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EDITORIAL:

EARTH TO FLORIDA: CLEAN UP YOUR LANGUAGE!

After many months of postponing consideration of a petition to downlist Florida manatees from "Endangered" to "Threatened" status under Florida law, the Florida Fish and Wildlife Conservation Commission (FWCC) has just taken a step toward such action (see story in this issue). Although the Commission's vote at its April meeting did not directly affect manatees, it preserved the objectionable regulatory language according to which "Threatened" in Florida is equivalent to what the rest of the planet calls "Endangered". The implication is clear, and the stage is now set: application of this lingo to manatees will sooner or later result in downgrading the degree of state protection for which they are deemed eligible.

Since we already editorialized at length on this topic in *Sirenews* Nos. 38 (October 2002) and 42 (October 2004), little needs to be added at this time. Even though federal protection for manatees remains in place (for now; but see news items below), and any move by the state to actually downlist manatees is still several months and several

procedural steps away, it is nonetheless disturbing that the FWCC continues to ignore the torrent of scientific criticism provoked by its idiosyncratic twisting of well-established, globally-accepted terminology.

On its website, the FWCC defends its language on the grounds that "these names are embedded in numerous Florida statutes, FWC rules and local ordinances. … FWC staff concluded that changing this terminology would be difficult, expensive and could lead to unintended problems with those statutes that might, indeed, reduce protections. In the end, staff believes the focus should be on identifying and protecting imperiled species, not on what the categories of imperilment are called. … Under the current and proposed processes, when a species is reclassified it receives a species-specific management plan that prescribes the actions and protections needed to recover the species. As such, even if a species is de-listed, it will still receive the protections necessary to protect the species."

Begging your pardon, but in the present political climate, this seems just a bit … well, naïve. We have legions of lawyers and lawmakers who are paid to get the language in our laws right; haggling endlessly over words is their bread and butter. Species-specific management plans? These are products of lengthy negotiation among numerous stakeholders, and as such are not immune to political influence. Even when a sound management plan exists, it takes more than a paper plan to ensure protection: the plan has to be backed by political support and political will, or it will not be implemented – as countless unenforced environmental laws in developing and developed countries bear witness. Names and labels are critical in galvanizing (or undermining) political support, and when you see someone trying to rewrite the dictionary in the midst of a political debate, you know it's not an accident.

In the end, this is far from being just a harmless quibble over words. The Florida manatee's first line of protection is the public's recognition that this species is, in fact, precariously balanced between survival and extinction, and endangered by long-term trends that will be difficult or impossible to reverse. Downlisting of manatees by the state would significantly weaken this line of defense; it would undermine efforts to implement additional protection measures, even as threats from development, boating, and other human activities increase without limit; and it would hand manatee opponents a huge propaganda victory that would immediately be used to mislead the public about the manatee's true status.

Those opponents understand very well the significance of a designation like "Endangered", and they want a public-relations label that evokes less urgency, no matter what the actual data show. Although they have signaled that they seek only to block future protection measures and not overturn existing ones, don't bet they won't change their minds once the re-labeling is done and the State of Florida has "officially certified" that manatees are no longer "Endangered", but merely "Threatened".

The threat level has just gone up. - **DPD**

SIRENIA SPECIALIST GROUP MEMBERSHIP

Based on discussions at the last meeting of the SSG in December 2004, a new membership list has been developed:

Executive Members: John Reynolds (co-chair), Buddy Powell (co-chair), Helene Marsh, Toshio Kasuya, Tony Mignucci, Ester Quintana, Miriam Marmontel, Vera da Silva, Akoi Kouadio, P.K. Ofori-Danson, Daryl Domning, Dan Odell (12)

Regular Members: Benjamin Morales-Vela, Donna Kwan, Fernando Weber Rosas, Ivan Lawler, Janet Lanyon, Jorge Calvimontes, Judith Vallee, Lem Aragones, Lynn Lefebvre, Tom O'Shea, V.G. Cockcroft, Hans de Iongh, Chip Deutsch, Ron Mezich, Nicole Adimey, Jim Valade, Nicole Auil, Caryn Self-Sullivan, Bob Bonde, Rogelio Diaz-Fernandez (20)

Please review the list and send any additions or recommendations to: Cynthia R. Taylor, Conservation Biologist, Wildlife Trust, 15 Paradise Plaza #369, Sarasota, Florida 34239-6905 USA; tel.: 941-232-4587 (cell), e-mail: <**taylor@wildlifetrust.org**>; website: <**www.wildlifetrust.org**>

COURSE ON GIS/REMOTE SENSING FOR COASTAL AND MARINE SCIENTISTS

Over the course of the last decade, marine and coastal applications of GIS and remote sensing have gained wide acceptance in the scientific and GIS communities. In recognition of this growing trend, the GIS certificate program at San Francisco State University is offering a course dedicated to those interested in incorporating GIS/remote sensing technologies in the study of the marine and coastal zones.

Previous offerings of this class have been very successful for both student and instructor alike and we are proud to offer it to the community for the fourth time.

The course is entitled: GIS and Remote Sensing Applications for Coastal and Marine Scientists, Geog 9023, Schedule No. 95083, held 14-18 June at San Francisco State University.

Days 1 & 2: Introduction to GIS. This course is an introduction to the concepts and uses of GIS as it relates to coastal and marine science. Lecture topics include history of GIS, GIS data structures and sources of data, GIS tools, vendors and software, applications, and resources. Exercises include spatial data display and query, map generation, and simple spatial analysis using ArcGIS software. Instructor: Ellen Hines teaches GIS at San Francisco State University. Her research on marine mammals includes studies on dugongs in southern Thailand, gray whales in British Columbia, and harbor seals in San Francisco Bay. Her research interests include the integrated use of GIS and remote sensing in delineation of marine mammal habitat.

Days 3 & 4: Remote Sensing Course. This course is an introduction to the physical principles of electromagnetic radiation through earth's atmosphere and remote sensing sensors relevant for coastal and marine studies. The course is designed for beginning level users. Instructor: Toby Garfield is an Associate Professor of Geosciences and conducts his research at the SFSU Environmental Campus, the Romberg Tiburon Center for Environmental Studies. His research interests include oceanic circulation along continental margins and estuarine circulation. His fieldwork emphasizes combining traditional data collection techniques with remote sensing data collection.

Day 5: Hands on! Bring your own field data, or we can supply you with material to work with.

Cost for the 5 days of instruction is US$1095.00. This course is offered through the SFSU GIS Certificate Program (http://gis.sfsu.edu/cert) in the College of Extended Learning (http://www.cel.sfsu.edu/); 4.0 continuing education units (CEU) can be earned. To guarantee a space in the class, please register early. Class size is limited. A list of accommodations is available.

For further information, please contact Ellen Hines (ehines@sfsu.edu; tel. 1-415-405-0921) or Barry Nickel (bnickel@sfsu.edu; tel. 1-415-338-3566).

LOCAL NEWS

BRAZIL

Another Amazonian Manatee Captive Birth. – On 6 April 2005, another female manatee gave birth to the fifth Amazonian manatee conceived and born in captivity at the Aquatic Mammal Laboratory of INPA in Manaus. This time it is a female calf. The baby is feeding without problems. Mother and baby are well. The calf's name will be chosen in a contest with the children from local schools to increase the awareness of the need to conserve these animals. - **Vera da Silva**

FLORIDA

(NOTE: For detailed coverage of manatee matters in Florida, read *Manatee News Quarterly*, published by the Florida Fish and Wildlife Conservation Commission.)

Florida Continues March Toward Downlisting Manatees. – On 14 April 2005, the Florida Fish and Wildlife Conservation Commission (FWCC) voted to adopt amendments to state rule criteria that govern the listing and delisting of Florida's imperiled species. These amendments only slightly improved the rule criteria, and fell short of the substantive changes that manatee advocates and other critics considered necessary to protect endangered wildlife. This action opens the way to potential downlisting of Florida manatees from "Endangered" to "Threatened" status, based purely on semantics and without any actual improvement in the animals' prognosis for survival.

After conducting a final public hearing on the proposal, during the first day of their two-day meeting in Tallahassee, the Commissioners voted to adopt updated listing criteria developed by the World Conservation Union (IUCN) since 1999. In addition, the Commission will ask IUCN experts to train FWCC scientists in how to apply the criteria. The Commissioners expressed their confidence in the updated process, but in acknowledgement of many stakeholders' concerns about how it might impact certain species, they pledged to review the listing process if unforeseen problems arise during its implementation.

(The Commission is a five-member board appointed by the governor to oversee hunting, fishing and wildlife protection.)

The Commissioners also voted to lift the present moratorium on considering classification of listed species; but their decision does not immediately affect the listing status of any of the 118 animal species classified as Endangered, Threatened, or Species of Special Concern in the state list – including manatees, for which a

biological status review by the state has not yet been completed.

According to FWCC endangered species coordinator Dan Sullivan, a key strength of the proposed process is how appropriate recovery actions will be identified and put in place. Whenever the agency considers listing, reclassifying or delisting a species, he said, FWCC staff will develop a management plan tailored to that individual species' needs. The plan will outline species-specific protections, replacing less-effective blanket prohibitions of the past, which were tied to categories rather than species' individual needs. The new updates also will strengthen the process by involving a biological review panel throughout the evaluation process and requiring an additional peer review of that panel's assessment. Details on the proposed updates are available at <**MyFWC.com/imperiledspecies**>.

But critics are not convinced.

As reported at length in *Sirenews* No. 38 (October 2002), Florida adopted some years ago the basic listing criteria used by the IUCN for classifying imperiled species and the threats they face. What Florida has *not* adopted, however, are the *names* for the categories in the IUCN classification. Instead, Florida's wildlife managers modified the IUCN language so that in order for a species to qualify as "Endangered" in Florida, it would have to meet the IUCN standards for "Critically Endangered"; whereas a species that was "Endangered" in the eyes of the IUCN and the rest of the world would be called merely "Threatened" within the boundaries of the State of Florida.

Using one of the state's listing/delisting criteria, a species would have to undergo or be at risk of undergoing an 80% decline in its population in order to be listed as "Endangered". Listed species that have undergone precipitous declines historically, but are not continuing to decline at an 80% rate, could be downlisted despite the fact that their numbers are only a small fraction of their original populations. An 80% decline could easily cause a species to go extinct before conservation measures could be implemented. Population biologists point out that these criteria are particularly inappropriate for large, long-lived marine animals like manatees and sea turtles.

Because of this FWCC action, Florida's endangered species, such as manatees, panthers, and sea turtles, could potentially be reclassified as "Threatened" – or receive an even lower classification – all because of this misalignment of category names and definitions. Now that the rule amendments have been adopted, FWCC plans to move forward with the completion of its manatee biological status review precipitated in 2001 by a petition from an angler's lobby group, the Coastal Conservation Association.

Patrick Rose, a former state wildlife official and now Director of Government Relations for the Save the Manatee Club, commented that "State decision-makers are listening to special interests like never before. They have already downlisted the endangered red-cockaded woodpecker to a 'Species of Special Concern'. It will only be a matter of time before the state receives more petitions from special interest groups to downlist other species whose habitat requirements get in the way of developers' profit-making. Sales prices for individual boat slips built over

submerged lands held in public trust have soared to over US$1 million in some cases. With so much money to be made at the public's expense, it's no wonder that the [state regulatory] agencies are being pressured by the legislature to open the floodgates of development without adequate checks and balances to protect the environment and especially our imperiled species."

Fortunately, manatees in Florida are still protected by federal legislation including the Marine Mammal Protection Act and the Endangered Species Act. As long as the perennial attempts to weaken these federal laws are kept at bay, manatee protection measures that are already in place should remain. But even at the federal level, the possibility of downlisting the manatee has just been put back on the table with the announcement (with less than a 2-month deadline for submission of information) of a review of the manatee's status by the U.S. Fish and Wildlife Service (FWS) (see related story below).

Also less than encouraging are two personnel matters on the federal level. U.S. Interior Secretary Gale Norton has named as acting director of FWS one Matthew J. Hogan, a former chief lobbyist for the Safari Club International – an organization that encourages the hunting of big game, including endangered species, as well as promoting wildlife conservation.

FWS, in turn, has expanded the interagency Manatee Recovery Team from its traditional makeup of some 15-20 biologists and wildlife managers, inflating it to a membership of 120 that for the first time includes representatives of the boating, dock-building, and development industries in addition to manatee experts. The Recovery Team is charged with making recommendations on manatee management and listing to Secretary Norton.

Given all these developments, especially in the context of the June deadline for submissions to FWS's manatee status review, there is growing concern among manatee defenders.

"People are going to think that any species undergoing a downward category change is on the road to recovery – purely because the FWCC is obstinately refusing to align the IUCN categories and names for these categories with their own listing/delisting guidelines," said biologist Patti Thompson, the Save the Manatee Club's Director of Science and Conservation. "No matter what happens on the state level, manatees will still be listed as endangered by the federal government. Unfortunately, special interests will be pushing for species' reclassifications as a way to rid themselves of what they believe to be excessive regulations," said Thompson.

Earlier, a state review of 24 listed species found that a majority of the species could be downlisted or even delisted when the state's flawed criteria were applied. It is possible that the Florida panther, with an estimated 80 individuals living in the wild, could fall down a category from endangered to threatened status. The black bear would have a good chance of being delisted altogether, paving the way for the bear to once again be hunted. The federal Marine Mammal Commission has stated that the northern right whale – the most endangered marine mammal in America, with a population of fewer than 350 individuals – would likely fall down a category as well under the state's too-stringent criteria. David Laist of the Marine Mammal Commission agreed

that the FWCC action "establishes an unreasonably low standard of protection for endangered species" that is "inconsistent with federal law."

"Manatees and, in fact, all of the state's wildlife will continue to face mounting pressures from Florida's fast-paced growth," said Rose. "To illegitimately downlist a species won't do anything to protect our wildlife. We want the state to base the biological status of any species on scientific benchmarks, including stable or increasing survival rates, comprehensive habitat protection, and significant reduction of human-related mortality." - **DPD**

Fish and Wildlife Service Announces 5-year Status Review for the Florida Manatee. - The U.S. Fish and Wildlife Service (FWS) announced on 14 April 2005 that it is conducting a five-year review of the Florida manatee, which is federally protected as endangered under the U.S. Endangered Species Act (ESA). The five-year review will assess the best available scientific and commercial information to determine how the manatee is faring since its original listing in 1967.

According to Dave Hankla, the Service's field supervisor for its North Florida Ecological Services Office in Jacksonville, the Service is particularly interested in new information which has become available since the last revision to the Florida Manatee Recovery Plan in 2001.

"There has been a tremendous amount of effort put into manatee conservation and research over the last several years," Hankla said, "and this is an opportunity for our biologists and conservation managers to conduct a comprehensive review of the latest and best scientific and commercial data available."

In the case of the Florida manatee, the Service is looking for new information related to five specific areas:

1) species biology, such as population trends, distribution, demographics and genetics;

2) habitat conditions such as amount, distribution and suitability;

3) conservation measures which have been implemented that benefit the species;

4) threat status and trends; and

5) other new information, data or corrections, such as improved analytical methods, nomenclatural changes, or identification of errors in the information contained in the original listing.

To be of greatest use to Service biologists conducting the review, any new information submitted should be supported by documentation such as maps, bibliographic references, methods used to gather the data, and/or copies of any pertinent publications, reports or letters from knowledgeable sources.

Five-year reviews allow the Service staff to determine if sufficient information is available to warrant a recommendation to reclassify a species or even take it off the ESA list altogether. According to Hankla, any recommendation to change the manatee's status would only be considered if substantiated by the data and would not be made without due consideration.

"If, after reviewing all the information, we determine nothing has changed, the manatee's status will remain Federally-listed as endangered," Hankla said. "However, if the data substantiates that a reclassification or de-listing is warranted, we could recommend either. Any such decision to recommend reclassification or de-listing

would require a separate rulemaking process which would include ample opportunity for public review and comment."

The *Federal Register* notice announcing this solicitation of new information and data is available online at <**northflorida.fws.gov**> or may be requested by e-mail to <**manatee@fws.gov**>, by fax at 904-232-2404, by mail at U. S. Fish and Wildlife Service, Attn: Manatee Five-year Review, 6620 Southpoint Drive, Suite 310, Jacksonville, FL 32216-0958, or by telephone at 904-232-2580.

New information and comments may be mailed, hand-delivered, faxed, or submitted electronically. Please mail or deliver comments to the address or fax number listed above. Comments submitted electronically should be embedded in the body of the e-mail message itself or attached (please see Notice for details), and should not use special characters or encryption. Please include "Attn: Manatee 5-year Review" in your subject line, and your full name, return address, and, if appropriate, your company, government agency, or organization you represent, in your e-mail message. Comments submitted to <**manatee@fws.gov**> will receive an automated response confirming receipt of your message.

In order for biologists and conservation managers to have sufficient time to consider any new information, the information and any supporting data or documents must be received by the Service no later than 13 June 2005. -(FWS press release)

New Manatee Biological Population Assessment Released. – [ED. NOTE: The following are excerpts from the summary of the latest annual report from the Manatee Population Status Working Group (MPSWG), an advisory body to the U.S. Fish and Wildlife Service (USFWS) composed of scientists from the U.S. Geological Survey, Marine Mammal Commission, USFWS, Florida Fish and Wildlife Conservation Commission, Montana State University, Coastal Conservation Association, Save the Manatee Club, and Wildlife Trust. The MPSWG is the most authoritative source there is on the status of the Florida manatee.]

… The Northwest and Upper St. Johns River subpopulations exhibit very similar dynamics: mortality is low, reproduction is high, and subpopulation growth rate is positive. Most known mortality of non-adults is from natural causes, while adult mortality is due primarily to human-related causes, mostly watercraft. Because these two populations are small and because they appear to depend on a small number of winter aggregation sites, relatively small fluctuations in habitat or the number of mortality and birth events could substantially influence population growth rate and trend. At the present time, the observed growth rates suggest that these subpopulations are below the environmental carrying capacity for manatees and additional growth can reasonably be expected. …

The status and dynamics of the Atlantic subpopulation are less clear than the Northwest or Upper St. Johns River subpopulations. Adult survival and reproductive rates are moderate, but evidence regarding recent growth rate of the subpopulation is inconclusive: it is possible that the population is growing slowly, but also possible that apparent growth in the early 1990s has tapered off and the subpopulation may be stable or declining. The manatee population

growth rate estimates from two different analyses vary, and resolution of the difference will require additional study. For adults, watercraft-related mortality as a proportion of all sources of mortality is more than in the Northwest and somewhat less than the Upper St. Johns River, but because the total mortality *rate* is higher for the Atlantic Coast (as indicated by lower survival rates), watercraft mortality has a greater impact on population dynamics than in the Northwest or Upper St. Johns River subpopulations. Mortality of non-adult animals appears to be primarily from natural causes. …

The Southwest subpopulation appears to be the most vulnerable to decline. Estimates of adult survival are low and the growth rate estimates indicate the subpopulation appears to be declining. For non-adults, most mortality is natural. For adults, watercraft mortality is the highest ranked cause of death. The Southwest subpopulation is unique in that it faces major, periodic mortality events due to red tide. Red tide is responsible for nearly one-fourth of known-cause mortality across ages. Based on the available data, it appears that if this subpopulation is to stabilize or indeed increase in size, it cannot sustain any further increases in mortality. Two factors make it difficult to assess some aspects of the status of the Southwest subpopulation. First, the time series of data is shortest for this subpopulation, thus the survival and reproductive estimates are less precise than for the other subpopulations. Second, the subpopulation is found in diverse habitats from Tampa Bay to Everglades National Park, and demographic data are lacking for individuals in the southernmost parts of the region. …

State-wide patterns concerning mortality risk can be discerned by comparing the relative causes of death in the four subpopulations. For adults in each subpopulation the most prominent source of mortality is watercraft collision. The second ranked cause of death varies by subpopulation. In the Northwest it is cold stress; in the Upper St. Johns River it is crushing by gates or locks; in the Atlantic it is unspecified natural causes; and in the Southwest it is red tide. For non-adults in all subpopulations, perinatal death is the leading cause of mortality with watercraft collisions ranked second. Cold stress ranked third for non-adults in all subpopulations except the Southwest, where red tide is the third leading cause of mortality. …

The Southwest and Atlantic Coast subpopulations show larger uncertainty in demographic rates than the Northwest and Upper St. Johns River. Such differences are expected. The natural world is intrinsically variable, and each region is characterized by its own set of confounding factors regarding data collection, manatee behavior and analysis of population dynamics. The MPSWG makes several recommendations in this report to reduce uncertainty and improve estimates. Analyses that incorporate data from multiple sources such as photo-identification, aerial surveys, carcass recovery, and genetic markers will be important. These new approaches, however, will require development of new data collection protocols and analysis, which may take years of directed effort. New applications should be pursued, while at the same time maintaining and improving monitoring

for annual assessments under current methods. …

The MPSWG evaluated available manatee data and analyses to determine whether they were adequate to assess recovery under the existing demographic recovery criteria as provided in the Florida manatee recovery plan. Available data and analyses are largely adequate for assessing the survival rate criterion; they are inadequate, however, for assessing the reproductive criterion as written and vary in adequacy for assessing the growth rate criterion for the different subpopulations.

Are Thirsty Cities Thwarting Manatee Recovery Efforts? - The Florida manatee's prospects for survival may depend less on boaters -- who for decades have been scorned for mauling the animals with propellers and boat hulls -- and more on the unquenchable thirst of booming cities like Orlando, Tampa and Fort Myers, the federal official overseeing recovery efforts said yesterday.

That surprising assessment by Dave Hankla, field supervisor of the Fish and Wildlife Service's North Florida Ecological Services Office, sets the stage for what promises to be a robust debate over the service's five-year status review for one of Florida's most enduring wildlife symbols.

Other findings expected from the review are that manatees would not survive without hot water discharges from power plants, and that recurring red tides along the Gulf Coast threaten to set recovery back decades, FWS officials said. Yet of all the marine mammal's threats, the one with the least chance of reversal is Florida's exploding population, which is expected to reach 20.7 million by 2025, and the resulting drawdown of underground water resources.

Freshwater springs, extending from the Floridan aquifer in the east-central part of the state, are essential to manatees during the winter, where they congregate by the hundreds in warmer, shallow inlets to stave off hypothermia. Without the warmer water, the animals would experience mass die-offs, federal officials say.

"The more water you take out, the less chance these natural springs have of replenishing themselves. And if the warm water isn't there, there's a good chance these animals will freeze to death," Hankla said in a telephone interview.

Such is the complex balance between human and wildlife needs in Florida, one of the most biologically diverse places in North America, and home to more federally protected species than all but three other states -- California, Hawaii and Alabama.

In the past month alone, two federal courts have ruled FWS failed to adequately protect the endangered Florida panther and eight other species (Greenwire, April 7). Those rulings followed FWS's finding late last month that the American crocodile had recovered sufficiently to revise its protective status from "endangered" to "threatened" (Greenwire, March 28).…

Some observers, like Pat Rose of the nonprofit Save the Manatee Club, believe the manatee will be the next high-profile Florida species proposed for relisting, even if the science does not justify it. "There is tremendous political pressure to have the Service come up with new [recovery] criteria so that the manatee can be downgraded" to threatened, Rose said.

Hankla denied such claims, noting that FWS is meeting an obligation it made in 2001 when it last revised the manatee's recovery plan. "There's really nothing behind this," he said. "We're doing it to reel in all the statistics and see where things stand."

Depending upon who is doing the counting, the manatee's status varies wildly -- from not meeting FWS recovery goals to far surpassing Florida's recent historic baseline for manatees.

Ted Forsgren, director of the Coastal Conservation Association of Florida, which represents 10,000 saltwater anglers, said his members see more manatees in Florida's inlets and bays than ever. Yet he complained "there is no measurable biological goal for the manatee herd," and therefore no end to the regulations that many anglers believe are excessive and unwarranted.

Slow-speed boating zones have been adopted across a quarter million acres of peninsular Florida, Forsgren said, affecting virtually every recreational, commercial and industrial waterway in the region. He added that the Coastal Conservation Association avoided the manatee issue for years until lawsuits filed in 2000 called on regulators to impose new regulations on 115 waterways where manatees were believed to live or migrate, including "some of the premier saltwater fishing areas of the state."

As a member of a federal advisory committee for manatee recovery, Forsgren is pressing FWS to revise its approach to determining the species' status. "There are challenges, there's no doubt about it," he said of the upcoming status review process. "But we've argued that without some way to remove emotion from the discussion, and finding a way to better quantify manatee success or failure, all you're going to do is argue about this forever."

But boating regulations are just one component of the manatee recovery program, and in the end possibly one of the easiest to resolve. The more difficult problem is ensuring that manatees do not perish from hypothermia in the winter months, when water temperatures in peninsular Florida can drop into 50-59 degrees Fahrenheit.

For years, manatees have relied on both natural and manmade sources of warm water to avoid winter stresses. These include warm springs that emerge from the Floridan aquifer as well as hot water discharges from power plants that are scattered throughout the manatee's range.

Virtually all of the state's electric utilities -- including Florida Power & Light (FPL), Progress Energy, and Tampa Electric Company (TECO) -- now manage water discharges from their generators' turbine-cooling systems to aid manatees. At some power plants, like FPL's Cape Canaveral Plant on the Indian River east of Orlando, manatees have been known to congregate by the hundreds in waters warmed by FPL's warm water discharges. The same is true for the company's Riviera Plant in Palm Beach County and its Fort Myers plant on the Gulf Coast.

"From a utility's perspective it's a very complicated issue," said Winifred Perkins, FPL's manager of environmental relations. "As the state's largest electricity provider, we can't dismiss this. We do what we have to do."

Currently that means adhering to a wastewater discharge permit clause calling for five FPL plants to provide a continuous source of warm water to manatees through the winter months.

Similar measures are in place at the state's other large utilities, like Progress Energy and TECO.

Dave Bruzek, a spokesman for Progress Energy, which operates three power plants on the Gulf Coast, said the wastewater permits "were negotiated with the state to maximize the use of those plants while minimizing effects to manatees…. The company is more than willing to do that as long as those constraints do not threaten the reliability of our electric service."

With near universal agreement, even among environmentalists, that power plants provide an essential benefit to manatees and that warm water will continue to flow from discharge pipes to wintering areas, concern about water resources has shifted to broader questions of water consumption in Florida.

Hankla said securing clean, warm water -- particularly from natural springs -- is the top issue facing manatee recovery this century. "The animals don't go out and randomly look for warm water. The adults teach their offspring where these water sources are," he said.

Another pressing issue is red tides, a form of toxic algae that can poison manatees who come into contact with it. Some believe red tides, which tend to form in warm waters, are related to nutrient loading and other forms of human pollution.

At current population growth rates, officials expect the Floridan aquifer to be drawn down more regularly, which combined with other events like droughts, could pre-empt the natural feeding of warm springs that manatees need to survive.

Teresa Monson, a spokeswoman for the St. Johns River Water Management District, which includes booming Orlando, acknowledged the district's "dramatic increase in demand on water resources over the last few decades." She described the St. Johns region as having "a very productive aquifer," but added, "At the same time, we have quite a lot of demand on it, so it's one of those ongoing battles." She said the water management district works closely with the state to ensure that withdrawals do not exceed safe levels for wildlife and the environment.

Rose, of the Save the Manatee Club, noted that a number of warm springs have been lost over the last 50 years due to population growth and fresh water demand. And those that remain face imminent risk from overuse, landscape alterations, and agricultural and wastewater pollution.

"When you go out and add thousands and thousands of homes in these recharge areas, these people are not going to go away," Rose said. "They may find other sources of drinking water. But if that doesn't happen, it's the natural springs and ultimately the manatees that are going to suffer." - **Daniel Cusick** (Greenwire Southeast reporter)

Owner to Sell Landmark Crystal Springs, Florida, Manatee-Themed Store. -- By draping a long, uncut piece of plush fabric from the tail to the mouth on the bottom of the stuffed animal, Marie Bienkowski found that it gave her plush manatees' mouths an unrivaled, distinct look.

To be honest, no one else made stuffed manatees back then. But the former fifth-grade science teacher stitched her first while on maternity leave, and the next thing she knew everyone wanted one. Even Ty Warner, the creator of the famed Beanie Babies, she claims, used her patented method to

stitch his own version of stuffed manatees.

From Bienkowski's garage, the Manatee Toy Co. has grown into a downtown Crystal River landmark that continues to draw customers worldwide. For Bienkowski, it's more than she could have dreamed of, and it's something she's had to let go of this year after she, as founder, sold the store to another manatee lover who will continue to cater to those seeking anything that resembles the gentle sea giants.

Inside the small homey store with wood floors and Jimmy Buffett songs playing on a constant loop, manatees adorn baby clothes, wine corks, mugs, drain stoppers, champagne flutes, shot glasses, wind chimes, figurines, backpacks, shopping bags, baby bags, cutting boards, Christmas cards, postcards, street signs, T-shirts, sweat shirts, license plates and salt shakers.

But before there was all this, there were two stuffed manatee dolls.

Bienkowski, who has a background in design, stitched them and gave them to her daughter Nicole in 1981. The 3-year-old dragged them everywhere, naming the larger gray toy Mandy and the smaller, plush one Sweet Tea.

"People saw them," Bienkowski said. "Someone saw them at Port Paradise Dive Shop, and they asked if they could have three." Soon, every dive shop in the city -- which claims to be "Home of the Manatee" -- wanted to sell some.

By the next year, Bienkowski had sold a few hundred. Over the next decade, her small company sold the stuffed manatees wholesale out of her Crystal River garage, where Bienkowski drew up the designs, a hired sewer stitched them and the animals were packed and shipped.

"My kids were babies, and that's how they learned how to count," Bienkowski said. "Twelve manatees went into a box."

In 1991, the Manatee Toy Co. moved to its current location, where offerings of just five sizes of toy manatees grew to include gator Christmas stockings, manatee puppets and stuffed shrimp until the store became the menagerie it is today.

Guests from far away are not uncommon at the store, and a guest book bears testament to the world travelers who have stopped in. Recent pages show customers from Wyoming, Louisiana, Oregon, New Jersey, Pennsylvania and Germany. Once, a German man told Bienkowski he'd be gracious enough to sign her book, thinking he'd be the only European to grace her pages.

Just above his signature were signatures of people from Finland, Japan and Colombia.

"Every day is unique in here," Bienkowski said, with a tinge of regret. She recalled the old movie stars, cancer survivors and famous authors she has met and the conversations she has had that make her wish she had kept a daily journal.

But it's too late. Bienkowski sold the store on Nov. 15 to Helen Anderson, a former laboratory supervisor, who wanted to run her own business. Bienkowski said she wants to spend more time with her grown children, design more stuffed animals and firm up her manatee patent with a lawyer and begin asking other companies to stop using it. She'd rather her manatee design be used on toys that have a connection to the city of Crystal River, Bienkowski said in a schoolteacher's soft, firm tone.

She also hopes to go back into teaching.

But during the first three weeks of December, Bienkowski helped Anderson make the transition as the new store owner. She taught Anderson that pink flamingo hats sell, how the price-tag gun works, that yellow items are popular (though Anderson doesn't like the color) and how to get in touch with vendors.

"You just don't give your baby to anybody," Bienkowski said.

Anderson, a former customer who bought the store as soon as she found out it was for sale, said she loves manatees because of their "sheer size -- the primitiveness of them."

"And their cute 'lil blue eyes," Bienkowski added like a proud mother. - **Justin George** (*St. Petersburg Times*, 7 January 2005)

INDONESIA

Recent Dugong Research in Balikpapan Bay, Indonesia. - I would like to report on a recent study implemented by Paulien de Bruyn, Budiono, Danielle Kreb and the undersigned (2003) in Balikpapan Bay, East Kalimantan, Indonesia. The study was a collaboration between the NGO RASI, the Mulawarman University (Indonesia), and the Institute of Environmental Sciences of Leiden University, The Netherlands.

The main research effort has been done in Balikpapan Bay, East Kalimantan, during 2002, while continued observations were made during 2003 and 2004. It is the intention to continue this research also during the coming years.

Our research covered three aspects of the ecology of Balikpapan Bay: a) water quality, b) the presence of seagrass beds, c) observations of dugongs.

Dugong observations were made from an engine-powered boat. On this boat, four persons would observe, each at a different angle from the boat for one hour, while the engine was switched off. Two persons would search with binoculars, two would search without binoculars. Every 15 minutes the binoculars would switch between the persons. In this way, the entire area surrounding the boat was covered with and without binoculars without wearing out the persons too much for them to stay concentrated.

Dugongs were spotted 15 times in Balikpapan Bay. Dugongs were mostly seen swimming alone, but a group of three dugongs was also seen, and on one occasion a mother with her neonate was seen. Though the research area in Balikpapan Bay contained three seagrass fields, all dugongs were seen near one of these fields next to Kariangau, a small fishermen’s village within the vicinity of the State Oil Refinery.

We found seagrass in different areas, but only in shallow water. Most seagrass beds were small and coverage was low; only three seagrass beds were large (2500, 1500 and 2000 m²). In deeper parts of the bay and parts where a thick layer of mud was on the bottom, no seagrass would grow. In addition, turbidity in the Bay was found to be medium to high, and historical data showed that the Bay had been severely affected by oil pollution in the past.

Balikpapan Bay, East Kalimantan, is situated next to the city of Balikpapan. Some activities around this city are oil refining, timber harvesting, and shrimp farming. These last two activities cause more mud to be flushed

into the bay, either by taking away the trees on the hills around the bay, or (for the shrimp farms) by reducing the amount of mangrove forest around the bay, which decreases the buffer zone for the mud. The foundation Proyek Pesisir (a NGO with financial support from USAID) shows that per year 68,669 tons of sediment are washed into the bay (Proyek-Pesisir 2002).

Our observations show that the mud in the bay forms a threat for the seagrass in two ways, both by forming a thick muddy layer on parts of the bay bottom on which nothing grows, and by making the bay more turbid, so the sunlight does not reach the bottom of the bay anymore. In addition, historical data show impact of oil pollution on both the mangrove ecosystem and seagrass beds.

Local fishermen also confirm that the amount of seagrass and the number of dugongs have declined in the last ten years. They also say they do not hunt the dugong. - **Hans de Iongh**

SIERRA LEONE

The West African Manatee in Sierra Leone. - In January-February 2005 a waterbird census in all coastal wetlands of Sierra Leone was carried out. All larger estuaries were visited, including the Scarcies estuary, the Sierra Leone River estuary, Yawri Bay, and the Sherbro Island estuary. During this waterbird survey most mudflats, sandbanks and shallows were visited by boat. All areas have a strong tidal influence and are characterized by brackish habitats with muddy or sandy soils. The shallows are bordered by mangrove forests and especially in the Scarcies area with rice fields.

At one location a manatee was observed. The animal lifted its head twice above the water and went down under when the boat approached too close. It was observed in troubled, less than 1.5 m deep salt water close to the shore of Yelibuya Island at the Great Scarcies River mouth (08° 57.037' N, 13° 15.429' W).

Apart from this observation, 11 fishing villages along the coast were visited, and interviews with local fishermen were organized in order to get information about wildlife and related hunting pressure. These interviews showed manatees still to occur along the entire coast in all estuaries, especially in the Scarcies area and the Sherbro Island region. The animals seem to move quite far inland, and it was stated by locals that manatees are more common in the rainy season (June-August). However, more accurate information about spatial and temporal movements is urgently needed. Unfortunately, manatees are hunted intensively in all wetlands. They are captured for consumption with special traps constructed in creeks. In one village the local hunters mentioned two captures in the last two weeks. We got the strong impression the species is severely threatened in Sierra Leone. Therefore, the high hunting pressure needs immediate attention. - **Jan van der Winden** and **Alhaji Siaka** (Working Group, International Waterbird and Wetland Research (WIWO), The Netherlands, and The Conservation Society of Sierra Leone (CSSL); e-mail: <**jvdwinden@ hetnet.nl**>)

ABSTRACTS

The following abstract is of a paper presented at the 64th annual meeting of the Society of Vertebrate Paleontology, Denver, Colorado, 6 November 2004:

Eocene and Oligocene Evolution and Structure of the Aquatic Herbivore Adaptive Zone in the West Atlantic and Caribbean

M. Clementz[1], D. P. Domning[2], L. G. Barnes[3], and B. L. Beatty[4]
(1. Smithsonian Inst. Marine Station, Fort Pierce, FL; 2. Howard Univ., Washington, DC; 3. Natural History Museum of Los Angeles County, CA; 4. Univ. of Kansas, Lawrence, KS)

Modern marine ecosystems support fewer herbivorous mammals than their terrestrial counterparts, and include only four nonsympatric species of Sirenia (e.g., sea cows, dugongs, and manatees). Yet, the diversity of aquatic herbivores through most of the Cenozoic was typically higher, encompassing periods when multiple species co-inhabited the same regions, including species other than sirenians (i.e., desmostylians, xenarthrans). With so many large mammal species foraging within a single locality, available resources of aquatic vegetation were likely to have been finely partitioned among herbivores, creating several distinct feeding niches. We have begun to define these feeding niches using features of cranial morphology, enamel carbon isotope values, and dental microwear as evidence of dietary preferences. Together, these independent lines of dietary evidence allow us to explore long-term patterns in the appearance and diverisification of these niches, providing insight into the development and structure of ancient aquatic communities. Three key regions we plan to study include the West Atlantic-Caribbean, Tethys-Mediterranean, and Eastern Pacific, all of which were sites of diverse aquatic herbivore faunas throughout most of the Cenozoic. Here we present initial data collected from Eocene and Oligocene fossil localities in the West Atlantic-Caribbean region. Fossils of aquatic herbivores collected from these deposits include multiple species from three separate families of Sirenia, including the earliest and most primitive family, the Prorastomidae. Morphological evidence suggests that the locomotor capabilities, habitat preferences, and dietary preferences of these species were quite distinct and, when combined with carbon isotope evidence collected from tooth enamel, may reflect differences in the amount and type of seagrass included in each species diet.

The following abstracts are of papers and posters presented at the Florida Marine Mammal Health Conference, University of Florida, Gainesville, 7-10 April 2005. The conference website has links to PDFs of most of the presentations:
<**http://www.vetmed.ufl.edu/marinemammal/flmmhc/Conf2005/ConfHome.htm**>

Levels of Polycyclic Aromatic Hydrocarbons in Subcutaneous Blubber Samples from the Florida Manatee (*Trichechus manatus latirostris*).

Bigelow, M.M., Keith, E.O *(Oceanographic Center, Nova Southeastern University)*

Polycyclic aromatic hydrocarbons (PAHs) have been recognized as human carcinogens since 1775. Since that time, PAHs have been shown to have many other deleterious effects, and 16 PAHs have been listed as priority pollutants by the Environmental Protection Agency in the Clean Water Act. PAHs have a strong potential to pollute the waters around Florida electricity generating plants due to contaminated effluents. PAHs are also known to occur in many Florida ports because of large ship bilge pumping. Because Florida manatees (*Trichechus manatus latirostris*) frequent both power plants and ports, especially during the cold weather months, there is a high potential for PAH accumulation. In addition, the characteristic high turbidity of Florida waters causes PAHs to become more bioavailable, and thus manatees could ingest PAHs when they feed on vegetation with surface PAH accumulations.

Recently manatees have shown symptoms characteristic of PAH accumulation, i.e. impaired immune responses, prolonged umbilical healing, and eye pathology. To date many studies have been published on the effects of PAH accumulation in marine mammals, but none have been published on manatees. The purpose of this study was to conduct an introductory investigation on the levels of PAHs in the Florida manatee.

Twenty-eight subcutaneous manatee blubber samples were obtained from the Florida Fish and Wildlife Conservation Commission Marine Mammal Pathobiology Laboratory archive. PAHs were extracted using

an ASE 100 Accelerated Solvent Extraction System (Dionex Corporation, Sunnyvale, CA), and the 16 primary pollutant PAHs were quantified using High Pressure Liquid Chromatography (Perkin-Elmer Corporation, Boston, MA) with a Vydac 201TP5415 reverse-phase (C18, 5 µm, 4.6 mm ID x 150 mm) HPLC column (Grace Vydac, Hesperia, CA), and calibrated by comparison to a standard priority pollutant PAH mixture.

PAHs were found in the concentrations range of 0.001-23.565 ug/g. All animals examined were found to have at least one priority pollutant PAH, and trace amounts of all 16 priority pollutant PAHs were found in one animal. These preliminary results indicate that Florida manatees are accumulating PAHs and that this accumulation may result in deleterious effects on their health, reproduction, and survivability.

Belize Manatee *(Trichechus manatus manatus)* Epibionts – SEM Viewing Techniques

[*,+]Bonde, R. K., [+]Lewis, P., [+]Samuelson, D., [±]Self-Sullivan, C., [#]Auil, N., and [#]Powell, J. A.
([*]U.S. Geological Survey – Sirenia Project; [+]University of Florida, College of Veterinary Medicine; [±]Texas A&M University; [#]Wildlife Trust)

This is the first reported evidence of epibiont fauna on the skin of West Indian manatees (*Trichechus manatus*) outside of Florida and Cuba. Published records only exist for the identity of two copepods (*Harpacticus pulex*) observed on the skin of a manatees from southern Florida (Humes 1964) and (*Harpactichecus manatorum*) as reported for manatees in Cuba (Ortiz et al. 1992). In both these cases the copepods were observed on the skin with no tissue reaction. Other than occasional barnacles on the epidermis of manatees in marine environments throughout their range, there is little documentation of true ecto-parasitic associations with manatees. This study identifies and details one new ecto-parasitic association involving the amphipod crustacean (*Sinelobus stanfordi*) that readily attaches itself firmly into the epidermis. Additionally, this case documents several additional epibionts (at least one other crustacean, a bryozoan, a diatom, and a nematode) obtained from the dorsal skin surface scrapings of two manatees examined off the Drowned Cayes in coastal Belize during May of 2004.

Specimens were preserved and examined using both light dissection and scanning electron microscopy. All specimens were collected in the course of radio-tagging studies that have been conducted in Belize since 1997. To date, 77 manatees have been captured repeatedly and valuable health assessment data have been collected and evaluated for each animal. Ongoing studies are planned for detailed monitoring of manatees in this region of Central America.

Manatee Protection Rulemaking by the FWC: How the FWC Implements its Statutory Responsibilities

Scott Calleson *(Florida Fish and Wildlife Conservation Commission)*

The state of Florida has regulated boat speed and operation to protect manatees since the late 1970s. This management responsibility has been handled by the Florida Fish and Wildlife Conservation Commission (FWC) since 1999. The primary purpose of the regulations, as stated in the Florida Manatee Sanctuary Act, is to protect manatees from harmful collisions with motorboats and from harassment. The regulations appear in Chapter 68C-22 of the Florida Administrative Code.

The rule making process can be divided into three basic steps: [1] evaluating manatee use; [2] evaluating the threats manatees face; and [3] determining the appropriate management actions to address the threats. This process is usually highly controversial with many boating advocates believing that too much regulation is being established and many environmental advocates believing that too little regulation is being established. The FWC is in the middle, charged with the task of finding the appropriate balance.

To meet its statutory responsibilities, the FWC considers many types and sources of information. For the first step in the process, evaluating manatee use, the statute requires that the FWC determine where manatee sightings are frequent and the available information supports the conclusion that manatees inhabit the area on a regular or periodic basis. The information that the FWC uses to make this determination includes manatee distribution data collected by aerial surveys, manatee tracking (telemetry) studies, seagrass data, and bathymetry data, to name a few.

Although there can be some controversy associated with the FWC's evaluation of manatee use, there is typically more controversy over the last two steps in the process, evaluating the threats to manatees and determining the appropriate actions to take. Both of these latter steps involve an assessment of boating information, including how boats and manatees are likely to interact in a given area.

The amounts and types of available information on boat use often vary considerably from area to area. In some parts of Florida, such as Charlotte Harbor and Lee County, there is a substantial amount of information while in other areas there is very little. Whatever the case may be, the FWC is required to use

the best available information in its rule making process. The primary need is for the FWC to be able to consider where and how boats are being operated as well as the intensity of boat use. Although other factors are also considered, areas that are high-use for both boats and manatees are often identified as being most in need of some form of boat speed regulation.

Using this process, the FWC (or predecessor agencies) has established manatee protection rules in most areas of Florida that manatees use on a regular basis. Many of the existing rules were established between 1990 and 1994. The most recent new area to be addressed on a large scale was Tampa Bay, where rules were adopted in December 2004. The focus of future FWC rulemaking will most likely be on re-assessing existing rules to determine if changes are needed to either increase, decrease, or reconfigure the regulations. A considerable amount of effort is being spent investigating ways to evaluate the effectiveness of existing zones. At the present time there is no clear-cut methodology for how this should be done or what types of information should or could be used. One management tool that is being investigated is the development of a risk-assessment model that could provide insight into whether the potential for manatees to be hit by boats has been affected by regulations.

Structural Properties of Florida Manatee Ribs

Clifton, K.B., Mecholsky, J.J. Jr., and Reep, R.L. *(University of Florida)*

On average, 25% of all Florida manatees that die each year are killed by boats. Boat strikes account for 85% of deaths attributed to humans. Reducing watercraft-related mortality is a high priority in state and federal manatee recovery efforts, which focus primarily on regulating boating activities. In order to establish safe boat speeds for manatee protection, an estimate of the forces required to fracture their bone is needed. The goal of this project is to estimate the structural properties of whole manatee ribs. Impact tests were used to estimate the load required to initiate a fracture, and the amount of energy needed to fracture whole ribs. Manatee ribs from the mid-thoracic region were impacted with an air cannon. Fractographic analysis was applied to the fracture surfaces to calculate the loads that led to failure. Loads ranged from 91-173 MPa. Epoxy casts of the fracture surfaces were used to calculate the fractal dimension (D*). D* is directly related to the fracture energy of a material; the higher the fractal dimension, the greater the fracture energy. Preliminary results indicated D* for manatee bone is at the low end of the range for ceramics, suggesting a low amount of energy is needed to cause fracture. These impact tests will allow us to determine whether the kinetic energy generated by typical watercraft under normal operation is sufficient to fracture manatee ribs. This information will contribute to our understanding of manatee-boat interactions, and will be critical in establishing speed zones adequate to minimize fatal impacts.

Boats, Manatees, Regulation, and Education

Richard O. Flamm
(Fish & Wildlife Research Institute, Florida Fish and Wildlife Conservation Commission)

One aim of manatee protection is to reduce the frequency of collisions between vessels and manatees while minimizing intrusions on the boating experience. Two common approaches for achieving this aim are education and regulation. Education attempts to encourage desirable behaviors through the distributing of information and conducting outreach. Regulation seeks to steer individuals away from undesirable behaviors through the posting of information and the threat of enforcement. One repercussion of regulation is that conflicts might arise between the regulators and those affected by the regulations. In contrast, education is considered non-controversial because there are no consequences if the messages are ignored. Education can complement regulation, but only if it results in shifts toward more environmentally safe behaviors. To date, very little has been done to assess the efficacy of marine-oriented environmental education programs. To increase our understanding of educational efficacy, we conducted a study, where we compared the effects of a boater education program conducted by a local environmental organization with the effects of regulations implemented by the local government on boating patterns and behavior. We observed boats and recorded their movements and registration numbers. More than 101,000 boat passes were observed. In addition, we conducted three telephone surveys over 4 years. The first survey was a baseline characterization of knowledge and attitudes of the owners of the boats observed in the study areas, the second evaluated the effectiveness of the education program, and the third measured boater's reactions to the regulations. Principal results of these surveys were: social norms strongly influenced boater behavior, boaters preferred education over regulation, and outreach activities by the local environmental group had no measurable effect on boater intent. After regulatory signs were installed at one site, there was a dramatic change in boating patterns; fewer vessels transited through the site, boats operated at slower speeds, and

personal watercraft use became uncommon. These results are helping to improve environmental stewardship approaches and also have implications for management.

Manatees: A Management Mess

Kipp Frohlich *(Florida Fish and Wildlife Conservation Commission, 620 South Meridian Street , Tallahassee, FL 32399; 850 922-4330, kipp.frohlich@MyFWC.com)*

The manatee was first protected in 1893 by the Florida Legislature, making it one of our country's earliest-protected species. The cornerstone of state manatee protection, however, was laid in 1978 with the passage of the Florida Manatee Sanctuary Act. This law provides the state the authority to protect manatees from death or injury. A state trust fund dedicated to manatee and marine mammal conservation has provided the financial base as the state's program has grown in size and scope and received international recognition. Throughout the past several decades, management has focused on ways to reduce the risks to manatees from anthropogenic impacts such as watercraft collisions, coastal development, and crushing in locks and dams. During this time, as protection measures have been implemented throughout many areas of the state, the manatee population has grown in size. Concurrently, organized opposition to certain protection strategies (particularly boat speed zones) has also grown significantly. In the last several years manatee protection has become Florida's most hotly contested environmental issue, spawning numerous lawsuits and countersuits. Manatees, their supporters and critics have garnered the attention of state and federal political leaders. In response to the imbroglio, efforts are now underway to bring opposing stakeholder groups together to try and create a more civil dialogue, find common ground if possible, and develop ways where groups can work cooperatively to find lasting solutions.

Of Manatees and Men: Using SOUND Science to Understand and Mitigate the Acoustical and Sensory Causes for Vessel Collisions

Edmund R. Gerstein1,2 Laura A. Gerstein2, Joseph E. Blue2, and Steven E. Forsythe3 *(1Florida Atlantic University, 2Leviathan Legacy Inc., and 3Naval Undersea Warfare Center, 1318 SW 14th Street, Boca Raton, Florida 33486; (561) 338-9185, Gerstein2@aol.com)*

A comprehensive series of controlled underwater psychoacoustic tests was conducted to measure and document the overall hearing abilities of the West Indian manatee. Pure tones, complex noise and real-world sounds were presented to captive manatees under various acoustical conditions. These studies yielded the first behavioral audiogram, directional hearing and masked threshold measurements for any sirenian species. The results from more than 30,000 threshold trials definitively measured the manatees' overall range of hearing, sensitivity, signal-to-noise thresholds, critical ratios, and directional hearing. Complementing these investigations, underwater acoustical measurements of manatee habitats and vessel noise propagation in these environments were conducted to evaluate the acoustical factors that can render Florida manatees vulnerable to repeated collisions with vessels. Physical boundary effects in manatee habitats severely limit the acoustical propagation of the dominant low frequency spectra produced by most watercraft. The manatees' auditory constraints together with shallow water and near surface propagation limits dictate that the noise produced by slow-moving boats is more difficult for manatees to hear and locate than the louder and higher frequency spectra produced by cavitating faster-moving vessels. In clear-water habitats, where boaters and manatees can effectively see and actively avoid each other, slow speed zones may be effective and appropriate. Unfortunately, this strategy and other measures that are reliant upon visual feedback or surveillance are not effective during periods of poor visibility or in turbid water conditions, and do not address the underlying acoustical challenges manatees and other passive listening marine mammals face. Ironically, such intuitive strategies, derived by visually biased species such as ourselves, can be counter-productive. Slow speed zones implemented in turbid waterways can exacerbate the problem, making vessels more difficult or impossible for manatees to hear, while increasing vessel transit times and the subsequent opportunities for collisions. Acoustical masking from typical ambient conditions, and the noise of distant faster-moving boats, can further obscure the quieter sounds of approaching slow-moving vessels. With all these auditory detection challenges, perhaps the most deceptive acoustical challenge manatees and even the "great whales" share is "acoustical shadowing." This phenomenon occurs when the noise produced by a ship's propellers is blocked from projecting forward by the ship's hull. The effect is prominent when propellers are positioned above keel level. In these instances a large silent area (an acoustical shadow) is cast directly ahead (at the bow) of an approaching tug, barge or large ship. Animals swimming or resting near the surface in a direct path with such a vessel will not hear

its approach, while animals off to the side that can detect the vessel may then seek refuge by swimming directly in front of the approaching vessel where it is quiet.

By exploiting the manatee's best hearing capabilities, a very low intensity, highly directional, and thus environmentally sensitive acoustic warning device has been developed for attachment to boats, barges and larger slow-moving vessels. While manatees are not adapted for hearing or locating the dominant spectra from these watercraft, they are very well equipped to detect and locate higher-frequency modulated sounds. This hearing sensitivity provides a narrow sensory window through which to alert manatees of approaching vessels. The efficacy of this technological approach will be evaluated through controlled tests with wild manatees. A similar directional array that utilizes modulated ship noise is under development to selectively fill-in acoustical shadows ahead of vessels to alert whales near the surface of approaching ships.

Characterization of Boat Traffic Patterns and Boater Compliance

Jay Gorzelany *(Mote Marine Laboratory)*

A better understanding of recreational boating patterns and boater behavior is critical to the long-term survival of the Florida manatee. A great deal of effort at the federal, state, and local levels has been placed on reducing collisions with manatees by regulating boating through the use of speed-restricted zones and exclusion areas. In spite of recent protection efforts, boat strikes remain the most significant problem faced by manatees in Florida (U.S. Fish and Wildlife Service, 2001), and still account for 25-33% of the annual manatee mortality. Along with human pressure on Florida's natural system comes increasing recreational pressure; primarily more boats and increased access to waterways. Consequently a great deal of effort has been placed on reducing manatee boat-strike deaths by regulating boating through the use of speed-restricted zones and exclusion areas. Speed zone effectiveness, and the extent to which speed zones change boater behavior, are unclear.

A series of recreational boat traffic and boater compliance studies have been performed in southwest Florida over the past eight years. These studies have included both aerial boat traffic surveys, and fixed-point boat traffic and compliance studies. Aerial surveys are useful in determining the spatial distribution of boat traffic within a specific area. This includes the identification of popular boating destinations, high-use areas, and travel corridors. Temporal patterns can also be identified, including daily, weekly, and seasonal use patterns. Aerial survey data are also used to create GIS layers which can be merged with other database layers to identify areas of potential resource conflict. This also serves as an important management tool which can be used to characterize boater use patterns – an important component in the development of manatee protection plans. Finally, these data may be used to identify and document potential changes in boater behavior and travel patterns resulting from regulatory changes in a given area.

Studies of boater compliance are useful in determining the effectiveness of a posted speed-regulated area. Results to date have indicated the levels of compliance tend to be site-specific, and may be related to variations in local use patterns, traffic volume, vessel composition, sign placement, level of regulation, and enforcement presence. The relative proportion 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. Acceptable levels of non-compliance have not been established. A more reasonable determination may be to assess the level of non-compliance an area can sustain before manatee protection becomes a serious concern, and this will likely vary from location to location. Recently, compliance studies conducted prior to newly established regulatory sign placement have provided additional insight as to their effect on reducing boat speeds. Additional studies of boater compliance in other areas are likely needed in order to 1) provide important baseline information for the development of future management plans, 2) test and evaluate the effectiveness of existing management plans, and 3) assist in the identification and assessment of areas of potential human/manatee resource conflicts.

Immunohistochemical Localization in Wounded Manatee Integument

*Graham, AR., *Samuelson, D.A. and *Lewis, P.A. *(*University of Florida)*

Through the use of a number of antibodies, both monoclonal and polyclonal, it was the hope of this research to understand wound response in the integument of the Florida manatee that could possibly lead to the development of a wound healing timeline. To detect the occurrence of angiogenesis, polyclonal antibodies for vascular endothelial growth factor receptor 1 (VEGFR-1) and vascular endothelial growth factor receptor 2 (VEGFR-2) were used. To determine if there was any wound contraction going on the

monoclonal antibody for smooth muscle actin was used. Monoclonal antibodies for matrix metalloproteinases 2 and 9 (MMP2, MMP9) were applied to wounded tissues to observe active breakdown and/or reconstruction of the extracellular matrix within the dermis.

All wounded tissue samples were fixed in 10% neutral buffered formalin for 24 hours, placed into phosphate buffered saline solution, and routinely processed for paraffin embedding. Sections were cut at 6 microns, deparaffinized and appropriately prepared for immunohistochemical localizations. Localization procedures varied in the use of antibodies, detection kits, incubation times, and chromagen used. Negative controls were used in all localizations, and normal manatee specimens were used for a comparison. All immunohistochemical localizations were successful and yielded positive results. All of the wounded samples reacted positively more than the reaction of normal samples. The wounded samples varied with expression of antibodies based on the stage of wound healing. Although a timeline is not yet possible to develop due to the preliminary nature of the study, this research has formed a solid baseline for continued investigation on the wound healing of the Florida manatee. Moreover, the successful localization of both VEGF receptors and both MMPs, 2 and 9, in the skin encourages the further use of commercially available antibodies for future immunolocalization studies in this species.

Histological Comparison of Manatee and Elephant Integument

Graham, AR*, Samuelson, DA*, Isaza, R*, and Lewis, PA* *(*Univ. of Florida College of Veterinary Medicine)*

The integument of mammals is in direct contact with an external, shaping environment that serves to determine its structure and functions. In mammals the skin acts as a barrier to the environment but also has several other roles, such as preventing dehydration and temperature regulation. In marine mammals, specifically, the skin is involved in drag reduction and buoyancy control. Modifications of the skin can be used for reproductive or feeding purposes as well.

The manatee's closest living terrestrial relative is the elephant. These two mammals have different external appearances and live in completely different habitats. The manatee is completely aquatic, and the elephant is completely terrestrial. Elephants have been known to be attracted to the water; even to depths well over their heads. Fossil evidence and molecular data have provided the association between these seemingly unrelated orders of mammals. The specialized, unique morphology of the wrist bones organized serially, their horizontal tooth replacement, and experiments with amino acid sequencing of proteins all have proven the manatee and elephant are related.

Samples were collected from 25 sites of the body, including both dorsal and ventral regions where applicable. Analogous sites of the elephant were used for this histological comparison. These samples were analyzed morphologically through paraffin embedding, using a variety of stains including special stains for the extracellular matrix. The manatee and elephant have some similarities in their integuments, including epidermal organization and overall thickness. It is interesting to note that the stratum granulosum of the epidermis is mostly underdeveloped in the elephant and non-existent in the manatee. Though similar in some ways the manatee skin is more irregular with respect to its hyperplastic characteristics of the epidermis as well as hyperkeratosis. The dermis of the manatee and elephant vary in anatomical architecture and density as well, being more organized and pronounced in development in the manatee, especially in specific regions such as the fluke.

Vascularization of the Cornea in the Florida Manatee

J.Y. Harper, D.A. Samuelson, and P.A. Lewis *(Department of Small Animal Clinical Sciences, College of Veterinary Medicine, University of Florida, Gainesville, FL 32610-0126)*

This study continues the investigation of corneal angiogenesis of the Florida manatee (*Trichechus manatus latirostris*). We have consistently found the presence of blood vessels within the corneas of every animal that has been examined. In all specimens, no signs of infection or injury were present. In order to determine the amount of angiogenesis that has occurred in these individuals and observe possible vascular patterns within the anterior stroma and adjacent epithelium, that may or may not result in visual hindrance, corneas from a mixed population of Florida manatees were assessed both histologically and by three-dimensional (3-D) reconstruction.

Twenty-six eyes from 22 manatees including one fetus were provided by the Florida Marine Research Institute (FMRI) in St. Petersburg, FL along with additional information, including gender, size, location and time when the animal was found. All eyes were preserved in 10% formalin. Corneal specimens were measured and notched for orientation and embedded in paraffin. Each cornea was serially

sectioned having used a frontal approach. Sections were stained with Masson's trichrome and 3-D reconstructions of the vasculature where performed, all at 25X (Fig. 1) and 3 at 200X, the latter having been divided into dorsal, ventral, medial and lateral quadrants. Vessels were morphometrically evaluated for percent volume of total tissue.

Blood vessels were found in all corneas, having varied in location and to a lesser extent in shape and size even between corneas of the same individual. A network of vessels was observed in both corneas of the fetus. Vasculature at 200X was similar to that at 25X in that the vessels did not form repeating patterns and appeared randomly distributed in the examined region. The vascular patterns at 200X occupied more volume, 0.1-5.3% vs. 0.1-1.2%, and were smaller in average diameter, 27 mm vs. 84 mm. Additionally, vessels could be observed frequently penetrating the anterior epithelium from the stroma with the higher magnification reconstructions. The level of detailed vascularization could not be detected at 25X. Examination of the specimens at 400X and 1000X revealed the presence of small blood vessels next to and within the anterior epithelium.

The statistics were calculated using the SAS computer program by means of a one-way ANOVA. The effect of gender (male versus female), age class (calf, juvenile, or adult), coast found (east versus west), and season found (Spring, Summer, Fall, or Winter) based on blood vessel as a percent of the total volume (which was calculated using the MCIP computer program) of tissue was examined in 20 individuals. The unknown and fetus samples were not used. In the case of three individuals where both eyes were examined, the average between the two eyes was taken. There was no significant gender effect found ($F_{1,18}=1.34$, $P=0.2622$); no significant age class effect found ($F_{2,17}=0.82$, $P=0.4588$); no significant coast effect found ($F_{1,18}=0.07$, $P=0.7996$); and no significant season effect found ($F_{3,16}=0.30$, $P=0.8259$).

In the absence of edema, inflammation, or any other abnormalities, the presence of blood vessels in all specimens including the fetus suggests that corneal vascularization in the Florida manatee is a developmental process, possibly related to an usually thick tear film. The greater amount of vessels detected at the highest magnification was due to the ability to visualize and trace small vessels. The size and density of the small vessels were most likely too small to interfere with light transmission and are most likely not affecting manatees' ability to survive in their different aquatic environments.

Acute Phase Proteins

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Inflammation is a response to a perceived pathogen or severe tissue trauma that enables the body to maintain homeostasis. The acute phase response (APR) is a nonspecific component of inflammation (infection, autoimmune disease, etc.) or tissue damage (trauma, surgery, or tumors). Leukocyte (white blood cell) count and fever are relatively sensitive indicators of systemic, innate inflammation and infection in many mammalian species including humans. In a few species, e.g., cattle and manatees, leukocytosis and left shifting (increased immature cell types) do not occur unless disease is severe and then may rapidly progress to leukopenia as leukocyte utilization exceeds bone marrow production. For this reason, leukocyte count, though occasionally useful in bovids and manatees, is not a sensitive indicator of inflammation. Additionally, adequately assessing the core temperature of a 500 kg aquatic animal is inaccurate at best. Positive APR proteins (serum amyloid A (SAA), haptoglobin, C-reactive protein, fibrinogen, alpha1 acid glycoprotein, and others) are produced by the liver during APR in response to cytokines released at the site of injury to either protect the body or to combat a potential pathogen. In humans, APR proteins (APP) are nonspecific indicators of disease similar to fever or leukocyte counts. Plasma concentrations of the individual proteins change at different rates after the initial insult thus providing useful information not only about the inflammation, but also about duration of disease. Sequential measurement can also aid in assessment of treatment response.

Acute phase response (APR) proteins, such as SAA and haptoglobin, are used as a primary indicator in horses and cattle because APR proteins have proven to be sensitive measures of internal inflammation/infection. In Europe, appropriate APR proteins are used as screening tests for inflammatory disease in livestock. SAA has proven to be a valuable screening diagnostic for inflammation in manatees.

Several practical factors must be considered when identifying and validating an APR protein for diagnosis of inflammation in manatees. These include physiologic activity of the protein within manatees, stability of the protein over time during transport with potential temperature change, accuracy of the

methodology employed in identifying the protein in this species, and clinical use in different disease states specific to manatees. All of these factors must be evaluated prior to clinical use as a diagnostic test.

Serum Amyloid-A. Serum amyloid-A (SAA) is produced by the liver in inflammatory states and circulates complexed to a lipoprotein. It is also elevated in many autoimmune diseases, polyarthritis, granulomatous disease, and neoplasia. Deposits of amyloid-A (AA) protein are most often found in the kidneys, liver, and spleen in chronic disease states but may be found in any organ. In horses, SAA has been reported to be a very sensitive indicator of inflammation. In equine species, SAA is found in trace amounts in healthy animals and increases dramatically in nonspecific inflammatory states, especially bacterial and viral infections.

Haptoglobin. Haptoglobin (Hp) is an alpha2-glycoprotein that irreversibly binds hemoglobin (Hb). Hp-Hb complexes are large enough to prevent or greatly reduce renal filtration of free Hb in plasma and its iron. The complexes are removed rapidly by hepatocytes and Kuppfer cells which degrade the proteins, and iron and amino acids are reutilized. The Hp-Hb complex is also a peroxidase that hydrolyzes peroxides released by neutrophils at sites of inflammation. Hp also functions as a natural bacteriostatic agent for iron-requiring bacteria by preventing the utilization of hemoglobin iron by these organisms.

Haptoglobin is quickly consumed in hemolytic syndromes. Severe hepatocellular disease also results in decreased synthesis of haptoglobin. It is increased during the acute phase response. In humans, it is also increased in response to exogenous glucocorticoid and non-steroidal anti-inflammatory drug (NSAID) administration, during some protein losing syndromes such as nephrotic syndrome, and during severe biliary obstruction. Haptoglobin is undetectable in the blood of healthy cattle. In cattle with inflammation or infection, e.g., mastitis, metritis, pyometra, traumatic reticulitis, abomasal displacement, bacterial nephritis, and hepatic lipidosis, haptoglobin levels increase markedly. It has proven to be a sensitive indicator of inflammatory disease in cattle.

Fibrinogen. Fibrinogen was the first APR protein recognized. Increased production by the liver results in increased levels in inflammatory states, as well as pregnancy. It is integral in platelet aggregation. In the coagulation cascade, it is cleaved by thrombin to form fibrin, the backbone of the thrombus. Though only mildly increased concentrations are present in many species during inflammatory disease, it has proven very useful in detecting inflammation in ruminant species, specifically cattle. Clinical reports from Sea World veterinarians indicate that hyperfibrinogenemia is also the diagnostic of choice in Cetacea. Hypofibrinogenemia can occur in disseminated intravascular coagulation, liver failure, and cachexia.

A heat precipitation method is used as a quick estimate of fibrinogen concentration. More accurate methods include modifications of the Ratnoff-Menzie assay, measurement of clot weight, and quantification of immunoprecipitate formed with specific antifibrinogen antisera.

Techniques for Establishing a Cell Culture and Cytogenetic Characterization of the Florida Manatee, *Trichechus manatus latirostis*

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The Florida manatee, *Trichechus manatus latirostris*, is an endangered subspecies of the West Indian manatee and is found in the coastal waters and lagoons of Florida. In an effort to better understand the molecular nature of manatee chromosomes, cell cultures were established. Cartilage and kidney tissue were collected at necropsy shortly after euthanasia on animal SWFTm9728b, an adult male with extensive boat strike injuries. Primary cell cultures were established, subcultured and cryopreserved. A high-resolution karyotype was prepared using GTG-banded chromosomes. The chromosomes from these cell cultures will facilitate additional cytogenetic analyses.

Observations on Digesta Passage Rates in the Florida Manatee (*Trichechus manatus latirostris*)

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The Florida manatee, *Trichechus manatus latirostris* (Sirenia: Trichechidae), is an herbivorous marine mammal found within coastal areas throughout the state of Florida, feeding on both fresh and salt water sea grasses. Manatees, like other Sirenia, are a tropical species with little tolerance for water temperatures below 68° F, rely on a relatively poor nutritional food source, and have a low metabolic rate. Although manatees are hind-gut herbivores, they are very efficient at extracting nutrients from the plants on

which they feed. Slow passage rates of digesta have been suggested to be a factor in this increased efficiency. This study monitored the digesta passage times and mixing of particulate digesta within the manatee digestive tract using MicroGrits colored corn as a fecal marker. Captive Florida manatees were fed red MicroGrits on three consecutive mornings, followed by blue MicroGrits for a further three mornings. Fecal samples were subsequently collected and grit pieces removed, counted and measured. The digesta passage times for the three manatees included in the study ranged from 5.4 – 8 days, similar to other studies previously conducted. Less than 1% of the marker fed was recovered. Minimal to no mixing of the two different colored markers fed and recovered suggest the digesta from a given day traveled through the tract as a bolus It is hypothesized that the majority of the 99% of marker not recovered was retained in the perpendicular folds of the large intestine and digested, but some may also have been lost to coprophagy, missed fecal samples at night, and to the filtration system.

Vocalizations and Hearing in Florida Manatees

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Two approaches to reduce boat collisions with manatees have been to study the sounds produced by manatees so that detection devices to warn boaters could be devised, and to study the hearing abilities of manatees to understand what sounds they can detect.

Manatee vocalizations are relatively stereotypical in that they are short tonal harmonic complexes with small frequency modulations at the beginning and end. Vocalizations range from almost pure tones to broader-band tones with a raspy quality. The loudest frequency is typically the second or third harmonic. Signal parameters measured from calls of manatees from Belize and Florida show they have overlapping distributions of sound duration, peak frequency, harmonic spacing, and signal intensity, indicating no obvious distinguishing characteristics between these isolated populations. Data on vocalization rates suggest that manatees vocalize more often in the presence of snorkelers, and in one case a vocal interaction was recorded between a snorkeler and a manatee. The nature of manatee sounds makes them fairly easy to automatically detect with a computer system. A real-time signal-processing scheme for detecting manatee vocalizations was implemented and able to detect these vocalizations. Further research needs to be done to determine how often and under what circumstances manatees vocalize.

Manatee hearing was studied with auditory evoked potential (AEP) techniques, which involve playing sounds to a manatee and simultaneously measuring the response of the brain to the sounds. AEP amplitudes measured from manatees are relatively small in comparison to what can be measured from cetaceans, presumably because the manatee brain is located deep within the head. AEP audiograms underestimate hearing thresholds measured with behavioral techniques, however the overall audiogram shape is similar. Temporal resolution measurements made with AEP techniques show that manatees have a temporal resolution intermediate between that of humans and cetaceans. Sound pathways in the manatee body have also been mapped with AEP techniques to determine if there are specific acoustic pathways to the ear, like those found in dolphins. Results from these studies suggest that there are multiple sound pathways to the ear.

Manatees and Boats Can Co-exist

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Understanding the root cause of a problem is requisite to solving it. Solutions implemented to protect manatees from vessel collisions have suffered from insufficient understanding of the problem and a resistance to accept data that challenges long-held beliefs. Despite more than a decade of slow speed restrictions, the rate of manatee mortality associated with watercraft collisions has not declined and it has remained constant and in some instances has even increased following the implementation of speed restrictions. Though the collision problem remains, sound scientific evidence vital to our understanding and which questions speed zone policy has been ignored by regulators and the Save the Manatee Club. Until recently, the physics of vessel noise propagation in shallow water and irrefutable data on manatee hearing, had been dismissed or rejected in favor of less rigorous and anecdotal observations more in line with traditional held beliefs and assumptions. Many of the efforts to protect the manatee have been based on the unsupported assumptions that both excessive vessel speed and increasing numbers of registered vessels are the primary causes of watercraft-related mortality. The validity of these assumptions has never been tested,

and the effectiveness of regulations based on these assumptions has never been evaluated. The recorded increase in the manatee population during the past 30 years and the direct correlation between an increasing manatee population and the associated increase in total mortality and the increase in watercraft-related mortality has been ignored and distorted. Inappropriate use and representation of available data have resulted in prejudicial regulatory decisions based on opinion rather than actual science and has led to a general lack of trust in a large segment of the general population. If the driving force behind the regulatory process can be shifted from being based on opinion to being based on science and using available technology, then the manatee will not only continue to co-exist with boats, it may thrive in a world where manatee-boat collisions will be dramatically reduced.

Rehabilitation of a Manatee Calf in Quintana Roo, México

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A male manatee calf was found alone on September 14, 2003, in the Guerrero Lagoon, Quintana Roo, México. For being yet a dependent calf and for not having found an adult manatee that could be the mother, Dr. B. Morales-Vela decided to transfer the manatee to Chetumal city to take care of it. Since then he is responsible for the calf's rehabilitation and has the support and authorization of municipal and federal authorities.

The objectives of this program are: to rehabilitate the manatee so that it can go back and survive in the wild, and to obtain knowledge and experience about manatee rehabilitation methods and procedures.

The calf was named "Daniel" and was kept in a round 3 meter in diameter plastic pool at El Colegio de la Frontera Sur (ECOSUR) facilities for 8 months. A filter and temperature system was attached to the pool to have a strict water quality and temperature control. Another PVC tubes system was put into the pool for water circulation in the same direction of the Coriolis force.

"Daniel" was fed each 3 hours day and night with a modified formula based on the Sea World formula for manatees. We began with next formula: 500 gr of Multi-milk, 1 liter of water, 60 ml of canola oil, and ½ taurine capsule. Formula was changing because it was very dense and "Daniel" had problems to defecate. The formula that we continue using since November 2003 is next: 200 gr of Multi-milk, 1 liter of water, and 36 ml of canola oil. Daily consumption by May 2004 was about 1100 ml of formula. Lettuce was offered to "Daniel" but he did not like to eat it.

"Daniel" was taken out of the pool to assess him once a week. Weight and length were measured and clinical samples were taken. When "Daniel" was found in September 2003, he weighted 21 kg and was 108 cm length. In May 2004 his weight was 60.5 kg and his length was 140 cm.

In May 2004 "Daniel" was transferred to a pen in Guerrero Lagoon, where his rehabilitation program continues. The first pen was 5 X 5 meters. Night feeding was eliminated. Besides milk formula, since July 2004 "Daniel" has been fed with liquidized local aquatic vegetation. In November 2004, his daily consumption reached 1.5 liters of milk and 700 ml of liquidized vegetation. Since February 2005 some vegetables (carrots, spinach, tomatoes, broccoli, potatoes) have also been liquidized to be included in his diet.

Every two weeks "Daniel" is taken out from the pen to weigh and measure him. Every month blood and other samples are taken for clinical analysis. Results of these have shown that "Daniel" is in good health condition. In September 2004 (one year old), he weighed 66 kg and his length was 152 cm. In his last assessment in March 2005, he reached 93 kg and 166 cm. Basic clinical treatments have been applied to "Daniel". Antibiotics have not been necessary.

A temperature recorder was fixed in the pen in June 2004 for water temperature monitoring. Records of water temperature have varied from 27 to 33°C between June and September 2004. From October to November 2004 temperature has varied from 24 to 26°C.

In September 2004, another pen was built so "Daniel" had more area to swim. A larger rectangle of 4 X 7 meters in which depth varies from 1 to 1.6 meters was added. Last March, 2005, another larger pen about 25 X 20 meters was built and "Daniel" is beginning to use it.

Main challenges now are that "Daniel" learn to find and eat solid aquatic vegetation by himself and that he can survive in the wild interacting with other manatees. Plans and procedures to achieve these objectives are now developing.

Acoustic-Based Manatee Avoidance Technology

Christopher Niezrecki, Diedrich O. Beusse, Michael Meyer, Richard Phillips, and Zheng Yan

The West Indian manatee has become endangered partly because of watercraft collisions in Florida's coastal waterways. Several boater warning systems, based upon manatee vocalizations, have been proposed to reduce the number of collisions. One aspect of the feasibility of an acoustically based system will rely upon the distance in which a manatee vocalization can be detected. The magnitude of environmental noise and manatee vocalizations, as well as the acoustic spreading properties of the habitat, are required to estimate the detection range of a manatee avoidance system. Within the presentation, manatee vocalization levels, sound propagation within the shallow waters of Florida, background noise levels and sources, and detection ranges are discussed. Techniques that can be used to extend the detection range by using background noise cancellation are also presented.

Development of Microsatellite DNA Markers for Genetic Studies on the Florida Manatee (*Trichechus manatus latirostris*)

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The Florida manatee is an endangered species and, in spite of its dependence on people and artificial warm water sources during winter, appears to be on its way to recovery. The management of this species could be improved by incorporating genetic data into the current recovery plan. Due to limitations of allozymes, mtDNA, and a lack of genetic diversity, previous studies failed to resolve questions regarding the Florida manatee population structure. This low genetic diversity could be explained by a bottleneck event due to a decreased population size or a founder effect resulting from a recolonization of their range after the last glaciation (approximately 12,000 years ago). Microsatellites are known to show high levels of polymorphism, even in small populations with low diversity, as is often the case with an endangered species. Microsatellites are genomic DNA markers with a repetition of a short sequence (1-5 base pairs). These markers can be used for individual identification (DNA fingerprints), pedigree studies, assessment of general population structure and status, and various other applications. Microsatellites vary among different species, and therefore must be designed and tailored to fit each species being examined.

This study requires the development of additional microsatellite primers due to the low allelic diversity of previously published primers. Microsatellite libraries, previously developed for USGS, have been screened for additional loci. Among the primers developed from these libraries, four appear to be polymorphic for the Florida population. These markers will be fluorescently labeled and tested on a larger set of manatee samples from different regions throughout Florida. Additional microsatellite libraries are being produced in an effort to identify more polymorphic loci.

Serological Survey of Infectious Disease Agents and Parasites in Wild Manatee (*Trichechus manatus*) in Coastal Quintana Roo, Campeche and Tabasco, Mexico

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The West Indian manatee is protected in Mexico by the Ecological Act of 1994, under which it is classified as a species in danger of extinction. Despite this, the health status of the manatee populations has not been evaluated in the country yet. In recent years, however, some infectious diseases such as *Mycobacterium marinum, Toxoplasma gondii,* and *Brucella* spp have been reported in manatees in Florida. Also, in Florida and Puerto Rico, some endoparasites such as *Heterocheilus heterocheilus* and *Chiorchis groschofti* are commonly found in manatees.

The present study was aimed at detecting the presence of infectious disease agents and parasites in manatees living off the coasts of Quintana Roo, Campeche and Tabasco, in Mexico. This was done as a first step toward the evaluation of their health status. The study sites were Chetumal Bay, Ascención Bay in Quintana Roo, and the delta of the Usumacinta River in Tabasco and Campeche. These three areas are home to the largest populations of manatees in Mexico.

To determine the presence of antibodies of infectious agents potentially harmful to manatees and the presence of oocytes of endoparasites, we captured 23 manatees: 15 in Chetumal Bay; 4 in Ascención Bay; and 4 in Tabasco. We collected 50-ml blood samples in vacutainer tubes containing SST and Lithium heparine. Serum samples were stored in cryovials and kept frozen at -20ºC. We ran microscopic

agglutination tests (MAT) against 12 serovars of *Leptospira interrogans* and against *Toxoplasma gondii*. To detect the presence of antibodies specific to *Brucella abortus* we ran card agglutination tests at 3 and 8%, as well as a complement fixation test (FCT). Feces were also collected and analyzed to determine the presence of endoparasites using the sedimentation and McMaster test. The tests were performed at the Department of Veterinary Microbiology and Immunology (Universidad Nacional Autónoma de México).

Twenty of 23 manatees (87%) tested positive to one or more of the 12 serovars of *Leptospira interrogans*. This high frequency was similar between sexes: 12 of 13 females (92%), and 10 of 11 males (91%) were positive. The most common antibodies detected were those against serovars *bratislava* (65%)*, grippothyphosa* (43%)*, tarassovi* (30%)*, autumnalis* (28%) and *pomona* (28%). The serovars *betavia, icterohaemorrhagiae, canicola, hardjo, pyrogenes* were less common with 17, 13, 9, 9, and 4% respectively. No individual was found positive to serovars *celledoni* and *wolffi* 3705. Three females (13%) were positive to *T. gondii* and only one female (4%) was positive to *B. abortus.* No male tested positive to either *T. gondii* or *B. abortus*. Only two endoparasites were found in the feces: *Heterocheilus heterocheilus* and *Chiorchis groschofti*, but they appeared at high frequencies (97% for *H. heterocheilus* and 71% for *C. groschofti*). However, pathologies are rarely associated with these parasites. Clinical signs of disease or active infections due to these bacteria, protozoan and parasites have not been described in wild populations of manatees. Our results suggest that further investigation is required to elucidate the role of *L. interrognas* in the health status of the Caribbean manatee in the study region.

Cytochrome Oxidase Staining Reveals Topographical Organization of Manatee Cerebral Cortex

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Manatee primary somatosensory, auditory and visual areas were previously localized using cytochrome oxidase (CO) staining on a neonatal postmortem Florida manatee brain. In order to extend these findings, we performed CO staining on the flattened left hemisphere of a juvenile postmortem Florida manatee brain, and on coronal sections from the right hemisphere. Adjacent sections from both hemispheres were stained with cresyl violet and used for cytoarchitectural orientation. Both the neonate and the juvenile show similar trends overall but with some distinctions. The frontal region of both reveals dense CO patches that are present within, but do not span the extent of, cytoarchitectural areas CL1, CL2, DL1, DL2, and DD. These areas represent presumptive primary somatosensory area S1. However, in the neonate there are four distinct patches which may represent tail, body, flipper and face, whereas the corresponding juvenile patches appear to be blended and extend caudally towards the lateral fissure. The temporal lobe reveals dense CO staining that represents the presumptive primary auditory area in areas CL1, CL2 and CL3 of both the neonate and the juvenile. Within the occipital lobe, CO staining is dense in areas DD2, DL3, and DL4 (presumptive primary visual cortex) as well as area CL4 (presumptive visual association cortex). However, distinct patches of CO-rich visual cortex are present in the neonate but appear to be blended into one patch in the juvenile. These findings also hold true in the preliminary analysis of a second adult specimen and indicate a general outline of S1, A1, and V1 topography that is consistent across specimens as well as the possibility of some level of refinement and reorganization through development.

Mapping and Characterizing Recreational Boating Patterns for Marine Resource Management

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Boating is a key element in Florida's coastal lifestyle and a major contributor to the state's population growth. Florida is the number one destination for marine recreation with an estimated 22 million participants in the United States. Florida ranks third in the nation in recreational boat registrations—one boat for every 17 residents. As the quantity of boats that ply coastal waterways increases, so does the need for improved waterway access and maintenance, greater public safety, improved boater education, and enhanced resource management. Lack of adequate information has hindered local efforts to plan for recreational boating. This paper reports on a project to map and characterize spatial patterns of coastal recreational boating within a geographic information system (GIS).

We mailed a map-based questionnaire to a random sample of 6,500 boaters that actively use the Tampa and Sarasota Bay boating region. The sample design generated group-specific information for users of (1) marina wet-slips, (2) dry storage facilities, (3) public ramps, and (4) private docks. Questionnaire recipients identified trip departure sites, travel routes and favorite destinations on a map. Spatial information from 1908 returned surveys was digitized into a GIS. Also, descriptive data about boaters including demographic (e.g., seamanship skills, local knowledge, motivations, and perceptions) and trip

information (e.g., starting time, duration, activities, and frequency) was collected and linked to the spatial data within the GIS. Descriptive and spatial analyses highlight use according to user-group, vessel type, vessel draft, and activity. It is intended that this information will be used to help locate boating infrastructure, and to support waterway management and manatee protection plans.

Boats and Manatees: Cooperation and Coexistence – A Broken Dream?

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When public policy is developed to influence human behavior under the umbrella of unreasonable and unachievable laws, and those laws are interpreted by lawsuit settlements, the process is doomed to failure. Valuable resources are squandered, doing nothing to enhance manatee protection. Interpreting what constitutes a "take" under the Marine Mammal Protection Act and the Endangered Species Act is the essence of the problem. In the case of manatee lawsuit settlements the focus has primarily concentrated on boating. New terms were developed, such as "areas of inadequate protection", without defining what adequate was. Policy changes appeared to be knee-jerk reactions to manatee mortality. Speed zones, manatee protection plans, etc. were developed under the guidance of these settlements without adequate data that demonstrate watercraft mortality is reduced by Draconian measures. Boaters and Industry question the inequity of ignoring the fact that most artificial warm discharges also constitute a "take" under the Marine Mammal Protection Act. If the focus of the Endangered Species Act is the recovery of the species, why after decades of research, isn't there accurate population information? When policy makers make decisions that are viewed as illogical or arbitrary, it fosters a greater lack of trust and compliance. Today, boaters and the marine industry are faced with a dilemma. In the desire to be proactive and work on balanced solutions to protect the manatee, hard-found compromises collectively agreed upon in good faith are not honored and arbitrarily discarded. Manatee Forums are created by the agencies in an attempt to bring parties together, yet manatee advocates continue to file lawsuits that drive decisions that keep moving the bar. The end of the rope has been reached. In Lee County, a recently adopted consensus Manatee Protection Plan is being challenged. Assessing the effectiveness of protective measures is paramount. There is only one way to achieve a "buy in" by all the stakeholders and that is to restore confidence in the applied "science" and "protection measures". If that isn't done, there are not enough financial resources to "force" compliance. Until everyone focuses on the recovery of the species with a clear goal of what that is; stops the litigation and works openly and cooperatively, efforts to protect the species will not work.

Supporting Science-Based Strategies in a Politically Motivated World - An Advocacy Group's Perspective on the Boater/Manatee Conflict

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Save the Manatee Club advocates for science-based decisions and management strategies that will best protect manatees and manatee habitat, and will lead to the recovery of the species including a sustainable, viable population and the restoration and preservation of habitat over the long-term. Advocacy groups play an important role in supporting science-based conservation efforts by speaking up for the science, holding decision makers accountable, and disseminating accurate information to the community. While science should "speak for itself," the reality is often science is not understood by, or is ignored by groups influencing policy makers who, in turn, make political, short-term decisions for long-living, slowly reproducing species like the Florida manatee. Further, countless hours that could be spent working on research and management strategies are expended in a continuing attempt to create "buy-in" from groups who actively work against manatee protection. In terms of the boat/manatee conflict, this narrow focus on creating buy-in may lead to unnecessary controversy, the weakening of much-needed protection measures, and the diversion of funding from high priority research goals to low priority research goals. Part of the solution to the boat/manatee conflict is agencies must do a better job explaining the science to the layperson, defending the science, and letting science, not politics, dictate research and management strategies and priorities.

Fatty Acid Signature Analysis as a Potential Forensic Tool for Florida Manatees (*Trichechus manatus latirostris*) and Other Marine Mammals

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Fatty acid signature analysis (FASA) has become an important tool by which marine mammal scientists gain insight into foraging ecology. FASA is also an extremely promising biomarker by which marine mammalogists may be able to assess exposure to certain natural and anthropogenic stressors. Florida manatees are well studied, and an excellent necropsy program provides a basis against which to ground-truth this promising tool. Preliminary results on manatees assigned to four cause-of-death categories indicate that those exposed to or dying due to brevetoxin exposure demonstrate a unique fatty acid profile and animals suffering long-term health stress have certain fatty acids not found in animals that die quickly. If further study demonstrates that exposure to harmful algal blooms, contaminants, or other factors provides a clear and diagnostic fatty acid profile in manatee livers, this approach could: a) provide an additional forensic tool to assist scientists and managers to understand cause of death or debilitation in manatees; and b) serve as a model that could be subsequently applied to studies designed to better assess cause of death in other marine mammals.

The Potential for Underwater Infrared Video Cameras to Reduce Boater-Induced Mortality of the Florida Manatee

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In calendar year 2004, watercraft-related mortality was the second leading cause of death of the Florida manatee (*Trichechus manatus latirostris*), accounting for 25% of total known manatee deaths. Such watercraft-related mortality is defined by the Florida Fish and Wildlife Conservation Commission as "manatees hit by boats, barges or any type of watercraft. Death may result from propeller wounds, impact, crushing, or any combination of the three". In an attempt to reduce this significant cause of manatee mortality, the Florida Fish and Wildlife Research Institute has instituted two rounds of Manatee Avoidance Technology grants. Herein we report on the preliminary results of the evaluation of underwater infrared video cameras to detect captive manatees and other non-living targets. If such cameras are found to detect manatees at sufficient distances, they could be mounted in the bows of watercraft and the resultant images could be projected at the helm of the vessel, enabling the vessel operator to reduce speed, take evasive action, or both.

Two types of cameras were examined, 1) a SeaView underwater video camera system from PowerLinx, St. Petersburg, FL, and 2) an Atlantis underwater camera system (AUW-535C) from JJC Communications, Inc., Englewood, NJ. Preliminary investigations of the ability of these cameras to detect small objects indicated that their resolution decreased with distance from the target and depth, with the highest resolution closest to the target at the surface. However, even at optimal depth, the maximum detection distance for the small target with the Seaview Camera was less than 3 m, and less than 5.5 m for the Atlantis camera. Thus, the Atlantis camera was marginally better able to detect the small target than was the SeaView camera.

The cameras were then tested on a plywood silhouette of a manatee placed vertically in the water. In this case the detection distance increased with depth, being greatest at a depth of 2 m, but in no case was the detection distance greater than 5 m. As before, the Atlantis camera was marginally better able to detect the plywood manatee silhouette than was the SeaView camera.

The cameras were then tested using living captive manatees at the Lowry Park Zoo (LPZ). Due to the clarity of the water at LPZ, manatees were visualized by both cameras at a distance of up to approximately 5 m, independent of depth. The Atlantis camera was better able to detect the living manatees than was the SeaView camera. Because these cameras emit infrared light in order to enhance their water penetration and image detection, there was some concern on the effect of this light on the manatees. However, the infrared light emitted by the cameras appeared to elicit no alarm or aversion from the manatees, and in fact seemed to increase their curiosity about the cameras and to attract them to the cameras. The larger size of the Sea View camera also appeared to draw the attention of the animals to the camera, and to prompt them to approach it in a playful manner.

The currently available underwater infrared camera technologies evaluated here do not seem to have sufficient detection distances to enable their immediate incorporation into an operator manatee awareness system, in order to utilize the cameras as described above. Our plans at this time are to approach the manufacturers of these cameras to determine if the technology can be enhanced to enable the cameras to detect manatees at sufficient distance to enable them to be used as described above. We also plan to evaluate the ability of these cameras to detect free-ranging manatees, once the appropriate permits are obtained from the U.S. Fish and Wildlife Service.

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SIRENIAN WEBSITE DIRECTORY

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Belize Coastal Zone Management Authority & Institute's Manatee Research Program: <**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>**

Dugongs: <**http://www.hans-rothauscher.de/dugong/dugong.htm>**

Dugong necropsy manual (available for downloading): <**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/**>

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

Friends of the Manatee Association, Manaus & Balbina, Brazil: **<http://www.amigos dopeixe-boi.org.br/english/Ing_index2.htm**> [Includes a bibliography of INPA aquatic mammal project publications and abstracts]

Fundación Salvemos al Manatí de Costa Rica: <**www.fundacionmanati.org**>

Great Barrier Reef dugongs: **<http://www.gbrmpa.gov.au/corp_site/info_services/publications/dugong/index.html**>

IBAMA manatee project, Brazil: **<www.projetopeixe-boi.com.br>**

Jacksonville University (Florida) Manatee Research Center Online: <**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**>

SEMARNAP, Secretaria de Medio Ambiente, Recursos Naturales y Pesca, Mexico: <**http:www.semarnap.gob.mx/naturaleza/especies/manati/descrip.htm**>

Sirenews (texts of current and recent issues): <**http://www.marinemammalogy.org/snews.htm**>; <**http://www.sirenian.org/sirenews.html**> (for archive of most 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.hans-rothauscher.de/steller/steller.htm**>. This site also includes a searchable database of museum collections worldwide that contain bones of *Hydrodamalis gigas*: <**http://www.hans-rothauscher.de/steller/museums.htm**>. See also the website [in Finnish] of Dr. Ari Lampinen, Univ. of Jyvaskyla, Finland: <**http://www.jyu.fi/~ala/ilmasto/steller.htm**>

Trichechus senegalensis skull: <**http://digimorph.org/specimens/Trichechus_senegalensis/**> **[NEW SITE]**. [CT imagery of an African manatee skull and mandible, viewable as individual thin slices, 3-D rotational movies, and slice movies. Excellent detail!]

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

Xavier University manatee web site (Midwest Manatee Research Program; Chuck Grossman): <**www.xu.edu/manateeresearch**> **[NEW]**

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