

Sirenews



Newsletter of the IUCN/SSC Sirenia Specialist Group

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HELENE MARSH NEW SIRENIA SPECIALIST GROUP CHAIRPERSON

It is with great regret that we announce the resignation of Robin Best, leader of the Amazonian manatee project in Manaus, Brazil, as Chairperson of this group. Robin was responsible for the recent re-establishment of this group, which then led to the establishment of this newsletter. The new Chairperson is Helene Marsh of James Cook University, Townsville, Australia. In the following guest editorial, she summarizes some of the results of the recent workshop in Edmonton and offers some thought-provoking proposals for the group's future directions.

WHERE DO WE GO FROM HERE?

This past August, the first Sirenian Workshop was held in Edmonton, Canada as part of the Fourth International Theriological Congress. The Workshop consisted of an inspiring and provocative opening address by Daryl Downing, a poster session during which more than twenty high-quality posters provoked considerable interest and discussion, and an afternoon of comprehensive review papers. In all, contributions were received from scientists from nine countries. The Workshop was scheduled to conclude with a round-table discussion entitled



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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"Where do we go from here?". I thought that the discussion rather faded out; we had all had too much by then. However, I keep thinking about this problem - what can we of the IUCN Sirenia Specialist Group do to facilitate the effective management of sirenian populations?

The Edmonton meeting also provided the opportunity for Gren Lucas and Bob Scott of IUCN to meet the chairpersons and deputy chairpersons of a number of the IUCN/SSC Specialist Groups both individually and collectively. At these meetings, there was much discussion about methods of devising a series of objective criteria by which members of a Specialist Group could assign priorities to different projects. The intent is to use this mechanism to help Specialist Groups communicate their concerns and considered judgments in an effective way.

Many Specialist Groups are responsible for advising IUCN about a large number of species with numerous isolated populations. This can make the determination of priorities complex, controversial and potentially divisive. The situation with respect to the Sirenia is comparatively simple, perhaps deceptively simple. There are only four species and all are considered vulnerable to extinction. I am not aware of any objections to the policy of the group which drew up the Sirenia Section of the "UNEP Global Plan of Action for the Conservation, Management and Utilization of Marine Mammals". This group decided that support was needed for fundamental research on sirenian biology as well as status surveys. Sirenian biologists also seem to be unanimous in giving the highest priority to research on the least studied species, the West African manatee.

However, there is potential for conflict about how to assign priorities to the areas or countries in which status surveys should be undertaken. The four species of sirenians collectively occur in 90 or so countries, of which only Australia, Japan, and the United States are classified as developed. There are never going to be enough international funds to finance work in all these countries. How should we assign priorities?

I suggest that the most important criterion should be a firm expression of interest from nationals of the country concerned who are in a position to assist in the implementation of a management plan once it is developed.

Although it is theoretically possible to assign priorities based on what is known about the stocks and on the likely logistical problems of carrying out a successful survey, it is very difficult for an outsider to evaluate such information. In particular, anecdotal information on the abundance of sirenians is often unreliable.

Sirenians are generally cryptic. My experience suggests that they are usually less rare than the locals think. The most dramatic example of this comes from Moreton Bay, adjacent to the major city of Brisbane. The general consensus in the early 1970s was that the dugong population of Moreton Bay had been irretrievably depleted by extensive exploitation for meat and oil around the turn of the century. The results of the first dedicated dugong survey of Moreton Bay in 1976 were a pleasant surprise. A huge herd of some 200 dugongs was seen congregated in clear water over white sand not ten minutes' flying time from

Brisbane International Airport. Clearly, it is inappropriate to make assumptions about the likely abundance of sirenians without proper surveys - and, alas, there are very few places where that has been done.

It has also become obvious that even with an intensive survey effort, it will not be possible to prove whether a given sirenian population is increasing, decreasing or stable for many years. The recent work on the life history of dugongs and manatees has confirmed that they are long-lived animals with a low reproductive rate. No sirenian population is likely to increase at more than about five percent per year, even under optimum conditions of recruitment and survival. Furthermore, because of the patchy distribution of the animals, it is prohibitively expensive to obtain precise indices of abundance. For example, recent surveys for dugongs in Australia have been carried out at an overall sampling intensity of about seven percent. The resultant minimum population estimates have a precision of only about 18 to 20 percent. I calculated that an exorbitantly expensive sampling intensity of over 50 percent would be required to increase the precision of these estimates to 10 percent. The combination of probable low rates of change and imprecise population estimates means that it will be a long time before we can reliably track trends in numbers. There is no point in waiting until we can prove that there is a problem. Effective management programmes need to be developed now.

So what can we do? I believe that the Sirenia Specialist Group should give high priority to educating influential (and potentially influential) nationals of as many of those 90 countries as possible about the need to manage their sirenian stocks. Once the appropriate local officials are convinced of this need, we can offer advice and expertise if required.

There are a number of low-cost ways of facilitating this education process. There are now several good films about sirenians. Perhaps we should be investigating the cost of making them more accessible to people who do not speak English. It is important that sirenian researchers communicate results of importance to management through popular as well as scientific articles, and that some of these popular articles be in languages other than English. The development of personal contacts is also potentially valuable. Please take advantage of every opportunity to develop such contacts. A one-to-one interaction is always the most effective way of stimulating interest and concern.

And when you have developed your contacts, please do advise Daryl Domning - so that he can add their names to the mailing list of this newsletter. - Helene Marsh

NEW SIRENEWS DISTRIBUTION POLICY

The IUCN Species Survival Commission has proposed the setting up of a central office for distributing copies of Specialist Group newsletters to individuals, libraries, and media organizations requesting them. The recipients would be charged a fee to cover the cost of printing and mailing the newsletters. In our case, I anticipate that this would mean that libraries

presently receiving Sirenews would be asked to subscribe, at a price yet to be determined. Individuals presently on the mailing list would continue to receive Sirenews free, at least for the foreseeable future. Additional persons or institutions wishing to receive it would probably be encouraged to subscribe through the central SSC office, unless this would be impractical due to currency exchange rates or otherwise impose a hardship.

The editorial in the first issue stated that Sirenews was to be an informal forum rather than a "citable" publication. This policy will continue. The proposal for a potentially wider distribution, however, raises the question of whether the sort of communication we wish to carry on in Sirenews would be appropriate in this more public setting. Although some sensitive and controversial topics have been broached in these pages, my personal feeling is that we have nothing to lose by obtaining a wider readership, nor should we alter in any way the tone or emphasis of the newsletter's contents to cater to a more general audience. This is and should remain the newsletter of and for the sirenian conservation and research community. The sole implication of wider distribution is that contributors should bear in mind that the information and opinions they submit for publication will be more widely disseminated than formerly. The caveat against quoting statements in Sirenews without the author's written permission would be repeated in each issue under the new policy, and I hope this distribution policy would not discourage contributors from expressing themselves as openly as they have in the past.

It is not yet certain when or if this new policy will go into effect. I would welcome comments from readers, particularly as to whether they would feel more reticent in contributing to a more widely read newsletter. - DPD

LOCAL NEWS

FLORIDA

Protection of Manatee Habitat. - In March 1980, the U.S. Fish and Wildlife Service (FWS) approved a Recovery Plan identifying actions needed to protect and manage West Indian manatees in Florida and Puerto Rico. Among the highest-priority actions recommended were efforts to acquire and protect areas of essential habitat. During the past several years, cooperation between FWS, the State of Florida, the U.S. Marine Mammal Commission (MMC), and The Nature Conservancy has resulted in substantial progress towards meeting this need. A network of federal and state refuges and reserves now includes much of the habitat essential to the subpopulation of manatees which winter along the west-central coast of peninsular Florida.

Reasons for concentrating on this part of the coast are several: First, a larger number of manatees (over 120) depend for winter habitat on the natural warm-water springs at the headwaters of the Crystal and Homosassa Rivers than on any other natural warm waters in Florida. Second, under the direction of Galen Rathbun and, more recently, Tom O'Shea, scientists with the

Gainesville Field Station of the FWS Denver Wildlife Research Center have built upon Daniel S. Hartman's pioneering research to provide a better understanding of the ecology and demography of the Crystal River/Homosassa manatees than exists for any other sirenians. Their data on summer and winter habitat use suggests that the most intensively used habitat lies in the mouths of coastal rivers between the Suwannee River, about 40 miles north of the Crystal River, and the Chassahowitzka River about 20 miles to the south. Third, this group of manatees appears to be a more or less discrete subpopulation and is the only group in Florida known to have increased in size in the last several years. Fourth, important summer and winter habitat for these manatees includes areas that are relatively undeveloped compared to most other parts of coastal Florida. Fifth, a number of coastal refuges and reserves already exist or are being developed. The 60-mile stretch of coast between the Suwannee and Chassahowitzka Rivers includes four National Wildlife Refuges, two State Preserves, a State Aquatic Preserve, a State Park, and several proposed state land acquisition projects. Although the existing protected areas do not include many of the areas most used by manatees, they do provide a substantial basis for maintaining the integrity of the region's broader coastal ecosystem. Finally, there is considerable state and federal interest in expanding habitat protection in this area prior to the onset of intensive development, which seems inevitable in the coming years.

To help establish a regional perspective for manatee conservation, FWS and MMC cooperated to support the development of a "Proposed Research/Management Plan for Crystal River Manatees". This plan, which was prepared under contract to FWS by Jane Packard [see Sirenews No. 1], was recently completed, and FWS is now carrying out its recommendations. Besides providing a comprehensive overview of available information on the regional manatee subpopulation, the Plan identifies long-term needs for both research and management. The Plan was complemented by a MMC report entitled "Habitat Protection Needs for the Subpopulation of West Indian Manatees in the Crystal River Area of Northwest Florida". Completed in September 1984, this report compares information on essential manatee habitat with information on available habitat protection programs, including regional refuges and reserves. Based on these assessments, it presents recommendations and priorities for expanding the coastal network of state and federal protected areas to incorporate the most essential habitat areas. The MMC report, which was provided to FWS and the Florida Department of Natural Resources, gave highest priority to actions along the Crystal, Suwannee, and Homosassa Rivers.

Regional cooperation in habitat protection has progressed on several fronts. The most important winter habitats in this area are the headwaters of the Crystal River (Kings Bay) and the Homosassa River (Homosassa Springs). To prevent development on a number of small islands in Kings Bay, which could have posed threats to manatees by increasing boat traffic and water-related recreation and degrading water quality in the warm waters directly adjacent to the islands, The Nature Conservancy raised funds to acquire and set aside the islands in a natural

condition. This was done in 1983, and in 1984 the Conservancy transferred the islands to FWS, which incorporated them into the National Wildlife Refuge System as the Crystal River National Wildlife Refuge.

Unlike Kings Bay, the headwaters of the Homosassa River consist of a large spring which empties through a narrow spring run. The surrounding land is largely undeveloped except for a small area adjacent to the spring, which is operated as a "nature world" featuring a floating underwater viewing pavilion. The owner of the facility recently expressed an intent to sell the property and, as a stopgap measure to prevent intensive development, Citrus County purchased the 150+-acre site in 1984 [see Sirenews No. 3]. The County would now like to transfer the property to the State of Florida, and the latter recently added the site to a list of recommended state land acquisition projects. A net stretching across the mouth of the spring run prevents access to the actual spring by manatees; however, three captive manatees are presently on display around the underwater viewing station. Should the State acquire the site, it would have outstanding potential as a public education and interpretive center as well as a preserve for protecting vital manatee habitat.

Perhaps the most important summer habitat in the region is the lower Suwannee River. A maximum count of 33 manatees has been reported by FWS in this area, and the maximum level of seasonal use probably exceeds this count. Most of the uplands and wetlands surrounding the lower seven to ten miles of the river are included within the boundaries of the proposed 56,000-acre Lower Suwannee National Wildlife Refuge. In the last several years, The Nature Conservancy, the State's Suwannee River Water Management District, and FWS have cooperated in acquiring about 37,000 acres of this total.

Two additional areas of extreme importance are the lower Crystal and lower Homosassa Rivers. These areas, which are still relatively undeveloped, are essential travel corridors for manatees moving to and from the warm-water winter refuges at the heads of the two rivers. They also are used during winter warm spells, when manatees frequently move downriver to feed. Finally, these areas are used during the summer by a small but significant portion of the population for feeding, cavorting, and mating. As a step toward protecting the shorelines of the Crystal River, the State began in the early 1980s to acquire a large tract of land along the upper and middle portions of the river. In 1984, however, both the State Bureau of Land Acquisition and MMC independently developed virtually identical recommendations for acquiring wetlands and uplands along the lower, as well as the middle, portions of the river. As a result, in early 1985, the State placed this new acquisition project (entitled the Crystal River State Preserve) on its land acquisition priority list. Although listing alone does not guarantee acquisition, it is an essential first step.

Habitat protection efforts along the lower Homosassa River are not so far advanced; however, one possible approach would be to expand northward the northern boundary of the existing Chassahowitzka National Wildlife Refuge, which lies just south of

the river. MMC recently recommended to FWS that it evaluate and, as possible, acquire undeveloped wetlands and uplands along the lower Homosassa for incorporation into the Chassahowitzka refuge.

These cooperative and complementary steps by federal and state agencies may offer the best hope for the long-term protection not only of manatees, but also of the many other species of fish and wildlife indigenous to the coastal region. Indeed, this ambitious approach has, as its ultimate objective, protection of the region's coastal ecosystem of which Crystal River manatees are but a part. Complementary federal and state actions taken in the past two years provide a foundation for achieving this objective. With persistence and luck, the habitat required to support manatees and other coastal species will be secure for future generations. - David Laist (U.S. Marine Mammal Commission)

The following item was published in the Fort Lauderdale (Florida) News/Sun Sentinel on July 31, 1985, and reprinted in abridged form in the Florida Department of Natural Resources and Florida Audubon Society's Save the Manatee Club News (October, 1985), whence it is here quoted with permission:

Port Salerno Commercial Fisherman Given Prison Term for Killing a Manatee. - A South Florida man on July 30, 1985, became the first person in the United States ordered to federal prison for butchering a manatee.

Ignoring a plea deal that called for no jail time, U.S. Magistrate Ann Vitunac sentenced Jimmy Malmsten, a Port Salerno commercial fisherman, to six months behind bars and a \$750 fine.

State and federal courts have levied fines against people accused of killing manatees, usually by riding over them in propeller-driven boats, but officials said Malmsten is the first to be sent to prison.

Malmsten pleaded guilty last month of possessing manatee meat when he was stopped by Florida Marine Patrol officers May 16, 1984, in the St. Lucie River in Martin County. He admitted he carved the harmless animal for its meat, but said the death itself was an accident, occurring when his boat hit it in pre-dawn darkness.

Malmsten was charged under the Endangered Species Act after Marine Patrol officers noticed chunks of meat floating in the water behind his boat. He could have received up to a year in prison and a \$20,000 fine for illegally possessing a manatee carcass.

Prosecutors agreed to a suspended sentence and \$750 fine, but Ann Vitunac ordered that Malmsten serve six months in a federal prison after she learned of repeated fishing and boating violations on Malmsten's record.

According to court records, Malmsten had been arrested five times since 1980 for violations ranging from illegally taking snook with a net to speeding in an idle zone and careless operation of a boat. Vitunac noted that the speeding charge came only two days after the manatee incident.

[The Save the Manatee Club News commented on the above story that "This was a combined effort of several government agencies working in cooperation with the judicial system. They are all to be commended for their dedication and perseverance." Sirenews adds to this its commendation of all concerned for setting a welcome example of law enforcement.]

SAUDI ARABIA

Dugong Replenishment Project. - MEPA (the Meteorology and Environmental Protection Administration) of the Kingdom of Saudi Arabia is planning to establish and develop a program to conserve the endangered Arus-al-bahr or dugong in the Saudi Arabian waters of the Arabian Gulf and Red Sea. Arus-al-bahr, the Arabic name for the dugong, means "bride of the sea" or mermaid. By invitation from MEPA, I visited Saudi Arabia in February 1985 and prepared a work plan and report for a research program to determine the status of dugongs in Saudi Arabian and adjacent waters. Part of the report included a summary of available recent information on dugongs in Saudi Arabian and adjacent waters.

The present interest in dugongs by the Saudi Arabian government results from investigations made during and following the disastrous Nowruz oil spill in 1983 and 1984, when huge quantities of oil spilled into the Arabian Gulf from war-damaged oil wells in the Nowruz Field located in Iranian waters [see Sirenews No. 1]. MEPA reported that 36 dead dugongs were found in March and April 1983 along the Arabian Gulf coast of Saudi Arabia. An additional two dead dugongs were reported from Bahrain during this time. [In July 1983, Begley et al. reported 53 dugong carcasses beached; see Recent Literature section below.] It was not established what actually killed these dugongs and other marine life, which included fish, sea snakes, marine turtles, dolphins, and one whale, and it is not certain that these kills were even a direct result of the Nowruz oil spill, as the kills preceded the actual arrival of oil from the Nowruz wells. It is not known if more than the above 38 dugongs were killed, nor was the size of the Arabian Gulf dugong population known, although MEPA referred to a 1979 estimate of 50 to 60 dugongs for the Arabian Gulf. This most likely was an estimate for the Arabian Gulf waters near Bahrain (Gulfs of Bahrain and Salwah). Because of the large numbers of dugongs known to have been killed, the MEPA assessment was that following the Nowruz oil spill, the Arabian Gulf dugong population had probably been reduced to a dangerously low and possibly non-viable level and could become extinct, and that dugongs from elsewhere (e.g., the Red Sea) might have to be reintroduced into the Arabian Gulf in order to maintain dugongs as part of the Arabian Gulf fauna.

Dugongs are still present in the Arabian Gulf, although they are threatened by oil and other pollution, habitat changes (land filling and dredging), and accidental capture in monofilament fishing nets. There have been sightings of live dugongs reported from the Arabian Gulf during and since the Nowruz oil spill. MEPA observers sighted two live dugongs in the Gulf of Salwah in late April 1983. There is an as yet unconfirmed report that 30 live dugongs with a couple of calves were sighted off the United Arab

Emirates in October 1983. During a 2-1/2 hour helicopter flight on 18 February 1985, covering the entire length of the Gulfs of Bahrain and Salwah, I saw one dugong between the Bahrain and Saudi Arabian coasts. From September 1984 through January 1985, 8 separate sightings of 1 to 70 dugongs have been reported to D. H. Vousden (State of Bahrain Environmental Protection Organization), with the largest group, more than 70 dugongs, seen on 12 January 1985. Seventy dugongs had also previously been sighted in Bahrain waters in November 1983. Two dead dugongs were found on Gulf of Salwah beaches of Saudi Arabia between January and the end of May 1984 by staff of the University of Petroleum and Minerals, Dhahran, and a third dead dugong was reported but not located during this period.

There is very little information on dugongs in the Red Sea. An IUCN report on the distribution of habitats and species in the Saudi Arabian waters of the Red Sea, done for MEPA, suggests that dugongs only occur there in very low numbers. During the IUCN Red Sea survey conducted from March 1982 to October 1983, only two observations of dugongs were made (one live animal tentatively identified as a dugong and one dead dugong). The IUCN report also states that in 1983 two dead dugongs, a male and a female, believed to have been collected in the Gulf of Aqaba, were delivered to the King Abdul Aziz Marine Station at Sharm Obhur. Dr. B. Albassam (King Abdul Aziz University, Jeddah) reported that in 1974 two dugongs were reported in the Red Sea region, one from the Farasan Island region and the other from the Gulf of Aden. In October 1984, 20 animals, probably dugongs, were seen from a helicopter in a shallow bay in the northern Red Sea east of the mouth of the Gulf of Aqaba during a MEPA coastal habitat survey. Although there is a paucity of dugong sightings and records for the Saudi Arabian waters of the Red Sea, it is possible that with its large areas of seagrass beds, some in isolated regions, the approximately 2000 km-long Saudi Arabian coast of the Red Sea could contain large populations of dugongs.

The available information shows that while dugongs are still present in the Arabian Gulf and Red Sea, their numbers and distribution are not known. Comprehensive and careful aerial and other surveys of both regions, which MEPA plans to carry out, are required as the first step in establishing an Arus-al-bahr or dugong replenishment program. - George Heinsohn

ABSTRACTS

The Digestive Strategy and Efficiency of the West Indian Manatee, *Trichechus manatus* (Douglas M. Burn). - During the winters of 1982/83 and 1983/84, the digesta from 8 West Indian manatee (*Trichechus manatus*) carcasses were sampled sequentially along the length of the gut. Samples were analyzed for dry matter content, organic matter, crude protein, crude fat, acid-detergent fiber, lignin, and cellulose. Apparent digestibilities were calculated using the lignin-ratio method.

The voluminous large intestine of the manatee is responsible for considerable water reabsorption, as well as being the major site of organic matter, crude protein, crude fat, and cellulose

digestion. Overall digestibility coefficients for organic matter (71.1%), crude protein (61.0%), and crude fat (77.3%) are comparable to those of terrestrial herbivores. Manatees have one of the highest digestibility coefficients for cellulose (79.6%) of any mammalian herbivore. This high efficiency of cellulose digestion is probably due to an extremely slow rate of passage in concert with a less fibrous diet. [Abstract of a master's thesis in Biological Oceanography submitted to the University of Miami, Florida, in May 1985 and supervised by D.K. Odell.]

The following abstracts are of papers and posters presented at the Sirenian Workshop of the Fourth International Theriological Congress, Edmonton, Canada, Aug. 13-20, 1985.

THE PARASITES OF SIRENIANS. C. Beck, U. S. Fish and Wildlife Service, Denver Wildlife Research Center, Gainesville, Florida, USA 32609, D. Blair, Department of Zoology, University of Canterbury, Christchurch 1, New Zealand, and G.B. Rathbun, U. S. Fish and Wildlife Service, Denver Wildlife Research Center, Gainesville, Florida, USA 32609.

Ten species of parasites have been reported from manatees: four trematodes, one nematode, one protozoan, one cestode, and two ectoparasitic crustaceans from the West Indian manatee, Trichechus manatus; one trematode, one nematode, and one protozoan from the Amazonian manatee, T. inunguis; and one trematode, one nematode, and one crustacean from the West African manatee, T. senegalensis. Several of the same parasites occur in all three species of manatees. In contrast, 23 parasitic species have been described from dugongs, Dugong dugon: 22 trematodes and one ascarid nematode. The helminths of manatees are commonly encountered, as is one crustacean (a barnacle), and an eimerian protozoan from the Amazonian manatee. The cestode, a copepod, and a protozoan were seen only once in individual West Indian manatees. Many of the dugong helminths are commonly recovered after close examination of a carcass. However, the presence of some species varies by host range. Each of these parasites are listed according to site within the sirenian host and whenever possible, parasite prevalence data are included.

A Comparison of Differences in Behaviors of Captive-Born and Non-Captive Born Manatees (Trichechus manatus) as a Measure of Adjustment to a Contained Natural Environment. Barbara Bernier and John Morris, Florida Institute of Technology.

A qualitative and quantitative behavioral study, comparing a pair of male and female two-year-old captive-born manatees (Trichechus manatus) to natural-born manatees of the same age class, was made to assess the ability of captive-born animals to acclimate to a contained natural environment. This study was conducted in anticipation of the release of the captive-born animals into the natural environment. A catalogue of 27 behavioral units were defined based on general observations of manatees. A behavioral unit consists of a core movement accompanied by typical but dispensable accessory movements. From the catalogue a checksheet of the behaviors was designed. Observations were recorded by a single observer in the water using snorkelling gear. Behavior of a focal animal was recorded at 30-second intervals during 30-minute observation periods. An Inter-Observer Reliability Test demonstrated 89% agreement between two observers making simultaneous recordings on a focal animal. Following 79 hours of observation, no significant difference was found between captive- and natural-born manatees in percent time spent in various activities. The data collected establishes a baseline for future quantitative behavioral studies of manatees. Following the radio-tagging and release of the captive-born juveniles this study will be important in assessing the progress of acclimatization of these animals to the natural environment.

MORTALITY PATTERNS IN MANATEES FROM FLORIDA. R.K. Bonue, T.J. O'Shea, U. S. Fish and Wildlife Service, Denver Wildlife Research Center, Gainesville, Florida, USA 32609 and D.K. Odell, Rosenstiel School of Marine and Atmospheric Sciences, University of Miami, Miami, Florida, USA 33149.

A total of 813 West Indian manatees (Trichechus manatus) was recovered and examined at necropsy in Florida from January 1975 through December 1984. Probable cause of death was recorded and each case was placed into one of six major death categories. The total numbers of specimens in each of the six categories were: collision with a boat or barge, 183 (22.5%); crushed or drowned in a flood dam or canal lock, 51 (6.3%); other human-related causes, 29 (3.6%); dependent calves, 132 (16.2%); natural, 95 (11.7%); and undetermined, 323 (39.7%). During the ten years that these data were collected several major trends have become apparent. Sixty-seven percent of all manatee deaths attributed to entrapment in flood control structures came from Dade County. More than 65 percent of the deaths due to collisions with boats or barges occurred along the heavily human populated east coast of Florida. Due to very cold temperatures the total number of deaths reported for the winters of 1977, 1981, and 1984 were much higher than other winters, and predominately affected younger, subadult manatees that are more susceptible to cold exposure and perhaps lack the experience to avoid cold spells by seeking shelter in warm water refugia. And finally, the first recorded die-off of manatees involving exposure to red tide organisms occurred in Lee County in 1982 and resulted in the deaths of at least 37 animals in less than three months. A more detailed examination of each of these associations will be presented.

DISTRIBUTION, STATUS AND CONSERVATION OF MANATEES IN MEXICO. L.C. Colmenero-R., Department of Zoology, University of Mexico. Apdo. Postal 70-153, Coyoacan 04510, Mexico, D.F.

West Indian manatees (*Trichechus manatus*) inhabit coastal areas, estuaries and associated rivers of southeastern Mexico, and the distribution is related to their need for warm water and the distribution of freshwater and submerged aquatic and marine food plants. Land survey and interviews were conducted to determine their status, distribution and conservation. Data were collected from March 1980 through November 1984. Illegal hunting is identified as the major source of mortality and stricter enforcement of existing laws would help preserve the remaining population. Manatees are protected in Mexico under Official Act of 1981, gazetted on October 30, 1981. There is not one conservation group of consequence in Mexico in the actuality. The main Governmental Institution, Secretaria de Desarrollo Urbano y Ecologia (S.E.D.U.E.), moulds government policies toward the environment, and is behind manatee protection, and prepared to do whatever it can to preserve the species. The most pressing immediate need for manatee conservation is proper enforcement of the Official Act. An environmental education campaign should make it possible to increase local cooperation in enforcement.

THE SIRENIA: PAST, PRESENT, AND THE FUTURE? Daryl P. Domning, Department of Anatomy, Howard University, Washington, D.C. 20059 U.S.A.

The characteristics of the Sirenia were established in much their present form by some 40 million years ago. They are strongly "K-adapted" and little able to withstand heavy mortality from human or other sources. Probably due to lack of diversity in their food plants, they have never become very diverse themselves, and have remained anatomically and ecologically conservative. But they do not lack evolutionary potential, as shown by the evolution of striking adaptive novelties within the last 10 million years by each of the 3 Recent genera. Each has had a unique history with unique implications for management. We researchers must learn as much as possible about sirenians while there is still time, and also make greater efforts to explore the relevance of sirenian phenomena to the rest of biology. At the same time, we bear the major responsibility for preventing their extinction, which could occur in our lifetimes. Human population growth and habitat destruction must be stopped, for our own good and that of other species. Natural systems must be permitted to function independently of human manipulation. Management strategies must be consciously designed to preserve them not just for the next century but for thousands of years to come. This is a moral imperative, but also necessary for both our physical survival and our mental and spiritual health.

MANATEE RESPONSE TO A POWER PLANT SHUT-DOWN IN SOUTHWESTERN FLORIDA.

R. Kipp Frohlich, Denver Wildlife Research Center, Gainesville, Florida, U.S.A. 32601. Jane M. Packard, Florida Cooperative Fish and Wildlife Research Unit, University of Florida, Gainesville, Florida, U.S.A. 32611.

Dependence of manatees (*Trichechus manatus*) on artificial sources of warm water during winter has been of concern in areas where natural sources of warm water have not been identified, such as southwestern Florida. The abundance and distribution of manatees in Lee County was monitored one year prior to and during the temporary shut-down of a power plant. Aerial surveys were conducted twice a month during the year and for 3 to 5 successive days following each winter cold front. Movements of 13 manatees were monitored by radio telemetry during the change in power plant operation. Manatees were found in the Caloosahatchee River system throughout the year, although numbers increased and distribution shifted toward the power plant in the winter months. There was no significant difference in manatee counts between the two winters ($t = 1.09$; 24 d. f.; $p = 0.28$). During the first part of the second winter, manatees aggregated in areas that were naturally 1-2°C warmer than the unheated power plant canal. The manatees returned to the plant as temperatures at the new aggregation sites dropped to 16°C and concurrently the power plant resumed operation. Although manatees found alternative temporary warm-water sites, they were still dependent on the thermal effluent during the coldest part of the winter.

ANALYSIS OF STOMACH CONTENTS OF WEST INDIAN MANATEE CARCASSES SALVAGED FROM BREVARD AND DUVAL COUNTIES, FLORIDA. L.A. Hurst, Florida Cooperative Fish and Wildlife Research Unit, University of Florida, Gainesville, Florida, USA 32611 and C.B. Rathbun, U. S. Fish and Wildlife Service, Denver Wildlife Research Center, Gainesville, Florida, USA 32609.

Frequency occurrence and percent composition of food items in West Indian manatee (*Trichechus manatus*) stomachs from Brevard and Duval Counties, Florida, were documented. Manatee stomachs collected from salvaged carcasses were analyzed using a modified microscope point technique. Fragments of marine and freshwater macrophytes were identified microscopically to genus, while algae, rhizomes, and grasses were recorded as separate categories. Results of this study will be discussed in terms of conservation implications in the two contrasting habitats.

A CENTURY OF OBSERVATIONS OF SIRENIAN BRAINS. J. I. Johnson, Anatomy Department, Michigan State University, East Lansing, Michigan, U. S. A. 48824; R. L. Reep, Department of Physiological Sciences, University of Florida, Gainesville, Florida, U. S. A. 32610; and R. I. Welker, Department of Neurophysiology, University of Wisconsin, Madison, Wisconsin, U. S. A. 53706.

The actual number of observations, in the past 120 years, of sirenian brains, is few enough that we can present virtually all of them here. The earliest illustrations were the sketches of manatee brains shown by Murie (1872), Chapman (1875) and Garrod (1877). Miklouho-Maclay (1885) showed the first sketches of a dugong brain. Murie in 1885 published beautiful drawings of a manatee brain, showing morphology and vasculature. More sketches appeared, of M. inunguis by Beddard (1897), of T. manatus by Elliott Smith (1902), and of dugong by Hill (1945). Modern standards are met in studies of dugong: spinal cord by Dexler and Eger (1911), and brain by Dexler (1913), with excellent photographs, and photomicrographs of stained sections. Photomicrographs of sections from manatees were shown by Jelgersma (1934); these were improved by Verhaart (1972). Friant (1954) shows a photograph of a brain of M. inunguis. The next studies are ours, and we present casts and photographs of the brain of Trichechus manatus, and photomicrographs of sections of special interest. (Supported by NSF grant BRS 8503687.)

THE STOMACH OF TRICHECHUS MANATUS - A COMPARISON WITH OTHER MAMMALIAN HERBIVORES. Peter Langer, Institut f. Anatomie & Zytobiologie, Justus-Liebig-Universität, Aulweg 123, D-6300 Giessen. Fed. Rep. of Germany.

The stomach of Trichechus manatus, the Caribbean manatee, is an organ with an off-set gland that has proper gastric gland mucosa. The stomach is very muscular and has a massive pylorus, which is followed aborally by a voluminous duodenal ampulla of approximately the same size as the stomach proper. Two diverticula branch off from the duodenal ampulla. In semischematic illustrations the different steps of gastric digestion in the manatee are compared with those of pig, ruminant, and hippopotamus. In the manatee salivary amylolysis and proteolysis take place one after the other. The voluminous duodenal ampulla gives sufficient volume to allow removal of contents from the stomach and a start of another feeding bout after a period of non-feeding activity.

COINCIDENCE BETWEEN THE SEASONAL PATTERNS OF SEAGRASS GROWTH, DENTINAL GROWTH LAYER DEPOSITION, AND CALVING IN THE DUGONG. J. Lanyon, Departments of Zoology, Monash University, Melbourne, and James Cook University, Townsville, Australia, and H. Marsh, Department of Zoology, James Cook University, Townsville, Australia.

In the dugong, dentinal Growth Layer Groups (GLGs) consist of a wide zone of intermediate optical density containing numerous faint accessory layers followed by a relatively narrow zone in which the layering is enhanced. Study of the seasonal pattern of deposition of these GLGs in the tusks of 106 dugongs from the Townsville and Mornington Island areas of North Queensland indicates that one GLG is deposited each year, formation of the narrow zone generally occurring from July to October inclusive. Photographic and coring techniques have been employed to monitor changes in seagrass biomass, density, species composition, and nutrient levels along permanent transects at three study sites where dugongs feed in the Townsville area. Results to date indicate a significant drop in biomass through the winter months, with regrowth at the onset of spring in September. These results suggest that the pattern of GLG deposition may reflect nutritional status. Seagrass regeneration also coincides with the onset of calving, most births occurring from August-September through December.

IMPROVING DUGONG AERIAL SURVEY TECHNIQUE. H. Marsh, Department of Zoology, James Cook University, Townsville, Australia.

Dugongs occur along some 15,000 km of coastline in northern Australia. Aerial surveys, based on the technique developed by Caughley to census kangaroos, are being used in an effort to obtain precise indices of the relative density of dugongs in different areas as a basis for monitoring population trends. Survey design is being improved by comparing the precision of the population estimates obtained with different levels of survey intensity. Analysis of variance is being used to compare densities of dugongs observed under different experimental combinations of survey height and transect width, and with different intensities of glare off the surface of the water. The counts of independent tandem observers sitting behind each other on the same side of the aircraft are being compared to develop factors to correct for the number of dugong groups visible on the transect line which are missed by an observer. Vertical aerial photogrammetry of dugong groups in clear water is being used to develop confidence intervals for the proportion of dugongs which are below the surface. The results of this work to date will be presented.

OCCURRENCE OF DUGONGS IN OFFSHORE WATERS. H. Marsh, Department of Zoology, James Cook University, Townsville, Australia.

Recent aerial surveys in northern Australia indicate that dugongs may use offshore habitats much more than had been supposed. During a survey of the Torres Strait area in November 1983 along a series of parallel transects, only about 20% of sightings were within about two km of islands or reefs. In November 1984, the waters of the Great Barrier Reef lagoon between 14° 10'S and 15° 15'S were surveyed along a series of east-west transects (approximately perpendicular to the coast). Dugongs (including calves) were sighted up to 55 km from the coast, and using surface sightings as an index of relative density, it was estimated that more than 60% of dugongs in the area were greater than 20 km from the coast at the time of the survey. Dugongs were sighted in inter-reefal areas in waters up to 20 to 30 m deep. Although dugongs may shelter offshore during daylight hours as a behavioural response to hunting pressure in the Torres Strait area, this is an implausible explanation for their observed distribution in Great Barrier Reef waters.

POPULATION BIOLOGY OF SIRENIA: IMPLICATIONS FOR CONSERVATION: H. Marsh and L.M. Marsh, Departments of Zoology and Mathematics, James Cook University, Townsville, Australia.

Information on the life history of the West Indian Manatee obtained by direct observation in Florida indicates that females can become sexually-mature as early as four years old and that mature females give births every two or three years. Gestation period is 12 to 14 months, and the usual litter size one. Twins are occasionally seen. In contrast, information on the life history of the dugong obtained from carcass analysis in northern Australia, suggests that females do not become sexually-mature before they are nine years old (and sometimes not until age 15-17) and that mature females give birth every three to seven years. The gestation period and litter size are similar to those of the West Indian manatee. There are no reliable age-specific mortality or fecundity data available for either species, although members of both may live for 50-60 years. A series of simple population models will be developed for a range of pre-reproductive periods, calving intervals and hypothetical mortality schedules. The implications of the results of these models for conservation will be discussed.

A SATELLITE-MONITORED RADIO TAG TRACKS THE MOVEMENTS OF A MANATEE IN FLORIDA. B. E. Mate, Hatfield Marine Science Center, Oregon State University, Newport, Oregon 97365 and G.B. Rathbun, U.S. Fish and Wildlife Service, Denver Wildlife Research Center, P.O. Box 70, San Simeon, California 93452

In February 1985 a West Indian manatee (Trichechus manatus) was radio-tagged with a 401.650 MHz transmitter monitored by Argos Data Collection Systems on board polar-orbiting NOAA satellites. The radio floated in a cylinder and was attached by a 2m tether to a belt around the peduncle. Locations of the manatee were calculated from doppler shifts resulting from the satellite movement. The transmitter's temperature and summaries of its attitude were sent once each minute. During the first two weeks, the manatee was captive in a 4 acre area and locations were consistently within 500m. As many as 6 locations have been acquired in a single day. At this writing the radio has provided movement and telemetered information for 43 days from both fresh- and salt-water areas.

ESTIMATING AGE OF YOUNG WEST INDIAN MANATEES, TRICHECHUS MANATUS, FROM DENTAL LAYERS. A.C. Myrick, Jr., NMFS, P.O. Box 271, La Jolla, California, U.S.A.

Despite the problem that the teeth of manatees are continuously replaced by newly formed teeth erupting from the rear of the jaw, dentinal and cemental growth layer groups (GLGs) continue to accumulate until a tooth is lost anteriorly. All teeth formed and being formed at the time of birth exhibit a neonatal line in the dentine, but a neonatal line is absent in teeth formed after parturition. The number of dentinal GLGs in any tooth with a neonatal line will represent the age of the animal from which it was taken. A count of GLGs from a tooth containing no neonatal line will represent the age of the tooth and a minimum age of the animal from which it was taken. Maximum ages of older animals may be estimated using GLG counts from periosteal bones. These observations are based on material from 12 specimens including a twice tetracycline-labeled animal.

BRAIN-BODY WEIGHT RELATIONSHIPS IN SEA COWS

Thomas J. O'Shea and Roger L. Reep, U.S. Fish and Wildlife Service, Sirenia Project, 412 NE 16th Ave., Gainesville, FL 32609 and Department of Physiological Sciences, College of Veterinary Medicine, J-144, JHMRC, University of Florida, Gainesville, FL 32610.

Much recent work has centered on the topic of relative brain size in mammals. Comparative studies to date have typically not included the Sirenia, however sirenians are an interesting outlying group in terms of encephalization, with brain sizes much smaller than would be predicted on the basis of body size using the average mammalian plot. We have directly determined brain and body weights for over 30 West Indian manatees. E.Q.'s range from about 0.03 to 0.08 in the 10 adults from our sample ($\bar{X} = 0.06 \pm 0.01$), some of the lowest values of all living mammals. We calculated E.Q. values of about 0.07 for dugongs, using data published by Japanese investigators. Steller's sea cows were also characterized by low E.Q.'s. In addition to these recent forms, fossil sirenians also had small brains. Unlike the Proboscideans, which have evolved relatively large brains, the sirenians have retained the small-sized brains typical of their basal ancestors. We discuss the possible importance of metabolic rate and other physiological, developmental, behavioral and life history characteristics of the Sirenia in relation to brain size.

FEMALE-OFFSPRING BEHAVIOR IN WEST INDIAN MANATEES. T.J. O'Shea, U. S. Fish and Wildlife Service, Denver Wildlife Research Center, Gainesville, Florida, USA 32609 and S.H. Shane, Center for Marine Studies, University of California, Santa Cruz, California 95064

Mother-young pairs of manatees (*Trichechus manatus*) were observed at Blue Spring Run and the contiguous St. Johns River, Florida. Techniques included instantaneous sampling of behavior of 11 pairs at the clear spring over 4 winter seasons, radiotracking of females with calves or their independent offspring during warm seasons, and underwater sound recording. Pairs usually keep within 1m apart, and nursing bouts of 3 min duration occur every 48±22 min. The period of nutritional dependency varies from 1 to 2 years, but correlates of this variation are unknown. Calves range from 210 to 260 cm total length at weaning. Individual recognition occurs between cows and calves, probably based on vocalizations, and a variety of evidence suggests that recognition persists beyond weaning. Young of both sexes occupy the maternal range when independent, and dispersal from the study area has not occurred in offspring as old as 7 yr. Natal philopatry, long term kin recognition, and tradition may be of importance in ameliorating winter mortality.

STRATEGIES FOR PROTECTION OF NON-EXPLOITED SIRENIA POPULATIONS. Jane M. Packard, Department of Wildlife and Fisheries Sciences, Texas A & M University, College Station, Texas, U.S.A. 77843. Patrick M. Rose, Florida Department of Natural Resources, St. Petersburg, Florida, U.S.A. 33701.

In protection of Sirenia populations that are not traditionally exploited, the major issues include (a) reduction of human-related mortality, (b) reduction of harassment indirectly affecting the population, (c) alteration of habitat and (d) the difficulties involved in monitoring population changes. After briefly reviewing the relative importance of these issues world-wide, we will focus on the strategy used in protection of the West Indian manatee (*Trichechus manatus*) in Florida. Although federal and state laws provide legal protection and some funding, the implementation of protective measures on a local basis has been difficult. Development of non-legislative programs has been instrumental in raising state funding, public awareness and local support for measures such as slow boat speed zones, sanctuaries at warm-water refuges, and redirection of water-front development. These non-legislative solutions have included public education, clubs, volunteer patrols, industrial funding, land-use planning, statewide and site-specific research/management plans. This strategy is briefly compared with strategies used in other nations for protection of Sirenia.

STATUS OF THE WEST AFRICAN MANATEE IN THE GAMBIA, WEST AFRICA

Powell, James A.
University of Washington, Seattle, WA

There is little available information on the status or biology of the West African manatee (*Trichechus senegalensis*). This study was conducted in Senegal and The Gambia to obtain data on their distribution, general biology and habits, and to assess the potential impact of a proposed series of dams on the Gambia River. This investigation concluded that West African manatees, like West Indian manatees, are found along the coast, in estuaries and far up rivers. They require calm waters, access to freshwater, and adequate food. In estuaries they frequent sources of freshwater and feed extensively on mangrove. The recent Sahelian drought has reduced freshwater runoff which has resulted in a dieback of mangroves in many rivers. Manatees have disappeared from many of the rivers affected by the drought. The proposed dams will further reduce freshwater flow and will limit the manatees access to food during draw-downs. Even though they are protected they continue to be hunted by harpoon and nets. The combination of reduced food, limited freshwater and continued hunting may have a significant impact on their current status. The drought and its effects present a new dimension to their

DISTRIBUTION OF MANATEES IN PUERTO RICO. G.B. Rathbun, T. Carr, and N.H. Carr, Florida State Museum, University of Florida, Gainesville, Florida, USA 32611.

The distribution of manatees (Trichechus manatus) around the Caribbean island of Puerto Rico was determined by flying 19 aerial surveys in a Cessna 172 airplane from March through July 1984. Four of the surveys were of the entire island, while 15 were restricted to Vieques Island and Roosevelt Roads Naval Station (RRNS) in southeastern Puerto Rico. A total of 377 manatee sightings was made, 17 of which were calves (4.5%). Over 41% of the sightings made during the four entire-island surveys were found in the region of RRNS. On the RRNS/Vieques Island surveys, about 1/4 of the sightings were on the north side of Vieques and 2/3 of the sightings were in the coves along the southern shore of the naval station. The manatees feed on the rich seagrass beds in the coves and drink freshwater from a nearby sewer plant effluent. In Puerto Rico, the naval station serves as a de facto sanctuary for manatees, which is reflected by their distribution.

BEHAVIORAL ECOLOGY OF SIRENIANS. G.B. Rathbun and T.J. O'Shea, U. S. Fish and Wildlife Service, Denver Wildlife Research Center, Gainesville, Florida, USA 32609.

A comparison of the Dugongidae and Trichechidae reveal that many aspects of their behavioral ecology are similar, such as their low reproductive rate, lack of a rigid social structure, absence of territoriality, etc. Many of these features can be related to the quality and distribution of their food resources (aquatic plants), a low reproductive output, and a low potential for male parental investment. However, several aspects of their behavioral ecology are distinctive: Dugongs form large herds, exhibit sexual dimorphism, and perform some distinctive mating displays. Manatees normally form small fluid groups, are not sexually dimorphic, and do not exhibit any distinctive mating displays. These, and other differences, are discussed in terms of morphology, physiology, habitat preference, and predation pressure in the two groups. The features of the behavioral ecology of Sirenia that make them vulnerable to extinction are also discussed.

CATALOGING WEST INDIAN MANATEES IN FLORIDA. G.B. Rathbun and J.P. Reid, U. S. Fish and Wildlife Service, Denver Wildlife Research Center, Gainesville, Florida, USA 32609.

Since 1982, photographs of distinctively scarred manatees (Trichechus manatus) in Florida have been compiled annually in a state-wide manatee identification catalog, which now totals 746 individuals. Resightings of known individuals at winter aggregation sites (mostly warm water discharges and natural springs) have provided information on the movements and site fidelity of manatees in Florida. Site fidelity has been documented for 80 individuals, including nine animals known to have used the same sites on four or more years. Thirteen manatees, however, changed winter aggregation sites between winter seasons and three changed within a single season. A total of 36 manatees have been resighted at different aggregation sites with the greatest movements, both in number and distance, occurring on the east coast. Three individuals are known to have traveled nearly 600 km between Jacksonville and Port Everglades, indicating that long distance movements are not uncommon. Seasonal movements from south to north have been documented for nine manatees. The catalog has demonstrated that manatees can move frequently and great distances, which has important implications in developing effective conservation strategies.

RADIO-TAG ATTACHMENTS FOR SIRENIA. J.P. Reid, G.B. Rathbun, and J. Bourassa, U.S. Fish and Wildlife Service, Denver Wildlife Research Center, Gainesville, Florida, USA 32609.

A major obstacle in studying the movements and life history of Sirenia that occupy saltwater habitats has been a safe method of attaching radio-frequency transmitters that would overcome the problem of saltwater attenuation. After nearly five years of cautious development, we have achieved such an attachment for manatees and designed a prototype for dugongs. The assembly is composed of a peduncle belt with a quick-fit buckle, a two meter long nylon-rod tether, and a floating polypropylene cylinder housing a 164 megahertz transmitter. This arrangement has been successfully used to radio-track manatees (Trichechus manatus) in saltwater habitats in Florida with no ill effects to the animals.

MANAGING AND CONSERVING SIRENIAN POPULATIONS SUBJECT TO TRADITIONAL EXPLOITATION. A. Smith, Sir George Fisher Centre, James Cook University, Qld, Australia; B.E.T. Hudson, Dept. Biol. Sci., JCU; J. A. Powell, Uni. of Washington, Seattle, USA.

All extant Sirenians are under severe threat. Complex issues such as: 'traditional rights'; their being no guarantee that Sirenian population decline can be reversed; conflicts with other users; make sustained management difficult. Sirenians are long-lived, slow reproducing animals that are totally unsuited to commercial exploitation. Rapid change in hunting technology and increase in human populations have precluded the formation of self-regulatory laws being made by users; management agencies are often unused to dealing with traditional cultures; forces for exploitative development often outweigh sustained management requirements. Management agencies may decide to let problems resolve themselves; all Sirenian killing can be banned; co-operative management can be undertaken. Case studies from Papua New Guinea, Australia, Africa and America are discussed. A better understanding of the needs of Sirenians and the human cultures that impinge on them is required to formulate and implement sustained management of Sirenians and for the societies which exploit them.

THE MANATEE CECUM. R.L. Snipes, Institut fur Anatomie und Zytobiologie, Justus Liebig Universitat, Aulweg 123, 6300 Giessen, West Germany.

The large intestine of the West Indian manatee, Trichechus manatus, endemic to the coastal freshwaters of Florida, most probably represents not only a vast fermentation vat but also a most economic organ for conservation of water. The cecum is in relation to the enormous length and circumference of the colon relatively small. Its form is reminiscent of the ceca in many avian forms, namely, it possesses two horns. The ileum enters the cecal corpus from which the horns project. The corpus opens into the ampulla ceci via a wide communication with indications on the bordering walls of folds possibly for directing flow of digesta. The entrance into the colon proper is at the base of the ampulla. The entire internal mucosa of the cecum is lined by stratified keratinizing squamous epithelium, an unusual feature in ceca and apparently in unique sirenian characteristic.

ULTRASTRUCTURAL PROPERTIES OF THE EPIDERMIS IN THE MANATEE (TRICHECHUS TRICHECHUS) AND THE BOTTLE-NOSED DOLPHIN (TURSIOPS TRUNCATUS) AS ADAPTATIONS TO VARIED SALINITY. V.E. Sokolov and L.V. Stepanova, Institute of Evolutionary Animal Morphology and Ecology, USSR Academy of Sciences, Moscow 117071 USSR.

The skin of marine mammals has undergone considerable adaptation to aquatic life. The epidermis of Trichechus trichechus, which lives in the littoral zone and is exposed to a wide range of salinity, and Tursiops truncatus, which lives in the open sea, in relatively constant salinity, both have a thick stratum corneum with many Odland granules. The latter are the sources of the lipid material of the intercellular cement of stratum corneum. Epidermal corneocytes of the manatee have, in addition, a cross-linked envelope that functions as an osmotic membrane and permits the animals to sustain osmotic stresses and thus occupy a range of salinity that includes freshwater. Dolphin epidermal cells are not fully keratinized and the cross-linked envelope is absent, which explains why irreversible changes occur in them after long exposure to freshwater (Harrison and Tarley, 1974).

DUGONG (DUGONG DUGON) IN NEW-CALEDONIA. J.P. Sylvestre, S.E.C.T.T. 4, allée de la forêt, 92360 Meudon la Forêt, France and B. Richer de Forges, Orstom, B.P. A5, Noumea-Cedex, Nouvelle-Calédonie.

Information concerning the population of dugong in New-Caledonia is fragmentary. These animals are relatively abundant in the New-Caledonia lagoon but they are difficult to approach and to observe. They are protected and sometimes, the tribes have permits to catch few individuals in the occasion of a festival. From the account-book of the Gendarmerie Nationale of 16 dugongs caught during these occasions between 1978 and 1984, 7 were males, 8 were females and another, unlawfully caught, was of unknown sex; 9 of them were harpooned and the other 7 were caught by nets. The lengths of those dugongs were between 1.2 and 2.9 m. The majority of them were solitary, however one male was accompanied by a female and a juvenile, and a female was accompanied by another individual of undetermined sex. Among the females, milk was present in the udder of one individual (caught in April or May 1983). The first months of the year would probably be the breeding season for that population.

WINTER MOVEMENT PATTERNS AND POPULATION STRUCTURE OF THE WEST INDIAN MANATEE, TRICHECHUS manatus, IN HOMOSASSA SPRINGS, FLORIDA. Nina N. Thumser and John G. Morris, Florida Institute of Technology.

Observations were made the winters of 1984 and 1985 on the manatees which congregated in the Blue Water Run (BWR), headwaters of the Homosassa River. Manatees were identified by their scar patterns using aerial and underwater photographs. In addition to photographic records, the sex, approximate length, behavior, time of day, and air and water temperatures were recorded for each encounter with a manatee. Sixty-two animals were identified over the course of the study, indicating that the BWR is used by more manatees than previously thought. Manatees were also found to have a distinct preference for a specific area within the BWR, but the area preferred differed between the two years. It appears that the current slow speed zone should be extended farther down the river. No manatees were found to reside within the BWR for the entire winter; however, the considerable variation in the percentage of time individual manatees were sighted within the run can be used to estimate the relative home ranges. Of the sixty-two animals identified at BWR, 40% had been sighted in Crystal River by the U.S. Fish and Wildlife Service and 29% were recorded in both refugia during a single winter.

AGE DETERMINATION IN THE WEST INDIAN MANATEE BASED ON THORACIC FLIPPER RADIOGRAPHS. Alastair G. Watson, Nancy K. Hensen, College of Veterinary Medicine, University of Florida, Gainesville, FL USA 32610

Plain film radiography was used to analyze the developmental sequence of bones in the thoracic flipper, as a technique for age determination in salvaged carcasses from a Florida population of West Indian manatees, Trichechus manatus. Radiographs of the scapula, humerus, radius and ulna, carpus and manus were examined from 125 manatees ranging in total length from 103 cm newborns to 355 cm adults. Individuals were assigned to particular developmental stages based upon the radiographic indications of ossification events - initial appearance or fusion. Newborns had 22 ossification centers: diaphyses of scapula, humerus, radius, ulna, 5 metacarpals and 13 phalanges (phalangeal formula = 2.3.3.3.2). The remaining developmental stages were defined by a sequence of appearance of 40 epiphyseal ossification centers and their subsequent fusion to their respective diaphyses. In addition 8 ossification centers were detected in the carpus and resulted in 6 carpal bones (2 rows of 3 each); there being 2 or 3 separate centers contributing to the distomedial ("carpal 1+2") carpal bone of the adult. All metacarpals and most phalanges had separate proximal and distal epiphyseal ossification centers. The chronology of these events may be established by comparing these data with radiographs from known-age, known-length manatees. Supported by USFWS PO# 83981205.

RESEARCH PROGRAM IN INFORMATION PROCESSING AND SOCIAL BEHAVIOR IN CAPTIVE WEST INDIAN MANATEES. H.D. Woodward, Department of Psychology, University of Windsor, Windsor, Ontario, Canada N9B 3P4.

Information processing in West Indian Manatees (Trichechus Manatus) was investigated in series of discrimination problem experiments involving captive manatees at Marineland near St. Augustine, Florida and at Miami Seaquarium. With controls to rule out echolocation, odor taste cues, and other alternative explanations it has been demonstrated that manatees can visually discriminate underwater targets on the basis of differences in brightness, size, shape, horizontal/vertical movement, colour, and horizontal/vertical orientation of stripes. Although most of the prior speculation in the literature suggested poor vision in manatees these results indicate an ability to make use of a variety of visual information. These findings are consistent with results from some recent anatomical research on manatee eyes. The lack of clear evidence for cones make the successful colour discriminations particularly interesting. Ability to solve relatively complex problems was demonstrated by successful development of learning sets on size reversal discrimination problems and by success with a variety of visual matching to sample problems. Long term recall was demonstrated on visual size discriminations involving durations up to 17 months. Place learning experiments results indicated some manatees relied on left-right discrimination while others learned to locate a place. Observations on social behaviour in the same settings suggest some hypotheses about nursing, sexual and agonistic behaviours and individual differences that might be useful in guiding research on free roaming manatees.

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[EDITOR'S NOTE: Beginning with this issue I will be including in the "Recent Literature" department citations dealing with the Order Desmostylia, extinct herbivorous marine mammals of the North Pacific region. Once considered sirenians and now viewed as near relations of the latter, they have enough history, ancestry, and ecology in common with sirenians to merit an honorary place in these pages.]

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[Sirenews thanks Helene Marsh for its new dugong logo, which will alternate with our manatee in future issues.]

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