Sirenews

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IN THIS ISSUE

U.S. FISH AND WILDLIFE SERVICE RECLASSIFIES WEST INDIAN MANATEE

Below we present three articles related to the recent West Indian manatee reclassification by the U.S. Fish and Wildlife Service.

(Re-print of U.S. Fish and Wildlife Service Press Release – March 30, 2017; https://fws.gov/southeast/news/2017/03/manatee-reclassified-from-endangered-to-threatened-as-habitat-improves-and-population-expands-existing-federal-protections-remain-in-place/)

Manatee Reclassified from Endangered to Threatened as Habitat Improves and Population Expands - Existing Federal Protections Remain in Place;
Partnerships bringing giant sea cow back from brink of extinction

On the heels of Manatee Appreciation Day, the U.S. Department of the Interior announced the downlisting of the West Indian manatee from endangered to threatened. Notable increases in manatee populations and improvements in its habitat allowed the U.S. Fish and Wildlife Service (FWS) to change the species' status under the Endangered Species Act (ESA). The downlisting comes after

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diverse conservation efforts and collaborations by Florida and other manatee states, the Commonwealth of Puerto Rico, Caribbean nations, public and private organizations and citizens, there have been notable increases in manatee populations and improvements in its habitat.

"The Fish and Wildlife Service has worked hand in hand with state and local governments, businesses, industry, and countless stakeholders over many years to protect and restore a mammal that is cherished by people around the world," said U.S. Secretary of the Interior Ryan Zinke. "Without this type of collaboration and the commitment of state and local partners, this downlisting would not have been possible."

In its review, FWS considered the status of the West Indian manatee throughout its range, which includes the Florida manatee subspecies, found primarily in the southeastern United States, and the Antillean manatee, found in Puerto Rico, Mexico, Central America, northern South America and the Greater and Lesser Antilles (see range map). The downlisting means that the manatee is no longer considered in danger of extinction throughout all or a significant portion of its range, but is likely to become so in the foreseeable future without continued ESA protections.

Map of the West Indian manatee's range. Jane Cooke, USFWS.

Although the downlisting represents a milestone for the manatee, the agency underscored that important challenges still remain to ensuring the species' long-term future throughout its range. As such, FWS biologists emphasized that the downlisting will not diminish any existing federal protections that will continue to play a vital role in the recovery of the species. The manatee will also continue to be protected under the Marine Mammal Protection Act.

"While there is still more work to be done to fully recover manatee populations, particularly in the Caribbean, manatee numbers are increasing and we are actively working with partners to address threats," said Jim Kurth, the U.S. Fish and Wildlife Service's acting director. "Today we both recognize the significant progress we have made in conserving manatee populations while reaffirming our commitment to continuing this species' recovery and success throughout its range."

Today's estimated population of 6,620 Florida manatees is a dramatic turnaround from the 1970s, when just a few hundred individuals remained. Actions by the FWS, Florida Fish and Wildlife Conservation Commission (FWC), local communities, and industry on behalf of the manatee include:

- Retrofitting water control devices such as those found at locks and levees, resulting in significant decreases in manatee fatalities.
- Power companies working cooperatively with federal and state conservation managers to address future loss of warm water outflows where manatees winter.
- Florida counties implementing manatee protection plans and reducing boater impacts.
- Increasing manatee access to several Florida natural springs while establishing sanctuaries for the wintering manatees in those areas during winter cold snaps.
- FWS working with the U.S. Coast Guard and FWC to minimize manatee collisions with vessels during highspeed marine events and other activities.
- Fishing gear cleanup and recycling programs reducing the threat from fishing gear entanglements.
- Rescue, rehabilitation and release efforts that help save dozens of manatees annually.

Outside the United States, manatee population and abundance estimates are less certain. There are likely as many as 6,300 Antillean manatees spread over a much broader range, from the Mexican Gulf coast to northern Brazil and the Caribbean.

Download the final rule reclassifying the West Indian manatee from endangered to threatened (https://www.fws.gov/southeast/pdf/west-indian-manatee-reclassification-final-rule.pdf). Learn more about the Florida and Antillean subspecies on the West Indian manatee species profile (https://www.fws.gov/southeast/wildlife/mammal/manatee/). Download the Frequently Asked Questions for additional information related to the decision (https://www.fws.gov/southeast/pdf/frequently-asked-questions/manatee-reclassification-to-threatened.pdf). **Contacts:** Interior_Press@ios.doi.gov; Chuck Underwood, USFWS, chuck_underwood@fws.gov, (904) 731-3332; Phil Kloer, USFWS, philip_kloer@fws.gov, (404) 679-7299.

EPILOGUE FROM *FLORIDA MANATEES* by John E. Reynolds III

On 8 January 2016, the US Fish and Wildlife Service published a proposal indicating that the West Indian manatee (including both subspecies) had recovered sufficiently to warrant downlisting from an endangered to a threatened species under the US Endangered Species Act (ESA). This change in status would not mandate any reductions in federal protection of manatees, although state and other agencies may or may not maintain legal regulations under their jurisdictions. Practically, downlisting has the potential, under pressure from some stakeholder groups, to reduce protective measures for manatees. The Fish and Wildlife Service has therefore solicited public comments to guide its final decision.

This downlisting proposal is not unexpected, since the number of Florida manatees has grown in recent years, due to protective measures and compliance with them. Yet in the face of ongoing habitat degradation, poorly controlled threats to manatees, and even deaths from uncertain causes, an important question still exists. Does this decision reflect an adequately precautionary approach to conservation? If the human population in Florida grows by 30 percent in the next fifteen years, as expected, can consequent effects on manatee habitat and on the animals themselves be controlled and mitigated? In

addition, if protection under the ESA actually is reduced, and if the manatee population declines, current survey methods are imprecise enough for their reduced numbers not to be spotted for some time, suggesting that drops in population and species levels could go undetected and unmitigated for a considerable period.

For the Antillean subspecies, populations of manatees are either declining or of uncertain status in 84 percent of the nations in whose waters they are found, and threats to these animals are poorly controlled. In some countries, this means that there probably will be fewer than 100 manatees. Thus manatees could disappear from the majority of their Caribbean range in the not-too-distant future.

The people of Florida, in particular, deserve great credit for adjusting their behaviors in ways that have allowed that state's manatee population to rebound from decades, and even centuries, of excessive takes. The US Fish and Wildlife Service, as the responsible federal agency, has indicated that the downlisting of this species would not be accompanied by any diminution of protection for it. That is excellent news, but, as I believe and have noted in my comments to the US Fish and Wildlife Service, until this agency conducts more-complete analyses of existing data to ensure that the best-available information is used in making its final decision, and until threats to manatees are better understood and under control now and in the future, it is premature to downlist the species. An important preliminary step, in my opinion, is that before any change in status is adopted, the agencies should work with communities throughout the range of the West Indian manatee to adopt a strong conservation ethic and thus continue to ensure this species' future.

(The above excerpt is taken from FLORIDA MANATEES by John E. Reynolds III with photography by Wayne Lynch. Published by Johns Hopkins University Press © 2017. Reprinted by permission of the publisher.)

WEST INDIAN MANATEE DOWNLISTED IN FLORIDA: HOW THIS DECISION MAY AFFECT THE SPECIES ON A GLOBAL SCALE

Last month, the federal government of the United States took the decision of downlisting the West Indian manatee (*Trichechus manatus*) from 'Endangered' to 'Threatened'. This includes both subspecies inhabiting U.S. territory: the Florida manatee (*T. m. latirostris*) in Florida, and the Antillean manatee (*T. m. manatus*) in Puerto Rico. Manatee experts *outside* of the United States are very concerned about the consequences that this decision may have on the regional population of Antillean manatees.

Gross calculations estiimate 6,700 Antillean manatees ranging from Mexico to Brazil, with most countries populations estimated at below 100 individuals (Quintana-Rizzo & Reynolds, 2010); the majority of them are found in Mesoamerica and the Gulf of Mexico. In general, population size and trend estimates are unknown for most of Antillean manatees' distribution area of the Wider Caribbean (Castelblanco-Martínez et al., 2012).This subspecies is widely distributed but highly fragmented, and the lack of connectivity altogether with the low reproductive rates of the species also have important implications for the population viability. Additionally, the level of genetic diversity reported for some populations of the Antillean subspecies corresponds with levels observed in other endangered species (Hunter et al., 2010; Nourisson et al., 2011; Hunter et al., 2012). There is not sufficient data to justify the downlisting of the Antillean subspecies for the U.S. and territories.

More importantly, Antillean manatee mortality in large part is attributed to human-related causes, with some scenarios more severe (or better documented) than others. Historically, these manatees were hunted for their meat and other parts. Although poaching has been controlled in some areas, within the developing region manatees continue to be killed for food, often in poor coastal communities where

protein options might be limited. Additionally, they are at risk of death during incidental captures in fishing nets, and collisions with high-speed vessels. The loss of suitable habitat and available vegetation due to burgeoning tourism or urban development within the Wider Caribbean also impacts manatee survival. As a consequence of the number of female manatees being killed, the number of orphan calves rescued yearly is not decreasing in developing countries (Adimey et al., 2012). While local organizations make efforts to rehabilitate for potential future release, some live strandings do not survive their injuries, or they remain captive and therefore do not contribute genetically or reproductively to the wild populations.

In the majority of countries, the situation for the Antillean manatee is alarming and the particular geopolitical and economic situation of some developing nations have significant implications for manatee conservation at the local level.

In Belize, for example, the doubling of reported manatee mortality in the last five years (a total of 44 deaths in 2015 alone) and the 600% increase in live strandings requiring rehabilitation is recognized by the Belize Manatee Working Group as a critical one that needs to be effectively and urgently addressed, particularly as it relates to enforcing boat speed limitations in known manatee areas. In Mexico, the Antillean manatee has been suggested to be at the brink of extinction in the Veracruz State (Serrano et al., 2017), due to the reduced numbers of manatees surviving in the Alvarado Lagoon System and documentation that manatee populations in the north of the state have disappeared (Serrano et al., 2007).

In Cuba, manatees are already threatened by poaching activity and inappropriate fishing gear, leading to an unknown number of immature individuals found stranded every year. This situation is expected to be aggravated by the future tourism development to be implemented in the frame of Cuba-US relationships normalization. In Colombia, only 9.15% of the distribution area of the Antillean manatee falls within the Natural Protected Areas System (Castelblanco Martínez et al., 2015). This country has been immersed in an internal conflict for more than 50 years, and hundreds of hectares of primary forest have been devastated affecting the local flora and fauna. Nevertheless, the conflict itself seems to have favored the survival of some groups of Antillean manatees (Aguilar & Castelblanco-Martínez, 2014). In the face of the peace agreement, it is expected that human populations will have more access to manatee areas, and without a clear conservation strategy, their future for this population is uncertain.

The Antillean manatee in Brazil is considered the most critically endangered mammal by the Brazilian government, and the subspecies is classified as extinct in the southern portion of the range, from Sergipe to Espírito Santo states and along the Alagoas and Pernambuco state boundary (Luna et al., 2012). Strandings of dependent calves is one of the main causes of mortality in the Northeast region of Brazil, presumably because pregnant females are not gaining access to quiet and protected estuarine waters to give birth, due to critical habitat degradation (Luna et al., 2012).

The former are only examples of the Antillean manatee situation in some countries, but the scenario is likely the same for most of this subspecies' range, and includes increasing mortality, loss of habitat and local extinction of the species. Most countries have not carried out population viability models to support a decrease in threat to the subspecies, in large part because of a lack of data. As a consequence, none of the countries inhabited by Antillean manatees (except for the U.S. population in Puerto Rico) has considered changing the species' status. Conversely, most governments and environmental agencies are working towards the species recovery through management and protection strategies across the Wider Caribbean.

The downlisting of the species runs contrary to all recent information on the regional Antillean manatee populations and will likely have serious consequences on global conservation efforts to reverse

the inevitable population decline. The decision sends to the global community a wrong message of a successful recovery of the West Indian manatee species, negatively impacting the local perception of the need for critical management measures. Likewise, the possibility of accessing funding to implement the much needed research, conservation and management plans in developing countries will be compromised due to a false perception of optimism.

The authors and many other colleagues pointed out the above issues to the US government and to the public, urging them to reconsider the decision, or at least to assess the two species independently. In light of the downlisting, the response from conservationists and biologists from countries that have the Antillean subspecies' will certainly be one of increased strategic engagement and creativity to ensure that management measures, enforcement of laws, and research is conducted to save this subspecies, which remains under threat.

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HEALTHY SEAGRASS, HAPPY DUGONGS, AND THRIVIING COMMUNITIES: UPDATE ON THE DUGONG AND SEAGRASS CONSERVATION PROJECT

The Dugong and Seagrass Conservation Project is an unprecedented global movement for the conservation of dugongs and their seagrass habitats across eight countries from Africa to Asia and into the Pacific. Efforts to save dugongs and seagrass meadows in these countries include providing economic incentives to fishing communities, building national and international partnerships and ensuring local knowledge is better integrated into conservation practices. The global project, financially supported by the Global Environment Facility (GEF), implemented by the United Nations Environment Programme and executed by the Mohamed bin Zayed Species Conservation Fund, is a $6 million effort consisting of 38 projects across Indonesia, Madagascar, Malaysia, Mozambique, the Solomon Islands, Sri Lanka, Timor-Leste and Vanuatu.

The project, now in its third year of implementation, is demonstrating results. Recently, at a meeting of dugong and seagrass conservationists and policy makers in the United Arab Emirates (MOS3; more information available at http://www.cms.int/en/meeting/third-meeting-signatories-dugong-mou), the Dugong and Seagrass Conservation Project presented some of its accomplishments. Project partners from participating countries discussed their projects and presented posters (available at http://www.dugongconservation.org/news/dugong-seagrass-project-poster-presentations-mos3-032017/) which summarized their achievements. The 38 projects go beyond science and move into policy, education and creating economic incentives for local communities to protect these valuable species and habitats. It is through these local initiatives that the global Dugong and Seagrass Conservation Project is beginning to prove its success.

The Dugong and Seagrass Conservation Project boils down to two key concepts. First, seagrass meadows are crucial to the environmental quality of coastal communities. When the environment is in a good state, dugongs are present and communities benefit. Second, working with communities to protect their environment is crucial not only across the project countries, but also across the rest of Africa, Southeast Asia and into the Pacific. Coastal communities need healthy ecosystems to ensure a more prosperous and secure future. We all need to find a balance between nature and our livelihoods. This is a lesson not only for the coastal communities, but for all of us.

Here are a few highlights of the global project. For more information about the project as a whole visit, www.dugongconservation.org.

Economic Incentives for Communities in Puttlam Bay and Kalpitiya in Northwestern Sri Lanka: The Sri Lanka Turtle Conservation Project (SLTCP) is establishing economic ventures with communities in Kalpitiya, Sri Lanka. From artistic enterprises (batik, stitching, and embroidery) to making household items with local materials, and aquaculture, the local communities are seeing additional income sources beyond fishing. Each of these incentives are backed by a memorandum of understanding signed between the project partner and the local community resulting in a commitment to protecting local dugong and seagrass habitats. Community-based capacity building also facilitates the delivery of conservation, empowering communities to continue the conservation efforts after the end of the project.

Conservation Ambassadors now Monitoring Seagrass and Dugong Populations in Nosy Hara Marine Park in Northwestern Madagascar: Little is known about the seagrass and dugong populations living in a difficult to access area of Northwest Madagascar, but Community Centred Conservation (C3) is making a lot of progress after establishing a network of conservation ambassadors in this MPA. Economic incentives, social benefits, improved access to potable water and medical services and local policy implementation is also progressing to ensure the long-time protection and monitoring of populations there.

Local NGO Discovers Details of Dugong Populations in Remote Vanuatu and Works to Protect Them: The last time anyone studied dugong and seagrass systematically in Vanuatu was 1988, that is, until the Vanuatu Environmental Science Society (VESS) began working here in 2015. To date their extensive fieldwork across 28 islands has allowed more than 500 interviews to be completed. Local community leaders are demonstrating keen interest in protecting dugongs and seagrass and beginning to understand the important ecosystem services they provide.

Seagrass & Dugong Population Monitoring with Drones in Sarawak, Malaysia: The Sarawak Forestry Corporation is systematically surveying seagrass meadows and dugong populations for the first time in this part of Malaysia. The team regularly flies transects across key habitats employing a fleet of drones that includes a fixed wing plane, quadcopter and hexi-copter. The team is beginning to share their knowledge and practical lessons learned with partners and other conservation teams in the area. The same methodology is now expanding to other habitats and regions of the country and the region's capacity to conduct aerial surveys for wildlife is expanding.

Posters and additional information about each aforementioned project are available at www.dugongconservation.org.

SIRENIAN BIBLIOGRAPHY - CORRECTION

The URL provided in the October 2016 edition of *Sirenews* for the on-line *Bibliography of the Sirenia and Desmostylia* was incorrect. The correct URL for accessing the bibliography is http://67.59.130.204/biblio/. Further updates will be provided when a permanent and secure home for the database is established.

MOZAMBIQUE DUGONG MANAGEMENT PLAN AVAILABLE

An updated management plan for the dugongs of the Bazaruto Archipelago, Mozambique is now available. To request a copy of the plan, please contact Vic Cockroft (20237640@worldonline.co.za).

LOCAL NEWS

Utilization of sirenians in South America, Africa and South and Southeast Asia. Historically, sirenians have been killed for human consumption and other purposes throughout most of their distribution range. A comprehensive (yet not exhaustive) review was carried out on the use of sirenians in South America, Africa and South and Southeast Asia. Several dozen scientific papers and reports from the published and unpublished literature (in English, Spanish and French) were reviewed. A summary is shown in Table 1. Sirenians have been used in most countries, obtained both intentionally through directed hunts, as well as incidentally (e.g., bycatch). It is worth noting that while hunts occur in most countries, the value they hold varies between communities. In fact, for some communities they are considered sacred and are not harmed. No reports (recent or otherwise) were found for some countries, however, one should be cautious in concluding that sirenians are not utilized in these locations. All references found are kept in a private database and are available upon request. Additionally, the author is also developing an online database of the use of aquatic mammals highlighting the areas of greater concern that will soon be available. A preliminary version is available at: https://aquaticbushmeat. shinyapps.io/bushmeat/.

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Table 1: Utilization of sirenians throughout their distribution range, in South America, Africa, South and Southeast Asia.

MANATEES	Historical	Recent	Hunts	Uses
South America				
Bolivia	*no*	*no*		
Brazil	*yes*	*yes*	*yes*	*Food, medicine*
Colombia	*yes*	*yes*	*yes*	*Food, medicine, aphrodisiac*
Ecuador	*yes*	*yes*	*yes*	*Food*
French Guiana	*yes*	*no*	*yes*	*Food, medicine, traditional ceremonies*
Guyana	*yes*	*no*	*yes*	*Food*
Peru	*yes*	*yes*	*yes*	*Food, medicine*
Venezuela	*yes*	*no*		*Food, medicine*
Africa				
Angola	*yes*	*yes*	*yes*	*Food, traditional ceremonies, rituals*
Benin	*yes*	*yes*	*yes*	*Food, traditional ceremonies, medicine*
Cameroon	*yes*	*yes*	*yes*	*Food, medicine, cosmetic*
Chad	*yes*	*yes*	*yes*	*Food, medicine*
Republic of Congo	*yes*	*yes*		*Food, medicine*
Democratic Republic of Congo	*yes*	*no*		*Food*
Equatorial Guinea	*yes*	*no*		*Food, rituals*

MANATEES	Historical	Recent	Hunts	Uses
Gabon	*yes*	*yes*	*yes*	*Food*
Ghana	*yes*	*yes*	*yes*	*Food, rituals*
Guinea	*yes*	*yes*	*yes*	*Food, medicine, aphrodisiac*
Guinea-Bissau	*yes*	*no*	*yes*	*Food, medicine, traditional ceremonies*
Ivory coast	*yes*	*yes*	*yes*	*Food*
Liberia	*yes*	*no*	*yes*	*Food*
Mali	*yes*	*no*		*Food, medicine, traditional ceremonies, aphrodisiac*
Mauritania	*no*	*no*		
Niger	*yes*	*yes*		*Food, traditional ceremonies, medicine*
Nigeria	*yes*	*yes*	*yes*	*Food, medicine, aphrodisiac*
Senegal	*yes*	*no*	*yes*	*Food, medicine*
Sierra Leone	*yes*	*no*	*yes*	*Food*
The Gambia	*yes*	*no*	*yes*	*Food, medicine*
Togo	*yes*	*no*	*yes*	*Food, traditional ceremonies, medicine*
DUGONGS				
South Asia				
Bangladesh	*no*	*no*		
India	*yes*	*no*	*yes*	*Food*
Maldives	*no*	*no*		
Nepal	*no*	*no*		
Pakistan	*no*	*no*		
Sri Lanka	*yes*	*yes*	*yes*	*Food*
Southeast Asia				
Brunei	*no*	*no*		
Cambodia	*no*	*no*	*no*	*Food, medicine,*
Christmas Island	*no*	*no*		
East Timor	*no*	*no*		
Indonesia	*no*	*no*		
Laos	*no*	*no*		
Malaysia	*yes*	*yes*	*yes*	*Food, medicine*
Myanmar (Burma)	*yes*	*yes*	*yes*	*Food, medicine*
Philippines	*no*	*no*		
Singapore	*no*	*no*		
Thailand	*yes*	*no*	*no*	*Food, medicine*
Vietnam	*yes*	*no*		

BRAZIL

On the potential use of the Amazonian manatee for pisciculture: lessons from an old book.

Amazonian manatees (*Trichechus inunguis*) were once widely hunted for their skin, meat and blubber (Domning 1982). In remote areas of the Brazilian Amazon, it is estimated that approximately 140,000 manatees were killed between 1935 and 1954, not counting subsistence hunting (Best 1983, Rosas and Pimentel 2001), which persists in modern times (Marmontel et al. 2016).

To understand such prominent levels of manatee hunting, it is indispensable to look back at their importance and employment. The book by Amando Mendes entitled "As Pescarias Amazônicas e a Piscicultura no Brasil (Notas e Sugestões)", published in 1938 by Livraria Editora Record (São Paulo), gives us a glimpse into their past and proposed use in "modern" times. This book is a very early publication on pisciculture in Brazil, issued by a program supported by the Federal Government. The author lists all commercial fish of the Amazon basin with potential to be used in fish farming. The

Amazonian manatee appears among them, including the well-known pirarucu (*Arapaima gigas*). For this reason, just after page 30, one picture of pirarucu fishing in a lake in the Amazon documents this hunting pressure. Several manatees can be seen in the picture, laying backwards near a huge pirarucu (Figure 1). The chapter on the manatee ("O Peixe-boi", pgs 47-53), is rich describing their utility for several purposes and how the country could benefit from industrial activity to produce leather products on a large scale. Mendes describes the appearance of industrial plants in São Paulo that improved their ability to work on manatee leather.

More intriguing, but even more curious, are his final words suggesting the potential for Amazonian manatee farming in man-made reservoirs in São Paulo. If the fishery succeeded, the author states that it will produce wealth and provide tasty meat, leather and other products such as glue and lard for industrial use. Apparently, this proposal was never launched, as there is no information that manatees were ever translocated to these reservoirs. Furthermore, A. Mendes' book is clear in denoting the Amazonian manatee as a "fish resource" ready to be purposely or opportunistically harvested. The rare old pictures of their capture in Amazonian lakes usually point out the pirarucu or other fish harpooned. If they were not the target, but were so abundant that they could not be disregarded, will remain an open question. It leaves us with a lesson to be learned from the not so distant past, when animals were considered to be solely for human welfare and nothing more. -**Salvatore Siciliano (Instituto Oswaldo Cruz/Fiocruz, Rio de Janeiro, RJ, Brazil).**

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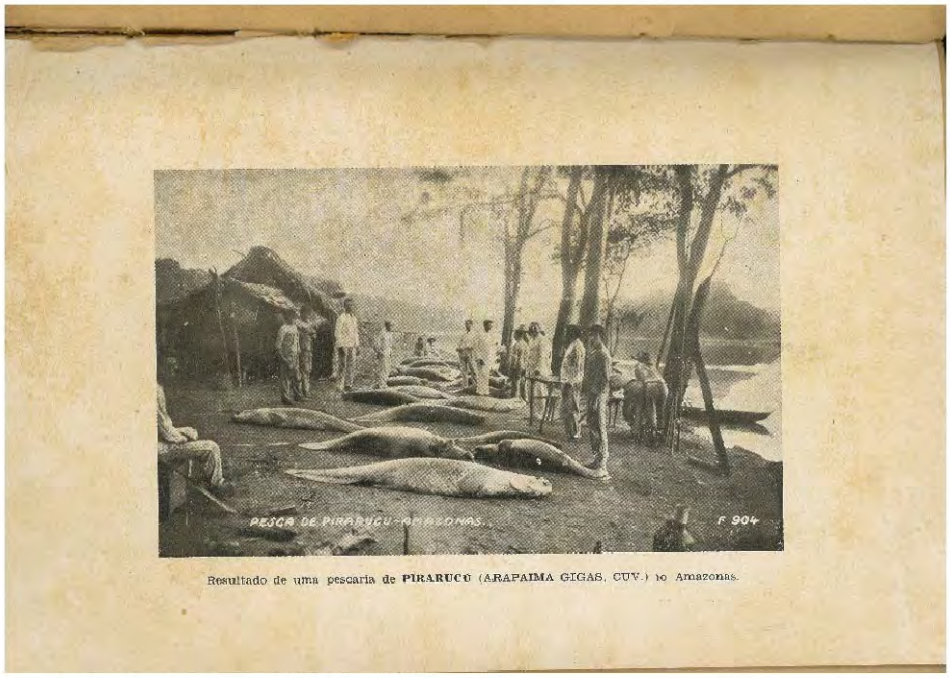
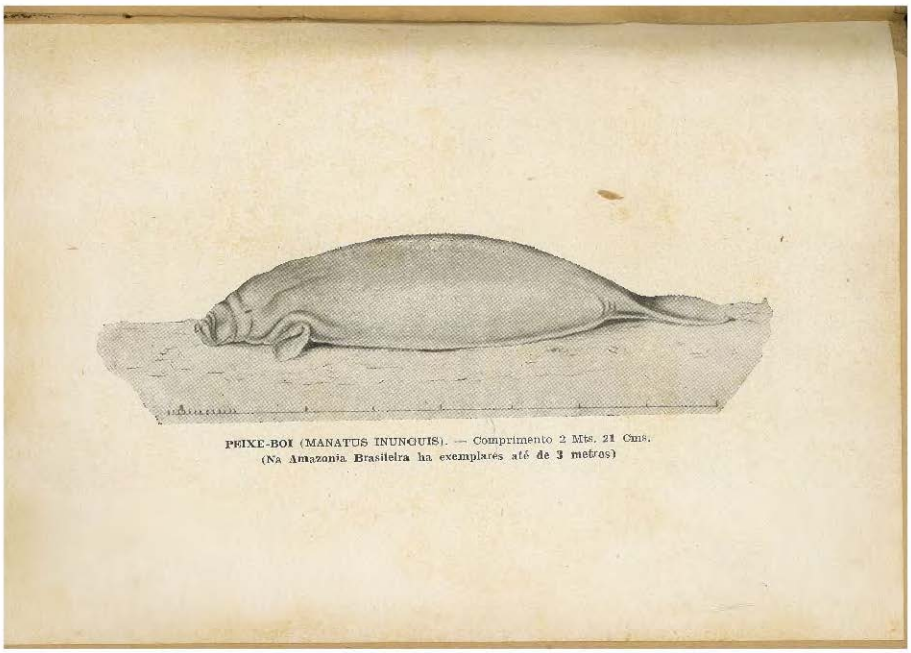


Resultado de uma pescaria de **PIRARUCÚ** (ARAPAIMA GIGAS, CUV.) no Amazonas.

Figure 1. Pirarucu fishing in a lake in the Amazon, Brazil. Several manatees can be seen on the picture, laying backwards of a huge pirarucu. Credit to A. Mendes (As Pescarias Amazônicas e a Piscicultura no Brasil: Notas e Sugestões).



PEIXE-BOI (MANATUS INUNGUIS). — Comprimento 2 Mts. 21 Cms.
(Na Amazonia Brasileira ha exemplares até de 3 metros)

Figure 2. A picture of an Amazonian manatee opening the chapter of the Amando Mendes book describing its use, wide utility and potential for pisciculture in Brazil. Credit to A. Mendes (As Pescarias Amazônicas e a Piscicultura no Brasil: Notas e Sugestões).

MEXICO/BELIZE

Small drones: a tool to study, monitor, and manage free-ranging Antillean manatees in Belize and Mexico. Non-invasive detection and monitoring of wild sirenians is essential, both in studying their biology and in monitoring populations to support the development of effective adaptive management practices in increasingly threatened habitats. Detecting manatees and dugongs underwater in frequently turbid habitats remains a major challenge: It limits the ability to assess the effects of anthropogenic impacts both on population health and on individual manatees. Surveying populations generally requires expensive manned aerial surveys, while individual identification and health assessments require potentially invasive vessel approaches, capture, and/or tagging.

Unmanned aerial vehicles (UAVs), or drones, are revolutionizing the fields of marine mammal science and conservation. These systems are often customizable, easy to use, and relatively low cost, providing the means to collect high-resolution georeferenced aerial imagery and simultaneous onboard flight sensor data. The time-synced multi-sensor datasets produced during drone flights provide the opportunity to detect and count individual animals, to track fine-scale animal behavior and movement patterns over time, and to evaluate population health (Hodgson *et al.,* 2013; Christiansen *et al.,* 2016). Most drone research with sirenians to date has focused on using fixed-wing drones to survey Florida manatees (*Trichechus manatus latirostris*; Jones *et al.,* 2006), and more extensively, dugongs (*Dugong dugon*; Hodgson *et al.,* 2013). In recent years, the use of small rotary-winged copters has surged in a broad array of research applications in the study of cetaceans and pinnipeds (*e.g.,* Christiansen *et al.,* 2016); however, their potential for studying and monitoring sirenians has not been extensively explored.

Belize and Mexico are critical areas for the remaining populations of Antillean manatees (*T. m. manatus*) in the Caribbean, where they suffer high rates of mortality from vessel collision (Castelblanco-Martínez *et al.,* 2012). Improved low-cost methods for monitoring and designing effective protections is vital to manatees' long-term preservation in these areas, as funding limitations restrict monitoring and enforcement. Here, we briefly describe our multifaceted transnational research project applying small drones as tools to study and monitor Antillean manatees throughout Belize and Quintana Roo, Mexico. We discuss some of our early insights with regards to 1) testing methods of detection and abundance estimation, and 2) identifying individual manatees and tracking their interactions with vessels.

Study area

Our project focuses on Antillean manatee populations found along the coastal and offshore waters of the Mexican-Caribbean and Belize. The various study areas include a range of habitats and ecosystems, ranging from brackish, shallow coastal habitats (1–5 m water depth) to highly saline lagoons in an offshore atoll. We conducted more than 150 drone flights in various protected and unprotected areas throughout Quintana Roo, Mexico (Sian Ka'an Biosphere Reserve, Chetumal Bay Manatee Sanctuary, Guerrero Lagoon) and Belize (Corozal Bay Wildlife Sanctuary, Belize River mouth, the Drowned Cayes including Swallow Caye Wildlife Sanctuary, St. George's Cay, and Turneffe Atoll Marine Reserve; Figure 1).

Drone flights

From 2015–2017, we used DJI Phantom 3 and 4 quadcopters to gather high-resolution georeferenced video and still imagery of manatees and their habitats to examine the efficacy of small drones for addressing conservation-related aims. Most of our flights were conducted with the Phantom 3 in non-rainy conditions with wind speeds below 30 km for ~15 min per flight. The pilot remotely controlled the copter from a small boat or from land, using a remote and mounted tablet, at distances of up to 2.5 km. The drone was flown to an altitude of 20–200 m, and deployed either from the ground or hand-held

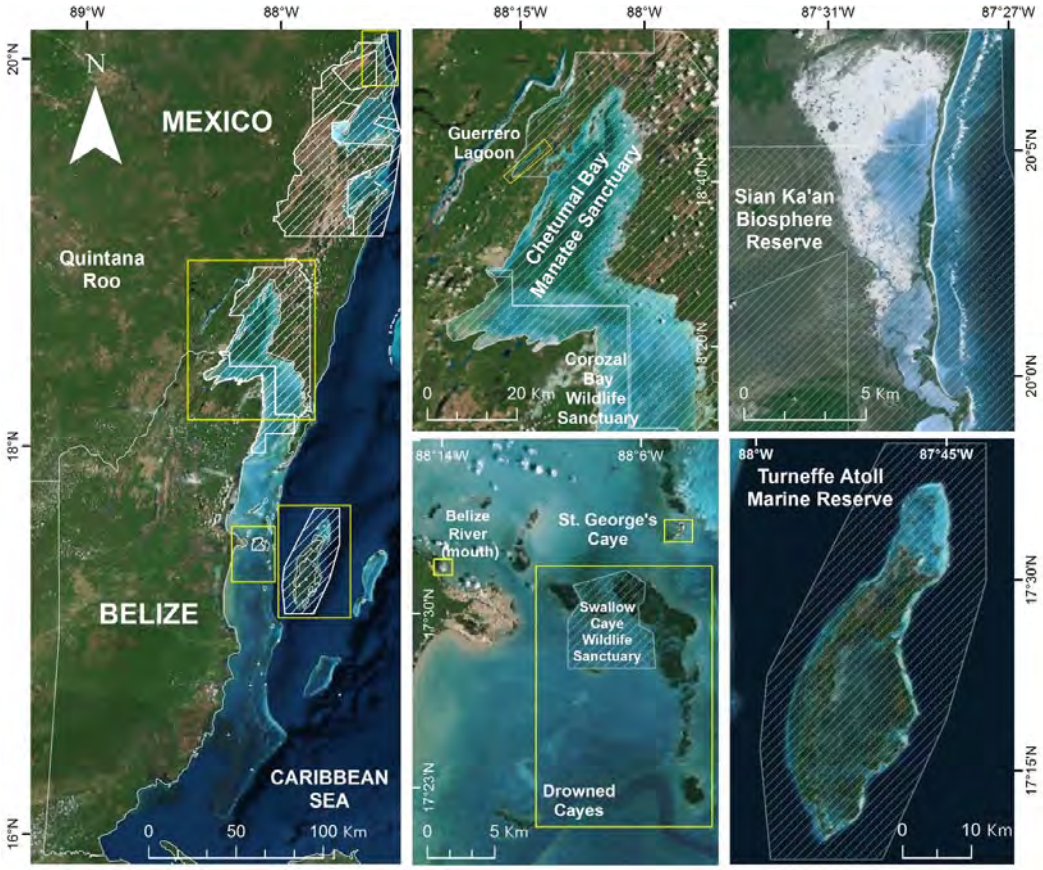


Figure 1. Map of the study region in Quintana Roo, Mexico and Belize. Yellow rectangles indicate study areas. Polygons with white lines represent protected areas.

overhead during launch. The pilot monitored the craft's status and its streaming video signal through the DJI GO iPad application. The copter is equipped with a 4K high-definition camera mounted on a gimbal with 3-axis stabilization and movement. The camera was angled downward to acquire the best view of manatees and their associated habitats. Video files were integrated with drone sensor data and analyzed using several methods according to our different aims, which are detailed below.

Testing methods of detection and abundance estimation

The needs for manatee detection vary depending on populations and habitats. In January 2017, we conducted more than 30 aerial transects of varying designs to detect and estimate manatee abundance throughout Sian Ka'an Biosphere Reserve and Chetumal Bay Manatee Sanctuary using video analysis (Figure 1). Animal detections will be used to estimate the abundance of manatee populations. These results will also be compared to datasets from aerial survey observations to examine the effectiveness of drones relative to manned aerial surveys for monitoring manatees. Our preliminary transects thus far support the potential of drones to supplement expensive manned aerial surveys for manatee population counts, providing us with numerous animal detections in areas that are large and difficult to survey.

In Corozal Bay Wildlife Sanctuary, the current monitoring program for manatees managed by the Sarteneja Alliance for Conservation and Development (SACD) involves conducting boat-based visual scans for manatees at remote resting holes. However, animal disturbance by vessels, and the great distance of these resting holes from populated areas (and the long boat trips that result), restrict effective monitoring of these critically important sites. To improve the effectiveness of regular monitoring of manatee resting holes, we used a Phantom 4 in March 2017 to image these habitats and software to

stitch images together and generate orthomosaic maps of the surrounding areas. These maps allowed us to pinpoint the exact location of each resting hole, evaluate whether manatees were present or absent, and identify dangerous illegal nets near critical manatee habitat. These methods will facilitate future boat- and drone-based monitoring in CBWS by limiting the disturbance from the research vessel and saving time during long boat trips.

Identifying individuals and tracking their interactions with vessels

Remotely identifying individual manatees and tracking their behavior requires reliably re-identifying animals using individually distinctive body scarring. Because of this need, detailed studies on the behavior of individual Antillean manatees are rare unless radio telemetry tags are attached to animals (*e.g.,* Castelblanco-Martínez *et al.,* 2013). In Belize and Mexico, our videos captured with small drones reveal powerful potential for these systems to collect high-quality behavioral data on wild manatees. Using high-resolution video frames, we identified and re-identified many individual manatees within our study area, ranging from repeated daily individual re-sights to re-identification of animals photographed over 5 years ago.

From July 11 to July 1, 2016 at St. George's Caye (SGC), we observed an adult manatee (SGC001) 16 times across 14 days. As it lacked clear fluke scars or other large identifying marks, SGC001 was only identifiable by a small cross-shaped mark on its left side (Figure 2). Its full body length was estimated to be 290 cm using methods from Flamm *et al.* (2000). On June 17, we obtained footage of SGC001 as it surfaced underneath an oncoming vessel moving at about 4 knots, and was struck by the hull. SGC001 rapidly dove away through deeper water. While the strike seemed minor and the animal appeared to behave normally in the following days, on June 24 the movements of the same vessel were observed apparently disrupting SGC001's feeding. On June 23, a new scar appeared on SGC001's back near its head: a ~1 m angular slice with a small protruding piece of skin over the wound, most likely the result of a close interaction with the propeller of an outboard engine. Over the course of the next week the wound appeared to seal and heal (Figure 2).

Figure 2. Images tracking the appearance and healing of a wound (yellow box) on an adult manatee (SGC001) at St. George's Caye in Belize. The white circles show a distinct scar.

The findings of high site fidelity of SGC001 to the leeward side of SGC, and the manatee's repeated interactions with vessels, illustrates the power of combining photo-identification methods and behavioral observations from small drones to gain novel perspectives on the individual lives of manatees. Repeated observations of this individual feeding and resting within a relatively small area (0.7 km^2) suggests that this region serves as an important core habitat or periodic stopover point. These insights into the source of physical impacts offer the potential to track fine-scale changes in health, behavior, and location of manatees pre- and post-vessel collision. Our observations suggest current regulations are minimally effective at protecting this highly-threatened species from its major man-made threat. Working with various partners in Belize (ECOMAR), we're using the data gathered during our

study to design No-Wake zones at SGC, and other marine mammal protections throughout coastal Belize and Mexico.

Conclusions

Our preliminary findings and early successes demonstrate the power of small drones to study and monitor wild Antillean manatees. Drones provide an array of benefits that strongly compliment traditional methods and aid in gathering novel data on the lives of these cryptic animals and their interactions with threats. The georeferenced imagery data generated with these systems are versatile in their future applicability to ecological and management related questions. For example, we are also planning to conduct population health assessments through photogrammetric measurement and the quantification of vessel impacts on manatees at different sites. Our work illustrates the importance of considering small drones as an integral component in the toolbox of available technologies for advancing field-based studies of free-ranging sirenian populations—particularly in developing countries when aerial surveys are often unaffordable. However, we recommend thorough investigation of the legality of drone flights, as restrictions vary regionally. We advise trialing of these systems for specific study needs, and we advocate for caution in the use of drones at low altitudes with manatees due to the possible risk of disturbance or harm caused by UAV flight. **-Eric A. Ramos[1,2,3], Nataly Castelblanco-Martínez[3,4], Sarah Landeo-Yauri[5], Carlos Alberto Niño-Torres[3,6], Marcelo O. Magnasco[7] , & Diana Reiss[1,2]** ([1]The Graduate Center, City University of New York; [2]Hunter College, CUNY; [3]Fundación Internacional para la Naturaleza y la Sostenibilidad; [4]Consejo Nacional de Ciencia y Tecnología, Universidad de Quintana Roo; [5]Universidad Nacional Autónoma de México; [6]Universidad de Quintana Roo; [7]The Rockefeller University; Email: eric.angel.ramos@gmail.com).

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Daniel, the orphaned manatee, returns to the protection offered by transboundary protected areas. In September 2003 we rescued an orphaned manatee in the Guerrero Lagoon system (GL), Chetumal Bay, Mexico. This bay is a Manatee Sanctuary (CHBMS) that shares waters with Corozal Bay Wildlife Sanctuary in Belize. We decided to rescue this small calf to provide medical attention and he was housed in ECOSUR facilities. Eight months later this orphan, named Daniel, was returned to GL and was placed in a small confinement in the lagoon where he remained for several years.

In 2008, when Daniel was five years old, we decided to give him free access to the lagoon, opening the confinement doors each afternoon. Daniel returned every morning to receive food and he stayed inside the facilities all day long. These "open doors" give Daniel the opportunity to explore the lagoon and be in contact with other free-ranging manatees that inhabit the lagoon. GL has access to the northwest side of CHBMS through a system of mangroves channels. At the end of 2015, Daniel began to stay away from the confinement facilities for longer and more frequent periods of time. He also began to refuse the food offered. The changes in Daniel's behavior prompted us to tag him with an Argos-linked GPS tag for more accurate spatial monitoring. Unfortunately when Daniel left GL in May 2016 he lost the tag, so we have limited information about his travel routes. We are able to follow Daniel via reports from local fishermen, tourists and staff of the marine reserves in Mexico and Belize. After one month, on June 12, two fly fish tourists reported his presence close to Xcalak Village on the border with Belize.

Daniel entered Belizean waters on June 18 and on June 21 he was in the vicinity of San Pedro Island (Ambergris Caye). At that point Daniel had moved more than 145 km along the coast since leaving GL. After a few days he returned to Mexican waters and on August 21, on the east side of CHBMS, we had the opportunity to re-tag him and follow his travel routes back to GL. Observing his travel route, it is clear that Daniel was never lost; he stopped at places that are often used by other wild manatees and with low human presence. At thirteen years of age, Daniel is a friendly manatee, and people informed us that Daniel accepted contact with them but after awhile he would swim away.

This first long trip by Daniel was an excellent opportunity to implement an active collaboration between the groups that work with manatees in this border area of Mexico and Belize. Also, there was a very positive response from fishermen and tourists who uploaded images and comments on the websites about Daniel. Thanks to Victor Hernandez and Heladio Juárez from the CHBMS; Joel Verde from SACD; Zoe and Paul Walker from Wildtracks; the staff of Xcalak National Park, Mexico; and Bacalar Chico and Hol-Chan Reserves, Belize. -**Benjamin Morales-Vela** (El Colegio de la Frontera Sur (ECOSUR) Av. Centenario km 5.5, C.P. 77014, Chetumal, Mexico; bmorales@ecosur.mx)

Parasites in feces of the orphan manatee Daniel. The orphan manatee named Daniel, rescued in 2003, was under human care in the Guerrero lagoon in Chetumal Bay, Mexico. During his second year of life, Daniel started consuming lettuce, several vegetables, and fruits, and this was his diet for several years. Some years later, Daniel was given free access to the lagoon daily, and during these short excursions he has the opportunity to explore and consume the aquatic vegetation available in the area. Recently Daniel moved outside of the lagoon to Chetumal Bay for several weeks.

We collected a feces sample from Daniel after this movement to evaluate the presence of heminth parasites. The analysis showed the presence of eggs of the lung trematode *Pulmonicola cochleotrema* (Travassos and Vogelsang, 1931; Batron and Blair, 2005), with low parasite intensity (≤ 10 eggs/lamella). The presence of eggs of *P. cochleotrema* in feces of free-ranging manatees in Florida is reported in Bando *et al* (2014) and in Mexico (personal observation, first author). In addition, adult helminths are commonly present in several organs of stranded manatees in Florida, Puerto Rico, the Dominican Republic and Brazil (Beck and Forrester, 1988; Mignucci-Giannoni *et al*., 1999a, 1999b; Carvalho *et al*., 2009).

The life cycle of this trematode in manatees is unknown. Manatees are likely infected by incidental ingestion of the larval trematode (metacercariae) associated with small invertebrates such as snails present in the aquatic vegetation consumed by the manatees (Raga *et al.,* 2002) or by metacercariae encysts in the aquatic vegetation. The helminths *Chiorchis groschafti* and *Heterocheilus tunicatus* were not present in Daniel's fecal sample. Both of these both helminths are common in adult

manatee carcasses from the Caribbean. The absence of these parasites could be associated with their main diet of vegetables supplied by humans. However, it also could be indicative that the lagoon ecosystem where Daniel has been for years does not have the host intermediate infected by the larval trematode.

Daniel could have more exposure to infection by helminths in the future if he continues increasing his travel distances and ingesting the aquatic vegetation present in Chetumal Bay and Caribbean waters. -**Arturo Hernández-Olascoaga** and **Benjamín Morales-Vela (**El Colegio de la Frontera Sur (ECOSUR), Av. Centenario Km. 5.5, C.P. 77014, Chetumal, México. arhernandez@ecosur.edu.mx).

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USA

Florida Springs Restoration Summit and Manatee Conservation. During September 2016, Ocala, Florida hosted the first Florida Springs Restoration Summit. The Florida Springs Council hosted the summit in conjunction with the Florida Springs Institute, Save the Manatee Club, Sea to Shore Alliance and Normandeau Associates. The aim of the summit was to bring together like-minded individuals, scientists, policy makers, advocates and citizens to discuss springs health with an aim to develop long term protection and restoration. As part of the summit a Florida Springs Restoration Action Plan was developed. The plan brought together key points and future steps for preserving springs, educating the public and motivating policy makers.

The summit included plenary sessions, keynote speakers, panel discussions and poster session. Presenters included Florida congresswoman Gwen Graham, representatives from the water management districts throughout Florida, advocacy groups, the U.S. Geological Survey, Department of Agriculture, Florida Department of Environmental Protection, Florida Fish and Wildlife Conservation Commission, Eckerd College, Stetson University, the Florida Springs Institute, the Florida Springs Council, Save the Manatee Club, media and local artists.

One poster session included a review of the importance of protecting natural warm water sites for manatee health and conservation. The reviews focus was the Florida manatee (*Trichechus manatus latirostris*), sub-species of the West Indian manatee (*Trichechus manatus).* The following is the abstract of the poster. The full, currently unpublished review paper can be requested. **-Jenny Saxby (**markjenfl@cox.net)

The importance of protecting natural warm water sites for manatee health and conservation
Jenny Saxby (U.S. Geological Survey Sirenia Project Volunteer. Student; University of Florida, Manatee Health and Conservation)

Abstract
The Florida manatee (*Trichechus manatus latirostris*) is a sub-tropical species, with Florida representing the northern limit to its winter range. With a critical lower temperature of 68ºF, and no ability for thermoregulation, during winter months the manatee must seek out warm water habitats. These consist of both natural and artificial sites (discharges from power plants). With the uncertain future of artificial warm water sites, and the better habitat provided by natural sites, the importance of natural springs is increasingly critical to manatee conservation.

Cold-stress is one of the leading, non-human, causes of mortality in Florida manatees. Juveniles are particularly at risk, not having the experience to seek out warm water sites. The maintenance of warm water sites is vital for manatee health, particularly in years of extreme cold.

The most important natural warm water sites for manatees include the springs at Crystal and Homosassa Rivers and Blue Springs. Manatee use of Blue Springs has increased 8% per year in the last 28 years. Reduction in springs flow has an effect on the ambient temperature of the water, carrying capacity and suitability of the habitat. The importance of the health of the springs, and its correlation to the health of the eco-systems it supports, should be addressed. We need a multi agency approach that protects the eco-system as a whole. Educational tools can be utilized to target people who are passionate about the springs and those passionate about other aspects of the eco-system such as the beloved manatee.

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NOTE FROM THE EDITOR: I've had the honor of editing *Sirenews* for over a decade – I can't believe it's been that long! It has been a pleasure and a privilege to work with such an amazing group of sirenian researchers, educators, managers, conservationists and enthusiasts from around the world. I've thoroughly enjoyed providing a platform to broadly share your news, research, and updates. Your continued interest and dedication is inspiring. I will be stepping down as co-editor after *Sirenews 67,* but the newsletter will remain in the capable hands of Dr. Buddy Powell. Over the next few months he will be identifying a co-editor to assist with the publication process. Please continue to enthusiastically submit your articles, references, and abstracts, and I look forward to reading your news and updates in future editions of *Sirenews*.

-Cyndi Taylor

⇨ **COPY DEADLINE FOR NEXT ISSUE: OCTOBER 1, 2017** ⇦

Material may be submitted (in Microsoft Word format, 500 word limit) to Buddy Powell at: **jpowell@sea2shore.org**

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