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IN THIS ISSUE:

- TRIBUTE TO DR. AKOI KOUADIO (pg. 1)
- OLDEST DUGONG CEREMONIAL SITE (pg. 8)

Tribute to Dr. Akoi Kouadio
World Renowned Conservationist with the Wildlife Conservation Society



Dr. Akoi Kouadio, a West African manatee scientist and conservationist and Coordinator of the Wildlife Conservation Society's (WCS) Côte D'Ivoire Coastal Wetland and Biodiversity Conservation Projects, died Thursday, August 13, 2009 in Côte D'Ivoire.



UNION INTERNATIONALE POUR LA CONSERVATION DE LA NATURE ET DE SES RESSOURCES
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Commission de la sauvegarde des especes-Species Survival Commission

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Cynthia R. Taylor, Wildlife Trust, 233 Third St. N., Suite 300, St. Petersburg, FL 33701 USA
and

James A. Powell, PhD, Sea to Shore Alliance, 200 Second Ave. S., #315, St. Petersburg, FL 33701 USA

Sirenews is available online at www.sirenian.org/sirenews.html

Dr. Kouadio's quiet demeanor belied the deep conviction and passion he had for the protection of manatees and Ivorian wildlife and forests.

Dr. Kouadio spent more than 30 years of his life working principally on West African manatee research, education and conservation. He was highly regarded as one of the world's foremost experts on West African manatees.

The son of a cocoa farmer, Dr. Kouadio began his conservation efforts as a young Officer of the Ivorian Ministry of Water and Forests serving as assistant director of the Azagny National Park. After four years at the Azagny Park, Dr. Kouadio chose to pursue his true love and passion: the conservation of manatees.

Beginning in January of 1989, Dr. Kouadio developed the Wildlife Conservation Society's West African Manatee Conservation and Education Project in the coastal lagoons of Côte D'Ivoire close to Azagny. During the course of the next several years, he conducted research and worked closely with leading experts to develop a manatee conservation project, including the establishment of an educational program for the local fishing communities and sponsoring story-telling competitions and inspiring nature clubs. His work also continued in Azagny National Park, which includes important populations of elephants, West African chimpanzees and pygmy hippopotamuses.

Since July 2003, Dr. Kouadio acted as Coordinator of WCS's Coastal Wetland and Biodiversity Conservation Project, based in Côte D'Ivoire. While managing this project, Dr. Kouadio was awarded his PhD in 2004 from the University of Kent, UK. He remained as Coordinator until his death.

Dr. Kouadio's work with West African manatees was one of the few bright spots for this creature. WCS is deeply concerned that this already vulnerable species is close to being eradicated from much of its range throughout West Africa. The loss of Dr. Kouadio means the manatees have lost a true champion and someone who was able to develop solutions to the many threats the manatees face in the region jeopardizing their long-term survival.

Many of Dr. Kouadio's colleagues recall his truly remarkable ability to create bonds and build friendships across cultures and communities. They say this trust and respect made Dr. Kouadio a powerful and very effective environmental teacher and conservationist. "A truly dedicated individual, and a champion of conservation, Dr. Kouadio will be missed tremendously," says John Robinson, the Executive Vice President for Conservation and Science at the Wildlife Conservation Society. "Dr. Kouadio's death creates a void in the sphere of conservation of aquatic mammals, especially the West African manatee. The commitment he showed to conservation is unmatched. The Wildlife Conservation Society has lost a great colleague."

Dr. Kouadio died at age 47. He is survived by his wife, Mme. Akoi Kouadio née Ahou Juliette and daughter, Marguerite Akoi.

Special Note – WCS would be glad to facilitate private donations to the family of Dr. Akoi Kouadio in Côte D'Ivoire to help them through this difficult time.

To make a donation by check, please contact Amy Pokempner at apokempner@wcs.org for details. Please include in your email to Amy the subject line "Akoi Kouadio Family Fund". Please remember that, in accordance with the requirements of the U.S. Internal Revenue Code, any such donation would not be tax deductible to a U.S. taxpayer.

Editor's Note – Akoi and I met in 1986 when I began a research project on West African manatees in Côte d'Ivoire. He and I worked closely together for three years. During that time, his passion for manatees grew and his commitment as a conservation biologist strengthened. Akoi was my colleague, friend, teacher, translator and doctor during those years living in the bush of West Africa. I shall forever be grateful to him. I will remember Akoi as one of the most gentle, kind, considerate and dedicated individuals I have ever met.

The survival of endangered manatees in Côte d'Ivoire will be attributed to his lifelong achievements. –**Buddy Powell**

JAPANESE NGOs PROMOTE “2010 INTERNATIONAL YEAR OF THE DUGONG”

As the result of the adoption of “Promotion of Dugong *during the UN 2010 International Year for Biodiversity*” at the 4th IUCN World Conservation Congress, Japanese NGOs (including WWF Japan) decided to announce the year 2010 as the “International Year of the Dugong”. It will increase awareness of the present situation of the dugong worldwide. Throughout the year 2010, various promotional activities will be held. WWF Japan is now calling on related groups all over the world to support “2010 the International Year of the Dugong”. Promotional posters, leaflets and activities schedules will be available on WWF Japan’s website (scheduled to be available in November): <http://www.wwf.or.jp/dugong/>.

The Save the Dugong Campaign Center (SDCC) is now conducting an online petition campaign to “Call for Immediate Implementation of the IUCN Resolution for Dugong Conservation”. Please take action now! <http://www.thepetitionsite.com/1/save-the-okinawa-dugong>

One urgent case is in Okinawa, Japan, where the northernmost dugongs in this habitat face the possibility of extinction due to Japanese and U.S. government plans to construct a U.S. Marine Corps facility. It is crucial to create an international framework to promote the understanding of and implement existing and forthcoming measures for dugong conservation while also calling for the responsibility and accountability of the Japanese and US governments in their undertaking of the construction plan.

In January 2008, however, the U.S. Federal District Court delivered an extremely important decision, ruling that the U.S. government was responsible and had failed to comply with the National Historical Preservation Act (NHPA) in drawing up the construction plan. The court also ordered the U.S. government to comply with the NHPA by reviewing the Japanese government’s environmental impact assessment (EIA) and to find a way to avoid or mitigate adverse effects on the dugong from the construction of the facility. The U.S. court decision provides an excellent opportunity and a vital framework for the IUCN Congress to urge the Japanese and US governments to conduct a joint EIA for the conservation of the Okinawa Dugong.

For your reference, you can find the resolution of the World Conservation Congress in Barcelona, 2008, at the following website:

http://intranet.iucn.org/webfiles/doc/IUCNPolicy/Resolutions/2008_WCC_4/English/RES/res_4_022_promotion_of_dugong_during_the_un_2010_international_year_for_biodiversity.pdf

For further information, please contact to Yoshiko Machida, Senior Communication Officer, WWF Japan e-mail:machida@wwf.or.jp tel: +81 3 3769 1713

REPORT FROM THE SCB INTERNATIONAL MARINE CONSERVATION CONGRESS WORKSHOP ON IMPROVING THE CONTRIBUTION OF MARINE PROTECTED AREAS TO THE CONSERVATION OF SIRENIANS

A four day workshop from 21-24 May 2009 was held at the Society for Conservation Biology’s International Marine Conservation Congress at George Mason University in Fairfax, Virginia, USA. Attendance ranged from 26-36 participants over the four days from 16 countries, including Australia, Belize, Brazil, Colombia, Cote d’Ivoire, Dominican Republic, Guatemala, India, Japan, Malaysia, Mexico, Senegal, South Africa, United Arab Emirates, USA, and the UK. The U.S. Marine Mammal Commission was the main sponsor of the workshop, providing much needed travel funds for participants from around the world.

Seventeen speakers gave presentations during the first three days of the workshop (abstracts presented below in the Abstracts section), and five posters were presented. The final day of the workshop consisted of an interactive group exercise facilitated by Helene Marsh on developing effective protected areas for sirenians in developing countries.

A bulleted summary of the interactive session is presented below:

1. SWOT analysis of Protected Areas as a tool to reduce the risk to sirenians in developing countries

Strengths of Protected Areas:

- Identifies areas for protection
- Legal framework of the Protected Area
- Access to funding
- Inclusion of sirenians as flagship species within the species to protect
- Official presence within the areas
- Attracts civil support (NGO, community, university)

Weaknesses of Protected Areas:

- Mostly too small
- Low representation of the range of sirenians
- Not usually implemented
- No rules; creation of a paper park
- Enforcement is lax
- Many are multiple use
- Massive tourism
- Lack of continuous funding
- Based on inadequate knowledge of sirenians
- Capacity deficit of park staff
- Often dependent on the enthusiasm and energy of short term champions
- Lack of succession planning for managers and scientists
- Ephemeral funding
- Lack of alternative livelihoods
- May not resolve hunting problems
- Top-down imposition of rules and regulations
- Mismatch between geopolitical and ecological scales

Opportunities that could potentially be provided by Protected Areas

- Multiple use areas can be designed to meet different objectives
- Community involvement in conservation
- Funding
- Educational outreach
- Research
- Improved habitat protection
- Hunting controls

- High protection for areas of high sirenian density migratory corridors
- Buffer zones
- Influence behavior of impacting communities including communities external to protected area
- Protection at range of temporal and spatial scales
- Advocacy
- Co-management
- Sirenians as flagships
- Livelihood to the local people.
- Enhancement of cultural rights

Threats to Sirenians in Protected Areas:

- Unsustainable tourism
- Illegal hunting
- Continued use of fishing gear that causes sirenian mortality and destroys habitat
- Lack of continuous funding
- Lack of connectivity between protected areas
- Illusion of protection
- Deleterious activities can influence the creation of protected areas
- Failure to manage impacts outside the protected area
- Political conflict between nation states
- Lack of political will to manage the protected areas

2. Features of a Protected Area that reduce the risk to sirenians in developing countries

1. Community involvement that incorporates local knowledge
2. Management plan that reflects legal framework and includes goals specific to sirenians
3. Legal framework with political will to implement protected area
4. Strong education and outreach program
5. Protected Area network large enough to protect ecological processes and include a high proportion of the sirenian population throughout the year
6. Long-term funding adequate to implement management plan
7. Co-management involving government, NGOs, local communities and researchers
8. Effective enforcement of management plan
9. Capacity building including succession planning for all partners in the co-management arrangement: government, NGOS, community, researchers
10. Management informed by active research program
11. Alternative livelihoods for those community members affected by the implementation of the management plan

Additional recommendations

- Reduction of human-induced mortality to sirenians should be the highest priority for sirenian conservation.
- Regional workshops and community level exchanges would provide valuable opportunities to exchange ideas.
- Workshop on the challenge of ecotourism as an alternative livelihood would be timely.

-Helene Marsh¹, Caryn Self-Sullivan², Ellen Hines³, and Cyndi Taylor⁴ (¹helene.marsh@jcu.edu.au, ²caryns@sirenian.org, ³ehines@sfsu.edu, ⁴taylor@wildlifetrust.org)

LOCAL NEWS

CUBA

Report from the Second Cuban Sea Turtle and Marine Mammal Necropsy Workshop. The Second Sea Turtle and Marine Mammal Necropsy Workshop in Cuba was held at the Central University “Marta Abreu” of Villa Clara from 22-24 April 2009. The workshop was organized jointly through collaborations with the Marine Research Centre of Havana University (CIM), the National Enterprise for the Protection of Flora and Fauna (ENPFF) and the University of Villa Clara, within the framework of the Fourth International Conference of Agriculture. Special support was provided by Wildlife Trust, the Sea to Shore Alliance and the John D. and Catherine T. MacArthur Foundation. Specialists from the United States, Puerto Rico, and Belize participated in the workshop, along with 25 biologists and veterinarians from various marine protected areas within Cuba. The main goal was to increase knowledge and skills in order to analyze mortality events of sea turtles and marine mammals throughout Cuba. A manatee carcass was transported from Florida and theoretical and practical work sessions were conducted on anatomy, stranding proceedings, sample collection and experiences from other countries. The workshop was an opportunity for the sharing of knowledge and information between Cubans and colleagues from other countries. –**Anmari Alvarez** (Marine Research Centre of Havana University, anmari@cim.uh.cu)

SOLOMON ISLANDS

Interview surveys to establish dugong population status in the Solomon Islands. In 2008 and 2009 interview surveys were conducted in Papua New Guinea and the Solomon Islands to establish population status, distribution and mortality of dugongs.

Several surveys for dugongs have been conducted in Papua New Guinea since the 1970's. Hudson (1976) conducted postal surveys in Papua New Guinea in 1973-74 and listed the Samarai Islands of Milne Bay, Kairiru Island off Wewak, and Lou and St. Andrew Island groups off Manus as the most important areas for dugong conservation in Papua New Guinea. In 1977, Ligon and Hudson conducted aerial surveys of Lae, the southeast and northwest coasts of Papua New Guinea and the northwest coast of West New Britain. The most recent dugong surveys were done in the Samarai Islands in Milne Bay Province (Yen 2006). Whilst there are records for dugong sightings in the Solomon Islands, no specific surveys have been done to assess dugong abundance.

Survey locations were targeted for this survey, based on the previous survey data, advice from local fishermen and available seagrass habitat mapping. Surveys were completed in Manus, Bougainville and four provinces of the Solomon Islands. We hope to continue this work in other provinces of Papua New Guinea as funding becomes available.

Interviews were conducted in 13 coastal locations on the island of Manus in Jan-Feb 2008. A total of 64 adults and 18 dugong calves were reported along the coast of the main island and surrounding smaller islands of Manus (Figure 1). Respondents estimated to have seen approximately 952 dugongs in the past 5 years around Manus. The areas that were reported as supporting the largest number of dugongs were Malabang, Pere, Tawi Island and Sori Island.

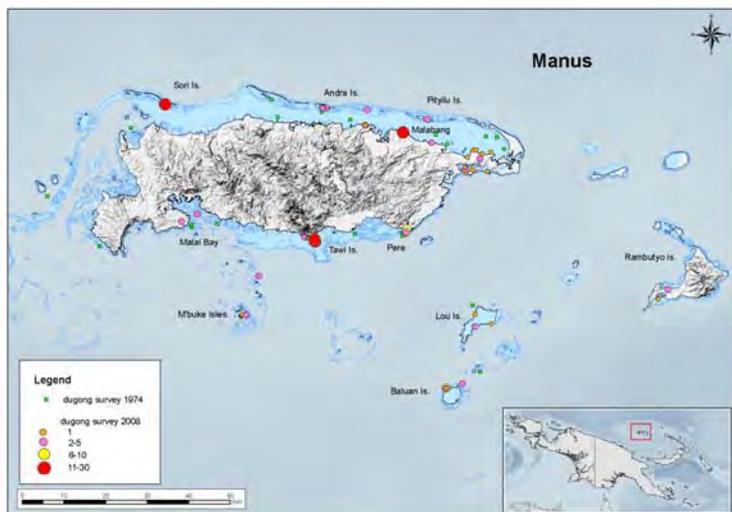


Figure 1. Dugong sightings recorded for Manus in 2008 compared with 1974 surveys.

A total of 34 stranded dugongs were reported since the 1980's. More than half of these were trapped in nets. Whilst dugongs are hunted in Manus, on average people reported that only 1-2 dugongs are caught in their village each year. Seventeen percent of people interviewed do not eat dugong because of religious beliefs or taboos and 35% percent of respondents had eaten dugong in the last year.

Interviews were conducted in 25 locations in 5 coastal areas of Bougainville (Figure 2). A total of 20 adults and 10 calves were reported for the period from Jan-Feb 2008, with a total of 37 adults and 17 calves reported overall for 2007-2008. There were six dugong strandings reported since 2003. Fifty two percent of respondents do not eat dugong. Dugongs are not usually consumed by local communities, unless one is found trapped in a net, or in times of crisis when food is in short supply.

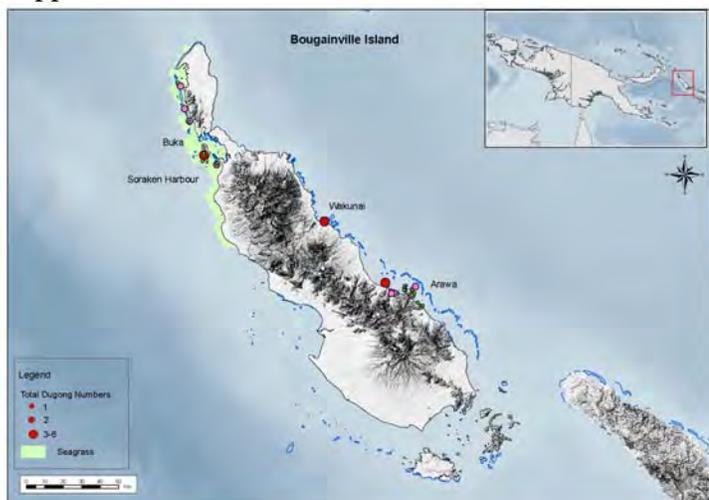


Figure 2. Dugong distribution in Bougainville recorded in the 2008 survey.

Interview surveys were conducted with 98 people from 24 locations in Malaita, Central, Isabel and Western Provinces of the Solomon Islands in February 2009. A total of 300 dugongs were reported and respondents estimated having seen 742 in the past 10 years. A total of 56 dugongs were reported stranded from nets but this was both accidental and intentional netting. Whilst dugong are hunted in 47% of the areas

surveyed, only 36% of people reportedly eat dugong, and generally only once or twice a year. **-Deborah Bass** (Conservation International, Indonesian-Pacific Field Division, 47 Maunds Road, Atherton 4883, QLD. Tel: 07 40918830, debbbass@hotmail.com)

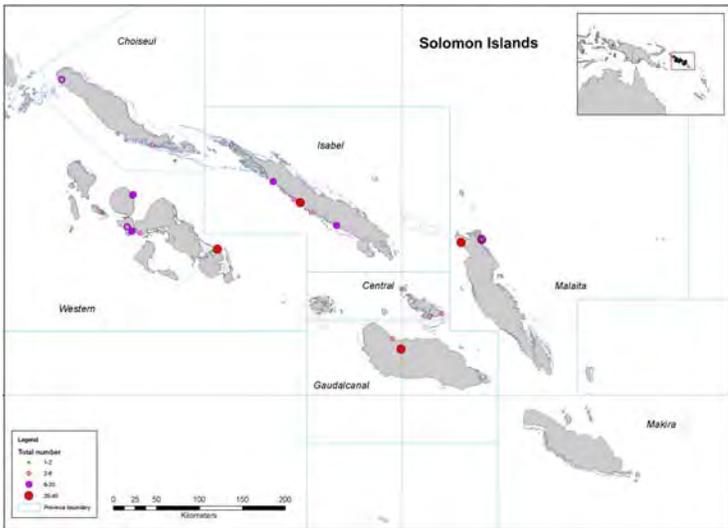


Figure 3. Dugong distribution in the Solomon Islands recorded from 2009 survey.

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Ligon, S. and B. E. T. Hudson. 1977. Aerial survey of the dugong *Dugong dugon* in Papua New Guinea, Wildlife in Papua New Guinea. Konedobu, Papua New Guinea, Wildlife Division, Department of Lands and Environment. **77**: 53-76.

Yen, Robert. 2006, Preliminary assessment of the status of dugong population in Samarai, Milne Bay Province. The Milne Bay Community-Based Coastal and Marine Conservation Project.

UNITED ARAB EMIRATES

The oldest sanctuary dedicated to the dugong (*Dugong dugon*): Akab Island (Umm al-Quwain U.A.E.). The French archaeological mission to the United Arab Emirates and the museum of the Umm al-Quwain Emirate (UAE) have recently discovered the oldest sanctuary in Arabia (3500-3200 BC), as well as the oldest known ceremonial site dedicated to the dugong (*Dugong dugon*).

Introduction

The Arabian Peninsula has provided very little data on the beliefs and ritual practices that preceded Islam. Located in the United Arab Emirates, near the Strait of Hormuz, the Akab sanctuary (3500 BC) today provides us with the first evidence of the rituals practised by the prehistoric coastal societies of the Gulf.

Test excavations were made in the “dugong mound” of Akab in the 1990’s and it was interpreted as a sea cow butchering site. The excavation was resumed between 2006 and 2009 by a new team of pre-historians and faunal experts of the French mission. This work has shown that this is not an unorganized accumulation of bones,

but an intentionally *structured* one whose construction was accomplished in stages. A ^{14}C dating realized directly on a dugong bone attributes it to the second half of the fourth millennium (5140 ± 55 BP. 3568-3116 BC) (Méry & al 2009). This complex construction consists of an ovoid platform extending to approximately 10 m^2 and 40 cm in height. It contains the remains of at least forty dugongs. The top level was organised with two rows of skulls directed toward the east and a third row of skulls with the same orientation on the northern edge of the mound. All of the skulls were carefully wedged into place with the premaxilla deeply embedded into the lower part of the structure and wedges of ribs, sometimes doubled or even tripled, placed all around them. Bundles of ribs were deposited just in front of the first row of skulls to the east.

The lower level of the platform was almost entirely impregnated with an ochre solution that reddened the bones and the natural sediment. This level is characterised by dugong mandibles laid flat, and in some areas, piled several high.

Juveniles, including very young dugongs, are well represented in the mound. We also observe that no animal was deposited whole in the structure, or even a large part of an animal. Moreover, certain anatomical parts, such as the ribs, vertebrae or limbs, are under-represented, which is evidence of intentional selection. The deposition of portions of freshly killed animals is verified by the presence of limbs in anatomical connexion. Today, the bones present the stigmata of a long exposition to sun and wind.

Archaeological remains in the sanctuary

The quantity of archaeological remains within the ritual structure is exceptionally high, with 1,862 objects found within 10 m^2 . These objects were intentionally deposited or inserted into the monument. As most of them are ornamental elements, they have no relation with the dismemberment or butchering of the dugong. Though beads made from shell are present (*Spondylus* sp. *Engina mendicaria*, *Strombus decorus decorus*, *Ancilla* sp. etc.), the most frequent are the tubular beads with an angled distal double perforation of a type very rare in the Gulf. These ornamental elements were found in association with tools (oyster shell fishhooks, bone awls, shell knives, flint flakes) and pebbles. Finally, the remains of gazelle, sheep and goat, sometimes partly articulated, were incorporated in the structure.



The dugong bone mound of Akab, Umm al-Quwain, © S. Méry/MAFUAE

Akab, a marine sanctuary

The excavations at Akab have revealed complex manipulations of carefully selected dugong remains, a very large construction and purposeful arrangements of bones. Intentional deposits of numerous objects (personal ornaments, selected tools, rare or exotic objects) and the remains of domestic and wild terrestrial mammals are associated with the construction, as well as large quantities of ochre.

All of these elements indicate that the organization and use of the Akab monument responded to precise rules during the fourth millennium. The ensemble contributes to the spectacular and ritualized display of a large marine mammal, and we can only be astonished by the fact that at Akab the dugong skulls are directed fully eastward, as are the deceased in certain Neolithic necropolises, such as Jebel al-Buhais 18 (Sharjah Emirate, UAE). This display is also reminiscent of that of the green turtle (*Chelonia mydas*) in the necropolis of Ra's al-Hamra 5 (Sultanate of Oman), which is contemporary with the Akab monument. Here, the animal skulls were placed near the face of the deceased or on the tomb and elements of the shell were placed on the body.

The Akab monument is unique in the Middle-East and has no parallel in the Neolithic in other parts of the world. The only comparable constructions are those on the Australian coasts of the Torres Strait in the ceremonial sites known as *kod* sites, but the dates of these sites are much more recent (fourteenth-twentieth century AD). As at Akab, these constructions contained the remains of dugongs (from a few to several hundred) among which objects were deposited (individual ornaments, various tools and imported objects), as well as terrestrial and marine fauna. In this country, the dugong is an animal of special status, which was, and still is, the subject of propitiatory rites concerning the preparations for its capture, the transport of its remains to land, its dismemberment and/or its consumption. But these rites are related to totemic factors as well as many fishing clans have marine totems, such as shark, marine turtle and the dugong.

The analogy is so strong between the Akab monument and the Australian dugong constructions that we believe the link with fishing rites is highly probable. We can deduce that the Akab monument, with its preconceived organization and construction that was meant to last, was a sanctuary.

Was it exclusively dedicated to rites related to the dugong, whose capture was certainly not without risk, or with sea hunting/fishing in general? We have no elements to respond to this question.

Did the Neolithic fishermen of Akab belong to a society in which not only beliefs and rites were related to animals, but which was also founded on the totem-clan pair, and thus on exogamy? Nothing allows us to affirm this idea. What we observe is the proximity of coastal populations that were separated by several hundreds of kilometres, such as those of Akab and Ra's al-Hamra, but which nonetheless shared many elements of their material culture and technologies, as well as practices of a spiritual order with certain marine animals. - **Sophie Méry¹ & Vincent Charpentier²** (¹French archaeological mission in the UAE, UMR 7041 du CNRS, Nanterre, France; ²Inrap, French National Institute for Preventive Archaeology Research, UMR 7041, Paris, France)

Reference

Méry, S. Charpentier, V. Auxiette, G. Pellé, E. 2009. A dugong bone mound: the Neolithic ritual site on Akab in Umm al-Quwain, United Arab Emirates. *Antiquity* 83.321: 696-708.

UNITED STATES

First Manatee Tagged in Alabama Waters. On Friday, 4 Sep 2009, Dauphin Island Sea Lab's Mobile Manatees Sighting Network (MMSN) successfully tagged a manatee in Alabama waters, the first for the state. This first Alabama capture, a female manatee weighing over 1,000 pounds, has been dubbed "Bama."

The capture and tagging effort was a collaboration among DISL, SeaWorld Orlando, Wildlife Trust

Florida, US Fish and Wildlife Service Alabama Field Office, Alabama Department of Conservation and Natural Resources, and Sea to Shore Alliance.

The two-day capture effort, which started on Friday morning, resulted in the successful tagging of two Alabama manatees, the female Bama and one male. The crew also captured a large female, named Ellie, who is known to be from Crystal River, Florida. Ellie was first identified as a visitor to Mobile Bay, Alabama in 2007 from photographs sent to the Mobile Manatees Sighting Network.

“It was very informative to find Ellie again and learn that she apparently travels between Mobile Bay and Crystal River, Florida, with some repetition,” said Dr. Ruth Carmichael, Senior Marine Scientist at the Dauphin Island Sea Lab and Founder of the Mobile Manatees Sighting Network.

Researchers worked together smoothly and quickly to capture the animals and take the needed information about size and health before fitting the new tags. The specially designed tags will allow each manatee to be tracked continuously by satellite and radio telemetry. Each captured manatee weighed over 1000 lbs, with Ellie alone topping the scale at over 1600 pounds.



Capture crew searching for manatees in Mobile Bay, Alabama.

“It is a very powerful feeling to take a collaborative project like this one from a concept to reality. This is a real pioneering effort for manatee research in the northern Gulf of Mexico. I am very grateful to everyone who helped us make it happen,” stated Dr. Carmichael.

The West Indian manatee is federally protected and the northern Gulf of Mexico is thought to be fringe habitat for these manatees. Data from this research will be used to help manage and conserve manatees in Alabama and other fringe areas.

“Historically, this is the first time we’ve ever tagged manatees in the state of Alabama,” said USFWS biologist Dianne Ingram. “Our goal is to study their travel routes and get data on where they spend time in Alabama. Knowing this will help us learn about their migration patterns and habitat to aid in their recovery,” said Ingram.



MMSN asks the public to observe the animals and report any sightings as soon as possible. A float is attached to the tag, which can be spotted when the animal is near the surface. If you see a tagged animal, do not try to lift, remove, or touch the tag. The tags are constructed to break away if an animal becomes entangled. Federal law prohibits interfering with the manatee's behavior, or harassing them in any way. The best rule is to stay at least 100 feet away and report the sighting to authorities at MMSN, 1-866-493-5803.

If you would like to support this study and other manatee research in Alabama, please commit to purchase a distinctive license plate. For more information visit <http://manatee.disl.org>.

This work was funded by a grant from the Alabama Division of Wildlife & Freshwater Fisheries under traditional Section 6 funding from the US Fish & Wildlife Service and the Mobile Bay National Estuary Program. *—Press release from the Dauphin Island Sea Lab and U.S. Fish and Wildlife Service, 9 Sep 2009*

ABSTRACTS

Castelblanco-Martínez, D. N., A. L. Bermudez-Romero, I. Gómez-Camelo, F. C. W. Rosas, F. Trujillo, & E. Zerda-Ordoñez. 2009. **Seasonality of habitat use, mortality and reproduction of the Vulnerable Antillean manatee *Trichechus manatus manatus* in the Orinoco River, Colombia: implications for conservation.** *Oryx* 43 (2) :235–242.

The Vulnerable Antillean manatee *Trichechus manatus manatus* (Mammalia, Sirenia) is threatened by hunting, entanglement in fishing nets and habitat degradation but most knowledge of the species comes from coastal and estuarine populations. We therefore studied an Antillean manatee population located 1,100 km from the Caribbean coast, in the Orinoco River of Colombia, during 2001–2005. To verify the occurrence of the manatee and to investigate its habitat use throughout the annual hydrological cycle, we carried out surveys for manatees and manatee feeding signs over c. 40 km of the Orinoco River, between El Burro and Bachaco. We made 870 sightings in 1,003 hours of observation, and found 69 feeding areas in 776 hours of surveys. From 82 interviews in a total of 28 locations in Venezuela and Colombia we compiled 90 reports of manatees injured or killed in the Orinoco during 1980–2004. Both habitat use by the manatee and anthropogenic impacts on the species vary with the annual hydrological cycle. Reproduction appears to occur during the low water period in restricted areas that retain deep water. Improved knowledge of the dynamics of manatee migration and regulation of human activities, especially those related to use of nets and boat traffic, are required for conservation of the Antillean manatee in this freshwater habitat.

Parametric projectors protecting marine mammals from vessel collisions. 2009. Gerstein, E.¹, L. Gerstein¹, and S. Forsythe²; ¹Leviathan Legacy Inc., 1318 SW 14th St., Boca Raton, FL 33486, ²U.S. Naval Undersea Warfare Ctr. Div. Newport, Newport, RI

Marine mammals are vulnerable to ship collisions. Measurements of controlled ship passages through vertical hydrophone arrays demonstrate a confluence of propagation factors and near surface effects that obscure the sounds of approaching vessels which then pose serious detection challenges for marine mammals. Joe Blue, who first identified these challenges, later conceived of a parametric method to mitigate them. A highly directional, dual-frequency parametric array has been developed to reduce collision risks by selectively alerting only those animals in the direct path of approaching vessels. The system projector is comprised of multiple elements, band-centered to transmit a high carrier frequency along with a lower side band signal. A single-side band modulation and phase-shift method are employed. The non-linearity of water then demodulates the mixed high frequency carrier into a lower frequency waveform audible to both manatees and whales. The bow mounted array projects a narrow beam directly ahead of vessels, and “fills in” acoustical shadows to alert marine mammals of approaching danger. Controlled field tests of the manatee device in Florida's NASA wildlife refuge are proving effective. Real-world deployments on select Navy and DOD vessels are planned this year and sea tests of a larger whale system will start next year. [Funded by U.S. Department of Defense Navy Legacy Resource Management Program.]

Lanyon, J.M., H. L. Sneath, J. R. Ovenden, D. Broderick, & R. K. Bonde. 2009. **Sexing sirenians: Validation of visual and molecular sex determination in both wild dugongs (*Dugong dugon*) and Florida manatees (*Trichechus manatus latirostris*).** *Aquatic Mammals* 35(2):187-192.

Sexing wild marine mammals that show little to no sexual dimorphism is challenging. For sirenians that are difficult to catch or approach closely, molecular sexing from tissue biopsies offers an alternative method to visual discrimination. This paper reports the results of a field study to validate the use of two sexing methods: (1) visual discrimination of sex vs (2) molecular sexing based on a multiplex PCR assay which amplifies the male-specific SRY gene and differentiates ZFX and ZFY gametologues. Skin samples from 628 dugongs (*Dugong dugon*) and 100 Florida manatees (*Trichechus manatus latirostris*) were analysed and assigned as male or female based on molecular sex. These individuals were also assigned a sex based on either direct observation of the genitalia and/or the association of the individual with a calf. Individuals of both species showed 93 to 96% congruence between visual and molecular sexing. For the remaining 4 to 7%, the discrepancies could be explained by human error. To mitigate this error rate, we recommend using both of these robust techniques, with routine inclusion of sex primers into microsatellite panels employed for identity, along with trained field observers and stringent sample handling.

Silva, F. M. O., J. E. Vergara-Parente, J. K. N. Gomes, M. N. Teixeira, F. L. N. Attademo, & J. C. R. Silva. 2009. **Blood chemistry of Antillean manatees (*Trichechus manatus manatus*): Age variations.** *Aquatic Mammals* 35(2):253-258.

The Antillean manatee (*Trichechus manatus manatus*) is the most endangered aquatic mammal in Brazil. Sampling blood data from such critically endangered marine mammal species is extremely challenging. Although several hematological studies have been developed for captive manatees, captivity studies addressing the environmental and physiological effects on blood values are scarce. The present work describes blood biochemistry values for captive Antillean manatee adults and calves and verifies the occurrence of possible physiological adjustments due to age, sex, and dietary influences. Blood from 13 clinically healthy manatees (eight calves and five adults) were analyzed for 13 blood serum chemistry parameters using a semi-automatic analyzer. Descriptive analysis was performed for all parameters, and differences between sex and age were determined. Calves had higher means of urea (6.29 ± 5.58 mg/dL), total proteins (5.07 ± 0.94 g/dL), globulin (3.06 ± 1.32 g/dL), and alanine aminotransferase (6.19 ± 2.18 U/mL), levels, and lower means of creatinine (1.42 ± 0.64 mg/dL), aspartate aminotransferase (7.24 ± 3.21 U/mL), phosphate (3.03 ± 1.63 mg/dL), and uric acid (0.71 ± 0.17 g/dL) than adults. Further studies are necessary, especially when considering handling and alimentary management in captivity, to provide important data for better monitoring and clinical management of manatees.

The following abstracts are from the SCB International Marine Conservation Congress sirenian workshop, Fairfax, VA, 21-24 May 2009:

Dugongs in Asia. Kanjana Adulyanukosol¹ and Ellen Hines²; ¹ Phuket Marine Biological Center, Phuket, Thailand; ² San Francisco State University, USA

Dugong populations in Asian regions have dramatically declined in number. There are small scattered groups of dugongs throughout their range in Asia. Dugongs are most likely extirpated in Taiwanese waters and Maldives. The northern-most range of dugongs is Okinawa Island, Japan. Dugongs have been reported through interviews, sightings, and carcasses in southern China, Philippines, Indonesia, Brunei, Malaysia, Vietnam, Cambodia, Thailand, Myanmar, Sri Lanka and India including the Andaman Nicobar Islands. Since the 1990s aerial surveys for dugong populations have been conducted in Thailand, Malaysia, Indonesia, and

Japan. Observations of dugongs from high places (mountain and tower) were conducted in Con Dao, southern Vietnam and Mindanao Island, Philippines. Dugong populations have been estimated at between 250 and 1,000 dugongs in Thai and Indonesian waters respectively. Research on the movement and home ranges of dugongs by satellite radio transmitters were applied to 4 dugongs in Indonesia. The study tracked individual dugongs travelling between 17 and 65 km from the site of capture. Most threats to dugongs in Asian regions are from direct hunting and accidental entanglement in fishing gears, particularly gill nets, trawl and set nets, and habitat loss and degradation. It is very challenging to conserve the dugong in Asian countries since dugongs in each country are present in such low numbers. Regional cooperation in research and management for dugongs and their habitats is crucial if these small remnant populations are to be conserved.

Integrating dugong habitat at use with ecosystem-based estuarine conservation planning. Choo Chee Kuang¹, Louisa Ponnampalam², Anna Norliza Zulkifli Poh¹, and Elise Granek³; ¹ Department of Marine Science, Faculty of Maritime Studies and Marine Science, Universiti Malaysia Terengganu, 21030, Kuala Terengganu, Terengganu, Malaysia; ² Institute of Ocean and Earth Sciences, C308, IPS Building, University of Malaya, 50603, Kuala Lumpur, Malaysia; ³ Environmental Sciences and Management, Portland State University, Portland OR 97201, USA

Integrating dugong habitat use with ecosystem-based conservation planning can provide strong scientific basis to justify the need to protect important foraging and sheltering areas, and the connectivity between the two. This approach can substantially increase the size of the protected area designation and guide conservation zoning. The paper discusses on how scientific survey and traditional ecological knowledge on dugongs are incorporated into a proposal to establish a conservation area for the Pulau River Estuary, Malaysia. To identify high conservation priority dugong habitats, three survey methods were, and will be, employed: (1) Aerial surveys to study distribution of dugongs at incoming and outgoing tides, (2) Great balloon fixed on seagrass meadows with attached CCTV to gauge the timing and duration of foraging activity, and (3) Feeding trails survey as an inference to the intensity of seagrass meadows utilized as foraging grounds. The locations, time and date of sightings, incidental captures, strandings and boat strikes associated with dugongs were gathered from fishers to complement a scientific survey designed to determine high conservation priority for dugong habitats. The development of zoning and management measures (e.g., boat speed restrictions, gear prohibition and time-area closures) would require participatory process involving multiple stakeholders.

Dugongs and MPAs off East Africa (Western Indian Ocean). Vic Cockcroft, Centre for Dolphin Studies and The Dugong Trust

Throughout the Western Indian Ocean (WIO) the near-shore zone is highly productive and subject to massive exploitation and development. Coastal resources provide for 'wealth creation' and a cheap and easy way to feed increasing populations. In many states, economic priorities and social upheaval have led to massive human demographic changes and environmental degradation. Livestock overgrazing, poor farming practice, the denudation of coastal and inland forests (increased topsoil erosion) and coastal residential or industrial development all lead to the destruction of sea-grass and coral beds and a reduction in coastal zone productivity. Dugongs are entirely dependent on sea-grass and reef resources.

Historically, dugong distribution extended from Somalia in the north, through Kenya, Tanzania, Mozambique and further east off the islands of the Comoros, Seychelles, Madagascar and Mauritius. Despite the establishment of numerous MPAs, recent data indicate that dugong populations in the region have declined steeply since the 1960s. This is due largely to an increase in hunting for meat, captures in ever proliferating net fisheries and habitat degradation - pollution, development and poor agricultural practices that lead to increased river silt loads. Throughout the region, qualitative and quantitative surveys over the past 15 years suggest that dugongs have all but disappeared and only small, isolated and scattered, relict populations remain. The largest known aggregation is some 240 animals within the Bazaruto Archipelago, central Mozambique.

Finding solutions for the conservation and management of dugongs in the WIO offers extraordinary opportunities for innovative research and approaches to conservation, including multiple use MPAs.

Role of marine protected areas in the Arabian Gulf for conservation of dugongs and their habitat. Himansu S. Das, Biodiversity Management – Marine Sector, Environment Agency, Abu Dhabi, UAE, PO BOX 45553, Email: hsdas@ead.ae

A significant proportion of world's dugongs occur in the Arabian Gulf. The Arabian Gulf and Red Sea host an estimated population of more than 7000 dugongs, which constitutes the largest population outside Australia, making the region particularly significant in terms of global dugong conservation efforts. Long term dugong research programs including regular aerial and filed surveys of species and habitats have been ongoing in the countries of United Arab Emirates (UAE), Bahrain and Qatar. The findings of these studies have been instrumental in declaring some of the dugong rich sites as Marine Protected Areas. At least 85 % of total UAE dugongs occur within the Marawah Marine Biosphere Reserve and Al-Yasat Marine Protected Area. In the kingdom of Bahrain, Hawar Islands Protected Area supports a significant population of dugongs and extensive seagrass meadows. However, all these

protected areas are new with respect to their formation. The actions towards implementation of management plan for these protected areas are underway and their success in protecting dugongs and their habitats depend on appropriate monitoring. The presentation intends to cover dugong research findings from the region and document strength, weaknesses and opportunities of the protected areas to protect dugongs and their habitats.

Manatees and marine protected areas in the island of Hispaniola. Haydée M. Domínguez Tejo, Centro de Investigaciones de Biología Marina, Universidad Autónoma de Santo Domingo (CIBIMA-UASD). Santo Domingo, Dominican Republic

In the Dominican Republic, by Law 202-04, the national system of protected areas (SINAP) is currently comprised of 86 units, of which 29 can be considered coastal marine protected areas (CMPA's). Manatees are protected by national laws, since 1938, and by international agreements CITES, CBD and the Cartagena Convention. The general distribution of manatees in the country is known. Furthermore, manatee presence has been recently confirmed in at least nine of the CMPA's located all around the country by means of: (a) direct observations during land, boat and aerial surveys, as well as carcass recoveries; and (b) reliable sighting reports from land, water and during commercial flights, all dating from 2004 until present. In addition, site specific studies have been conducted in the two marine mammal sanctuaries by CIBIMA-UASD from 2007-2008, and in CMPA's around Samana Bay in 2008-2009 by Wildlife Trust.

In Haiti the current status of manatees is unknown, but important progress is underway. In 2007, there were manatee sightings in the Port-au-Prince bay area, along the seagrass beds north of Arcahaie. There are no national laws that specifically protect manatees in the country. However, recent progress has been made towards establishing Haiti's first MPA; a presidential decree has been prepared and is currently under evaluation. The proposed protected area includes the location of the latest manatee sightings. Information regarding the current situation in Haiti was kindly provided by Jean W. Weiner, Director of the marine conservation NGO Fondation pour la Protection de la Biodiversité Marine (FoProBim).

Spatial management of indigenous hunting: dugong case study. Jillian Grayson, Alana Grech, Helene Marsh, and Mark Hamann; School of Earth and Environmental Sciences, James Cook University, Townsville, Qld 4811, Australia

Torres Strait has the largest population of dugongs in the world. This population has persisted despite substantial hunting in the past 300 years of a 4000 year hunting period. We proposed that this situation was possible if a substantial proportion of the dugong population occurred in areas that have never been hunted. Our study used information from Indigenous hunters to compare the spatial distribution of dugong hunting with a spatial model of dugong distribution in the theoretical context of source-sink dynamics. Our study revealed that dugong hunting mainly occurs in waters close to inhabited islands or on reef tops whereas most of the high density dugong habitat identified by aerial surveys occurs outside the main hunting areas. Hence these non-hunted or lightly hunted areas with a high density of dugongs could serve as a source for the population and the main hunted areas as a sink. Dugongs are known to undertake individualistic large-scale movements which would enable them to disperse between the main hunting areas and non-hunted or lightly hunted refuges. Therefore, source-sink dynamics may help explain the sustained harvest of dugongs over the previous 300 years but they alone may not be sufficient to conserve this population. However, we show that spatial closures should afford considerable protection to dugongs and their habitats in Torres Strait while more comprehensive community-based approaches to regulate legal harvests are negotiated and implemented.

An overview of the protection afforded to dugongs from MPAs in Australia and the Pacific. Alana Grech^{1,2} and Helene Marsh^{1,2}; ¹School of Earth and Environmental Sciences, James Cook University, Townsville, QLD 4811, Australia; ²Reef and Rainforest Research Centre, P.O. Box 7772, Townsville, QLD 4810, Australia

Dugongs inhabit the shallow, protected tropical waters of the Indo-Pacific. Their range spans at least 37 countries and an estimated 140,000 km of coastline. Dugongs have a high biodiversity value as the only strictly herbivorous marine mammal and the only member of the family Dugongidae, and are listed as vulnerable to extinction by the IUCN, the World Conservation Union (IUCN 2006). Throughout their range dugongs are threatened by anthropogenic activities including hunting and bycatch. Their coastal seagrass habitats are threatened by multiple anthropogenic activities, including activities that occur in adjacent land catchments. Managing the anthropogenic threats to dugongs with spatial tools (including Marine Protected Areas) is challenged by: the dugong's extensive range and their tendency to undertake individualistic and large scale movements; and the paucity of information on the magnitude and distribution of their anthropogenic threats. In this seminar we summarize the protection currently afforded to dugongs from Marine Protected Areas in Australia and the Pacific, and explore the benefits and weaknesses of a spatial approach to dugong management. We use examples taken from developing and more developed regions including the Great Barrier Reef World Heritage Area and Torres Strait to illustrate our argument.

Ossification patterns of cranial sutures in the Florida manatee (*Trichechus manatus latirostris*) (Sirenia, Trichechidae). Osamu Hoson^{1*}, Shin-ichiro Kawada², and Sen-ichi Oda¹; ¹Laboratory of Animal Management and Resources, Graduate School of Bio-Agricultural Sciences, Nagoya University; ²Department of Zoology, National Museum of Nature and Science, Tokyo 169-0073, Japan

We examined the ossification of the skull of the Florida manatee with regard to its growth pattern. We observed ten sutures in 137 crania (70 males and 67 females). Based on these results, the sutures can be classified into two groups by their ossification pattern. The first group contains the maxilloincisive suture, median palatine suture, frontal suture, and coronal suture. This group begins to ossify early in growth. The age of suture closure does not differ among the sexes. The second group consists of sutures related to the basicranium. This group is characterized by slower ossification compared to the first group. Suture ossification in this group proceeds from anterior to posterior. In this suture series, ossification occurred at later ages in males than in females. Ossification of the spheno-occipital synchondrosis occurred earlier than that of the occipital condyle. This pattern is unique among mammals, including the dugong. Osteological maturity was determined by the status of the sutures. The sutures of the basicranium ossify slowly, and thus they are more valuable in evaluating the growth status of the skull than those of the viscerocranium and calvaria. The supraoccipital-exoccipital synchondrosis was the last to begin ossification, starting when individuals were more than 15 y old and 11 y old in males and females, respectively. We conclude that the ossification of the basicranium exhibits a unique pattern in the Florida manatee and that it is possible to determine the osteological maturity of the skull from the ossification of the supraoccipital-exoccipital synchondrosis.

Protected areas for manatees (*Trichechus inunguis*) in the Colombian Amazon. Sarita Kendall, Casimiro Ahue, Luis Hernando Peña; Fundacion Natütama, Apartado Aereo 20089, Bogotá, Colombia, Email: saritaken@yahoo.com

Amazonian manatees (*Trichechus inunguis*) have been hunted for their meat and hides since pre-Columbian times. Due to loss of habitat, continued hunting and incidental captures by fishermen, manatees are classified as Vulnerable (IUCN) or Endangered (Ecuador, Colombia, Brazil). A research and conservation programme in the Colombian Amazon from 1998 to 2008 collected data on distribution, abundance, feeding, habitat use, mortality and threats. Community education and the conversion of manatee hunters into researchers and guardians of the species virtually eliminated hunting in the Puerto Nariño area, with no cases recorded since 2004. Detailed seasonal migration patterns between flooded forest, lakes, tributaries and the River Amazon were established by observation (over 1600 manatee sightings between 2002 and 2008) and feeding evidence.

Areas with high manatee presence and special importance (e.g. new-born calves) were characterized as priority areas. However, manatee use of different habitats during high, transitional and low waters complicates the protection of priority areas frequented by fishermen and boats. Some areas change over time, while dry season priority areas include the river Amazon, an international border with Peru where hunting is still common. Protected areas (national parks and reserves covering aquatic habitat) in Amazon countries have not necessarily led to significant reductions in manatee hunting. The Colombian experience shows that, while eliminating hunting must be a priority, it is not sufficient for the protection of manatees: they are vulnerable to incidental fishing captures and increasing boat traffic. Protected wetland areas established through community agreements designed to limit certain fishing activities would greatly benefit manatees and other species.

Overivew of West African manatees: the West African manatee – a forgotten sirenian. Akoi Kouadio, Wildlife Conservation Society, West African Manatee Conservation, Abidjan, Côte d'Ivoire, Email: akouadio@wcs.org or akoi_k@hotmail.com

The West African manatee is an herbivorous aquatic mammal found along the Atlantic coast of Africa from the Senegal River in the north to the Cuanza River of Angola in the south. It has also been recorded far inland, some 2000 km from the sea, in the Niger River, from Koulikoro to Gao, in lake Debo in Mali, lakes Lere and Trene in Chad. Preferred habitat appears to be the quiet estuarine coastal lagoons and river mouths. Until fairly recently, the West African manatee was among forgotten marine mammals as it remains the living sirenian about which the least information is known. A population estimate has never been done for the West African manatee over the continent. Past and current population size is unknown. However, it is believed that the West African manatee population has drastically declined and that several local populations have even been extirpated. High mortality, primarily associated with human pressure particularly hunting for food, continues to threaten the future of the species. In most of countries over its range the West African manatee is legally protected by law. It is also listed as Vulnerable by the IUCN and in Annex II of CITES. Current conservation initiatives include: the West African manatee conservation and education project in Cote d'Ivoire with Wildlife Conservation Society, the Regional conservation project for the West African Manatee (IUCN, WWF, WI, FIBA), the West African manatee Research project in Sevre-Mopti, Mali, the evaluation of present distribution and condition of the West African manatee in the Cuanza River in Angola, the ICAM initiative in The Gambia and most importantly the current Action Plan for manatee formulated by the CMS and Wetland International.

The current status and future of the dugong in Okinawa. Taiko Kudo, Association to Protect Northernmost Dugong

The draft of environmental impact assessment (EIA) of the U.S. military base construction which is planned to be constructed in Henoko concluded inappropriately that the new base has little effect on the population of dugong. The area around Henoko is the habitat of the endangered dugong in Okinawa, Japan. According to the EIA draft, the aerial survey results show that the minimum population of Okinawan dugong is three. One dugong seems to stay around Kayo being located 5km ENE of Henoko. The other two are mother and a big calf. They mainly have been seen around Kouri island on opposite side of Okinawa. Sometimes they take a long trip (about 88km) to Kayo. Kayo is the essential feeding ground for the single dugong. There, seagrass coverage is 5 – 35% and *Thalassia hemprichii* is dominant. Feeding trails have been always found there by monthly survey. Most seagrass beds in Okinawa disappeared or degraded by development, or unavailable by military activities. It seems that Kayo is the last best available feeding place. However, if the base construction begins, several hundreds of work vessels will come and go near the habitat at a peak period. If the base operation begins, several tens of military helicopters will fly over Kayo that locates under the taking-off and landing route of the aircrafts. If we do not take any measure to protect the extremely endangered and increasingly threatened dugongs, they will extinct in near future.

Mangrove clearing and bottom dredging: how is manatee habitat at use affected by coastal development in Belize? Katherine S. LaCommare and Solange Brault, University of Massachusetts-Boston, Lansing Community College

The Drowned Cays in Belize, Central America are important habitat for Antillean manatees (*Trichechus manatus manatus*). However, recent resort development and boat traffic, including large cruise ships, may impact manatee habitat use in the area. In 2006, substantial dredging and mangrove clearing occurred to facilitate such development at a location that had been monitored for manatee use and seagrass bed characteristics since 2001. Turbidity, percent bottom cover, seagrass biomass and turtle grass (*Thalassia testudinum*) shoot density was measured in 2000-2002 and then again in 2007. MANOVA will be used to determine if there were differences in seagrass bed characteristic before and after the disturbance. Manatee sighting probability was determined using a point sampling survey design. Surveys were conducted from 2001-2005 and then again in 2007 to determine if manatee occurrence and habitat use changed as a result of the disturbance. Preliminary data analysis suggests that manatee sighting frequencies were higher after the disturbance ($G=31.0$, $df=1$, $p<0.001$). Manatee sighting frequencies did not vary before and after in undisturbed control sites (Pooled $G=1.5$, $df=1$, $p = 0.22$). These results will give resource managers in Belize specific information about the impact of coastal development on manatee feeding areas and habitat use.

The potential contribution of MPAs to manatee conservation in the West African coastal zone. Mamadou Niane and Emma Greatrix, Wetlands International Africa, Rue 111, Villa No 39, Zone B, Dakar, Senegal / BP 25 581 Dakar-Fann (Sénégal)

Since 1970, the creation of Marine Protected Areas has been a key strategy in the management and conservation of marine and coastal resources in the northern part of West Africa. Manatees are present in many of the 23 MPAs between Guinea and Mauritania, with high concentrations found in Guinea Bissau in particular. Since few studies have been carried out on the West African manatee, a lack of baseline data on population numbers makes it difficult to draw precise conclusions about whether the MPAs have helped to maintain, or increase, manatee numbers. However, we are able to draw more general conclusions about the role of these legally protected areas in species conservation. The Joal MPA in Senegal is the site of the only recorded case of a manatee beaching incident in an MPA in the region. The local community called in wildlife authorities but the cause of death was not found.

With this one exception, death through hunting or capture in fishing nets is unheard of in MPAs. In comparison, elsewhere in the region, manatees often become trapped in nets or in channels because of dams. Anecdotal evidence shows that MPAs certainly make a valuable contribution to manatee protection in this region, however the main challenge now will be build up a scientific base of data and statistic on the protected and non-protected habitat of the manatee, clearly showing the trends and effects of habitat status on manatee populations

Manatee triangle: conservation through science, protected areas, and local people in South America. Miriam Marmontel¹, Caroline Alvite², Sarita Kendall³; ¹Instituto de Desenvolvimento Sustentável Mamirauá-Brazil; ²Instituto Chico Mendes de Biodiversidade-Brazil; ³Fundación Natütama-Colombia

Trichechus inunguis and *T. manatus manatus* are protected in the 8 countries where they occur in northern South America. Both species share a suite of threats to their survival, ranging from traditional hunting to accidental entanglement, habitat loss and pollution, to strandings and removal of calves, ingestion of debris and boat strikes.

Most of the fieldwork with manatees is done within protected areas. Besides the pristine status, those areas have better chances at obtaining logistical and financial support. Techniques used range from non-invasive methods such as basic interviews with

local inhabitants, through capture and manipulation of specimens for genetic and conservation medicine studies, all the way through modeling. Other techniques include the use of sonar to estimate abundance, tracking animals with VHF- or UHF-telemetry, and compiling this information with habitat analyses, satellite imagery and bathymetry into GIS databases to allow modeling distribution and understanding migration.

PAs generally benefit from multidisciplinary research, incorporating both social and biological aspects, and enlisting the involvement of local peoples. Of approximately 150 protected areas in Amazonia, only about 1/6 harbor manatees, and a mere 6 conduct research on them. Along the Brazilian coast, some areas have been designated specifically to conserve manatees. Protected areas with local people are excellent sites to release previously illegally-maintained or orphaned-and-rehabilitated young manatees, so that they can rejoin the genetic pool with the help of local inhabitants. Those then have a chance to understand the importance and be a part of manatee conservation, a fundamental approach to ensure the success of programs.

Marine protected areas in Mesoamerica and the conservation of manatees. Benjamín Morales-Vela¹ and Ester Quintana Rizzo²;
¹El Colegio de la Frontera Sur, Quintana Roo, Mexico; ²Fundación Defensores de la Naturaleza, Guatemala

The countries from Mexico to Panama along the Atlantic coast are considered the Mesoamerica region. These seven States (Mexico, Belize, Guatemala, Honduras, Costa Rica, Nicaragua and Panama) support a very widely dispersed manatee population among the countries. In most parts of the region, the population status of manatees is unknown, population sizes have never been estimated in most of these countries, and population trends are uncertain. A crude estimated population (based on data of highly variable quality) from Mesoamerica region is from 1550 to 4000 manatees, with a significant portion in Belize and Mexico. Manatees face similar threats throughout this range, which include habitat degradation and loss, watercraft collisions, incidental catch/accidental take in fishing gear, pollution, human disturbance, natural disasters, and hunting. Pollution from agriculture is consistently noted in Mesoamerica region. Poaching has been documented in different areas of these countries. One of the best strategies to conserve manatees could be to improve the protected areas like biosphere reserves with special management in discrete areas and local human collaboration and opinions in the decision-making process. Recent information on tagged manatees shows long distance traveling and trans-boundary movements of manatees in the region with travel distances over 260 km and stopping in specific sites. Management of discrete areas is also an important way for the protection and conservation of other marine mammals. All the countries have a national system of protected areas; this represents a good long-term chance to conserve manatees and its habitat.

Status of manatees in the Caribbean islands and the role of marine protected areas in the conservation of this endangered species. Ester Quintana-Rizzo¹ and Benjamin Morales-Vela²;

¹Fundación Defensores de la Naturaleza, Guatemala; ²El Colegio de la Frontera Sur, Quintana Roo, Mexico

The Antillean manatee (*Trichechus manatus manatus*) has been reported in eight of the Caribbean Islands (Bahamas, Cuba, Jamaica, Haiti, Dominican Republic, Puerto Rico, and Trinidad & Tobago). In some of the islands, however, like Haiti and Suriname, the current situation of manatees is unknown. In other islands like the Bahamas, manatees have never been common and sightings occur infrequently with no known area of persistent use. Manatees are more common in Puerto Rico, Cuba and Dominican Republic. All Caribbean islands, except for Haiti, have some type of marine protected area, including RAMSAR sites, and they have ratified the United Nations Convention on Law of the Sea and the International Convention for the Prevention of Pollution from Ships. Those conventions protect manatee habitat by establishing general obligations for safeguarding the marine environment and controlling pollution from the shipping sector. Cuba has the largest RAMSAR site covering a total of 1,188,411 hectares. The Dominican Republic is the only Caribbean island that has a protected area dedicated specifically to the conservation of manatees. In general, marine protected areas exist throughout the Caribbean but their importance to manatees is unknown. Scientific investigations should be used to identify key habitats for designation as protected areas. Investigations should also identify areas of biological importance (e.g., mating and calving) and those areas should be designated as critical habitats. We will discuss the role of the existing protected areas in the conservation and protection of manatees in the region.

Triumph on the commons in Belize: the importance of traditional knowledge and stakeholder input to successful MPAs.

Caryn Self-Sullivan^{1,2}, Katherine S. LaCommare^{3,4}, Gilroy Robinson⁵; ¹Sirenian International, Fredericksburg, Virginia USA; ²Georgia Southern University, Statesboro, Georgia USA; ³University of Massachusetts, Boston, Massachusetts USA; ⁴Lansing Community College, Lansing, Michigan USA; ⁵Hugh Parkey Foundation for Marine Awareness & Education, Belize

Over 15 years ago, fishermen-turned-manatee guides identified Swallow Caye as a 'hot spot' for manatees near Belize City. The site became a primary site for swim-with-manatee tours and by 1992, harassment of manatees by uncontrolled guests on this public commons led to fewer manatee sightings--and a corresponding loss of income to tour guides. In response, "Chocolate" Heredia led other manatee tour guides in lobbying efforts that resulted in the Forest Department prohibiting commercial swim-with-manatee

tours at the Swallow Caye site. Between 1992 and 1998, Heredia and others worked closely with CZMA&I to develop a set of “best practices” for manatee tour operators and a voluntary “manatee tour guide” specialty course. In contrast to top-down management of the commons recommended in Hardin's "Tragedy", the bottom-up development of best practices has resulted in a "Triumph on the Commons" due to high levels of stakeholder compliance.

In 1999 Heredia founded Friends of Swallow Caye, which lobbied local representatives and the Ministry of Natural Resources to establish Swallow Caye Wildlife Sanctuary (SCWS) specifically for the protection of manatees. SCWS was established based on local knowledge, opportunism, some scientific data, and compromise--just as Callum Roberts described for most MPAs in 2000. To determine whether this opportunistic MPA was the best area within the Drowned Cayes range to set aside as an MPA, we evaluated the probability of encountering a manatee inside and outside the boundaries of SCWS both before and after its legislation in 2002. We found a significantly higher probability of encountering a manatee at 2 points within SCWS than at any other points within the Drowned Cayes, confirming traditional knowledge as an important component in the establishment of MPAs in Belize.

Reconciling the needs and aspirations of indigenous peoples as “landholders” with the large scale systematic conservation planning model used for MPAs in Australia. Kristen Weiss, James Cook University, Australia

In Australia, dugongs are a protected marine species, and the significance of the Great Barrier Reef Region for dugongs was one of the reasons that the area was given a World Heritage listing. Within the Great Barrier Reef World Heritage Area, dugongs are managed under a region-wide zoning plan called the ‘Representative Areas Program’, based on the principles of biodiversity conservation and ecosystem-based management. Dugong Protection Areas have been established to further protect the species from activities including netting. Australia’s Native Title Act allows Traditional Owners to harvest dugongs, and has provided an imperative for Indigenous management of traditional resources. Various approaches to Indigenous resource management have been attempted throughout the GBR region, the most recent being TUMRAs (Traditional Use of Marine Resources Agreements), formal agreements developed by Traditional Owner groups and accredited by the Great Barrier Reef Marine Park Authority (GBRMPA) and the Queensland Environmental Protection Agency. TUMRAs describe how Traditional Owner groups work with government to manage traditional use activities in sea country, with a heavy emphasis on dugong and marine turtle hunting. Despite these attempts by Indigenous communities and government entities to cooperatively manage marine resources, the success of such programs has thus far been limited due to disparate priorities, aspirations, and obligations at the community level versus state and national levels. Additionally, cross-cultural knowledge-sharing and communication between these stakeholders is inadequate, often resulting in conflicting attitudes towards dugong management. Bridging these cultures and their associated knowledge systems will be a significant step forward for managers and policy makers.

The future of the dugong in the Indian sub-continent. Dipani Sutaria, Erika D’Souza and Vardhan Patankar; School of Earth and Environmental Sciences, James Cook University, Townsville, Qld 4811, Australia

The Dugong is legally protected under Schedule I of the Wildlife (Protection) Act, 1972 in India. Hunting, capture, killing, buying, and selling of dugong meat is prohibited and punishable by imprisonment. The current distribution of Dugongs in India is limited to three regions: Gulf of Kachchh Marine Protected Area, Gulf of Mannar Biosphere Reserve, and the Andaman and Nicobar Island Marine National Parks. Dugong sightings are rare and the chance of saving the populations in the three regions seems low. Gill nets, shark nets and dynamite fishing have been identified as a major source of mortality. Industrial development, toxic runoffs, heavy marine vessel traffic, siltation, occasional oil spills, bottom trawling and dredging are major causes of habitat loss. Sporadic hunting for personal consumption continues in the Andaman and Nicobar Islands and in the Gulf of Mannar. Low quality ecological data, low population numbers and lack of management and enforcement underlies the current scenario. In April 2008, the Indian Government signed a specific Memorandum of Understanding under the Convention of Migratory Species (CMS) to conserve and manage dugong and its habitats in India, though no information is available regarding the actions taken. Coastal development goals dominate the sub-continent’s agenda. Local information regarding the changing perceptions and socio-economic conditions of the communities that hunt or depend on fishery resources from the three regions is required to curtail any further loss in Dugong numbers. Species focused conservation efforts, monitoring and enforcement of protection will be required to save any animals found along the Indian coastline.

Conserving a critically endangered population of dugongs in the United Republic of Tanzania. Lindsey West and Catharine Joynson-Hicks; Sea Sense, P.O. Box 105044, Dar es Salaam, Tanzania, Email: lawest2000@yahoo.co.uk, catharine@seasense.org

The dugong (*Dugong dugon*) was thought to be extinct in Tanzania until two individuals drowned in a gill net in shallow seagrass beds off the Rufiji Delta in 2004. In early 2005, another two animals were caught in a gillnet in the same area. Evidence of the continued survival of the dugong in Tanzanian waters has prompted Sea Sense, a Tanzanian NGO, to implement a set of priority

conservation actions: a stranding network has been established; aerial and ground surveys have been conducted in the Rufiji Delta to estimate dugong abundance; and local knowledge and beliefs have been assessed through interviews with local fishers. In addition, a public awareness campaign has been conducted including school art competitions, a 'dugong parade' and distribution of educational materials.

The exact dugong population size and range in Tanzania is unknown but evidence suggests that numbers are small. Since 2004, 12 live dugongs have been observed and reported by fishers but no dugongs or feeding trails have been observed during aerial surveys. Eleven dugongs have been recorded drowned in gillnets. Incidental by-catch in gillnets poses the biggest threat to dugong survival. Legislation protecting dugongs is rarely enforced in Tanzania and there is little institutional capacity to support dugong conservation programmes. Sea Sense is working with local communities to incorporate conservation measures into key marine resource action plans and local bylaws. Funding is also being sought to map critical seagrass habitats and produce a National Dugong Management Plan.

The following abstracts are from the 156th Meeting of the Acoustical Society of America, Miami, Florida, 10-14 November 2008:

Overall hearing abilities of manatees and ecological acoustical challenges. Gerstein, E.¹, L. Gerstein¹, J. Blue¹, and S. Forsythe²; ¹Leviathan Legacy Inc., 1318 SW 14th St., Boca Raton, FL 33486, ²U.S. Naval Undersea Warfare Ctr. Div. Newport, Newport, RI

A comprehensive series of underwater psychoacoustic tests was conducted to measure the hearing abilities of West Indian manatees. Pure tones, complex and real world sounds were presented to manatees under controlled acoustical conditions. The results from 30 000 threshold trials measured their audiogram, temporal integration, critical ratios, MMAs and directional hearing. Complementing these investigations, underwater acoustical measurements of manatee habitats and vessel noise propagation were conducted to evaluate acoustical factors that render Florida manatees vulnerable to repeated collisions with vessels. Both low-frequency cutoffs in shallow water and near surface boundary effects limit the propagation of the dominant low-frequency spectra from slow moving boats. Slow speed zones implemented to protect manatees do not address this underlying acoustical challenge. Ironically, the strategy can be counter-productive in turbid waters and can exacerbate the problem, making vessels more difficult or impossible for manatees to detect while increasing transect times and the opportunities for collisions. While manatees are not adapted for hearing the dominant low-frequency spectra from a slow watercraft, they are well equipped to detect and locate higher-frequency modulated sounds. This provides a narrow sensory window through which to alert manatees of approaching vessels. A specially designed alarm to alert manatees is being tested. [Work funded by the U.S. Department of Defense Legacy Resource Management Program, Navy, Florida Inland Navigation District, and Florida Fish and Wildlife Conservation Commission.]

Ship strike acoustics: A paradox with a parametric solution. Gerstein, E.¹, J. Blue¹, and S. Forsythe²; ¹Leviathan Legacy Inc., 1318 SW 14th St., Boca Raton, FL 33486, ²U.S. Naval Undersea Warfare Ctr. Div. Newport, Newport, RI

Marine mammals are vulnerable to ship collisions when they are near the surface. Here acoustical laws of reflection and propagation can limit their ability to hear and locate the noise from approaching vessels. Defining the physics of near surface acoustical propagation as it relates to ship noise and hearing is central to understanding and mitigating ship strikes. Field data from controlled ship passages through vertical hydrophone arrays demonstrate a confluence of acoustical factors that poses detection challenges including (i) downward refraction, (ii) spreading loss, (iii) Lloyd's mirror effect, (iv) acoustical shadowing, and (v) masking of approaching ship noise by ambient noise and distant ships. A highly directional, dual-frequency parametric sonar has been developed to mitigate these challenges and to alert marine mammals of approaching vessels. The system projector is a planar array, comprised of 45 elements, band centered to transmit a high carrier frequency along with a lower side band signal. The nonlinearity of water is used to demodulate the mixed high-frequency carrier into a lower-frequency waveform audible to both manatees and whales. The bow mounted arrays project a narrow beam directly ahead of vessels and "fill in" acoustical shadows in an effort to alert marine mammals of the approaching danger. [Work funded by the DOD Legacy Resource Management Program (Navy).]

Field tests of a directional parametric acoustic alarm designed to alert manatees of approaching boats. Gerstein, E.¹, L. Gerstein¹, J. Blue¹, J. Greenewald², and N. Elasm²; ¹Leviathan Legacy Inc., 1318 SW 14th St., Boca Raton, FL 33486, ²Florida Atlantic Univ., College of Sci., 777 Glades Rd., Boca Raton, FL

The efficacy of the alarm was documented during controlled slow boat approaches under two experimental conditions: (1) approaches without an alarm and (2) same boat approaches with an alarm. Experiments conducted in a NASA security area provided

controlled environmental conditions and minimized anthropogenic acoustical variables. An array of GPS instrumented buoys were deployed to acoustically and visually grid sites. HD aerial video synchronized with these buoys documented behavior and acoustic conditions at focal animal positions and throughout sites. Bathymetry and propagation measurements indicate shallow water constraints along with Lloyd's mirror effect resulting in significant transmission losses at frequencies of 1 kHz. This could account for the lack of response observed during 94% of the boat approaches without the alarm. In contrast, 100% of the alarm approaches elicited overt avoidance responses. The change in behavior during approach trials was significantly greater during alarm trials ($F=76.74$, $df=1$, $p<0.01$). The distance at which manatees responded was significantly greater during alarm trials ($F=143.42$, $df=1$, $p<0.01$). Applying conservative critical ratio estimates for wideband noise, manatees could not detect no-alarm approaches at distances of 9 m, while manatees responded to alarm approaches up to 35 m away at levels 18 dB above their estimated critical ratios. [Work funded by the U.S. Department of Defense Legacy Resource Management Program, (Navy), Florida Inland Navigation District, and Florida Fish and Wildlife Conservation Commission.]

Ultrasonic hearing and vocalizations are used in communication by West Indian manatee mothers and calves. Gerstein, E.¹, L. Gerstein¹, J. Blue¹, and S. Forsythe²; ¹Leviathan Legacy Inc., 1318 SW 14th St., Boca Raton, FL 33486, ²U.S. Naval Undersea Warfare Ctr. Div. Newport, Newport, RI

Ultrasonic hearing thresholds above 46 kHz were first measured with a test-sophisticated manatee in 1997. Using staircase and method of constants paradigms, pure tones (38–96 kHz) were presented in force-choice two-alternative tests. Repeatable detection thresholds were measured at 38, 46, 56, 66, and 76 kHz. These extended ultrasonic hearing results precipitated additional tests using the CHP-87-L acoustic tag, which regulatory biologists routinely attach to manatees. The tag produces a 75 kHz pulsed tone at 155 dB. The received SPL at manatee ears approximates 149 dB. Over a tag's 2 year life expectancy, permanent selective hearing loss may occur. This is a concern because ultrasonic hearing may be important for directional hearing and communication between mothers and calves. Using a four hydrophone array, calls between wild mothers and calves were sampled at 100 kHz. Individual callers were localized, and some individuals could be identified. Peak source levels of 121 dB re 1 Pa at 2 m were directly recorded with significant energy (103 dB) at 46 kHz. These calls are highly directional and were only documented when manatee callers were positioned on axis with a hydrophone's acoustic center. Vigorous duets between calves and mothers had call rates up to 20 calls/min.

RECENT LITERATURE

Colbert, D.E., J.C. Gaspard III, R. Reep, D.A. Mann, and G.B. Bauer. 2009. Four-choice sound localization abilities of two Florida manatees, *Trichechus manatus latirostris*. *Journal of Experimental Biology* 212(13):2104-2111.

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