, with support from the Friends of the Manatee Association (AMPA), has promoted the reintroduction of Amazonian manatees raised in captivity. Nowadays the animals are being released at the Piagaçu-Purus Sustainable Development Reserve, located in the lower Purus river, Central Amazon, Brazil. From 2016 to 2019, a total of 31 manatees (17 females and 14 males), from 4 to 16 years old, were released, 18 with VHF-transmitters. All reintroduction phases had the support of the local communities, aiming the protection and post-release monitoring of the animals.

The complexity of the habitats associated with the cryptic behavior of this species makes recapturing these animals challenging. However, to evaluate the health of the released manatees and the conditions of the VHF belts, a tentative recapture has been made once per year during the dry season of the Purus river. The capture team involves about 12 people including a biologist, a veterinarian, animal keepers and experienced fishermen. For the capture procedures, first, the animal is located using VHF signal and if its location is suitable, such as a small and shallow lake, it is surrounded with nets specifically designed for this species. Once surrounded, it is carefully

moved to the margin of the lake with the help of a stretcher. After biometrics and biological data collection (e.g. blood and feces samples) for its health assessment, the manatee is released again into the river.

So far four manatees were recaptured six to 18 months after release, showing an average increase of 45kg in body mass and 10cm in length. One of the animals recaptured was Baré, a female that was rescued as an orphan calf and reintroduced at 16 years of age. To our surprise, after 18 months in the wild, she increased 12cm and gained 106 kg; after hormonal analysis we confirmed her pregnancy. These results along with other indicators, such as the selection of suitable habitats, the survival of the individuals over at least one complete river flood pulse, the interaction of the released animals with wild Amazonian manatees and the absence of contact with humans confirms the success of our Manatee Reintroduction Program.

Our results proved that the protocol with the semi-captivity phase before release is working and can provide subsidies to improve the Amazonian manatee conservation in the long term. In 2020, 10 other manatees living in the semi-natural facility, are ready to go back to the wild.

The Reintroduction Program is being conducted by INPA (National Institute of Amazonian Research) and AMPA (Associação Amigos do Peixe-boi - www.ampa.org.br), under support of the Projeto Mamíferos Aquáticos da Amazônia from Petrobras, Japan International Cooperation Agency (JICA), Kyoto University, Itochu (Japan) and São Paulo Aquarium.

-Diogo A. de Souza[1], Vera M. F. da Silva[1,2], Rodrigo S. Amaral[1,3] and José A. d'Affonseca Neto[1,2]
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Figure 1. Encircling with nets, during the recapture of one released Amazonian manatee at a margin of the lake on the Piagaçu-Purus Reserve.

Figure 2. Biometry of a female Amazonian manatee six months after release.

Figure 3. The pregnant female Baré during her recapture 18 months after release.

Marine manatee conservation in Brazil during the COVID-19 pandemic

The Projeto Cetáceos da Costa Branca of the Universidade do Estado do Rio Grande do Norte (PCCB/UERN) and the Centro de Estudos e Monitoramento Ambiental (CEMAM) carry out the rescue and rehabilitation of marine manatees in Rio Grande do Norte (RN), Brazil. Currently, there are eight manatees in rehabilitation, all of them in good health waiting to be released soon into the

wild. Since 2019, the manatee reintroduction project of RN has been structuring, which was scheduled to start in the first half of 2020.

The COVID-19 pandemic surprised everyone around the world; however, the teams of the PCCB/UERN and CEMAM have been maintaining their activities to ensure that manatees undergoing rehabilitation are minimally affected. Some activities such as daily monitoring of the beach have been suspended and the management team has been developing the home office. However, the technical team involved in the care of the animals remains on standby, but in compliance with all established health standards and requirements (Figure 1).

The use of personal protective equipment, such as gloves and masks, as well as the use of alcohol gel and footbath, has not been new in our routine, as these procedures were already adopted even before this pandemic. The disinfection of food, carried out with sodium hypochlorite, has ensured that animals receive only clean and sanitized food. As an institutional standard, the presence of people close to the animals is not allowed, except during feeding or treatment. Even so, all precautions were redoubled, such as reducing the team, observing the minimum distance of two meters between employees and training employees on COVID-19.

The management team has been dedicated to the elaboration of the manatee reintroduction project in RN, now postponed to the second half of 2020. The implantation of an acclimatization enclosure and a reintroduction program on the coast of Rio Grande do Norte will allow the connection of returned manatees to nature in Brazil in the states of Alagoas and Paraíba. Together with the manatees that should be released in Ceará soon, will strengthen the conservation actions for the species, allowing a greater population increase.

It should also be noted that RN is the second state with the largest number of calf strandings in Brazil. In this way, the release of these animals may reduce the impact caused by these strandings and, thus, strengthen the population of manatees in the state. Studies and collection of environmental samples have already started, but samples analyses have been interrupted because of the pandemic. Pending the results and the return to normality of all activities, the search for partners and sponsorships continues to occur.

PCCB/UERN and CEMAM, which, in addition to activities with animals, carry out a great deal of environmental education in fishing communities and schools in RN, have been trying to guide partners to the #StayHome campaign, as well as to publicize the correct way of cleaning for disease prevention. In this way, helping to maintain the quality of life of these employees' key characters in the manatee conservation in Brazil.

-Flavio José de Lima Silva, Fernanda Loffler Niemeyer Attademo, Gabriela Colombini Corrêa, Daniel Solon Dias de Farias, Ana Bernadete Lima Fragoso, Augusto Carlos da Bôaviagem Freire, Simone almeida Gavilan, Stella Almeida Lima, Radan Elvis Matias de Oliveira, Rafael Ângelo Revorêdo, Heloisa Cristina de Morais e Sá Leitão, Aline da Costa Bomfim Ventura
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Centro de Estudos e Monitoramento Ambiental - CEMAM

Figure 1: Technical team involved in the care of the rehab manatees.

INDIA

Role and importance of training and capacity building of stakeholders for saving dugongs in India

In India, dugongs occur in the Gulf of Kutch (Lal Mohan 1963; Frazier & Mundkur 1990), Gulf of Mannar and Palk Bay (Jones 1967; James 1974; Lal Mohan 1976; Frazier & Mundkur 1990) and in the Andaman and Nicobar Islands (Das 1996; Das & Dey 1999). Dugongs habitats in India are highly fragmented and threatened due to various reasons, including the capacity required for its managing and restoring with the participation of various stakeholders. Despite the tremendous ecological and economic importance and the existence of a policy and regulatory framework, dugongs and their habitats are under threat. Numerous direct and indirect pressures arising from different types of economic development, especially fisheries associated activities, are having adverse impacts on this species.

In India, there are multiple governance frameworks and structures that oversee the dugong's habitats. While these are intended to have positive outcomes, overlapping jurisdictions, contradictory mandates, and limited coordination hinder multiple agencies from working effectively in managing coastal and marine biodiversity in India. Efforts are currently underway in securing and strengthening community participation in the management of the habitats of dugongs in India. However, management agencies in India are still having a limited understanding of the management of multiple-use coastal and marine areas. Given this scenario, the challenge lies in reconciling livelihood needs and development vis-a-vis conservation. In this connection, as part of the Dugong Recovery Programme of the Ministry of Environment, Forest and Climate Change, Government of India, the Wildlife Institute of India with supports from the State Forest and Fisheries departments of Tamil Nadu, Gujarat and Andaman and Nicobar islands, Indian Navy, Indian Coast Guard and NGOs, has started strengthening the capacities of various stakeholders for the long term conservation of dugongs.

We have started with state-level stakeholders consultation workshops in each Dugong range states in India to identify the gaps and finalized the requirements and modalities related to building capacities of various enforcement agencies, especially the Forest and Fisheries departments as part of this CAMPA-Dugong Recovery Project. Consultation workshops have been chaired by the concerned the Chief Wildlife Wardens of concerned states.

We started with a large number of sensitization workshops of two-three days with the staff of various enforcement agencies such as Forest, Fisheries, Navy, and Coast Guard. The primary objective of these workshops was to sensitize the staff about the importance of conservation of dugongs and their habitats in India with its conservation implications. Later, we expanded these sensitization workshops to communities and civil societies. Afterward, we conducted a series of training workshops for frontline staff of Forest and Fisheries departments towards underwater biodiversity monitoring and management with focus to dugongs. In 2017-19, a total of 20 training programs were conducted with 400 participants who were successfully trained towards the management of marine biodiversity and monitoring of marine biodiversity using SCUBA. The courses also included illegal trade in wildlife and the role of wildlife forensics in dealing with wildlife crime and the use of drones. We have been conducting special nature camps for the Dugong Ambassadors. Dugong Ambassadors are school going children of fishermen families whose education has been supported by the CAMPA-Dugong Project with Dugong Scholarships. We could reach out to the parents of these dugong ambassadors who largely fish in the dugong habitats and successfully minimized the illegal catching of dugongs.

Several sensitization meetings were organized at field site offices of the Indian Coast Guard and Indian Navy at Andaman, Gujarat, and Tamil Nadu to streamline the reporting of dugongs and other marine mammals by these agencies. Dugong monitoring logbook has been developed for involving stakeholders to help to generate ground information on marine megafauna in and around critical Dugong habitats.

The effective capacity building benefits both the partners and local stakeholders by generating inclusive processes that strengthen trust and build commitment and good relationships. With continuous streaming of information on dugong distribution and stranding, our team and forest department have been enabled to respond swiftly and initiate necessary action on the ground. During 2016-2019, under state forest department supervision, so far, ten dugongs have been

successfully rescued and released in all three dugong ranging sites in India. Incentives to compensate the fishing net and one day labor of five fishers costing about Rs. 6000 paid to those fishermen who rescued and released back Dugong from the CAMPA Dugong Project. Most importantly, the saviors of dugongs has been honored at public meetings that were carried by local media of both print and visual.

In the future, we are also planning to build capacity to handle stranded dugongs with the help of UNEP-CMS Dugong MoU Secretariat and Internal Whaling Commission (IWC). We believe that illegal capture of dugongs has been reduced in India, and reporting of stranded dugongs has also increased through our volunteer networks. Most importantly, more than ten incidentally captured dugongs were successfully rescued and released into the sea, an indication of the success of this program. Further, our enforcement agencies are now equipped to manage the dugong habitats with a better understanding of their conservation implications.

- Prachi Hatkar, Swapnali Gole, Sohini Dudhat, Rukmini Shekar, Sameeha Pathan, Madhu Magesh, Sagar Rajpurkar, Diksha Dikshit, Chinmaya Ghanekar, Himani Saini, Sumit Prajapati, Deven Mehta, Srabani Bose, Vabesh Tripura, Anant Pande, J.A. Johnson and K. Sivakumar.
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Figure 1: 2nd Special training course Training with SCUBA Diving, Ramanathapuram Tamil Nadu

Figure 2: Biodiversity Monitoring Training for SCUBA certified Frontline staff of the Tamil Nadu Forest Dept

Figure 3: Orientation program with the Indian Navy -INS UTKROSH, Andaman Islands

Figure 4: Scuba Diving training for Gujarat Forest Department frontline staff

JAPAN

Dugongs are not yet extinct in Japan but need the life support of a gill net ban

As reported in the October 2019 issue of *Sirenews*, the last known dugong in the waters of Okinawa, one of the Nansei Islands that occur in Japanese waters between Kyushu and Taiwan died as a result of being impaled by a string ray barb in in March 2019 (Ministry of the Environment Okinawa Amami Natural Environment Office 2019, pers comm.).

This Japanese Dugong Sub-Population is the northern most dugong sub-population in the world (Marsh *et al*. 2011). It is geographically distinct and demographic or genetic exchange with other sub-populations is unlikely (Brownell *et al*., 2019). The sub-population has been under serious threat of local extinction for decades (Uchida, 1994; Kasuya and Brownell, 2001). A scientifically valid estimate of its size is not available, but numbers are certainly very low (Shirakihara *et al*., 2007). The dugong must be of grave risk of becoming the eighth mammal to be recorded as extinct in Japan and was declared Critically Endangered by IUCN in December 2019 (Marsh *et al*., 2011). There has been considerable conflict over this population's future since the 1990s involving the governments of Japan and the USA and their courts, the provincial government, and local and international NGOs. The plan to move the US Marine Corps Air Station in Futenma, Okinawa to dugong habitat in Henoko-Oura Bay catalyzed these concerns because of the belief that the resultant habitat loss would cause the extinction of the Japanese dugong.

This threat to the Japanese dugongs was misjudged. The major threat to the Japanese dugong is fisheries bycatch rather than the airstrip in Henoko Bay (Marsh *et al*., 2011). The airstrip has caused the loss of <2% of the dugong's seagrass habitat in the Nansei Islands, which must be a much less serious threat to such a depleted population than the ongoing fisheries mortality. Unfortunately, the international press continues to consider the construction of the base as the main threat.

An expert group met in Toba, Japan last September and developed a Research Plan for the Japanese Dugong Population (Sirenia Specialist Group, 2019). The Plan outlines multiple approaches to determine if any dugongs remain in Japanese waters because the numbers are so low that any single approach is unlikely to be sufficient.

Guided by this Plan, the Japanese Department of Environment initiated a program to receive reports of dugong sightings and dugong feeding trials from fishers. Single dugongs were sighted off Hateruma Island and Irabu Island, two islands more than 150 km apart and some 300-450 km south-west of Okinawa, on several occasions. Two individuals were sighted off Irabu Island on one occasion.

These numbers are very small but we can be sure that the dugong that died in March 2019 was not the last dugong in the Nansei sub-population. Further surveys are urgently needed followed by a gill net ban.

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MEXICO

First documented case in 20 years of an Antillean manatee killed by a watercraft collision in the Mexican Caribbean

Boat collisions are an important cause of manatee mortality in Florida (Runge *et al*., 2015), Puerto Rico (Mignucci-Giannoni *et al*., 2000) and Belize (Auil-Gomez, 2011); but not considered a significant threat in Mexico (Padilla-Saldívar *et al*., 2018). Here, we document for the first time a case of an Antillean manatee (*T. m. manatus)* dead after being struck by a boat in Quintana Roo, Mexican Caribbean.

On March 6th 2020, the Marine Mammal Stranding Network of Quintana Roo (Red de Varamientos de Mamíferos Marinos del Estado de Quintana Roo, RVMMQROO) received a report of a dead manatee found by fishermen near El Playón (19° 48’ 15” N, 87° 30’ 26” W), at Ascención Bay, Sian Ka’an Biosphere Reserve, SKBR (Figure 1). According to the informants and photographic records, the manatee was found just few hours after death and showed a fresh appearance (Figure 2a), hence we classified the case as Code 2 (Pugliares *et al*., 2007). Due to logistical constraints, the carcass was recovered and transported to the city of Chetumal two days after the event.

On March 8th, the carcass underwent a necropsy at the University of Quintana Roo (Chetumal Campus), aiming to get further insight into the cause of death and to gather information on the life history of the animal. External measurements were taken, and a genetic sample was collected from the fluke. A total external body examination was performed looking for lesions. The carcass was carefully palpated for evidence of trauma and then skinned to look for hematomas or abscesses in subcutaneous, fat or muscle tissues. At the examination of the head, we observed a deep muscle hematoma with damaged fat and subcutaneous tissue (Figures 2b and c). Upon the injury dissection, we noticed a comminuted fracture of the parietal and tympano-periotic bones with cerebrospinal fluid leaking (Fig. 2d). Subsequently, the carcass was positioned in dorsal recumbency, and a full necropsy was completed. Internal organs were examined for evidence of trauma or pathologies. Digestive contents, blubber, muscle, and other tissues were collected for further analysis.

The manatee, a healthy juvenile female (total length = 205 cm), did not present any external or internal injuries or pathologies, except the skull fracture above mentioned. The presence of food along the digestive track suggested that the animal had a normal feeding behavior before death. We concluded that the cause of death was a depressed comminuted skull fracture as a result of a collision by a boat at high speed.

Manatee mortality caused by boats can be classified in two categories according to the type of injuries sustained (Lightsey *et al*., 2006): 1) blunt-force trauma, which consists in non-penetrating injuries and are seen in animals struck by hulls, keels, blunt skegs, boat strakes, and others (Rommel *et al*., 2007); and 2) sharp-force trauma resulting in external lacerations caused by sharp skegs, fins, and propeller blades. The observed case corresponds to a blunt-force trauma. The severity of this injury was not evident externally because of the thickness and pigment of manatee epidermis, which is common in manatees killed by blunt trauma (Rommel *et al*., 2007). Additionally, depressed skull fractures are not easy to observe in this species, due to the size and shape of the skull. This type of death is likely resulted from a strike by a vessel navigating at high speed (Beck *et al*., 1982), and the severity of the injuries is directly related to the boat weight and its speed at the time of collision (Calleson and Frohlich, 2007). Previous research suggests manatees do not react until boats are close enough for the animal to perceive the vessel as a threat (Nowacek *et al*., 2004), in consequence, when a manatee is surprised by a speeding oncoming boat, it may not be capable to avoid it, and can receive a potentially deadly punch (Beck *et al*., 1982).

Collision of manatees by boats in the neighboring country of Belize are relatively common, leaving wounds and scars in dorsum and tail of several individuals (Self-Sullivan, 2007), and is the principal cause of manatee mortality in this country (Castelblanco-Martínez *et al*., 2018). In the Mexican Caribbean, the scenario is quite different, and watercraft collisions do not seem to be an important source of mortality. Morales-Vela *et al*. (2002) reported two cases of boat-related deaths which occurred in 1990 and 1999 in Chetumal Bay. However, from 72 manatees attended by our stranding networks between 2000 and 2020 (Morales-Vela *et al*., 2002; Padilla-Saldivar *et al*., 2018; RVMMQROO, unpub. data), the case presented here is the first one showing clear evidence of watercraft collision. Additionally, during recent drone monitoring surveys in SKBR, no manatee presented the typical scarring pattern of propeller wounds, suggesting that boat collisions are unusual in the area. Nevertheless, through semi-structured interviews conducted

during our manatee monitoring in SKBR (2018-2019), local fishermen and tour operators informed us about at least two more events where a manatee died presumably as a result of vessel collision (one in Ascención Bay and another in Espíritu Santo Bay). Those cases apparently took place during the last five years, but no necropsy was conducted, and the information remains anecdotic.

The SKBR is an important refuge for manatees due to the availability of high-quality habitats for sheltering, feeding, drinking, and calving (Landero *et al*., 2014). However, the recent growing of tourism affluence has raised concerns on the fate of this manatee population due to the increase of boat traffic (Castelblanco-Martínez *et al*., 2019), and therefore, the augmentation of the potential risk of boat-related injuries to manatees. This is particularly worrisome for Ascención Bay, where manatee and dolphin watching activities are normally offered to tourists. We recommend considering the establishment of speed limit zones, according to manatee habitat, vessel traffic patterns, geographic and hydrologic conditions, and public opinion. The RVMMQROO should increase its actions in SKBR and strength the local Community Monitoring Group by providing necropsy kits and capacitation in manatee carcasses salvage. We also recommend the continuation of the ongoing manatee research project, aiming not only to monitor the local population but also to build local capacity and community empowerment towards manatee conservation.

-Castelblanco-Martínez DN[1,2,3,4]; Pérez-Flores JS[4]; Garcés-Cuartas N[2,4]; Padilla-Saldívar JA[4,5], Romero-Tenorio A[4,6]; Lara-Sánchez LE[2,4]; Niño-Torres CA[2,3,4]

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[5] El Colegio de la Frontera Sur
[6] Fundación Amikoo AC-Dolphinaris

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Table 1. Body measurements of the juvenile female manatee *Trichechus manatus manatus* collided by a vessel in Sian Ka'an, Quintana Roo, Mexico.

No	Measurement	Value (in cm)
1	Total body length	205
2	Snout to center of anal opening	135
3	Snout to center of genital opening	130
4	Snout to center of umbilicus	80
5	Snout to anterior origin of the pectoral fin	35
6	Snout to eye	13
7	Snout to external auditory meatus	24
8	Eye to external auditory meatus	13
9	Eye to eye	17
10	Eye to nostril	12
11	Anterior flipper length	33
12	Posterior flipper length	24
13	Flipper width	12
14	Fluke length	51
15	Fluke width	48
16	Tail stock girth	72
17	Dorsal fat thickness	0.6
18	Lateral fat thickness	1.5
19	Ventral fat thickness	3.5

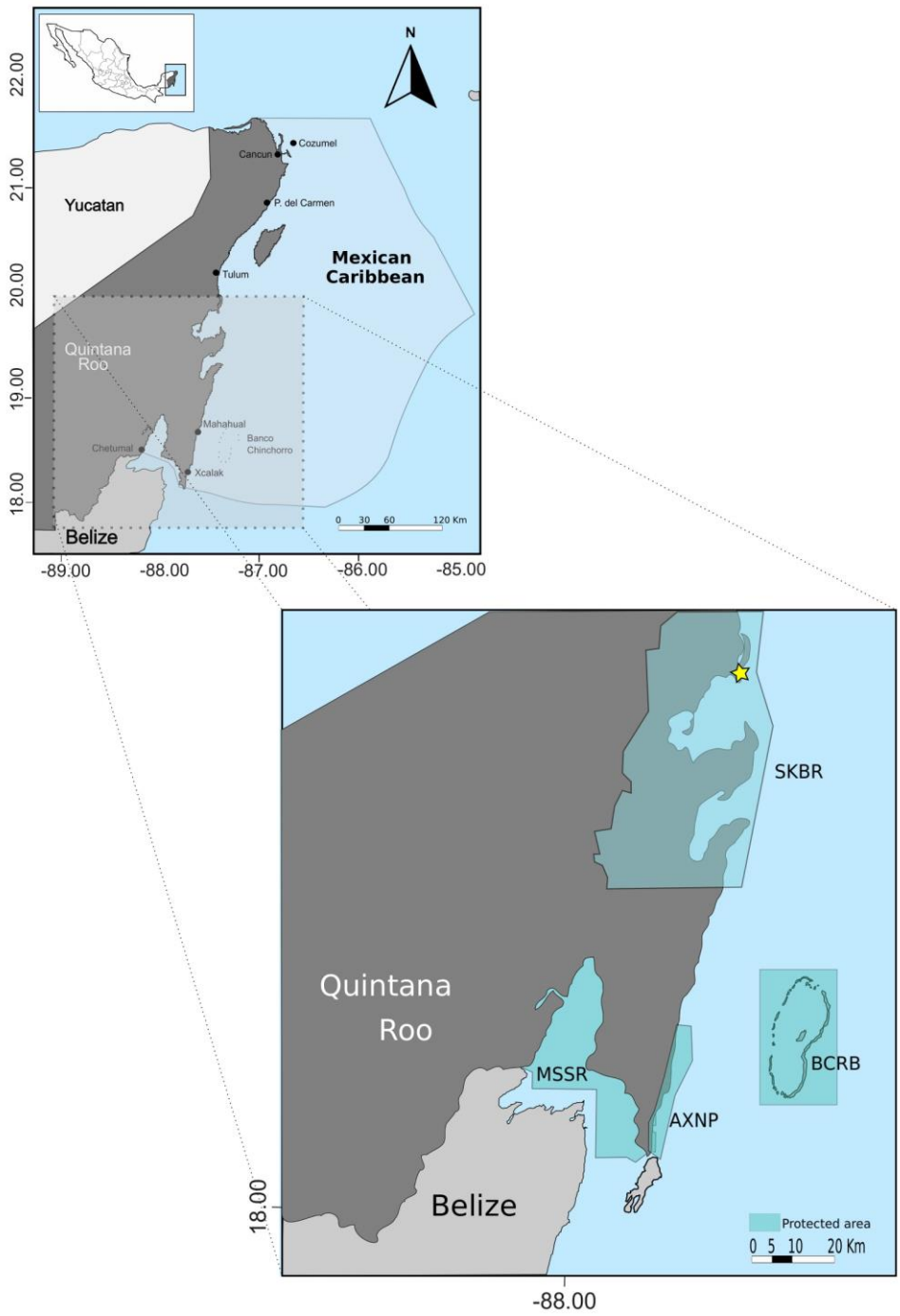

Figure 1. The Mexican Caribbean. The yellow star indicates the location of the manatee stranding. SKBR: Sian Ka'an Biosphere Reserve; BCBR: Banco Chinchorro Biosphere Reserve; AXNP: Arrecifes de Xcalak Natural Park; MSSR: Manatee Sanctuary Statal Reserve.

Figure 2. A. Aspect of the carcass of the female manatee at the moment of the finding; B. Abraded epidermis at the animal´s face two days after decease; C. Deep muscle hematoma with fat and subcutaneous damage tissue; D. Palpation evidencing comminuted fracture of the parietal and tympano-periotic bones. Photo credits: J. Ramírez Canul (2A) and J. A. Padilla-Saldívar (2B – 2D).

Strong evidence of how an orphan Antillean manatee (*Trichechus manatus manatus*) responds to the cold fronts in Chetumal Bay, Mexico.

Daniel is a 16 year old orphan male manatee rescued in September 2003 in Laguna Guerrero (LG) (Guerrero lagoon) (18.711709^0 N; 88.245116° W), Chetumal Bay (Figure 1). It was kept in captivity under intensive care in a pool and after seven months Daniel was released at LG, building soft-release facilities for this purpose. In 2015 Daniel starts exploring outside around the facilities and we decided to track his movements. By 2016 Daniel made a long trip outside of LG and returned several months later in good body condition. After this travel, Daniel has remained in the LG freshwater complex system using the entire ecosystem (Figure 2).

During the winter season of 2017-2018 and when more severe cold fronts arrived, Daniel quickly changed his movement pattern. He restricted its distribution to LG, entering on December 11, staying there until March 30, 2018. In the following 2018-2019 winter season, Daniel again entered LG on December 10th and stayed until February 20th, 2019 (Figure 3).

The responses of the Florida manatee and dugongs to cold fronts are well known, they can rapidly change their local or seasonal movements in response to low water temperatures (Marsh *et al.*, 2011, pp 196-200). This report is the first field-based evidence that the Antillean manatee (*T. m. manatus*) can change its regular local distribution in response to cold fronts. We installed a temperature water recording sensor on the belt of Daniel's tagging equipment and HOBO water-temp sensors in two zones of this freshwater hydrological system to monitor changes in water temperature and Daniel's response. On a recent aerial survey to assess the current distribution of manatees in Quintana Roo, we conducted a survey in Chetumal Bay on December 4 and 5, 2019. Surprisingly, a significant proportion of manatees was aggregated in a small area of the bay. I have never seen that before in previously surveys (Morale-Vela, pers comm.).

Based on this new evidence, it will be necessary to increase studies with the Antillean manatee to assess whether changes in water temperature during cold fronts may result in a new threat to this more tropical water subspecies.

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Figure 1. Manatee Daniel in waters of Laguna Guerrero. He has been tracked with a GPS-TMT 464-3 Telonics tag.

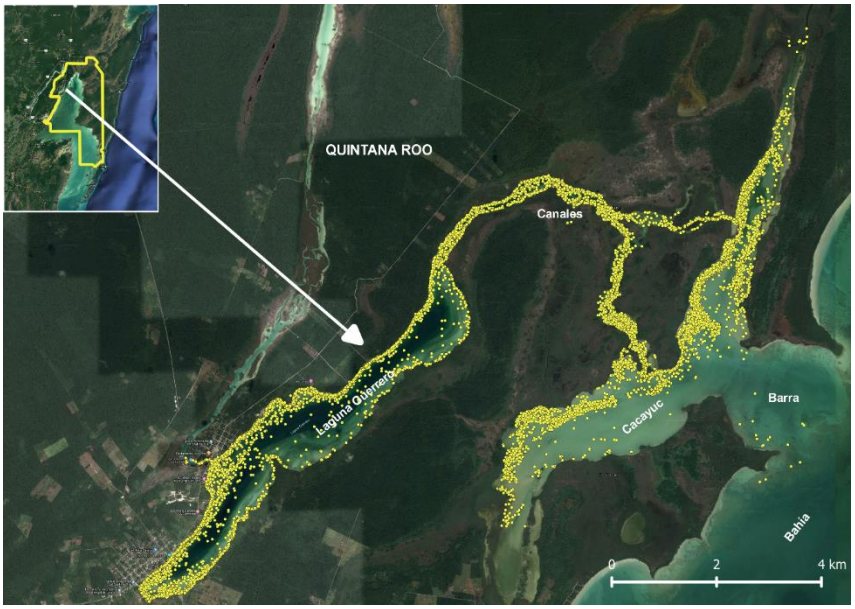

Figure 2. The area occupied for Daniel from March 24, 2017 to June 6th, 2019. Daniel´s GPS positions are indicted in points. The system includes four zones: the lagoon (Laguna Guerrero), mangrove channels (Canales), estuary (Cacayuc and Barra), the latter zone connects to the Bay of Chetumal (Bahía). This freshwater complex ecosystem covers an area of 25km² approximately.

Figure 3. Winter refuge area of Daniel in the Chetumal Bay in the winter season of 2017-2018 and 2018-2019. Daniel restricted his movements mainly to the low side of the lagoon with an area of 7 km².

PHILIPPINES

Supporting the knowledge base on caring for orphaned dugong calves through documenting Philippine cases

The dugong population in the Philippines has been locally assessed as "Critically Endangered" (Aquino *et al*. 2012) even as the IUCN global assessment is "Vulnerable." Adding to deaths due to fishing gear and seagrass destruction, several orphaned dugongs are known from the Philippines. Unfortunately, the systematic documentation of circumstances surrounding these dugong calves has been confined to a few cases. A lesser number is available to researchers, with even fewer such documentation available to the public. For majority of the cases, the circumstances remain anecdotal.

One Philippine case with documentation is "Serena", the name given to an orphaned dugong calf cared for 34 years. Based on 2019 videos available on the internet (Norikyo 2019; UNEP 2019), a technique used by Thai scientists for feeding milk to orphaned dugong calves named "Marium" and "Yamil" have similarities to the method developed by a joint team of Japanese and Filipino scientists in the 1980s to provision "Serena" with enhanced infant formula. Now in Toba Aquarium, research with "Serena" has provided further insights into dugong biology.

Given such example where a technique developed years ago may still be of use decades later, we started an effort to compile any documentation of techniques used for orphaned dugong calves in

the Philippines. We draw inspiration from our experiences with "Serena", MS on February 2020 and DT from 1986-7.

During 15-years of Philippine wildlife journalism, one of us (MS) joined part of the team that conducted video coverages of the orphaned dugong calf, "Zambo", in 2008. Thus, video would be the preferred compilation format. Unlike the 1980s technology, compiling videos available on demand to researchers and the public is now possible. Hopefully, the dream underlying this effort is to help dugong populations by providing useful information that supports care of orphaned dugong calves focusing on the paradigm: "rescue-rehabilitate-release."

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UNITED ARAB EMIRATES

Remarks on the SSC/IUCN Leaders Meeting in Abu Dhabi, October 2019

Various topics were discussed at the meeting; one of them was the review of the Red List evaluation procedures and the correct application of its criteria. In our case, the West Indian Manatee (WIM) update will be sent to the IUCN Red List for review this summer of 2020. Tony Mignucci, Chip Deutsch, Jim Valade and I are working to update the WIM information and submit it. I would like to take this moment to express our acknowledgment to all the experts who contributed by sending us the new regional and national information on the Antillean manatee published in reports and newspapers. We also appreciate your willingness to share your

experience in the field, and for answering the survey sent to some of you. It is very pleasing to see the enormous amount of scientific and general publications on the Antillean subspecies.

During the meeting the SSC announced the Abu Dhabi call for Global Species, is important that all the members know them, for details on the call and other information of the meeting: https://www.iucn.org/species/about/species-survival-commission/ssc-leadership-and-steering-committee/ssc-leaders-meeting-2019.

The Action Plans were another important topic analyzed in Abu Dhabi meeting, their effectiveness in the species recovery and in addressing the challenges for the conservation of biodiversity in the face of Global Change. Its importance was endorsed but a call was also made to the specialist groups for the urgent need to act.

A particular effort was focused on evaluating the Species Conservation Cycle developed during 2017-2018 as a framework to enter the CSS strategy with three essential functions: Assess, Plan and Act. These conform the Species Conservation Cycle. For more details, see the https://www.iucn.org/sites/dev/files/content/documents/ssc-iucn-components-a4-digital_0.pdf

This cycle will support the IUCN SSP 2021-2024 SSC framework, with its five components: Network, Evaluate, Plan, Act and Communicate (Figure 1).
Unfortunately, Helene Marsh was unable to attend the meeting this time.

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Figure 1: The Species Conservation Cycle, SSC/IUCN

UNITED STATES

The Significance of Webcams for Continued Manatee Research at Blue Spring State Park, Florida

The manatee population at Blue Spring State Park, a warm water winter aggregation site for the West Indian manatee in Orange City, Florida, is well studied (Hartman 1979; Powell & Waldron, 1981; Bengtson, 1981; O'Shea & Hartley, 1995; O'Shea & Langtimm, 1995). Between the months of November - March ("Manatee Season"), Save the Manatee Club conducts daily morning "roll calls"

to count and identify individual manatees (Figure 1). This large body of research, joined by Wayne Hartley almost 40 years ago as a Blue Spring Park Ranger and then as the SMC Manatee Specialist, has established an extensive life history program allowing researchers to track some manatee genealogies over seven generations.

In collaboration with the Florida Park Service, Save the Manatee Club established above and underwater webcams at the park at the beginning of the 2011/2012 winter season (Figure 1 and 2). The AXIS PTZ cameras can be watched live by viewers from around the world (ManaTV.org), but they also have significant impact for our research. While we are able to gather a lot of important data on individual manatees, reproduction, rapid growth of calves, and boat strikes acquired during the winter season during the morning roll calls, the webcams have provided a unique opportunity for monitoring behavior of individuals, determining gender of calves, and assessing sick and injured manatees.

Some interesting things we have learned: During the 2017/2018 season, BS676 "Swale" suffered a moderately-severe boat strike. While his behavior was lethargic when he was by himself near the head spring in the mornings, he was observed on the camera following female manatees near the river in the afternoons. During the 2018/2019 season, BS715 "Cree" was observed on the underwater camera with her large calf. The calf was seen socializing with other manatees and nursing from other females in addition to Cree. Cree's carcass was recovered two days later in the lagoon near Blue Spring, (cause of death undetermined). From the earlier observations on the webcam, we had evidence that the calf would most likely be okay without the mother. During the 2018/2019 season, we observed an individual manatee swimming on his side, and rescue was considered. While it was difficult to approach the manatee with the research canoe to film the behavior without further disturbance, the webcam provided us with valuable footage.

In addition, the webcams have provided us with additional photos of individuals that were submitted to the statewide Manatee Individual Photo-identification System database (MIPS) at the U.S. Geological Survey. Starting in 2016, we also began utilizing the webcams to document manatee summer sightings at Blue Spring (Figure 3). While historically very few manatees visited the park during the summer months, in June 2019, the webcams documented up to 224 manatee sightings in a single month (number of times a manatee was seen on the camera, not number of individuals seen during the course of the month). This new data validates that additional measures are needed to protect manatees from human harassment during the summer months.

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Figure 1: Manatee aggregation filmed with the above water camera at Blue Spring.

Figure 2: A manatee cow and calf are monitored with the underwater camera at Blue Spring.

Figure 3: SMC staff and volunteers install the underwater camera.

First documented round-trip movement between Cuba and the continental United States by a Florida Manatee

Photo-identification of the Florida manatee (*Trichechus manatus latirostris*), a subspecies of the West Indian manatee, dates to the late 1960's (Beck & Reid, 1995). Through the cooperative efforts of three main partners, U.S. Geological Survey (USGS), Florida Fish and Wildlife Conservation Commission (FWC), and Mote Marine Laboratory (MML), the Manatee Individual Photo-identification System (MIPS) database has grown to include over 114,000 sightings of more than 4,900 individually identifiable manatees. Many additional organizations and individuals have played a vital role in contributing photographs and associated data for inclusion in the database. This long-term research and monitoring effort has enabled documentation of habitat use, site-fidelity, and long-distance movements and provides high-quality mark-recapture data used to model population dynamics for state and federal assessments of the status and recovery of the Florida manatee.

Over the course of more than 50 years of manatee sightings data, seven individual manatees, cataloged in MIPS following strict criteria (Beck & Reid, 1995), have been documented in the continental United States and then subsequently at islands in the Caribbean or the North Atlantic Ocean (unpublished MIPS data, USGS/FWC/MML). These sightings represent movements of both males and females; interestingly, four of the five animals with confirmed sex were female. Movements to outside of the continental United States originated from both the west (five manatees) and east (two manatees) coasts of Florida. Two manatees known to inhabit the west coast of Florida have been subsequently documented in Cuba (Alvarez-Alemán *et al*. 2010, 2018). Three manatees documented on the west coast of Florida and two from the east coast of Florida have been subsequently identified in the Bahamas; the first of these individuals was reported by Reid (2000) and Lefebvre *et al*. (2001).

Adult manatee FM582 presents an interesting case history as this is the first manatee documented to move from the continental United States to a Caribbean island and then back again (Figure 1). FM582 was first seen in December 2006 at a warm-water site in southwest Florida and was regularly sighted in that region through January 2017 (mainly at warm-water sites in the Fort Myers area during the winter, but also occasionally during non-winter months in the Marco Island area; Figure 2). Through the photographs taken by a local from the Almendares River community of Cuba that were then shared with the Center for Marine Research at the University of Havana and the MIPS partnership, FM582 was next identified (with a calf) in November 2017 in Cuba (Alvarez-Alemán *et al*. 2018; Figure 3). The last known chapter of FM582's history is a result of response efforts by the Dauphin Island Sea Lab to a cold-stressed manatee in potential need of rescue in January 2020 in Halstead Bayou near Ocean Springs, Mississippi, United States. Photographs shared with the MIPS partnership confirmed that the animal in question was FM582 (Figure 4). Unfortunately, after mobilization of many agencies to assist in the rescue of this animal, the manatee was unable to be relocated. We look forward to uncovering the next chapter of this individual's life, wherever that may be.

The above cases underscore the increased understanding of manatee population dynamics that collaborative efforts can yield on an international scale and emphasize the importance of strengthening the scientific collaboration among regional and national partners to better understand these dynamics. As manatee occurrences increase in areas outside of Florida (e.g., Cummings *et al*. 2014, Heib *et al*. 2017), such integrated collaboration will be critical to better understanding connectivity and distribution to inform recovery efforts across the species range.

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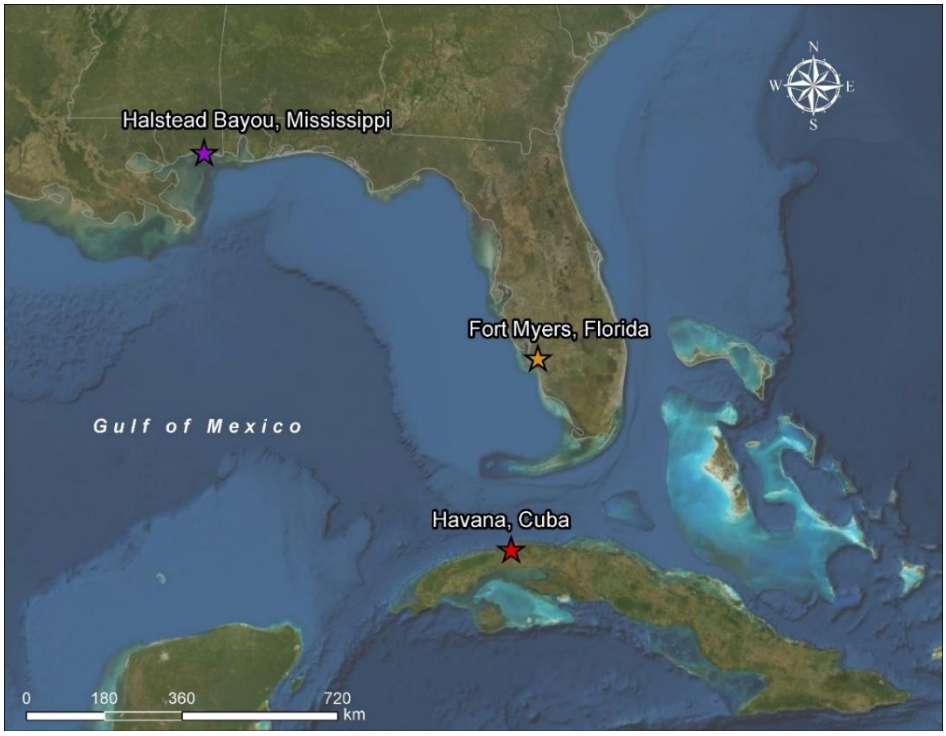

Figure 1. Sighting locations of FM582: Fort Myers, Florida (Dec 2006 – Jan 2017); Havana, Cuba (Nov 2017); and Halstead Bayou, Mississippi (Jan 2020).

Figure 2. FM582 seen on January 16, 2012 at Lee County Manatee Park (Ft. Myers, Florida United States). Photo credit: Mote Marine Laboratory

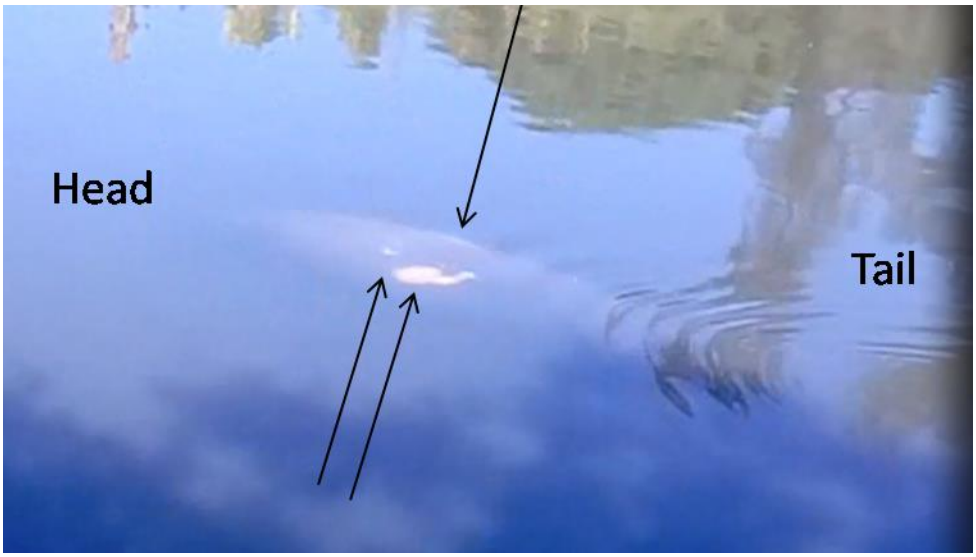

Figure 3. FM582 seen on November 11, 2017 in Cuba. Photo credit: A. Ruiz Abierno

Figure 4. FM582 seen on January 14, 2020 in Halstead Bayou (Ocean Springs, Mississippi United States). Photo credit: Dauphin Island Sea Lab

UPCOMING SYMPOSIA/CONFERENCES

19th Working Meeting of South American Specialists in Aquatic Mammals (19th RT) and XIII Latin American Society of Specialists in Aquatic Mammals Congress (XIII SOLAMAC)

The 19th Working Meeting of Latin American Specialists in Aquatic Mammals (19th RT) and XIII Latin American Society of Specialists in Aquatic Mammals Congress (XIII SOLAMAC) are the most important Latin American scientific fora on the research and conservation of aquatic mammals. Since the 80's, the event takes place in a South American country every two years. The last RT happened in Lima, Peru, in November 2018 and in 2020 it will take place at Praia do Forte, Bahia, Brazil, between September 13th and 17th. Traditionally, the event dedicates space for research dissemination, workshops and debates on Sirenian conservation, involving renowned researchers from Latin America and other regions.

The 19th RT will start on Sunday September 13th, with an opening ceremony. Pre-conference workshops, short-courses and symposia will be held on Friday, Saturday and Sunday, September 11-13. From Monday, September 14, the meeting will continue with lectures, oral and poster exhibitions, round tables and opportunity rounds. The program also includes evening cultural activities, such as video exhibitions, music and the traditional SOLAMAC awards.

The Organizing Committee of the 19th RT and XIII SOLAMAC is formed by researchers representing a consortium of Brazilian research and conservation organizations, involving Universities, NGOs and Government Institutions. The team has been working since December 2018, developing the program, building partnerships and structuring the event to provide its attendees with an excellent learning experience and exchange of scientific information.

The organizing and scientific committees are in solidarity with the rest of the world in this moment of crisis due to COVID-19, trying to adapt to the current reality. To this end, we have been holding virtual meetings on a weekly basis to make decisions on the best way to serve our target audience. Thus, for the time being, the event's date is maintained, though we are attentive and following the information and recommendations provided by health authorities on the COVID-19 pandemic. So far, we have adopted the following measures: a) The early-bird registration period has been extended to August 31; b) Authors no longer need to pay the registration fees in order to submit abstracts and c) The abstract submission deadline has been extended to July 15, 2020.

The forms of participation or support, as well as any changes that may occur during this period, will be informed on our social networks, and may be followed by all interested.

All up-to-date information will be available on the event's website: www.rtbrasil2020.com
We hope to see you all in Brazil soon!

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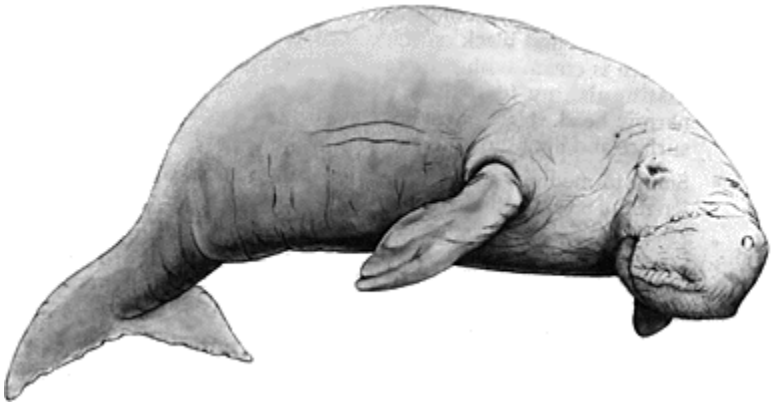

Sirenews – Dugong

(End of local news and upcoming conferences)

SYMPOSIA/CONFERENCES

THE NINTH INTERNATIONAL SIRENIAN SYMPOSIUM
DECEMBER 8, 2019

The Ninth International Sirenian Symposium was held on December 8, 2019 in Barcelona, Spain. This all-day event was in conjunction with the 23rd Biennial Conference on the Biology of Marine Mammals, with the purpose to support and promote Sirenian conservation. Approximately 80 scientists from around the globe attended, representing 25 countries. Thirty-seven abstracts were submitted and presented as full-length oral presentations, speed talks or posters aimed primarily at continued and new research, focused on regional initiatives or pressing management challenges addressing global conservation of the Sirenians. Support was provided by the Columbus Zoo and Aquarium and private donations.

ABSTRACTS

ORAL PRESENTATIONS
(in speaking order)

Antillean manatee as a landscape species for biodiversity conservation in the Magdalena Medio Region, Colombia

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The Wildlife Project started in 2014, implementing strategies for the conservation of biodiversity on a landscape scale in three regions of Colombia: Middle Magdalena Basin, Llanos and Putumayo. The Antillean manatee *Trichechus manatus manatus* L. was used as one of the focal species on the middle Magdalena basin. After the identification of areas with confirmed presence of the manatee in this landscape, the area of interest was selected by means of physical characteristics (e.g., seasonality, water depth, water bodies connectivity), biotic conditions (presence of manatees, food supply, shore land cover) and social aspects (e.g., human settlements, land use, boat traffic). The selected wetland system includes the San Juana Swamp and San Juan River with the objective of ensuring the presence of the manatee over time, making it a potential refuge for this species. This leads to the creation of a Natural Reserve of the Civil Society on a private property that borders the San Juana swamp. Currently, a team of different institutions are actively working to declare the "San Juana Swamp and San Juan River" as a regional protected area that encompasses forests and streams that feed this wetland system. The further declaration as a protected area will shield the territory from several large-scale threats (e.g. deforestation, water contamination). Whilst working together with different state holders aiming the conservation of the manatee's habitat with empowerment, restoration, monitoring and good productive practices.

An evaluation of trial management strategies for dugong and seagrass conducted by local communities in Sibu and Tinggi Island, Johor, Malaysia

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Sibu and Tinggi islands, which are located in Johor, peninsular Malaysia contains a small dugong population with sizable seagrass beds. In this region, dugongs face threats such as incidental entanglement in fishing nets, propeller and boat strikes, coastal development, and habitat destruction. Since these were mostly anthropogenic activities, 73 inhabitants in Sibu and Tinggi islands were interviewed on whether they would be interested to trial a management program to protect dugongs and seagrasses. Topics included views on the degree of importance of dugong and seagrass conservation, extent of involvement in dugong and seagrass management and conservation activities, waste management as well as eco-leader initiatives. Twenty-four people who were interested in becoming a conservation leader were selected from this survey to participate in management initiatives. They included stopping open burning, managing waste, reporting illegal activities to the management authorities, being guardians for a specified area, slowing down in dugong and seagrass areas, preventing seagrass degradation, good practices for tourism, mentoring others to follow management practices, first response when seeing a dead or live animal. Activities such as stopping open burning, recycling, reusing, being guardians for an area, slowing down in seagrass areas, mentoring others, and strengthening relations with management authorities appear comparatively harder to do than reducing waste, picking up litter, and seagrass degradation prevention. This is generally because the activities they could do were easy, they were not willing to change their lifestyles or inconvenience themselves and spend funds. The challenges of conducting the management activity and the suggestions to improve the implementation of the activity were also discussed. Based on these results, recommendations include target audience education programs, incentive programs in exchange for conservation, developing a comprehensive plan for waste management, improving relations with government managing authorities, and policy implementation to go slow in seagrass areas.

New satellite technology applied to monitoring of Antillean manatees (*Trichechus manatus*)

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In 1994, when the Antillean manatee Reintroduction Program in Brazil started, no transmitters (VHF or PTT/GPS) were manufactured in the country, so all had to be imported. We hereby report the generation of a new satellite technology applied to the monitoring of Antillean manatees. The transmitters were designed using the GlobalStar system, engineered from a SPOT Messenger module, programmed to receive commands from the controller board, generated by a Microchip PIC family microcontroller. To complete the hardware, a VFH transmitter was added to the device. The programming of the transmissions can be adjusted according to each user's interest; for Antillean manatees in Brazil, the setting is of 15' ON (sending 3-4 coordinates) and 2'45" OFF. Geographic coordinates made available through GlobalStar have enabled maps to be viewed through Google Maps and Google Earth. The packaging of the technological apparatus was designed to remain inside a housing measuring 16.5 cm and weighing 1.9 kg, which is adapted to the animals through the traditionally used attachment accessories. Regarding transmission mechanisms, the GPS locations provided were quite satisfactory, with

excellent accuracy of the coordinates received. As to the VHF device, it assisted field monitoring, enabling the researcher to locate the animal for studies or recover the transmitters for maintenance/repair. Thus, keeping the premise of designing this equipment from low-cost materials available in the national market, the final product obtained proved technically feasible and economically accessible for other initiatives of this nature. Based on all the studies performed, the equipment and the system designed are suitable for monitoring activities of free-ranging Antillean manatees.

Bycatch of dugongs in the blue swimming crab fishery of northwestern Sri Lanka

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Marine mammal bycatch, a major threat to sustainable populations, poses a particular challenge in developing countries. Data to document bycatch and the effects of bycatch are often lacking. We have created a spatial and temporal risk bycatch risk assessment (ByRA) toolbox that makes use of existing data and creates a framework for data acquisition that provides local practitioners and scientists the tools they need to evaluate bycatch risk. ByRA calculates areas of bycatch risk based on the presence or absence of management strategies, the intensity of fishing activity by gear type, and an estimate of the spatial likelihood of interaction between fisheries and species. Our objective was to apply the ByRA toolbox to assess the spatial exposure of dugongs to incidental bycatch in the blue swimming crab (*Portunus pelagicus*) fishery in Palk Bay and the Gulf of Mannar in northwestern Sri Lanka.We traveled to Sri Lanka to meet with agency experts and local scientists. In Palk Bay and the Gulf of Mannar, we met with community leaders and traveled to fishing villages, mapping net use and fishing areas. From observations and conversations, we concluded that the exposure of dugongs to the crab nets is low, due to the placement and configuration of the nets. However, shark/ray nets commonly used by villagers, and illegal commercial trawling close to coasts are risky to dugongs, and also have a highly unsustainable bycatch of marine turtles. ByRA outputs show that the risk of bycatch is most directly associated with areas of fishing occurrence. For the dugong, most of this risk is in the Gulf of Mannar, in areas with illegal trawlers and shark/ray nets. As uncertainty is quite high in this analysis, we caution that risk could be generalized and overestimated. There is a critical need for formal surveys in this area.

Integrating morphology, karyotype and DNA sequences for manatee species identification

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The discovery of manatees displaying morphologic attributes shared by *T. manatus* and *T. inunguis* has led to a taxa hybridization hypothesis. Nail loss in adult specimens has been reported, suggesting an unfixed trait, while another hybrid confirmation characteristic, the karyotype, has been indicated. Morphology and/or mitochondrial marker-based hybrid identification and nuclear marker-based species identification have also been reported, although nuclear marker sequences are unavailable. Recently, at least two nuclear markers, RAG1 and vWF, were reported as displaying no phylogenetic signal for taxonomic *T. manatus* and *T. inunguis* distinction. Therefore, the

best identification marker is the karyotype, since *T. manatus* displays 2n= 48, FN=96 (*T. m. latirostris*) or FN=90 (*T. m. manatus*), while *T. inunguis* displays 2n=56, FN=82, and several rearrangements are necessary for one to derive another. Omar, a manatee from Marajó Island, Pará, Brazil, shares morphologic *T. manatus* and *T. inunguis* attributes, but displays a *T. manatus* karyotype (2n=48) and a *T. inunguis* cytochrome b and D-Loop region. This suggests morphologic attribute and mitochondrial marker polymorphism. Alternatively, Omar's morphology could indicate a female *T. inunguis* (suggested by the mitochondrial marker) and a male *T. inunguis* hybrid. However, Omar's karyotype is conclusive for *T. manatus*. Also, the hypothesis of several backcrossings until a 2n=48 karyotype appearing in a hybrid is very unlikely. Marajó Island has been monitored weekly for 13 years (2005-2019), with double the number of *T. inunguis* recovered compared to *T. manatus*, and only two reports of shared morphologic attributes. If hybrids were so common to allow the number of required backcrossings for Omar to be considered a hybrid, other manatees displaying hybrid morphologic attributes would have been found. Furthermore, for a 2n=48 through backcrossing, males should necessarily be *T. manatus*. Therefore, morphological manatee identification is inconclusive, and an integrated study is necessary for atypical morphologic species identification.

Carbon and nitrogen isoscapes of Antillean manatee (*Trichechus manatus manatus*) along the Brazilian coast

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Marine mammals show high variability and flexibility in their foraging strategies. Feeding tactics are related with the local environmental characteristics and may vary among populations, ontogenetic classes, sexes and individuals. To understand the feeding ecology of *Trichechus manatus* in Brazil, diet and habitat-use variation were assessed through stable-isotope analysis. Teeth samples from *T. manatus* were obtained from scientific collections located in the North and Northeastern regions. The study area was divided into North Coast (NC), Dry-Northeastern Coast (Dry-NEC) and Humid-Northeastern Coast (Humid-NEC) according to coastal and oceanographic characteristics. The isotopic niche of all individuals was calculated and the isoscapes were generated from isotopic values. The $\delta^{13}C$ values for animals from Dry-NEC were higher (-8.1 ± 1.2 ‰) than for animals from the North Coast (18.7 ± 5.5 ‰). The isotopic-niche width of manatees was greater in Humid-NEC (SEAc = 18.2 ‰^{2}), followed by North Coast (SEAc = 6.4 ‰^{2}) and Dry-NEC (SEAc = 5.0 ‰^{2}). Differences in the availability of food sources and habitats (freshwater, estuarine and marine) are probable explanations for most of the spatial variation in isotopic values. The geographic variation in carbon and nitrogen isotopic values of manatee teeth reflects the environmental characteristics of coastal habitats; $\delta^{13}C$ values were lower in manatees from areas with predominantly mangrove, riverine and estuarine habitats and $\delta^{15}N$ values increased in the most dense and urbanized areas along the Humid-NEC. *T. manatus* are opportunist and generalist species, feeding from a large diversity of habitats presumably due mainly to differences in availability.

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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Noninvasive genetic sampling approaches have been widely used to study terrestrial species but applied scantly to their aquatic counterparts. 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), Tissongo (n=60) and Sanaga River (n=82), Cameroon, between 2016- 2017. From 235 isolates, we selected 110 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%. PCR success rate was high (80%) and allelic dropout rate moderate (ADO=24%). We successfully assigned sex to 86% of isolates. Total DNA concentration and PCR success were significantly (P=0.0002) higher for samples from rivers (21.9ng/µl, 87.5%) than lakes (11.8ng/µl, 79.4%). ADO was significantly (P=0.006) lower in rivers compared to lakes (18.5% versus 29.1%, respectively). This suggests that fecal samples from rivers are fresher than those found in lakes, where water can be stagnant and feces can remain in the system for longer, 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 genetic sampling of this imperiled manatee more accessible.

The First Dugong Survey in Tolitoli, Indonesia

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Indonesia has at least 34 species of marine mammals species and all have been fully protected by the law, yet the distribution and population remain unclear. The first Dugong survey in Tolitoli, Indonesia was conducted during 19—26 September 2016. The study was an activity under the Dugong and Seagrass Conservation Project. The objectives of the study were to confirm the existence of Dugong and discover the distribution in Tolitoli, discover the condition of the seagrass ecosystem, and reveal the perception of the local community on Dugong and Seagrass in their area. Several methods such as visual survey by boat and drone, as well as acoustic method, transect method, focus group discussion (FGD) method and CMS-Questionaire method were applied. The findings from visual methods confirmed the existence of Dugongs in Tolitoli area by sighting by boat survey, some

documentation by drone and feeding trails on some seagrass meadows. Feeding trails were found on seagrass meadow of *Halodule uninervis, Cymodocea serrulata*, *Halophila* ovalis and *Thallasia hemprichii.* One from 14 recordings of acoustic recording confirms the Dugong existence by "Chirp" sound. Seagrass habitat examined by the transect method suggests that Tolitoli has 10 species of seagrass, namely *Cymodocea rotundata, Cymodocea serrulata, Enhalus acoroides, Halodule pinifolia, Halodule uninervis, Halophila decipiens, Halophila major, Halophila sulawesii, Syringodium isoetifolium,* and *Thalassia hemprichii*. Seagrass habitat in Lingayan Island and Dusun Babanji were in good condition, while seagrass in the Dusun Jaleje was in the medium condition. The results from the questioner method were extracted from 29 individuals respondences from 7 different villages. FGD and questioner methods showed the local community's perception of Dugong and seagrass conservation programs and their threats to the Dugong. From the FGD it can be concluded that the local community in Tolitoli has to be empowered in order to support their involvement in Dugong and seagrass conservation.

Conservation battles can have perverse outcomes: the case of the northernmost dugong population

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In March 2019, a 2.9m female dugong died on west coast of Okinawa, Japan stabbed by a ray barb, presumably while bottom feeding. This animal is the last known dugong in the waters of Okinawa, one of the Nansei islands that stretch between Kyushu and Taiwan. Okinawa is the site of a long battle to conserve dugong habitat threatened by the planned relocation of a U.S. Marine Corps air base. The fight to protect this habitat focused attention away from the main threat, incidental bycatch in fishing operations. Dugongs were widely distributed in the Nansei Islands, probably in the low hundreds during the late 19th century but were hunted at an unsustainable rate until the early 20th century. During the past 50 years (1969-2019), the major causes of dugong mortality have been incidental and illegal direct catches. Habitat loss and degradation are becoming greater concerns. Construction of the new base has recently destroyed ca. 160 hectares, a substantial proportion of the total area of seagrass around Okinawa but a relatively small proportion of the seagrass habitat in the Nansei Islands. The Japanese dugong population is a geographically distinct and there appears to be little demographic or genetic exchange with other populations. This isolated population has been considered to be under serious threat of local extinction for decades. It is now uncertain whether any remain. The IUCN Sirenia Specialist Group has lodged a listing assessment for this population with IUCN and held a workshop in Japan to develop a plan to use multiple approaches to determine if any dugong remain in Japanese waters.

The dugongs' use of the Vavouto mining port in the lagoonal reefs of New Caledonia – Preliminary results

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The movement behaviour of dugongs in lagoonal coral reefs is poorly understood and even more so in reef systems that overlap with industry activities such as mining port activities. We are currently conducting a study on the movements of dugongs in the Voh-Kone-Pouembout area (VKP) in the North Province of New Caledonia, where a world-class mining complex has been implanted adjacent to the lagoon. Our objectives are to identify and characterize habitats preferred by dugongs in the VKP area and to identify the drivers (natural and

anthropogenic) of dugong movement in the area. We are using a combination of animal-borne telemetry (GPS/satellite and mini-diaries) and novel drone-based survey techniques to collect distribution and movement data at several spatial and temporal scales in the VKP area. Data exploration indicated that dugongs routinely use the vicinity of the industry Port, whether it is in the muddy bay, the reticulated reefs or the deeper channels. One of the tracked dugongs routinely swam inside a small and shallow bay only at night. This shows the benefit of using telemetry tools in parallel with aerial surveys which can only be operated in daylight. Our presentation will also touch on the lessons learned from conducting this type of study on dugongs in areas where dugong numbers are low.

Sea cows and their meadows: Isotope analysis of historic samples from dugong (*Dugong dugon*) populations throughout the Indo-Pacific

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Large data gaps still exist for many dugong *Dugong dugon* populations in the Indian Ocean, despite their vulnerable' conservation status. Due to a paucity of contemporary samples, access to museum samples allowed the investigation of historic changes in δ13C and δ15N ratios of dugong populations throughout the Indo-Pacific and over time. A total of 85 museum samples of bone and tooth powder from individual dugongs located in ten natural history collections, mainly in Europe, were analysed. The oldest possible date, which ranged from 1857 to 1996, was obtained from available catalogue information and grouped into 30-year intervals, while geographic location had been determined through prior genetic analysis. Our results showed a significant difference in δ13C and δ15N ratios between geographic locations within the Indian Ocean populations (df = 4; P = 0.002). Post-hoc pairwise tests indicated this result originated mainly from differences of samples from East Africa and Madagascar/Comores with those from other regions. The δ13C and δ15N ratios showed the same trend over time, with an increase over two consecutive 30-year intervals from 1850 to 1910, followed by a decrease during the 1940 interval and another increase in the 1970s. PERMANOVA results corroborated these changes in ratios, showing a significant difference between time intervals (df = 4; P = 0.048). East African populations appear to be isotopically distinct, which could reflect differences in feeding or habitat quality to populations elsewhere, while the shift in ratios of δ13C and δ15N during 1910 to 1940 could also reflect some sort of change in diet during this time. These results may help with the design of effective conservation and management strategies of vulnerable populations in the Indo-Pacific region

African manatee threat assessments: preliminary results from five countries

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The African manatee faces serious threats from intense hunting, fisheries bycatch, dams and other human development. Two years ago, we initiated the first countrywide threat assessments in five West and Central African countries: Senegal, The Gambia, Nigeria, Cameroon, and the Democratic Republic of the Congo (DRC). The

goals of this project are to quantify threats and numbers of manatees captured and 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 in order to implement effective conservation actions. Data is collected both through dedicated surveys as well as collaboration with local reporting networks in each country. In the first phase of this project we have documented over 400 manatees killed or captured alive. Documented threats differed significantly by country and include illegal poaching using two types of traps, harpoons, specialized nets, and guns, as well as fisheries bycatch and manatee mortality due to both entrapment behind dams and entrapment in dam control structures. We have also documented two walk-in freezers in Nigeria and DRC where manatee carcasses are stockpiled until they can be shipped to other parts of those countries and sold for higher prices. After analyzing three years of data, the next step will be to begin working with government and NGO enforcement agencies to increase public awareness and enforcement. The results of this study will also be used to determine feasible locations for protected areas and alternative livelihood programs to reduce manatee hunting, bycatch, and/or habitat destruction. Creative programs are imperative, because there is currently no enforcement of manatee hunting in any African country.

Research and citizen monitoring towards the conservation of manatees in the Sian Ka'an Complex (Quintana Roo, Mexico): preliminary results

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The Sian Ka'an Complex (SKC) is a relevant refuge for Caribbean manatees (*Trichechus manatus manatus*) in Quintana Roo, Mexico, due to the availability of high-quality habitats for manatee feeding and calving. However, the recent increase of tourism affluence has raised concerns on the fate of this manatee population. We started a long-term monitoring of manatees in SKC in 2018, by initiative of the CONANP. Between 2018 and 2019, in order to detect and count manatees, we carried on 247 hrs of navigation in boats equipped with outboard motor at low speed (<15km/h); covering 2 571 km in Espiritu Santo Bay, Ascención Bay and the Coastal Lagoon System. We also performed 56 aerial surveys using light quadropter drones Phantom 3 and 4 at 100 m above the water surface and recorded 228 min of underwater sounds aiming to detect manatee's vocalizations. Additionally, we applied 41 interviews to local inhabitants, with the goal of collecting information about manatee status and human perception on the species. So far, we have recorded 36 sightings of manatees, 30.5% consisting in a mom-calf pair, and 14 events of manatee vocalizations. Manatees were more abundant in coastal lagoons and prefer mangrove areas near to sinkholes and other freshwater sources. Those areas were also frequently visited during touristic trips sold in Tulum or Punta Allen, often offering manatee watching as one of the main attractions. We develop a series of awareness activities including workshops to tour guides, talks to students and a local festival during the Manatee Month (September). Aiming to build local capacities towards manatee conservation, we conformed a Group of Community Monitoring, which members are being trained for good practices of manatee watching and monitoring. A strong collaboration among government, stakeholders and researchers is necessary in order to control/minimize the current and potential threats on SKC manatees.

Bone-collagen stable isotope analysis indicates manatee feeding preferences in the Mexican Caribbean

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The endangered Caribbean manatee (*Trichechus manatus manatus*) inhabits marine, estuarine and freshwater environments, feeding on a wide variety of aquatic and semi-aquatic vegetation, and has an important role in the trophic cycle of these ecosystems. Previous studies have described the diet of manatees in the Mexican Caribbean by analyzing digestive tract contents and feces. The aim of this study was to evaluate the possible temporal and spatial variation in manatee's dietary preferences in the Mexican Caribbean. For this, a total of 68 manatee bone samples –obtained along three decades- and 827 aquatic vegetation samples of 95 species, were collected. The Carbon ($\delta^{13}C$) and Nitrogen ($\delta^{15}N$) isotopic ratios were analyzed for bulk samples. $\delta^{13}C$ values showed significant differences among locations ($p < 0.05$), but not among decades, sex or age class ($p > 0.05$), while $\delta^{15}N$ values were no significantly different among the studied variables ($p > 0.05$). The $\delta^{13}C$ and $\delta^{15}N$ values found on manatee bone-collagen suggest a feeding preference on seagrasses from marine ecosystems, which has been maintained during the last three decades. This stable isotope analysis provided a complementary approach to understand the importance of different types of vegetation from which manatees feed upon in the Mexican Caribbean. Our results suggest that habitats with a large offer of subaquatic vegetation, particularly seagrasses, are critical for manatees in the Caribbean, and deserve special management.

Successful evidence of Amazonian manatee reintroduction in Brazil

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Due to illegal hunting and entanglement in fishing nets, Amazonian manatee calves are rescued and taken to INPA`s facility in Manaus, Brazil. The success of the rehabilitation program produced a potential reintroduction group. Between 2008-2009, four manatees were released directly into the wild showing adaptation difficulties. The reintroduction protocol was reviewed and since 2011 selected manatees have been moved to a 13ha semi-natural lake for adaptation to natural conditions. A second phase began in 2016 at the Piagaçu-Purus Reserve, Central Amazon. A total of 31 manatees, 4 to 16 years old, were released, 18 with VHF-transmitters. Manatees were monitored by trained ex-hunters, from 192 to 638 days, totaling 3.670 records. The maximum displacement was 37km/day (average 1.4km/day). *T. inunguis* move with the river flood pulse, 1.1 and 4.7km/day in high and low water season, respectively. Home Range using the minimum convex polygon showed amplitude of 11 to 1332km^2, with movements' difference between males (341km^2) and females (606km^2). During high water, manatees spent 65% in *chavascal* habitat with abundant food, and at low water, 73% of encounters were in deeper areas of the Purus river. Released individuals spent 96% of their time separately, but interactions with wild manatees were recorded. The semi-captivity stage before release increased 100% of the survival success. The selection of suitable habitats, the survival of the individuals over at least one complete flood pulse and the absence of contact with humans are strong success indicators. Additionally, four manatees were recaptured six to 18 months after release, showing increased body mass and length. One female was confirmed pregnant. The engagement and support of local people has been fundamental to the protection and monitoring of the

manatees in the Reserve. Our results provide subsidies for managers and local communities to establish effective conservation zones for the species in long-term.

Establishment of community-driven Dugong (*Dugong dugon*) conservation area in Calawit Island, Busuanga, Palawan

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The dugong (*Dugong dugon*) is listed as 'vulnerable' on the IUCN Red List (Marsh *et al*, 2002) and 'threatened with extinction' under CITES Appendix I. Dugongs in the Philippines are understudied; thus, the number of remaining dugongs in the Philippines is unknown, decreasing, sparse and scattered caused by habitat loss and degradation and fisheries by-catch. Palawan is one of the dugong's last strongholds and the most promising hope for its national survival. In Calawit Island, Busuanga, Palawan, there are a few semi-habituated dugongs feeding on the seagrass beds also used by the indigenous *Tagbanw*a tribe. These individuals provide a unique opportunity to better study and conserve the species, employing standardised techniques (drones, boat and land-based surveys, seagrass surveys) to determine dugong core habitats, population and distribution as well as community perceptions and beliefs. These studies conform with the Palawan Council for Sustainable Development's (PCSD) Strategic Environmental Plan for enhanced community centered conservation of critical marine species and habitats in Busuanga municipality. Using the results from research conducted by C3 since 2011, the Calawit *Tagbanwas* in May 2018 declared 8 sites in their ancestral waters as Dugong Conservation Areas (DCAs) covering a total area of 617.36 hectares and with the assistance of C3 have created monitoring and management plans for the areas. This paper will share the processes for the establishment of the DCAs in Busuanga, Palawan which can serve as a model and guide for the replication of dugong conservation programs throughout the region. Furthermore, the blueprint will be scaled up and shared through a 4 year Climate Initiative (IKI) seagrass ecosystem services project implemented by CMS Dugong MoU Secretariat across 5 countries; the Philippines, Malaysia, Timor Leste, Indonesia and Thailand.

Manatees re-appear in Haiti and immediately become in peril

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Manatees in Haiti are highly endangered and thought to be practically extinct. The population was estimated in the single digits based on 1980s aerial surveys. On 11 September 2019 we assisted on a manatee rescue in the Nippes region of southwest Haiti. We helped in the initial steps to move the animal to a pool, but the animal did not survive the machete injuries received from fishermen. A necropsy was conducted, and samples and bones were collected for future analysis. Reports stated that the animal was accompanied by another manatee, but the second one was never found. The Haitian Ministry of Environment reacted immediately to condemn the incident, but only with words. We were alerted again to the butchering of 3 out of 4 manatees on Anse a Foleur on the Nord-ouest section of north Haiti on 8 October 2019. The fourth animal escaped the nets of fishermen, but the other 3 were killed with machetes and their meat divided and sold among the local population. There was so much meat, that a full bucket of manatee meat was sold for 50 gourdes ($0.52). Together, we are committed to help in this situation, in which a Caribbean endangered species is finally re-appearing in a country where it was almost extinct, but immediately the specimens found were butchered and taken in for food. Two animals are still

alive and free if luck persists on their side. But emergency international help is needed to ascertain the status of the manatees in Haiti through local interviews and aerial surveys, educate the locals about their need for protection taking into consideration their cultural and socio-economic needs, and directly protect the remaining manatees with local volunteers dispersed throughout the Haitian coasts. While the sightings of 6 manatees in Haiti in September and October 2019 is good news since they were thought almost extinct, this news comes immediately with the very bitter taste as the animals were killed and butchered. International action and involvement are desperately needed.

How healthy are our urban dugongs? Insights from a decade of health assessment

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Annual health assessment of dugongs has been conducted on the east coast of Australia since 2008. Each year, up to 20 dugongs are captured and medically examined in Moreton Bay, adjacent to a major city, Brisbane. Clinically informative samples (blood, urine, feces, tears, saliva, skin) and body morphometrics (length, weight, girths) have been collected from 190 dugongs, and the dugongs' vital signs recorded. Reference intervals for haematology and serum biochemistry have been generated. We have also determined baseline levels of reproductive and stress hormones, immune function factors (immunoglobulins), and normal gut microbial profiles across sex and size/maturity cohorts. Our results to date suggest that the dugongs of Moreton Bay are mostly healthy with no evidence of disease outbreaks during the study period. However, some health findings of concern include broad antibiotic resistance, evidence of exposure to pathogens of terrestrial origin and detectable levels of heavy metals that increase after coastal flooding events. Health assessment has also provided opportunity for physiological studies including measurement of metabolic rate (see Speed talk in main conference), osmoregulation, and reproductive status and activity, as well as body allometry and social behaviour. This presentation will summarize some of the major findings obtained from this program so far.

SPEED TALKS

(in speaking order)

Effects of body size, food type, and ontogeny on chewing cycle duration in West Indian manatees (*Trichechus manatus*)

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Mastication is the cyclical pattern of mandibular movements in mammals and can be measured as a rate (chews/sec) or the inverse (chewing cycle duration; CCD). Mastication rate is a key variable in models of feeding ecology. A positive, interspecific relationship exists within mammals between CCD and body mass; however, intraspecific patterns have not been as clear. This study investigates the effects of body size, food type, and ontogeny on CCD in West Indian manatees (*Trichechus manatus*). We recorded 18 captive manatees of varying body lengths consuming two food types. Additionally, nine of these manatees were recorded on two separate occasions, six years apart, allowing us to examine ontogeny. Curved body length was measured along the dorsal

surface. CCD was extracted from the recordings using Raven Pro 1.5. Food type (r = 0.78, p = 6.8x10-5, n = 17) and body length (r = 0.53, p = 0.033, 95%CI 0.14-1.00, n = 17) significantly affected CCD. Individual variation remained consistent even while CCD changed during growth. Both CCD and body length increased over time; however, our small sample lacked the statistical power needed to show a significant correlation between ΔCCD and Δbody length (r = 0.44, p = 0.24, 95%CI -0.198-1.00, n = 9). Considering all three contributing factors influencing CCD, we conclude from our study that it might be difficult to accurately estimate body length from mastication sounds due to individual variation (independent of body size and food type). It may be possible to determine relative body size if food type is controlled for. In addition, while mean CCD (543 ms) varied between manatees by as much as 144ms, each individual chewed at a consistent rate (mean SD = 41), which may allow individuals to be distinguished from each other in the wild.

Manatee habitat characterization and use using side-scan sonar

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In this study, the reliability of low-cost side-scan sonar to accurately identify soft substrates such as grass and mud was tested. Benthic substrates can be hard to classify from the surface, necessitating an alternative survey approach. A total area of 11.5 km^2 was surveyed with a Humminbird® side-scan sonar unit in a large, brackish mangrove lagoon system on Isla de la Juventud, Cuba. Individual points were opportunistically ground-truthed for comparison with the sonar recordings to provide a measure of accuracy. Five substrate types were identified: Dense seagrass, sparse seagrass, mangrove soil, mangrove soil with rock, and silt. A zoned benthic substrate map was created from the sonar recordings using Quantum Geographic Information System (QGIS) software. Dense seagrass was most accurately identified when compared with the observed substrates at the ground-truthed points. Sparse seagrass had the lowest accuracy. A bathymetric map was created from the sonar recordings using ReefMaster software. Depths ranged from 0 m to 10.3 m. Manatee sighting locations were overlaid on these maps to make a preliminary assessment of habitat use. A total of 95 sightings were recorded between 2007 and 2014. There was a significant difference in the number of sightings by substrate type. Manatees were sighted in areas characterized as mangrove soil, silt, and dense seagrass, with most sightings recorded in mangrove soil areas. There was a significant difference in sightings by depth with most sightings occurring in areas 2–6 meters deep.

First catalog for manatee photo-ID using small drones in the Caribbean: a protocol proposal

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Manatees can acquire permanent scarrings from watercraft injury and other incidences that can be used to photo-identify individuals over time and space. Small drones are affordable and practical

platforms to study and monitor wildlife. We propose a novel method for photo-ID of Antillean manatees (*Trichechus manatus manatus*) using aerial imagery captured during flights with a small multirotor drone in the Caribbean. Between 2016 and 2017 we conducted 103 flights to detect and observe manatees in Belize, primarily at St. George's Caye near the Belize Barrier Reef. Review of aerial videos from these flights resulted in 279 sightings of manatees (245 adults, 34 calves). High-resolution images of individual manatees were extracted and classified according to image quality and distinctiveness of individual manatee for photo-ID. Images of manatees classified as sufficiently distinctive were used to create a catalog of 17 identifiable individuals. At St George's Caye (SGC), 21% of all sighted adult manatees (45, N=214) were considered photo-identifiable over time. We suggest that the method can be used for investigating on individual site fidelity, habitat use and behavior of manatee populations. This drone-based photo-ID protocol has the potential to improve long-term monitoring of Antillean manatees in Belize and be applied throughout clear, shallow waters in the Caribbean and elsewhere.

Are Florida manatees (*Trichechus manatus latirostris)* wearing their teeth beyond functionality? Interspecific and intraspecific mesowear in manatees

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Manatees (*Trichechus* spp.) are herbivorous aquatic mammals found in warm waters. At maturity, they possess only supernumerary molars (SM), with 5-8 in occlusion in each quadrant. Manatees exhibit a dental replacement system in which they shed old teeth anteriorly and erupt new teeth posteriorly. This adaptation is thought to have arisen to deal with abrasive foods. Mesowear (facet development on occlusal surfaces of teeth) increases from posterior to anterior. Tooth functionality is linked to level of mesowear, with increased amounts resulting in decreased food-processing ability. Less functional teeth can result in an increase in feeding time, potentially decreasing fitness. Domning (1982) noted that Florida manatees (*T. manatus latirostris*) appeared to experience greater levels of mesowear compared to other manatee populations, however he did not quantify the difference. To address this we examined museum specimens from all manatee taxa: Florida (n=64), Antillean *T. m. manatus* (n=49), Amazonian *T. inunguis* (n=121) and African *T. senegalensis* (n=4) manatees. Photographs of the dental arcade (upper and lower) were taken and analyzed. Each SM in occlusion was numbered (posterior to anterior) per quadrant and classified into one of five discrete wear categories (level 5, extreme, being considered as non-functional). Total number of teeth per quadrant (TNTQ) and total number of functional teeth (TNFTQ) per quadrant were counted including missing teeth (evidenced by dental alveoli). Florida manatees had significantly fewer mean TNTQ ($H=130.03$, $p<0.001$) than other taxa except Antillean manatees, and fewer mean TNFTQ ($H=362.21$, $p<0.001$) than all other manatee taxa. In addition, except for SM1, Florida manatees had greater mean levels of mesowear (SM2-SM6) compared to all other taxa. Florida is not only a marginal habitat for manatees because of seasonally cooler water, but also because of the additional dental burden: where it appears they are wearing down their teeth faster than the replacement process.

Skin temperature pattern in Antillean manatees (*Trichechus manatus manatus*) in Belize – A comparison with Florida manatees (*T. m. latirostris*)

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Florida manatees (*T. manatus latirostris*) are one of the two subspecies of the West Indian manatee (*T. manatus*) and are the largest extant sirenian species. They are known to be very sensitive to cold, due to their sparse body insulation, and limited adaptations to control peripheral heat loss. Florida manatees cope with their lack of thermoregulatory adaptations by moving to warm water refuges when water temperatures fall below approximately 20°C in winter. Antillean manatees (*T. m. manatus*), the other subspecies, are much smaller than Florida manatees. Knowledge about their potential sensitivity to cold is only anecdotal, since they live in warm Caribbean waters and are usually not exposed to water temperatures below 15°C. Here, we present preliminary data of skin temperature measurements in six wild Antillean manatees captured for health assessments in two habitats in Belize and compare them to skin temperatures measured in two captive Florida manatees over the course of two years. We found average skin temperature in Antillean manatees significantly higher than in Florida manatees. Moreover, skin temperatures of manatees captured in Southern Lagoon were significantly higher as compared to manatees captured in Placencia, south of Southern Lagoon. Interestingly, both Antillean and Florida manatees exhibited very similar temperature distribution patterns on the skin. However, while in the Florida manatees, skin temperature differed by less than 1°C between measuring spots, temperature range in Antillean manatees was with 2.5°C significantly higher. Skin temperature in mammals can serve an indicator for heat exchange with the environment. In Florida manatees, uncontrolled heat loss at low water temperatures in winter, apparent in skin temperatures higher than ambient water temperature, may cause severe health issues, encompassed by the "manatee cold stress syndrome". By contrast, the warm Belizean waters suggest that heat stress may be a more likely risk for manatees, in which case heat dissipation were favorable.

Behavior related vocalizations of the Florida manatee (*Trichechus manatus latirostris)*

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Manatees produce five broadly defined call types (squeaks, squeals, high squeaks, chirps, squeak-squeals) (paper in review) but their function in social and nonsocial settings is unclear. In this study, multiple hydrophones were used to record manatee vocalizations in four different environments and broad behavioral states. Vocalizations recorded from resting, cavorting, stressed and feeding animals were subjected to mixed linear effects models to test whether vocalizations produced varied with behavior and group composition. Measures of duration, entropy, and frequency modulation were extracted from vocalizations to investigate if structural parameters differ between behaviors. Results demonstrate that manatee vocalization usage and structure varies with calf presence and behavior. An increase in use of the hill- shaped high squeak was correlated with calf presence. Noisy, high entropy squeals were proportionally higher during cavorting suggesting they may be related to a heightened state of arousal. Squeaks were the dominant call type produced amongst all behavioral states and were longer in duration and higher in frequency modulation when animals were stressed. Chirps and squeak-squeals were not frequently observed within behavioral states. This analysis indicates that manatees primarily vocalize using three call types and alter structural parameters depending on behavioral state. This research provides a foundation for comparative studies on behavior related vocalizations for the Florida manatee as well as the Antillean manatee

Impact of the spread of *Salvinia molesta* on the observation frequency of African manatee (*Trichechus senegalensis*) in Lake Ossa Wildlife Reserve, Cameroon

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The Lake Ossa Wildlife Reserve (LOWR) is the site where the African manatee (*Trichechus senegalensis*) has been most observed in Cameroon for a decade, according to a survey conducted by the African Marine Mammal Conservation Organization (AMMCO) Fishermen's Network. Poaching and by-catch are the main threats recorded in this area, which could contribute to reducing the manatee population. Therefore, a manatee monitoring system was established in Lake Ossa by AMMCO, to measure the status and evolution of the manatee population in the LOWR and to detect the threats they may face. One of such threat recently identified is the invasive plant *salvinia molesta*. The aim of this study was to determine the impact of the spread of *salvinia* on the observation frequency of *T.senegalensis* in LOWR. Boat surveys in the LOWR was conducted to quantify the presence and distribution of *T.senegalensis*, through a system, integrating the biological parameters (faeces and manatee observation). Data were collected using boat-based point scanning methods, where five sites were monitored four times a month. The monitoring period was divided in two: 1) pre-salvinia proliferation period, between January 2015 and October 2017, and 2) during-Salvinia proliferation period between November 2017 and August 2019. The Student t-test was used to compare the mean frequency between periods. Thus, in 24 months of period 1 (n=667 scans), the mean monthly observation frequency was significantly ($P<0.0001$) higher (17.3±12.2) compared to the mean monthly observation frequency of 4.6±5.5 for period 2 with 21 months (n=349 scans). The results of this survey suggest that the proliferation of *salvinia molesta* severely impacts the population of manatees in lake Ossa. Implementing mitigation strategies to stop the proliferation of the plant is imperative to preserve the lake and its manatee population.

Is natural selection shaping Florida manatees? An investigation into the body shapes between the subspecies of the West Indian manatee

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The West Indian manatee (*Trichechus manatus*) is currently divided into two subspecies: the Antillean (*T. m. manatus)* and Florida manatee (*T. m. latirostris)*. Florida manatees are found at the northern extreme of the species range, primarily inhabiting the waters around the Florida peninsula, while the Antillean manatee inhabits the remaining range from the Caribbean islands to eastern Brazil. Only in the range of the Florida manatee does water temperature drop below 20ºC during the winter, and these manatees have to seek warm water refuge for thermal regulation. Allen's rule predicts that in colder climates animals will adapt to have smaller surface area to volume ratios (SA:V). It has been reported that on average, Florida manatees are larger in absolute body size than Antillean manatees. However, no one has explored differences in body shape independent of size between the two subspecies. This study proposes that Florida manatees have stockier body shapes (smaller SA:V) compared to Antillean manatees due to the selective pressure of the colder water. Data on Florida manatee morphometrics (n=543) were obtained from the Florida Fish and Wildlife Commission, while Antillean measurements (n=90) came from live captures in Quintana Roo and Tabasco, Mexico. SA:V was calculated by creating a geometric model of manatee shape using standard morphometric measurements. An ANCOVA on SA:V controlling for total length indicated that the SA:V of Florida manatees was significantly smaller ($p=0.004$). It appears natural selection has not only increased the total body size of Florida manatees, but also altered the body shape in relation to

Antillean manatees. Our results lend further support for Allen's rule and indicate that Florida and Antillean manatees are diverging on separate adaptive trajectories.

Advancements and investigations into the health of the Florida manatee (*Trichechus manatus latirostris*)

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Rehabilitation of the Florida manatee (*Trichechus manatus latirostri)* allows for opportunistic investigations into the health and physiology of Florida manatees and can likely be extrapolated to all Sirenia. Establishing coagulation references and use of thromboelastography provided solid evidence of hypercoagulation in manatees. Manatees with brevetoxicosis have been found to have elevated eosinophil levels. Atropine use, as done for horses with organophosphate toxicity, has been found to reduce the recovery time of manatees affected. Standardized echo cardiology exam are now utilized in wild and rehabilitated manatees. Review of mortalities in long term captive female manatees demonstrated fibroids and granulosa cell tumors. Symmetric dimethylarginine (SDMA) is a valuable indicator for early renal insufficiency in domestic animals and is now established in manatees. Review of known pregnancy in manatees has shown prolactin to have potential as a single sample pregnancy diagnostic modality in manatees. Tulathryomycin (Draxxin™), a macrolide antibiotic, has beneficial properties and has been utilized in manatees for several years. Opportunistically timed blood samples are providing the first pharmacokinetic data on any Sirenia species. A diet high in energy and digestibility is idea for critical care but prolonged use may have unwanted consequences including metabolic syndrome and diabetes. Fructosamine levels in wild manatees are similar to horses and cattle. Clinical diabetes has been diagnoses in rehabilitated manatees. Permanent captive manatees are at high risk and have developed complications of diabetes. Nebulization of young manatees has proven to be a useful modality to manage pneumonia but has led to other insights about manatee thermoregulation via the respiratory tract. Clinical response to hypothermia with the provision of warm air is leading to investigations of providing passively warmed air as a warm air refuge for manatees during Florida winters.

Linking use of ship channels by West Indian manatees (*Trichechus manatus*) to seasonal migration and habitat use

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Most research on marine mammal occurrence in ship channels focuses on large cetaceans in offshore shipping routes, while nearshore research largely addresses small vessel strikes. Marine mammals, such as the West Indian manatee, that reside in or migrate through nearshore areas, have potential to travel through a wide range of channel types, encountering a greater diversity of vessels than previously recognized. Understanding how and when manatees use shipping channels can help evaluate risk associated with channel use, especially as manatees increasingly occupy habitats outside of their traditional Florida range. We tested the extent and conditions of ship channel use by manatees along the north-central Gulf of Mexico (nGOM) coast by combining data from satellite-tagged individuals, opportunistic citizen-sourced sightings, and environmental attributes linked to manatee movements. Manatees used both nearshore ship channels (130 and 300m wide) and open water fairways but

used nearshore channels more frequently, consistent with known habitat requirements. Satellite-tagged individuals swam faster and moved more directly in all channel types, indicating use of these channels as migratory and travel corridors. Accordingly, generalized additive models revealed that manatees used channels most often during spring/early summer and fall and at temperatures coincidental with timing of typical, regional entry and exit migration. Manatees also occurred in ship channels when freshwater discharges were lower, likely because timing of peak manatee occurrence in the nGOM coincides with seasonally lower discharge. Expanded shipping activity world-wide is likely to increase interactions between marine mammals and a variety of vessel types, and these effects may be particularly impactful to migratory animals like manatees that use nearshore habitats at the interface of recreational boating and commercial shipping. By predictably linking ship channel use to migration and habitat use, our approach can aid in risk-assessment for vessel collision and other shipping related activities for migratory marine species globally.

THE NINTH INTERNATIONAL SIRENIAN SYMPOSIUM
DISCUSSION PANEL PARTICIPANTS

Nataly Castelblanco-Martínez

Dr. Castelblanco is a Colombian biologist who has dedicated 20 years of her life to manatee research in several Latin American countries, and tutored dozens of students from developing nations. The main objective of her research work is to contribute to develop strategies that have an impact on manatee conservation in Latin America, through science, education and community involvement. Currently, she is based in the Mexican Caribbean conducting a long-term monitoring program of marine mammals.

Lucy Keith-Diagne

Dr. Lucy Keith-Diagne is the Director of the African Aquatic Conservation Fund based in Senegal, West Africa. She has spent the past 30 years conducting field research with marine mammals around the world, including 21 years working with West Indian and African manatees. Lucy's work aims to raise awareness and reduce threats for the African manatee in its 21 range countries, to define populations across the species range, and to reduce the impacts of bycatch for all African marine mammals. She has also trained over 90 African biologists and works collaboratively with governments, universities, and other NGOs for protection and increased knowledge of African manatees and cetaceans.

Christophe Cleguer

Chris is a Postdoctoral research fellow at Murdoch University in Perth, Australia and Technical Advisor to the Dugong MoU Secretariat. Chris conducts innovative science using cutting edge technology such as drones, Artificial Intelligence, animal borne telemetry to study the abundance, distribution, habitat use and movements of dugongs. Chris's work focuses on developing methods that can inform conservation and management issues at scales relevant to local communities. Chris has an extensive experience in collaborating with end-user groups in several cross-cultural situations.

Miriam Marmontel

Dr. Miriam Marmontel received her Master's degree on manatee reproductive anatomy and her PhD doctorate on aging manatees from the University of Florida. Miriam is an active researcher conducting Amazonian manatee studies in the Research Group on Ecology and Conservation of Felids in Amazonia, Mamirauá Institute for Sustainable Development in Tefé. Miriam has many peer reviewed publications

and remains very active in promoting manatee awareness and education in remote areas of Brazil. Dr. Marmontel serves as the Editor-in-Chief for the Latin American Journal of Aquatic Mammals.

Donna Kwan

Dr. Donna Kwan is the Programme Manager – Dugongs, CMS Dugong MoU Secretariat.
Donna heads the CMS Dugong MoU Secretariat based in Abu Dhabi which services over 40 dugong range states across the Indo-Pacific ocean basin. Donna holds a PhD in dugong biology and conservation from James Cook University, Townsville, Australia.

Reynante Ramilo

Reynanate "Rey" Ramilo has a Masters Degree in Tropical Marine Ecosystem Management, with a background in Forestry, Fisheries and Entrepreneurial Management. He has 20 years of experience working with NGO's which promote environmental conservation and protection in the Philippines. Rey is a National Geographic Explorer doing research on dugong distribution and population in Busuanga, Palawan using drone technology. For the past 5 years being the Programme Coordinator of C3Philippines working on a holistic approach to sustainable management of natural ecosystems.

POSTER PRESENTATIONS

(in alphabetical order)

Creation of a community stranding network as a tool for the conservation of the Antillean manatee in the Magdalena River Basin, Colombia

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The events involving the strandings of manatees *Trichechus manatus manatus* in the swamps and rivers of the Magdalena Basin during the low season are becoming more and more frequent. These strandings appear to be related to the increasing sedimentation of the rivers, which causes loss of connectivity between the main rivers and marshes, and may have important implications on seasonal migrations of the species. Some of the manatees are alive and may be stranded, entangled, wounded or orphaned calves requiring assistance. The areas where those events occur normally are far from cities and unreachable in a short time by specialists. Therefore, the first aid to manatees in a contingence situation is critical to guarantee their survival. Necropsies of dead manatees also can bring important information on the cause of death, distribution, and other biological issues. However, the local fishermen most of the times do not have the knowledge to assist these events. As a management measure for the conservation and monitoring of the species in this region, we started a cooperation in order to build and reinforce local capacities in this regard. We conducted two workshops in the municipalities of Magangué and Yondo, Lower and Middle Magdalena River respectively during 2019. The workshops targeted at fishermen in the areas of interest and aimed to educate the local residents in the actions that should be taken when they face a manatee stranding event, including knowing how to distinguish an emergency or if it is only necessary to monitor individuals to prevent stranding and death. In total, we reached a public of 23 fishermen, inhabiting the localities of Magangué, Yondó 27. The processes of awareness and environmental education in order to preserve manatees have been conducted for many years in this area, and the conformation of Stranding Networks is a natural and further step in the toolbox of strategies to protect the species. Local fishermen show a genuine interest and motivation to participate in this network but demanded more involvement from the government.

Digestive efficiency of manatees in Quintana Roo, Mexico

Katerin Arévalo-González[1,2,3], Nataly Castelblanco-Martínez[3,4], Arturo Serrano[2], Alberto Pereira-Corona[5]

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The digestive efficiency (DE) of manatees is little known, especially for the subspecies *T.m.manatus*. This study evaluated this physiological parameter in captive manatees in two different facilities, and wild manatees in the Mexican Caribbean in different environments (freshwater, estuarine and marine). Manganese concentration was used as a non-digestible marker, determined by flame spectroscopy, in manatee food and feces. Under human care, the diet was known and constant during the months prior to the study, but the diet in the wild was estimated according to the ecosystem where the feces were found. In captivity the ED was 77.38% ± 9.95, showing significant differences according to the age class ($t = 2.51$, $p = 0.029$) and the facility (Mann-Whitney, $p = 0.012$), suggesting that the variation lies on the diet composition. In free-living manatees, greater digestive efficiency was determined for those that feed on marine plants (between 25.52% and 90.73%) compared to those who have a diet of freshwater plants (between 21.50% and 27.71%). The use of plants with high protein content, such as spinach and broccoli, as well as wild plants such as seagrasses and algae, is recommended.

Trends of the Florida manatee (*Trichechus manatus latirostris*) rehabilitation admissions 1991-2017

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A retrospective study of admission data of 401 West Indian manatees (*Trichechus manatus latirostris)* presented to the David A. Straz Jr. Manatee Critical Care Center at Zoo Tampa for rehabilitation was conducted from August 1991 through October 2017. Causes of admittance, location of rescue, gender, and age class were all recorded for each manatee admitted. Admittance categories as defined by the Florida Fish and Wildlife Conservation Commission (FWC) included watercraft collisions, natural causes, entanglement, entrapment, orphaned calves, captive born, mothers of rescued calves, calves of rescued mothers, human, and other. The admitted population was primarily from the southwest and northwest coasts and related waterways of Florida. The gender difference was relatively equivocal (54% female) while the adults comprised 79% of the admissions. The overall total admissions increased steadily over the study period as did the admissions for each individual categories of admission. Watercraft collisions and natural causes combined were 71% of all admissions for the entire study period and are the dominant causes of admission. Watercraft collisions are more likely to occur during May through October, whereas natural causes of admittance are more likely to occur between December and March. Rehabilitated manatees may reduce overall manatee mortality and can provide insight into population-based health concerns if evaluated appropriately. Future efforts can incorporate physical examination findings, hematology, biochemistry profiles, and ancillary diagnostic testing to continue to improve the individual welfare of this marine mammal in its natural range. Admissions data could also potentially serve the wider conservation and recovery efforts if it is proven that the data obtained is at least as informative as that obtained by the carcass salvage program. Limited conservation resources could then be re-directed as new challenges arise with the expanding population and potentially expanding range of this species.

Using an Unmanned Aerial System (UAS) to monitor abundance and distribution of Florida manatees (*Trichechus manatus latirostris*) at warmwater aggregation sites

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We modeled UAS collected data (four winter surveys, 2017-2019) to help us determine the impact of the Comprehensive Everglades Restoration Plan's Picayune Strand Restoration Project on Florida manatee (*Trichechus manatus latirostris*) use of warm-water sites in Southwest Florida. Information from this study will serve as a baseline for manatee distribution and abundance before changes to these sites occur. Our UAS was programmed to hover for 10 minutes and record 4K video over several aggregation sites in Collier County, FL. The video clips were reviewed using an open source video analysis software and a recapture history was created for each by identifying individuals that were available each minute of film for 10- and 6-minute intervals. We used a closed capture-mark-recapture model (implemented with a Bayesian approach) to estimate the number of manatees in each location and visit while accounting for imperfect detection (animals missed by observers)—an important problem when enumerating animal species. Average mean estimates of the probability of detection for 1-minute occasions varied by occasion, year and location but were the same for both 6- and 10-min intervals ranging from 0.29–0.54. Mean detection at the site level was high ranging from 0.69–1.00 for 10 mins. and 0.62–1.00 for 6 mins. Abundance at each site varied by survey, location and year. Abundance estimates were similar between surveys but had slightly higher SDs for 6-min. intervals. The highest cumulative count of manatees over 6 mins. occurred in 2018, the year with the coldest weather (range N =113 (CI:110-118); 2017) to 158 (CI:141-190; 2018)). Reliable baseline estimates of abundance and distribution will help us document impacts of restoration and assess the viability of manmade mitigation measures to help manatees avoid cold related injury or death at these sites in winter.

Effects of cold on skin temperature in Florida manatees (*Trichechus manatus latirostris*)

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Cold stress is one of the major threats to Florida manatees. Every year Cold Stress Syndrome (CSS) affects and kills Florida manatees during prolonged or intense cold weather periods. In contrast to other marine mammals, manatees lack essential thermoregulatory anatomical and physiological adaptations: sparse thermal insulation, the lack of arteriovenous anastomoses in the skin, and limited capabilities for shivering/non-shivering thermogenesis are only a few of the causes for sensitivity to cold. So far, CSS has been associated mainly with exposure to water temperatures below approximately 20°C. However, the impact of low air temperatures on manatee physiology and manifestation of cold stress is not known. In a long term study we have been investigating the impact of air temperature on skin temperature in two adult male Florida manatees, held in an outdoor sea water tank at constant water temperature. For 2.5 years and under varying environmental conditions we have been collecting skin temperature measurements at 25 spots distributed across the entire body surface. Measured skin temperatures in the smaller, more active individual have been consistently higher than those in the larger less active manatee. Within individuals, average temperature varied by less than 1°C between measuring spots. Interestingly, the temperature distribution pattern between measuring points has been

congruent in both individuals. This congruent and consistent temperature pattern is another indicator for manatees' lack of control of peripheral heat loss, causing their low tolerance of cold. The pattern may reflect underlying anatomical conditions, such as distribution, number and size of blood vessels, and distribution of blubber composition and thickness, requiring further investigation.
Our measured values indicate an impact of air temperature on skin temperature in both manatees. However, more cold air data are necessary for a sound conclusion, which we anticipate to obtain during the coming winter.

The unknown but apparently critical situation of manatees in Complejo Lagunar Ciénaga Grande de Santa Marta (Colombia)

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The local communities have historically created close relationships with their natural environment. It has been reflected in a set of knowledge, practices, rules, and beliefs associated with natural resources accumulated across the time; known as 'local ecological knowledge' (LEK). In a context of development and demographic growing, local communities have transformed the way they are related to their environment. In some regions of Colombia, such as Complejo Lagunar Ciénaga Grande de Santa Marta (CLCGSM), the impact of those changes on the endangered Caribbean manatee is still unknown. Likewise, it is a priority to understand the implications of environmental transformation on this species, as well as to assess the linkages between local communities and the manatee in terms of LEK. This research was conducted in September 2019; we applied 30 interviews to local men inhabiting in the localities of Nueva Venecia, Buenavista, and Tasajera villages in CLCGSM. Additionally, we carried on a participative workshop with community leaders of Nueva Venecia. According to our results, manatees in the region have been historically threatened by humans due to hunting for meat consumption, leather goods, medicine, and entertainment. According to many interviewees, some historical milestones such as highway constructions, ENSO events, the appearance of new fishing methods, and the disappearance of traditional ones may have favored the decrease of direct pressure by hunting on the manatee. However, current habitat degradation due to crop fumigation, rivers diversions, and agricultural and livestock expansion, continue severely threatening manatee populations in CLCGSM. Here, manatees can be used like umbrella species for the conservation of this wetland, however, awareness campaigns are still necessary. Research and monitoring of the species in CLCGSM are urgently needed, in order to understand the situation of this population and to inform management decisions taken for the environmental authorities.

A history of trends, patterns, and case studies of manatee mortality in the northcentral Gulf of Mexico

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Mortality of the West Indian manatee (*Trichechus manatus*) has increased in the northern Gulf of Mexico (nGOM) in recent years, corresponding with an overall increase in reported live manatee sightings in the region. To better understand manatee mortality in the nGOM, we used data jointly collected by the Dauphin Island Sea Lab's Manatee Sighting Network and the Alabama Marine Mammal Stranding Network for manatee strandings in Alabama and Mississippi. Since 1912, 19 manatee carcasses have been reported in Alabama and 10 in Mississippi, with nearly 70% of carcasses reported during the last decade. Carcasses included 16 males, 5 females, and 8 cases

where sex could not be determined. Based on photo-identification, straight length, and histological aging data, carcasses ranged from 0 (stillborn calf) to ~40 years of age. Half of reported mortalities were attributed to cold stress associated with seasonally occurring water temperatures below 20°C. Other documented causes of death in the nGOM included the first confirmed mortality attributed to harmful algal bloom (red tide) exposure in Mississippi in 2015 and three cases of watercraft-related mortality in 2013 in Mississippi and 2015 and 2018 in Alabama. These recent mortalities highlight the diverse and possibly increasing anthropogenic and naturally occurring threats to manatees in the nGOM region. As manatee occurrence increases in the nGOM and other areas outside of Florida, mortality data can provide important ecological and life history data to inform conservation and management practices and support recovery efforts for this protected species throughout its range.

The ecosystems growing on Antillean manatees: preliminary results

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Any aquatic organism can be exposed to colonization by biofouling (e.g., the accumulation of microorganisms, macroorganisms, plants, algae, or animals on wetted surfaces). The epibiosis is considered as an ecosystem, but studies related to this issue in manatees have not been framed on the ecosystem concept. The objective of this research is to characterize the epibiosis of Antillean manatees (*Trichechus manatus manatus)*, and to establish the differences in epibiosis composition, diversity and abundance between individuals and between parts of the body. We sampled 12 manatees (males, females) of all age classes, held in facilities of Quintana Roo, Mexico. The samples were collected by scraping the manatee skin of several parts of the body including the dorsal and ventral area, and the pectoral fins; totalizing ten samples per manatee. The samples were preserved in alcohol, and brought to the Laboratory of zoology of the Instituto Tecnológico de Chetumal, and subsequently observed under an optical and stereoscopic microscope. The detected organisms were identified to the lowest possible taxa with the help of specialized literature. We identified twelve different morphological groups (Copepods, unidentified, sessilia, nematoda, polychaeta, foraminifera, ostracoda, amphipoda, Gastropoda, unidentified, prostigmata, unidentified), of which the most abundant is the group of copepods. These preliminary results suggest an inverse relationship between the abundance of copepods and macroalgae. The abundance of copepods also had a tendency to decrease in the presence of amphipods. These findings help us to elucidate the trophic and chemical relationships occurring in the micro environment of manatee skin. So far, we did not find any variation of epibionts between individuals of different age class or sex, however, further analysis are currently conducted in order to have more clarity in this regard.

African manatee (*Trichechus senegalensis*) threat assessments in Senegal

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In Senegal, the African manatee exists both along the coasts as well as inland in rivers, lakes and seasonal floodplains. Manatees were previously heavily hunted in Senegal and were believed to be almost extinct, but recent surveys have shown it to be present in all aquatic and marine systems. In 2018-2019, we conducted 167 interview surveys to identify and quantify threats with fishermen and other local people on Senegal's central coast from Mbour to Toubacouta, in 22 villages around Lake Guiers, and along the Senegal, Faleme and Gambia Rivers within Senegal. Questions 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) accidental capture in fishing nets, mortality in dam structures, entrapment behind dams, illegal poaching, and habitat loss due to human development. Results indicated that fisheries bycatch is frequent in both marine and inland waterways throughout the country, but difficult to quantify due to fishermen's fear of arrest. Two dams along the Senegal River have killed a minimum of 10 manatees since 2009, through capture in gates and entrapment during the dry season. We found only three locations where manatees are still poached in Senegal. Rainy season floodplain habitat loss along the Senegal River was quantified for the first time using Google Earth. We also documented locations of motorized boats, as they are likely an emerging threat for manatees. Results are being provided to the Senegal Water and Forestry and Fisheries Ministries as evidence for them to enforce laws to stop poaching and bycatch mortality. We are also working with the dam authorities to reduce mortality in the Senegal River. Lastly, we are raising awareness through education programs and encouraging reporting through a new hotline.

***Sirenews* – Florida manatee**
(Last page of abstracts)

RECENT GRADUATE STUDENTS
COMPLETED PROJECTS

Molecular identification of trematode parasites of West Indian manatees (*Trichechus manatus*), and their role as bio-indicators of their distribution

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Master of Science in Biology with a Specialty in Molecular Biotechnology
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Bayamón Campus
December 2018

Abstract: The sirenians are hosts of a variety of ecto- and endo-parasites, which are normally found in different species and appears to cause little or no pathogenesis. In the Greater Caribbean, manatees (*Trichechus manatus*) harbor four major metazoan endoparasites: a nematode in the stomach (*Heterocheilus tunicatus*), a nasal trematode (*Pulmonicola cochleotrema*) and five intestinal trematodes (*Nudacotyle undicola*, *Monoligerum blairi*, *Anaplocephala* sp., *Chiorchis fabaceus,* and *Chiorchis groschafti*). Parasitological studies have recommended the use of the last two mentioned intestinal parasites as bioindicators of population distribution, as has been described for other species of marine mammals. Since not all West Indian manatee populations have been studied, and some live in very different habitats (marine, estuarine, fluvial, lake), I aimed to identify at the molecular level the trematode parasites. These tremetodes, which live in their body, include a digenea trematode described from a dugong in Malaysia. Species of *Chiorchis* (*C. fabaceus* and *C. groschafti*) and *Solenorchis travassosi*, the last from the dugong, were identified at the molecular level, determining that the trematodes, *C. fabaceus* and *C. groschafti*, appear to serve as ecological bio-indicators of the distribution of the West Indian manatees, also serving as markers of their diet, either marine or freshwater plants.

Rivera Pérez, C.I. 2018. Molecular identification of trematode parasites of West Indian manatees (*Trichechus manatus*), and their role as bio-indicators of their distribution. MS Thesis, Inter American University of Puerto Rico, Bayamon Campus, Puerto Rico. 45pp.

Recent and future plans: After my master's degree I enrolled in a PhD program at Ross University.

Aspects of the feeding ecology and physiology of Antillean manatee (*Trichechus manatus manatus*)

Gloria Katerin Arévalo-González
Master of Science in Marine and Coastal Ecosystem Management
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March 2020

Abstract: Manatees (Order: Sirenia) are very important aquatic mammals for the ecosystems where they live, including river, estuaries and saline seas. Although there is information on the feeding ecophysiology of the Florida manatee (*Trichechus manatus latirostris*), little is known on this subject for the Antillean subspecies (*T. m. manatus*). This study aimed to determine the digestive efficiency in

captivity, to assess the bromatological composition of manatee diet in wildlife; and to evaluate the presence of viable seeds in feces and digestive contents of the Antillean manatee in the Mexican and Belizean Caribbean. Digestive efficiency was estimated from measurements of manganese concentration in both feces and dietary spectrophotometry, finding an average value of 77.29% for individuals in captivity. The bromatology tests for wild manatee's diet were carried out in specimens of 15 plant species, obtaining raw protein values (3.95 - 11.58%), ethereal extract (2.98 - 26.43%), total ashes (5.13 - 75.66%) and crude fiber (4.28-23.62%). Based on these values, the total digestible nutrients (22.08 - 95.59%) and digestible energy (0.97 - 4.21%) were determined. Additionally, seeds were found in 31.1% of reviewed material but they did not show viability for germination. We also found mollusks (11.11%), porifera (13.3%), single-celled algae (17.8%), plastics (6.7%), glass (2.2%) and cloth (2.2%) in fecal and digestive samples. The information gathered through this research will be useful to recommend, feeding protocols for manatees in captivity (in rehabilitation process or not); and to design proper conservation strategies of manatee's habitat and feeding resources.

Arévalo-González, G.K. 2020. Aspects of the feeding ecology and physiology of Antillean manatees (*Trichechus manatus manatus*). MS Thesis, Universidad Veracruzana, Facultad de Ciencias Biológicas y Agropecuarias, Región Poza Rica – Tuxpan,Vera Cruz, México. 102pp.

Recent and future plans: After my master's degree I returned to Colombia to continue with conservation projects on manatees and other species. I hope to continue working in this line and later complete my PhD.

Gonadal function, semen characterization, and morphometry of the spermatozoa in the Florida manatee (*Trichechus manatus latirostris*)

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December 2019

Abstract: Increases in our understanding of the reproductive physiology of the Florida manatee (*Trichechus manatus latirostris*) have not been adequately represented in the expansive growth of sirenian research. The current threats and high annual mortality faced by this species necessitate a better understanding of reproduction as it has implications for the survival and growth of the population. To address the significant gaps in knowledge, this dissertation assessed multiple reproductive parameters through three specific objectives: (1) individual, developmental, and seasonal differences in gonadal function, (2) characterization of semen characteristics, and (3) morphometric and structural analysis of spermatozoa. For objective 1, testes were collected postmortem from calves, juveniles, and adults. A proliferating cell nuclear antigen (PCNA) immunohistochemical methodology was developed to investigate gonadal function via spermatogonial proliferation. From this, seasonal breeding was further confirmed with the highest levels of gonadal function in adult males during the non-winter season. Additionally, a transitional time-period between non-winter and winter seasons was suggested to account for sexually mature males transitioning from a spermatogenically active to inactive state. For objective 2, computer-aided sperm analysis (CASA) coupled with sperm integrity and seminal characteristics were used to assess the quality of ejaculates collected from a single, captive male manatee. Ejaculates had an average sperm motility of 85% and several kinematic parameters were evaluated. Sperm integrity parameters such as DNA integrity (93%) and chromatin integrity (99%) were excellent while morphology (47%) and plasma membrane integrity (45%) were only fair. For objective

3, CASA and electron microscopy were utilized to provide accurate morphometric measurements and ultrastructural descriptions of the spermatozoon. Normal reference ranges were established for each morphometric parameter. Ultrastructural analysis showed enlargement of four outer dense fibers, a previously undescribed feature of the manatee spermatozoon. Size and volume of the midpiece showed similarities to species that exhibit multi-male mating systems, thus providing more evidence for the occurrence of sperm competition. Overall, many gaps remain in our knowledge of Florida manatee reproductive biology. Gaining a better understanding is critical for monitoring the reproductive health of the population as well as providing effective management and conservation for this protected marine mammal species.

Cowart, J.R. 2019. Gonadal function, semen characterization, and morphometry of the spermatozoa in the Florida manatee (*Trichechus manatus latirostris*). PhD Dissertation, University of Florida, Gainesville, Florida. 148pp.

Recent and future plans: Since graduating, I started as a postdoctoral research associate within the Aquatic Animal Health Program at UF's College of Veterinary Medicine where I am continuing my manatee reproduction research. Additionally, I am starting to move forward with some cetacean and river otter reproduction research. I maintain important collaborations with researchers at Hubbs-SeaWorld Research Institute, Mount Holyoke College, Texas A&M, and Florida Fish and Wildlife Conservation Commission (amongst others) and am hoping to continue to establish new research collaborations to facilitate new and innovative marine mammal research.

Genetic diversity, diet, and habitat quality of the African manatee (*Trichechus senegalensis*) in the downstream of the Sanaga River Watershed, Cameroon

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December 2019

Abstract: The African manatee is a threatened and poorly known aquatic herbivorous mammal that inhabits the coastal and inland waters of the western and central Atlantic coast of Africa. The downstream of the Sanaga River watershed (DSRW) is an essential habitat for the species in Cameroon. However, it suffers alarming threats from poaching, accidental catch in fisheries, and habitat degradation that may jeopardize their survival. This study is aimed at improving the conservation status of the African manatee in Cameroon by generating scientific knowledge for its protection.

To assess the quality of the habitat of manatees in Lake Ossa, the physical, chemical, and biological parameters of the lake were monitored and the relationship between the parameters was established to predict the submerged aquatic vegetation (SAV) surface and quantified areas with suitable depth for the species during the low-water season. Estimates indicated that almost no SAV in the lake (<5% of the lake surface) was due to low water transparency. Only 6% of the lake surface provided suitable water depth for the species during the low-water season.

To determine manatee feeding ecology in the DSRW, we surveyed the shoreline vegetation and identified plant fragments from 112 feces. We found that the shoreline vegetation was diverse (>160 plant species). A total of 36 food plants was documented. *Echinochloa pyamidalis* was the most represented species (53.5%). Location and season had a significant effect on diet composition.

To assess the reliability of African manatee fecal DNA for genetic analysis, we used noninvasive fecal samples to obtain DNA for PCR amplification and genotyping mitochondrial and microsatellite markers. For the first time, the fecal DNA of a manatee species was used to successfully identify individuals and sex with high amplification success (80%) and moderate allelic dropout (24%).

We assessed the level of diversity and connectivity of the manatee population within the DSRW using both microsatellite and mtDNA markers. Results showed high genetic diversity in the DSRW (He=0.66, Na=5) but low effective population size (Ne=45.5). Manatees in the DRSW constitute a single population, while manatee populations in Cameroon and Gabon were found to be genetically distinct ($\theta ST=0.374$, $P<0.0001$).

Takoukam Kamla, A. 2019. Genetic diversity, diet, and habitat quality of the African manatee (*Trichechus senegalensis*) in the downstream of the Sanaga River Watershed, Cameroon. PhD Dissertation, University of Florida, Gainesville, Florida. 295pp.

Recent and future plans: I am currently in Cameroon running my NGO African Marine Mammal Conservation Organization (AMMCO); with my team, we are work to address the proliferation of *Salvinia molesta* (an aquatic invasive plant species) in Lake Ossa that has been negatively impacting its African manatee population. From Cameroon, I work in collaboration with researchers from the US on a research project related to the acoustic monitoring of the African manatee. I am also working with Dr. Larkin, the educational coordinator of the aquatic animal health program at UF, to develop an online course on aquatic research and conservation in Africa. I hope to start a post-doc position focusing on the African manatee research whenever I will get the opportunity.

Population genetics and conservation of the West Indian manatee (*Trichechus manatus*) in Cuba

Anmari Alvarez Aleman
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School of Natural Resources and Environment, University of Florida
Gainesville, Florida
2019

The Antillean manatee is categorized as Endangered by the IUCN due to reduction in abundance of animals and habitat loss. Scientific-based knowledge being translated into good conservation practices exists primarily for the population in Florida, which has been important for its recovery. Conversely, other populations of the species continue to be understudied, and as consequence the criteria about their status remains inconclusive, as is the situation for Cuba. In coastal waters surrounding Cuba, manatees have been in peril for a long time, yet, the proximate causes of mortalities are not well documented or evaluated in a systematic manner and appropriate conservation-oriented management plans have not been implemented. The overall goal of my research is to address the genetic status of the West Indian manatee population in Cuba and, together with an assessment of the threats, produce a diagnosis of its

conservation status. To accomplish this, I synthesized the state of knowledge existing for manatees in Cuba, which includes historical and contemporary information. Then, I evaluated the occurrence and distribution of manatee strandings in Cuba as a proxy for current threats. Here, I reviewed reports (some historical and others consistently available since 2001) of dead, stranded, or captured manatees to assess patterns in mortality. Moreover, I conducted a large-scale genetic analysis on West Indian manatees. The focus was the Cuban manatee but, through incorporation of other regional populations, I developed a Caribbean-wide model of population phylogeographic structure, for a better understanding of Cuba's position in the regional dynamics. Some of the results obtained showed that human related mortality constitutes an important group of threats in Cuba and that these events have persisted in fishing subzones where the use of nets is widespread, despite the presence of MPAs. Moreover, evidence supports non-panmixia, with substantial east-west genetic structure in Cuba manatee population and a connection between the populations in Florida and Cuba. Finally, results revealed a putative regional connection among manatee populations through the island of Cuba, emphasizing that Cuba should be considered an important hub shaping the historic and potential future regional connectivity. Finally, with the evaluation of previous knowledge, the description and magnitude of the threats, and the characterization of the genetic status and demographic parameters, I generated a concluding chapter containing a scientific diagnosis of the conservation status of the population in Cuba and the implications of this status for conservation of this species at a regional level.

Alvarez-Aleman, A. 2019. Population genetics and conservation of the West Indian manatee (*Trichechus manatus*) in Cuba. PhD Dissertation, University of Florida, Gainesville, Florida. 200pp.

Recent and future plans: I'm the Caribbean Director of Research in the Clearwater Marine Aquarium Research Institute. My current work include design, implement, and oversee research and conservation projects oriented towards conservation of marine megafauna and their habitats in the Caribbean region.

***Sirenews* – Florida manatee**

(Last page of graduate students completed projects)

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<END OF CITATIONS>

NOTES FROM THE EDITORS: We would like to thank all of those who have contributed articles for *Sirenews*. 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 like to acknowledge Dr. Anmari Alvarez-Aleman for compiling and editing this current issue of *Sirenews*. This will be the last issue that Dr. Bob Bonde will serve as co-editor of the newsletter. Bob's role of grandparent extraordinaire, increased workload in retirement and revising his book with Dr. Roger Reep prevents him from committing as much time as he would like to editing and publishing *Sirenews* into the future. I am extremely grateful to all of the time and effort Bob has contributed as co-editor to the newsletter over the past few years. I'm pleased to report that Anmari Alvarez-Aleman has agreed to serve as the new co-editor of *Sirenews* going forward.

Bob, Anmari and I would like to wish everyone in the Sirenia research and conservation family, safe and healthy voyages through this extremely difficult time as we deal with the COVID-19 pandemic.

⇨ **COPY DEADLINE FOR NEXT ISSUE: October 1, 2020** ⇦

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