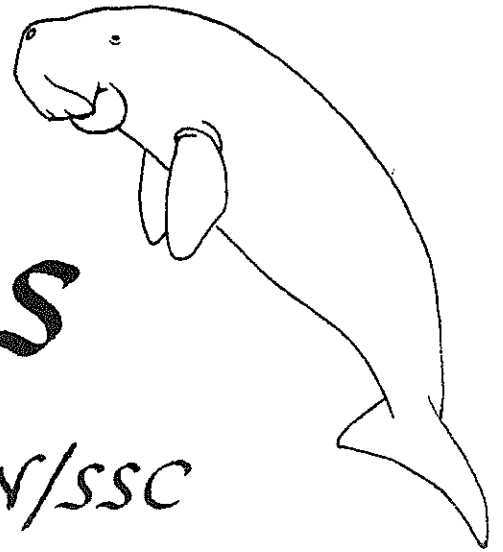


# Sirenews



## Newsletter of the IUCN/SSC Sirenia Specialist Group

NUMBER 32

OCTOBER 1999

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### EDITORIAL: 6,000,000,000 AND NO END IN SIGHT

It is likely that as I am writing this, or maybe as you read it, the six billionth person is being added to the Earth's living human population. Officially, United Nations demographers have estimated that this will occur on or about October 12, 1999. This also happens to be 507 years to the day since Christopher Columbus first sighted the New World. Which of these events will go down in history as being of greater consequence?

Columbus' discovery was one of history's sharpest inflection points: in one precisely defined moment, much was changed, and the human story shifted onto a very different track (though of course it took many years more for this to become fully apparent). New vistas of opportunity were opened to Europeans and, in the long run, to many others; it was truly a moment for optimism. Of course, the view from the Native Americans' perspective was different. They faced dispossession, slavery, genocide, and mass extinction. Theirs was the half of the glass that was empty. But no one and nothing was left unaffected.



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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In contrast, it is hard to argue that the birth of person number six billion is more momentous than that of, say, number six billion and one. We are arbitrarily fascinated by round numbers with lots of zeroes. The mathematically interesting event, the inflection point in the exponential curve of population growth (when the curve's slope changed from more nearly horizontal to more nearly vertical), actually occurred nearly a hundred years ago. Since then the population has quadrupled. In 1960, the year I entered high school, the world's population stood at three billion; it has doubled in less than 40 years. The curve will not return to horizontal for several decades to come. Neither, presumably, will the curve tracking the current mass extinction of other species.

But milestones do measure something; and in demography, absolute numbers do matter. As with 1492, it can equally be said of this Year of Six Billion that no one and nothing will be left unaffected by it. Here, however, the effects are not so mixed: there is no upside to this event. The glass - *everyone's* glass - is rapidly being emptied of resources. The October 12 *Washington Post* and other news media are giving this a positive spin by stressing that the *rate* of growth is slowing faster than expected, as though this were consequently a day to celebrate. But there is no hiding the fact that growth meanwhile continues at a frightening rate. There is no cause for optimism in the demographic data; the present slowing of the growth rate means, at best, only that we may avoid the worst that was once anticipated. But reality will be more than bad enough to vindicate the pessimists.

It will also, in all probability, be more than bad enough for Baby Number Six Billion. One concerned organization, Population Communications International, estimates some of the odds against this baby as follows:

- ◆ there is a 40% chance that he/she was unplanned;
- ◆ he/she has only a 50% chance of being immunized against preventable infectious diseases, like polio and measles;
- ◆ he/she has a 35% chance of not having access to clean water; and
- ◆ there is an 80% chance that he/she will live in substandard housing.

Meanwhile, we in the USA, with some 5% of the world's population, consume nearly one-third of the resources. Fair distribution of wealth is obviously needed, but will not solve the problem by itself, contrary to the mantra of many overpopulation-deniers. Tautologically, if anyone takes even slightly more than his fair share, someone else must make do with less than a fair share. If everyone were raised to the same material standard of living that we Americans now enjoy, we would need half a dozen additional planet Earths to supply them. Failing that, the "everyone" the present Earth could support at that level would not amount to anywhere near six billion. And we are now on the way to seven billion, and will probably pass eight billion before leveling off half a century from now. If equitable distribution of resources is our goal, what level of misery are we all jointly willing to settle for in exchange for squeezing as many people around the table as possible?

Clearly, sirenians and other species have no more cause to celebrate this October 12 than Native Americans had to celebrate the arrival of Columbus. The implications are obvious, at least to us biologists. But how many others among us six billion - including many of those with the greatest power and influence - are still in a state of denial concerning this issue? As the following announcement shows, some Americans are acting

to address this problem, and in the part of the U.S. most critical to manatee survival. Their poster slogan, "**Overpopulation -- Talk About It**", suggests a simple, cost-free, and effective way for everyone in the world to start helping. How about you?

(A useful reference: L.R. Brown, G. Gardner, and B. Halweil. 1998. Beyond Malthus: sixteen dimensions of the population problem. *Worldwatch Paper* 143: 1-89. Available for US\$5.00 + postage from the Worldwatch Institute, 1776 Massachusetts Ave., Washington, D.C. 20036-1904 USA; phone 1-800-555-2028; fax 1-202-296-7365; e-mail <[wwpub@worldwatch.org](mailto:wwpub@worldwatch.org)>) - **DPD**

FLORIDIANS FOR A SUSTAINABLE POPULATION  
ANNOUNCES  
FLORIDA OVERPOPULATION AWARENESS WEEK  
October 17 - 23, 1999

This fall, Floridians for a Sustainable Population will bring the message of too much and too rapid population growth to Floridians across the state. Having passed the 15 million mark in February 1999, with a 1.8% growth rate and a doubling time of 39 years, not enough alarm bells are being sounded in the halls of the legislature, on our university campuses, or in our print and electronic media. In 39 years, less than a full lifetime, we will have to double the miles of highways, the number of classrooms, the number of libraries, hospital beds, jail cells, court rooms, police officers, fire fighters, and double the pumpage of drinking water - just to stay even.

What will it mean to the everyday lives of Floridians in terms of marginal and more expensive drinking water, of school overcrowding, jammed highways, and overflowing waste dumps? In terms of lost agricultural land and depleted marine life? Do Floridians realize what the future holds when Florida's Department of Community Affairs under the Growth Management Act has already approved build-out plans for 101 million people to reside in Florida?

In October, the Population Institute will observe its 15th annual World Population Awareness Week. In that month the United Nations projects that the six billionth person will be added to those already on this planet. That event means it took only 11 years to add one billion people to the earth's population. What is the impact on Florida's growth when the U.S. Congress is allowing a million people a year to legally immigrate to the U.S. and has yet to control illegal entries which add 300,000 to 500,000 persons to our population each year? How many more amnesties by Congress will swell the current U.S. population of 273 million beyond the projected 335 million in 2025?

Florida Overpopulation Awareness Week has been designated for October 17-23. A statewide poll will be conducted on the viewpoints of Floridians on the issues of population growth, immigration, campaign platforms and tax policies that can encourage or discourage growth.

We invite and encourage all environmental, educational, political, and social issues organizations to think about and join in efforts to move Floridians to confront a future that cannot be sustained under current policies and leadership. The goal of Florida Overpopulation Awareness Week is to provide impetus for Floridians to begin a statewide discourse on overpopulation. In the past we have avoided discussion on

population issues due to a preponderance of myth, and unjustified emotional reactions. The motto of FSP's poster campaign is:

### "Overpopulation -- Talk About It."

Bumper stickers with this motto [shown on last page of this issue] are available for US\$.50 apiece.

To co-sponsor this "Awareness Campaign" or to obtain additional information on the materials and resource people we have available, contact: Joyce Tarnow at <president@flsuspop.org> or 954-942-7278, David Caulkett at <info@flsuspop.org> or 561-279-8845, or <www.flsuspop.org>.

Floridians for a Sustainable Population (P. O. Box 6212, Pompano Beach, Florida 33060 USA) is a statewide, non-profit environmental organization whose purpose is to make all Floridians aware of the disadvantages of unrestricted population growth and the advantages associated with a stable population. We propose population stabilization and sustainable lifestyle practices to assure a reasonable quality of life for this and future generations.

### The Culture Corner

... Being an Occasional Sampling of the Inexorable Penetration of Popular Culture by Sirenia

For better or worse, the manatee has now entered the literary armamentarium of the American language, as exemplified in the *Washington Post* of 27 July 1999 by staff writer Gene Weingarten's description of the trials of aging - such as "... when I stand up and my joints pop like a manatee thrashing on bubble wrap."

Sort of makes one wonder what Shakespeare or Byron could have done with sirenians.

### LOCAL NEWS

#### FLORIDA

**Marine Interests Want Manatees Off the Endangered Species List.** - Claiming that the number of manatees in Florida is growing, the state's largest marine business interests have quietly formed a group to try to get the sea cows removed from the federal endangered species list. "Perhaps the time has come to delist the manatee, much as the alligator and the eagle have been delisted," reads a Sept. 3 memo penned by Wade Hopping, a top business lobbyist who represents the

National Marine Manufacturers Association.

"Last week, the marine manufacturers and dealers met in Orlando," the memo continues. "Manatees were foremost on their mind. They believe that they have been on the defense far too long, and therefore they are planning to create a proactive program on manatee issues. Their fear is that the thrust of all the manatee protection activities are designed to limit the number of docks and marinas, and to limit the number of boats that are on the

water. Obviously, they have a tremendous interest in this issue."

Hopping's memo, written on the letterhead of his law firm, says that besides pushing to take manatees off the endangered species list, marine interests have two other goals. One is to get the Legislature to rewrite state law to exempt marinas from Florida's rigorous Development of Regional Impact review, which can require studies of imperiled plants and animals. The other is to take money from the state's Manatee Protection Trust Fund and use it to put more marine enforcement officers on the water to enforce speed limits. The money in the trust fund comes from sales of the specialty manatee automobile license plate.

Hopping's memo says the new Manatee Task Force also wants to reach out to other groups, like the Florida Home Builders Association. But the reception may be cool.

"None of us have heard anything about it," said Wellington Meffert, the home builders' lobbyist. "We really don't consider it to be our issue."

Scientists working to protect manatees say the idea of stripping away protections is ridiculous. Manatee populations may be stable or even growing a little in some locations, they say, but the number of boats is growing too. This year, they predict, Florida will set a record for the number of manatees killed by boats.

The formation of Hopping's business group, called the "Manatee Task Force", comes as 22 environmental groups are poised to sue the state and federal governments because, they say, manatee protection laws have not been properly enforced. The creatures have been on the endangered species list since 1967. The groups claim that even though

Florida directed 13 counties to create special manatee protection plans in 1989, it has never enforced the law. Although 10 years have passed, only three counties have written their required manatee protection plans.

The Endangered Species Act allows Florida to impose a host of protections for manatees, from requiring boaters to slow down in places where manatees congregate to limiting development near their habitat.

A gregarious and well-known fixture at the State Capitol, Hopping has long been the nemesis of Florida environmentalists. He fought against the state's 1985 growth management law. He opposed a bill that would have required propeller guards to protect manatees from passing boats. In 1997, he tacked an amendment on a bill that would have allowed a boat manufacturer to do high-speed testing in a canal that a state official called "the worst place in the state for manatee deaths." Opponents leaked the amendment to the media, and the measure quickly died.

[NMMA's website, <<http://www.nmma.org>>, says it is "recreational boating's largest trade association," and includes a page titled "environmental and safety compliance" which claims NMMA is "working to safeguard the environment." Their Florida lobbyist who is organizing the "Manatee Task Force" to de-list manatees is Wade Hopping, of the law firm Hopping, Green, Sams & Smith. Other clients of Hopping's firm (according to online lobbyist registration with the State of Florida) include: the Florida Chamber of Commerce, the Florida Electric Power Coordinating Group, Mobil Oil Corp., the Property Rights Coalition, and Sugar Cane Growers Cooperative of Florida.]

- (Sources: *The St. Petersburg Times*, Sept. 30, 1999; Audubon Internet discussion list for Florida.)

***Manatee Has Spinal Surgery.*** - Surgeons in Miami have performed what is believed to be the first operation of its kind on a manatee. The animal was severely injured in a collision with a boat off the coast of Florida.

Doctors from the University of Miami performed more than five hours of surgery on Nash, a manatee being cared for at the Miami Seaquarium since a July 16 collision with a boat in the waters off Fort Lauderdale. The boat's propeller sliced 25 pounds of skin away from Nash's backbone, which was also fractured in the collision.

After Nash was stabilized with antibiotics and other care at the aquarium, a team of veterinarians and neurosurgeons used the same rod and pin system used to repair human spinal cord injuries to repair the 12-foot, 1,000-pound sea mammal's spine.

Nash, about 9 years old, was in critical condition after the surgery. Doctors hope he will recover but expect that he will remain partially paralyzed. There is little chance he will be returned to the sea. - (Source: *The Washington Post*, Aug. 16, 1999.)

***Seagrass Species Listed as Threatened.*** - The U.S. National Marine Fisheries Service has issued a final rule (63 FR 49035) listing the seagrass *Halophila johnsonii* as a threatened species under the Endangered Species Act, with the conclusion that it is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. It already has one of the smallest geographic ranges of any seagrass, being found only

in lagoons on the southeastern coast of Florida.

*Halophila johnsonii* is not known to employ sexual reproduction; the plant extends only by branching and by growth of the rhizomes. This limited reproductive capacity further threatens the ability of this rare plant to survive human-induced or natural disturbances. Because it is most abundant amid the heavy boating traffic of south Florida coastal inlets and channels, potential threats to this diminutive seagrass include dredging, boat propeller and anchor damage, and storm events.

- (Source: *Aquaphyte* 19(1), Spring 1999; published by the Center for Aquatic and Invasive Plants, University of Florida, Gainesville.)

[EDITOR'S NOTE: The Center for Aquatic and Invasive Plants maintains a **literature collection and information retrieval system on seagrasses**. This searchable database, the Aquatic, Wetland and Invasive Plant Information Retrieval System (APIRS), now contains nearly 5,000 references on seagrasses, and hard copies of over 90% of these are available for the free use of researchers. In exchange, those researchers are expected to contribute reprints of their published work to APIRS. To access the database, go to <http://aquat1.ifas.ufl.edu/> and click on the **Online APIRS Database** link. You must have a telnet application specified in your Internet browser. To request free searches of the database, contact Karen Brown at [kpb@gnv.ifas.ufl.edu](mailto:kpb@gnv.ifas.ufl.edu) or at the Center for Aquatic and Invasive Plants, 7922 N.W. 71<sup>st</sup> St., Gainesville, Florida 32653-3071 USA. Bibliographies can be printed and mailed, or sent via e-mail.]

## FRANCE

*Eocene Fossil Sirenian Site Now On Exhibit.* - The world's most spectacular deposit of fossil sirenian remains is now accessible to public inspection. Scenically perched in a high ravine amid the Alps of Haute-Provence in southeastern France, the fossil site of Taulanne contains thousands of bones of extinct dugongids that died and were buried along a rocky seacoast during the Late Eocene epoch, some 35 to 40 million years ago.

First discovered in the 1930's, the site was studied in the late 1960's by Dutch paleontologists, who collected several sirenian skulls and many other bones. Since 1994, a new series of excavations has been undertaken by the Geological Reserve of Haute-Provence, a government agency responsible for the protection, study, and interpretation of the numerous important geological and paleontological sites in the region.

In addition to collecting additional specimens for scientific study, the personnel of the Geological Reserve, under the energetic leadership of Dr. Myette Guiomar, have specially prepared one large section of the site as a permanent outdoor exhibit, which opened to the public in summer 1998. Here, a large portion of a dip slope exposing a single bedding plane has been enclosed under a heavy glass-and-steel protective cover. On this slope can be seen skulls, jaws, and scores of other disarticulated bones, still embedded in the hard calcareous sandstone. Other parts of the site, less favorable for public viewing, are being reserved for future excavation. (Collecting of fossils by members of the public is prohibited.)

The Taulanne site lies at the end of a 1-km hiking trail, which begins at

the pass of Col des Leques (elevation 1148 m), located 10 km northwest of Castellane, the largest town in the region and a popular tourist stop. Castellane, in turn, is about 80 km northwest of Cannes on the Mediterranean coast.

Explanatory signs are provided at the fossil site, but the main interpretive exhibit is located in Castellane, in a new museum (also opened in summer 1998) called La Maison des Sirènes et des Siréniens (The House of Sirens and Sirenians). Installed in a renovated former jail next door to the city hall, this attractive museum divides its display space between the themes of mermaids and their folklore, and genuine sirenians. The biology, evolution, distribution, and conservation status of the latter are concisely presented, and the geology and paleontology of the Taulanne site (the main focus of the exhibit) are thoroughly treated. The object of the museum exhibit is to interest and invite visitors to make the trip up the mountain to see the site itself and its exquisitely preserved fossils.

The bones found at Taulanne are exclusively sirenian, and represent a single species of either *Eosiren* or *Prototherium*. Its morphology and taxonomy are being studied as a thesis project by doctoral student Claire Sagne, working under the guidance of Drs. Pascal Tassy (Paris) and Daryl Domning (Washington). The availability of this sizable population sample of a single species should help considerably to clarify the presently confused systematics of Eocene dugongids. One notable discovery that has already emerged from the rock is the oldest known articulated manus (hand skeleton) of a sirenian. This will shed light on the relationships among seacows, elephants, and other mammals. - **DPD**

## MALAYSIA

***Dugong Mortality.*** - A message posted by **Hugh Kirkman** (Coordinator, UNEP East Asian Seas Regional Coordinating Unit, Bangkok) on the Seagrass Research Discussion List, May 6, 1999, reports that "in the past couple of months 5 dead dugongs have been found on the shores of southern peninsular Malaysia. As far as I can determine they were examined and found to have no food inside them. The fact they were found in a region where dugongs were not well known and that there were five dead in a short time has raised public interest in seagrass meadows. Representatives of the Environment Agency in Malaysia are looking into this [incident]. Hopefully it will also protect seagrasses."

Do any of our readers have more information on this?

## SINGAPORE

***Captive Dugong In Singapore.*** - On 25 Sept. 1998, two dugongs were reported to be in trouble off the shores of Pulau Ubin, an island northeast of mainland Singapore. Underwater World Singapore was contacted and the staff responded by going out to assess the situation on site.

Judging by its size of about 140 cm, our marine mammal specialist and vet estimated that one of the dugongs was a young calf approximately 10 months old. In the vicinity was a drowned 268 cm adult female dugong that had washed up onshore. They presumed that it might be the calf's mother, particularly when traces of milk were found in its mammary glands. They judged that chances for survival of the young dugong would be slim if left in the wild. In consultation with the local

governing body (Primary Production Department), a decision was made to place the young dugong under human care. Back at the aquarium, efforts were being made to get more information on hand-rearing dugongs. Several aquariums have tried but not succeeded in maintaining dugongs for extended periods.

Through consultations made with Toba Aquarium, Sea World Enterprises Australia, and the University of Miami, we were able to develop basic husbandry procedures for her. She was, and is still, being fed an infant milk formula that has been enriched with coconut milk powder and multivitamins. The milk is fed using a modified nipple attached to an extended tube. Initially, various varieties of seagrass were offered to her, but these were left untouched. She started to eat one specific variety, which we have since been feeding her. In an effort to maintain normal feeding patterns, seagrass is "planted" on rubber sheets and placed on the bottom of her enclosure for her to graze on.

Presently, approximately a year from when she was found, she consumes an average of 1.4 liters of milk and about 16 kilograms of seagrass daily. Monthly weighing sessions have showed a rather steady increase in body weight. Upon arrival in September 1998, she weighed about 65 kilograms, but when last weighed in September 1999, she was 115 kilograms.

Future plans for her remain uncertain and considerations are being made to either release her or relocate her to another aquarium. The publicity generated by her has resulted in increased public awareness in the region about dugongs. - **Ei Lin** (Underwater World Singapore)



## ABSTRACTS

The fossil dugongs of Akab Island (Umm al-Qaiwain, United Arab Emirates): paleoenvironmental and archeozoological implications (**Hélène Jousse**, Centre des Sciences de la Terre, Université Claude Bernard, Lyon 1, France). - The Neolithic site of Akab Island (Umm al-Qaiwain, United Arab Emirates), 6000 years old, is the oldest site containing remains of the dugong (*Dugong dugon* [Müller, 1776]). The fossils are very close to modern representatives of the species, and there is no criterion that allows recognition of an endemic subspecies in the Arabo-Persian Gulf. The former environment of the lagoon of Umm al-Qaiwain differs little from the modern one. This archeozoological study has yielded better understanding of the function of this site: dugong hunting seems to have been seasonal, and focused on young individuals; the bones show signs of butchering. The inhabitants of the site utilized dugong meat and oil, but certainly the hide as well. The presence of other animal remains, notably those of small ruminants and mollusks, indicates that the subsistence activities of the human populations were diversified. [Translated from French. Abstract of a doctoral thesis supervised by Claude Guérin.]

An analysis of fluke structure and function in sirenians and cetaceans (**Lauren E. C. Miles and Nick Milne**, Department of Anatomy and Human Biology, University of Western Australia, Nedlands, Perth 6907). - The tail and flukes act as the primary locomotor organ in cetaceans and sirenians. The shape and structure of the flukes is important in locomotor performance and there are interspecies differences as well as developmental factors which affect the parameters of the tail flukes. This study examined a small sample of sirenian (calf and sub-adult dugongs) and cetacean (calf and adult bottlenose dolphin, calf pilot whale and sub-adult fin whale) flukes that became available from deaths and strandings on the coast of Western Australia during 1998. The shape of the flukes was assessed by standard measures of aspect ratio and sweep angle.<sup>1</sup> The internal structure of each fluke core and cortex was examined histologically. Tests to determine the material properties of the flukes were performed on samples taken from the core and cortex of an adult bottlenose dolphin fluke. These data were used to produce computer models of the flukes to examine the contributions of the fluke components to stiffness and flexibility of the fluke as a whole.

In regard to species variation the sub-adult and adult cetacean specimens (fin whale, pilot whale and bottlenose dolphin) studied had a higher aspect ratio and lower sweep angle than those of the sub-adult dugong. The relative swimming performance of these species corresponds well with their fluke parameters. Dolphins, in general, can achieve much higher average and maximum speeds (20+ knots) than those of the dugong.<sup>2</sup> Age differences in fluke shape were also evident in the sample of dolphin and dugong specimens examined. Not only did calves have relatively smaller flukes for their body size, but they also had lower aspect ratios and higher sweep angles than their sub-adult and adult counterparts. Thus, the documented slower pace of calf cetaceans may not only be due to a impediment in fluke size to body size ratio, but also to their fluke shape. The results confirm previous research that swimming performance increases with age, and that faster species have high aspect ratios coupled with low sweep angles.<sup>1,3</sup>

Histological analysis revealed intra- and interspecific differences in internal fluke structure. The bulk of the fluke in these species was comprised of core material that consisted of densely woven multi-directional bundles of collagen fibers. The cortex of cetacean flukes consists of epidermis, dermis and a dense 'ligamentous layer', consisting of highly organized bundles of collagen fibers.<sup>4</sup> The internal fluke structure of the dugong specimens differed from that of the cetaceans. The distinctive ligamentous layer identified in the cetacean species was lacking in both dugongs. Instead, the analogous area was occupied by a thicker dermis containing collagenous bands interspersed by fat cells and other collagen fibers. The dugong specimens also differed from each other. In particular, the core of the sub-adult dugong had a more organized collagen arrangement. Differences between the two dugongs may be accounted for by the difference in age of these specimens, calf and sub-adult. This contrasts with the bottlenose specimens in which the calf and adult had an extremely similar internal structure. This suggests that changes in internal, as well as external, fluke structure may occur during growth in dugongs.

The mechanical tests on the components of the dolphin fluke revealed that structures of the fluke are very poor in withstanding tensile and compressive forces, and that the cortex material was an order of magnitude stiffer than the core. Computer modelling (Fast Lagrangian Analysis of Continua) of transverse and sagittal sections of the fluke under load revealed that the cortex acted to absorb tensile stresses during bending. This supports Felts'<sup>4</sup> view that this layer is important in absorbing tensile forces, and thus acts to resist bending incurred during locomotion.

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The following abstracts are of posters presented at the annual meeting of the American Society of Mammalogists, held at Seattle, Washington, 20-24 June 1999.

**NEW RECORDINGS OF DUGONG VOCALIZATIONS:  
VOCALIZATION IN SOCIAL CONTEXTS.**

Paul K. Anderson, Dept. of Biol. Sciences, Univ. of Calgary,  
Calgary, Alberta, Canada T2N 1N4

Sound is the medium of choice for marine mammal communication and sirenians have had at least as long as cetaceans to elaborate communication in the marine environment. This is especially the case for the dugong whose habitat is closer than that of manatees to the mode that must have prevailed throughout some 45 million years of the dugong's wholly marine evolution.

A previous study (Anderson & Barclay, 1995) described and analyzed vocalizations of solitary male dugongs occupying territories at a traditional (lek) mating site. In September and October, 1997 recordings were obtained in contexts where dugongs were foraging and interacting in groups. Sounds recorded in these contexts included some ("chirp squeaks") that differ only moderately in duration, fundamental frequencies, and spectral patterns from those produced by the solitary males. Other sounds, however, differ strikingly. These observations suggest that dugongs are highly vocal mammals with the ability to produce a wide variety of complex sounds. It follows that dugong acoustic communication may be complex, and that communication may play a significant role in social organization and in individual interactions outside of the lek context.

Spectra of vocalizations recorded in these different circumstances are presented, and sounds can be heard on a cassette recorder.

**TRICHECHID DENTITION: TOOTH WEAR AND  
STRUCTURE IN MARINE MAMMAL HERBIVORES.**

Christopher D. Marshall and Tracy E. Popowics. Depart.  
Orthodontics, Univ. Washington, Seattle, WA.

This study examines the relationship of dental morphology with diet in trichechids (manatees). In general, the dentition of herbivorous mammals are structured to resist wear with high crowned teeth. Open rooted teeth, or modified enamel structure. Trichechids, marine mammal herbivores, use an alternative strategy by employing supernumerary, bilophodont molars. These molars erupt in the back of the tooth row, migrate forward as they wear, and are shed anteriorly. An unlimited number of molars are available to replace lost teeth. This study specifically characterizes the extent and direction of wear, and changes in tooth morphology within a dental arcade by examining patterns of loph wear, cusp height, tooth position, and tooth structure. The majority of loph wear occurs in the posterior tooth row. Of the two lophs per tooth, the anterior loph appears to wear faster than the posterior loph. Transverse scratches in dentine were observed in most specimens examined, and in some positions, lingual cusps were shorter than buccal cusps. In addition to behavioral observations, these data suggest translational movement of the mandible during feeding. Further work will investigate correlation of specific diets with tooth wear characteristics within the order Sirenia.

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### SIRENIAN WEBSITE DIRECTORY

- The Call of the Siren (Caryn Self Sullivan): <<http://members.aol.com/caryn1001/index.html/homepage.html>>
- Caribbean Environment Programme, Regional Management Plan for the West Indian Manatee: <<http://www.cep.unep.org/pubs/techreports/tr35/ct35indx.htm>>
- Caribbean Stranding Network: <<http://netdial.caribe.net/~mignucci/>>
- Dugongs: <<http://home.t-online.de/home/rothauscher/dugong.htm>>
- Florida Fish and Wildlife Conservation Commission, Bureau of Protected Species Management: <<http://www.state.fl.us/fwc/psm/>>
- Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute (Florida manatee mortality data): <<http://www.fmri.usf.edu>>
- Jacksonville University (Florida) Manatee Research Center Online: <[www.ju.edu/juconnect/research/marco](http://www.ju.edu/juconnect/research/marco)>
- Manatee neuroanatomy: <<http://www.neurophys.wisc.edu/Manatee/>>
- News clippings on Florida manatees: <<http://www.n-jcenter.com/menus/enmanate.htm>>
- Philippines Dugong Research and Conservation Project: <<http://www.wwf-phil.com.ph>>
- Save the Manatee Club: <<http://www.savethemanatee.org>>
- Sea World of Florida: <<http://www.seaworld.org>>

*Sirenews* (texts of current and recent issues): <<http://pegasus.cc.ucf.edu/~smm/>>

Sirenia Project, U.S. Geological Survey: <<http://www.fcsc.usgs.gov/sirenia>> or  
<<http://www.nfrcg.gov/sirenia>>

Smithsonian Institution sirenian bibliography: <<http://www.si.edu/resource/faq/nmnh/sirenia.htm>> [This is a relatively short bibliography, compiled by Joy Gold, that provides a very good introduction to both the technical and the popular literature.]

Steller's sea cow: <<http://www.online.de/home/Rothauscher/steller.htm>>; also the website [in Finnish] of Dr. Ari Lampinen, University of Jyvaskyla, Finland: <<http://www.jyu.fi/~ala/ilmasto/steller.htm>>

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