

# Sirenews



## Newsletter of the IUCN/SSC Sirenia Specialist Group

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### MANATEE POPULATION ECOLOGY AND MANAGEMENT WORKSHOP HELD IN FLORIDA

The Manatee Population Ecology and Management Workshop was held in Gainesville, Florida, 1-4 April 2002. The **goal** of the workshop was to better understand and integrate the roles of research and management in achieving recovery of the Florida manatee. The specific workshop **objectives** were:

- To review progress in manatee population research, and demonstrate the value of current approaches.
- To improve data analyses and population models for future population assessments, e.g., the planned status reviews by the U.S. Fish and Wildlife Service (FWS) and Florida Fish and Wildlife Conservation Commission (FWCC) in 2003.
- To promote peer review of current population research by a panel of wildlife population experts outside of the manatee research community.
- To make recommendations and promote collaborations for future population research.

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UNION INTERNATIONALE POUR LA CONSERVATION DE LA NATURE ET DE SES RESSOURCES  
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- To synthesize current results in a technical report that will be made available to the public, scientific community, managers, and policy-makers.
- To achieve a balanced approach to manatee conservation.

New data analyses were presented at the workshop, and a group of 8 scientists with expertise in wildlife population assessment (Solange Brault, Daniel Goodman, Aleta Hohn, Fred Johnson, Gil McRae, Helene Marsh, Jim Nichols, Ken Pollock) reviewed the current techniques used to assess manatee population status.

Approximately 100 people participated in the 2002 workshop. The last time biologists convened a formal meeting to review and discuss manatee population biology was in 1992. That meeting did not include managers, while the attendance at the 2002 workshop was a mixture of research and management biologists, and representatives from boating and conservation groups. A few reporters also attended.

The workshop sponsors were: The U.S. Geological Survey (USGS), U.S. Fish and Wildlife Service, Marine Mammal Commission, Florida Fish and Wildlife Conservation Commission, Ocean Conservancy, Florida Power & Light Co., Pegasus Foundation, Mote Marine Laboratory, and Wildlife Trust.

John Reynolds gave the first of 14 presentations, briefly reviewing the history of manatee population research and its application to manatee recovery efforts. He emphasized that we have more and better quality data on manatees than on any other marine mammal. He also pointed out that long-term manatee data sets, some of which date back to the late 1960's, increase in value over time. The quantitative population criteria that appear in the third revision of the Florida Manatee Recovery Plan were based on analyses of long-term life history data, published in the proceedings that resulted from the 1992 Technical Workshop on Manatee Population Biology (*Population Biology of the Florida Manatee*, 1995. O'Shea, Ackerman, and Percival, eds. Copies available from USGS or FWCC).

Five management and 8 research presentations followed. Among other research findings, biologists reported new information on the age structure of dead manatees, adult survival rates, reproductive rates, and use of models to determine population growth rates. Although the workshop did not attempt to incorporate habitat and carrying capacity issues, the need to integrate population and habitat data was voiced by both researchers and managers. Some of the highlights were the following.

Meghan Pitchford (FWCC) reported finding that of the female manatee carcasses that have been aged, 73% did not live long enough to produce more than one calf, and only 20% lived long enough to produce more than 2 calves. Excluding the 0-1 year age class, the average age of recovered carcasses is 7.7 yr. Only 1% of the manatees aged (n=2026) were 30 or more years old. She also found that one can "read between the lines" that form growth-layer-groups in manatee ear bones, i.e., changes in growth rate (determined from growth-layer measurements) may indicate the onset of sexual maturity.

However, the above findings based on carcass data differ from those based on photo-id data. Resightings of living adult females, particularly at Crystal River in the Northwest region and Blue Spring in the Upper St. Johns region, indicate that many individuals live well beyond 20 years, and several of those who were first documented over 30 years ago continue to be resighted. Most of these females also produce calves every 2-3 years. Several reviewers recommended comparison and integration of the

carcass recovery and photo-id data in order to better our understanding of the manatee population's age structure.

Bill Kendall and Cathy Langtimm (USGS) presented new estimates of manatee reproduction and survival based on resightings of live manatees, which were incorporated into a stage-based model presented by Mike Runge, also with the USGS. The Runge et al. estimated population growth rates for the Northwest, Upper St. Johns River, and Atlantic Coast manatee populations yield results very similar to those obtained by Eberhardt and O'Shea (1995): the Northwest and Upper St. Johns River groups are increasing, while the Atlantic group could be increasing at a somewhat lower rate, or possibly even declining. Runge modeled the latter group under optimistic and pessimistic scenarios. In the optimistic scenario, he assumed that adult survival, reproduction, and annual variation in these and other model parameters were moderate, i.e., that they matched the current estimates of survival and reproduction for this region. In the pessimistic scenario, he used a lower survival rate, moderate reproduction, and higher variability in model parameters. Runge emphasized that many of the manatee's life history parameters are still poorly known, particularly for the Atlantic Coast population, and even the best estimates (e.g., of adult survival) have sizeable sampling error. Given the uncertainties, the take-home message seems to be that although there are hopeful signs of manatee recovery in at least some regions, they aren't out of the woods yet!

The reviewers were unanimous in their rejection of the synoptic survey data as a means to determine population trend. However, several managers felt that having some idea of the minimum population size was useful. Use of aerial surveys to determine manatee distribution and habitat was strongly supported by both researchers and managers.

Cathy Langtimm, Ken Pollock, Jim Nichols, Fred Johnson, and others recommended that future studies be designed to better understand causal relationships between management actions and population response, rather than simply being retrospective. Examples would be development of an adaptive management model to evaluate the potential impacts of changes in warm water availability on manatees, and determining efficacy of management actions to reduce deaths caused by manatee/watercraft collision.

Dan Goodman emphasized that managers will need to trust complex models that integrate information from different data sets in order to make sound decisions. The influence of habitat quality and nutrition on reproductive rates must also be incorporated.

Solange Brault and Aleta Hohn expressed concern about the lack of information on manatee reproduction in the Southwest region. They cautioned against extrapolating parameter estimates from other regions to the Southwest, and suggested that genetic markers and other tools need to be further developed to understand potential differences among regional groups.

The reviewers and many other participants believed that Population Viability Analysis (PVA) would be the best way to integrate available data sets and estimates to develop a forward-looking projection of manatee status. The impact of growth of Florida's human population (projected to double in the next 30 years) cannot be overlooked in development of a manatee PVA.

The strongest recommendation to come out of the workshop that is important to manatee status re-evaluation is that status needs to be projected forward in time. Any status re-evaluation must, therefore, also include assessment of potential changes in manatee habitat, particularly in light of human population growth and coastal development.

The reviewers unanimously called for better communication among managers, researchers, and other stakeholders concerned with manatee recovery issues. This workshop was a huge step in the right direction, but renewed commitments to improve communication must be acted upon immediately to keep the momentum going.

The FWS plans to follow up quickly with a smaller meeting to specifically address negligible impact under the Marine Mammal Protection Act, as their draft rule for manatees is due by 5 November 2002. They plan to review manatee status in early 2003. The FWCC will be reviewing the State's designation of manatee status even sooner. Both agencies will undoubtedly draw upon information presented at the April workshop, and may use some of the same scientists to assist them in their review processes. - Lynn Lefebvre (Sirenia Project, U.S. Geological Survey, Florida Caribbean Science Center)

## MARINE MAMMAL CONFERENCE IN MEXICO

La Sociedad Mexicana de Mastozoología Marina, A.C.

Anuncia/Announce the

XXVII Reunión Internacional para el Estudio de los Mamíferos Marinos

XXVII International Annual Meeting for the Study of Marine Mammals

Mayo 12-15, 2002/May 12-15, 2002

Hotel Villa del Mar/ Villa del Mar Hotel and Acuario de Veracruz/Veracruz Aquarium

City of Veracruz, Veracruz, México.

Información más detallada en la página de internet de la SOMEMMA

More information at the web page of the SOMEMMA, <<http://sodemma.ens.uabc.mx>>

También puedes contactar al Comité Organizador de la XXVII reunión

Or contact the Conference Committee:

Presidente Académico: Dr. Luis Medrano G., <[lmg@hp.fciencias.unam.mx](mailto:lmg@hp.fciencias.unam.mx)>

Presidenta Ejecutiva: Biol. Blanca Cortina, <[corblan@hotmail.com](mailto:corblan@hotmail.com)>

## CALL FOR PROPOSALS

Sirenian International is a grassroots organization dedicated to worldwide manatee and dugong conservation through research and education. We are interested in sponsoring research, conservation, and education projects involving manatees and/or dugongs around the world, with priority given to projects in developing nations where funding is traditionally difficult to secure. We funded one project (on dugongs in Vietnam, by Nick Cox; see report in this issue) in 2001; we expect to fund two projects in 2002; typical awards are US \$500 - \$1,000.

There is no deadline for application; proposals are accepted year-round. HOWEVER, grants are awarded subject to review by our Scientific Advisory Council and the availability of funds. Please send a preliminary email to Sirenian International Grant Proposals (c/o <[caryn@sirenian.org](mailto:caryn@sirenian.org)>) to determine current availability of funds and status of the review process, which is semi-annual and roughly correlated with *Sirenews* publication dates of April and October.

In keeping with our mission of sirenian conservation through inter-cultural collaboration, we encourage networking, community outreach, and student development components in all proposals. We will use the following criteria to evaluate grant proposals:

- Involvement of recognized representatives of host countries (e. g. governmental agencies, NGOs, academic institutions, local students) in the planning, implementation and/or evaluation of the proposed project.
- Inclusion of local people/communities in project design, implementation, data collection, and/or data reduction.
- Sound project design, meeting the standards of peer review.
- Demonstrated effectiveness at presenting results to popular and technical audiences.
- Intent to publish findings at scientific meetings, in peer-reviewed journals and/or through the public media (e.g., popular magazines, newsletters, radio, TV, Internet).
- Plan for information outreach prior to, during, and/or after the conclusion of the project (e.g. newsletter articles, local presentations).

Sirenian International believes that the benefits of projects meeting the above criteria reach far beyond research and academia, to facilitate sharing of knowledge with local communities, students, governmental agencies, non-governmental agencies, and other conservation groups. Although our focus is on manatees and dugongs, SI hopes that our grant applicants will better understand the complexity of conservation issues, and the compelling need for partnerships among all parties involved, in both developing and industrialized nations.

Each grant recipient agrees to register with Sirenian International as a Participating Member and to submit information about their project to SI for use on our website and in our newsletter. To apply for a small grant, please submit the following:

- Cover letter, briefly outlining your request for funds (1-2 pages).
- A concise proposal (5-10 pages) that includes:
  - relevance of study and appropriate background information, including a literature review;
  - clearly stated objectives and how the anticipated results of the project relate to the stated goals of any appropriate manatee or dugong conservation efforts within your host country or at the regional level if your host country has no conservation program;
  - clearly stated methods, estimated duration of the project, and plans for follow-up, application of results, and/or future work;
- resume or CV (1-2 pages) for each investigator listed;
- detailed budget (1-2 pages), including matching funds, if necessary to complete project and whether matching funds are applied for or already secured.
- Two (min) to three (max) letters of recommendation (1-2 pages), complete with your reference's contact information (e-mail addresses and phone numbers preferred). If you are a student, one letter should be from your academic advisor; if you are working within an organization, one letter should be from your supervisor or executive director.

**IMPORTANT:** Electronic submissions are preferred. DO combine the cover letter, proposal, CV, budget, etc., in ONE file and send as attachment to e-mail [MSWord document (.doc) or Rich Text Format (.rtf)]. DO NOT use fancy formatting; DO NOT include images or photos in the document; DO have your reference letters sent in the same manner. Submit to <caryn@sirenian.org>. For more information, please visit our website at <<http://www.sirenian.org>> or contact Caryn Self Sullivan (snail mail: 200 Stonewall Drive, Fredericksburg, VA 22401 USA; e-mail: <caryn@sirenian.org>). All applications will be sent for review to our Scientific Advisory Council (SAC); grants will be awarded by our Board of Directors (BOD) based on recommendations from the SAC and the availability of funds. Sirenian International, Inc. is a non-profit, tax-exempt 501(c)(3) corporation.

## THE EMILY B. SHANE AWARD

The Emily B. Shane Award supports conservation-oriented, non-harmful field research on free-ranging odontocetes and sirenians. ("Non-harmful research" is that which poses a minimal risk to the health and life of an individual animal and to other species within the ecosystem. Research that entails capture or invasive techniques is acceptable only if carried out by competent, experienced personnel and provides clear benefits in terms of conservation and scientific knowledge. Applicant must document previous experience and outcomes.)

The award honors Emily B. Shane (1924-1995), a fine amateur naturalist and dedicated conservationist. Funds are awarded to projects with clear conservation priorities for an odontocete or sirenian species, population, or habitat critical to the species. Research that also impacts a local human community in terms of increased public awareness, capacity building, or education may be given special consideration. The award, given annually, will total approximately US\$10,000. The award committee *may* opt to divide the award among two or more applicants. Although awards will be made for no more than one year at a time, applicants may apply more than once for the same project.

Applications are due by **Monday, 10 June 2002**. Proposals must be submitted via e-mail as .rtf or .pdf files to <EBSA2002@bellsouth.net> and should not exceed 200 KB. Do not include figures or photographs in the proposal. Applicants unable to submit an application by e-mail may request permission to send three printed copies; requests must be submitted to the e-mail address above. Award recipient(s) will be announced by 2 September 2002.

**Evaluation Criteria:** The application must include the following materials:

- A proposal, not exceeding three pages in length (Times font, 12 point type, single space, 2 cm margins). Briefly outline the proposed research, objectives of the study, methods, role of the proposed work in conservation, the time period for the research, person(s) conducting the field research and role of each, and literature cited.
- A budget, including other funding applied for, or already held, for the proposed research. Applicants with reasonable budgets who demonstrate the greatest financial need will be given special attention. **Funding requests should be for direct field research expenses only.**
- A current C.V./resume of the applicant, up to three pages in length.
- Three references with e-mail address, phone number, and relationship to applicant.

**Eligibility:** The award is available to students and other researchers who meet the evaluation criteria. The application should be submitted by the person conducting the research. A student's professor should send a cover letter of support, if his/her involvement in the project is essential to the completion of the project. Applicants must have obtained any necessary permits or authorizations for conducting the proposed research before the award funds are disbursed.

## LOCAL NEWS

### AUSTRALIA

#### *Hand-Raised Dugong Calf Rehabilitated and Released.*

- On Tuesday, 12 March 2002, a hand-raised male dugong aged 3 years 3.5 months was returned to the wild in a joint operation by Sea World Enterprises (Gold Coast, Australia) and the Queensland Parks and Wildlife Service (QPWS). This is the same individual that was featured in *Sirenews* No. 31 (April 1999) and No. 33 (April 2000), who

arrived at Sea World on 28 November 1998 at 109.1cm / 19.7kg and upon release was 219.7cm / 197.5kg. To the best of our knowledge he may be the first neonatal dugong to have been hand-raised to independence and the only hand-raised dugong to have been released, although I would welcome being corrected if this is a misconception (in *Sirenews* No. 33, staff of Toba Aquarium, Japan mentioned "an infant" when describing the rehabilitation and

release of accidentally-caught dugongs at Palawan Island, Philippines).

The Queensland dugong, known by those closest to him simply as "the pig", was released into Moreton Bay in southeastern Queensland complete with a peduncle belt, 3m tether and PTT/VHF transmitter, the latter generously loaned to us by Prof. Helene Marsh and Dr. Ivan Lawler of James Cook University, Townsville. Prior to final release the dugong was staged for 4 months in a large, naturally-formed saltwater lagoon on Moreton Island. In this lagoon, which contained abundant seagrass, the pig gained 5kg in weight, grew about 5cm in length, and demonstrated a remarkable capacity to evade people, boats and nets during numerous unsuccessful attempts to recapture him. Unfortunately (for us, but probably not the animal), his entire tracking harness was recovered from the southern end of Moreton Island on Friday, 15 March, 2.75 days after release into the Bay. The harness had broken through the deliberate weak link within the peduncle belt, and the transmitter pod bore numerous unmistakable shark teeth marks.

Detachment of the tracking device thwarts our intention to monitor the dugong's progress, but should not significantly alter his survivability (unless he does something completely inappropriate like head out into the Pacific Ocean). He has two forms of permanent identification - freeze brands on the shoulder region, and two titanium turtle tags in the trailing edge of his fluke - although neither will be obvious to the casual and/or distant observer. Local residents from Moreton Island and dugong researchers from the University of Queensland are keeping an eye out for him, and so far we have received two reports from fishermen of sightings of a

solitary dugong of the appropriate size, in the vicinity of where his transmitter was found. We will be revisiting the release area as weather permits to search systematically in that locality. - **Wendy Blanshard** (Sea World Enterprises, P. O. Box 190, Surfers Paradise, Queensland 4217 Australia; tel.: 61-7-5588-2222; fax: 61-7-5588-2266; e-mail: <[wendyb@seaworld.com.au](mailto:wendyb@seaworld.com.au)>)

## BRAZIL

### *A New Baby Amazonian Manatee.* -

The team of the Aquatic Mammal Lab of INPA, Manaus, are proud to announce the third birth of an Amazonian manatee conceived and born in captivity. This is the second successful birth, this time from a female called Tukano, kept in captivity since 1984. Intense courtship and copulation behavior were observed in February 2001. In April, due to the constant harassment of the males, Tukano was separated and maintained in a different pool with Boo and her two adopted calves (see *Sirenews* No. 36, 2001). Once the pregnancy was suspected, she was kept alone.

The pregnancy was confirmed visually about 10 weeks prior to the birth when it was observed that the vulva was swollen and extended. An ultrasound examination was performed on 19 January, to confirm the pregnancy and to try to estimate the size of the fetus. From late January until 3 weeks after the birth, Tukano and her calf's behavior were monitored by underwater TV and recorded on videotape. On 21 February, after 2:20 hours of intense labor, a male calf weighing 18 kg and 101 cm long was born. From the rupture of the placenta and the exposition of the tail there was an interval of 1:10 hours before birth. The calf went straight to the surface to breathe; records of the sounds revealed that mother and calf were vocalizing all the time. Differently from

the other mother manatee Boo (*Sirenews* No. 30, 1998), Tukano wasn't very cooperative in nursing her calf. After 48 hours without letting him feed we decide to intervene. The mother was restrained in shallow water while we raised her flipper, directing the calf to the teat. For 8 days, every hour or every time we noticed the baby wanted to feed, a team of 3 people held the mother and helped the calf nurse. Although the calf wasn't losing weight, when we had almost given up to start an artificial diet, Tukano finally decided to let her calf nurse, slowing down, waiting for him and stretching her flipper. After two weeks nursing from his mother, the calf gained 2 kg.

Milk collection, diving frequency, behavior and vocalization are being recorded. - Vera M. F. da Silva

## COLOMBIA

*Amazonian Manatee Rehabilitated and Released.* - On 8 February 2002, Airuwe, an Amazonian manatee aged 3 years 8 months, was returned to the wild by the Omacha Foundation of Leticia and the community of Puerto Nariño. Airuwe was released in the Tarapoto lake system in the Colombian Amazon, close to well-established manatee feeding areas. He was captured in a net near Puerto Nariño in mid-1998 and wounded by fishermen, then transferred to the Omacha Foundation. The Foundation fed, cared for and rehabilitated Airuwe with a view to reintroduction, and he became the focus of a manatee conservation campaign in the region.

Airuwe was examined by Marcia Picanco, a Brazilian veterinarian, before release and found to be in good health. He was fitted with a belt-mounted

transmitter donated by the Instituto Mamirauá (Brazil) and is being tracked by a team of local fishermen and former manatee hunters. During the first ten days after release he moved back and forth through channels in the flooded forest to nearby lakes, returning close to the release point. Freshly chewed aquatic grasses and plants were found near his main resting place.

We would like to thank all the people who have helped us with the difficult but satisfying task of bringing up and reintroducing an Amazonian manatee, in particular veterinarians Greg Bossart and Marcia Picanco, Miriam Marmontel of the Instituto Mamirauá, Jim Reid and Bob Bonde of the Sirenia Project, Salud Colpatria, the Columbus Zoo, Save the Manatee Club, Corpoamazonia (Leticia), Fauna and Flora International, the British Embassy Bogotá, Jim Valade, Antonio Mignucci, Ruby Montoya, Timothy Ross, Elizabeth Kendall, and numerous fishermen in the Puerto Nariño area. - (Source: SIRENIAN Listserv)

## DENMARK

*New Antillean Manatee Exhibit in Denmark.* - The Zoo of Odense, Denmark, has just imported four Antillean Manatees from Georgetown, Guyana to accompany the solitary Henriette which, I understand, was born in the Nuernberg Zoo in Germany.

The four apparently arrived in good shape. I haven't been there yet but in the TV feature their aquarium within the new South America Complex appears very spacious and attractive both for animals and visitors. The Zoo hopes the animals will breed. The Zoo of Nuernberg, where Henriette came from, claims that they raised 14 manatees and



are the most successful zoo at breeding Antillean manatees in captivity.

Two Web pages, <<http://www.dr.dk/fyn/manatus/>> and <<http://www.odensezoo.dk/aktuelt/aktuelt.htm>>, give more details in Danish, of which I speak zero - now at least I know that søko means seacow and søkøer is the plural. - Gisela & Hans Rothauscher <<http://rothauscher.bei.t-online.de/>>

## FLORIDA

### *To Downlist or Not to Downlist?*

- On 30 Oct. 2001, the U.S. Fish and Wildlife Service (FWS) approved the Third Revision of the *Florida Manatee Recovery Plan*, following public review of two prior drafts. These drafts updated the Second Revision of the plan, issued in 1996. As reported in recent issues of *Sirenews*, the main points of contention in the Third Revision involved the proposed population benchmarks that have to be achieved before downlisting (from Endangered to Threatened status) or delisting of manatees can be considered.

In the end, FWS still did not completely accept the recommendations of its own experts on the Manatee Population Status Working Group (MPSWG). The most important remaining differences in the critical numbers adopted were: average annual adult survival rate of at least 90% (as opposed to at least 94%, with statistical confidence that it is not less than 90%); and average annual rate of population growth of zero or greater (as opposed to at least 4%, with statistical confidence that it is not less than zero). (A 95% confidence level applies throughout both the MPSWG and FWS versions.) Although the final numbers were an improvement over the earlier drafts,

nonetheless the inescapable conclusion is that FWS has lowered the bar to downlisting. Whereas the two smallest Florida subpopulations (Northwest and Upper St. Johns River) already meet either set of criteria, the much larger Atlantic Coast subpopulation meets only the less stringent FWS criteria for potential downlisting (data from the Southwest area are incomplete).

In 2001, at least 325 manatees died from various natural and human-related causes; at least 81 of these deaths were caused by watercraft. Both total deaths and watercraft-caused deaths increased from the year before. Since these figures represent only known manatee deaths, the actual numbers of both total deaths and watercraft-caused mortalities are likely considerably greater. Even using these figures, however, the total number of manatee deaths is 10% of the 3,276 manatees counted during the winter synoptic aerial surveys conducted in January 2001 -- which was the highest number of manatees ever recorded in such a survey.

The situation thus far this year is even more bleak. According to the Florida Marine Research Institute, as of March 22, 38 manatees have been killed by boats since the beginning of the year. This figure compares to 12 watercraft mortalities at the end of March 2001.

Thus, the manatee is currently confronting precisely the situation which the FWS has declared (in its Biological Opinion on the CSLNG Development Project, Aug. 17, 1998, p. 7) to be a "critical threshold for the survival and recovery" of the species: an overall mortality rate at or exceeding 10% of the population. Under these circumstances, the FWS has declared (*ibid.*, p. 6) that avoiding jeopardy to the species "depends on reducing" -- not merely avoiding further increases in -- manatee

mortality. In turn, any serious effort to reduce overall manatee mortalities depends on reducing the number of manatees killed by boats, since "[t]he most significant problem faced by manatees in Florida is death or serious injury from boat strikes" (*Recovery Plan*, p. 23). Indeed, the FWS has declared (*Recovery Plan*, pp. 116, 121) that "[m]inimiz[ing] collisions between manatees and watercraft" is an "action that must be taken to prevent extinction" of the species. Until this is done, talk of downlisting seems premature.

## JAPAN

***Stomach Contents of Dugongs from Okinawa, Southern Japan, from 1992 to 2000.*** - Quantitative analyses of the stomach contents from four mature dugongs, two females and two males, obtained at Okinawa Island (two from the western coast on January 1996 and August 2000 and two from the eastern coast on May 1992 and April 2000, respectively) due to stranding and by-catch, were conducted under a collaborative study program with Okinawa Expo Aquarium and Mie University. The stomach contents of the four animals consisted almost entirely of seagrasses; annelids, ascidians and algae were very minor components of the contents. Each stomach contained 4 to 6 species of seagrass, and a total of 7 species of seagrass, belonging to 5 genera in 2 families, were identified from stomach contents and are known to occur commonly in coastal waters of Okinawa Island: *Cymodocea rotundata*, *C. serrulata*, *Halodule uninervis*, *H. pinifolia*, *Halophila ovalis*, *Syringodium isoetifolium*, and *Thalassia hemprichii*. However, the number and relative abundances of seagrass species from the

stomach contents differed among the specimens. *Halophila ovalis* occurred in any stomach; *S. isoetifolium* was abundant in the stomachs from the eastern coast of the island, while *C. serrulata* was on the western coast. This evidence may suggest that the dugongs in Okinawan waters show little food preference, or dominant seagrass distribution is different between the western and eastern coasts of Okinawa Island. We will continue our study to analyze stomach contents of the dugongs, as well as to survey distributions of feeding trenches of dugongs, and species composition and abundance of seagrass beds in the coastal waters of the Island. - **Kana AKETA** (Aquatic Ecology Laboratory, Faculty of Bioresources, Mie University, 1515 Kamihama, Tsu, Mie 514-8507; Japan (tel.: +81-59-232-1211 (ext.2510), +81-59-231-9649 (ext.2510); fax: +81-59-231-9538; e-mail: <[oe31236@muse.cc.mie-u.ac.jp](mailto:oe31236@muse.cc.mie-u.ac.jp)>

## NEW ZEALAND

***Dugong Mitochondrial Genome Sequences Obtained.*** - Modern molecular techniques are currently being used to answer some interesting questions about dugong evolution and population structure. The complete mitochondrial genomes from two dugongs have recently been sequenced, one by a group of researchers at Massey University, New Zealand and the other by the Lund University research group in Sweden. These sequences will be used to help resolve ancestral relationships amongst mammals.

Mitochondria are the powerhouses of cells. Their main function is respiration and they exist in many copies per cell. Vertebrate

mitochondrial (mt) DNA is about 17,000 base pairs in length, and codes for 20 transfer RNAs and 13 proteins that are involved in processes common to all living things. Complete mt genomes have proven to be useful for phylogeny reconstruction, particularly for mammalian evolution. Latest results in this field are showing a high congruence between trees constructed using mt data and those from nuclear markers. One of the problems with earlier trees was that the branch leading to the elephant was very long, and this can mislead tree reconstruction methods (this is the problem of "long branch attraction"). Dugongs are thought to be one of the closest living relatives of elephants. Adding the dugong sequences to the data set appears to break up the long elephant branch, thereby improving both the stability and the reliability of the mammalian tree.

Mitochondrial DNA also contains a small, extremely variable region known as the D-loop/control region. This region is useful for addressing ecological questions about existing dugong populations. An initial analysis of this region in the two recently sequenced dugongs, by researchers from James Cook University in Queensland, Australia, showed that the two dugongs came from different areas, one from the seas around Brisbane and the other from further north. - **Trish McLenachan** (Allan Wilson Centre for Molecular Ecology and Evolution, Massey University, Palmerston North, New Zealand)

## PHILIPPINES

*Dugongs at Hinatuan, Surigao del Sur, Mindanao, Philippines.* - My name is Rowan Byrne and I am an Irish

marine and freshwater biologist working in Mindanao, Philippines. I am based in Surigao del Sur, in a small place called Hinatuan. It has extensive seagrass beds that are in exceptionally good condition. - the main reason why a small population of dugongs reside there.

When I first arrived I was told of the presence of dugongs and up to 5 species of endangered turtles in the area, and was given pictures to prove it -- quite a surprise, as I found out afterwards when I reported it to the National Government; they were unaware that the population existed!

Modern records support the presence of dugongs (*Dugong dugon*) in Hinatuan as far back as 1950, but they most likely inhabited the area even before this date. Over the past several decades, dugong numbers have slowly decreased due to (1) illegal fishing techniques such as dynamite and cyanide fishing; (2) the extensive uncontrolled use of fish corrals and illegal mesh size fishing in protected areas; and (3) illegal over-expansion of fish ponds.

For decades, the DENR (Department for Environment and Natural Resources) assumed the population was extinct in Surigao. As a result, no new endeavors were initiated to protect or preserve this endangered species in the Surigao del Sur region. My initial research indicates that, in the Surigao region, dugongs can only be found in Hinatuan. They appear to be extinct in the surrounding areas of Surigao del Sur, with unconfirmed recent reports at Sairgao Island, Surigao del Norte.

In April 2001, a baby dugong was killed in a fish corral, and after interviewing local people, I found that two other baby dugongs had been killed

in the last 6 months. I contacted national governmental agencies and the World Wide Fund for Nature (WWF), who acknowledged that they were unaware of the presence of dugongs in the Hinatuan area, and stated that they had terminated recent surveys 200 km south of there, thus missing the whole area.

From October 2000 to October 2001, five baby dugongs were killed, and one tagged and released by fishermen, all in Hinatuan municipal waters. This is strong evidence that either the population did not go extinct, or that the area has been re-populated in recent years. But, with five infants killed in the past year, and increasing fishing intensity, is there hope for continued recovery? At present the outlook is bleak. The dugong's plight here is very serious and will require equipment, funding, support and enforcement. I am publicizing these data to raise the profile of dugongs in the Philippines. I have done this already in national papers, magazines both national and international, and have national and international TV channels documenting my work here, such as National Geographic Channel Asia.

There is massive opportunity here for scientific research, not to mention Ph.D. possibilities. If anyone has suggestions I would be delighted to hear from you. - **Rowan Byrne** (Centre for Empowerment & Resource Development Inc. (CERD) and Voluntary Service Overseas, Philippines (VSOP); [dugongresearch@yahoo.com](mailto:dugongresearch@yahoo.com))

*Dugong Death at Hinatuan Bay, Surigao del Sur, Mindanao.* - An approximately 200-300kg male dugong (total length 197cm) was killed in Hinatuan Bay, not far from Mahaba Island and near the Municipal Fish

Sanctuary. It was found floating dead inside a fish corral, and its abdomen was severely bloated. It appeared to have been dead 2-4 hours when the fish corral owner arrived at about 8 AM on 14 December 2001. It was taken to Mahaba Island for examination and photographs, where it was then buried and not eaten, despite its being Christmas -- showing that the people are concerned about the species and its conservation.

It had fish net markings and scars all over its dorsal surface (back) that looked like coral cuts, and up to 6 slashes behind its head and upper dorsal region that appeared not to be from netting; they could be described as man-made. These slashes were 1 to 2 inches deep, cutting deep into flesh, and blood flow could be seen 3-4 inches behind the left eye. In one of the photos there appear to be remains of blood flow from the right nostril. It appears that the dugong was caught in a net, and as the net was being pulled in the dugong was found alive, so the net owners tried unsuccessfully to kill the animal with some sort of knife or machete, and the dugong somehow managed to get free and swim for safety. It began to approach or return to the area inshore that may serve as a safe haven for dugongs in Hinatuan Bay, and somehow it may have been disturbed and began to return to the open sea when it entered a fish corral and later died from the incisions and cuts it received. The dugong also appeared severely bloated, so there is a possibility of poisoning, maybe due to dynamite or cyanide fishing. - Compiled by **Rowan Byrne**; field details taken by **Gary Cacho**.

VIETNAM

*Observations of the Dugong in Con Dao National Park, Vietnam, and*

***Recommendations for Further Research.***

- The dugong is perhaps the most endangered sea mammal in Vietnam. There are few scientific records available about the distribution, abundance and ecology of dugongs in Vietnam. Con Dao archipelago in southern Vietnam is the only location in the country where dugongs are regularly seen. Local fisher interviews conducted in October 2000 in Con Dao (Cox, unpublished) revealed that dugongs were seen much more regularly and in greater abundance 10-25 years ago than they are now. Whilst it appears that dugongs were often hunted specifically for meat and medicinal purposes, dugongs caught now are caught accidentally, and mortality is presumably as a result of drowning in nets. Nine dugong carcasses were recorded in Con Dao between 1997 and 2000. The results of this study add important information about this species to the sparse information currently available; further research is required particularly for Vietnam and neighboring countries.

The study area consisted of a number of small sheltered bays within the Con Dao archipelago, located approximately 85 km southeast of mainland Vietnam in the South China Sea. The group of 14 islands has a mountainous landscape, and is largely forested and fringed with coral reefs and small patches of mangrove forest. Con Dao National Park protects 80% of the total land area, including 5,998 ha of forest, 14,000 ha of sea and an additional sea buffer zone of 20,000 ha. The present study was undertaken in three sites in Con Son Bay, although predominantly in Dat Doc Bay.

Dugongs were observed during November 2001-January 2002 from a number of elevated hillside vantage

points. Observations were made with unaided and aided sight, using 10x50 binoculars mounted on a tripod for long-range observations. On spotting dugongs at the water surface, notes were taken on the period of time the animal spent at the surface, the time spent submerged between successive surfacings, and also on the behavior of the dugong at the surface including the number of breaths taken. If the dugong was in shallow water, notes were also made on behavior under the water surface. Free-ranging dugongs were observed on 13 separate days in November 2001, 7 days in December 2001 and 9 days in January 2002, out of a total of 37 days spent observing. Transect surveys were conducted at two sites in order to assess seagrass species composition and density of dugong feeding trails.

Thirty-three free-ranging dugongs were observed between November 2001 and January 2002. Dugongs were seen during morning and afternoon observation periods and at both high and low tide. Dugongs were observed feeding in seagrass beds ranging from 3-10m in depth. On several occasions, mothers and calves were seen together and in each case the behavior of the juvenile dugong was observed rather than the adult. On one occasion 3 dugongs were seen together.

Insufficient data were recorded to enable comparison between submergence times of dugongs feeding in deep water (up to 12m) and submergence times in shallower water (1-4m), although there may be other factors involved, such as seagrass cover. However, there appears to be an effect of tides on submergence times, with dugongs appearing to surface more frequently at low tide than at high tide.

The mean submergence time of 4.2 minutes compares favorably with observations recorded in Indonesia by De Iongh et al. (1997) of 4.6 minutes, surveys that were also done in deeper water up to 9m depth, compared to observations made in shallow water up to 3m in Australia by Anderson and Birtles (1978) who recorded an average submergence time of 1.2 minutes. This supports the suggestion by De Iongh et al. that submergence-time correlates with the depth of the seagrass bed.

#### Recommendations for further research:

1. Long-term study of the dugong population in Con Dao in association with seasonal changes in seagrass composition and abundance. Construct portable viewing platforms for erection in subtidal seagrass beds in Lo Voi and on Lo Voi Cape. This would be an ideal study for a Vietnamese Masters or Ph.D. student with support from an institution such as the NTIO.
2. Research into the possibility of stabilizing slopes adjacent to Con Dao's roads in an attempt to reduce soil erosion during heavy rains.
3. Surveys in other known seagrass habitats in Vietnam, including Phu Quoc island, and Nha Trang.
4. Local community interviews in other Vietnamese coastal provinces.
5. Collaboration with Cambodian and perhaps Thai authorities on transboundary dugong conservation initiatives.

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## ABSTRACTS

The following abstracts are of papers and posters presented at the 14<sup>th</sup> Biennial Conference on the Biology of Marine Mammals in Vancouver, B.C., Canada, 28 Nov.-3 Dec. 2001.

### **Current Research on the Status, Distribution and Biology of the Dugong (*Dugong dugon*) in Thailand.** Adulyanukosol, Kanjana<sup>1</sup>, Hines, Ellen<sup>2</sup>

(1) Phuket Marine Biological Center, Dept. of Fisheries, PO Box 60, Phuket, 83000, Thailand

(2) San Francisco State University

The dugong in Thailand is close to extinction, and has been declared a reserved and protected aquatic species under the Thai Fishery Act since 1947. Although the overall population consists of small groups scattered along the coast, sizeable numbers of animals have been observed by aerial surveys at Talibong and Muk Islands, Trang province, in the Andaman Sea. Areas including and surrounding these seagrass beds are highly recommended for protection as the first Dugong and Seagrass Sanctuary in Thailand. For the past 2 years, aerial surveys using strip transects have been completed in areas with known dugong presence based on interviews, as well as previous aerial and seagrass surveys. The estimated minimum abundance in Trang at this time is 123 animals, with a maximum of 13 calves. The largest group size seen is 53 dugongs in the seagrass beds southeast of Talibong Island. Interviews have also been conducted with villagers since 1994 along the coast to determine the distribution of the dugong both modern and historically in the areas that border populations. Attempts to keep stranded dugongs in captivity have been conducted at Phuket Marine Biological Center, the center for research on endangered marine mammals along the Andaman coast, since 1979, and the maximum period that a dugong survived was 200 days. Age determination research using tusks has been conducted on 12 dugong carcasses, and has shown that they were between 1 and 43 years old. In addition, the stomach contents of 6 dugongs were examined and 9 species of seagrasses were found. The dominant seagrass species observed was the species found most commonly in places where the carcasses of dugongs had been found. *D. dugongs* are occasionally entangled or drowned in fishing gears. Among various types of gears, gill nets are considered to be the main cause of death of dugongs. To continue this research and create an adequate plan for the conservation of the dugong in Thailand, especially in areas like Trang province, there urgently needs to be more cooperation between government and non-government organizations and local people.

### **Stomach Content Analysis of a Dugong (*Dugong dugon*) from Okinawa, Southern Japan.** Aketa, Kana<sup>1</sup>, Uchida, Senzo<sup>2</sup>, Higashi, Naoto<sup>2</sup>, Kawamura, Akito<sup>1</sup>

(1) Faculty of Bioresources, Mie University, 1515-Kamihama, Tsu, Mie, 514-8507, Japan

(2) Okinawa Expo Aquarium

We performed a detailed quantitative analysis of the stomach contents from an adult male dugong (*Dugong dugon*), 255 cm in body length and 190kg in body weight, stranded on the central beach along the western coast of Okinawa Island, on 5 April 2000. Dugong strandings are rare in Japan and this carcass provided us with a first opportunity to understand the feeding ecology of dugongs in Okinawan waters. The contents from the stomach were collected and preserved in 10% formaldehyde. Each fragment was identified to species and categorized as leaf, rhizome or root using dissecting microscopy. Five seagrass species were identified: leaf material of *Halophila ovalis* was mainly found in contents, followed by that of *Syringodium isoetifolium*, *Halodule pinifolia* and *H. uninervis*; rhizome and root materials, mainly consisted of *H. ovalis* and *S. isoetifolium*. It is thought the seagrasses on which dugongs feed in Okinawan waters are presented at least 5 species, nevertheless 10 species have distributed in this waters. It is difficult to consider that the dugong accidentally feeds on *H. ovalis* and *S. isoetifolium*, since *S. isoetifolium* commonly distributes along the western coast of Okinawa Island while *H. ovalis* does not commonly. The number of seagrass species, fed on by the examined dugong in Okinawan waters, was smaller than the number fed on by dugongs in other waters such as Australia and Indonesia. Although several seagrass species on which the dugongs fed in those waters are found in Okinawan waters, the examined dugong did not feed on these seagrasses, mainly fed on the whole material, from leaf to root, of *H. ovalis*, followed by that of *S. isoetifolium*.

### **Individual Variation in the Vocal Behavior of the Antillean Manatee (*Trichechus manatus*).** Alicea-Pou, Jose<sup>1</sup>, Harvey, James<sup>2</sup>, Mignucci-Gianoni, Antonio<sup>1</sup>, Mellinger, Dave<sup>3</sup>

(1) Caribbean Marine Mammal Laboratory, PO Box 334395, Ponce, 00733, Puerto Rico

(2) Moss Landing Marine Laboratories

(3) Oregon State University

The individual variability in sound characteristics and call types categories among four captive Antillean manatees was studied. We selected a set of sound parameters to characterize individual manatee vocalizations and to quantify the distinctive features that we recognized as important for distinguishing the manatee calls. The discriminant function analysis was used to find a linear combination of the measured sound parameters that grouped individual manatees based on similarities and differences in their acoustic characteristics. An analysis of variance performed among the repertoire of four individual manatees revealed that each was significantly ( $P < 0.05$ ) from the others. The four captive animals included in the analysis had an increasing level of complexity in their vocal behavior. Tamaury's calls had one visible band, same sound quality, and very little modulation. Moises' calls were classified as the same call variant, but had a harmonic structure with more variability in modulation and multiple emphasized harmonics. Katsy had one call variant but some of the calls were classified as subvariants due to a slightly different sound quality. A higher number of her calls had different spectrographic structures (harmonic, noisy, formant-like, nonlinear phenomena). Lastly, calls from Baby were classified as two variants and under three spectrographic structures. Here also the variability in frequency modulation, number of bands, emphasized frequency and location of the sound energy bands was more complex. The moderate variability among individuals suggested that these features have been selected for stereotype, and possibly could be useful for individual recognition.

Additional to the inter-individual variability, among these manatee there was also sources of intra-individual variability in the number of bands, the modulation, duration, peak frequency, call structure, and frequency range. The levels of acoustic variation we described still need to be empirically tested by playback manipulation to be validated as significant within manatee acoustic behavior.

**Assessment of the Use of San Juan Bay, Puerto Rico, by Dolphins and Manatees.** Alsina-Guerrero, Mayela M.<sup>1</sup>, Rodríguez-López, Marta A.<sup>1</sup>, Mignucci-Giannoni, Antonio A.<sup>1</sup>

(1) *Caribbean Marine Mammal Laboratory, Universidad Metropolitana, PO Box 361715, San Juan, PR, 00936-1715, United States*

Dolphins and manatees were commonly seen in San Juan Bay in the 1970s and 1980s, but recently the number of sightings has dramatically been reduced. The manatee (*Trichechus manatus*) has been documented at the entrance of the bay and in its southern-most areas, using the channels connecting to the rest of the estuarine system. Bottlenose dolphins (*Tursiops truncatus*) were commonly seen in the entrance of the bay and channels near the Isla Grande Airport. Twenty-nine strandings and mortality cases have been reported from Toa Baja to Loiza in the past 30 years. Thirty-eight sightings have been reported in a period of thirty years. Interviews with local fishermen and harbor patrol captains have revealed a significant decrease in sightings of these animals. We present a systematic study to assess the population status of dolphins and manatees that use San Juan Bay Estuary. Observations were made using ship and air-based line transect methods. Boat surveys were conducted since April 2000 aboard a 6.7-m Angler boat, once a week during the semester and four times a week during the summer, and aboard an A-star AES350B helicopter along the shelf edge, inside the bay, Laguna del Condado, Laguna San José and Laguna Torecilla. Sighted animals were photographed for photo-identification purposes and the events were entered in a sighting database. From 1999 to 2001, only six sightings have been documented, two bottlenose dolphin sightings and four manatee sightings, clearly indicating a recent reduced use of the San Juan Bay by these species. The reason for this decline still remains to be identified.

**The Status and Conservation of Marine Mammals in the Philippines.** Aragonés, Lemnuel V. *Institute of Biological Sciences, University of the Philippines Los Baños, Animal Biology Division, Los Baños, Laguna, 4031, Philippines*

Starting in early 1997, an assessment of the status and conservation of the marine mammals within the Philippine waters was conducted by compiling relevant information in some selected sites in the Luzon, Visayas, and Mindanao areas. Presence of marine mammals, relative abundance, and interaction with fisheries were gathered several ways: interview surveys, designated and opportunistic boat surveys, collaboration with trained observers aboard dolphin watching boats, examination of specimens (e.g. skull) and review of unpublished and published reports and other forms of media. To date, a total of 25 species out of the 27 reported marine mammals reported within the Philippine waters have been confirmed. These included 22 cetaceans, the dugong, 1 pinniped (*Phoca largha*), and 1 otter (*Amblonyx cinereus*). The large seal was an extralimital recording. The small clawless otter, a part-time riverine species, could also be found in the estuaries of Palawan. Among the 22 cetaceans, 18 are odontocetes, and 4 are mysticetes. Out of the 18 odontocetes, 13 are delphinids (spinners, pantropical spotted, striped, Fraser's, Risso's, rough-toothed, and Irrawaddy dolphins, and short-finned pilot, melon-headed, pygmy killer, false killer, and killer whales), 2 kogiids, 2 ziphiids (Blainville's and Cuvier's beaked whales), and 1 Physeterid. The 4 mysticetes include minke, Bryde's, humpback and fin whales. The spinner dolphin is the most commonly sighted species, while the Irrawaddy dolphin has the most restricted distribution. The dugong is the most threatened marine mammal species of all. The major hotspots for cetaceans include Tanon Strait, and the Philippine, Sulu, and Bohol Seas, while those for dugongs include the waters off Palawan, southern Mindanao and northeast Luzon. Major threats to marine mammals are incidental mortalities, habitat loss, and pollution. This is aggravated by insufficient institutional support, the low priority from the government, and the scarcity of basic information necessary for conservation and management.

**Manatee (*Trichechus manatus*) Encounters and Research Vessel Effects in the Drowned Cayes, Belize, Central America.** Bilgre, Barbara A. *Oceanic Society, PO Box 270, Belize City, Belize*

The objectives of this study were to estimate manatee (*Trichechus manatus*) abundance in the Drowned Cayes of Belize, Central America and to record their behavior in the presence of our research vessels. Between July 28, 2000 and February 22, 2001, 73 manatee surveys were conducted on 42 days. Surveys were conducted from 8 m boats utilizing 75 hp outboard motors, and included opportunistic searches (vessel in motion) and dedicated searching (vessel stationary and motor turned off). Manatees were encountered in 89% of the surveys. One hundred nine sightings produced a field count of 220 manatees (mean group size = 2.02, SD = 1.53) including 10 calves and 17 yearlings. Opportunistic sightings resulted in 47% of sightings, and dedicated searching in 41 different locations resulted in 53% of sightings. To determine potential effects of the research vessel on manatee behavior, I analyzed encounters of 82 manatees, in groups of 3 or less, where the boat was within 50 m of the manatees. I adhered to rigid manatee-boat protocols designed by the Government of Belize. Boat activities included motoring, drifting, poling, and tied, and the manatee responses were swimming toward, away from, ignoring, or observing the boat. Manatees ignored the boat more than any other response (72%). Responses to boat activity were significantly different ( $X^2 = 20.3, 9 \text{ df}, P = 0.05$ ). Three responses (Toward, Ignore, Observe) were more likely to occur when the boat was tied than during any other boat activity. Manatees did not differentially avoid the boat even when the boat was motoring ( $X^2 = 3.06, 1 \text{ df}, P = 0.05$ ). Our boat did not negatively affect manatees; in fact, a quiet, stationary boat was more likely to attract manatees. These results demonstrate the usefulness of Belize manatee-boating legislation in regulating manatee-watching tour boats for the protection of the manatees.

**Biological Assessment and Handling of Captured Free-Ranging Manatees in Belize.** Bonde, Robert<sup>1</sup>, Agurrie, Alonso<sup>2</sup>, Powell, James<sup>2</sup>

(1) *U.S. Geological Survey, Florida Caribbean Science Center, 412 NE 16th Ave., Room 250, Gainesville, FL, 32601-3701, United States*

(2) *Wildlife Trust*

Free-ranging West Indian manatees (*Trichechus manatus*) were captured for a radio tagging study in Southern Lagoon, Belize. Manatees were approached by boat and a 152 m long, 6 m deep, 13 cm stretch mesh nylon net was set in open water 1-1.5 m deep. Captured individuals were then transported a short distance to a beach for examination. Fifteen individuals were captured 35 times between November 1997 and March 2001. Nine manatees were captured more than once. Out-of-water holding time ranged from 24



to 140 minutes with an average duration of 90 minutes. Most animals were tagged with VHF and UHF radio tags connected to belts fitted around the tailstock and passive integrated transponder chips were inserted to facilitate re-identification. Fat thickness measurements were recorded using ultrasound. Morphometrics, blood, urine, fecal and tissue samples were collected and analyzed or archived. Results of urine analyses revealed a new species of diplogasterid-nematode. Fecal samples were not pathologic but did allow for identification of local vegetation types. Blood values for CBC and serum chemistry profiles indicated normal levels comparable to manatees previously examined in Florida and Puerto Rico. Duplicate samples were collected from 6 animals and analyzed to check for laboratory quality control. Dugongs have been prone to capture myopathy and typically display elevated serum enzymes and biological indicators of tissue damage. Florida manatees have been documented to tolerate capture and handling activities without susceptibility to capture stress. Variables examined to address potential affects of capture stress included the serum enzymes SGOT (range, 9.4-60.6 U/L), SCPK (10.1-287 U/L), and LDH (0-260 U/L); as well as biochemical indicators such as BUN (2.0-11.6 mg/dL), creatinine (0.76-3.0 mg/dL) and potassium (3.6-6.42 mmol/L). Higher-than-normal elevations of serum enzymes were not detected in 12 individuals sampled 20 times. No adverse affects of capture stress were detected post-release.

### **Updating the Florida Manatee Recovery Plan.** Brooks, William B.<sup>1</sup>; Walker, Linda D.<sup>1</sup>

(1) U.S. Fish and Wildlife Service, 6620 Southpoint South, Suite 310, Jacksonville, FL, 32216-0958, United States

To support recovery of the endangered West Indian (Florida) manatee, the U.S. Fish and Wildlife Service (FWS) is finalizing a third revision of the Florida Manatee Recovery Plan. The original plan was developed in 1980 and subsequently revised in 1989 and 1996. The October 2001 target for completing this revision is based upon a renegotiated time line specified in the Save the Manatee Club *et al.* v. Ballard settlement. In 1999, the FWS established an 18-member recovery team comprised of public, private and agency stakeholders to assist in the third revision of the plan. A draft plan was published for public comment on November 30, 2000. The most significant comment regarding the plan was that it did not contain delisting criteria addressing the ESA Section 4(a)(1) five listing factors as required by the 1995 Grizzly Bear ruling (*Fund for Animals v. Babbitt*). Additionally, on February 12, 2001, the U.S. District Court found that in *Defenders of Wildlife v. Babbitt* that the FWS did not adequately address the 5 statutory listing factors in the Sonoran Pronghorn Recovery Plan. Thus, the FWS further revised the Florida Manatee Recovery Plan to provide additional recovery criteria that address the five listing factors. This substantial change necessitated a second public comment period. The current revision presents criteria for reclassification to threatened as well as delisting. The criteria set benchmarks for population demographics (survival, reproduction, and growth rate), as well as new targets that evaluate the success of conservation measures to remove existing and long-term threats to recovery. Each target specifically relates to threats identified in the five listing factors. The most pressing threat to manatee recovery is injuries and deaths caused by watercraft collisions (24% of all mortalities are attributable to watercraft). A long-term problem facing manatee recovery is maintaining adequate sources of warm water for the species to survive the cold in winter.

### **Caño La Brea, an Endangered Species Ecosystem: A Reconsideration of Its Status as Protected Area (Sucre State, Venezuela).** Ceballos, Natalia<sup>1</sup>; Müller, Daniel<sup>1</sup>; Briceño Linares, José Manuel<sup>1</sup>; Müller, Klaus<sup>1</sup>; Boher, Salvador<sup>2</sup>

(1) Fundación Vuelta Larga, calle 4 transversal 41 Residencias la Barraca Piso, Caracas, D.C., 1020, Venezuela

(2) Parque Zoológico de Caricuao, Caracas, Venezuela

Caño La Brea is located in Sucre State, Venezuela, and contains several habitats: mangrove, forested and grassy wetlands. Several endangered or threatened species have been reported in this area, such as otter, manatee, jaguar, cunaguaro, guacamaya, baba cayman, and terecay turtle, among others. In spite of high animal diversity, its current status is one of total absence of state wildlife management. Currently, Caño La Brea borders with the Guarapiche Forest Timber Reserve. However, this legal instrument cannot grant the protection level required for a rich ecosystem like this. Our monthly periodic visits to this place have shown what is happening: a rapid process of fauna depletion and vegetation is being strongly disturbed, by intentional fires and hunting carried out by native Amerindians and local residents. An urgent need is felt that this area be declared under a more restricted legal instrument of protection. Several governmental (INPARQUES, PROFAUNA, MARN) and non-governmental organizations have proposed this area be declared a Wildlife Reserve. However, this has not been accomplished. Its location, relatively distant from populated centers and with a single marine entrance by Caño La Brea, would allow strategic control of access and activities that are otherwise performed unrestrained. If this can be achieved, this imperiled region will enjoy adequate protection and new opportunities will appear for scientific research and the development of its tourism potential.

### **Mermaids and Mariners - Management and Protection Challenges in Achieving Successful Coexistence.** Cinalli, David<sup>1</sup>; Shaw, Cameron<sup>2</sup>; Martinez, Carlos<sup>3</sup>

(1) U.S. Coast Guard, 909 SE 1st Ave., Miami, FL, 33131-3050, United States

(2) U.S. Fish & Wildlife Service

(3) U.S. Coast Guard

Collisions with watercraft are the leading cause of human-related mortality to the Florida manatee (*Trichechus manatus latirostris*) within the coastal waters of the southeastern United States (Wright *et al.* 1995). This mortality category has been increasing steadily and accounts for approximately 25% of all known manatee mortality from 1974-2000. This percentage has been increasing in the last five years. Recovery efforts of the Florida manatee hinges largely on this important component of mortality. Zoning of manatee-occupied waters for reductions in boating activities and speed is essential to safeguard the manatee population. If boating regulations being implemented by the state of Florida in each of the 13 key coastal counties are completed, enforced, and effective, manatees and human recreation could coexist indefinitely. If regulation is unsuccessful, the Florida manatee population is likely to decline slowly toward extinction (Marmontel *et al.* 1997). Law enforcement agencies at the Federal, state and local levels have recently enhanced protection efforts in response to accelerated manatee mortality rates. Analyses of these efforts reveals a wide spectrum of results, from a marked decrease in mortality to increased mortality problems. Managers face many challenges in dealing with this complex, highly controversial problem. These include a continued rapidly increasing human population (both resident and transient), changes in

watercraft operator demographics and watercraft performance, and escalating opposition to protection efforts. It is essential for managers to implement improvements in manatee protection strategies to address these issues.

### **Fractographic Analysis of Manatee Rib Bone.** Clifton, K.B.<sup>1</sup>; Mecholsky, J.J.<sup>2</sup>; Reep, R.L.<sup>1</sup>

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Watercraft-related mortality of the Florida manatee (*Trichechus manatus latirostris*), caused by propeller wounds or impact, accounts for 24% of all deaths from 1976-2000, and comprises 78% of anthropogenic-related deaths. Sixty-six percent of animals killed by impact suffered broken or luxated ribs. Reducing watercraft-related mortality is identified as a high priority in the manatee recovery plan. To date, efforts have focused primarily on regulation of boating activities by establishing speed zones in areas where manatees and boats coexist. Creation of boat speed zones is a highly subjective process, not based on information pertaining to the biological effects of boat strikes on manatees. In order to establish safe boat speeds for manatee protection, an estimate of the forces required to fracture manatee bone is needed. Quantitative fracture surface analysis can be applied to manatee bone to estimate the force needed to break ribs. These data will be instrumental in shifting the focus to a more objective approach for establishing boat speed regulatory speed zones adequate to reduce watercraft-related mortality. Fractographic analysis was used to calculate fracture toughness of manatee rib bone. Fracture toughness is the ability to resist fracture, measured as critical stress intensity ( $K_{Ic}$ ). This is an estimate of the amount of energy required to initiate a macrocrack that can lead to breakage. Parallelepipeds were machined from ribs from anterior, middle, and posterior body regions, and fractured in three-point bending. Measurements of fracture surfaces were taken under light microscopy to calculate  $K_{Ic}$ . Average toughness was 2.9  $\text{Mpa}\cdot\text{m}^{1/2}$  ( $\pm 0.9$  SD). In comparison, human and bovine bone ranges from 2 - 6  $\text{Mpa}\cdot\text{m}^{1/2}$ , indicating that manatee bone is on average less tough (i.e. fractures more easily). Preliminary data further indicate that toughness increases caudad, which corresponds to a decrease caudad in rib mineral content reported by others.

### **Underwater Visual Acuity of a Florida Manatee (*Trichechus manatus latirostris*).** Colbert, Deborah<sup>1</sup>, Bauer, Gordon B.<sup>1,2</sup>, Fellner, Wendi<sup>1</sup>

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Two male Florida manatees were trained on a two-choice simultaneous discrimination procedure to select between grating stimuli, black and white striped targets. The black and white stripes were of equal area to control for brightness. One target with 1mm stripes, the standard, appeared on all trials. The comparison targets had stripes of greater width than the standard. Subjects swam toward the targets and had to make a selection at a divider located one meter from the targets. The comparison stimulus was the designated correct target. A free-swimming approach, as opposed to a fixed stationing distance, was selected based on ambiguity in the literature concerning optimal distances for manatee visual acuity. A method of constant stimuli was employed, in which a range of comparison stimuli were used from above and below threshold. Threshold, measured in minutes of arc, was determined at the interpolated 75% correct point. One of the manatees has completed training. His threshold underwater visual acuity from one meter under bright light conditions (greater than 1500 microEinsteins) was determined to be 23' and 50% acuity was found at 16'.

### **Comparative Analysis of Marine Mammal Utilization in the Southeastern Caribbean.** Creswell, Joel E.<sup>1</sup>, Romero, Aldemaro<sup>1</sup>

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Although some recent progress has been made in better understanding marine mammal utilization in the southeastern Caribbean, no comparative analysis has been carried out to see how such practices originated, developed, and finally impacted the marine mammal populations in that region. We conducted field and archival studies for Venezuela, Trinidad and Tobago, Grenada, and St. Vincent and the Grenadines. We analyzed records of whaling, dolphin fisheries, and manatee exploitation for those countries, interviewed local fishers, and explored the remains of whaling stations in the area. Our results show that each one of those countries developed a different pattern of marine mammal exploitation when it came to whaling and dolphin fisheries but similar patterns regarding manatee exploitation. In Venezuela there was little whaling, all carried out by Yankee whalers in the nineteenth century; in Trinidad and Tobago whaling was essentially an activity promoted by local elites that did not survive into this century. Whaling in Grenada was introduced and developed by Norwegians in the 1920's. Yankee whalers did have a great influence on whaling practices in St. Vincent and the Grenadines since the 1830's. Dolphin fisheries in Venezuela have been intense and carried out by local fishers with some influence from Far-east fishers; this activity is restricted to accidental catches in Trinidad and Tobago and is nonexistent in Grenada. Dolphin fisheries have been a well-organized operation in St. Vincent and the Grenadines since the 1920's. Most local populations of manatees in this part of the Caribbean were depleted during colonial times. We conclude that marine mammal utilization in these four neighboring countries developed differently due to historical, political, social, and economic circumstances.

### **Site Fidelity of West Indian Manatees (*Trichechus manatus*) along the Atlantic Coast of the United States.** Deutsch, C.J.<sup>1,2</sup>, Reid, J.P.<sup>1</sup>, Bonde, R.K.<sup>1</sup>, Easton, D.E.<sup>1</sup>, Kochman, H.I.<sup>1</sup>, O'Shea, T.J.<sup>1</sup>

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West Indian manatees along the Atlantic coast exhibit several different patterns of seasonal movement, ranging from year-round residents to long-distance migrants (median migratory distance = 280 km). We investigate the degree of consistency of individuals to movement patterns across years, and quantify within-season and interannual fidelity to seasonal ranges. We test the hypotheses that adult males move more extensively and exhibit lower site fidelity than adult females during the diffusely seasonal breeding period. We radio-tagged and tracked 78 manatees between the Florida Keys and southern South Carolina using VHF and Argos satellite telemetry over a 12-year period (1986-1998). Non-parametric cluster analysis was employed to define the spatial structure of individuals' seasonal ranges, where location clusters represent separate components of an animal's range. Manatees were highly consistent in their

seasonal movement patterns over time and showed strong fidelity to warm season and winter ranges both within and across years. Manatee movements were not nomadic: within a season individuals usually occupied 1 or 2 core use areas, encompassing about 90% of daily locations. Adult males had a higher daily travel rate and lower site fidelity than adult females within the warm season, presumably because males were searching for and consorting with estrous females; there was no sex difference in these movement parameters, however, during the winter (non-breeding season). Most manatees returned faithfully to the same seasonal ranges year after year: the median distance between range centers across successive years was 3.4 and 4.8 km for winter and warm seasons, respectively. Familiarity with the spatial arrangement of essential resources, travel routes, and hazards in a given locale probably enhances survival and reproductive success. The existence of traditional migrations and of strong philopatry to specific areas have implications for the design of protected area networks and for selection of release sites for rehabilitated manatees.

### **Is Fluctuating Asymmetry an Effective Bio-indicator for Manatees?** Dorsey, Candice<sup>1</sup>; Schaeff, Catherine<sup>1</sup>

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Fluctuating asymmetry is a condition where individuals in a population exhibit small random deviations from symmetry in otherwise bilaterally symmetrical traits. Since the degree of FA exhibited often correlates with individual survivability and/or reproductive success, FA has been used to assess individual and population health and reproductive fitness. Marine mammals are affected by numerous human-related impacts, many of which have become much more severe over the past few decades. For this study we assessed the impact of these increasing stresses by comparing the level of FA exhibited by in Florida manatees, *Trichechus manatus*, collected over the past century. FA was assessed using six skull measurements; three cranial and three mandibular. An ANOVA analysis of 100 randomly chosen animals indicated the presence of FA in all skull traits and low measurement error. We therefore expanded the comparison to include 500 animals born between 1890 and 1995 to see whether the degree of asymmetry has changed over this time period. As well, because most animals collected over the past few decades died prematurely (5-20 years of age), we also compared asymmetry in animals that died prematurely from specific causes (boat kills n=150, cold stress n=100, and the 1996 red tide episode n=200) with asymmetry in animals that were at least 25 years old at their time of death (N=30).

### **Aerial Survey Research to Develop a Numeric Correction Factor for Wintertime Florida Manatee (*Trichechus manatus*) Counts at Power Plants.** Edwards, Holly H.<sup>1</sup>; Ackerman, Bruce B.<sup>1</sup>; Reynolds, John E.<sup>2</sup>; Powell, James A.<sup>3</sup>

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In winter 1999/2000 and 2000/2001, an intensive study was conducted to estimate site-specific bias in manatee aerial surveys. Six manatee flight series were flown over the Tampa Electric Company (TECO) power plant discharge canal in Tampa Bay, Florida. Flights were conducted to estimate visibility bias under varying weather conditions. Data will be used to develop a numeric correction factor to adjust counts based on an estimate of the percentage of manatees undercounted. To quantify bias: 1) sixty-eight flights were flown; 2) marker flags were mounted on the tails of 15 manatees for identification from land and air; 3) land-based observers were used to compare counts from the air; 4) time/depth data loggers were used to estimate percentage of time manatees were at the surface; 5) tandem surveys (one plane following another) were used to compare observer counts. Results indicated that manatee counts are strongly affected by environmental conditions. Cold temperatures caused manatees to aggregate at the power plant. Maximum counts were recorded 3-5 days following a cold front, on warm days with sunny conditions and light winds. When weather conditions were cold, cloudy or windy, manatees spent less time surface resting and were more likely to be missed. Daily high counts increased by up to 211% (102 to 318; ~23%) between days and by up to 181% (73 to 205; ~16%) from morning to afternoon. Highest counts occurred in the afternoon during 68% of the surveys. Data from time/depth loggers showed that during cold weather, some manatees remained submerged for up to 16 minutes with a very short surface interval. In the winter of 2001/2002, we will begin the third year of our research. Accurate estimates of population size are needed to develop strategies for protecting manatees to ensure the recovery of the species.

### **Alternatives for Characterizing Statewide Boat-Strike Manatee Mortality Using a Geographic Information System.** Flamm, Richard *Florida Marine Research Institute, St. Petersburg, FL 33701-5095 USA*

Deaths of Florida manatees (*Trichechus manatus*) due to collisions with boats contributes to 27-32% of the annual manatee mortality. This class of mortality is considered relatively preventable, and as such, has garnered considerable interest from scientists, managers, and the public. Since the pattern of manatee deaths from boat strikes is spatial, we used a Geographic Information System (GIS) to explore various methods for mapping manatee boat-strike deaths. This work involved 2 characterizations to date. The first is a fixed-grid method where a grid is draped over a map of manatee boat-strike deaths and the total counts are added per cell. The problem with this method is that the positioning of the grid is arbitrary and can greatly influence the result. This problem was resolved by combining the results of several fixed grid maps where the grid was positioned randomly, the result being a contoured boat-strike characterization. The second characterization is a nearest-neighbor method based on Thiessen polygons. Thiessen polygons are generated by drawing lines that evenly separate points, in this case boat-strike carcass recovery sites, and continuing the lines until they intersect with another line. The result is a map of polygons formed around the points of interest. Points clustered together will result in many small polygons. One problem with this method is that polygons are drawn with respect to the points only, not to other features of the landscape, such as land. This problem was solved by creating an algorithm such that Thiessen polygons could only be drawn in manatee habitat. Future work will involve including these characterizations as part of a multivariate assessment of manatee boat-strike mortality, manatee habitat, and human use.

### **Underwater Masked Thresholds and Critical Ratios of the West Indian Manatee.** Gerstein, Edmund<sup>1,2</sup>; Gerstein, Laura<sup>3</sup>; Forsythe, Steve; Blue, Joseph<sup>1</sup>

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Underwater acoustic masked thresholds at 0.5, 1.6, 3, 6, 12, 18, 26 kHz were obtained from two test-sophisticated West Indian manatees using a forced-choice, two alternative, paradigm and an up-down staircase psychometric method. Pure tones were presented under two different stimulus conditions: (1) as pulsed signals, and (2) as non-pulsed signals. Under both stimulus conditions the tones were presented against a 1/3 octave continuous white-noise masker. Three different masking intensities were used to simulate moderate ambient noise levels recorded from manatee habitats. Masked thresholds across frequencies increased in a linear fashion with increased masking intensity. Critical ratios for both stimulus conditions increased with higher frequencies, however, thresholds for pulsed signals were significantly lower than non-pulsed signals suggesting some attenuation or higher order inhibitory process affected the perception of non-pulsed tones. Comparisons of critical ratios with other marine mammals suggests manatees have acute filtering abilities for detecting pulsed tones under continuous noise conditions. While manatees do not exhibit a rich vocal repertoire to account for acute filtering abilities, they are passive listeners which may be adapted to selectively filter out continuous noise in favor of detecting biologically significant sounds like their pulsed 200-500 ms species-specific calls. The ecological consequence of which could be serious with respect to the detection, recognition and habituation of the continuous noise from distant fast moving boats.

**Delayed Matching-to-Sample and Short and Long-Term Memory Abilities of West Indian Manatees.**  
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A series of matching-to-sample tests were conducted to investigate the short-term memory of one West Indian manatee as well as the long-term associative learning and memory of two West Indian manatees. The auditory short-term memory of a West Indian manatee was measured using a delayed same-different or delayed probe matching-to-sample task. The subject was first presented with a "sample" sound, a probe was presented following a 5-90 s delay. In a two-choice forced paradigm the manatee indicated whether the probe was same or different by selecting one of two paddles. The presentation of same or different probes was randomized using a Gellerman series. Four classes of sample/probe pairings were selected to investigate remembering as function of signal characteristics and delay (amplitude modulation, frequency modulation, pulse repetition, and frequency) Short-term memory was strongest for modulating tones paired with non-modulating at 90% correct for 90 s delays. The manatee demonstrated good acoustic discrimination and short-term memory on a par with some primates and marine mammals tested on similar tasks. Acquisition of the sameness rule was demonstrated during presentation of novel sample and probe pairings with immediate generalization at 94% correct discriminations of 40 unique novel to novel trials. The ability to recognize acoustic signals provides a bases for temporal learning and the remembering of acoustic events. Two test-sophisticated manatee subjects were trained to associate static targets with a set of acoustic signals and later perform delayed matching to sample discriminations by pushing the representative target for the acoustic signal presented. The learned associations were tested after 5 and 7 years in which time neither subject had been exposed to the stimuli. In single trial tests, both subjects selected the correct targets (100%) Their ability to learn and remember abstract associations suggests these long-lived smooth brained creatures have some remarkable cognitive abilities.

**Evaluation of Boater Compliance in Association with Manatee Speed Zones in Two Key Florida Counties.** Gorzelany, Jay F. *Mote Marine Laboratory, 1600 Ken Thompson Pkwy, Sarasota, FL, 34236, United States*

The adverse effect of watercraft on the Florida manatee (*Trichechus manatus latirostris*) has been well-documented. It has been demonstrated that the vast majority of adult manatees in Florida bear wounds that are representative of single or repeated collisions with powerboats. While continued basic research is vital to the overall protection of the species, the evaluation of current recovery strategies, including the establishment of speed-restricted zones, is also necessary in order to provide for effective species management. To this end, a series of boater compliance studies was performed during 1995 and 1998 in order to determine the effectiveness of existing manatee speed zones in two key Florida counties (Sarasota County and Lee County). Field surveys involved teams of boat- or land-based observers within a designated speed-restricted waterway. Boat type, size, activity, origin, destination, and observed speed were recorded for each surveyed vessel. Multiple sites were surveyed in each county. A total of 26,000 vessels were surveyed and evaluated. Overall boater compliance was 63% in Sarasota County and 57% in Lee County, though results varied significantly among individual survey sites. Compliance varied significantly with vessel type and size. This was largely due to the influence of personal watercraft, which had the lowest levels of compliance overall. Compliance did not vary significantly with time of day, day of the week, or time of the year. Differences in compliance between survey sites was also statistically significant, and was related to variations in local use patterns, traffic volume, vessel composition, sign placement, level of regulation, and enforcement presence. The percentage of boater compliance may be less important than the absolute number of non-compliant boaters in a given area. In high-traffic areas, for instance, the level of compliance may be high, but the absolute number of non-compliant boaters may still pose a significant threat to manatees.

**Cytogenetic Characterization of the Florida Manatee (*Trichechus manatus latirostris*) by Chromosome Banding Techniques.** Gray, Brian<sup>1</sup>; Zori, Robert<sup>1</sup>; McGuire, Peter<sup>2</sup>; Felton, Shelly<sup>1</sup>; Bonde, Robert<sup>3</sup>

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Published cytogenetic data for the order Sirenia is limited and, thus far, karyotypes produced have been restricted to conventional or solid chromosome staining techniques. To facilitate identification of individual chromosome homologues for the Florida manatee (*Trichechus manatus latirostris*), we have applied primary chromosome banding techniques, G- and Q-banding to metaphase chromosomes prepared from T- and B-cell peripheral blood lymphocyte cell cultures established from six individuals (three males; three females). Following brightfield and fluorescence microscopic analyses, a previously published modal chromosome number of 48 was confirmed for this species. Digital imaging methods were subsequently employed and individual homologues were identified by unique G-band patterns and chromosome morphologies. A standard banded karyotype was constructed, for both sexes, based on the G-band chromosome pattern obtained in these studies. Characterization of additional cytogenetic features of this species by

supplemental chromosome banding techniques, C-banding (constitutive heterochromatin), Ag-NOR staining (nucleolar organizer regions), and DA/DAPI staining was also performed. Cytogenetic features, including chromosome morphology and banding patterns, of *T. manatus latirostris* are described. These studies may provide a basis for more precise inter and intra specific comparisons by cytogenetic methodologies.

**Toxicology Analysis in Four Types of Tissues from Manatees in Puerto Rico.** Guzman-Ramirez, Liza<sup>1</sup>; Falcon-Matos, Limarie<sup>1</sup>; Mignucci-Giannoni, Antonio<sup>1</sup>

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In recent years the presence of organochlorines and heavy metals have been found to bioaccumulate in food webs. Since oceans are the ultimate sinkholes for these persistent compounds, marine mammals have become the endpoint reservoirs for these contaminants. Numerous studies have been conducted in other parts of the world documenting the presence of organochlorines in marine mammal tissues, but no studies have been conducted in the Caribbean. To assess the presence of dichlorodiphenyltrichloroethane (DDT) and its metabolites, polychlorinated biphenyls (PCB) and lindane in one Caribbean marine mammal, we collected samples of skin and blubber, liver, heart, lungs, kidneys, muscle and brain of stranded manatees (*Trichechus manatus*) in Puerto Rico. Of these tissues, we analyzed skin and blubber, muscle, liver and kidneys from six animals. Concentrations found were analyzed and compared to published values for manatees in Florida and other marine mammals.

**Present Status of Threats to Marine Mammals in India.** Hanfee, Fahmeeda<sup>1</sup>

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Though marine mammals have been declared as endangered species in Indian waters there is very little by way of conservation and protection for these creatures. Clearly the importance that is given to other terrestrial species like Tiger, Elephant far overrules the scant attention that is being paid to the critically endangered marine animals. Virtually, no efforts have been undertaken to sensitize the fisherfolk communities and others who are directly associated or who encounter them frequently. In general not much attention has been given to this group of animals in India, though there is an increasing attention being paid world over to protect and conserve the marine mammals. They are considered the most vulnerable group of sea animals worldwide. A few premier national organizations like Central Marine Fisheries Research Institute [CMFRI] have some information on stranding of whales and capture of Dolphins and Dugongs along the Indian coasts dating back to 1980's, although this is incoherent and scanty. Though these early reports reveal that incidental catches have increased greatly and also warned about the possible decline in the Dugong population in 1975 it also reports an average capture figure of 40 per year. Subsequently a report from CMFRI mentioned that about 250 Dugongs were caught and butchered between April 1983 to August 1984, an average of 4 per week. The Whales, Dugongs and Dolphins suffer mortality along the Indian coast due to various reasons i.e., 1. Inadvertent killing by the fishing nets 2. Accidental death due to straying into the shallow waters and other natural causes 3. Wanton killing by the fishermen by deploying the gillnets in the area where the marine mammals frequent during certain seasons. It is to be noted with grave concern that very little conservation measures were taken in the 70s and 80s. The data however is sketchy and old which has little relevance today. There is no latest information on Whales, Dolphins and Dugongs except for a few scattered notes here and there by interested scientists. In Kakinada (Andhra Pradesh coast of India) as many as 20 incidence of mammal landings by the drift gillnet in the last 2 years have been reported. There is scanty data available on the stray landings of these species along the Indian coast and no reliable information available on the areas where they occur in good frequency. This presentation highlights the various threats and urgent need for an enhanced management and conservation program for marine mammals in India.

**Dugong (*Dugong dugon*) Abundance in Trang Province along the Andaman Coast of Thailand.**

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In 2000 and 2001, dugong abundance was investigated using aerial surveys along the Andaman coast of Thailand. The largest population group was found in Trang province, as are the largest seagrass beds on the west coast of Thailand. A microlite, a light, single engine plane was used to fly in sampling blocks over seagrass beds. The total area surveyed was 245.5 km<sup>2</sup>, and the length of transects totaled 387.7 km. The microlite flew at an average height of 152 meters, and an average speed of 46.5 knots. Visibility from the microlite was approximately 200 meters on each side. All surveys were done during rising tides as the dugongs came to the seagrass beds to feed. The total number of sightings during 22 days of surveys was 264, out of which 31.5% were single dugongs. The largest group seen in 2000 was 30, and in 2001, 53. The maximum number of calves seen in one day was 13. Statistical analysis of survey data indicates that the best minimum estimate of population abundance is 123 animals (C.V. = 70.76%). Average density for both years is 0.5148/100 km<sup>2</sup> (C.V. = 41.91%). Higher numbers of dugong sightings and cluster sizes correspond with higher tides until the highest spring tide when water turbidity impeded sightings. Trang province is a primary feeding site for dugongs along this coast, and probably has the largest population group of dugongs remaining in Southeast Asia. The transect methodology created should be continued to increase the validity of knowledge about the number of dugongs in these areas. While a statistically powerful trend estimate is not possible with this small a population and the necessary intervals between surveys, more assessments are still needed to provide a complete picture of dugong habitat and animal distribution.

**Fine Scale Habitat Use and Movement Patterns of Dugongs Determined from Archival GPS Tags.**

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The use of GPS for tracking dugongs is a new technique that increases our ability to determine fine scale spatial and temporal usage in order to adequately manage and conserve dugongs and seagrass habitat in Shark Bay, Western Australia. Dugongs were caught by a rodeo technique with assistance from a local indigenous community. Using a harness and tether attachment system, five Lotek GPS tags were deployed for a period of six weeks during August- October 2000. The tags were later located through telemetry and retrieved through the development and use of a novel remote release mechanism that released the tag and harness from the dugong without the need for re-capture. During the deployment period over 4500 fixes were obtained and with GPS now giving sub ~10m accuracy this facilitated ground truthing of locations to determine seagrass and benthic composition. Locations were downloaded into Arcview GIS and plotted. Using available GIS of bathymetric and seagrass cover these positions are shown relative to these factors. A selection of 30 fixes were assessed by using underwater videography to more accurately assess benthos and seagrass cover and composition. Combined with later deployments, the outcomes are a series of maps showing dugong positions within Shark Bay in relation to habitat. These maps and the determination of temporal and spatial use of favoured seagrass species can be used as a management tool to aid in decision making in relation to activities such as aquaculture that may have an adverse impact upon dugongs and habitat within Shark Bay. The further development of combining GPS with more established satellite telemetry is further enhancing the utility of this technology for use in many multi-scaled sirenian studies.

### **Hunting Threats and Feeding Areas: An Approach to the Conservation of the Amazonian Manatee (*Trichechus inunguis*) in Colombia.** Kendall, Sarita<sup>1</sup>; Orozco, Diana<sup>1</sup>; Fuentes, Libia<sup>1</sup>; Padilla, Adriana<sup>1</sup>

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In 1998 the Omacha Foundation began a research and education program with the aim of establishing strategies for the conservation of the Amazonian manatee, *Trichechus inunguis*, in the area of Puerto Nariño, Colombia. During 2000 we completed monthly surveys of feeding areas by identifying stalks of floating pasture eaten by manatees. In addition, over 80 in-depth interviews with manatee hunters and specialists were carried out in 2000-2001. About half those interviewed attended workshops to discuss findings and conservation problems. Surveys identified 167 manatee feeding areas through the year. Feeding areas were reported for the lakes from February to August, during high water, and for Amazon river banks for all months except June. The cutting of pasture and placing of trot lines by fishermen did not appear to deter manatees from feeding; however, manatees did not feed on patches near beaches where rice was being grown during low water, despite the scarcity of pasture at this time. Data for more than 90 hunting events showed that most captures were made by pirarucú (*Arapaima gigas*) fishermen using harpoons (73.5%), although traps were also used (18.8%) and young manatees were occasionally caught in nets (7.7%). Most individuals (78%) were hunted when the Amazon waters were rising or falling. Information from interviews and feeding area surveys was combined to clarify distribution and feeding ecology, with the identification of Amazon islands as an important habitat for manatees. The involvement of local people in the process allowed extensive debate on conservation strategies in four communities, with recommendations that included a campaign to diffuse new legislation and penalties for manatee hunting in Colombia, Brazil and Peru as well as information on the low reproductive rate of manatees. Danger spots and regular hunters were identified by the communities, leading to more intensive conservation efforts in specific areas.

### **Do You See What I See? Use of Tandem Aerial Surveys to Estimate Manatee Visibility Biases.**

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Aerial surveys are an important tool for assessing relative abundance and distribution of Florida manatees (*Trichechus manatus latirostris*). However, an unknown number of manatees are missed because of visibility biases. To quantify these biases, we conducted tandem aerial surveys in Sarasota County, Florida. This was the first study conducted to estimate the error in standard manatee counting procedures by using tandem counts. Manatees observed by two experienced aerial survey teams, 20-60 minutes apart, were compared to determine how many were seen by both teams or missed by either team. Between August 1998 and November 1999, teams conducted 17 pairs of tandem aerial surveys, during the warm season (April - December). Team I, the more experienced team in this study area, counted more manatees (Team I: mean = 70.8, Team II: mean = 59.8 manatees/flight;  $p=0.003$ ). A comparison of the mapped position of the groups seen indicated that the two teams sometimes saw different groups and counted different numbers of manatees within groups. Team I observed 78% of the groups and 82% of the manatees that were observed by both teams combined. Team II observed 64% of the groups and 78% of the manatees. Smaller groups were more likely to be missed by either observer. Using mark-recapture methods to estimate the number of unobserved groups, Team I alone observed 64% of the groups estimated to be present. These results suggest a site-specific average correction factor of 1.57 for a single team conducting manatee aerial surveys in Sarasota Bay. This correction factor should not be applied universally to manatee aerial surveys in other environments without further research.

### **Distribution and Foraging Ecology of Antillean Manatees (*Trichechus manatus*) in the Drowned Cays Area of Belize, Central America.** LaCommare, Katherine S.<sup>1</sup>; Sullivan, Caryn Self<sup>2</sup>; Brault, Solange<sup>1</sup>

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The Drowned Cays in Belize, Central America harbor an important population of Antillean manatees (Morales-Vela 2000, Auil 1998, O'Shea and Salisbury 1991). This study has three principal objectives. 1) Determine the distribution and seasonal distribution of manatees within the study area. 2) Determine which grassbeds in the study area are important feeding areas. 3) Compare the community structure of grassbeds where manatees feed to grassbeds where they do not feed. Utilizing point transect methodology, we regularly surveyed, by boat, 45 points that were distributed evenly throughout the study area. We conducted the surveys during the winter of 2000, and the winter and summer 2001. During the surveys, each point was approached with the engine off; upon reaching the point the area was scanned for twenty minutes. The number of manatees and their behavior was recorded. During the surveys and along travel routes between points, all manatees encountered that were feeding were recorded. This information will be used to map

feeding areas. In order to compare community structure of grazed versus ungrazed beds, a subset of the survey points were chosen to conduct intensive community sampling. We measured percent of bottom covered with seagrass, relative abundance, biomass, shoot density, leaf area index of *Thalassia testudinum* and productivity of *T. testudinum*. Preliminary results indicate that manatees utilize the northern portion of the study area more heavily than the southern portion of the study area. Manatees feed in certain grassbeds much more frequently than others. Grassbeds grazed by manatees had a lower percent cover, lower density, but a greater mean blade height than grassbeds not grazed by manatees. We will test for differences in productivity between grazed and ungrazed beds, and characterize the environmental correlates of areas with different manatee visitation/utilization rates.

**Evaluation of the Twenty-Year West Indian Manatee Project of the National Environmental Authority of the Ministry of the Environment in Brazil.** Lima, Regis Pinto<sup>1</sup>; Luna, Fabia de Oliveira<sup>1</sup>; Marcondes, Milton Cesar<sup>2</sup>; Castro, Denise De Freitas<sup>2</sup>; Alvite, Carolina Matosinho<sup>2</sup>

- (1) Centro Mamíferos Aquáticos/Ibama, Estrada do forte Orange S/N CP 01, Itamaracá, Pernambuco, 53.900-000, Brazil
- (2) Fundação Mamíferos Aquáticos

The West Indian Manatee (*Trichechus manatus*) is the aquatic mammal most endangered in Brazil. Its historical distribution was since 20°23'S to 04°25'N. In 1980, the West Indian Manatee Project was created by Brazilian government to act towards the protection of the species. This paper will approach strategies developed throughout these 20 years for the diagnosis of the species' status, the rescue of calves, their rehabilitation and reintroduction, and conservationist campaigns. The species' status was determined through a research in the area of its historical occurrence (5,000 km<sup>2</sup>), doing interviews with population of the coast. The great number of run aground newborn calves has triggered the development of rescuing and rehabilitation methods. A program of reintroduction of these animals with radio-telemetry monitoring was established. It was verified that the species is extinct in some states, presenting discontinuous distribution. The size of population is 500 animals and it still suffers hunting threats in North coast and damages to the habitat in Northeast, thus being classified in the Action Plan (IBAMA-National Environmental Authority, 1997) as critically endangered. The survey subsidized the creation of 3 federal environment protection areas spread 742,000 ha. 24 calves have been rescued alive, since 1989, with 58% survival rate. The first reintroduction occurred in 1994. Since then, 7 animals have been reintroduced, and 4 are being monitored daily. 4 animals were born in captivity, with one rare case of twins. We may conclude then, that Project has generated important information to classification the species and has developed strategy for its conservation, which has involved the population not only in the diminishment of the intentional captures, the rescue, and reintroduction of calves, but also in the awareness of the importance of the species, no longer as a direct source of food, but as a generator of jobs in the Project activities and in ecotourism.

**Serologic Evidence of Leptospirosis in Florida Manatees.** Lounsbury, Valerie J.<sup>1</sup>; Geraci, Joseph R.<sup>1,2</sup>; Yates, Nathan S.<sup>1</sup>; Arnold, Jill<sup>1</sup>

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- (2) University of Maryland School of Medicine, Comparative Medicine Program

A serologic survey of archived Florida manatee (*Trichechus manatus latirostris*) sera was conducted from 1996 to 2000 to identify pathogens to which this population may be exposed. The test panel included a range of infectious agents in domestic and wild mammals in the United States. As part of the study, 142 sera collected from 1979 to 1996 from free-ranging, rescued, and captive manatees were tested for up to 13 serovars of *Leptospira* interrogans using the microscopic agglutination test. Leptospirosis is a common zoonosis affecting mammals worldwide. Related data were compiled on animal origin, sex, age, health and history, and sample collection dates. Thirty-six of 142 (25.4%) samples were positive (□1:100) for one or more serovars. Positive results were obtained for nine of the 13 serovars tested; the most common were bratislava (22/142), autumnalis (16/136), and australis (9/136). When correlated with case histories, results indicate that leptospiral infections may be particularly common in the Florida west coast manatee population. The data show a positive relationship between seroreactivity and age, higher prevalence of infections after 1990, evidence that titers drop within a few months, and little evidence of association with clinical disease. These results suggest that Florida manatees may serve as maintenance hosts for one or more serovars. In other species, maintenance host leptospiral infections are often associated with generally mild illness and high rates of reproductive failure. Further studies are required to determine current patterns of infection in manatees; characterize the serovars involved; identify possible sources of exposure; and examine potential impacts on health - particularly any relationship to the high rate of perinatal mortality in this population. Manatee salvage and rehabilitation program managers should evaluate current operational, quarantine, and release protocols to minimize risks of disease transmission to humans as well as to captive and wild manatee populations.

**Capture and Utilization of the Amazonian Manatee (*Trichechus inunguis*) in the State of Amazonas, Brazil.** Luna, Fabia de Oliveira<sup>1</sup>; Lima, Regis Pinto<sup>1</sup>; Castro, Denise De Freitas<sup>2</sup>; Vianna, Juliana De Abreu<sup>3</sup>

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- (2) Fundação Mamíferos Aquáticos
- (3) Universidade Católica de Minas Gerais

The Amazonian manatee (*Trichechus inunguis*) lives in the Amazonian basin. It is classified as vulnerable by IUCN (2000). This species has been extremely hunted in Brazil since the colonization, and is still so. The understanding of the traditional customs of the river bank dwellers regarding the manatees subsidizes the creation of conservationist measures for the species. Between May and September/2000, the Aquatic Mammals Center and the Aquatic Mammals Foundation have conducted an extensive survey on the capture and destination of the Amazonian manatees. For that purpose, 352 interviews were held with the river bank dwellers, preferably hunters, in 236 places and 6,400 km of the main rivers in Amazon state. Hunting in the region is intensive. 33% of the interviewees have already hunted the animal and 34% have helped in the hunting. The manatees were hunted with spear in 97% of cases and were choked to death by introducing wood in their nostrils. 65% of those who have already hunted the animal still do. The capture technique is difficult, requires patience and is passed on from father to son. The capture is exclusively for consumption in 60% of the cases and in 40% for consumption and selling. 90% of the interviewees have already consumed manatee meat in several formats: sausages, mixira (meat conserved in fat). Although parts of the animal are used as medicine, folklore and utensils, its capture

for this purpose has not been registered. Most of the interviewees (97%) knew that the animal is protected by law. Concluding that future works for the conservationist of the species need to aim at diminishing the intentional capture, which is fundamental in order to prevent the species from reaching critically endangered status in the country as has the West Indian Manatee (*Trichechus manatus*) because of its intense hunting on the Brazilian coast.

### **Shark Control Records Hindcast Dramatic Decline in the Dugong on the Urban Coast of Queensland.** Marsh, Helene<sup>1</sup>; De'ath, Glenn<sup>1</sup>; Gribble, Neil<sup>2</sup>; Lane, Baden<sup>3</sup>

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(2) Northern Fisheries Centre, Cairns, Australia

(3) Queensland Shark Control Program, Mineral House, Brisbane

The dugong (*Dugong dugon*) is listed as vulnerable to extinction by IUCN - the World Conservation Union. This evaluation is essentially based on anecdotal information from 37 countries and territories because of the difficulty in detecting trends in population size in the dugong's turbid coastal habitat. We used records from a government shark control program and log-linear models to hindcast changes in dugong numbers over 38 years along a 10 latitude stretch of the eastern coast of Queensland, Australia. The shark control program used standard nets at up to a total of 47 beaches in 8 localities. Dugong by-catch was recorded as a condition of the netting contracts. For a balanced data set of records from 6 localities, the overall capture rate declined at an average of 8.7% per year [95% CI = (7.1, 10.6)]. For the full data set from 8 localities, the overall capture rate declined at 8.2% per year (6.8, 9.7), only marginally lower than for the balanced data set. The estimated decline in shark net by-catch of dugongs was used to estimate the decline in dugong numbers from all causes averaged over the areas where nets were deployed. This hindcasting suggests that dugong numbers have declined to about 3 percent of 1960s levels, if dugongs have not learned to avoid the nets or been alienated from the beaches where the nets have been deployed by increased human use.

### **Training of Medical Behaviors in an Orphan Manatee to Be Re-introduced into Wild in Puerto Rico.** Martinez-Diaz, Kiari<sup>1</sup>; Perez-Lewis, Miriam<sup>1</sup>; Quijano-Rosy, Adriana<sup>1</sup>; Valentin-Narvaez, Jose A.<sup>1</sup>; Mignucci-Giannoni, Antonio A. Caribbean Marine Mammal Laboratory, Universidad Metropolitana, San Juan 00936-1715, Puerto Rico

Training of medical behavior are well known to facilitate husbandry and physiological assessment of captive marine mammals by caretakers and veterinarians, making it less stressful for the animals. Only recently, this training method has been used in manatees, and is at present being considered for animals to be released to the wild after rehabilitation. To prepare for the re-introduction of a male Antillean manatee in Puerto Rico, the animal was trained to perform six different behaviors: come to clicker, go to station (move the animal from one trainer to another), station (to control the animal and give commands), head show (to examine eyes, mouth and nostrils), roll-over (to check on the individuals general condition, examine its ventrum, directly collect fecal sample, take heartbeat and morphometrics), and pec-show (to collect blood samples). A dog clicker was used as secondary reinforcement and monkey chow (Purina biscuits) were used as primary reinforcement. It took from one to three weeks to teach each behavior. Two trainers and a judge were used in daily one-hour training sessions. Each session consisted of a teaching section, a testing section and a refinement section. Refining the behaviors took at times about a month. The rate of mistake in doing a behavior was relatively low, although compared to dolphins, for example, reaction to carry out a behavior was low, although ultimately was carried out. This training will ultimately benefit the animal once released and will enhance caretakers and veterinarians post-release monitoring of rehabilitated and re-introduced marine mammals.

### **Manatee Behavioral Responses to Vessel Approaches.** Nowacek, Stephanie M.<sup>1,2</sup>; Wells, Randall S.<sup>1,2</sup>; Nowacek, Douglas P.<sup>1</sup>; Owen, Edward C.G.<sup>1</sup>; Speakman, Todd R.<sup>1,2</sup>; Flamm, Richard O.<sup>3</sup>

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(2) Chicago Zoological Society

(3) FWC Florida Marine Research Institute

Watercraft continue to be a serious source of mortality and injury for Florida manatees (*Trichechus manatus latirostris*), accounting for about 25% of manatee deaths each year, and they can affect manatee distributions. In spite of the importance of watercraft interactions, few systematic observations of manatee responses to approaching boats have been reported. Using a remotely operated video recording system suspended from a tethered, helium-filled aerostat, we conducted focal animal observations of 30 manatees during opportunistic boat approaches and experimental controlled approaches. The overhead video system allowed us to see both surface and subsurface behaviors thus affording us the opportunity to determine whether manatees respond to approaching vessels. To do this, we compared changes in behaviors (swimming speed, heading, inter-animal distance, and distance to the channel) during 170 boat approaches as compared to control periods (no boats present). Significantly more changes in swimming speed and distance to the deeper water (channel) were found during boat approach segments than during control segments. Manatees increased swimming speed and moved from shallows towards channels. These responses were oftentimes initiated when the range to the approaching vessel was 25 to 50 m, which is likely to be greater than the distance at which manatees could visually detect targets. After determining that manatees do in fact respond to approaching vessels, we examined which boat and/or habitat parameters affect whether a change in behavior occurred. Movement towards the channel occurred during all types of approaches. Swimming speed was significantly affected by individual, approaching boat habitat and distance, and manatee habitat. Current efforts are extending this research to relate manatee behavioral responses to vessels to received levels of sound via a digital data logger tag. Knowledge of factors leading to manatee responses as boats approach is crucial to mitigating this source of mortality and serious injury.

### **Manatee Distribution in Relation to Some Habitat Features within an Antillean Manatee (*Trichechus manatus manatus*) Sanctuary in Mexico.** Olivera, L.D.<sup>1</sup>; Mellink, E.<sup>1</sup>

(1) Centro de Investigacion Cientifica y Educacion Superior de Ensenada, CICESE, PO Box 434844, San Diego, CA 92143, USA

The study of habitat features associated with manatee distribution and abundance has not been well studied, specially outside Florida. This is an important issue for research and management plans of manatees and for the design of protected areas for this endangered



mammals. We conducted a study in Bahía de Chetumal, an state manatee sanctuary in Southeastern Mexico, to explore associations between spatial location and abundance of manatees and some habitat features reported as important for this species. We conducted 17 manatee aerial surveys following straight transects parallel to the coast covering mostly areas less than 4 m deep. Observations were bounded to 400 m to each side of the plane. Sampling of habitat features were based on 400 X 500 m units, located along the strips covered by flights. Fix characteristics were measured directly from topographic charts and digital images of the study area, and from results of a bathymetric survey conducted at the same time of this study. In the overall study manatees occupied 35% of the units, most of them in just one occasion (distribution of occurrence per unit fitted well a negative binomial function). We found significant Spearman correlations with depth, cover of aquatic vegetation and distance to main fresh water sources. Other features like presence of physical barriers to wave action were independent of manatees. Manatees were located mainly near of freshwater sources and in waters between 2.5 and 4 m, specially where bathymetric perfils drop from shallow to more deep waters. Our study shows that growing of aquatic vegetation is poor in this bay and is limited only to a small portion of the area, we suggest to include this issue in the management plan of this sanctuary.

### **A Regional Manatee Recovery Plan for the Alvarado Lagoon System, Veracruz, Mexico.** Ortega-Argueta, Alejandro<sup>1</sup>, Portilla-Ochoa, Enrique<sup>2</sup>, Keith, Edward O.<sup>3</sup>

(1) *Instituto de Ecología, A.C., Km 2.5 Carretera antigua a Coatepec 351, Congregación El Haya, Xalapa, Veracruz, 91070, Mexico*

(2) *Institute of Biological Research, University of Veracruz, Xalapa, Veracruz*

(3) *Oceanographic Center, Nova Southeastern University, Ft. Lauderdale FL, USA*

The historical range of the Antillean manatee (*Trichechus manatus manatus*) extended along the entire coast of the Gulf of Mexico, especially the mouths of the principal rivers. The decline in manatees in this region has been due to hunting and destruction of breeding habitat. Studies in the mid-1980's reported the disappearance of the manatee from the Alvarado Lagoon in Veracruz State, Mexico. Nevertheless, recent reports from the indigenous people, and the incidental capture of three manatee calves during 1998, have confirmed their reappearance in this area. A recent study assessing manatee distribution in the Alvarado Lagoon System (ALS) found that they ranged over a larger area than previously recorded. Poaching continues due to tradition, a lack of awareness of their legal protection, and insufficient vigilance from the authorities. Our group began studies in 1998, selecting the manatee as a representative species for the natural resource conservation projects to be carried out in the ALS. We are preparing a manatee recovery plan for the ALS that describes the actions needed to ensure manatee conservation, and identifies those groups and organizations that could facilitate these actions. The specific objectives of this plan are: (1) to continue current studies of the status of the manatee population in the ALS, (2) the assessment of critical habitat areas in the ALS, (3) the identification of priority actions needed to ensure the recovery of the Antillean manatee, (4) to expand the educational program in the local communities to ensure the conservation of the Antillean manatee, and (5) to improve the legal strategies for manatee and habitat protection. Because of its endangered status in Mexico the recovery of the Antillean manatee has a high priority.

### **LMRIS: The Living Marine Resources Information System.** Petitpas, Linda S.<sup>1</sup>, Norris, Thomas<sup>2</sup>, Loftus, Christine<sup>2</sup>, Clarke, Janet<sup>2</sup>, Gregg, Jim<sup>1</sup>, Lynch, Jim<sup>2</sup>, David, Clark<sup>1</sup>

(1) *Spawar System Center (SSC), 53560 Hull St., San Diego, CA, 92152-5001, United States*

(2) *Science Applications International Corporation*

LMRIS is an information and mapping system being developed to provide geographic information about occurrence, population estimates, and the natural history of marine mammals and sea turtles. The main purpose of LMRIS is to provide information about when, where, and estimates of how many animals occur in an area so that the U.S. Navy can plan and conduct their activities with minimal environmental impact. LMRIS currently includes data for the central and eastern North Pacific (CENPAC), the Western North Atlantic (WNATL), the Gulf of Mexico (GOM), and the Caribbean Sea. In general, data sources are restricted to peer-reviewed publications, U.S. government agency reports (e.g. NOAA Fisheries reports) and government contract reports. Presently, LMRIS contains information for all (49) species of cetaceans, sea otters (*Enhydra lutris*), manatees (*Trichechus manatus*) and all federally protected pinnipeds (9 species) and sea turtles (7 species). In the CENPAC, cetacean density estimates were derived from line-transect marine mammal survey data that were analyzed (by NOAA Fisheries La Jolla, CA) specifically for LMRIS using 5 x 5 degree sub-strata (blocks). With this information, LMRIS will provide the capability to sum estimates for multiple species within a block, or to pool estimates across multiple blocks for a single species. In the WNATL, GOM and Caribbean Sea, 10 x 10 minute grid resolution is available for displaying relative occurrence data where available. For the WNATL, cetacean densities are displayed geographically for the entire study region (i.e. strata or sub-strata) for which the estimate was made. Presently, access to LMRIS is restricted to the Navy, however in 2002 it will be turned over to the Navy's Oceanographic and Atmospheric Master Library (OAML) for general use. Future plans include a collaborative effort (with NOAA Fisheries La Jolla, CA) to develop and integrate a predictive model of cetacean distribution and abundance based on oceanographic data. [work supported by CNO-N45G]

### **Interpretation of Life History Events of the Florida Manatee (*Trichechus manatus latirostris*)**

#### **Recorded in Growth-Layer-Groups.** Pitchford, Meghan E.<sup>1,2</sup>, Rommel, Sentiel A.<sup>1</sup>

(1) *Florida Marine Research Institute, Marine Mammal Pathobiology Laboratory, 3700 54th Ave South, Saint Petersburg, FL, 33711, United States*

(2) *University of California, Santa Cruz*

For some mammalian species, life history information is recorded in the growth patterns of hard tissues. Variations in annual growth may be indicated by the spacing of growth-layer-groups (GLGs). Periods of above or below average growth can reflect biological and environmental events such as the onset of sexual maturity, pregnancy/lactation, injury, and periods of low food abundance. Currently, GLGs in the earbone of the Florida manatee are used only to determine absolute ages. To test the feasibility of collecting additional life history information of manatees from GLG spacing, we examined earbones from manatees with well-documented histories. Relative spacing between GLGs was consistent around the entire section of earbone, indicating that a set of measurements can be obtained along any single radius. Documentation for each known manatee included information such as behavior, calving intervals, and wound acquisition. The timing of events from an individual's life history was compared to the timing of interannual variations in

growth observed in the measurements of GLGs. Graphs of annual growth rate, derived from the GLG spacing, showed distinct variations throughout the individuals' lives. Results indicated that: (1) a consistent and relatively large amount of growth was observed during the first three years for all individuals examined, (2) all individuals had a distinct change in growth rate between years 3 and 5, consistent with the documented timing of sexual maturity and field observations of the manatees examined for this study, and (3) after age 5, each manatee had intervals of inconsistent growth which may reflect individual life history events. Thus, GLG spacing could be a useful method for obtaining life history information of manatees. Growth-layer intervals could be used for both species assessment by examining long-term trends in age of sexual maturity, and for individual assessment by identifying short-term biological and environmental events.

### **Characterizing Watercraft from Watercraft-Induced Mortality in Florida Manatees.** Pitchford, Thomas D.<sup>1</sup>, Pitchford, Meghan E.<sup>1</sup>, Rommel, Sentiel A.<sup>1</sup>

(1) *Florida Marine Research Institute, Marine Mammal Pathobiology Laboratory, St. Petersburg, FL 33711, USA*

In the past 10 years, nearly 600 Florida manatees (*Trichechus manatus latirostris*) have been killed by watercraft collisions. Until recently, formalized necropsies did not routinely attempt to characterize the watercraft properties from wounds. Our research focuses on methods of wound examination and wound description which are used to suggest: 1) properties and features of the propeller such as diameter, pitch, and rotation; 2) features of the hull or other parts of the vessel that may indicate vessel type; 3) orientation and direction of travel of the vessel relative to the manatee; and 4) posture and behavior of the animal at the moment of collision. Watercraft can inflict both sharp- and blunt-force trauma to manatees. Sharp-force trauma generally includes injuries from propeller blades and skegs while blunt-force trauma includes injuries from hulls, keels, and rudders. Propeller wounds, generally in a series, may vary in appearance depending on depth of penetration. A series may contain linear, crescent, and/or sigmoid wounds. Measurements of the length, depth, and distance between propeller wounds help estimate propeller diameter and pitch. The angle of each element of the wound pattern compared to the wound axis indicates rotation of the propeller. Individual, linear wounds are considered to be from skegs, keels, rudders, or other non-rotating features of the vessel; these lesions are generally superficial and are typically accompanied by deep tissue trauma. These methods for wound analysis will significantly improve the characterization of watercraft responsible for manatee deaths.

### **Biology and Movements of Manatees in Southern Lagoon, Belize.** Powell, James A.<sup>1</sup>, Bonde, Robert<sup>2</sup>, Aguirre, A. Alonso<sup>1</sup>, Koontz, Charles<sup>1</sup>, Gough, Mesha<sup>1</sup>, Auil, Nicole<sup>3</sup>

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(2) *USGS Sirenia Project*

(3) *Belize Coastal Zone Management Authority*

Although relatively little information is known about manatees (*Trichechus manatus*) outside of Florida, studies in other regions offer opportunities to better understand the behavioral ecology and life history of manatees where they are less affected by anthropogenic factors and cold weather. Since 1997, we have studied manatees in Southern Lagoon, Belize. Southern Lagoon is an enclosed estuary approximately 37 km<sup>2</sup> in size with a single outlet to the sea. Eleven males and four females were captured and released. Twelve were fitted with either VHF or satellite radio tags. Two calves and one juvenile manatee were not tagged with radio tags. All individuals were marked with PIT tags and by taking a skin sample from the tail that also was used for genetic analyses. Most of the tagged manatees were recaptured biannually to replace the tags or batteries. At each capture and recapture event, health assessments were conducted based on clinical exams, ultrasonic fat measurements, hematology and blood chemistry, and urine and fecal analyses. Morphometric data were taken and reproductive condition observed. Data were also collected in Southern Lagoon on seagrasses and environmental parameters such as salinity, water turbidity and temperature. Aerial surveys by helicopter were conducted twice a year to monitor population numbers. The tagged females and some males stayed in the Southern Lagoon area, whereas some males roamed the coast. The calving interval for the three females was longer than expected relative to Florida manatees. Differences in movement patterns among males, and between males and females, pose interesting questions regarding reproductive strategies. Extended calving intervals during periods of possible nutritional stress may suggest that environmental changes or density dependent factors may affect reproduction. The health assessments complemented the tracking studies and those results will be presented in another paper.

### **Evaluation of Manatee Foraging Ecology by Stable Isotope Analysis.** Reich, Kimberly J.<sup>1</sup>, Worthly, Graham A.J.<sup>1</sup>

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*Trichechus manatus* is the only Sirenian, other than the West African manatee, to utilize both fresh and salt water as habitat, feeding primarily on aquatic vegetation, including seagrasses, and some species of exotic plants. They have also been known to feed on terrestrial grasses and overhanging vegetation. Objectives of the present study were to: (1) Evaluate long-term foraging patterns of free-ranging individual manatees by examining samples of skin collected from dead animals, (2) Analyze vegetation commonly consumed by manatees from freshwater, estuarine and marine environments for stable isotope content, and (3) Compare geographic differences in foraging habits by analyzing samples representing four geographic regions of the state of Florida. Manatee samples (n=26) were obtained from dead free-ranging manatees. Tissue samples were identified by the region from which they were collected and micro-samples, taken from three tissue layers, were analyzed for carbon and nitrogen isotopes. Samples of 28 different plant species consumed by manatees were opportunistically collected from five locations in Florida where manatee foraging has been observed. When the  $\delta^{15}\text{N}$  and  $\delta^{13}\text{C}$  values of the vegetation and tissue samples were compared, there was a distinct separation of plant types and manatee tissue in geographic regions.  $\delta^{15}\text{N}$  and  $\delta^{13}\text{C}$  values in the tissue suggest that seagrasses represent a greater percentage (~60%) of the diet of *T. manatus* on the east coast with freshwater vegetation being a relatively minor component of the diet. Data from the west coast samples indicate an increased consumption of freshwater species (~45% of diet). These data suggest that manatees may be employing different foraging strategies in different regions.

**Radio Tracking Manatees to Assess the Impact of Hydrologic Changes in Southwest Florida.** Reid, Jim<sup>1</sup>; Easton, Dean<sup>1</sup>; Butler, Susan<sup>1</sup>; Lefebvre, Lynn *U.S. Geological Survey, Sirenia Project, Gainesville, FL 32601, USA*

We are conducting a multi-year project to develop ecological models necessary to understand and predict the effects of hydrologic restoration on manatees (*Trichechus manatus latirostris*) in Southwest Florida. As part of this effort, we initiated a radio tracking study in June 2000 to determine manatee movement patterns and habitat use prior to hydrologic alterations. We hypothesize that manatee distribution and movements will be influenced by changes in water flow patterns, particularly in the Ten Thousand Islands region downstream from the Southern Golden Gate Estates and Faka Union Canal. Twelve manatees have been tagged and tracked using satellite-monitored Argos tags from June 2000 – June 2001. Weekly movement patterns suggest a preference for foraging in marine areas with brief trips to inland creeks and canals, which provide sources of fresh water. During the winter months, one adult female migrated from the Pavilion Key/Chatham River area south to Whitewater Bay, where she spent several months before returning to her previous warm season range. A data-logging GPS tag, which collects locational data at 15-minute intervals, was deployed on 3 manatees for two-week periods during 2000 and 2001. These data will allow us to determine fine-scale habitat use and provide accurate information on travel paths.

**A Comparative Anatomical Study of the Larynx in Aquatic Mammals and Proposed Mechanisms of Pneumatic Sound Production and Transference to Water.** Reidenberg, Joy S.<sup>1</sup>; Laitman, Jeffrey T.<sup>1</sup>

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Sound production in aquatic mammals is poorly understood. In particular, there is little information on how their pneumatically generated sounds are transferred to water. This project explores the anatomy and possible mechanisms of sound generating and transferring structures in 25 terrestrial and 25 aquatic genera. Postmortem cetacean, pinniped, and sirenian specimens were obtained from United States strandings. Results show that the larynx of non-cetacean aquatic mammals appears similar to that of land mammals, which use a pneumatic system for sound generation based mostly upon vocal fold vibration. Vocalizations may be transferred to water via laryngeal vibrations directly impinging upon the overlying throat tissues, such as a fat pad found in manatees. Mysticete vocal folds are re-oriented parallel to airflow and remain separated along most of their length. The folds fuse caudally, forming a U-shape that may regulate airflow into a ventral sac. Fold vibrations may transfer to attached sac walls, then to overlying throat tissues, and subsequently to water. The corniculate cartilages have large flaps that may also vibrate to generate sound. Odontocete vocal folds are also re-oriented parallel to airflow, but unlike mysticetes folds, fuse rostrally in the midline. While echolocation clicks are generated nasally, the source of whistles and other communication sounds is unclear. One possibility is vibration of the midline vocal fold. These vibrations may transfer epicranially through tight coupling of the larynx to the skull and septal cartilage of the rostrum. Although vibrations might emerge ventrally, no cervical fat pads were found to facilitate this transfer. Lateral sound projection appears blocked by the air-filled pterygoid sacs. While non-cetaceans appear similar to land mammals, cetaceans have derived special mechanisms that may enable production and transference of low or high frequency sounds underwater.

**The Likelihood of Sperm Competition in Manatees - Explaining an Apparent Paradox.** Reynolds, J.E.<sup>1</sup>; Rommel, S.A.<sup>2</sup>; Bolen, M.E.<sup>2</sup>; Powell, J.A.<sup>3</sup>

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(2) *Florida Fish and Wildlife Conservation Commission*

(3) *Wildlife Trust*

Florida manatees (*Trichechus manatus latirostris*) exhibit promiscuous mating behavior. Even adolescent males participate in "mating herds" and may be able to impregnate females (onset of spermatogenesis starts in manatees as young as two years old and as small as 237 cm). This behavior suggests that manatees are sperm competitors. Surprisingly, manatee testes are not remarkably large. For adult males in non-winter (the testes regress during winter), testicular size is about twice what is expected for "typical" male mammals of similar size, based on established allometric relationships, with the combined testicular weight for manatees representing about 0.10% of the total body weight. Testicular size was generally largest (i.e., > 1 kg for both testes) in older manatees (greater than 10 years old) although two seven-year-olds had large testes as well (n = 37 manatees). In such animals, the testes accounted for up to 0.32% of the body weight. However, one would expect testicular size for a sperm competitor to be perhaps an order of magnitude larger than this. For comparison, in some cetaceans the testes account for 4-8% of the body weight. Perhaps in compensation, the seminal vesicles of mature manatees may be larger than the testes. Thus, ejaculate volume may remain high, allowing manatees to function as sperm competitors. We speculate that production of large volumes of semen, rather than of sperm, could have positive energetic consequences for species such as the manatee with extremely low metabolic rates (15-20% of what would be predicted based on allometry). This means, however, that sperm density may normally be low in manatee ejaculates. Male manatees may be especially vulnerable to the effects of xenestrogens, which are known to reduce sperm counts in other species to levels where fertilization is impaired.

**Population Genetic Structure of Manatees in Puerto Rico.** Rodriguez-Lopez, Marta A.<sup>1</sup>; Caballero-Gaitan, Susana<sup>2</sup>; Falcon-Matos, Limarie<sup>1</sup>; Mignucci-Giannoni, Antonio A.<sup>1</sup>

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(2) *Fundacion Omacha*

A 1995 study delineated the population structure and phylogeography of the Antillean manatee (*Trichechus manatus*) in Florida and the Greater Caribbean, including samples from Puerto Rico. The study compared mitochondrial (mt) DNA control region sequences among individuals of 8 countries. The samples from Puerto Rico showed two matrilineal lines, one of them shared with the Floridian haplotype and the other with the Dominican Republic haplotype. These samples analyzed were mostly from one location in Puerto Rico. Our study analyzed 54 samples from individuals throughout the Island including bones and skin from stranded carcasses, and skin and blood from live animals either in rehabilitation or captured for telemetry studies. A fragment of 410 bp of the mtDNA D-loop was analyzed and compared with the sequences from previous studies with the purpose of corroborating the existence of the two

already described haplotypes throughout the Island, evaluate the possible existence of additional haplotypes, and to observe the distribution of these haplotypes along the coast.

### **Regional Heterothermy in Seals, Dolphins, and Manatees.** Rommel, Sentiel<sup>1</sup>; Pabst, Ann<sup>2</sup>; McLellan, William<sup>2</sup>

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In healthy terrestrial mammals, colonic probes usually show relatively uniform core temperatures. In contrast to this terrestrial mammal homeothermic paradigm, some marine mammals display regional heterothermy in colonic temperatures. These marine mammals have stable, regionally specific temperatures at different locations along their colons; observed temperature differences are related to vascular adaptations that inhibit elevated temperatures at their reproductive tissues. We have shown that seals, dolphins, and manatees possess vascular structures which permit shunting of cooled superficial blood to positions deep within their bodies to avoid reproductive hyperthermic insult. These marine mammals divert cooled venous blood to tissues surrounding their reproductive organs before it is mixed with the core circulation -- coopting extrinsic venous circulation that is separate from the intrinsic circulation of their reproductive tissues. To quantify thermal effects of these vascular structures, we have measured temperatures simultaneously at several locations along the colon in the harbor seal, bottlenose dolphin, and Florida manatee. In seals, the distal colon follows the midline and thus, passes between cooled venous plexuses that line the abdominal and pelvic cavities; the venous plexuses are juxtaposed to the testes or uterus, thus providing direct cooling for these thermally sensitive tissues. We have observed colonic temperature differences greater than 2°C deep within the pelvic and abdominal cavities in the harbor seal. In dolphins, the distal colon follows the midline and passes between paired arteriovenous countercurrent heat exchangers that are found between the hypaxial muscles and the testes or uterus. Colonic temperatures within the region of the heat exchanger were maximally 1.3°C cooler than temperatures in front of and behind this region in bottlenose dolphins. Temporary heating and cooling of the dorsal fin and flukes affected colonic temperatures at the heat exchanger, but had negligible effect on colonic temperatures outside this region. In manatees, the distal colon follows the left lateral margin of the abdominal cavity and passes over the region occupied by a venous plexus that is supplied with cooled blood from the skin. On either side of the body, these paired cooled venous plexuses function as direct heat exchangers between the hypaxial muscles and the epididymides or ovaries. Colonic temperatures adjacent to the heat exchanger were maximally 3.7°C cooler than colonic temperatures measured in front of and behind this region in male Florida manatees. The temperature distribution changed as the colon shifted when the animal was rolled on its axis. In summary, we have shown that seals, dolphins, and manatees display regional heterothermy that reflects convective thermoregulation of their reproductive tissues. Individual temperature profiles may change with season, physical activity, posture, and handling. Consideration of these normal healthy profiles should be given when measuring and explaining body temperatures of diving mammals. Clinical interpretation of temperature profiles may provide valuable insights for assessing health and physiological state of marine mammals.

### **Aerial Surveys for Marine Mammals off the Southwest Coast.** Rosado-Odom, Vera M.<sup>1</sup>; Rodriguez-Lopez, Marta A.<sup>1</sup>; Mignucci-Gianonni, Antonio A.<sup>1</sup>; Laborde-de-Crescioni, Ivette<sup>2</sup>

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Whales, dolphins and manatees have been known to use Guayanilla Bay in Puerto Rico and its surroundings coasts for daily activities. It is not known whether the use of the area and specifically the Bay, is for feeding or as harbor in adverse weather conditions. We conducted aerial surveys using an A-star AES350B helicopter to provide valuable data on distribution aspects and group associations of individual marine mammals sighted. Two observers and a recorder participated in each flight. A total of four synoptic surveys were conducted, each one based on a four-hour flight with an average altitude of 560 feet and speed of 90 knots. The survey included an offshore route, flown at a higher altitude (~750 ft) searching for large whales, and a coastal route flown at lower altitudes (~400 ft) for smaller marine mammals. An average of 12 sightings was recorded per flight. All sightings were of manatees and no cetaceans were observed. Manatee sightings were frequently composed by cows and calves. If not, they were lone individuals feeding or traveling. The area of Guayanilla Bay, both inside the Bay and its adjacent eastern cays, appear to be important habitat for manatees. Data from this effort will be used by wildlife managers to delineate future research needs in documenting marine mammal habitat use of the Bay and adjacent areas, and any management actions needed to protect the species.

### **Adoption and Growth of a Captive Amazonian Manatee (*Trichechus inunguis*) Calf.** Rosas, Fernando C.W.<sup>1</sup>; da Silva, Vera M.F.<sup>1</sup>; Sousa-Lima, Renata S.<sup>1</sup>; d'Affonseca Neto, J.A.<sup>1</sup>; Mattos, Galia E.<sup>1</sup>

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The purpose of this study is to document the adoption of an orphaned Amazonian manatee calf at the Instituto Nacional de Pesquisas da Amazônia (INPA) (Manaus, Brazil) and report its growth for up to 100 days. In February 2001, Boo, an adult captive female gave birth to a stillborn calf at INPA's pools. A few days before, INPA had received an orphaned male calf (L1 = 81 cm; Wt = 8.2 kg) that was placed with the lactating female. The calf was immediately adopted by Boo. The body weight-length relationship for the adopted calf after 100 days was:  $Wt = 0.0000001592 \times L^{4.04}$ . We compared this relationship to Boo's first calf (Erê), born in April 1998, which had nursed on its mother for 24 months, and whose weight-length relationship for the first 100 days was:  $Wt = 0.00000003097 \times L^{4.41}$ . The length exponents (4.12 and 4.41) were not significantly different ( $P > 0.05$ ), indicating that the adopted calf was growing in a similar way to Erê. However, these exponents were significantly greater than 3 ( $P < 0.05$ ), which is the mean value for most species. It is interesting to note that the length exponent of Erê gradually decreased during the lactation period, reaching 3.00 on the 730th day after birth. A similar result was obtained for two bottle-fed calves raised with artificial milk: the length exponents of these two calves (up to 100 days) were 4.1 and 4.9, dropping to 3.4 and 3.6, respectively, at the end of the lactation period (about 520 days of life). The results suggest that Amazonian manatees grow more in weight than in length at the beginning of their lives, but that at the end of lactation the species shows a weight-length relationship around 3, indicating that longitudinal and transversal body growth follows similar patterns to most species.

**Seasonal and Diel Patterns of Manatee Habitat Selection.** Ross, Monica<sup>1</sup>, Weishampel, John F.<sup>1</sup>, Flamm, Richard O.<sup>2</sup>

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(2) Florida Fish and Wildlife Conservation Commission, St. Petersburg, FL

Florida Fish and Wildlife Conservation Commission 1991-1996 manatee (*Trichechus manatus latirostris*) telemetry data were analyzed to quantify patterns of habitat selection along the west coast of Florida from Tampa Bay to Charlotte Harbor. Satellite point data for 42 manatees were examined using ArcView GIS for differences in water depth, water temperature, seagrass density, distance to shoreline, and distance to warm water sources. To assess differences in habitat utilization based on sex or reproductive status, manatees were divided into the following classes: Males (M, N=20), females (F, N=22), females with calves (FWC, N=13), and females without calves (FNC, N=16). Telemetry data extended before or after the calving period for seven cows, FWC + FNC > F. The proportion of points associated with different habitat covers were analyzed for the four manatee classes for winter (Dec. - Feb.) versus summer (May - Oct.) and day (times between a hour after sunrise and before sunrise) versus night (times between a hour after sunset and before sunset) periods. Results suggested that males utilized a larger distribution of distant habitats than females thus placing them further from warm water sources at different times of the year. FWC selected habitats closer to warm water sources during the winter than FNC. Preliminary results indicated that all classes of manatees occupied seagrass space more frequently during the night than during the day. Gaining an understanding of the manatee habitat use at different times of the day or year could potentially help managers identify more precisely the areas which should be protected for manatees and those which would be more suitable for human recreational use as well as perhaps providing a more efficient way of regulating warm water discharge by power plants.

**Assessing Boater Compliance with Posted Manatee Speed Zones in Florida.** Shapiro, Sara<sup>1</sup>, Powell, James<sup>2</sup>

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(2) Wildlife Trust

To address boat-related injuries and deaths of Florida manatees, managers created watercraft speed zone restrictions. An important step in evaluating effectiveness of these speed zones is to examine boater compliance. Previous boater compliance studies concentrated intensive sampling efforts at specific locations. This research provided a snapshot of statewide vessel traffic and boater compliance data, and a springboard for future statewide boater compliance research. We divided the research into 3 components: 1) Long-term baseline - 6 zones sampled (5 slow, 1 idle) twice monthly for one year; 2) Short-term baseline - 4 of the 6 sites intensively sampled for 9 days (4 weekend days and 5 weekdays); and 3) Law enforcement study - 4 additional sites sampled to evaluate the effects of law enforcement on compliance. We designated vessel speeds as idle, slow, plow, plane, or cruise. Compliance was characterized as compliant (obeying the speed limit), technically noncompliant (1 category faster than the speed limit), and blatantly noncompliant (2+ categories faster than the speed limit). Vessel types and sizes varied significantly between locations ( $\chi^2=230$ ,  $p=0.00001$ ). Average compliance in the slow zones was consistent (55-57%). Idle zones had less compliance, but traffic traveled slower, with >80% of vessels moving slow or idle speed. Compliance increased with vessel size ( $\chi^2=230$ ,  $p=0.001$ ). Different vessel types in each location may explain differences in compliance among the study sites. Compliance increased significantly with the presence of a law enforcement officer ( $\chi^2=129$ ,  $p=0.000001$ ). The strong dependence of compliance on law enforcement negated any effects of either vessel type or size on compliance. Based on results, management options could include: increasing the number of law enforcement officers; focusing outreach and enforcement efforts on weekends and in areas most accessible to smaller watercraft; and designating critical manatee areas as idle speed zones.

**Managing Manatees through Mapping.** Shaw, Cameron<sup>1</sup>, Barron, Robert<sup>2</sup>, Santos, Stewart<sup>2</sup>, White, Linda<sup>1</sup>

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(2) U. S. Army Corps of Engineers

Mapping has been used as a tool to design Florida manatee (*Trichechus manatus latirostris*) management and protection strategies for many years. These efforts have primarily been conducted on relatively limited geographic scales to address site specific needs. While this management method has been successful in manatee issues within a relatively small area, problems arise when these individual areas and the respective management programs are joined together-jigsaw puzzle fashion. Inconsistencies and omissions in the network of protective regulations and management efforts become evident when viewed on an ecosystem scale as defined by the current range of the species. A Geographic Information System (GIS) program has been developed to evaluate management decisions on a scale that encompasses the primary range of the Florida manatee. This program employs information on characteristics of coastal and riverine habitats, including hydrology, vegetative coverage and bathymetry. These data were used to identify habitats with similar characteristics. These distinct aquatic habitats formed the framework for analysis of marine development, boat navigation patterns and waterway regulatory zones as well as manatee use patterns and areas of watercraft-related manatee mortality. Using this overlay approach, managers can discern problem sites and deficiencies in the network of current manatee protection measures. Managers are using the analyses from this GIS program in current Section 10 of the Rivers and Harbor Act permitting activities and for establishing additional protective measures and areas for the Florida manatee on a range-wide, ecosystem scale.

**Minimizing Negative Impacts from Human Interactions with the West Indian Manatee (*Trichechus manatus*) in Crystal River, Florida, U.S.A: A Values Conflict.** Sorice, M. Texas A&M University, College Station, TX-77843, USA

Each winter, over 300 endangered West Indian manatees (*Trichechus manatus*) migrate to Crystal River, FL to thermoregulate in its naturally warm springs. This phenomenon draws approximately 100,000 tourists who take advantage of the easy access and clear water to observe and interact with manatees. The manatee encounter experience is unique, allowing tourists the opportunity to interact with a large, docile marine mammal. Participants often touch, pet, and even "play" with manatees during encounters. However, the potential for harassment concerns some stakeholders within the manatee protection community. In an effort to understand the management of manatee encounters in light of these concerns, this study examined the context in which decisions regarding the

acceptability of manatee encounters are made. Field research included participant observation, formal interviews, and document analysis involving four stakeholder groups: the business community, manatee encounter participants, research/management agencies, and an advocacy group. Stakeholder perspectives on manatee encounters varied based on the perceived potential costs of harassment, scientific information on negative impacts, and the perceived benefits of permitting encounters (e.g., increased conservation support). These perspectives corresponded with each group's interpretation of the Endangered Species Act policy prohibiting harassment. Groups with stricter interpretations tended to perceive any physical contact as harassing, whereas other groups interpreted harassment as direct harm to the animal. The management of manatee encounters is a "wicked problem." The problematization of encounters is not the result of scientific information on negative impacts; rather, it is an issue of divergent values. Consequently, there is no technical or "right" solution. To minimize negative impacts and achieve a sustainable relationship with the resource, the business community must willingly invest in manatee protection, and management decisions on manatee encounters must incorporate stakeholder input. Planning processes, such as the Limits of Acceptable Change, provide proactive consensus-based frameworks that can be applied to the management of human-wildlife interactions.

**Four-Year Consistency in Individual Vocal Patterns of *Trichechus inunguis*.** Sousa-Lima, Renata S.; da Silva, Vera M.F. *Inst. Nacional de Pesquisas da Amazônia / Lab. Mamíferos Aquáticos, CP 478, Manaus, Amazonas 69083, Brazil*

The vocal signature hypothesis described for bottlenose dolphins assumes that one animal produces an individually distinct and stereotyped sound (signature whistle) to broadcast its identity. In an earlier paper we identified individual vocal patterns in the isolation calls of Amazonian manatees and discussed the possible presence of vocal signatures in this species. One of the assumptions of the vocal signature hypothesis is that there is consistency in the vocal pattern over time. Isolation calls of two captive Amazonian manatees were recorded between 1998 and 2001 in order to verify this assumption. The spectrogram contours of the isolation calls illustrate the maintenance of an individually distinct and stereotyped vocal pattern for both individuals over a period of four years. For bottlenose dolphins, the stereotypy of signature whistles comes from the contour configuration, i.e., the overall shape of the spectrogram rather than from more simple and discrete measurements of acoustic characteristics, such as frequency and duration. Therefore, our results support the applicability of the vocal signature hypothesis to the isolation calls of the Amazonian manatee.

**The Epidemiology of Perinatal Mortality in the Florida Manatee (*Trichechus manatus latirostris*).**

Spellman, Ann C.; Smith, Jamison M. *Florida Fish & Wildlife Conservation Commission / FMRI, Melbourne, FL, 32901 USA*

Perinatal mortality rates in free-ranging wild animal populations vary, but in many populations they can contribute significantly to overall mortality rates. Numerous factors contributing to perinatal deaths can have especially profound effects on the recovery of endangered species. The population of the endangered Florida manatee is currently estimated at approximately 3300 individuals. The slow growth of this population may be due to the fact that females reach sexual maturity at 6-10 years of age and produce on average only one calf every 3-5 years. Calves nurse for 18 to 24 months. Birth and mortality rates during the first two years are unknown, and cause of death is often undetermined due to rapid carcass decomposition in subtropical conditions. In an effort to better understand perinatal mortality, state manatee mortality records from 1974-2000 (n=4042) were examined to identify any trends. Perinatal deaths accounted for approximately 21% of all mortalities (n=857). Six calves died because of natural predation or human interaction, 57 were stillborn, and 234 died from other natural causes. Cause of death could not be determined in 558 cases. There was no significant difference between the number of male and female calves recovered. Two counties, Brevard and Lee, together accounted for 35.9% of all perinatal deaths, and for 35% of all mortalities during the same period. Although perinatal deaths occurred throughout the year and state, the highest number occurred in spring and early summer months, along the central East and West Coast, and may have been latitude dependent. GIS analyses show consistent overlap between known manatee calving grounds and locations where carcasses were recovered. GIS analyses were used to compare aerial population distribution and abundance data to perinatal mortality patterns within genetically and geographically distinct stocks.

**Seasonal Occurrence of Male Antillean Manatees on the Belize Barrier Reef.** Sullivan, Caryn Self<sup>1</sup>;

Smith, Gregory W.<sup>2</sup>; Packard, Jane M.<sup>1</sup>

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Most research on West Indian manatee distribution has been done on the Florida subspecies (*Trichechus manatus latirostris*), whose movements are directed by seasonal temperature changes. Antillean manatees (*T. m. manatus*) inhabit tropical waters throughout the Caribbean area where temperatures are relatively constant. Using photo-id methods to investigate the distribution of the Antillean subspecies on the Belize Barrier Reef, we identified a seasonal distribution pattern previously un-discovered using aerial survey and remote tracking methods in Belize. From 30 March 1995 to 15 Mar 1997, 338 twenty-minute surveys were conducted at Basil Jones Cut. Manatees were sighted in 143 (42%) of the surveys with a probability of sighting significantly different among survey month (Kruskal-Wallis H = 116.493, P < 0.0001). Group size increased from zero in January and February to a maximum of six in May. Eighteen individual manatees were identified and accounted for 87% of the manatee encounters; 20 (17 identified and three unmarked) animals were males; gender of the remaining manatees was undetermined, but no females were documented. From 5 February to 22 March (dry season) and 22 July to 13 August (wet season) 1999, 22 twenty-minute surveys were conducted at Gallows' Reef (approx. 65 km SSW of Basil Jones Cut) to determine if this seasonal distribution pattern existed at other reef sites in Belize. A highly significant difference in manatee encounters by season was also found at Gallows' Reef (Fisher's Exact Phi = .756, P-value = .001, df = 1). Manatees were never encountered on the reef during the dry season surveys, but they were encountered during 73% of the wet season surveys. These results reinforce the need for small-scale site-specific studies in addition to broad-scale regional studies (e.g. aerial surveys) in determining seasonal distribution of Antillean manatees in Belize.

**Release Criteria for Captive West Indian Manatees (*Trichechus manatus*).** Valade, James A.; Adimey,

Nicole M. *U.S. Fish and Wildlife Service, 6620 Southpoint South, Suite 310, Jacksonville, FL, 32216-0912, United States*

The USFWS and its manatee recovery partners have been involved in a manatee rescue, rehabilitation, and release program dating back to the late 1940's. While the program's initial focus was on treatment and husbandry, the Endangered Species Act expanded the

program to include the release of rehabilitated individuals. Distressed manatees are brought into captivity due to natural (cold stress, orphans, red tide) and human-related (watercraft, marine structures, entanglements, entrapments) causes. Subsequent to successful treatment, most rescued manatees are released back into the wild and adaptive success is monitored. As the program progressed, it became apparent that wild-born, adult manatees involved in short-term rehabilitation were most successful adapting back into their native habitat. Protocols were adopted to establish and improve the release program. General guidelines include a minimum length of 200 cm, a demonstrated ability to swim, dive and forage independently, and approved medical clearance. Pre-release conditioning includes: limiting human interactions to only those which are necessary, avoidance of hand feeding, reversal of conditioned behaviors, and offering native vegetation from water level and bottom feeders. Animal preparation includes recent photographs, blood chemistry analyses, PIT tagging and, if required, freeze brands, and PTT, sonic, VHF, and satellite tags. Release sites include returning the animal to the nearest location from where it was rescued or, in the case of hand or foster-reared individuals, the rescue site/origin of the dam. Naive animals are released at warm-water sites during the winter. Release sites are evaluated for potential hazards including vessel traffic, water-control structures, and proximity to nuisances. Other considerations include food availability, water depth, salinity, availability of fresh water, presence of other manatees, and a contingency plan if necessary. Time in captivity, release location, and monitoring methods are determined for each animal on a case by case basis.

**Preliminary Observations of the Antillean Manatee, *Trichechus manatus manatus*, Behaviour in a System of Natural Environmental Captivity in Barra de Mamanguape, Paraíba State, Brazil.** Vianna, Juliana; Zanon, Cibele; Vergara, Jociery *Pontifícia Universidade Católica de Minas Gerais, Rua São Paulo 925 / 1202 - Centro, Belo Horizonte, Minas Gerais, 30170-131, Brazil.*

The research goal was to learn the behavior of the Antillean Manatee in a natural environmental captivity, located in a branch of the Mamanguape river within the state of Paraíba, Brazil. The work was realized with two male manatees, both four years of age, named Guape and Guaju. They had been transferred from the main unit of the Brazilian Manatee Project, located in Pernambuco, on December of 1999. The captivity encompasses a total area of 2852m<sup>2</sup>, and is enclosed by wood stakes and a mesh net 12 cm thick. The registers, duly noted on a spreadsheet, began on the date of transfer and continued until 09 March of 2000. Observation duration was four hours daily, during a period of 79 days. The animals were viewed from a tower ten meters in height, located adjacent to the captivity, to avoid infringing upon the animals' behavior. A total of 19 behaviors were notified, rest being the most frequent (80%). Within the three kinds of observed rest, the most frequent position found the animal leaning on the bottom of the pool, while leaving the back exposed above water-level (68.6%). Other behaviors observed include: relocation (10.4%), feeding (7.1%), playing (1.8%) and social (0.7%). Nutritional intake was based upon vegetables and algae, and was offered on the bottom of the pool. Accordingly, the animals were observed mainly feeding at this local. Play was characterized by swimming around the animal's own axle or swimming in ventral position. The latter behavior was common of Guaju. Socially agonistic behavior, pursuit, approach or running from the observers were uncommon. It is important to know these animals' behavior and adaptation to the environment to better understand the Antillean Manatee as a species, one that is currently in critical danger of extinction in Brazil.

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#### SIRENIAN WEBSITE DIRECTORY

(NOTE: Not all of these sites have been visited recently by your Editor, and some may no longer be active, or their addresses may have changed.)

Belize Coastal Zone Management Authority & Institute's Manatee Research Program:  
<[http://www.coastalzonebelize.org/pr\\_manatee.html](http://www.coastalzonebelize.org/pr_manatee.html)>

The Call of the Siren (Caryn Self Sullivan): <<http://www.sirenian.org/caryn.html>>

Caribbean Environment Programme, Regional Management Plan for the West Indian Manatee: <<http://www.cep.unep.org/pubs/techreports/tr35/ct35indx.htm>>

Caribbean Stranding Network: <<http://netdial.caribe.net/~mignucci/>>

Columbus (Ohio) Zoo manatee exhibit: <[http://www.colszoo.org/animalareas/shores/manatee\\_coast/index.html](http://www.colszoo.org/animalareas/shores/manatee_coast/index.html)>

Columbus (Ohio) Zoo manatee exhibit, live camera: <<http://www.discovery.com/cams/manatee/manatee.html>>

Dugongs: <<http://home.t-online.de/home/rothauscher/dugong/dugong.htm>>

Dugong necropsy manual (available for downloading): <[http://www.gbrmpa.gov.au/corp\\_site/info\\_services/publications/research\\_publications/rp64/index.html](http://www.gbrmpa.gov.au/corp_site/info_services/publications/research_publications/rp64/index.html)>

Florida Fish and Wildlife Conservation Commission, Bureau of Protected Species Management: <<http://www.floridaconservation.org/psm/>> [NEW]

Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute (Florida manatee mortality data): <<http://www.floridamarine.org>> [NEW]

Friends of the Manatee Association, Manaus & Balbina, Brazil: <[http://www.amigosdopeixe-boi.org.br/english/Ing\\_index2.htm](http://www.amigosdopeixe-boi.org.br/english/Ing_index2.htm)> [Includes a bibliography of INPA aquatic mammal project publications and abstracts] [NEW]

Great Barrier Reef dugongs: <[http://www.gbrmpa.gov.au/corp\\_site/info\\_services/publications/dugong/index.html](http://www.gbrmpa.gov.au/corp_site/info_services/publications/dugong/index.html)>

IBAMA manatee project, Brazil: <[www.projetopeixe-boi.com.br](http://www.projetopeixe-boi.com.br)>

Jacksonville University (Florida) Manatee Research Center Online: <[www.ju.edu/juconnect/research/marco](http://www.ju.edu/juconnect/research/marco)>

Manatee neuroanatomy: <<http://www.neurophys.wisc.edu/Manatee/>>

"Manatee Watchers" Internet discussion list: <<http://www.listbot.com/archive/MANATEE>>

News clippings on Florida manatees: <<http://www.n-jcenter.com/menus/enmanate.htm>>

Philippines Dugong Research and Conservation Project: <<http://www.wwf-phil.com.ph>>

Save the Manatee Club: <<http://www.savethemanatee.org>>

Sea World of Florida: <<http://www.seaworld.org>>

*Sirenews* (texts of current and recent issues): <<http://pegasus.cc.ucf.edu/~smm/>>; <<http://www.sirenian.org/>> (for archive of many older issues)

Sirenia Project, U.S. Geological Survey: <<http://www.fcsc.usgs.gov/sirenia>> or <<http://www.nfrcg.gov/sirenia>>

Sirenian International, Inc.: <<http://www.sirenian.org/>> [Includes a bibliography of sirenian literature, and an archive of *Sirenews* issues.]

Smithsonian Institution sirenian bibliography: <<http://www.si.edu/resource/faq/nmnh/sirenia.htm>> [This is a relatively short bibliography, compiled by Joy Gold, that provides a very good introduction to both the technical and the popular literature.]

Steller's sea cow: <<http://www.online.de/home/Rothauscher/steller.htm>>; also the website [in Finnish] of Dr. Ari Lampinen, University of Jyväskylä, Finland: <<http://www.jyu.fi/~ala/ilmasto/steller.htm>>

West African manatee in Chad (Jonathan H. Salkind): <<http://members.aol.com/neeii/manatee-index.html>>

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