

Sirenews



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EDITORIAL: THE ENDANGERED RIO SUMMIT

The United Nations Conference on Environment and Development (the so-called Earth Summit) is now only a few weeks away. At this writing it appears that many of the hopes for this unprecedented meeting will be dashed. The great gathering in Rio de Janeiro is in acute danger of degenerating into a media show, largely devoid of substance in the form of binding international treaties to protect the environment. Much of the blame for this belongs to one government - that of the United States of America.

The U.S. is the only nation on Earth that stands in the way of an international global warming treaty, refusing to pledge to reduce or even stabilize its emissions of greenhouse gases. The Bush administration has shown some movement on this issue in recent weeks, but not nearly enough. What is needed is a binding commitment to a 20% reduction of carbon dioxide emissions by the year 2000. The National Resources Defense Council and other energy advocacy groups have estimated that such a policy, far from demanding a major sacrifice on the part of Americans, would actually save the U.S. \$2.3 trillion over 40 years.

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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At a moment when dramatic and visible leadership are called for, not only in the national interest but in the planetary interest, President Bush has only belatedly and reluctantly agreed to attend the Rio summit. This disappointing performance merely leads the long list of environmental issues on which effective American leadership has been sorely lacking - ranging from increased energy efficiency at home, to debt relief and increased aid for the developing world, to an effective response to the root problem of overpopulation.

Unfortunately, leaders do not always appear in the moment of need. As the U.S. approaches a national election, neither political party appears capable of meeting the challenge to think anew and act anew.

Fortunately, in society as in science, revolutions sometimes come not from lone, charismatic leaders but from the ranks of ordinary individuals who come to share a common vision of a better way. These people will be represented at Rio by a wide variety of non-governmental organizations (NGOs), which will be holding their own forum in parallel with the meeting of heads of government - and hopefully pressuring the latter to act responsibly. Many of this newsletter's readers belong to one or more of these NGOs; all of us should be involved in these activities. As scientists and citizens, we must continue to sound the alarm, today and long after the Rio summit, over what is happening to our world. We must seize every opportunity to convince other ordinary people that we may, can, and must take responsibility for, and control of, what our societies are doing.

As sirenologists, we can speak authoritatively about a group of endangered species which are increasingly well-known and popular among the public worldwide, and on which the impacts of human activities can be vividly demonstrated. The message is getting out. Even organizations such as Zero Population Growth are now citing the death toll of Florida manatees as a prime example of human-caused environmental havoc.

The Rio summit may fizzle out in futility; at least it will probably fall short of its goals. This will be the fault of the greedy elites of both North and South, who wish to go on profiting at the expense of the needy majority and of Earth itself. But the resulting, well-deserved reproach to the U.S. government and other obstructors of global sanity will itself bear eloquent witness to how far we have yet to go - as eloquent as any mangled manatee. - DPD

AERIAL SURVEYS FOR SIRENIA: WHERE DO WE GO FROM HERE?

I spent the first five weeks of this year as a guest of the Sirenia Project in Gainesville, Florida. The workshop on the population biology of the Florida manatee in the last week of my stay was the highlight of my very fruitful, interesting and enjoyable visit.

The workshop reviewed most aspects of manatee population ecology through a series of working groups, each of which reviewed a specific topic. I was surprised at the consensus. There was strong agreement that the lack of an accurate

population estimate for the Florida manatee is the major obstacle to evaluating its status.

Workshop participants were not optimistic about the suitability of using the data base on scarred animals for estimating absolute abundance. So we will probably have to continue relying on aerial surveys to obtain information on the sizes of sirenian populations.

Most aerial surveys for sirenians still use techniques developed in the 1970's. Animals are usually counted from aircraft flying at fixed heights and parallel to shore. If a large group is detected, a count is made while the aircraft circles. Such surveys assume that sirenians mainly occur close to shore, although in some studies additional transects are flown over areas where suitable habitat is known to extend further offshore. No corrections are made for animals which are not seen by observers.

This technique has proved very useful for identifying major areas of inshore sirenian habitat, especially in developing countries where its ease of implementation is an advantage. However, the method is of limited use in large embayments and areas where the continental shelf is broad, particularly in the case of dugongs which tend to be more coastal than manatees.

The method is also unsuitable for tracking temporal changes in abundance, especially at large spatial scales, because:

- a) The number of animals sighted is dependent on their distribution relative to the shoreline, which can be very variable.
- b) The sampling fraction is probably variable.
- c) The method yields a count without a standard error.
- d) The method has no mechanism for compensating for changes in the visibility biases.

The fixed-width survey technique was developed for use at large spatial scales (tens of thousands of square km) and has been used successfully for dugongs in Australia and the Arabian region. The technique incorporates methods for estimating perception bias (animals that are visible but missed) and standardizing for availability bias (animals that are unavailable due to water turbidity). This technique provides a repeatable, standardized minimum population estimate and is useful for producing density distribution maps, for monitoring trends in abundance over large spatial scales and long time periods, and for assessing the likely impact of direct anthropogenic mortality. However, even at large spatial scales, the population estimates produced by the technique have a precision of 12% at best, which means that it would take at least a decade to detect a low-level chronic decline in abundance. The precision of the population estimate is negatively correlated with the population size, which means that it would take even longer to detect changes in smaller populations (or at smaller spatial scales).

Tim Gerrodette of the Southwest Fisheries Center in La Jolla, California, has done simulations which indicate that for populations in the low hundreds of animals, the most likely outcome of any series of surveys will be a non-significant trend even when the population is actually declining.

Thus it will probably be impossible to detect trends in most

sirenian populations. Even in areas such as Australia where densities are relatively high, it will not be possible to detect trends in localized areas of impact.

In most areas, a demographic approach will be more productive. We know from population models of other mammals with similar life histories that the crude death rate of stable populations is likely to be between two and ten percent per year. Provided an accurate population estimate is available, this allows us to estimate a sustainable level of mortality for a sirenian population, or at least to put estimates of anthropogenic mortality in perspective. For example, on the basis of his experience in two Aboriginal communities, Andrew Smith estimated that their combined take of dugongs was substantially less than the sustainable yield of the associated dugong population, which I estimated to be on the order of 8,000 animals using a very conservative correction for availability bias. When I repeated the survey five years later, the estimated population estimate had increased slightly (but not significantly). I am optimistic that we were correct in advising the management agencies that the hunting should be allowed to continue.

Where do we go from here? The biggest obstacle to obtaining accurate estimates of sirenian abundance is lack of a method of compensating for the variable proportion of the animals which are invisible to observers due to water turbidity. I have made a first attempt to do this for dugongs, but improvements are needed.

I believe that we should be putting a great deal of effort into obtaining data which will allow us to model the diving and surfacing behavior of dugongs and manatees under a range of conditions. These models could then be used to calculate appropriate corrections for availability bias so that accurate population estimates can be obtained.

Lack of accurate population estimates is a major obstacle to the evaluation of the status of all sirenians, not just Florida manatees. - Helene Marsh

LOCAL NEWS.

CARIBBEAN REGION

International Conservation Agreement. - Recently a second Protocol was added to the Convention for the Protection and Development of the Marine Environment in the Wider Caribbean Region: the Protocol Concerning Specially Protected Areas and Wildlife (SPAW). This Protocol was adopted in two stages: its text on 18 January 1990 and the initial versions of its three Annexes on 11 June 1991. The Annexes list protected marine and coastal flora (Annex I), fauna (Annex II), and species to be maintained at a sustainable level (Annex III). The Protocol will enter into force following ratification by nine Contracting Parties.

The Conference of Plenipotentiaries for the adoption of these annexes, which was convened in Kingston, Jamaica, 10-11 June 1991, adopted the draft annexes in their entirety, and

showed the region's commitment to a strong Protocol by listing entire groups of species, such as most corals, all mangroves, all sea turtles, and major groups of sea mammals. Listed under Annex II are all species of Cetacea, Sirenia, and Phocidae. Listed under Annex III are all mangroves and a number of species of seagrasses.

The first meeting of the Interim Scientific and Technical Advisory Committee to the Protocol will be held in Kingston, 4-8 May 1992. The agenda will include protection of manatees as well as other threatened species. (Sources: UNEP Caribbean Environment Programme, CEPNEWS 5(3), September 1991; Dr. M. M. Kaufmann, Monitor International).

FLORIDA

Synoptic Manatee Aerial Surveys. - Another statewide aerial survey of Florida's manatee population was conducted on January 17 and 18, 1992. Biologists surveyed coastal and river areas throughout peninsular Florida and four sites in southern Georgia. The survey included known winter habitats but concentrated on warm-water refuges such as natural springs and power plant discharge canals.

Raw counts based on verbal reports from each participating biologist indicate that a record 1,856 manatees were counted, 907 on the East Coast and 949 on the West Coast. These figures are preliminary and may be subject to revision.

These results will be used to update information from two statewide surveys conducted in 1991 (See Sirenews No. 15). Those two surveys counted 1,268 and 1,470 manatees, respectively. Each count provides a minimum count of the population, and is a single event that cannot be used to reliably estimate population size. Surveys over several years are necessary to assess the actual status of the population and determine population trends.

We attribute the higher count this year to better (in fact, nearly perfect) survey conditions such as colder temperatures, improved water clarity, and less wind, rather than a large increase in the population. The count of 1,856 manatees is about as high as the most optimistic researchers would have guessed possible three or four years ago. While it of course does not mean that manatees are no longer endangered, it does give them a little more "breathing room"; the number of mortalities we have been seeing could be better sustained by a population of that size. In any case, this is the first really good news about manatee population biology in some years.

The manatee is still considered endangered because total population size is not the only factor to be considered when determining endangered status. Biologists must also consider other factors affecting the Florida manatee population, such as low reproductive rates, high infant mortality rates, high mortality rates from boat collisions and other causes, water pollution, and loss of habitat. In particular, the record numbers of documented deaths in recent years remain a major impediment to the recovery of the species. More manatees died from human-related causes (68) in 1991 than ever before. Likewise, more small ("perinatal") calves died (53) than ever before. This

survey certainly provides no reason to halt any ongoing manatee conservation strategies.

The Department of Natural Resources would like to thank the 27 biologists - representing 14 local, state, and federal agencies, private research groups, and educational institutions - as well as all the other staff who made this survey possible. For example, apart from tasks directly connected with the survey, other staff had to cover two rescue attempts while the local biologists were flying the survey. Ten aircraft were in the air simultaneously on the first day, nine on the second!

The survey was funded largely by the Save the Manatee Trust Fund, which derives its funds from manatee auto license tag sales, boat registration fees, and contributions. Additional funding was provided by the Florida Power and Light Company. - Bruce Ackerman (Florida Dept. of Natural Resources)

Manatee Telemetry Project. - The Florida Department of Natural Resources' Florida Marine Research Institute and the U.S. Fish & Wildlife Service tagged eight manatees at Tampa Electric Company's Big Bend Power Plant in Apollo Beach on December 16 and 17, 1991. Researchers captured and released 15 animals during the two days, but only eight (five females and three males) were found suitable and fitted with satellite transmitter tags. These eight join one male tagged earlier in 1991. Their movements will be monitored for at least three years.

Each transmitter is 21 inches long and is marked by unique colored bands for visual identification. A four-foot tether (designed to break away if entangled) connects the transmitter housing to a rubber harness that encircles the base of the tail. Sensors in each transmitter record water temperature and animal activity. The information is transmitted via satellite to a computer database, and also provides the location of the tagged animals.

A pilot study of four males tagged in Tampa Bay in February 1991 showed that the animals migrated from Tampa Bay as far north as the Suwannee River and as far south as Charlotte Harbor.

In addition to tagging the eight manatees, biologists also obtained measurements of all 15 captured, photographed distinctive scar patterns, and drew blood samples for genetic analysis. The project was funded by the Save the Manatee Trust Fund. - Florida Dept. of Natural Resources

Population Biology Workshop. - A Workshop on Manatee Population Biology was held in Gainesville on February 4-6. A panel of eleven national and international experts on marine mammals, population dynamics and modeling, and wildlife statistics was convened to comment on existing research programs and suggest innovations. Bruce Ackerman and Tom O'Shea served as co-chairmen. (See also the article by Helene Marsh, above.)

Save the Manatee Club Sues for Independence. - In an unusual outbreak of hostility between environmental groups seeking to protect the Florida manatee, the Save the Manatee Club (STMC) has filed suit in Circuit Court to gain corporate independence from its parent organization, the Florida Audubon Society (FAS).

STMC currently has a \$640,000 annual budget which is separate from that of FAS, and some 30,000 members compared with FAS's 65,000. In addition, some 60% of FAS's income (exclusive of STMC funds) reportedly comes to them for manatees.

In response to recent efforts by STMC to gain a more independent role for itself, the FAS board of directors voted in late March against allowing STMC to incorporate itself. Judith Delaney Vallee, STMC's executive director, has been fired and FAS has advertised for a replacement. Meanwhile, the locks on STMC's office have been changed and Michael Nelson has been appointed acting director.

According to court papers filed by STMC's attorney, FAS launched "a hostile takeover" against his clients, improperly taking charge of STMC's budget, copyrights, trademarks, and property. The lawsuit also discloses a 1989 memo in which a FAS vice president expressed concern about losing donations to STMC if the organization incorporated. (Based in part on reports in the Orlando Sentinel)

INDONESIA

More Sea Piggery. - At the recent Marine Mammal Conference I had the pleasure of talking with Hans de Iongh about dugong studies in Indonesia, and I took advantage of the opportunity to ask about precise translations of local names for the dugong. He kindly followed up on this and wrote to me as follows: "With respect to your specific question, I traced some information which might interest you through my colleague anthropologist Gerard Persoon, who did his Ph.D. on Siberut. According to him the local people on Siberut call the dugong sakoko ka koat, which literally means 'pig in the sea'. In the Indonesian Dictionary 'Purwadanuda', the seacow is called babi duyung which means 'sea pig'."

There may be a conservation angle to this discussion. It has been suggested that it would be judicious to promote "seapig" and "seacow" as alternatives, according to which local taboos would provide maximum protection! Better yet, as a reporter from the Times of India once suggested, we could promote the idea that dugong "products" were anti-aphrodisiacs! - Paul K. Anderson

IVORY COAST

World Bank Changes Policy on Commercial Logging. - As reported in Sirenews No. 16, the Ivory Coast was discovered to be continuing construction on a major road that threatened coastal ecosystems used by manatees and other wildlife, contrary to an agreement with the African Development Bank (which was funding the project) and a request from the World Bank. The subsequent controversy over this loan, which environmentalists feared would open huge tracts of pristine forest to unsustainable logging, has reportedly led the World Bank to change its former policy and promise to stop funding commercial logging operations in undisturbed tropical forests. No news is available, however, on the present status of the actual road construction. (Source: Environmental Defense Fund, EDF Letter 22(5), November 1991)

THE NETHERLANDS

Manatee Births. - In a letter to Warren Zeiller dated October 29, 1991, Dick Dekker of the Amsterdam zoological park Natura Artis Magistra reports that their male West Indian manatee Joop and female Mary are doing fine, and that the female is pregnant again. The calf born in 1977 was sent to the Antwerp Zoo in 1981, where, unfortunately, he died three years later. Mary's second calf, a female, was stillborn in 1987. Her third calf, a male, was born in 1989 and is now living with other manatees at Burgers Bush at Arnheim.

PHILIPPINES

The Feeding Ecology of Dugongs at Calait Island, Busuanga, Philippines. - As part of my Master's degree studies, I developed a simultaneous monitoring system which used a team of local observers to count dugongs around Calait Island from nine shoreline vantage points. Monitoring was implemented each month from March 1989 to May 1990. This allowed me to identify the important dugong habitats around the island. On average, five dugongs were seen per survey day. More dugongs were observed during the months of March and July 1989. These periods coincided with the lull between monsoons that year. The site where dugongs were most often sighted was about 1.5 m deep and supported a seagrass biomass averaging 1060 g/sq. m (wet weight).

The dugongs were shy, making observations difficult. They were observed to graze once per day, usually starting in the late afternoon or at night. Animals usually stayed in front of the spur and groove sections of the reefs. Short seagrasses such as Halodule uninervis, Cymodocea rotundata, C. serrulata, Syringodium isoetifolium, and Thalassia hemprichii showed more evidence of being grazed than the taller species Enhalus acoroides. By direct observations of the area grazed by a single dugong, I estimated that it consumed an average of 68.5 kg (wet weight) of seagrass per day.

I have outlined appropriate conservation measures for dugongs on this island, which is a nature reserve. - Lemuel Aragon

PUERTO RICO

Protecting the Caribbean Manatee through Education. - The Caribbean Stranding Network and the University of Puerto Rico's Sea Grant College Program have coordinated the printing of 13,000 copies of a full-color manatee poster in Spanish. The poster is based on the theme of "Miss them now, or miss them forever", and its purpose is to let the residents of different Spanish-speaking Caribbean islands learn about how they can help protect this species from extinction.

Save the Manatee Club, the Interamerican University's Biology Department in Puerto Rico, and Joe Pauley sponsored the printing of the poster. It will be distributed free of charge in public and private schools, fishing villages, marinas and natural

resources government agencies in Puerto Rico. With the purpose of encouraging other Caribbean organizations to initiate similar education projects, a number of posters have been reserved for distribution in other Caribbean countries.

In a related effort, the Caribbean Stranding Network and the Chelonia Society of Puerto Rico received a small grant from Save the Manatee Club and Puerto Rico's Conservation Foundation to print additional "Caution - Manatee Area" signs in Spanish. The signs are being placed in areas identified as inhabited by manatees and where manatees are in danger of being hit by speeding boats. In addition, Yuisa y Salvador, a natural-size sculpture of a manatee mother and calf, was produced by high-school students and professor Frank Rodriguez at the Commonwealth School in San Juan. The sculpture has visited different schools and activities in Puerto Rico, educating those who were not aware of these sirens' endangered status. - Antonio Mignucci

THAILAND

Dugong Research on the Coast of Thailand. - Dugong dugon, a marine mammal that is very close to being extirpated in Thailand, has long been an interest of Mr. Suwan Salaueng, a marine scientist working with the Research Section of Thailand's National Park Division. He was the driving force behind establishing a small group of scientists as a dugong research team that is presently studying a dugong population in southern Thailand. The team chose to conduct their research in Had Chac Mai National Park and Koh Libong Non-Hunting Area, where dugong sightings were often reported. These two protected areas are located in Trang Province and both are composed of islands, beaches and extensive seagrass beds in the surrounding waters of the Andaman Sea.

The team decided to carry out three aerial surveys of five days each, to estimate the number of dugongs remaining. Permission from the Ministry of Agriculture and Extension was granted to use their 4-passenger helicopter.

The first survey began on December 7, 1991. Transects were mapped out and a direct count was made covering approximately 72 km. Of the five days flown on the first survey, only three proved to be conducive for observing dugongs; the other two were overcast and rainy. From the first survey, the team estimated that there were about 14 dugongs living in the surrounding area. Of interest was one sighting that appeared to be of a mother with twin calves. Another sighting, of an albino calf, was met with slight skepticism. However, the albino calf sighting was reconfirmed on the second survey.

The second survey occurred in January 1992. Again the team flew for five days, with similar results. This time they were fortunate enough to see the largest herd sighted so far, a group of 20 animals. An albino calf was again sighted, as well as the mother with twin calves. After the second survey the team recalculated the number of dugongs to be approximately 30.

The third survey is scheduled to take place at the end of March 1992, before the monsoon season begins. The actual number of days on which dugongs will be counted is only two. The other

three days will be set aside to allow local village headmen the opportunity to see the dugongs from the air. The team realizes that the dugong's survival depends on the cooperation of fishing villages in the area. Dugongs accidentally caught in fishermen's nets are killed for their meat, oil, and bones, all of which help to enhance the fishermen's very meager income. At present, programs have been initiated to educate and inform villagers on the importance of conserving the endangered dugong. Educational efforts seem to be paying off; after the first aerial survey, on two separate occasions villagers accidentally caught dugongs in their nets and released them instead of killing them. An additional seven days will be spent in the area mapping the seagrass beds, calculating biomass and density, and measuring water temperatures in different areas.

The plight of the dugong in Thailand has been much publicized since the team's first aerial surveys. Legislators, governors, academicians, musicians, actors and actresses, and local villagers have all expressed a desire to help protect the species.

Unfortunately, aerial surveys are quite expensive and impossible to conduct on a regular basis in Thailand. Therefore, the team is now investigating the possibility of establishing a small observation platform on a small mountain in the area. It is still uncertain whether this idea is feasible, since only one dugong has ever been sighted near the mountain. The team is also looking into using radiotelemetry to assist in obtaining vital data on the dugongs. If these animals are to be protected in Thailand, information is vitally needed on their population, distribution, migration, ecology, and habitat requirements. The dugong research team welcomes any advice or suggestions, especially in regard to radiotagging, and surveying small populations. Correspondence should be addressed to either Suwan Saiueng or Sean O'Sullivan, Attn.: Dugong Project, National Park Division, Royal Forest Department, Jatujak, Bangkok 10900, Thailand; FAX # 579 2791. - Sean O'Sullivan

ABSTRACTS

The following abstracts are of papers and posters presented at the Ninth Biennial Conference on the Biology of Marine Mammals, Chicago, Ill., Dec. 5-9, 1991.

MANATEE SYNOPTIC AERIAL SURVEY IN FLORIDA AND GEORGIA

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Aerial surveys have been used since 1968 to document distribution and abundance of the West Indian manatee (*Trichechus manatus longirostris*) in Florida, however, no reliable estimates of the population size have been made. Comprehensive data on population size would allow improved population management and assessment of the impact of observed high mortality. A two-day "synoptic" aerial survey of potential manatee winter range was designed to obtain the highest possible count by maximizing survey effort under the most optimal conditions. While not a statistical estimate, this count improves data on the minimum size of the population, and may serve as a baseline for future counts.

A two-day survey was planned to follow each of two major winter cold fronts. Intense or prolonged cold weather concentrates manatees at warm-water refugia.

Counts on Florida's east coast were conducted the first day after a front; the west coast the second. Aerial surveys were conducted by experienced observers in Cessna 172s or helicopters following methods previously used in Florida (altitude 150 m, speed about 130 km/hr). As many as 13 aircraft were in the air on survey days, surveying 28 count zones. Ground counts were used in two areas with poor aerial visibility. On the first survey, 23-24 January 1991, 1265 manatees (8.6% calves) were counted. During the second survey, 17-18 February 1991, 1465 manatees (8.8% calves) were counted.

Previous "state-wide" counts were made in the summer of 1972 (255) and winter of 1976 (733). In the last decade, biologists had summed counts at winter refuges to obtain totals of 1000-1240. The record count of 1465 can be attributed to use of more observers, counting areas most likely to contain manatees, and very good survey conditions. Whether the population actually increased through time, however, cannot be determined since methods differed between surveys. The high count does not provide evidence that manatees are any less endangered or that ongoing conservation strategies should be relaxed.

TERRITORIALITY, DISPLAY, AND MATING IN A WESTERN AUSTRALIAN DUGONG POPULATION: A "CLASSIC" LEK ?
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My wife and I watched dugongs from the deck of a 35' catamaran in a shallow clear-water cove in eastern Shark Bay during the presumed breeding seasons of 1988 and 1989. Methods included photo-identification, focal observation, habituation of selected individuals to the vessel, recording of acoustic signals, and periodic census of resident animals.

Despite near absence of macroscopic vegetation (forage species in particular) individually identifiable solitary adult dugongs maintained, patrolled, and defended mutually exclusive territories in this cove for up to 5-6 weeks. Behaviors postulated to constitute display included sit-ups, belly-ups, bottoms swims, bottom rooting and acoustic signalling. In contrast to the mating herds reported for sirenians elsewhere, mating in this context involved prolonged herding by a single territory holder, and repeated copulations within a territory.

This food-impooverished site was adjacent to areas of abundant high-quality forage grazed by large herds which included numerous females.

PIT TAGS: PERMANENT IDENTIFICATION MARKERS FOR THE WEST INDIAN MANATEE.

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Passive Integrated Transponder (PIT) tags are a widely used permanent marking technique in various animals including fish, marine mammals, pets, and many species of terrestrial wildlife. The major advantage of the tags is that they are internal, implanted subcutaneously, and therefore not easily lost. The tags are small (2mm X 11mm), glass-enclosed microchips with no internal power source, that provide a unique 9-digit identification code when scanned with an external reader. These tags are being tested in captive manatees, prior to the marking of wild animals, to assess individual reactivity, subcutaneous tag migration and tag loss.

The implantation technique and tag location were determined on fresh manatee carcasses. Five captive manatees were implanted with PIT tags. Two tags were implanted in each animal, one on either side of the upper head region, behind the ear opening. The animals were also marked with freeze brands around the implantation site to monitor tag migration. The manatees have been monitored for 3-10 months, every two weeks for the first two months and then once a month.

No health complications were observed from the marking of the five captive manatees. All tags functioned properly and no apparent migration of the tags was noted. Testing of PIT tags on captive manatees has shown that these tags are a safe and accurate permanent identification marker for manatees and this marking technology could be applied to the wild manatee population.

MANATEE AERIAL SURVEYS IN GUATEMALA

Caddick, G.B., Ackerman, B.B., Calvo, L., and Cardona, J.M.
1 Lowry Park Zoological Gardens, 7530 North Boulevard, Tampa, FL 33604
2 Florida Department of Natural Resources, Florida Marine Research Institute, 100 Eighth Avenue S.E., St. Petersburg FL 33701-5095
3 Wildlife Preservation Trust International, Parque Zoológico Nacional "La Aurora", 7a. Ave. Zona 13, Ciudad de Guatemala, Guatemala
4 Centro de Estudios Conservacionistas, Universidad de San Carlos de Guatemala, Avenida de la Reforma 0-63, Zona 10, Ciudad de Guatemala, Guatemala

Little is known about West Indian manatees (*Trichechus manatus manatus*) in Guatemala. Manatees live along the Caribbean coast and in three low-elevation river and lake systems. Manatee populations have been depleted by commercial exploitation from the 1500s to the early 1900s, and subsistence hunting at least until the mid-1900s. Aerial surveys for manatees were conducted in April 1991 covering areas where manatees were previously reported. Methods were similar to those used in Florida (Cessna 172, volunteer local pilots, altitude 150m, speed 140-160km/hr). Four Guatemalan biologists participated and were trained in aerial survey methods. Survey conditions were not good; muddy water, floating vegetation, and overhanging rainforest trees hampered observations.

Nine manatees were seen in 9.8 hours of surveys. Manatees were observed in Lake Izabal (n=2), El Golfete (4), and along the south Caribbean coast (3). Based on surveys under similar conditions in Florida, these counts may indicate a total population of 30 to 50 manatees. Some interchange likely occurs with larger populations in adjacent Belize and Honduras. Interviews were conducted with fishermen to assess local knowledge of manatee occurrence. While poaching manatees appears rare, a few recent mortalities from the extensive gillnet fishery and boat collisions were documented. These may be sufficient to keep the population at low levels.

SPECIES COMPOSITION OF PHILIPPINE MARINE MAMMAL FAUNA.
Aragones, Lemuel V. 1, Leatherwood, Stephen 2, Dolar, Maria Louella 3 and Hill, Cynthia L. 4
1/ University of the Philippines at Los Banos, College, Laguna, 4013 Philippines;
2/ IUCN Cetacean Specialist Group, Texas A & M University, Wildlife and Fisheries Sciences, 210 Nagle Hall, College Station, TX 77843-2258 USA; 3/ Marine Laboratory, Silliman University, 6200 Dumaguete City, Philippines; 4/ Chrysalis Enterprises, 728 Solana Circle East, Solana Beach, CA 92075 USA

Until 1990, there were only two published papers which documented the occurrence of marine mammals (total of seven species) in Philippine waters. In 1990, the authors began compiling information (from strandings, interviews, unpublished sources, examination of specimens taken in fisheries and our own surveys) on marine mammal presence, relative abundance and involvement in fisheries in this nation of over 7,000 islands. The fauna can now be documented to include: dugongs (+), Bryde's (+), minke, humpback, sperm, pygmy sperm (+), melon-headed (+*X) and short-finned pilot whales and Fraser's (+*X), common, bottlenose (+), Risso's (*), pantropical spotted (+*), and long-snouted spinner (+*) dolphins. At least the species indicated are involved in directed fisheries (+) or taken incidental to gillnetting and seining operations (*). Two species generally accounted as rare elsewhere are seen frequently in several areas of the Central and Southern Visayas (X). Other species for which yet unconfirmed reports exist are: blue, dwarf sperm, southern bottlenose, goosbeaked, killer and false killer whales and striped, Indo-Pacific humpbacked and rough-toothed dolphins. For the Philippines as for Peru and Sri Lanka there is evidence that incidental takes in fishing operations have given rise to directed fisheries for small cetaceans as other traditionally harvested marine species have declined. Specimens are being deposited at Silliman University, the University of the Philippines at Los Banos and the National Museum in Manila.

FEEDING RELATED SCATTERED OCCURRENCE OF DUGONGS IN THE MOLUCCAS, EAST INDONESIA

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Dugongs consume large amounts of seagrass daily, leaving distinct feeding tracks after grazing. Our research in the Moluccas (East Indonesia) demonstrates that regeneration of seagrass in these tracks is very slow. Unlike in Australia where large seagrass beds are available to feed on, the small volcanic islands of the Moluccas offer only small fringing reefs where seagrass can grow. Consequently the dugongs inhabiting waters around those islands need to adopt a different feeding strategy. They will move in relatively small groups from one seagrass field to the other, sometimes covering large distances. This type of dispersal behaviour hampers population assessment and requires intensive survey techniques. Since dugongs are still accidentally caught and actively hunted for their meat, ivory teeth and supposedly magical tears, despite legal protection, their occurrence in small stocks renders them more vulnerable to local extinction.

Because they are widely scattered in small groups in these volcanic areas it is difficult to implement an adequate protection strategy for conservation of the dugong population in such habitats.

MOVEMENTS OF WEST INDIAN MANATEES (*TRICHECHUS MANATUS*) IN DADE COUNTY, FLORIDA, BASED ON PHOTO-IDENTIFICATION

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Movements of West Indian manatees (*Trichechus manatus*) have been documented in Dade County, Florida from February 1984 to June 1991 using photo-identification techniques developed by the U.S. Fish and Wildlife Service. Individual identifications, based on distinct scar patterns, were obtained for over 150 manatees. Resighting data document a seasonal influx of manatees into Dade County coastal waters from more northerly sites during the winter months. Individuals wintering in Dade County were known to travel to warm-water aggregation sites at the Coral Gables Waterway and the Port Everglades Power Plant in Broward County during periods of cold winter weather. Some manatees move upstream of flood control structures to inland canals. These individuals are dependent upon the operation of these structures, which are a known cause of manatee mortality. Data collected are being used to establish a manatee protection plan in Dade County.

SPERMATOGENESIS IN THE FLORIDA MANATEE, *TRICHECHUS MANATUS LATIROSTRIS*

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A histological study of the testis and epididymis of the Florida manatee, *Trichechus manatus latirostris*, was conducted to assess reproductive potential. Testes and/or epididymides of 74 animals were analyzed for presence of sperm. In addition, qualitative and quantitative examination of the seminiferous tubules from 30 manatees ranging in size from 98 to 320 cm revealed 11 stages within the spermatogenic cycle characterized by distinct cell associations. The smallest manatee exhibiting spermatogenesis was 237 cm long, and was between 3 and 4 years old. Spermatogenesis was not continuous and was clearly affected by season. In winter (December through February) spermatogenesis was observed in only 12% of the manatees recovered that measured 240-270 cm long, and in only 22% of those longer than 270 cm. By contrast, 50% of the 240-270 cm long animals and 95% of the 270+ cm long animals recovered in non-winter months (March through November) had mature sperm. During winter regressed seminiferous tubules (characterized by immature cell stages and reduced diameters) suggest reduction, if not cessation, of reproductive activity.

MARINE MAMMAL MORTALITY ASSESSMENT IN THE CARIBBEAN AND THE NEWLY ESTABLISHED CARIBBEAN STRANDING NETWORK.

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Marine mammal mortality, either in the form of stranded or poached animals, poses a threat to the protection of these species in the Caribbean. The magnitude of this problem is dramatic, with, for example, hundreds of beached and stranded whales, dolphins and manatees informed in Puerto Rico during the past four decades, although many more deaths have gone unreported. The large number of undetermined mortality causes for all species in this area, clearly indicates that the majority of the cases were not thoroughly documented or necropsied to determine cause of death. Where the cause is known, frequently these were the result of human activity. Antillean manatees, the most endangered of all marine mammals in the area, are the most common species found dead, for example in Puerto Rico accounting for 54% of all previous mortality records. The leading manatee mortality causes are human related, either by poaching, incidental takes or boat collisions. Live and mass strandings of injured or sick dolphins and whales also pose a problem. A practical approach to unraveling the mortality and stranding problem in the Caribbean requires a program focusing the talents of all those responsible for and interested in their conservation. This program needs to include an integrated plan to rescue, rehabilitate, and release those which strand alive. In the absence of a complete plan and funded program, a first step taken was the creation of the Caribbean Stranding Network, an international effort by 38 organizations throughout 8 Caribbean countries.

PRESENT STRUGGLES AND FUTURE UNCERTAINTIES FOR FLORIDA MANATEES.

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A number of agencies, organizations and individuals have worked diligently over the last two decades to conserve Florida manatees (*Trichechus manatus latirostris*) and their habitat. Along the way, scientists have learned where manatees exist, their general habitat requirements, where, when, how, and how often they die, and other information to facilitate management efforts. The efforts to date, however, have not assured the survival of the subspecies. Consider the following paradoxes: despite provisions of protective Federal and State legislation, manatees are taken daily by human activities that harass, injure or kill manatees or destroy critical habitat; despite more time, money and effort going into manatee protection, and despite knowledge regarding locations, times, and causes of human-related manatee mortality, average annual mortality from all causes rose about 6% between 1976 and 1990, with watercraft and perinatal mortality rising at average annual rates of 10.4% and 11.5%, respectively, over that same time period; despite evidence that manatees learn to use areas containing critical resources from which human activities are excluded, very few permanent sanctuaries have been created in Florida; and despite intensive education and public awareness efforts, lobbies against manatee protection continue to exert powerful influences.

The State of Florida focuses its manatee and habitat conservation efforts on local management plans, with certain "key counties" being targeted first. The plans restrict boat speeds and human activities in locations critical to manatees. The Fish and Wildlife Service continues numerous section 7 consultations, the thrust of which is to prevent activities that could jeopardize manatees. Federal and State agencies, as well as other groups of individuals, continue research on manatees, and a 1992 workshop will attempt to use long-term data bases to create population models and perhaps detect trends in abundance.

The current efforts are appropriate and the individuals involved are dedicated and diligent. But will manatees survive? By the time local management plans are enacted, enforced, and evaluated in terms of their effects on manatee mortality and habitat destruction, years will pass. If manatee mortality does not drop appreciably, those years of high mortality could place the subspecies on the brink of extinction. I believe it is critical to: a) continue to enact and monitor the effects of tough local management plans; b) provide funds to permit sufficient enforcement of local, State, and Federal rules; c) continue and expand interagency cooperation, particularly in the area of habitat protection; BUT d) develop contingency plans in case the "best laid plans go awry"; and e) knock on wood.

AGE-SPECIFIC FECUNDITY IN FLORIDA MANATEES

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Mammalian fecundity is measured as the number of offspring produced per individual over an interval of time, to account for changes occurring with age. Age-specific fecundity values (m_x) usually include only female offspring. A sample of 287 female Florida manatees (*Trichechus manatus latirostris*) collected as part of the Southeastern United States salvage program between 1974 and 1990 was examined for reproductive condition and age estimation. Each specimen was classified as reproductively inactive (immature or resting) or breeding (pregnant or lactating). Age classes were estimated using growth-layer groups in the dome portion of the tympano-periotic bone. Ages ranged from 0 to over 30 years. An age-specific fecundity table was calculated, assuming a sex ratio at birth of 1:1 and litter size of 1. Animals classified as older than age class 15 were pooled into a single class. Fecundity values ranged from 0.033 to 0.333, the overall average being 0.165. Fecundity rate rises from the age of first parturition at age class 5, peaks at the interval 7 to 9 years, and levels off at later ages. The inclusion of a fecundity schedule in the life table will permit the estimation of the population's net reproductive rate. This in turn will provide insight into the viability of the population.

WEST INDIAN MANATEE *Trichechus manatus* LINNAEUS (1758): OBSERVATIONS ON THE OCCURRENCE IN PERNAMBUCO STATE - NORTHEASTERN BRAZIL

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To determine areas of distribution and occurrence of manatee *Trichechus manatus*, surveys over three years were conducted along the Pernambuco coast. Many areas where manatees used to frequent are no longer reported as areas of occurrence. Currently Santa Cruz Channel - Itamaracá Island (07°42'S; 034°50'W) - mangrove area - is the only area where they still occur. There are some tributaries, some of them polluted, where manatees enter, probably to eat seagrasses and drink fresh water. Interviews with fishermen and local villagers indicate that problems such as mangrove destruction, estuary pollution, and even hunting are still present. Fishermen report that animals are directly affected by noise and illumination from factories. Discharges of solution of cellulose and chlorine from industries are frequent. Because the manatee population is so small, any destruction of his habitat causing mortality, such as net entanglement and environmental changes, could have deleterious impact on his status.

RESULTS OF WINTER AERIAL SURVEYS FOR MANATEES (*TRICHECHUS MANATUS LATIROSTRIS*) AROUND SELECTED FLORIDA POWER PLANTS: 1977-1991.

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Aerial surveys have assessed abundance and distribution of Florida manatees around five power plants in eastern and southwestern Florida in a consistent manner for 14 years. The surveys capitalized on manatees' requirement for warm water to survive cold winter weather; at such times the animals predictably aggregated at natural and artificial warm-water refugia, including power plant discharges. One day counts have exceeded 200 manatees at four individual plants (Canaveral, Riviera, Port Everglades, and Fort Myers Plants), and 338 manatees were observed on one survey at Fort Myers. Single day total counts for all locations surveyed were as high as 804 manatees. Although the survey results do not provide quantifiable indices of manatee abundance, they have documented manatee high use areas that warrant protection and helped establish minimum population estimates. Further, the survey results suggest a possible declining trend in calf abundance. Between 1977 and 1987, calves represented more than 10% of the manatees sighted during 7 of 10 winters. However, from 1987 to 1991, calves represented only between 6.8% and 8.2% of the manatees sighted. The maximum number of calves observed during any single-day survey, even during very cold weather when females with calves seek warm-water refugia, also dropped in recent years. Although data regarding manatees located at the plants do not necessarily reflect what may be happening elsewhere, any actual reduction in calf abundance around the five plants surveyed is real cause for concern, given documented increases in dependent calf and total manatee mortality.

DISTRIBUTION AND ABUNDANCE OF MANATEES IN DUVAL COUNTY, FLORIDA, 1988-1990.

Valade, James A.

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The coastal and riverine waters of Duval County, Florida, provide important seasonal habitat for the West Indian manatee (*Trichechus manatus*). Aerial surveys to document distribution and abundance of manatees were flown over portions of the lower St. Johns and Nassau Rivers, including most tributaries. Biweekly surveys (n = 52, May 1988 - April 1990) were conducted from a Cessna 172 at an altitude of 150 m and speed of 130 km/hr. A total of 1823 manatee sightings were documented (\bar{x} = 35 manatees per survey). Manatee counts varied seasonally; highest counts occurred during the warm months April-September (\bar{x} = 54). The number of manatees declined through the fall, and was lowest during the cold months January-March (\bar{x} = 4). Strong seasonal patterns reflect manatee movements into and out of Duval County waters.

Typically, manatees arrive in the early spring from wintering sites on the coast of south and central Florida. Manatees spend the summer and early fall months here or travel through the area to southern Georgia. At the onset of winter, the majority of the animals return further south to their wintering sites. The few manatees remaining in the area overwinter at warm-water industrial discharges. The most common activities observed were travelling (33% of sightings) and feeding (26%). Manatees typically travelled along the shorelines throughout the study area and fed on beds of submergent vegetation in the southern portions of the St. Johns River. Certain tributaries were heavily used during the summer season.

These data are being used in a Geographic Information System, together with manatee mortality data and satellite radio-telemetry locations. These data are currently being used to implement manatee protection measures in Duval County.

SATELLITE TELEMETRY OF MANATEES TAGGED IN TAMPA BAY.

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Extended north-south seasonal movements are characteristic of manatees on the east coast of Florida, but the extent of such movements along the west coast has not been well determined. To define migratory routes, habitat preferences, and behavior of manatees in west-central Florida, a multi-year study was initiated. Four adult males (275-325 cm) were captured and tagged with combination satellite/VHF radio transmitters in February, 1991, in northeast Tampa Bay. A rehabilitated female (272 cm) was also tagged and released in northwest Tampa Bay in July. Data from satellite fixes and twice-weekly field observations of each animal were loaded into a Geographic Information System (GIS) and animal movements were automatically plotted using customized GIS programming routines. Telemetry data are being used in conjunction with other manatee data sets to develop regional protection plans.

Activity of the four males differed. One left Tampa Bay in March and moved at least 310km north, stopping briefly in Crystal River on his way to the Suwannee River area, before returning to Tampa Bay in May. Another traveled over 250km south to Charlotte Harbor and the Myakka and Peace Rivers. The two males that remained in the Bay area each established distinctive movement patterns. Results from VHF tracking necessitated increasing the VHF signal strength in 10 new tags because manatees can move long distances between accurate satellite fixes and are often found in areas inaccessible to tracking from land.

INTERACTION OF MANATEE SERA WITH MARINE ANAEROBES
Wetzold, M.D., Bradley, J.L., Yang, C.J., Towers, M.A., Klein, P.A., Green, L.G., *Wright, S.D., *Walsh, M.T., *Campbell, T.W., and McGuire, P.H.
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The endangered status of the manatee (*Trichechus manatus*) makes imperative the study of its biology and medical management. Current case studies associating *Clostridium difficile* infections with colonic disorders of orphan manatee calves served as the impetus for this project in which 24 manatee sera were screened for antibodies to 51 anaerobic bacterial isolates, provided by Sea World and the Florida Department of Natural Resources following necropsy or physical examination. Sera were evaluated by ELISA analysis utilizing protein G-alkaline phosphatase conjugate as the secondary reagent. To date we have found that 7 out of 46 bacterial isolates (19.6%) have been bound by \geq 50% of the serum samples. By determining which isolates have clinical significance, research may be focused on the pathobiology of these bacteria with regard to treatment and prophylaxis. This research may also lead to a greater understanding of the immune system of individual manatees and of the species in general.

A RETROSPECTIVE ANALYSIS OF WATERCRAFT-RELATED MORTALITY OF THE WEST INDIAN MANATEE IN FLORIDA (1979-1989).

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Manatee deaths (*Trichechus manatus*) in Florida have increased from 1974 to present. The most frequent cause of human-related death is collision with watercraft (25% of all deaths). Propeller scars are so common that they can be used to identify many living adults. From 1979 through 1989, 452 sets of fatal or healed propeller cuts were measured on 389 dead manatees. All wound patterns were measured, including total length of the series of cuts (pattern), length of each cut, and distance between adjacent cuts. Depth of cut was measured on fresh wounds. Collisions with watercraft caused 285 of these deaths; the remainder died from other causes. Propeller cuts caused 114 (40%) deaths, impact injuries caused 162 (57%) deaths, and 9 (3%) manatees had both propeller cuts and impact injuries, either of which would have been fatal. For fatal and healed propeller wounds combined, the mean total length of the pattern was 48 cm, the mean length of the longest cut was 23 cm, the mean distance between cuts was 12 cm, and each pattern had a mean of four propeller cuts. Some animals had survived multiple boat injuries, with one animal having 14 separate propeller patterns.

Impact injuries killed more manatees than did propeller wounds. Impact often caused only minor surface wounds, but resulted in massive internal injuries including broken or dislocated ribs (\bar{x} = 9) and fractured organs. Among fatal propeller wounds only, mean length (\bar{x} = 36 cm) of the longest cut suggests that deaths are most often caused by medium-sized or larger vessels. In contrast, fatal impact injuries are suspected to have resulted from fast-moving, small to medium-sized watercraft. The proportion of impact deaths has increased through time. These data can be used to implement better watercraft regulations in manatee protection zones by targeting all classes of watercraft.

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