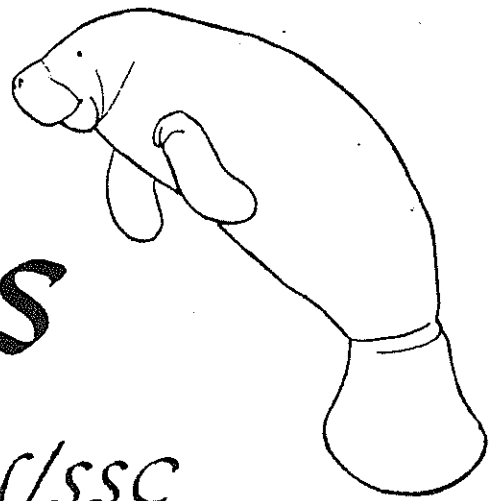


Sirenews



Newsletter of the IUCN/SSC Sirenia Specialist Group

NUMBER 29

APRIL 1998

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EDITORIAL: WHO ARE THE CANARIES?

Two news items in this issue report serious damage to environments that serve as habitats for both humans and manatees. Logging in Nicaragua, and oil production in Nigeria, both have been conducted by large transnational corporations; both have polluted the land and waters and entailed the oppression of indigenous people; and both have aroused the opposition of the local inhabitants, some of whom have paid with their lives for attempting to defend their human rights. Though manatees or other endangered species have not become an explicit issue in these cases, or in similar cases in the past which *Sirenews* has occasionally reported, these happenings nonetheless deserve a place in this newsletter in order to alert conservationists to locales where critical threats to sirenians may reasonably be presumed to exist.

Endangered species, including sirenians, have often been likened to "canaries in coal mines" that warn of environmental threats before these start to have an impact on humans. In many countries, however, it is the human beings who are forced into the role of the canaries, because their suffering from environmental disasters typically attracts attention long before any harm to wildlife is noticed, at least by international news media. By the time this happens, the damage to the wildlife (which probably began much earlier) may have progressed so far that it is too late for some of the affected species, even if anything were done to help them - which is itself unlikely to occur under corrupt, oppressive, or simply cash-poor governments.

UNION INTERNATIONALE POUR LA CONSERVATION DE LA NATURE ET DE SES RESSOURCES
INTERNATIONAL UNION FOR CONSERVATION OF NATURE AND NATURAL RESOURCES

Commission de la sauvegarde des espèces—Species Survival Commission



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Humanity at the end of the twentieth century is cursed with increasing overpopulation, intensifying poverty, worsening polarization between rich and poor, and growing tolerance for (or resignation in the face of) rapacious laissez-faire global capitalism. The oppressive effects of these trends inevitably fall as well on the other species with which we share this planet. On the positive side of the balance are trends toward greater democracy and freer, more efficient exchange of information, both of which shift power to those who have traditionally been denied it. Whether the balance will tip toward a desperate fight for the necessities of life aboard a spaceship whose life-support systems are failing, or whether community-spirited individuals of all nations will seize the controls in time to avert this disaster: this is the critical question of the coming century. - DPD

DUGONG ACTION PLAN: CAN YOU CONTRIBUTE?

I am working for Professor Helene Marsh on the Dugong Action Plan. I would be very grateful to those who could contribute in any way to increasing and updating the database on dugongs. Could you give me any information on the following points:

- Distribution of dugongs: - per country,
 - regular sighting or unusual sightings of dugongs,
 - area where dugongs are present along the coast.
- Abundance: - large groups?
 - would you say the population is healthy, increasing, or decreasing?
- Pressure on dugong populations: - habitat loss,
 - fisheries impact on dugongs,
 - effects of nets on dugongs, and direct hunting,
 - coastal development, destruction of seagrass
 beds.

Any past, present or future conservation project contributing to the protection of dugongs. Any recommendation on what could be beneficial to conservation of dugongs.

Any information you might think beneficial to the Action Plan will be welcome. You can contact me at: <Helene.Marsh@jcu.edu.au>; phone: +61 7 4781 6278 or fax: +61 7 4781 4020. Mark your correspondence Dugong Action Plan. Thank you! - Joanna Hugues

LETTER

In *Sirenews* No. 28 (Oct. 1997) it was stated by Newton Banks that the first case of [manatee] twins [conceived] in captivity occurred in Brazil on 10 April 1997. This is not correct! Since 1981 we have had 15 births of manatees at [our] zoo, and on 24 April 1986 we had the first case of twins (male and female), which live now at Singapore and Berlin. The second case of twins we had on 8 August 1992 (male and female). The male we had to euthanize on 14 August 1992 because of hydrocephalus and myopathia. The female lives now at Yashima Sea Palace in Japan.

At the moment we are collecting data for an international studbook on manatees. If anyone has a survey of [captive] manatees in the United States, I would greatly appreciate getting a copy. We are especially interested in getting information on zoos breeding manatees. Historical data are welcome too. - Dr. Peter Mühling (Director, Tiergarten Nürnberg, Am Tiergarten 30, 90480 Nürnberg, Germany; fax: (0911) 54 54 802; e-mail: <tg@stadt.nuernberg.de>)

DESPERATELY SEEKING SIRENIA

I am producing a comprehensive and practical field guide to marine mammals of the world, supported with illustrations and photographs. My major areas of weakness are Sirenia and the marine otter. I am seeking assistance from *Sirenews* readers in finding suitable photos. Ideal images will show typical surface postures of the various species, underwater full-body and detail shots, behaviors, and anything else that would be helpful in identifying the species. A use fee will be paid. Photographers will retain all rights. If you can help please contact: **Pieter Folkens**, 940 Adams St., Suite F, Benicia, California 94510-2950 USA, tel.: 1-707-746-1049; fax: 1-707-746-5599; e-mail: <animalbytes@earthlink.net>.

FLORIDIANS FOR A SUSTAINABLE POPULATION

Residents of Florida (or elsewhere) who are as concerned as they should be about the explosive growth of that state's human population now have their very own advocacy group. Floridians for a Sustainable Population, headquartered in Winter Park, publishes an informative quarterly newsletter (the *Florida Population Forum*) and periodically holds meetings and conferences at various locations around the state. Individual dues are US\$25 per year, tax-deductible (see advertisement in this issue). Remember, human population growth is the principal and underlying threat to the survival of the Florida manatee (and many other species)!

LOCAL NEWS

AUSTRALIA

Dugong Studies at Shark Bay, September-October 1997. - Projects included collection of submerged and surface times over a range of depths, a study of the costs and benefits of dugong-watching cruises, and collection of recordings of dugong vocalizations. The team consisted of two graduate students, Carol Churchward and Cedric Gerrard, and myself. We were based at Monkey Mia and most of our observations were made in the eastern Bay. Our observation platform was the 35-foot catamaran *Nortrek*.

An unexpected observation was that dugongs in southern Hopeless Reach continued to forage on seagrass (*Amphibolis antarctica*) until early November. An aerial reconnaissance on 22 September revealed no large aggregations. No dugongs were sighted in deep-water areas where they had been seen in winter surveys. Most were along the western edge of the Wooramel Bank. Animals were present at the lek site near Gladstone.

Over the course of the expedition,

Carol collected 100 sets of submerged and surface times over a range of depths from 1.5 to 11.5 m. Cedric made 30 trips on dugong-watching cruises aboard Monkey Mia Wildlife Sailing's 50-passenger, 60-foot catamaran *Shotover* to record dugong reactions to the dugong-viewing operation, and evaluate tourist knowledge and responses to the cruises. He had returns of 300 "entrance" and 300 "exit" questionnaires designed to evaluate prior knowledge of, and interest in, dugongs, as well as resulting attitude changes and the impact of the experience. During the September-October period *Shotover* may have carried as many as 1500 passengers to view dugongs.

In the western Bay all of us were privileged to make trips as guests on cruises on Craig and Jessie Shankland's research charter catamaran *James Scheerer* and observe "high-end small-group" wildlife tourism. The Shanklands also made possible a foray to the southern Freycinet Estuary, where evidence of dugong foraging on invertebrates was again observed.

Recordings of dugong vocalizations are yet to be analyzed. They included a set

obtained during a "cavorting" interaction and another in which there was active vocalization in a foraging group of 24 adults and cow-calf pairs.

- In April 1997, a film crew aboard the *James Scheerer* documented a successful attack by tiger sharks on an adult dugong that was apparently ill and unable to submerge. Initial attack by small sharks had little effect, but larger individuals later took up the attack and killed and consumed the dugong in less than an hour. The episode did not evoke any apparent response on the part of other dugongs in the vicinity. Later in the year, a developing shark research program at the Bay indicated that tiger sharks may prey regularly on dugongs, at least at some seasons in some years.

In the course of our project, there were opportunities to provide information and seagrass demonstration materials to assist the *Shotover* crew and the staff of the Monkey Mia Dolphin Information Centre in their interpretive roles, to give informal public lectures, and to make recommendations to the Shark Bay World Heritage scientific advisory group with respect to priorities for further dugong research. - **Paul Anderson**

EAST AFRICA

East African Dugongs Disappearing. - I am sad to report that we are rapidly losing the battle to protect the last of the dugongs on the east African coast. Kenya and Tanzania have all but lost their populations, and the last viable population in the Bazaruto Archipelago in Mozambique is down from 110 in 1993 to about 21 in September 1997, according to my last air survey. Gillnets set in seagrass habitats for shark harvesting still continue to plunder the populations in spite of repeated attempts to have the gillnets banned.

Current legislation in Mozambique sets a fine of 7.5 million meticaís (about R3000 in South African currency [or about US\$600 - Ed.]) and 3 months in prison for killing a dugong, even if it is an accidental gillnet fatality. An inevitable aftermath of 16 years of war is the breakdown of law enforcement. The dugong's flesh is favored by local fishermen, while some officials are reluctant to implement the law. It is now a frequent sight for tourists to watch dugongs

being butchered within view of Inhassoro village.

Just recently I discovered a pregnant female dugong tethered to a jetty at Vilankulo (a coastal town opposite the Bazaruto Archipelago about 800 km north of Mozambique's capital city of Maputo), and on inquiry found out that the local Port Captain had confiscated the dead animal from the gill netters and was planning to serve the meat as a special treat to President Chissano during his tour of the district. I managed to have the President informed of the dire straits of the dugong and advised him not to take part in the meal.

The next time I communicate with you will be to pronounce that the dugong, like the dodo, no longer survives in the southern Indian Ocean region. - **Paul Dutton** (Dutton Environmental Consultants, 118 Mansfield Road, Durban 4001, South Africa; tel./fax: (031)215 788; e-mail: <dutton@icon.co.za>)

FLORIDA

1997 Florida Manatee Mortality. - During 1997, a total of 242 manatee deaths were documented in Florida. This is well below the record of 415 set in 1996 (which included a major red tide-related die-off), but well above both the 10-year (1986-1995) annual average of 161 and the 5-year (1991-1995) average of 175. In fact, it is the second-highest total since recordkeeping began in 1974.

The 1997 total included 16 deaths associated with a red tide bloom in November, in the same geographic area (Caloosahatchee River basin) where the major 1996 die-off took place. Tissues of some of these 16 manatees tested positive for brevetoxin, but the necropsy findings appeared less severe. Fortunately, this time the red tide cell counts were not as extreme as in 1996, the event was shorter-lived, and it did not trigger a response under the *Contingency Plan for Catastrophic Manatee Rescue and Mortality Events* prepared last year by the U.S. Fish and Wildlife Service.

Collisions with watercraft accounted for 55 deaths (23%) in 1997, on a par with recent years. As in years past, most of these deaths resulted from blunt impact rather than propeller cuts. As usual, the greatest number of these occurred in Brevard County (the

Cape Canaveral area).

Entrapment in flood gates or canal locks caused 8 deaths (3%), mostly in Dade County (the Miami area) as usual; this is comparable to the previous 4 years, which collectively represent the worst years for this cause of death on record. "Other Human-related" deaths also totaled 8 (3%), exceeded only by 9 in 1979.

Perinatal deaths totaled 61 (25%), and "Undetermined" deaths totaled 63 (27%), both comparable to recent years. "Other Natural" deaths, including the 16 from red tide and 3 that were cold-related, amounted to 47 (20%).

Study of the recovered carcasses incidentally produced the first description (by Dr. Ruth Ewing, University of Miami School of Medicine) of a virus isolated from manatees. This papilloma-like virus causes vacuolated skin lesions, most frequently on the lips and face. At present, there is no evidence that it does any serious harm to manatees.

Statewide synoptic aerial surveys in 1996 counted an all-time high minimum number of 2,639 manatees, thanks to excellent weather conditions; the highest count obtained in 1997 was 2,229. These numbers cannot, of course, be interpreted as accurate census totals or as reliable indices of trends, since they are so sensitive to survey conditions. Indeed, any one statistic taken in isolation can give a misleading impression. For example, the number of carcasses recovered per year has increased by an average of 5.8% per year from 1976 through 1997 (excluding 149 red tide deaths in 1996), but some of this increase in the body count may be explained by an increasing manatee population.

Little comfort, however, can be taken in this conclusion. Population modeling by the Florida Department of Environmental Protection (FDEP), putting together all these and other data, indicates that the number of deaths per year is increasing faster (5.8%/year) than the population itself is increasing (2-4%/year). "If this trend continues in the future," say FDEP biologists Bruce Ackerman and Kari Clifton, "and the number of deaths becomes larger than births each year, then the population will start to steadily decline." - (Source: *Manatee News Quarterly* 1(4).)

Power Plants: Good or Bad for Manatees?

- In October 1997 the Florida Department of Environmental Protection (FDEP) received a petition challenging the department's intent to issue a permit to Florida Power and Light Company (FPL) to operate a thermal discharge at its power plant in Lee County. Water from the Caloosahatchee River is used to cool the plant, then discharged into the nearby Orange River. The plant began operation in 1958. Over the years the warm water has become a major winter manatee aggregation site with over 300 manatees using the area each year.

The State of Florida has entered into an agreement with the federal Environmental Protection Agency in which FDEP will administer the National Pollution Discharge Elimination System (NPDES) permit process. The NPDES permit includes variances for thermal discharges. The Southwest Florida Marine Trades Association (SWFMTA) initiated a challenge of FDEP's intent to permit the continued operation of the thermal discharge associated with FPL's Lee County power plant. SWFMTA challenged the issuance of the permit for a number of reasons. They maintained that FDEP had not adequately researched the long-term effects of the power plant on the manatee. Historically, it has been generally assumed that the power plant effluent provided a benefit to manatees by providing a warm-water refuge that would contribute to lower numbers of cold-stressed animals. SWFMTA advanced the idea that the power plant may actually be detrimental to the manatees. Their reasons included: concentrating manatees in the Caloosahatchee River (which is dangerous because it is a major boat traffic area), concentrating manatees in numbers that cannot be supported by aquatic vegetation in the area, disrupting the manatees' presumed natural migratory patterns, and concentrating manatee numbers in an area that has historically high incidence of red tide.

Numerous meetings were held with FPL, SWFMTA, FDEP, and the U.S. Fish and Wildlife Service (USFWS). A settlement was reached averting the need for the administrative hearing. As a result of the settlement a number of actions will occur. FPL agreed to collect and compile available scientifically-valid literature and data regarding manatees as well as existing power plant data on the

thermal effluent in Lee County. The USFWS will hold a meeting in the late summer of 1998 to identify the information that will be needed to make informed management decisions regarding the manatee-power plant issue. They plan to bring together noted manatee researchers and resource managers to review existing data and develop proposals for research needed to fill data gaps. FDEP agreed to host a public workshop with SWFMTA following the USFWS meeting to further discuss the manatee-power plant issue and specifically the circumstances surrounding the Lee County power plant.

The effects of power plants on manatees deserve further discussion and research. The presumed benefits of these plants are not being taken for granted any longer. Probable future changes in the power-generating industry (see Pat Rose's article in *Sirenews* No. 28) will require that we have a better understanding of the positive and negative effects of power plants. This will likely be a major area of future research by FDEP. - R. Kipp Frohlich (FDEP)

JAMAICA

Status of Captive Manatees in the Alligator Hole River. - According to a report by Patti Thompson in the March 1998 *Save the Manatee Club Newsletter*, three of the four manatees impounded years ago in a Jamaican river are still alive and may yet be released.

As reported in previous issues of *Sirenews* (nos. 12, 16), four female manatees were originally rescued from fishermen and placed in the Alligator Hole River on the south coast of Jamaica. The river is the centerpiece of a small nature park. In 1992 the Save the Manatee Club (SMC) supported a successful effort, in conjunction with Jamaica's Natural Resource Conservation Authority (NRCA), to remove a rope from the injured peduncle of one of the manatees. However, plans to release the animals so they could rejoin the breeding population came to naught.

In late 1996, when NRCA reported that the vegetation in the river was becoming sparse, SMC again came to the manatees' aid by contributing funds for supplemental feeding. The idea of release was raised once again, and in October 1997 a team of three

manatee biologists inspected the site: Thompson from SMC, Bob Bonde from the Sirenia Project in Gainesville, Florida, and Buddy Powell, who has recently taken a position with the Florida Department of Environmental Protection in St. Petersburg. The death of one manatee was confirmed by recovery of skeletal remains, but the other three animals seemed to be fat and healthy.

The next phase of the plan calls for an aerial survey of the entire island by Powell, capture of the manatees, release at a site already chosen, and subsequent monitoring with the help of a Jamaican graduate student. SMC promises future updates.

MEXICO

Manatee Recovery Committee Established. - A meeting of manatee specialists, representatives of the Instituto Nacional de Ecología, and Mexican governmental authorities on 27-29 November 1997 established a new Consultative Committee for the Protection and Recovery of the Antillean Manatee in Mexico (Comite Consultivo para la Protección y Recuperación del Manatí del Caribe en México). Beginning in March 1998, this committee will define policies and strategies for manatee conservation in Mexico, and select priorities for research and other activities. The committee is chaired by **Luz del Carmen Colmenero Rolón**, who can be contacted at: <shaman@cancun.ree.com.mx>.

NICARAGUA

Logging Threatens Coastal Environment. - The Rainforest Action Network reports (in its *Action Alert* 134, January 1998) that rainforests on the east coast of Nicaragua are imperiled by continuing operations of a logging company that have already been ruled illegal.

The affected area (known as the North Atlantic Autonomous Region), which features the largest intact tropical rainforest in the Western Hemisphere outside of the Amazon, includes the homelands of the Miskito and Rama Indians, who traditionally are manatee hunters. Toxic chemicals from the company's wood treatment plants run directly into the rivers and streams, and therefore could affect manatee habitat downstream in addition to

polluting the Indians' drinking water.

The Nicaraguan government granted logging concessions in the area to Solcarsa, a subsidiary of the Korean-based transnational company Kumkyng; but last February, Nicaragua's Supreme Court ruled the concession unconstitutional because the company had failed to consult regional advisory councils about the project's environmental impact. Nonetheless, the government has made no effort to enforce the Supreme Court's ruling, and Solcarsa is still building roads and cutting down old-growth rainforest trees. Solcarsa has demonstrated no respect for community interests or needs, has built logging facilities without approval, and has relocated entire indigenous settlements that were in the path of logging.

In early October, the Human Rights Commission of the Organization of American States ruled that the Nicaraguan government violated international law by ignoring its own Supreme Court ruling. The Rainforest Action Network and other activists have requested that letters supporting preservation of the rainforest and respect for indigenous rights be sent to: President Arnoldo Aleman, Casa de Presidente, Managua, Nicaragua.

NIGERIA

Oil Pollution in the Niger Delta. -

Serious environmental problems caused by petroleum and natural gas extraction are threatening the health and livelihood of the Ogoni people of Nigeria, according to an article in the March 27, 1998 issue of the *National Catholic Reporter*. The Niger River delta, where the Ogoni live, is in the center of the range of the African manatee, whose status in the region is believed to be precarious and whose future is likely to be jeopardized by massive pollution of the delta's waters.

The article reports that the oil-rich Niger Delta "has been exploited for decades by Dutch-owned Shell Oil. Amid increasing pressure from environmental activists, Shell ceased operations in the Ogoni region in 1993. However, critics say, oil spills and gas flares continue.

"A broad range of environmental and human rights groups have urged Shell to clean up numerous oil spills it allegedly caused and to compensate people who say

their health or property was damaged as a result of Shell's operations. ...

"Although there have been no formal studies of the effects of years of oil-drilling and flaring gas ..., Dr. Vincent Idemyor, president of [the Movement for the Survival of the Ogoni People], said reports of asthma, bronchitis, skin diseases and emphysema have grown.

"Dr. Owens Wiwa, brother of [executed human-rights activist Ken] Saro-Wiwa, said he observed these trends in his medical practice in Ogoni.... Wiwa fled Nigeria three days after his brother was killed [in November 1995 by the military regime of General Sani Abacha].

"Water and soil sampling in Ogoni shows that levels of pollution are 360 times higher than levels allowed in the European community. Idemyor noted that the samples were taken under very crude conditions, and he believes that the levels would be even higher if commonly accepted testing standards were applied.

"Speakers [at a March 14 conference in St. Louis, Missouri] also accused Shell of collusion with Nigeria's military government, whose troops have used deadly force to quell protests in Ogoni."

The exiled Ogoni activists have called for a boycott of Nigerian oil to focus attention on environmental and human rights abuses in their country.

SENEGAL

Senegal Manatees Close To Extinction. - During August and October 1997, researchers Rosario Navaza and Owen Burnham made a detailed survey of the wildlife of Senegal, paying special attention to the West African manatee which used to be common in the Casamance, Gambia, and Senegal rivers in the 1970s. Burnham was born and raised in Senegal and hence is very familiar with the habits and habitat of the species.

The survey consisted of a combination of search and enquiry among fishermen in areas where the manatee used to occur. In almost all areas, fishermen reported not having seen any manatees for many years. This was the case in most parts of the Casamance River from the murky river estuary at Elenkine and Carabane to Kolda, at

which point the river is very narrow and fast-flowing in the rainy season.

In only two areas did local people report the continued presence of the species. A pair were captured below the Kolda bridge, where the river is only 30 m wide, in 1990. Two manatees had been observed for several days, swimming calmly below the bridge and feeding on the abundant "water lettuce" that grows there. Finally it was decided that these two would be captured and eaten, and nets were brought in from Gudomp town, about 80 km away. The first net was broken in the struggle, but another, stonger net did succeed in capturing them. The drama did not end here, as a van brought to carry the manatees lacked the power to pull them clear of the river edge. After repeated efforts, an intervention by the local spiritual leader led to an extraordinary happening. The holy man decreed then and there that the two manatees should be immediately released, as they were the spirit incarnate of the local river and killing them would bring dire consequences on the town. In accordance with the decree, the two manatees were released, apparently unharmed, and swam away, never to be seen again. There is plenty of water vegetation along this stretch of river and it is likely that the manatees have simply moved to another part of the river and become more surreptitious, as is the way of their species.

It is interesting to note that since that time there have been reports of at least one manatee in a calm stretch of the same river about 15 km away. Both sites were visited by day and night, and though no manatees were observed, their presence was confirmed by several independent fishermen. They are regarded as semi-sacred here and have not been molested. The river is about 40 m wide at this point, near the town of Bantankountou, with dense overhanging vegetation and stands of water grasses in the shallower areas. If one wades in the water, "manatee holes", dug out by their flippers, are quite obvious. They appear to tolerate water at depths of a little over a meter to feed on the grasses. It was impossible to ascertain how deep the river is at its deepest point, but it is probably not more than 4 m deep except where manatees have been digging.

In all other areas surveyed, there were no recent reports of sirenians. One was

washed up on the beach at Kap Skirring near the border with Guinea Bissau in 1991 (Malang Mane, pers. comm.). Another was caught by Lebou fishermen at Grand Yoff, Dakar in 1993. Manatees are still reported to occur in the delta of the Sine Saloum near Kaolack in northern Senegal, but firsthand accounts of sightings are not available as fishermen seem very unfamiliar with them there.

With regard to the digging habits of the manatees, we can only assume that they dig in order to find roots or tubers. The large quantities of silt they churn up while digging were a giveaway of their presence to hunters, who used to harpoon them with a spear attached to a float. The wounded manatee would then be followed by canoe until exhausted. The manatees used to leave the main river in the rainy season and enter the adjacent freshwater swamps, where they would feed on water lily tubers and on rice where this was planted. They were easily caught if found in these swamps. When digging in the slow-moving river they were probably feeding on the roots of grasses that grow in the water. It is a sad fact that the great holes they used to dig are often the only reminders of their presence long after the manatees are gone.

In conclusion, we believe the Senegalese population of *Trichechus senegalensis* to be gravely threatened. Populations in most of the Casamance have been lost due to overfishing and the terrible salinization that has affected the region. In many areas there are not even any mangroves left, and some studies have reported the river to be three times more salty than the sea in places. The water is still fresh at Kolda and Bantankountou, but whether manatee populations there are viable is another issue. Surveys urgently need to be carried out to determine the population of manatees remaining in these two areas. Survey work in these areas may become more difficult if the current war spreads as it seems likely to do. - **Rosario Navaza and Owen Burnham** (3 Dawn Close, Hounslow, England TW4 7EN; tel./fax: +44 181 577 2006)

ABSTRACTS

The seasonal occurrence and ecology of Florida manatees (*Trichechus manatus latirostris*) in coastal waters near Sarasota, Florida (Jessica K. Koelsch). - Although well studied at winter aggregation sites, Florida manatee (*Trichechus manatus latirostris*) ecology is less known at summer sites. In one of the first intensive non-winter (March-November) studies of manatees on Florida's west coast, I monitored animals in Sarasota Bay from 1993-1996. I used resightings of recognizable individuals to document life history traits, site fidelity and seasonal residency, movements, social behaviors, habitat use and selection, and food selection.

Numerous identifiable manatees used the Sarasota Bay area and provided the basis for extensive studies. The scar catalog contained 128 individuals from 1993 to 1996; 88% were resighted in Sarasota Bay and 95% were sighted more than once including at winter locations in Tampa Bay, Myakka River, Ft. Myers, the Everglades, and Crystal River. Many manatees (60.2%) returned to the Sarasota area multiple years, similar to some winter site return rates. I developed an average monthly residence index (AMRI) and documented both seasonal residents and transients. Manatees displayed differential fidelity to specific sites and traveled between sites via distinct travel corridors. Residency and site fidelity of independent calves resembled that of their mothers, possibly indicating tradition. Life history parameters were similar to those documented by other studies.

The manatee social structure appeared non-random and fluid. Manatees associated weakly gender groups with strongest associations between individuals of same gender. Males appeared more social than females.

Manatees exhibited distinct patterns of resource use and selection. Individuals used certain habitats for specific behaviors; shoal/sand bars, grassbeds, dredged basins, and dredged channels were used most universally. Compared to resource availability, manatees preferentially selected habitats (dredged basins and channels) and food (*Thalassia testudinum*).

These findings may have numerous management implications: life history data can provide the basis for estimates of survival rates; individualistic site fidelity, residency, and movement patterns reinforce that manatee protection may require complicated strategies; long-distance migrations helped delineate subpopulations; travel corridors, habitat use and selection, and food selection data indicated key local resources for protection. In addition, manatee association patterns helped to define the extent to which manatees may be social. The techniques used in this study may be transferable to studies of manatees at other non-winter sites.

Adrenal gland circulatory anatomy in the Florida manatee, *Trichechus manatus latirostris* (Mário Jorge Mota). - Adrenal glands subserve a vital role in maintaining proper physiological levels of mineralcorticoids, glucocorticoids, and catecholamines. Mineralcorticoids control blood pressure and electrolytes; glucocorticoids have an anti-inflammatory potency and regulate carbohydrate, protein and lipid metabolism; and catecholamines are involved in an organism's response to emergency situations. Adrenals were collected from seven fresh manatee carcasses, of both sexes, by the Florida Department of Environmental Protection Marine Mammal Pathobiology Laboratory. Glands were injected with a mixture of gelatin and India ink either retrogradely via the adrenal vein, or antegradely via adrenal arteries. This permitted separate visualization of the cortical and medullary circulation. Glands were fixed, dehydrated, cleared, embedded in paraffin, sectioned at 6-7 μm , and stained with hematoxylin and eosin or with Gomori's trichrome stain. Using light microscopy, serial sections were examined to follow the origin, course and distribution of specific vessels to develop the description of the adrenal circulatory and nervous systems. Histological sections were also scanned with a NIH Image 1.52 program that measured the area occupied by connective tissue, cortex and adrenal medulla.

Results show that the Florida manatee adrenal glands consist of approximately $53.34 \pm 4.51\%$ connective tissue, $39.86 \pm 3.21\%$ cortex, and $6.81 \pm 3.32\%$ medulla. They are relatively small organs measuring 0.019 cm/cm body length and weighing 0.02 g/kg body weight.

The manatee adrenal circulatory system displays the eutherian pattern. Blood enters the adrenal capsule and forms a plexus that supplies the capsule before it drains into the cortex.

Here, it percolates through the sinuses of the three cortical zones, providing nutrients essential for cellular maintenance. The cortico-medullary junction is surrounded by a relatively thick layer of connective tissue through which a large spidery capillary network drains cortical blood directly into the medulla. The medulla is relatively large and has a medullary-cortical ratio of 1:5.8, which is similar to that of the dog. This hormone-rich cortical blood is collected into one main vessel that exits the organ as the adrenal vein.

Using the values obtained from a correlation between the adrenal gland weight (g) and the body weight (kg) of 46 species of eutherian mammals, the manatee adrenal glands' weight was extrapolated to be approximately one-third smaller than its "optimal" size. This corresponds to an adrenal gland/body weight ratio (AGBW) of 0.02 g/kg, which is one of the smallest among mammals. Since this ratio is an indicator of metabolism, it suggests that the manatee's weight-specific metabolic rate is similar to that found in the much bigger mysticetes, instead of an animal of comparable size. [Abstract of a thesis for the degree of Master of Science in Biology, submitted to the University of Central Florida, Orlando in 1997.]

Radiographic Analysis of the Osteological Development in the Manus of the Florida Manatee (*Trichechus manatus latirostris*) as an Age-Estimating Technique (Danette M. S. Goodyear). - Radiographs from a developmental series of 179 flippers salvaged from 167 dead Florida manatees, *Trichechus manatus latirostris* (1.0-3.6 m total body length (TL)), were examined for the first appearance and fusion of 34 carpal and epiphyseal ossification centers in the manus. Chronological age has been estimated by counts of growth-layer-groups in the petrous temporal bone and correlated with known-age manatees (Marmontel, M., 1993. Age determination and population biology of the Florida manatee, *Trichechus manatus latirostris*. Ph.D. dissertation, Univ. of Florida, Gainesville, 408 pp.). Radiographed flippers from 106 of these age-estimated individuals were included in the current study. Objectives of this study were to: identify the separate ossification centers in the manus; determine when each ossification center first appeared as related to TL; determine when each epiphyseal ossification center fused to its diaphysis as related to TL; determine the sequence of development of ossification centers; correlate ossification events with chronological age by comparing TL of radiographed manatees with TL of aged manatees; and examine the unusual developmental ossification patterns of the fifth digit.

Results from this cross-sectional study revealed that at birth, the diaphyses of the radius, ulna, metacarpals I-V and phalanges (I-1, II-3, III-3, IV-3, V-1-3) were well ossified, and that after birth, 7 carpal bones and 27 epiphyseal ossification centers developed. Carpal bones and bony epiphyses first appeared at 1.9 m TL. Other epiphyseal centers, including the separate proximal and distal epiphyses of the five metacarpals and the phalanges, first ossified between 1.9 and 2.8 m TL (sexual maturity). These postnatal centers first appeared in proximal and distal sequences. First fusion, bony bridges spanning the epiphyseal cartilage growth plate, was first seen in metacarpal bones at 2.3 m TL and continued to appear throughout the manus until 3.0 m TL. Full fusion of epiphyses to diaphyses continued through 3.6 m TL. The number of diaphyseal and epiphyseal ossifications in the second and third phalanges of the fifth digit varied from zero to four. Moreover, the data suggest that these second and third phalanges coalesce into a single bone, the composite terminal phalanx. Correlation of these radiographic data with known-age specimens may be useful for the estimation of age of salvaged and living Florida manatees. [Abstract of a thesis for the degree of Master of Science in Anatomy, Pathology, and Pharmacology, submitted to the College of Veterinary Medicine, Oklahoma State University, Stillwater, in 1997 and supervised by Alastair G. Watson.]

The following abstracts are of papers and a poster presented at the Forum on Wildlife Telemetry held at Snowmass Village, Colorado, 21-23 September 1997.

Locational Accuracy of the Argos Satellite Telemetry System in a Marine Environment: Implications for Spatial Data Analysis and Wildlife Management

Charles J. Deutsch, Dean E. Easton, Howard I. Kochman, and James P. Reid, Sirenia Project, U.S. Geological Survey, Biological Resources Division, Florida Caribbean Science Center, 412 NE 16th Avenue, Rm. 250, Gainesville, FL 32601 USA

Satellite-based telemetry has been widely used for tracking the movements of large animals over long distances. The extent to which spatial data provided by Service Argos' Data Collection and Location System may be useful for finer-scaled analyses of movements or habitat use depends upon the accuracy and precision of the locations. We have used platform transmitter terminals (PTTs) deployed in buoyant, tethered housings to track the movements of West Indian manatees (*Trichechus manatus*) along the Atlantic coast of Florida and Georgia since 1986 and in Puerto Rico since 1992. We carried out a study to assess the bias and precision of the Argos spatial data generated by these satellite-monitored tags in the coastal environment that is typical for manatee tracking.

Service Argos initiated the classification of locations according to their quality in April 1987 and switched to a new set of classification algorithms in mid-June 1994. The advertised standard deviations of the latitudinal and longitudinal components of the locational error for both classification systems are as follows: LC3, $\sigma_y = \sigma_x = 150$ m; LC2, 350 m; and LC1, 1000 m. Service Argos states that 68% of locations should fall within one error standard deviation from the true latitude and longitude. Assuming a bivariate normal error distribution, these errors translate into total error radii of 226, 528, and 1510 m, respectively (Keating et al. 1991). Also in June 1994, location class zero (LC0, $\sigma > 1000$ m) was split into four classes: a new LC0 ($\sigma > 1000$ m), 'A' and 'B' (no precision estimates), and 'Z' (rejected as implausible).

We conducted two experiments in the Banana River, an estuary on the east coast of central Florida. The first test used six PTTs moored in a 6-m radius circle for 51 days from June to July 1992. The second test was conducted from August to November 1994 with three PTTs moored in a 3-m radius circle over a 104-day period. PTTs were also attached to three manatees enclosed in pens adjacent to the fixed PTTs for periods of 16-30 days, as part of a "soft-release" project for captive rehabilitated manatees. "True" locations of the fixed PTTs and of the pen centers were determined to within 5 m accuracy using differentially-corrected GPS.

In 1992 the locations were significantly biased (by about 250 m) to the West of the actual test site, whereas in 1994 the extent of bias was minor. Locational precision improved significantly from the old to the new location class system, as indicated by the respective 68-percentile error radii for the fixed PTTs (1992/1994): LC3 - 312/218, LC2 - 622/360, LC1 - 1824/834, LC0 - 8824/4043, LCA - --/3527, and LCB - --/13294 m ($n = 1394/1653$). This change was accompanied by a marked redistribution in the relative frequency of location classes. Errors in longitude were significantly greater than errors in latitude, and only the latter consistently met Argos' specifications of expected precision. There was considerable variation in performance (i.e., % high-quality locations) across PTTs, but not in locational precision. The frequency of good locations (LC1-3) from tagged manatees during the 1994 experiment (67% for penned, 71% for free-ranging) was high compared to that obtained from other marine mammals but was lower than that from fixed PTTs (83%). For location classes 1-3, precision of locations from penned manatees was significantly poorer than that from stationary tags.

Empirical information on the bias and precision of PTT locations, combined with a knowledge of the spatial scale of the scientific or management question, should be used to determine which Argos location classes, if any, are appropriate for analyses of animal movements or habitat use. Caution should be applied when pooling or comparing Argos spatial data from before and after June 1994 because of the marked change in the relative frequency and precision of location classes.

MOVEMENT PATTERNS AND HABITAT USE OF RADIO-TAGGED FEMALE MANATEES

Monica Ross, Richard O. Flamm, Bradley L. Weigle, Florida Department of Environmental Protection, Florida Marine Research Institute, 100 Eighth Avenue S.E., St. Petersburg, FL 33701 USA

The Florida Department of Environmental Protection's radio-telemetry project tagged 27 female manatees (*Trichechus manatus latirostris*) between 1991 and 1996. Travel paths for female manatees with calves and those without calves were compared for differences in distance traveled along the west coast of Florida and for differences in habitat use within Tampa Bay. Satellite telemetry data and visual observations were entered into a Geographic Information System (GIS). GIS-based programs connected sequential point locations using empirically-based bathymetry rules to estimate a travel path between points. Distance classes in ten kilometer increments were established from a winter aggregation capture site. The distance increments were overlaid onto travel paths and, for each animal, the percentage of total travel within each increment was calculated. Travel path data indicated that females without calves occupied areas greater than 100 km from the winter site over 40% of the time and half of these paths were in areas greater than 200 km. In comparison, areas greater than 60 km were utilized only 0.5% of the time by females with calves. Habitat use was assessed by comparing telemetry point locations to the nearest seagrass patch. Distributions of distance-to-the-nearest-seagrass patch for female manatees with calves and those without calves were compared to each other and then to a random distribution of points. Results suggested that female manatees with calves selected habitat closer to their preferred winter aggregation site while female manatees without calves occupied a wider geographic range. The use of GIS to model and compare movement patterns derived from telemetry data have increased our knowledge of manatee travel behavior and is expected to help in manatee protection efforts.

MODELING MANATEE HABITAT USE WITH TELEMETRY DATA IN A GIS

Bradley L. Weigle and Richard O. Flamm, Florida Department of Environmental Protection, Florida Marine Research Institute, 100 Eighth Avenue S.E., St. Petersburg, FL 33701 USA

Marine mammal biologists at the Florida Department of Environmental Protection (FDEP) conducted a six-year telemetry study of 59 Florida manatees (*Trichechus manatus latirostris*) along the west-central coast of Florida between 1991 and 1996. Primary objectives of the study were to determine habitat utilization and travel patterns of this endangered sirenian as they dispersed from and returned to a winter aggregation site in Tampa Bay. Satellite transmitter signals processed by Service Argos provided over 33,000 animal locations of location classes one to three. Field tracking using VHF signals allowed collection of an additional 3,000 visual observations. Satellite data were integrated into a geographic information system (GIS) as point locations using a set of programs that combined the monthly update from Service Argos with a database containing information on individual animals and tag attachment/detachment dates. Visual data were entered into the GIS using "heads-up" digitizing from field data sheets based on 1:40,000 scale nautical charts. The two data sets were combined.

Analyses to estimate movement paths of individuals between sequential points, while keeping the path in the water, used a customized program centered on the "cost-path" function of ARC/INFO's GRID module and required the creation of two raster grids. The vector marine shoreline was used to create a grid with 25-m by 25-m cells containing land and water values. A grid with cells containing the maximum depth at mean low tide was generated from the bathymetry coverage. These cell values were reclassified to reflect manatee depth preferences determined from an empirical analysis relating each satellite point with location class three to its corresponding bathymetry. Cells with depths preferred by manatees were assigned a smaller value (cost) than deeper cells that were rarely used. The cost-path function then calculated the path between two sequential points with the lowest associated total cost. Each path was converted to a vector line for storage with attribute data including manatee information; duration; and time, date, and location class at start and end points of the path.

The line data set can be queried to select specific subsets such as individual animals, reproductively mature males, females with calves, nocturnal periods, or specific months. Another set of programs then reconstructs a set of five raster surfaces for the selected line data. A total time grid that accumulates time data for each line is generated: the total time in minutes between the start and end points is apportioned equally into each cell along the path. Four other grids contain values for 1) the number of times a path crossed each cell (total visits); 2) maximum time spent in a cell by any one path; 3) minimum time spent; and 4) sum of squares of time from each path. A circular spatial filter applied to each grid smooths the data over an area corresponding to a circle of 175-m diameter. By dividing the total time grid by the total visits grid, a grid surface depicting the average time per visit is created. To further simplify the data, four cell classes are created: cells with few visits and low mean time; few visits and higher mean time (secondary habitat); many visits and low mean time (potential travel corridors); and many visits and higher mean time (primary habitat). Model results can be overlaid on marine habitat data layers (sea grasses, boating channels, dredging projects, etc.) to explore and evaluate anthropogenic effects on the manatee population.

THE CHALLENGES OF CAPTURING AND TAGGING MANATEES ALONG WEST COASTAL FLORIDA

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The Florida Department of Environmental Protection (FDEP) captured and tagged 59 wild manatees on the west coast of Florida between 1991 and 1996. The tagging assembly, developed by the U.S. Geological Survey Sirenia Project, Gainesville, Florida, included a rubber peduncle belt and a tethered floating platform transmitter terminal (PTT). The 39 x 9 cm-diameter transmitter housing contained satellite, VHF, and ultrasonic transmitters. Tags remained on individuals from 2 weeks to 5 years, with breaks in the tagging period.

Two techniques were used for catching free-ranging manatees, land sets and open water captures. Using land sets, manatees were captured in the discharge canal of a power plant during winter using a 150 m long x 10 m deep net. This method required baiting manatees to a specific site with freshwater from a hose, manually pulling a net behind the animals, pursuing them in the net, and hauling them to shore. It required 15 people and worked better for catching random animals rather than specific individuals. This method was compromised in the summer when freshwater was widely available and manatees were widely dispersed. The open water capture technique was developed by FDEP in 1992, first as a means of rescuing injured manatees and then to catch specific individuals for research. The net was deployed from a 6-m open transom mullet boat while circling manatees in open water. The manatees were then pursued in the net and pulled on board. This method required 8 people and enabled researchers to catch random animals as well as specific individuals multiple times. The challenges of the open water technique included: "blind sets" and animals due to poor water quality; poor bottom types such as mud and oyster beds; catching very large manatees, multiple animals, and/or mother/calf pairs; catching sting rays or debris along with the manatees; and trying to catch previously captured animals that learned how to escape capture. The use of an airplane and spotter helped in locating manatees in a large area and in making "blind sets." In February 1997, 21 manatees were caught over 4 days by open water captures with assistance from an aerial spotter.

There were numerous obstacles and impediments to keeping manatees tagged over the course of the study. Tag exchanges to replace transmitter batteries every 6 months required a snorkeler to quietly approach a manatee and change the transmitter on the distal end of the tether. Depending on the skill of the researcher and disposition of the manatee, individual animals varied on their tolerance to tag exchanges. Damage to transmitter housings occurred from boat strikes and alligator bites, causing complete tag loss or loss of satellite function from water intrusion.

Tethers broke at the designed weak-link due to mating activity, boat strikes, alligator bites, and entanglement in crab trap line and floats, monofilament line and fixed structures. People with both good and bad intentions pulled tags off. During warm months, rapid algal and barnacle growth interfered with satellite function and caused some tag loss. Manatees that loss their tags were often retagged by FDEP snorklers clipping tethers with temporary VHF tags to the peduncle belt until they could be caught by open water capture to securely attach the PTT tagging assembly.

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SIRENIAN WEBSITE DIRECTORY

- Caribbean Environment Programme, Regional Management Plan for the West Indian Manatee:
< <http://www.unep.mx/cepnews/ing/ct35indx.htm> >
- Caribbean Stranding Network: < <http://netdial.caribe.net/~mignucci/> >
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- Florida Department of Environmental Protection, Bureau of Protected Species Management:
< <http://www.dep.state.fl.us/psm/> >
- Florida Department of Environmental Protection, Florida Marine Research Institute (Florida manatee mortality data): < <http://www.fmri.usf.edu> >
- Manatee neuroanatomy: < <http://www.neurophys.wisc.edu/Manatee/> >
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- Sea World of Florida: < <http://www.bev.net/education/seaworld/teachersguides.html> >
- Sirennews*: < <http://pegasus.cc.ucf.edu/~smm/> >
- U.S. Fish and Wildlife Service: < <http://bluegoose.arw.r9.fws.gov/nwrsfiles/Wildlifemgmt/SpeciesAccounts/Mammals/Flmanatee/FlmanateeTableofContents.html> >

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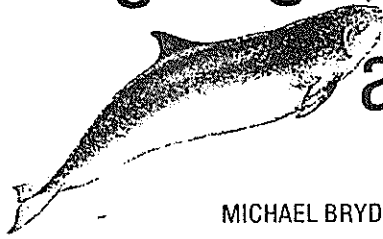
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Dugongs, Whales, Dolphins and Seals



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SEA MAMMALS OF AUSTRALASIA

MICHAEL BRYDEN, HELENE MARSH AND PETER SHAUGHNESSY

The marine mammals of Australasia have been hunted by man for centuries, yet despite hundreds of thousands being killed, until quite recently the undersea life of these animals has been a secret one. The development of recording devices which can be attached to individual animals has unravelled many secrets about these extraordinary animals — revealing the temperatures in which they live, the incredible depths to which they dive, and the extended periods they can remain submerged. *Dugongs, Whales, Dolphins and Seals* is the first book to bring together the history and biology of the sea mammals that inhabit the oceans surrounding Australia and New Zealand.

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Michael Bryden, Helene Marsh and Peter Shaughnessy are among the world leaders in research on sea mammals. All three have had more than 30 years experience in research, their emphasis on the study of these animals. All have published extensively in scientific literature and are recognised worldwide as experts in their field.

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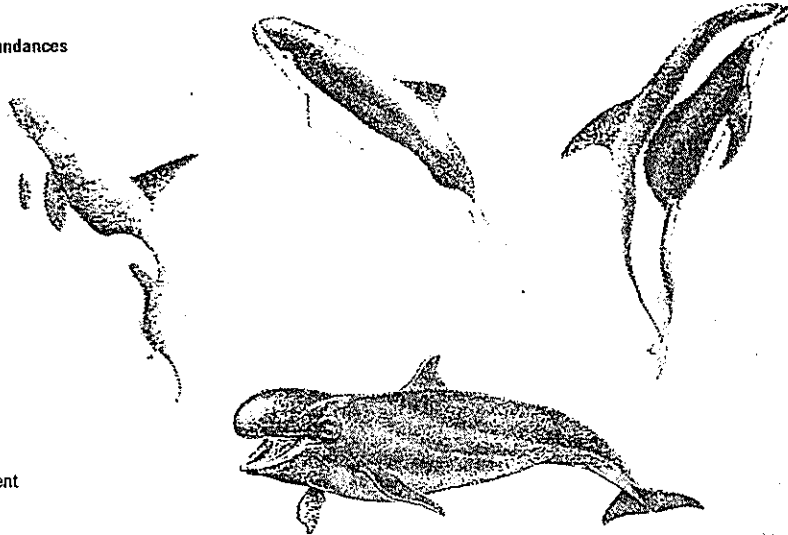
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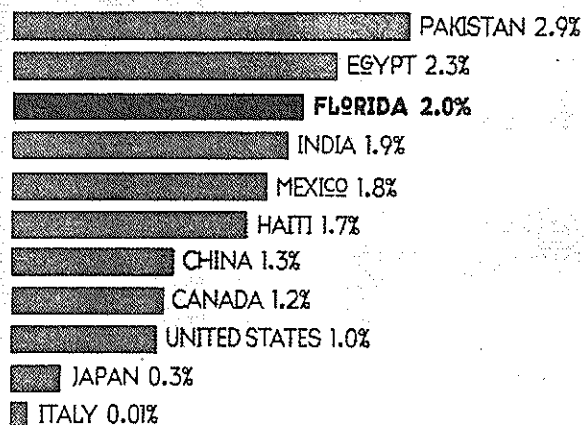
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