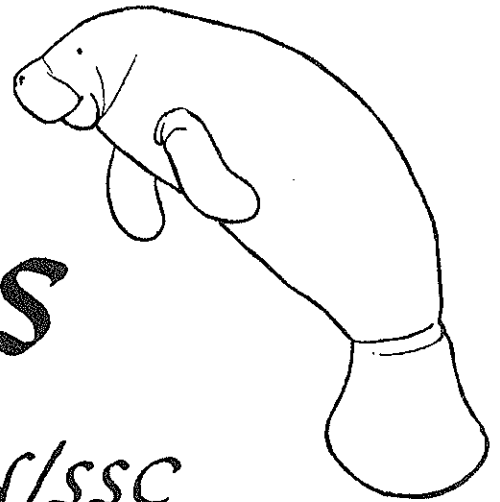


Sirenews



Newsletter of the IUCN/SSC Sirenia Specialist Group

NUMBER 9

APRIL 1988

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 - EXTENSIVE DYNAMITING PLANNED IN MANATEE HABITAT IN MEXICO (p. 7)

NEW SIRENEWS SUBSCRIPTION POLICY

The IUCN Species Survival Commission has been forced to cut back on its support of Specialist Group newsletters, including this one. In order to meet our publication costs, we must therefore institute a subscription policy, beginning with the first issue of 1989. The following policy is being considered; comments are invited.

Executive and Corresponding Members of the Sirenia Specialist Group (listed in Sirenews No. 5) will continue to receive the newsletter free of charge. All other individuals and institutions will be asked to subscribe at the rate of US\$5.00 per year, payable in U.S. currency only. Those with addresses in the U.S. will be required to pay; those in other countries for whom payment in U.S. currency is difficult or impossible will, upon request, be sent the newsletter free.



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

Sirenews is edited by Daryl P. Domning, Dept. of Anatomy, Howard University, Washington, D.C. 20059 USA. It is supported by the Species Survival Commission of IUCN, the U.S. Fish and Wildlife Service, and the U.S. Marine Mammal Commission.

At the same time Sirenews will be purging its mailing list in an effort to reduce costs. Those who have not informed us positively by April 1, 1989 that they wish to continue receiving the newsletter (and sent payment if required) will be dropped from the list.

CONSERVATION ACTION PLAN

The Conservation Action Plan for the Sirenia is being drafted by Helene Marsh (dugongs) and Tom O'Shea (manatees). The draft will eventually be circulated for comments; however, the drafters request that anyone with suggestions or contributions to offer for inclusion in the plan send them at this time to either Helene or Tom, as appropriate. The response to this request so far has been extremely disappointing. The initiative and cooperation of other active sirenian researchers are badly needed so that the necessary labor can be shared and not fall exclusively on these two individuals, who are already overburdened with other research and management tasks.

LETTER

To Sirenews:

After reading Helene Marsh's suggested guidelines for capture and holding of dugongs in captivity [Sirenews No. 8], I feel that item 5 (food supply) should be modified as follows: "A nutritious food source should be available." I think that, in time, experimentation will yield an alternative food supply (e.g., mats of hydroponically grown sprouts) that is cheaper to produce than it is to gather seagrasses. This will also serve to minimize human impact on seagrass beds.

Daniel K. Odell

LOCAL NEWS

AUSTRALIA

Situation Looks Brighter for Dugongs in Torres Strait. - In November 1983, I conducted an aerial survey for dugongs in the Torres Strait region between Australia and Papua New Guinea. I knew that the resultant population estimate of 1455±276 was a minimum estimate as it was not corrected for the proportion of dugongs visible in the transect that are missed by observers (perception bias) or the proportion that were unavailable to observers due to water turbidity (availability bias). On the basis of this estimate, I concluded that there were not enough dugongs in Torres Strait to sustain recent harvest levels, a conclusion reinforced by Brydget Hudson's statistics on the catch levels at Daru (PNG), which had plunged despite sustained hunting effort.

Last November, we repeated the survey using the upgraded aerial survey technique developed for use in the Great Barrier Reef Marine Park, which includes survey-specific correction factors for perception and availability biases. The revised population estimate based on this survey is 12521±1487, which may be enough to sustain the present, much-reduced level of hunting.

A public education program is being developed in the Australian parts of Torres Strait to encourage the Islanders to limit their hunting activities, and a sanctuary area has been declared west of the main hunting islands. It is unfortunate, however, that the sanctuary supports only a low density of dugongs, and the excellent public education program developed by Brydget Hudson in PNG has been discontinued due to lack of funds.

- Helene Marsh

Radiotracking Update. - The immature male tagged with a VHF transmitter in Cleveland Bay near Townsville ranged over only 11 sq. km during the 16 months before his transmitter finally came off. Four adult males tagged with satellite PTTs in the Starcke River area north of Cooktown were all relatively sedentary during the periods (4-11 weeks) for which they were monitored. Most locations were from core areas of only 5 to 11 sq. km. Occasionally the dugongs journeyed to nearby bays or up tidal creeks.

The cause of the transmitters coming off is causing some concern. The VHF transmitter apparently came off due to failure of the buckle after the tether became entangled. Fortunately the transmitter and tether were found on a beach by one of my students. The first of the four PTTs failed after 4 weeks, apparently due to an electronic fault, and has not been recovered. Another PTT came off after 7 weeks. The transmitter was recovered without the tether or harness, suggesting human interference. Another PTT came off its dugong after 11 weeks and has been recovered with the tether intact but minus the tailstock belt, suggesting failure of the weak link. The fourth PTT is still beeping away on a remote beach near the Aboriginal community of Lockhart River, and I am hopeful that a \$500 reward will lead to its recovery over Easter. - Helene Marsh

FLORIDA

Radiotagging: An Overview. - One of the major activities of the U.S. Fish & Wildlife Service's Sirenia Project and its collaborators over the last two years has been a radiotelemetry study of the movements and local use areas of manatees along the east coast of Florida. Although we anticipate continuing fieldwork for another three years, hopefully at an increased level of effort, initial findings are intriguing. We have tracked a total of 22 manatees thus far, with a number of re-taggings of the same individuals. Most have been tagged with VHF transmitters, but eight have been tracked with satellite-monitored PTTs (see Sirenews No. 6, Oct. 1986). The objectives of the study have been to determine seasonal movement patterns and key resource areas. Telemetry data should provide a basis for decisions regarding protection of important areas and regulation

of waterfront development and boating traffic. Eastern Florida has had a significantly higher proportion of boat-killed manatees in recent years, and is undergoing prodigious development.

Tagging activities have centered on the Brevard County area of the central east coast, particularly on Merritt Island National Wildlife Refuge. Manatees have also been tagged at Fernandina Beach on the Georgia-Florida state boundary (see report by Lynn Lefebvre in this issue). Several animals previously tagged at these sites have been re-tagged at power plant effluents in southeastern Florida in winter when the tethered floating transmitters malfunctioned or became detached at the weak safety link. A few individuals have been tracked continuously for over a year. One has been tracked during three winter-spring periods following a series of re-taggings. Thus far, most captured animals have been adult females.

Movement patterns are complex. Some individuals spend most of the annual cycle in the same general areas of Brevard County, whereas others move southward to winter near Riviera Beach, Fort Lauderdale, or Miami. Those that have not ventured farther south than Brevard County spend long periods resting at power plant effluents in winter, whereas those that travel the 300 km south spend much less time at warm-water effluents. Some manatees combine strategies and spend the early part of the winter at Brevard County effluents, but later move to south Florida. In spring and summer, individuals will range north to Georgia, and one adult female travelled the 450-km circuit between Brevard County and Georgia several times within one summer, making the one-way leg of the trip in as little as four days. This same female wintered in southern Florida.

Despite variability in total range of travel, within these ranges manatees may be relatively predictable in their local use areas, showing heavy use of the same limited locations from one summer to the next. During radiotracking we have found important feeding and resting areas, determined rates of travel, and learned more about interchange among wintering sites. We continue to be impressed with the variability and flexibility in individual ecological and behavioral strategies shown by this species. Some individuals switch from foraging for weeks in Spartina salt marshes in Georgia to grazing on seagrass meadows in southern Florida. We also continue to be impressed with the knowledge individual manatees possess on the locations of traditionally visited point resources (such as freshwater sources, safe resting places, or thermal refuges) located hundreds of kilometers apart.

Radio and satellite tracking has been a formidable task due to the complexity of movement patterns, range of movements, and rates of travel. We have therefore relied heavily on cooperation and funding from a variety of other groups outside of the National Ecology Research Center, including the Florida Department of Natural Resources, Florida Power and Light Company, Florida Audubon Society, Merritt Island National Wildlife Refuge, U.S. National Park Service, U.S. Army Corps of Engineers, U.S. Navy, and the Save the Manatee Club, as well as a variety of other organizations and volunteers. Hopefully, our community effort will expand over the next few years to allow us to better

understand the variability we see, and to apply this understanding to manatee conservation. - Tom O'Shea

Radiotracking in Florida and Georgia. - The movements and ecology of radiotagged manatees were studied during the spring and summer of 1987 in the Cumberland Sound region, near the Georgia/Florida border. Two manatees were tagged at Fernandina Beach (near Cumberland Sound in Nassau County, Florida) in March, and two that were tagged in Brevard County, Florida migrated to Cumberland Sound in May. Time spent in the Cumberland Sound region by tagged manatees, areas of greatest use, and manatee feeding behavior were noted.

TNC-01, an adult (330-cm) female, made three round trips between Cumberland Sound and Brevard County, 250 km to the south. TNC-02, an adult (305-cm) male, remained in the North River, Camden County, Georgia from 13 March to mid-April before travelling north to the Altamaha River/Brunswick area in Glynn County, Georgia. TBC-06, a subadult-sized (260-cm) male, and TBC-08, an adult (325-cm) female with a calf, were first reported in Kings Bay on 19 May. TBC-06 stayed in Kings Bay until early July, made a southward trip to Ormond Beach, Volusia County, Florida in mid-July, and returned to Kings Bay by 27 July. In August, he ranged down to Tiger Island and Fernandina Beach, and by mid-September, he had returned to Brevard County. TBC-08 was located in the Satilla River and several creeks in the north Cumberland Sound region until 11 June. She was recovered dead from unknown causes on 4 September in the St. Johns River in Jacksonville, Florida.

Several areas in the Cumberland Sound region were frequently used by tagged manatees, including the Kings Bay Nuclear Submarine Base. The sound appears to be an important travel corridor for manatees. While water temperatures were low in early spring, the Gilman Paper Company warm-water discharge provided a source of warmth used by TNC-02 and other manatees. At high tide, TNC-02 left the effluent to feed on Spartina growing along the river banks. The Fernandina Municipal Marina and sewage treatment plant outfall provide sources of fresh water for manatees. The Kings Bay submarine base was a focal point for two tagged manatees (TNC-01 and TNC-06). Availability of food at both low and high tides, as well as fresh water, may attract manatees to Kings Bay. Since Kings Bay is a restricted military zone, manatees may also seek refuge there from boat traffic.

This report covers results obtained in 1987 only. Two additional manatees were radiotagged on 25 February 1988 in Fernandina Beach. Two of the originally tagged animals, TNC-01 and TBC-06, are still carrying functional transmitters, and may return to Cumberland Sound during spring or summer 1988.

This research has provided some valuable insights into the ecology of manatees in the Cumberland Sound region. Through the continued cooperative efforts of the National Park Service, the U.S. Navy, the U.S. Fish & Wildlife Service, and the Port of Fernandina, radiotracking efforts will be continued during the spring and summer of 1988 and 1989. The manatees were captured and tagged by personnel of the Fish & Wildlife Service's Sirenia Project, with assistance from National Park Service personnel.

The radiotracking has been conducted by Barbara J. Zoodsma, technician for the National Park Service Cooperative at the University of Georgia, and James A. Valade, working for the Port of Fernandina. Barbara will be continuing the study in 1988-89 as her master's thesis research at the University of Florida.
- Lynn Lefebvre

Hobe Sound Seagrass Study. - The National Marine Fisheries Service, U.S. Fish & Wildlife Service, and Florida Department of Natural Resources are cooperating in an investigation of the submarine light regime and ecological status of the seagrasses in Hobe Sound on Florida's east coast. AN important objective of the study is to evaluate the effect of boat traffic on submarine light attenuation through the implementation of an experimental no-wake zone. It is hoped that information on manatee feeding ecology will also be obtained. Hobe Sound is used by manatees during the winter, and they may have a substantial impact on the seagrass community. Data collected in the past year have documented the annual cycle in seagrass biomass and productivity in Hobe Sound, as well as changes in temperature and light available for seagrass photosynthesis. Results thus far indicate an improving light regime from March through September, followed by a dramatic reduction in light penetration in November and December, associated with winter cold fronts and winds from the north. Spring and summer are the periods of highest productivity for Syringodium and Halodule, respectively, which are the dominant seagrasses in Hobe Sound. Although seagrass biomass and net productivity are indicative of a healthy and productive submerged aquatic vegetation community, seagrasses grow on only 15-20% of the bottom, at depths less than 2 m. An hypothesis has been formulated that if light attenuation were maintained for an extended period at the best conditions (on average) observed thus far, seagrass coverage would significantly increase in Hobe Sound. Implementation of a no-wake zone will allow testing of this hypothesis. - Jud Kenworthy, Lynn Lefebvre, Mark Ludlow, and Don McIvor

INDIA

Dugong Status in South India. - As Chairperson of the Sirenia Specialist Group, I was asked by the IUCN Special Projects Officer in Geneva, Mr. Simon Stuart, to investigate the status of the dugong in the Palk Bay-Gulf of Mannar region of southern India as a result of the very disturbing reports by Dr. Eric Silas and Mr. Bastion Fernando of a huge increase in the illegal take of dugongs in this area. My visit from December 5 through 11, 1987, was arranged by Mr. J. C. Daniel of the Bombay Natural History Society.

During my visit, I was escorted by Mr. S. A. Hussain of the Bombay Natural History Society, and Mr. A. Balakathiresan of the Indian Forestry Service, which has responsibility for conservation and wildlife management. I visited the Central Marine Fisheries Research Institute at Mandapam and had talks with the Director, Dr. P. V. Rao, and Mr. Bastion Fernando of his staff who had collected the information on dugong mortality in

the region.

After discussions with the local scientists, I am convinced there is a major problem. Silas and Fernando have data which indicate that 250 dugongs were illegally caught and butchered at the villages of Kilakarei and Peripattinum alone between April 1983 and August 1984. The harvest rate is likely to be much less than this at present because of the disturbance associated with the Tamil terrorists.

In order to evaluate the likely impact of this harvest, it will be necessary to estimate dugong numbers in this region with an aerial survey, and I had discussions with the Indian officials about the logistics of doing this.

Meanwhile, we had fruitful discussions about how to reduce the illegal take, and developed specific suggestions for increased surveillance coupled with a public education program. I have written to the appropriate Indian officials about implementing these measures. - Helene Marsh

MEXICO

Manatee Research in Quintana Roo. - A manatee project is currently in progress at the Centro de Investigaciones de Quintana Roo (C.I.Q.R.O.) in Cancun, with the support of the U.S. Fish and Wildlife Service. The general objective of the study is to determine the status and distribution of the manatee in the state of Quintana Roo. The project also seeks to study the habitats of manatees and identify the areas where manatees congregate along the Caribbean coast of Mexico.

Existing information about manatees in this region, compiled from interviews and boat and aerial surveys, shows that the manatee population has drastically declined from past levels, probably due principally to past hunting pressure. An important population has been found to exist in Chetumal Bay and the Hondo River, to the south of Quintana Roo. This is probably the most important population of this species in the Mexican Caribbean. We will continue this study for six months in order to verify this information. We have also proposed further research in the area, with the aim of conserving the species in the future. - Luz del Carmen Colmenero Rolon

Potential Threat from Mining and Dredging. - In view of the above report, it is significant that an American gravel company is planning a major mining operation on the coast of Quintana Roo. According to the Rainforest Action Network (Alerts #21, January 1988, and #24, April 1988), Vulcan Materials (P.O. Box 7497, Birmingham, Alabama 35253) has collaborated with a Mexican construction firm to establish a 5000-acre quarry in tropical dry forest (a threatened habitat type) 50 miles south of Cancun. (The company, however, claims that their property covers only 2800 acres.) They will dynamite the limestone to produce gravel for road-building, and dredge a deep-water port to ship the gravel to the U.S.

It is not clear whether the quarrying will be carried out on the coast itself or further inland. However, the construction of the port, presumably involving further dynamiting as well as

dredging, can certainly be expected to have a significant impact on coastal waters, and the area of coastline in question was considered by Colmenero and Zavala (1986) to provide important habitat for manatees. A Mexican environmental organization, the Grupo Ecologista del Mayab (GEMA), has already begun to organize opposition to the mining proposal. It would appear worthwhile for international conservation organizations to also watch these developments closely.

SAUDI ARABIA

Dugong Workshop. - In December 1987, George Heinsohn and I spent 10 days in Saudi Arabia as guests of the Meteorological and Environmental Protection Administration, the agency that has sponsored Tony Preen's work on dugongs in the Arabian Gulf and Red Sea. We spent the first week helping Tony prepare a draft management plan for dugongs in Arabian waters for presentation at a workshop in Jeddah the next week. The draft plan was well received by the biologists and environmental managers from throughout the Kingdom who attended the workshop and who made many useful suggestions.

The draft plan recognizes the importance of the Arabian region to the conservation of world dugong stocks and advocates a regional approach to dugong management. The most important recommendations concern a series of protected areas in the Arabian Gulf and Red Sea. Management requirements for the most crucial areas include the exclusion of gill netting and industrial shrimp trawling and the preparation of oil spill contingency plans.

Other recommendations cover the inclusion of the dugong on the regional lists of protected species, the protection of seagrass beds, the initiation of an environmental awareness program and the development of a research and monitoring program for dugongs.

The Dugong Replenishment Program in Saudi Arabia was initiated in response to fears that dugongs had been exterminated in the Arabian Gulf by the Nowruz oil spill. Five years later, the region has been established as the most important dugong area in the world outside Australia, with an estimated 6460±2130 dugongs in the Gulf and a further 830±270 in the Red Sea. The Saudi Arabian Meteorological and Environmental Protection Administration is to be congratulated for supporting an excellent research program. I hope that this research will lead to an equally successful management program for dugongs in this region.

- Helene Marsh

WASHINGTON, D.C.

Sirenian Bibliography Project. - As many of you know, for some time (actually since 1967!) I have been at work on an exhaustive, fully annotated bibliography and index of the literature on sirenians and desmostylians. Since this project has now reached the mature age of 21, I think it is about time for a progress report.

The bibliography presently exists in the form of some three

to five thousand handwritten 3x5 index cards. These include references dating from the early 16th century to the present, on all aspects of sirenian biology, paleobiology, and ethnobiology, as well as on the extinct Desmostylia. About a third of these are indexed and annotated. The index consists of several thousand additional cards and over 800 subject headings, including all published scientific names and combinations ever used for sirenians or desmostylians, and all reported species of food plants and parasites. Each index entry is an abbreviated citation (by author and date) of the work indexed, followed by a brief annotation and an exact page reference.

This project has been proceeding very slowly for many years because it has been emphatically a spare-time effort; I have allowed many other activities to take precedence over it. Now, spurred by signs of activity in other areas of marine mammal bibliography, I am rather rapidly converting the files to computer-processable form. At this writing all of the author entries through the letter E have been loaded into the computer, as well as all of the subject headings for the index (but no actual index entries).

The software I have adopted for this purpose is called Notebook II, which is described as a "database manager for unlimited text." It is available from Pro/Tem Software, Inc., 2363 Boulevard Circle, Walnut Creek, Calif. 94595 USA (phones 415-947-1000, 800-826-2222), for the remarkably low price of about \$189. The most recent issue is version 2.3. It is available for IBM and compatible computers, the HP 150, HP 110, and other MSDOS-based computers. (My machine is an IBM PC-XT.) It permits the use of international characters, underlining, and italicization, which I am making full use of. It also permits Boolean searches of records and fields and has many other desirable features. So far I am pretty well satisfied with its capabilities, and suggest that anyone who wants to use what I eventually produce in its electronic form might want to purchase a copy of this very versatile program.

My chief aim, however, has always been to produce the bibliography and index in hard-copy (i.e., printed) form. I find paper copies easier to use for many purposes than magnetic disks, and a lot more convenient for those users who don't have instant access to a computer! I have designed the index to accomplish on paper most of what the typical "keyword" systems accomplish with on-line computer searches (my indexing system is not keyword-based), so a computer will not be needed to make efficient use of the bibliography. However, the computerization I am now undertaking, aside from being the most efficient way to produce a hard copy, will generate the still more versatile electronic version with no additional effort, so I expect that those wishing to acquire copies will eventually have a choice of either or both versions. The printed version will also include several appendices, one of which will be an up-to-date classification and synonymy of the Sirenia and Desmostylia.

If progress continues at near its present rate, I should have the entire bibliography (including both verified and unverified citations, but without the index) computerized by the end of 1988. (Or soon thereafter ...?) This would permit the

production of a first printed edition that would be similar in form to, but far more inclusive than, the sirenian bibliography compiled in 1979 by Marsh, Channells, and Morrissey and currently the largest and most up-to-date one available. However, I would prefer to delay publication until at least a first draft of the index is ready, because the bibliography will be of only limited use without it. Please give me your thoughts on this point.

No decision has yet been made concerning place or manner of publication, or price. However, I expect that revised editions would be produced at intervals as I work through the huge backlog of verification and indexing and continue to incorporate the current literature.

Meanwhile, I ask all my colleagues to continue to send me reprints and other citations for inclusion in this bibliography. Its aim is no less than the greatest degree of completeness achievable. I feel - and I consider myself a good judge of the matter - that no one should ever have the misfortune of doing this job over again! For the sake of posterity, please help me get all the fish into the net!

Finally, it should be noted that efforts are also underway at several other places in the U.S., such as Woods Hole, to create marine mammal bibliographic databases. Those involved have been in at least informal contact, and we have become aware that several different software packages (e.g., Cymate, Inmagic, Notebook) are being used for this purpose. The people at Woods Hole seem to feel that interface programs can probably be written without much difficulty to translate data among these various packages. However, I strongly suspect it would be a good idea for the parties concerned to seriously look into this as soon as possible, to avoid nasty surprises later. I suggest that it might be best to create a formal Bibliography Committee under the auspices of the Society for Marine Mammalogy, with the aims of coordinating these various projects, insuring mutual compatibility of software and other features, exploring the possibility of on-line access, and preventing duplication of effort. - DPD

DUGONG TISSUES AVAILABLE

The Papua New Guinea Museum holds specimens of the following formalin-fixed tissues of dugongs:

Adrenal	Caecum	Fat
Heart muscle	Foetal muscle	Liver
Salivary gland	Kidney	Tongue
Spleen	Eye	Thyroid

These are available to interested scientists, who should contact: Dr. Jim Menzies, National Museum & Art Gallery, P.O. Box 5560, Boroko, Papua New Guinea.

ABSTRACTS

The following abstracts are of papers and posters presented at the Seventh Biennial Conference on the Biology of Marine Mammals, Miami, Florida, Dec. 5-9, 1987.

THE PARASITES OF FLORIDA MANATEES

Beck, C. and D. J. Forrester
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and University of Florida, College of Veterinary Medicine,
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We examined at necropsy 215 Florida manatee (*Trichechus manatus latirostris*) carcasses from October 1974 through October 1982 to determine their parasite fauna. Two ectoparasitic crustaceans and six species of helminths (four trematodes, one nematode, and one cestode) occur in Florida manatees. One species of crustacean and the cestode have been documented from only one manatee each. Data on the prevalence of five species and the intensity of four species of the helminths were collected. The infections were analyzed for effects of host sex, age class, recovery location, recovery season, and cause of death category.

No associations were found between any of the host factors and the intensity of the helminth infections. No associations were found in the prevalence of any helminth and host sex, season of recovery, or cause of death category. Differences in helminth prevalence between age classes were highly significant for two trematodes, *Chlorchis fabaceus* and *Cochleotrema cochleotrema*, and the only nematode, *Heterocheilus tunicatus*, due to a low number of infected calves. A higher prevalence of *Cochleotrema* was found in manatees recovered from eastern Florida and *Heterocheilus* was found in more manatees from southern Florida. At least one species of helminth infected 73% of the manatees examined. The mean number of species per manatee was 1.4 (range=1-4). Fifty-nine manatees were helminth-free and 30 of these were calves.

The prevalence and intensity of helminth infections in Florida manatees may not be similar to other populations of manatees and are distinct from the parasite fauna of dugongs (*Dugong dugon*). A summary list of all parasites known to infect the four extant species of sirenians will be presented.

RELATIVE ABUNDANCE AND DISTRIBUTION OF THE WEST INDIAN MANATEE IN LEE COUNTY, FLORIDA, 1984-1985

Clemons, M. A., and R. K. Frohlich
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National Ecology Center, Sirenia Project, 412 N.E. 16th Ave.
Gainesville, FL 32609.

Aerial surveys to determine seasonal abundance and distribution of manatees (*Trichechus manatus*) in Lee County, Florida were conducted twice monthly from January 1984 through December 1985. A total of 2769 manatee sightings was made with a mean of 57 manatees per survey (SD = 41.21). The highest count on a survey was 238 (29 January 1985) and the lowest was 14 (24 September 1984). There was no significant difference in relative abundance between years. Calves accounted for 11% of the total number of manatees seen. Manatee abundance in Lee County was seasonal, with highest mean counts per survey in January, November, and December ($x = 104, 103, 87$ respectively) and lowest in March, August, and September ($x = 32, 36, 30$, respectively). Manatees were most abundant in the Caloosahatchee River and its tributary, the Orange River, which is warmed by the discharge of an electrical generating plant. Over 42% of all manatee sightings occurred in the Caloosahatchee River and 21% were in the Orange River. Although the Caloosahatchee River had the highest manatee use in all seasons, distribution in other areas was seasonal. Manatees were abundant in the Orange River during the winter months, but were rarely found there at other times of the year. During late summer and fall manatees were relatively abundant along the western edge of Estero Bay, southern Pine Island Sound, and portions of San Carlos Bay and Matlacha Pass.

MANATEE ABUNDANCE, DISTRIBUTION, AND MOVEMENTS IN BREVARD COUNTY, FLORIDA

Bonde, R.K. and I.E. Beeler
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The waters of the Banana and Indian Rivers in Brevard County, Florida offer a unique diversity of habitat and are utilized by manatees (*Trichechus manatus*) throughout the year. During winter months manatees aggregate in the warm water effluents of two local power plants and disperse during warmer months. Fifty-nine intensive, biweekly aerial surveys were flown over the Banana River and portions of the Indian River in Brevard County between December 1985 and January 1987, to establish information on abundance, distribution, and movements of manatees. The information from this series of flights are compared to data acquired during similar flights by Shane (1981) between June 1978 and February 1980, in which an identical survey route was flown. Survey methods also were consistent with Shane's. The highest count for manatees from the Indian River was 128 animals in February 1986, while the highest count for the Banana River was 292 in April 1986. These counts are both higher than all previous counts by Shane.

We are unaware of any environmental changes which could account for an increase in manatee usage of this area. The number of deaths each year from Brevard County have remained relatively constant; therefore, other possible reasons for this increase are immigration and increased natality. An overview of high-use manatee areas within Brevard County will be presented, along with data collected during each survey on boat traffic and activity patterns within these critical areas.

MOVEMENTS OF WEST INDIAN MANATEES IN SOUTHWEST FLORIDA

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Sixty-seven West Indian manatees (*Trichechus manatus*) were captured and released at a winter warm water refuge in Lee County, Florida in January 1985 and 1986, and 32 were fitted with floating, 164 MHz radio transmitter assemblies. Radio tracking was conducted from boats, land vehicles, and Cessna 172 aircraft. The average duration that manatees were tracked was 119 days in 1985 and 228 days in 1986. During January and February the focus of manatee activity was the Orange River, a tributary of the Caloosahatchee River that is warmed by the discharge of an electrical generating plant. Some radio-tagged manatees travelled down the Caloosahatchee River between cold fronts, apparently to feed. In 1985, manatees dispersed from the Caloosahatchee in late February and early March, primarily to Charlotte Harbor via Matlacha Pass. In 1986, spring dispersal was later and less distinct, with many individuals using the lower Caloosahatchee throughout the spring and into early summer. Six tagged manatees, one in 1985 and five in 1986, were known to have returned to the capture site in the Orange River. The greatest range of individual manatees was 200 km: a subadult female travelled south to the Broad River in the Everglades (and returned to the Orange River the following winter), and an adult female and adult male moved north to Tampa Bay. Several other manatees moved relatively large distances to Marco Island and the Turner River to the south, and Lemon Bay and Sarasota Bay to the north. Of 25 manatees radio tracked for at least three months, 19 were never located outside of the Charlotte Harbor Region, including the Peace and Myakka rivers, Charlotte Harbor, Matlacha Pass, Pine Island Sound, San Carlos Bay, and the lower Caloosahatchee River. Thus the majority of manatees utilizing the Orange River as a winter refuge may spend the warm season within the Charlotte Harbor Region.

PRELIMINARY UNDERWATER ACOUSTICAL THRESHOLDS OF A CAPTIVE WEST INDIAN MANATEE, *TRICHECHUS MANATUS*, A QUANTITATIVE BEHAVIORAL APPROACH
Gerstein, Edmund, Geoffrey Patton, William Tavolga
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A simple two choice paradigm was initiated to measure the ability of an adult male manatee to hear a range of amplified frequencies projected underwater. Upon presentation of a visual command the subject was trained to discriminate between two submerged paddles: pushing one if it detected an underwater tone or the other paddle if no tone was detected. Electrical switches on each paddle insured the reliable recording of test selections, while double blind and randomized on/off acoustical presentations served as precautions against experimenter bias and Clever Hans variants.

An HP signal generator delivered single tones through an EV/DU-30 underwater speaker, while an H505 hydrophone monitored background and acoustical signal strength. After establishing a reliable behavioral baseline for paddle selections @ 80% accuracy, 16 test trials were run for a total of 240 recorded selections. A hearing threshold minimum range of 0.15 kHz-15kHz is demonstrated @ p<.05. Results show significant hearing beyond acoustical limits previously determined through behavioral and physiologically evoked brain potential studies.

Contrary to skepticism that manatees are difficult to motivate and train for extended behavioral studies, the discrimination and task learning ability demonstrated by this subject has encouraged further study to quantify the acoustical mass thresholds, signal-to-noise detection ratios and typical directional hearing sensitivity of the species, by testing this and other captive and wild manatees. Our applied conservation goal is to evaluate the manatees' sensory awareness of typical propeller frequencies and environmental noise, and if applicable, investigate and develop an effective acoustical warning system or sonic device to alert manatees of a boat's proximity.

AN OVERVIEW OF LONG-TERM RESEARCH ON FLORIDA MANATEES
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Continuous research on manatees (*Trichechus manatus*) in Florida has existed since 1974. Numerous workers have been involved, and participation continues to be dynamic. The nucleus of the program, however, has centered on two complementary activities: carcass salvage and longitudinal field studies of known individuals. Integration of results from these two activities, as well as from shorter-term spin-off studies, is yielding an outline of manatee ecology and behavior. An intriguing amount of variation is also being revealed, emphasizing the need for long-term research when the scaling of animal life histories is considered.

Sirenians are unique among marine mammals in that the food resource of aquatic plants is of relatively low quality. Characteristics of the food resource constrain their behavioral ecology. They have low metabolic rates and a limited capacity for heat production. This limits distribution, and in Florida imposes an annual cycle of migration involving a winter refuging strategy focused on point sources of warm water. Long-term records for individuals which return to these locations provide the only information on manatee reproductive traits, and indicate a relatively low maximum potential rate of population increase. These traits also show considerable variation, as do aspects of maternal care.

Aquatic plants are not a concentrated resource and do not allow for selection of social organizations such as territoriality or resource defense polygyny. Sexual dimorphism is negligible. The mating system is a "default" strategy whereby individuals occupy large, overlapping home ranges and travel extensive circuits. Estrous females attract males from overlap areas into a mating herd and may copulate with more than one. The social system also plays an important role in population genetics, with relatively high heterozygosity and no regional differentiation. Individual recognition may occur between cows and older weaned offspring, and there seems to be a strong element of traditional learning of the locations of important resources. Winter mortality, particularly during the first years after weaning, is a major factor promoting tradition in the lives of manatees.

TEST OF REPLICATE MANATEE COUNTS TO DETERMINE TRENDS IN ABUNDANCE IN FLORIDA
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Packard, Siniff, and Cornell (Wildl. Soc. Bull. 14:265-275, 1986) described an aerial survey method using repeated counts within survey units to minimize error caused by short-term variation in visibility of manatees (*Trichechus manatus*). We tested this method at Crystal and Homosassa Rivers, whose spring-fed headwaters provide thermal refuges for manatees during the winter. The study area was divided into 20 survey units: 10 primary units in which we expected to observe manatees during every survey, and 10 secondary units, in which fewer manatee observations were expected. Surveys were conducted on four consecutive days following a cold front in each of three months (December 1985-February 1986) by two observers in a Cessna 172 aircraft.

The observers were unable to reliably reidentify individual manatees, thus we did not attempt to estimate population size using a capture-recapture method as proposed by Packard et al. We believe that several fundamental assumptions of capture-recapture sampling are violated by the Packard et al. survey methodology. Variance components of the replicate count data from primary units were estimated to evaluate the relative magnitude of random effects in the experimental design. The largest source of random variation was the interaction of survey unit with date, suggesting that differences among units varied among surveys. The second largest source was variation among replicate counts. Variation among cold fronts (i.e., months) was moderate, and variation among dates and observers was smallest. The data did not meet distributional assumptions of parametric analysis of variance regardless of transformation, thus significance tests must be viewed with caution. Parametric statistics may be more appropriately applied to a smaller subset of units associated with major springs, where manatee counts are consistently high. Otherwise, it may be necessary to employ nonparametric methods based on ranks.

DUGONG MOVEMENTS DETERMINED BY SATELLITE AND CONVENTIONAL TELEMETRY
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In northeastern Australia, where dugongs (*Dugong dugon*) are locally abundant, it is important to understand their movement patterns in order to manage Aboriginal subsistence hunting and manage the Great Barrier Reef National Park. A method of capturing dugongs and attaching radio transmitters was developed, based largely on the successful manatee (*Trichechus manatus*) model.

Two dugongs were captured and instrumented near Townsville, Queensland, in October 1986. TIROS weather satellites were used to monitor the movements of one dugong for nine weeks, while conventional tracking was used to follow the other dugong for over 32 weeks. The latter, which is still being radio-tracked, has remained within 9 km of its capture location for the entire time. The satellite-monitored dugong, however, moved a straight-line distance of 140 km south immediately after capture and made one round-trip journey back to its capture site before the transmitter attachment failed.

These are the first data on the movements of free-ranging, individual dugongs. Based on this successful use of telemetry, several additional satellite transmitters will be deployed on dugongs in northeastern Australia in late 1987.

FRONTAL CEREBRAL CORTEX ANATOMY IN THE WEST INDIAN MANATEE
(*Trichechus manatus*)

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Cortical structure was examined in Nissl, myelin, AChE and cytochrome oxidase material from four brains. Sections reveal a well laminated cortex with areal variations and regional specializations such as a striated layer VI.

In the pragenual region the medial wall and ventromedial cortex have a prominent layer II that is compact and continuous, broad layer III, no granular layer IV, and a large-celled layer V with clear Vb. Moving from the midline onto the dorsolateral surface, layer II becomes progressively less distinct; layer V is thinner, contains smaller cells more sparsely distributed, and a less distinct layer Vb. Here there does appear to be a granular layer IV which merges with the small pyramidal cells of layer III.

Moving ventrally and laterally from the midline, the medial wall structure continues until the olfactory peduncle joins the basal cortex. Dorsal to the shallow rhinal fissure layer II becomes more irregular and a lamina dissecans is seen between poorly defined layers III and V. There is no visible extreme capsule, and only a small claustrum "affixed" to the deep layers of cerebral cortex; this arrangement is similar to that seen in monotremes, microbats and most rodents. In layer VI, distinct cell clusters (150-500µm dia) are seen, extending dorsally into an otherwise typical dorsolateral cortex. The clusters are spaced fairly regularly at intervals of 500-1000µm. Also, a deeply situated AChE-positive band extends dorsally from the rhinal fissure, becoming fragmented and coextensive with the cell clusters in layer VI. Dexler (1913, Gegenbaurs morphol. Jahrbuch 45:97) first noted these cell clusters in the brains of dugongs, and termed them Kindenkerne, or cortical nuclei. They may represent a specialization peculiar to somatic sensory cortex.

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COORDINATED MANATEE AERIAL SURVEYS ON THE EAST COAST OF FLORIDA DURING 1986

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To determine areas of seasonal manatee use and associated migratory routes, coordinated intensive biweekly aerial surveys were conducted in 1986 over 210 km of estuarine manatee habitat between Riviera Beach and Titusville on Florida's east coast. The area was divided into 4 survey zones from south to north: 1) Riviera Beach to Ft. Pierce; 2) Ft. Pierce to Grant; 3) Indian River lagoon from Grant to Cocoa; 4) Cocoa to Titusville and entire Banana River. Each of the 4 survey teams used standardized survey procedures.

Northward manatee migration began in late January. During February and early March, counts in the Indian River lagoon between Ft. Pierce and Sebastian Inlet peaked at 185. Manatees were primarily observed moving north and feeding on vegetation around Vero Beach and near Sebastian Inlet. Manatees also frequented fresh water discharges. In March and April, the advancing front of migrating animals left the Indian River for the Banana River where they were joined by animals which probably wintered at the Titusville warm water effluents. Summed total counts made during this period were over 68% of the estimated east coast manatee population (600): 412 in March and 413 in April. After feeding on extensive vegetation around the Kennedy Space Center in the upper Banana River, some manatees apparently continued to migrate north out of the study area as total counts dropped to 229 in May. During summer and fall, manatees were observed to disperse over the northern portion of the study area. Composite counts fluctuated with monthly maximums around 340 between June and early November. Southward migration appeared to begin in November as counts in the southern areas rose at the same time Banana River counts declined. Survey results documented manatee migratory behavior, travel routes, and areas of high manatee abundance where protection efforts should be focused.

The following abstracts are of papers presented at the annual meeting of the American Society of Mammalogists, Albuquerque, New Mexico, June 21-25, 1987.

CURRENT DISTRIBUTION AND STATUS OF THE WEST INDIAN MANATEE IN VENEZUELA

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We conducted field interviews and aerial surveys in February, March and April 1986 to determine the current status and distribution of the West Indian manatee (*Trichechus manatus*) in Venezuela. There is a major discontinuity in the range of this species along the entire Caribbean coastline of Venezuela. There is also no historical evidence for the presence of manatees in this region. This discontinuity is probably due to habitat unsuitability. A remnant population exists in parts of Lake Maracaibo. Manatees are commonly reported from eastern Venezuela, especially the Orinoco Delta and the middle Orinoco, where an interesting folklore is also attached to them. Drastic fluctuations in water levels associated with seasonal rainfall may have major effects on activities and movements of manatees in the Orinoco system. Hunting has caused past manatee population reductions in Venezuela, but manatee hunting activities have been greatly curtailed in recent years. Relaxed hunting pressure and the continued existence of suitable habitat in eastern Venezuela leads to a cautiously optimistic outlook for the future of manatees in this region. Aerial surveys did not provide useful results because of poor water quality.

HOW TO BULLDOG, RADIO-TAG, AND TRACK SEA COWS (DUGONG DUGON)

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Dugongs are rarely captured for purposes other than eating. We tried bulldogging, hoop-netting, and gill-netting dugongs in Morton Bay, Queensland, and determined that hoop-netting is the safest and best method of capture. Two dugongs were radio-tagged with peduncle-belt, tether, and floating radio transmitter assemblies. One dugong was tracked with a conventional VHF transmitter and the other with a satellite-monitored UHF transmitter. The data gathered from these two dugongs are the first on the movements of free-ranging dugongs.

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