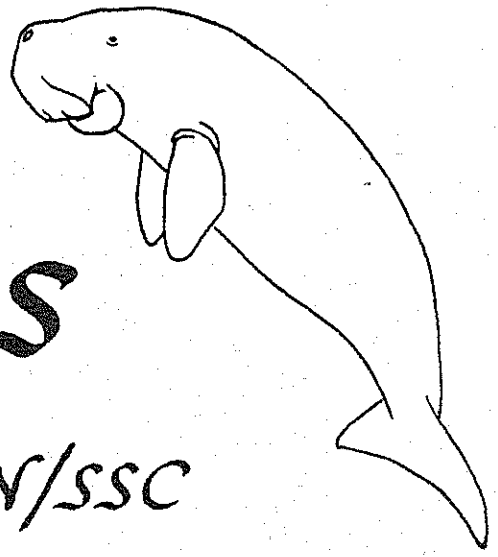

Sirenews

Newsletter of the IUCN/SSC Sirenia Specialist Group

NUMBER 20 OCTOBER 1993

IN THIS ISSUE:
- NEW JOURNAL ON MANATEES PUBLISHED IN BRAZIL (p. 5)
- DUGONGS IN OMAN? (p. 7)
- REPORT AND ABSTRACTS OF SYDNEY WORKSHOP (pp. 3, 10)

EDITORIAL: HOW MANY PEOPLE DO WE NEED?

The state and various county governments of Florida have for several years been locked in a series of agonizing disputes with the boating industry and commercial and recreational boaters over regulation of waterborne activities for manatee protection. Where boat-speed and other regulations have been implemented, there are encouraging signs that manatee mortality from watercraft impacts may be abating. However, the struggle to enact such regulations in the remaining critical areas only seems to get harder as, with every passing month, the numbers of people and boats in Florida increase. According to Dr. Miriam Marmontel, computer models of the manatees' population structure show that their situation is precarious: their predicted survival or decline to extinction in the state is highly sensitive to changes in mortality rates, and there seems to be no room for error in those estimates that predict survival (see abstract in this issue).

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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It is clear that the future of manatees in Florida, not to mention other species in other parts of the world, depends critically on self-restraint by humans of their own numbers and per-capita environmental impact. Apart from our moral obligation to preserve endangered species for our descendants, federal legislation such as the Marine Mammal Protection Act of 1972 and the Endangered Species Act of 1973 mandates whatever actions are needed to maintain a viable manatee population. I submit that the time has come to address seriously the issue of human population growth in this country, and to do so in part by setting national and regional goals for a desirable total population size.

Why do this now? Why start doing it here (in Florida or the USA)? And most of all, why should we (the sirenian research/conservation community, or the marine mammalogy community in general) be talking about it, let alone taking the lead in it?

We need to do it now because manatees and other endangered species can't wait. The increasingly strained physical environment can't wait. On a global scale, the exploding numbers of destitute human beings can't wait. This also happens to be an opportune time: public appreciation of the problems and the stakes is at an all-time high, and the new political atmosphere in Washington is relatively conducive to addressing these problems. A "Warning to Humanity", circulated by the Union of Concerned Scientists and endorsed by more than 1,670 scientists from 71 countries (including 104 Nobel laureates), states that "we must accept limits" to population growth and stabilize the world's population without delay. Furthermore, governments of all countries have been requested to prepare national population reports for the U.N. International Conference on Population and Development to be held in Cairo, Egypt, 5-24 September 1994. What form the United States' report takes, and how close it comes to meeting the need for a realistic and prudent national population policy, will depend largely on the extent and effectiveness of the demand for such a policy.

We need to do it here in the U.S. because of the deteriorating environmental situation here (especially in Florida), and because if we can't do it here we can hardly expect others to do it elsewhere. The developing nations are rightly indignant over the developed nations' attempts to portray overpopulation as strictly a Third World problem. As long ago as 1972, the Commission on Population Growth and the American Future, appointed by President Nixon, concluded, "after two years of concentrated effort," that "no substantial benefits would result from continued growth of the nation's population." That is as good a definition of overpopulation as I know, and that was a generation (and more than 45 million new Americans) ago.

Finally, WE ought to be the ones to start the ball rolling because we have (a) many years of hard data showing (b) a dramatic impact on manatee survival by (c) a rapidly growing human population that is both (d) affluent, educated, and environmentally sophisticated and (e) having this impact largely through activities that are recreational rather than (as in most of the world) vital to human survival. As we have said more than once in recent years, manatees are an ideal test case of human ability and will to protect endangered wildlife: there is simply no respectable excuse we Americans could give to the world for the demise of manatees in Florida.

Furthermore, the official Florida Manatee Recovery Plan has as its stated goal the downlisting of Florida manatees from "endangered" to "threatened" status. The Plan itself specifies that "Downlisting should be considered when ... the population is growing or is stable, when mortality factors are controlled at acceptable levels or are decreasing, and when habitats are secure and threats are controlled or are decreasing." Given that human population growth is a *prima facie* mortality factor and threat to the manatees' environment, it is patently obvious that, despite all the good the Plan may accomplish, the threat cannot possibly decrease as long as the human population of Florida continues to grow, and therefore the Recovery Plan is doomed to failure according to its own criteria. The "Recovery Plan" is an excellent research and management plan, but as it stands it is not a recovery plan.

For these reasons I propose that a careful and objective study be done to estimate, as nearly as the available data permit, the maximum size of Florida's human population that is likely to be compatible with the long-term survival of manatees in the state. This would be a modest yet significant step on the long road to a national population policy. The study could

appropriately be carried out under the auspices of a respected, nonpartisan entity having both responsibilities for marine mammal protection and a strong history of commitment to it - for example, the Florida Department of Environmental Protection (formerly the Department of Natural Resources), the U.S. Fish and Wildlife Service, or (best, perhaps) the U.S. Marine Mammal Commission. The study should be done by a specially appointed panel of biologists, demographers, and other qualified specialists. The resulting estimate would stand as a challenge to the political system(s) involved, either to devise acceptable ways of reaching the implied goal, or to plan for the consequences of not doing so. Even if the study did no more than stimulate public debate on the issue, this would be a marked improvement over the present conspiracy of silence among our civic leaders regarding overpopulation.

The slogan's familiarity has not diminished its force: If not now, when? If not us, who? - **DPD**

REPORT OF THE SIRENIA SPECIALIST GROUP MEETING

Members of the Sirenia Specialist Group of the Species Survival Commission of the IUCN met in Sydney, Australia, on 10 July 1993, as part of a workshop on sirenians and seagrasses held during the Sixth International Theriological Congress [see Abstracts, below]. The Sirenia Specialist Group members noted that sirenians have been well studied in relatively few of the 60 countries whose waters they occupy. Nonetheless, there is growing interest in developing sirenian research or conservation programs by scientists in countries with unstudied or poorly studied sirenian populations. In many cases, the scientists possess great enthusiasm, but lack funds. Some of the scientists wish to initiate expensive, high-technology programs (e.g., telemetry) at the outset. The Sirenia Specialist Group recommends a more fundamental, cost-effective approach to initiating a sirenian research or conservation program.

The Sirenia Specialist Group discussed research priorities for unstudied sirenian populations. The Group recommends the following research activities, listed in the order in which they should be implemented:

1) determine the presence or absence of sirenians in the regions;
2) assess overall distribution and define high-use areas;
3) describe general characteristics of important habitats;
4) assess impacts of humans on the animals and plants;
5) evaluate major aspects of population dynamics.

The Sirenia Specialist Group advises that scientists undertaking studies of relatively unstudied sirenian populations start with fundamentals, including, but not limited to: 1) becoming familiar with literature dealing with sirenians elsewhere; 2) interviewing local people who might provide insight regarding presence/absence, important habitat, impacts (including directed take), and cultural attitudes that might either facilitate or retard conservation efforts; 3) using knowledge already available and generally applicable (e.g., preference for low-fiber seagrasses by dugongs, sirenian gestation periods) as a framework for developing research questions that may assess area-specific biological traits (e.g., age at first reproduction); and 4) developing interdisciplinary alliances with specialists (e.g., anthropologists, sociologists, ecologists, or Geographic Information System specialists) whose expertise could be valuable in understanding and conserving sirenians or habitat. The Sirenia Specialist Group noted that the most important studies of sirenians will develop long-term databases, which probably can only be maintained by developing local/regional expertise, enthusiasm, and financial support.

The sirenians are "flagship species", a term reflecting in this context their visibility and the enthusiasm with which the public often address sirenian-related issues. Efforts to preserve sirenians may, therefore, be easier to fund or to engender public support for than efforts to preserve other components of ecosystems. Nonetheless, adequate and appropriate conservation of sirenians within a particular region will have important consequences for habitat conservation.

In this regard, the Sirenia Specialist Group notes that education and awareness efforts should parallel research to achieve regional goals of sirenian or habitat protection. Education, like research, should have a local focus, and should be region-specific to accommodate cultural or socio-economic practices. However, effective education programs also involve educating managers and administrators who can provide funds for initiation and continuation of programs, and the scientists themselves (i.e., through familiarity with relevant literature). The Sirenia Specialist Group recommends that development of multi-focal education programs accompany development of research programs.

In summary, the Sirenia Specialist Group recommends a step-wise approach to research, as well as a multi-focal education program, to learn about and conserve unstudied sirenian populations. A great deal can be learned and accomplished using fundamental approaches that require neither high levels of funding nor extensive technological expertise. - **John E. Reynolds, III**

FIRST INTERNATIONAL MANATEE AND DUGONG RESEARCH CONFERENCE

The First International Manatee and Dugong Research Conference will take place at the Hilton Hotel in Gainesville, Florida, Friday-Sunday, 11-13 March, 1994, and will deal with all aspects of sirenian biology, conservation, and evolution. The conference will include a field trip to Homosassa Springs on 11 March, with oral and poster presentations on the other two days. Seven invited speakers will give 30-minute talks, each followed by several 15-minute contributed papers. The banquet speaker on Saturday evening will be Tom O'Shea.

Those wishing to give a presentation should submit a 1-3 page manuscript (8.5" x 11" paper, 1" margins, 10-point or larger font) by 1 December 1993. Tables and line drawings may be incorporated, but not halftones. Indicate your preference for an oral or poster presentation. Slots for oral presentations are limited and will be allocated by the organizing committee. Manuscripts, and questions on conference content, can be directed to Roger L. Reep, Dept. of Physiological Sciences, Box 100144 JHMHC, University of Florida, Gainesville, FL 32610; phone (904) 392-4700, ext. 3859; fax (904) 392-5145; Internet REEP@CORTEX.HEALTH.UFL.EDU.

Established investigators, students, and interested lay people are encouraged to attend. Each attendee will receive at the meeting a bound volume of the papers presented at the meeting. Participation is limited to 250 people. Registration costs are $70 for non-student participants, $30 for students; late registration (after 1 December) is $110 or $50, respectively. The charge for the banquet is $18, and for the field trip, $15 (lunch included). For registration, contact Pat Neilson, University of Florida, IFAS Office of Conferences, P.O. Box 110750, Gainesville, FL 32611-0750; phone (904) 392-5930; fax (904) 392-9734.

MARINE MAMMAL E-MAIL DISCUSSION LIST

A marine mammal research and conservation e-mail discussion list has been established, using the listserver at the University of Victoria. The purpose of this is to facilitate discussion regarding research and conservation of marine mammals, as well as for posting conference or meeting announcements, volunteer opportunities, new techniques or equipment available, new books or journals published, etc.

There is no cost for subscribing. Messages sent to the list (marmam@uvvm.uvic.ca) will be forwarded to all members subscribing to the list. To subscribe, send a message to the listserver (listserv@uvvm.uvic.ca or listserv@uvic.bitnet), with a message in the text saying:

subscribe MARMAM your name

The subject line in the message should be left blank.

Please forward this message to any colleagues working on marine mammal research or conservation topics. Questions regarding the list can be sent to the list managers, David Duffus (ddvffvs@uvvm.uvic.ca) or Robin Baird (rbaird@sfu.ca). - **Robin Baird**

LOCAL NEWS

BRAZIL

New Manatee Journal. - The Brazilian environment agency IBAMA has inaugurated a new technical journal devoted entirely to research on the nation's manatees. Entitled *Peixe-Boi*, or manatee, it is published in Portuguese by IBAMA's National Center for Conservation and Management of Sirenians, and is edited by Danielle Paludo.

Publication began in 1992 with Ano 1, No. 1, a spiral-bound issue of 73 pages containing six articles (see Recent Literature, below). The contents deal with both Amazonian and West Indian manatees and cover such topics as distribution, status, and conservation in the wild and diet, growth, behavior, and blood chemistry of captive animals.

Peixe-Boi (ISSN 0103-9431) has its editorial offices at the Centro Peixe-Boi/IBAMA, Av. Dom Pedro II, no. 3484, João Pessoa, Paraíba, CEP 58040-440, Brazil. All submissions and correspondence regarding the journal should be directed to that address. No price for subscriptions is given.

We congratulate the editor and publishers of this welcome addition to the sirenian literature, and wish *Peixe-Boi* a successful future.

Conservation Recommendations. - The 5a. Reunión de Trabajo de Especialistas en Mamíferos Acuáticos de América del Sur, held in September of 1992 in Buenos Aires, Argentina, included a round-table meeting on the problems of sirenian conservation in Brazil. This meeting, coordinated by Ricardo J. Soavinski, recommended the following (translated from Portuguese):

1. A survey of the distribution and occurrence of the Amazonian manatee, and continuation of surveys of distribution and occurrence of West Indian manatees in Brazil.

2. Evaluation and quantification of incidental entanglements of manatees in fishing nets, as well as of intentional captures of manatees for food.

3. Evaluation of the quality of manatee habitats in Brazil. Evaluation of heavy-metal and organochlorine levels in sirenian tissues should be emphasized.

4. Monitoring of manatees in their principal areas of occurrence and in areas of demonstrated importance in their life cycles.

5. Studies of population dynamics and genetics in order to evaluate groups and populations.

6. Creation and establishment of Conservation Units in priority areas in order to preserve sirenians and the ecosystem as a whole.

7. Immediate creation of the Barra do Rio Mamanguape Environmental Protection Area in Paraíba; of a conservation unit in the Rio Timonhas estuary, in Piauí; and of another in the coastal region of Tabuba, in Alagoas - areas of demonstrated importance for conservation of the West Indian manatee in the Brazilian Northeast.

8. Development of environmental education campaigns in the area of distribution of sirenians, in order to prevent their extinction.

9. Greater participation of aquatic mammal specialists in discussions about sirenians and mustelids in future meetings and congresses.

10. Extension of these recommendations to other South American countries where sirenians occur and that possibly face the same problems as Brazil.

COLOMBIA

Conditions for Captive Manatees Improved. - **Rubby Montoya** of the Caribbean Stranding Network (CSN), Puerto Rico, reports on the status of a young female West Indian manatee, formerly held in very inadequate facilities at the Jardin Zoológico de Barranquilla. Following unsuccessful attempts to have the animal transferred to other facilities, the latter institution has now been taken over from the city government by a

new, privately-sponsored enterprise, the Fundaciòn Zoològico de Barranquilla. This new foundation has promised to treat the manatee's welfare as its top priority, implementing some of CSN's recommendations for improvements in the animal's diet and contracting more capable zookeepers. Construction of a new holding facility and development of managerial and educational programs are being monitored by INDERENA (the Colombian government's natural resources agency) and by CSN.

Several other manatees held in CSN-sponsored semicaptive colonies in the towns of Maganguè and Pinto were also examined recently, and found to be in good health. With the help of CSN and the Save the Manatee Club (Florida), educational efforts in Maganguè are also bearing fruit. A "Club Amigos del Manatì", comprising 113 high school students, was created in October 1992. They have been spreading the word about manatee conservation to other schoolchildren, assisting in fieldwork, and representing their state at a science fair in Bogotà, and are now seen by the Maganguè community as a symbol of conservation education for the new generation.

FLORIDA

Manatees "Introduced" into Florida??? - In the course of a rancorous debate like the one presently raging in Florida over boat speed limits, it is to be hoped that the parties to the discussion will try to get their facts straight. This ideal, however, is not always achieved, as seen from the inaugural issue of a newsletter published by the Boat Owners Association of The United States. In *BOAT/U.S. Reports*Florida*, Vol. 1, No. 1, April 1993, a letter to the editor from Jim Walters of Jupiter, Florida, is published with an editorial endorsement stating that "... every once in a while we get a letter on a controversial issue which is so well written that it deserves to be widely shared. Whether you agree or disagree with Mr. Walters, we would like to hear from you." Excerpts from Mr. Walters' letter follow:

"Having been in the marine industry in our state, I have seen countless numbers of rules and regulations regarding our waterways grow, many of them good and many of them bad.

"Here is my plan to solve the greatest boating issue placed before the Governor and Cabinet members: the dispute between the recreational boaters, the manatee and the DNR (Florida Dept. of Natural Resources).

"Years ago, manatees were brought here to Florida and released in the freshwater canals to eat and maintain the overgrowth of hyacinths. It seemed to be a good idea, but it really didn't work. Instead, the giant manatees worked their way through the canal network and ventured out into the intracoastal waterways and ocean. This was not part of the plan and they easily adapted to the salt water....

"Like all other endangered animals in the world, the manatee is faced with the same problems as the elephant, the rhinoceros and the buffalo. They have become endangered because they got in the way of man's progress....

"The current attempt to crush boating and restrict God's greatest mammal, man, from his greatest Florida pastime, boating and water sports, is absolutely ludicrous.

"Let's handle the manatee like all other endangered species we have dealt with in the past. We will select for them one of the largest and most beautiful lakes we have to offer in Florida. We will build them the ultimate habitat....

"Let's get our rescue team out there and gather up the remaining manatees and transport them to their new, safe home in the middle of the state where they can live happily ever after...." [Emphasis added]

Just for the record, the oldest currently known *Trichechus* fossils from Florida are Early Pleistocene in age (about 1.0-1.5 million years old), and the earliest remains of any sirenians in the state are Middle Eocene (around 45 million years old). In fact, at the moment Florida happens to be the only place on the planet where fossil sirenians are known from every geological epoch from Eocene to Recent!

If you would like to respond to the invitation of the editors of *BOAT/U.S. Reports*Florida* to comment on this letter, their address is 880 S. Pickett St., Alexandria, VA 22304 USA. - **DPD**

INDONESIA

Dugong Seminar in Ambon. -

During 7, 8 and 10 April 1993 an International Seminar was held in Ambon on Coastal Zone Management of Small Island Ecosystems, with special reference to turtle and dugong conservation.

The seminar was funded by the European Economic Community and was organized by the Environmental Studies Centre of the Pattimura University in Ambon, in cooperation with the National Science Institute LIPI, AID Environment Amsterdam, and the Centre for Environmental Science, Leiden University, The Netherlands.

Some 65 participants from Indonesia, Canada, USA, Australia, UK and The Netherlands participated in the seminar. Although its scope covered a wide range of subjects related to coastal zone management and marine conservation, the importance of the seminar for the conservation of Sirenia in Indonesia was the official recognition of the need for conservation and proper management of dugong populations in Indonesian coastal waters.

The seminar was attended by the Governor of the Moluccas Province, the Assistant Minister for the Environment (representing the Minister), the Ambassador of the EEC, and the Rector of the Pattimura University.

During his keynote speech the Assistant Minister stressed the importance of the conservation of endangered and vulnerable marine species such as sea turtles and dugongs, and the need for an integrated system of coastal zone management. Hans de Iongh presented an overview of the results of ongoing research on dugong feeding ecology in the Moluccas.

During workshop sessions, the participants elaborated on a large number of specific recommendations, such as the need for further inventories of dugong populations in Indonesian coastal waters, the establishment of a National Conservation Strategy and Action Plan for Dugongs in Indonesia, and the need to increase the number of Marine Conservation Areas.

The International Seminar also marked the start of a Coastal Zone Management Project, funded by the EEC. Drs. Henk Blaauw, project leader, and Mark van der Wal, ecologist, have been assigned to this project to assist the staff of the Environmental Studies Centre of the Pattimura University to implement coastal zone inventories, mapping, planning, and a range of pilot projects in support of coastal communities. A specific research programme, with cooperation between Dutch and Indonesian staff and students, covers the distribution, migration, and feeding ecology of dugongs in the Moluccas.

Further information on the project and the seminar proceedings can be obtained through: Drs. Henk Blaauw, Mark van der Wal, and Desi Norimarna, Environmental Programme Maluku (EPM), POB 221, Ambon, Indonesia (telephone 62-911-61236; fax 62-911-61455). - **Hans de Iongh**

OMAN

Does the Dugong Occur in Omani Waters? - From our knowledge of the present world distribution of the dugong (e.g., Thornback & Jenkins, 1982, *IUCN Mammal Red Data Book*; Bertram & Bertram, 1973, *Biol. J. Linn. Soc.*), it is not expected along the coast of eastern Arabia except as stray migrants, but there are only two references to this ever occurring: remarks attributed to W. Travis to the effect that there are "occasional strays at Mukalla and Kuria Muria Islands" (Bertram & Bertram, 1973: 307), and mentions of Bab el Mandeb in the past (Preen, 1989, *MEPA Coastal & Marine Management Series* (Saudi Arabia), *Rept.* #10, Vol. 1).

Oman has a coastline in excess of 1800 km between Yemen and the Arabian Gulf, so the question "Does the dugong occur in Omani waters?" has never been far from our thoughts. It gained prominence again during the preparation of the Whale Hall extension (opened in December 1992) to the Oman Natural History Museum at Muscat, where we were able to include one exhibit exclusively for the dugong, its range, status, habits and threats.

Beds of seagrasses along the coast of Oman are small, sparse and ephemeral (IUCN, 1988, *Oman: Coastal Zone Management Plan - Quriyat to Ra's al Hadd*, Report for Ministry of Commerce & Industry, Oman), with the notable exception of the area of Barr al Hikman (opposite the island of Masirah), and the Ghubbat Hashish in particular. Here Salm (1991, *Shoreland and Marine Environments, Sultanate of Oman*,

Report for Ministry of Commerce & Industry, Oman) reports the densest and greatest variety of seagrasses in the Sultanate, with at least five genera present (*Halodule, Halophila, Thalassia, Thalassodendron*, and *Syringodium*), all of potential use to dugongs, which, however, have never been reported here.

When it was suggested by other States during the Gulf War that dugongs under threat in the Arabian Gulf might be translocated to Oman, we pointed out that though the area just mentioned seemed suitable, the fact that dugongs were not present was probably an indication of its unsuitability, particularly because this coast is affected by the very cold current generated by the strong winds of the southwest monsoon of summer.

So far, our searches on the islands and the coast of Oman during the last 17 years have yielded no evidence of dugongs. However, dugongs may very occasionally stray eastward in the Arabian Gulf to reach Omani shores in the Musandam region. Individuals may also occur in Omani waters when on passage between the populations of the Red Sea and Africa and those to the east, when they would not necessarily keep to shallow water or pause to feed.

Nevertheless, the report of "occasional strays ... on the Kuria Muria Islands" attributed to Travis is most unusual, and it would be good to have confirmation of this. - **Michael D. Gallagher** (Natural History Museum, P.O. Box 668, Muscat 113, Sultanate of Oman, fax 602735)

PUERTO RICO

New Newsletter. - The Caribbean Stranding Network (Red Caribeña de Varamientos) has begun publication (in Spanish) of a newsletter entitled *Alerta Neptuno*. The first issue came out in March 1993, the second in June, and subsequent issues are scheduled to appear every three months. Regular features will deal with research, rescue and rehabilitation, and public education concerning endangered aquatic fauna, including manatees. The editor is Gloribel Delgado (Apartado 908, Lajas, PR 00667-0908).

As part of its development efforts, the Caribbean Stranding Network is also opening membership to supporters and sponsors (US$10/year student membership, $15 individual, $25 family, as well as higher-level sponsor and corporate memberships). The benefits of membership include a subscription to *Alerta Neptuno*. Further information can be obtained from the address above.

We wish the Stranding Network the best of luck with its newsletter and membership drive, and anticipate that these will make valuable contributions to marine conservation efforts in the Caribbean region.

Radiotelemetry and Hematology Projects. - During May 1993, biologists of the U.S. Fish and Wildlife Service's (FWS) Sirenia Project began the second stage of a manatee radiotracking project in Puerto Rico. Other participants included the Caribbean Stranding Network, the Department of Marine Sciences of the University of Puerto Rico, the FWS Caribbean Field Office, the Department of Natural Resources, and the U.S. Navy.

The project seeks to investigate the migratory patterns of manatees on Puerto Rico's east coast, specifically within the Roosevelt Roads Naval Base. Three males were tagged in 1992. According to Jim Reid and Bob Bonde, the project's directors, these animals often moved large distances in the course of a day, but individual movement patterns differed significantly. This year, three more manatees were tagged with transmitters.

Blood samples were also taken for a study of comparative hematology in manatees from Puerto Rico, Colombia, and Florida. This project, which will serve as Rubby Montoya's master's thesis, aims to establish normal blood-chemistry parameters for the Antillean manatee. Skin samples are also being taken for individual identification and studies of the genetics of the Caribbean manatee population. - (Translated and abridged from *Alerta Neptuno* 1(2), June 1993.)

THAILAND

Surrogate Mothers for Dugongs??? - The following excerpts are from an article that appeared in the *Bangkok Post* in early May 1993:

"WANTED: A tender-loving woman volunteer to breast-feed a baby dugong who

has lost his mother. Mermaids need not apply.

"A stray baby dugong housed at the Marine Biological Centre in Phuket desperately needs a generous woman to be his 'mother', Fisheries Department chief Plodprasop Suraswadi told the *Bangkok Post* on May 3.

"The baby dugong needs a woman volunteer to be with him at least three hours a day to nurse him and breast-feed him, Mr Plodprasop said.

"Mr Plodprasop said the baby marine mammal was thought to be about six months old when he was caught unintentionally by fishing nets at night on April 22 off Phumriang beach in Chaiya District of Surat Thani Province....

"The baby dugong was 97 centimetres long and 14 kilogrammes in weight ....

"The problem, he said, is that the baby dugong refuses to take milk from a bottle and the centre officials may have to try breast-feeding from a woman...."

Sirenews looks forward to hearing from readers the denouement of this story.

VENEZUELA

Manatee Research Base Established. - Project Mermaid, an expedition from the University of Newcastle upon Tyne (UK), traveled to the Gulf of Paria, Sucre State, Venezuela (see *Sirenews* No. 19). Over a period of three months (July to September 1992) the team constructed a 9m x 4m floating platform. This was sailed over 100 km to the study river, Cano La Brea. Surveying from dugout canoes over a period of 20 days, the team made 14 records of manatees (*Trichechus manatus*) in the 30 km of navigable river. Of the 14 records, ten were considered to be "definite", two to be "probable" and two to be "possible". Seven of the records are of between one and five manatees feeding on floating and submerged vegetation (*Pistia stratiotes, Lemna* sp., and *Myriophyllum* sp.), a further two records are of manatees resting just below the surface, and three records are of manatees traveling along the cano. Examination of feces revealed grasses (Gramineae), black mangrove (*Avicennia nitida*), and *Rhabdadenia biflora*. Black mangrove only occurs in the first 7 km from the mouth of the cano; the feces containing black mangrove were collected 30 km upstream, indicating significant manatee movements.

The results from this brief survey indicate that Cano La Brea is an excellent wet-season habitat for manatees. Of great importance is the possibility raised by O'Shea et al. (*Biol. Conserv.* 46: 281-301, 1988) that in the dry season Cano La Brea forms a feeding sanctuary for manatees from a wider area. Cano La Brea, along with Rio Morichal Largo (Maturin State), are unique in the area in that they are deep freshwater streams that provide access to savanna feeding areas, unlike the majority of mangrove-lined canos which are accessible for feeding only at high tide. If manatees do use the cano as a refuge in the dry season, then Cano La Brea is of critical importance for the manatee in Venezuela.

Project Mermaid is applying for charity status. Members of the original team are returning to the floating platform in January 1994, to commence six months' continuous research on the river. This will include a feasibility study for the use of radiotelemetry, as well as research on the area's other wildlife. The floating platform is established as a research base and the team is interested in hearing from manatee specialists who would like to visit the area with research in mind. At present, providing sufficient funding can be found, Project Mermaid intends to support an Environmental Impact Assessment and Management Plan, to be undertaken by Provita, A Venezuelan non-governmental conservation society, starting in late 1994. Contact: Project Mermaid, Trees Cottage, Froxfield, Petersfield, Hampshire, GU32 1DN, UK (fax: 0263-71-3100). - **Richard Cuthbert**

WASHINGTON, D.C.

Sirenian Bibliography. - Domning's *Bibliography and Index of the Sirenia and Desmostylia* has been formally accepted for publication in *Smithsonian Contributions to Paleobiology*. Funds are now being obtained to support its publication, which is expected to take place during 1994. Stay tuned for further bulletins, and please send me copies of your publications as promptly as possible, since the database will be closed sometime in the next few weeks. - **DPD**

ABSTRACTS

The following two abstracts, here translated from Portuguese, are of papers presented by personnel from INPA (Manaus, Brazil) at the 5a Reuniôn de Trabajo de Especialistas en Mamíferos Acuàticos de Amèrica del Sur, held in Buenos Aires, Argentina, 28 Sept.-2 Oct. 1992.

Hematocrit, Hemoglobin and Mineral Content of the Serum of the Amazonian Manatee (Trichechus inunguis) (**Kesa K. Lehti & Fernando C. W. Rosas**). - We analyzed blood samples from 8 Amazonian manatees, 5 males and 3 females held captive at INPA, to determine hematocrit and hemoglobin. The serum of the same animals was analyzed by atomic absorption spectrophotometry to determine the concentrations of zinc, sodium, copper, magnesium, manganese, iron, and calcium. The hematocrit varied between 23 and 34% (mean 27%), and the hemoglobin between 10.9 and 15.2%. The levels of zinc varied from 6.25 to 8.0 ppm; sodium, 7.209-8.331 ppm; copper, 0.51-0.91 ppm; magnesium, 26.08-26.74 ppm; iron, 1.11-2.00 ppm; and calcium, 39.5-56.5 ppm. Manganese was not present in any sample. The low hematocrit values obtained in this study, though similar to others obtained for the Amazonian manatee (32-35%, mean 33%), are probably due to monotony of the diet provided since 1986. These results are lower than the hematocrit values cited for *T. manatus* (39.3-46.6%), whereas the hemoglobin values are similar for both species. The sodium concentrations are almost double those cited in the literature for *T. manatus* (3.412-3.471 ppm; Irvine et al., 1980; Medway et al., 1982), whereas the magnesium values were half those found in the West Indian manatee (53.49 ppm). The calcium values are much lower than those for *T. manatus* (348.7-412.8 ppm). The concentrations of the other elements could not be compared due to lack of published data.

Growth of Amazonian manatee Calves Raised on Artificial Milk (**Fernando C. Weber Rosas**). - Techniques of raising *Trichechus inunguis* calves have been developed by the Laboratory of Aquatic Mammals of INPA, which has successfully raised calves orphaned by the illegal hunting that continues in the region. These animals are nursed for 1-2 years with powdered milk enriched with soy oil, using special nursing bottles. Size and weight data were analyzed for 15 manatees raised at INPA. The sexes were analyzed separately, but no significant differences between them were found. The equations obtained to express the growth in length (1) and weight (2), after testing the linearity of the relations, were:

Ct (cm) = 96.764 + 2.749 X (months), n=236, r=0.86 (1)

Pt (kg) = 11.696 + 3.502 X (months), n=262, r=0.86 (2)

The relation weight/length obtained for the 15 calves was:

Pt (kg) = 5.105x10-6.Ct3.31 (cm), n=233, r=0.97.

Although the growth data presented here pertain to animals raised on artificial milk, they are very similar to data for *T. manatus* nursed by their mothers (Odell, 1978).

The following abstracts are of papers and posters presented at the Sixth International Theriological Congress held in Sydney, Australia, 4-10 July 1993.

RECENT OBSERVATIONS AND FEEDING ECOLOGY OF DUGONGS AT CALAUIT ISLAND, BUSUANGA, PALAWAN, PHILIPPINES

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A simultaneous monitoring system which used a team of local observers to count dugongs around Calauit Island from nine vantage points was developed and employed. Monitoring was implemented each month from March 1989 to May 1990. This allowed the identification of 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 for that year.The site where dugongs were most often sighted was about 1.5 m deep and supported a seagrass biomass averaging 1060 g/m^2 (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 *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, an average consumption rate of 68.5 kg (wet weight) of seagrass per day was estimated.

The results from this study were used to identify reserve areas for the protection of dugong habitats. This study suggests that the dugong populations of unknown size in Calauit Island and the rest of Palawan, Philippines should receive further attention and implementation of conservation measures.

HERBIVORE-PLANT INTERACTIONS BETWEEN DUGONGS AND SEAGRASS COMMUNITIES IN MALUKU, EAST INDONESIA.

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Dugong (Dugong dugon) grazing interactions with intertidal, Halodule uninervis dominated, seagrass meadows in Nang Bay, East coast of Ambon, were investigated between December 1990 until December 1991. Dugong prefered meadows of H. uninervis. Dugong grazing was concentrated in three distinct grazing plots, maintaining H.uninervis pioneer vegetations. The frequency of feeding during 1991 showed a strong correlation with total C (%) in the below-ground fraction, indicating that the dugongs preference for the H.uninervis meadow seems based on a strategy of energy maximization. Total C (%) in the below-ground fraction showed a significant increase from dry to wet season. In contrast total N(%) and P(%) levels in below-ground H.uninervis samples showed a decrease from dry season to wet season. Above-ground biomass of H. uninervis showed a sudden significant collapse at the onset of the wet season in May, whereas biomass and the level of soluble carbohydrates in the below-ground fraction showed simultaneously a significant increase, resulting in a visible 'sparse' seagrass meadow, with a nonvisible high below-ground biomass in August 1991, total C(%) was highest. This phenomenon could explain the reported preference of dugongs for 'sparser' stands of seagrass. Dugong grazing removed 93 % of the shoots and 75 % of the below ground biomass between 0 and 4 cm depth. Seagrass biomass in fresh grazing tracks was restored to control levels after five months during the onset of wet season, but no significant restoration took place during the dry season.

WHY DUGONGS ARE FUSSY EATERS: A NUTRITIONAL BASIS TO FOOD SELECTION IN DUGONGS

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The dugong is a benthic-feeding herbivore grazing almost exclusively on seagrass in tropical Australia. Dugongs are selective in their feeding habits, preferring small delicate seagrasses such as *Halophila ovalis* and *Halodule uninervis* (narrow leaf) to more 'robust' seagrass such as *Zostera capricorni* . Diet selection in the dugong is correlated with the chemical or 'nutrient' composition of seagrass, where the preferred species are those lowest in fibre, and highest in "available" nitrogen. In addition, the preferred seagrasses also have the highest fracture properties, which are primarily a function of fibre level but also arrangement of this fibre within the plant tissue. The high fracture properties of the preferred seagrasses are reflected in the specialised mouthparts of the dugong. The morphology, structural composition, small size and high variability of the cheekteeth of the adult dugong indicate that the teeth do not play an important role in the maceration of seagrass. In contrast, the development of opposing horny pads provides a highly effective food ingestion and processing organ capable of processing large quantities of low fibre seagrass during short dive times. The nature of low fibre seagrass also makes it particularly amenable to mechanical and fermentative reduction during passage through the long digestive tract of the dugong. Digestibility of low fibre seagrass is high in comparison to more fibrous seagrass, based on particle size reduction of the digesta. The high degree of specialisation of the mouthparts with the loss of functional teeth may impose constraints on the feeding niche of the dugong so that only certain tropical seagrass meadows constitute suitable dugong habitat.

STATUS OF THE WEST INDIAN MANATEE

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The West Indian manatee, *Trichechus manatus*, is tropical to subtropical in range within the western Atlantic region. Considerable information exists on the Florida subspecies (*T. m. latirostris*), whose survival is still threatened by collision with boats, despite strong protective measures to regulate boating activity. Florida (USA) is near the limit of the manatee's year-round range, although they frequently occur in the coastal salt marshes of southern Georgia in warm seasons (Zoodsma, 1991). The Suwannee River is the northern limit of the manatee's usual range on the Gulf coast of Florida (Powell and Rathbun, 1984). Physiological studies of metabolic rates as well as shifts in manatee distribution and their use of available warm water sources (natural springs and heated industrial effluents) demonstrate that energetic requirements influence the range limits of manatees (Lefebvre et al., 1989). Manatees migrate hundreds of kilometers along both coasts of Florida to seek warmer waters in the winter, thus travel corridors and warm season dispersal areas must be protected as well as warm-water aggregation sites (Reid et al., 1991). The minimum number of Florida manatees is estimated to be 1856 (Ackerman, 1992). No method yet exists to monitor trends in manatee numbers; however, a growing body of population biology data suggests that Florida manatee population viability is high provided that mortality levels do not increase and reproductive rate does not decline (e.g., Marmontel, 1993). The Florida population shows no regional genetic differentiation, and levels of observed genic variability suggest that this population has not been subjected to the loss of variability caused by bottlenecks in population size that are characteristic of some endangered species (McClenaghan and O'Shea, 1988).

Far less information is available on the biology and status of the Antillean manatee (*T. m. manatus*), which occurs in the Greater Antilles, Mexico, and portions of Central and South America. The subspecies has protected status throughout most of its range, but opportunistic taking by fishermen continues to threaten the survival of manatees in many countries. Manatees are still reasonably abundant in Belize and some areas of Mexico, in comparison with other countries of Central America. A radio telemetry study of manatees in Puerto Rico was initiated in 1992. Recent efforts to launch research and conservation education projects on the West Indian, the Amazonian (*T. inunguis*), and the West African manatee (*T. senegalensis*) are an encouraging sign that the uniqueness of the sirenians is widely recognized.

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ASSESSING MANATEE GRAZING EFFECTS ON SEAGRASSES

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Sea cows and seagrasses have co-evolved over millions of years (Domning, 1981). Seagrasses, particularly *Syringodium filiforme* and *Halodule wrightii*, are an important part of the Florida manatee's (*Trichechus manatus latirostris*) diet. Since 1987, we have examined ways to assess short-term and long-term impacts of manatee grazing on seagrass beds in coastal Florida lagoons. Studies conducted in Hobe Sound and Jupiter Sound on the east coast of Florida indicated that, on average, grazing removed approximately 80-90% of the shoot biomass and 50% of the rhizome biomass in disturbed areas (Lefebvre and Powell, 1990). Shoots were counted in permanent 1-m^2 plots established in 16 sampled feeding sites immediately after grazing occurred in winter 1989, and again in May and August 1989. Most of the plots showed significant recovery by August. *H. wrightii* shoots increased at a faster rate than *S. filiforme* shoots.

DUGONGS AND SEAGRASSES IN AUSTRALIA: THE BIG PICTURE

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Large-scale quantitative aerial surveys for dugongs have been conducted over a total area of some 200,000 km^2 in northern Australia. The estimated densities are still probably underestimates and do not allow for presumed variations in availability bias due varying proportions of time dugongs spend on the surface in different water depths. Despite these inadequacies, large-scale patterns emerge. There is an approximately linear relationship between dugong numbers and known area of seagrass in the Great Barrier Reef region and in the Western Gulf of Carpentaria. Quantification of this relationship may provide a basis for assessing the status of dugong populations without reference to their rate of change. For example in the Great Barrier Reef region, five of the six areas with the lowest density of dugongs have high levels of boat traffic.

In several areas (Torres Strait, Starcke River area, Hervey Bay and Shark Bay), high numbers of dugongs ($\geq$ 1400) are associated with extensive tracts of seagrass (mostly *Halophila*) in relatively deep water (> 9m). Most of these seagrass meadows were revealed to western science as a result of ground- truthing following dugong surveys.

Large scale (100's km^2) loss of seagrass following natural disturbances such as floods and cyclones has occurred in the Gulf of Carpentaria, Townsville region and Hervey Bay. Extensive dieback of seagrass of unknown aetiology was also recorded in Torres Strait in the 1970's. These events tend to be followed by the death of dugongs from starvation. Other animals suffer a severe loss of body fat followed by several years of low reproductive activity. The need to delay reproduction during times of stress is consistent with the dugong's K-selected life history.

THE STATUS OF THE DUGONG

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The range of the dugong, Dugong dugon, extends through the tropical and sub-tropical coastal and island waters of the region east to the Solomon Islands and Vanuatu, and between about 26° to 27° north and south of the equator. Over much of this region, dugongs are now believed to be reduced to relict populations which are separated by large areas where they are close to extinction or extinct. This assessment is almost entirely based on anecdotal information and the actual extent to which the dugong's range has contracted is unknown.

Large-scale quantitative aerial surveys for dugongs have been conducted over some 200,000 km^2 in northern Australia and 50,000 km^2 in the Arabian region. The estimated densities are still probably underestimates and do not allow for presumed variations in availability bias due varying proportions of time dugongs spend on the surface in different water depths. Even though not all areas of suitable habitat have been surveyed, the population estimates sum to more than 80,000 in Australia more than 10,000 for the Arabian region. There are no comparable data from other parts of the dugong's range.

The major problem in determining the status of the dugong is the difficulty of detecting trends in abundance. For example, if the estimated 8000 dugongs in the northern Great Barrier Reef region were declining at 5 % per year, it would take at least 10 years of annual surveys before it could be determined within the usual limits of statistical error that the population was in fact declining. By that stage, numbers would have declined to about two thirds of their value at the time of the first survey. The difficulties of detecting such a trend at a more localised level are much greater than this. It will be impossible to detect trends at spatial and temporal scales which are relevant to environmental planning and management using present techniques.

It may be more productive to use a demographic approach to assess the status of the dugong by assessing the level of anthropogenic mortality in an area in the context of an absolute estimate of abundance and population models. For this approach to be useful, anthropogenic and natural mortality will have to be quantified. There are currently few reliable estimates of mortality. Dugongs are still killed for food in many parts of their range although much of this hunting is now illegal. They are also killed incidentally in gillnets in many parts of their range. Habitat degradation as a result of pollution is likely to be a major impact in areas such as the Arabian Gulf.

Given these problems, it would be prudent to manage dugongs by identifying and protecting areas which still support large numbers of animals.

In October 1990, two 12.8 x 12.8 m manatee exclosures were constructed in a mixed-species seagrass bed in the northern Banana River on the east coast of Florida. This is an important feeding area for a large number of manatees in the late winter and spring. A paired open area of the same size was established near each exclosure. Species composition was mapped and random biomass cores were taken of the co-dominant species, *S. filiforme* and *H. wrightii*, in all 4 areas in October, February, and July of 2 consecutive years (through July 1992). A multivariate ANOVA on log-transformed biomass indicated that manatee grazing reduced biomass in the open study areas, but that differences occurred in the impact to and response of *S. filiforme* and *H. wrightii* at one of the exclosure sites (Fig. 1). The results of these studies will help biologists to assess impacts and estimate manatee carrying capacity of repeatedly grazed seagrass beds in areas of special significance to manatee conservation.

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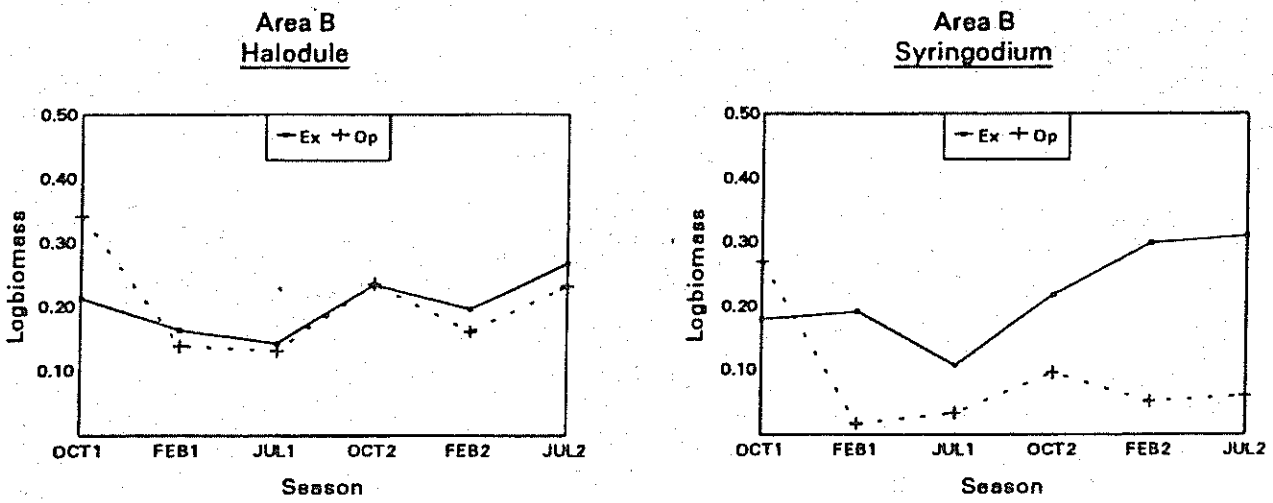

Fig. 1. Seagrass logbiomass by Species, Season x Year, and Treatment (Exclosed vs Open to manatee grazing) in Area B, northern Banana River, Florida, USA

AGE DETERMINATION AND POPULATION BIOLOGY OF FLORIDA MANATEES, *TRICHECHUS MANATUS LATIROSTRIS*

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Florida manatees (*Trichechus manatus latirostris*) are endangered by watercraft strikes and habitat alteration (O'Shea and Ludlow, 1992), but population studies have been hampered by the lack of a method of age estimation. Results consistent with known age, minimum known age or tetracycline-labeling were obtained by histological techniques only from the dome region of the periotic bone. Age-specific aspects of mortality and reproduction were evaluated for 1,212 manatee specimens collected between 1976 and 1991. Approximately 59 layers were found in the periotic dome of one manatee of unknown age, and several had growth-layer-group counts ranging from 21-39. Sexual maturation occurred between 3 and 4 years of age, with first calving probably at age class 4. At any one time 33 % of the mature females were pregnant, indicating an average calving period of 3.0 years. Fecundity remained relatively unchanged (0.24 female offspring/adult female/year) from age of first parturition throughout life. Half the carcasses belonged to age classes 0, 1 and 2, and average age was low (5.7 years). Survival rate was low among the very young, increased up to age class 4, and remained constant (89.9 % $\pm$ 0.013) from age class 4 to at least 25. Manatee survivorship curve is consistent with the type expected in a long-lived mammal, but lacks a plateau through middle age. The steeper gradient is attributed to exacerbated levels of adult mortality represented by the constant threat of collision with watercraft. Death from intense cold affected mostly juveniles, but the effect of boat strikes was constant across age classes. Life table analyses revealed a finite rate of increase $r = 0.5\%$, indicating virtually zero population growth. Computer simulation (VORTEX51: Lacy, in press) projected a 97.3 % chance of persistence of the population for 1,000 years. The current situation allows no margin of error. If increasing number of boats result in more deaths, the manatee population will tend toward extinction. Only cultural change will prevent this outcome.

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THE STATUS OF DUGONG HABITATS IN THE GREAT BARRIER REEF REGION

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One of the greatest pressures on Australian dugong populations is habitat degradation. By identifying threats to seagrasses, the status of dugong habitats may be assessed. Dugong habitats at risk from degradation have been identified in the Great Barrier Reef Marine Park using seagrass data, dugong distributions, and information on coastal developments, boating and waste discharge. Regions north of Cooktown were found to be relatively free of anthropogenic pressures. Only 12% of the meadows were found to be within five kilometers of an anthropogenic activity. Forty-eight percent of the meadows in the Cairns section were within five kilometers of a disturbance, however this is not a region of high seagrass or dugong abundance. Several areas within the Central and Mackay/Capricorn Sections are utilised by dugongs. A large portion of these seagrass meadows (48%) were found to be within five kilometers of at least one of the identified anthropogenic activities. In these areas, the greatest potential disturbance was from boating, followed by tourism and residential developments. Sewage and waste outlets were of concern, especially in regions such as the Whitsunday's where there are numerous tourist operations. However, this problem is now being addressed as new guidelines will be enforced by January 1996. With both the expansion of tourism and increasing populations, the preservation of habitats needs to be considered as habitats are generally small and sparse in areas south of Cooktown.

AGE ESTIMATION IN 'PERINATAL' FLORIDA MANATEES (TRICHECHUS MANATUS LATIROSTRIS)

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Monitoring manatee mortality in Florida began in 1974 under a program established jointly by the University of Miami and the United States Fish and Wildlife Service (O'Shea et al, 1985). The program was transferred to the Florida Department of Natural Resources in 1986 (Ackerman et al, 1992). Included among the objectives of the program is the determination of cause of death, especially those causes that are human-related. Manatee mortalities are categorized in several ways, including natural and human-related causes. One category that has been particularly troublesome is 'perinatal' or 'dependent' calf. Historically, a 'perinatal' calf has been defined as an individual with a total body length of 150 cm or less. This definition came about because the largest known fetus was 150 cm long. The smallest viable calves are about 100 cm long. The 'perinatal' category is ill-defined in that it can include animals ranging in age from newborn to several months. The categorization of manatees in the 100-150 cm range as 'dependent' calves is a better term, however it is not inclusive since dependent calves may be well over 150 cm long. In recent years, the number of deaths in the 'perinatal' or 'dependent' calf category has increased dramatically (Ackerman et al, 1992). To properly assess this situation, the truly "perinatal" animals in this category must be separated from the older animals. If all calf carcasses were fresh upon discovery, this determination could be made at necropsy. Unfortunately, many carcasses are badly decomposed upon recovery leaving primarily skeletal remains. The objective of this study was to develop a method for estimating the relative age of calves in the 'perinatal' (dependent calf) category using tooth growth patterns.

Skulls and related data on individual manatee calves were collected during 1992 by the Florida Department of Natural Resources' manatee carcass salvage program. Data from orphans that died during rehabilitation are also included. We also included animals up to 200 cm body length for reference because these animals are clearly not 'perinatal'. Forty-five animals have been examined as of 20 March 1993. Skulls were cleaned by boiling. Bones were stored dry. After documenting tooth counts and eruption pattern, individual teeth were removed from the skull, measured (tooth length = root + crown) and stored in a 1:1 mixture of glycerol and 70% isopropyl alcohol. The third lower right molar (LR3) was sectioned in an anterior-posterior plane at about 125μ on a Buehler Isomet Low Speed saw. Sections were examined at 10X or greater under polarized light on a binocular dissecting microscope. Tooth eruption patterns, total tooth length (LR3) and the presence/absence of post-natal dentine deposition were related to total body length.

All but one of the calves examined in the 100-150 cm body length range (n=39) had three molars fully erupted above the level of the bony alveolus in each jaw quadrant. Total tooth length (LR3) increased from about 10 mm at 100 cm body length to 15-16 mm at about 130 cm body length and remained relatively constant up to body length of 200 cm. However, there was as much as 5-6 mm variation in tooth length (LR3) within body length classes. There is evidence of post-natal dentine deposition in one calf 138 cm long. Calves in the 180-200 cm body length range had extensive post-natal dentine deposition with dentinal layering. These animals also had 5-7 teeth erupted in each quadrant and crown wear. Using the above-described methodology, it appears that almost all of the calves in the 100-150 cm length range lacked post-natal dentine deposition and may well have died at around the time of birth (i.e.

perinatal). This suggests that the number of calves in the 'perinatal/dependent calf' mortality category may have actually increased in recent years. However, lacking a series of known age calves, we do not know when post-natal dentine deposition actually begins. Examination of decalcified and stained tooth sections is probably necessary to verify postnatal dentine deposition in questionable cases.

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DRAMATIC IMPACT OF SEAGRASS LOSS ON A LARGE DUGONG POPULATION

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Until recently, Hervey Bay, in south-east Queensland, supported the second largest seagrass meadow and dugong 'population' in eastern Australia. In February 1992 the area was affected by the third largest flood this century, followed three weeks later by a cyclone and a second flood. The impacts of turbid water and wave action appear to be responsible for the death of virtually all of a 1,000 km^2 seagrass meadow that stretched from the intertidal to a depth of 20 m. During a survey in 1988, seagrass cover at the 53 of 97 sites (55 %) in the south-west of the Bay that contained seagrass, averaged 39.5 % (±SE 3.9), with a maximum of 100 % . In the same area in January 1993, only 11 of 79 sites (14 %) contained seagrass, and their mean cover was just 1.5 % (±0.7), with a maximum of 7 %.

During the second half of 1992, unprecedented numbers of dead dugongs were recorded from Hervey Bay, and areas to the north and south. Autopsies revealed that most of the animals were emaciated, and starvation was likely to be the ultimate cause of death. Some animals had unusual food items in their stomach, including algae, decomposing fibre and sand. The number of dugongs that died in Moreton Bay (260 km south of Hervey Bay) and in New South Wales (NSW), south of the dugongs' normal range, suggested there had been a mass exodus of dugongs from Hervey Bay. While only eight dugongs had been recorded in NSW in more than 30 y prior to 1992, at least 17 dugongs were reported from that state in the second half of 1992.

The population of dugongs in southern Hervey Bay in 1988 was estimated to be 1,466 (±326). In November 1992, the same area had an estimated population of 50 (± 33). At the same time, the population in the Great Sandy Strait (GSS), immediately south of Hervey Bay, changed from 291 (± 135) to 656 (±272), confirming local fisher's suggestion that many of the displaced dugongs moved into this area. However, the estimated total population of the Hervey Bay region (including GSS) changed from 1,971 (±359) in 1988 to 787 (± 277) in 1992, suggesting that a large number of dugongs died or left the area. Seventy-four dead dugongs can be accounted for.

Ten months after the perturbations that killed the seagrass no germination and recovery could be detected, except in some intertidal locations. Experience in other areas suggests that recovery could take up to a decade. Assuming that seagrass will not be limiting, recovery of the dugong population will take a **minimum** of 30-60 years (depending on assumptions).

The events of 1992 have important implications for the conservation of dugongs. Large populations associated with large areas of deep-water seagrasses (like Hervey Bay) may not be as stable as previously presumed.

DUGONGS: 'CULTIVATION' GRAZERS OF SEAGRASSES

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Dugongs feed primarily on seagrasses, which they destructively grub from the sediment, removing roots, rhizomes and leaves. In Moreton Bay, south-east Queensland (27.5° S, 153.3° E), the nutritional composition of the dugongs' preferred species of seagrass (*Halophila ovalis* ≥ *alodule uninervis*-thin > *Halophila spinulosa* ≥ *Syringodium isoetifolium* > *Zostera capricorni*-broad), suggests that they select primarily on the basis of high nitrogen and low fibre content. This preference list approximates the successional sequence of seagrasses, from pioneer species (*H. ovalis*) to slower growing, dominant species (Z. *capricorni*-broad).

Dugongs in Moreton Bay often graze in large herds (median herd size is 140), concentrating their feeding at single locations for up to 35 days. Such grazing can reduce the abundance of seagrass by as much as 95 % over large areas (40-75 ha) and can have significant effects on seagrass meadows. This so-called 'cultivation' grazing can alter the species composition, age structure and nutrient status of the meadows. Relatively high biomass, mid-seral stage communities can be converted to ones of low-biomass and early seral stage. *H. ovalis* is advantaged at the expense of

Z. capricorni-broad. These changes result in a meadow-wide increase in nitrogen concentration and decrease in fibre levels.

By concentrating their grazing in favoured regions, dugongs may alter the composition of seagrass communities over large areas (several km^2). There is correlative evidence that grazing by dugongs is responsible for some of the broad-scale spatial heterogeneity of seagrass communities.

MANATEES AND SEAGRASSES IN THE NORTHERN BANANA RIVER, FLORIDA, USA

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Systemic aerial surveys, conducted since 1977, and GIS applications are being utilized for the monitoring of the distribution and abundance of manatees utilizing the Kennedy Space Center (KSC) waters of the Banana River (Provancha and Provancha 1988)..Baseline data collection on seagrasses in these waters began in 1983 including: periodic photointerpretation and mapping of submerged aquatic vegetation (SAV), data entry to a GIS, and annual sampling of the SAV along 34 permanent transects. In 1985, significant increases in the number of manatees using these waters indicated a need to understand relationships between these herbivores and the existing SAV resource. Anthropogenic changes in these beds versus naturally induced changes (i.e. herbivory) need to be determined for KSC's long-term monitoring of these waters.

Two preliminary studies of these relationships were conducted in 1986 and 1987 (Provancha and Hall, 1991). Six temporary exclosures ($2.25m^2$), each paired with an open area, were assessed for changes in composition, percent cover and biomass before and after the predictable spring influx of manatees in 1986. Shoot biomass was reduced by approximately 50% and percent cover was reduced by 90% in the areas open to manatees. Grazing trails, approximately 45cm wide were observed in many areas. Complete uprooting of vegetation was not typical. Some of the changes in the SAV affected relatively large areas and were very apparent in low altitude photographs. The 1987 study involved sampling the biomass and percent cover at 50 randomly selected stations throughout the northern Banana River and overlaying these data onto the manatee distribution data. It was determined that manatee distributions were negatively correlated with the macroalga, Caulerpa prolifera and positively related to the seagrasses, Syringodium filiforme and Halodule wrightii.

To assess the long-term effects and define details about recovery rates of seagrass beds routinely grazed by manatees, we began a co-operative study with the U.S. Fish and Wildlife Service/Sirenia Project in 1990. The study involves the use of two large ($100m^2$) exclosures and the details of this ongoing project will be presented in the following presentation.

Provancha and Provancha, 1988, Mar. Mam. Sci. 4(4):323-338
Provancha and Hall, 1991, Fla. Sci. 54(2):87-98

ECOLOGICAL RESEARCH PRIORITIES FOR UNSTUDIED POPULATIONS OF SIRENIA

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The faunas of over 60 countries include manatees or dugongs, but often little is known about the biology of these elusive animals. Over the last 15 years, we have advised and assisted biologists in several countries with their sirenian research needs. In the process, we have developed a list of BASIC information that is necessary to better understand, manage, and protect local Sirenia populations. The following topics are listed in increasing priority.

1. Presence (or absence) of sirenians in the region.
2. Overall distribution, and definition of high-use areas.
3. General condition of important habitats.
4. Impacts of humans on animals and habitats.
5. Major aspects of population dynamics.

The following research methods generally follow the sequence of information needs above.

1. Literature review.
2. Field interviews of knowledgeable residents.
3. Aerial surveys of animals and habitats.
4. Radio-tracking using conventional transmitters.
5. Radio-tracking using satellite-monitored transmitters.
6. Long-term life history observations of individuals.

Generally, the more complicated the research the higher the cost. Therefore, the higher the number on the above lists, the greater the expense. However, meaningful conservation actions can be initiated with even the simplest information, such as that gathered from a literature review and interviews with local people.

We strongly suggest that the sequence of information needs (and research techniques) outlined above be followed. To short-cut the sequence, and attempt to gather information at the end of the list, is inviting failure. The information and methods developed in the early stages of a research program build the foundation of information and experience needed to successfully implement later research activities.

POPULATION MANAGEMENT OF THE DUGONG (*DUGONG DUGON*)

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Dugongs have traditional importance in the culture and diet of Aboriginals, Torres Strait Islanders and Papua New Guineans. Today they are hunted legally using traditional methods in areas which have varying protection laws. Concern for an apparent decline in dugong numbers led to their being listed as a species vulnerable to extinction. The varied protection of dugong populations and concern for conservation indicates a strong need for an effective management regime. If dugongs are to be effectively managed in the Torres Strait and northern Australia, it is important to determine the relationship between the different geographical populations and the survival of dugongs in those areas. What is a sustainable population size to maintain the gene pool? How much, if any, interbreeding occurs between populations, and could that population be replaced in the event of a local extinction? What degree of hunting can the dugong populations sustain? The first step in answering these questions for management and the objective of this study is to determine how many genetically distinct stocks, or dugong populations, exist. This is, whether dugongs exist as a series of separate populations around the Australian coast, with little genetic exchange between them, or as a single panmictic population.

MANATEE HABITAT USE IN FLORIDA: THE ROLE OF GEOGRAPHIC INFORMATION SYSTEMS AND TELEMETRY

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Research and management efforts on the Florida manatee (*Trichechus manatus latirostrus*) have significantly increased over the last ten years. The State of Florida, through the Department of Natural Resources (FDNR), increased marine mammal staff from three permanent positions in 1985 to over 20 in 1993 with additional temporary positions in the seven operational offices distributed over both coasts. Concurrently, the U.S. Fish and Wildlife Service (FWS) has expanded staff working on manatee issues in its two offices. Increases in personnel and funding levels have been utilized to expand research on manatee abundance, distribution, habitat preference, migratory routes, and causes of mortality and to manage impacts to manatees and their habitat through additional protection rules and reviews of marine permit applications.

In 1987, FDNR staff realized that historic and ongoing research data stored in standard database structures were not accessible in a format that would allow accurate spatial display. The Marine Resources Geographic Information System (MRGIS), established at FDNR in 1982 for the analysis and display of geographically referenced data, was used for developing techniques in remote sensing and image analysis to map and monitor coastal wetlands but did not have sufficient staff to enter manatee data into the system. The marine mammals section at FDNR initiated GIS development of manatee data layers using ARC/INFO software on personal computers as an integral part of the MRGIS. By 1991, GIS coverages of mortality and aerial survey locations were entered for analyses in conjunction with MRGIS coverages of shoreline and habitat. Examination of the data allowed identification of areas with high manatee abundance and mortality for increased protection measures through establishment of boating speed zones.

Telemetry studies conducted by FWS and FDNR on Florida's west coast in the 1980's utilized VHF transmitters to track manatees tagged primarily at Crystal River and Ft.Myers. The studies documented movement of animals from these warm-water refuges to nearby summer feeding habitats. Satellite telemetry data from a five year FDNR study initiated in Tampa Bay during 1991 have demonstrated long distance migration north to the Suwannee River (270 km) and south to Charlotte Harbor (170 km) and the western Everglades (300 km). One mature male traveled over 2100 km in the 11 months he was tagged, moving both north to the Suwannee River area, south to Charlotte Harbor, and returning to Tampa Bay. A mature female swam over 1700 km in 1992, moving from Tampa Bay to Charlotte Harbor, later continuing on to the 10,000 Islands in the western Everglades before returning north to Tampa Bay for the winter. Similar movements have been documented for seven of 10 manatees that retained tags for more than three months and the data parallel results from the FWS satellite telemetry study on Florida's east coast. Telemetry data from both FWS and FDNR have been incorporated into the MRGIS through customized programming routines.

Satellite telemetry has provided extensive data on manatee habitat use and migratory corridors through both remote monitoring provided by Service Argos and field observations by project staff. Additional GIS analyses of both aerial survey and telemetry data, using the new GRID module of ARC/INFO, will permit calculation of spatial and temporal manatee densities for most of Florida's coastline and allow testing of models to evaluate critical habitat requirements.

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