Sirenews

Newsletter of the IUCN Sirenia Specialist Group

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IN THIS ISSUE:

2009 INTERNATIONAL SIRENIAN CONSERVATION CONFERENCE ATLANTA, GEORGIA: MARCH 23-24, 2009

This meeting was the next progression from the First International Manatee and Dugong Research Conference held in Gainesville Florida, March 11-13, 1994. As the keynote speaker Tom O'Shea noted, "It has been a long 15 years since our first meeting and an abundance of new information on Sirenian natural history, anatomy, physiology, genetics, medicine and conservation is now available".

The idea for the conference was initiated by Dr. Greg Bossart and deftly organized by fellow colleagues from Harbor Branch Oceanographic Institute at Florida Atlantic University, Dr. Juli Goldstein and Stephen McCulloch. Together, they worked to acquire the necessary funding and target a select group of esteemed speakers (above) from around the world to make presentations at the renowned Georgia Aquarium.

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

INTERNATIONAL UNION FOR CONSERVATION OF NATURE AND NATURAL RESOURCES

Commission de la sauvegarde des especes-Species Survival Commission

SSC Species Survival Commission

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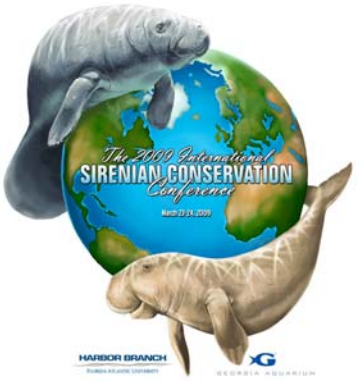
Specifically, the two-day international conference combined a variety of internationally known experts to share a broad spectrum of manatee conservation issues from a global perspective. The conference was comprised of three moderated sessions that included Current Field and Laboratory Research, Management Perspectives and Veterinary Aspects of Rehabilitation and Release. Additionally, four student travel awards were made to encourage and expose young new researchers to a wide variety of Sirenian experts.



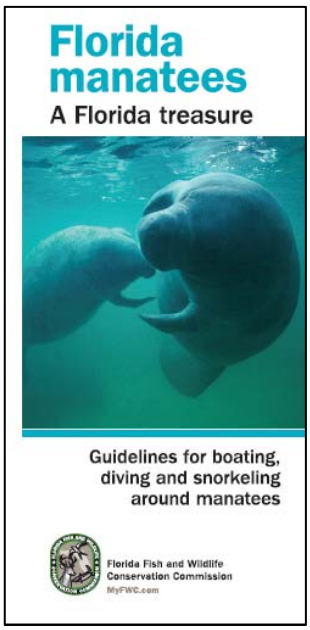
Special acknowledgements were made to the Matthews estate for providing funding assistance for this meeting, and also to the manatees and dugongs we have known over the years that have made our lives so much better.

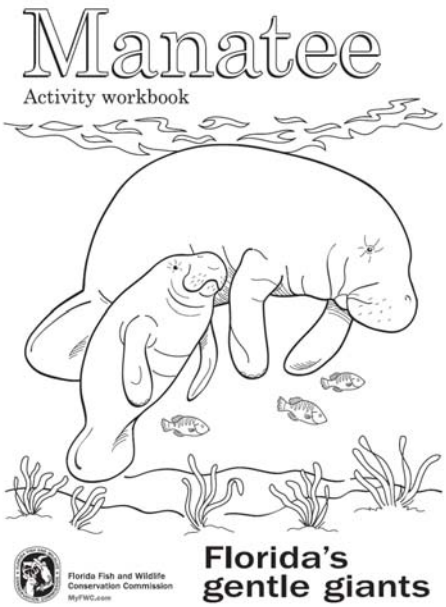
The conference organizers wish to acknowledge the Georgia Aquarium, their wonderful staff and their dedicated volunteers who helped in every aspect and made this event such a wonderful success for everyone involved. At the same time, all of the (30) speakers did a superlative job in making their respective presentations and sharing a wealth of knowledge obtained from six countries, and thereby providing all of us a truly global perspective. ***Abstracts from all presentations are published below in the *Abstracts* section.**

-Stephen McCulloch (Harbor Branch Oceanographic Institute at Florida Atlantic University, smccull5@hboi.fau.edu)

MANATEE BROCHURES AVAILABLE

The Florida Fish and Wildlife Conservation Commission would like to announce two brochures that are currently available. "Florida Manatees, A Florida Treasure: Guidelines for boating, diving and snorkeling around manatees" is available in Spanish and English versions. The "Manatee Activity Workbook" was updated in 2008, is geared towards grades 3-7, and is correlated to the Florida education Sunshine State Standards. To request copies of the brochures please write to: Florida Fish and Wildlife Conservation Commission, 620 S. Meridian Street, 6-A, Tallahassee, FL 32399-1600.





WORKSHOP ANNOUNCEMENT

The International Marine Conservation Congress, organized by the Marine Section of the Society for Conservation Biology, will be held at George Mason University in Fairfax, Virginia on May 20-24 2009. The major themes of the congress include global climate change, the land-sea interface, ecosystem-based management, and poverty and globalization. In addition, cross-cutting issues will encompass topics of global relevance and importance to marine conservation that relate to the major themes. Cross-cutting issues will include: marine protected areas; education, outreach and capacity building; governance arrangements; fisheries and aquaculture; and economics. A sirenian workshop entitled "Improving the contribution of marine protected areas to the conservation of sirenians (manatees and dugongs)" will take place in daily two hour sessions from May 21-24. For more information please go to http://www2.cedarcrest.edu/imcc/index.html or contact one of the workshop organizers (Ellen Hines, ehines@sfsu.edu; Helene Marsh, helene.marsh@jcu.edu.au; Caryn Self-Sullivan, caryns@sirenian.org; Cynthia Taylor, taylor@wildlifetrust.org).

FUNDING OPPORTUNITIES

The Mohamed Bin Zayed Species Conservation Fund was launched at the IUCN Congress in Barcelona. Although the online application process is not yet available, early applications are now being accepted by email or post for grants up to USD 5000 or up to USD 25,000. More information and the application form are available here: http://www.mbzspeciesconservation.org/grant-applictions.html. No deadlines have been posted as of yet.

The Rufford Foundation offers small grants of up to £6000 for projects in developing countries and accepts applications anytime in the year (decisions are usually made within three months). This page on their website provides directions for how to apply: http://www.ruffordsmallgrants.org/rsg/criteria.

WEST AFRICAN MANATEE CONSERVATION PROGRAMME *(Trichechus senegalensis)*

Since August 2008, Wetlands International Africa (WIA) has been implementing the second phase of the West African Manatee Conservation programme under the Regional Coastal and Marine Conservation Programme for West Africa (PRCM). This is the continuation of initiatives implemented for nearly 5 years for a better understanding of the species' values, status and interests.

The West African Manatee *Trichechus senegalensis* is a large aquatic mammal of the Sirenia order, living in coastal and inner wetlands of West Africa, between Mauritania and Angola, and inland up to Mali, Niger and Chad. It is an endangered species which is found on IUCN's red list of vulnerable animal species. The West African Manatee trade is restricted as the species is on Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and the Convention on Migratory Species (CMS).

An endangered and harmless species, the Manatee suffers from various threats and is subjected to catches in fishing nets, hunting, trade, and changes to its habitat, including mangrove destruction (for rice farming, wood, fish smoking, salt extraction and other needs), as well as development projects such as dams. Despite these threats, the West African Manatee remains the least understood Sirenian in terms of its biology (reproduction), population and distribution and also its movement (migratory paths). Luckily, initiatives for a better understanding and conservation of the species are being developed.

Between 2004 and 2007, Wetlands International obtained financial support from the Royal Netherlands Embassy in Dakar to implement the first regional project for the species' conservation in the PRCM region. The results revealed the status of the species' conservation as well as the threats to and values of the mammal. Communication tools were developed to raise maximum awareness about its vulnerability. On this basis, a Regional Strategy for West African Manatee Conservation was developed with the support of national PRCM partner institutions and other regional organizations. This work was the basis for the Memorandum of Understanding with an action plan that was developed under the auspices of the Convention on Migratory Species (CMS).

Following achievements from the first phase, Wetlands International, supported by its network of partners, is now working on second phase of the project, which will consolidate achievements and implement the regional manatee conservation strategy in the PRCM region.

The three and a half year project (2008-2011) intervenes in six countries (The Gambia, Guinea, Senegal, Guinea-Bissau, Mauritania, Sierra Leone) and will focus on I) policy measures, II) strengthening local initiatives for protection, III) extending research on the species and IV) education, raising awareness.

The various activities were developed in a participatory manner with a forum organized in December 2006 which helped to define priority interventions. A species census will provide information on their numbers. The decrease noted so far is based primarily on existing data and anecdotal evidence. Collaborations with individuals or international institutions with expertise in this field will be prioritised. –**Dr. Mamadou Niane (Project Manager, mamadou@nianefamily.com) and Momar Sow (Project Associate, momarsow2000@yahoo.fr);** Wetlands International Africa (WIA), Rue 111, Villa No 39, Zone B Dakar, Senegal, P.O. Box: 25 581 Dakar-Fann, Tél +221 33 869 16 81, Fax +221 33 825 92 12, Email wetlands@orange.sn, www.wetlands.org.

FINALIZATION OF THE NATIONAL DUGONG CONSERVATION STRATEGY AND ACTION PLAN FOR INDONESIA

Summary

The National Conservation Strategy and Action Plan for Dugongs (NDCSAP) in Indonesia was finalized as a joint Indonesian-Dutch effort after two years of preparation during a workshop in Manado (North Sulawesi) in December 2008. It has been published in April 2009 and is now available in two Parts (I and II). Part I covers the Scientific Report, covering data on the ecology and distribution of dugongs in Indonesia (and recommendations for research). Part II covers the actual strategy with a total of 10 actions covering database development, capacity building, awareness raising and education, and community based management of the remaining dugong populations. The Strategy will be launched during the World Ocean Conference in Manado from 11-15 May 2009. The main objective of this programme was to use the available scientific data on dugong distribution and ecology in Indonesia, to draft a National Dugong Conservation Strategy and Action Plan (NDCSAP) for the remaining dugong population in Indonesia. This

programme was implemented with support by the UNEP Regional Seas Programme and the Convention of Migratory Species (CMS), the Ocean Park Conservation Foundation, Hong Kong (OPCFHK), the Ecosystem Grant Programme of the Netherlands Committee for IUCN and the Regional Network for Indigenous Peoples (TMF-RNIP) as an Indonesian-Dutch collaboration.

Background and aims of the final workshop in Manado

We have already reported in SIRENEWS on the results of earlier workshops organized in Jakarta (April 2007) and in Bali (October 2008). On 3 and 4 December 2008 a meeting and Final NGO workshop on the "role of indigenous and local communities in dugong conservation and management" was organized in Manado around the framework of the National Conservation Strategy and Action Plan for the Dugong in Indonesia. During an adjacent meeting the Steering Committee approved the latest version of the National Conservation Strategy and Action Plan for Dugongs in Indonesia Part I and Part II. The overall aims of the final workshop were defined as follows:

1) Involvement of the members of the Regional Network for Indigenous Peoples (RNIP) in the completion of the National Strategy
2) To establish a national NGO network (dugong network) with NGO members active in all relevant Indonesian provinces, where dugongs occur
3) To discuss implementation of the National Conservation Strategy and Action Plan for Dugongs in Indonesia;
4) To share experiences between NGO Network members

Sub-objectives of the workshop were:

1) Developing the National Dugong Database with updates in the population size and distribution of dugongs in Indonesia
2) Identification of available seagrass habitat and associated dugong grazing swards, to estimate maximum sustained population size
3) Identifying main threats to dugong survival and defining the NDCSAP for dugong conservation and management in Indonesia
4) Reinforcing a national network of NGO's as part of the National Dugong NGO network in Indonesia

The Global Status report and Action Plans for countries and territories, published by Marsh et al. (2002) was used as a background document. Linkages have been made with other initiatives in the region, notably the Australian sponsored initiative to develop a Memorandum of Understanding under CMS on the conservation and management of dugongs and their habitats throughout their range and an associated conservation and management plan. Consistency and cross-reference with the provisions of this instrument, currently in its final stage of negotiation, will be researched to the fullest extent possible. Other National Dugong conservation strategies (e.g. Philippines) have also been considered. The dugong thereby is considered to be a flagship species for coastal conservation efforts in the region, including environmental education and increased awareness. Coastal areas throughout Asia are threatened by habitat destruction through unsustainable fishing practice (dynamiting, the use of cyanide), while inshore seagrass meadows are impacted by land based activities resulting in excessive sedimentation.

Organizational setting - Manado workshop

The Research Centre of Oceanography in Jakarta and the Institute of Environmental Sciences in Leiden have signed a Memorandum of Understanding (MOU) for the NDCSAP. Under this MOU a Joint Steering Committee was established, which has provided guidance and technical advice to the coordinators of the project. Two coordinators have been appointed to execute the project; Drs. Wawan Kiswara for the Research Centre of Oceanography and Dr. Hans de Iongh for the Institute of Environmental Sciences in Leiden. The

Director of the Research Centre of Oceanography in Jakarta (Dr Suharsono) is Chair of the Steering Committee (SC).

SC members were selected during the first months of the project, based on the expertise in a relevant field for the NDCSAP. The initial sponsors of the project (UNEP; Regional Seas programme, CMS and COBSEA) are represented in the Steering Committee. During 2007 additional funding was obtained from the IUCN Netherlands Committee Ecosystem Grand Programme (EGP) and during 2008 by the Hong Kong Ocean Park Conservation Foundation.

The consultative workshop on 4 December 2008 in Manado was an important step in the completion of the National Strategy. The following organizations (based in Indonesia) were represented in the Manado workshop: WWF-Indonesia, Conservation International, IUCN Sirenia specialist group, The Nature Conservancy, TNC CTC, Yayasan Nazareth, University of Papua, Manokwari, Udayana University Bali and the Mulawarman University, Samarinda. The following international research groups were represented: Leiden University (Netherlands), James Cook University (Australia) and the University of Malaysia, Sabah (Malaysia) and there was also a representative of the Torres Strait islanders association in Australia.

Summary of Discussions during the workshop and main conclusions

During the workshop a large number of issues and recommendations related to the NDCSAP were discussed, as summarized below:

- The MOU signed at Abu Dhabi by a large number of members of the Convention on migratory species was discussed during the workshop. All participants agreed that an appeal should be made to the Indonesian government to co-sign this MOU. This would give NGOs in Indonesia access to the 3 million USD funds made available for dugong conservation.
- The NDCSAP Part I proposes a total number of five new research programmes on different subjects, including research on transboundary populations with Malaysia, Philippines and Australia. The research on dugong seagrass interactions, as carried out so far, proved that the intertidal and subtidal monospecific seagrass meadows of *Halodule uninervis* are an important seasonal resource for dugongs in Indonesia, although they may forage on a wide range of seagrasses. The proposed NDCSAP should therefore include an inventory of intertidal meadows in Indonesia and an action plan for their protection.
- A total of 10 Action programmes are included in the NDCSAP Part II, the latter covering the further development of the National dugong database and a number of projects covering community based conservation in all regions of Indonesia, where dugongs are known to occur. International and local NGOs have been requested to actively participate in the funding and implementation of these programmes.
- Several cases of community based conservation of seagrass habitat and dugong populations were discussed. It was concluded that community based conservation should be a mainstream approach in the National Dugong Conservation Strategy in Indonesia. Also the importance of involving indigenous communities was stressed.
- The proposed NDCSAP should include a proposal for the establishment of dugong sanctuaries to be included in the marine protected area network for Indonesia to be proposed to the central and local government, covering a selected number of dugong “core areas”'.
- With respect to dugong populations, it is suggested that these had in the past significance in terms of protein production and use of other products such as oil, ivory and bones, while in the present their significance is more of a biological indicator of the quality of the environment, socio-cultural significance in terms of ancestral beliefs, and as a tourist object.

- It was concluded that dugong populations are still threatened by extinction in Indonesia. More publicity should be given to the protected status of the dugong, as provided by Government regulation (Undang No. 5 of 1990), and the importance of enforcement of this law is stressed. This aspect will be elaborated in the proposed NDCSAP.
- It was concluded that during the period of calving, neonate dugong calves often fall victim to fishermen's nets. An adaptation in fishing intensity during this critical period may reduce high mortality among neonate calves and thus reinforce dugong populations in the area. The proposed NDCSAP will include recommendations for adaptations in community based coastal fisheries practice, e.g., during periods of high *Halodule* rhizome/root biomass, in certain sanctuary zones, fishing with gillnets should be restricted.
- Staff and students of different relevant Indonesian universities and research institutes, e.g. the Mulawarman University (UNMUL), Pattimura University (UNPATTI), the Hassanudin University (UNHAS), Cendrawasih University, other universities and the National Research Institute for Oceanography (RCO) will be trained in research methodology covering dugong biology and seagrass dynamics in the project area. The proposed NDCSAP will include recommendations for continued research and data gathering by RCO, UNMUL ,UNHAS and UNPATTI.
- With respect to communication, information and awareness campaigns it is recommended that the rural target groups should be reached through an integrated communication strategy including the production and distribution of dugong posters, leaflets and t-shirts, among government offices, village leaders, schoolteachers and pupils and households in the project area. The proposed NDCSAP should therefore include the production and distribution of information material, in close cooperation with the Asian Wetland Bureau, PHPS, WWF Jakarta, Oceanarium Ancol and Seaworld in Jakarta and the Yayasan Hualopy in Ambon. **-Hans de Iongh (deiongh@cs.com), Hutomo Malikusworo, Wawan Kiswara and Marloes Moraal**

LOCAL NEWS

AUSTRALIA

Understanding the economics of traditional dugong hunting and its long-term management in the Torres Strait, Australia. The waters of Torres Strait and of the Great Barrier Reef regions in Northern Australia support the largest populations of dugongs in the world (Marsh*, et al.*, 1999). Australians regard dugongs as iconic species for the important place they have in Australia's rich and unique marine biodiversity. In the mean time, Indigenous Australians highly value dugongs for their economic, social, cultural and spiritual importance and Torres Strait Islanders are allowed under Australian law to hunt dugongs for the purpose of subsistence. Management arrangements that seek to respect all these values will need to ensure the sustainable use of dugongs in the Torres Strait waters and cannot be developed without the strong involvement of Torres Strait Islanders. Optimally, this can be achieved if policy makers are given information on the full costs and benefits (market and non-market) that influence dugong hunting in this area. The intended research seeks to gather the relevant information on all the costs and benefits associated with this traditional hunting activity. This project will not only focus on the financial costs and benefits of hunting but will consider these costs and benefits in a wider context. This can involve money, time, social benefits and/or cultural benefits that do not have a $ value but that are important and need to be recognised. The project will also look at the costs and benefits of management programs from the community's point of view. Field work is scheduled to take place throughout the next two years in partnership with 2-3 communities in the Torres Strait. Data will be collected through the

use of group exercises and semi-structured interviews so as to elicit the values associated with dugong hunting from the point of view of different segments of the communities and assess the possible consequences of different hunting management options. The results of the project could then be used to inform Australian policy makers as well as other communities that want to develop their own sustainable management arrangements.
-**Aurélie Delisle** (School of Earth & Environmental Sciences/ School of Business, James Cook University, Townsville QLD 4811 AUSTRALIA, P (07) 4781 5014, F (07) 4781 4019, aurelie.delisle@jcu.edu.au)

References

Marsh, H., C. Eros, P. Corkeron, & B. Breen. 1999. A conservation strategy for dugongs: implications of Australian research. *Marine and Freshwater Research*, 50(8): 979-90.

Research into the history of commercial dugong fishing in Queensland. Until recently, the history of commercial dugong fishing in Queensland since European settlement has received comparatively little scholarly attention. However, research has been undertaken at James Cook University, Queensland, to reconstruct the environmental history of the Great Barrier Reef and Queensland coastal waters based on extensive archival and oral history methods. Our research demonstrates that diverse dugong fishing practices occurred in coastal Queensland and that the sustained exploitation of dugongs led to observable declines in their numbers. In general, for most of the period of European settlement, commercial dugong fishing remained a small industry that operated intermittently in response to a limited market for dugong oil. Due to the low reproductive rate of the species, however, even a relatively small dugong fishery apparently caused a decline in dugong numbers and contributed to the reported scarcity of the animals. Furthermore, the commercial dugong fisheries operated with insufficient, if any, regulation and scientific monitoring – at least during their earliest periods. Thus the industry occurred on a basis that was largely unsustainable. Our evidence indicates that the commercial dugong fishery probably had a significant negative impact on dugong numbers, and a severe impact on localised dugong populations. Large harvests of the animals, especially between the 1930s and 1969, probably increased the vulnerability of dugong populations to a range of modern pressures.

Our research underlines how intensive historical commercial fisheries could be in the absence of effective regulation and of adequate marine protected areas. Since the formation of the Great Barrier Reef Marine Park (GBRMP) in 1975, scientific knowledge of dugongs has greatly improved, enabling our historical account to be placed in a broader context. Modern approaches reveal that caution is required in reconstructing the impacts of the commercial dugong fisheries because the effects of their over-exploitation may have been confounded by those of the large-scale movements of the animals. This would account for the scarcity of dugongs reported in the historical literature at some locations, in some years, and for the (biologically impossible) apparent rapid recovery of the population. In particular, fluctuations in dugong numbers observed in Moreton Bay, Queensland, may be attributed to dugongs moving in response to changes in their food supplies and exploitation.

We conclude that reconstructions of historical dugong populations based only on secondary documentary sources can be highly problematic. Whilst such estimates are valuable as triggers for conservation, they are unrealistic as targets for the recovery of vulnerable populations. Inadequate catch records mean that the accurate reconstruction of the abundance of dugongs is impossible using historical sources. Instead, historical population sizes must be estimated in the light of modern ecological knowledge of the species and its habitat. For instance, better scientific understanding of the diving behaviour of dugongs now informs more accurate aerial survey estimates of their abundance and suggests that the response of dugongs to anthropogenic and natural pressures may be complex. Further scientific research and monitoring, linked with agreed performance

indicators, is now vital for understanding local changes in the abundance of dugongs, and to underpin their conservation. Although the commercial dugong fisheries in Queensland have now ceased, other human impacts on dugongs in Queensland waters continue to require long-term, effective management to reduce the mortality of these animals and the degradation of their habitat. **-Dr. Ben Daley, Dr. Peter Griggs and Professor Helene Marsh (**James Cook University, Queensland, Australia)

SENEGAL

Senegal Manatee Rescues and Research. There are several new and exciting initiatives to report for West African manatees in Senegal. Manatees have been documented in the Senegal River at least as far back as Michel Adanson's collection of the first specimen brought to Europe in 1753. This river forms the northern boundary of Senegal with Mauritania in the north, Mali in the east and Guinea-Bissau in the south. Since the construction of the Diama Dam near the mouth in 1984, manatees behind the dam have been isolated in the river, its seasonal tributaries and Lac de Guiers. Due to the remoteness of most of the river, the muddy water quality and its huge seasonal fluctuations, little was known about manatees there until the recent (and ongoing) construction of smaller dams on seasonal tributaries of the Senegal River in eastern Senegal. In 1998, Oceanium Dakar conducted the first rescues of manatees stranded in a seasonal tributary that became cut off from the main Senegal River as the water level fell in the dry season. Since then, many small dams have been constructed on tributaries to hold water longer for crops, vital in this dry Sahel region. However, as water levels fall each year, manatees that swam into the tributaries during the rainy season became trapped, and as the numbers of dams increase, so do the number of places that manatees are trapped. In some cases the water completely dries up before the next rainy season, so manatees left there would eventually die, while in other cases enough water remains but there are no plants for them to eat as water levels fall.

Several government agencies and NGOs have begun working together to try to solve the problems imposed by the dams, while also working with the communities to ensure that manatees are taken into consideration in future construction planning. Manatee rescues (the animals are captured from the tributaries and moved back to the Senegal River) are now an annual event, and officials and tourists come from across the country to witness the translocation and to see this rare species firsthand. This past November 2008, it was once again reported that manatees were trapped in several locations in eastern Senegal, near the towns of Matam, Navel and Wendou Kanel. Two manatees were captured and released from Navel on 26 November, but 5 others remained stuck in the tributary there. This was the first time captures took place at Navel and it was decided that better organization and equipment was needed for the rest of the captures.

The next round of captures took place on 14-15 January 2009 and included several months of preparation and involvement by Senegal National Parks, Senegal Water and Forestry Direction, the fisheries department of Kanel, the regional fisheries office at Matam, SAED (regional land management agency), Oceanium Dakar, Wetlands International, CBD-Habitat, the Spanish Ministry of the Environment and Wildlife Trust. The government organizations, Wetlands International and Oceanium Dakar worked closely with the

communities, conducting outreach on the importance of the species, coordinating fishermen to conduct the captures and providing fishing nets to those who helped with the rescues. SAED provided a tractor and trailer for manatee transport to the release site. Since this was such a rare opportunity to easily capture these normally elusive animals, CBD-Habitat purchased satellite tags to track the manatees and Wildlife Trust provided expertise and training on manatee transport, health assessment, tagging and tracking to biologists from Senegal, Guinea-Bissau and Spain. Genetics samples and morphometric data were collected on all five manatees and three adults were tagged prior to release (2 males, 1 female). This is the first time satellite tracking has been used to study this species anywhere in Africa. This data will help us understand manatee migration patterns in the Senegal River for future conservation efforts there.

In southern Senegal near the mouth of the Casamance River, researchers from Oceanium Dakar have documented up to 30 manatees per day near a submarine freshwater spring. Manatees are observed from a land-based tower which reduces potential disturbance. Scar patterns have been recorded for 14 individuals so far, and daily activity logs indicate there may be some seasonal variation in use of this site. Regular documentation of individual wild manatees is impossible in most of Africa, making this site unique. Additionally, manatees with large barnacles have been photographed, indicating that these animals are spending time in a saline environment. The Casamance River borders Guinea-Bissau and manatees are known to occur both coastally there in rivers and bays, as well as around the offshore islands of the Bijagos Archipelago. Oceanium Dakar, CBD-Habitat and Wildlife Trust plan to expand research in this area to learn more about manatee movements, behavior, genetics and physiology; information which will be relevant for conservation of the species in other parts of Africa as well. -**Lucy Keith** (Wildlife Trust, keith@wildlifetrust.org), **Pablo Fernandez de Larrinoa** (CBD-Habitat, pablo.fernandezdelarrinoa@cbd-habitat.com) and **Tomas Diagne** (Oceanium Dakar, fondsdev@yahoo.fr)

The multi-national team included biologists from Senegal, Guinea-Bissau, Spain and USA (T. Diagne, Oceanium Dakar).

On their way to the release site, the manatees were transported by trailer across the top of the dam that had entrapped them (T. Diagne, Oceanium Dakar).

UNITED STATES

Living on the Edge: Manatees in Alabama Waters. The endangered West Indian manatee is a discreet but surprisingly common visitor to Mobile Bay and adjacent waters. Although manatees are generally found in Florida (FL), there has been an increase in the number of manatee sightings in recent years in coastal waters of Alabama (AL) and Mississippi (Fig. 1), an area considered to be the outer limits of manatee habitat. Despite increased sightings, little was known about where manatees go when they visit, what they do, and how long they stay.

To begin to collect these data, researchers at the Dauphin Island Sea Lab (DISL), in collaboration with Wildlife Trust in Florida, started the Mobile Manatees Sighting Network. In 2007, Mobile Manatees became the first formal network to receive and track manatee sightings in AL waters. The Mobile Manatees Sighting Network is part of a larger project led by DISL Senior Marine Scientist, Dr. Ruth H. Carmichael and funded by the AL Wildlife and Freshwater Fisheries Division (AWFF) under traditional Section 6 funding through the U.S. Fish and Wildlife Service and by the Mobile Bay National Estuary Program.

The project is focused on defining where manatees live and what they eat in local waters and sharing these data with other researchers, managers, and the public. These data are useful immediately is to inform local stakeholders about when and where to expect to find manatees. Since boat strikes are the primary human-related cause of death among manatees in the U. S., this knowledge should help reduce the likelihood of negative interactions and allow manatees and people to more safely share local waters. Manatees in AL and other adjacent waters also are more likely to be sensitive to environmental changes because they are at the edge of their habitat range. Hence, the ecological data collected from these animals through time may help researchers understand how manatees and other marine animals are affected by and respond to large-scale change and natural disasters such as hurricanes, red-tides, global climate change and sea level rise, or environmental toxins.

The Mobile Manatees project has collected a large amount of data about manatees from western FL through Mississippis. The network successfully processed 104 sightings in 2007 and 105 in 2008 for AL (in contrast, only 156 sightings were recorded for AL in the entire 20 years prior; Fig. 1). The network also served as a contact for sightings from Mississippi, Florida, North Carolina, and Georgia, and maintains regional sighting records. The most recent sighting data suggest manatees typically enter Alabama waters as early as March and stay through mid-November. During this time, manatees travel throughout the Mobile Bay area, from the upper reaches of the Mobile-Tensaw Delta to Dauphin Island and along the intracoastal waterway, but spend most of their time in rivers and subembayments. Groups of up to 15 manatees have been reported, but sightings of 1-2 manatees are most common. From these and other recent observations, the AL Natural Heritage Program reclassified manatees in AL waters from accidental (SA) to priority (SI), recognizing manatees as regular seasonal residents to AL. MMSN photographs provided to USGS Sirenia Project also resulted in the positive identification of one AL manatee. A Crystal River manatee identified as "Ellie" was sighted in AL in summer 2007. After her visit to AL, "Ellie" was seen back in Crystal River in December 2007. "Ellie" was recently fitted with a belt and tag so that she can be tracked if she returns to AL waters.

This past winter, MMSN tracked three manatees between late November and early January, when local water temperatures were below 20° C and animals were in danger from cold stress. One manatee was sighted in the Jourdan River, MS, and the other two were sighted in central Mobile Bay and in the Mobile-Tensaw Delta in Satsuma, AL. One of the AL manatees succumbed to cold stress before it could be relocated. The status of the other two manatees is unknown, but a second manatee was found washed ashore on the Dauphin Island, AL beach in early February. Manatee deaths in AL waters are not common, and these were the first reported in many years. It is not clear why the animals remained in AL waters during colder months, but the sightings

raise interest in whether some manatees over-winter in AL and adjacent waters during mild winters. MMSN, worked with USFWS and FL Wildlife Conservation Commission, to perform necropsies and collect valuable samples from the carcasses.

Carmichael and her students look forward to another busy season in 2009. MMSN plans to expand their project to include radio telemetry and GPS tagging of two manatees in Mobile Bay during summer 2009. This research effort will provide cutting edge data to better define local movements, migratory patterns, and habitat use for manatees in regularly frequented AL waters. -**R. H. Carmichael[1,2]* and C. Pabody[1]** ([1]Dauphin Island Sea Lab, Dauphin Island, Alabama; [2]University of South Alabama, Mobile, Alabama; *Corresponding author: rcarmichael@disl.org)

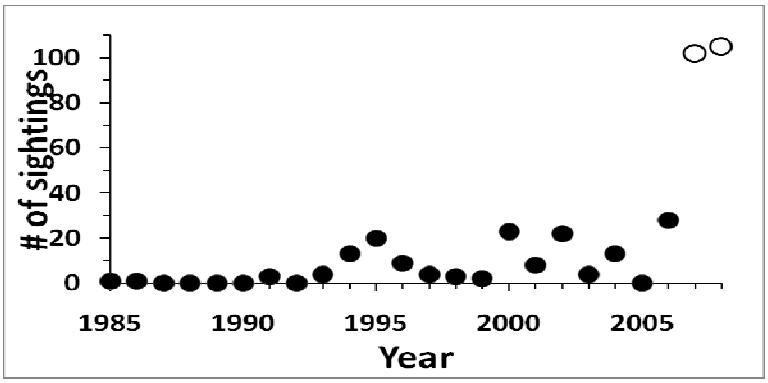


Figure 1. Reported manatee sightings in AL waters increased significantly from 1985-2006. The spike in number of sightings in 2007 (open dot) corresponds to establishment of the Mobile Manatees Sighting Network. Given the lack of consistent prior monitoring, it is unclear whether past increases reflect increasing numbers of manatees in AL waters or variation in reporting.

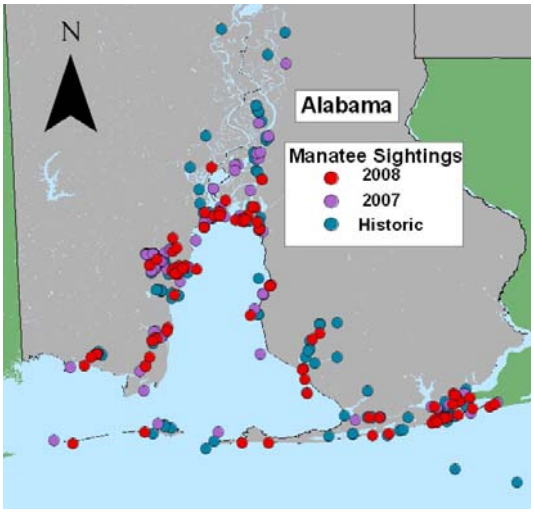


Figure 2.
Manatee sightings in Alabama waters from 1985-2006 (blue dots) and reported to the Mobile Manatees Sighting Network in 2007 (purple dots) and 2008 (red dots).

ABSTRACTS

Adaptive Enhancement of Marine Mammal Vocalizations
Berke M. Gur, PhD Dissertation, Department of Mechanical Engineering, University of Massachusetts Lowell, Lowell MA

In this dissertation, adaptive signal enhancement and noise reduction algorithms for marine mammal vocalizations (specifically, manatee vocalizations) are investigated motivated by the recent advances in speech processing. There has been a recent growing interest in the scientific community for acoustically monitoring marine mammals. Noise-free vocalization measurements are crucial for effective detection and classification. However, the vocalizations are generally distorted due to multi-path channel transmission, and further corrupted with background noise. In this research, the problem is approached in the unsupervised adaptive filtering framework. Several signal models are proposed for modeling the vocalizations and background noise. First, wavelet domain denoising (WDD) is proposed as a single channel noise reduction approach. Numerical simulations and tests conducted using real vocalization and noise data show that the WDD algorithm outperforms linear filtering. Second, blind source separation (BSS) is employed for enhancing vocalization signals buried in acoustic noise such as propeller cavitation noise emitted from surface vessels. A new time domain BSS algorithm based on the affine projection (AP) algorithm is proposed. The signal enhancement performance of the new algorithm is compared to several well-known decorrelation based BSS algorithms. Numerical simulations and experiments conducted with real recordings indicate that the AP based BSS algorithm can enhance weak vocalization signals in the presence of other point noise sources. Finally, weak signal detectors that complement the signal enhancement algorithms are proposed. The contribution of this dissertation is the introduction of contemporary adaptive signal enhancement schemes which constitute viable alternatives to conventional noise cancelling and beamforming techniques for enhancing marine mammal vocalizations.

Effects of Tidal and Diel Cycles on Dugong Habitat Use
James K. Sheppard[1], Rhonda E. Jones[2], Helene Marsh[1], Ivan R. Lawler[1]; [1]School of Earth and Environmental Sciences, James Cook University, Townsville 4811, Queensland, Australia; [2]School of Tropical Biology, James Cook University, Townsville 4811, Queensland, Australia; JOURNAL OF WILDLIFE MANAGEMENT 73(1):45–59; 2009

Quantifying the factors influencing behaviors of aquatic mammalian grazers may enhance the generic understanding of grazer ecology. We investigated diel and tidal patterns in movements of the dugong (Dugong dugon) by Global Positioning System–tracking 12 animals in 5 inshore–intertidal and 3 offshore–subtidal habitats along the coast of Queensland, Australia. We examined effects of tide height and time of day on the dugong's distance from 1) the nearest coast, 2) water .3 m deep, 3) actual water depth (bathymetry + tide ht) experienced, and 4) distribution of the directions of movements. Both tidal and diel cycles influenced dugong movement. Tracked dugongs tended to be closer to shore at high tide than at low tide and closer to shore at night than during the day. Onshore movement was more prevalent on incoming tides and in the afternoon and evening. Offshore movement was more prevalent on outgoing tides and from midnight through the morning until midday. Tidal and diel variation in water depths used by the inshore–intertidal dugongs was small, but probably underestimated, hidden by a sampling bias in the telemetry equipment. Onshore movement at high tide allowed dugongs to exploit intertidal seagrass beds. Dugongs are closer to shore in afternoons and evenings than in mornings. This behavior may be related to the avoidance of predators or watercraft. Our findings can be used to predict spatial patterns of dugongs within areas of conservation management significance and to assess, avoid, and mitigate adverse effects of anthropogenic disturbance.

Characterization of resting holes and their use by the Antillean manatee (*Trichechus manatus manatus*) in the Drowned Cayes, Belize
Bacchus, M.-L. C., S. G. Dunbar, and C. Self-Sullivan. 2009. *Aquatic Mammals* 35 (1):62-71. Department of Earth and Biological Sciences, Loma Linda University, Loma Linda, CA 92350, USA; E-mail: mlbacchus@gmail.com

In the Drowned Cayes area of Belize, manatees (*Trichechus manatus manatus*) are commonly observed resting in depressions in the substrate, locally referred to as *manatee resting holes*. To understand why manatees prefer locations with resting holes, the physical and environmental attributes of the depressions were characterized and diurnal and nocturnal use by manatees at four resting hole sites were documented over two summers. Twelve resting hole sites were compared with 20 non-resting hole sites in the Drowned Cayes, using water depth, substrate type, vegetation, water velocity, salinity, and water temperature. Four resting holes were chosen for repeated diurnal and nocturnal observations, during which sea and weather conditions were recorded in addition to the presence/absence of manatees. Resting holes were significantly deeper and had slower surface water velocity than areas without resting holes. A total of 168 point scans were conducted over 55 d, resulting in 39 manatee sightings over two summers. There was a significant difference in the number of sightings between research years and between day and night scans. Given the large number of resting holes in the Drowned Cayes, many of which are in sheltered areas with slow currents, it is possible that manatees select these

spots based on the tranquility of the water and environment. The combination of slow currents, protection from waves, low numbers of boats, and nearby seagrass beds would make these ideal resting areas. These findings have implications for the conservation of important manatee habitat.

The following abstracts are from the Proceedings of the 2009 International Sirenian Conference, Atlanta,GA, March 23-24:

Manatee research and conservation at Mote Marine Laboratory: Same vision, new directions

John E. Reynolds, III[1], Dana L. Wetzel[1], and W.E. Roudebush[2]; [1]Mote Marine Laboratory, Sarasota, FL; [2]Beckman Coulter, Inc., Chaska, MN

We live in an exciting time for research and conservation. Reports from groups such as the Pew Foundation and the President's Ocean Policy Commission underscore that the ways in which people have been doing marine science and management simply have not worked well. Those reports called for new partnerships, new approaches, and even whole new paradigms if people truly wish to ensure the viability and persistence of various taxa for future generations. More specifically, Ragen et al. (2002) noted that for manatees and other marine mammals, traditional approaches to assessing status provide an incomplete picture of the present or future prospects of species and populations. At Mote Marine Laboratory, we are developing a three-pronged approach to maintain our commitment to provide enhanced science and conservation of manatees and other marine mammals. *Approach #1* represents traditional, long term research that a number of entities in Florida have done for decades (photo-identification, aerial surveys, behavioral ecology) or more recently (genetics). *Approach #3* represents an expansion of the policy and conservation efforts in which Reynolds, in particular, has been actively engaged through the Marine Mammal Commission, IUCN Sirenian Specialist Group, and science advisor to the UNEP Caribbean Marine Mammal Action Plan. Mote continues to actively support State and Federal partners by testifying at hearings and formal meetings, and continues to provide input to assist real-time enforcement efforts and permitting issues. Two projects of particular note with regard to novel conservation actions are: a) promoting acquisition of Warm Mineral Springs as a manatee sanctuary in perpetuity, and b) the innovative re-introduction project in Guadeloupe (Magnin et al., this conference). Mote/Reynolds are also intimately involved in helping to ensure that the imminent shutdown and repowering of critical power plants in Florida has no negative effects on manatees. *Approach #2* involves novel research and partnerships. Although the conservation actions mentioned above will likely have more important longterm consequences than almost any particular research approaches, there may be exceptions. We have developed or are developing partnerships throughout the world to promote the use of biomarkers to demonstrate *effects* of human-related or natural stressors on sirenians and other marine mammals. For example a pair of markers developed to quantify fertility status of male and female humans works very well with manatees too. Preliminary assays, using serum generously provided by R. Bonde, show differential responses of males and females, large and small individuals, and individuals sampled at different seasons. Soon, we expect to be able to state what fertility potential of manatees is, as a function of location, contaminant burdens, nutritional status and other variables. More remarkably, we are setting up the only reference lab for these assays in the US, and we expect them to work equally well on other endangered mammals. Exciting times are truly here as we help promote enhanced ways to clarify species status and to promote informed conservation actions.

An update from the FWC Florida manatee necropsy and rescue program

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The Florida Fish and Wildlife Conservation Commission (FWC) assumed responsibility for the State's manatee mortality and rescue program in 1985. Since then, the average number of reported manatee carcasses has tripled, with recent carcass counts ranging between 300 and 400 annually. The program provides important information for managers in their efforts to mitigate human-related causes of manatee death as well as a valuable tool to monitor the health of the population. The fraction of mortality due to watercraft represents a critical and long-term threat to the species that requires ongoing monitoring and continued development of forensic methods for improved wound diagnostics. Naturally occurring threats to manatee health include exposure to cold water and harmful algal blooms (i.e. red tide). While red tide has been recognized as one of the major natural sources of manatee mortality in the southwest region of Florida, the stability and longevity of warm-water refuges is one of the greatest threats statewide. Over the years, FWC's necropsy program has identified numerous appearances of cold stress disease, most of which are related to chronic exposure to cold, but some of which are more acute or possibly even peracute. An additional health concern during the cold season may involve the spread of pathogens when manatees are aggregated in warm water; however, until today there is no evidence of pathogens that have an impact on the manatee population. Numbers of perinatal mortality have followed the overall increase in carcass numbers. "Perinatal" deaths include aborted fetuses, orphaned or abandoned calves, or other natural causes. Over the last few years,

several congenital defects have been documented, including umbilical hernia, skeletal defects, and atresia ani. Along with the carcass salvage, the number of rescued manatees has increased over the years. Both the rescue and mortality program have provided valuable insight in the pathophysiology of manatee diseases and continue to be an important monitoring tool for possible emergent health threats to the population.

The History of Rescued Manatees in Mexico: Where we came from and where we are

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The modern history of manatees living under human care in Mexico goes back to the mid 1970s. During this time Lake Xochimilco in the urban area of Mexico City, received 2 or 3 animals with the idea of controlling the development of water lilies in this important aquifer. The manatees died quickly due to the low water temperatures in the aquifer. In 1978 the Mexican government authorized the capture and transport of 2 animals to the aquarium in Okinawa in Japan. This capture was repeated again 11 years later in 1997.In 1988 the Payo Obispo Zoo in the city of Chetumal received two young manatees. One manatee died shortly after arrival to the zoo. Local biologists and conservationists pressured the zoo to release the other surviving manatee. It was subsequently released to the Bay of Chetumal. A few months later in Zapata, Tabasco 2 sub-adult males were found stranded in a dry area. They were captured and transported to a lagoon in the Yumka Park Zoo in Villahermosa. Under the same conditions a year later 2 more manatees were stranded and relocated to the Yumka Zoo. Again in 1988 the Aquarium of Veracruz rescued 1.1 manatee orphaned calves. Pablo and Silvia become the first of this species that successfully lived in captivity in Mexico. In 1999 the Marine Coastal Zone Institute in Belize rescued an orphan calf. A few days later it was transported to Xcaret Park in Quintana Roo, Mexico. 2 years later in 2001 the calf was rehabilitated and returned to Belize it was release and monitored since then. In 2000 a young injured manatee arrived to Yumka zoological park but he died a few months later.In Jonuta, Tabasco, a small village captured 4 manatees and kept them in a lagoon. There was insufficient food source for these manatees. In 2001, after several years of negotiations, studies and various meetings between the state government, community college, research centers and companies specializing in management of marine mammals 2 manatees were transported to Dolphin Discovery and 2 manatees to Via Delphi for rehabilitation and care. In 2003 the first calf was born in captivity at the Veracruz Aquarium and the second calf was born at Dolphin Discovery. Since this year other calves have been born and survived at Veracruz Aquarium, Dolphin Discovery and at Via Delphi. In September of 2003 a male calf 1 week old is rescued and housed in a temporary location in the Bay of Chetumal. The calf, named Daniel, survives but is determined that it cannot be released. Nowadays, Daniel remains under human care- living in a pen in the Chetumal Lagoon. The pen remains open and he is free to come and go. Daniel takes part in education, conservation and research programs.
Since the mid 1970's we have learned how to successfully care for manatees living in captivity. We now have successful reproduction programs, preventive medicine care, and can provide excellent nutrition. We have also learned about the cognitive abilities of the manatee due to the training for interactive programs as well as husbandry behaviors. Dolphin Discovery has been a pioneer in many of these advances. Husbandry behaviors include blood sampling, stool, urine, DPE, ultrasound. All these behaviors are voluntary and performed on a routine basis. Additionally we have made substantial progress in the nasogastric gastroscopy and exposure of the penis to take samples of semen for possible use in artificial insemination. Conservation of this species and its habitat as been greatly enhanced due our failures and success of manatees living in captivity in Mexico.

Manatee Research and Conservation in Cuba

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There is little information on the status of manatees in Cuba. The Institute for Marine Investigations has been collecting data on the status of manatees for nearly a decade under the guidance of Dra. Maria Elena Ibara. The Enterprise for Flora and Fauna along with other Cuban agencies have been developing manatee conservation actions including a country-wide manatee conservation plan and interagency manatee conservation team. In 2001, Wildlife Trust began working in Cuba to strengthen and facilitate manatee research and conservation. Joint activities have included interviews with coastal residents and boat surveys, a marine mammal necropsy workshop, in-depth manatee study in the Isle of Youth and participation by Cuban biologists in manatee research activities in Belize. Cuba contains extensive coastal manatee habitat on both northern and southern coasts. Additionally, expansive riverine and estuarine habitats are available along the southern coasts particularly in Zapata Swamp and around the Guacanayabo Gulf. Manatees are reported from around the entire coast and also the Isle of Youth off the southwest coast of the Island. It is likely that Cuba contains the largest population of manatees in the Greater Antilles. Manatees are attracted to sources of freshwater and sheltered lagoons dominated by *Halodule* sp. There is evidence of Florida manatee movement to Cuba. In January 2007 a female manatee with calf, first sighted in Crystal River 30 years ago, was photodocumented in the intake canal of a power plant located about 60km east of Havana

(Alvarez-Aleman, Beck & Powell. in prep). Threats to manatees in Cuba include hunting, drowning and entanglement in fishing gear and modification of habitat. Increased awareness as a consequence of the manatee necropsy workshop resulted in reports of manatee deaths in several areas and better capacity to determine causes of mortality. Manatee deaths led to a moratorium on inshore trawling in that particular area. Genetic samples are being collected and awaiting analysis from carcasses and existing specimens from around the country. An in-depth manatee study is being conducted along the western coast of the Isle of Youth by the Institute for Marine Investigations. The study includes distribution and abundance surveys, habitat analysis and fecal analysis. The Enterprise for Flora and Fauna, Villa Clara provincial office is taking a lead in manatee conservation, through the focused and dedicated efforts of Jose Antonio "Pepe Tony" Santos. Initiatives include changes in fisheries practices, establishment of coastal biological stations, training of biologists in manatee research and conservation techniques, establishment of sanctuaries, manatee sighting and carcass recovery network, public education and awareness activities, and linkages and student participation from the Universidad Central Marta Abreu de Las Villas. This work is providing a foundation for future manatee research and conservation activities throughout the country. The relationship and status of the manatee population in Cuba to Florida and Antillean populations are of particular interest and has implications for manatee conservation in the Caribbean region.

Analysis of ten years of monitoring Antillean manatee (*Trichechus manatus manatus* Linnaeus, 1758) in Barra de Mamanguape Protected Area, Paraíba state, Brazil

Camile Lugarini[1], Camila R.G.C. Aerts[2], Carolina M. C. Alvite[1], Iran C. Normande[1]; [1]National Centre for Research, Conservation and Handling of Aquatic Mammals (CMA) - Chico Mendes Biodiversity Conservancy Institute (ICMBio), Ilha de Itamaracá, Pernambuco, Brazil; [2]Universidade Luterana do Brasil, Porto Alegre, Rio Grande do Sul, Brazil

The Antillean manatee *(Trichechus manatus manatus*) is classified as vulnerable by IUCN (IUCN, 2008), and considered the most endangered aquatic mammal in Brazil (IBAMA, 2001), although the present status of Brazilian populations remain poorly understood. The estimated population is about 500 individuals, non-continuously distributed in North and Northeast Brazil coast, from Amapa to Alagoas states (Lima, 1997; Luna *et al.*, 2008). Manatee Project from National Centre for Research, Conservation and Handling of Aquatic Mammals and Aquatic Mammal Foundation is accompanying wild manatee populations with the purpose of monitor the species conservation status. Seven points in the North and Northeast coast has being monitored since 1987. These points were determined based in concentration areas of manatees, according status conservation evaluation realized in 1990 to 1993 (Lima, 1997). The aim of this study was analyze ten years of monitoring in the point build in Barra de Mamanguape Protected Area to characterize the utilization of this specific area for manatee groups, defining occurrence pattern and seasonal preference. Dates were collected from direct observation in four squares, totalizing 0,25 km2, in a fixed station build in Barra de Mamanguape Protected Area, Paraíba State, Brazil (06°46'22"S, 034°55'10"W). Barra de Mamanguape estuary is protected by a reef line and sand banks, turning the water calm, with 1-5 m deep and maximum tide amplitude of 2.8 m. Tide is semidiurnal. Population indicators established were: (1) Occurrence Frequency (OF): number of days of watching manatees (DW) divided by total of monitoring days (MD) (OF = DW/MD x 100) and (2) Median estimated density (D): total number manatee watched (MW) by total of monitoring days (MD) (D =MW/MD). To trace the relation between manatee occurrence and moon, tide and month, Pearson Chi-square test was applied. Manatee monitoring was made three times per week (Monday, Wednesday and Friday) at 6 to 10 a.m., totalizing effort of 6.004 hours, since April 1999 to December 2008. OF was 22.32%, representing use of this area by manatees. Median estimated density was 0.46, a density relatively low. Seasonality was verified: percentage of manatees was statistically lower (13.4%) in June and higher (33.8%) in October ($p = 0.046$). Chi-square showed association between manatee presence and tide/moon variation. Manatee presence were more common in full moon (33,4%) and less common in first quarter (10.7%). In relation to tide, in high water the presence of manatees was higher (45.4%), followed by turning tide (24.9%). The median permanence in the area was 35 min and 30 sec. Solitary individuals were seen more common, registered in 47.8% of observations. Groups varied from two to ten individuals (mean ± SD: 3.03±1.49). Groups of ten individuals were watched once (0.57%). Groups with two individuals were more commonly observed (53.14%), followed by three (20%), four (12.57%), six (6.86%), five (4.57%), seven (1.14%) and eight (1.14%) individuals. Observation of calves represented 15.43% of group watched and 1.80% overall monitored days. Only in December 2008 was observed two calves in the groups. This observation coincides with a calf stranding and immediate release. The other observations were correspondent to one calf. Calves were seen more commonly in December (33.33%), followed by November, October and February (11.11%) and were not seen is June and August. These results showed that Barra de Mamanguape still being used as rest, reproductive and alimentary place for manatees, in spite of the low density observed in this area. Maranhão and Ceara states seem have higher medium density and abundance (Alvite, 2007). Manatees have preference in use this habitat, being more common in high tide and in Spring and Summer months. Calves also are more common in this period. The strategy of creating a Protected Area by Government in 1993 is the major help to protect this population, since motorboat traffic and coastal occupation is illegal. Antillean manatees require continued research efforts to improve conservation status in Brazil.

Conservation of Antillean Manatees in the Drowned Cayes Area of Belize

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For the past decade, we have investigated the behavior and ecology of West Indian manatees using Swallow Caye, the Drowned Cayes, and Gallows Reef, three distinct habitat types within the Belize Barrier Reef lagoon system near Belize City. Data were collected during two 3-month field seasons/year, using boat-based point scan methods with the assistance of volunteers. Presence/absence and photo ID methods ensured consistency of data collection despite a changing pool of volunteer researchers. Results confirmed the mangrove and seagrass ecosystem between the Belize Barrier Reef and Belize City as important manatee habitat. Inconsistent with the prevailing "seasonal distribution hypothesis" for manatees in Belize (Auil 2004), the probability of encountering manatees at Swallow Caye and in the Drowned Cayes was equal between dry and wet seasons. However, manatees were only observed at Gallows Reef during the wet season. Swallow Caye had the highest probability of encountering manatees, confirming traditional knowledge held by local tour operators, which led to the establishment of Swallow Caye Wildlife Sanctuary in 2002. In contrast to previous studies (O'Shea and Salisbury 1991), our data suggest that at least 44% of the manatee population carry scars from non-lethal boat strikes. The proportion of scarred animals did not vary as a function of habitat type, season, or year. The probability of encountering manatees did not change between years, despite an exponential increase in cruise ship tourism. However, there is still cause for concern. Manatees do not remain inside designated refuge boundaries; governmental agencies depend on co-management agreements with local non-governmental organizations for enforcement of rules inside MPAs; regulations governing human behavior outside MPAs are lacking; funds for monitoring and evaluation of MPAs are lacking. We recommend that manatee conservation strategies be integrated into a system of riverine, coastal, and marine protected areas supported by additional tactics such as required manatee training for boat captains, slow zones at hot spots outside MPAs, and continued educational outreach. With few modifications and increased enforcement and monitoring, the Belize model for manatee conservation could lead to a shared "triumph on the commons" for the manatees and the user groups that share their habitat.

Environmental Education and Participative Planning for Manatee (*Trichechus manatus manatus*) Conservation at the Alvarado Lagoon System, Veracruz, Mexico (1999 – 2008)

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The Alvarado Lagoon System (ALS) is one of the most productive wetlands in Veracruz, and the third largest ecosystem of this type in Mexico. Here occurs an Antillean manatee (*Trichechus manatus manatus*) population, highly endangered by hunting, pollution and habitat loss (Ortega-Argueta, 2002). In 1999 it was established a strategy focused on Environmental Education (EE) under the vision of developing integral conservation actions to catch the local people attention. Two phases were set: the first one under the anthropological perspective consisted in personal interviews to local fishermen in order to know their perception about the presence and importance of the manatee at economical, social and cultural levels. We were able to record uses, ways of consumption, hunting techniques, beliefs, myths and customs; and after we built a complete diagram of the relationships between the coastal communities and manatees. The second phase consisted in the application of EE workshops based mainly in the environmental problematic showed previously with the interviews. Workshops were applied to fishermen, children, clam catchers, and women. Until date, we applied 245 workshops at 10 municipalities, with the participation of 2,200 people. Also, 102 courses about the ecological importance of manatee had been taught. Thanks to these efforts, through the participative planning three cooperatives were formed, bringing to local fishermen (women and men) alternatives of development and an attitude change about conservation of manatees. This fact produced twelve experience interchanges in other parts of the country, where fisherwomen exposed their conservation efforts towards manatee and their habitat. All these 10-year activities had been published in media such as radio, television, newspaper, videos, fliers and posters. With these efforts, manatee mortality has decreased and instead more sightings have been recorded. Seven animals have been rescued from nets, being the fishermen the main informers and rescuers. In general, people who were hunters years ago now are protectors thanks to the intense campaign through 10 years of work promoting sustainable projects to both improve life quality without impact the manatee habitat and contribute to its conservation.

Density, Abundance, Distribution and Manatee (T*richechus manatus manatus*) Health Status in the Alvarado Lagoon System, Veracruz State, Mexico

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The Alvarado Lagoon System (ALS) has an extremely high biodiversity so it was declared a Ramsar site in 2004 with an extension of 267,000 hectares. . The ALS has over 100 lagoons and several rivers. The most emblematic mammal in the system is the manatee (*Trichechus manatus manatus*). Since 1975, the manatee is considered as threatened with extinction by CITES; in 1982 was included in the Red List of the IUCN as vulnerable; and is considered as threatened with extinction by the Mexican government. Knowledge about the distribution and abundance of the manatee along the coast of the Mexican state of Veracruz is scarce, but it has been reported as distributed along the entire state (Colmenero and Hoz, 1986). However, recent studies proved that the manatee has disappeared along the northern region of Veracruz (Serrano *et al.*, 2007). It is believed that the manatee population that inhabits the ALS is one of the few populations remaining in the state. Therefore, the goal of our study is to determine the density, abundance, distribution and manatee health status in the ALS. From October to November we carried out over 34 line transects with a total survey effort of 72.8 hours covering about 10,000 hectares. We have detected 8 animals: three were observed during the surveys, four were detected by means of passive acoustics, and one was detected with sonar. We used the distance sampling methodology and the software Distance to estimate the manatee density and abundance. The estimated density was 0.93 animals/hectare (C.V. 48%), and it was not possible to estimate the abundance due to our sampling effort. Currently, we are expanding this study by including an evaluation of the manatees' health status. Also, we will increase our sampling effort in order to have enough data to estimate the abundance and in order to reduce our data C.V.

Status and recovery of the Antillean manatee (*Trichechus manatus manatus*) in the Alvarado Lagoon System, Veracruz, Mexico

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Since 1999 we have developed a research and conservation program for the Antillean manatee (*Trichechus manatus manatus*) in the Alvarado Lagoon System (ALS), in central Veracruz State. We focused on delivering educational courses and workshops to fishers and local communities with the objective of reducing poaching and habitat loss, the principal reasons this species is endangered. Historically, manatees were relatively common in the ALS, but studies in the 1980s documented their abundance reduction in this region. Nevertheless, recent rescues of three calves (between 2000 and 2004) and the continuous reporting of sightings have reemphasized the ALS as an important manatee area. Manatee and habitat surveys from 2000-2003 along the entire coast of Veracruz corroborated ALS as a critical wetland site for the conservation and recovery of the species. Potential manatee habitat comprises 315,000 ha of low human-development areas including coastal lagoons,and interior lagoons, estuaries, mangrove wetlands, rivers, and canals. We focused on delivering educational courses and workshops to fishers and local communities with the objective of reducing poaching and habitat loss, the principal reasons this species is endangered. We also conducted interviews of the inhabitants of the ALS to determine their knowledge of manatee biology and the cultural and historical importance of manatees. We have found that clam divers and river and lagoon fishers possess a traditional knowledge of manatees in the ALS because they are continuously working in manatee habitats. In the ALS manatees are most commonly sighted in the Limon River and adjacent lagoons, and are rarely sighted in the Acula River and adjacent lagoons; the marine zone appears not to be utilized by manatees, except when moving locally between rivers along the coast. Manatee hunting was still common in the 1970s. Locals described uses of manatee as food and medicine, and for the elaboration of artifacts. One of our most significant achievements in conservation was the designation of the ALS as Ramsar Site No. 1355, encompassing 267,010 ha of wetlands, including critical manatee habitats. With the potential for an increase in the population of manatees in the ALS, continued educational and informational campaigns are essential to educate the local communities about the need to protect and conserve manatees and their habitats.

Ongoing investigation looking at community involvement in the efforts to conserve Antillean manatees *(Trichechus manatus manatus)* in Central America

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The Antillean manatee *(Trichechus manatus)* is classified as endangered under Belize's Wildlife protection act of 1981. Belize is considered the last stronghold for these vanishing mermaids in Central America. As a result, current conservation work in Belize

is focused on national efforts to preserve the species and its habitat, with a recognition that efforts also need to go beyond the country's borders. As such, Belize is an ideal place to study the human aspect of conservation, exploring involvement at the community level in conservation and research initiatives, relating to Antillean manatees. Similarly, in Mexico, research and conservation work is ongoing to ensure the survival of the Antillean manatee in Mexican territory. Known for being one of the remaining areas with a concentrated population of Antillean manatees in Mexico, Bahía de Chetumal has been designated a natural manatee protected area (1999). This area is invariably linked to Belize and the Corozal Bay Wildlife Sanctuary for manatees (1998) and is important to explore in relation to inter-country collaboration efforts. With the aim of understanding community experiences, opinions and participation in the manatee conservation effort in Mexico and Belize, a total of sixteen extended interviews and 146 questionnaires were administered. Fieldwork was carried out in Chetumal in Mexico, as well as Sarteneja, Caye Caulker and Placencia in Belize. In this case study approach, surveys and interviews with locals and others involved in manatee conservation projects in Belize and Mexico have reiterated the need do more to save the Antillean manatee. Initiatives are varied and inconsistent between the fieldwork sites I explored suggesting the need for a more integrated conservation approach. Additionally, community outreach and education needs to be further enacted; many individuals reported knowing the name of a person and/or organization that is involved in the protection of manatees in their community, but are not informed as to what they do or how they can get involved, if at all. Preliminary analysis of the data shows that in Chetumal 72% of people surveyed had seen at least one manatee in their lifetime, compared to 84% of respondents in Sarteneja, 89% in Caye Caulker and 78% in Placencia. That so many people have had personal experiences with manatees is promising. However, compared with data showing self-indicated participation in manatee conservation or education (administering or participating), numbers are much lower with only 13% of those surveyed involved in Chetumal, 39% in Sarteneja, 29% in Caye Caulker and 18% in Placencia. Interestingly, tour guides, who are leading 'manatee tours,' did not always rate themselves as being involved in conservation or education projects, even though they were presenting information about manatees and taking people to see them. The results presented here, provide significant insight into what changes need to be made to better protect the manatee populations in Belize and Mexico. That, said, further analysis of qualitative data from the open ended survey questions and interviews using ATLAS.ti will seek to identify additional relationships between the data and further explore people's relations with manatees and current research and conservation work. Further research will hope to incorporate GPS and GIS technology, to map manatee population distribution against 'pockets' of community involvement, to assess whether focused conservation and education work is taking place in the appropriate areas where manatee populations are most dense and where the risk of injury or death to manatees is greatest.

The situation of Amazonian manatee in Iquitos-Peru and efforts for environmental education

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The Amazonian Manatee (*Trichechus inunguis*) is the smallest sirenian and the only one restricted to freshwater habitats. This species is endemic to the Amazon river basin, founding them in Brazil, Peru, Colombia, Ecuador, Guyana and Venezuela. In Peru they have been reported mostly in the region of Loreto, in rivers such as Ucayali, Huallaga (Grimwood, 1968), Napo, Tigre, Marañon, Pastaza, Samiria, Pacaya (Soini et al., 1996 y Álvarez, 1996) Amazonas and others. In this country their biggest threat are the hunters and opportunist fisherman. As they are a great source of protein and fat people have been hunting them for their meat hundreds of years. A more recent threat is the illegal pet trade of baby manatees. The 2007 IUCN Red List of Threatened Species categorizes *T.inunguis* as vulnerable. This species is protected by law in most countries. Hunting them for meat or any type of commercialization, dead or alive, is forbidden. In Peru, since 1973 these animals have been protected by laws; however hunting kept going as always (Soto, 2007). A recent regulation for manatees and other aquatic mammals in Loreto-Peru have been approved in June 2008. Environmental education needs to be done in order to stop the hunting and the illegal traffic of manatees. Some education projects are currently ongoing in Loreto. The principal target is the children, as they influence directly on their parents. Work with communities living next to rivers seems to be the more significant as they interact more with wildlife than the population of the city. However education in the city is very important as the pet trade occurs with wealthier people. A survey was done in the city of Iquitos-Loreto in order to explore the knowledge of the people towards the manatee. This research was done by interviewing people of all ages and social status. 316 persons were interviewed with the help of questionnaires. On this sample population, only 56% affirmed they knew what a manatee was. When asked what other names they know for the manatee, many answered sea lion, otter, dolphin and many others. This suggests that a significant number of persons that affirmed to know what a manatee was were actually thinking of another animal. This survey shows also how only 31.6% have seen live manatees; however 14.6% referred to the captive animals being rehabilitated by ACOBIA (Association for the Conservation of the Amazonian Biodiversity) in the last year. It is a fact that manatees are no longer seen easily in the wild. Even a lower percentage (10.8%) of people knew about laws that protect this animal, and none knew exactly the regulations. However many did know about the threats that are lowering their populations. The majority agree that fishermen are their biggest threat, as well as meat hunting, pet trade, commercialization of sub products and pollution of their habitats. The research objectives were not only statistics, but to gather information that could guide us deeper into the actual situation of this aquatic mammal in the region. Information about manatee mythology, folklore and tradition, as well as places where they can be found was collected.

The results support the idea that environmental education is the key for the conservation of *Trichechus inunguis* together with reinforcement of law, rescue and rehabilitation projects and deep research of this unique species.

Possible reintroduction of the Antillean manatee (*Trichechus manatus manatus*) in the Grand Cul-de-Sac Marin (Guadeloupe, Lesser Antilles)

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The National Park of Guadeloupe has undertaken a project of noble intent : re-establishing the Antillean manatee, an endangered species according to the IUCN Red List of Threatened Species (Self-Sullivan and Mignucci-Giannoni, 2008), in the waters of the "Grand Cul-de-Sac Marin." This large (37,070 acre) protected area is currently managed by the National Park. Manatees were extirpated from the waters of Guadeloupe several decades ago by hunters for food, but currently the Grand Cul-de-Sac Marin represents a well-managed area with relatively few, minor threats to manatees, compared to many other locations in the wider Caribbean. The project is part of a larger initiative that seeks to: a) overcome and reverse loss of biodiversity in Guadeloupe; b) improve the global conservation status of the species and subspecies; and c) to provide a transferable model for other conservation projects. A feasibility study (Lartiges et al., 2002) concluded that the reintroduction of manatees had merit, even if hurdles needed to be overcome to ensure success. The conclusion was echoed by the assessment of the Mote Marine Laboratory (Reynolds and Wetzel, 2008) during a workshop in April, 2008 in Guadeloupe. Factors that will contribute to the possible success of the project include: the large area of seagrasses (about 13 700 acres [Chauvaud et al., 2005]) within a protected marine park; presence of little boat traffic and relatively few other apparent threats; and general acceptance (and even some enthusiastic endorsement) of agency scientists and managers, politicians, and local citizens around the Grand Cul-de-Sac Marin. The first part of the project is the preparation phase (3 years), during which studies of environmental contaminants of seagrasses and sediments, seagrass productivity, and socio-economic factors will be done. In addition, there will be discussions with regard to the optimal location(s) from which manatees might be taken to populate the new area, and to organize a cooperative network of scientists and managers from various Caribbean countries to advise the project. The second part will last about 5 years, and involves the actual reintroduction of selected manatees. It will begin once everyone is assured that environmental and other possible threats to manatees have been identified and are under control. The reintroduction will involve soft releases and VHF and satellite monitoring of the animals. The success of the project depends to a large extent on its endorsement by the people of Guadeloupe. Therefore, throughout the project, it is essential to develop an education and awareness program for the island. The project has the support of the French Ministry of Ecology which has provided funding since 2008. In Europe, governmental agencies and private firms will be approached in 2009 to solicit additional financial support. The National Park has also established partnerships with the Mote Marine Laboratory for scientific guidance and with the Aquarium of Gosier for a future care center dedicated to manatees.

Feeding Ecology of Manatees in Chetumal Bay, México

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Chetumal Bay (BCH) supports one of the largest populations of manatees (*Trichechus manatus manatus*) in the Caribbean. In order to understand the habitat requirements and the role of manatees in the structure and functioning of BCH, we estimated the Centers of Activity (COA) defined as the geographical locations of the point of greatest activity within the home range. Nine areas were selected on the basis of the preliminary COAs. Additionally, 3 areas were randomly created where manatee's COAs were not registered. Plant cover and soil type were determined for each climatic season (Northern winds, dry and rainy season) and for each area. Besides, manatee fecal samples were analyzed by comparing the vegetal fragments in the samples with voucher microscope slides or illustrations. Using vegetation data, and other ecological information of the BCh, we built a trophic model of the system using the Ecopath software. The main submersed aquatic vegetation in the bay includes *Bathopora* sp., *Halodule wrightii*, *Thalassia testudinum, Chara* sp., *Najas marina* and *Ruppia maritima.* All the species excepting *Bathopora* sp. were found in the fecal samples. However, local people saw manatees consuming *Bathopora* sp., and it's possible that this procedure was not appropriate to detect this algae in the feces samples. We did not find *Syringodium filiforme*, a seagrasss distributed in the neighboring reef lagoon system but not in BCH, suggesting that manatees spend an important part of their time in estuarine and freshwater areas. More than 80% of samples had *Rhizophora mangle* tissues, enforcing the need of mangrove conservation as an important source of food for manatees. The Ecopath model showed that manatees play a decisive role in the trophic dynamic of the BCH, due to their abundance, biomass and function in the detritus cycle.

Manatee biogeography and sirenian health assessment

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Biogeography

To date, thousands of manatee tissue samples have been collected from throughout the Florida and Caribbean populations, providing a good foundation for future genetic assessments and comparisons between population units. This massive effort will allow for inferences about manatee life history and population structure, including reproductive potential, movements, and overall population size. Manatees have had an uncanny ability to establish new populations within their subtropical range, as evidenced by their evolutionary history and genetic traits (Domning, 2005). Although vicariance separated the taxa over time, the vagility of this unique group of aquatic mammals enabled populations to disperse through deliberate migration or stochastic events. This phenomenon of population expansion is characteristic when the existing population is large enough to act as a source to populate new areas. Although novel habitats are not always suitable, the trichechines exhibit adaptive plasticity as evidenced by behavioral modification and distinct, subtle morphological characteristics among populations (Domning and Hayek, 1986). The Florida population is recently established within the last 20,000 years and contains a newly differentiated population unit in the northwest part of the state near Crystal River. Thus, within peninsular Florida, where populations are more established, distinct habitat types require different survival strategies by the resident manatees. Previous studies have examined the genetic diversity of the Florida population in detail (Garcia-Rodriguez et al., 1998; Vianna et al., 2006). Early studies using allozymes and nuclear microsatellites determined that Florida manatees have low to average genetic variation (McClenaghan and O'Shea, 1988; Bradley et al., 1993; Pause et al., 2007), which could be explained by panmictic breeding and the absence of barriers to gene flow between contiguous areas. Nevertheless, questions arise as to the fitness and health of this population. The genetic data suggest that even with adequate gene flow, there may be issues regarding low allelic diversity among Florida manatee population units due to inbreeding, bottleneck events, and founder effects. The best remedy for this low genetic diversity in the population would be to encourage growth and address conservation practices in order to promote breeding between population units throughout all regions of Florida. Although there has been an increase in the population size of Florida manatees in recent decades, genetic evidence of prior founder events are still evident in the population. Manatees were subject to anthropogenic take for centuries, and it will likely take many generations to resolve the genetic consequences. Genetic connectivity and pedigree studies can give us information on breeding among different population units. Knowledge of the genetic composition of the Crystal River group will determine whether, and to what extent, breeding with parapatric populations is occurring, and may play a role in understanding the population structure by complementing efforts to model various manatee life history strategies.

Health Assessment

The concept of using marine mammals as ecosystem sentinels has been proposed (Bonde et al., 2004; Wells et al., 2004; Bossart, 2006; Moore, 2008). Detailed health assessment studies in sirenians have provided information on the health of the individuals and populations. These assessments have been conducted in Florida, Puerto Rico, Belize, Mexico, and recently in Australia. The information has provided data on basic biology and allowed researchers to establish normal baseline criteria for comparing the health status of individuals within populations. These studies are akin to recent studies underway on other marine mammals (Wells et al., 2004; Fair et al., 2006). Various capture and restraint strategies have been employed to evaluate and sample individuals. Currently, data are collected and basic health status is assessed through physical examination, medical evaluation and intervention as necessary, morphometrics, photo-documentation, ultrasound, biopsy, genetics, immunology, endocrinology, microbiology and cytology, virology, hematology and blood chemistry, toxicology, urine, milk and fecal examination, and radio-telemetry follow-up. Capture-release assessment of wild sirenians will continue to expand over time as it attracts more collaborative researchers. In this presentation we will discuss some of the mechanisms that have enabled sirenians to adapt to different environments and habitats throughout their range. This adaptive resilience has aided their ability for population expansion, but may have an underlying associated cost. Through health assessment studies, researchers are able to gauge some of the limits to adaptive resilience from a population and habitat perspective.

Monitoring oral temperature, heart rate, and respiration rate of manatees (T*richechus manatus latirostris, T. m. manatus*) exposed to capture and handling in the field.

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In veterinary medicine, the monitoring of oral temperature (OT), heart rate (HR), and respiration rate (RR) is often performed to assist in evaluating the health of an individual animal. Protocols for monitoring these vital signs are well defined in many species of domestic and wild animals, but not with manatees. Normal manatee OT, HR, and RR values have been defined under captive conditions (Scholander and Irving 1941, Bossart 2001, Murphy 2003). However, many manatee research studies require the capture and handling of free ranging manatees to collect data. Understanding how manatee OT, HR, and RR can change during a capture event is important for researchers who want to ensure an animal's well-being. Furthermore, the correlation of manatee OT, HR, and RR with blood chemistry have not been studied in a field setting. To determine the effects of capture on healthy, awake, juvenile/adult manatee vital signs: a total of 38 Florida manatees (*Trichechus manatus latirostris*) and 48 Antillean manatees (*T. m. manatus*) was continuously monitored for OT, HR, and RR during field research captures, for 50 minutes. Creatine kinase (CK), potassium (K+), serum amyloid A (SAA), and lactate values were examined for each animal to assess possible systemic inflammation and muscular trauma (Harr et al. 2006, Harvey et al. 2007). Antillean manatees had higher initial OT, HR, and RR than Florida manatees ($p<0.0001$). Over time OT, HR, and RR were no longer significantly different between the subspecies. Mean OT of Florida and Antillean manatees was initially low then increased to a normal value. Mean HR of Florida and Antillean manatees was initially high then decreased to a normal value. Mean RR of Florida and Antillean manatees was initially high and decreased over time, but did not reach a normal value. High mean respiratory rate over time was associated with high lactate values ($p=0.018$). Antillean manatees had higher overall lactate values than Florida manatees ($p<0.001$). Monitoring of manatee OT, HR, and RR in the field is recommended as a standard protocol for researchers, to better assess the condition of an animal.

Demography, ecology and health assessment of manatees in Quintana Roo and its genetic interpretation in Mexico: 2004-2008
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One of the most important manatee populations in Mexico inhabits the Caribbean coast of Quintana Roo (QR). This population is estimated to be from 200 to 250 manatees. In order to know regional manatee movements, health status, habitat use, home range, and genetic structure and variability, an intensive research project was carried out from 2004 to 2008 in QR., with the participation of several research institutes in Mexico and U.S.A. Fifty four manatees (29 males and 25 females) were captured to get morphometric measures, weight, blood, biopsy samples, feces, commensals, photos for ID and documentation, and a general evaluation of body condition was done. Fifteen of them (8 females and 7 males) were radio-tracked with GPS tags in Chetumal Bay to follow its movements. All the manatees were captured with a locally developed technique, and PIT tags were used to identify each manatee. Biological and health data were obtained as normal base line criteria for conservation management and to compare among manatee populations in the world. Data like morphometrics, hematology and blood chemistry, toxicology, nuclear genetics analysis, fecal examination, parasites, movements, home range estimations, habitat use are currently analyzed. In general the males had larger movements that the females. Those movements along the Mexico-Belize coast also show regional connectivity among areas of localized manatee occurrence with movements between distant sites and site fidelity (Morales-Vela et al. 2007). During this project manatee commensals and epibionts were collected from 47 manatees, in eight of them well established epibiotic copepod communities of the tanaidacean Hexapleomera robusta (Moore) were found (Morales-Vela et al. 2008). This tanaid formed patches of tubes adhered to the skin surface, the tanaid probably captures suspended particles as the manatee feeds. The international collaboration in this project also gives us the opportunity to determine baseline concentrations of polychlorinated biphenyls (PCBs) and organochlorine pesticides (OCPs) in nine manatees sampled in Chetumal Bay **(**Erin L. Pulster et al, 2007). The PCB concentrations ranged from 0.022 to 20.1 mg/g wet weight in blubber. These high levels exceed current thresholds for toxic endpoints and warrant further research. Future plans include expanding the range of contaminant analysis and attempt comparable studies with other sirenian populations. All of this base line biological information will be very useful for implementing better conservation strategies and to encourage developing stronger trans-border manatee conservation strategies between Mexico and Belize.

Field research on Antillean Manatees in Marine Mammal Sanctuaries of Dominican Republic
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In Dominican Republic, the general distribution of Antillean manatees (*Trichechus manatus manatus*) has been documented through different country-wide survey efforts (Lefebvre *et al*., 2001). However, there is a lack of site-specific studies on manatees and their habitat within their three main distribution areas: (1) the northwest coast, from Manzanillo Bay to the Bajabonico River mouth; (2) the northeast coast, along the north coast of the Samana Peninsula, and in the south coast of Samana Bay; and (3) the southwest coast, in the Neiba and Ocoa Bays, and east of the Oviedo Lagoon. Recent research efforts have been made in the northwest and northeast coast to contribute to our knowledge and management of the species. Information was gathered through literature reviews, interviews with locals, and both land and boat based surveys. The latter consisted of non-invasive 30 minute point-scans in selected stations, following the methodology described in LaCommare *et al.*, (2008). In addition, a video camera with underwater housing was used to determine the feasibility of pursuing manatee photo identification studies at both sites. In the northwest coast, surveys were conducted in the Marine Mammal Sanctuary of Estero Hondo in 2007-2008, to determine manatee distribution, habitat use and threats. A total of 138 interviews were carried out in six nearby communities, where locals proved to be very knowledgeable about manatees. Of 119 sighting reports, 61% occurred in Caño Estero Hondo, a coastal saltwater lagoon surrounded by mangroves located within the Sanctuary. Sampling for environmental variables and manatee surveys were limited to Caño Estero Hondo and its immediate surroundings. Shallow protected warm waters, freshwater sources and abundant seagrasses make this an ideal habitat for manatees. A total of 270 hours of effort resulted in 103 sightings: 27 within the point-scan sampling design and 76 opportunistic. Presence of manatees, including calves, was confirmed throughout the year. Group size varied from one to nine individuals. Manatee distribution was related to the location of seagrasses and resting holes. Although evasive, manatees have been observed feeding, resting, travelling, socializing and milling within Caño Estero Hondo. Tagging and tracking studies are recommended to determine individual movements and residency in this manatee activity center. The principal threat to manatees is the illegal use of fishing nets within the Sanctuary. A conservation action plan for the Sanctuary is currently in progress. In October 2008, a five day field visit was conducted in the north coast of the Samana Peninsula, which is part of the Marine Mammal Sanctuary of Banco de la Plata y de la Navidad. According to interviewed locals (n=17), sighting reports were most common in El Estillero and Portillo. In the former, land based surveys were conducted for a total of 9.5 hours of effort, resulting in five opportunistic manatee sightings in four consecutive days. Group size varied from one to five individuals, and calves were present. Shallow protected waters and abundant seagrasses favor manatee presence in this bay. Animals were mostly milling during observations, but feeding evidence was found. Coastal development and watercraft use were identified as the principal threats to manatees. Continued research effort is recommended to determine manatee distribution and habitat use in this study area. Due to the poor water visibility of Caño Estero Hondo, capturing underwater images for manatee identification purposes is only recommended for the north coast of the Samana Peninsula. This study was made possible with the support of the Secretaría de Estado de Educación Superior Ciencia y Tecnología (SEESCyT) and the Fundación Brugal.

Use of Argos-linked GPS tags to document specific habitat use patterns of manatees in eastern Puerto Rico

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The population of manatees in Puerto Rico is the only group of Antillean manatees (*Trichechus manatus manatus*) under the jurisdiction of the United States. Unlike Florida manatees, which make extensive use of estuarine and freshwater habitats, Antillean manatees in Puerto Rico are found almost exclusively in marine habitats and are dependent on seagrass and other marine plants for food. Increasing human activity and development in the coastal zone threaten the longterm existence of this protected species in Puerto Rico. Federal manatee recovery efforts mandate the need for data on manatee movements and habitat utilization. The U.S. Navy, faced with the pending closure of the former U.S. Naval Station Roosevelt Roads, requested detailed information on manatee activity patterns in the vicinity of the naval base. To address these concerns, the U.S. Geological Survey initiated a study to document the movement and habitat use patterns of manatees in eastern Puerto Rico and assess the resources they depend on. In spring 2005, nine manatees were tagged in eastern Puerto Rico using satellite-linked Global Positioning System (GPS) tags. GPS receivers coupled with Argos satellite transmitters, encased in floating tethered housings, provided accurate locations of the manatees and enabled us to remotely monitor the detailed movements of tagged individuals. GIS analysis of these data with aerial imagery and USGS benthic habitat maps allowed us to correlate their movements with habitat types, and to identify travel corridors, sources of fresh water for drinking, and feeding locations. Tagged manatee movements ranged along the coast of eastern Puerto Rico from Fajardo to Humacao and Vieques Island, with the greatest documented use in shallow areas having extensive seagrass beds. They accessed fresh water at the mouths of rivers (Fajardo, Daguao, Blanco, and Humacao) and from the Naval Station's wastewater treatment plant discharges

(Capehart and Bundy). Detailed data from GPS tagged manatees have proven valuable in the development of manatee and habitat protection recommendations related to the transfer of Naval Station lands to public and private ownership.

Release and radiotracking of long-term semicaptive West Indian manatees (*Trichechus manatus*) in the Sinú River of Colombia

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West Indian manatees (*Trichechus manatus*) in Colombia are protected by national legislation and their conservation is implemented through a National Recovery Plan (Ministerio de Ambiente & Fundación Omacha 2005). As part of these efforts, manatees were rescued from being butchered in the 1990s, and through local NGOs and regional environmental government agencies, 43 manatees were placed in custody in semicaptivity to secure their survival. Two main colonies were established in the Caribbean region to house these animals, one in the Magdalena River (33 animals), and one in the Sinú River (11 animals). Since 2003, we have begun field studies and conservation in the Sinú River swamp, including basic interviews with local residents, public outreach, and field observations and documentation of distribution and life history parameters of manatees in the area. This set up the proper conditions for releasing back to the wild, the previously rescued manatees. As a first phase of the release project, four manatees were medically examined and cleared for release. They were fitted with belt and floating VHF transmitters following a combination of techniques used in Brazil with Amazonian manatees and in Florida with West Indian manatees. Two of the animals were fitted as well with UHF transmitter to monitor their movements via Argos satellite tracking. Two males and two females were released on 14 February 2009 and are at present being tracked on a daily basis along the Sinú River. Parallel, a public education and outreach campaign is being conducted with local fishermen and schools to protect the released animals and to achieve community involvement in manatee conservation. This release and monitoring effort, first in Colombia, together with the public outreach campaign, will lead to a second phase of releasing the remaining six animals semi-captive in the Sinú River colony, and a third phase of releasing the 22 manatees semi-captive in the Magdalena River colony. Future telemetry studies using wild manatees off the Sinú, are also planned to understand natural movements and habitat use of West Indian manatees throughout the Sinú River swamp.

Synoptic aerial surveys for West Indian manatees (*Trichechus manatus*) off the south coast of Puerto Rico—2001-2008

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The West Indian manatee (*Trichechus manatus*) is a protected species in Puerto Rico due to its endangered status. They were hunted for food up to the early 1990s, but nowadays, they face threats from boat collisions, habitat encroachment, and industrial pollution. Manatees have been reported to use the south coast of Puerto Rico, especially the industrialized estuaries of Guayanilla and Jobos bays for daily activities, both also reported to be areas of high manatee mortality. We document the population dynamics and the extent of usage by manatees of these two estuaries and its adjacent coastline through a series of aerial surveys using a helicopter platform. The study comprised of a series of surveys to document the presence of manatees along Puerto Rico's south coastline between Cabo Rojo and Maunabo. Given the flying capabilities of helicopters versus fix-winged airplanes, a Eurocopter A-Star 350B helicopter was used as the survey platform, flying 500 m parallel to shore at an altitude of 150 m. Smaller cays distant from shore, were surveyed by flying over the cay's land, with observers searching the water over to each side of the aircraft. Twenty-four surveys were flown along the south coast between January 2001 and November 2008. Sixteen of these were conducted for Guayanilla Bay and vicinities, and 8 were conducted for Jobos Bay and vicinities. A total of 77.4 flight hours were conducted, representing 53.9 overall hours of survey effort. A total of 271 sightings were recorded during the 24 surveys conducted. The number of sightings per survey averaged 11.8 (min 3, max 30). The average sighting per effort hour for manatees was 5.2. The average number of manatees observed per survey was 21.7 (min 6, max 61), higher than that found for the same area by Powell et al. (1981) (0-14), Rathbun et al. (1985) (0-10) and Freeman and Quintero (1990) (0-8). However, there was a slight difference between the average number of manatees observed in the southeast coast (mean 27.9, min 9, max 61) in comparison to those observed in southwest coast (mean 18.4, min 6, max 37). The average number of manatees per effort hour was 9.7, much higher than that found for the area by Powell et al. (1981) (3.1), Rathbun et al (1985) (5.6), and Freeman and Quintero (1990) (2.1), and considerably higher when comparisons are made with other manatee survey studies in the Caribbean. Manatees utilize the entire south coastline of Puerto Rico, from Cabo Rojo to Patillas.

In the southwest coast, manatees are evenly distributed, with patches of higher use in Bahía Montalva (Lajas and Guánica), Ensenada las Pardas, Bahía de Guánica off Río Loco (Guánica), Punta Verraco, on both sides of Punta Guayanilla, cayos Caribe, Palomas, Río and María Langa in Peñuelas, Isla del Frío in Ponce. Manatees constantly use the mouth of Río Loco in Guánica, at times venturing within the river, which seems to be one of the most important fresh water sources for manatees in the area. Ensenada las Pardas in Guánica and Punta Verraco in Guayanilla as well as windward side of Punta Guayanilla and the cays at Bahía Tallaboa serve as important feeding areas. The leeward side of Punta Guayanilla seems to provide them with shelter. Manatees were repeatedly observed in La Parguera's Bioluminescent Bay and Parguera's offshore cays, particularly Arrecife Margarita. On the southeast coast of Puerto Rico, manatees are found from Ponce, east to the mouth of Rio Jacaboa in Patillas. They are commonly observed in Santa Isabel between Punta Aguila and Isla Puerca, in Sailnas near Cayo de la Mata and Puerto de Salinas, and in Puerto de Patillas. The highest concentration of sightings was recorded in Jobos Bay, specifically within an imaginary triangle consisting of north of Punta Pozuelo, east of Central Aguirre and west of Puerto de Jobos. Of interest, was the use of manatees of the cays off the coast, including Cayos de Barca, Cayos de Ratones in Salinas, and Cayos Cabezasos, Cayo Caracoles and Cayo Barbería off Santa Isabel. Given that manatee survival in Puerto Rico is threatened by anthropogenic impact, now a days mostly by watercraft collisions, habitat use maps and analysis resulting from these surveys, together with radiotelemetry data, may serve to delineate critical manatee habitat in southern Puerto Rico in order to put in place a buoy system that will warn boaters of probable manatee presence in heavily used areas, establish speed limits in these areas, and thus help protect this species from human-induced mortality.

Reduced genetic diversity and delineation of management units in *Trichechus manatus* populations

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Effective management of imperiled species requires detailed genetic and taxonomic information to identify properly species, subspecies, and distinct population segments. The threatened West Indian manatee (*Trichechus manatus*) is a slowly reproducing aquatic mammal, whose small, isolated populations are negatively impacted by habitat destruction and anthropogenic mortality. Relatively little information is available on the amount or distribution of genetic diversity in the West Indian manatee, presenting challenges to conservation biologists seeking to promote healthy ecological and evolutionary processes. Consequently, genetic studies, using microsatellite and mitochondrial DNA, were implemented to quantify the genetic diversity and identify unique populations or regions in need of protection. The Florida (*T. m. latirostris*) and Puerto Rico (*T. m. manatus*) manatee populations are currently listed together under the U.S. Endangered Species Act. The 2007 species status review suggested the downlisting of the populations from endangered to threatened, primarily due to the recent recovery of the Florida population (USFWS, 2007). Here, a survey of microsatellite DNA variation in the Florida and Puerto Rico populations identified highly significant differentiation ($FST = 0.16$, $P < 0.001$), which suggests that each population should be considered a unique unit of management. The Puerto Rico population is considerably smaller, occupies a strictly marine habitat, experiences distinctive threats, and would benefit from a separate management plan. Long-term exploitation and small population sizes can lower genetic diversity, which results in decreased fitness, reduced adaptation to environmental change, and potentially leads to extinction (Frankham et al., 2002). A meta-analysis of population genetic studies determined that disturbed, hunted or fragmented, mammalian populations (Aave = 6.9) have appreciably lower genetic diversity than large outbred mammalian populations (Aave = 8.8; DiBattista 2002). The Florida, Belize, and Puerto Rico manatee populations have reduced genetic diversity (Aave = 5.3, 3.4, and 3.9, respectively) as compared to the average disturbed mammalian population, emphasizing the need for conservation practices that protect and maximize the existing genetic diversity. Additionally, the Florida population has a smaller effective population size, Ne, relative to the Ne and size of the Belize and Puerto Rico populations. Ne is defined as the number of individuals in an idealized population that would show the same amount of inbreeding or loss of genetic diversity as the population under consideration (Wright 1931, 1938). These data suggest that although Florida is the largest West Indian manatee population, levels of genetic diversity have not yet recovered to allow for long-term sustainability. Small population sizes, reduced genetic diversity, and lack of understanding of evolutionary relationships underscore the need for continued research, monitoring, and conservation of all West Indian manatee populations.

Genetic Studies and Population Structure of the West Indian Manatee (*Trichechus manatus manatus*) in Mexico

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The West Indian manatee (Trichechus manatus manatus) is an endangered species that inhabits the Atlantic coast from the Gulf of Mexico to Brazil. It is a protected species under international agreements and in each country further protected under national laws. To

date there is little known about the population estimate in Mexico. For the state of Quintana Roo there is an estimation of between 200 to 250 manatees, which represent close to the suspected total of individuals occurring in the Yucatan Peninsula. The conservation of the manatee in Mexico could be improved by incorporating genetic data into the management plan. Manatee population analysis, using mtDNA, from different areas of its worldwide distribution, illustrates a low level of genetic variability (Garcia-Rodriguez *et al*., 1998, Vianna *et al.,* 2006). In Mexico, the Gulf population shows a lower level of genetic diversity compared to the Caribbean population (Castañeda and Morales, 2005). Microsatellites, for their high level of variability between individuals, is used for better evaluation of the level of genetic variability tends to more accurately reflect the genetic differentiation not only of the maternal genes but that of both parents. We analyzed 98 samples from Quintana Roo (66), Tabasco (18), Chiapas (5) and Veracruz (9) for sixteen microsatellites. We observed high variability among individuals using these polymorphic microsatellites that allows us to identify each individual (Sib P(ID) = 1,65E-05; HW P(ID) = 2,68E-13). Genetics structure results indicate a moderate differentiation (RST = 0.1042) between the Caribbean Coast cluster and the Gulf of Mexico one, as has been previously suggested by mtDNA analysis. The Caribbean Coast appears as a mixture of manatees from the Gulf of Mexico and Florida. The information generated from microsatellites is used to make recommendations to determine management units and for conservation. It will also be used to better estimate the number of individuals, determine the reproductive success of the individual manatees in the population in Mexico as well as propose a baseline for reproduction in captivity to minimize inbreeding.

Auditory and Tactile Detection by Florida Manatees

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The turbid waters that manatees inhabit in conjunction with poor visual acuity (Bauer et al., 2003) suggested to researchers that the senses of hearing and touch would play a substantive role. This has been born out for both hearing (Gerstein et al., 1999; Mann et al., 2005; Colbert et al., 2007) and active touch (Batchteler and Dehnhardt, 1999; Bauer et al., 2005). Our recent research further emphasizes the manatees' specializations for detecting high frequency pressure waves using auditory mechanisms and low frequency vibrotactile stimuli. A behavioral audiogram indicated that manatee auditory frequency detection for tonal stimuli ranged from 0.25 to 90.5 kHz with peak sensitivity extending from 8 to 32 kHz. Critical ratios, thresholds for tone detection in the presence of background masking noise, were determined with one-octave wide noise bands, 7 – 12 dB (spectrum level) above the thresholds determined for the audiogram under quiet conditions. Manatees appear to have quite low critical ratios, especially at 8 kHz. This suggests that manatee hearing is sensitive in the presence of background noise, which also suggests that they have relatively narrow filters in this frequency range. Interestingly, many manatee vocalizations are tonal harmonic complexes that often include a tonal component in the 4-8 kHz range. Manatees possess specialized sensory hairs (vibrissae) that cover their face and body, a unique attribute among mammals. Reep (2002) has suggested that they use these vibrissae to tactually sense hydrodynamic stimuli. The first phase of a planned, multistage investigation of the role of the vibrissae in detecting low frequency vibrations has been completed. Two Florida manatees were tested in a go/no-go paradigm using a modified staircase method to assess their ability to detect water movements created by a sinusoidally oscillating sphere that generated a dipole field at frequencies below the apparent functional hearing limit. The detection data were used to generate a tactogram, a graphic representation of thresholds for particle velocity at various frequencies. The manatees detected stimuli down to a frequency of 5 Hz.

The Neural Basis for Tactile Hair Sensation in Manatees

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All sirenian hairs are vibrissae (tactile hairs), distributed over the entire face and postfacial body, in contrast to the restricted distribution seen in most other mammals. This suggests an expanded functional role for vibrissae in sirenians. The facial vibrissae are used most often in direct tactile contact during feeding or investigation of novel objects. The postfacial vibrissae appear to detect hydrodynamic stimuli, potentially including significant environmental stimuli such as approaching animals, water currents and tidal flows, and changes in topographic contours of the shallow water environment. Therefore, this system may be used for "touch at a distance", analogous to the lateral line system in fish. As revealed by immunofluorescence, all manatee vibrissae follicles have many types of C, Aδ and Aβ innervation including Merkel, club, and longitudinal lanceolate endings at the level of the ring sinus (Sarko et al., 2007a). Manatee follicles have two unique types of Aβ-fiber endings: exceptionally large-caliber axons that branch to terminate as novel, gigantic spindle-like endings located at the upper ring sinus, and smaller-caliber Aβ fibers that terminate in the trabeculae of the cavernous sinus as an ending that resembles a Golgi tendon organ. Postfacial follicles are markedly smaller than those of the face. Each postfacial follicle is supplied by ~30 axons, compared to ~50 axons innervating follicles of the perioral bristles, and 70-225

axons per oral disk follicle. A total of ~5000 follicles are present on the body, innervated by a total of ~210,00 axons. The brainstem, thalamus, and cerebral cortex exhibit anatomical specializations likely associated with processing the large amount of information from the vibrissae. In the brainstem these include large, lobulated trigeminal nuclei for inputs from oral disk vibrissae and perioral bristles, an intricately patterned cuneate-gracile complex for vibrissal projections from the forelimb flipper and trunk of the body, and a large Bischoff's nucleus in the caudal brainstem that presumably receives input from the fluke (Sarko et al., 2007b). In the thalamus large, subdivided ventral posterior thalamic nuclei that receive input from these brainstem somatosensory nuclei constitute a disproportionately high volume of the thalamus. The trigeminal-recipient ventral posteromedial thalamic nucleus and the ventral posterolateral nucleus, which receives inputs from the postfacial body, are comparable in size (Sarko et al., 2007b). Within cerebral cortex, the large presumptive somatosensory cortex appears to contain multiple functional representations, including neuron aggregates that may correspond to vibrissal specializations seen in the cortices of other taxa (Sarko and Reep, 2007). The putative primary somatosensory cortex of the manatee is disproportionately large relative to primary auditory and visual cortices, as in other somatosensory specialists like the naked mole-rat, echidna and platypus. Many of the somatosensory specializations present in manatees are also seen in dugongs, and thus appear to be associated with adaptation to aquatic herbivory. Unusual cases such as these are important not only because of their relationship to taxon-specific behavioral adaptations, but also because they represent the range of variation present in sensory systems and their central representations, and thus the known extent of evolutionary potential.

The Manatee Respiratory System in Health, Rehabilitation, Anesthesia, and Disease

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The Florida Manatee, *Trichechus manatus latirostris,* has a number of interesting and unique anatomic characteristics of its respiratory system that have evolved for success in the aquatic environment (Rommel and Reynolds, 2000). These anatomic differences impact the severity of lesions from traumatic episodes and can affect the level of care given to injured, ill and anesthetized animals. With the initiation of a new respiratory cycle the nasal flaps fold ventral caudally. Expiration is rapidly initiated and is closely followed by a strong more prolonged inspiration. Air travels the nasal passage divided into channels (meatus) before converging at the caudal pharynx. Here it passes by relaxed pharyngeal tissue that also may serve to protect the animal from accidental inspiration before entering the open glottis. The distance from the glottis to the separation of the trachea into right and left main stem bronchus is very short often less than 10 cm depending on the size of the animal. The manatee lungs are elongate, nonlobed, and relatively flattened structures. The lungs are situated longitudinally along the back with each lung anchored to the vertebrae along the medial border and completely separated from the other by a complete hemi diaphragm. Each hemidiaphragm is attached to the ventral surface of the vertebrae in a horizontal pane. The clinician involved with manatee anesthesia is aware that intubation through the oral cavity is difficult since the mouth is very narrow, the surface of the tongue is curved and the soft palate extended interfering with access to the glottis. The first attempts at oral intubation were unsuccessful so the nasal cavity was used providing direct access to the glottis. Once intubated the tube placement is checked with a bronchoscope to verify that the endotracheal tube is placed in the short trachea and not extended into one lung. The upper respiratory system may be affected by parasites (*Cochleotrema cochleotrema*). A severe infection of these trematodes can cause nasopharyngitis. *C. cochleotrema* can also be found in the airways of the lungs. Inhalation of aerosols of brevetoxin can lead to mucosal congestion in the nasopharynx. Cold stress may affect the borders of the nasal flaps resulting in epidermal and dermal necrosis. Fishing hooks have been embedded in the caudal pharyngeal tissue or soft palate resulting in abnormal inspiratory and expiratory noise. The lower respiratory system of the manatee may be affected by a number of etiologies similar to other species including bacterial (broncho)pneumonia, pleuritis, and abscessation. However, the most common pathologies of the lower respiratory system are trauma-related. Sharp propeller trauma can expose the chest, and in some cases a lung prolapses through the wound. Acute blunt trauma may involve fractured ribs, lung damage/collapse, pneumothorax, hemothorax, and/or subcutaneous emphysema. Secondary infection of the damaged tissues can lead to pulmonary adhesions, pneumonia, pyothorax, open fistulous tracts and chronic pulmonary consolidation. Other complications from trauma involve diaphragmatic hernia and lung torsion when the caudal loose portion of the lung folds anteriorly and becomes trapped. When large amounts of blood, purulent material, or air accumulate in the damaged hemithorax, the animal will function on only one lung and exhibit buoyancy problems. Bacterial etiologies include aerobic and anaerobic organisms and require therapy geared toward both categories. Knowledge of the common complicating factors in injured animals can allow the clinician to prevent additional deterioration with the proper use of antibiotics, fractured rib management techniques and sedation to minimize additional chest damage during handling and feeding.

Manatee Brevetoxicosis and Cold Stress Syndrome: Pathologic Features of 'Natural Disease'

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The Florida manatee (*Trichechus manatus latirostris*) is one of four living species in the scientific order Sirenia and is considered endangered due to human-related and perinatal mortality, as well as destruction and degradation of habitat caused by widespread development in Florida. Manatees appear to be remarkably resistant to natural disease although brevetoxicosis (intoxication with Florida red tide toxins) and cold weather conditions have taken a toll during the last decade. The pathologic features of these natural mortality events are unique. Manatee brevetoxicosis can occur via ingestion and/or inhalation. The inhalational route of brevetoxin exposure appears to be unique in manatees but shared with humans. The gross lesions of brevetoxicosis include severe asopharyngeal, pulmonary, hepatic, renal and cerebral congestion and nasopharyngeal and pulmonary edema and hemorrhage. Consistent microscopic lesions may consist of catarrhal rhinitis, pulmonary hemorrhage and edema, multiorgan hemosiderosis and nonsuppurative leptomeningitis. Immunohistochemical staining using a polycolonal primary antibody to brevetoxin (GAB) demonstrates intense positive staining of lymphocytes and macrophages in the lung, liver and secondary lymphoid tissues. Additionally, lymphocytes and macrophages associated with inflammatory lesions of the nasal mucosa and meninges also are positive for brevetoxin. The data suggest that manatee mortality resulting from brevetoxicosis may not necessarily be acute but may occur after chronic inhalation and/or ingestion. Immunohistochemical staining with interleukin-1-β-converting enzyme shows positive staining with a cellular tropism similar to GAB. This suggests that brevetoxicosis might initiate apoptosis and/or the release of inflammatory mediators that culminate in fatal toxic shock. Manatees from Florida's coastlines have continuous potential brevetoxin exposure because red tide blooms are common in these areas. Therefore mortality-associated brevetoxicosis may be cumulative and the result of high dose or prolonged low dose exposure to these biotoxins. Additionally, prolonged non-lethal toxin exposure may compromise normal immunologic responses predisposing these manatees to opportunistic disease. Chronic exposure to cold water produces a cascade of clinical signs and disease processes termed the manatee cold stress syndrome (CSS). Emaciation, fat store depletion, serous fat atrophy, lymphoid depletion, epidermal hyperplasia, pustular dermatitis, enterocolitis and myocardial degeneration are consistent lesions of CSS. The data indicate that CSS is a complex multifactorial disease process that involves compromise to metabolic, nutritional and immunologic homeostasis and culminates in secondary opportunistic and idiopathic diseases. These findings are critical for developing future management strategies for this endangered species due to the apparent increased prevalence of red tides and the disappearance or sporadic availability of man-made sources of warm water that manatees habituate. Additionally, the two diseases may be synergistic further complicating management strategies.

Manatee papillomavirus (TmPV-1) infection among captive and free-ranging manatees

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Manatees are among the oldest existing species. During the last decade, we identified and characterized papillomavirus, TmPV-1, from Florida manatees (Trichechus manatus latirostrosis) captive in Homosassa Springs State Wildlife Park (HSSWP) (Rector et al., 2004). This manatee-specific PV causes sessile lesion on the skin of manatees. TmPV is the only PV identified in Florida manatees, but also is one of oldest among almost 250 PV identified so far. Safe and efficacious vaccine against human PVs have been approved by FDA. It is certain that such a vaccine can be produced against TmPV-1 infection, and we generated large quantities of genetically engineered recombinant TmPV VLPs as well as anti-immunoglobulin of manatee. We used these materials to survey for serological evidence of TmPV-1 infections in manatees. Our initial pilot sero-epidemiological study showed that TmPV is highly contagious among captive manatees housed in a pool without clear evidence of the presence of TmPV in free ranging manatees. Later on, however, a large seroepidemiological study carried out on 176 sera collected from 157 different individuals over a period of 11 years at the Florida Integrated Science Center indicated that TmPV infections are common among free-ranging manatees as well as captive ones. 35.0% (14/40) of captive animals were sero-positive for TmPV and 29.1% (34/117) among the free-ranging ones. Close observation showed clinical evidence of papillomas in only the former. This accumulated information can be used in conservation of manatees.

Evaluation of trace metals in the Florida manatee (*Trichechus manatus latirostris*) from the Gulf Coast

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The potential impact of anthropogenic contaminants is a growing concern in many aquatic species, as these animals are exposed to a diverse group of toxicants and chemicals, including trace metals, from their surrounding environment. The Florida manatee habitat

often coincides with areas of human use, placing manatees in very close proximity to anthropogenic influences by residing in many urban areas. While many studies have examined trace metal concentrations in cetaceans and pinnipeds, only two studies have been reported for metal levels in manatees (O'Shea et al. 1984, Stavros et al. 2008). Under the supervision of USGS Sirenia Project and Florida Fish and Wildlife Conservation Commission researchers, whole blood samples from 42 free-ranging manatees were collected during health assessments at 3 different sites throughout the state of Florida (Crystal River, Lemon Bay, and Everglades). Our results suggest that trace metal concentrations in whole blood of manatees differs from other marine mammals. Zinc was quite elevated at 14.88±1.31ppm, while selenium was quite low at 0.22±0.09ppm. However, it is unclear whether the unusual levels of trace metals are due to local environmental influences or to differences in metal metabolic processes. Whole blood metal concentrations were then compared across three sites. For example, copper concentrations in the Everglades (0.4±0.19ppm) were significantly lower than those in Crystal River (0.82±0.19ppm) or Lemon Bay (0.75±0.11ppm). These results demonstrate that the local environment can affect trace metal levels in manatees. To investigate factors that may contribute to site specific differences, plant, sediment and water samples are currently being analyzed, in addition to trace metal distribution. We have obtained various tissues from a number of different age groups and sex combinations to determine distribution of trace metals. Due to the dramatic differences in zinc levels, we are interested in how manatees maintain these levels without apparent adverse effects. Metallothionein (MT) is a small metal binding protein involved in divalent metal homeostasis in most mammals. MT has been characterized in many aquatic animals, however, has yet been examined in the Florida manatee and may play an integral role in trace metal homeostasis. We are currently developing tools to determine expression of metallothionein in tissues from the Florida manatee and the response of MT to metal exposure. We anticipate that we may be able to develop MT expression assays as a biomarker of metal exposure in the manatee.

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